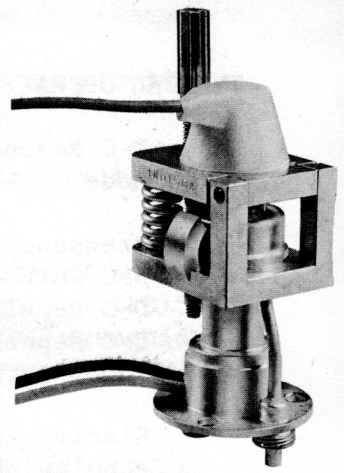
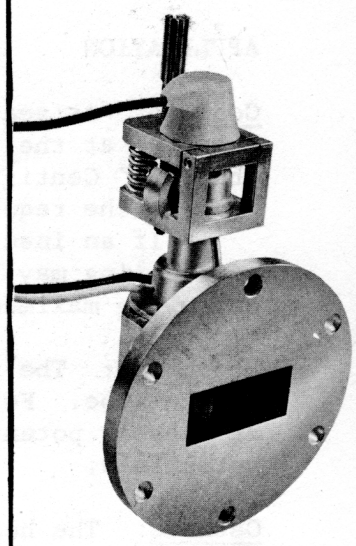
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

PRELIMINARY DATA

1K015CA
1K015CG
C-BAND
REFLEX KLYSTRONS



1K015CA



1K015CG

The Eimac 1K015CA and 1K015CG are ceramic and metal, ruggedized, internal-cavity reflex klystrons designed for local oscillator service in the frequency range of 5350 to 5950 megacycles. These tubes are capable of delivering a minimum output power of 70 milliwatts into a load VSWR of 1.5 to 1 under conditions of shock, vibration or sustained acceleration.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated.		
	Warm-up time - -	60	seconds
Heater:	Voltage - - -	6.3	volts
	Current - - -	1.0	ampere
Minimum Output Power (Load VSWR=1.5:1)		70	milliwatts
Frequency Range - -		5350 to 5950	megacycles

MECHANICAL

Operating Position - - - -		Any	
Mounting:			
	1K015CA - - -	Three hole flange	
	1K015CG - -	UG-344/U waveguide flange	
R-F Output Coupling:			
	1K015CA - -	Miniature coaxial fitting	
	1K015CG - -	RG-50/U waveguide	
Electrical Connections - -		Flexible leads	
Cooling - - -		Convection and conduction	
Maximum Overall Dimensions:		1K015CA	1K015CG
	Length - -	3.4	5.3 inches
	Width - -	1.3	3.1 inches
	Depth - -	1.2	1.5 inches
Net Weight - - -		4.2	17.5 ounces
Shipping Weight (Approximate)		2	6 pounds

ENVIRONMENTAL

Maximum Ambient Temperature - - - -	100° C
Maximum Altitude - - - - - -	No limit
Maximum Operating Shock (11 ms duration)* - -	40 g
Maximum Operating Vibration (20-2000 cps)** - -	10 g

*Based on a maximum permanent frequency shift after drop of 1.5 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 1.0 megacycle.

MAXIMUM RATINGS

D-C RESONATOR VOLTAGE*	350	MAX. VOLTS
D-C CATHODE CURRENT	55	MAX. MA.
RESONATOR DISSIPATION	20	MAX. WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0	MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500	MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

D-C Resonator Voltage*	300	350	volts
Mode	4-3/4	3-3/4	
Frequency	5650	5650	megacycles
D-C Cathode Current	35	49	milliamperes
D-C Repeller Voltage*	-135	-240	volts
D-C Repeller Current	1	1	microampere
Power Output	35	130	milliwatts
Electronic Tuning Range (3 db-bandwidth)	45	45	megacycles
Modulation Sensitivity	1600	900	Kc/volt
Peak-to-peak FM Deviation (10g, 20-2000 cps)	75	75	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level, these tubes will not require forced air cooling when operated at their maximum rated dissipation with an ambient temperature less than 100° Centigrade. The mounting flange or waveguide flange will normally provide the required heat sink connection for conduction cooling.

If an insulator is used between the tube and waveguide or chassis, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 200° Centigrade.

Resonator: The resonator of the 1K015CA and 1K015CG is integral with the body of the tube. For this reason, it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ± 5% of the rated value of 6.3 volts if variation in performance is to be minimized and best tube life obtained.

The heater and cathode of the 1K015CA and 1K015CG are internally connected. When the resonator of these tubes is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: Mechanical tuning is accomplished by a single screw tuner with a differential thread. A tuning rate of approximately 100 megacycles per turn and a maximum tuner torque of four inch-pounds is provided by this design. Mechanical stops, capable of withstanding a maximum torque of 10 inch-pounds, are provided at the extremes of the tuning range. Tuner cycling in excess of 100 cycles will not damage the vacuum seals.

A clockwise rotation of the tuner will produce an increase in frequency.

Mounting: The 1K015CA should be mounted by the three-hole tube flange provided. The 1K015CG is mounted by the UG-344/U waveguide flange to the appropriate waveguide connector.

Electrical connections are made to both tubes by means of the flexible leads provided.

Output Coupling: The R-F terminal of the 1K015CA is a miniature coaxial connector described in detail in the outline drawing. For waveguide coupling, the 1K015CG utilizes the Eimac transition section and mates with standard RG-50/U waveguide. An adapter is available on special order to adapt the 1K015CA to standard BNC type coaxial output.

Special Applications: For additional information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California. All such requests will be handled confidentially.

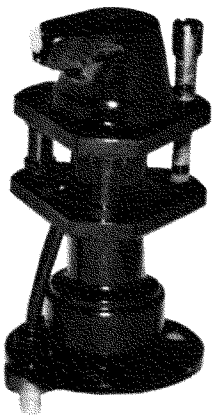
Eitel-McCullough, Inc.
February 16, 1960
AE245

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

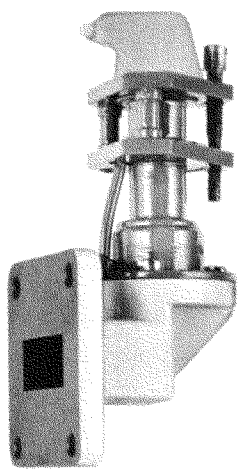
1K015XA AND 1K015XG KLYSTRONS • X-BAND OSCILLATORS

The EIMAC 1K015XA and 1K015XG are ruggedized, integral-cavity, X-band, reflex klystrons intended for local oscillator service under conditions of severe shock, vibration or sustained acceleration.

The 1K015X type tubes are available with either coaxial output or waveguide output. The r-f terminal of the 1K015XA is a coaxial connector. For waveguide output, the r-f terminal of the 1K015XG is the Eimac transition section.



1K015XA
(Coaxial Output)



1K015XG
(Waveguide Output)

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Coated Unipotential

Heater Voltage	6.3	volts
Heater Current	0.80	amperes
▶ Frequency Range - - - (8400 thru 9600 Mc)	900	Mc

(See paragraph: Mechanical Tuning in Application)

MECHANICAL

High Impact Shock*	100	g
Axial Vibration Test (20-2000 cycles)*	10	g

Mounting (See Outline Drawing):
- 1K015XA: Three-hole flange and coaxial r-f terminal
- or
- 1K015XG: In conjunction with an Eimac transition section mounts directly on a UG-39/U waveguide flange

Connections:

Heater	White wire at base
Heater and Cathode	Black wire at base
Resonator	Shell of tube
Repeller	White wire at top

Output (See Outline Drawings): 1K015XA: Coaxial fitting, 1K015XG: UG-39/U waveguide flange

*The shock and vibration tests are applicable to both coaxial and waveguide outputs.

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▶ Indicates change from sheet dated 7-22-54

Mounting Position	Any	
Cooling	Convection and Radiation	
Maximum Over-all Dimensions:	Coaxial Output	Waveguide Output
Length	2-3/8 inches	3-9/16 inches
Diameter	1-3/16 inches	———
Width	———	1-15/32 inches
▶ Net Weight	1.5 ounces	3.2 ounces
Shipping Weight	4 ounces	8 ounces

MAXIMUM RATINGS

D-C RESONATOR VOLTAGE	350 MAX. VOLTS
RESONATOR DISSIPATION	15 MAX. WATTS
D-C CATHODE CURRENT	50 MAX. MA
D-C REPELLER VOLTAGE	
Positive Limit	0 MAX. VOLTS
Negative Limit	500 MAX. VOLTS

TYPICAL OPERATION (With flat load)

Mode	6¾	7¾	5¾	6¾	
D-C Resonator Voltage	250	250	300	300	volts
D-C Cathode Current	36	36	47	47	mA
D-C Repeller Voltage	-110	-65	-170	-95	volts
Power Output	45	30	100	65	mW
Frequency	9000	9000	9000	9000	Mc/s
Electronic Tuning Range	40	55	40	60	Mc/s

APPLICATION

Mounting—The 1K015XA is provided with a three-hole base flange for solid mounting directly to the equipment chassis, to an insulating support or to the Eimac transition section to make the 1K015XG. No socket or tube clamp is necessary.

Cooling—No special provisions are ordinarily required for the cooling of the 1K015XA or 1K015XG. The resonator will dissipate 15 watts of power by radiation and convection in ambient temperatures up to 100°C.

Resonator—The resonator of the 1K015XA and 1K015XG is integral with the shell of the tube. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials. The coaxial output connection also lends itself to d-c isolation of the resonator from chassis potential. All voltages given in the list of Maximum Ratings and in the Typical Operation data are measured with respect to the cathode of the tube.

Cathode—Heater voltage should be at the rated value of 6.3 volts. Variations should be kept within the range of 5.7 to 6.9 volts. The cathode is internally connected to one side of the heater. If the resonator is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator potential.

▶ Indicates change from sheet dated 7-22-54

Repeller—There will be an optimum repeller voltage for any given output frequency, and the range of electronic tuning or frequency modulation under control of the repeller voltage will vary with output frequency and choice of repeller mode. These relations are shown for a typical tube in the accompanying curves.

Repeller voltages must be negative with respect to the cathode at all times.

Mechanical Tuning—Mechanical tuning is accomplished by a single screw with a differential thread. The tuning rate is approximately 100 Mc. per turn. The particular range desired should be specified. Standard tuning range adjustment, unless otherwise specified, will be for 8600 to 9400 Mc.

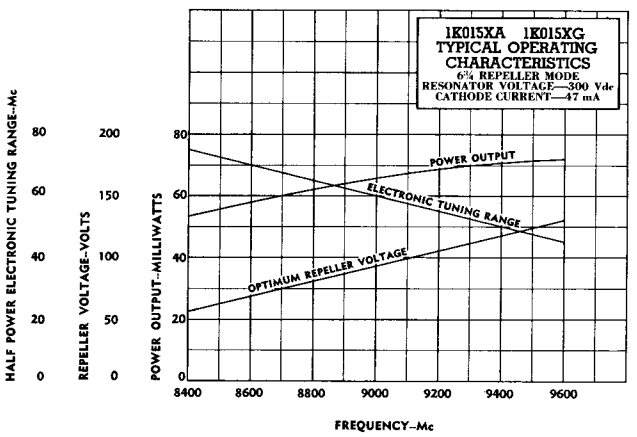
Output—Curves illustrating the variation of power output with operating frequency for a typical tube are shown below. These curves assume a flat load and optimum repeller voltages at all frequencies. With a VSWR mismatch of 2 to 1, the power output will not fall below one-half the indicated power.

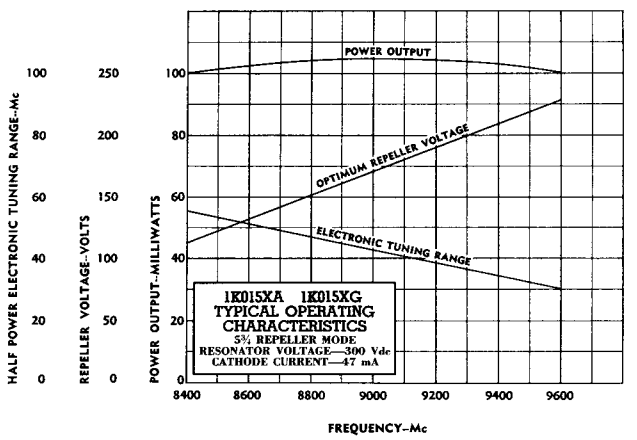
Frequency Stability—Under axial vibration of 10g maximum acceleration, the spectrum width is less than 1.0 Mc. The frequency modulation response to vibration along other axes of the tube is approximately one-half that for the axial direction.

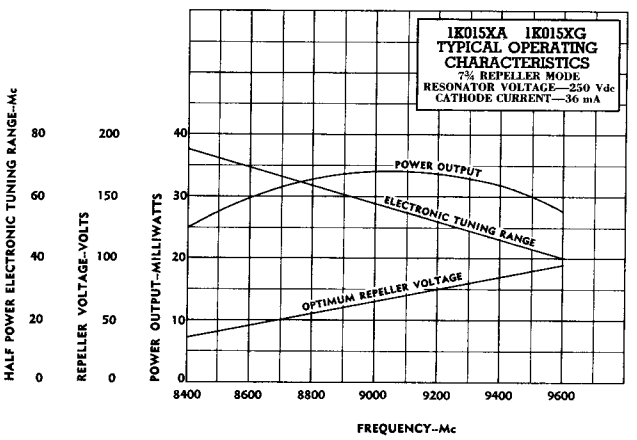
Frequency variations within the range of normal operating temperatures do not exceed ±0.1 Mc/°C.

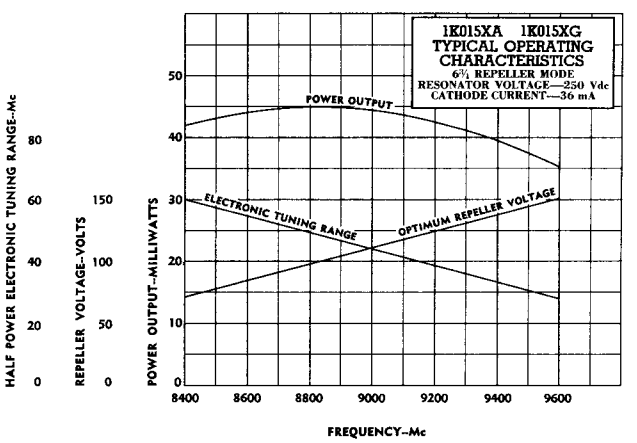
Starting Time—The 1K015XA and 1K015XG will be within ±10 Mc of operating frequency in less than one minute after applying voltages.

TYPICAL OPERATING CHARACTERISTICS 1K015XA AND 1K015XG

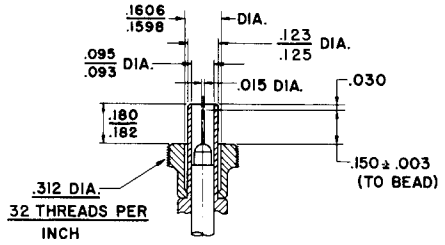




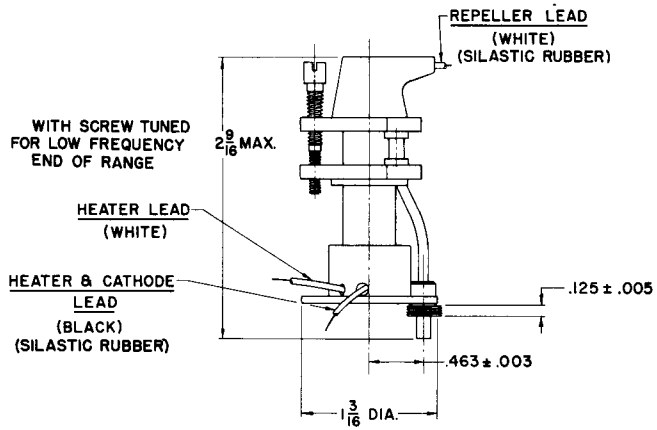




▶ Indicates change from sheet dated 7-22-54

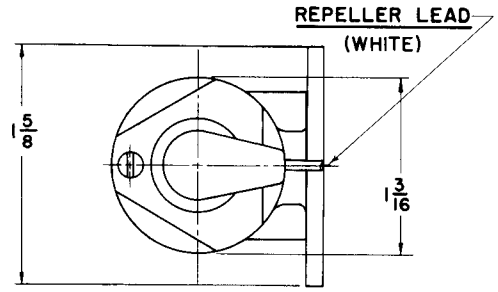


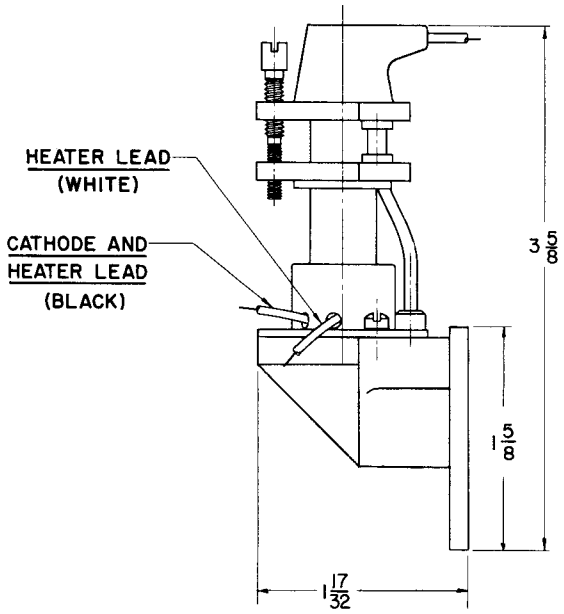
CONNECTOR DETAIL



BOTTOM VIEW

IKO15XA (COAXIAL OUTPUT)





IKO15XG (WAVEGUIDE OUTPUT)

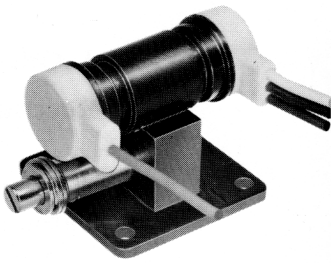
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EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K20XD-A

X-BAND REFLEX KLYSTRON



The Eimac 1K20XD-A is a ceramic and metal, conduction-cooled reflex klystron designed for local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 75 milliwatts over the frequency range of 10,000 to 10,700 megacycles.

The stacked-ceramic construction results in an extremely rugged design and low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up time	30	seconds
Heater:	Voltage	6.3	volts
	Current	0.8	ampere
Typical Output Power (Load VSWR = 1.15:1)		75	milliwatts
Frequency Range		10,000 to 10,700	megacycles

MECHANICAL

Operating Position	Any	
Mounting	UG-39/U waveguide flange	
Cooling	Conduction	
Electrical Connections	Flexible leads	
RF Output Coupling	RG-52/U waveguide	
Net Weight	4	ounces
Shipping Weight (approximate)	2	pounds
Maximum Overall Dimensions:		
Height	1.50	inches
Width	1.63	inches
Length	2.50	inches

ENVIRONMENTAL

Maximum Ambient Temperature	150°	C
Maximum Altitude	No limit	
Maximum Non-Operating Shock* (11 ms Duration)	40	g
Maximum Operating Vibration** (20 to 2,000 cps)	10	g

*Based on a permanent frequency shift after drop of 2 megacycles.

**Based on a maximum peak-to-peak frequency deviation of 200 kilocycles.

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MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	350 MAX.	VOLTS
DC CATHODE CURRENT	55 MAX.	MA
RESONATOR DISSIPATION	20 MAX.	WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0 MAX.	VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX.	VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

DC Resonator Voltage*	300	350	volts
Mode	5-3/4	5-3/4	
Frequency	10,350	10,350	megacycles
DC Cathode Current	26	35	milliamperes
DC Repeller Voltage*	-165	-150	volts
DC Repeller Current	1	1	microampere
Power Output	50	75	milliwatts
Electronic Tuning (3db bandwidth)	30	30	megacycles
Modulation Sensitivity ($\Delta E_r = \pm 3$ volts)	2.0	2.0	Mc/volt
Peak-to-Peak FM Deviation (10g, 20-2000 cps)	200	200	kilocycles
Residual FM	50	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 150° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the body temperature below the maximum rating of 175° Centigrade.

Resonator: The resonator of the 1K20XD-A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

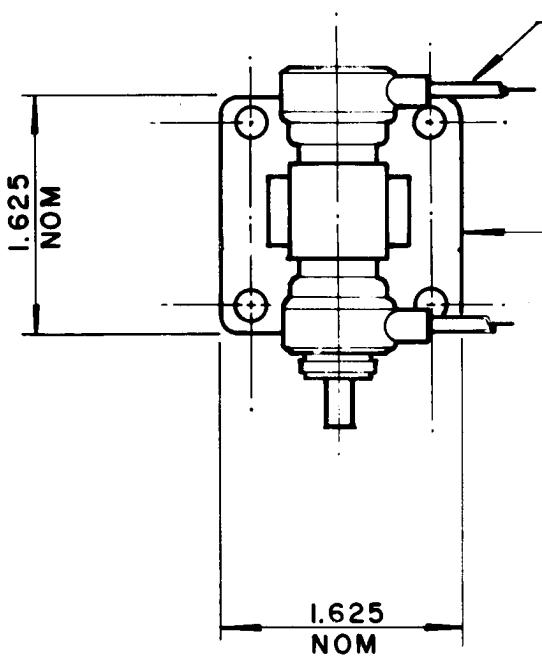
Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the 1K20XD-A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the 1K20XD-A a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

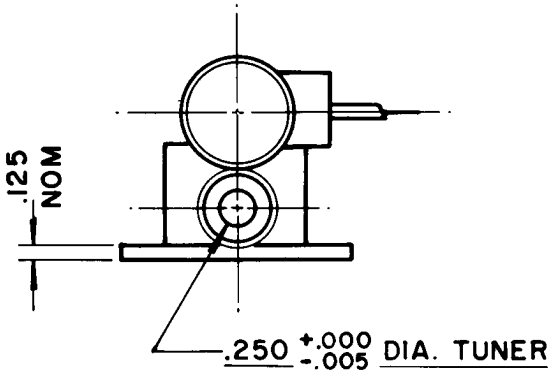
1K20XD-A

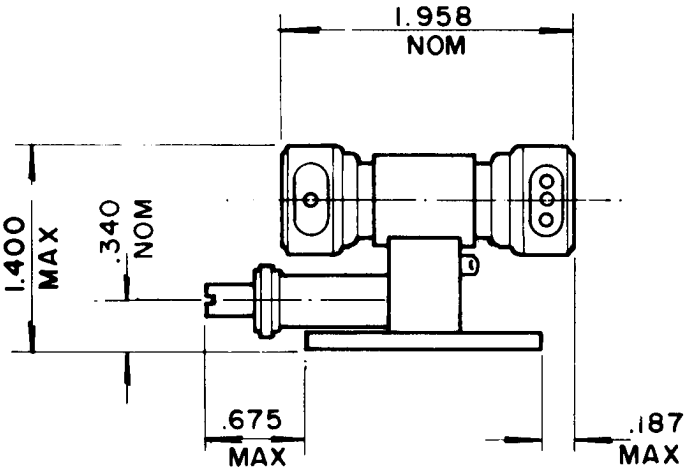


CONNECTIONS

HEATER	WHITE
* CATHODE	BLACK
* HEATER	BLACK
REPELLER	RED

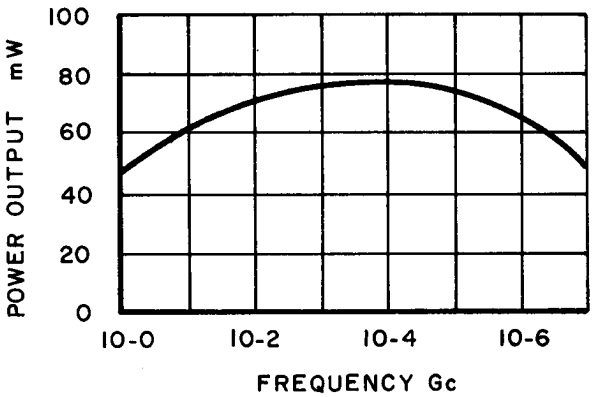
* INTERNALLY CONNECTED

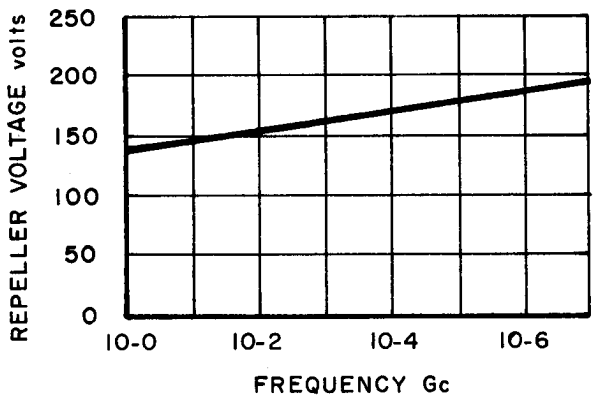




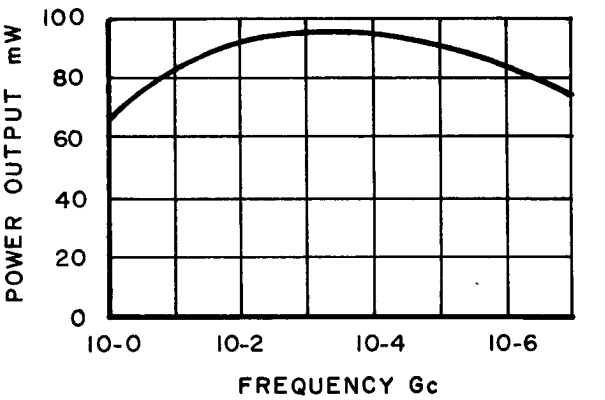
1K20XD-A TYPICAL OPERATING CHARACTERISTICS

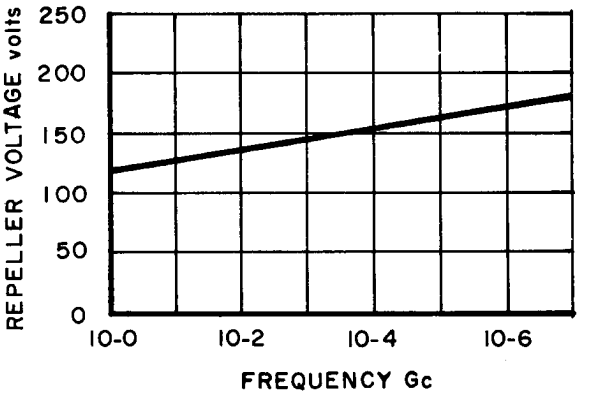
Ers = 300 Vdc
Ik = 26 mAdc
$5\frac{3}{4}$ MODE





Ers = 350 Vdc
Ik = 35 mAdc
$5\frac{3}{4}$ MODE



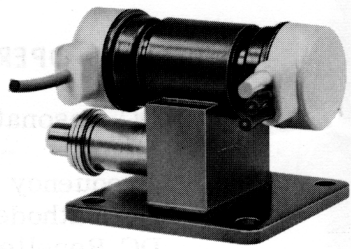


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K20XD-S

X-BAND REFLEX KLYSTRON



The Eimac 1K20XD-S is a ceramic and metal, conduction-cooled reflex klystron designed for transmitter or local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 120 milliwatts over the frequency range of 10,500 to 11,000 megacycles.

The stacked-ceramic construction results in an extremely rugged design and a low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up time	30	seconds
Heater:	Voltage	6.3	volts
	Current	1.0	ampere
Minimum Output Power (Load VSWR 1.15:1)		100	milliwatts
Frequency Range		10,500 to 11,000	megacycles

MECHANICAL

Operating Position	any	
Mounting	UG-39/U waveguide flange	
Cooling	conduction	
Electrical Connections	flexible leads	
RF Output Coupling	RG-52/U waveguide	
Net Weight	4	ounces
Shipping Weight (Approximate)	2	pounds
Maximum Overall Dimensions:		
Height	1.50	inches
Width	1.63	inches
Length	2.50	inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C	
Maximum Altitude	No limit	
Maximum Non-Operating Shock* (11 ms Duration)	40	g
Maximum Operating Vibration** (20 to 2000 cps)	10	g
Maximum Operating Shock* (11 ms Duration)	40	g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 200 kilocycles.

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MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	450 MAX.	VOLTS
DC CATHODE CURRENT	45 MAX.	MA
RESONATOR DISSIPATION	25 MAX.	WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0 MAX.	VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX.	VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15:1)

DC Resonator Voltage*	400	volts
Mode	-	5-3/4
Frequency	10,750	megacycles
DC Cathode Current	40	milliamperes
DC Repeller Voltage*	-175	volts
DC Repeller Current	1	microampere
Power Output	120	milliwatts
Electronic Tuning (3 db bandwidth)	30	megacycles
Modulation Sensitivity (ΔE_r = ±3 volts)	1.7	Mc/volt
Peak-to-Peak FM Deviation (10g, 20-2000 cps)	200	kilocycles
Residual FM	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 150° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-ceramic seal temperatures below the maximum rating of 250° Centigrade.

Resonator: The resonator of the 1K20XD-S is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

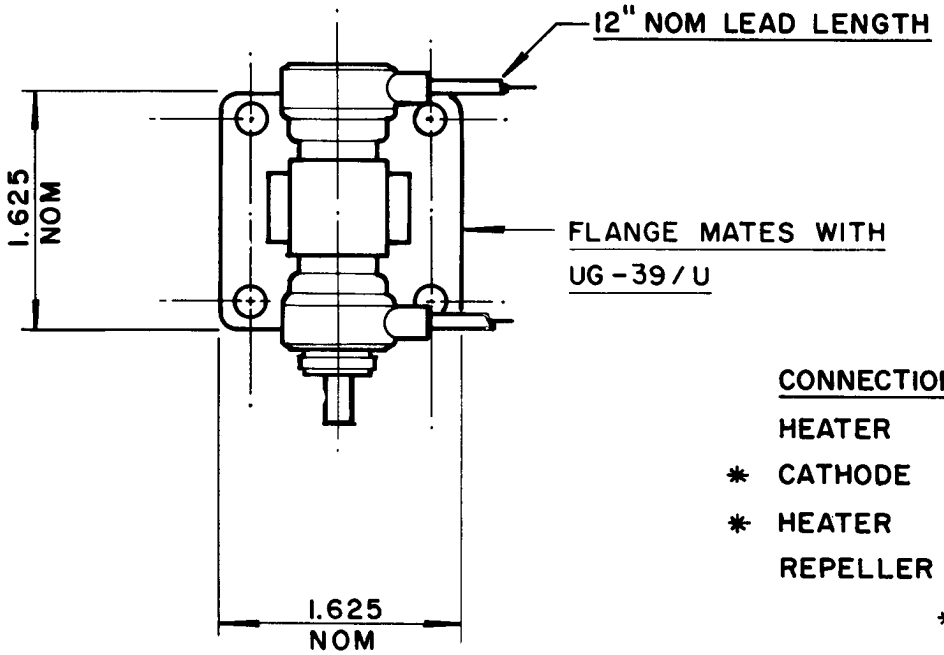
Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the 1K20XD-S are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the 1K20XD-S a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

1K20XD-S



CONNECTIONS

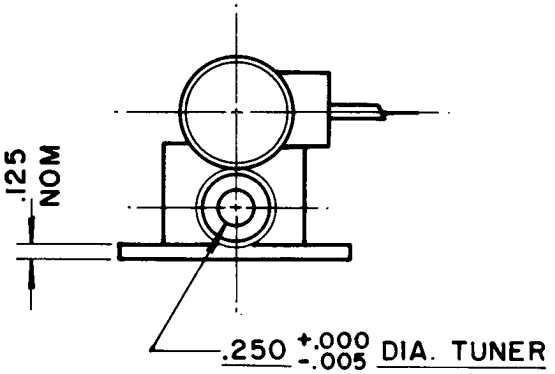
HEATER

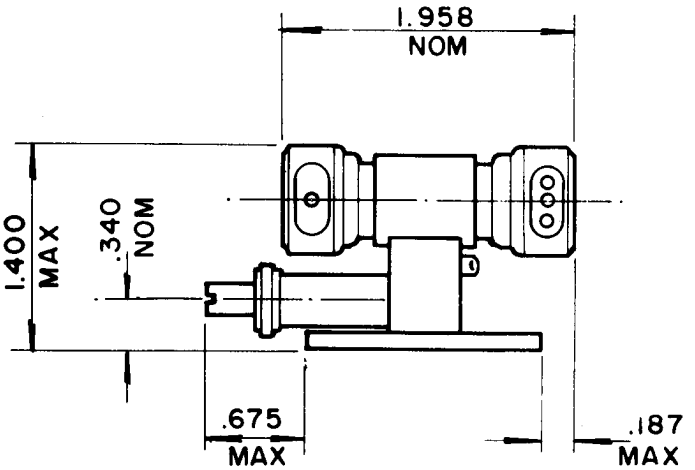
* CATHODE

* HEATER

REPELLER

* INTERNALLY CONNECTED



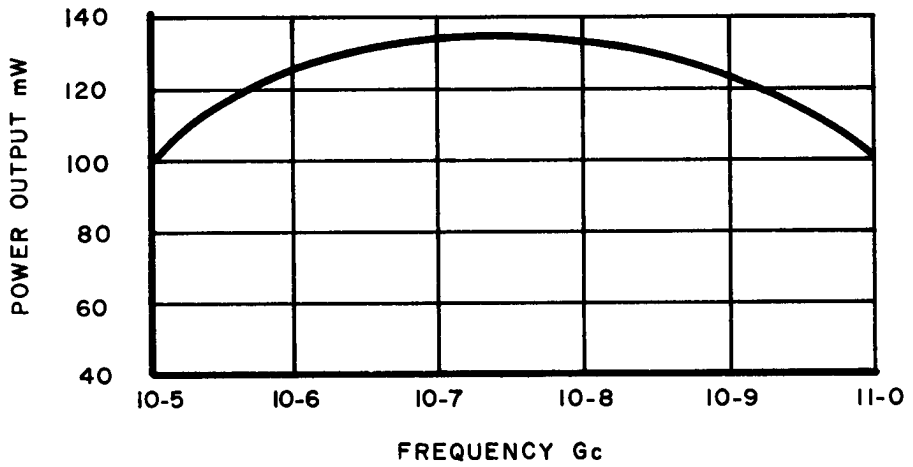


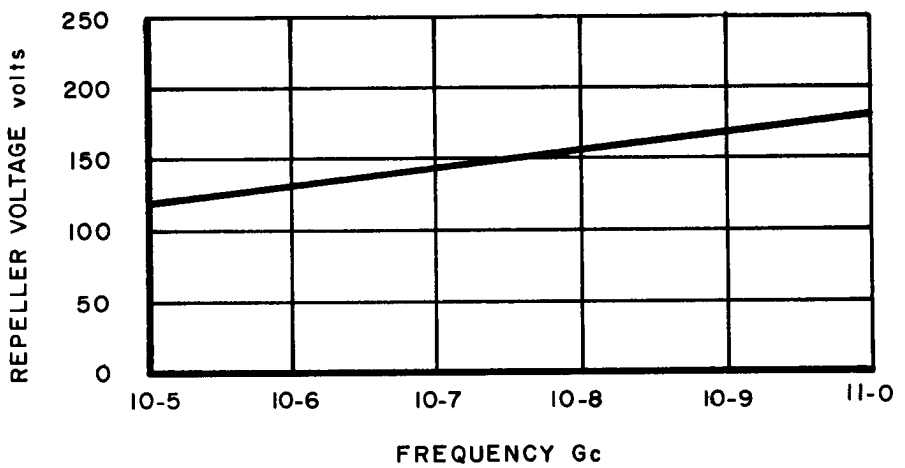
1K20XD-S TYPICAL OPERATING CHARACTERISTICS

Ers = 400 Vdc

Ik = 40 mAdc

$5\frac{3}{4}$ MODE



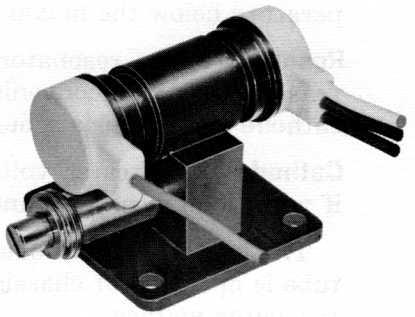


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K20XF-B

X BAND
REFLEX KLYSTRON



TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency range	10.061 to 10.452 Gc
Mechanically tunable	391 Mc
Power output	40 mW min.
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	300 Vdc
Cathode current	25 mA
Repeller voltage	−80 to −120 Vdc
Modulation sensitivity	3.0 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	0.7 A max.
Mode	5¾
VSWR of load	1.1:1
Temperature coefficient	−200 +100 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	400 Vdc
Cathode current	50 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	RG-52U wave-guide flange
Cooling required	conduction
Net weight	5 oz. max.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100° C
Altitude	100,000 ft.
Vibration*	10G, 20 to 2000 cps
Shock*	40G, 11 ms

*As required

OUTLINE DIMENSIONS

Height	1.400 in.
Width	1.625 in.
Length	2.570 in.

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APPLICATION

NOTE: All voltages are referred to the cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at less than 20 watts resonator dissipation and an ambient temperature of less than 150° C. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If the tube is operated at a resonator dissipation of greater than 20 watts or if an insulator is used between the tube and waveguide for DC isolation, forced air cooling will be required to maintain the body temperature below the maximum rating of 175° Centigrade.

Resonator: The resonator of the 1K20XF-B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

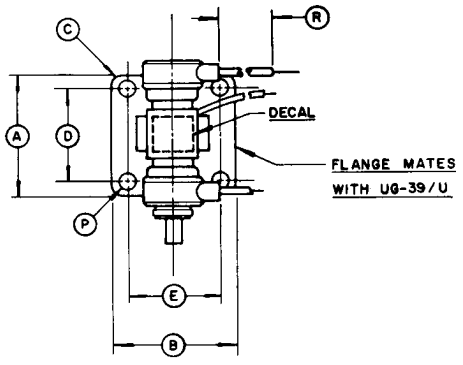
Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the 1K20XF-B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2,000 cps) or shock of up to 40g (11 milliseconds duration).

With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 200 kilocycles.

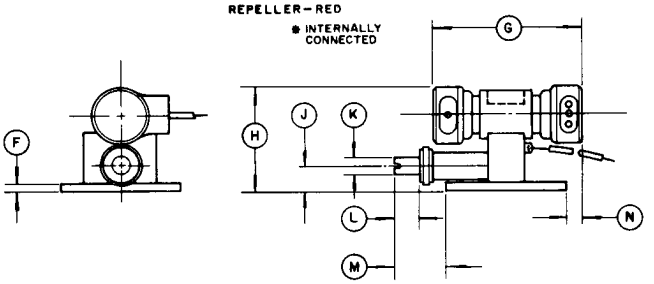
Special Applications: For additional information regarding any specific application, write to Microwave Division, Eitel-McCullough, Inc., San Carlos, California, telephone Lytell 1-1451, Cable EIMAC.



DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF	MIN	MAX	NOM
A			1.625
B			1.625
C			.125 R.
D	1.276	1.284	
E	1.216	1.224	
F			.125
G			1.958
H		1.400	
J			.340
K	.245	.250	
L	.290		
M		.800	
N		.187	
P	.169	.174	
R	12±1 TYP LEAD LENGTH		

CONNECTIONS
BODY – BROWN
HEATER – WHITE
* CATHODE – BLACK
* HEATER – BLACK
REPELLER – RED
* INTERNALLY CONNECTED

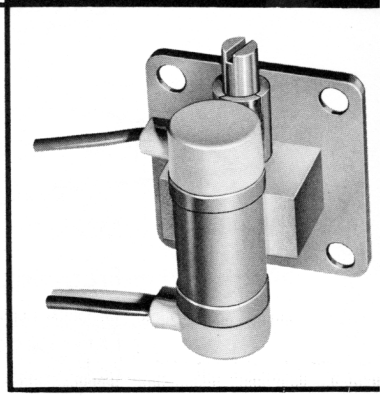


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K20XK

X-BAND
REFLEX KLYSTRON



The Eimac 1K20XK is a ceramic and metal, conduction-cooled reflex klystron designed for local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 75 milliwatts over the frequency range of 9200 to 10,000 megacycles.

The stacked-ceramic construction results in an extremely rugged design and a low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated.	
Warm-up time	30 seconds
Heater: Voltage	6.3 volts
Current	0.8 ampere
Typical Output Power (Load VSWR = 1.15:1)	75 milliwatts
Frequency Range	9200 to 10,000 megacycles

MECHANICAL

Operating Position	Any
Mounting	UG-39/U waveguide flange
Cooling	Conduction
Electrical Connections	Flexible leads
R-F Output Coupling	RG-52/U waveguide
Net Weight	4 ounces
Shipping Weight (Approximate)	2 pounds
Maximum Overall Dimensions:	
Height	1.40 inches
Width	1.63 inches
Length	2.28 inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-Operating Shock (11 ms Duration)	40 g
Maximum Operating Shock* (11 ms Duration)	40 g
Maximum Operating Vibration** (20 to 2000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 100 kilocycles.

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	350 MAX. VOLTS
D-C CATHODE CURRENT	55 MAX. MA.
RESONATOR DISSIPATION	20 MAX. WATTS
PEAK REPELLER VOLTAGE*	
POSITIVE WITH RESPECT TO CATHODE	0 MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

D-C Resonator Voltage*	300	350	volts
Mode	5¾	5¾	
Frequency	9600	9600	megacycles
D-C Cathode Current	40	50	milliamperes
D-C Repeller Voltage*	−170	−155	volts
D-C Repeller Current	1	1	microampere
Power Output	70	90	milliwatts
Electronic Tuning (3 db bandwidth)	35	35	megacycles
Modulation Sensitivity ($\Delta E_r = \pm 3$ volts)	1.7	1.7	Mc/volt
Peak-to-Peak FM Deviation (10g, 20-2000 cps)	50	50	kilocycles
Residual FM	50	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced-air cooling when operated at its maximum rated dissipation with an ambient temperature less than 150° Centigrade. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for D-C isolation, forced-air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 250° Centigrade.

Resonator: The resonator of the 1K20XK is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

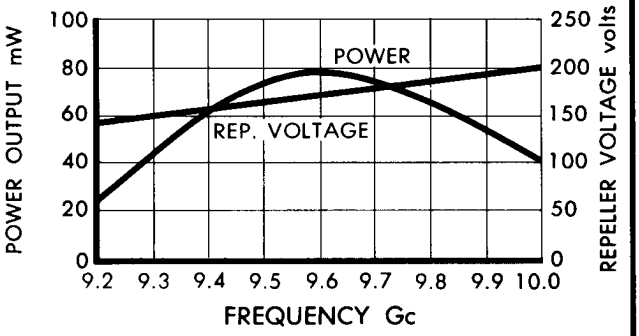
The heater and cathode of the 1K20XK are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

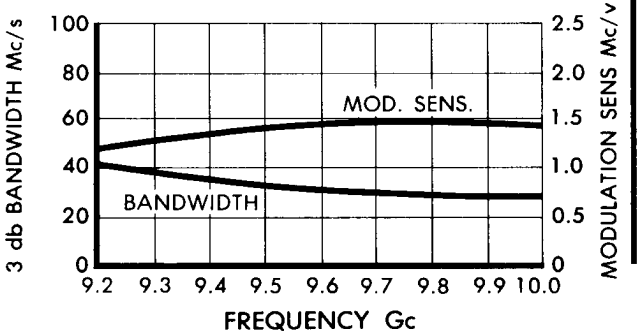
Mechanical Tuning: In the 1K20XK a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

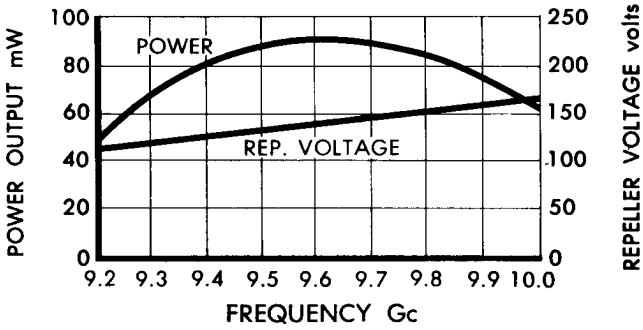
IK20XK TYPICAL OPERATING CHARACTERISTICS

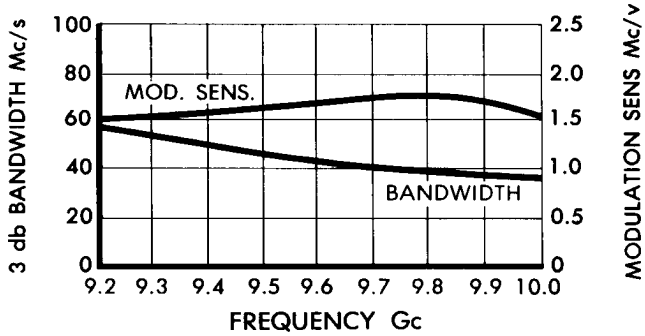
E_{RS} = 350 Vdc
I_K = 50 mAdc
5¾ MODE



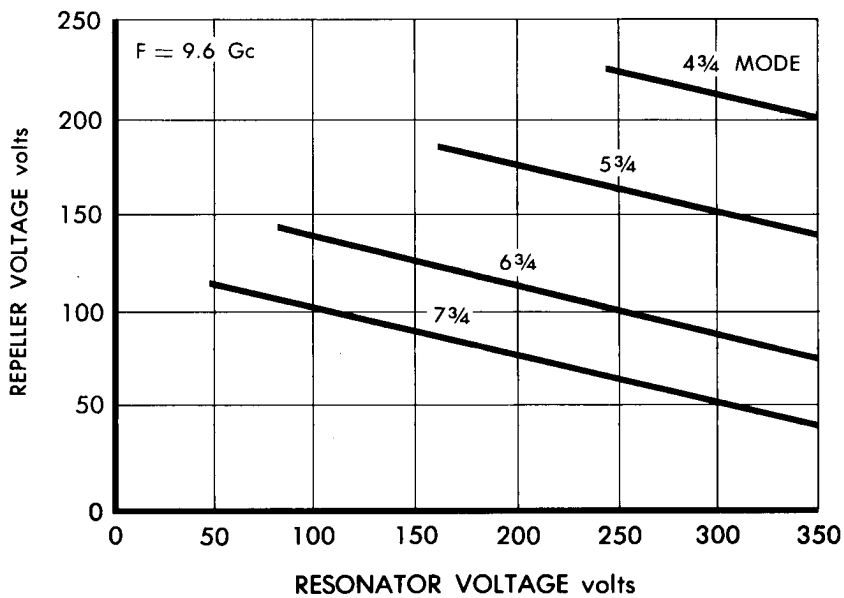


E_{RS} = 300 Vdc
I_K = 40 mAdc
5¾ MODE



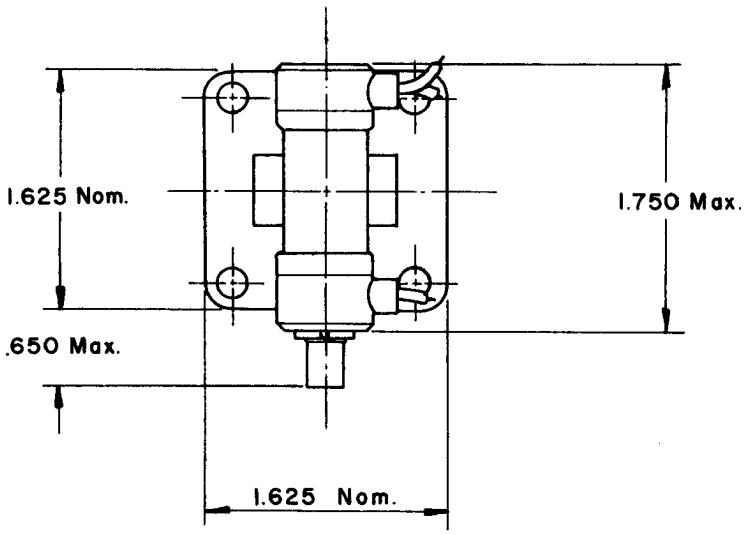


MODE CHARACTERISTICS



EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

1K20 XK

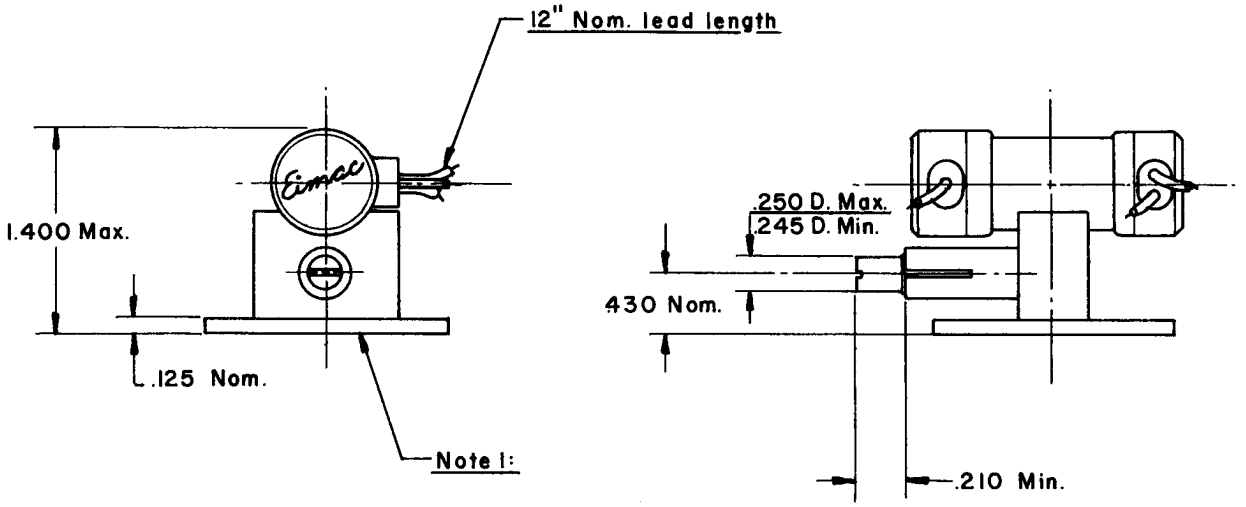


NOTE:

1. Mates with UG-39/U flange for RG-52/U waveguide

CONNECTIONS

1. REPELLER - RED
2. CATHODE - BLACK
3. HEATER - WHITE

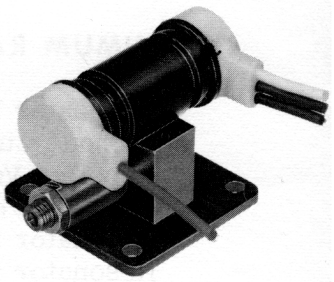


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K20XN-A

X-BAND REFLEX KLYSTRON



The Eimac 1K20XN-A is a ceramic and metal reflex klystron which is especially well-suited for parametric amplifier pump applications. This tube is available at any factory pre-set frequency between 8.5 and 11.0 Gc, and the lock-tuner can be trimmed ± 50 Mc. for fine tuning adjustments.

The 1K20XN-A provides a minimum output power of 150 milliwatts and is conservatively warranteed for 1,000 hours.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, Oxide Coated		
	Warm-up Time	30	seconds
Heater:	Voltage	6.3	volts
	Current	0.8	ampere
Connections			flexible leads

MECHANICAL

Operating Position		any
Mounting		UG-39/U Waveguide flange
RF Output Coupling		RG-52/U Waveguide
Net Weight		4 ounces
Shipping Weight (approximate)		2 pounds
Maximum Overall Dimensions:		
	Height	1.50 inches
	Width	1.63 inches
	Length	2.50 inches

ENVIRONMENTAL

Maximum Ambient Temperature		150° C
Maximum Altitude		no limit
Maximum Shock* (11 ms duration)		40 g
Maximum Operating Vibration** (20-2,000 cps)		10 g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 200 kilocycles.

TYPICAL OPERATION

Mode	4-3/4	
Frequency	10.6	Gc
Resonator Voltage	400	Vdc
Output Power	200	MW
Cathode Current	40	mAdc

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TYPICAL OPERATION (continued)

Repeller Voltage*	-290	Vdc
3 db Bandwidth	25	Mc
Modulation Sensitivity	0.8	Mc/V

*All voltages referred to cathode.

MAXIMUM RATINGS

Resonator Voltage	450	Vdc
Cathode Current	50	mAdc
Repeller Voltage	500	Vdc
Ambient Temperature	150°	C
Resonator Dissipation with conduction cooling	20	watts
Resonator Dissipation with forced air cooling	30	watts

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at less than 20 watts resonator dissipation and an ambient temperature of less than 150° C. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If the tube is operated at a resonator dissipation of greater than 20 watts or if an insulator is used between the tube and waveguide for DC isolation, forced air cooling will be required to maintain the body temperature below the maximum rating of 175° Centigrade.

Resonator: The resonator of the 1K20XN-A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the 1K20XN-A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

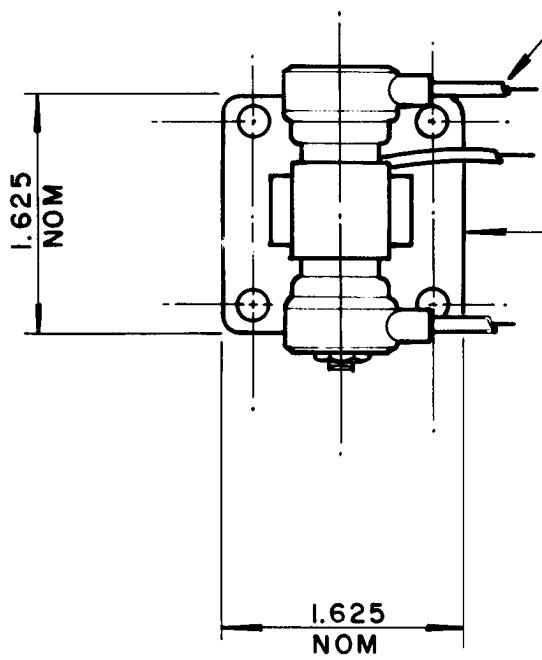
Mechanical Trimming: The 1K20XN-A is fitted with a locking tuner that allows ±50 mc trimming. The center frequency is factory pre-set to your specification.

Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20-2,000 cps) or shock of up to 40g (11 milliseconds duration).

With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 200 kilocycles.

Special Applications: For additional information regarding any specific application, write to Microwave Division, Eitel-McCullough, Inc., San Carlos, California, telephone Lytell 1-1451, Cable EIMAC.

1K20XN-A



CONNECTIONS

HEATER - WHITE

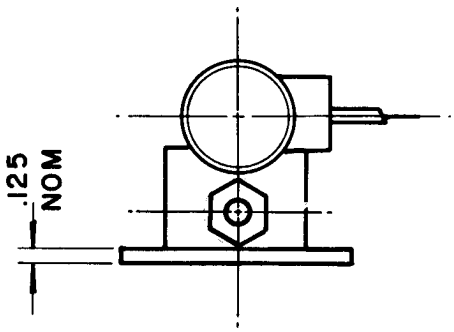
* CATHODE - BLACK

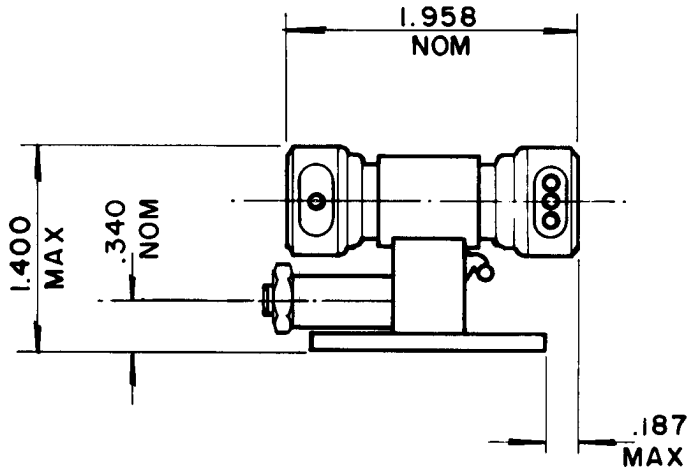
* HEATER - BLACK

REPELLER - RED

BODY — BLACK-WHITE

* INTERNALLY CONNECTED



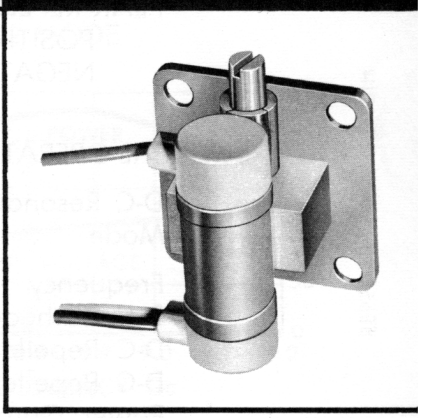


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K20XS

X-BAND
REFLEX KLYSTRON



The Eimac 1K20XS is a ceramic and metal, conduction-cooled reflex klystron designed for local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 75 milliwatts over the frequency range of 8500 to 9200 megacycles.

The stacked-ceramic construction results in an extremely rugged design and a low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated.	
Warm-up time	30 seconds
Heater: Voltage	6.3 volts
Current	0.8 ampere
Typical Output Power (Load VSWR = 1.15:1)	75 milliwatts
Frequency Range	8500 to 9200 megacycles

MECHANICAL

Operating Position	Any
Mounting	UG-39/U waveguide flange
Cooling	Conduction
Electrical Connections	Flexible leads
R-F Output Coupling	RG-52/U waveguide
Net Weight	4 ounces
Shipping Weight (Approximate)	2 pounds
Maximum Overall Dimensions:	
Height	1.40 inches
Width	1.63 inches
Length	2.28 inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-Operating Shock (11 ms Duration)	40 g
Maximum Operating Shock* (11 ms Duration)	40 g
Maximum Operating Vibration** (20 to 2000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 100 kilocycles.

MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	350 MAX. VOLTS
D-C CATHODE CURRENT	55 MAX. MA.
RESONATOR DISSIPATION	20 MAX. WATTS
PEAK REPELLER VOLTAGE*	
POSITIVE WITH RESPECT TO CATHODE	0 MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

D-C Resonator Voltage	350	300	volts
Mode	5¾	5¾	
Frequency	8850	8850	megacycles
D-C Cathode Current	50	40	milliamperes
D-C Repeller Voltage*	135	150	volts
D-C Repeller Current	1	1	microampere
Power Output	90	70	milliwatts
Electronic Tuning (3 db bandwidth)	40	40	megacycles
Modulation Sensitivity ($\Delta E_r = \pm 3$ volts)	1.5	1.5	Mc/volt
Peak-to-Peak FM Deviation (10g, 20-2000 cps)	50	50	kilocycles
Residual FM	50	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced-air cooling when operated at its maximum rated dissipation with an ambient temperature less than 150° Centigrade. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for D-C isolation, forced-air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 250° Centigrade.

Resonator: The resonator of the 1K20XS is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

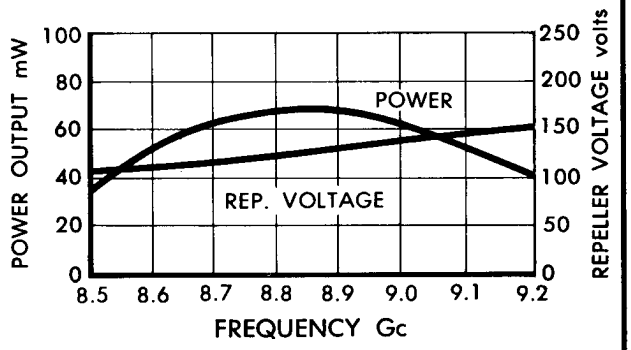
The heater and cathode of the 1K20XS are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

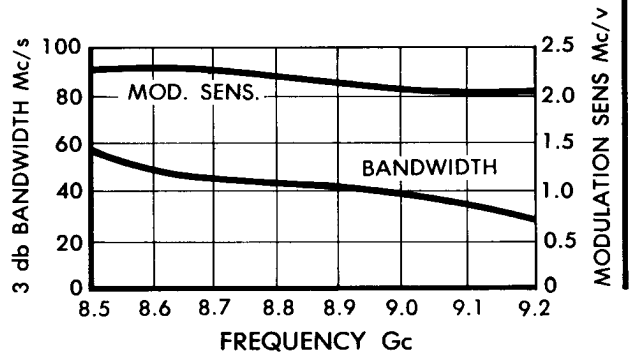
Mechanical Tuning: In the 1K20XS a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

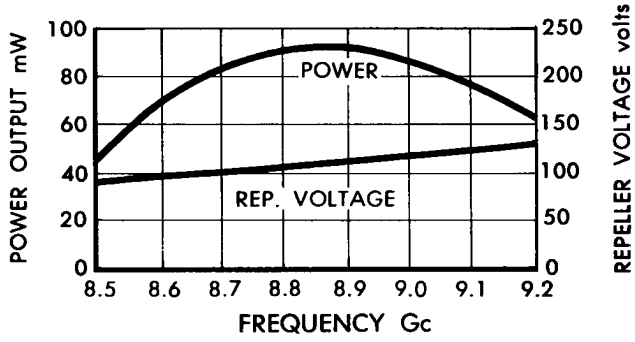
IK20XS TYPICAL OPERATING CHARACTERISTICS

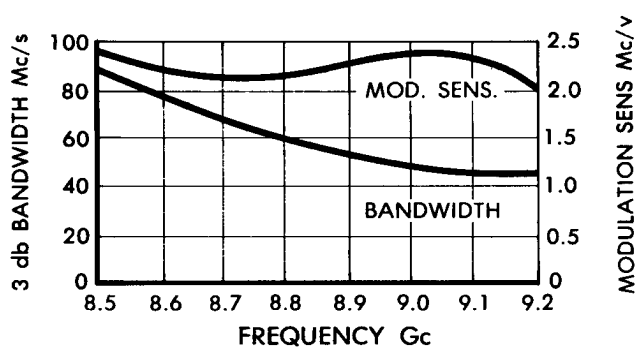
E_{RS} = 300 Vdc
I_K = 40 mAdc
5¾ MODE



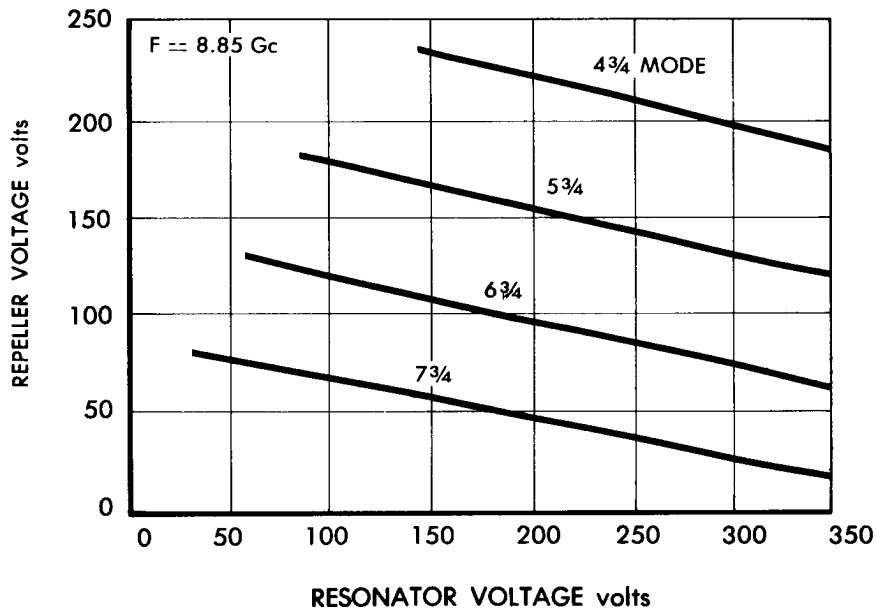


E_{RS} = 350 Vdc
I_K = 50 mAdc
5¾ MODE



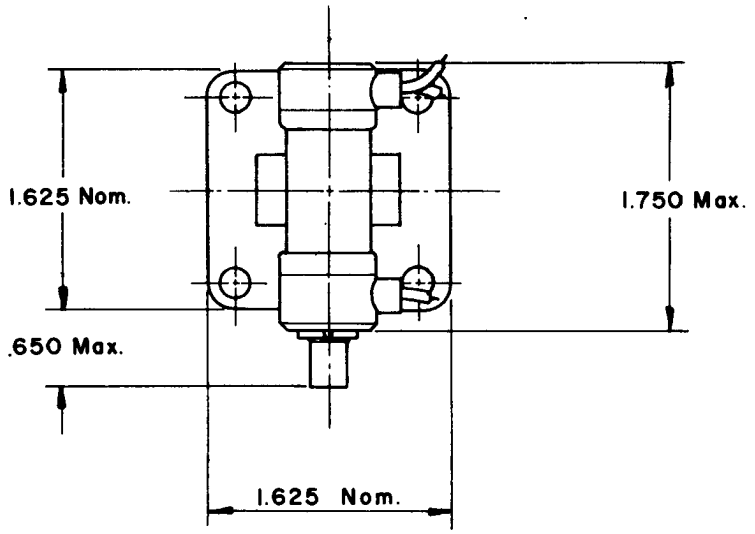


MODE CHARACTERISTICS



EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

IK20XS

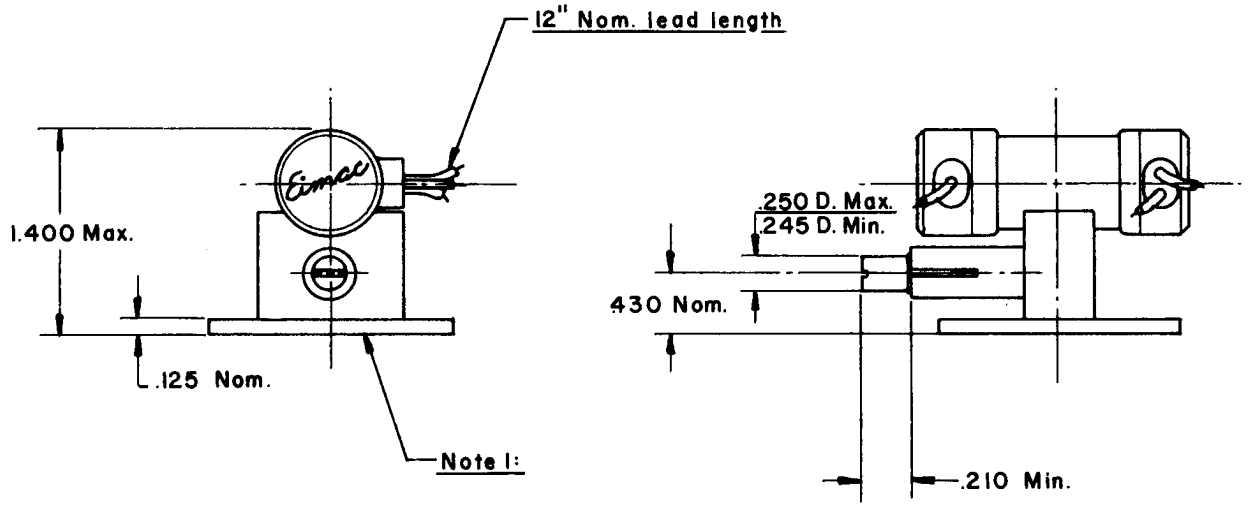


NOTE:

1. Mates with UG-39/U flange for RG-52/U waveguide

CONNECTIONS

1. REPELLER - RED
2. CATHODE - BLACK
3. HEATER - WHITE



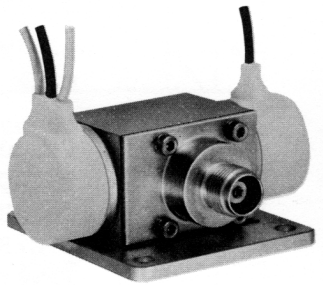
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

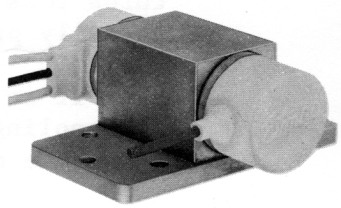
1K75CH
1K75CK

C-BAND
REFLEX KLYSTRONS

The Eimac 1K75CH and 1K75CK are low noise, ceramic and metal, ruggedized, internal cavity, reflex klystrons designed for use in altimeter applications at a fixed frequency of 4300 ± 50 megacycles. These conduction-cooled tubes are capable of delivering a minimum output power of one watt into a load VSWR of 1.15 to 1 under conditions of severe shock, vibration or acceleration extremes.



1K75CH



1K75CK

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up Time - -	60	seconds
Heater:	Voltage - -	6.3	volts
	Current - -	1.0 to 1.5	amperes
Minimum Output Power (Load VSWR=1.15:1)		1.0	watts
Operating Frequency - -		4300 ± 50	megacycles

MECHANICAL

Operating Position - - -		Any	
Mounting:			
	1K75CH - - -	Heat sink flange	
	1K75CK - -	Special waveguide flange	
R-F Output Coupling:			
	1K75CH - - -	Insulated TNC jack	
	1K75CK -	Special half-height waveguide	
Electrical Connections	- -	Flexible leads	
Cooling - - -		Convection and conduction	
Maximum Overall Dimensions:	1K75CH	1K75CK	
Depth - -	1.13	1.19	inches
Width - -	2.50	2.76	inches
Length - -	2.51	2.73	inches
Net Weight - -	8.5	8.0	ounces
Shipping Weight (Approximate)	2	2	pounds

ENVIRONMENTAL

Maximum Heat-Sink or Ambient Temperature - -	125° Centigrade
Maximum Altitude (1K75CK, and 1K75CH with TNC jack at body potential) - - - -	No Limit
Maximum Altitude (1K75CH with TNC jack at cathode potential)	40,000 Feet
Maximum Non-Operating Shock (11 ms duration) (1K75CH) -	15 g
Maximum Non-Operating Shock (11 ms duration) (1K75CK) -	30 g
Maximum Operating Vibration (20-2000 cps)* - - -	10 g

*Based on a maximum peak-to-peak frequency deviation of 100 kilocycles.

MAXIMUM RATINGS

D-C RESONATOR VOLTAGE*	850	MAX. VOLTS
D-C CATHODE CURRENT	100	MAX. MA.
RESONATOR DISSIPATION	75	MAX. WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0	MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500	MAX. VOLTS
PEAK HEATER TO CATHODE VOLTAGE	±45	MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

D-C Resonator Voltage*	550	750	volts
Mode	4-3/4	2-3/4	
Frequency	4300	4300	megacycles
D-C Cathode Current	35	60	milliamperes
D-C Repeller Voltage*	-150	-350	volts
D-C Repeller Current	1	1	microampere
Power Output	0.25	1.0	watt
Electronic Tuning (3 db bandwidth)	60	30	megacycles
Modulation Sensitivity (ΔE_r = ± 5 volts)	1600	160	Kc/volt
Residual FM	40	40	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level, these tubes will not require forced-air cooling when operated at their maximum rated dissipation with heat-sink and ambient temperatures less than 125° Centigrade. The mounting flange or waveguide flange will normally provide the heat sink connection required for conduction cooling.

If an insulator is used between the tube and waveguide or chassis, forced-air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 175° Centigrade.

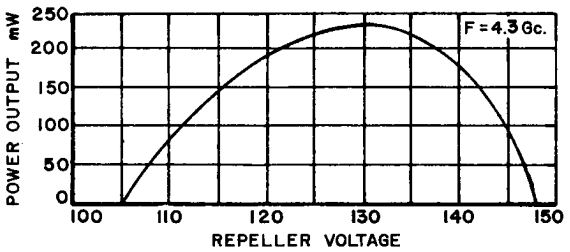
Resonator: The resonator of the 1K75C series tubes is integral with the body of the tube. For this reason, it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

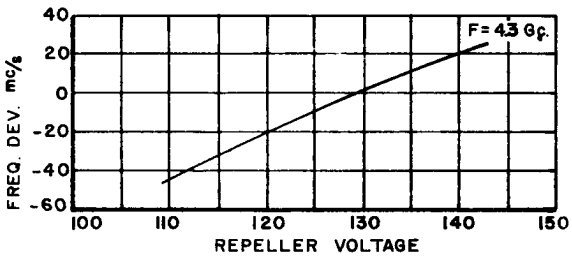
Cathode: The heater voltage should be maintained within ± 5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of these tubes are not internally connected and the heater-to-cathode voltage should not exceed ± 45 volts. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

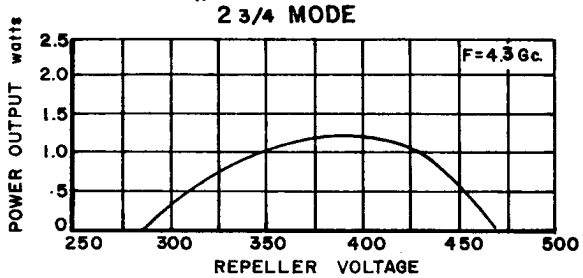
IK75CH/CK TYPICAL OPERATING CHARACTERISTICS

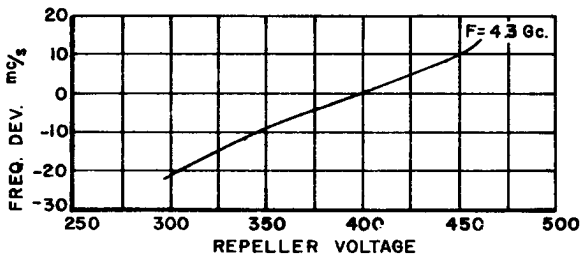
E_{RS} = 500 Vdc
I_K = 35 mAdc
4 3/4 MODE



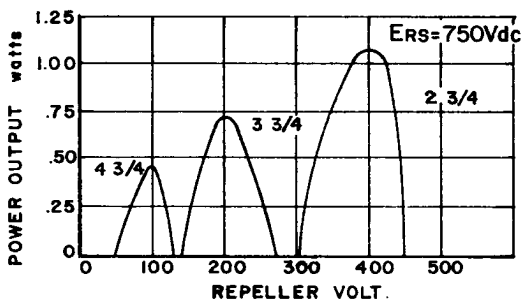


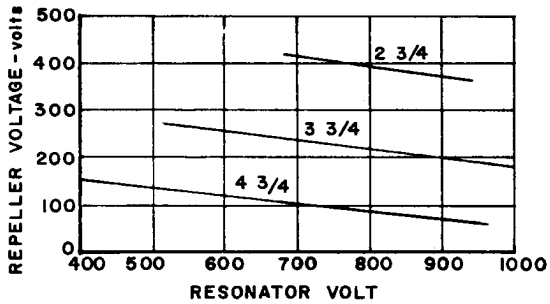
E_{RS} = 750 Vdc
I_K = 60 mAdc
2 3/4 MODE



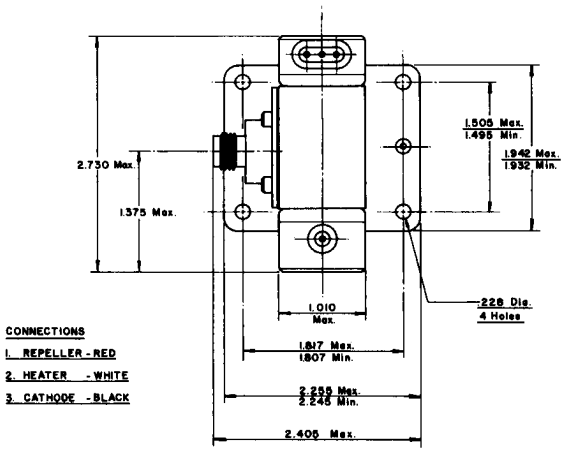


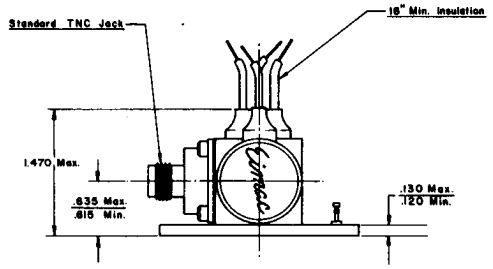
MODE CHARACTERISTICS



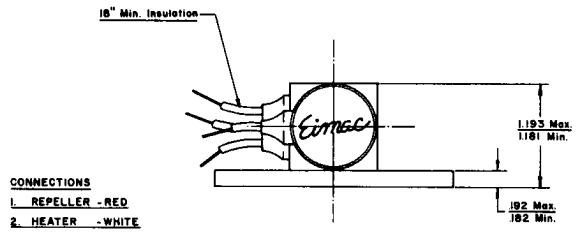


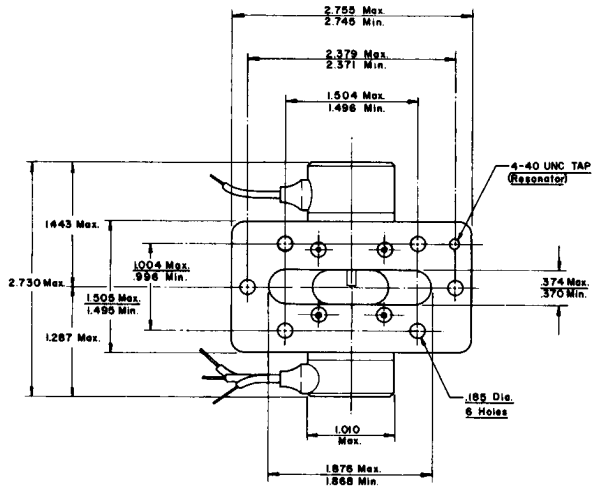
IK75 CH





IK75 CK





EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

1K75CLA

REFLEX

KLYSTRON

TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency Setting	4.300 to 4.375 Gc
Power Output	240 mW
Electronic Tuning Range (3 db bandwidth)	50 Mc
Resonator Voltage	550 Vdc
Cathode Current	38 mA
Repeller Voltage	−93 Vdc
Modulation Sensitivity	1.0 to 2.0 Mc/V
Heater Voltage	6.3 V(ac or dc)±5%
Heater Current	1.5 A max
Mode	4-3/4
VSWR of Load	1.05:1
Temperature Coefficient	±150 Kc/°C max
Warm-up Time	120 seconds max
[redacted]	[redacted]

*MAXIMUM RATINGS

Resonator Voltage	900 Vdc
Cathode Current	85 mA
Repeller Voltage (negative with respect to the cathode)	−50 to −500 Vdc

*Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Electrical Connection	Flexible Leads
RF Output Coupling	1/2 height, RG 49 A/U waveguide flange
Cooling Required	Conduction
Net Weight	10 ounces
Shipping Weight (approximate)	4 Pounds

ENVIRONMENTAL PERFORMANCE

Temperature Range	−55 to +90° C
Altitude	50,000 ft. max
Vibration	10 G, 20-2000 cps
Shock	30 G, 11 ms

OUTLINE DIMENSIONS

Height	2-1/32 inches
Width	2-49/64 inches
Length	1-9/16 inches

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APPLICATION NOTES

NOTE: All voltages referred to the cathode.

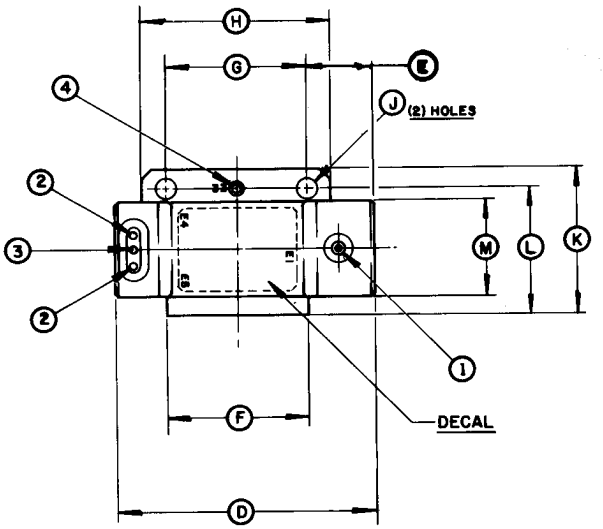
COOLING: At sea level, these tubes will not require forced-air cooling when operated at their maximum rated dissipation with heat-sink and ambient temperatures less than 125° Centigrade. The mounting flange or waveguide flange will normally provide the heat sink connection required for conduction cooling.

If an insulator is used between the tube and waveguide or chassis, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 175° Centigrade.

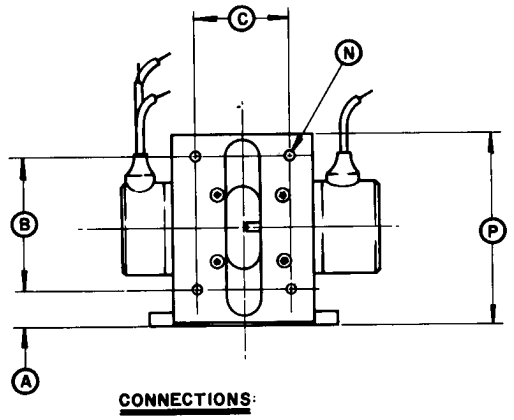
RESONATOR: The resonator of the 1K75C series tube is integral with the body of the tube. For this reason, it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

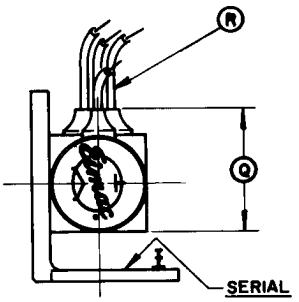
CATHODE: The heater voltage should be maintained with ± 5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of these tubes are not internally connected and the heater-to-cathode voltage should not exceed ±45 volts. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	.365	.385	
B	1.396	1.416	
C	.990	1.010	
D		2.730	
E		.684	
F		1.520	
G	1.495	1.505	
H		1.968	
J	.215 DIA.	.225 DIA.	
K		1.593	
L	1.339	1.349	
M		1.010	
N	#6-32 UNC-2B (4) HOLES		
P		2.030	
Q		1.345	
R	18" MIN. INSULATION		





CONNECTIONS:

1. REPELLER—RED
2. HEATER—WHITE
3. CATHODE—BLACK
4. RESONATOR—TERMINAL

FINISH:

TUBE BODY—PAINTED
TUBE FLANGE—GOLD PLATED

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

1K75CS

C-BAND REFLEX KLYSTRON



The Eimac 1K75CS is intended to ease the system designers' logistics and performance problems by providing a ruggedized, load-insensitive reflex klystron/isolator package for the 4200-4400 Mc. radio-altimeter band. Combining these two components into one integral package allows them to be matched for optimum performance. Operating in the 4-3/4 mode, the 1K75CS provides more than 300 mW and 100 Mc. electronic tuning range into a load VSWR of 2:1 with only 8 Mc. maximum frequency pulling. Alternately, this tube can be factory pre-set to provide approximately 1 watt and 30 Mc. electronic tuning range.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up Time	60	seconds
Heater:	Voltage	6.3	volts
	Current	1.0 to 1.5	amperes
Minimum Output Power (4-3/4 mode)		0.3	watts
Operating Frequency (Fixed)		4300 ± 50	megacycles

MECHANICAL

Operating Position	Any	
Mounting	Heat Sink Flange	
RF Output Coupling	Special Half-Height Waveguide	
Electrical Connections	Flexible Leads	
Maximum Overall Dimensions:		
Depth	4.16	Inches
Width	2.81	Inches
Length	2.76	Inches
Net Weight	1.5 Pounds Max.	
Shipping Weight (Approximate)	3	Pounds

ENVIRONMENTAL

Maximum Heat-Sink Temperature	125	°C
Maximum Non-Operating Shock (11 ms Duration)	15	g
Maximum Operating Vibration (20 - 1500 cps)*	10	g

*Based on a maximum peak-to-peak frequency deviation of 100 kilocycles.

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MAXIMUM RATINGS

DC RESONATOR VOLTAGE	900 MAX.	VOLTS
DC CATHODE CURRENT	85 MAX.	MA
RESONATOR DISSIPATION	75 MAX.	WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0 MAX.	VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX.	VOLTS

TYPICAL OPERATION

Mode	4-3/4	
Frequency	4300	megacycles
DC Resonator Voltage*	700	volts
DC Cathode Current	55	milliamperes
DC Repeller Voltage	-85	
DC Repeller Current	1	microampere
Output Power	325	milliwatts
Electronic Tuning (3 db bandwidth)	110	megacycles
Modulation Sensitivity	3	Mc/volt
Residual FM	40	kilocycles
Temperature Coefficient (-55 to +125 C)	±75	Kc/°C

*Based on a maximum peak-to-peak frequency deviation of 100 kilocycles.

APPLICATION

Cooling: At sea level, these tubes will not require forced-air cooling when operated at their maximum rated dissipation with heat-sink and ambient temperatures less than 125° Centigrade. The mounting flange or waveguide flange will normally provide the heat sink connection required for conduction cooling.

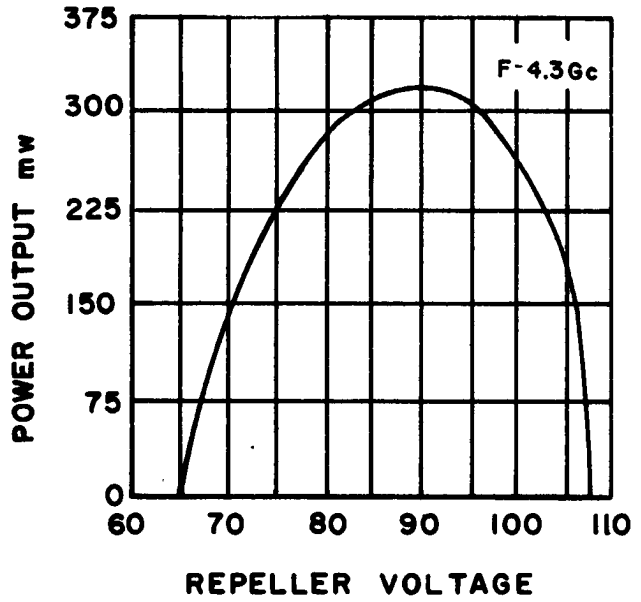
Resonator: The resonator of the 1K75CS is integral with the body of the tube. For this reason, it is convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

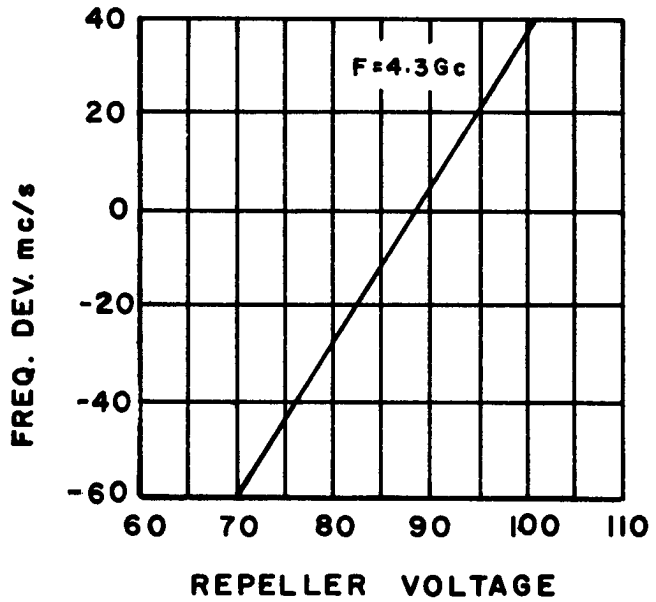
Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of these tubes are not internally connected and the heater-to-cathode voltage should not exceed ±45 volts. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

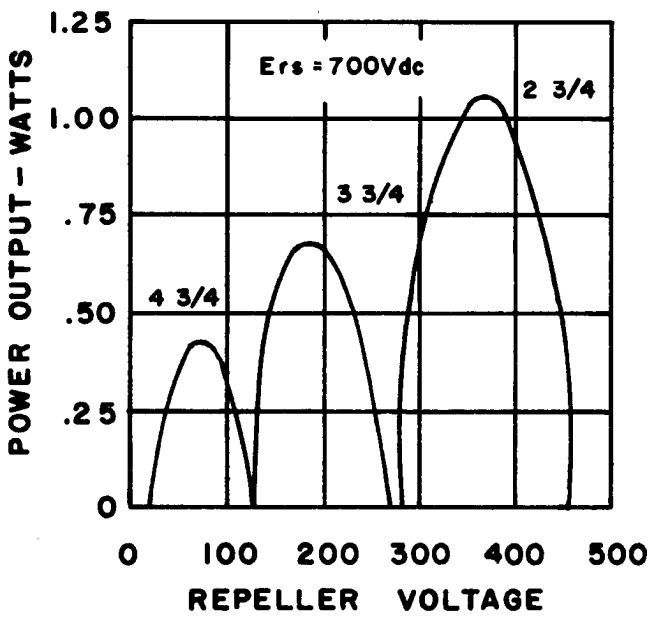
1K75CS TYPICAL OPERATING CHARACTERISTICS

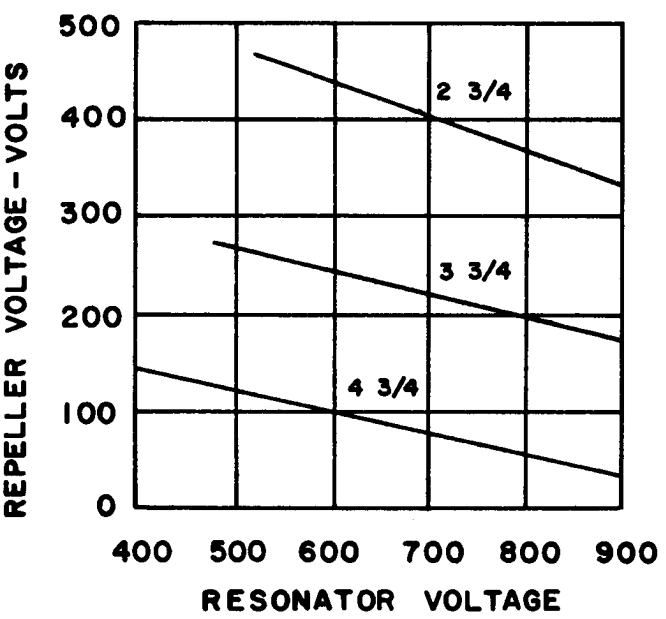
Ers = 700 Vdc
Ik = 55 mAdc
4 3/4 MODE





MODE CHARACTERISTICS





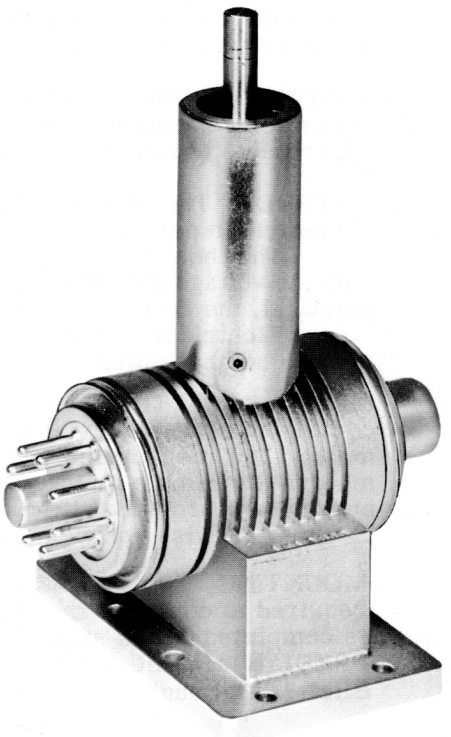
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

PRELIMINARY DATA

1K125CA

C-BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency Range	3.7 to 4.4 Gc
Mechanically Tunable	700 Mc
Power Output	1.25 W min
Electronic Tuning Range (3 db bandwidth)	25 Mc min
Resonator Voltage	1000 Vdc
Cathode Current	80 mAdc
Repeller Voltage	−400 Vdc
Modulation Sensitivity	250 to 550 Kc/v
Heater Voltage	6.3 V(ac or dc)±5%
Heater Current	1.5 A max
Mode	2-3/4
VSWR of Load	1.15:1
Temperature Coefficient	±75 Kc/°C
Warm-up Time	120 seconds
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator Voltage	1200 Vdc
Cathode Current	110 mA
Repeller Voltage (negative with respect to the cathode)	−100 to −750 Vdc

Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position	any
Electrical Connection	Octal Socket
RF Output Coupling	CMR 187 waveguide flange
Cooling Required	10 cfm @ sea level
Net Weight	19 ounces
Shipping Weight (approximate)	5 pounds

ENVIRONMENTAL PERFORMANCE

Temperature Range (Ambient)	−25 to +65 C
Altitude	10,000 ft. max
Vibration	10 G, 40 cps
Shock	10 G, 1 ms

OUTLINE DIMENSIONS

Height	4.700 max
Width	2.797 max
Length	3.450 max

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APPLICATION NOTES

NOTE: All voltages are referred to the cathode.

COOLING: At sea level, with an ambient temperature of 50° Centigrade, a minimum air-flow rate of 10 CFM, directed over the klystron body, is required to adequately cool the tube when operated at maximum ratings.

For conditions other than the above, the criterion for proper cooling is to maintain the klystron ceramic-to-metal seal temperatures below 175° Centigrade. Cooling in excess of the minimum recommended flow rate will result in longer tube life and more stable operation. If extended tube life is of primary concern, the body temperature should not exceed 100° Centigrade.

RESONATOR: The resonator of the 1K125CA is integral with the body of the tube. For this reason, it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

CATHODE: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the 1K125CA are not internally connected and the heater-to-cathode voltage should not exceed ±45 volts. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

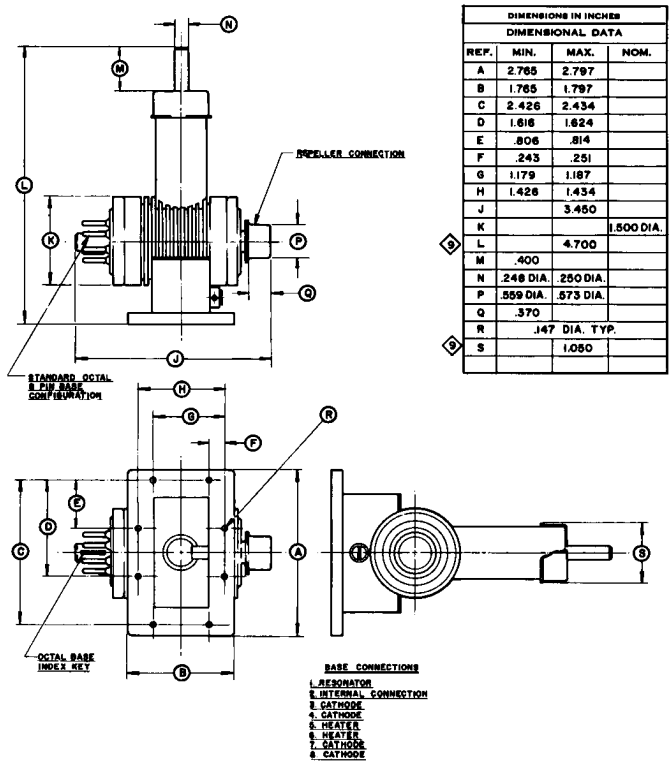
Electrical connection to the cathode of this tube should be completed by utilizing all four of the cathode base pins.

MECHANICAL TUNING: A screw-driven bellows, coupled to a ceramic-slug tuner, allows tuning cycling in excess of 1000 cycles without damage to the vacuum seals. The tuning rate of approximately 100 megacycles per turn and the low tuner starting-torque permits the use of miniature motors for remote tuning. Mechanical stops, capable of withstanding a maximum torque of 10 inch-ounces, are provided at the extremes of the tuning range to prevent damage to the tube.

Clockwise rotation of the tuner-shaft produces an increase in frequency.

MOUNTING: The 1K125CA should be mounted by the output-waveguide flange. An octal socket is required to complete the electrical connections to the heater and cathode. The repeller connection is completed with a standard medium cap connector.

SPECIAL APPLICATIONS: For additional information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California. All such requests will be handled confidentially.



DIMENSIONS IN INCHES

DIMENSIONAL DATA

REF.	MIN.	MAX.	NOM.
A	2.765	2.797	
B	1.765	1.797	
C	2.426	2.434	
D	1.616	1.624	
E	.806	.814	
F	.243	.251	
G	1.179	1.187	
H	1.426	1.434	
J		3.450	
K			1.500 DIA.
◇9 L		4.700	
M	.400		
N	.246 DIA.	.250 DIA.	
P	.559 DIA.	.573 DIA.	
Q	.370		
R	.147 DIA. TYP.		
◇9 S		1.050	

2C39A

HIGH-MU UHF TRIODE

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA



The Eimac 2C39A is a ceramic-metal high-mu planar triode with a plate-dissipation rating of 100 watts, designed for use as a power amplifier, oscillator, or frequency multiplier at frequencies to above 2500 megacycles. The new ceramic-metal construction results in extreme ruggedness, mechanical uniformity, reliable operation at seal temperatures up to 250°C, and longer life expectancy than its glass prototypes.

The 2C39A in a class-C r-f grounded grid circuit at 500 megacycles will typically deliver 27 watts useful power output with 6 watts driving power. As an r-f oscillator at 2500 megacycles the 2C39A will deliver a minimum of 12 watts useful power output.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide-Coated, Unipotential				
Heating Time	–	60		seconds
Heater: Voltage (See "Applications")	–	6.3		volts
Current	0.95		1.10	amperes
Amplification Factor	–	100		
Direct Interelectrode Capacitances (In Shielded Fixture):				
Grid-Plate	1.86		2.16	uuf
Grid-Cathode	5.60		7.60	uuf
Plate-Cathode	–	–	0.035	uuf
Transconductance (I_b = 70 ma.)	20,000		30,000	umhos
Frequency for Maximum Ratings	–	–	2,500	mc

MECHANICAL

Base, Socket and Connections	See drawing
Operating Position	Any
Cooling	Forced Air
Maximum Operating Temperatures:	
Metal-to-Glass Seals	250° C
Anode Core	250° C

Maximum Over-all Dimensions:	
Length	2.75 inches
Diameter	1.27 inches
Net Weight	2.5 ounces
Shipping Weight (Single Tube, Approx.)	7.0 ounces

RADIO-FREQUENCY POWER AMPLIFIER, OR OSCILLATOR

MAXIMUM RATINGS (Per tube)

D-C PLATE VOLTAGE	1000 MAX. VOLTS
D-C CATHODE CURRENT	125 MAX. MA
D-C GRID VOLTAGE	—150 MAX. VOLTS
D-C GRID CURRENT	50 MAX. MA
HEATER VOLTAGE	SEE APPLICATION NOTES
INSTANTANEOUS PEAK POSITIVE GRID VOLTAGE	30 MAX. VOLTS
INSTANTANEOUS PEAK NEGATIVE GRID VOLTAGE	400 MAX. VOLTS
PLATE DISSIPATION	100 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Key-down conditions, per tube)
(Power-Amplifier Grid-Isolation Circuit, CW Operation, 500 Mc.)

D-C Plate Voltage	800 volts
D-C Grid Voltage	—20 volts
D-C Plate Current	80 ma
D-C Grid Current	32 ma
Driving Power (approx.)[1]	6 watts
Useful Power Output	27 watts

TYPICAL OPERATION
(R-F Oscillator, 2500 Mc.)[2]

D-C Plate Voltage	900 volts
D-C Grid Voltage	—22 volts
D-C Plate Current	90 ma
D-C Grid Current	27 ma
Useful Power Output	12 watts

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS (Carrier conditions, per tube)

D-C PLATE VOLTAGE[3]	600 MAX. VOLTS
D-C GRID VOLTAGE	—150 MAX. VOLTS
D-C GRID CURRENT	50 MAX. MA
D-C CATHODE CURRENT	100 MAX. MA
PEAK INSTANTANEOUS POSITIVE GRID VOLTAGE	30 MAX. VOLTS
PEAK INSTANTANEOUS NEGATIVE GRID VOLTAGE	400 MAX. VOLTS
PLATE DISSIPATION	70 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION
(Plate-Modulated Radio-Frequency Power Amplifier Grid-Isolation Circuit, 500 Mc., Per Tube)

D-C Plate Voltage	600 volts
D-C Grid Voltage	—16 volts
D-C Plate Current	65 ma
D-C Grid Current	35 ma
Driving Power (approx.)[1]	5 watts
Useful Carrier Power Output	16 watts

[1]Driving power listed is the total power which must be supplied to a practical grid circuit at the frequency shown.
[2]These 2500-megacycle conditions conform to the minimum requirements of the MIL-E-1 specifications for the 2C39A.
[3]For less than 100% modulation, higher d-c plate voltage may be used if the sum of the peak positive modulating voltage and the d-c plate voltage does not exceed 1200 volts.

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▶ Indicates change from sheet dated 1-10-58

APPLICATION

MECHANICAL

Mounting—The 2C39A may be operated in any position. It should be firmly held in place by spring-finger collets bearing on the terminal surfaces. The tube should seat against the under side of the "anode flange" (see outline drawing). In applications involving severe shock and vibration, the tube may be clamped in place by applying a suitable clamping device to the anode flange. It is recommended that no other portion of the tube be subjected to clamping forces.

Connections—The tube terminals are in the form of concentric cylinders of graduated diameters so that the 2C39A may be conveniently used with coaxial tuning devices. Spring-finger collets should be used to make contact with the anode, grid, cathode, and heater terminals. Adequate contact area and spring pressure should be provided to minimize heating and to prevent erratic circuit performance at the higher frequencies. Non-contacting or intermittently-contacting collet fingers will cause troublesome circuit behavior, especially at very-high and ultra-high frequencies. Electrode contact surfaces should be kept clean and free of oxide coatings.

▶ **Cooling**—Sufficient cooling must be provided for the anode and body seals to maintain operating temperatures below the rated maximum values:

Ceramic to Metal Seals	250°C
Anode Core	250°C

At sea level, with an inlet air temperature of 25°C, 13.0 cubic feet per minute of air flow is required to cool the anode at 100 watts plate dissipation when the air cowling as illustrated is used. Pressure across the anode under these conditions is 0.6 inches of water. Operation at higher altitudes or with higher inlet temperatures requires increased volumes of flow to obtain equivalent cooling. When using the anode cowling as illustrated here, it is necessary to provide additional facilities for seal cooling.

It should be borne in mind that operating temperature is the sole criterion of cooling effectiveness, regardless of the coolant type, flow rate or coolant temperature.

ELECTRICAL

Heater Operation—The rated heater voltage for the 2C39A is 6.3 volts and the working voltage should be determined from the table below. The heater voltage should be maintained within plus or minus 10% of its intended value to minimize variations in circuit performance and to obtain maximum tube life.

At ultra-high frequencies transit-time effects can influence the cathode temperature. The amount of r-f driving power diverted to heating the cathode by back-bombardment will depend upon the frequency, the plate current, and the r-f driving power being supplied to the tube. The following table is intended as a general guide.

Frequency (Mc.)	E_f (Volts)
Up to 400	6.3
400 to 1000	6.0
1000 to 1500	5.5
1500 to 2000	5.0
2000 and above	4.5

If the conditions of operation result in extreme cathode back-heating, it may be necessary to start dynamic tube operation at normal heater voltage followed by a reduction of heater voltage to the proper value.

Cathode Operation—The oxide-coated unipotential cathode in the 2C39A and one side of the heater are connected internally. The absolute maximum rated d-c current is 125 milliamperes.

It is recommended that rated heater voltage be applied for a minimum of 30 seconds before other operating voltages are applied. Tube performance will become stabilized approximately 60 seconds after the heater voltage is applied.

Control-Grid Operation—The maximum rated grid dissipation is 2.0 watts.

At operating frequencies near 500 megacycles, the driving power necessary for maximum output of a typical grounded-grid amplifier is in the order of 6 watts and as the operating frequency is increased, the driving power requirements increase. Most of this additional driving power is absorbed in circuit losses other than grid dissipation, however, and the actual grid dissipation will increase very little.

The grid bias required by various 2C39A tubes may vary between limits approximately 50% above and below the nominal value and means should be provided in the equipment to accommodate such variations.

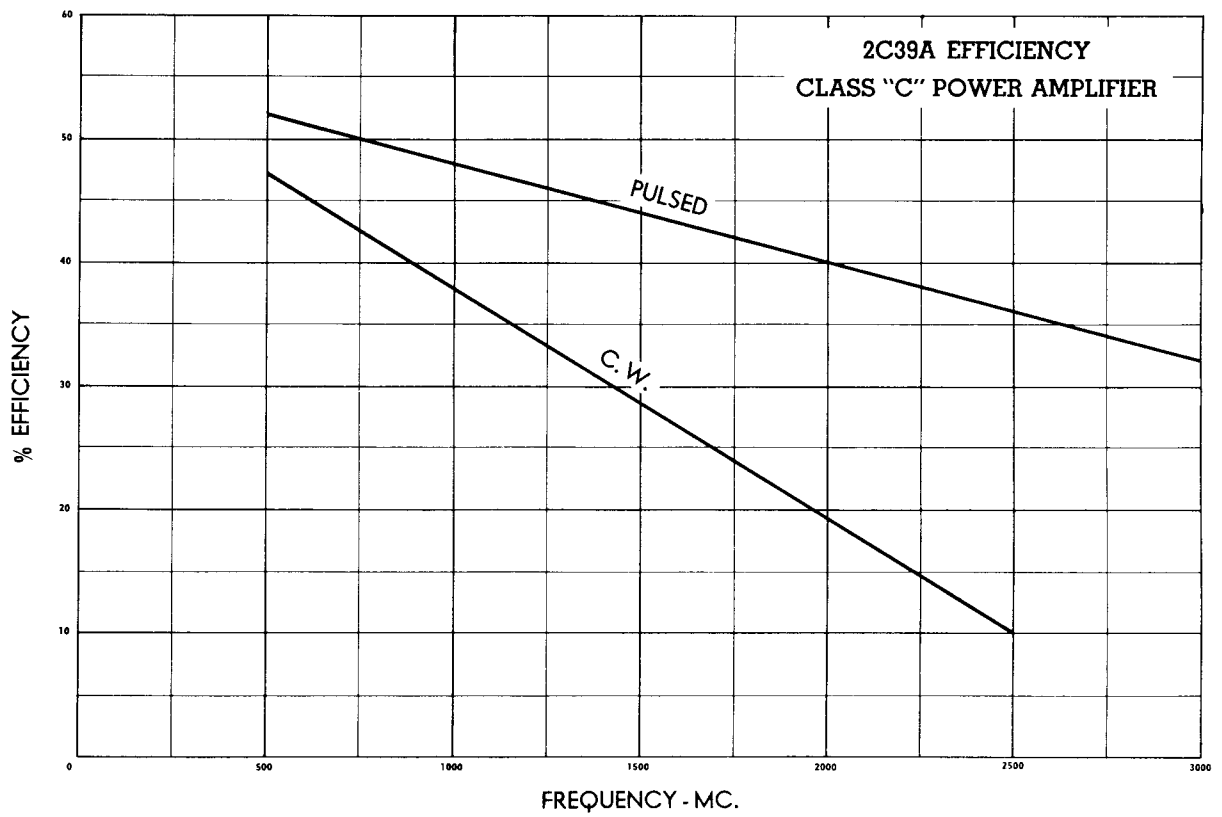
When grid-leak bias is used, suitable means must be provided to protect the tube against loss of excitation at plate voltages above 600 volts and the grid-leak resistor should be made variable to facilitate maintaining the bias voltage and plate current at the desired values when tubes are changed in the equipment.

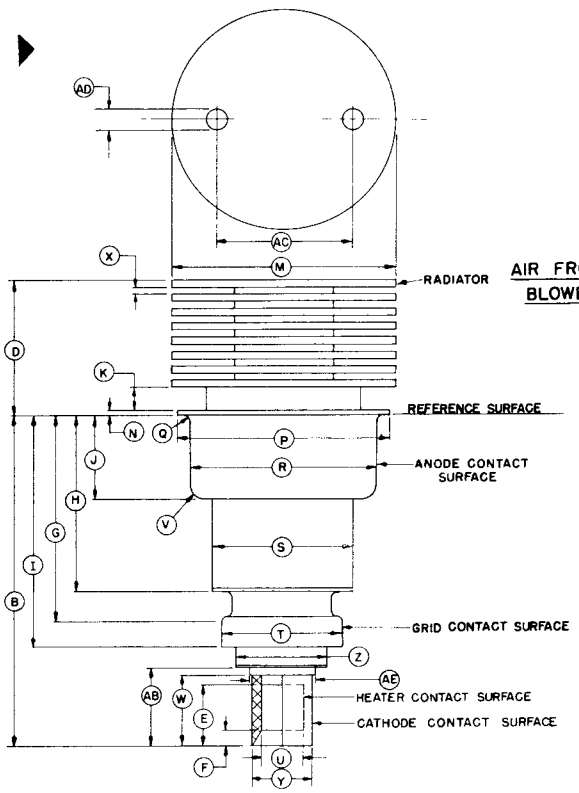
Plate Operation—The maximum rated plate dissipation is 100 watts. In plate-modulated applications, the plate dissipation under carrier conditions must be limited to 70 watts to avoid exceeding the plate-dissipation rating with 100% sine-wave modulation.

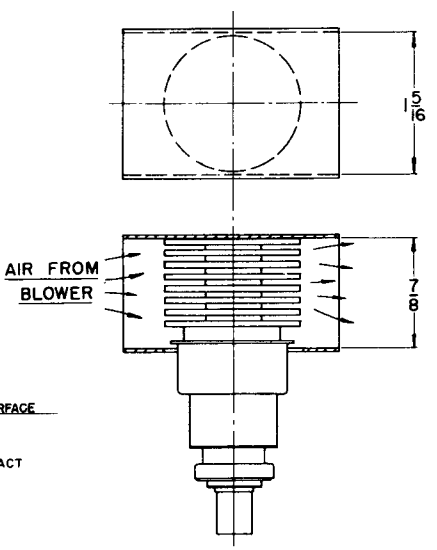
In general, low-voltage high-current operation is preferable to high-voltage low-current operation from the standpoint of optimum life.

An excellent indication of operating conditions is the ratio of grid current to plate current; when the 2C39A is operated with grid-current values greater than half those of the plate current, either the drive is excessive or the plate loading is too light for the excitation present. The tube should never be operated unloaded, even for short periods of time. Drive should be held to the lowest value consistent with reasonable efficiency.

Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to Eitel-McCullough, Inc., San Carlos, California, for information and recommendations.







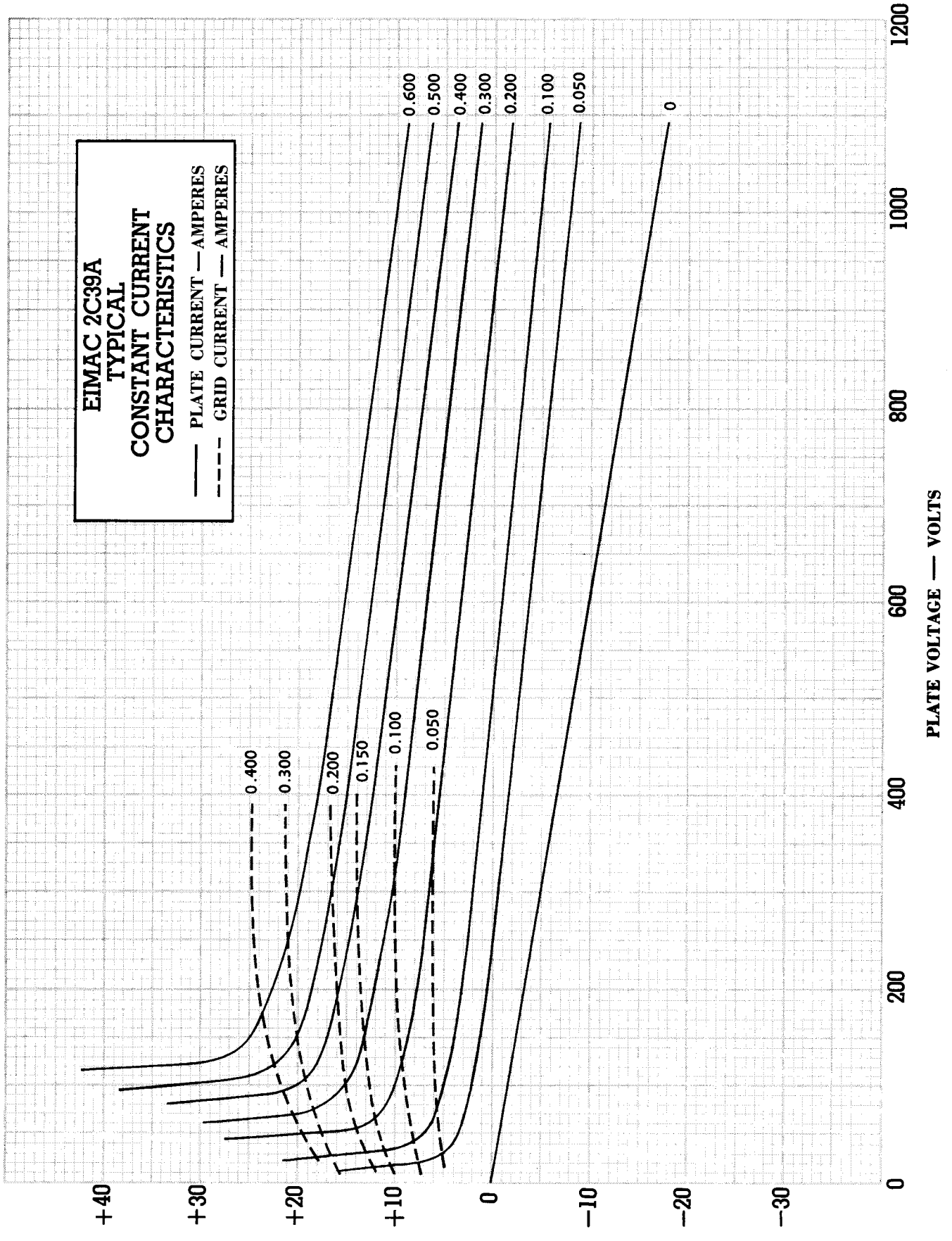
RECOMMENDED COWLING FOR FORCED-AIR COOLING OF ANODE

REF.	NOM.	MIN.	MAX.
B		1.815	1.875
D		.766	.826
E		.341	.401
F		.026	.086
G		1.095	1.135
H		.880	.920
I		1.289	1.329
J		.462	.477
K		.125	.185
M		1.234	1.264
N	.031		
P		1.180	1.195
Q	.031		
R		1.024	1.039
S		.752	.792
T		.653	.668
U		.213	.223
V	.094		
W		.400	.460
X		.016	.046
Y		.313	.328
Z		.455	.470
AB		.420	.480
AC	.750		
AD	.125		
AE		.333	.348

NOTES:

1. The total indicated runout of the anode contact surface and the grid contact surface with respect to the cathode contact surface shall not exceed .020.
2. The total indicated runout of the cathode contact surface with respect to the heater contact surface shall not exceed .012.

▶ Indicates change from sheet dated 1-10-58



Printed in U.S.A. 967

TENTATIVE DATA

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

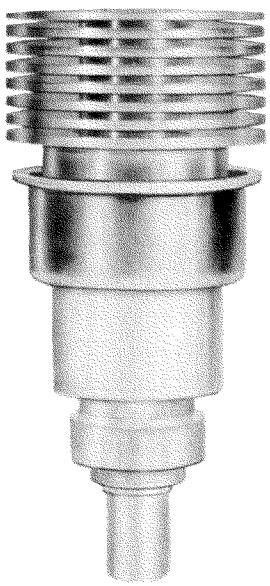
2C39B

HIGH-MU UHF TRIODE

Supersedes Types 2C38, 2C39, 2C39A

The Eimac 2C39B is a ceramic-and-metal UHF transmitting triode with a plate dissipation rating of 100 watts. It is useful as a CW amplifier or oscillator at frequencies up to 2500 mc., and in pulse applications at frequencies up to 3000 mc.

The terminals of the 2C39B are a graduated series of cylindrical surfaces, which fit conveniently into sockets made integral with coaxial circuit elements. The maximum envelope-temperature rating for the 2C39B is 200°C, and the tube is cooled by forced air. The 2C39B is the unilateral replacement for the 2C39A.



GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Oxide-Coated, Unipotential	
Heater Voltage	6.3 volts
Heater Current	1.025 amperes
Heating Time	60 seconds
Amplification Factor	100
Transconductance (Plate Current 70ma.)	25,000 μmhos
Direct Interelectrode Capacitances, (average)	
Grid - Plate	2.01 μμfds
Grid - Cathode	6.60 μμfds
Plate-Cathode	0.035 μμfds
Highest Frequency for Maximum Ratings	2500 mc.

MECHANICAL

Terminal Location	See Outline Drawing
Mounting Position	Any
Cooling	Forced Air
Maximum Envelope Temperature	CORRECTION: MAXIMUM ENVELOPE TEMPERATURE = 250°C. 200°C.
Maximum Over-all Dimensions:	
Length	2 3/4 inches
Diameter	1 17/64 inches
Net Weight	2.5 ounces
Shipping Weight (Approximately)	7 ounces

RADIO-FREQUENCY POWER AMPLIFIER, OSCILLATOR OR MODULATOR

MAXIMUM RATINGS (Per tube)

D-C PLATE VOLTAGE	1000 MAX. VOLTS
D-C CATHODE CURRENT	125 MAX. MA
D-C GRID VOLTAGE	—150 MAX. VOLTS
D-C GRID CURRENT	50 MAX. MA
HEATER VOLTAGE	SEE APPLICATION NOTES
INSTANTANEOUS PEAK POSITIVE GRID VOLTAGE	30 MAX. VOLTS
INSTANTANEOUS PEAK NEGATIVE GRID VOLTAGE	400 MAX. VOLTS
PLATE DISSIPATION	100 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Key-down conditions, per tube)
(Power-Amplifier Grid-Isolation Circuit, CW Operation, 500 Mc.)

D-C Plate Voltage	800 volts
D-C Grid Voltage	—20 volts
D-C Plate Current	80 ma
D-C Grid Current	32 ma
Driving Power (approx.)[1]	6 watts
Useful Power Output	27 watts

TYPICAL OPERATION
(R-F Oscillator, 2500 Mc.)[2]

D-C Plate Voltage	900 volts
D-C Grid Voltage	—22 volts
D-C Plate Current	90 ma
D-C Grid Current	27 ma
Useful Power Output	15 watts

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS (Carrier conditions, per tube)

D-C PLATE VOLTAGE[3]	600 MAX. VOLTS
D-C GRID VOLTAGE	—150 MAX. VOLTS
D-C GRID CURRENT	50 MAX. MA
D-C CATHODE CURRENT	100 MAX. MA
PEAK INSTANTANEOUS POSITIVE GRID VOLTAGE	30 MAX. VOLTS
PEAK INSTANTANEOUS NEGATIVE GRID VOLTAGE	400 MAX. VOLTS
PLATE DISSIPATION	70 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION
(Plate-Modulated Radio-Frequency Power Amplifier Grid-Isolation Circuit, 500 Mc., Per Tube)

D-C Plate Voltage	600 volts
D-C Grid Voltage	—16 volts
D-C Plate Current	75 ma
D-C Grid Current	40 ma
Driving Power (approx.)[1]	6 watts
Useful Carrier Power Output	18 watts

[1]Driving power listed is the total power which must be supplied to a practical grid circuit at the frequency shown.

[2]These 2500 Mc. conditions conform to the proposed requirements of the USAF specification for the 2C39B.

[3]For less than 100% modulation, higher d-c plate voltage may be used if the sum of the peak positive modulating voltage and the d-c plate voltage does not exceed 1200 volts.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION," POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.

(Effective 6-1-56)Copyright 1956 by Eitel-McCullough, Inc.

APPLICATION

MECHANICAL

Mounting—The 2C39B may be operated in any position. It should be held firmly in the socket by the contact fingers bearing on the terminal surfaces, and in cases of extremely heavy vibration or shock the tube can be clamped in place. Clamping forces may be applied only to the flange above the anode terminal surface. The under side of this flange should make contact with the stop which controls the vertical position of the tube in the socket. No other surfaces of the tube should be used for vertical reference points, nor should clamping forces be applied to any part of the tube other than the flange referred to above.

Connections—The tube terminal surfaces are in the form of concentric cylinders having graduated diameters, as illustrated on the outline drawing. Spring collets or fingers should be fitted to these cylindrical surfaces to make contact with the anode, grid, cathode and heater terminals. It is important to provide adequate contact area and spring pressure, and to maintain good contact by keeping the contact surfaces free of oxidation and accumulated dirt.

Cooling—The maximum rated temperature of the ceramic-to-metal seals used in the 2C39B is 200°C., and sufficient cooling air must be forced to flow over the envelope surfaces to maintain their temperatures below the maximum rated value.

The anode is cooled by forced air flow through the fins on the anode cooler. When the air cowling illustrated here is used, the air flow required to dissipate 100 watts at sea level, with the air at 25°C, is 12.5 cubic feet per minute.

The only criterion for cooling effectiveness is temperature. Under operating conditions involving less than the rated maximum power dissipation from the anode, reduced air-flow rates are permissible providing the temperatures are maintained below the maximum rating. This also applies when air cowlings, different from that type shown here, are used.

A convenient method of measuring temperature is the use of a temperature-sensitive paint, which melts and changes its appearance permanently above certain specified temperatures. One such product is "Tempilac" sold by the Tempil Corporation, 11 West 25th Street, New York, 10, N. Y.

The air flow-rate should be increased at high altitudes to obtain equivalent cooling. The flow rates in cubic feet per minute at 35,000 feet altitude will usually be double the sea level requirements.

ELECTRICAL

Heater Voltage—The maximum rated heater voltage for the 2C39B is 6.3 volts, which provides adequate cathode emission for applications requiring peak cathode currents in excess of 3.0 amperes.

When the 2C39B is used in applications requiring less than 3.0 amperes peak cathode emission, the heater voltage can be reduced to 5.6 volts, to prolong the life of the tube.

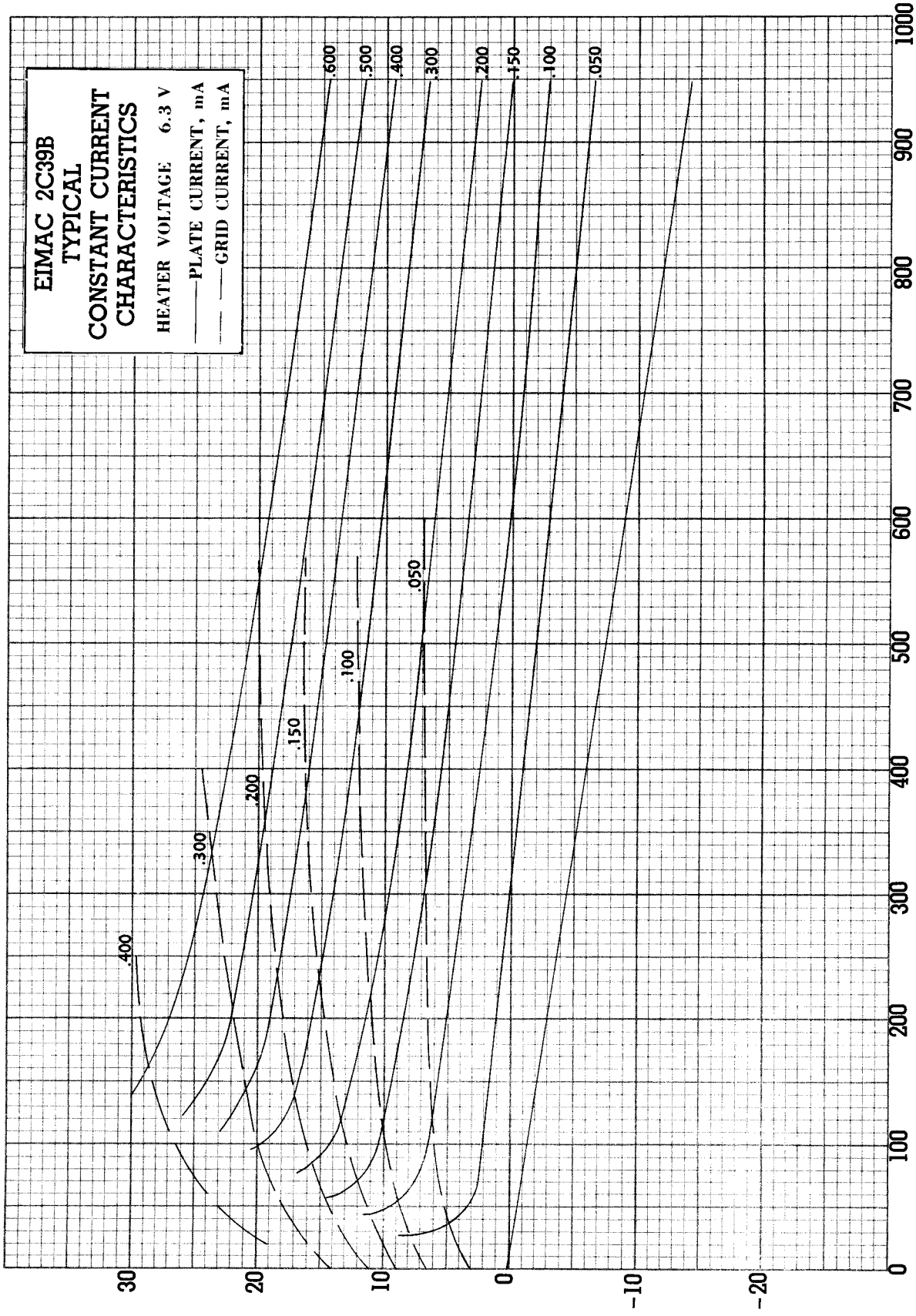
The heater voltage should be maintained within ± 5% of the selected operating voltage to maintain uniform circuit performance. For best tube life the heater voltages must be kept within the range from 5.1 volts to 6.9 volts, except in circuits where transit-time effects occur.

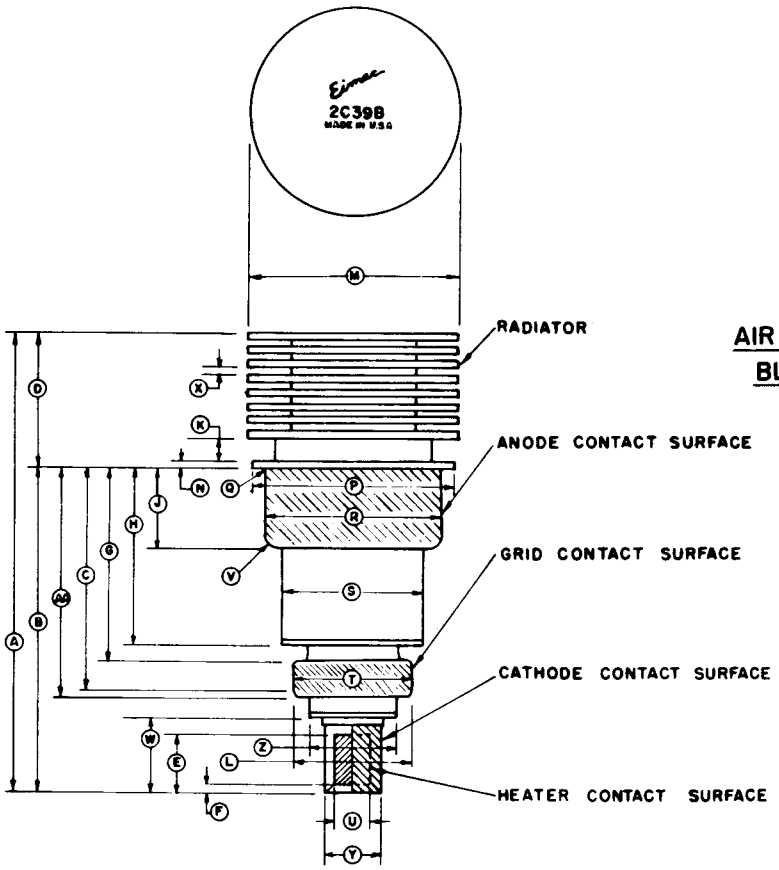
Transit-time effects can result in r-f heating of the cathode when the tube is operated near its upper useful frequency limit, with large driving power. The amount of r-f heating depends on the frequency, driving power, grid current and several other circuit variables whose effects can not be predicted reliably, so no fixed rule can be given by which these effects may be compensated. In each individual case it is necessary to systematically reduce the heater voltage until a point is identified where the circuit performance starts to deteriorate with further heater voltage reduction. The operating voltage should be ten percent greater than that voltage, but not less than 4.5 volts. In cases where the heater voltage is too low to permit immediate circuit operation, the heater voltage may be raised to 6.3 volts until dynamic operation of the circuit starts, after which the heater voltage can be reduced to the selected operating voltage.

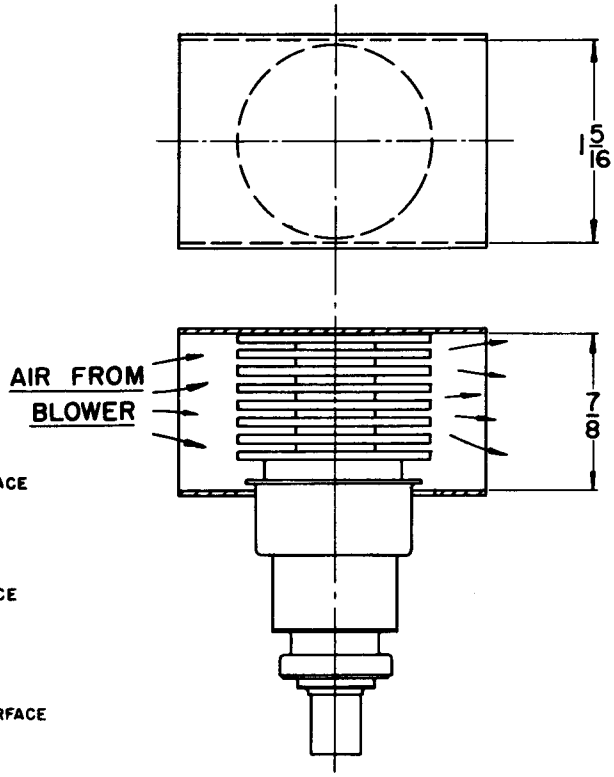
Operation—Longer tube life will be obtained when the tube is operated at low voltage and high current, instead of high voltage and low current. The plate circuit must always be kept adequately loaded and the grid driving power should be kept as low as possible, consistent with satisfactory efficiency.

The ratio of grid current to plate current is a good indicator of circuit conditions. Grid current in excess of half the plate current indicates that the driving power is excessive for the circuit conditions and should be reduced.

Equipment which relies on grid-leak bias to protect the tube should have effective plate-current overload protection when operating at more than 800 volts. Grid-leak resistors should be made variable, to permit adjustment of the bias and the plate current to the correct values under changing circuit conditions.


EIMAC 2C39B
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
HEATER VOLTAGE 6.3 V
——PLATE CURRENT, mA
— — —GRID CURRENT, mA
.600
.500
.400
.300
.200
.150
.100
.050
.400
.300
.200
.150
.100
.050
30
20
10
0
-10
-20
0
100
200
300
400
500
600
700
800
900
1000
GRID VOLTAGE – VOLTS
PLATE VOLTAGE — VOLTS





RECOMMENDED COWLING FOR FORCED-AIR COOLING OF ANODE

NOTES:

1. THE TRUE INDICATED RUNOUT OF THE ANODE CONTACT SURFACE AND THE GRID CONTACT SURFACE WITH RESPECT TO THE CATHODE CONTACT SURFACE SHALL NOT EXCEED .020.
2. THE TRUE INDICATED RUNOUT OF THE CATHODE CONTACT SURFACE WITH RESPECT TO THE HEATER CONTACT SURFACE SHALL NOT EXCEED .012.

	NOM.	MIN.	MAX.
A			2 3/4
B		1.805	1.875
C		1.258	
D		.736	.826
E		.341	
F			.086
G			1.135
H		1.000	
J		.459	.479
K		1/8	
L			.668
M		1 15/64	1 17/64
N	1/32		
P		1.175	1.199
Q			1/32
R		1.021	1.039
S			13/16
T		.652	.668
U		.213	.223
V			3/32
W		.400	
X		1/64	
Y		.312	.328
Z			.515
AA		1.289	1.329

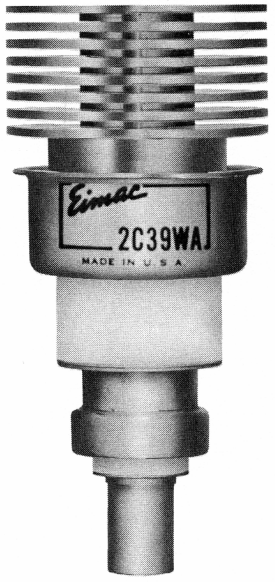
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EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

TENTATIVE DATA

2C39WA

HIGH-MU UHF TRIODE



The Eimac 2C39WA is a planar triode of ceramic and metal construction designed for use as an oscillator, frequency multiplier, or power amplifier in the VHF and UHF ranges and particularly suitable for use in grid-isolation circuits. The Eimac 2C39WA is manufactured and tested to exacting tolerances to insure consistent and uniform tube performance.

CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide-Coated, Unipotential				
Heating Time	-	60		seconds
Heater: Voltage	-	5.8		volts
Current (E_f=5.8v)	0.87		1.03	ampere
Amplification Factor	-	100		
Transconductance (E_f=5.5v, E_b=600v, R_k=30ohms)	18,000		30,000	umhos
Frequency for Maximum Ratings	-	-	2500	mc

Interelectrode Capacitances (In Shielded Fixture):	Min.	Max.	
Grid-Cathode	5.6	7.6	uuf
Grid-Plate	1.86	2.16	uuf
Plate-Cathode		0.035	uuf

MECHANICAL

Terminals	Graduated cylindrical surfaces
Maximum Seal and Anode Core Temperature	200° C
Cooling	Forced air
Operating Position	Any
Maximum Over-All Dimensions:	
Length	2.75 inches
Diameter	1.27 inches
Net Weight	2.5 ounces
Shipping Weight (Approximate)	7 ounces

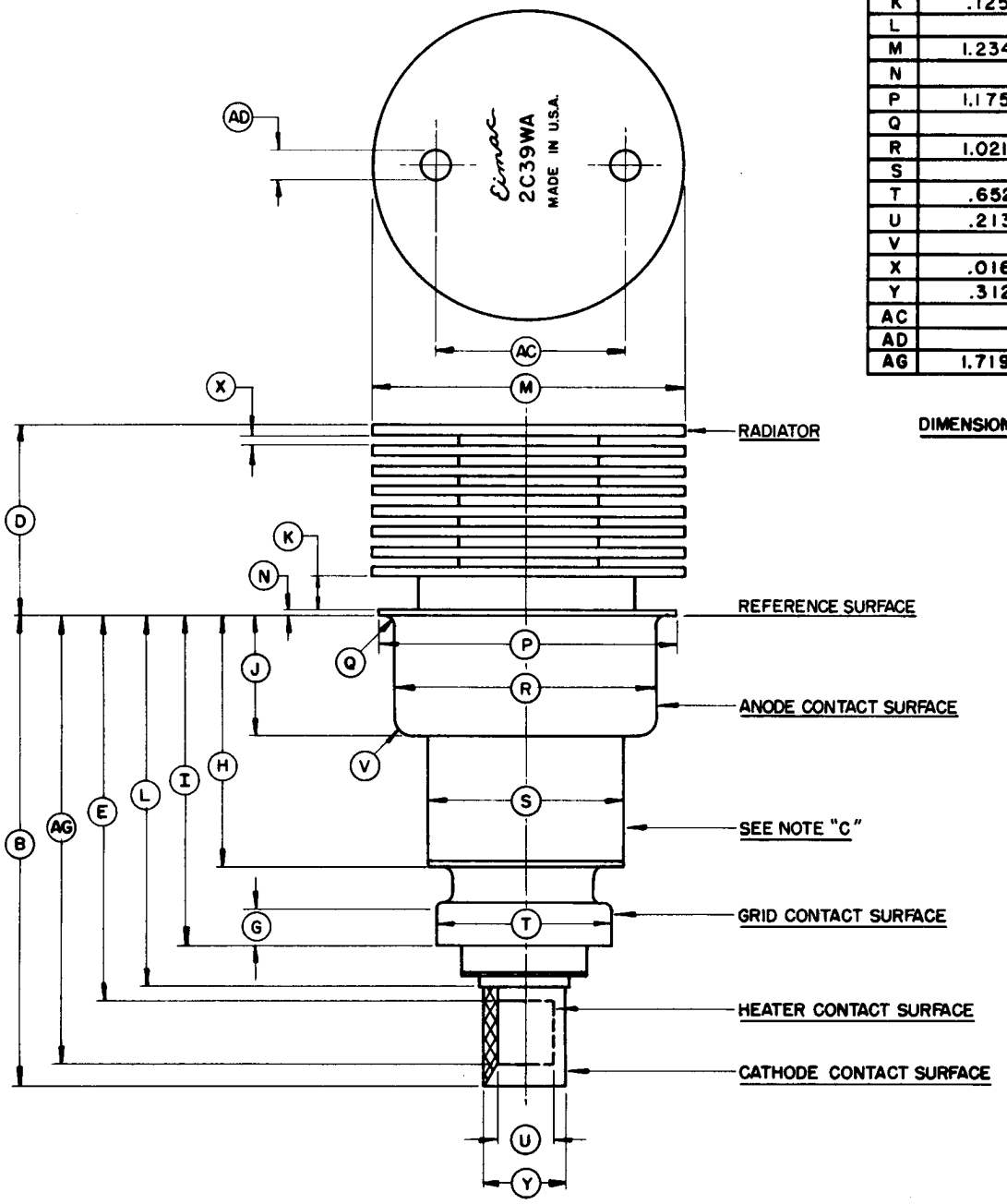
MAXIMUM RATINGS Class-C oscillator, multiplier, or amplifier.

(Carrier or key-down conditions)	(Plate Mod)	(Teleg. or FM)
D-C PLATE VOLTAGE	600	1000 MAX. VOLTS
D-C CATHODE CURRENT	100	125 MAX. MA
D-C GRID VOLTAGE	-150	-150 MAX. VOLTS
D-C GRID CURRENT	50	50 MAX. MA
INSTANTANEOUS PEAK POSITIVE GRID VOLTAGE	30	30 MAX. VOLTS
INSTANTANEOUS PEAK NEGATIVE GRID VOLTAGE	400	400 MAX. VOLTS
PLATE DISSIPATION (WITH 12.5 CFM AIR FLOW)	70	100 MAX. WATTS
GRID DISSIPATION	2	2 MAX. WATTS

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DIMENSION DATA		
REF.	MIN.	MAX.
B	1.805	1.875
D	.736	.826
E		1.534
G	.140	
H		1.000
I	1.289	1.329
J	.459	.479
K	.125	
L		1.475
M	1.234	1.266
N	.031	
P	1.175	1.199
Q	.031	
R	1.021	1.039
S		.813
T	.652	.668
U	.213	.223
V		.094
X	.016	
Y	.312	.328
AC	.750	
AD	.125	
AG	1.719	

DIMENSIONS IN INCHES

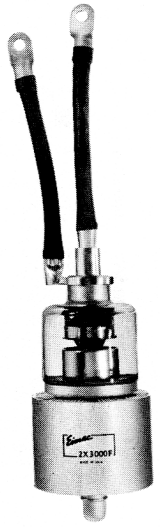


Printed in U.S.A. 43917

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

2X3000F

HIGH-VACUUM RECTIFIER



The Eimac 2X3000F is a high-vacuum, forced-air cooled, external-anode diode intended for use in high-power rectifier units whenever high peak-inverse voltages, extreme ambient temperatures, high operating frequency, or the production of high-frequency transients would prevent the use of mercury-vapor or gas-filled rectifier tubes.

CHARACTERISTICS

ELECTRICAL

Filament:	Thoriated Tungsten	
	Voltage	7.5 volts
	Current	51 amperes

MECHANICAL

Operating Position	Vertical, base down or up
Maximum Operating Temperatures:	
Glass-to-Metal Seals	175° C
Anode Core	175° C
Net Weight	5.7 pounds
Shipping Weight (Approximate)	17 pounds

MAXIMUM RATINGS

PEAK INVERSE PLATE VOLTAGE	25,000 MAX. VOLTS
PLATE DISSIPATION	3,000 MAX. WATTS
DC PLATE CURRENT	3 MAX. AMPERES
PEAK PLATE CURRENT	20 MAX. AMPERES

TYPICAL POWER-SUPPLY CAPABILITIES*

Circuit	Maximum AC Input Voltage (volts rms)	Approx. DC Output Voltage (volts)	Maximum DC Output Current (amps)
Single-Phase, Full-Wave (2 tubes)	17,700 total	8,000	6.0
Single-Phase, Bridge (4 tubes)	17,700 total	16,000	6.0
Three-Phase, Full-Wave (6 tubes)	10,200 per leg	24,000	9.0

*Choke-input filter with L equal to or greater than twice "critical"; zero circuit loss assumed.

COOLING

Sufficient forced air cooling must be provided to maintain seal and anode core temperature at 175°C or below. Air-flow must be started when filament power is applied and it is advisable to continue air-cooling for two minutes after all voltages are removed.

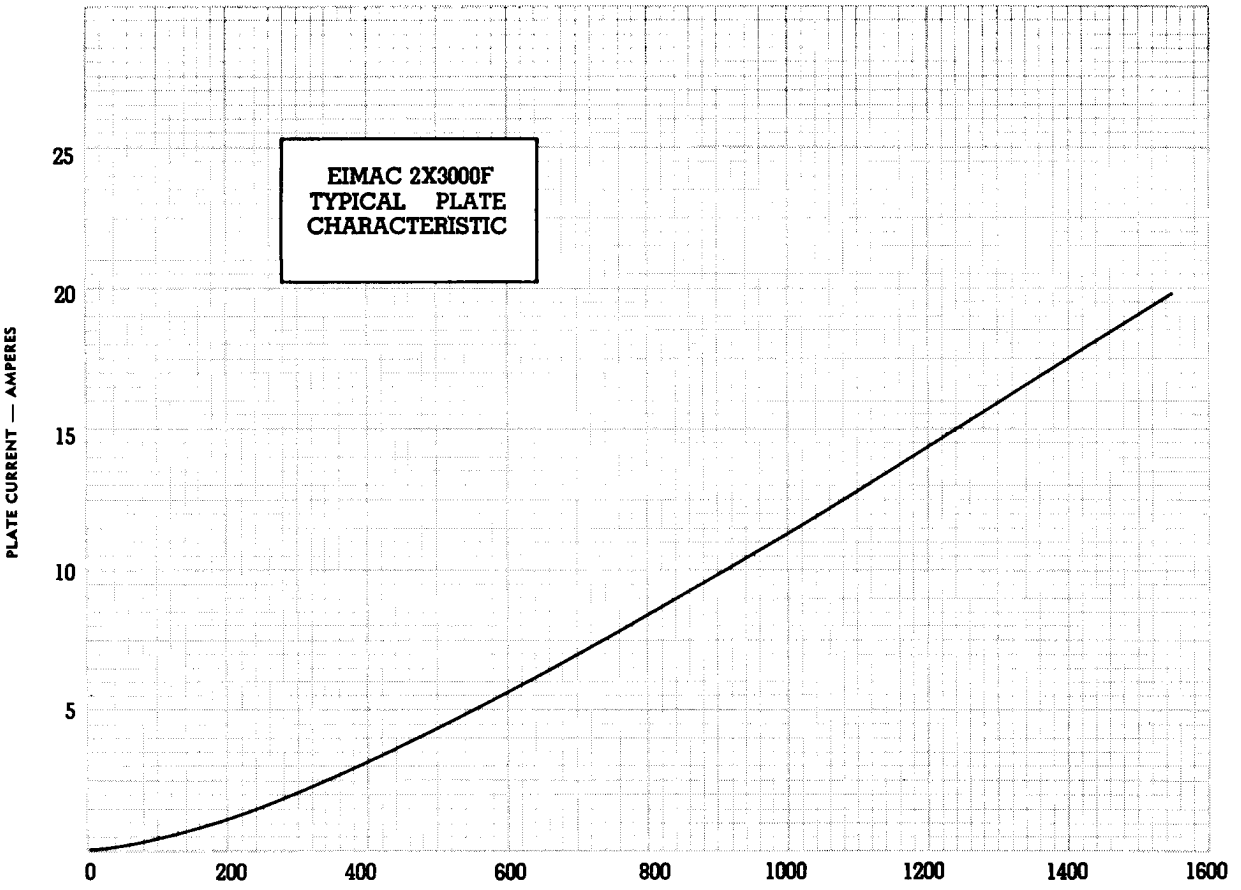
The table below lists minimum air-flow requirements to maintain tube temperatures below 175°C with air flowing in both the base-to-anode and anode-to-base directions. This tabulation presumes air at 40°C and sea level. A separate supply of approximately six cubic feet per minute, directed into the filament structure is also required to maintain rated filament seal temperatures. This is best accomplished using a small diameter insulating tubing directed into the stem, between the filament seals.

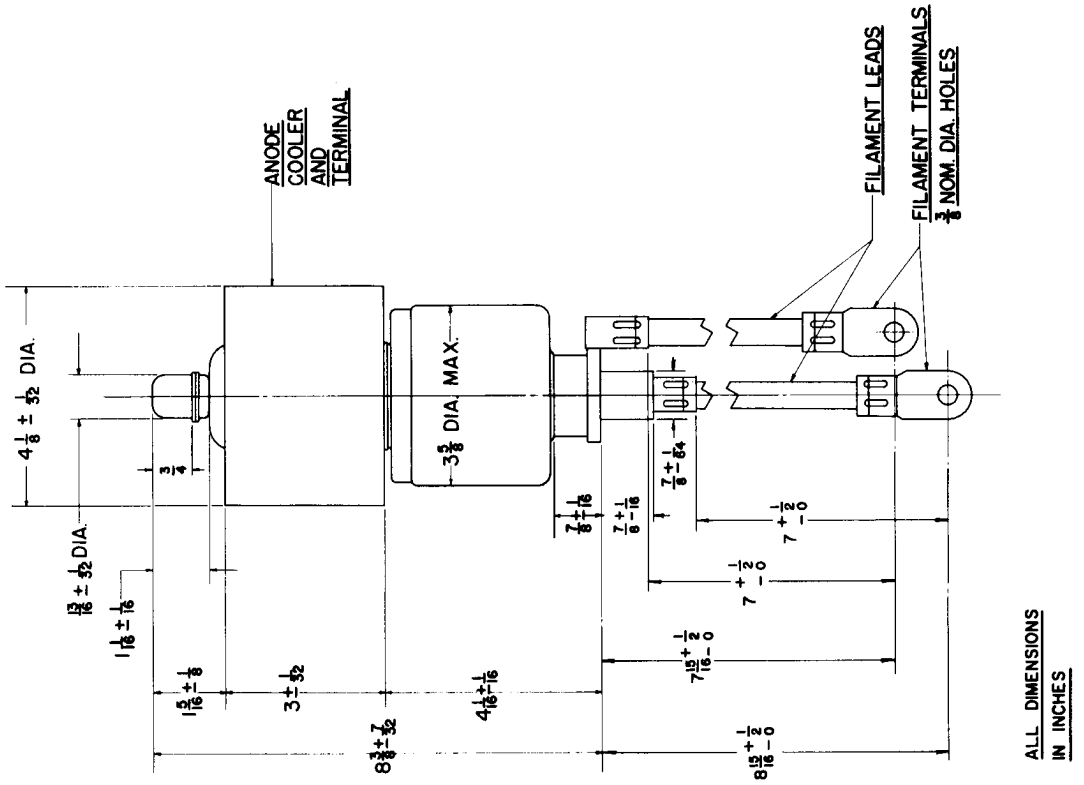
	MINIMUM COOLING AIR-FLOW REQUIREMENTS			
	BASE-TO-ANODE FLOW		ANODE-TO-BASE FLOW	
Plate Dissipation (Watts)	AIR-FLOW (CFM)	PRESSURE DROP (inches of water)	AIR-FLOW (CFM)	PRESSURE DROP (inches of water)
1000	15	0.1	25	0.2
2000	45	0.4	75	1.2
3000	95	1.4	155	4.5

Note: An extra 375 watts have been added to these plate dissipation figures in preparing this tabulation, to compensate for filament dissipation.

For operation at high altitudes or higher ambient temperatures, these quantities should be increased. In all cases it is suggested that actual temperatures be measured to insure adequate cooling.

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EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

3C24

MEDIUM-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER

The Eimac 3C24 is a medium-mu, power triode intended for use as an amplifier, oscillator or modulator. It has a maximum plate dissipation rating of 25 watts and can be operated at its maximum ratings at frequencies up to 60 megacycles.

The 3C24 is cooled by radiation from the plate and by air circulation around the envelope. The plate operates at a visible red color at maximum rated dissipation.

This tube is identical to the 25T except that the grid terminal is located at the side of the envelope instead of the base.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	6.3 volts
Current	3.0 amperes
Amplification Factor (Average)	24
Direct Interelectrode Capacitances (Average)	
Grid-Plate	1.6 $\mu\mu$f
Grid-Filament	1.7 $\mu\mu$f
Plate-Filament	0.2 $\mu\mu$f
Transconductance (i_b=25 ma., E_b=1000 v.)	2500 μmhos
Frequency for Maximum Ratings	60 Mc.

MECHANICAL

Base	UX Small 4-pin
Basing - Fits E. F. Johnson Co. No. 122-224, National Co. No. XC-4 or CIR-4, or equivalent socket	
Mounting	Vertical, base down or up
Cooling	Convection and Radiation
Recommended Heat Dissipating Connector:	
Plate	HR-1
Grid	HR-1
Maximum Over-all Dimensions:	
Length	4.38 inches
Diameter	1.44 inches
Net Weight	1.5 ounces
Shipping Weight (Average)	1.0 pound

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-B and AB

MAXIMUM RATINGS, PER TUBE

D-C PLATE VOLTAGE	2000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT	75 MAX. MA.
PLATE DISSIPATION	25 MAX. WATTS
GRID DISSIPATION	7 MAX. WATTS

TYPICAL OPERATION, CLASS AB_2
Sinusoidal wave, two tubes unless otherwise specified

D-C Plate Voltage	750	1000	1250	Volts
D-C Grid Voltage (approx.)*	—20	—30	—42	Volts
Zero-Signal D-C Plate Current	43	32	24	Ma.
Max-Signal D-C Plate Current	127	127	130	Ma.
Effective Load, Plate-to-Plate	12,000	17,000	21,400	Ohms
Peak A-F Grid Input Voltage (per tube)	110	120	135	Volts
Max-Signal Peak Driving Power	5.5	6.0	6.8	Watts
Max-Signal Nominal Driving Power (approx.)	2.8	3.0	3.4	Watts
Max-Signal Plate Power Output	60	85	112	Watts

*Adjust to give stated zero-signal plate current.

PLATE MODULATED RADIO FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	1600 MAX. VOLTS
D-C PLATE CURRENT	60 MAX. MA.
PLATE DISSIPATION	17 MAX. WATTS
GRID DISSIPATION	7 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	1000	1250	1600	Volts
D-C Plate Current	60	60	53	Ma.
D-C Grid Voltage	—120	—140	—170	Volts
D-C Grid Current	14	13	11	Ma.
Peak R-F Grid Input Voltage	235	255	280	Volts
Driving Power	3.3	3.3	3.1	Watts
Grid Dissipation	1.6	1.5	1.2	Watts
Plate Power Input	60	75	85	Watts
Plate Dissipation	13	15	17	Watts
Plate Power Output	47	60	68	Watts

The above figures show actual measured tube performance and do not allow for variations in circuit losses.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C PLATE CURRENT	75 MAX. MA.
PLATE DISSIPATION	25 MAX. WATTS
GRID DISSIPATION	7 MAX. WATTS

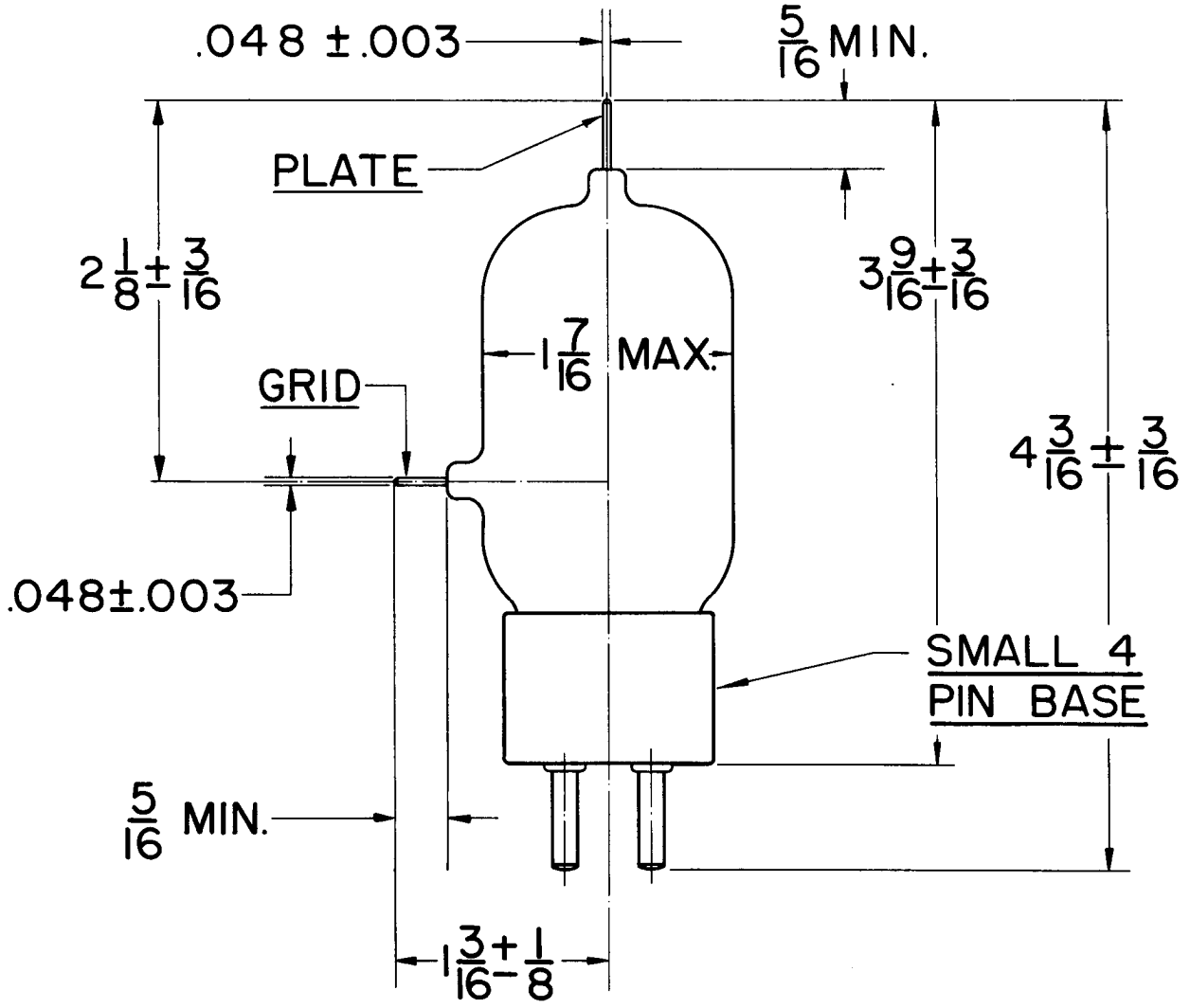
TYPICAL OPERATION

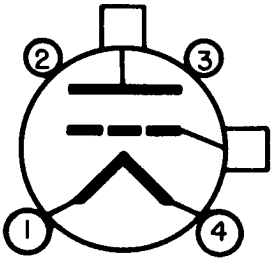
D-C Plate Voltage	1000	1500	2000	Volts
D-C Plate Current	72	67	63	Ma.
D-C Grid Voltage	—70	—95	—130	Volts
D-C Grid Current	9	13	18	Ma.
Peak R-F Grid Input Voltage	170	195	245	Volts
Driving Power	1.3	2.2	4.0	Watts
Grid Dissipation	.9	1.3	2.1	Watts
Plate Power Input	72	100	125	Watts
Plate Dissipation	25	25	25	Watts
Plate Power Output	47	75	100	Watts

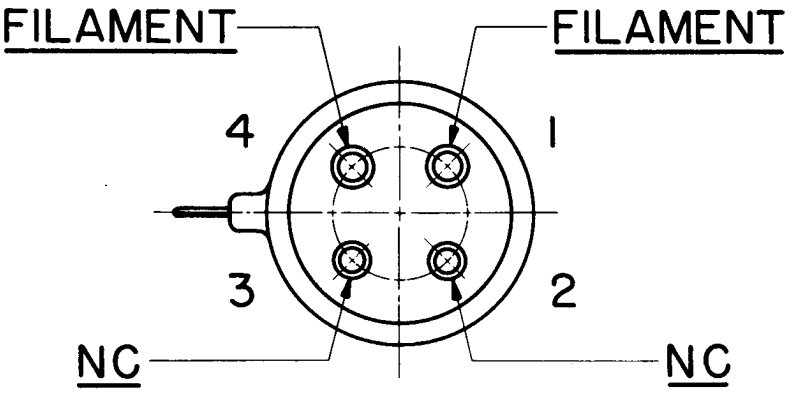
The above figures show actual measured tube performance and do not allow for variations in circuit losses.

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.048 ±.003
5/16 MIN.
PLATE
2 1/8 ± 3/16
3 9/16 ± 3/16
1 7/16 MAX.
GRID
4 3/16 ± 3/16
.048±.003
SMALL 4
PIN BASE
5/16 MIN.
1 3/16 − 1/8


2
3
1
4


FILAMENT
FILAMENT
4
1
3
2
NC
NC

BOTTOM VIEW

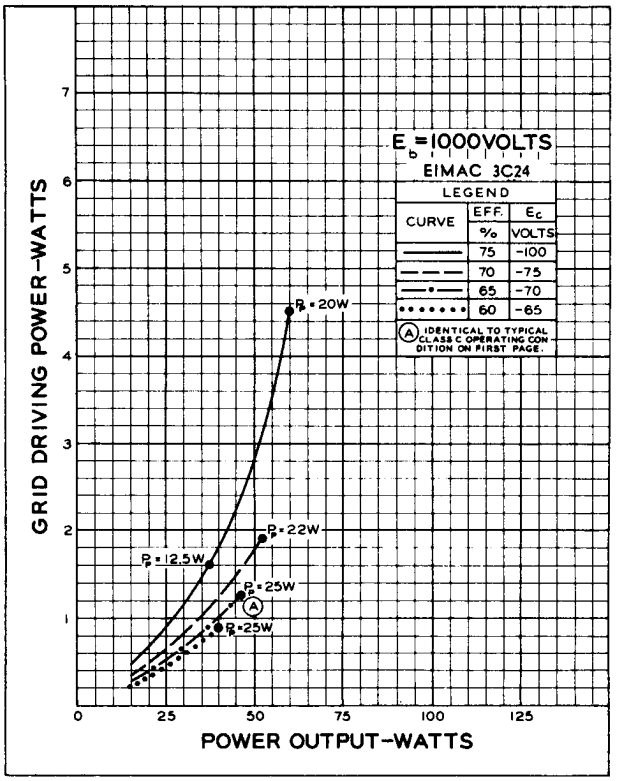
DRIVING POWER vs. POWER OUTPUT

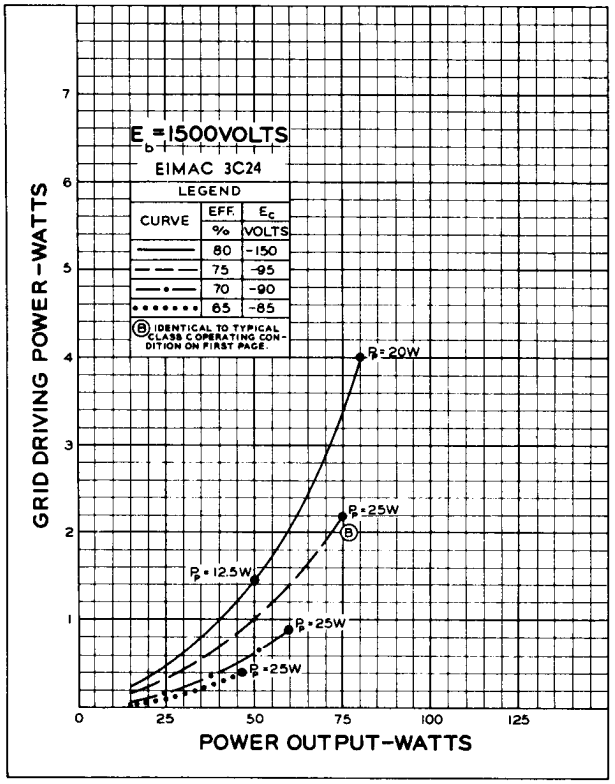
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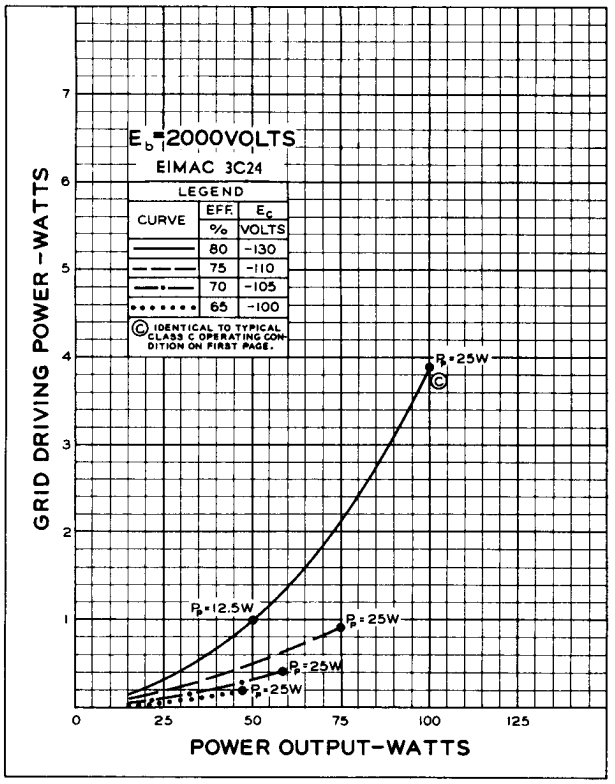
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

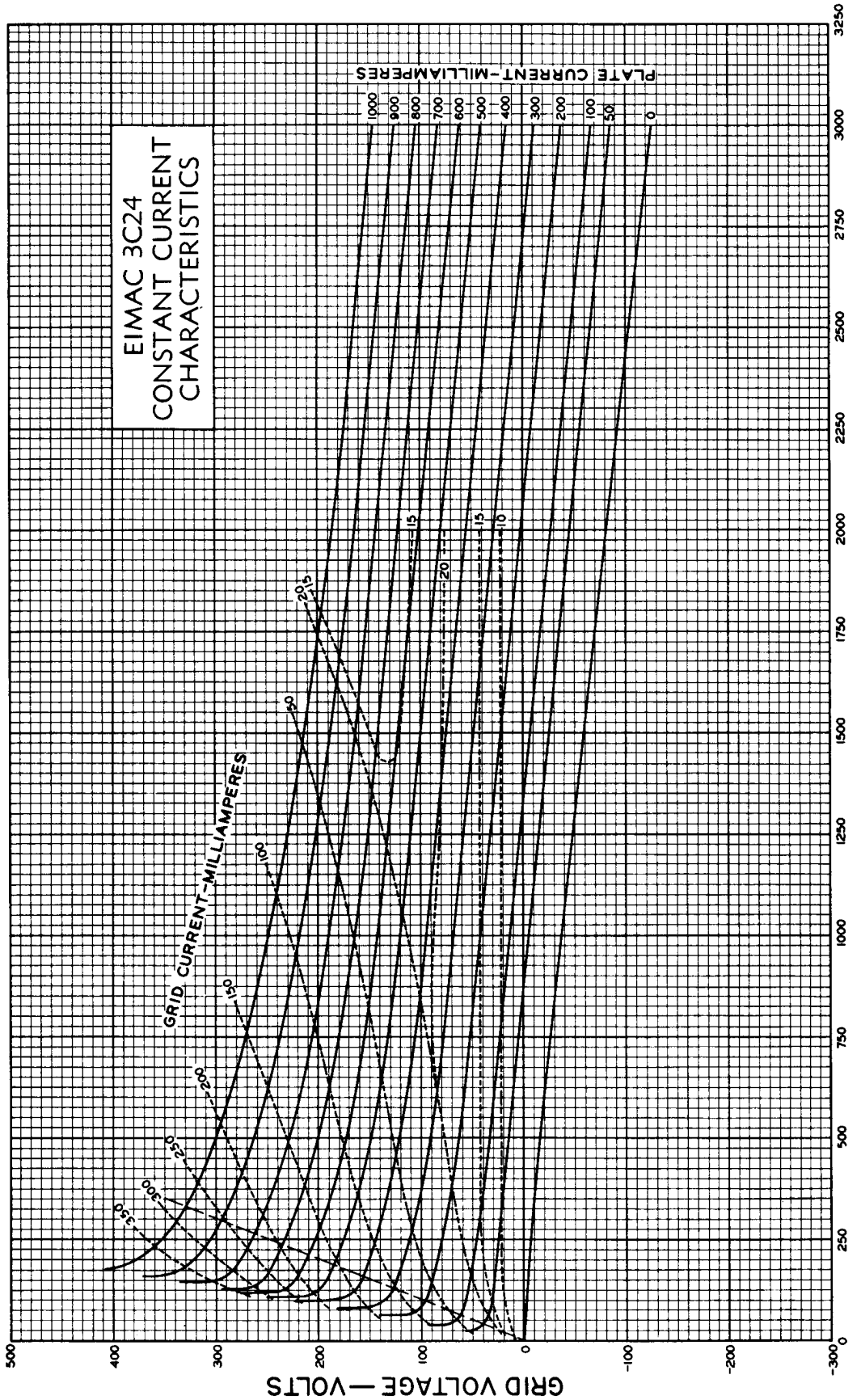
Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.

•








EIMAC 3C24
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT-MILLIAMPERES
1000
900
800
700
600
500
400
300
200
100
50
0
GRID CURRENT-MILLIAMPERES
25
20
15
10
5
2.5
GRID VOLTAGE — VOLTS
500
400
300
200
100
0
-100
-200
-300
PLATE VOLTAGE — VOLTS
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
3250

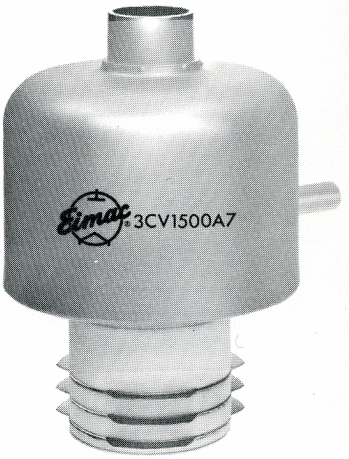
3CV1500A7

TECHNICAL DATA

HIGH-MU
POWER TRIODE

The 3CV1500A7 is an integral-boiler, ceramic/metal, vapor cooled zero-bias triode, intended for Class AB2 linear amplifier service in either grid driven or cathode driven configuration. Except for the anode dissipation rating, the 3CV1500A7 is electrically identical to the EIMAC 8283/3CX-1000A7.

The 3CV1500A7 is especially recommended when the ambient noise level must be reduced to a minimum, since high-pressure/high-volume forced-air cooling is not required.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten Mesh		
Voltage	5.0 ± 0.25	V
Current, at 5.0 volts	30	A
Amplification Factor (average)	200	
Direct Interelectrode Capacitances (grounded filament) [2]		
Cin	32.0	pF
Cout	0.15	pF
Cgp	14.0	pF
Direct Interelectrode Capacitances (grounded grid) [2]		
Cin	32.0	pF
Cout	14.0	pF
Cpk	0.15	pF
Frequency of Maximum Rating:		
CW	220	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as a result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube, as measured in a shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	5.110 in; 129.8 mm
Diameter	3.355 in; 85.2 mm
Net Weight	2.38 lb; 1.08 kg
Operating Position	Vertical, base down
Maximum Operating Temperature:	
Ceramic/metal seals	250°C
Cooling	Vapor and Forced Air
Base	Special Breechlock
Recommended Socket	EIMAC SK-861

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RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN Class AB_2

MAXIMUM RATINGS:

DC PLATE VOLTAGE	3500	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
GRID DISSIPATION	45	WATTS

1. Adjust to specified zero-signal dc plate current.
2. The intermodulation distortion products are referenced against one tone of a two equal tone signal.
3. Approximate values.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB2 Peak Envelope or Modulation Crest Conditions

Plate Voltage	2000	2500	3500	Vdc
Grid Voltage[1]	0	0	-12	Vdc
Zero-Signal Plate Current	238	305	129	mAdc
Single Tone Plate Current	875	800	857	mAdc
Two-Tone Plate Current	600	585	590	mAdc
Single-Tone Grid Current[3]	230	205	225	mAdc
Two-Tone Grid Current[3]	130	120	120	mAdc
Peak rf Drive Voltage[3]	80	74	110	v
Peak Driving Power	80	60	100	w
Plate Dissipation	800	830	940	W
Useful Output Power	940	1170	2060	W
Resonant Load Impedance	1100	1670	2300	Ω
Intermodulation Distortion Products[2]				
3rd Order	-29	-31	-31	db
5th Order	-37	-40	-39	db

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB_2, Grid Driven(Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE[1]	3500	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
GRID DISSIPATION	45	WATTS

1. See zero-bias operation in Application Section.
2. Approximate value.
3. Per Tube.
4. Nominal drive power is one-half peak power.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	2000	2500	Vdc
Grid Voltage	0	0	Vdc
Zero-Signal Plate Current	400	500	mAdc
Max. Signal Plate Current	2.0	2.0	Adc
Max. Signal Grid Current[2]	590	480	mAdc
Peak af Grid Voltage[3]	95	90	v
Peak Driving Power[4]	25	44	w
Plate Input Power	4000	5000	W
Max. Signal Plate Dissipation	1650	1900	W
Plate Output Power	2350	3100	W
Load Resistance (plate to plate)	1900	2580	Ω

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 5.0 volts	28.0	33.0	A
Cathode Warmup Time	5	---	sec.
Interelectrode Capacitance[1] (grounded grid connection)			
Cin	29.0	35.0	pF
Cout	12.0	16.0	pF
Cpk	---	0.2	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 3CV1500A7 must be mounted with its axis vertical, base down, with sufficient clearance for an insulated makeup water line to connect to the side of the integral anode boiler and an outlet steam line to attach to the top of the boiler. The use of the EIMAC socket SK-861 is recommended.

COOLING - Cooling is accomplished by the presence of distilled water at a controlled level in the integral anode boiler. The energy dissipated by the anode causes the water to boil at the anode surface, to be converted into steam and carried away to a condenser. This boiling action keeps the anode surface at approximately 100°C.

The water in the boiler must be maintained at the correct level, as shown on the outline drawing for the tube. This is normally accomplished with a special control unit, mounted with the correct relationship to the tube so as to maintain the water level in the tube boiler at the specified level. A condenser unit is used to convert the steam back to water, which is then returned to reservoir/control-box/boiler system.

Forced-air cooling of the tube base is required, with 15 cfm minimum directed across and through the socket and base of the tube. Air flow should be applied simultaneously with the application of electrode voltages, including the filament, and may be removed simultaneously with the removal of filament voltage.

ELECTRICAL

FILAMENT - Rated filament voltage for the 3CV1500A7 is 5.0 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain optimum performance and maximum tube life. In no case should it be allowed to deviate from 5.0 volts by more than plus or minus five per cent.

INPUT CIRCUIT - When the 3CV1500A7 is operated as grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended to obtain greatest linearity and power output. For best results with a single-ended amplifier, it is suggested that the cathode tank circuit operate at a "Q" of five or more.

CLASS-C OPERATION - Although designed for Class-AB2 service, the 3CV1500A7 may be operated as a Class-C power amplifier or oscillator, or as a plate-modulated rf amplifier. The zero-bias characteristic can be used to advantage in Class-C amplifiers by employing only grid leak bias. If driving power fails, plate dissipation is kept to a low level since the tube will operate at normal, static zero-bias conditions.

ZERO-BIAS OPERATION - Operating at zero-bias is not recommended with plate voltages over 2500 volts since plate dissipation may be exceeded. Similarly, the safety of zero-bias operation as mentioned above under "Class-C Operation" is not available at plate voltages above 2500 volts. Straight Class-C or Class-AB2 operation is, of course, permissible up to 3500 volts where other ratings are not exceeded. Higher plate voltage may be used with the proper bias.

PLATE DISSIPATION - The plate dissipation of 1500 watts attainable through vapor cooling provides a large margin of safety in most applications. The rating may be exceeded during tuning for brief periods.

Since the tube anode is usually at high potential to ground, water and steam connections to the anode are made through insulating tubing. These insulating sections should be long enough so that column resistance is above 100,000 ohms per 1000 supply volts. It is essential that high purity water be used to minimize power loss and corrosion of metal fittings. Good distilled or deionized water will have a resistance of 1 to 2 megohms per cm3. Water should be discarded if resistivity falls to 50,000 ohms cm3.

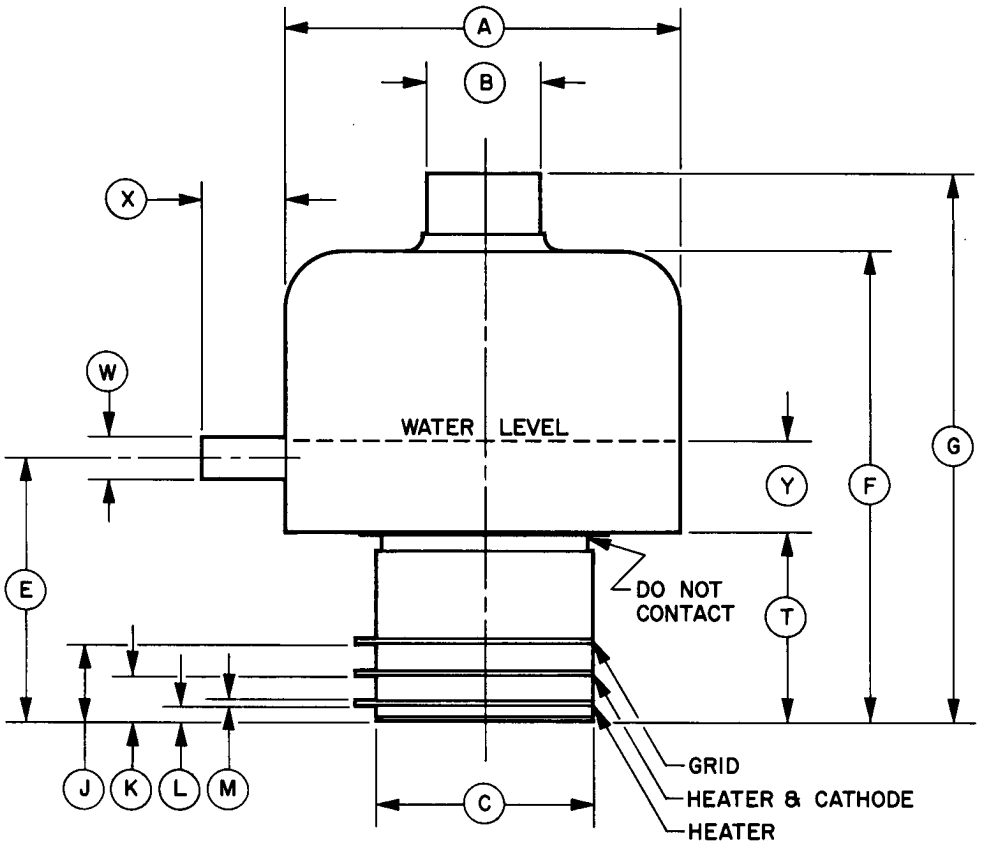
HIGH VOLTAGE - Normal operating voltages used with the 3CV1500A7 are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

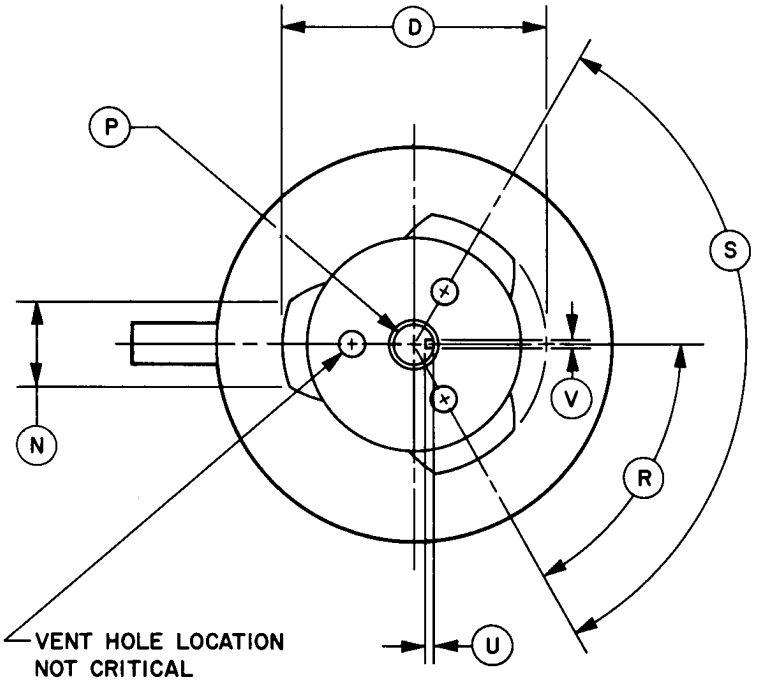
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

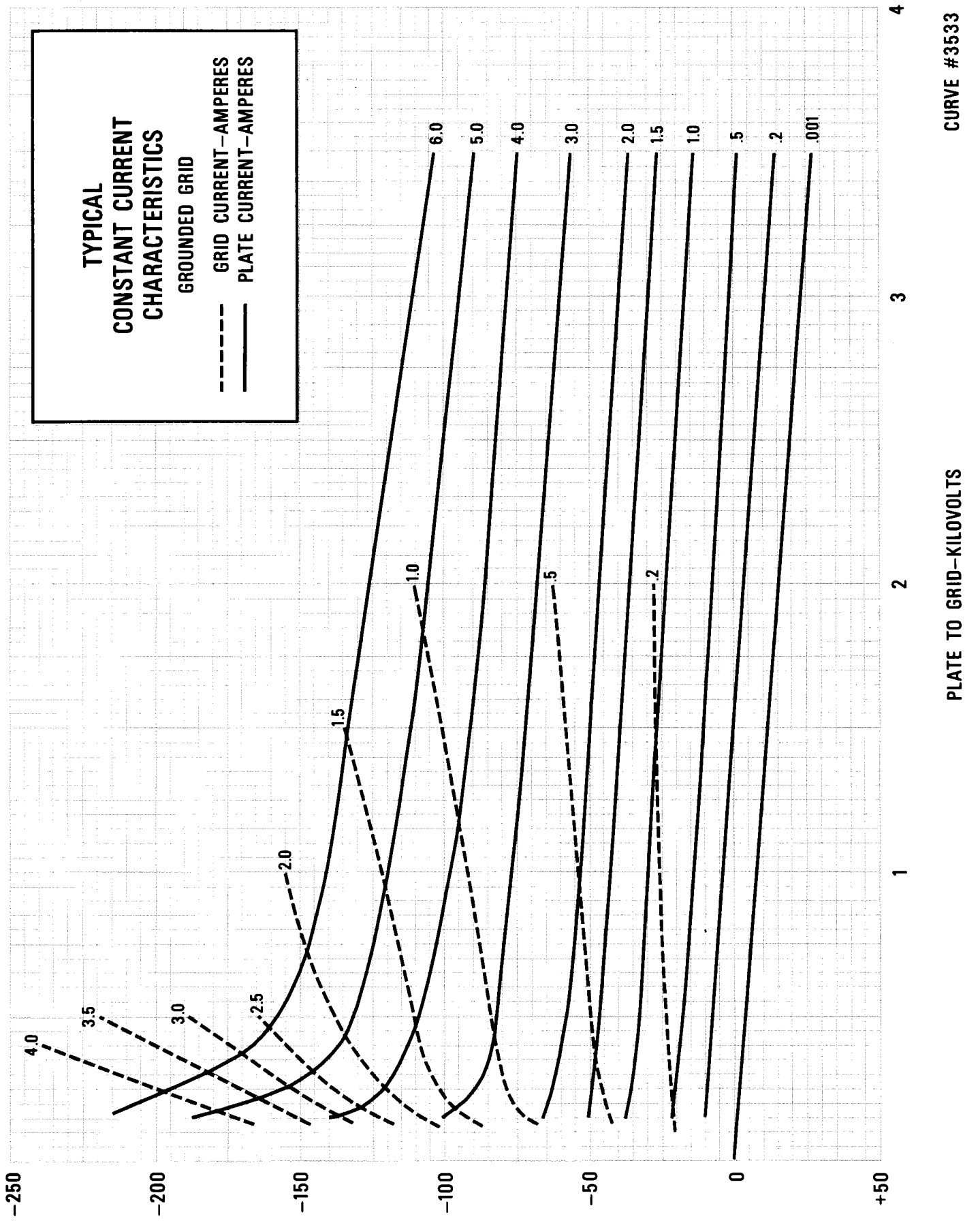




DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	--	--	3.355	--	--	85.22
B	--	--	1.000	--	--	25.40
C	1.870	1.900	--	47.50	48.26	--
D	2.250	2.300	--	57.15	58.42	--
E	--	--	2.400	--	--	60.96
F	4.190	4.315	--	106.43	109.60	--
G	4.850	5.110	--	123.19	129.79	--
J	0.690	0.710	--	17.53	18.03	--
K	0.415	0.435	--	10.54	11.05	--
L	0.140	0.165	--	3.57	4.19	--
M	0.020	0.030	--	0.50	0.76	--
N	0.700	0.800	--	17.78	20.32	--
P	0.314	0.316	--	7.98	8.03	--
R	55°	65°	--	55°	65°	--
S	115°	125°	--	115°	125°	--
T	--	--	1.720	--	--	43.69
U	0.025	0.048	--	0.64	1.22	--
V	0.045	0.070	--	1.14	1.78	--
W	--	--	0.375	--	--	9.53
X	--	--	0.750	--	--	19.05
Y	0.500	1.000	--	--	--	--

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
GRID CURRENT–AMPERES
PLATE CURRENT–AMPERES
CATHODE TO GRID–VOLTS
PLATE TO GRID–KILOVOLTS
CURVE #3533
−250
−200
−150
−100
−50
0
+50
1
2
3
4
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
.2
6.0
5.0
4.0
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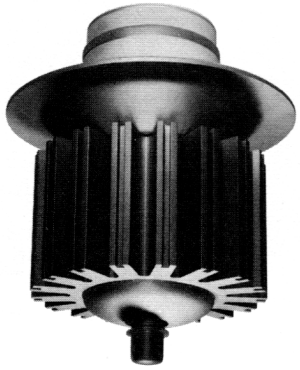
3CV30,000A3

MEDIUM-MU VAPOR-COOLED POWER TRIODE

The EIMAC 3CV30,000A3 is a vapor-cooled, ceramic-metal power triode designed primarily for use in industrial radio-frequency heating service. Its vapor-cooled anode is conservatively rated at 30 kilowatts of plate dissipation when mounted in an EIMAC BR-200 boiler.

Full input of 60 kilowatts is permissible up to 100 megahertz. Large reserve emission is available from its one kilowatt filament and the grid structure is rated at one ampere making this tube an excellent choice for severe applications.

It is also recommended as a grounded grid FM amplifier, a conventional plate-modulated amplifier or as a linear amplifier in new equipment designs.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated-Tungsten				
Voltage		6.3		volts
Current	152		172	amperes
Amplification Factor		20		
Interelectrode Capacitances, Grounded Cathode:				
Grid-Filament	48		58	pF
Plate-Filament	1.2		1.5	pF
Grid-Plate	30		38	pF
Frequency for Maximum Ratings				100 MHz

MECHANICAL

Base	Coaxial
Recommended Socket	EIMAC SK-1310
Recommended Boiler	EIMAC BR-200
Operating Position	Vertical, base up
Cooling	Vapor and Forced air
Maximum Operating Temperatures:	
Anode Flange	200°C
Ceramic-to-metal Seals	250°C
Maximum Dimensions:	
Height	8.75 inches
Diameter	7.5 inches
Net Weight	18 pounds

RF INDUSTRIAL OSCILLATOR

Class-C (Filtered DC Power Supply)

MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC PLATE CURRENT	6.0	AMPS
DC GRID CURRENT	1.0	AMP
PLATE INPUT POWER	60	KW
PLATE DISSIPATION	30	KW

TYPICAL OPERATION

DC Plate Voltage	7000	10,000	volts
DC Plate Current	6.0	6.0	amps
DC Grid Voltage	—600	—800	volts
DC Grid Current	.66	.315	amps
Peak Positive Grid Voltage	440	360	volts
Driving Power	660	365	watts
Plate Input Power	42	60	kW
Plate Dissipation	12	18	kW
Plate Output Power	30	42	kW
Approximate Load Impedance	600	750	ohms

(Revised 3-1-67) © 1967 Varian

Printed in U.S.A.

RADIO-FREQUENCY POWER AMPLIFIER PLATE-MODULATED

Class-C

MAXIMUM RATINGS

DC PLATE VOLTAGE	7000	VOLTS
DC PLATE CURRENT	5.0	AMPS
PLATE DISSIPATION	20	KW
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION

DC Plate Voltage	5000	7000	volts
DC Grid Voltage	—600	—820	volts
DC Plate Current	5.0	5.0	amps
DC Grid Current	600	600	mA
Driving Power	600	750	watts
Plate Output Power	17.8	27.5	kW

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_2

MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC PLATE CURRENT	6.0	AMPS
PLATE DISSIPATION	30	KW
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION

DC Plate Voltage	7000	10,000	volts
DC Grid Voltage*	—250	—400	volts
Zero-Sig Plate Current	2.0	2.0	amps
Max-Sig DC Plate Current	6.0	6.0	amps
Max-Sig DC Grid Current	375	333	mA
Peak RF Grid Voltage	530	700	volts
Driving Power	200	240	watts
Plate Output Power	26.4	41	kW

*Adjust to give specified zero-signal dc plate current.

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses has been made.

APPLICATION

ELECTRICAL

Filament—The rated filament voltage for the 3CV30,000A3 is 6.3 volts. Filament voltage, as measured at the socket, must be maintained at 6.3 volts plus or minus five percent for maximum tube life and consistent performance.

Control Grid Operation — The grid current rating is one ampere dc. This value should not be exceeded for more than very short periods such as during tuning and over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.4 to 0.6 amperes grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 500 watts.

Plate Operation — The maximum plate input power rating is 60 kilowatts at 10,000 volts and 6.0 amperes dc. This rating applies for Class C amplifier or oscillator service and for Class AB applications. When used as a plate modulated rf amplifier, input is reduced to 7000 volts at 5.0 amperes dc. Maximum input may be exceeded for short periods during tuning without exceeding plate dissipation ratings.

Plate over-current protection should be provided to remove plate voltage quickly in the event of an overload or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

Special Application—If it is desired to operate this tube under conditions widely different from these given here, write to Power Grid Tube Marketing Department, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, for information and recommendations.

MECHANICAL

Mounting — The 3CV30,000A3 must be mounted vertically, base up in an EIMAC BR-200 boiler. It is very important that the boiler tube assembly be mounted vertically, the water be maintained at the suggested level, and that the flange of the tube makes a vapor-tight seal against the rubber "O" ring and boiler.

Sockets—The EIMAC SK-1310 socket is available for use with the 3CV30,000A3. Filament and grid connection are made to this socket.

Cooling — Cooling is accomplished by immersion of the anode in a distilled water-filled BR-200 boiler. The energy dissipated at the anode causes the water to boil and be converted into steam. Steam is carried away by convection to the condenser where it is cooled and condenses into water. Condensate is then returned to the boiler.

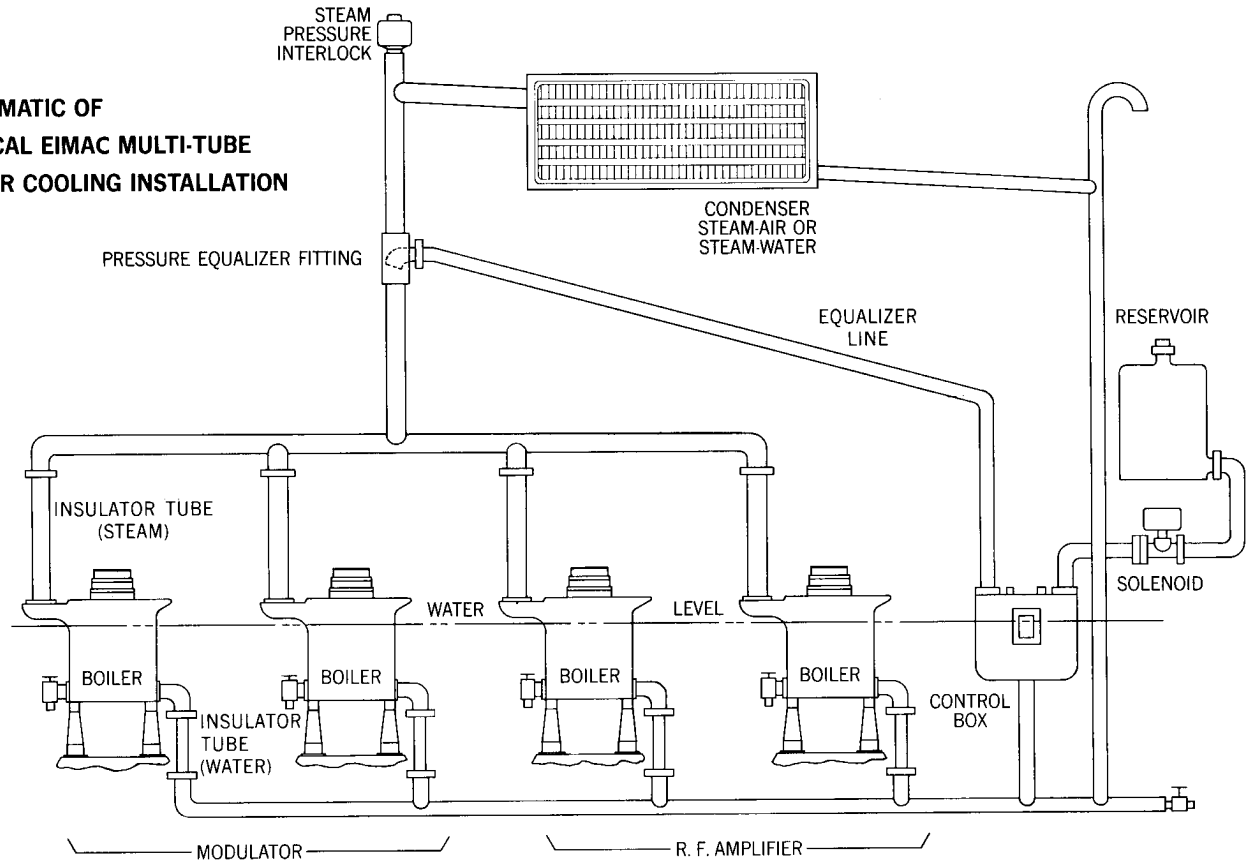
The boiling action maintains the anode surface temperature at approximately 100°C. In a properly designed system (such as the 3CV30,-000A3 and BR-200) it unlikely that anode surface temperature will ever exceed 125°C — well below the rated maximum for the tube — even at full plate dissipation levels.

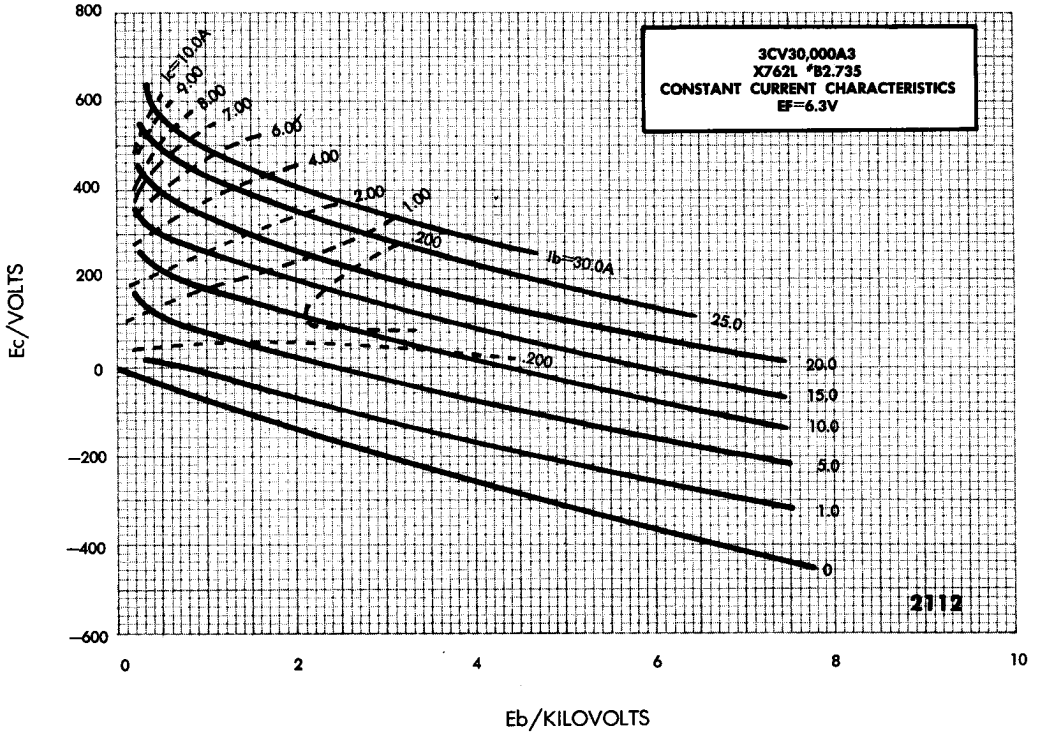
The water in the boiler must be maintained at a constant level, just below the top of the anode fins. This level is marked on the boiler. A recommended system for assuring constant water level is shown in the system diagram below. This system incorporates an EIMAC CB-202 Control Box to sense water level and a small reservoir to supply make-up water on demand. In the event of a drop in system water level, a switch is closed in the control box, energizing a solenoid water valve in the line from the reservoir. When the make-up water brings the system back to the proper level, the switch is opened, de-energizing the solenoid valve. A second switch in the CB-202 Control Box senses a lower, danger level and can be used to actuate an alarm or shut down the system.

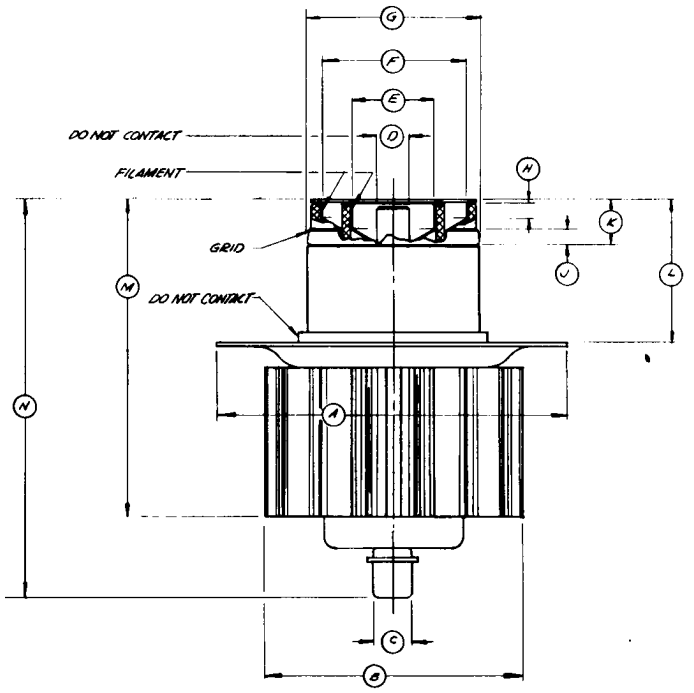
For reliable operation, it is essential that the Control Box be mounted so that the level sensed is the actual level in the boiler.

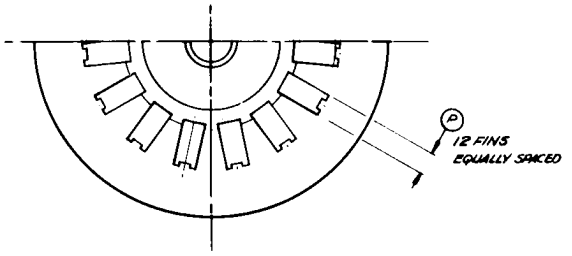
Separate cooling of the tube base is required and is accomplished by directing 100 CFM of cooling air into the base structure from the top of the socket.

SCHEMATIC OF TYPICAL EIMAC MULTI-TUBE VAPOR COOLING INSTALLATION









DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			7.750
B			5.812
C	.855	.895	
D	.720	.760	
E	1.896	1.936	
F	3.133	3.173	
G	3.792	3.832	
H	.188		
J	.188		
K	.986	1.050	
L			3.062
M	6.920	6.990	
N	8.250	8.750	
P			.510

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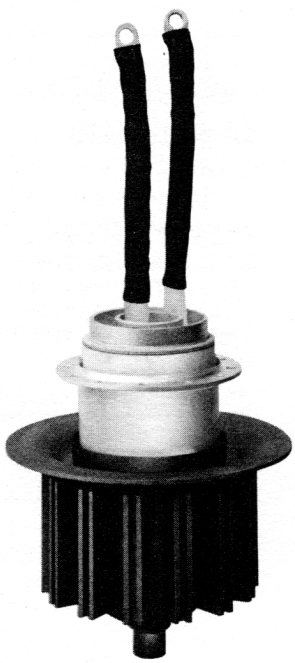
3CV30,000H3

MEDIUM-MU VAPOR-COOLED POWER TRIODE

The EIMAC 3CV30,000H3 is a vapor-cooled, ceramic-metal power triode designed primarily for use in industrial radio-frequency heating service. Its vapor-cooled anode is conservatively rated at 30 kilowatts of plate dissipation when mounted in an EIMAC BR-200 boiler.

Full input of 60 kilowatts is permissible up to 100 megahertz. Large reserve emission is available from its one kilowatt filament and the grid structure is rated at one ampere making this tube an excellent choice for severe applications.

It is also recommended as an audio amplifier, a conventional plate-modulated amplifier or as a linear amplifier in new equipment designs.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated-Tungsten				
Voltage		6.3		V
Current	152		172	A
Amplification Factor		20		
Interelectrode Capacitances, Grounded Cathode:				
Grid-Filament	48		58	pF
Plate-Filament	1.2		1.5	pF
Grid-Plate	30		38	pF
Frequency for Maximum Ratings				100 MHz

MECHANICAL

Filament Connections	Flexible Leads
Grid Connection	Terminal Ring
Recommended Boiler	EIMAC BR-200
Operating Position	Vertical, Base up
Cooling	Vapor and Forced air
Maximum Operating Temperatures:	
Ceramic-to-metal Seals	250°C
Maximum Dimensions:	See Outline
Net Weight	18 pounds

RF INDUSTRIAL OSCILLATOR

Class-C (Filtered DC Power Supply)

MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC PLATE CURRENT	6.0	AMPS
DC GRID CURRENT	1.0	AMPS
PLATE INPUT POWER	60	KW
PLATE DISSIPATION	30	KW

TYPICAL OPERATION

DC Plate Voltage	7000	10,000	volts
DC Plate Current	6.0	6.0	amps
DC Grid Voltage	-600	-800	volts
DC Grid Current	.66	.315	amps
Peak Positive Grid Voltage	440	360	volts
Driving Power	660	365	watts
Plate Input Power	42	60	kW
Plate Dissipation	12	18	kW
Plate Output Power	30	42	kW
Approximate Load Impedance	600	750	ohms

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RADIO-FREQUENCY POWER AMPLIFIER

PLATE-MODULATED

Class-C

MAXIMUM RATINGS

DC PLATE VOLTAGE	7000	VOLTS
DC PLATE CURRENT	5.0	AMPS
PLATE DISSIPATION	20	KW
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION

DC Plate Voltage	5000	7000	volts
DC Grid Voltage	-600	-820	volts
DC Plate Current	5.0	5.0	amps
DC Grid Current	600	600	mA
Driving Power	600	750	watts
Plate Output Power	17.8	27.5	kW

AUDIO AMPLIFIER

OR MODULATOR

Class-AB_2

MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC PLATE CURRENT	6.0	AMPS
PLATE DISSIPATION	30	KW
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (two tubes)

DC Plate Voltage	6000	9600	volts
DC Grid Voltage*	-280	-480	volts
Zero-Sig Plate Current	.5	.25	amps
Max-Sig DC Plate Current	4.2	3.1	amps
Max-Sig DC Grid Current	145	42	mA
Peak Driving Voltage	480	590	volts
Drive Power	140	50	watts
Plate-to-Plate Load Resistance	1300	2740	ohms
Power Output	31	36	kW

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses has been made.

APPLICATION

ELECTRICAL

Filament The rated filament voltage for the 3CV30,000H3 is 6.3 volts. Filament voltage, as measured at the socket, must be maintained at 6.3 volts plus or minus five percent for maximum tube life and consistent performance.

Control Grid Operation The grid current rating is one ampere dc. This value should not be exceeded for more than very short periods such as during tuning and over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.4 to 0.6 amperes grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 500 watts.

Plate Operation The maximum plate input power rating is 60 kilowatts at 10,000 volts and 6.0 amperes dc. This rating applies for Class C amplifier or oscillator service and for Class AB applications. When used as a plate modulated rf amplifier, input is reduced to 7000 volts at 5.0 amperes dc. Maximum input may be exceeded for short periods during tuning without exceeding plate dissipation ratings.

Plate over-current protection should be provided to remove plate voltage quickly in the event of an overload or an arc-over at the load. In addition, current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

Special Application If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, for information and recommendations.

MECHANICAL

Mounting The 3CV30,000H3 must be mounted vertically, base up in an EIMAC BR-200 boiler. It is very important that the boiler tube assembly be mounted vertically, the water be maintained at the suggested level, and that the flange of the tube makes a vapor-tight seal against the rubber "O" ring and boiler.

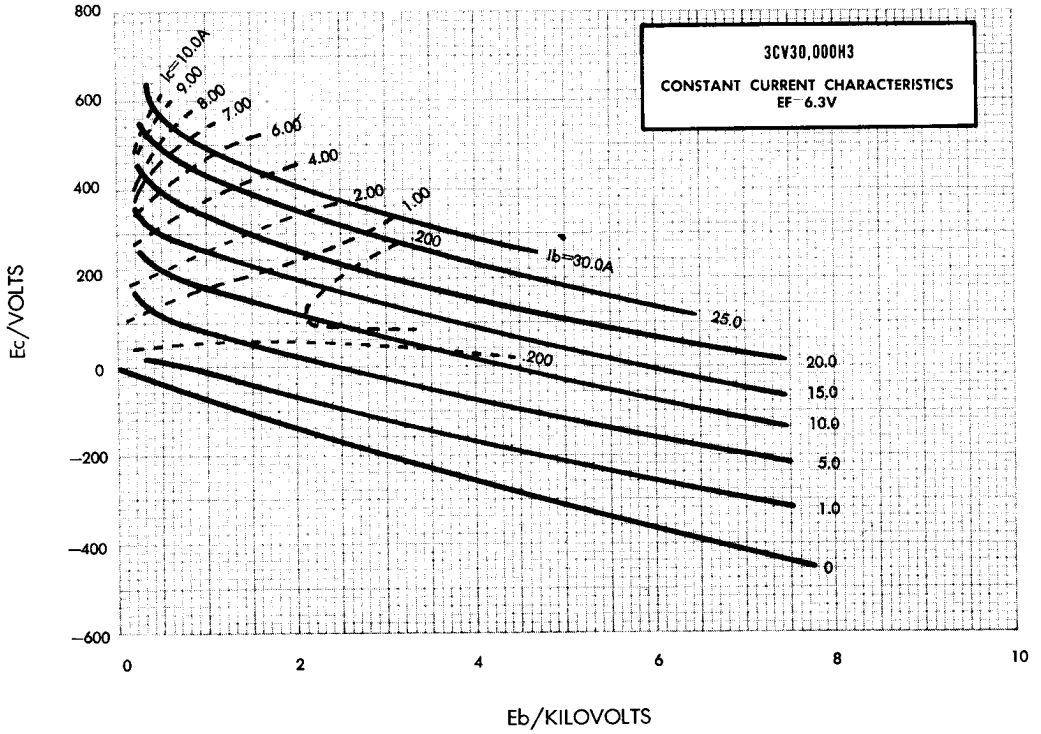
Cooling Cooling is accomplished by immersion of the anode in a distilled water-filled BR-200 boiler. The energy dissipated at the anode causes the water to boil and be converted into steam. Steam is carried away by convection to the condenser where it is cooled and condenses into water. Condensate is then returned to the boiler.

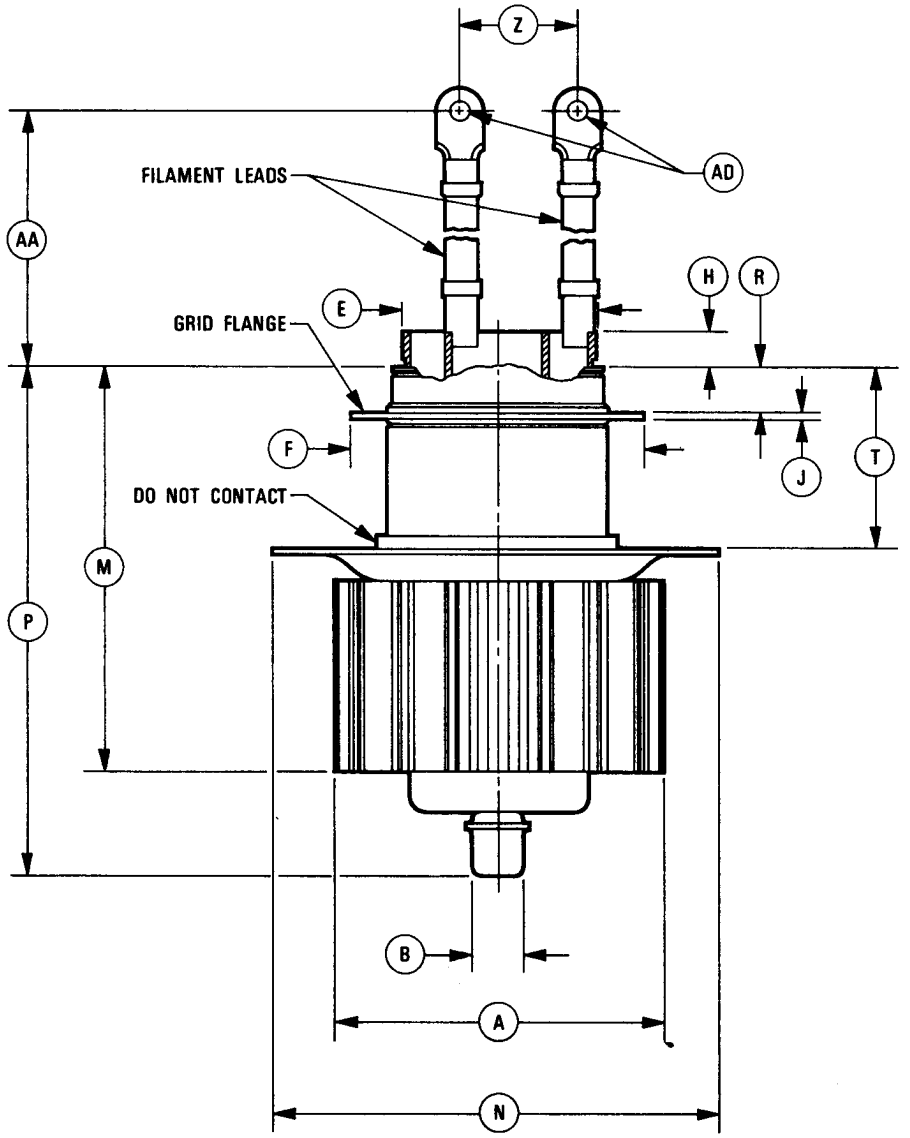
The boiling action maintains the anode surface temperature at approximately 100°C. In a properly designed system (such as the 3CV30,000H3 and BR-200) it is unlikely that anode surface temperature will ever exceed 125°C — well below the rated maximum for the tube — even at full plate dissipation levels.

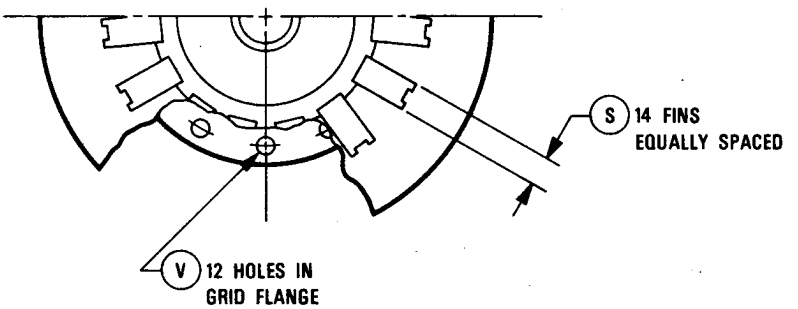
The water in the boiler must be maintained at a constant level, just below the top of the anode fins. This level is marked on the boiler. A recommended system for assuring constant water level is shown in the system diagram below. This system incorporates an EIMAC CB-202 Control Box to sense water level and a small reservoir to supply make-up water on demand. In the event of a drop in system water level, a switch is closed in the control box, energizing a solenoid water valve in the line from the reservoir. When the make-up water brings the system back to the proper level, the switch is opened, de-energizing the solenoid valve. A second switch in the CB-202 Control Box senses a lower, danger level and can be used to actuate an alarm or shut down the system.

For reliable operation, it is essential that the Control Box be mounted so that the level sensed is the actual level in the boiler.

Separate cooling of the tube base is required and is accomplished by directing 100 CFM of cooling air into the base structure from the top of the socket.







DIMENSIONS IN INCHES

DIMENSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A			5.812
B	.855	.895	
E	3.230	3.270	
F	5.030	5.090	
H	.530	.700	
J			.125
M	6.643	6.775	
N			7.750
P	8.400	8.625	
R	.700	.860	
S			.510
T			2.806
V			.265
Z			2.000
AA	8.500	9.000	
AD			.390

NOTE:
REF. DIMS. ARE FOR INFO. ONLY & ARE NOT REQ'D. FOR INSP. PURPOSES.

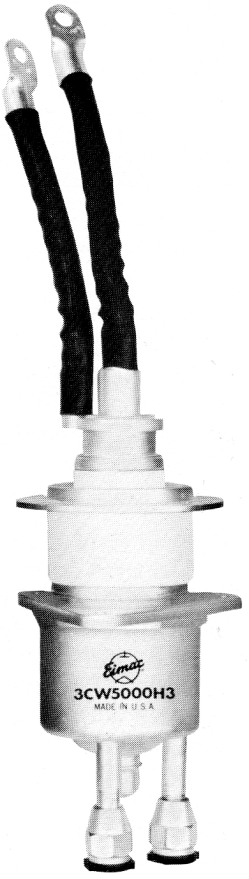
EIMAC

A Division of Varian Associates

SAN CARLOS, CALIFORNIA

3CW5000H3

INDUSTRIAL MEDIUM-MU WATER-COOLED POWER TRIODE



The EIMAC 3CW5000H3 is a water-cooled, ceramic-metal power triode designed primarily for use in industrial radio-frequency heating services. Its water-cooled anode is conservatively rated at 5 kilowatts of plate dissipation with low water flow and pressure drop.

Input of 12.5 kilowatts is permissible up to 75 megahertz. Plentiful reserve emission is available from its 375 watt filament. The grid structure is rated at 150 watts making this tube an excellent choice for severe applications.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated-Tungsten				
Voltage		7.5		Volts
Current	48		53	amps
Amplification Factor		20		
Interelectrode Capacitances, Grounded Cathode Connection:				
Grid-Filament	29.2		40.2	μμf
Plate-Filament	0.60		1.20	μμf
Grid-Plate	17.8		24.2	μμf
Frequency for Maximum Ratings			75	MHz

MECHANICAL

Base	See Outline
Operating Position	Vertical, base up or down
Cooling	Water and Forced Air
Maximum Operating Temperatures	250°C
Maximum Dimensions:	
Height	See Outline
Diameter	See Outline
Net Weight	7.5 Pounds

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

(Effective 4-1-66) © 1966 Varian

Printed in U.S.A.

RF INDUSTRIAL OSCILLATOR

Class-C (Filtered DC Power Supply)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	6000 volts
DC PLATE CURRENT	2.5 amps
DC GRID VOLTAGE	—1000 volts
DC GRID CURRENT	0.4 amp
PLATE INPUT POWER	12.5 kW
PLATE DISSIPATION (NOMINAL)	5 kW

TYPICAL OPERATION*

DC Plate Voltage	4000	6000 volts
DC Plate Current	2.5	2.08 amps
DC Grid Voltage	—300	—500 volts
DC Grid Current	.245	.180 amps
Peak Positive Grid Voltage	280	265 volts
Driving Power	142	136 watts
Plate Input Power	10,000	12,500 kW
Plate Dissipation	2,500	2,500 kW
Plate Output Power	7,500	10,000 kW
Approximate Load Impedance	910	1,625 ohms

*Loaded Conditions

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses has been made.

APPLICATION

ELECTRICAL

Filament

The rated filament voltage for the 3CW5000H3 is 7.5 volts. Filament voltage, as measured at the tube, must be maintained at 7.5 volts plus or minus five percent for maximum tube life and consistent performance.

Control Grid Operation

The grid current rating is 0.4 ampere dc. This value should not be exceeded for more than very short periods such as during tuning. Over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.275 amperes grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 150 watts.

Plate Operation

Maximum plate voltage rating of 6000 volts and maximum plate current of 2.5 amperes dc should not be applied simultaneously as rated plate dissipation may be exceeded. The 12.5 kilowatts input rating applies for Class C amplifier or oscillator service with no modulation.

Plate over-current protection should be provided to remove plate voltage quickly in the event of an overload or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

High Frequency Operation

The 3CW5000H3 is usable to 110 MHz. At this frequency, plate voltage must be reduced to 4000 volts in Class C service.

MECHANICAL

Mounting

The 3CW5000H3 must be mounted vertically, either base up or down. A grid contact flange is provided for bolting to a strap or a grid deck. Heavy flexible leads are provided for applying the filament voltage.

Cooling

Anode cooling is accomplished by circulating water through the integral anode-water jacket.

The table below lists the minimum water flow requirement for adequate anode cooling at various plate dissipation levels. In all cases, the outlet water temperature must not exceed 70°C nor should inlet water pressure exceed 60 psi. This table is based upon 15°C temperature rise inlet to outlet water.

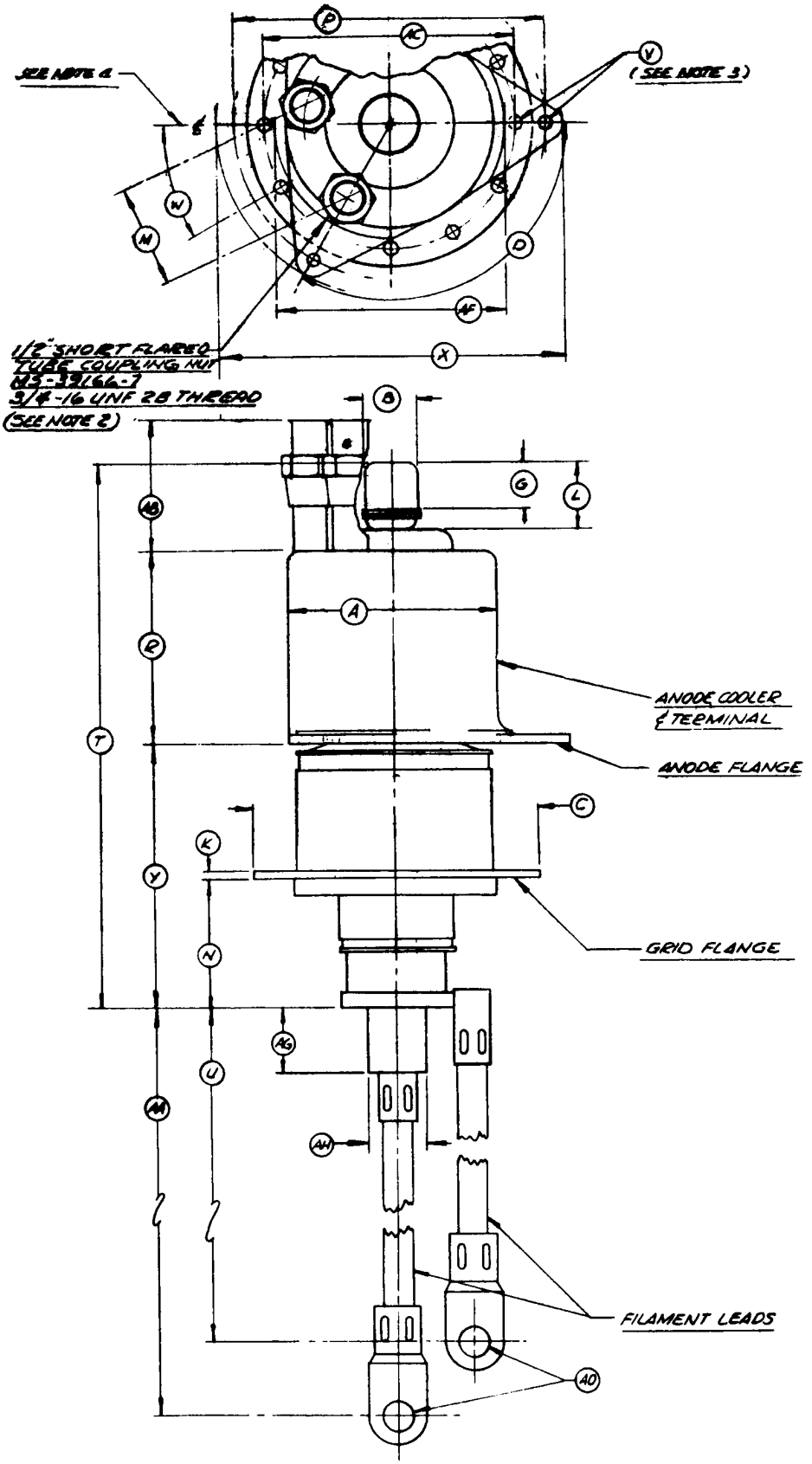
MINIMUM WATER-COOLING REQUIREMENT

Plate Dissipation (kW)	Water Flow (gpm)	Pressure Drop (psi)
3.0	0.65	0.27
5.0	1.10	0.70
7.0	1.75	1.75

Additional stem cooling air must be provided. 13 CFM of air directed against the center filament contact ring ½" below the outer filament contact ring by a 1½" I.D. air duct arranged at a 45° angle with the center line of the tube will provide adequate cooling.

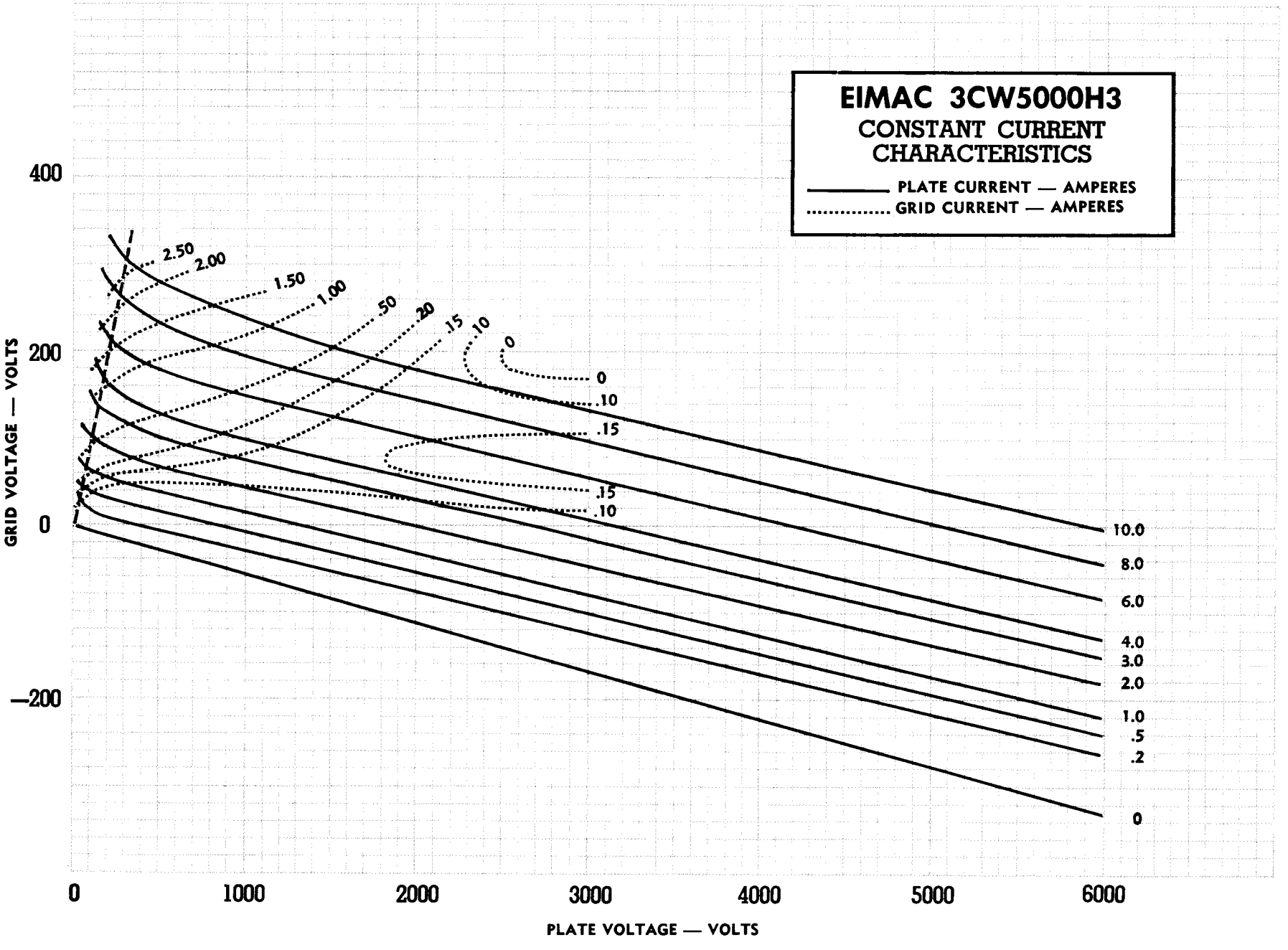
Special Application

If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Division, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California for information and recommendations.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A	3.300	3.400	
B	.780	.843	
C	4.230	4.250	
D	118°	122°	
G	.687	.812	
K			.125
L	1.000	1.125	
M			1.500
② N	1.703	1.953	
P	4.615	4.635	
R	2.625	2.875	
T	8.000	9.000	
U	7.937	8.037	
V			.250
W	29°	31°	
X	5.330	5.420	
Y	3.875	4.250	
AA	8.937	9.437	
AB			2.000
AC	3.855	3.885	
AD			.390
AF			3.625
AG	.812	.937	
AH	.859	.890	

NOTE:
1. REF. DIM. ARE FOR INFO ONLY & ARE NOT REQ'D FOR INSP. PURPOSES.
2. EITHER FITTING CAN BE USED AS INLET OR OUTLET.
3. 3 HOLES IN ANODE FLANGE, 12 HOLES IN GRID FLANGE.
4. MTG. FLANGE, FIL. LEADS & WATER FITTINGS ARE TO BE ORIENTED AS SHOWN.

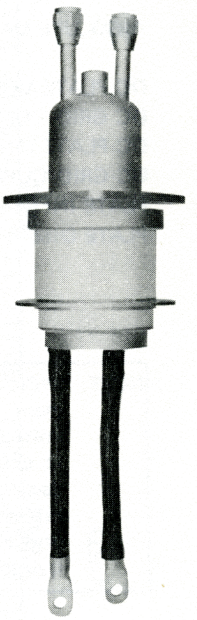

EIMAC 3CW5000H3
CONSTANT CURRENT CHARACTERISTICS
PLATE CURRENT — AMPERES
GRID CURRENT — AMPERES
GRID VOLTAGE — VOLTS
400
200
0
—200
2.50
2.00
1.50
1.00
.50
.20
.15
.10
.0
0
.10
.15
.15
.10
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.5
.2
0
0
1000
2000
3000
4000
5000
6000
PLATE VOLTAGE — VOLTS

3CW10,000H3

INDUSTRIAL
MEDIUM-MU

WATER-COOLED
POWER TRIODE

TECHNICAL DATA



The EIMAC 3CW10,000H3 is a water-cooled, ceramic/metal power triode designed primarily for use in industrial radio-frequency heating services. Its water-cooled anode is conservatively rated at 10 kilowatts of plate dissipation with low water flow and pressure drop.

Input of 30 kilowatts is permissible up to 90 Megahertz. Plentiful reserve emission is available from its 560 watt filament. The grid structure is rated at 150 watts making this tube an excellent choice for severe applications.

GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	7.5 ± 0.37	V
Current, at 7.5 volts	75	A
Amplification Factor (Average):	20	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Input	53.0	pF
Output	1.5	pF
Feedback	25.0	pF
Frequency of Maximum Rating:		
CW	90	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length (excluding leads)	10.450 in; 265.43 mm
Diameter	5.090 in; 129.29 mm
Net Weight	10 lb; 4.54 kg
Operating Position	Vertical, base down or up
Maximum Operating Temperature:	
Ceramic/Metal Seals	250 °C
Cooling	Water and Forced Air
Base	See Outline

(Revised 10-15-70) © 1966, 1970 by Varian Printed in U.S.A.

RADIO FREQUENCY INDUSTRIAL OSCILLATOR
Class C (Filtered DC Power Supply)
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC GRID VOLTAGE	-1000	VOLTS
DC PLATE CURRENT	3.0	AMPERES
DC GRID CURRENT	0.5	AMPERE
PLATE INPUT POWER	30,000	WATTS
PLATE DISSIPATION	10,000	WATTS

TYPICAL OPERATION (Frequencies to 90 MHz)[2]

Plate Voltage	7000	9000	Vdc
Grid Voltage	-700	-900	Vdc
Plate Current	2.88	2.90	Adc
Grid Current[1]	0.18	0.18	Adc
Peak rf Grid Voltage[1]	250	250	v
Calculated Driving Power	170	215	W
Plate Input Power	20.15	26.10	kW
Plate Dissipation	5.15	5.50	kW
Plate Output Power	15.0	20.6	kW
Resonant Load Impedance	1120	1470	Ω

1. Approximate value.
2. Loaded Conditions

NOTE: TYPICAL OPERATION data are obtained by calculation from published characteristic curves or actual measurment. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 7.5 volts	72	77	A
Interelectrode Capacitances[1] (grounded filament connection)			
Input	46.0	56.0	pF
Output	1.35	1.65	pF
Feedback	22.0	28.0	pF

1. Capacitance values are for a cold tube as measured in a shielded fixture.

APPLICATION

MECHANICAL

MOUNTING - The 3CW10,000H3 must be mounted vertically, either base up or down. A grid contact flange is provided for bolting to a strap or a grid deck. Heavy flexible leads are provided for applying the filament voltage.

COOLING - Anode cooling is accomplished by circulating water through the integral anode-water jacket.

The table below lists minimum water flow requirement for adequate anode cooling at various plate dissipation levels. In all cases, the outlet water temperature must not exceed 70°C nor should inlet water pressure exceed 60 psi. This table is based upon 15°C temperature rise of water from inlet to outlet.

MINIMUM WATER-COOLING REQUIREMENT		
Plate Dissipation (kW)	Water Flow (gpm)	Pressure Drop (psi)
8	3.2	5.5
10	4.4	8.1
12	5.8	13.4

Additional stem cooling air must be provided. 8 CFM of air directed against the center filament contact ring ½ inch below the outer filament contact ring by a 1½ inch I.D. air duct arranged at a 45° angle with the center line of the tube will provide adequate cooling.

ELECTRICAL

FILAMENT - The rated filament voltage for the 3CW10,000H3 is 7.5 volts. Filament voltage, as measured at the tube, must be maintained at 7.5 volts plus or minus five percent for maximum tube life and consistent performance.

GRID OPERATION - The grid current rating is 0.5 ampere dc. This value should not be exceeded for more than very short periods such as during tuning. Over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.25 ampere grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 150 watts.

PLATE OPERATION - Plate over-current protection should be provided to remove plate voltage quickly in the event of an overload or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

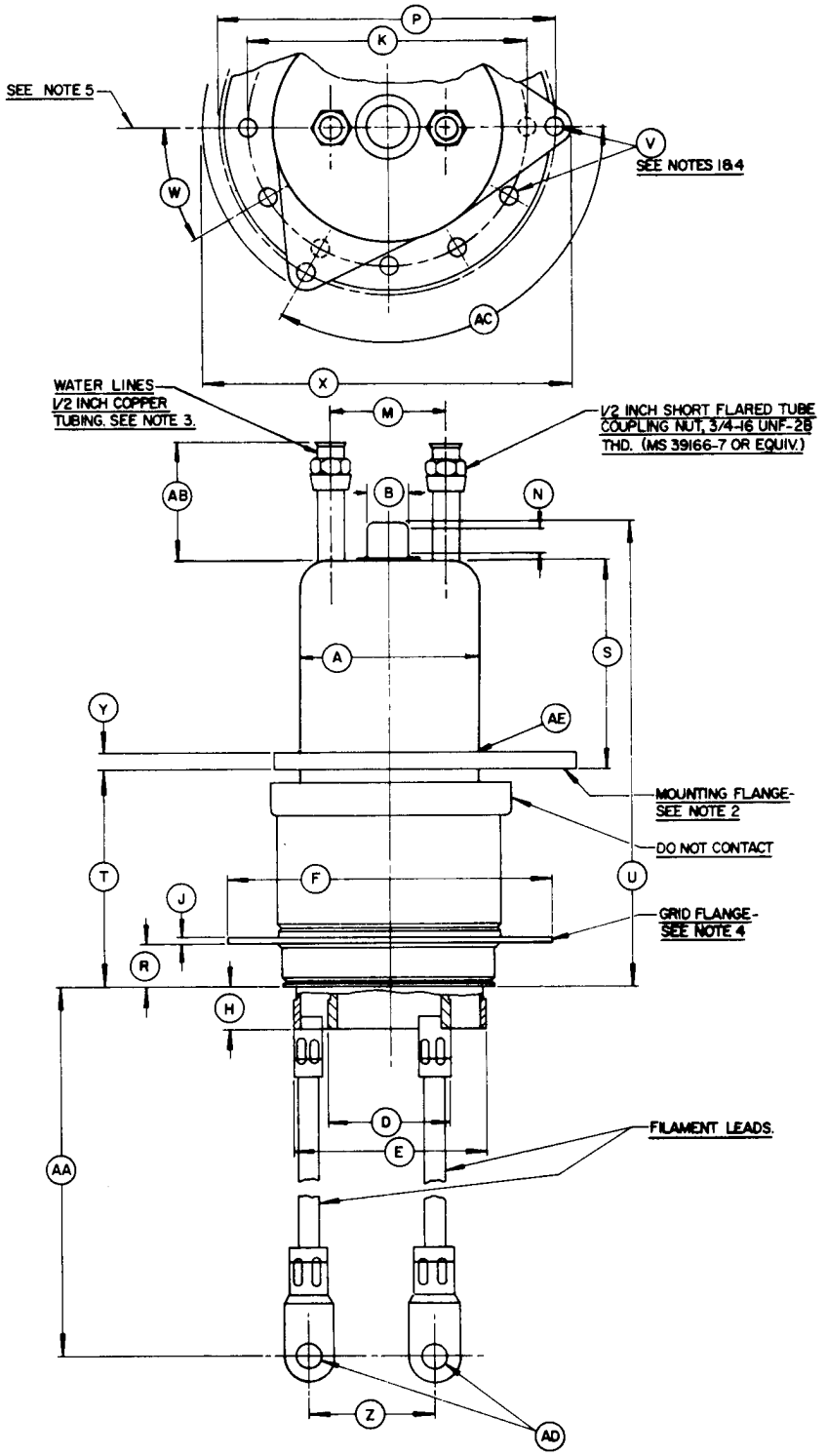
HIGH VOLTAGE - The 3CW10,000H3 operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RAY RADIATION - The 3CW10,000H3, operating at its maximum rated voltage and current, as an industrial oscillator is a potential X-ray hazard. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to changes in leakage paths or emission characteristics as they are affected by high voltage. Only limited shielding is afforded by the tube envelope. Additional X-ray shielding must be provided on all sides of the tube to provide adequate protection to operating personnel throughout the tube's life. X-ray caution signs or labels must be permanently attached to equipment using this tube directing operating personnel never to operate this device without X-ray shielding in place.

RADIO FREQUENCY RADIATION - Exposure of the human body to rf radiation becomes increasingly more hazardous as the power level and/or frequency are increased. Exposure to high-power rf radiation must be strictly prevented at any frequency.

Equipment must be designed to fully safeguard all personnel from these hazards. Labels and caution notices must be provided on equipment and in manuals clearly warning of these hazards.

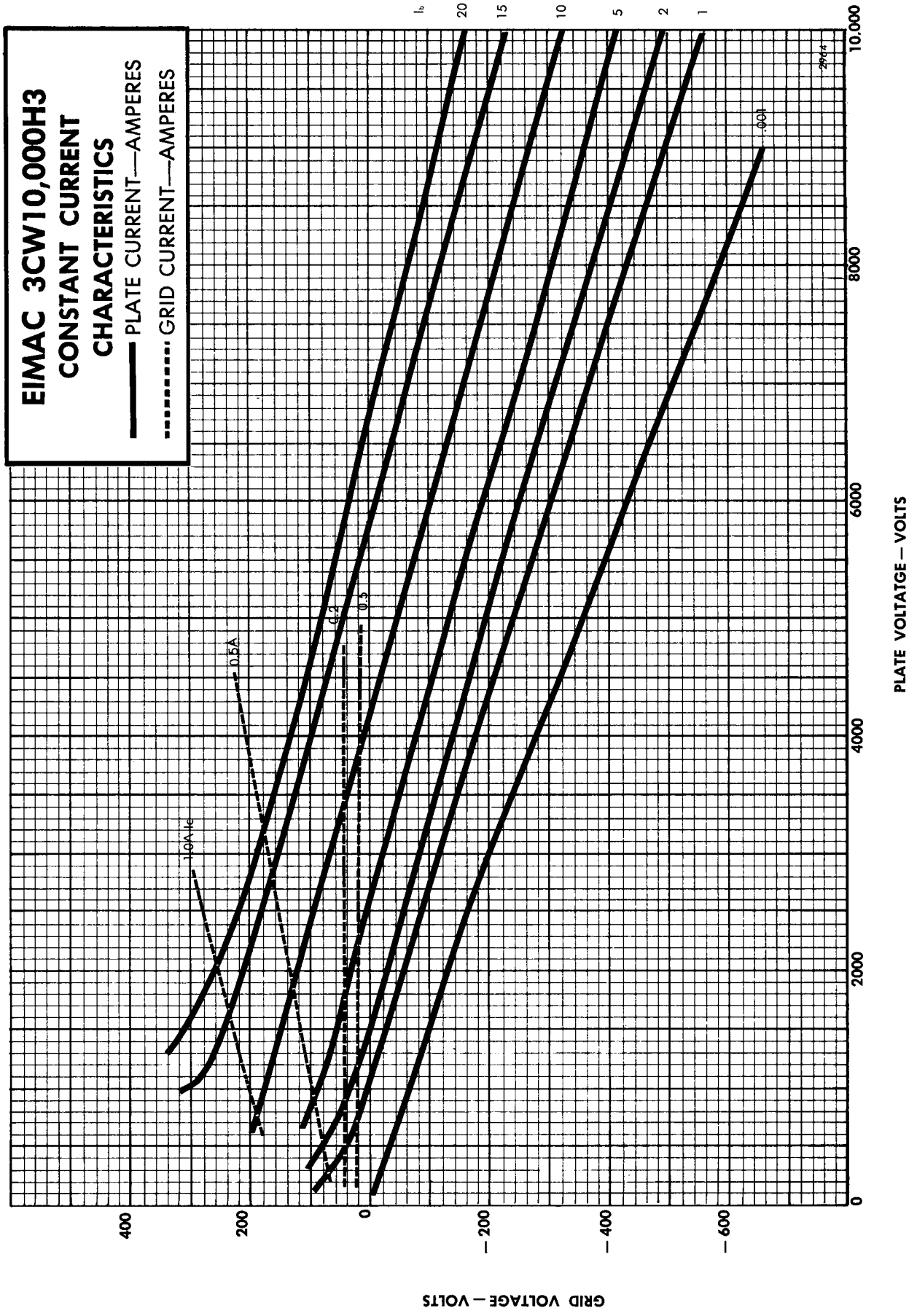
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.



DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	2.830	3.030	- -	71.88	76.96	- -
B	0.860	0.890	- -	21.84	22.61	- -
D	- -	- -	1.875	- -	- -	47.63
E	- -	- -	3.250	- -	- -	82.55
F	5.030	5.090	- -	127.76	129.29	- -
H	0.530	0.700	- -	13.46	17.78	- -
J	- -	- -	0.125	- -	- -	3.18
K	4.425	4.445	- -	112.40	112.90	- -
M	- -	- -	1.900	- -	- -	48.26
N	0.375	- -	- -	9.53	- -	- -
P	5.990	6.010	- -	152.15	152.65	- -
R	0.700	0.860	- -	17.78	21.84	- -
S	- -	- -	3.350	- -	- -	85.09
T	4.000	4.150	- -	101.60	105.41	- -
U	8.000	8.400	- -	203.20	213.36	- -
V	- -	- -	0.265	- -	- -	6.73
W	29°	31°	- -	29°	31°	- -
X	6.700	6.800	- -	170.18	172.72	- -
Y	- -	- -	0.250	- -	- -	6.35
Z	- -	- -	2.000	- -	- -	50.80
AA	8.500	9.000	- -	215.90	228.60	- -
AB	- -	- -	2.250	- -	- -	57.15
AC	118°	122°	- -	118°	122°	- -
AD	- -	- -	0.390	- -	- -	9.91
AE	- -	- -	0.062R	- -	- -	1.57R

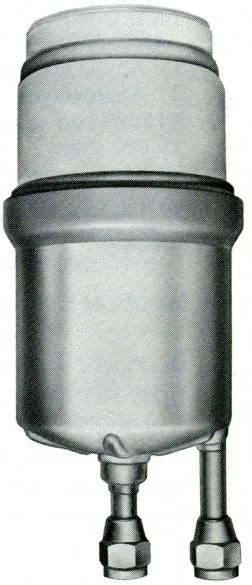
NOTES:
1. REF. DIMS. ARE FOR INFO. ONLY & ARE NOT FOR INSPECTION PURPOSES.
2. 3 MOUNTING HOLES IN MTG. FLANGE.
3. EITHER FITTING CAN BE USED AS INLET OR OUTLET.
4. 12 HOLES IN GRID FLANGE.
5. MTG. FLANGE, FIL. LEADS & WATER FITTING ARE TO BE ORIENTED AS SHOWN.


EIMAC 3CW10,000H3
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT—AMPERES
GRID CURRENT—AMPERES
I_b
20
15
10
5
2
1
.001
1.0A I_c
0.5A
0.2
0.3
400
200
0
— 200
— 400
— 600
0
2000
4000
6000
8000
10,000
GRID VOLTAGE — VOLTS
PLATE VOLTAIGE — VOLTS

3CW20,000A1

WATER-COOLED
LOW-MU
POWER TRIODE

The EIMAC 3CW20,000A1 is a ceramic/metal power triode intended primarily for use as an audio amplifier or modulator. This tube is also recommended for voltage-regulator applications where high current capability and low tube drop are important. Up to 20 kilowatts of plate power can be dissipated on its water-cooled anode. Except for plate dissipation, the tube is electrically identical to the 8158/3CX10,000A1.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten	
Voltage	7.5 ± 0.37 V
Current, at 7.5 volts	100 A
Amplification Factor (average)	6.2
Direct Interelectrode Capacitances (grounded cathode)[2]	
Cin	51.0 pF
Cout	4.1 pF
Cgp	28.5 pF
Transconductance (I_b = 2.0 Adc, E_b = 3000 Vdc)	20,000 μmhos
Frequency of Maximum Rating (CW)	110 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	11.22 In; 28.49 cm
Diameter	4.66 In; 11.83 cm
Net Weight	12 lbs; 5.5 kg
Operating Position	Vertical, base up or down
Maximum Operating Temperature:	
Envelope & Ceramic/Metal Seals	250°C
Cooling	Water and Forced Air
Base	Coaxial
Recommended Socket	EIMAC SK-1300

(Effective 9-1-74) © 1963, 1967, 1964 by Varian Printed in U.S.A.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR
Class AB_1

MAXIMUM RATINGS (Per Tube):

DC PLATE VOLTAGE	7000 VOLTS
DC PLATE CURRENT	5.0 AMPERES
PLATE DISSIPATION	20,000 WATTS
GRID DISSIPATION	100 WATTS

1. Adjust for Zero-Signal plate current.
2. Approximate value.

Effective grid circuit resistance must not exceed 20,000 ohms.

TYPICAL OPERATION, Two Tubes
Sinusoidal Wave

Plate Voltage	7000	7000	Vdc
Grid Voltage [1]	-1300	-1300	Vdc
Zero-Sig Plate Current	1.5	1.5	Adc
Max-Sig Plate Current	5.8	7.0	Adc
Load Res. Plate-to-Plate	2460	1720	Ω
Peak af Drive Voltage [2] (per tube)	1300	1300	v
Max-Sig Driving Power	0	0	W
Max-Sig Plate Output Power	24.4	29.1	kW
Total Harmonic Distortion [2]	2.9	3.6	%

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR
Class A

MAXIMUM RATINGS:

DC PLATE VOLTAGE	7000 VOLTS
DC PLATE CURRENT	See Class A derating table on P. 3.
PLATE DISSIPATION	20,000 WATTS
GRID DISSIPATION	100 WATTS

TYPICAL OPERATION

Plate Voltage	2500	Vdc
Grid Voltage [1]	-290	Vdc
Plate Current	4.0	Adc
Peak af Driving Voltage [2]	290	v
Load Resistance	212	Ω
Max. Sig. Plate Output Power [2]	1800	W
Second Harmonic Distortion [2]	6.75	%

1. Adjust for specified dc plate current.
2. Approximate value.

VOLTAGE REGULATOR SERVICE
Class A

MAXIMUM RATINGS:

DC PLATE VOLTAGE	10,000 VOLTS
DC PLATE CURRENT	See Class A derating table on P. 3.
PLATE DISSIPATION	12,000 WATTS
GRID DISSIPATION	100 WATTS

TYPICAL OPERATION

Plate Voltage (Tube drop)	5000	Vdc
Plate Current	0-2.0	Adc

(These values are chosen according to the Class A derating table on Page 3).

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the grid voltage to obtain the specified plate current at the specified bias, and plate voltages, is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 7.5 volts	94.0	104.0	A
Amplification Factor	4.8	6.8	
Interelectrode Capacitances (grounded cathode connection) [1]			
Cin	45.0	57.0	pF
Cout	3.6	4.5	pF
Cgp	25.0	32.0	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATIONS

MECHANICAL

MOUNTING - The 3CW20,000A1 must be operated vertically, anode down or up, and should be protected from shock and vibration. The EIMAC SK-1300 socket is available and recommended for simultaneously holding the tube in position and making all base contacts.

COOLING - The anode of the 3CW20,000A1 is cooled by circulating water through the integral water jacket. The cooling table shows minimum water-flow rates at various plate dissipation levels and assumes a temperature rise for the water of 10°C. Inlet water temperature should never exceed 55°C and outlet water temperature should never exceed 70°C. Where a liquid coolant other than water is used, the difference in cooling characteristics should be carefully considered and taken into account. Maximum system pressure should not exceed 50 psi.

Minimum Cooling Water-Flow Requirements		
Dissipation (watts)	Water Flow (gpm)	Press. Drop Approx. psi
10,000	11	11.5
15,000	12	13.5
20,000	14	17.0

A major factor effecting long life of water-cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 $K\Omega/cm^3$, and preferably above 250 $K\Omega/cm^3$. A relative water resistance check can be made by continuously measuring the leakage current which will bypass a short section of insulating hose column if metal nipples or fittings are used as electrodes.

Forced-air cooling of the base is also required, with 30 to 50 cfm of air at 50°C maximum directed up into and around the base of the tube to cool the filament and grid contact areas.

Both anode and base cooling should be applied before or simultaneously with electrode voltages, including the filament, and should normally be maintained for a short period of time after all voltages are removed to allow for tube cooldown.

ELECTRICAL

VOLTAGE REGULATOR OR CLASS A SERVICE - Maximum dc plate curren' and voltage are restricted according to the following table:

CLASS A DERATING TABLE	
DC Plate Voltage (Volts)	Max. DC Plate Current (mA)
0 - 2400	5000
3000	4000
4000	3000
5000	2000
6000	1500
7000	1000
8000	700
9000	500
10,000	350

FILAMENT OPERATION - Filament voltage should be measured at the socket with a one percent accuracy, rms responding meter. The peak emission capability of the tube at rated filament voltage is normally many times that required for for communication or regulator service, and a small decrease in filament temperature due to a reduction in filament voltage can increase the life of the tube by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect the equipment operation. This is done by measuring some important parameter of performance, such as plate current or power output, while filament voltage is slowly reduced. At some point in filament voltage there will be a noticeable reduction in plate current or power output, and operation must be at a filament volt-

age slightly higher than the point at which performance appeared to deteriorate. This point should be periodically checked to maintain proper operation, and line or filament voltage regulation must be such that this procedure for operating at slightly reduced voltage is feasible.

STANDBY OPERATION - Both anode and base cooling must be applied whenever filament power is applied even though no other voltages are present, since sixty to eighty percent of the filament power appears as heat at the anode. In the absence of cooling, temperatures will rise to levels which are detrimental to long life, and if the anode coolant lines are obstructed the cooling jacket may rupture from generated steam pressure.

HIGH VOLTAGE - Normal operating voltages used with the 3CW20,000A1 are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

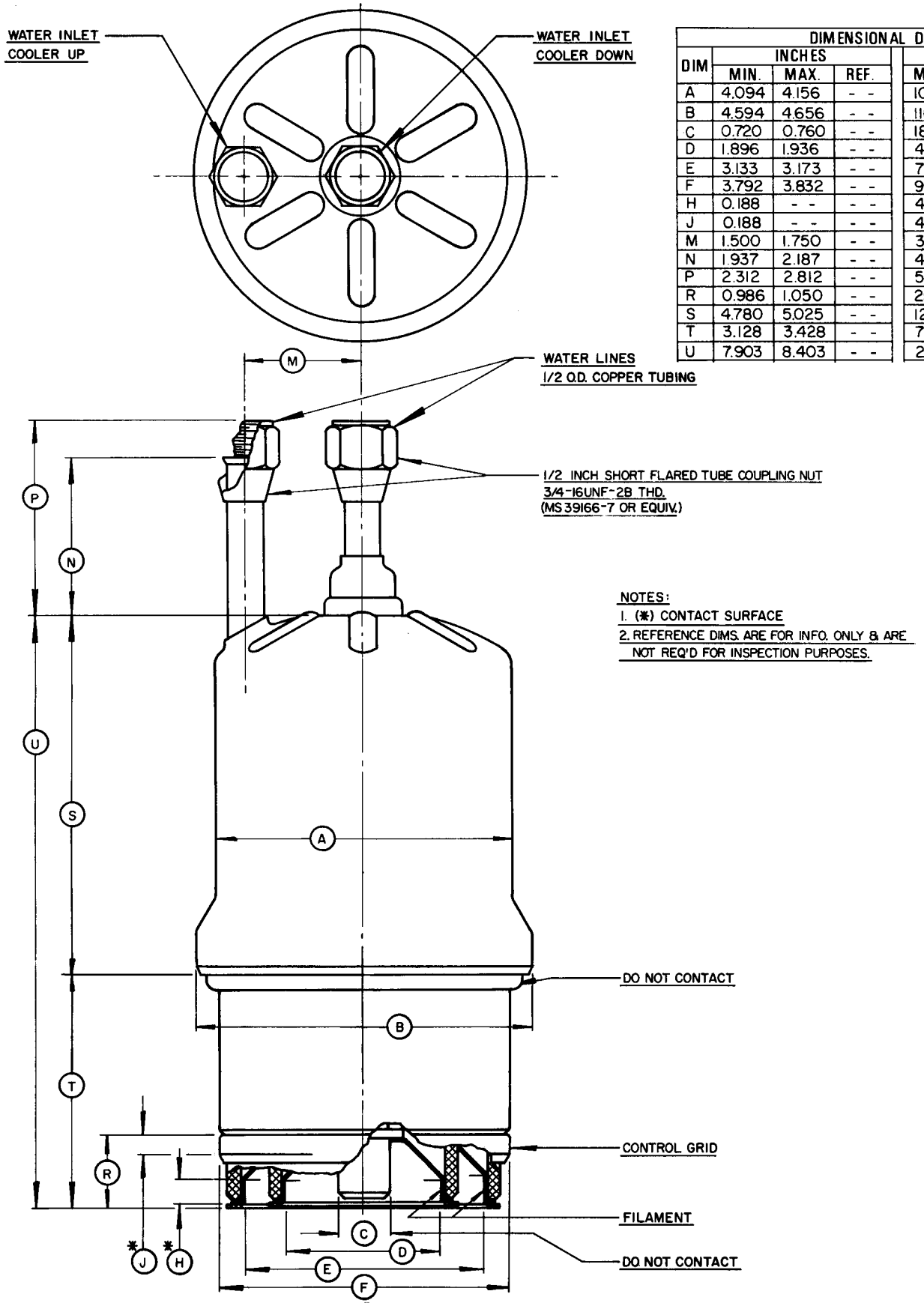
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as the 3CW-20,000A1, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry --- the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

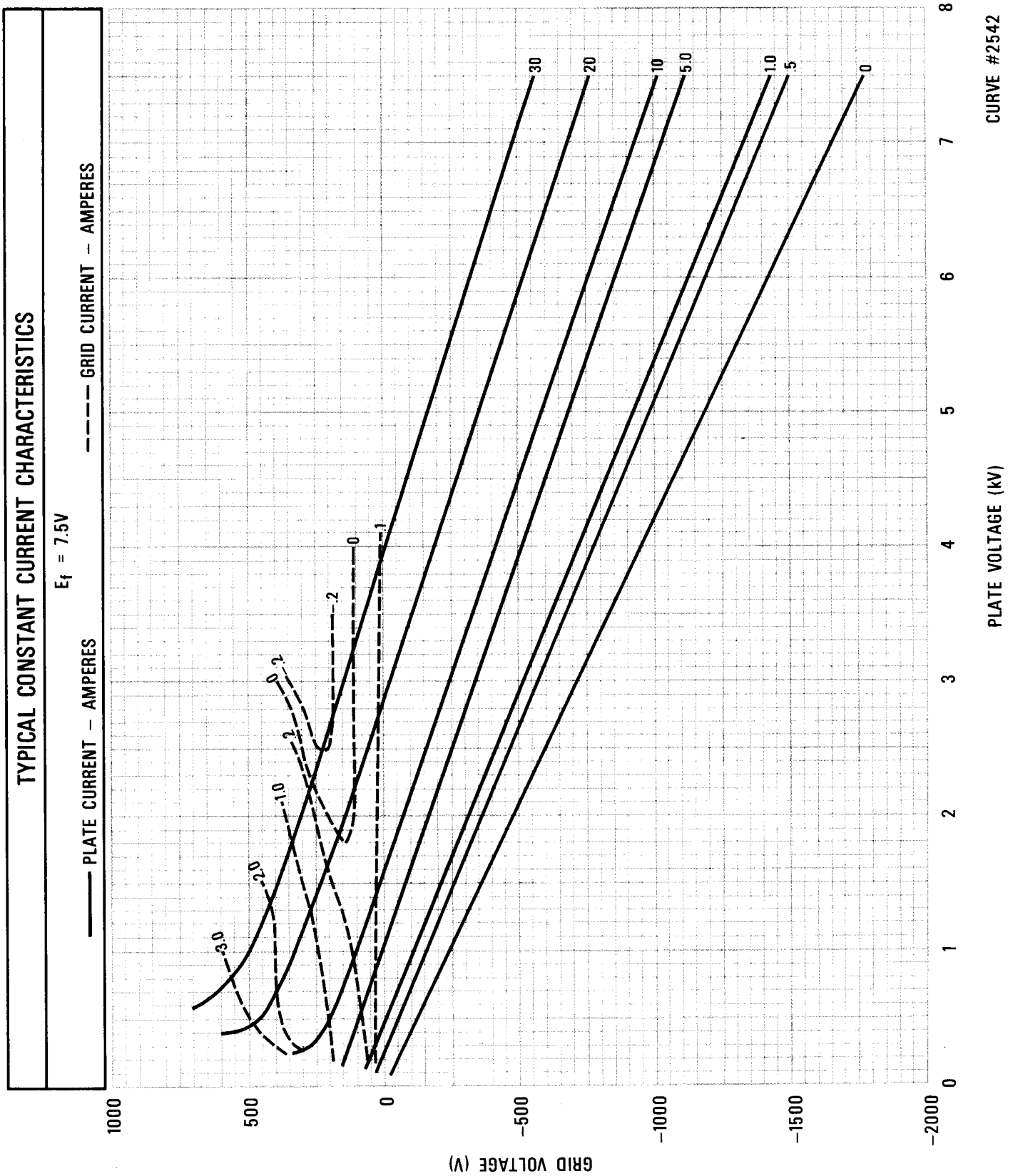
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

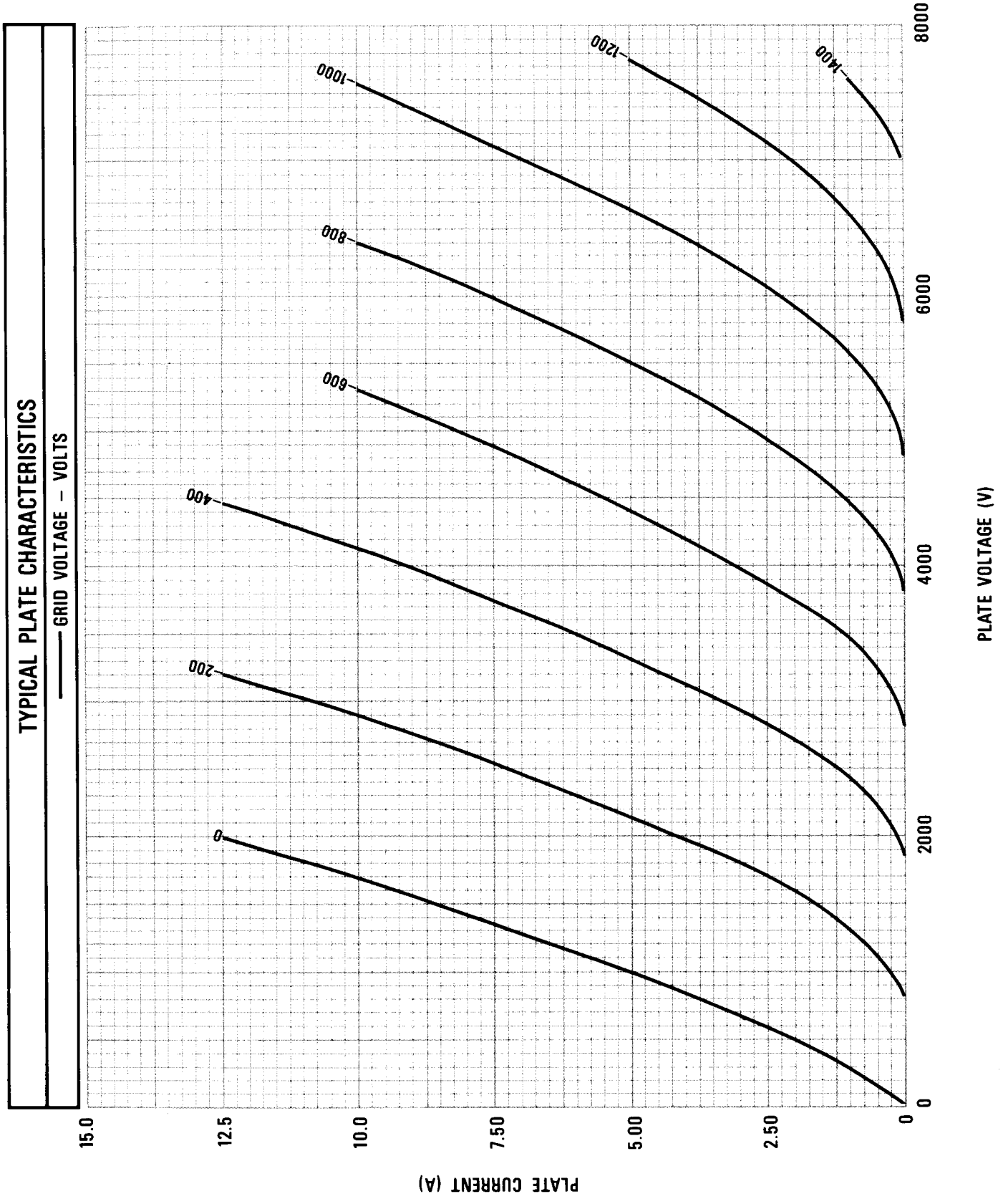
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to the Application Engineering Dept., Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Califomia, 94070 for information and recommendations.



DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.094	4.156	- -	103.99	105.56	- -
B	4.594	4.656	- -	116.69	118.26	- -
C	0.720	0.760	- -	18.29	19.30	- -
D	1.896	1.936	- -	48.16	49.17	- -
E	3.133	3.173	- -	79.58	80.59	- -
F	3.792	3.832	- -	96.32	97.33	- -
H	0.188	- -	- -	4.78	- -	- -
J	0.188	- -	- -	4.78	- -	- -
M	1.500	1.750	- -	38.10	44.45	- -
N	1.937	2.187	- -	49.20	55.55	- -
P	2.312	2.812	- -	58.72	71.42	- -
R	0.986	1.050	- -	25.04	26.67	- -
S	4.780	5.025	- -	121.41	127.64	- -
T	3.128	3.428	- -	79.45	87.07	- -
U	7.903	8.403	- -	200.74	213.44	- -

NOTES:
1. (*) CONTACT SURFACE
2. REFERENCE DIMS. ARE FOR INFO. ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.


TYPICAL CONSTANT CURRENT CHARACTERISTICS
E_f = 7.5V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
1000
500
0
−500
−1000
−1500
−2000
PLATE VOLTAGE (kV)
0
1
2
3
4
5
6
7
8
30
20
10
5.0
1.0
.5
0
-3.0
-2.0
-1.0
-.2
-.1
0
.1
.2
CURVE #2542


TYPICAL PLATE CHARACTERISTICS
GRID VOLTAGE – VOLTS
0
200
400
600
800
1000
1200
1400
15.0
12.5
10.0
7.50
5.00
2.50
0
PLATE CURRENT (A)
0
2000
4000
6000
8000
PLATE VOLTAGE (V)

TECHNICAL DATA

3CW20,000A3

WATER-COOLED MEDIUM-MU POWER TRIODE

The EIMAC 3CW20,000A3 is a ceramic/metal power triode intended primarily for use as a power oscillator in industrial-heating applications. It is also recommended for use as a grounded-grid FM amplifier, as a conventional plate-modulated amplifier, or as a linear amplifier.

The anode dissipation rating is 20,000 watts with water cooling.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	7.5 ± 0.4	V
Current, at 7.5 V	100	A
Amplification Factor (Average)	20	
Direct Interelectrode Capacitances [2]		
Cin	53	pF
Cout	1.35	pF
Cgp	34	pF
Frequency of Maximum Ratings (CW)	140	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special, Coaxial
Recommended Air System Socket	EIMAC SK-1300
Operating Position	Vertical, base up or down
Cooling	Water and Forced Air
Maximum Operating Temperature:	
Envelope and Ceramic/Metal Seals	250°C
Maximum Overall Dimensions:	
Length	10.21 in; 259.3 mm
Diameter	4.65 in; 118.1 mm
Net Weight	12 lbs; 5.5 kg

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Printed in U.S.A.

RADIO-FREQUENCY POWER AMPLIFIER PLATE-MODULATED

Class C

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	5500	VOLTS
DC PLATE CURRENT	3.0	AMPERES
PLATE DISSIPATION	13.5	KILOWATTS
GRID DISSIPATION	250	WATTS

TYPICAL OPERATION

DC Plate Voltage	4000	5000	Vdc
DC Grid Voltage	-480	-600	Vdc
DC Plate Current	3.0	3.0	Adc
DC Grid Current	660	550	mAdc
Driving Power	530	515	W
Plate Output Power	9.7	12.4	kW

RADIO-FREQUENCY LINEAR AMPLIFIER

Grounded-Grid, Class AB2

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	7000	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	20	KILOWATTS
GRID DISSIPATION	250	WATTS

TYPICAL OPERATION

DC Plate Voltage	6000	7000	Vdc
DC Grid Voltage[1]	-270	-325	Vdc
Zero-Sig. Plate Current	500	500	mAdc
Max-Sig DC Plate Current	4.0	4.0	Adc
Max-Sig DC Grid Current	300	250	mAdc
Peak RF Grid Voltage	540	585	v
Driving Power	1900	2050	W
Plate Output Power	18	20	kW

1. Adjust to give specified zero-signal dc plate current.

RADIO-FREQUENCY INDUSTRIAL OSCILLATOR

Class C

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	7000	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	20	KILOWATTS
GRID DISSIPATION	250	WATTS

TYPICAL OPERATION, Optimum Load

DC Plate Voltage	6000	7000	Vdc
DC Grid Voltage	-575	-670	Vdc
DC Plate Current	4.0	4.0	Adc
DC Grid Current	610	670	mAdc
Plate Input Power	24	28	kW
Plate Output Power	18.9	22.4	kW

RADIO-FREQUENCY POWER AMPLIFIER

Grounded-Grid, Class C

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	7000	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	20	KILOWATTS
GRID DISSIPATION	250	WATTS

TYPICAL OPERATION

DC Plate Voltage	6000	7000	Vdc
DC Grid Voltage	-535	-625	Vdc
DC Plate Current	4.0	4.0	Adc
DC Grid Current	545	530	mAdc
Driving Power	3700	4100	W
Plate Output Power	20.5	24.5	kW

NOTE: TYPICAL OPERATION data are obtained by calculation from published characteristic curves or actual measurement. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament Current at 7.5 Volts	94.0	104.0	A
Interelectrode Capacitance (grounded cathode connection)[1]			
Cin	48.0	58.0	pF
Cout	1.2	1.5	pF
Cgp	30.0	38.0	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 3CW20,000A3 must be operated vertically, anode down or up, and should be protected from shock and vibration.

COOLING - The anode of the 3CW20,000A3 is cooled by circulating water through the integral anode water jacket. The cooling table shows minimum water-flow rates at various plate dissipation levels and assumes a temperature rise for the water of 10°C. Inlet water temperature should never exceed 55°C and outlet water temperature should never exceed 70°C. Where a liquid coolant other than water is used, the difference in cooling characteristics should be carefully considered and taken into account. Maximum system pressure must not exceed 50 psi.

Minimum Cooling Water-Flow Requirements		
Plate Dissipation (kW)	Water Flow (gpm)	Pressure Drop Approx. psi
10	11.0	11.5
15	12.0	13.5
20	14.0	17.0

A major factor effecting long life of water-cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 $K\Omega/cm^3$, and preferably above 250 $K\Omega/cm^3$. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of insulating hose column if metal nipples or fittings are used as electrodes.

Forced-air cooling of the base is also required, with 30 to 50 cfm of air at 50°C maximum directed up into and around the base of the tube to cool the grid and filament contact areas.

Both anode and base cooling should be applied before or simultaneously with electrode voltages, including the filament, and should normally be maintained for a short period of time after all voltages are removed to allow for tube cooldown.

ELECTRICAL

FILAMENT OPERATION - Filament voltage should be measured at the terminals with a 1 percent rms responding meter. The peak emission at rated filament voltage of the EIMAC 3CW20,000A3 is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 3CW20,000A3 by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is done by measuring some important parameter of performance such as plate current, power output, or an increase in distortion. Operation must be at a filament voltage slightly higher than the point at which performance appears to deteriorate.

INPUT CIRCUIT - When the 3CW20,000A3 is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier, it is suggested that the cathode tank circuit operate at a "Q" of two or more.

STANDBY OPERATION - Coolant must be circulated through the anode water jacket whenever filament power is applied even though no other voltages are present. Sixty to eighty percent of the filament power appears as heat in the anode. In the absence of coolant flow, temperatures will rise to levels which are detrimental to long life. If the coolant lines are obstructed the coolant jacket may rupture from the generated steam pressure.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

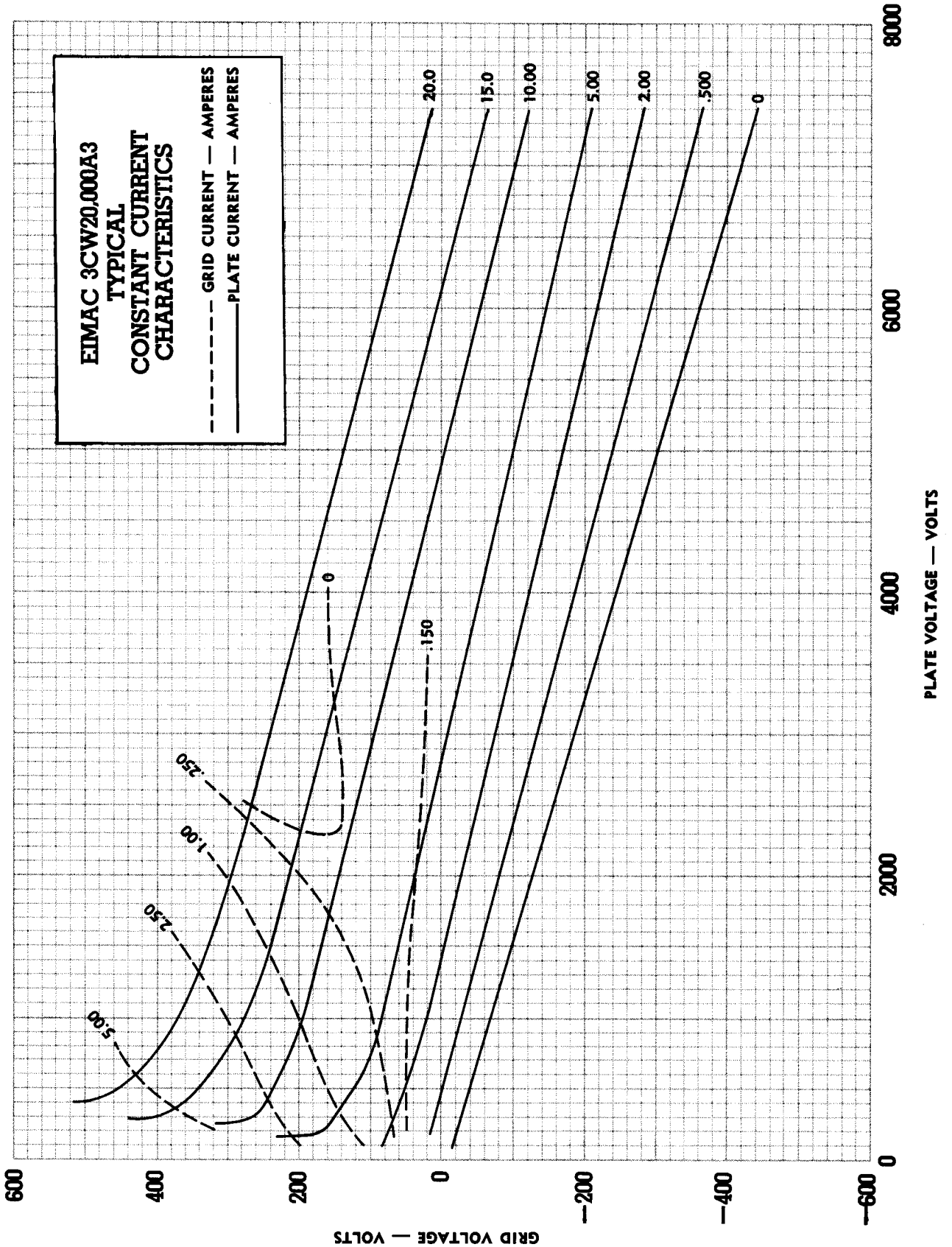
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

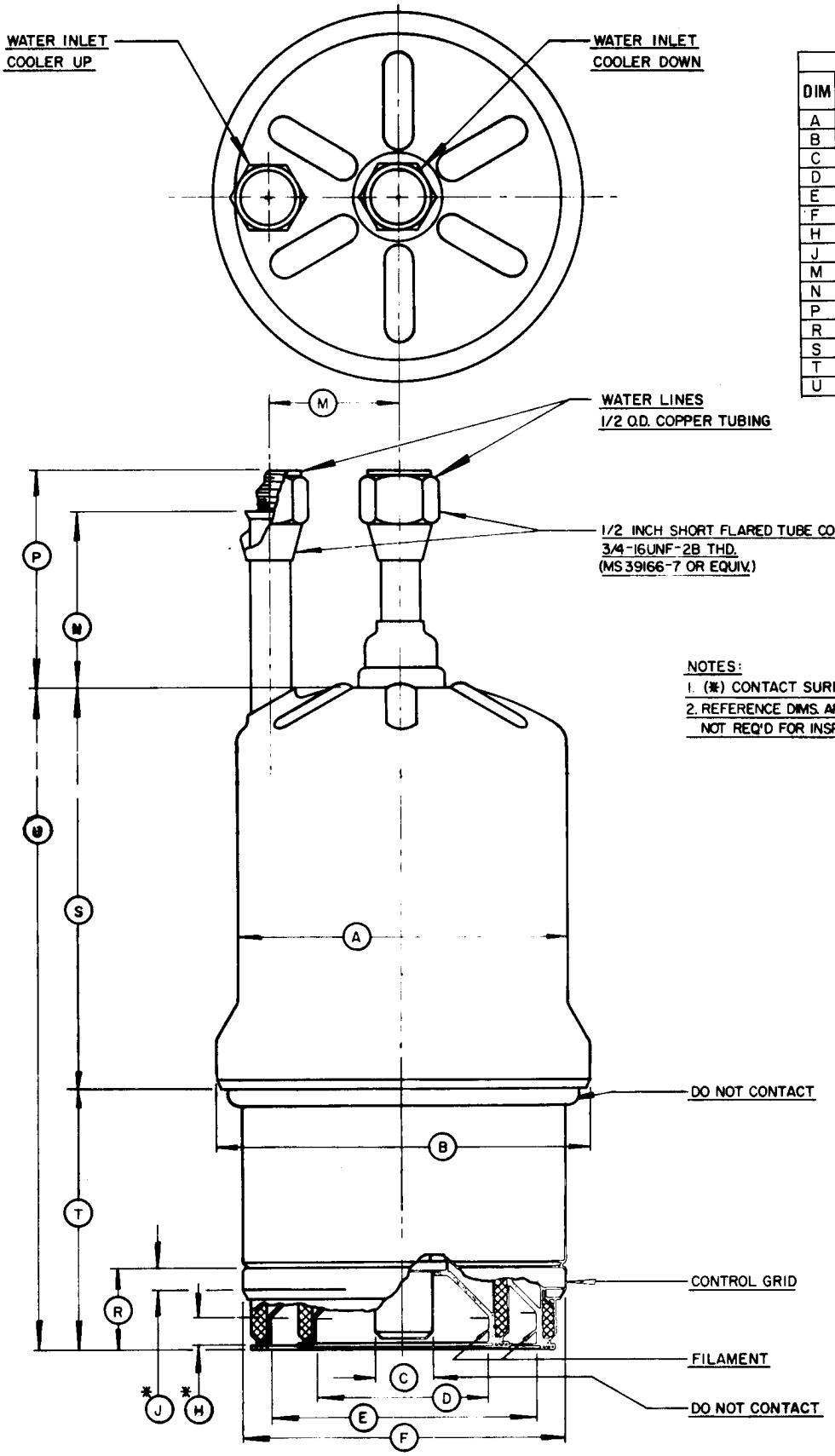
Many EIMAC power tubes, such as the 3CW-20,000A3, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry---the more power invloved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal plate over-current interlock and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltage.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with each tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, we strongly recommend use of some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc.

SPECIAL APPLICATION - Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


EIMAC 3CW20,000A3
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GRID CURRENT — AMPERES
PLATE CURRENT — AMPERES
20.0
15.0
10.00
5.00
2.00
.500
0
.150
0
.250
1.00
2.50
5.00
600
400
200
0
—200
—400
—600
0
2000
4000
6000
8000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS



DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.094	4.156	- -	104.0	105.6	- -
B	4.594	4.656	- -	116.7	118.3	- -
C	0.600	0.760	- -	15.2	19.3	- -
D	1.896	1.936	- -	48.2	49.2	- -
E	3.133	3.173	- -	79.6	80.6	- -
F	3.792	3.832	- -	96.3	97.3	- -
H	0.188	- -	- -	4.8	- -	- -
J	0.188	- -	- -	4.8	- -	- -
M	1.500	1.750	- -	38.1	44.4	- -
N	1.937	2.187	- -	49.2	55.5	- -
P	2.312	2.812	- -	58.7	71.4	- -
R	0.986	1.050	- -	25.0	26.7	- -
S	4.780	5.025	- -	121.4	127.6	- -
T	3.128	3.428	- -	79.4	87.1	- -
U	7.903	8.403	- -	200.7	213.4	- -

NOTES:
1. (*) CONTACT SURFACE
2. REFERENCE DIMS. ARE FOR INFO. ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.

3CW20,000A7

WATER-COOLED HIGH-MU POWER TRIODE

TECHNICAL DATA



The Eimac 3CW20,000A7 is a ceramic and metal power triode intended to be used as a zero-bias Class-B amplifier in audio or radio-frequency applications. Operation with zero grid bias offers circuit simplicity by eliminating the bias supply. In addition, grounded-grid operation is attractive since a power gain as high as twenty times can be obtained with the 3CW20,000A7.

The 3CW20,000A7 is electrically identical to the air-cooled 3CX10,000A7 except for its 20kW plate dissipation rating.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated-Tungsten				
Voltage		7.5		volts
Current	94		104	amperes
Amplification Factor		200		

Direct Interelectrode Capacitances:	Min.	Max.
Grid-Filament	50.0	62.0 uuf
Grid-Plate	32.0	40.0 uuf
Plate-Filament		0.3 uuf
Frequency for Maximum Ratings		140 Mc

MECHANICAL

Base	Coaxial
Recommended Socket	Eimac SK-1300
Operating Position	Vertical, base up or down
Cooling	Water and Forced air
Maximum Operating Temperatures:	
Anode Core	250° C
Ceramic-to-Metal Seals	250° C
Maximum Dimensions:	
Height	11.4 inches
Diameter	4.7 inches
Net Weight	12 pounds

RADIO-FREQUENCY LINEAR AMPLIFIER

Grounded Grid, Class-B

MAXIMUM RATINGS

DC PLATE VOLTAGE	7000 MAX. VOLTS
DC PLATE CURRENTS	5.0 MAX. AMPS
PLATE DISSIPATION	20 MAX. KW
GRID DISSIPATION	500 MAX. WATTS

*Approximate Values

TYPICAL OPERATION, Single-Tone Conditions

DC Plate Voltage	7000	7000 volts
Zero-Sig DC Plate Current*	0.60	0.60 amps
Max-Sig DC Plate Current	3.72	5.00 amps
Max-Sig DC Grid Current	0.71	1.00 amp
Driving Impedance	35	32 ohms
Resonant Load Impedance	1020	745 ohms
Max-Sig Driving Power	885	1540 watts
Peak Envelope Plate Output Power	17,700	24,200 watts
Power Gain	20.0	15.7 times

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AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-B, Grid Driven

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	7000 MAX. VOLTS
DC PLATE CURRENT	5.0 MAX. AMPS
PLATE DISSIPATION	20 MAX. KW
GRID DISSIPATION	500 MAX. WATTS

*Approximate Values

TYPICAL OPERATION, Two Tubes, Sinusoidal Wave

DC Plate Voltage	5000	7000 volts
DC Grid Voltage	0	0 volts
Zero-Sig DC Plate Current*	1.2	1.2 amps
Max-Sig DC Plate Current	10.0	10.0 amps
Max-Sig DC Grid Current	1.2	2.1 amps
Driving Power	290	560 watts
Peak AF Driving Voltage (Per Tube)	240	310 volts
Load Resistance, Plate-to-Plate	1030	1520 ohms
Max-Sig Plate Output Power	31,000	47,700 watts

RADIO-FREQUENCY LINEAR AMPLIFIER

Carrier Conditions, Grounded-Grid, Class-B_2

MAXIMUM RATINGS

DC PLATE VOLTAGE	7000 MAX. VOLTS
DC PLATE CURRENT	5.0 MAX. AMPS
PLATE DISSIPATION	20 MAX. KW
GRID DISSIPATION	500 MAX. WATTS

*Approximate Values
†Modulation Crest Conditions

TYPICAL OPERATION

DC Plate Voltage	7000 volts
DC Grid Voltage	0 volts
Zero-Sig DC Plate Current*	0.6 amp
DC Plate Current	2.4 amps
DC Grid Current	0.25 amp
Driving Impedance†	32 ohms
Peak Driving Voltage†	310 volts
Driving Power	330 watts
Plate Output Power	5650 watts

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR, Class-C

MAXIMUM RATINGS

DC PLATE VOLTAGE	7000 MAX.VOLTS
DC PLATE CURRENT	4.0 MAX. AMPS
PLATE DISSIPATION	20 MAX. KW
GRID DISSIPATION	500 MAX. WATTS

TYPICAL OPERATION

DC Plate Voltage	5000	7000 volts
DC Plate Current	4.0	4.0 amps
DC Grid Voltage	-210	-230 volts
DC Grid Current	840	775 mA
Peak RF Grid Voltage	510	555 volts
Grid Driving Power	420	530 watts
Plate Output Power	14	21.3 kW

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER, Class-C

MAXIMUM RATINGS

DC PLATE VOLTAGE	5500 MAX. VOLTS
DC PLATE CURRENT	3.0 MAX. AMPS
PLATE DISSIPATION†	13.5 MAX. KW
GRID DISSIPATION	500 MAX. WATTS

†Corresponds to 20 kW at 100% sine-wave modulation

TYPICAL OPERATION

DC Plate Voltage	5000 volts
DC Plate Current	3.0 amps
DC Grid Voltage	-200 volts
DC Grid Current	775 mA
Peak RF Grid Voltage	490 volts
Grid Driving Power	380 watts
Plate Output Power	11.9 kW

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made. Adjustment of the rf grid drive to obtain the specified zero-signal plate current at the specified bias and plate voltage is assumed.

APPLICATION

MECHANICAL

Mounting—The 3CW20,000A7 must be operated vertically, base down or up. The tube must be protected from severe vibration and shock.

Socket—The SK-1300 socket is available for use with the 3CW20,000A7. Base cooling is accomplished by directing approximately 30 cfm of air at a static pressure of 0.1 inch through the socket and over the base seals.

Cooling—The anode of the 3CW20,000A7 is cooled by circulating water through the integral anode-water jacket. The table below lists minimum water-flow rates at various plate dissipation levels

Minimum Cooling Water-Flow Requirements

Plate Dissipation (kW))	Water Flow (gpm)	Pressure Drop (psi)
10	6.3	4.9
15	9.0	9.2
20	12.0	15.0

*Since power dissipated by the filament represents 750 watts and grid dissipation can reach 500 watts, 1250 watts has been added to anode dissipation in preparing this tabulation.

The cooling table assumes that the maximum outlet-water temperature will be below 70°C to preclude "spot" boiling. Further, inlet-water temperature must not exceed 60°C. In all cases, maximum system water pressure must not exceed 50 pounds per square inch. Water flow and air flow must be started before applying any voltages to the tube and may be stopped simultaneously with the removal of tube voltages. Suitable flow and temperature interlocks should be provided to protect the tube from inadequate flow rates.

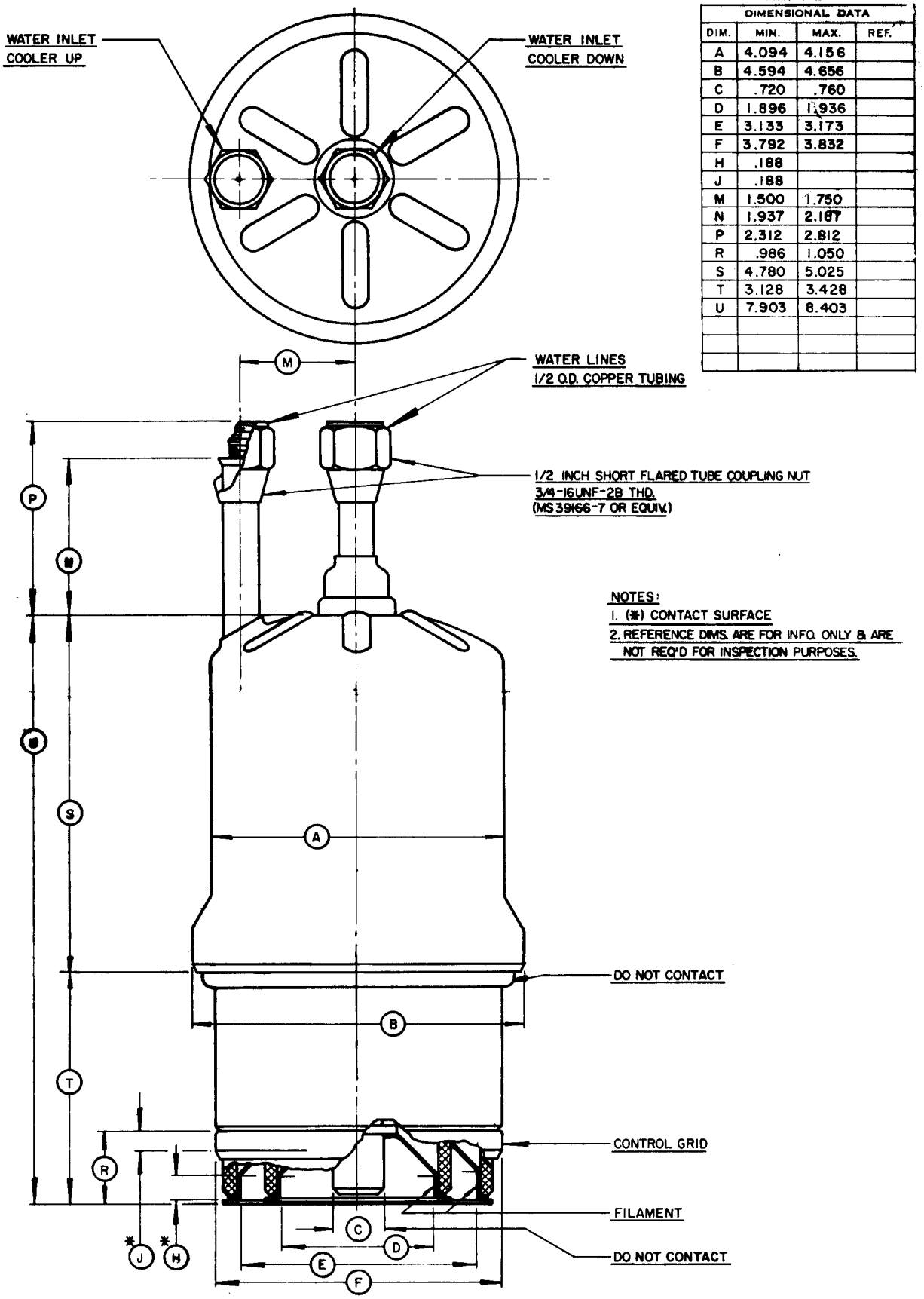
ELECTRICAL

Filament—The rated filament voltage for the 3CW20,000A7 is 7.5 volts Filament voltage, as measured at the socket, should be maintained at this value for consistent performance and maximum tube life. In no case should it be allowed to vary from 7.5 volts by more than plus or minus five percent.

Input Circuit—When the 3CW20,000A7 is operated as a grounded-grid rf amplifier, the use of a resonant tank line in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier, it is suggested that the cathode tank circuit operate at a "Q" of two or more.

Class-C Operation—Although designed specifically for Class-B service, the 3CW20,000A7 may be operated as a Class-C amplifier or oscillator or as a plate-modulated radio-frequency amplifier. The zero-bias characteristic can be used to advantage in Class-C amplifiers by employing only grid leak bias. If driving power should fail, plate dissipation is then kept to a low value because the tube will be operating at normal, static, zero-bias conditions.

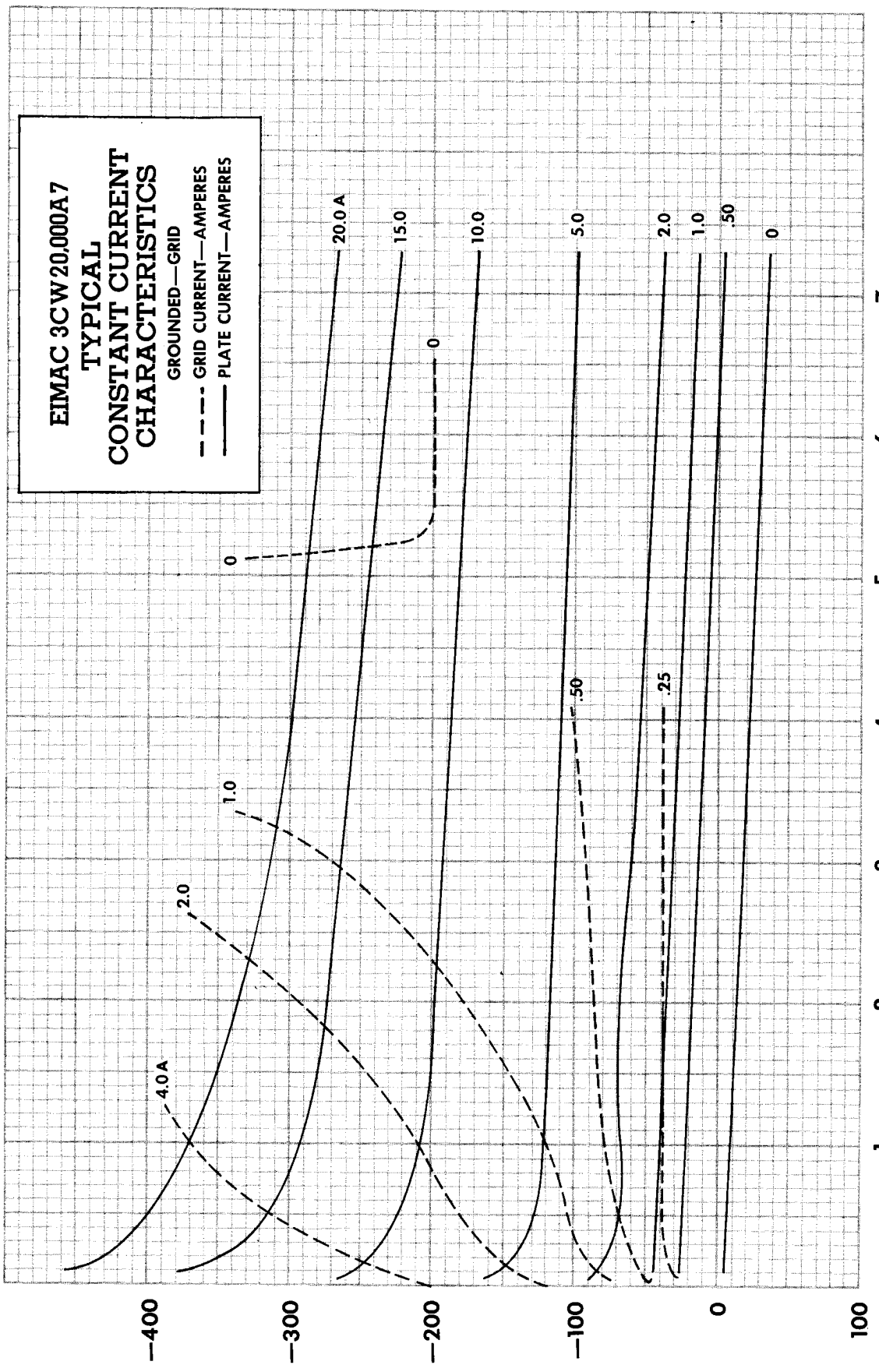
Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.

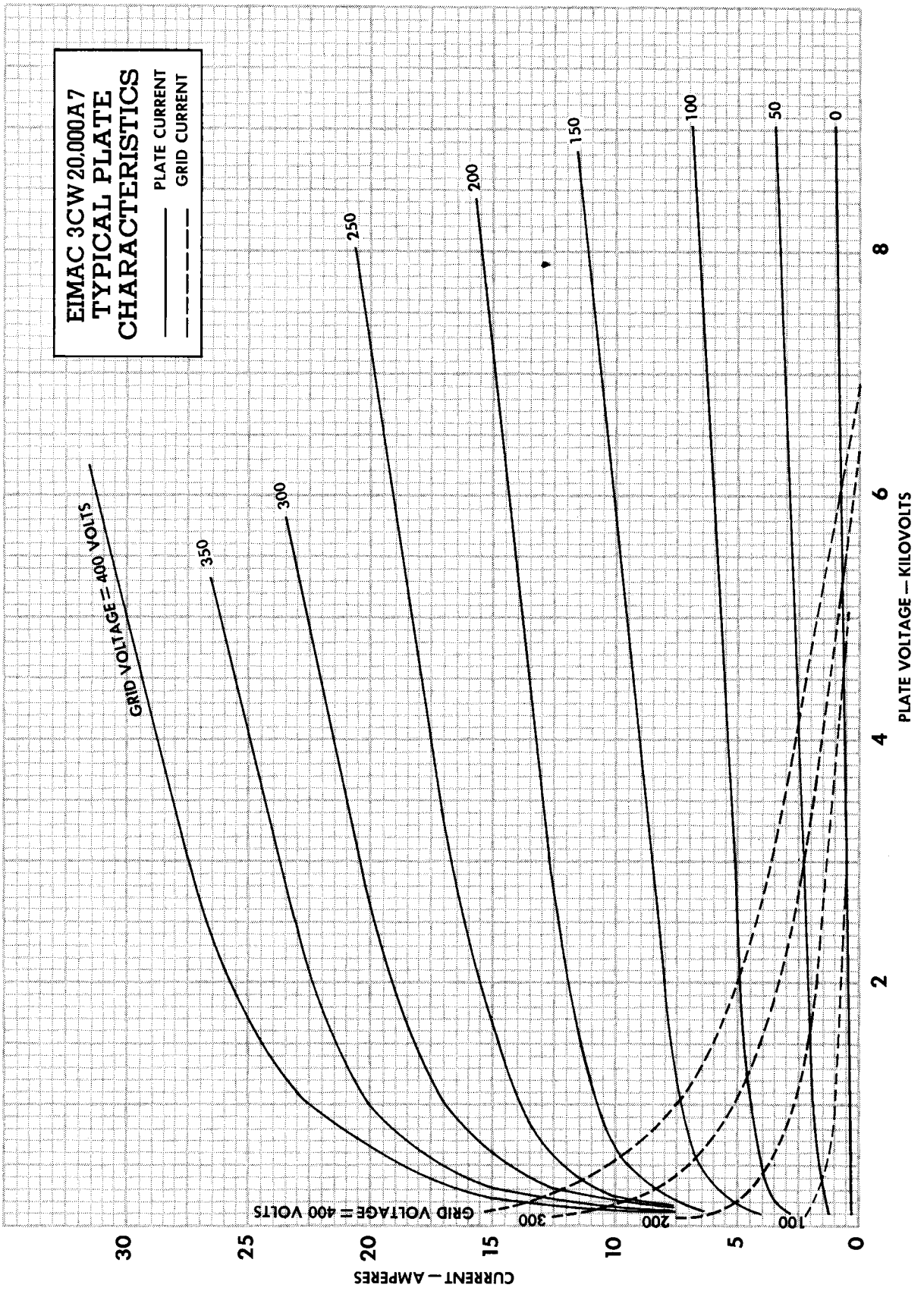


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A	4.094	4.156	
B	4.594	4.656	
C	.720	.760	
D	1.896	1.936	
E	3.133	3.173	
F	3.792	3.832	
H	.188		
J	.188		
M	1.500	1.750	
N	1.937	2.187	
P	2.312	2.812	
R	.986	1.050	
S	4.780	5.025	
T	3.128	3.428	
U	7.903	8.403	

NOTES:
1. (*) CONTACT SURFACE
2. REFERENCE DIMS. ARE FOR INFO. ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.


EIMAC 3CW20,000A7
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED—GRID
- - - - GRID CURRENT—AMPERES
——— PLATE CURRENT—AMPERES
20.0 A
15.0
10.0
5.0
2.0
1.0
.50
0
4.0 A
2.0
1.0
.50
.25
0
0
1
2
3
4
5
6
7
PLATE -TO-GRID VOLTAGE – KILOVOLTS
—400
—300
—200
—100
0
100
FILAMENT-TO-GRID VOLTAGE – VOLTS

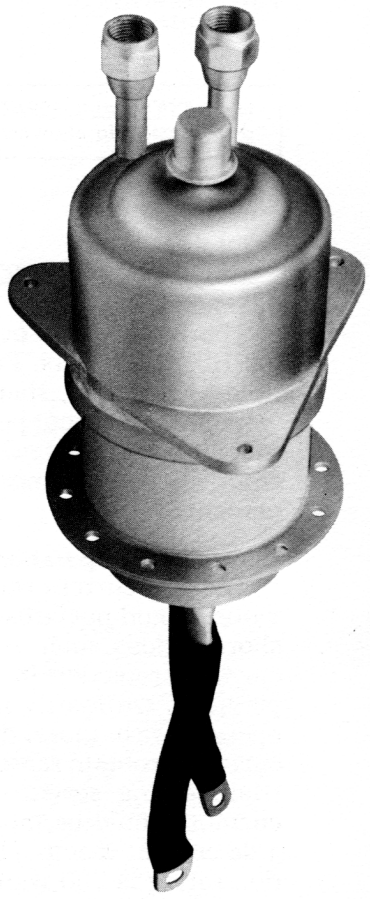

EIMAC 3CW 20,000A7
TYPICAL PLATE
CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
GRID VOLTAGE = 400 VOLTS
350
300
250
200
150
100
50
0
GRID VOLTAGE = 400 VOLTS
300
200
100
CURRENT — AMPERES
30
25
20
15
10
5
0
2
4
6
8
PLATE VOLTAGE — KILOVOLTS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

3CW20,000H3

MEDIUM-MU

WATER-COOLED
POWER TRIODE



The Eimac 3CW20,000H3 is a water-cooled, ceramic-metal power triode designed primarily for use in industrial radio-frequency heating services. Its water-cooled anode is conservatively rated at 20 kilowatts of plate dissipation with low water flow and pressure drop.

Input of 40 kilowatts is permissable up to 90 megacycles. Plentiful reserve emission is available from its 750 watt filament. The grid structure is rated at 250 watts, making this tube an excellent choice for severe applications.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated-Tungsten				
Voltage		7.5		volts
Current	94		104	amps
Amplification Factor		20		
Interelectrode Capacitances, Grounded Cathode:				
Grid-Filament	48		58	μμf
Plate-Filament	1.2		1.5	μμf
Grid-Plate	30		38	μμf
Frequency for Maximum Ratings			90	Mc

MECHANICAL

Base	See Outline
Operating Position	Vertical, base up or down
Cooling	Water and Forced Air
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250°C
Maximum Dimensions:	
Height	See Outline
Diameter	See Outline
Net Weight	12 pounds

(Effective 2-1-65) © 1965, 1968 by Varian

Printed in U.S.A.

RF INDUSTRIAL OSCILLATOR

Class-C (Filtered DC Power Supply)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	12,000 VOLTS
DC PLATE CURRENT	4.0 AMPS
DC GRID VOLTAGE	—1000 VOLTS
DC GRID CURRENT	0.6 AMP
PLATE INPUT POWER	40 KW
PLATE DISSIPATION (NOMINAL)	20 KW

TYPICAL OPERATION*

DC Plate Voltage	7000	10,000 volts
DC Plate Current	4.0	4.0 amps
DC Grid Voltage	—670	—800 volts
DC Grid Current	.275	.315 amps
Peak Positive Grid Voltage	340	340 volts
Driving Power	260	340 watts
Plate Input Power	28	40 kW
Plate Dissipation	9	12 kW
Plate Output Power	19	28 kW
Approximate Load Impedance	720	1270 ohms

*Loaded Conditions

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

APPLICATION

ELECTRICAL

Filament

The rated filament voltage for the 3CW20,000H3 is 7.5 volts. Filament voltage, as measured at the tube, should be maintained at this value for consistent performance and maximum tube life. In no case should it be allowed to vary from 7.5 volts by more than plus or minus five percent.

Control Grid Operation

The grid current rating is 0.6 ampere dc. This value should not be exceeded for more than very short periods such as during tuning and over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.2 to 0.4 amp grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 250 watts.

Plate Operation

Maximum plate voltage rating of 12,000 volts and maximum plate current of 4.0 amps should not be applied simultaneously as rated plate dissipation may be exceeded. The 40 kilowatts input rating applies for Class C amplifier or oscillator service with no modulation.

Plate over-current protection should be provided to remove plate voltage quickly in the event of an over-load or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

High Frequency Operation

The 3CW20,000H3 is usable to 140 Mc. At this frequency, plate voltage must be reduced to 7000 volts in Class C service.

MECHANICAL

Mounting

The 3CW20,000H3 must be mounted vertically, either base up or down.

Cooling

The anode of the 3CW20,000H3 is cooled by circulating water through the integral anode-water jacket. The table below lists minimum water-flow rates at various plate dissipation levels. The table is based upon a water temperature rise of 20°C.

MINIMUM COOLING WATER-FLOW REQUIREMENTS

Plate Dissipation (kW)	Water Flow (gpm)	Pressure Drop (psi)
10	2	2.5
15	3	3.0
20	4	3.5
25	5	4.0

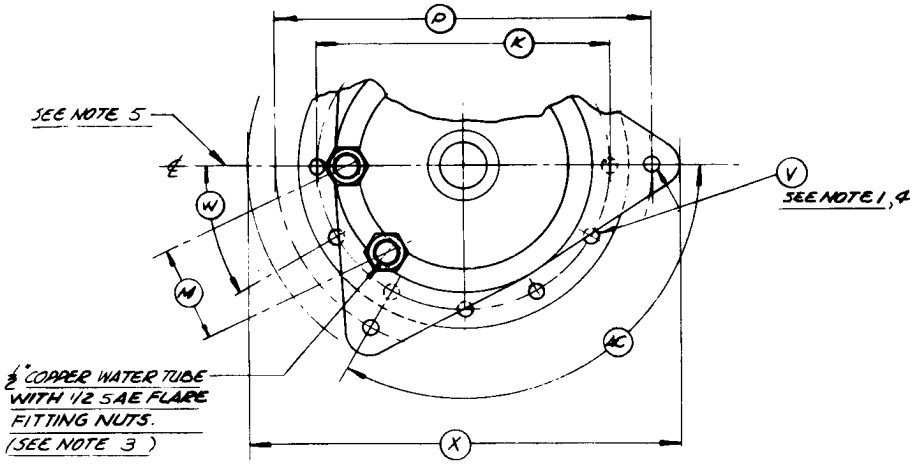
Since power dissipated by the filament represents 750 watts and grid dissipation can reach 250 watts, 1000 watts has been added to anode dissipation in preparing this tabulation.

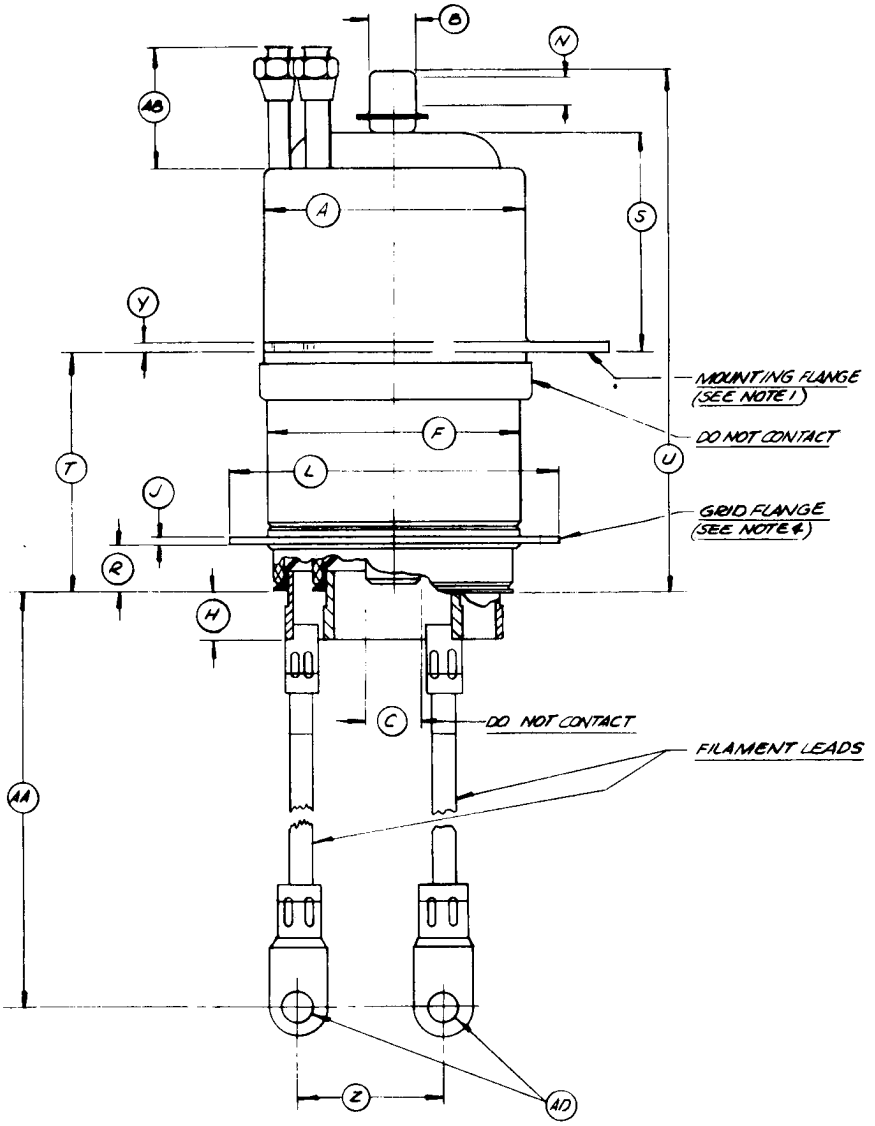
The cooling table assumes that the maximum outlet-water temperature will be below 70°C to preclude "spot" boiling.

Additional forced-air cooling of the tube's base is also required to maintain ceramic-to-metal seal temperatures below the 250°C maximum. Approximately 40 cfm of cooling air directed into the base structure will generally satisfy this requirement.

Special Application

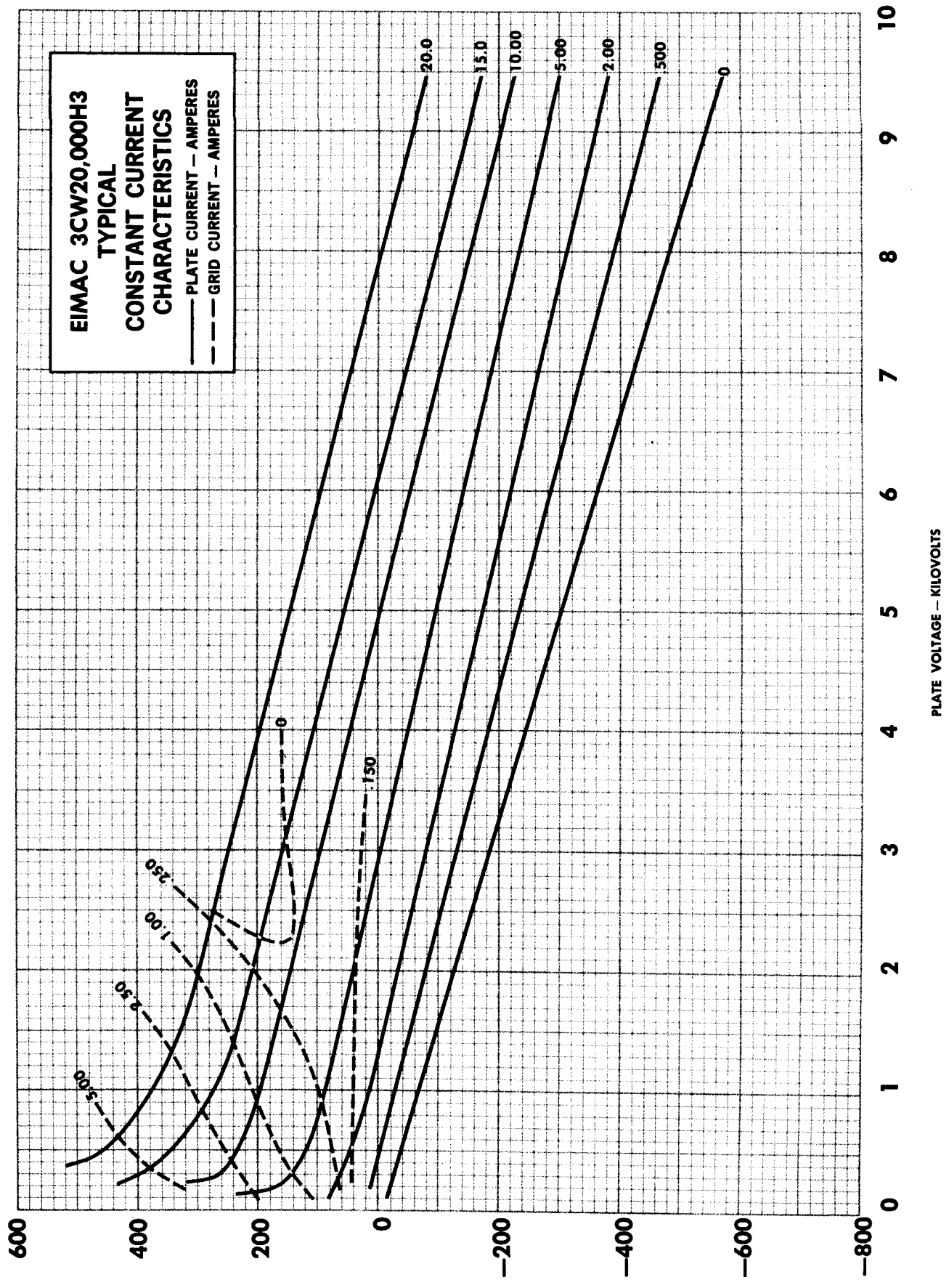
If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Div., Eimac Division of Varian, 301 Industrial Way, San Carlos, Calif. for information and recommendations.





DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A	4.050	4.250	
B	.860	.890	
C	.720	.760	
F	3.792	3.832	
H	.530	.700	
J			.125
K	4.425	4.445	
L	5.030	5.090	
M			1.500
N	.375		
P	5.990	6.010	
R	.800	.860	
S	3.300	3.500	
T	3.950	4.100	
U	8.250	8.750	
V			.250
W	29°	31°	
X			6.750
Y			.250
Z			2.000
AA	8.500	9.000	
AB			2.000
AC	118°	122°	
AD			.390

NOTES:
1. 3 MOUNTING HOLES IN MTG FLANGE.
2. REF. DIMS. ARE FOR INFO. ONLY AND ARE NOT REQ'D FOR INSP. PURPOSES.
3. EITHER FITTING CAN BE USED AS INLET OR OUTLET.
4. 12 HOLES IN GRID FLANGE.
5. MTG. FLANGE, FIL. LEADS & WATER FITTINGS ARE TO BE ORIENTED AS SHOWN.


EIMAC 3CW20,000H3
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
20.0
15.0
10.00
5.00
2.00
.500
0
5.00
2.50
1.00
.250
0
.150
600
400
200
0
-200
-400
-600
-800
0
1
2
3
4
5
6
7
8
9
10
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS

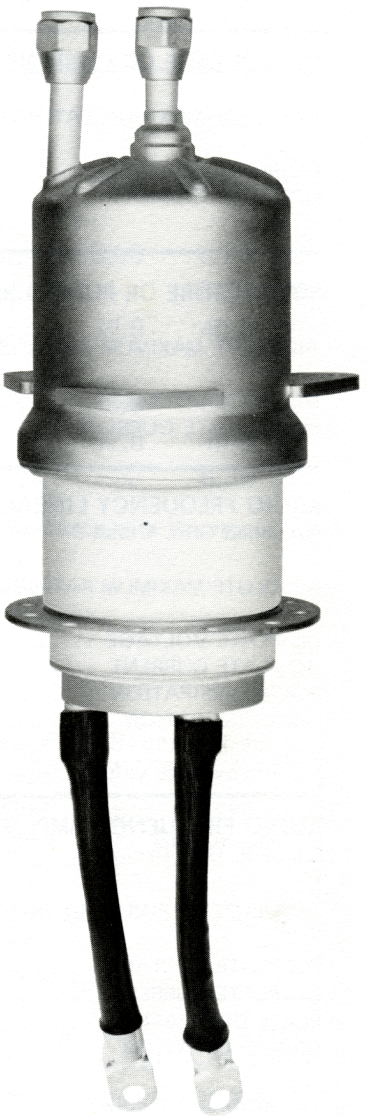
3CW20,000H7

WATER-COOLED
HIGH-MU
POWER TRIODE

The EIMAC 3CW20,000H7 is a ceramic/metal power triode intended for use as a dc voltage or current regulator, or in high-voltage switch tube or pulsed regulator service.

In addition, since the tube is identical to the EIMAC 3CW20,000A7 except for the anode and grid flanges and the addition of the filament flying leads, the tube is useful as a zero-bias Class B amplifier in audio or rf applications. Operation with zero grid bias offers circuit simplicity by eliminating the bias supply. In addition, grounded-grid operation is attractive since a power gain as high as twenty times can be obtained with the tube.

The anode dissipation rating is 20,000 watts with water cooling.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	7.5 ± 0.4	V
Current, at 7.5 V	100	A
Amplification Factor (Average)	200	
Direct Interelectrode Capacitances [2]		
Cin	59	pF
Cout	0.2	pF
Cgp	36	pF
Frequency of Maximum Rating (CW)	110	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special, with grid contact flange & filament flying leads
Operating Position	Vertical, Anode up or down
Cooling	Water or equivalent liquid & forced air

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Maximum Overall Dimensions:

Length (including filament leads)	20.7 in; 52.2 cm
Diameter (anode mounting flange pitch circle)	6.75 in; 17.1 cm
Maximum Operating Temperature:	
Envelope & Ceramic/Metal Seals	250°C
Net Weight (Approximate)	10.6 lbs; 4.8 kg

DC VOLTAGE OR CURRENT REGULATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20 KILOVOLTS	PLATE DISSIPATION	20 KILOWATTS
DC PLATE CURRENT	7.5 AMPERES	GRID DISSIPATION	500 WATTS

SWITCH TUBE OR PULSED REGULATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20 KILOVOLTS	PLATE DISSIPATION	20 KILOWATTS
PULSE PLATE CURRENT	40 AMPERES	GRID DISSIPATION	500 WATTS

RADIO FREQUENCY LINEAR AMPLIFIER

Grounded Grid, Class B

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7000 VOLTS
DC PLATE CURRENT	5.0 AMPERES
PLATE DISSIPATION	20 KILOWATTS
GRID DISSIPATION	500 WATTS

1. Approximate value.

TYPICAL OPERATION, Single-Tone Conditions

Plate Voltage	7000	7000	Vdc
Zero-Signal Plate Current[1]	0.60	0.60	Adc
Max. Signal Plate Current	3.72	5.00	Adc
Max. Signal Grid Current[1]	0.71	1.00	Adc
Driving Impedance	35	32	Ω
Resonant Load Impedance	1020	745	Ω
Max. Signal Driving Power[1]	885	1540	W
Peak Envelope Plate Output Power	17.7	24.2	kW
Power Gain[1]	20.0	15.7	times

AUDIO FREQUENCY AMPLIFIER OR MODULATOR

Class B, Grid Driven

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7000 VOLTS
DC PLATE CURRENT	5.0 AMPERES
PLATE DISSIPATION	20 KILOWATTS
GRID DISSIPATION	500 WATTS

1. Approximate value.

TYPICAL OPERATION
Two Tubes, Sinusoidal Wave

Plate Voltage	5000	7000	Vdc
Grid Voltage	0	0	Vdc
Zero-Signal Plate Current[1]	0.8	1.2	Adc
Max. Signal Plate Current	10.0	10.0	Adc
Max. Signal Grid Current[1]	1.2	2.1	Adc
Driving Power[1]	290	560	W
Peak Audio Driving[1] Voltage (per tube)	240	310	v
Load Resistance, plate-to-plate	1030	1520	Ω
Max. Signal Plate Output Power[1]	31.0	47.7	kW

RADIO FREQUENCY LINEAR AMPLIFIER (AM DOUBLE SIDEBAND)

Carrier Conditions, Grounded-Grid Class B

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7000 VOLTS
DC PLATE CURRENT	5.0 AMPERES
PLATE DISSIPATION	20 KILOWATTS
GRID DISSIPATION	500 WATTS

1. Approximate value.
2. Modulation Crest Conditions.

TYPICAL OPERATION

Plate Voltage	7000	Vdc
Grid Voltage	0	Vdc
Zero-Signal Plate Current[1]	0.6	Adc
Plate Current	2.4	Adc
Grid Current[1]	0.25	Adc
Driving Impedance[2]	32	Ω
Peak Driving Voltage[2]	310	v
Driving Power[1]	330	W
Plate Output Power[1]	5650	W

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C

ABSOLUTE MAXIMUM RATINGS:

PLATE VOLTAGE	7000	VOLTS
PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	20	KILOWATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.

TYPICAL OPERATION

Plate Voltage	5000	7000	Vdc
Plate Current	4.0	4.0	Adc
Grid Voltage	-210	-230	Vdc
Grid Current [1]	840	775	mAdc
Peak rf Grid Voltage	510	555	v
Grid Driving Power	420	530	W
Plate Output Power [1]	14	21.3	kW

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament Current @ 7.5 Volts	94.0	104.0	A
Interelectrode Capacitance[1] (grounded cathode connection)			
Cin	53.0	65.0	pF
Cout	---	0.30	pF
Cgp	32.0	40.0	pF
Interelectrode Capacitance[1] (grounded grid connection)			
Cin	53.0	65.0	pF
Cout	32.0	40.0	pF
Cpk	---	0.30	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 3CW20,000H7 must be operated vertically, anode down or up, and should be protected from shock and vibration. The anode mounting flange provides a convenient mounting means, and the grid is also provided with a flange for mating with a simple contact assembly. Both filament connections are made with flying leads approximately nine inches long with heavy lugs attached at the ends.

COOLING - The anode of the 3CW20,000H7 is cooled by circulating water through the integral anode water jacket. The cooling table shows minimum water-flow rates at various plate dissipation levels and assumes a temperature rise for the water of 10°C. Inlet water temperature should never exceed 55°C and outlet water temperature should never exceed 70°C. Where a liquid coolant other than water is used, the difference in cooling characteristics should be carefully considered and taken into account. Maximum system pressure must not exceed 50 psi.

Minimum Cooling Water-Flow Requirements		
Plate Dissipation (kW)	Water Flow (gpm)	Pressure Drop Approx. psi
10	11.0	11.5
15	12.0	13.5
20	14.0	17.0

A major factor effecting long life of water-cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 $K\Omega/cm^3$, and preferably above 250 $K\Omega/cm^3$. A relative water resistance check can be made continuously by

measuring the leakage current which will bypass a short section of insulating hose column if metal nipples or fittings are used as electrodes.

Forced-air cooling of the base is also required, with 30 to 50 cfm of air at 50°C maximum directed up into and around the base of the tube to cool the grid and filament contact areas.

Both anode and base cooling should be applied before or simultaneously with electrode voltages, including the filament, and should normally be maintained for a short period of time after all voltages are removed to allow for tube cooldown.

ELECTRICAL

FILAMENT OPERATION - Filament voltage should be measured at the terminals with a 1 percent rms responding meter. The peak emission at rated filament voltage of the EIMAC 3CW20,000H7 is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 3CW20,000H7 by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is done by measuring some important parameter of performance such as plate current, power output, or an increase in distortion. Operation must be at a filament voltage slightly higher than the point at which performance appears to deteriorate.

INPUT CIRCUIT - When the 3CW20,000H7 is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier, it is suggested that the cathode tank circuit operate at a "Q" of two or more.

CLASS-C OPERATION - Although designed specifically for Class-B service,the 3CW20,000H7 may be operated as a Class-C amplifier or oscillator or as a plate-modulated radio-frequency amplifier. The zero-bias characteristic can be used to advantage in Class-C amplifiers by employing only grid leak bias. If driving power should fail, plate dissipation is then kept to a low value because the tube will be operating at normal, static, zero-bias conditions.

STANDBY OPERATION - Coolant must be circulated through the anode water jacket whenever filament power is applied even though no other voltages are present. Sixty to eighty percent of the filament power appears as heat in the anode. In the absence of coolant flow, temperatures will rise to levels which are detrimental to long life. If the coolant lines are obstructed the coolant jacket may rupture from the generated steam pressure.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

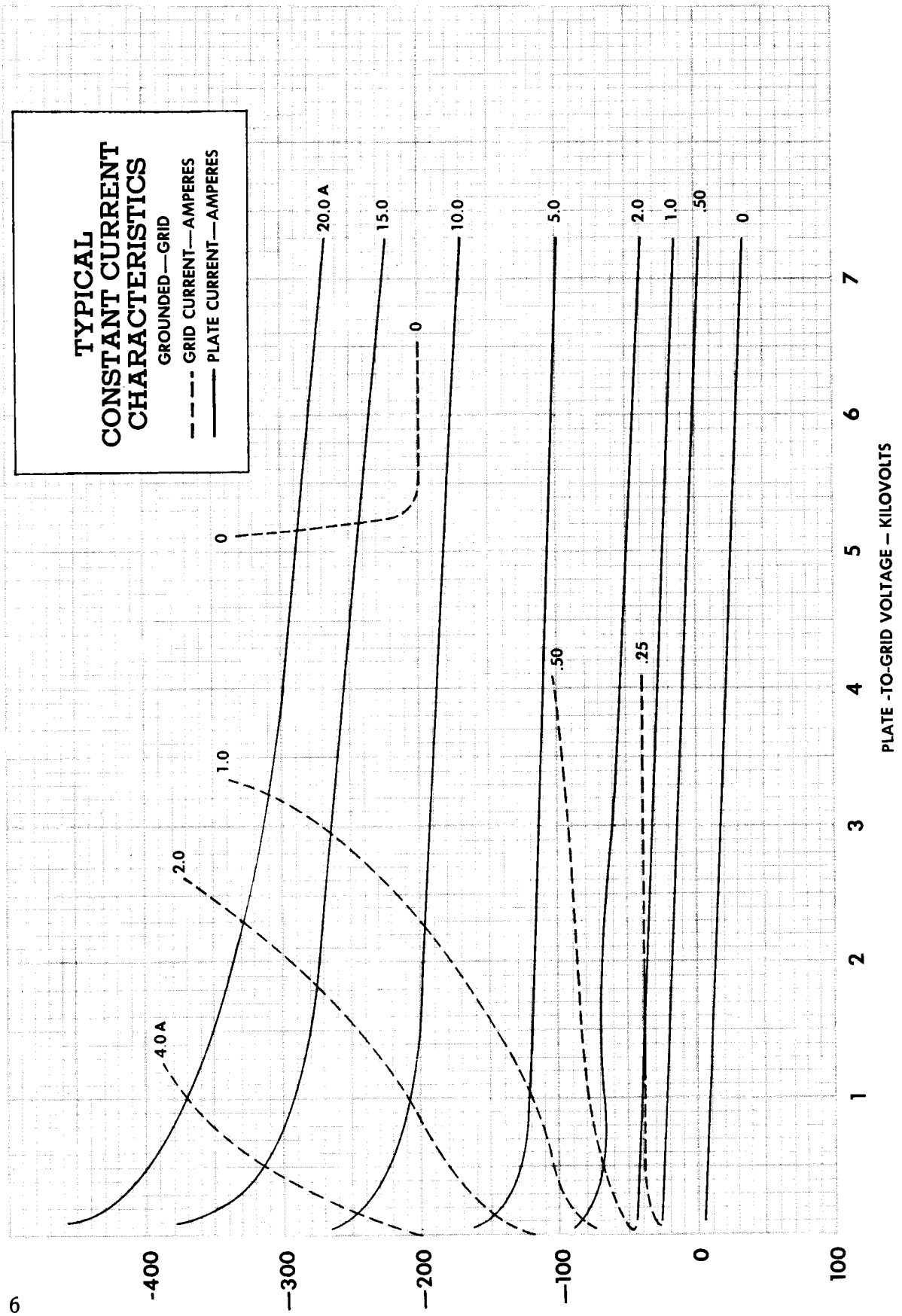
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

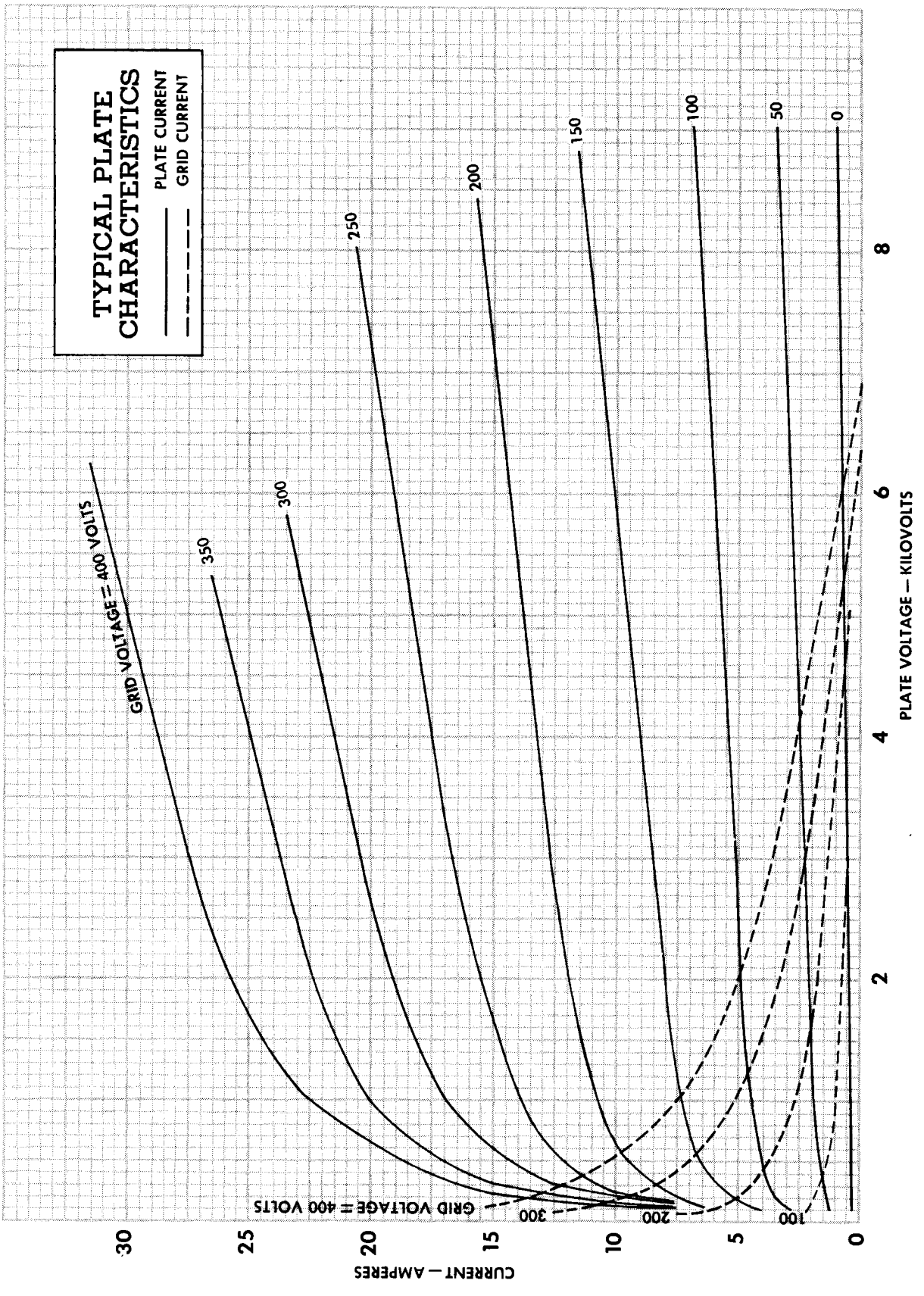
Many EIMAC power tubes, such as the 3CW-20,000H7, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry---the more power invloved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

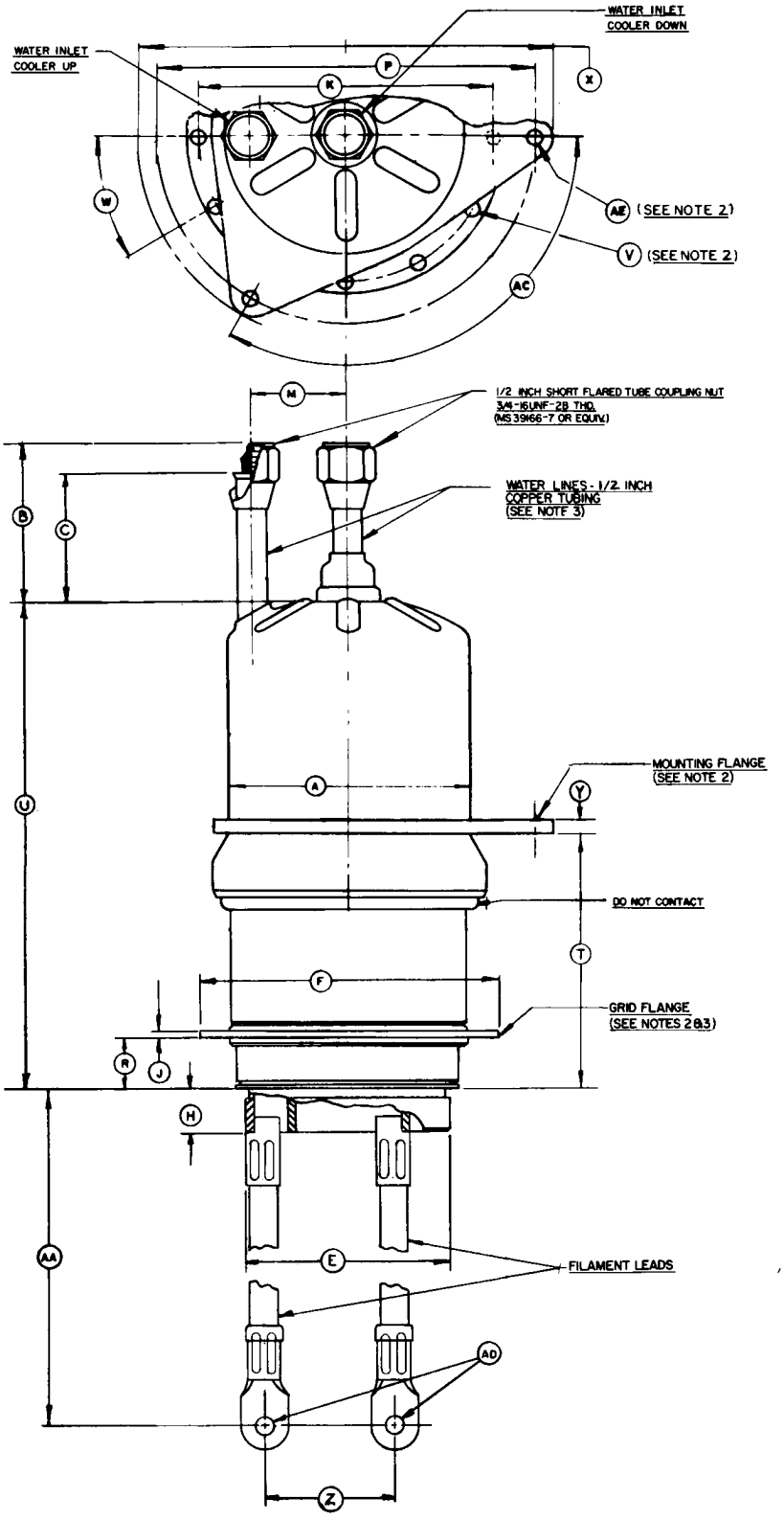
FAULT PROTECTION - In addition to normal plate over-current interlock, screen current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltage.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with each tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, we strongly recommend use of some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc.

SPECIAL APPLICATION - Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED—GRID
GRID CURRENT—AMPERES
PLATE CURRENT—AMPERES
20.0 A
15.0
10.0
5.0
2.0
1.0
.50
0
4.0 A
2.0
1.0
.50
.25
0
-400
-300
-200
-100
0
100
1
2
3
4
5
6
7
FILAMENT-TO-GRID VOLTAGE – VOLTS
PLATE -TO-GRID VOLTAGE – KILOVOLTS


TYPICAL PLATE CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
GRID VOLTAGE = 400 VOLTS
350
300
250
200
150
100
50
0
GRID VOLTAGE = 400 VOLTS
300
200
100
CURRENT — AMPERES
30
25
20
15
10
5
0
2
4
6
8
PLATE VOLTAGE — KILOVOLTS



DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.094	4.156	- -	103.99	105.56	- -
B	2.312	2.812	- -	56.72	71.42	- -
C	1.937	2.187	- -	49.20	55.55	- -
E	3.230	3.270	- -	82.04	83.06	- -
F	5.030	5.090	- -	127.76	129.29	- -
H	0.530	0.700	- -	13.46	17.78	- -
J	- -	- -	0.125	- -	- -	3.18
K	4.425	4.445	- -	112.40	112.90	- -
M	1.500	1.750	- -	38.10	44.45	- -
P	5.957	6.025	- -	151.31	153.04	- -
R	0.700	0.860	- -	17.78	21.84	- -
T	4.350	4.450	- -	110.49	113.03	- -
U	7.903	8.403	- -	200.74	213.44	- -
V	- -	- -	0.250	- -	- -	6.35
W	29°	31°	- -	29°	31°	- -
X	- -	- -	6.750	- -	- -	171.45
Y	- -	- -	0.250	- -	- -	6.35
Z	- -	- -	2.000	- -	- -	50.80
AA	8.500	9.000	- -	215.90	228.60	- -
AC	118°	122°	- -	118°	122°	- -
AD	- -	- -	0.390	- -	- -	9.91
AE	- -	- -	0.265	- -	- -	6.73

NOTES:
1. REFERENCE DIMENSIONS ARE FOR INFO ONLY AND ARE NOT REQ'D FOR INSPECTION PURPOSES.
2. 3 MTG. HOLES IN MTG FLANGE AND 12 IN THE GRID FLANGE.
3. GRID FLANGE, WATER FITTINGS, AND FIL. LEADS ORIENTED AS SHOWN.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

3CW25,000A3

MEDIUM-MU

WATER-COOLED
POWER TRIODE



The Eimac 3CW25,000A3 is a water-cooled, ceramic-metal power triode designed primarily for use in industrial radio-frequency heating services. Its water-cooled anode is rated at 25 kilowatts of plate dissipation with low water flow and pressure drop.

Full input of 60 kilowatts is permissable up to 100 megacycles. Plentiful reserve emission is available from its one kilowatt filament. The grid structure is rated at 500 watts making this tube an excellent choice for severe applications.

It is also recommended as a grounded grid FM amplifier, a conventional plate-modulated amplifier or as a linear amplifier in new equipment designs.

GENERAL CHARACTERISTICS

ELECTRICAL	Min.	Nom.	Max	
Filament: Thoriated-Tungsten				
Voltage		6.3		volts
Current	152		172	amperes
Amplification Factor		20		
Interelectrode Capacitances, Grounded Cathode:				
Grid-Filament	48		58	μμf
Plate-Filament	1.2		1.5	μμf
Grid-Plate	30		38	μμf
Frequency for Maximum Ratings				100 Mc

MECHANICAL	
Base	Coaxial
Recommended Socket	Eimac SK-1300
Operating Position	Vertical, base up or down
Cooling	Water & Forced air
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250°C
Maximum Dimensions:	
Height	9.4 inches
Diameter	5.0 inches
Net Weight	12 pounds

RF INDUSTRIAL OSCILLATOR

Class-C (Filtered DC Power Supply)

MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000 VOLTS
DC PLATE CURRENT	6.0 AMPS
DC GRID CURRENT	1.0 AMP
PLATE INPUT POWER	60 KW
PLATE DISSIPATION	25 KW

TYPICAL OPERATION

DC Plate Voltage	7000	10,000 volts
DC Plate Current	6.0	6.0 amps
DC Grid Voltage	–600	–800 volts
DC Grid Current	.66	.315 amps
Peak Positive Grid Voltage	440	360 volts
Driving Power	660	365 watts
Plate Input Power	42	60 kW
Plate Dissipation	12	18 kW
Plate Output Power	30	42 kW
Approximate Load Impedance	600	750 ohms

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RADIO-FREQUENCY POWER AMPLIFIER
PLATE-MODULATED

Class-C

MAXIMUM RATINGS

DC PLATE VOLTAGE	7000 MAX. VOLTS
DC PLATE CURRENT	5.0 MAX. AMPS
PLATE DISSIPATION	16.5 MAX. KW
GRID DISSIPATION	500 MAX. WATTS

TYPICAL OPERATION

DC Plate Voltage	5000	7000 volts
DC Grid Voltage	−600	−820 volts
DC Plate Current	5.0	5.0 amps
DC Grid Current	600	600 mA
Driving Power	600	750 watts
Plate Output Power	17.8	27.5 kW

RADIO-FREQUENCY
LINEAR AMPLIFIER Class-AB_2

MAXIMUM RATINGS

DC PLATE VOLTAGE	10000 MAX. VOLTS
DC PLATE CURRENT	6.0 MAX. AMPS
PLATE DISSIPATION	25 MAX. KW
GRID DISSIPATION	500 MAX. WATTS

*Adjust to give specified zero-signal dc plate current

TYPICAL OPERATION

DC Plate Voltage	7000	10000 volts
DC Grid Voltage*	−250	−400 volts
Zero-Sig Plate Current	2.0	2.0 amps
Max-Sig DC Plate Current	6.0	6.0 amps
Max-Sig DC Grid Current	375	333 mA
Peak RF Grid Voltage	530	700 volts
Driving Power	200	240 watts
Plate Output Power	26.4	41 kW

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses has been made.

APPLICATION

ELECTRICAL

Filament—The rated filament voltage for the 3CW-25,000A3 is 6.3 volts. Filament voltage, as measured at the socket, must be maintained at 6.3 volts plus or minus five percent for maximum tube life and consistent performance.

Control Grid Operation—The grid current rating is one ampere dc. This value should not be exceeded for more than very short periods such as during tuning and over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.4 to 0.6 amperes grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 500 watts.

Plate Operation—The maximum plate input power rating is 60 kilowatts at 10,000 volts and 6.0 amperes dc. This rating applies for Class C amplifier or oscillator service and for Class AB applications. When used as a plate modulated rf amplifier, input is reduced to 7000 volts at 5.0 amperes dc. Maximum input may be exceeded for short periods during tuning without exceeding plate dissipation ratings.

Plate over-current protection should be provided to remove plate voltage quickly in the event of an overload or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

High Frequency Operation—The 3CW25,000A3 is usable to 140 Mc. At this frequency, plate voltage must be reduced to 7000 volts in class A, B or C service. For plate-modulated applications at 140 Mc, plate voltage is reduced to 5500 volts.

Mounting—The 3CW25,000A3 must be mounted vertically, either base up or down. Where the tube is installed in a base up position, it is suggested that any clamping pressure or rf contact be made only in the area shown as "V" on the outline drawing.

Socket—The Eimac SK-1300 socket is used with the 3CW25,000A3 for making connections to the filament and grid. Where the socket is to be removable—as in base-up operation—the SK-1310 should be used.

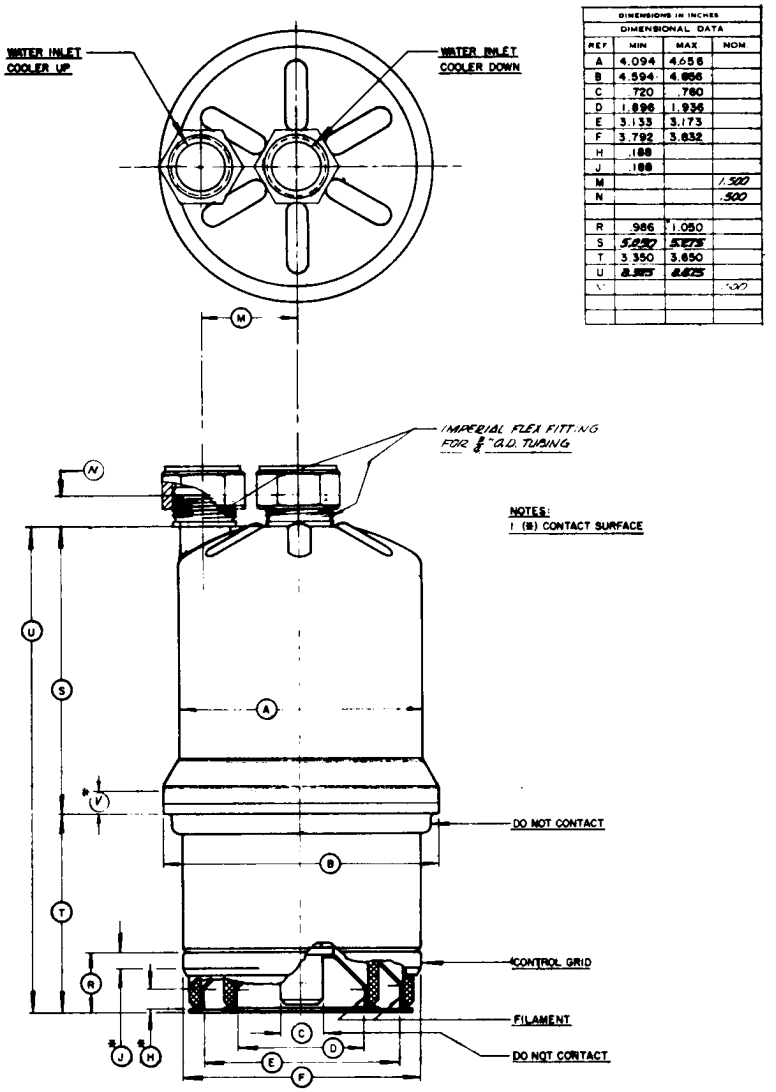
Cooling—Anode cooling is accomplished by circulating water through the integral anode—water jacket. With the tube in the anode-up position the water inlet is the outer water fitting and the outlet will be the center water fitting. When the tube is mounted base up, these are reversed.

The table below lists the minimum water flow requirement for adequate anode cooling at various plate dissipation levels. In all cases, inlet water temperature must be limited to 60°C or below, outlet water temperature must not exceed 70°C nor should inlet water pressure exceed 60 psi.

Minimum Water-Cooling Requirement		
Plate Dissipation (kW)	Water Flow (GPM)	Pressure Drop (PSI)
10	6	0.2
15	9	0.4
20	12	0.7
25	15	1.1

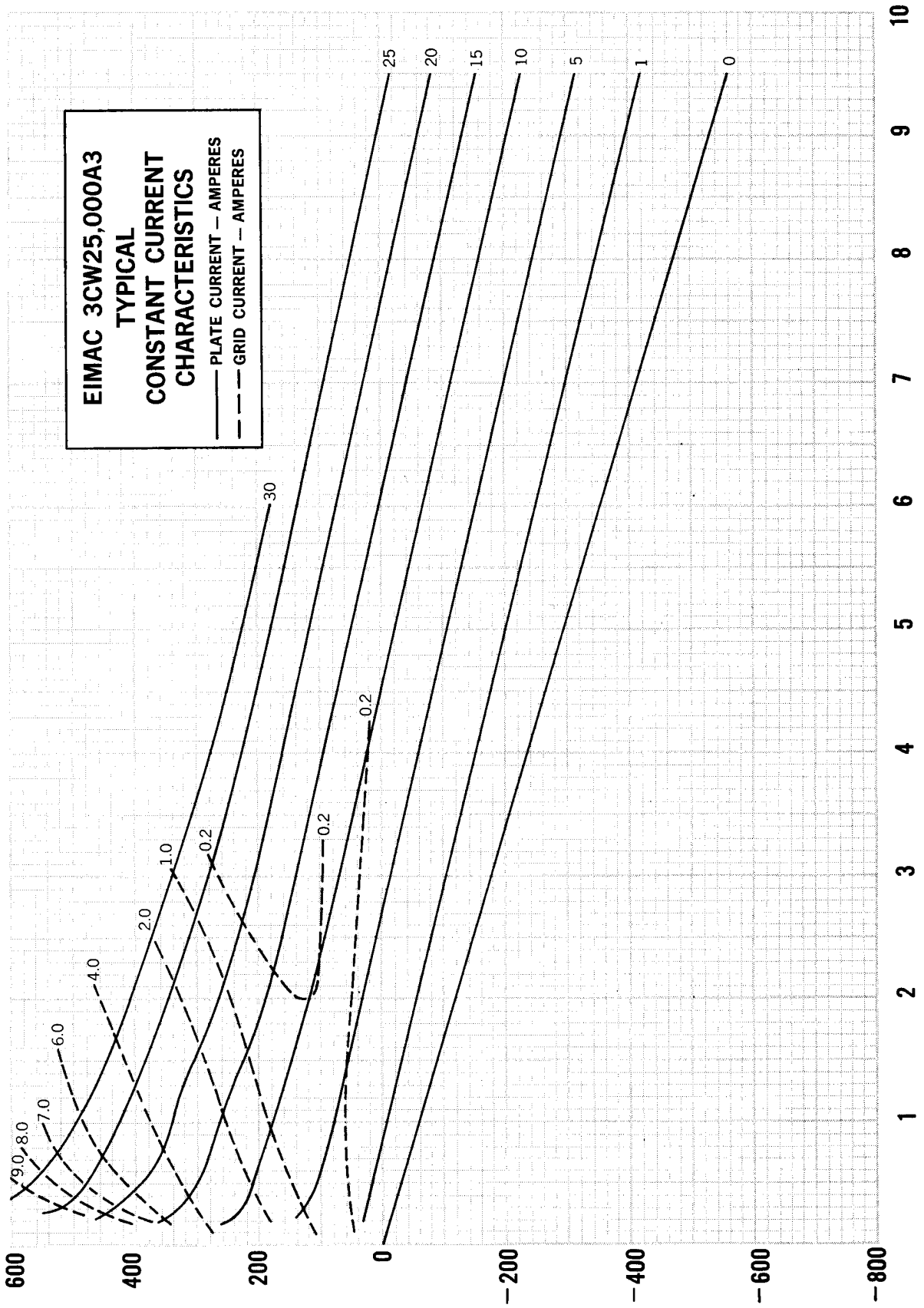
Additional forced-air cooling of the tube's base is also required to maintain ceramic-to-metal seal temperatures below the 250°C maximum. Approximately 50 cfm of cooling air directed into the base structure, through the socket will generally satisfy this requirement.

Special Application—If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California for information and recommendations.



DIMENSIONS IN INCHES
DIMENSIONAL DATA

REF	MIN	MAX	NOM
A	4.094	4.656	
B	4.594	4.656	
C	.720	.760	
D	1.896	1.936	
E	3.133	3.173	
F	3.792	3.832	
H	.188		
J	.188		
M			1.300
N			.500
R	.986	1.050	
S	5.250	5.375	
T	3.350	3.650	
U	8.375	8.625	
V			.100

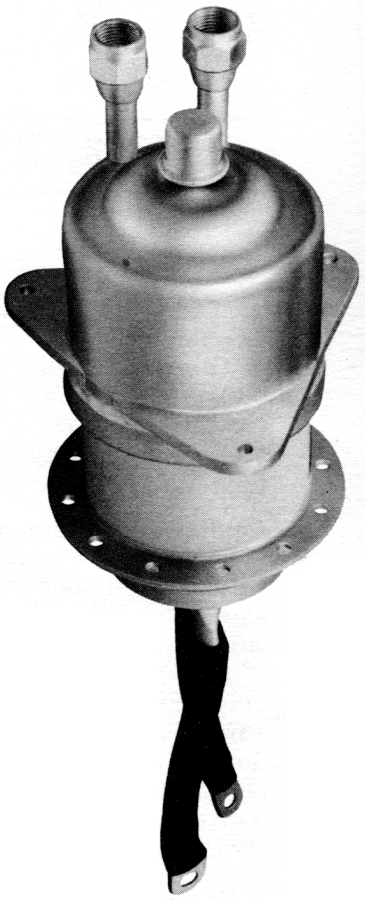

EIMAC 3CW25,000A3
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
25
20
15
10
5
1
0
30
9.0
8.0
7.0
6.0
4.0
2.0
1.0
0.2
0.2
0.2
600
400
200
0
−200
−400
−600
−800
1
2
3
4
5
6
7
8
9
10
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — KILOVOLTS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

3CW30,000H3

MEDIUM-MU

WATER-COOLED
POWER TRIODE



The Eimac 3CW30,000H3 is a water-cooled, ceramic-metal power triode designed primarily for use in industrial radio-frequency heating services. Its water-cooled anode is conservatively rated at 30 kilowatts of plate dissipation with low water flow and pressure drop.

Input of 60 kilowatts is permissable up to 90 megahertz. Plentiful reserve emission is available from its one kilowatt filament. The grid structure is rated at 500 watts making this tube an excellent choice for severe applications.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated-Tungsten				
Voltage		6.3		V
Current	152		172	A
Amplification Factor		20		
Interelectrode Capacitances, Grounded Cathode:				
Grid-Filament	48		58	pF
Plate-Filament	1.2		1.5	pF
Grid-Plate	30		38	pF
Frequency for Maximum Ratings			90	MHz

MECHANICAL

Base	See Outline
Operating Position	Vertical, base up or down
Cooling	Water and Forced Air
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250°C
Maximum Dimensions:	
Height	See Outline
Diameter	See Outline
Net Weight	12 pounds

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Printed in U.S.A.

RF INDUSTRIAL OSCILLATOR
Class-C (Filtered DC Power Supply)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	12,000 VOLTS
DC PLATE CURRENT	6.0 AMPS
DC GRID VOLTAGE	—1000 VOLTS
DC GRID CURRENT	1.0 AMP
PLATE INPUT POWER	60 KW
PLATE DISSIPATION (NOMINAL)	30 KW

TYPICAL OPERATION*

DC Plate Voltage	7000	10,000 volts
DC Plate Current	6.0	6.0 amps
DC Grid Voltage	—600	—800 volts
DC Grid Current	.66	.315 amps
Peak Positive Grid Voltage	440	360 volts
Driving Power	660	365 watts
Plate Input Power	42	60 kW
Plate Dissipation	12	18 kW
Plate Output Power	30	42 kW
Approximate Load Impedance	600	750 ohms

*Loaded Conditions

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses has been made.

APPLICATION

ELECTRICAL

Filament

The rated filament voltage for the 3CW30,-000H3 is 6.3 volts. Filament voltage, as measured at the tube, must be maintained at 6.3 volts plus or minus five percent for maximum tube life and consistent performance.

Control Grid Operation

The grid current rating is one ampere dc. This value should not be exceeded for more than very short periods such as during tuning and over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.4 to 0.6 amperes grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 500 watts.

Plate Operation

Maximum plate voltage rating of 12,000 volts and maximum plate current of 6.0 amperes dc should not be applied simultaneously as rated plate dissipation may be exceeded. The 60 kilowatts input rating applies for Class C amplifier or oscillator service with no modulation.

Plate over-current protection should be provided to remove plate voltage quickly in the event of an overload or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

High Frequency Operation

The 3CW30,000H3 is usable to 140 MHz. At this frequency, plate voltage must be reduced to 7000 volts in Class C service.

MECHANICAL

Mounting

The 3CW30,000H3 must be mounted vertically, either base up or down.

Cooling

Anode cooling is accomplished by circulating water through the integral anode-water jacket.

The table below lists the minimum water flow requirement for adequate anode cooling at various plate dissipation levels. In all cases, the outlet water temperature must not exceed 70°C nor should inlet water pressure exceed 60 psi. This table is based upon 20°C temperature rise.

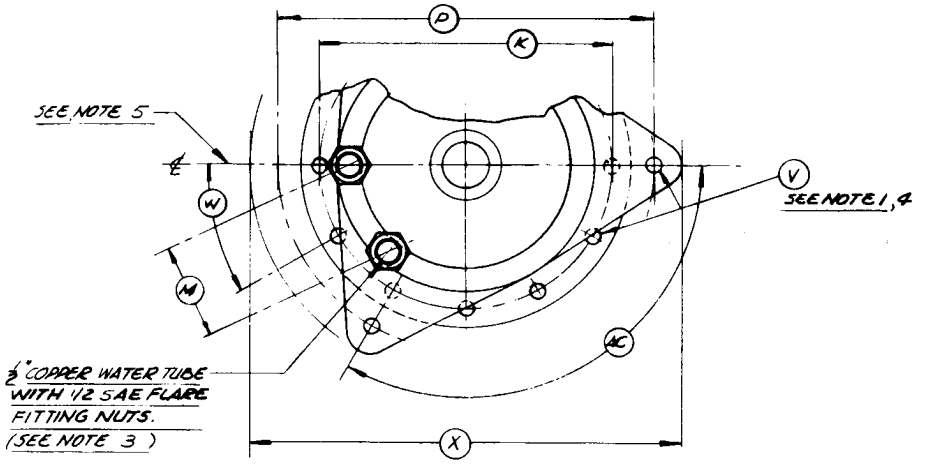
MINIMUM WATER-COOLING REQUIREMENT

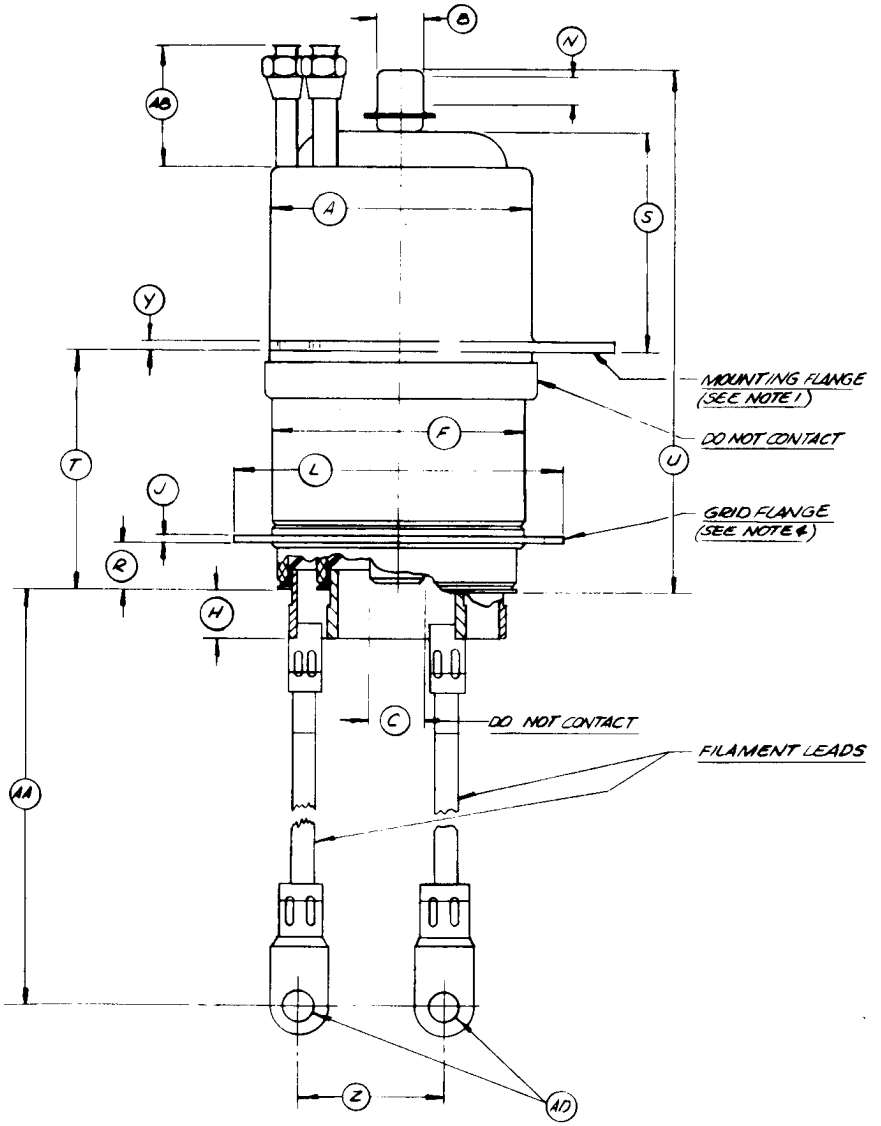
Plate Dissipation (kW)	Water Flow (gpm)	Pressure Drop (psi)
20	4	3.5
25	5	4.0
30	6	4.5
35	7	5.0

Additional forced-air cooling of the tube's base is also required to maintain ceramic-to-metal seal temperatures below the 250°C maximum. Approximately 50 cfm of cooling air directed into the base structure will generally satisfy this requirement.

Special Application

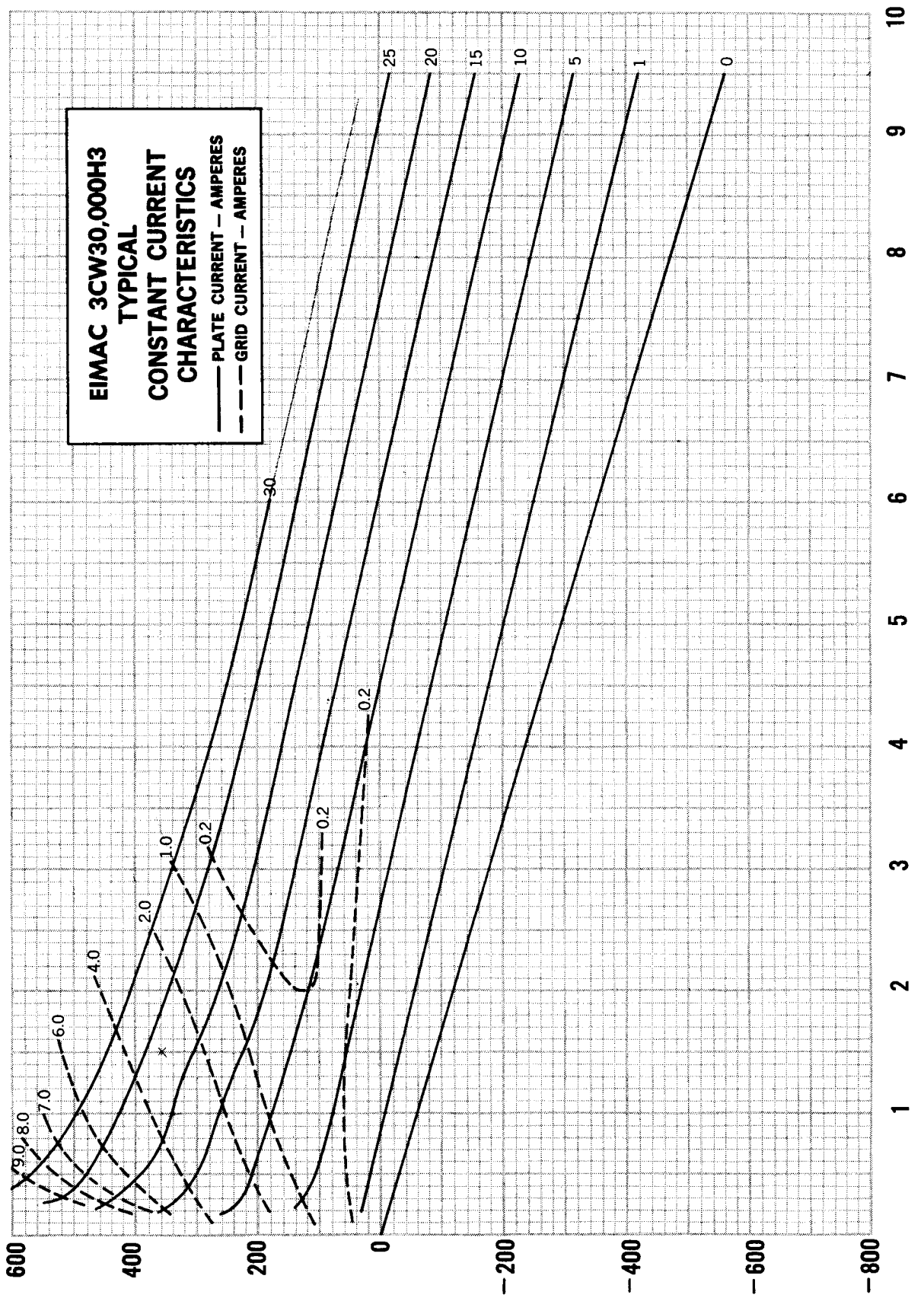
If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Div., EIMAC, Division of Varian, 301 Industrial Way, San Carlos, Calif. for information and recommendations.





DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A	4.050	4.250	
B	.860	.890	
C	.720	.760	
F	3.792	3.832	
H	.530	.700	
J			.125
K	4.425	4.445	
L	5.030	5.090	
M			1.500
N	.375		
P	5.990	6.010	
R	.800	.860	
S	3.300	3.500	
T	3.950	4.100	
U	8.250	8.750	
V			.250
W	29°	31°	
X			6.750
Y			.250
Z			2.000
AA	8.500	9.000	
AB			2.000
AC	118°	122°	
AD			.390

NOTES:
1. 3 MOUNTING HOLES IN MTG. FLANGE.
2. REF. DIMS. ARE FOR INFO. ONLY AND ARE NOT REQ'D FOR INSP. PURPOSES.
3. EITHER FITTING CAN BE USED AS INLET OR OUTLET.
4. 12 HOLES IN GRID FLANGE.
5. MTG. FLANGE, FIL. LEADS & WATER FITTINGS ARE TO BE ORIENTED AS SHOWN.


EIMAC 3CW30,000H3
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT — AMPERES
GRID CURRENT — AMPERES
30
25
20
15
10
5
1
0
0.2
0.2
0.2
1.0
2.0
4.0
6.0
7.0
8.0
9.0
600
400
200
0
−200
−400
−600
−800
1
2
3
4
5
6
7
8
9
10
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — KILOVOLTS

3CW30,000H7

TECHNICAL DATA

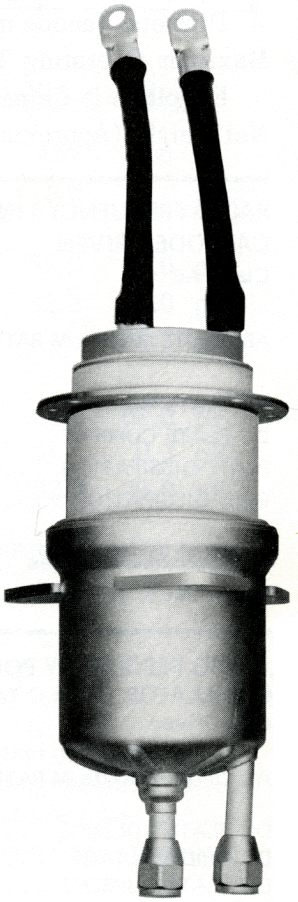
HIGH-MU
WATER-COOLED
POWER TRIODE

The EIMAC 3CW30,000H7 is a ceramic/metal water-cooled high-mu power triode intended for use as a Class C power amplifier or for zero-bias Class B or AB linear amplifier service, and also intended for use as a dc voltage or current regulator, or in high-voltage switch tube or pulsed regulator service.

Internally the tube is identical to the 3CX15,000A7, and except for anode dissipation capability, all ratings are the same.

Class B amplifier operation with zero grid bias offers circuit simplicity by eliminating the bias supply. In addition, grounded grid operation is attractive since a power gain as high as twenty times can be obtained.

The anode power dissipation rating is 30,000 watts with water cooling. No socket is required for the tube because of the mounting flanges attached to the anode and grid and the flexible filament leads on the base.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	6.3 ± 0.3 V
Current, at 6.3 volts	160 A
Amplification Factor (Average):	200
Direct Interelectrode Capacitance (grounded cathode)[2]	
Cin	61 pF
Cout	0.2 pF
Cgp	36 pF
Direct Interelectrode Capacitance (grounded grid)[2]	
Cin	61 pF
Cout	36 pF
Cpk	0.2 pF
Frequency of Maximum Rating:	
CW	110 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

(Effective 2-1-75) © by Varian Printed In U.S.A.

MECHANICAL

Base	Special, with grid contact flange & filament flying leads
Operating Position	Vertical, Anode up or down
Cooling	Water or equivalent liquid & forced air
Maximum Overall Dimensions:	
Length (including filament leads)	20.5 in; 52.1 cm
Diameter (anode mounting flange pitch circle)	6.75 in; 17.1 cm
Maximum Operating Temperature:	
Envelope & Ceramic/Metal Seals	250°C
Net Weight (Approximate)	10.6 lbs; 4.8 kg

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	8000	VOLTS
DC PLATE CURRENT	6.0	AMPERES
PLATE DISSIPATION	30,000	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate values
2. Adjust to obtain specified value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2

Plate Voltage	7000	7000	Vdc
Grid Voltage	0	0	Vdc
Zero-Signal Plate Current [1]	.6	.6	Adc
Single-Tone Plate Current [2]	5.92	5.0	Adc
Single-Tone Grid Current [1]	1.22	1.0	Adc
Driving Power [1]	1750	1540	W
Plate Dissipation	13.4	10.8	kW
Single-Tone Plate Output Power	29.6	24.2	kW
Resonant Load Impedance	693	745	Ω
Drive Impedance	27	32	Ω

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy or FM

Grid Driven

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	30,000	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	7000	Vdc
Grid Voltage	-230	Vdc
Plate Current	4.0	Adc
Grid Current [1]	775	mAdc
Peak rf Grid Voltage [1]	555	v
Calculated Driving Power [1]	430	W
Plate Input Power	28	kW
Plate Dissipation	6.7	kW
Plate Output Power	21.3	kW
Resonant Load Impedance	963	Ω

DC VOLTAGE OR CURRENT REGULATOR SWITCH TUBE OR PULSED REGULATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	28	KILOVOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT [1]	6	AMPERES
PULSE PLATE CURRENT	40	AMPERES
DUTY, PULSE SERVICE [2]	0.1	
PLATE DISSIPATION [2]	30	KILOWATTS
GRID DISSIPATION [2]	500	WATTS

1. Steady-state value in voltage or current regulator service.
2. With duty in excess of approximately 0.1 excessive element heating may occur during the pulse and consequent element dissipation derating may be required.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.3 volts	152	168	A
Cathode Warmup Time	5.0	---	sec.
Interelectrode Capacitances (grounded grid) [1]			
Cin	55.0	67.0	pF
Cout	32.0	40.0	pF
Cpk	---	0.3	pF
Interelectrode Capacitances (grounded cathode) [1]			
Cin	55.0	67.0	pF
Cout	---	0.3	pF
Cgp	32.0	40.0	pF

1. Capacitances values are for a cold tube as measured in a shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 3CW30,000H7 must be operated vertically, anode down or up, and should be protected from shock and vibration. The anode mounting flange provides a convenient mounting means, and the grid is also provided with a flange for mating with a simple contact assembly. Both filament connections are made with flying leads approximately nine inches long with heavy lugs attached at the ends.

COOLING - The anode of the 3CW30,000H7 is cooled by circulating water through the integral anode water jacket. The cooling table shows minimum water-flow rates at various plate dissipation levels and assumes an inlet water temperature of 50°C with the anode mounted either up or down. Care should be taken to use the correct cooling water connector for inlet water, which is dependent on the tube orientation (base up or down), and these are shown on the tube outline drawing.

Where a liquid coolant other than water is used, the difference in cooling characteristics should be carefully considered and taken into account. Maximum system pressure must not exceed 50 psi.

Minimum Cooling Water-Flow Requirements

Plate Dissipation (kW)	Water Flow (gpm)	Pressure Drop Approx. psi.
15	12	13.5
20	13	15.0
30	14	17.0

A major factor effecting long life of water-cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 KΩ/cm , and preferably above 250 KΩ/cm . A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of insulating hose column if metal nipples or fittings are used as electrodes.

Forced-air cooling of the base is also required, with a minimum of 50 cfm of air at 50°C maximum directed up into and around the base of the tube to cool the grid and filament contact areas.

Both anode and base cooling should be applied before or simultaneously with electrode voltages, including the filament, and should normally be maintained for a short period of time after all voltages are removed to allow for tube cooldown.

ELECTRICAL

FILAMENT OPERATION - Filament voltage should be measured at the terminals with a 1 percent rms responding meter. The peak emission at rated filament voltage of the EIMAC 3CW30,000H7 is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 3CW30,000H7 by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is done by measuring some important parameter of performance such as plate current, power output, or an increase in distortion. Operation must be at a filament voltage slightly higher than the point at which performance appears to deteriorate. For pulsed regulator or switch tube service full nominal filament voltage is recommended.

INPUT CIRCUIT - When the 3CW30,000H7 is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier, it is suggested that the cathode tank circuit operate at a "Q" of 5 or more.

CLASS-C OPERATION - Although designed specifically for Class-B service, the 3CW30,000H7 may be operated as a Class-C amplifier or oscillator or as a plate-modulated radio-frequency amplifier. The zero-bias characteristic can be used to advantage in Class-C amplifiers by employing only grid leak bias. If driving power should fail, plate dissipation is then kept to a low value because the tube will be operating at normal, static, zero-bias conditions.

STANDBY OPERATION - Coolant must be circulated through the anode water jacket whenever filament power is applied even though no other voltages are present. Sixty to eighty percent of the filament power appears as heat in the anode. In the absence of coolant flow, temperatures will rise to levels which are detrimental to long life. If the coolant lines are obstructed the coolant jacket may rupture from the generated steam pressure.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these

voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as the 3CW-30,000H7, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry---the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal plate over-current interlock, screen current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltage.

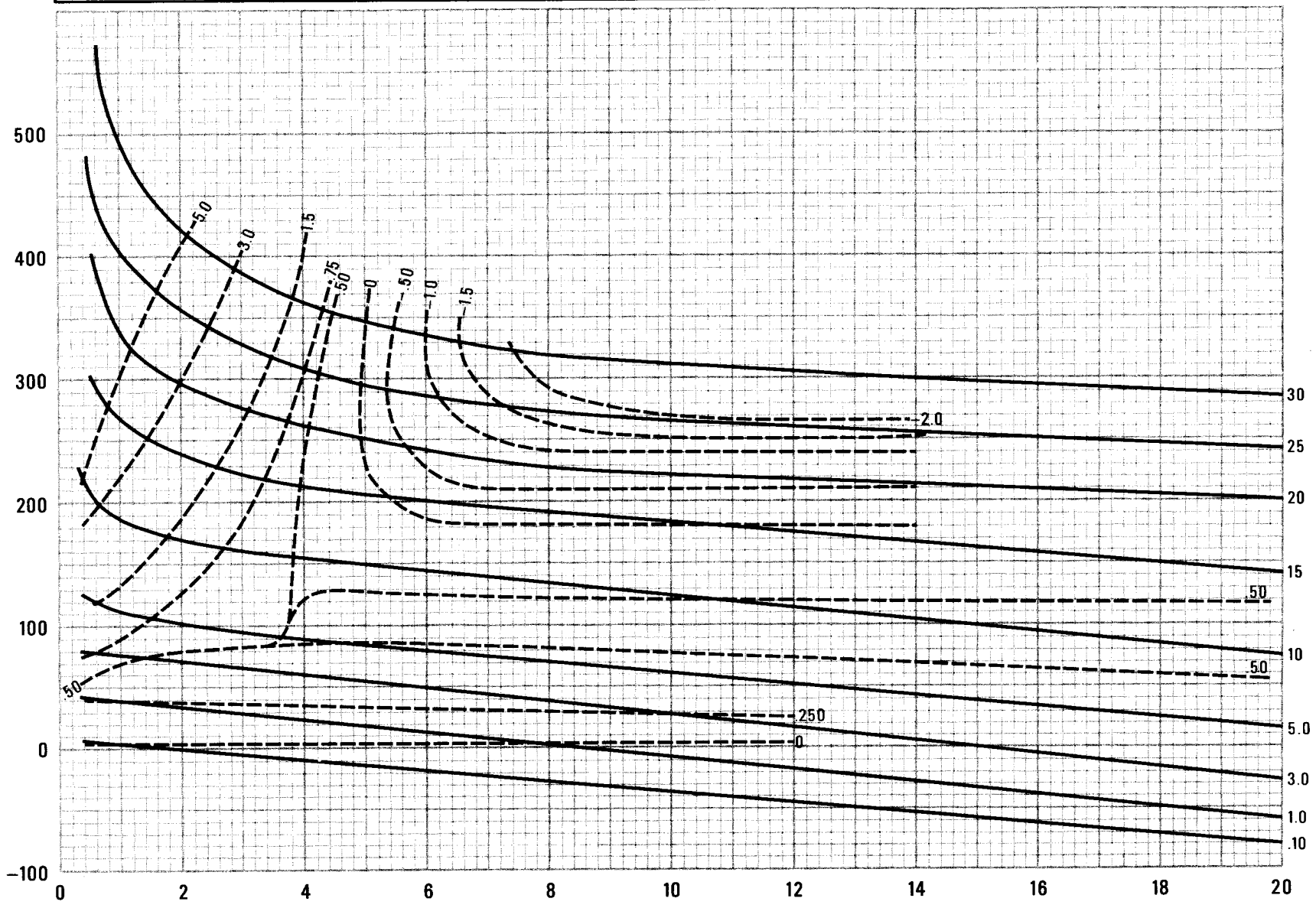
In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with each tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, we strongly recommend use of some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc.

SPECIAL APPLICATION - Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.

TYPICAL CONSTANT CURRENT CHARACTERISTICS

GROUNDED CATHODE

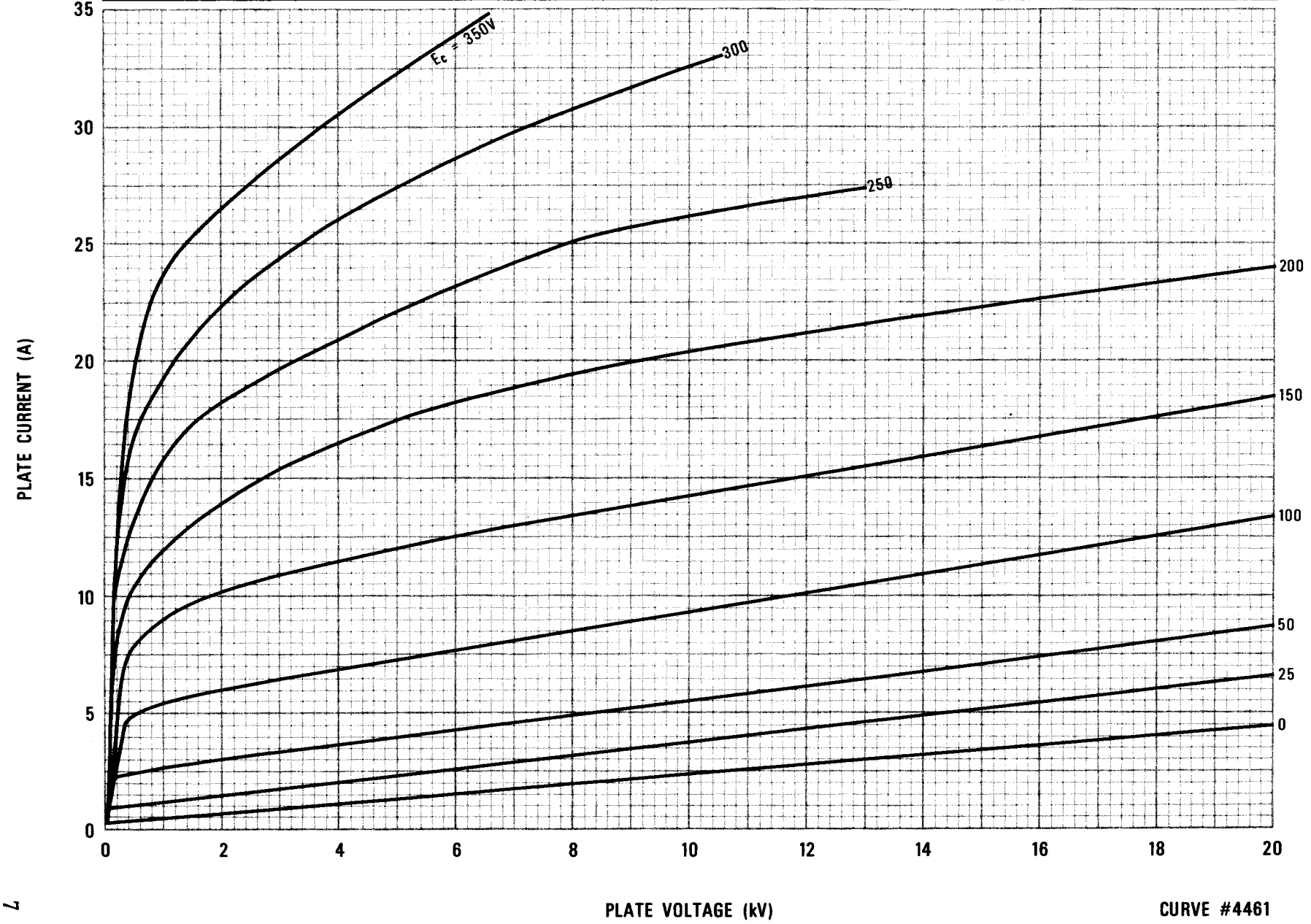
——— PLATE CURRENT – AMPERES - - - - GRID CURRENT – AMPERES



CURVE #4459

TYPICAL PLATE CHARACTERISTICS

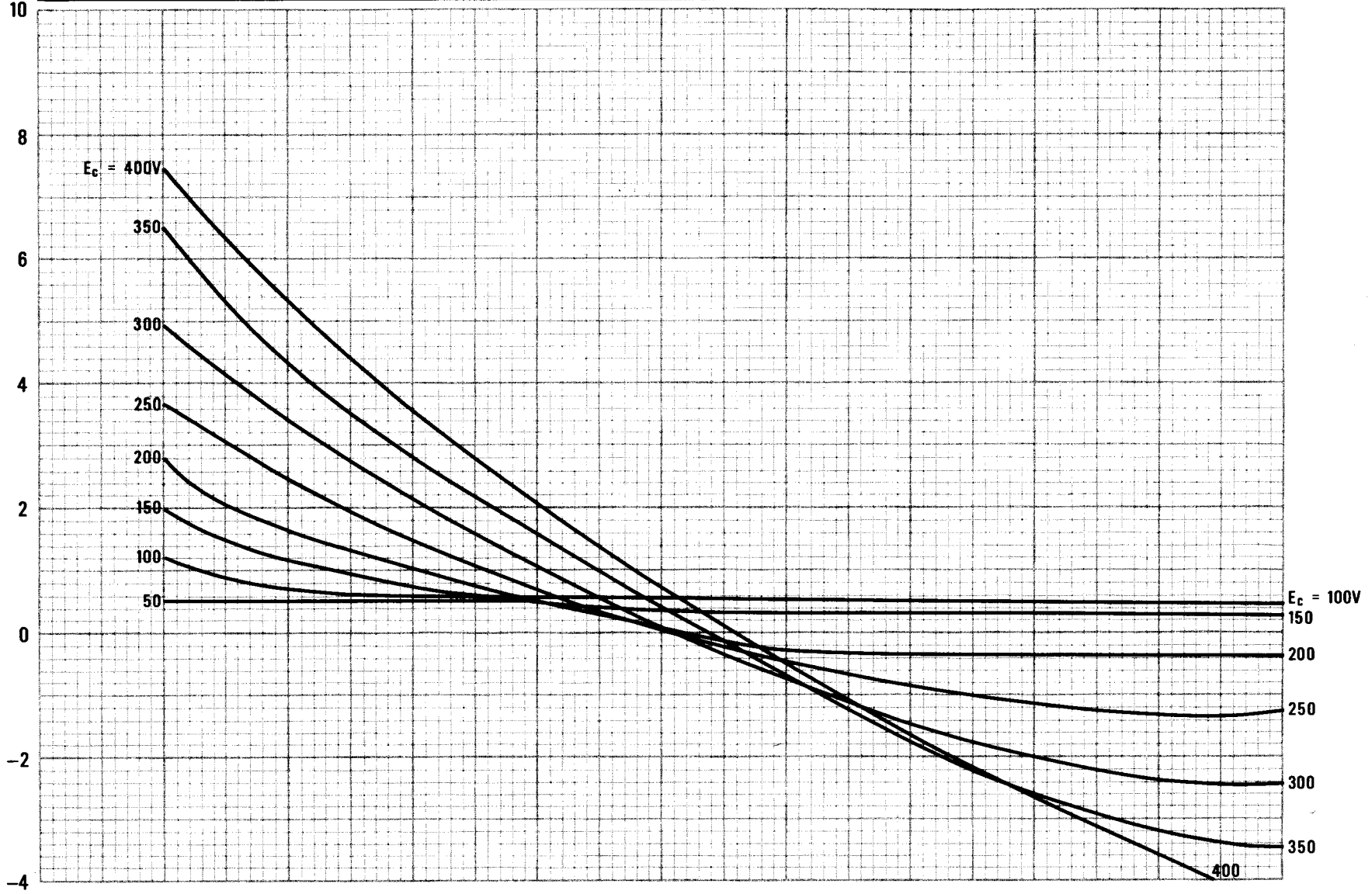
GROUNDED CATHODE



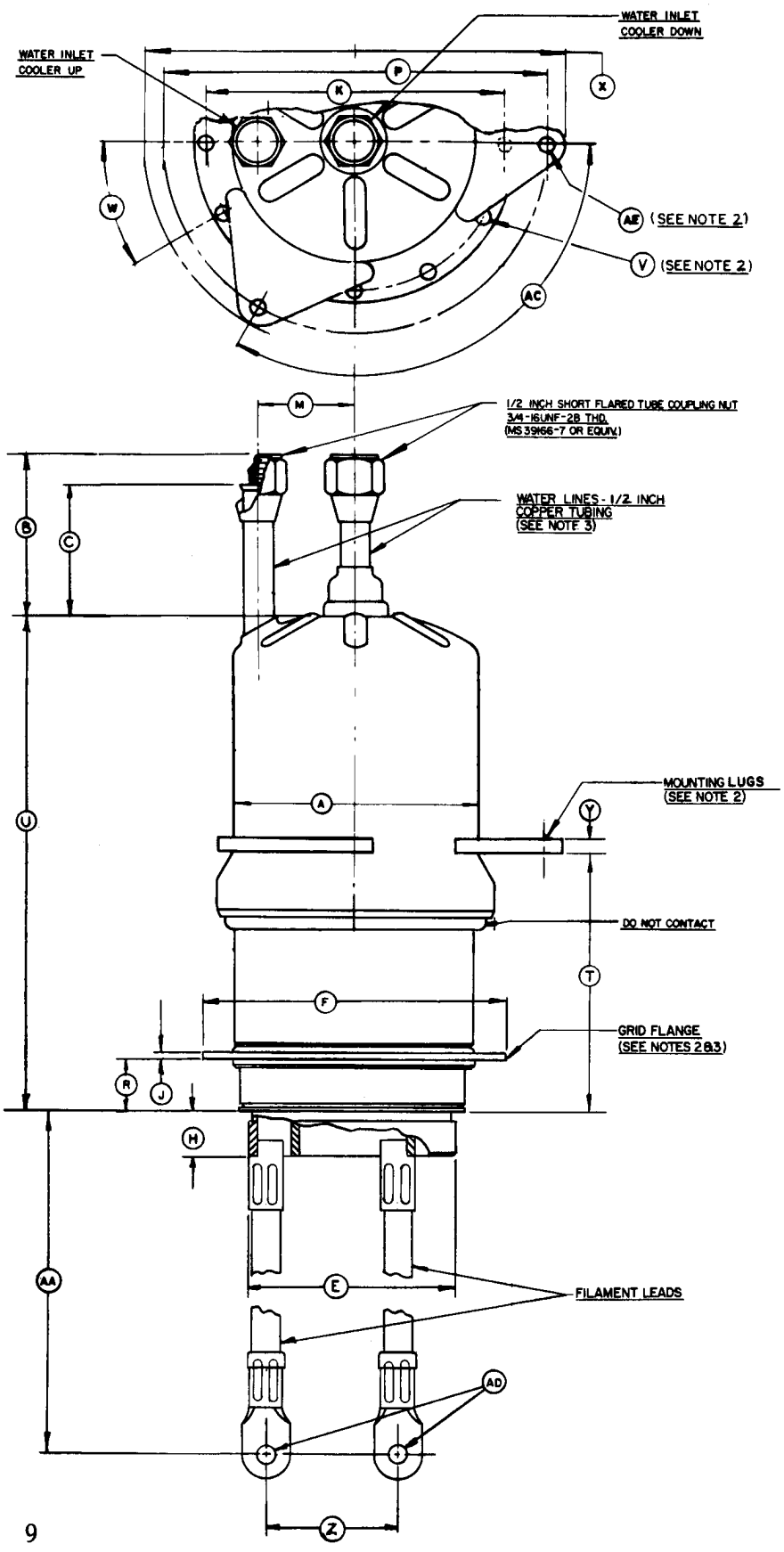
CURVE #4461

TYPICAL PLATE CHARACTERISTICS

GROUNDED CATHODE



CURVE #4462



DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.094	4.156	- -	103.99	105.56	- -
B	2.312	2.812	- -	56.72	71.42	- -
C	1.937	2.187	- -	49.20	55.55	- -
E	3.230	3.270	- -	82.04	83.06	- -
F	5.030	5.090	- -	127.76	129.29	- -
H	0.530	0.700	- -	13.46	17.78	- -
J	- -	- -	0.125	- -	- -	3.18
K	4.425	4.445	- -	112.40	112.90	- -
M	1.500	1.750	- -	38.10	44.45	- -
P	5.957	6.025	- -	151.31	153.04	- -
R	0.700	0.860	- -	17.78	21.84	- -
T	4.350	4.450	- -	110.49	113.03	- -
U	7.903	8.403	- -	200.74	213.44	- -
V	- -	- -	0.250	- -	- -	6.35
W	29°	31°	- -	29°	31°	- -
X	- -	- -	6.750	- -	- -	171.45
Y	- -	- -	0.250	- -	- -	6.35
Z	- -	- -	2.000	- -	- -	50.80
AA	8.500	9.000	- -	215.90	228.60	- -
AC	118°	122°	- -	118°	122°	- -
AD	- -	- -	0.390	- -	- -	9.91
AE	- -	- -	0.265	- -	- -	6.73

NOTES:
1. REF DIMS ARE FOR INFO ONLY AND ARE NOT REQD FOR INSPECTION PURPOSES.
2. 3 MTG. HOLES IN MTG. LUGS & 12 IN THE GRID FLANGE.
3. GRID FLANGE, WATER FITTING & FIL. LEADS ORIENTED AS SHOWN.

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

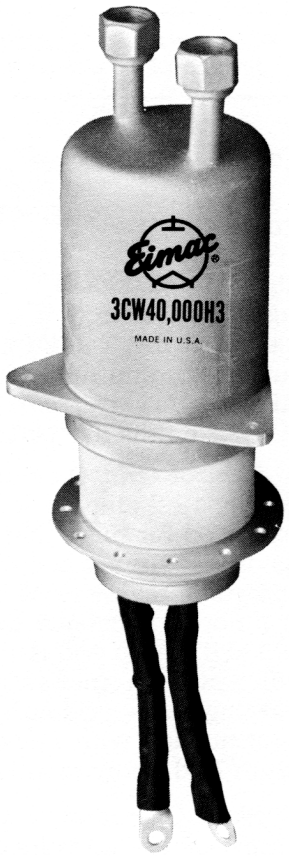
3CW40,000H3

MEDIUM-MU

WATER-COOLED POWER TRIODE

The EIMAC 3CW40,000H3 is a water-cooled, ceramic-metal power triode designed primarily for use in industrial radio-frequency heating services. Its water-cooled anode is conservatively rated at 40 kilowatts of plate dissipation with low waterflow and pressure drop.

Input of 80 kilowatts is permissible up to 90 megahertz. Plentiful reserve emission is available from its 1500 watt filament. The grid structure is rated at 750 watts, making this tube an excellent choice for severe applications.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated-Tungsten				
Voltage		10		volts
Current	152		168	amps
Amplification Factor		20		
Interelectrode Capacitances, Grounded Cathode:				
Grid-Filament	65		75	pF
Plate-Filament	2.0		2.6	pF
Grid Plate	38		48	pF
Frequency for Maximum Ratings			90	MHz

MECHANICAL

Base	See Outline
Operating Position	Vertical, base up or down
Cooling	Water and Forced Air
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250°C
Maximum Dimensions:	
Height	See Outline
Diameter	See Outline
Net Weight	14 pounds

(Effective 8-1-67) © 1967 Varian

Printed in U.S.A.

RF INDUSTRIAL OSCILLATOR

Class-C (Filtered DC Power Supply)

MAXIMUM RATINGS

DC PLATE VOLTAGE	12,000 VOLTS
DC PLATE CURRENT	9.0 AMPS
DC GRID VOLTAGE	-1200 VOLTS
DC GRID CURRENT	1.2 AMPS
PLATE INPUT POWER	100 KW
PLATE DISSIPATION	40 KW

TYPICAL OPERATION*

DC Plate Voltage	7000	10,000 volts
DC Plate Current	7.7	9.0 amps
DC Grid Voltage	-700	-850 volts
DC Grid Current	.53	.742 amps
Peak Positive Grid Voltage	440	550 volts
Driving Power	600	1040 watts
Plate Input Power	54	90 kW
Plate Dissipation	16	20 kW
Plate Output Power	37.7	70 kW
Approximate Load Impedance	408	526 ohms

*Loaded Conditions

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

APPLICATION

ELECTRICAL

Filament — The rated filament voltage for the 3CW40,000H3 is 10.0 volts. Filament voltage, as measured at the tube, should be maintained at this value for consistent performance and maximum tube life. In no case should it be allowed to vary from 10.0 volts by more than plus or minus five percent.

Control Grid Operation — The grid current rating is 1.2 ampere dc. This value should not be exceeded for more than very short periods such as during tuning and over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.3 to 0.6 amp grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 750 watts.

Plate Operation — Maximum plate voltage rating of 12,000 volts and maximum plate current of 9.0 amps should not be applied simultaneously as rated plate dissipation may be exceeded. The 100 kilowatts input rating applies for Class-C amplifier or oscillator service with no modulation.

Plate over-current protection should be provided to remove plate voltage quickly in the event of an over-load or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

High Frequency Operation — The 3CW40,000H3 is usable to 120 MHz. At this frequency, plate voltage must be reduced to 7000 volts in Class-C service.

MECHANICAL

Mounting — The 3CW40,000H3 must be mounted vertically, either base up or down.

Cooling — The anode of the 3CW40,000H3 is cooled by circulating water through the integral anode-water jacket. The table below lists minimum water-flow rates at various plate dissipation levels. The table is based on a water temperature rise of 15°C.

MINIMUM COOLING WATER-FLOW REQUIREMENTS

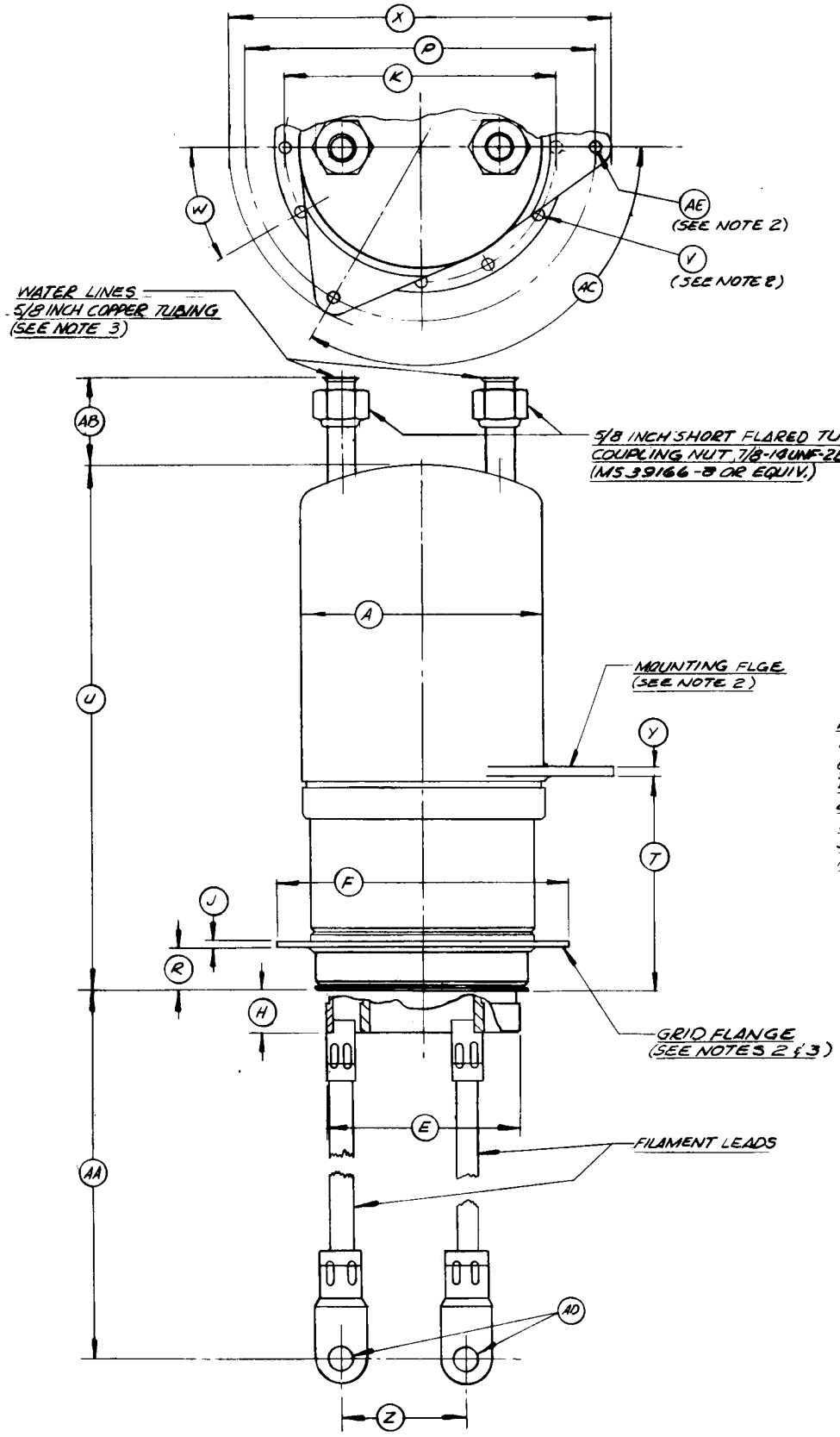
Plate Dissipation (kW)	Water Flow (gpm)	Pressure Drop (psi)
20	5.25	4.0
30	7.6	6.5
40	10.2	13.0
50	12.6	21.0

Since power dissipated by the filament represents 1500 watts and grid dissipation can reach 750 watts, 2250 watts has been added to anode dissipation in preparing this tabulation.

The cooling table assumes that the maximum outlet-water temperature will be below 70°C to preclude "spot" boiling.

Additional stem cooling air must be provided. 20 CFM of air directed against the center filament contact ring ½" below the outer filament contact ring by a 1½" I.D. air duct arranged at a 45° angle with the center line of the tube will provide adequate cooling for maximum frequency of 30 MHz, 50°C ambient, and 5000 ft. altitude.

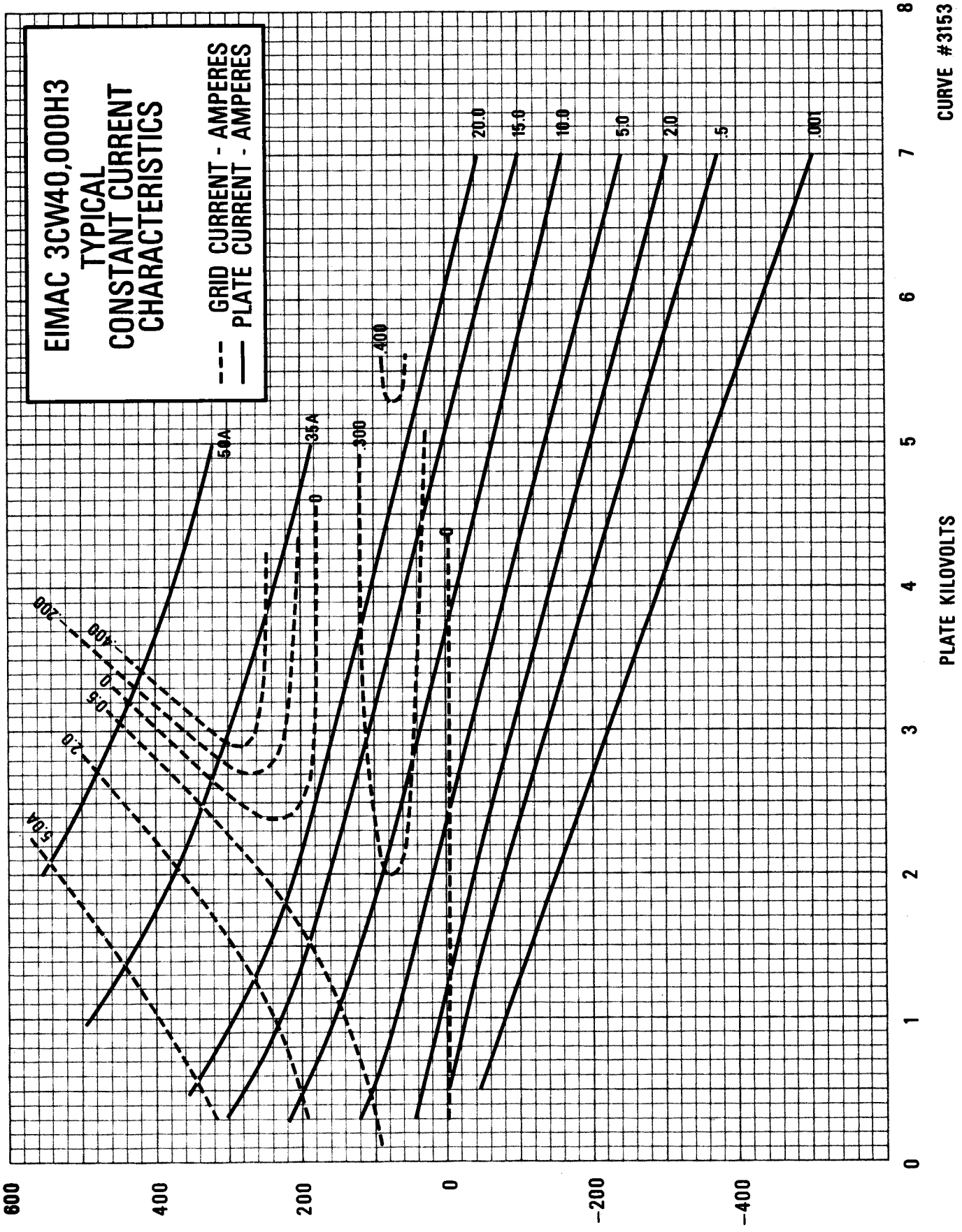
Special Application — If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



DIMENSIONS IN INCHES

DIMENSIONAL DATA			
DIM	MIN.	MAX.	REF
A	4.290	4.375	
E	3.290	3.270	
F	5.030	5.090	
H	.530	.700	
J			.328
K	4.425	4.445	
M			2.750
P	5.850	5.900	
R	.700	.860	
T	4.050	4.160	
U	9.800	10.050	
V			.250
W	29°	31°	
X			6.750
Y			.250
Z			2.000
AA	8.500	9.000	
AB			2.625
AC	118°	122°	
AD			.390
AE			.312

NOTES:
1. REF. DIMS. ARE FOR INFORMATION ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.
2. 3 MTG. HOLES IN MTG. FLANGE & 12 IN THE GRID FLANGE
3. GRID FLGE, WATER FITTINGS & FIL. LEADS ORIENTED AS SHOWN.


EIMAC 3CW40,000H3
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GRID CURRENT - AMPERES
PLATE CURRENT - AMPERES
20.0
15.0
10.0
5.0
2.0
.5
.001
50A
35A
0
-300
-400
-200
-400
0
.5
2.0
5.0A
GRID VOLTS
800
400
200
0
-200
-400
PLATE KILOVOLTS
0
1
2
3
4
5
6
7
8
CURVE #3153

3CX400U7

TECHNICAL DATA

HIGH-MU UHF TRANSMITTING TRIODE



The EIMAC 3CX400U7 is designed for use above 200 MHz as a CW, pulse, or linear rf amplifier, particularly in the 806 to 950 MHz portion of the spectrum allocated to land mobile services.

The 3CX400U7 is a high-mu triode designed with beam-forming cathode and control grid geometry, of all metal/ceramic construction, and an external anode rated for 400 watts of dissipation with forced-air cooling.

The combination of an amplification factor of over 200 and minimum current interception by the control grid provides good power gain in cathode-driven (grounded grid) amplifiers. Coaxial terminals and continuous cone-shaped conductors for the grid and cathode allow the lowest possible inductance between these tube elements and the cavity. The heater terminals are separate from the cathode.

200 watts of useful CW rf power may be obtained with better than 33% efficiency, and better than 10 dB of gain. At frequencies near 900 MHz the amplifier circuit may be essentially a quarter-wave radial or rectangular resonator for the anode, and a three-quarter wave coaxial line section between ground and cathode. The amplifier is described in this data sheet. Terminal collets are available and are listed.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide-Coated, Unipotential	
Heater Voltage, Nominal (see derating table for UHF use)	6.3 ± 0.3 V
Heater Current, at 6.3 volts	3.0 A
Cathode-Heater Potential, Maximum	±150 V
Transconductance, average (I_b = 250 mAdc)	29,000 μmhos
Amplification Factor, average	240
Direct Interelectrode Capacitances (grid grounded)[2]	
Cin	18.4 pF
Cout	6.1 pF
Cpk	0.07 pF
Ck-htr	6.0 pF
Frequency of Maximum Rating:	
CW	1000 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

(Effective 8-1-74) © 1974 by Varian Printed in U.S.A.

MECHANICAL

Maximum Operating Temperature:
- Ceramic/Metal Seals and Anode Core . . . . . 250°C

Cooling . . . . . Forced Air

Base . . . . . Special Coaxial

Recommended Contact Collets:

Tube Element	EIMAC Part No.
Inner Heater	008290
Outer Heater	008291
Cathode	008292
Grid	882931
Anode	154418

Maximum Overall Dimensions:
- Length . . . . . 2.51 in; 63.75 mm
- Diameter . . . . . 2.08 in; 52.83 mm

Net Weight (approximate) . . . . . 5.5 oz; 155 gms

RADIO FREQUENCY POWER AMPLIFIER CLASS C TELEGRAPHY OR FM

MAXIMUM RATINGS:

DC PLATE VOLTAGE	1500 VOLTS
DC GRID VOLTAGE	-100 VOLTS
DC PLATE CURRENT	0.400 AMPERE
PLATE DISSIPATION	400 WATTS
GRID DISSIPATION	5 WATTS

TYPICAL OPERATION, Cathode Driven, 850 MHz

Plate Voltage	1500 Vdc
Plate Current	400 mAdc
Grid Current	-5 mAdc
Measured Driving Power	13.0 W
Useful Output Power	225 W
Efficiency	37 %
Power Gain	12 dB

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater Current, at 6.3 volts	2.8	3.4	A
Cathode Warmup Time	60	---	Sec
Interelectrode Capacitances (grid grounded)[1]			
Cin	16.0	21.0	pF
Cout	5.0	7.0	pF
Cpk	---	0.1	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MOUNTING & SOCKETING - Part numbers of available EIMAC collets are listed under MECHANICAL. These collets may be soft-soldered to the appropriate UHF line or cavity elements. The collets provide low-inductance connections between tube and circuitry and serve to draw off a portion of the heat released during normal operation.

HEATER-CATHODE OPERATION - The nominal heater voltage for the 3CX400U7 is 6.3 volts. For CW operation at frequencies above 300 MHz the heater voltage should be reduced as the cathode receives additional heat from rf charging currents and a transit-time effect. The following table gives approximate values of heater voltage recommended versus operating frequency for CW

power levels at, or near, the typical operating conditions shown on Page 2. It is recommended that a mechanical relay, or other type of switching device, be provided so that near-nominal heater voltage will be provided during warmup and standby periods, and then dropped to the recommended level when rf drive is applied to the amplifier.

Frequency (MHz)	Heater Volts
300 or lower	6.3
300 to 400	6.1
400 to 500	5.7
500 to 600	5.3
600 to 700	4.9
700 to 800	4.5
800 to 900	4.0
900 to 1000	3.6

The heater voltage should be operated at nominal voltage of 6.3 volts for a minimum of 60 seconds before application of plate voltage or rf driving voltage.

INTERLOCKS - An interlock device should be provided to insure that cooling air flow is established before application of electrical power, including the heater. The circuit should be so arranged that rf drive cannot be applied in the absence of normal plate voltage.

COOLING - Forced-air cooling of the tube is required, with 11.5 cfm of air directed through the anode cooler when operating at full rated (400 W) dissipation. The pressure drop across the anode cooler only at this flow rate is approximately 0.2 inch of water, and these figures are based on an incoming air temperature of 50°C and a maximum tube anode temperature of 225°, at sea level, and with air flowing in a base-to-anode direction. When air is flowing in this direction, and the base contacting arrangement does not restrict flow in and around the base seals, additional base cooling provisions may not be required, but the designer is cautioned to verify whether base cooling is adequate before a circuit design is finalized, by means of temperature-sensitive paints which are available for this purpose, or other equivalent means.

Depending on the circuit or cavity design, allowance must also be made for other losses in the air system, in order to always assure sufficient flow for tube cooling. The designer is also cautioned that it is not good practice to operate at, or very close to, the absolute maximum temperature ratings for the metal/ceramic seals. Where long life and consistent performance are factors, cooling in excess of the minimum requirements outlined is normally beneficial.

UHF CAVITY AMPLIFIER - Included in this data sheet is an exploded view of a typical cavity amplifier of simple construction requiring little precise machine work. The dimensions shown are for an amplifier to be operated near 900 MHz. The typical operating conditions for 850 MHz, shown on Page 2, were obtained with this cavity.

The output circuit is essentially a quarter-wave rectangular cavity forming the tuned circuit between anode and grid. Output coupling is magnetic. A loop is formed by a post *F* which terminates at one end in the center conductor of the coaxial fitting, and at the other end it is solidly in contact with the opposite plate (or wall) of the cavity.

The input circuit, while simple mechanically, is not as easily visualized as an electrical circuit. Starting with the small inner conductor *A*, this is a heater conductor and rf choke. The next tube, *B*, is the second heater conductor and rf choke. The third tube, *C*, is the cathode line which may be considered as a broadly tuned three-quarter wave line. The next diameter of tubing, *D*, is a sleeve tuned to an electrical three-quarter wave-length by an adjustable capacity probe, *E*. The sleeve is excited by the input capacity probe, *F*. Current flows on the inside as well as on the outside wall of the three-quarter wave sleeve, thereby coupling energy to the cathode line. Sleeve *D* is electrically three-quarter wavelength because there is approximately a loaded quarter wavelength within the vacuum tube itself, *E*.

Suitable cowling (not shown) should be provided to introduce cooling air through three short tubes on each side of the output cavity for anode cooling. The air then exhausts through the anode cooling fins of the 3CX400U7. The three short tubes on each side of the cavity are dimensioned to serve as waveguide-above-cutoff frequency filters in the air openings.

HIGH VOLTAGE - Normal operating voltages used with the 3CX400U7 are deadly, and the equipment must be designed properly and opera-

ting precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

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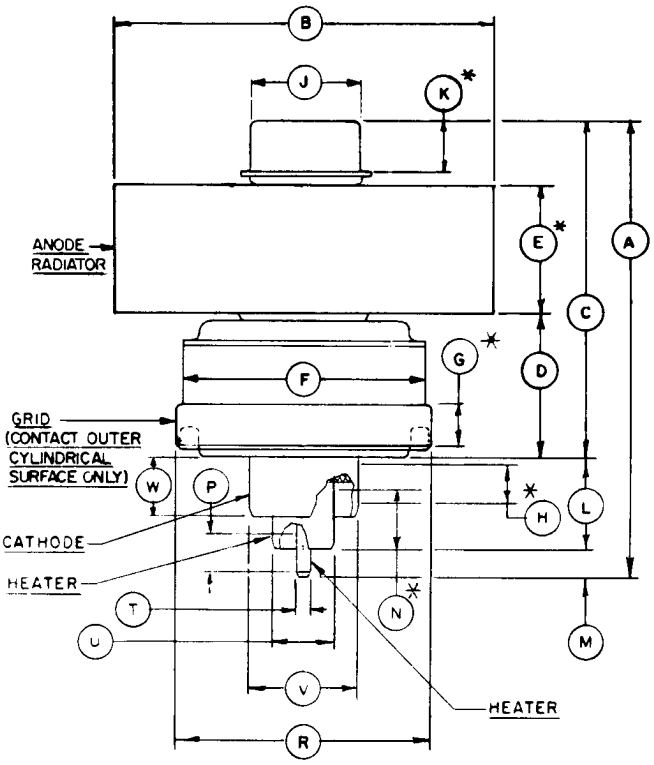
SPECIAL APPLICATIONS - If it is desired to operate these tubes under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, San Carlos, Calif. 94070 for information and recommendations.

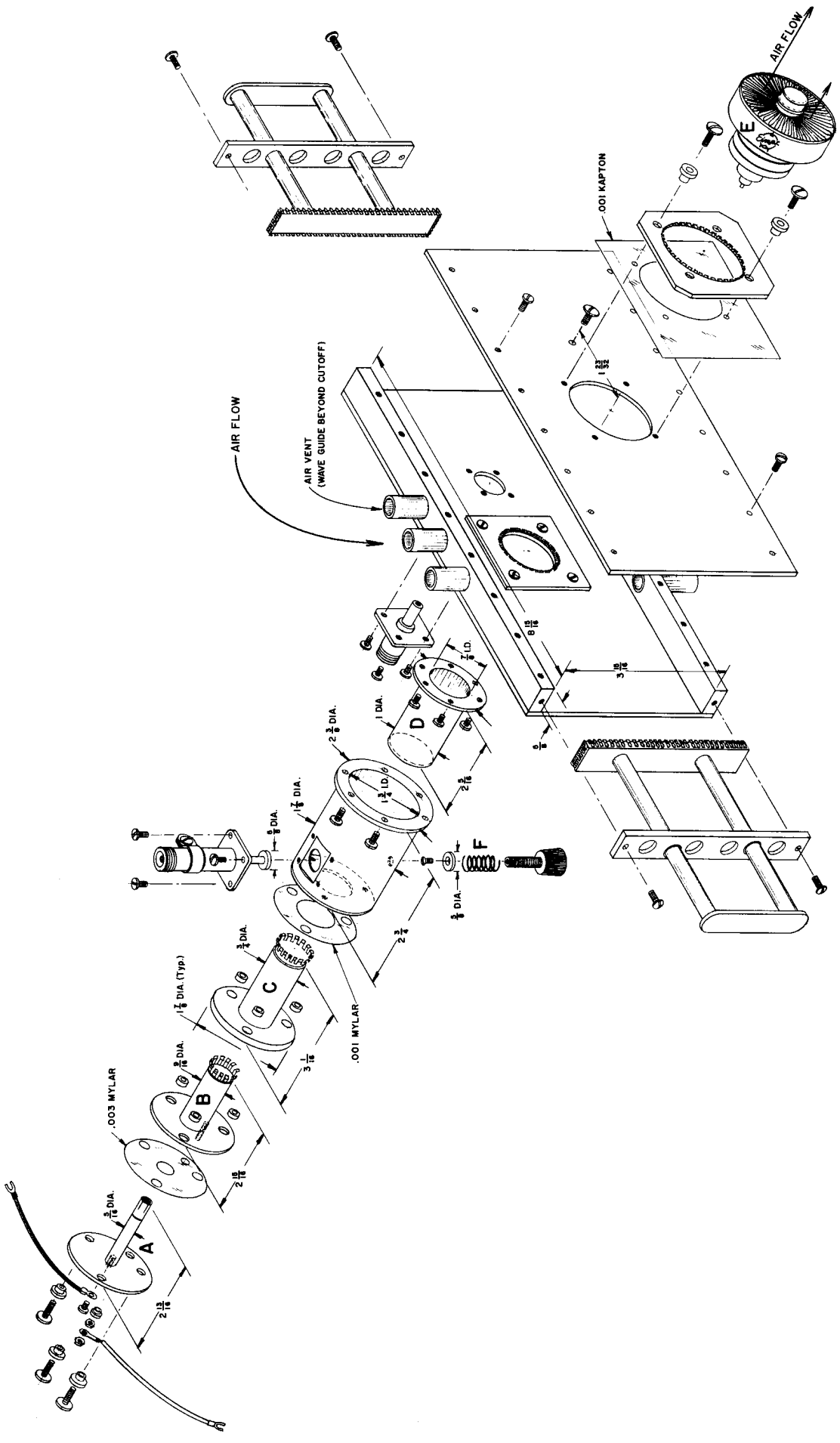
DIMENSIONAL DATA

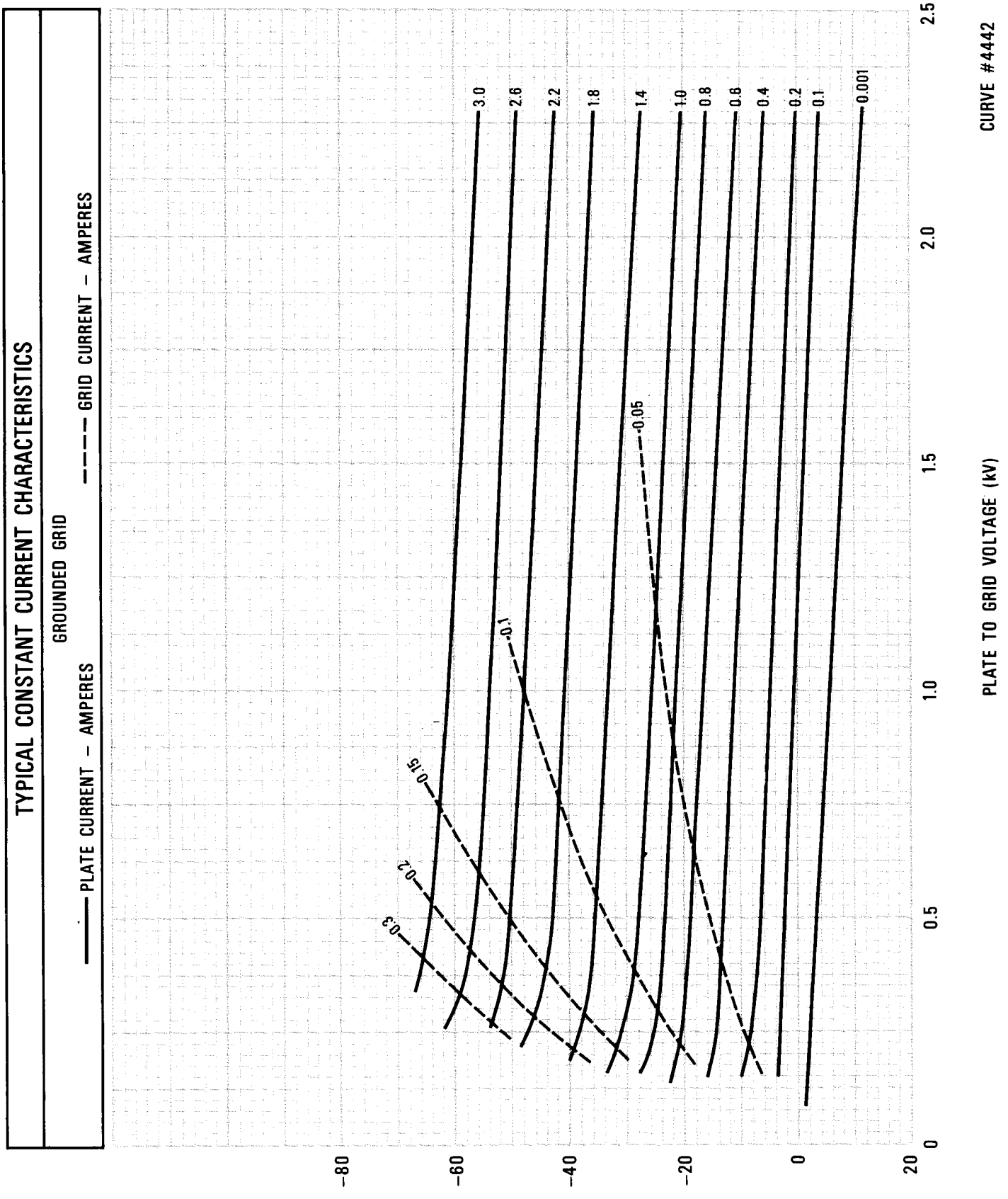
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	- -	- -	2.510	- -	- -	63.75
B	2.050	2.080	- -	52.07	52.83	- -
C	1.810	1.910	- -	45.97	48.51	- -
D	0.750	0.810	- -	19.05	20.57	- -
E	0.710	0.790	- -	18.03	20.07	- -
F	- -	1.406	- -	- -	35.71	- -
G	0.187	- -	- -	4.75	- -	- -
H	0.200	- -	- -	5.08	- -	- -
J	0.559	0.573	- -	14.20	14.55	- -
K	0.240	- -	- -	6.10	- -	- -
L	- -	- -	0.500	- -	- -	12.70
M	- -	- -	0.150	- -	- -	3.81
N	0.330	- -	- -	8.38	- -	- -
P	0.230	- -	- -	5.84	- -	- -
R	1.417	1.433	- -	35.99	36.40	- -
T	0.091	0.095	- -	2.31	2.41	- -
U	0.318	0.325	- -	8.08	8.25	- -
V	0.588	0.597	- -	14.93	15.16	- -
W	- -	- -	0.325	- -	- -	8.25

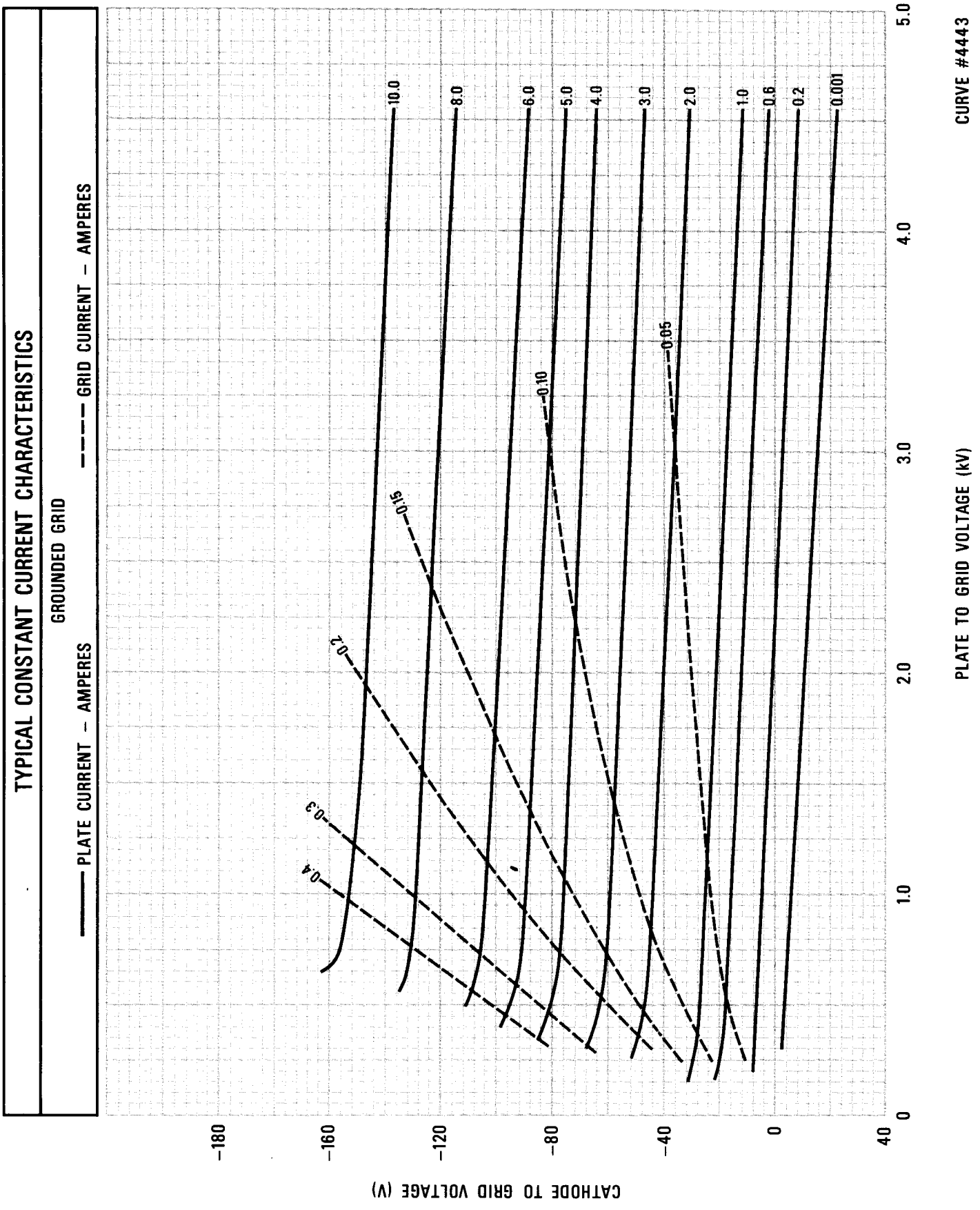
NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACE.




AIR FLOW
.001 KAPTON
AIR VENT
(WAVE GUIDE BEYOND CUTOFF)
AIR FLOW
.003 MYLAR
.001 MYLAR
A
B
C
D
E
F


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED GRID
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
3.0
2.6
2.2
1.8
1.4
1.0
0.8
0.6
0.4
0.2
0.1
0.001
0.3
0.2
0.15
0.1
0.05
-80
-60
-40
-20
0
20
0
0.5
1.0
1.5
2.0
2.5
CATHODE TO GRID VOLTAGE (V)
PLATE TO GRID VOLTAGE (kV)
CURVE #4442

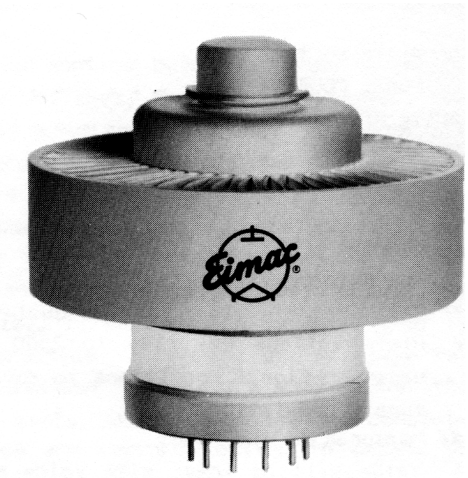

TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED GRID
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
10.0
8.0
6.0
5.0
4.0
3.0
2.0
1.0
0.6
0.2
0.001
0.15
0.10
0.05
0.3
0.4
2.0
CATHODE TO GRID VOLTAGE (V)
-180
-160
-120
-80
-40
0
40
0
1.0
2.0
3.0
4.0
5.0
PLATE TO GRID VOLTAGE (kV)
CURVE #4443

TECHNICAL DATA

3CX800A7
HIGH - MU
POWER TRIODE

The EIMAC 3CX800A7 is a compact power triode intended for use as a cathode-driven Class AB2 or Class B amplifier in rf applications including the VHF band. As a linear amplifier, high power gain may be obtained without sacrifice of low intermodulation distortion characteristics. Low grid interception and high amplification factor combine to make the 3CX800A7 drive power low for a tube of this power capacity. A single 3CX800A7 will deliver 750 watts PEP and 750 watts key-down CW output power to 350 MHz. The 3CX800A7 is useful to 600 MHz. (For typical cavity operation see page 10) A pulse rated version (3CPX800A7) is also available.

The anode is forced-air cooled for 800 watts of dissipation.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential

Heater Voltage	13.5 ± 0.6	V
Heater Current, at 13.5 volts	1.5	A
Cathode-Heater Potential (maximum)	± 150	V
Minimum Warmup Time (before application of rf drive and high voltage)	3	Min
Amplification Factor (approximate)	200	
Direct Interelectrode Capacitance (grid grounded)[2]		
Cin	26.0	pF
Cout	6.1	pF
Cpk	0.05	pF
Highest Frequency for Maximum Ratings	350	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions	
Length	2.52 in; 64.01 mm
Diameter	2.53 in; 64.26 mm
Net Weight	11.5 oz; 326 gm
Operating Position	Any
Cooling	Forced Air
Maximum Operating Temperature:	
Ceramic/Metal Seals or Anode Core	250°C
Base	Large Wafer Elevenar 11-Pin with Ring (EIA No. E11-81)
Recommended Socket	EIMAC SK-1900
Recommended Air Chimney	EIMAC SK-1906
Available Chimney Clamp for SK-1906 (needed if mounting is not vertical, anode up)	EIMAC SK-1916
Available Grid Collet with grounding flange to fit SK-1900 (for VHF operation)	EIMAC P/N 720359
Available Grid Bypass Capacitor Ring (1100 pF @ 1000 DCWV)	EIMAC SK-655
Available Anode Connector Clip	EIMAC ACC-1

VA5131 (Effective August 1989, Supersedes April 1987) Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER
CATHODE DRIVEN Class AB2

ABSOLUTE MAXIMUM RATINGS (to 350 MHz):

DC PLATE VOLTAGE #	2250	VOLTS
DC PLATE CURRENT	0.6	AMPERE
PLATE DISSIPATION	800	WATTS
GRID CURRENT	0.06	AMPERE
GRID DISSIPATION	4.0	WATTS

* Approximate value.
** Ref. against 1 tone of a 2-equal-tone signal.
# Plate voltage may rise to 2500 volts maximum under no-signal conditions to account for power supply regulation.
Measured at the load.
§ Value will be lower with voice modulation for the same PEP level.

TYPICAL OPERATION - Measured Data (to 150 MHz)
Class AB2 Cathode Driven

	CW/SSB	
Plate Voltage	2200	Vdc
Cathode Bias Voltage	+8.2	Vdc
Zero-Signal Plate Current *	15	mAdc
CW Plate Current	500	mAdc
CW Power Input	1100	W
Peak Envelope Power Input	1100	w
Two-Tone Plate Current §	313	mAdc
CW Grid Current *	36	mAdc
Two-Tone Grid Current * §	16	mAdc
Peak rf Cathode Voltage *	64	v
Peak Driving Power *	23	w
Useful Power Output ##	750	W
Useful Power Output, PEP ##	750	w
Cathode Input Impedance	54	Ohms
Resonant Load Impedance	2700	Ohms
Intermodulation Distortion **		
3rd Order Products	-36	dB
5th Order Products	-32	dB

PULSE MODULATOR OR REGULATOR

ABSOLUTE MAXIMUM RATINGS: (See Figure 2 PULSE DERATING CHART for pulse durations over 100 microseconds)

DC PLATE VOLTAGE	3500	VOLTS
AVERAGE PLATE DISSIPATION	800	WATTS
PEAK PLATE CURRENT (average during pulse)	8	AMPERES
AVERAGE PLATE CURRENT	0.6	AMPERE
AVERAGE GRID CURRENT	0.06	AMPERE
GRID DISSIPATION (average)	4	WATTS

TYPICAL OPERATION values are obtained by actual measurement or by calculation from published characteristic curves. Adjustment of the rf drive voltage to obtain the specified plate current at the specified bias and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid current. The grid current which occurs when the desired plate current is obtained is incidental and may vary from tube to tube. This current variation causes no performance degradation providing the circuit maintains the correct grid/cathode voltage in the presence of the current variation.

APPLICATION

MECHANICAL

MOUNTING & SOCKETING - The tube may be mounted in any position. If it is to be operated in an inverted (anode down) or horizontal position the SK-1916 clamp assembly should be used for reliable retention. The SK-1906 chimney is provided with four 4-40 tapped holes at one end for chassis mounting and four more 4-40 tapped holes at the other end for optional SK-1916 mounting. The combination of the SK-1906 with the optional SK-1916 clamp makes a rigid mounting assembly for the 3CX800A7. Outline drawings of the SK-1906 air chimney and the clamp assembly are shown in Fig.1.

COOLING - Forced-air cooling must be provided to maintain the anode core and seal temperatues at a safe operating temperature. Cooling data are shown for incoming cooling air at 25°C and 50°C, and represent the minimum requirements to limit tube temperatures to 225°C. The pressure drop figures are approximate and are for the mounting-plate (shown in Fig. 1), socket, tube and chimney combination as would be the case with pressurized-compartment mounting, where air is required to pass through the chassis slots and the anode cooler to the outside of the cabinet.

Cooling Air at 25°C

	SEA LEVEL		5000 FEET	
Anode Diss. W	Flow Rate cfm	Press. Drop In.Water	Flow Rate cfm	Press. Drop In.Water
400	6	0.09	7	0.10
600	11	0.20	14	0.23
800	19	0.50	23	0.57

Cooling Air at 50°C

	SEA LEVEL		5000 FEET	
Anode Diss. W	Flow Rate cfm	Press. Drop In.Water	Flow Rate cfm	Press. Drop In.Water
400	8	0.10	10	0.12
600	16	0.31	19	0.35
800	27	0.79	33	0.88

Some air from the pressurized compartment passes by the socket for base cooling. This mounting technique is effective in the HF region but rf leakage through the slots may cause amplifier instability or regeneration in the VHF region. Screening the holes or use of "wave-guide-beyond-cutoff" (honeycomb) air vents may be required in the VHF region.

Cooling must be applied before or simultaneously with electrode voltages, including the heater, and may be removed simultaneously with them. In all cases temperature of the anode and the ceramic/metal seals is the limiting factor, and the designer is encouraged to use temperature-sensitive paint or other temperature sensing devices in connection with any equipment design before the layout is finalized. It should also be noted that it is not good practice to operate at, or close to, the absolute maximum temperature rating for the metal/ceramic seals. Where long life and consistent performance are factors cooling in excess of minimum requirements is normally beneficial.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

HEATER/CATHODE OPERATION - The rated heater voltage for the 3CX800A7 is 13.5 volts, as measured at the base of the tube, and variations should be restricted to plus or minus 0.6 volt for long life and consistent performance.

CATHODE WARMUP TIME - In normal service it is recommended the heater voltage be applied for a minimum of three minutes before anode voltage and rf drive voltage are applied, to allow for proper conditioning of the cathode surface.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly. The equipment must be designed properly, and operating precautions must be followed. Design all equipment so that no one can

come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that **HIGH VOLTAGE CAN KILL.**

INPUT CIRCUIT - When this tube is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended to obtain greatest linearity and power output. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a "Q" of two or more.

GRID AND PLATE CURRENT LIMITATIONS - Note that grid current is a function of drive power and amplifier loading and can vary widely during tuning and loading. Under no circumstances should grid current exceed 60 mAdc during tuning or operation of the tube.
The maximum plate current rating is 600 mAdc. Drive level should be restricted during tuning periods so this rating is not exceeded. For monitoring purposes, peak meter readings on voice (taking into account inertia of the meter) will be approximately 200 mAdc. Under no circumstances is the plate current meter reading to exceed the maximum plate current rating of 600 mAdc.

INTERMODULATION DISTORTION - Typical Operating Conditions, with distortion values included, are the result of data taken during actual operation at 2 MHz. Intermodulation values listed are those measured at the full peak-envelope power noted and are referenced against one tone of a two-equal-tone signal.

FAULT PROTECTION - All power tubes operate at voltages which can cause severe damage in the event of an arc, especially in cases where large amounts of power supply stored energy are involved. Some means of protection is advised in all cases, and it is recommended that a series resistor be used in the lead from the power supply to the anode circuit to limit peak current and help dissipate the energy in the event of a tube or circuit arc. A resistance of 50 ohms, with at least a 25W rating, in the positive plate power supply lead will help protect the tube in the event of an arc.

VHF OPERATION - The base pin connections to the grid may be used at frequencies to 30 MHz. Above 30 MHz the available contact collets or grid bypass capacitor assembly (see Page 1) are recommended. VHF driving power will be greater than the typical values shown on page 2 because of higher circuit losses.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of a specially-constructed test fixture which shields all external tube leads or contacts from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown in the technical data are taken in accordance with Standard RS-191.
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in his application. Measurements should be taken with the mounting which represents the approximate final layout if capacitance values are highly significant in the design.

RADIO-FREQUENCY RADIATION - Exposure to strong rf fields should be avoided, especially at frequencies above 300 MHz, where energy absorption by the human body is significant. The human eye is particularly sensitive. Prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter (Occupational Safety & Health Administration (OSHA) standard). It is generally accepted that exposure to "high levels" of rf radiation can result in severe injury, including blindness. **CARDIAC PACEMEAKERS MAY BE EFFECTED.**

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC, attn: Product Manager, 301 Industrial Way, San Carlos, CA 94070 U.S.A.

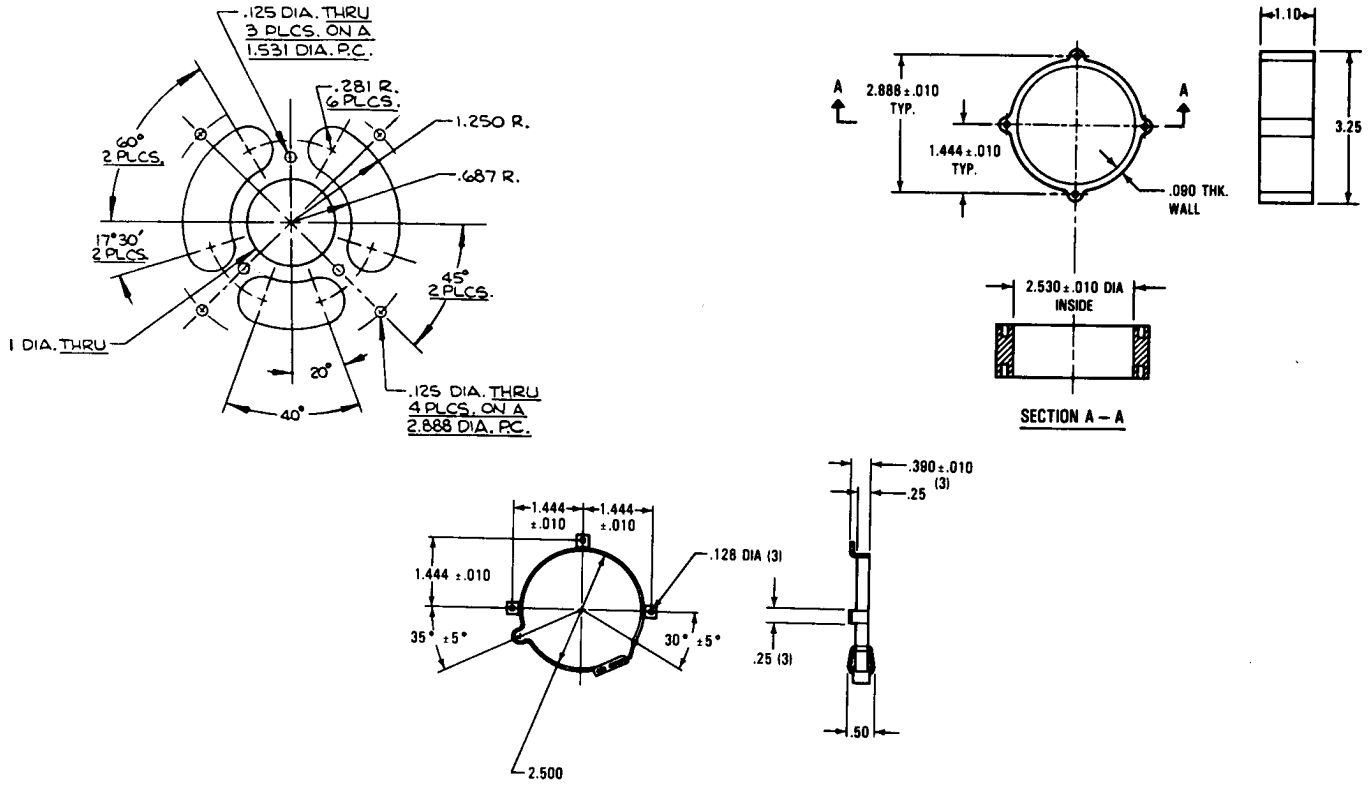


Figure 1 - Mounting Plate, Chimney SK-1906 and Clamp SK-1916, for SK-1900 Socket Assembly

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

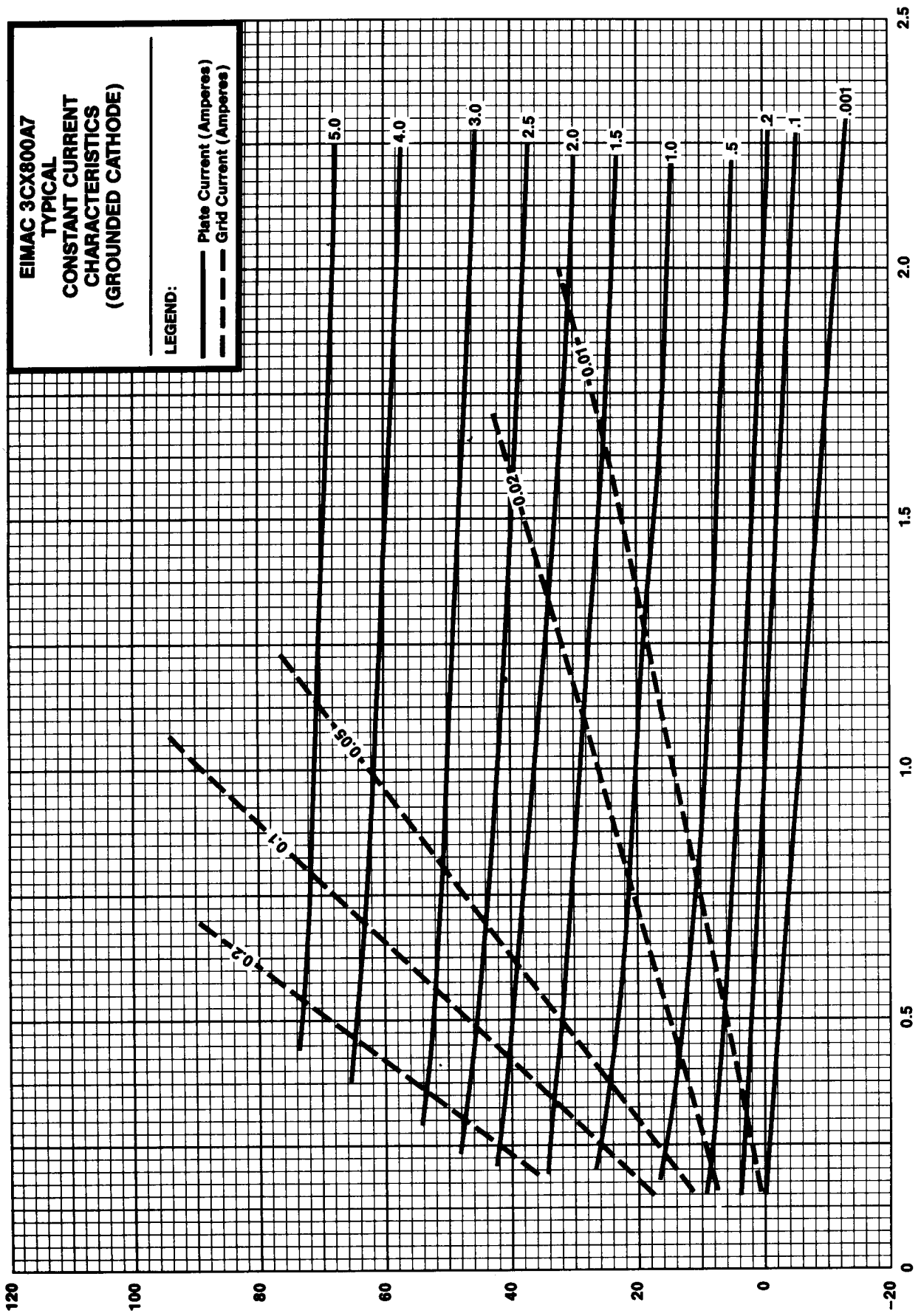
a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - Personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

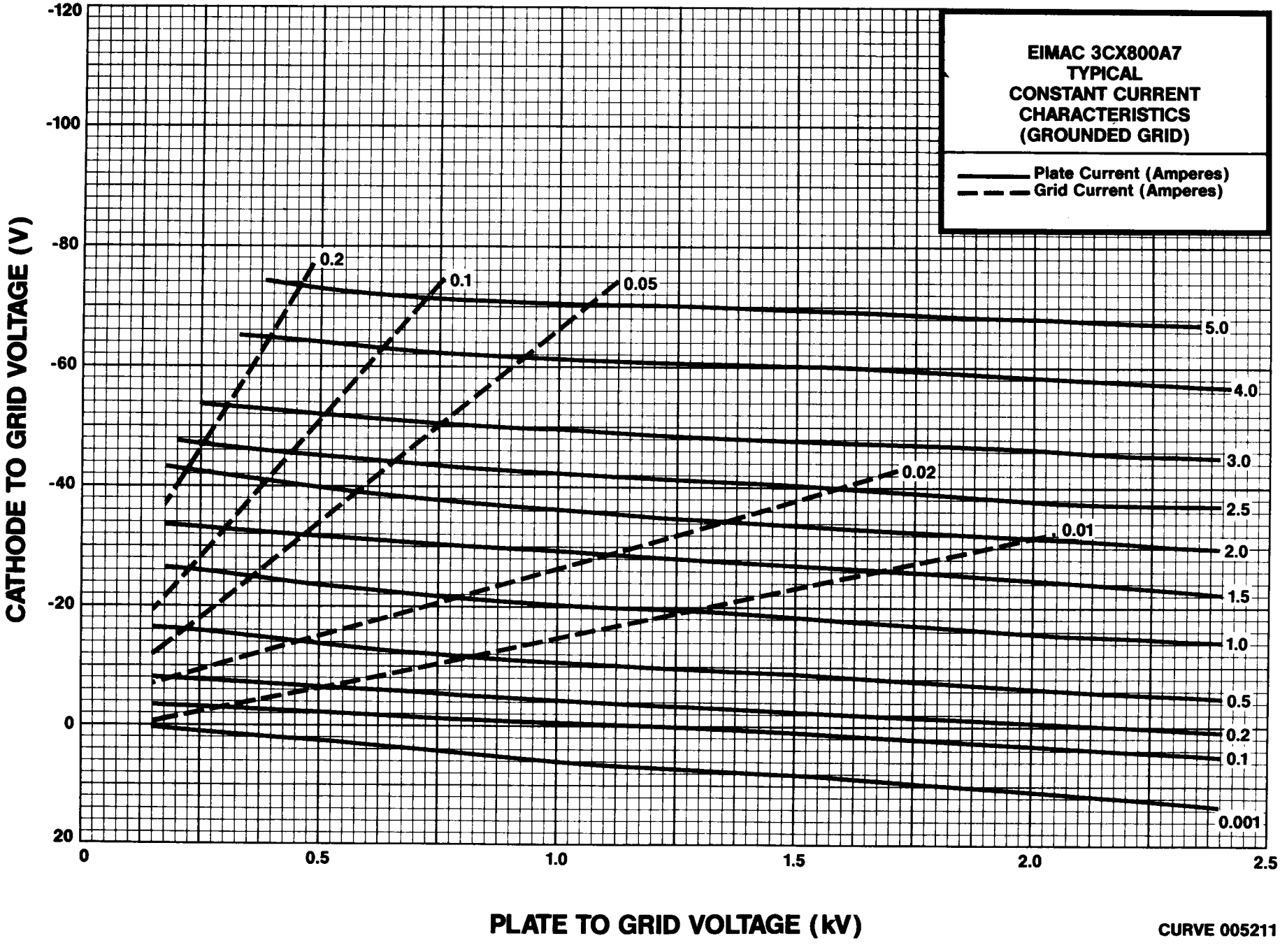
c. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

d. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.



CURVE 005202



CURVE 005211

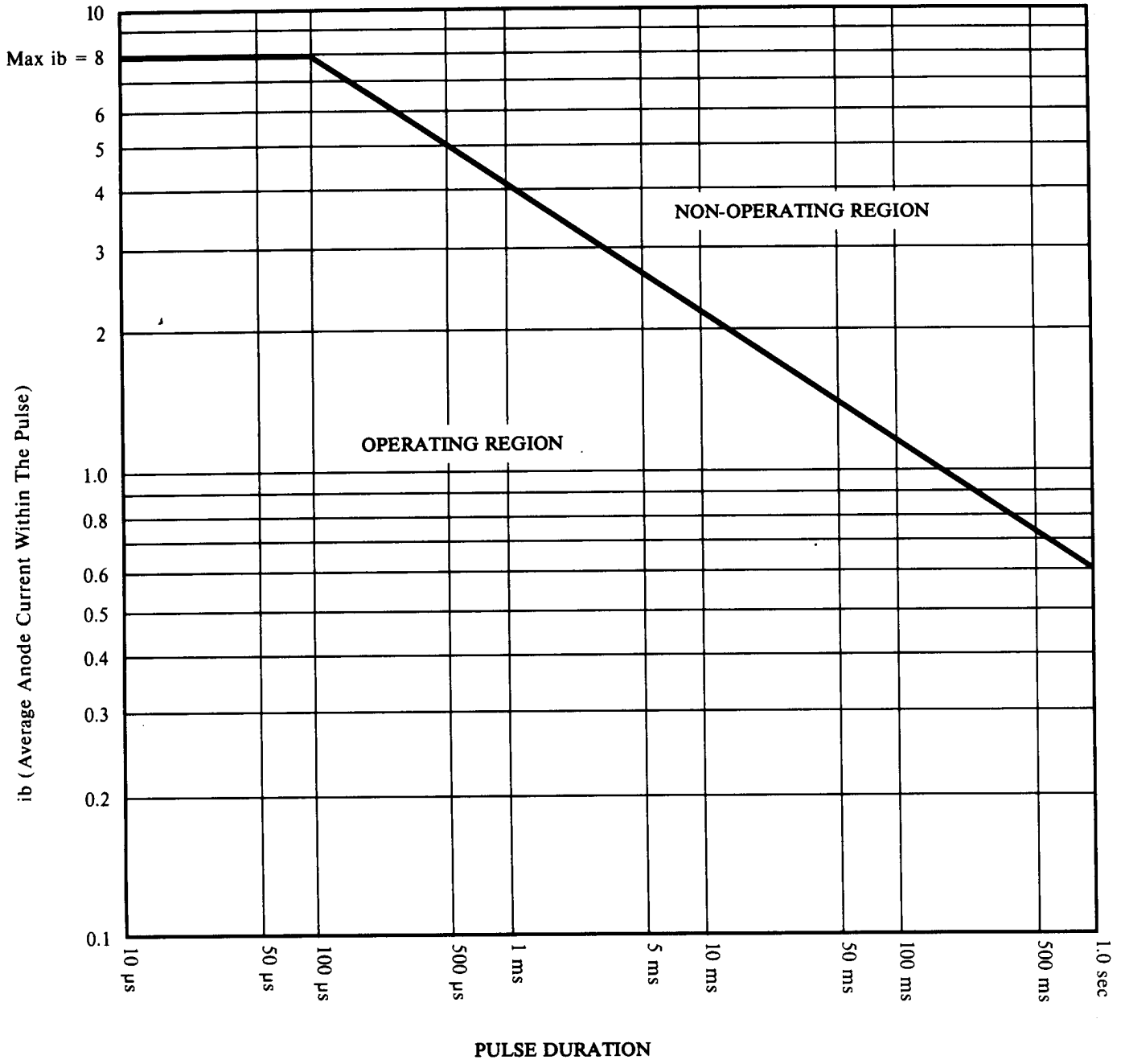


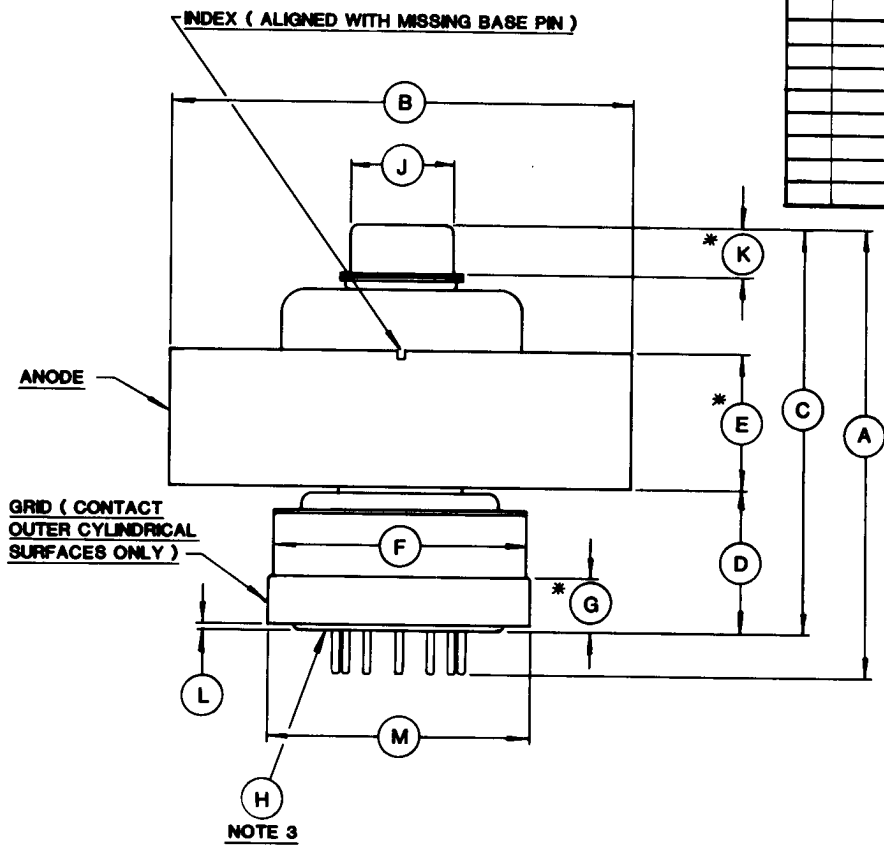
Figure 2 - Pulse Derating Chart, 3CX800A7

Pulse Modulator or Regulator Service

Pulse anode current (ib) capability is dependent on pulse duration (tp) and duty factor (Du). Maximum ib for a given tp is shown; maximum Du may then be derived from the relationship:

$$0.6 = ib\sqrt{Du}$$

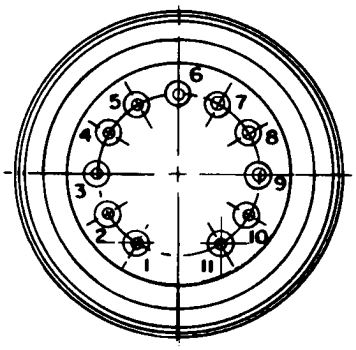
DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF
A	2.326	2.526		59.080	64.160	
B	2.486	2.515		63.119	63.881	
C	2.084	2.284		52.934	58.014	
D	.718	.838		18.237	21.285	
E	.710	.790		18.034	20.066	
F		1.406			35.712	
G	.187			4.750		
H	BASE: E11-61 (JEDEC DESIGNATION)					
J	.559	.573		14.199	14.554	
K	.240			6.096		
L			.027			.686
M	1.417	1.433		35.992	36.398	



NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACES
3. BASE IS BASIC JEDEC EXCEPT CERAMIC WAFER IS INSIDE SHELL

PIN No. 1 CATHODE
PIN No. 2 CATHODE
PIN No. 3 CATHODE
PIN No. 4 GRID
PIN No. 5 HEATER
PIN No. 6 HEATER
PIN No. 7 GRID
PIN No. 8 CATHODE
PIN No. 9 CATHODE
PIN No. 10 CATHODE
PIN No. 11 GRID



EIMAC UHF CAVITY AMPLIFIERS

EIMAC UHF CV-2400 series cavity amplifiers cover the range of 180 to 530 MHz. They are useful for communications service in the CW or FM mode. The designs incorporate the 3CX800A7 high-mu power triode for CW applications or the 3CPX800A7 in pulse applications.

Detailed information is shown for the CV-2401. Similar cavities available for other frequency ranges are listed.

CV-2407	180-200 MHz
CV-2403	280-300 MHz
CV-2405	330-370 MHz
CV-2402	375-420 MHz
CV-2406	450-470 MHz
CV-2404	470-530 MHz
CV-2408	585-615 MHz

Similar cavites can be adapted to specific requirements, including pulsed applications.

CV-2401 400 W POWER OUTPUT 390-450 MHZ

The CV-2401 is designed for use in the 390-450 MHz frequency range. It is designed for FM, CW or SSB linear amplifier service.

The amplifier tube is the EIMAC 3CX800A7, a high-mu triode designed with beam-forming cathode and control grid geometry. The tube is cathode driven for good linearity and high stage gain.

The triode design eliminates many cavity and equipment design complications associated with tetrode cavities.

CHARACTERISTICS

Tuning Range	390-450 MHz
Tube Type Used (not supplied	3CX800A7
Input rf Connector	Type N
Output rf Connector	Type N
Cooling Required	Forced Air
Mounting Position	Optional: normally mounts to fit 19-in Rack Panel
Overall Dimensions (nominal):	
Height	5.0 in; 12.7 cm
Width	8.5 in; 21.6 cm
Depth	8.25 in; 20.9 cm
Net Weight, approx. (tube not installed)	13 lbs; 6.0 kg

TYPICAL OPERATION (450 MHZ)

Heater Voltage	13.5	Vac
Heater Current *	1.5	Aac
Anode Voltage	1800	Vdc
Grid Bias Voltage	-8.0	Vdc
Anode Current	0.48	Adc
Grid Current *	10	mAdc
Driving Power *	15	W
Useful Power Output * #	400	W
Power Gain *	14.2	dB
Efficiency	46	%

* Approximate value # Power delivered to the load

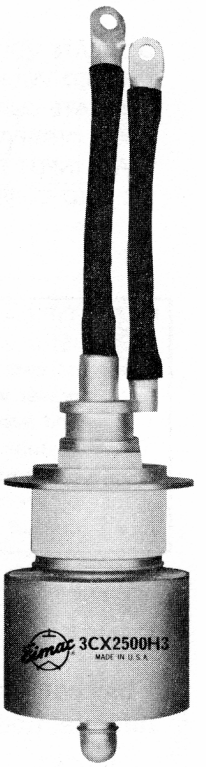
3CX2500H3

MEDIUM-MU
AIR-COOLED
POWER TRIODE

TECHNICAL DATA

The EIMAC 3CX2500H3 is a ceramic/metal, forced air cooled, external anode power triode designed primarily for use in industrial radio-frequency heating services. Its anode is conservatively rated at 2.5 kilowatts of plate dissipation with low air flow and pressure drop.

Input of 12.5 kilowatts is permissable up to 75 megahertz. Plentiful reserve emission is available from its 390 watt filament. The grid structure is rated at 150 watts making this tube an excellent choice for severe applications.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	7.5 ± 0.37	V
Current, at 7.5 volts	50	A
Amplification Factor (Average)	20	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Input	35.0	pF
Output	0.9	pF
Feedback	20.0	pF
Frequency of Maximum Rating:		
CW	75	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length (excluding leads)	9.000 in; 228.60 mm
Diameter	4.250 in; 107.95 mm
Net Weight	6.5 lb; 14.3 kg
Operating Position	Vertical, base up or down
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Cooling	Forced Air
Base	See Outline

(Effective 2-1-71) © by Varian Printed in U.S.A.

RADIO FREQUENCY INDUSTRIAL OSCILLATOR
Class C (Filtered DC Power Supply)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	6000	VOLTS
DC GRID VOLTAGE	-1000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	2500	WATTS
PLATE INPUT POWER	12.5	kW
DC GRID CURRENT	0.4	AMPERE

TYPICAL OPERATION (Frequencies to 75 MHz)[2]

Plate Voltage	4000	6000	Vdc
Grid Voltage	-300	-500	Vdc
Plate Current	2.50	2.08	Adc
Grid Current[1]	0.245	0.180	mAdc
Peak rf Grid Voltage[1]	280	265	v
Calculated Driving Power[1]	142	136	W
Plate Input Power	10.0	12.5	kW
Plate Dissipation	2.5	2.5	W
Plate Output Power	7.5	10.0	W
Resonant Load Impedance	910	1625	Ω

1. Approximate value.
2. Loaded Conditions

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 7.5 volts	48	53	A
Interelectrode Capacitance[1] (grounded filament connection)			
Input	29.2	40.2	pF
Output	0.6	1.2	pF
Feedback	16.8	23.2	pF

1. Capacitance values are for a cold tube as measured in a shielded fixture.

APPLICATION

MECHANICAL

MOUNTING - The 3CX2500H3 must be mounted vertically either base up or down. A mounting flange is provided on the grid terminal to allow bolting the tube to a grid deck or a strap. Filament voltage is applied through two heavy flexible leads.

COOLING - Forced-air cooling must be provided to hold the ceramic/metal seals and anode core temperature below the maximum rating of 250°C. At ambient temperatures above 50°C, at higher altitudes and at operating temperatures above 30 MHz, additional air flow must be provided. Sea level and 5000 foot altitude air flow requirements to maintain seal temperatures below 200°C in 50°C ambient air are tabulated below (for operation below 30 MHz).

Anode-to-Base Air Flow				
	Sea Level		5000 Feet	
Anode Dissipation watts	Air Flow CFM	Pressure Drop Inches Water	Air Flow CFM	Pressure Drop Inches Water
1500	33	0.6	40	0.74
2500	66	1.25	79	1.49

Base-to-Anode Air Flow				
	Sea Level		5000 Feet	
Anode Dissipation watts	Air Flow CFM	Pressure Drop Inches Water	Air Flow CFM	Pressure Drop Inches Water
1500	32	0.6	39	0.74
2500	57	1.0	68	1.23

*Since the power dissipated by the filament represents about 400 watts and since grid dissipation can, under some conditions represent another 150 watts, allowance has been made in preparing this tabulation for an additional 500 watts.

Additional stem cooling air must be provided. 14 CFM of air directed against the center rod ½'' below the outer filament contact ring by a 1½'' I.D. air duct arranged at a 45° angle with the center line of the tube will provide adequate cooling.

ELECTRICAL

FILAMENT - The rated filament voltage for the 3CX2500H3 is 7.5 volts. Filament voltage, as measured at the tube, must be maintained at 7.5 volts plus or minus five percent for maximum tube life and consistent performance.

GRID OPERATION - The grid current rating is 0.4 ampere dc. This value should not be exceeded for more than very short periods such as during tuning. Over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.275 ampere grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 150 watts.

PLATE OPERATION - Maximum plate voltage rating of 6000 volts and maximum plate current of 2.5 amperes dc should not be applied simultaneously as rated plate dissipation may be exceeded. The 12.5 kilowatts input rating applies for Class C amplifier or oscillator service with no modulation.

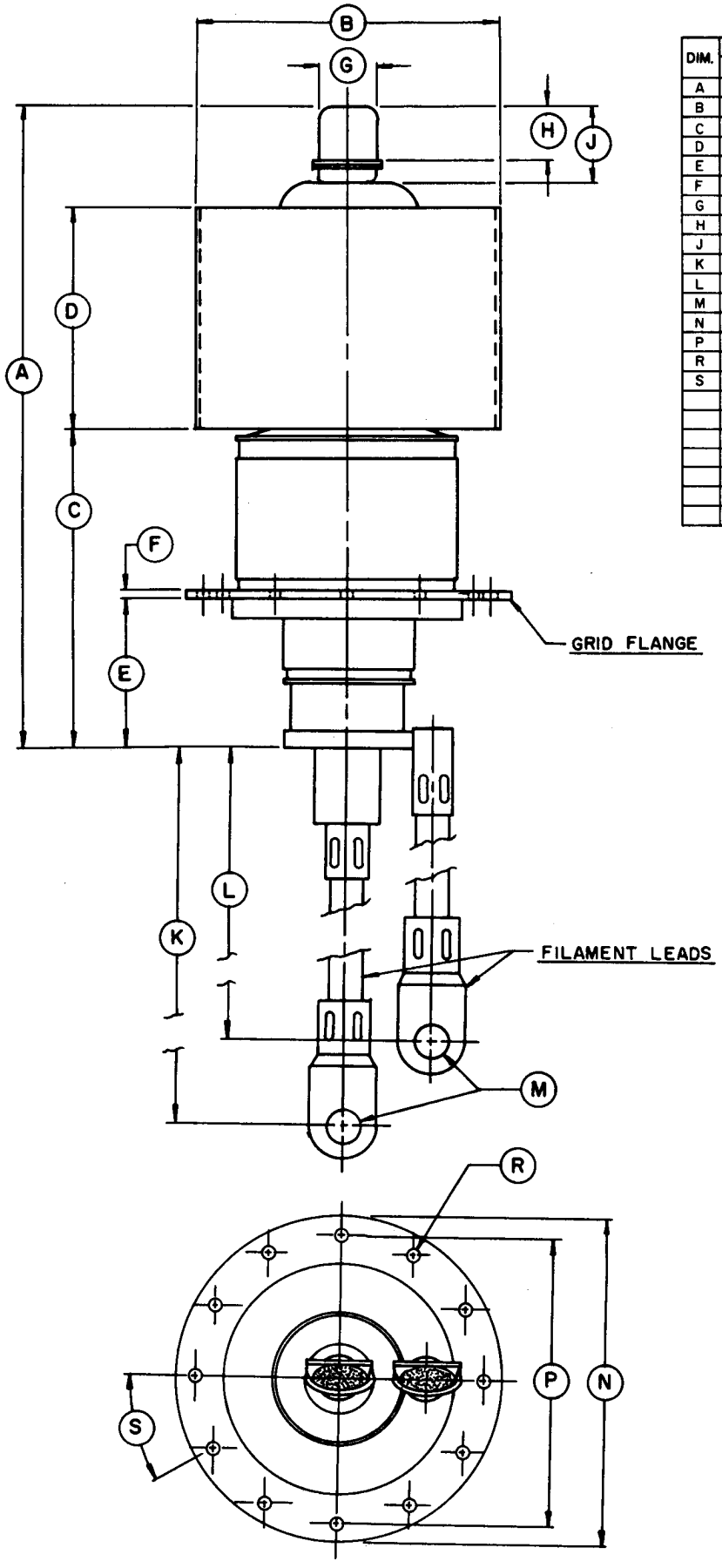
Plate over-current protection should be provided to remove plate voltage quickly in the event of an overload or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent voltages from flashing across the tube envelope during any fault conditions.

HIGH FREQUENCY OPERATION - The 3CX2500H3 is usable to 110 MHz. At this frequency, plate voltage must be reduced to 4000 volts in Class C service.

HIGH VOLTAGE - The 3CX2500H3 operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or ''cheated'' to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.

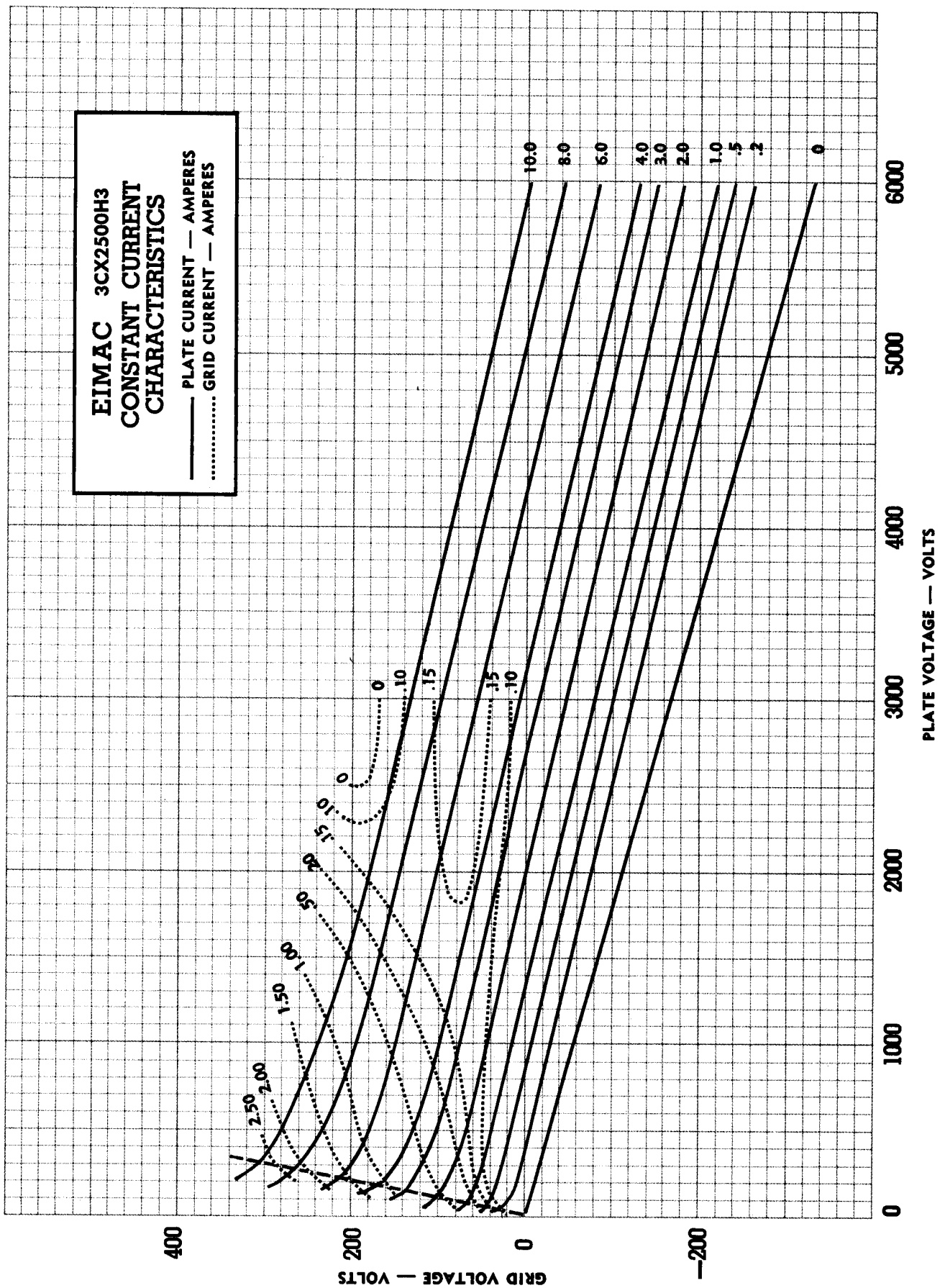


DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	8.000	9.000	- -	203.20	228.60	- -
B	4.093	4.156	- -	103.96	105.56	- -
C	3.875	4.250	- -	98.43	107.95	- -
D	2.937	3.062	- -	74.60	77.77	- -
E	1.703	1.953	- -	43.26	49.61	- -
F	- -	- -	0.125	- -	- -	3.18
G	0.781	0.843	- -	19.84	21.41	- -
H	0.687	0.812	- -	17.45	20.62	- -
J	1.000	1.125	- -	25.40	28.58	- -
K	8.937	9.437	- -	227.00	239.70	- -
L	7.937	8.437	- -	201.60	214.30	- -
M	- -	- -	0.390	- -	- -	9.91
N	4.230	4.250	- -	107.44	107.95	- -
P	3.855	3.885	- -	97.92	98.68	- -
R	- -	- -	0.250	- -	- -	6.35
S	29°	31°	- -	29°	31°	- -

NOTES:

1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. THERE ARE 12 HOLES IN GRID FLANGE.
3. GRID FLANGE AND FILAMENT LEADS ARE TO BE ORIENTED AS SHOWN


EIMAC 3CX2500H3
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT — AMPERES
GRID CURRENT — AMPERES
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.5
.2
0
2.50
2.00
1.50
1.00
.50
.20
.15
.10
.05
0
400
200
0
—200
GRID VOLTAGE — VOLTS
0
1000
2000
3000
4000
5000
6000
PLATE VOLTAGE — VOLTS

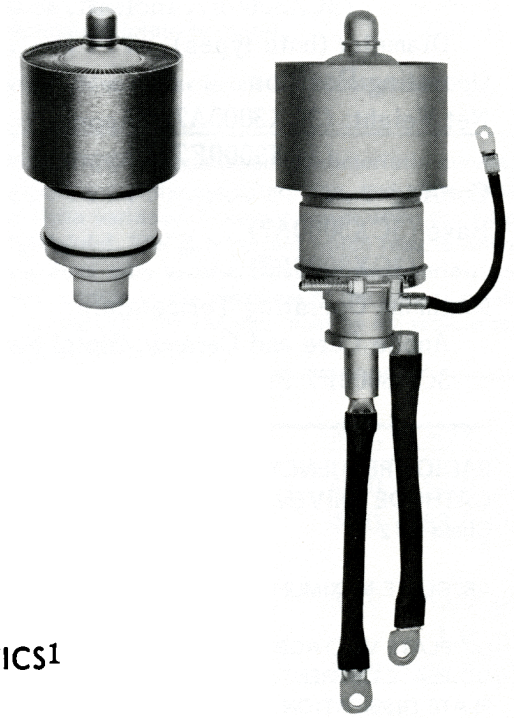
3CX3000A7
8162
3CX3000F7

HIGH-MU
AIR COOLED
POWER TRIODES

The EIMAC 3CX3000A7 high-mu forced-air cooled power triode provides relatively high power output as an amplifier, oscillator, or modulator at low plate voltages. The tube has a low inductance cylindrical filament-stem structure which readily becomes part of a linear filament tank circuit for VHF operation. The grid provides good shielding between the input and output circuits for grounded-grid applications and conveniently terminates in a ring between the plate and filament terminals.

Operation with zero grid bias in many applications offers circuit simplicity by eliminating the bias supply. Grounded-grid operation is attractive, since a power gain of over 20 times can be obtained.

The 8162/3CX3000F7 tube is identical except for the addition of flexible leads on the base for grid and filament connections which can simplify socketing in low-frequency applications.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten	
Voltage	7.5 V
Current @ 7.5 V (3CX3000A7)	51.5 A
(3CX3000F7)	50.5 A
Amplification Factor (Average)	160
Direct Interelectrode Capacitances (grounded filament)[2]	
Cin	38.0 pF
Cout	0.6 pF
Cgp	24.0 pF
Direct Interelectrode Capacitances (grounded grid)[2]	
Cin	38.0 pF
Cout	24.0 pF
Cpk	0.6 pF

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture, in accordance with Electronic Industries Association Standard RS-191.

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Frequency of Maximum Rating: 3CX3000A7 . . . . . 110 MHz
3CX3000F7 . . . . . 30 MHz

MECHANICAL

Maximum Overall Dimensions:
Length (3CX3000A7) . . . . . 9.000 in; 227.60 mm
(3CX3000F7, incl. fil. leads) . . . . . 18.437 in; 468.30 mm
Diameter (both types) . . . . . 4.156 in; 105.56 mm
Operating Position . . . . . Vertical, base up or down
Net Weight: (3CX3000A7) (Approx.) . . . . . 6.2 lb; 2.8 kg
(3CX3000F7) (Approx.) . . . . . 7.0 lb; 3.2 kg
Cooling . . . . . Forced Air
Base (3CX3000A7) . . . . . Special Coaxial
(3CX3000F7) . . . . . Special with Flying Leads
Maximum Operating Temperature:
Anode Core and Ceramic/Metal Seals . . . . . 250°C
3CX3000F7 Filament Lead/Tube Base Junctions . . . . . 150°C

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN

Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2, Peak Envelope or Modulation Crest Conditions

Plate Voltage	4000	4800	4800	Vdc
Zero-Signal Plate Current[1]	0.25	0.35	0.35	Adc
Single-Tone Plate Current	2.00	1.68	2.00	Adc
Single-Tone Grid Current[1]	0.61	0.46	0.60	Adc
Peak Driving Power	420	293	410	w
Plate Dissipation	2285	2275	2775	W
Single-Tone Plate Output Power	6030	6000	7266	W
Resonant Load Impedance	1210	1720	1425	Ω
Driving Impedance	47.5	50.0	46.3	Ω

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2, Grid Driven, Carrier Conditions

Plate Voltage	4000	Vdc
Zero-Signal Plate Current[1]	0.25	Adc
DC Plate Current	0.74	Adc
DC Grid Current[1]	0.13	Adc
Peak rf Grid Voltage[1]	85.0	v
Peak Driving Power[1]	11.5	w
Plate Dissipation	1830	W
Single-Tone Plate Output Power	1130	W
Resonant Load Impedance	1750	Ω
Peak rf Plate Voltage	2000	v

RADIO FREQUENCY POWER AMPLIFIER

Class C Telegraphy or FM, Cathode Driven
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

TYPICAL OPERATION (Frequencies to 110 MHz for 3CX3000A7, to 30 MHz for 3CX3000F7)

Plate Voltage	3500	4800	Vdc
Grid Voltage	-50	-60	Vdc
Plate Current	1.30	1.54	Adc
Grid Current[1]	0.42	0.48	Adc
Peak rf Cathode Voltage[1]	220	267	v
Calculated Driving Power[1]	310	435	W
Plate Dissipation	985	1480	W
Useful Output Power[2]	3300	5500	W

1. Approximate value.
2. Output circuit and filter loss of 10% assumed.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_2, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	4000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.
2. Per tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	4000	Vdc
Zero-Signal Plate Current[1]	0.50	Adc
Max. Signal Plate Current	3.58	Adc
Max. Signal Grid Current[1]	0.58	Adc
Peak af Grid Voltage[2]	190	v
Peak Driving Power[3]	115	w
Max. Signal Plate Dissipation	1850	W
Plate Output Power	10,500	W
Load Resistance (plate to plate)	2720	Ω

3. Nominal drive power is one-half peak power.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current @ 7.5 volts (3CX3000A7)	49.0	54.0	A
(3CX3000F7)	48.0	53.0	A
Interelectrode Capacitances[1] (grounded filament connection)			
Cin	30.0	45.0	pF
Cout	---	1.0	pF
Cgp	20.0	28.0	pF
Interelectrode Capacitances[1] (grounded grid connection)			
Cin	30.0	45.0	pF
Cout	20.0	28.0	pF
Cpk	---	1.0	pF
Zero Bias Plate Current (E_b = 5000 volts)	0.36	0.52	A
Cut-off Bias (E_b = 5000 volts, I_b = 1.0 mAdc)	---	-45.0	V

1. Capacitance values are for a cold tube as measured in a shielded fixture.

APPLICATION

MECHANICAL

MOUNTING - The 3CX3000A7 and 3CX3000F7 must be mounted vertically, base down or up at the convenience of the circuit designer. The filament connections to the 3CX3000A7 should be made through spring collets. These are available from EIMAC with the following part numbers:

149575 Inner line collet
149576 Outer line collet

Reasonable care should be taken that these collets do not impart undue strain to the terminals or the base of the tube.

COOLING - The maximum temperature rating for the anode core and the ceramic/metal seal areas of either tube is 250°C, and sufficient forced-air cooling must be provided to assure operation at safe tube temperatures. Tube life is usually prolonged if cooling in excess of absolute minimum requirements is provided for cooler tube temperatures.

The filament leads of the 3CX3000F7 are attached to the tube with soft solder, and care must therefore be taken to supply sufficient

cooling to this area of the tube to maintain temperatures below 150°C to avoid melting or loosening of these leads.

Minimum air flow requirements to maintain anode core and ceramic/metal seal areas below 225°C at sea level with an inlet-air temperature of 50°C are tabulated for air-flow in the base-to-anode and anode-to-base directions. At higher ambient temperatures, frequencies above 30 MHz, or at higher altitudes, a greater quantity of air will be required.

With air flowing in a base-to-anode direction, and with the specified air also flowing past the base section of the tube, no additional base cooling of either type is normally required. With air flowing in an anode-to-base direction, both types require additional cooling air directed into the filament stem structure, between the inner and outer filament terminals, in the amount of 5 cfm minimum, directed by an appropriate air nozzle or pipe.

It is suggested that temperatures, especially in the base area of the tube, be monitored in any new installation to insure proper cooling. Temperatures may be measured with any of the available temperature-sensing paint or crayon materials.

Base-to-Anode Air Flow				
	Sea Level		10,000 Feet	
Anode Dissipation watts	Air Flow CFM	Pressure Drop Inches water	Air Flow CFM	Pressure Drop Inches water
2000	49	0.31	71	0.45
3000	85	0.72	124	1.40
4000	127	1.40	185	2.55
Anode-to-Base Air Flow				
2000	54	0.37	79	0.68
3000	106	1.1	155	1.90
4000	178	2.50	260	4.50

ELECTRICAL

FILAMENT OPERATION - The filament voltage, as measured at the filament terminals, should be 7.5 volts, with maximum allowable variations due to line fluctuations of from 7.12 to 7.87 volts.

INTERLOCKS - An interlock device should be provided to insure that cooling air flow is established before application of electrical power, including the heater. The circuit should be so arranged that rf drive cannot be applied in the absence of normal plate voltage.

INPUT CIRCUIT - When operated as a grounded-grid rf amplifier, the use of a matching network in the cathode circuit is recommended. For best results with a single-ended amplifier, and depending on the application, it is suggested the network have a "Q" of at least 2, and higher if possible.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as these, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry--the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal cooling airflow interlock and plate over-current interlock it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high plate voltage.

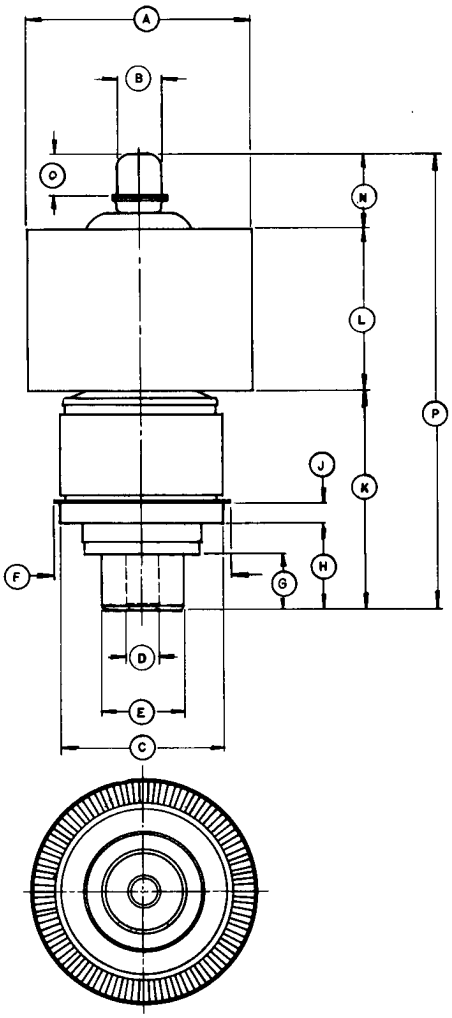
In all cases some protective resistance, at least 10 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur.

HIGH VOLTAGE - Normal operating voltages used with these tubes are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

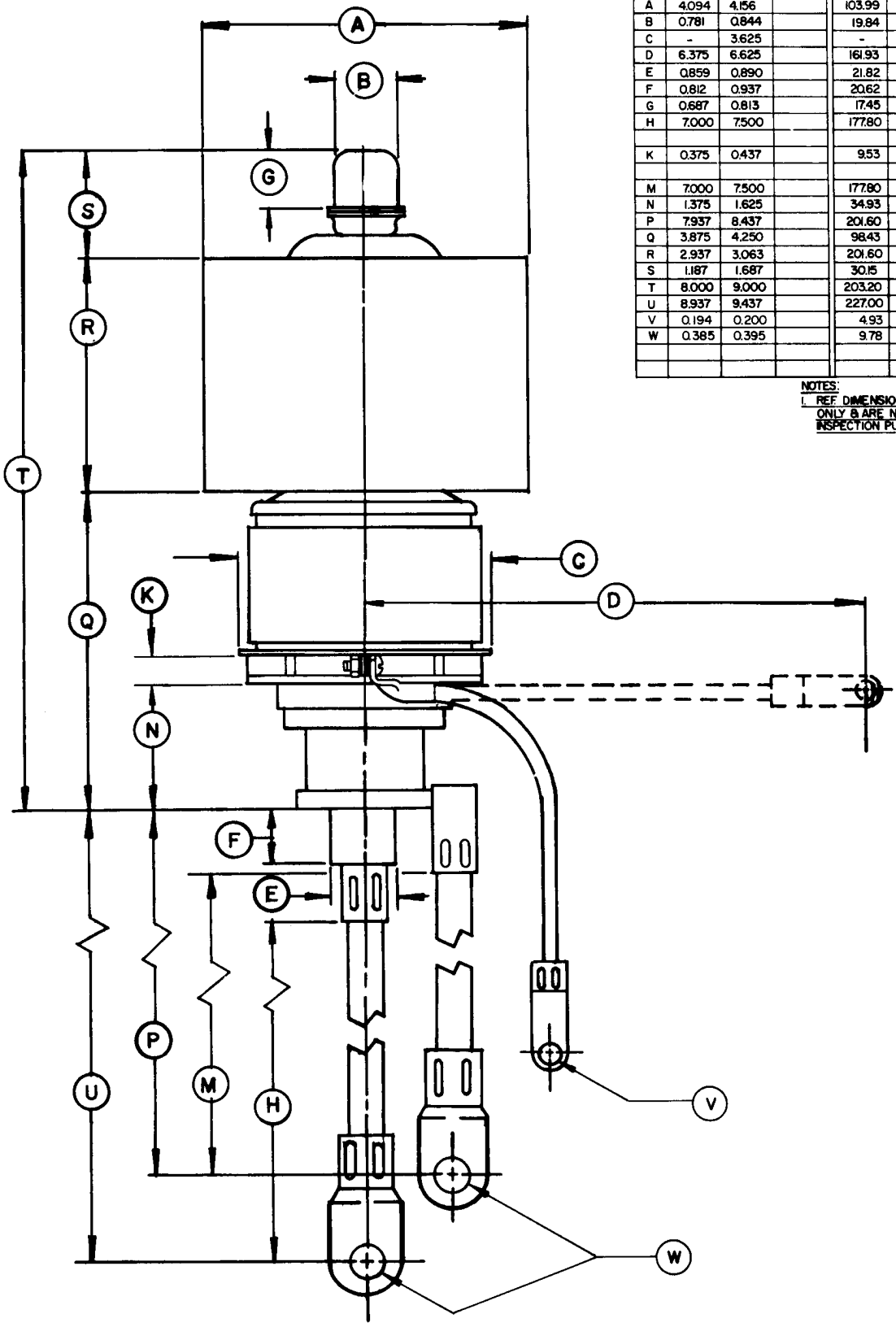
SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF	MIN.	MAX.	REF
A	4.094	4.156	- -	103.99	105.56	- -
B	0.781	0.844	- -	19.83	21.44	- -
C	2.990	3.010	- -	75.95	76.45	- -
D	0.615	0.635	- -	15.62	16.13	- -
E	1.490	1.510	- -	37.85	38.35	- -
F	- -	3.625	- -	- -	92.08	- -
G	0.813	0.937	- -	20.65	23.80	- -
H	1.375	1.625	- -	34.92	41.28	- -
J	0.391	0.422	- -	9.93	10.72	- -
K	3.875	4.250	- -	98.43	107.95	- -
L	2.937	3.063	- -	74.60	77.80	- -
N	1.187	1.687	- -	30.15	42.85	- -
P	8.000	9.000	- -	203.20	228.60	- -
Q	0.687	0.813	- -	17.45	20.65	- -

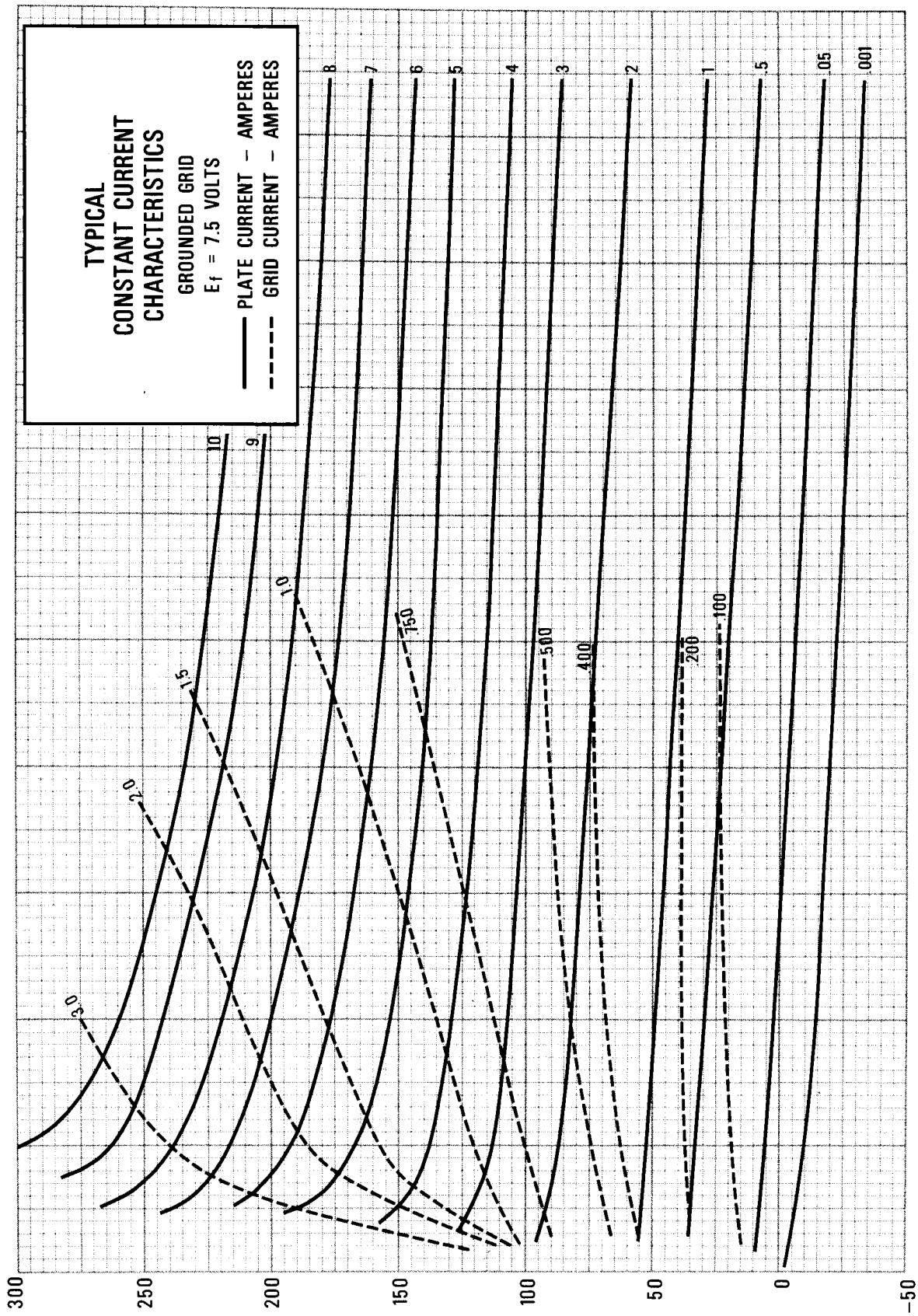
NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



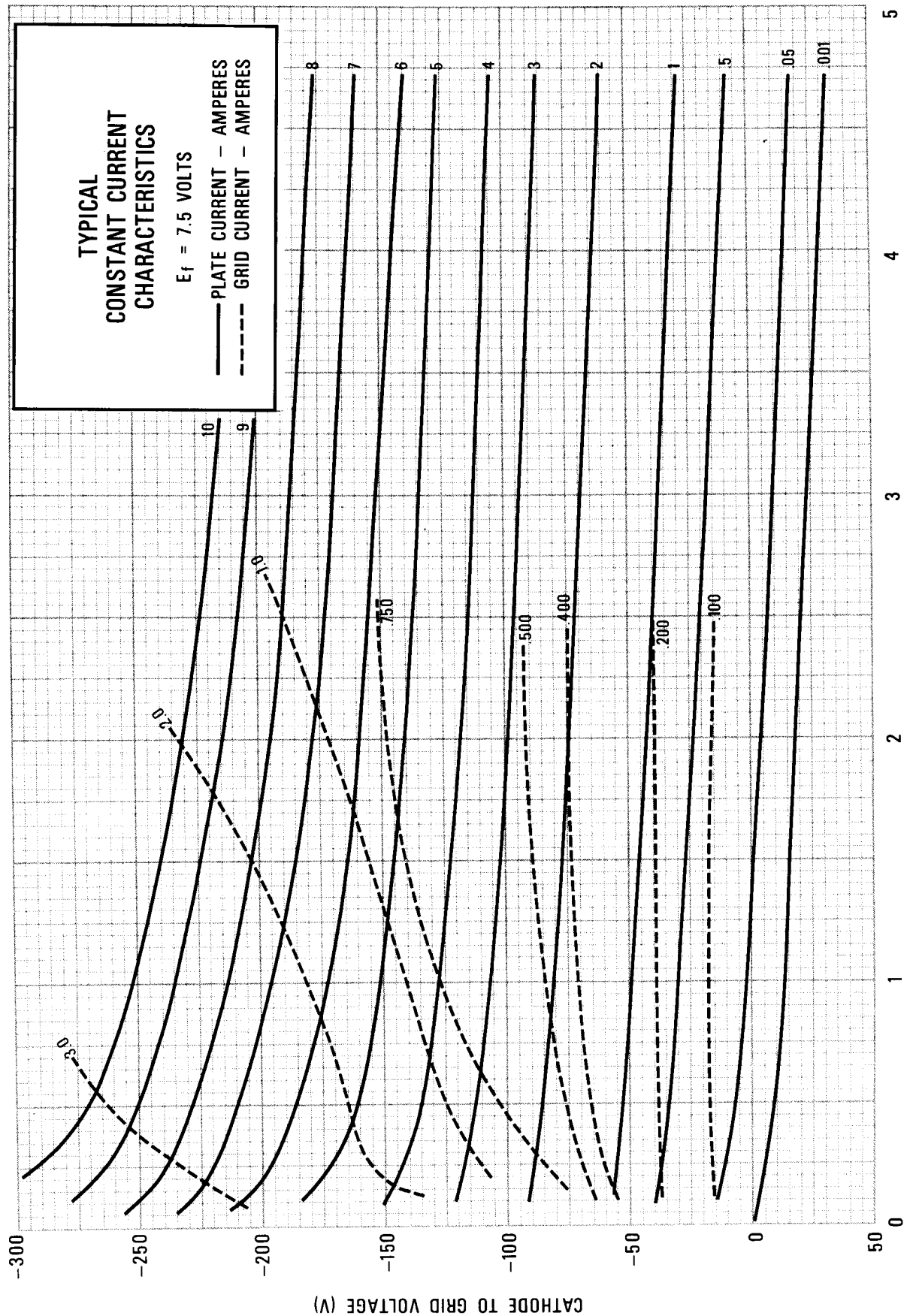
DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF	MIN.	MAX.	REF
A	4.094	4.156		103.99	105.56	
B	0.781	0.844		19.84	21.44	
C	-	3.625		-	92.08	
D	6.375	6.625		161.93	168.28	
E	0.859	0.890		21.82	22.61	
F	0.812	0.937		20.62	23.80	
G	0.687	0.813		17.45	20.65	
H	7.000	7.500		177.80	190.50	
K	0.375	0.437		9.53	11.10	
M	7.000	7.500		177.80	190.50	
N	1.375	1.625		34.93	41.28	
P	7.937	8.437		201.60	214.30	
Q	3.875	4.250		98.43	107.95	
R	2.937	3.063		201.60	214.30	
S	1.187	1.687		30.15	42.85	
T	8.000	9.000		203.20	228.60	
U	8.937	9.437		227.00	239.70	
V	0.194	0.200		4.93	5.08	
W	0.385	0.395		9.78	10.03	

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
Ef = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
8
7
6
5
4
3
2
1
.5
.05
.001
10
9
3.0
2.0
1.5
1.0
150
500
400
200
100
300
250
200
150
100
50
0
-50
0
1
2
3
4
5
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)

CURVE #3373


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
10
9
8
7
6
5
4
3
2
1
.5
.05
.001
3.0
2.0
1.0
.750
.500
.400
.200
.100
−300
−250
−200
−150
−100
−50
0
50
0
1
2
3
4
5
CATHODE TO GRID VOLTAGE (V)
PLATE TO GRID VOLTAGE (KV)

CURVE #3375

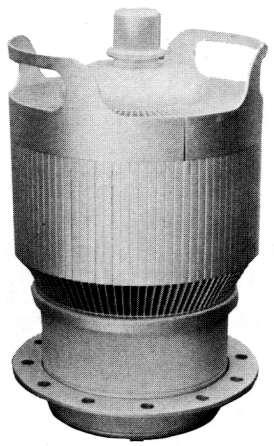
TECHNICAL DATA

3CX5000A7 HIGH-MU POWER TRIODE

The EIMAC 3CX5000A7 is a ceramic/metal high-mu power triode designed especially for use as a cathode-driven Class AB rf amplifier or Class C power amplifier. It is forced-air cooled, with an anode dissipation rating of 5000 watts.

The 3CX5000A7 makes use of a beam-forming cathode and control grid geometry to produce high gain, low grid interception, and outstanding intermodulation performance in linear amplifier service. These attributes make the tube well suited for cathode-driven circuitry, which reduces equipment cost and complexity.

The tube does not require a socket. It is designed to be bolted directly to the chassis by the grid flange. Cathode and heater connections are also made by bolting directly to the amplifier circuitry. This feature further reduces equipment cost and complexity.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide-coated Unipotential		
Heater Voltage	10.0 ± 0.5	V
Heater Current, at 10.0 Volts	17.5	A
Minimum Cathode Warmup Time, at 10.0 Volts[2]	5	Min
Amplification Factor	200	
Maximum Frequency For Full Ratings	110	MHz
Direct Interelectrode Capacitance (grounded cathode connection)[3]		
Cin	56.5	pF
Cout	0.42	pF
Cgp	34.0	pF
Direct Interelectrode Capacitance (grounded grid connection)[3]		
Cin	56.5	pF
Cout	34.0	pF
Cpk	0.42	pF

1. Characteristics and operating values are estimated. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.
2. Before high voltage and rf drive voltage are applied.
3. Capacitance values are for a cold tube as measured in accordance with EIA Standard RS-191 except no special shielding is used.

MECHANICAL

Overall Dimensions:	
Length	8.25 In; 20.96 mm
Diameter	4.94 In; 12.55 mm
Cooling	Forced Air
Net Weight (approximate)	9.5 lb; 4.3 kg
Recommended Air-System Chimney	EIMAC SK-306
Base	Designed for Direct Chassis Mounting

RADIO FREQUENCY POWER AMPLIFIER
CATHODE DRIVEN - Class AB Service

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	6500	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5.0	KILOWATTS
GRID DISSIPATION	50	WATTS

* Will vary from tube to tube
\# Delivered to the load
§ Referenced aginst 1 tone of a 2-equal-tone signal

Typical Performance, to 30 MHz (measured data)

Plate Voltage	4.0	5.0	6.0	kVdc
Zero Sig.Plate Current	0.4	0.4	0.4	Adc
Max.Sig.Plate Current	1.25	1.45	1.55	Adc
Cathode Bias *	+9.0	+11.0	+12.0	Vdc
Grid Current *	50	35	25	mAdc
Driving Power *	120	160	190	W
Useful Power Output #	3000	4000	5000	W
Power Gain *	14.0	14.0	14.2	dB
Cathode Input Impedance	33	33	33	Ohms
Resonant Load Impedance	1800	1800	1800	Ohms
Intermod. Distortion * §				
3rd Order Products	-37	-35	-38	dB
5th Order Products	-45	-45	-46	dB

358690(Effective Sept 1984)
VA4741

Printed in U.S.A.

APPLICATION

MECHANICAL

MOUNTING - The 3CX5000A7 may be mounted in any position and should be protected from shock and vibration. The tube is designed to be bolted directly to the chassis in equipment designed for dc and rf grounded grid circuit configuration. The mounting may be insulated for other circuitry. A flange with threaded holes is provided for a low-inductance cathode connection. Similar provisions are made for the heater connections.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250 Deg.C, and sufficient forced-air cooling must be used in all applications to keep the temperature of the anode (at the base of the cooling fins) and the temperature of the ceramic/metal seals comfortably below this rated maximum.
Cooling data shown is for air flow in a base-to-anode direction, and represents minimum anode cooling requirements. Pressure drop values are approximate.

Inlet Air Temperature = 25°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	2000	29	0.1
	3000	63	0.3
	4000	114	0.8
	5000	209	2.2
5000 Feet	**Plate Diss. Watts**	**Flow Rate CFM**	**Press. Drop In.Water**
	2000	35	0.1
	3000	77	0.3
	4000	138	0.9
	5000	218	2.0
10,000 Feet	**Plate Diss. Watts**	**Flow Rate CFM**	**Press. Drop In.Water**
	2000	43	0.1
	3000	93	0.4
	4000	167	1.0
	5000	264	2.3

Inlet Air Temperature = 35°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	2000	33	0.1
	3000	73	0.3
	4000	131	0.9
	5000	181	1.7
5000 Feet	**Plate Diss. Watts**	**Flow Rate CFM**	**Press. Drop In.Water**
	2000	40	0.1
	3000	88	0.4
	4000	159	1.1
	5000	253	2.5
10,000 Feet	**Plate Diss. Watts**	**Flow Rate CFM**	**Press. Drop In.Water**
	2000	48	0.1
	3000	107	0.4
	4000	192	1.3
	5000	306	3.0

Inlet Air Temperature = 50°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In.Water
	2000	41	0.1
	3000	92	0.5
	4000	165	1.3
	5000	262	3.1
5000 Feet	**Plate Diss. Watts**	**Flow Rate CFM**	**Press. Drop In.Water**
	2000	50	0.1
	3000	111	0.5
	4000	200	1.6
	5000	317	3.7
10,000 Feet	**Plate Diss. Watts**	**Flow Rate CFM**	**Press. Drop In.Water**
	2000	60	0.2
	3000	134	0.6
	4000	242	1.8
	5000	384	4.3

It is considered good engineering practice to design for a maximum anode core temperature of 225 °C, and temperature-sensitive paints are available for checking base and seal temperatures before any design is finalized. It is also considered good practice to allow for variables such as dirty air filters, rf seal heating, and the fact that the anode cooling fins may not be clean if the tube has been in service for some length of time.
Forced air cooling of the base is also required, with air directed past the seal areas. Special attention may be required in cooling the center of the stem (base), by means of special directors or some other provision. An air interlock system should be incorporated in the design to automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.
Air flow must be applied before or simultaneously with the application of power, including the tube heater, and should normally be maintained for a short period of time after all power is removed.

ELECTRICAL

HEATER-CATHODE OPERATION - The rated heater voltage for the 3CX5000A7 is 10.0 volts and should be maintained within plus or minus 0.5 volt when good life and consistent performance are factors. Voltage should be measured with a known-accurate (preferably plus or minus one percent) rms-responding voltmeter.
Heater voltage should be applied for five minutes

(minimum) before high voltage is applied to the tube and any operation is attempted, to allow for cathode warmup to full temperature.

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

INPUT CIRCUIT - When this tube is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a "Q" of five or more.

FAULT PROTECTION - All power tubes operate at voltages which can cause severe damage in the event of an internal arc, especially in those cases where large amounts of stored energy or follow-on current are involved. Some means of protection is advised in all cases, and it is recommended that a series resistor be used in the anode circuit to limit peak current and help dissipate the energy in the event of a tube or circuit arc. A resistance of 10 ohms in the positive plate power supply lead, together with a protective spark gap such as the Siemens #B1-C145 connected between the cathode and grid will help protect the tube in the event of an internal arc. A maximum of 4 joules total energy may be permitted to dissipate into a grid-to-cathode arc. Amounts in excess of this will permanently damage the cathode or grid structure.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn: Product Manager; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

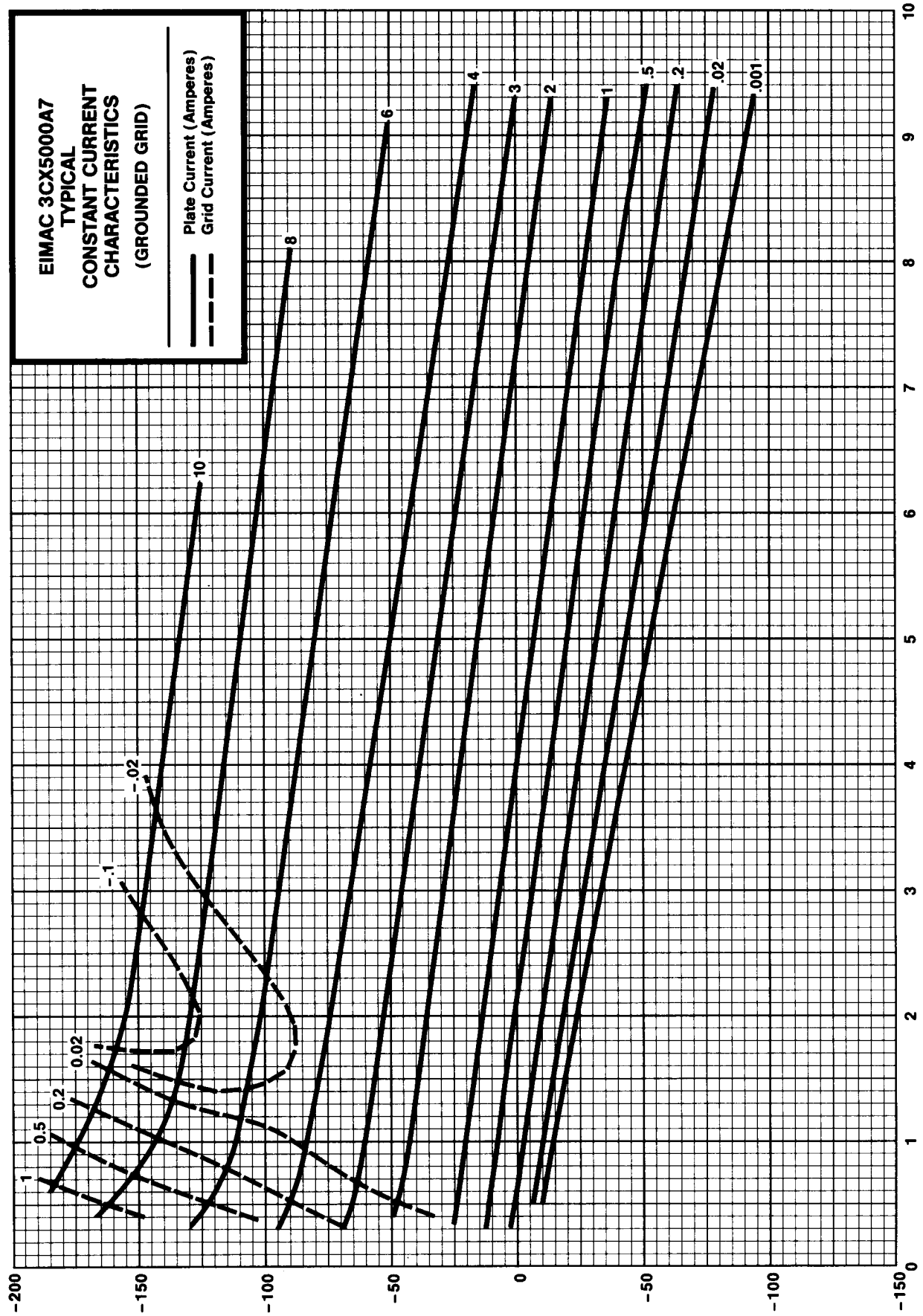
a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - Personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

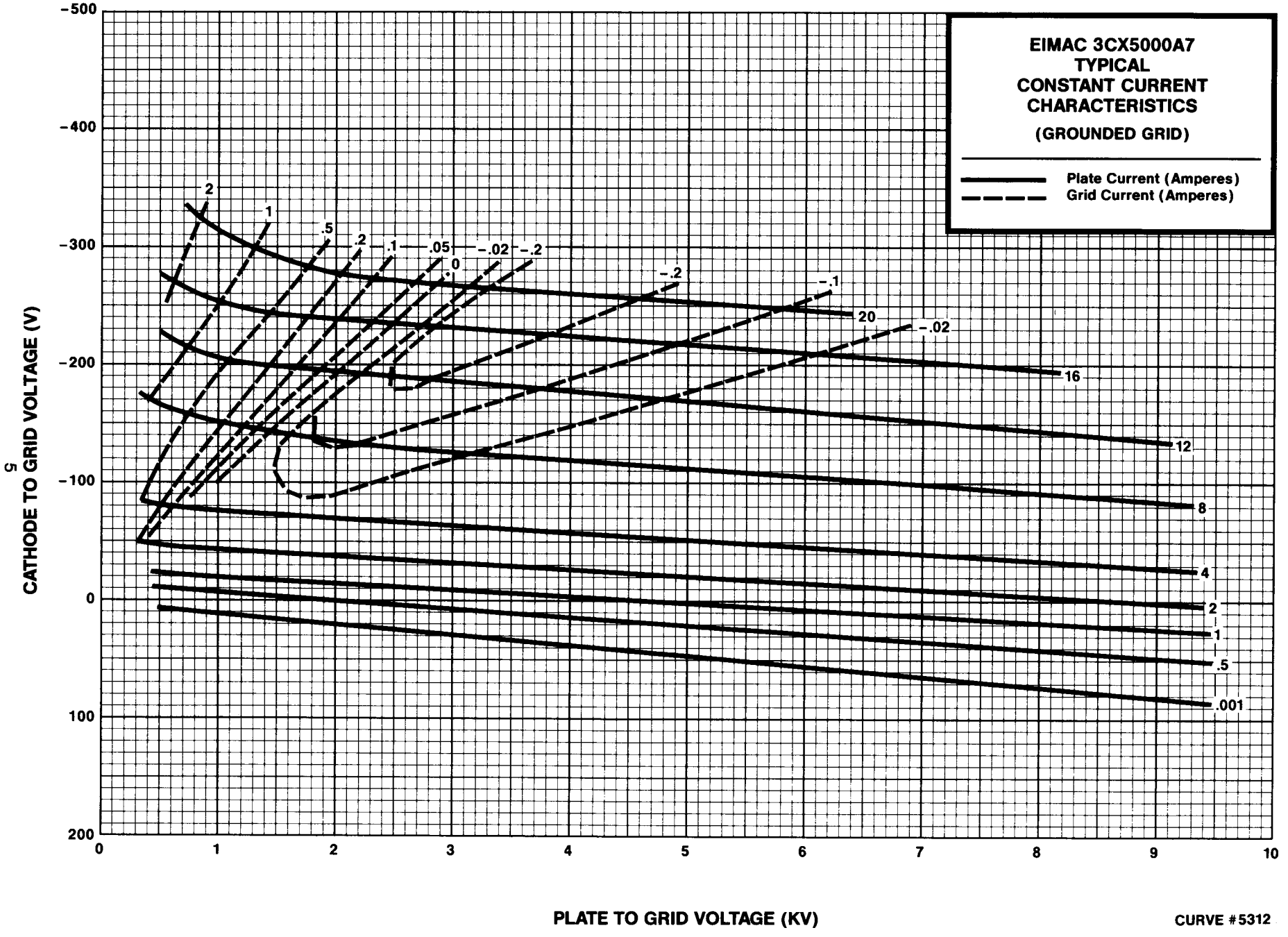
c. RF RADIATION - Avoid exposure to strong rf fields even at relatively low frequencies. The danger is more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

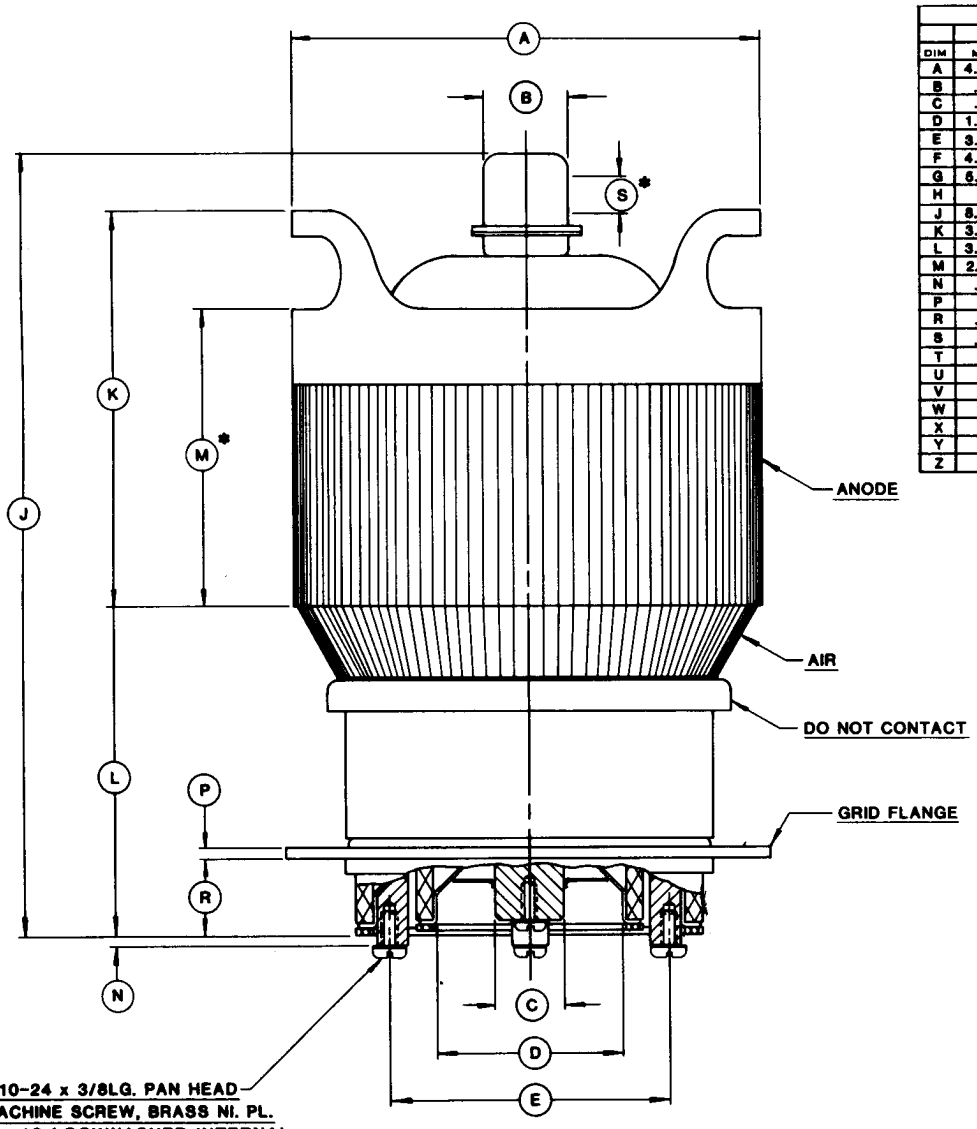
d. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.


EIMAC 3CX5000A7
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
(GROUNDED GRID)
Plate Current (Amperes)
Grid Current (Amperes)
10
8
6
4
3
2
1
.5
.2
.02
.001
1
0.5
0.2
0.02
.1
.02
-200
-150
-100
-50
0
-50
-100
-150
0
1
2
3
4
5
6
7
8
9
10
CATHODE TO GRID VOLTAGE (V)
PLATE TO GRID VOLTAGE (KV)

CURVE #5311

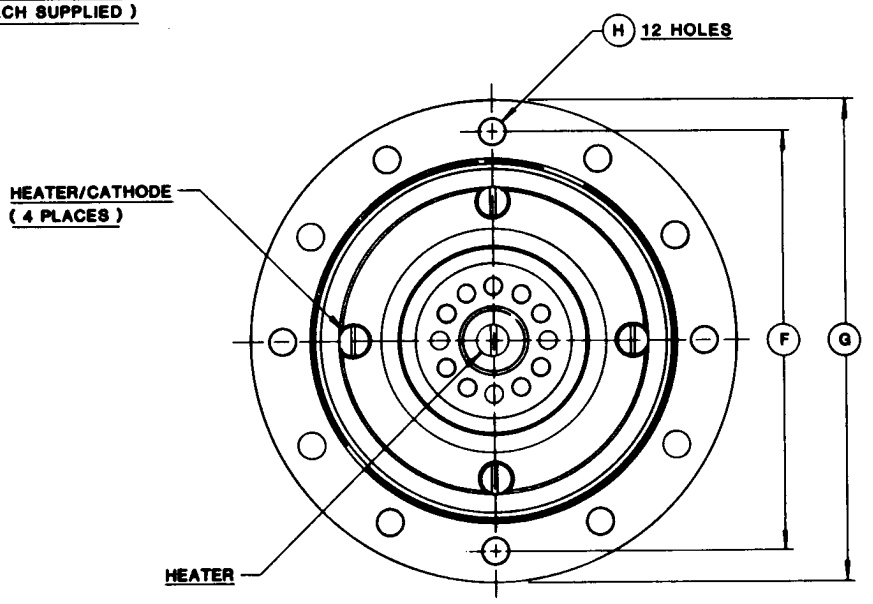

EIMAC 3CX5000A7
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
(GROUNDED GRID)
Plate Current (Amperes)
Grid Current (Amperes)
CATHODE TO GRID VOLTAGE (V)
-500
-400
-300
-200
-100
0
100
200
0
1
2
3
4
5
6
7
8
9
10
PLATE TO GRID VOLTAGE (KV)
2
1
.5
.2
.1
.05
0
-.02
-.2
-.2
-.1
-.02
20
16
12
8
4
2
1
.5
.001
CURVE #5312



DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM	MIN	MAX	REF.	MIN.	MAX	REF
A	4.812	4.938		122.22	125.43	
B	.855	.895		21.72	22.73	
C	.600	.760		15.24	19.30	
D	1.896	1.936		48.16	49.17	
E	3.326	3.450		84.48	87.63	
F	4.425	4.445		112.40	122.90	
G	5.030	5.090		127.76	129.29	
H			.265			6.73
J	8.017	8.267		203.63	209.98	
K	3.925	4.299		99.70	109.19	
L	3.223	3.597		81.86	91.36	
M	2.925	3.299		74.30	83.79	
N	.093	.156		2.36	3.96	
P			.125			3.18
R	.721	.845		18.31	21.46	
S	.376			9.53		
T						
U						
V						
W						
X						
Y						
Z						

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACE



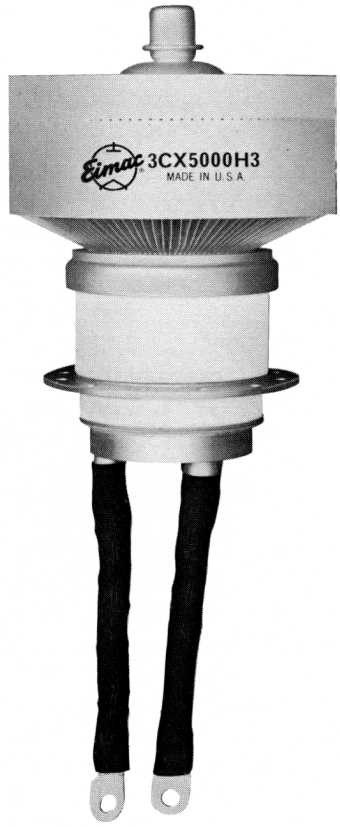
EIMAC

A Division of Varian Associates

SAN CARLOS, CALIFORNIA

3CX5000H3

INDUSTRIAL MEDIUM-MU AIR-COOLED POWER TRIODE



The EIMAC 3CX5000H3 is an air-cooled ceramic-metal power triode designed primarily for use in industrial radio-frequency heating services. Its air-cooled anode is conservatively rated at 5 kilowatts maximum plate dissipation with low pressure drop.

Input of 25 kilowatts is permissible up to 90 megahertz. Plentiful reserve emission is available from its 560 watt filament. The grid structure is rated at 150 watts making this tube an excellent choice for severe application.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated-Tungsten				
Voltage		7.5		Volts
Current	73		78	amps
Amplification Factor		20		
Interelectrode Capacitances, Grounded Cathode Connection:				
Input			53	$\mu\mu$f
Output			1.5	$\mu\mu$f
Grid-Plate			25	$\mu\mu$f
Frequency for Maximum Ratings			90	MHz

MECHANICAL

Base	See Outline
Operating Position	Vertical, base up or down
Cooling	Forced Air
Maximum Operating Temperatures	250°C
Maximum Dimensions:	
Height	See Outline
Diameter	See Outline
Net Weight	10 Pounds

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

(Effective 4-1-66) © 1966 Varian

Printed in U.S.A.

RF INDUSTRIAL OSCILLATOR
Class-C (Filtered DC Power Supply)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	10,000 Volts
DC PLATE CURRENT	3.0 Amps
DC GRID VOLTAGE	—1000 Volts
DC GRID CURRENT	0.5 Amp
PLATE INPUT POWER	25 kW
PLATE DISSIPATION	5 kW

TYPICAL OPERATION*

DC Plate Voltage	7000	9000 Volts
DC Plate Current	2.65	2.52 Amps
DC Grid Voltage	—700	—900 Volts
DC Grid Current	0.192	0.184 Amps
Peak Positive Grid Voltage	230	230 Volts
Driving Power	179	208 Watts
Plate Input Power	18.55	22.7 kW
Plate Dissipation	4.1	4.1 kW
Plate Output Power	14.45	18.6 kW
Approximate Load Impedance	1245	1725 Ohms

*Loaded Conditions

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses has been made.

APPLICATION

ELECTRICAL

Filament

The rated filament voltage for the 3CX5000H3 is 7.5 volts. Filament voltage, as measured at the tube, must be maintained at 7.5 volts plus or minus five percent for maximum tube life and consistent performance.

Control Grid Operation

The grid current rating is 0.5 ampere dc. This value should not be exceeded for more than very short periods such as during tuning. Overcurrent protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.25 amperes grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 150 watts.

Plate Operation

Plate over-current protection should be provided to remove plate voltage quickly in the event of an overload or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

MECHANICAL

Mounting

The 3CX5000H3 must be mounted vertically, either base up or down. A grid contact flange is provided for bolting to a strap or a grid deck. Heavy flexible leads are provided for applying the filament voltage.

Cooling

The maximum temperature rating for the external surfaces of the 3CX5000H3 is 250°C. Sufficient forced-air cooling must be provided to keep the temperature of the anode core and the temperature of the ceramic-metal seals below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below this maximum rating. Minimum air-flow requirements to maintain anode-core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated for frequencies below 30 MHz.

MINIMUM AIR FLOW REQUIREMENTS
(Anode-to-Base Air Flow)

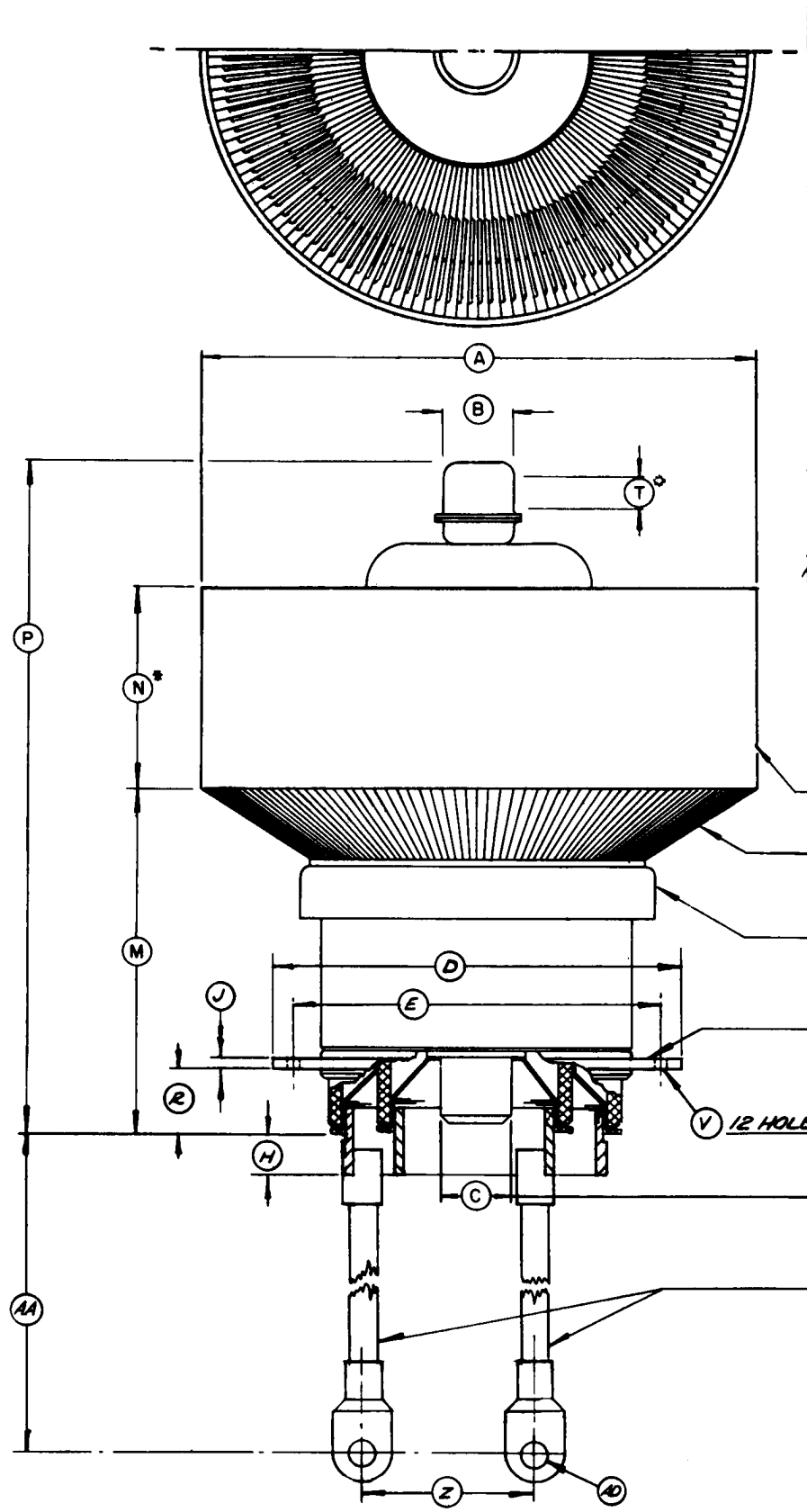
	Sea Level		5000 Feet	
Plate** Dissipation watts	Air Flow CFM	Pressure Drop inches water	Air Flow CFM	Pressure Drop inches water
4000	98	0.24	118	0.29
5000	152	0.49	182	0.59
6000	236	1.00	283	1.2

**Since the power dissipated by the filament is about 560 watts and since grid dissipation can, under some circumstances, represent another 150 watts, allowance has been made in preparing this tabulation for an additional 710 watts dissipation.

Additional stem cooling air must be provided. 8 CFM of air directed against the center filament contact ring ½" below the outer filament contact ring by an 1½" I.D. air duct arranged at a 45° angle with the center line of the tube will provide adequate cooling for 50°C ambient, 5000 ft. altitude, and 30 MHz or less.

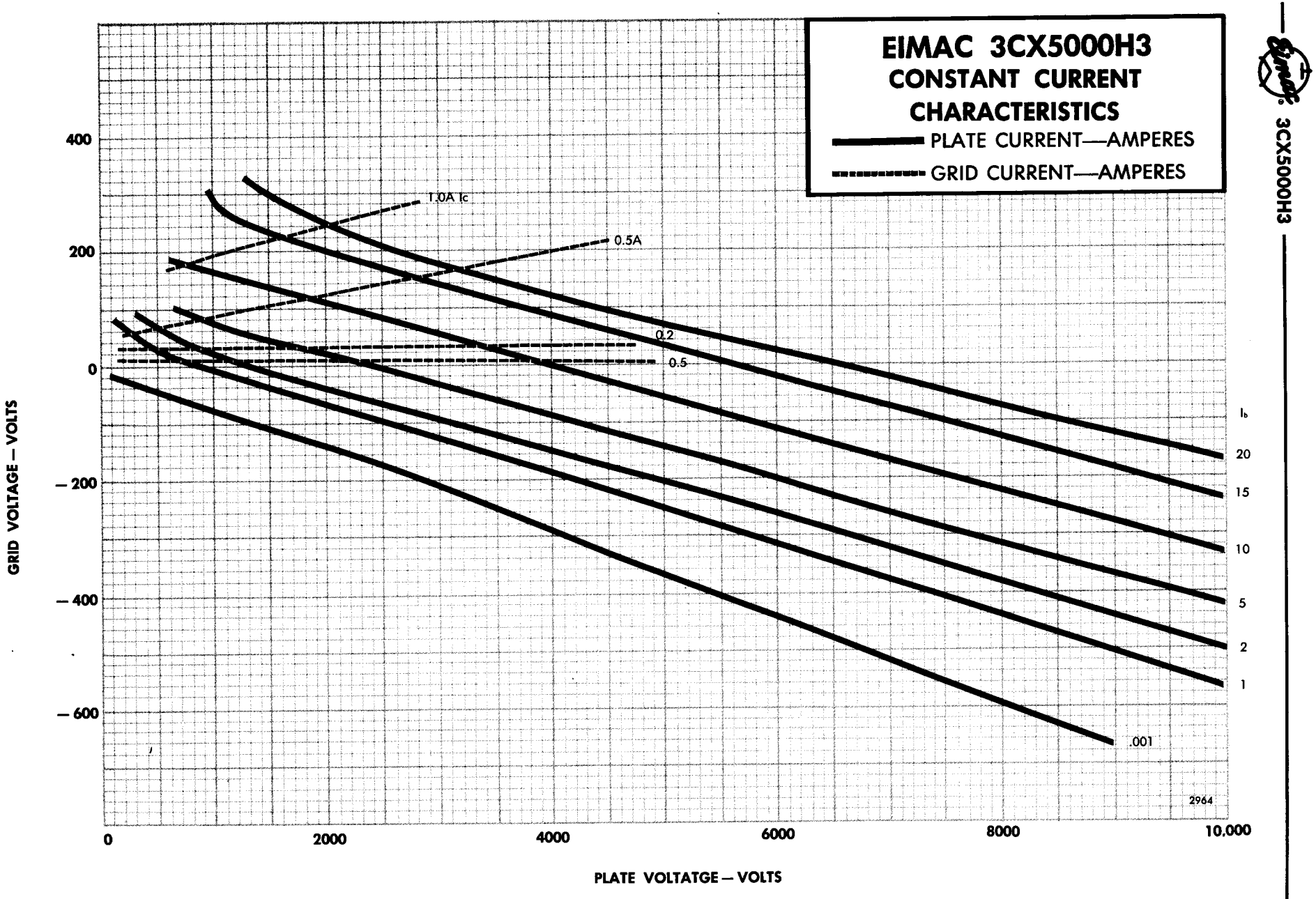
Special Applications

If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.



DIMENSION DATA			
DIM.	REF.	MIN.	MAX.
A		6.300	6.400
B		855	895
C		720	760
D		5.030	5.090
E		4.425	4.445
H		.580	.700
J	.125		
M		3.950	4.300
N		2.412	2.788
P		8 250	8.750
R		.800	.860
T		.375	
V	.250		
Z	2.000		
AA		8.500	9.000
AD	.390		

NOTES:
1. REF. DIMS. ARE FOR INFORMATION ONLY & ARE NOT REQ'D FOR INSP. PURPOSES.
2. (*) CONTACT SURFACE
3. DIMENSIONS IN INCHES


EIMAC 3CX5000H3
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT—AMPERES
GRID CURRENT—AMPERES
1.0A Ic
0.5A
0.2
0.5
.001
Ib
20
15
10
5
2
1
2964
400
200
0
— 200
— 400
— 600
0
2000
4000
6000
8000
10,000
GRID VOLTAGE — VOLTS
PLATE VOLTATGE — VOLTS

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

TENTATIVE DATA

8159

3CX10,000A3

MEDIUM-MU POWER TRIODE



The Eimac 3CX10,000A3 is a ceramic and metal power triode intended primarily for use as a power oscillator in industrial-heating applications. It is also recommended for use as a grounded-grid FM amplifier, as a conventional plate-modulated amplifier, or as a linear amplifier.

GENERAL CHARACTERISTICS

	Min.	Nom.	Max.	
▶ ELECTRICAL				
Filament: Thoriated-Tungsten				
Voltage	-	7.5	-	volts
Current	94	-	104	amperes
Amplification Factor	-	20	-	
Interelectrode Capacitances, Grounded Cathode:				
Input	48	-	58	μμf
Output	1.2	-	1.5	μμf
Feedback	30	-	38	μμf
Frequency for Maximum Ratings	-	-	-	140 Mc
MECHANICAL				
Base	-	-	-	Coaxial
Recommended Socket	-	-	-	Eimac SK-1300
Recommended Chimney	-	-	-	Eimac SK-1306
Operating Position	-	-	-	Vertical, base up or down
Cooling	-	-	-	Forced air
Maximum Operating Temperatures:				
Anode Core	-	-	-	250°C
Ceramic-to-Metal Seals	-	-	-	250°C
Maximum Dimensions:				
Height	-	-	-	8.5 inches
Diameter	-	-	-	7.0 inches
Net Weight	-	-	-	12 pounds

R-F INDUSTRIAL OSCILLATOR CLASS-C

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7000 MAX. VOLTS
D-C PLATE CURRENT	4.0 MAX. AMPS
PLATE DISSIPATION	10 MAX. KW
GRID DISSIPATION	250 MAX. WATTS

TYPICAL OPERATION, Optimum Load

D-C Plate Voltage	6000	7000 volts
D-C Grid Voltage	-575	-670 volts
D-C Plate Current	4.0	4.0 amps
D-C Grid Current	610	670 ma
Plate Input Power	24	28 kw
Plate Output Power	18.9	22.4 kw

R-F POWER AMPLIFIER GROUNDED-GRID, CLASS-C

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7000 MAX. VOLTS
D-C PLATE CURRENT	4.0 MAX. AMPS
PLATE DISSIPATION	10 MAX. KW
GRID DISSIPATION	250 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	6000	7000 volts
D-C Grid Voltage	-535	-625 volts
D-C Plate Current	4.0	4.0 amps
D-C Grid Current	545	530 ma
Driving Power	3700	4100 watts
Plate Output Power	20.5	24.5 kw

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▶ Indicates change from sheet dated 7-1-61

R-F POWER AMPLIFIER
PLATE-MODULATED, CLASS-C

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5500 MAX. VOLTS
D-C PLATE CURRENT	3.0 MAX. AMPS
PLATE DISSIPATION	6.5 MAX. KW
GRID DISSIPATION	250 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	4000	5000 volts
D-C Grid Voltage	-480	-600 volts
D-C Plate Current	3.0	3.0 amps
D-C Grid Current	660	550 ma
Driving Power	530	515 watts
Plate Output Power	9.7	12.4 kw

R-F LINEAR AMPLIFIER
GROUNDED-GRID, CLASS-AB2

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7000 MAX. VOLTS
D-C PLATE CURRENT	5.0 MAX. AMPS
PLATE DISSIPATION	12 MAX. KW
GRID DISSIPATION	250 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	6000	7000 volts
Zero-Sig Grid Voltage*	-270	-325 volts
Max-Sig D-C Plate Current	4.0	4.0 amps
Max-Sig D-C Grid Current	300	250 ma
Driving Power	1900	2050 watts
Plate Output Power	18	20 kw

*Adjust to give 500 milliamperes zero-signal d-c plate current.

Note: "TYPICAL OPERATION" data are obtained by caluclation from published characteristics curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

APPLICATION

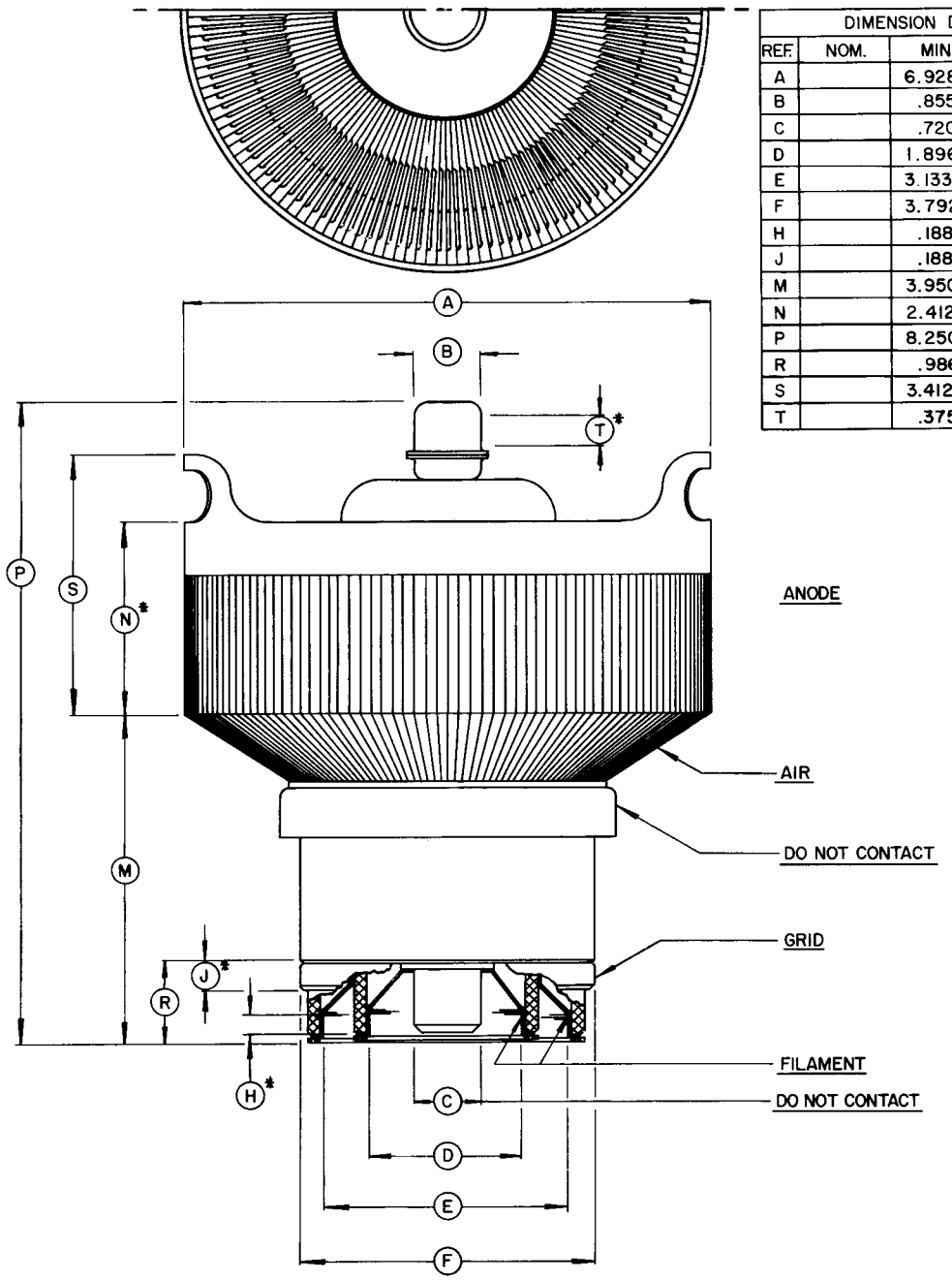
Cooling - The maximum temperature rating for the external surfaces of the 3CX10,000A3 is 250°C. Sufficient forced-air cooling must be provided to keep the temperature of the anode core and the temperature of the ceramic-metal seals below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below this maximum rating. Minimum air-flow requirements to maintain anode-core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated. The use of these air-flow rates through the recommended socket/chimney and tube combination in the base-to-anode direction provides effective cooling of the tube.

	Sea Level		10,000 Feet	
Plate** Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
4000	85	0.18	125	0.25
6000	145	0.38	210	0.55
8000	215	0.68	315	0.99
10,000	295	1.08	430	1.60
12,000	390	1.62	565	2.35

**Since the power dissipated by the filament is about 750 watts and since grid dissipation can, under some circumstances, represent another 250 watts, allowance has been made in preparing this tabulation for an additional 1000 watts dissipation.

Filament Operation - The rated filament voltage for the 3CX10,000A3 is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate from the rated value by more than five percent.

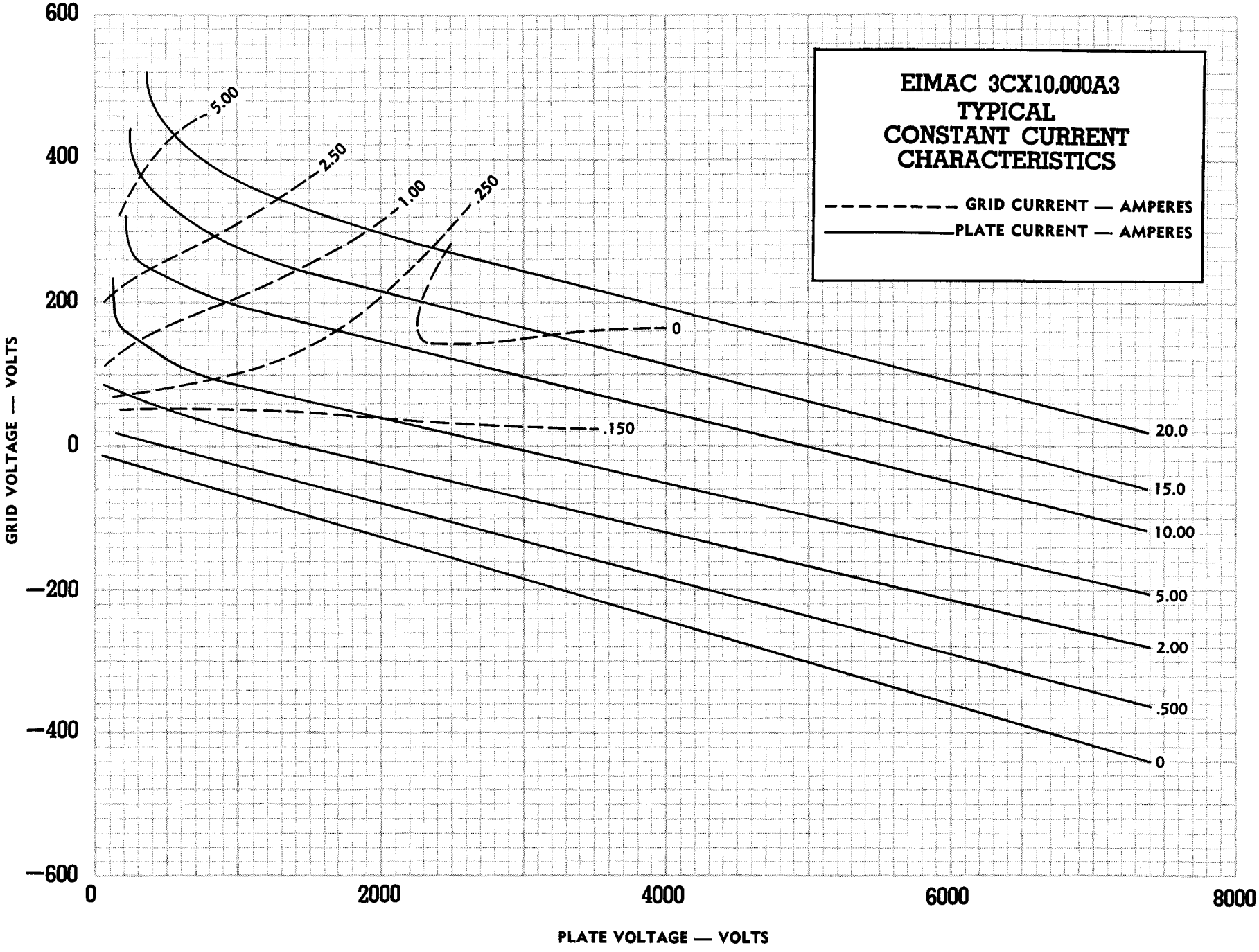
Special Applications - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.



DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		6.928	7.050
B		.855	.895
C		.720	.760
D		1.896	1.936
E		3.133	3.173
F		3.792	3.832
H		.188	
J		.188	
M		3.950	4.300
N		2.412	2.788
P		8.250	8.750
R		.986	1.050
S		3.412	3.788
T		.375	

*CONTACT SURFACE
ALL DIMENSIONS IN INCHES

▶ Indicates change from sheet dated 7-1-61


EIMAC 3CX10,000A3
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GRID CURRENT — AMPERES
PLATE CURRENT — AMPERES
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS
600
400
200
0
−200
−400
−600
0
2000
4000
6000
8000
5.00
2.50
1.00
.250
0
.150
20.0
15.0
10.00
5.00
2.00
.500
0

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

TENTATIVE DATA

3CX10,000A7

HIGH-MU POWER TRIODE



The Eimac 3CX10,000A7 is a ceramic and metal power triode intended to be used as a zero-bias Class-B amplifier in audio or radio-frequency applications. Operation with zero grid bias offers circuit simplicity by eliminating the bias supply. In addition, grounded-grid operation is attractive since a power gain as high as twenty times can be obtained with the 3CX10,000A7.

GENERAL CHARACTERISTICS

ELECTRICAL	
Filament: Thoriated-Tungsten	
Voltage	7.5 volts
Current	100 amperes
Amplification Factor	200
Interelectrode Capacitances:	
Grid-Filament	63 uuf
Grid-Plate	41 uuf
Plate-Filament	.05 uuf
Frequency for Maximum Ratings	110 Mc
MECHANICAL	
Base	Coaxial
Recommended Socket	Eimac SK-1300
Operating Position	Vertical, base up or down
Cooling	Forced air
Maximum Operating Temperatures:	
Anode Core	250°C
Ceramic-to-Metal Seals	250°C
Maximum Dimensions:	
Height	8.5 inches
Diameter	7.0 inches
Net Weight	12 pounds

R-F LINEAR AMPLIFIER
GROUNDED-GRID, CLASS B

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7000 MAX. VOLTS
D-C PLATE CURRENT	5.0 MAX. AMPS
PLATE DISSIPATION	12 MAX. KW
GRID DISSIPATION	500 MAX WATTS

TYPICAL OPERATION, Single-Tone Conditions

D-C Plate Voltage	7000	7000	volts
Zero-Sig D-C Plate Current*	0.60	0.60	amp
Max-Sig D-C Plate Current	3.72	5.00	amps
Max-Sig D-C Grid Current	0.71	1.00	amp
Driving Impedance	35	32	ohms
Resonant Load Impedance	1020	745	ohms
Max-Sig Driving Power	885	1540	watts
Peak Envelope Plate Output Power	17,700	24,200	watts
Power Gain	20.0	15.7	times

*Approximate Values

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AUDIO-FREQUENCY AMPLIFIER
OR MODULATOR - CLASS B

MAXIMUM RATINGS (Per Tube)

D-C PLATE VOLTAGE	7000 MAX. VOLTS
D-C PLATE CURRENT	5.0 MAX. AMPS
PLATE DISSIPATION	12 MAX. KW
GRID DISSIPATION	500 MAX. WATTS

TYPICAL OPERATION, Two Tubes, Sinusoidal Wave

D-C Plate Voltage	7000	7000	volts
D-C Grid Voltage	0	0	volts
Zero-Sig D-C Plate Current*	1.20	1.20	amps
Max-Sig D-C Plate Current	7.50	10.0	amps
Max-Sig D-C Grid Current	1.50	2.06	amps
Driving Power	315	560	watts
Peak A-F Driving Voltage (Per Tube)	250	310	volts
Load Resistance, Plate-to-Plate	2000	1520	ohms
Max-Sig Plate Output Power	35,600	47,700	watts

R-F LINEAR AMPLIFIER
CARRIER CONDITIONS, GROUNDED-GRID

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7000 MAX. VOLTS
D-C PLATE CURRENT	5.0 MAX. AMPS
PLATE DISSIPATION	12 MAX. KW
GRID DISSIPATION	500 MAX. WATTS

*Approximate Values
†Modulation Crest Conditions

TYPICAL OPERATION

D-C Plate Voltage	7000	volts
D-C Grid Voltage	0	volts
Zero-Sig D-C Plate Current*	0.60	amp
D-C Plate Current	2.40	amps
D-C Grid Current	0.25	amp
Driving Impedance †	32	ohms
Peak Driving Voltage †	310	volts
Driving Power	330	watts
Plate Output Power	5650	watts

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

	Sea Level		10,000 Feet	
Plate** Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
4000	85	0.18	125	0.25
6000	145	0.38	210	0.55
8000	215	0.68	315	0.99
10,000	295	1.08	430	1.60
12,000	390	1.62	565	2.35

**Since the power dissipated by the filament is about 750 watts and since grid dissipation can, under some circumstances, represent another 500 watts, allowance has been made in preparing this tabulation for an additional 1250 watts dissipation.

APPLICATION

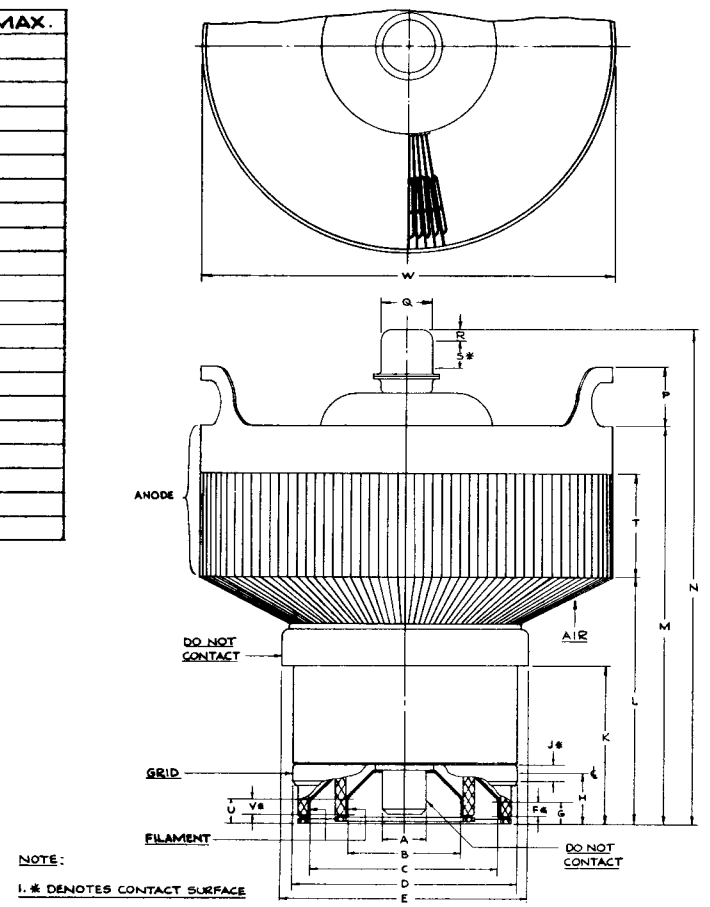
Input Circuit -- When the 3CX10,000A7 is operated as a grounded-grid r-f amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a "Q" of five or more.

Cooling - The maximum temperature rating for the external surfaces of the 3CX10,000A7 is 250°C. Sufficient forced-air cooling must be provided to keep the temperature of the anode core and the temperature of the ceramic-metal seals below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below this maximum rating. Minimum air-flow requirements to maintain anode-core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated.

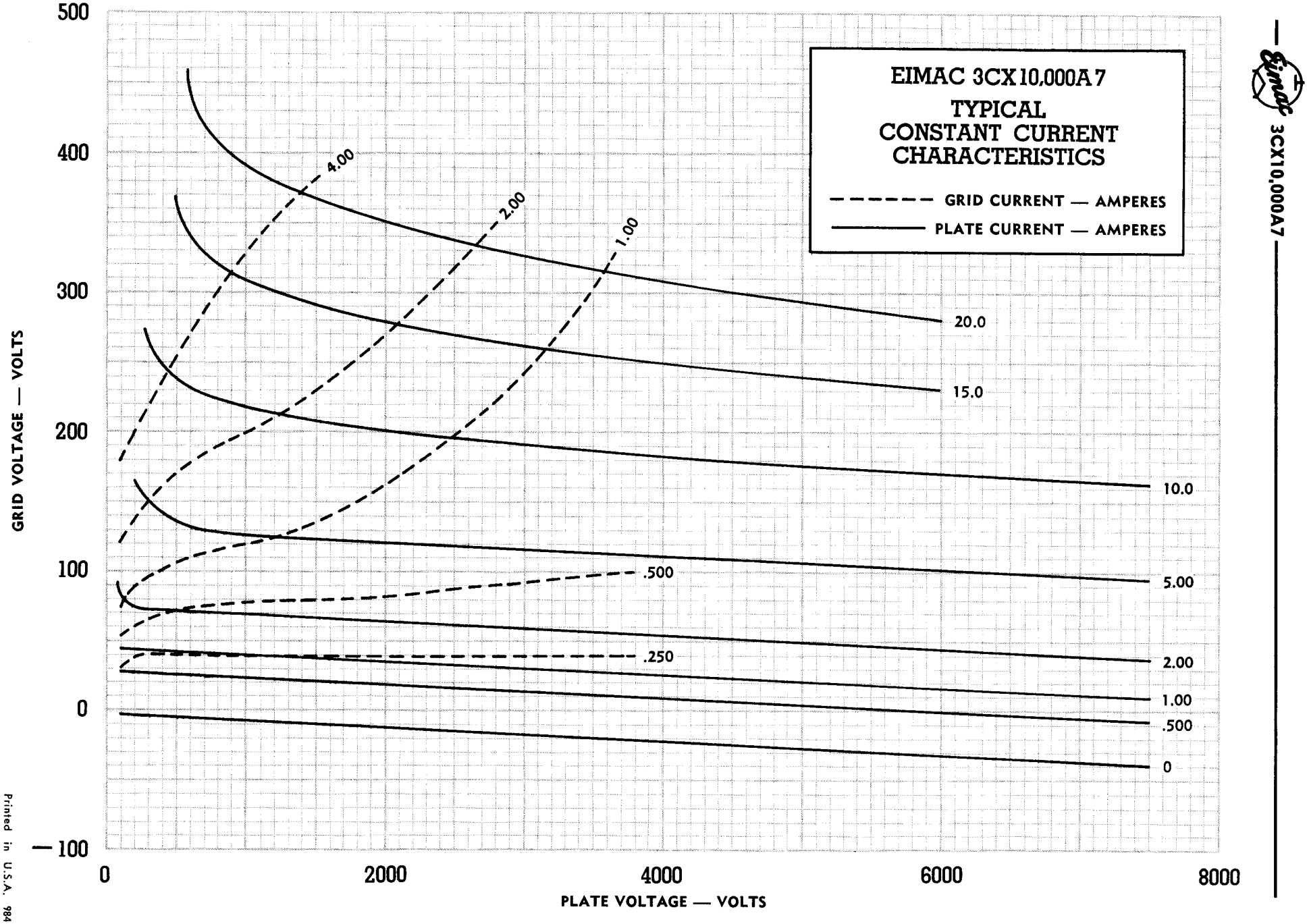
Filament Operation - The rated filament voltage for the 3CX10,000A7 is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate from the rated value by more than five percent.

Special Applications - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.

DIM	NOM.	MIN.	MAX.
A	.740		
B	1.916		
C	3.153		
D	3.803		
E	4.185		
F	1/4		
G	.384		
H	.864		
J	1/4		
K	2.706		
L	4 3/16		
M	6 51/64		
N	8 1/2		
P	1		
Q	.875		
R	3/16		
S	1/2		
T	1 13/16		
U	.394		
V	1/4		
W	6.995		



NOTE:
1. * DENOTES CONTACT SURFACE

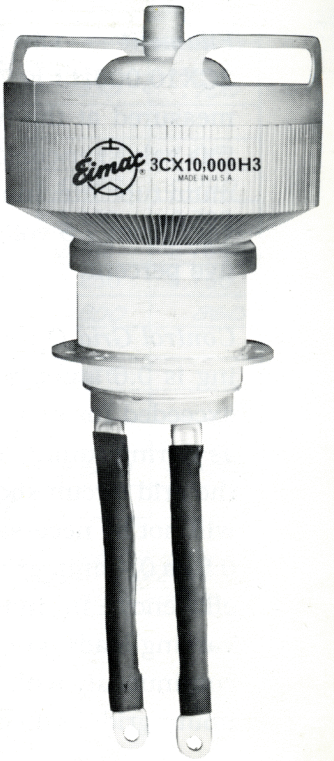


Printed in U.S.A. 984

3CX10,000H3

MEDIUM-MU AIR-COOLED POWER TRIODE

TECHNICAL DATA



The Eimac 3CX10,000H3 is an air-cooled, ceramic-metal power triode designed primarily for use in industrial radio-frequency heating services. Its air-cooled anode is conservatively rated at 10 kilowatts of plate dissipation.

Input of 40 kilowatts is permissable up to 90 megacycles. Plentiful reserve emission is available from its 750 watt filament. The grid structure is rated at 250 watts, making this tube an excellent choice for severe applications.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated-Tungsten				
Voltage		7.5		Volts
Current	94		104	Amps
Amplification Factor		20		
Interelectrode Capacitances, Grounded Cathode:				
Grid-Filament	48		58	μμf
Plate-Filament	1.2		1.5	μμf
Grid-Plate	30		38	μμf
Frequency for Maximum Ratings			90	Mc

MECHANICAL

Base	See Outline
Operating Position	Vertical, base up or down
Cooling	Forced Air
Maximum Operating Temperature	250°C
Maximum Dimensions:	
Height	See Outline
Diameter	See Outline
Net Weight	12 Pounds

RF INDUSTRIAL OSCILLATOR

Class-C (Filtered DC Power Supply)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	10,000 VOLTS
DC PLATE CURRENT	4.0 AMPS
DC GRID VOLTAGE	—1000 VOLTS
DC GRID CURRENT	0.6 AMP
PLATE INPUT POWER	40 KW
PLATE DISSIPATION	10 KW

*Loaded Conditions

TYPICAL OPERATION*

DC Plate Voltage	7000	9000 Volts
DC Plate Current	4.0	4.0 Amps
DC Grid Voltage	—670	—930 Volts
DC Grid Current	.275	.430 Amps
Peak Positive Grid Voltage	340	390 Volts
Driving Power	260	570 Watts
Plate Input Power	28	36 kW
Plate Dissipation	9	7 kW
Plate Output Power	19	29 kW
Approximate Load Impedance	720	1100 Ohms

NOTE: "Typical Operation" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

(Effective 3-15-66) Copyright 1966 by Varian Associates

APPLICATION

ELECTRICAL

Filament — The rated filament voltage for the 3CX10,000H3 is 7.5 volts. Filament voltage, as measured at the tube, should be maintained at this value for consistent performance and maximum tube life. In no case should it be allowed to vary from 7.5 volts by more than plus or minus five percent.

Control Grid Operation — The grid current rating is 0.6 ampere dc. This value should not be exceeded for more than very short periods such as during tuning and over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.2 to 0.4 amp grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 250 watts.

Plate Operation — Plate over-current protection should be provided to remove plate voltage quickly in the event of an over-load or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

High Frequency Operation—The 3CX10,000H3 is usable to 140 Mc. At this frequency, plate voltage must be reduced to 7000 volts in Class C service.

MECHANICAL

Mounting —The 3CX10,000H3 must be mounted vertically, either base up or down. A grid flange is provided for bolting to a grid strap or a grid deck. Heavy flexible leads are provided for the filament voltage connection.

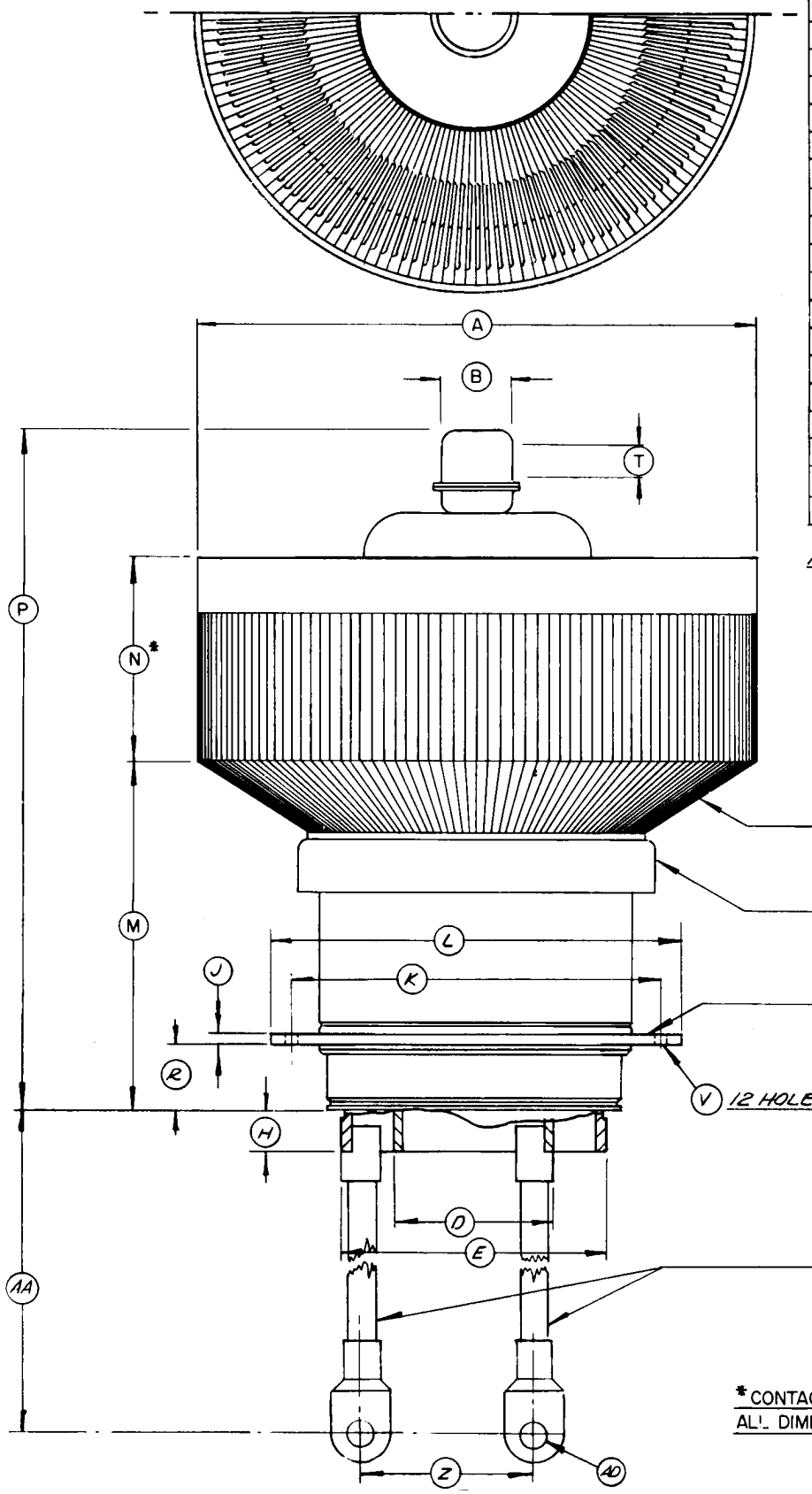
Cooling — The maximum temperature rating for the external surfaces of the 3CX10,000H3 is 250°C. Sufficient forced-air cooling must be provided to keep the temperature of the anode core and the temperature of the ceramic-metal seals below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below this maximum rating. Minimum air-flow requirements to maintain anode-core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated.

	Sea Level		5000 Feet	
Plate** Dissipation Watts	Air Flow CFM	Pressure Drop Inches Water	Air Flow CFM	Pressure Drop Inches Water
4000	85	0.18	105	0.21
6000	145	0.38	175	0.46
8000	215	0.68	260	0.82
10,000	295	1.08	360	1.32
12,000	390	1.62	470	1.95

**Since the power dissipated by the filament is about 750 watts and since grid dissipation can, under some circumstances, represent another 25 watts, allowance has been made in preparing this tabulation for an additional 1000 watts dissipation.

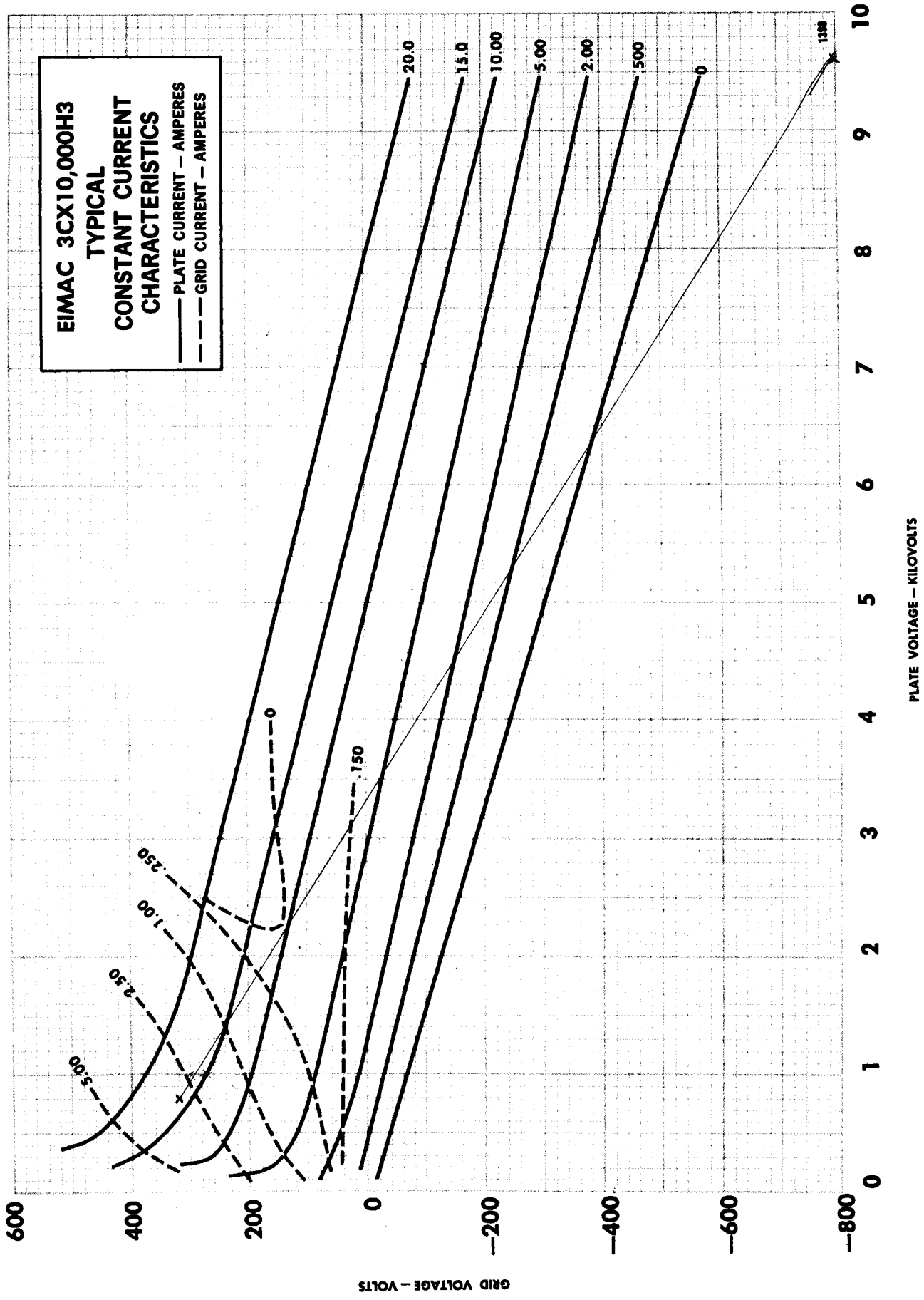
Additional stem cooling air must be provided. 10 CFM of air directed against the center filament contact ¾" below the outer filament contact ring by a 1½" I.D. air duct arranged at a 45° angle with the center line of the tube will provide adequate cooling.

Special Application — If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Div., Eimac, A Division of Varian Associates Inc., 301 Industrial Way, San Carlos, Calif. for information and recommendations.



DIMENSION DATA			
DIM.	REF.	MIN.	MAX.
A		6.928	7.050
B		855	895
D	1.875		
E	3.250		
H		.530	.700
J	.125		
K		4.425	4.445
L		5.030	5.090
M		3.950	4.300
N		2.412	2.788
P		8.250	8.750
R		.800	.860
T		.375	
V	.250		
Z	2.000		
AA		8.500	9.000
AD	.390		

NOTE: REF. DIMS. ARE FOR INFORMATION ONLY & ARE NOT REQ'D FOR INSP. PURPOSES.


EIMAC 3CX10,000H3
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
20.0
15.0
10.00
5.00
2.00
.500
0
1388
.150
0
.250
1.00
2.50
5.00
600
400
200
0
–200
–400
–600
–800
0
1
2
3
4
5
6
7
8
9
10
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS

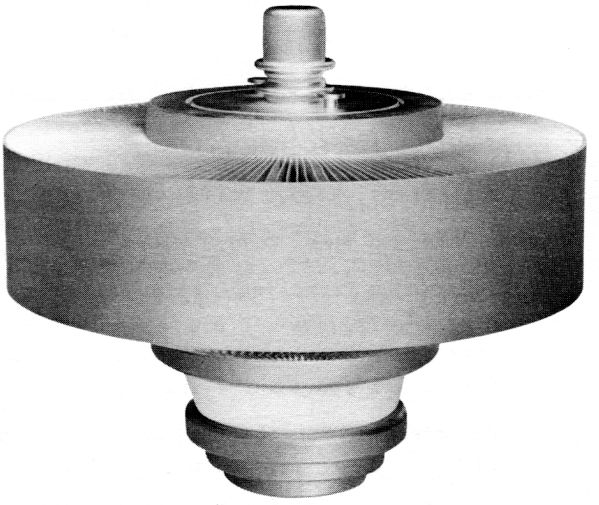
TECHNICAL DATA

3CX10,000U7
HIGH-MU VHF TRANSMITTING TRIODE

The EIMAC 3CX10,000U7 is a ceramic/metal high-mu power triode designed especially for use in the VHF and UHF spectrum as a cathode-driven Class AB rf amplifier or Class C power amplifier, and for pulsed rf amplifier service. It is forced-air cooled, with an anode dissipation rating of 10,000 watts. Cavity amplifier assemblies are available for the tube from EIMAC.

The 3CX10,000U7 makes use of a beam-forming cathode and control grid geometry to produce high gain, low grid interception, and outstanding intermodulation performance in linear amplifier service. These attributes make the tube well suited for cathode-driven circuitry, which reduces equipment complexity.

The tube has coaxial terminals for which contact collets are available from EIMAC.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Cathode: Oxide-coated Unipotential

Heater Voltage	15.0 ± 0.5	V
Heater Current, @ 15.0 Volts	13.5	A
Cathode Warmup Time, @ 15.0 Volts (minimum) [2]	300	Sec
Amplification Factor (average)	200	
Direct Interelectrode Capacitance (grid grounded) [3]		
Cin	86.5	pF
Cout	23.2	pF
Cpk	0.25	pF
Frequency of Maximum Rating:		
CW	260	MHz
Pulsed	500	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. VARIAN EIMAC should be consulted before using this information for final equipment design.
2. Before high voltage and rf drive voltage are applied.
3. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Overall Dimensions:

Length	7.30 In; 185 mm
Diameter	8.30 In; 211 mm

359150 (Effective 1 Sept 82; supersedes 1 Jan 81)
VA4533
Printed in U.S.A.

Cooling . . . . . Forced Air

Base . . . . . Special Coaxial

Recommended Contact Collets:

TUBE ELEMENT	EIMAC P/N	TUBE ELEMENT	EIMAC P/N
Heater	720638	Grid	720636
Heater-Cathode	720637	Anode	720635

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	Units
Heater Current, @ 15.0 Volts	12.5	14.5	Aac
Cathode Warmup Time, @ 15.0 Volts	300	---	Sec
Interelectrode Capacitance (grounded grid) [1]			
Cin	83.0	90.0	pF
Cout	22.7	23.7	pF
Cpk	---	0.5	pF
Interelectrode Capacitance (grounded cathode) [1]			
Cin	83.0	90.0	pF
Cout	---	0.5	pF
Cgp	22.7	23.7	pF

1 Values are for a cold tube as measured in a special shielded fixture in accordance with Electronics Industries Association Standard RS-191.

RADIO FREQUENCY POWER AMPLIFIER
CATHODE DRIVEN

Class AB Television Service

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	6500	VOLTS	PLATE DISSIPATION	10	KILOWATTS
DC PLATE CURRENT	4.0	AMPERES	GRID DISSIPATION	100	WATTS

TV TRANSLATOR SERVICE:

Measurements made in EIMAC cavities under CW conditions.

	Channel	f_o (MHz)	Gain (dB)	± 1 dB BW (MHz)	
LOW BAND: EIMAC Cavity CV-2240	4	69	15.3	6.26	Typical data taken at 2.5 kW single-tone output @ Eb = 4800 Vdc, Ibo = 1.9 Adc, Ib = 2.4 Adc
HIGH BAND: EIMAC Cavity CV-2250	11	201	16.7	6.27	Typical data taken at 2.5 kW single-tone output @ Eb = 4800 Vdc, Ibo = 1.9 Adc, Ib = 2.25 Adc
	E2	227.75	16.8	7.08	

Three-tone test under CCIR loading: Video -8 dB (below 2.5 kW peak output)
Sound -7 dB
Color -17 dB

Third order intermodulation products: -52 dB or better

LOW BAND TV VISUAL SERVICE

Measurements made in EIMAC CV-2240 Cavity
(CW Conditions)

f_o = 79 MHz BW = 6 MHz Min. ± 0.25 dB
BW = 7 MHz Min. ± 1.0 dB

Plate Voltage	5.0	5.5	kVdc
Zero Signal Plate Current	1.0	1.0	Adc
Max. Signal Plate Current	3.72	3.60	Adc
Cathode Voltage (bias) **	+25	+29	Vdc
Grid Current *	53	39	mAdc
Driving Power *	398	389	W
Useful Power Output	10	10	kW
Efficiency *	53.2	50.5	%
Gain *	14.0	14.1	dB

HIGH BAND TV VISUAL SERVICE

Measurements made in EIMAC CV-2250 Cavity
(CW Conditions)

f_o = 177 MHz BW = 6 MHz Min. ± 0.25 dB
BW = 7 MHz Min. ± 1.0 dB

Plate Voltage	5.0	5.5	kVdc
Zero Signal Plate Current	1.0	1.0	Adc
Max. Signal Plate Current	4.0	3.6	Adc
Cathode Voltage (bias) **	+25	+29	Vdc
Grid Current *	41	16	mAdc
Driving Power *	407	407	W
Useful Power Output	10	10	kW
Efficiency *	50.0	50.5	%
Gain *	13.9	13.9	dB

* May vary with particular installation.
** Cathode bias voltage is adjusted to produce specified Zero Signal (idling) Plate Current.

RADIO FREQUENCY LINEAR AMPLIFIER
CATHODE DRIVEN - Class AB

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	6.5	KILOVOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	10	KILOWATTS
GRID DISSIPATION	100	WATTS

* May vary with particular installation.
** Adjust for specified Zero-Signal Plate Current.
\# Measured at the load.
The intermodulation distortion products are referenced against one tone of a two-equal-tone signal.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB, Cathode Driven, Peak Envelope or Modulation Crest Conditions; Data Measured at 2.0 MHz.

Plate Voltage	6.0	kVdc
Cathode Voltage (bias) **	+42.9	Vdc
Zero-Signal Plate Current	0.5	Adc
Single-Tone Plate Current	2.58	Adc
Two-Tone Plate Current	1.7	Adc
Single-Tone Grid Current *	15	mAdc
Two-Tone Grid Current *	9.5	Madc
Peak rf Driving Voltage *	120	v
Driving Power *	240	W
Single-Tone Useful Power Out #	10	kW
Resonant Load Impedance	1100	Ohms
Intermodulation Distortion ##		
3rd Order	-45	dB
5th Order	-50	dB

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias and plate voltage is assumed. If this procedure is followed, there will be little variation in ouput power when the tube is replaced, even though there may be some variation in grid current. The grid current which occurs when the desired plate current is obtained is incidental and may vary from tube to tube. This current variation causes no performance degradation providing the circuit maintains the correct voltage in the presence of the current variation.

APPLICATION

MECHANICAL

MOUNTING & SOCKETING - The 3CX10,000U7 must be operated vertically, base up or down, and should be protected from shock and vibration. Collets are available from EIMAC (see page 2) for use in contacing the heater, heater-cathode, grid and anode terminals of the tube.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250 Deg.C, and sufficient forced-air cooling must be used in all applications to keep the temperature of the anode (at the base of the cooling fins) and the temperature of the ceramic/metal seals comfortably below this rated maximum.

The cooling data shown is for cooling air at 50°C with air flowing in a base-to-anode direction, and represents minimum anode cooling requirements. The pressure drop values shown are approximate and do not allow for any system losses, such as ducting or filters. (CFM = cubic feet per minute; CMM = cubic meters per minute)

Altitude: Sea Level

Plate Diss. Watts	Flow Rate CFM	Press.Drop In. Water	Flow Rate CMM	Press.Drop Millibars
2000	117	0.18	3.3	0.70
4000	117	0.19	3.3	0.74
6000	190	0.39	5.4	1.64
8000	318	0.84	9.0	3.97
10000	462	1.52	13.1	7.75

Altitude: 5000 Feet, 1524 Meters

Plate Diss. Watts	Flow Rate CFM	Press.Drop In. Water	Flow Rate CMM	Press.Drop Millibars
2000	141	0.21	4.0	0.84
4000	141	0.23	4.0	0.89
6000	229	0.47	6.5	1.97
8000	383	1.01	10.9	4.79
10000	558	1.83	15.8	9.35

Altitude: 10000 Feet, 3048 Meters

Plate Diss. Watts	Flow Rate CFM	Press.Drop In. Water	Flow Rate CMM	Press.Drop Millibars
2000	170	0.26	4.8	1.01
4000	170	0.28	4.8	1.07
6000	276	0.57	7.8	2.38
8000	462	1.22	13.1	5.77
10000	672	2.21	19.0	11.28

It is considered good engineering practice to design for a maximum anode core temperature of 225 °C, and temperature-sensitive paints are available for checking base and seal temperatures before any design is finalized. It is also considered good practice to allow for variables such as dirty air filters, rf seal heating, and the fact that the anode cooling fins may not be clean if the tube has been in service for some length of time.

The pressure drop in a typical installation will be higher because of system losses. Typical data for a VHF cavity assembly is shown in the EIMAC Technical Data for the CV-2240 and CV-2250 cavities, which are available on request.

Forced air cooling of the base is also required, with air directed past the seal areas. Special attention may be required in cooling the center of the stem (base), by means of special directors or some other provision. An air interlock system should be incorporated in the design to automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.

Air flow must be applied before or simultaneously with the application of power, including the tube heater, and should normally be maintained for a short period of time after all power is removed to allow for tube cooldown.

ELECTRICAL

HEATER-CATHODE OPERATION - The rated heater voltage for the 3CX10,000U7 is 15.0 volts and should be maintained within plus or minus 0.5 volt when good life and consistent performance are factors. Voltage should be measured with a known-accurate (preferably plus or minus one percent) rms-responding voltmeter.

Heater voltage should be applied for five minutes (minimum) before high voltage is applied to the tube and any operation is attempted, to allow for cathode warmup to full temperature.

ABSOLUTE MAXIMUM RATINGS - The values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the abso-

lute values will never be exceeded under any usual conditions of supply voltage variation in the equipment. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

INPUT CIRCUIT - When this tube is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a "Q" of five or more.

INTERMODULATION DISTORTION - Typical Operating Conditions, with distortion values included, are the result of data taken during actual operation at 2 MHz. Intermodulation values listed are those measured at the full peak envelope power noted and are referenced against one tone of a two-equal-tone signal.

UHF OPERATION - This tube is useful in the UHF region. High cathode emission makes it especially useful in pulse applications. Operation at UHF under CW conditions should be conducted with heavy plate loading and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

FAULT PROTECTION - All power tubes operate at voltages which can cause severe damage in the event of an internal arc, especially in those cases where large amounts of stored energy or follow-on current are involved. Some means of protection is advised in all cases, and it is recommended that a series resistor be used in the anode circuit to limit peak current and help dissipate the energy in the event of a tube or circuit arc. A resistance of 10 ohms in the positive plate power supply lead, together with a protective spark gap such as the Siemens #B1-C145 connected between the cathode and grid will help protect the tube in the event of an internal arc. A maximum of four (4) joules total energy may be permitted to dissipate into a grid-to-cathode arc. Amounts in excess of this will permanently damage the cathode or the grid structure. Additional information is found in EIMAC Application Bulletin #17 "FAULT PROTECTION". Copies are available on request.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that **HIGH VOLTAGE CAN KILL.**

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields, especially at frequencies above 300 MHz, where energy absorption by the human body is significant. The human eye is particularly sensitive. Prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter (Occupational Safety & Health Administration (OSHA) standard). It is generally accepted that exposure to "high levels" of rf radiation can result in severe bodily injury, including blindness. **CARDIAC PACEMEAKERS MAY BE AFFECTED.**

INTERELECTRODE CAPACITANCE - The interelectrode capacitance of a tube in a typical circuit is influenced by many variables, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of a specially constructed test fixture which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. The capacitance values shown in the manufacturer technical data are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal appliction. Measurements should be taken with the mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to VARIAN EIMAC; attn: Product Manager; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

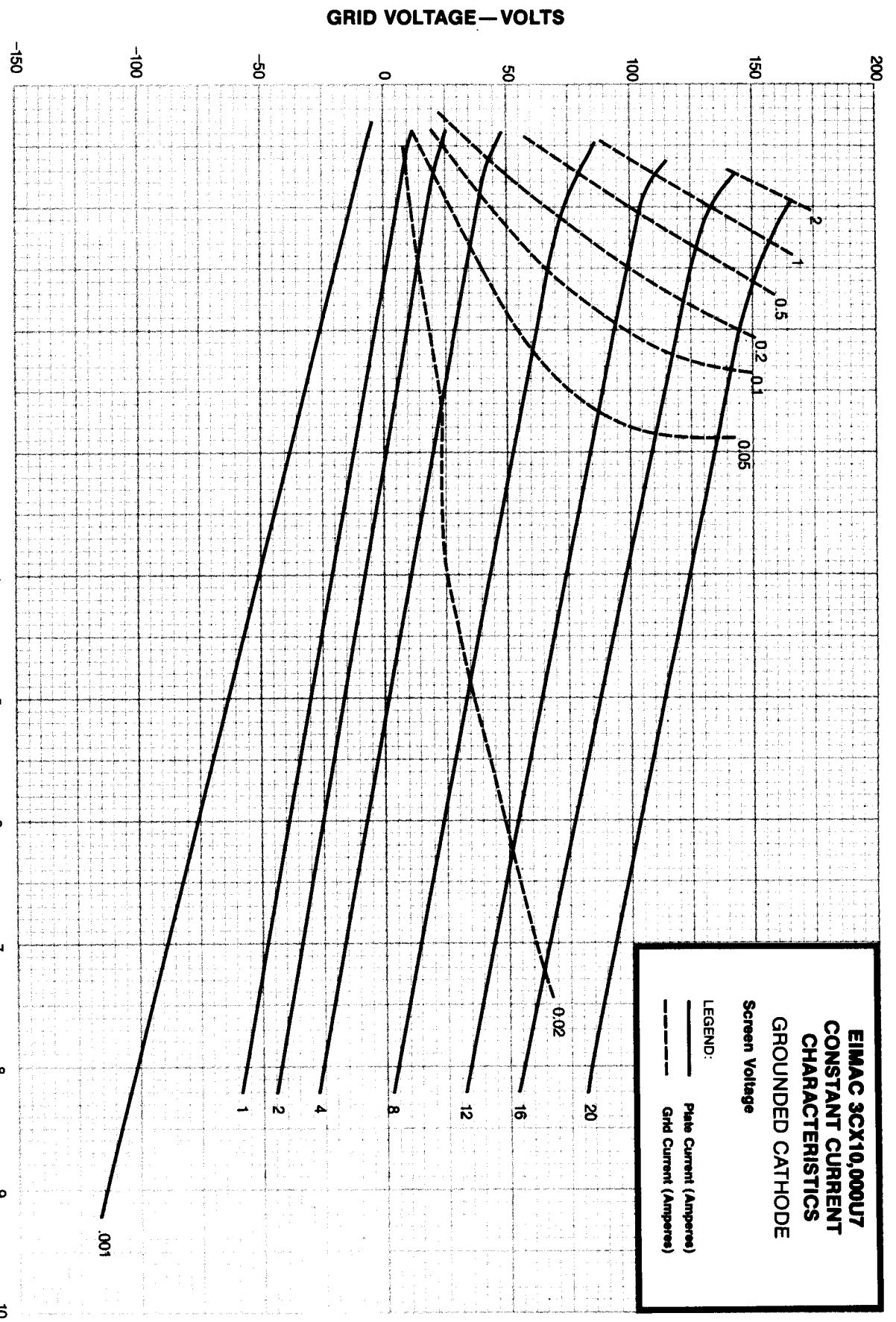
The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE - Normal operating voltages can be deadly.

b. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

c. HOT SURFACES - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred Degrees C and cause serious burns if touched for several minutes after all power is remove.

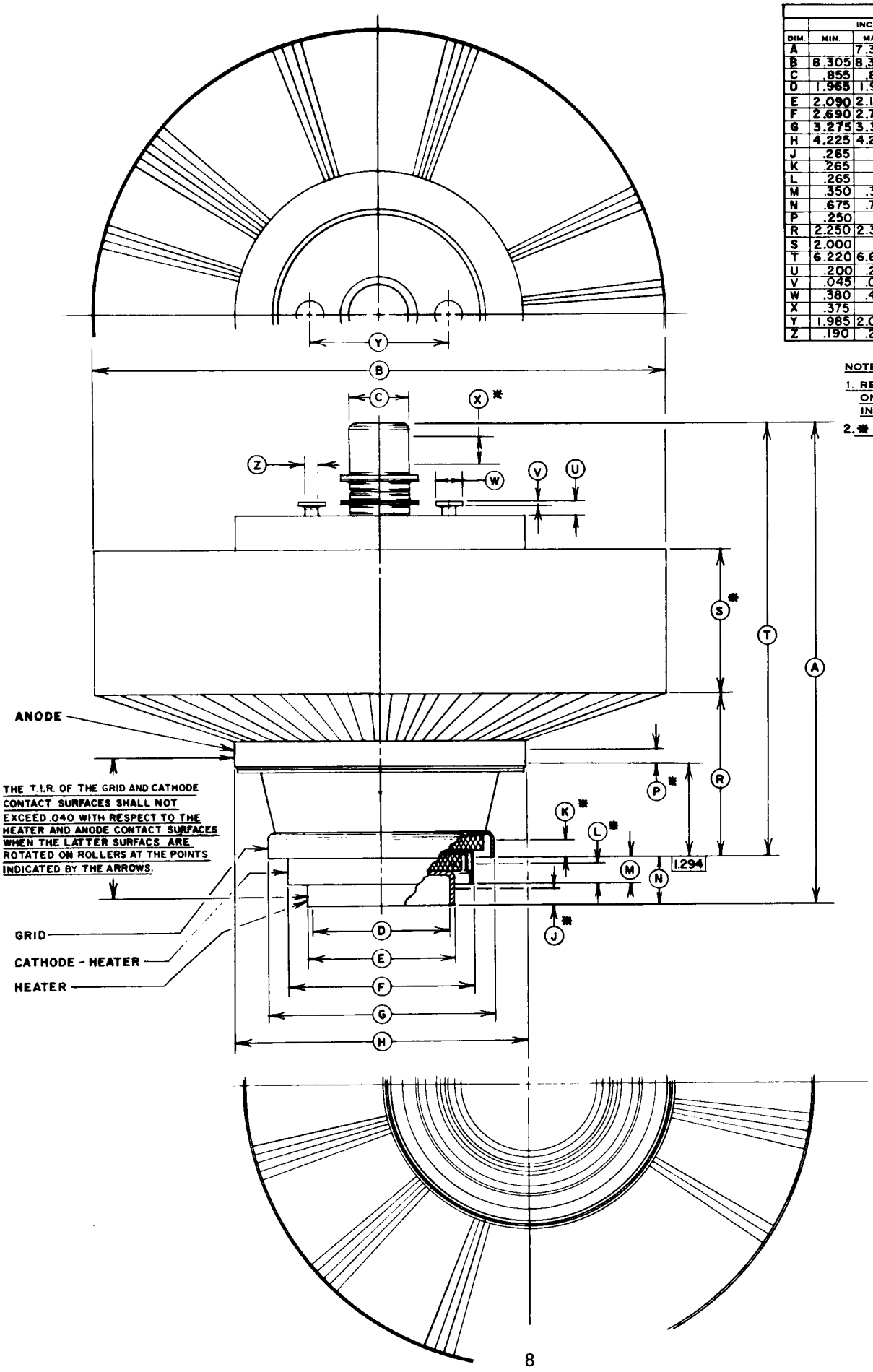
Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: VARIAN EIMAC, Power Grid Tube Division, 301 Industrial Way, San Carlos CA 94070.


GRID VOLTAGE—VOLTS
200
150
100
50
0
-50
-100
-150
0
1
2
3
4
5
6
7
8
9
10
PLATE VOLTAGE—KILOVOLTS
2
1
0.5
0.2
0.1
0.05
0.02
.001
20
16
12
8
4
2
1
EIMAC 3CX10,000U7
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
Screen Voltage
LEGEND:
Plate Current (Amperes)
Grid Current (Amperes)
CURVE 4924

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A		7.300				
B	8.305	8.355				
C	.855	.895				
D	1.965	1.985				
E	2.090	2.110				
F	2.690	2.720				
G	3.275	3.310				
H	4.225	4.245				
J	.265					
K	.265					
L	.265					
M	.350	.385				
N	.675	.715				
P	.250					
R	2.250	2.340				
S	2.000					
T	6.220	6.600				
U	.200	.240				
V	.045	.075				
W	.380	.430				
X	.375					
Y	1.985	2.015				
Z	.190	.200				

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACE



EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

3CX15,000A3
MEDIUM-MU
AIR-COOLED
POWER TRIODE

The EIMAC 3CX15,000A3 is an air-cooled, ceramic/metal power triode designed primarily for use as a power oscillator in industrial radio frequency heating applications. It is also recommended for use as a grounded grid FM amplifier, as a conventional plate-modulated amplifier, or as a linear amplifier. The one kilowatt filament and rugged 500 watt grid structure make this tube especially suitable for heavy duty service.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated-Tungsten

Voltage	6.3V ± 0.3	V
Current, at 6.3 volts	160	A
Amplification Factor	20	

Interelectrode Capacitance (Grounded Cathode)[2]

Grid-Filament	55	pF
Plate-Filament, max.	1.4	pF
Grid-Plate	34	pF
Frequency for Maximum Ratings	100	MHz

MECHANICAL

Dimensions

Height	8.5 in (216 mm)
Diameter	7.0 in (178 mm)
Net Weight	12 lb (5.54 kg)
Operating Position	Vertical, base up or down
Recommended Socket	EIMAC SK-1300
Recommended Chimney	EIMAC SK-1306

Maximum Operating Temperatures

Ceramic-to-Metal Seals	250° C
Anode Core	250° C
Cooling	Forced Air
Base	Coaxial

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1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values for a cold tube as measured in a special shielded fixture.

3. Adjust to give specified zero-signal DC plate current.

APPLICATION

FILAMENT - The rated filament voltage for the 3CX15,000A3 is 6.3 volts. Filament voltage, as measured at the socket, should be maintained at 6.3 volts plus or minus 0.3 volts for long tube life and consistent performance.

GRID OPERATION - A recommended maximum grid current is 1.0 Adc, This value should not be exceeded for more than very short periods such as during tuning. Over-current protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.4 to 0.6 A grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a DC current meter. The absolute maximum grid dissipation rating is 500 watts.

PLATE OPERATION - Absolute maximum plate voltage rating of 8 kV and maximum plate current of 6.0 A should not be applied simultaneously as rated plate dissipation may be exceeded. When used as a plate modulated RF amplifier, absolute maximum input is reduced to 6500 V at 5.0 Adc. Plate overcurrent protection should be provided to remove plate voltage quickly in the event of an over-load or an arc-over at the load. In addition, current limiting power supply resistors should be used. These precautions are especially important in industrial service having wide variations in plate current loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

HIGH FREQUENCY OPERATION - The 3CX15,000-A3 is usable to 140 MHz. At this frequency, absolute maximum plate voltage must be reduced to 7000 Vdc A, B, or C service. For plate-modulated application at 140 MHz, absolute maximum plate voltage is reduced to 5500 Vdc.

COOLING - Forced-air cooling is required to adequately maintain the rated ceramic/metal seal and anode temperature at 250° C or below. The table lists minimum air-flow requirements to maintain tube temperatures at 225° C in 40° C ambient air using the EIMAC SK-1300 socket and SK-1306 chimney. Airflow in the base-to-anode direction is recommended; reverse air-flow may be used, but users should contact the nearest Varian Field Office or EIMAC Division of Varian, San Carlos, California 94070, for specific recommendations.

MINIMUM AIR-FLOW REQUIREMENTS

*Plate Dissipation (kW)	Air-Flow (CFM)	Pressure Drop (Inches water)
5.0	85	0.2
7.5	195	0.7
10.0	360	2.0
12.5	590	4.9
15.0	970	10.5

*An additional 1500 watts has been included in preparing this tabulation to compensate for grid and filament power.

RF POWER AMPLIFIER OR OSILLATOR INDUSTRIAL

Class C Telegraphy or FM Telephony
(Key Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	V
DC PLATE CURRENT	6.0	A
PLATE DISSIPATION	15	kW
GRID DISSIPATION	500	W

TYPICAL OPERATING CONDITIONS

DC Plate Voltage	7000	Vdc
DC Plate Current	6.0	A
DC Grid Voltage	-600	Vdc
DC Grid Current	660	mAdc
Peak RF Grid Voltage	1040	V
Driving Power	660	W
Plate Input Power	42	kW
Plate Dissipation	12	kW
Plate Output Power	30	kW
Resonant Load Impedance	600	ohms

RF POWER AMPLIFIER PLATE-MODULATED

Class C

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	6500	V
DC PLATE CURRENT	5.0	A
PLATE DISSIPATION	10	kW
GRID DISSIPATION	500	W

TYPICAL OPERATING CONDITIONS

DC Plate Voltage	5000	6000	Vdc
DC Plate Current	2.9	3.9	A
DC Grid Voltage	550	600	Vdc
DC Grid Current	450	520	mAdc
Driving Power	375	490	W
Plate Output Power	13.0	18.0	kW

RF LINEAR AMPLIFIER

Class AB or B

ABSOLUTE MAXIMUM RATINGS

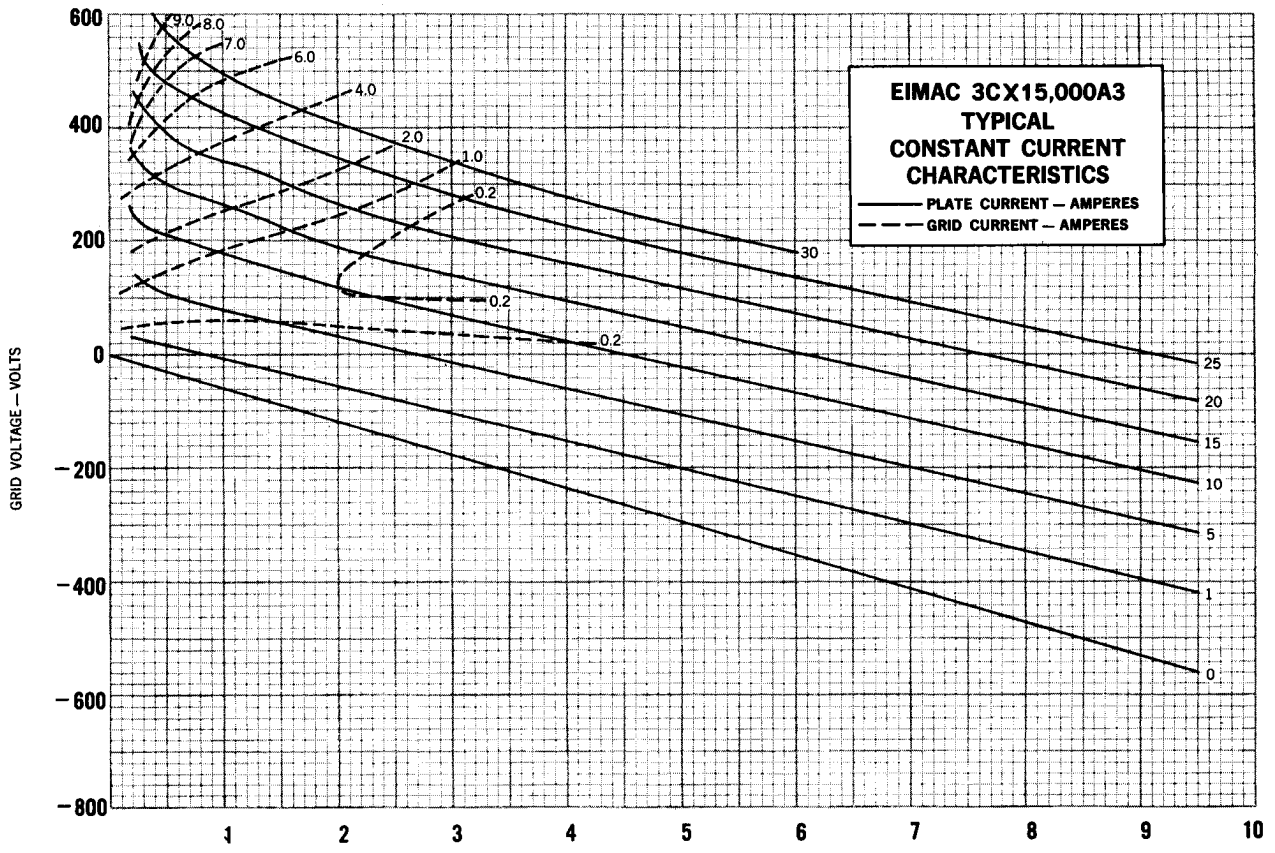
DC PLATE VOLTAGE	8000	V
DC PLATE CURRENT	6.0	A
PLATE DISSIPATION	15	kW
GRID DISSIPATION	500	W

TYPICAL OPERATING CONDITIONS
Class AB_2

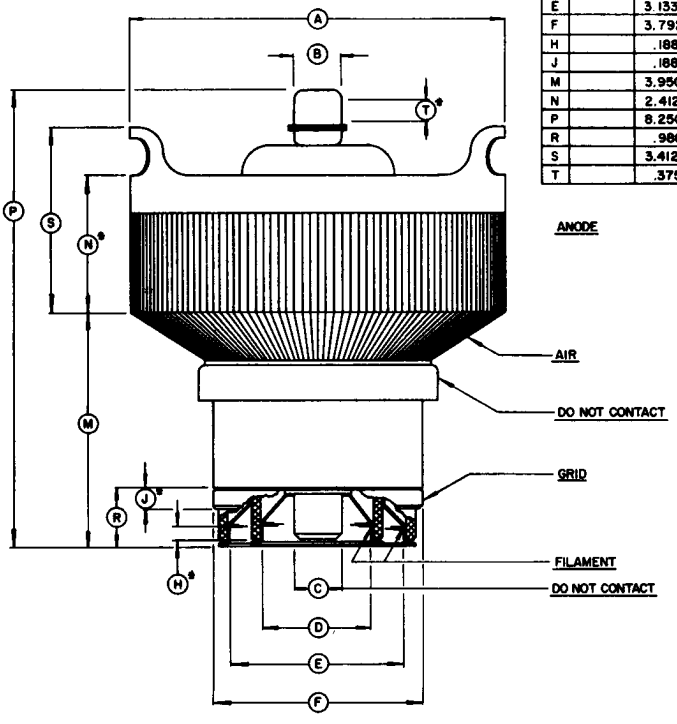
DC Plate Voltage	7000	Vdc
DC Grid Voltage	-270	Vdc
Zero-Sig Plate Current[3]	1.5	A
Max-Sig DC Plate Current	4.8	A
Max-Sig DC Grid Current	400	mAdc
Peak RF Grid Voltage	540	V
Driving Power	215	W
Plate Output Power	23	kW
Resonant Load Impedance	730	ohms

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current, at 6.3 volts	152	168	A
Interelectrode Capacitances[2]			
Grid-Filament	50	60	pF
Plate-Filament	1.3	1.6	pF
Grid-Plate	30	38	pF



DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		6.928	7.050
B		.855	.895
C		.720	.760
D		1.896	1.936
E		3.133	3.173
F		3.792	3.832
H		.188	
J		.188	
M		3.950	4.300
N		2.412	2.788
P		8.250	8.750
R		.986	1.050
S		3.412	3.788
T		.375	



*CONTACT SURFACE.
ALL DIMENSIONS IN INCHES

3CX15,000A7

TECHNICAL DATA

HIGH-MU
POWER TRIODE

The EIMAC 3CX15,000A7 is a ceramic/metal power triode intended for use as a zero-bias Class B rf amplifier or Class C power amplifier or oscillator. Class B operation with zero grid bias offers circuit simplicity by eliminating the bias supply. In addition, grounded-grid operation is attractive since a power gain as high as twenty times can be obtained with the 3CX15,000A7.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	6.3 ± 0.3	V
Current, at 6.3 volts	160	A
Amplification Factor (Average):	200	
Direct Interelectrode Capacitance (grounded cathode) [2]		
Cin	56	pF
Cout	0.2	pF
Cgp	36	pF
Direct Interelectrode Capacitance (grounded grid)[2]		
Cin	56	pF
Cout	36	pF
Cpk	0.2	pF
Frequency of Maximum Rating:		
CW	110	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:		
Length	8.75 in; 222.3	mm
Diameter	7.05 in; 179.1	mm
Net Weight	12 lb; 5.5	kg
Operating Position	Vertical base up or down	
Maximum Operating Temperature:		
Ceramic/Metal Seals	250°C	
Anode Core	250°C	

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Cooling	Forced air
Base	Coaxial
Recommended Air System Socket	SK-1300 or SK-1320
Recommended Air Chimney	SK-1306

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC PLATE CURRENT	6.0	AMPERES
PLATE DISSIPATION	15,000	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate values.

TYPICAL OPERATION (Frequencies to 110 MHz)
Class AB_2

Plate Voltage	7000	7000	Vdc
Grid Voltage	0	0	Vdc
Zero-Signal Plate Current[1]	.6	.6	Adc
Single-Tone Plate Current[2]	5.92	5.0	Adc
Single-Tone Grid Current[1]	1.22	1.0	Adc
Driving Power[1]	1750	1540	W
Plate Dissipation	13.4	10.8	kW
Single-Tone Plate Output Power	29.6	24.2	kW
Resonant Load Impedance	693	745	Ω
Drive Impedance	27	32	Ω

2. Adjust to obtain specified value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy or FM Telephony Grid Driven

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	15,000	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (Frequencies to 110 MHz)

Plate Voltage	7000	Vdc
Grid Voltage	-230	Vdc
Plate Current	4.0	Adc
Grid Current[1]	775	mAdc
Peak rf Grid Voltage[1]	555	v
Calculated Driving Power[1]	430	W
Plate Input Power	28	kW
Plate Dissipation	6.7	kW
Plate Output Power	21.3	kW
Resonant Load Impedance	963	Ω

1. Approximate value.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.3 volts	152	168	A
Cathode Warmup Time	5.0	---	sec.
Interelectrode Capacitances (grounded grid)[1]			
Cin	50.0	62.0	pF
Cout	32.0	40.0	pF
Cpk	---	0.3	pF
Interelectrode Capacitances (grounded cathode)[1]			
Cin	50.0	62.0	pF
Cout	---	0.3	pF
Cgp	32.0	40.0	pF

1. Capacitance values are for a cold tube as measured in a shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MOUNTING & SOCKETING - The 3CX15,000A7 must be operated vertically, base up or down, and should be protected from severe shock and vibration. The use of an EIMAC air-system socket is recommended. For grid-driven applications, the SK-1300 is used; for cathode-driven circuits, the SK-1320 should be used, as the grid is grounded to the socket frame in this unit. The SK-1306 air chimney is designed to fit around the tube's anode cooler and mount with either socket.

COOLING - The maximum temperature rating for the external surfaces of the 3CX15,000A7 is 250°C. Sufficient forced-air cooling must be provided to maintain the temperature of the anode core and the ceramic/metal seals below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below the maximum rating. Minimum air flow requirements (for air flowing in a base-to-anode direction) to maintain anode core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated below. The use of these air-flow rates through the recommended socket/chimney combination will provide effective cooling of the tube. Air flow should be applied before or simultaneously with the application of electrode voltages (including the filament) and should normally be maintained for a short period of time after all voltages are removed to allow for tube cool-down.

	SEA LEVEL		10,000 FEET	
Anode Diss. (watts) *	Air Flow (cfm)	Approx. Press. drop (In. H_2O)	Air Flow (cfm)	Approx. Press. drop (In. H_2O)
5,000	242	0.8	350	1.3
7,500	325	1.7	470	2.4
10,000	475	2.8	690	4.1
12,500	640	4.3	930	6.3
15,000	840	6.2	1220	9.7

* Since the power dissipated by the filament is about 1000 watts, and since the grid dissipation can represent another 500 watts, allowance has been made in preparing this tabulation for an additional 1500 watts of dissipation.

FILAMENT OPERATION - The rated filament voltage for the 3CX15,000A7 is 6.3 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate from the rated value by more than plus or minus five percent.

INPUT CIRCUIT - When the 3CX15,000A7 is operated as a ground-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier, it is suggested that the cathode tank circuit operate at a "Q" of two or more.

CLASS-C OPERATION - Although specifically designed for Class-B service, the 3CX15,000A7 may be operated as a Class-C power amplifier or oscillator. The zero-bias characteristic of the 3CX15,000A7 can be used to advantage in Class-C amplifiers by employing only grid-leak bias. If driving power fails, plate dissipation is then kept to a low value because the tube will be operating at the normal static zero-bias conditions.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

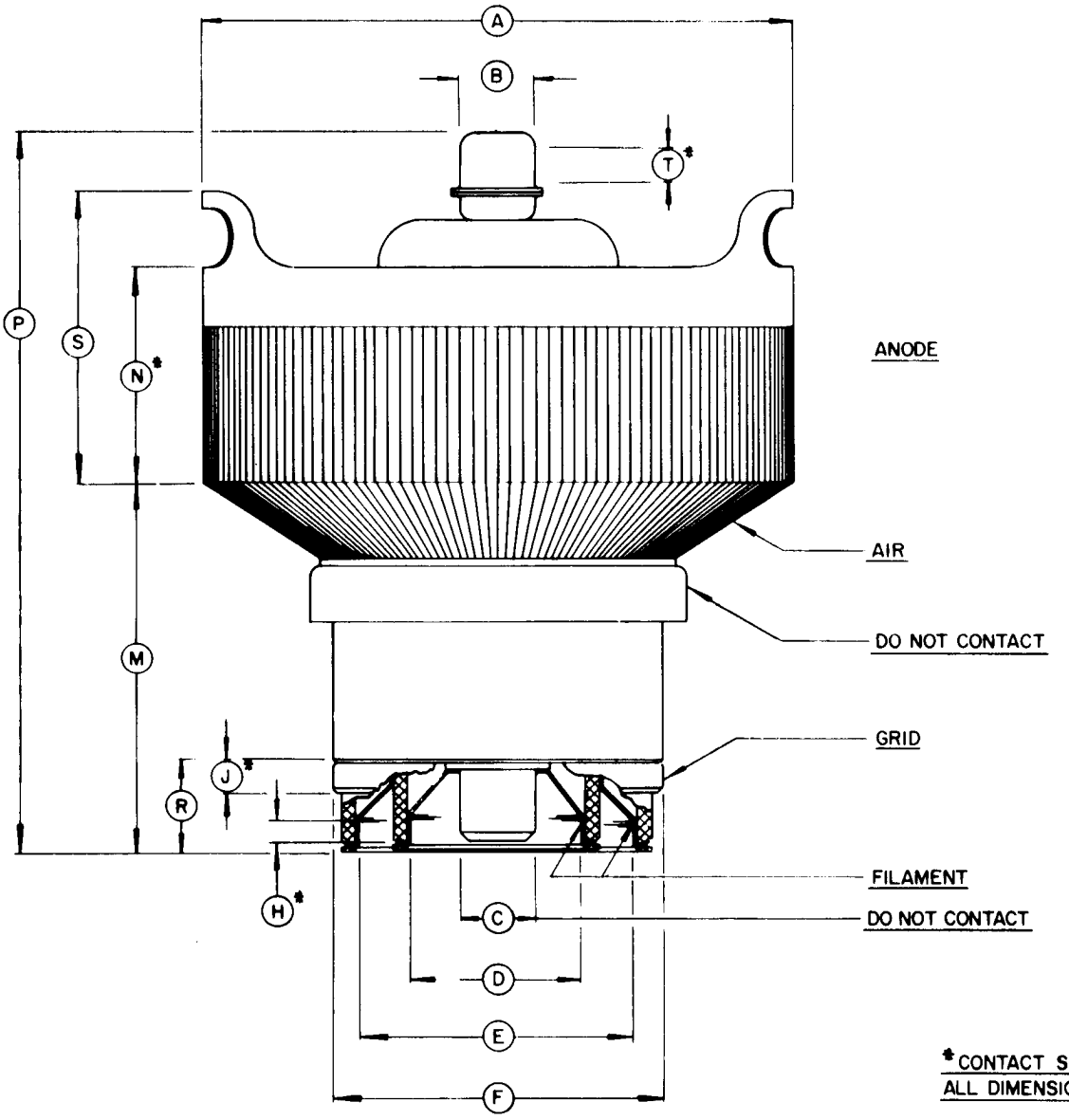
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

HIGH VOLTAGE - The 3CX15,000A7 operates at voltages which can be deadly, and the equipment must be designed properly and operating

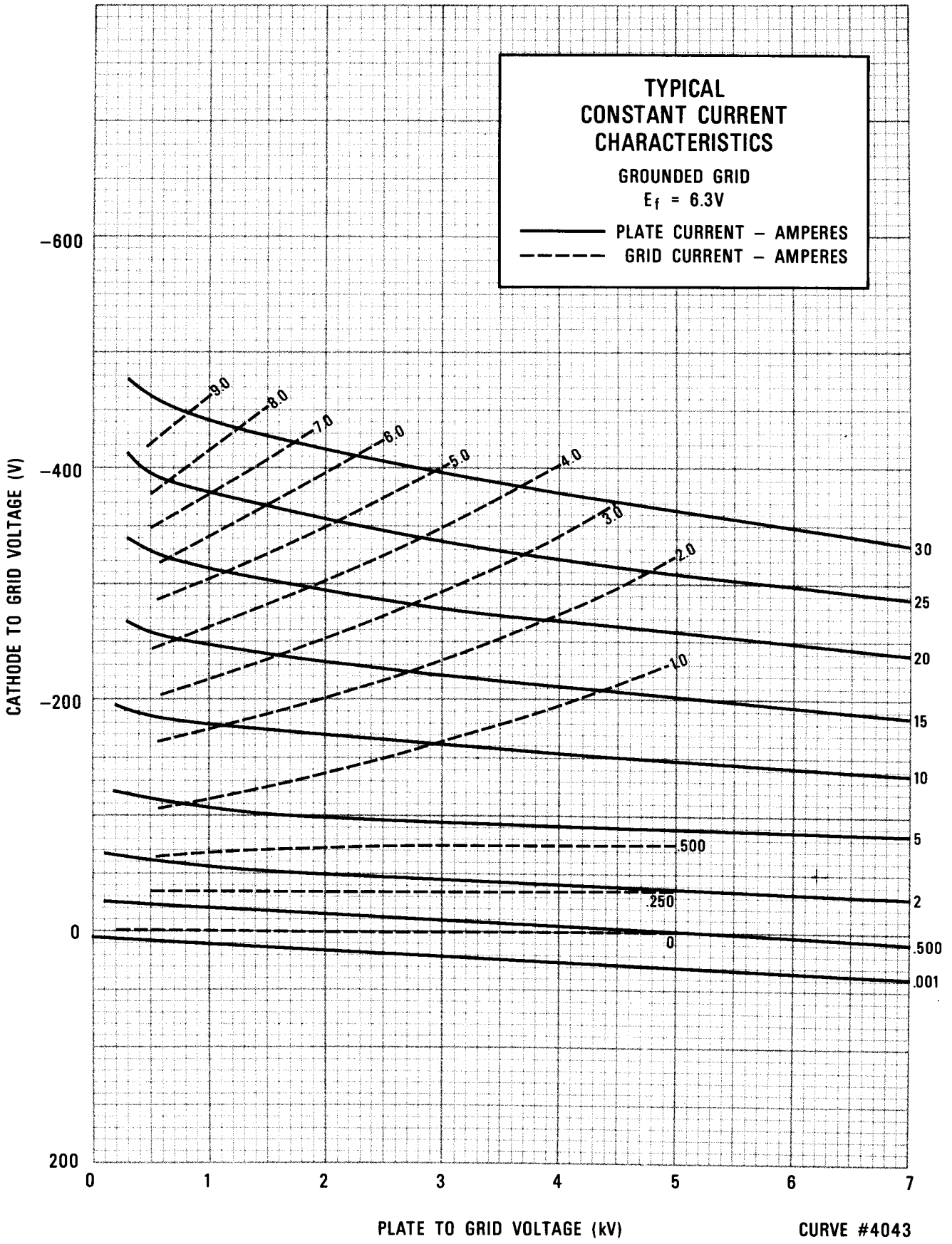
precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, CA 94070, for information and recommendations.

DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	6.928	7.050	--	175.97	179.07	--
B	0.855	0.895	--	21.72	22.73	--
C	0.720	0.760	--	18.29	19.30	--
D	1.896	1.936	--	48.16	49.17	--
E	3.133	3.173	--	79.58	80.59	--
F	3.792	3.832	--	96.32	98.86	--
H	0.188	--	--	4.78	--	--
J	0.188	--	--	4.78	--	--
M	3.950	4.300	--	100.33	109.22	--
N	2.412	2.788	--	61.26	70.82	--
P	8.250	8.750	--	209.55	222.25	--
R	0.986	1.050	--	25.04	26.67	--
S	3.412	3.788	--	86.66	96.22	--
T	0.375	--	--	9.53	--	--



*CONTACT SURFACE
ALL DIMENSIONS IN INCHES


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
E_f = 6.3V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
CATHODE TO GRID VOLTAGE (V)
-600
-400
-200
0
200
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.500
.250
0
30
25
20
15
10
5
2
.500
.001
0
1
2
3
4
5
6
7
PLATE TO GRID VOLTAGE (kV)
CURVE #4043

3CX15,000H3

INDUSTRIAL MEDIUM-MU AIR-COOLED POWER TRIODE

TECHNICAL DATA

The EIMAC 3CX15,000H3 is an air-cooled, ceramic-metal power triode designed primarily for use in industrial radio-frequency heating services. Its air- cooled anode is rated at 15 kilowatts of plate dissipation.

Full ratings apply up to 90 megacycles. Plentiful reserve emission is available from its one kilowatt filament. The grid structure is rated at 500 watts making this tube an excellent choice for severe application.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated-Tungsten				
Voltage		6.3		Volts
Current	152		172	amps
Amplification Factor		20		
Interelectrode Capacitances, Grounded Cathode Connection:				
Grid-Filament	50		60	μμf
Plate-Filament	1.3		1.6	μμf
Grid-Plate	30		38	μμf
Frequency for Maximum Ratings			90	MHz

MECHANICAL

Base	See Outline
Operating Position	Vertical, base up or down
Cooling	Forced Air
Maximum Operating Temperatures	250°C
Maximum Dimensions:	
Height	See Outline
Diameter	See Outline
Net Weight	13 Pounds

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

(Effective 4-1-66) © 1966 Varian

Printed in U.S.A.

RF INDUSTRIAL OSCILLATOR
Class-C (Filtered DC Power Supply)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	12,000 Volts
DC PLATE CURRENT	6.0 Amps
DC GRID VOLTAGE	—1000 Volts
DC GRID CURRENT	1.0 Amps
PLATE INPUT POWER	60 kW
PLATE DISSIPATION	15 kW

TYPICAL OPERATION*

DC Plate Voltage	7000	10,000 Volts
DC Plate Current	6.0	5.0 Amps
DC Grid Voltage	—600	—800 Volts
DC Grid Current	660	542 mA
Peak Positive Grid Voltage	440	400 Volts
Driving Power	660	650 Watts
Plate Input Power	42	50 kW
Plate Dissipation	12	8.8 kW
Plate Output Power	30	41.2 kW
Approximate Load Impedance	600	1025 Ohms

*Loaded Conditions

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses has been made.

APPLICATION

ELECTRICAL

Filament

For the 3CX15,000H3 the rated filament voltage is 6.3 volts. Filament voltage, as measured at the socket, should be maintained at 6.3 volts plus or minus five percent for long tube life and consistent performance. Maximum life will be obtained by operation at minus 5 percent.

Control Grid Operation

The grid current rating is one ampere dc. This value should not be exceeded for more than very short periods such as during tuning. Overcurrent protection in the grid circuit should be provided. Ordinarily it will not be necessary to operate with more than 0.4 to 0.6 amperes grid current to obtain reasonable efficiency. In industrial heating service with varying loads, grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 500 watts.

Plate Operation

Maximum plate voltage rating of 12,000 volts and maximum plate current of 6.0 amps should not be applied simultaneously as rated plate dissipation may be exceeded.

Plate over-current protection should be provided to remove plate voltage quickly in the event of an over-load or an arc-over at the load. In addition current limiting power supply resistors should be used. These precautions are especially important in industrial service with its wide variations in loading.

Spark gaps from plate to ground should be used to prevent transient voltages from flashing across the tube envelope during any fault conditions.

MECHANICAL

Mounting

The 3CX15,000H3 must be mounted vertically, either base up or down. A grid contact flange is provided for bolting to a strap or a grid deck. Heavy flexible leads are provided for applying the filament voltage.

Cooling

The maximum temperature rating for the 3CX15,000H3 is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic-metal seals below 250°C. Air-flow requirements to maintain seal temperature at 225°C in 50°C ambient air are tabulated below (for operation below 30 megacycles.)

MINIMUM AIR FLOW REQUIREMENTS
(Anode-to-Base Air Flow)

	Sea Level		5000 Feet	
Plate* Dissipation watts	Air Flow CFM	Pressure Drop inches water	Air Flow CFM	Pressure Drop inches water
7500	361	1.63	433	1.96
10,000	606	3.26	728	3.92
15,000	1260	10.00	1510	12.00

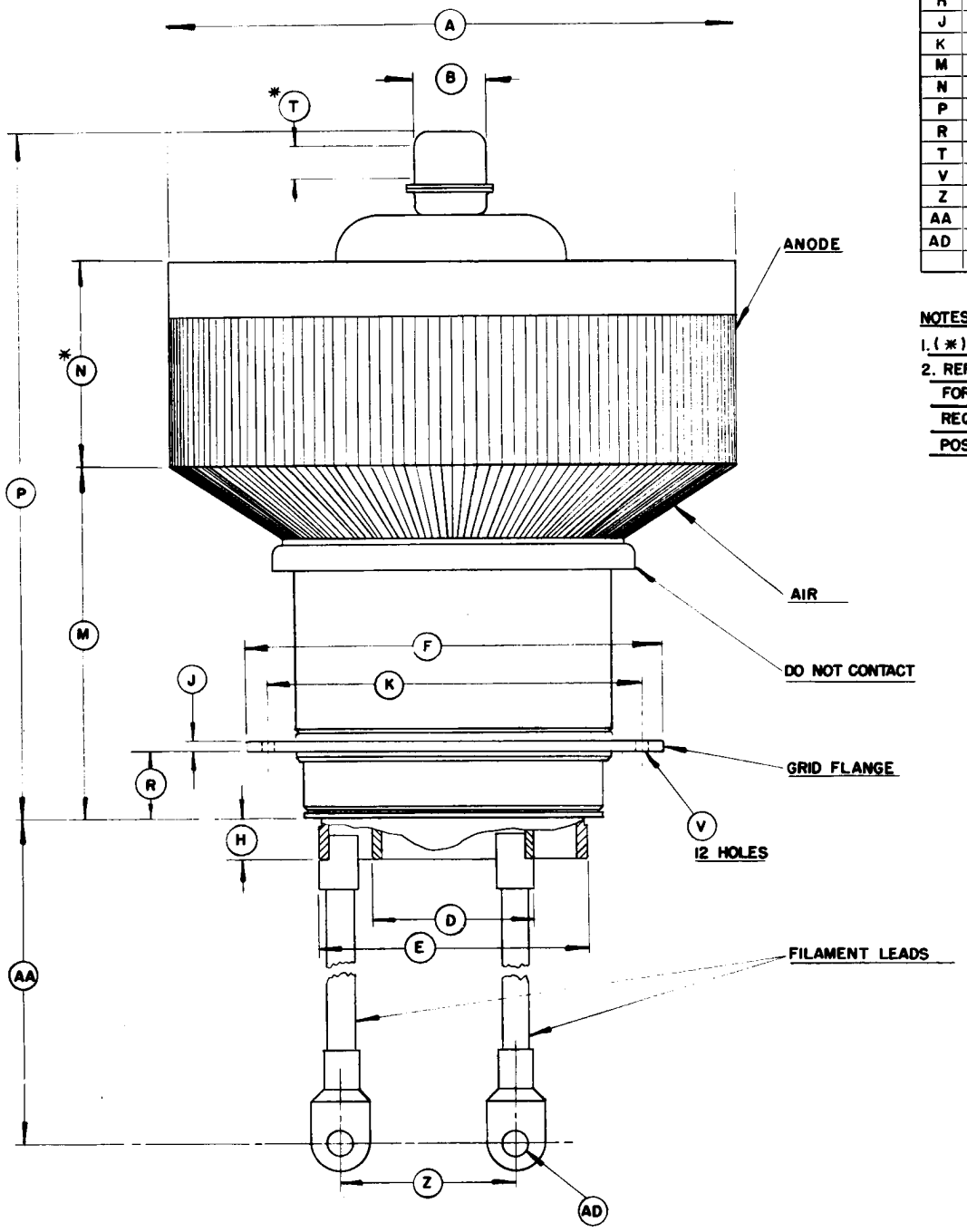
*Since the power dissipated by the filament represents about 1100 watts and since grid dissipation can, under some conditions represent another 500 watts, allowance has been made in preparing this tabulation for an additional 1600 watts.

Additional stem cooling air must be provided. 16 CFM of air directed against the center filament contact ring ½" below the outer filament contact ring by a 1½" I.D. air duct arranged at a 45° angle with the center line of the tube will provide adequate cooling for maximum frequency of 30 MHz, 50°C ambient, and 5000 ft. altitude.

Special Application

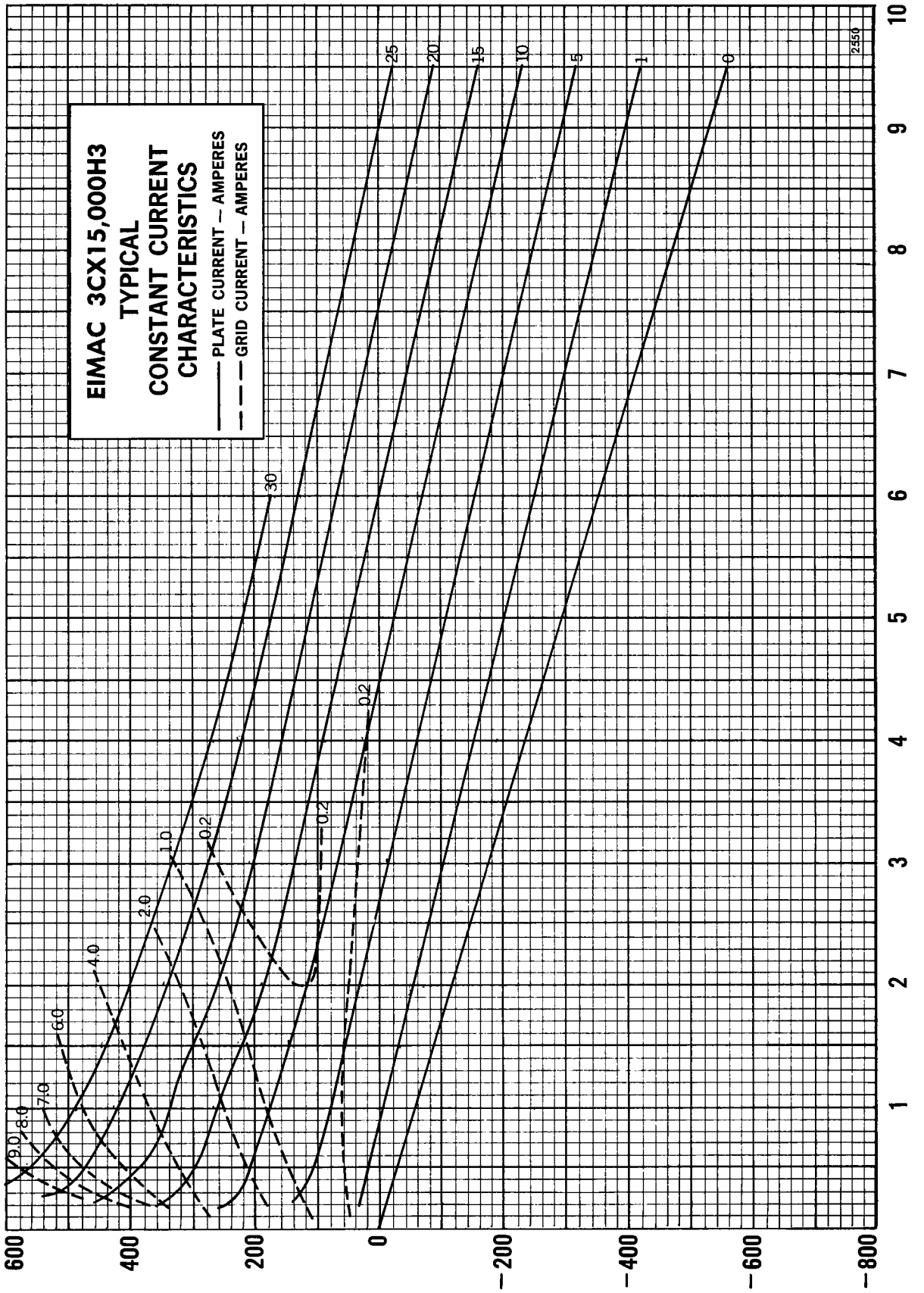
If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Product Manager, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A	6.928	7.050	
B	.855	.895	
D			1.875
E	3.230	3.270	3.250
F	5.030	5090	
H	.530	.700	
J			.125
K	4.425	4.445	
M	3.950	4.300	
N	2.412	2.788	
P	8.250	8.750	
R	.700	.860	
T	.375		
V			.250
Z			2.000
AA	8.500	9.000	
AD			.390



NOTES:

1. (*) CONTACT SURFACE
2. REFERENCE DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.

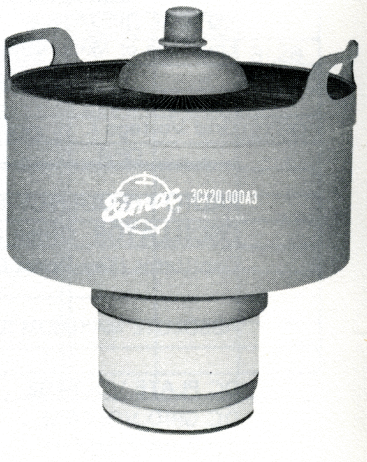

EIMAC 3CX15,000H3
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
25
20
15
10
5
1
0
30
0.2
0.2
1.0
0.2
2.0
4.0
6.0
7.0
8.0
9.0
2350
600
400
200
0
−200
−400
−600
−800
1
2
3
4
5
6
7
8
9
10
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — KILOVOLTS

3CX20,000A3

TECHNICAL DATA

MEDIUM-MU
INDUSTRIAL
TRIODE

The EIMAC 3CX20,000A3 is a ceramic insulated power triode for industrial oscillator or general communications service. It is recommended for Class C amplifier service, or Class B radio frequency and audio frequency amplifier use.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	10.0 ± 0.5	V
Current, at 10.0 volts	160	A
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	70.0	pF
Cout	2.3	pF
Cgp	43.0	pF
Frequency of Maximum Rating:		
CW	90	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Overall Dimensions:	
Length	10.00 in; 254.0 mm
Diameter	8.00 in; 203.0 mm
Net Weight	19.5 lb; 8.8 kg
Operating Position	Vertical
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Forced air
Base	Coaxial
Recommended Air System Socket	SK-1300

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RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN Class AB or B

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC GRID VOLTAGE	-2000	VOLTS
DC PLATE CURRENT	8.0	AMPERES
PLATE DISSIPATION	20.0	KILOWATTS
GRID DISSIPATION	750	WATTS

TYPICAL OPERATION Class AB_2, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	6500	7500	Vdc
Grid Voltage[1]	-320	-380	Vdc
Zero-Signal Plate Current	1.0	1.0	Adc
Single-Tone Plate Current	6.0	7.4	Adc
Single-Tone Grid Current[2]	460	630	mAdc
Peak rf Grid Voltage[2]	545	640	v
Driving Power	520	400	W
Plate Dissipation	11.5	15.1	kW
Single-Tone Plate Output Power	27.5	40.0	kW
Resonant Load Impedance	580	570	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy, Industrial Oscillator (Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	12,000	VOLTS
DC GRID VOLTAGE	-2000	VOLTS
DC GRID CURRENT	1.5	AMPERES
DC PLATE CURRENT	8.0	AMPERES
PLATE DISSIPATION	20.0	KILOWATTS
GRID DISSIPATION	750	WATTS

TYPICAL OPERATION

Plate Voltage	7500	10,000	Vdc
Grid Voltage	-800	-900	Vdc
Plate Current	8.0	7.9	Adc
Grid Resistor	575	1180	Ω
Grid Current[1]	1.4	.75	Adc
Peak rf Grid Voltage[1]	1200	1270	v
Calculated Driving Power[1]	1670	960	W
Plate Input Power	60.0	78	kW
Plate Dissipation	9.0	14	kW
Plate Output Power	51.0	64	kW
Resonant Load Impedance	480.0	640	Ω

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	6500	VOLTS
DC PLATE CURRENT	5.5	AMPERES
PLATE DISSIPATION[1]	13.0	KILOWATTS
GRID DISSIPATION[2]	750	WATTS

1. Corresponds to 20 kW at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION

Plate Voltage	6500	Vdc
Grid Voltage	-1300	Vdc
Plate Current	5.0	Adc
Grid Current[1]	900	mAdc
Peak rf Grid Voltage[1]	1660	v
Calculated Driving Power	1500	W
Plate Input Power	32.5	kW
Plate Dissipation	5.0	kW
Plate Output Power	27.5	kW
Resonant Load Impedance	610	Ω

1. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	8000	VOLTS
DC PLATE CURRENT	8.0	AMPERES
PLATE DISSIPATION	20.0	KILOWATTS
GRID DISSIPATION	750	WATTS

TYPICAL OPERATION (Two Tubes)

Plate Voltage	7500	Vdc
Grid Voltage[1/3]	-380	Vdc
Zero-Signal Plate Current	2.0	Adc
Max. Signal Plate Current	14.8	Adc
Max. Signal Grid Current[1]	1.26	Adc
Peak af Grid Voltage[2]	640	v
Driving Power	800	W
Max. Signal Plate Dissipation	30.2	kW
Plate Output Power	80.0	kW
Load Resistance (plate to plate)	1140	Ω

1. Approximate value.
2. Per Tube.
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

Heater: Current at 10.0 volts	152	168	A
Interelectrode Capacitances[1] (grounded cathode connection)			
Cin	65.0	75.0	pF
Cout	2.00	2.60	pF
Cgp	38.0	48.0	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

COOLING - The maximum temperature rating for the external surfaces of the 3CX20,000A3 is 250°C. Sufficient forced-air flow must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air flow requirements to maintain core temperature at 225°C in 50°C ambient air are tabulated below. These data are for air flowing in the base-to-anode direction, and the pressure drop figures shown are for the tube/socket/chimney combination.

BASE-TO-ANODE AIR FLOW				
	Sea Level		10,000 Feet	
Plate * Dissipation (watts)	Air Flow (CFM)	Pressure Drop In. H2O	Air Flow (CFM)	Pressure Drop In. H2O
10,000	320	1.0	464	1.6
15,000	625	3.0	910	4.4
20,000	1010	6.0	1475	8.7

* Since the power dissipated by the filament represents about 1680 watts and since the grid dissipation can, under some conditions, represent another 750 watts, allowance has been made in preparing this tabulation for an additional 2430 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures, the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

FILAMENT/CATHODE OPERATION - The filament voltage should be maintained within 5% of the nominal 10.0 V value, and for consistent tube life even closer control is advised. For most services the filament voltage may be less than the nominal 10.0 V for extended life. The exact value about which to control should be determined by experiment in any given service.

GRID OPERATION - The grid dissipation rating of 750 watts must not be exceeded. For the convenience of industrial heating operators a maximum grid current of 1.5 amperes is specified. This provides reasonable assurance that the 750 watt rating is not exceeded.

PLATE OPERATION - Allowable anode dissipation depends on provision of sufficient cooling air for the temperature and altitude environment. Anode dissipation will vary widely with load

changes in industrial heating service. It is important that the power level be adjusted so that under no condition of the load cycle does the anode dissipation exceed the level established by the available cooling air. When power tubes are operated in parallel, provision should be made to meter plate and grid currents individually. It is good practice also to provide separate plate current or cathode current overload relays when tubes are operated in parallel.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as the 3CX-20,000A3, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry---the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

HIGH VOLTAGE - Normal operating voltages used with the 3CX20,000A3 are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuitx and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 3CX20,000A3, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

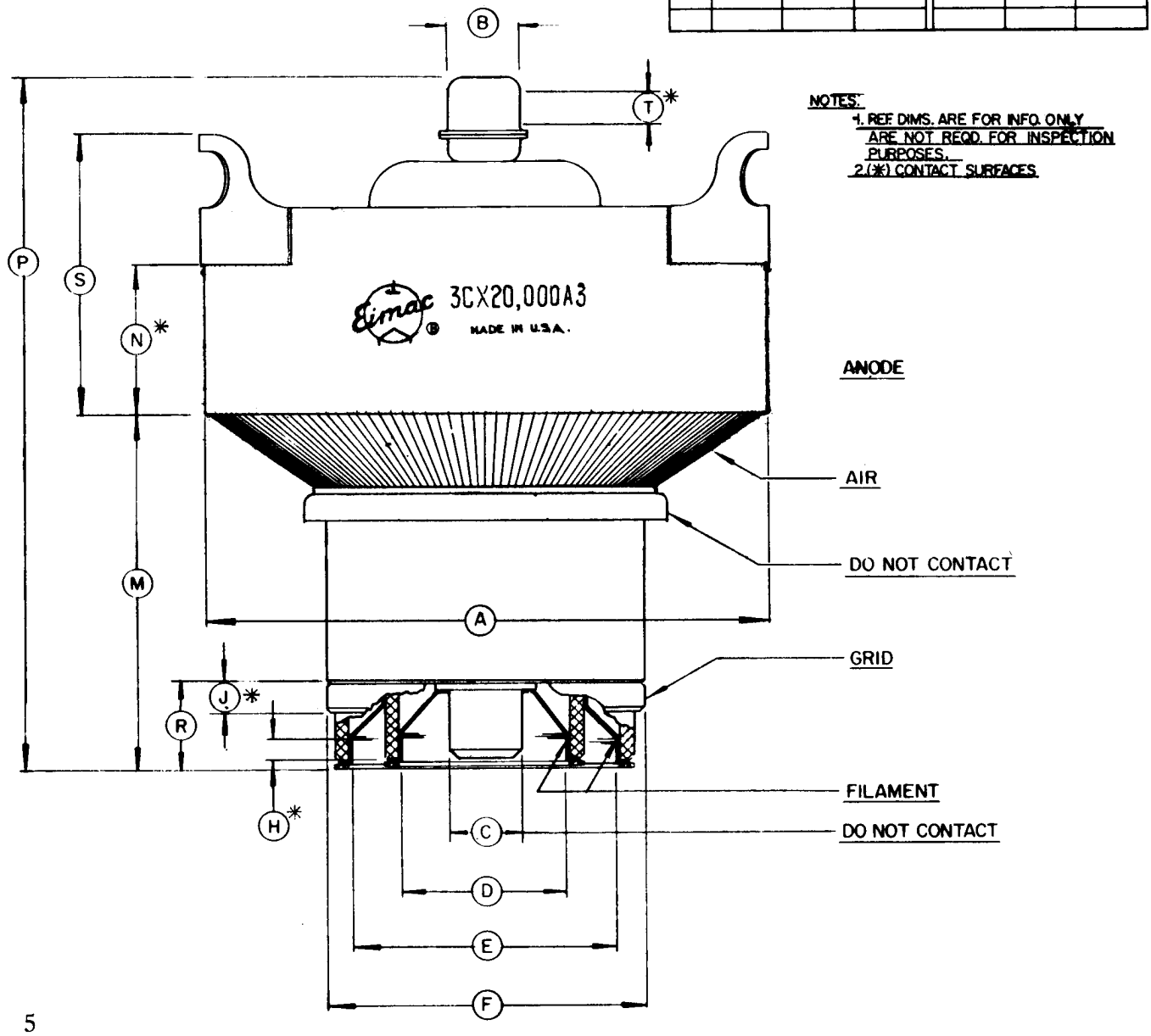
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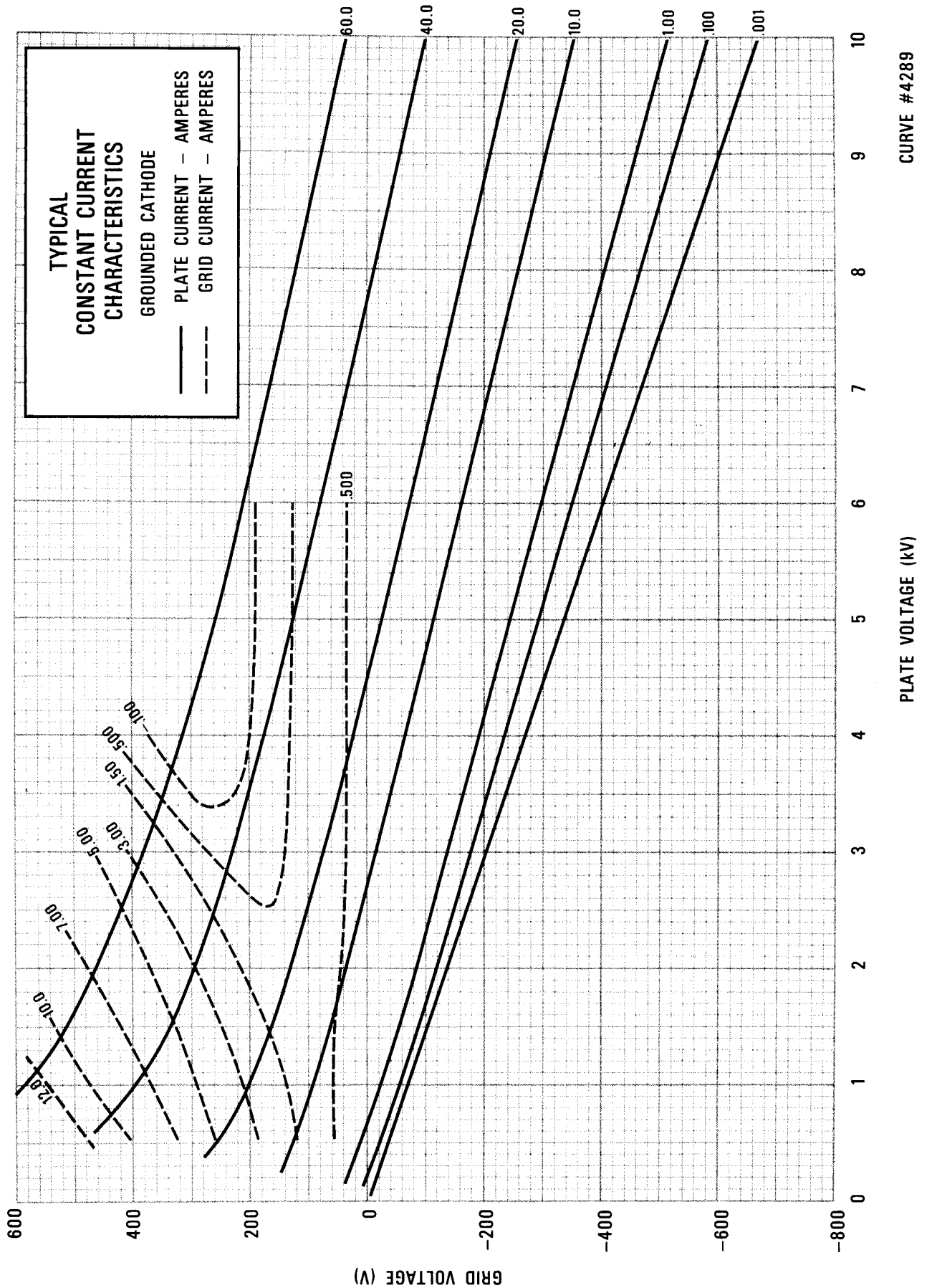
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	- -	- -	8.000	- -	- -	204.00
B	0.855	0.895	- -	21.70	22.70	- -
C	0.720	0.760	- -	18.30	19.30	- -
D	1.896	1.936	- -	- -	- -	48.67
E	3.133	3.173	- -	79.58	80.59	- -
F	3.792	3.832	- -	96.32	97.33	- -
H	0.188	- -	- -	4.77	- -	- -
J	0.188	- -	- -	4.77	- -	- -
M	3.800	4.150	- -	96.50	105.00	- -
N	- -	- -	3.200	- -	- -	81.28
P	- -	- -	10.000	- -	- -	254.00
R	0.986	1.050	- -	25.10	26.70	- -
S	- -	- -	5.000	- -	- -	127.00
T	0.375	- -	- -	9.50	- -	- -




TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
60.0
40.0
20.0
10.0
1.00
.100
.001
500
150
100
12.0
10.0
7.00
5.00
3.00
GRID VOLTAGE (V)
600
400
200
0
-200
-400
-600
-800
0
1
2
3
4
5
6
7
8
9
10
PLATE VOLTAGE (kV)
CURVE #4289

3CX20,000A7

HIGH-MU
POWER TRIODE

The EIMAC 3CX20,000A7 is a ceramic/metal power triode intended for use as a zero-bias Class B rf amplifier or Class C power amplifier or oscillator. Class B operation with zero grid bias offers circuit simplicity by eliminating the bias supply. In addition, grounded-grid operation is attractive since a power gain as high as twenty times can be obtained with the 3CX20,000A7.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	6.3 ± 0.3 V
Current, at 6.3 volts	160 A
Amplification Factor (Average):	200
Direct Interelectrode Capacitance (grounded cathode) [2]	
Cin	61.0 pF
Cout	0.2 pF
Cgp	36 pF
Direct Interelectrode Capacitance (grounded grid) [2]	
Cin	61.0 pF
Cout	36 pF
Cpk	0.2 pF
Frequency of Maximum Rating:	
CW	110 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Overall Dimensions:	
Length	8.50 in; 215.9 mm
Diameter	8.25 in; 209.6 mm
Net Weight	13.5 lb; 6.15 kg
Operating Position	Vertical base up or down
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C

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Cooling	Forced air
Base	Coaxial
Recommended Air System Socket	SK-1300 or SK-1320

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC PLATE CURRENT	6.0	AMPERES
PLATE DISSIPATION	20,000	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate values.
2. Adjust to obtain specified value.

TYPICAL OPERATION (Frequencies to 110 MHz)
Class AB_2

Plate Voltage	7000	7000	Vdc
Grid Voltage	0	0	Vdc
Zero-Signal Plate Current[1]	.6	.6	Adc
Single-Tone Plate Current[2]	5.92	5.0	Adc
Single-Tone Grid Current[1]	1.22	1.0	Adc
Driving Power[1]	1750	1540	W
Plate Dissipation	13.4	10.8	kW
Single-Tone Plate Output Power	29.6	24.2	kW
Resonant Load Impedance	693	745	Ω
Drive Impedance	27	32	Ω

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy or FM

Grid Driven

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	20,000	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (Frequencies to 110 MHz)

Plate Voltage	7000	Vdc
Grid Voltage	-230	Vdc
Plate Current	4.0	Adc
Grid Current[1]	775	mAdc
Peak rf Grid Voltage[1]	555	v
Calculated Driving Power[1]	430	W
Plate Input Power	28	kW
Plate Dissipation	6.7	kW
Plate Output Power	21.3	kW
Resonant Load Impedance	963	Ω

1. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER

Class C Cathode Driven

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	8000	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	20,000	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION

Plate Voltage	7200	7800	Vdc
Grid to Cathode Voltage	-200	-200	Vdc
Plate Current	3.7	4.2	Adc
Grid Current[1]	92	98	mAdc
Peak rf Cathode Voltage[1]	480	500	v
Cathode Driving Power[1]	1900	2300	W
Plate Dissipation	4500	5000	kW
Plate Load Resistance	1080	1020	Ω
Plate Output Power	22.0	27.5	kW

1. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER

Class B Television Service, Cathode Driven

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC PLATE CURRENT	6.0	AMPERES
PLATE DISSIPATION	20,000	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (Frequencies to 216 MHz)
Class B

Plate Voltage	7200	Vdc
Grid Voltage	0	Vdc
Zero Signal Plate Current[1]	1.2	Adc
Effective rf Load Resistance	605	Ω
Plate Current: Blanking Level	4.8	Adc
Sync. Peak Level	5.8	Adc
Grid Current: Blanking Level[1]	0.47	Adc
Sync. Peak Level[1]	1.14	Adc
rf Cathode Voltage Peak:		
Blanking Level[1]	230	v
Sync. Peak Level[1]	300	v
Driving Power: Blanking Level[1]	690	w
Sync. Peak Level[1]	1700	w
Plate Power Output: Blanking Level	16.5	kw
Sync. Peak Level	27.5	kw

1. Approximate value.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.3 volts	152	168	A
Cathode Warmup Time	5.0	---	sec.
Interelectrode Capacitances (grounded grid) [1]			
Cin	55.0	67.0	pF
Cout	32.0	40.0	pF
Cpk	---	0.3	pF
Interelectrode Capacitances (grounded cathode) [1]			
Cin	55.0	67.0	pF
Cout	---	0.3	pF
Cgp	32.0	40.0	pF

1. Capacitance values are for a cold tube as measured in a shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MOUNTING & SOCKETING - The 3CX20,000A7 must be operated vertically, base up or down, and should be protected from severe shock and vibration. The use of an EIMAC air-system socket is recommended. For grid-driven applications, the SK-1300 is used; for cathode-driven circuits, the SK-1320 should be used, as the grid is grounded to the socket frame in this unit.

COOLING - The maximum temperature rating for the external surfaces of the 3CX20,000A7 is 250°C. Sufficient forced-air cooling must be provided to maintain the temperature of the anode core and the ceramic/metal seals below the maximum rating. Air flow should be applied before or simultaneously with the application of electrode voltages (including the filament) and should normally be maintained for a short period of time after all voltages are removed to allow for tube cool-down.

Minimum air flow requirements (for air flowing in a base to anode direction) to maintain core and seal temperatures below 225°C with an inlet temperature of 50°C are tabulated here. Pressure drop for this tabulation is measured across the anode cooler and does not include drop across a socket or chimney. In cases where the tube base is not directly in the anode cooling air stream, provision should be made to direct an air stream of at least 50 CFM at the base from a 1-1/2 inch nozzle, or make other provision to conduct heat from the filament and grid terminals.

Anode Dissipation * kW	Sea Level		10,000 Feet Alt.	
	Air Flow CFM	Pressure Drop In. Water	Air Flow CFM	Pressure Drop In. Water
7.5	122	.25	203	.45
10.0	241	.70	350	1.00
12.5	400	1.40	580	2.25
15.0	590	2.45	940	3.90
17.5	840	4.25	1320	6.70
20.0	1180	6.90	1710	10.00

* Since the power dissipated by the filament is about 1000 watts, and since the grid dissipation can represent another 500 watts, allowance has been made in preparing this tabulation for an additional 1500 watts of dissipation.

FILAMENT OPERATION - The rated filament voltage for the 3CX20,000A7 is 6.3 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate from the rated value by more than plus or minus five percent.

INPUT CIRCUIT - When the 3CX20,000A7 is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier, it is suggested that the cathode tank circuit operate at a "Q" of two or more.

CLASS-C OPERATION - Although specifically designed for Class-B service, the 3CX20,000A7 may be operated as a Class-C power amplifier or oscillator. The zero-bias characteristic of the 3CX20,000A7 can be used to advantage in Class-C amplifiers by employing only grid-leak bias. If driving power fails, plate dissipation is then kept to a low value because the tube will be operating at the normal static zero-bias conditions.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

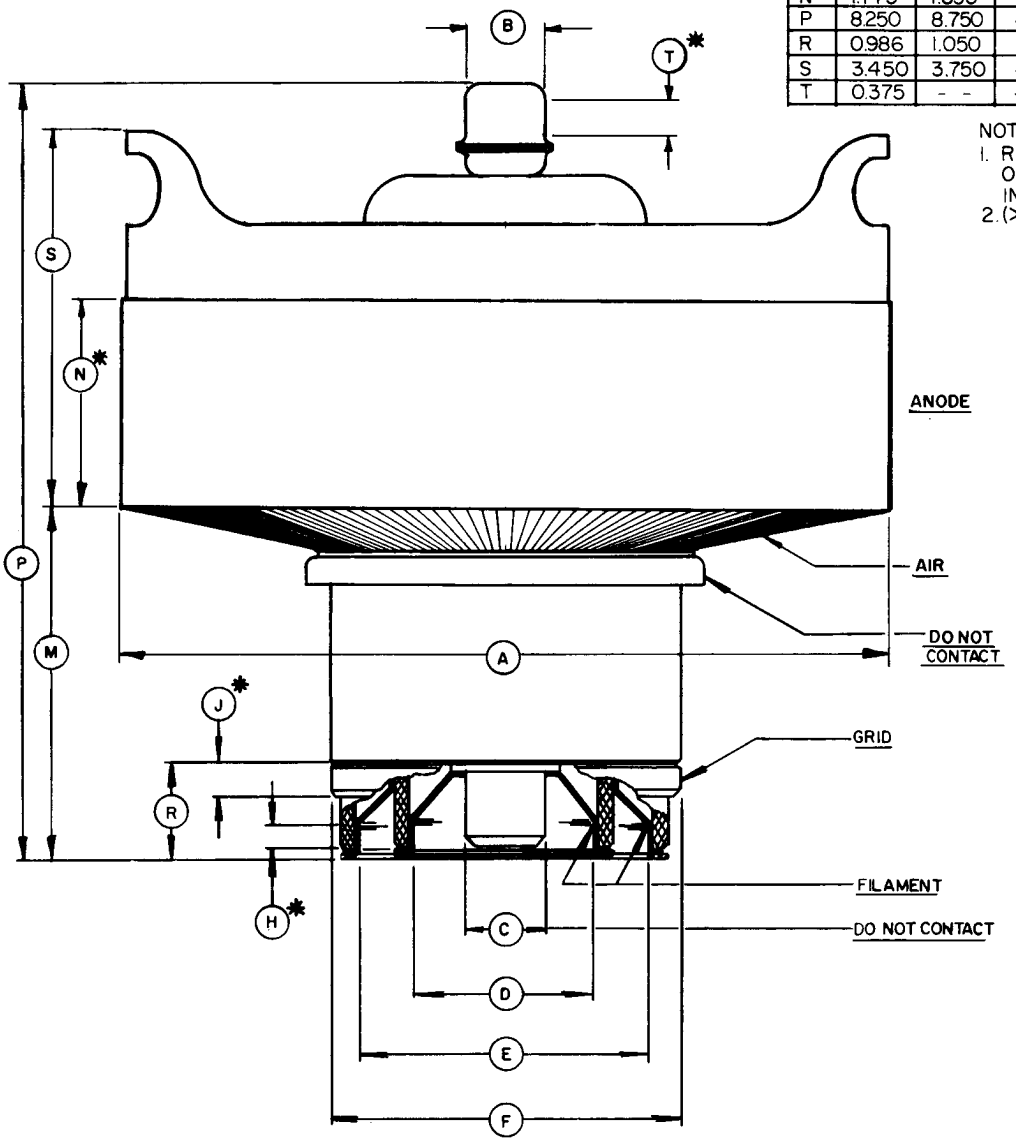
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

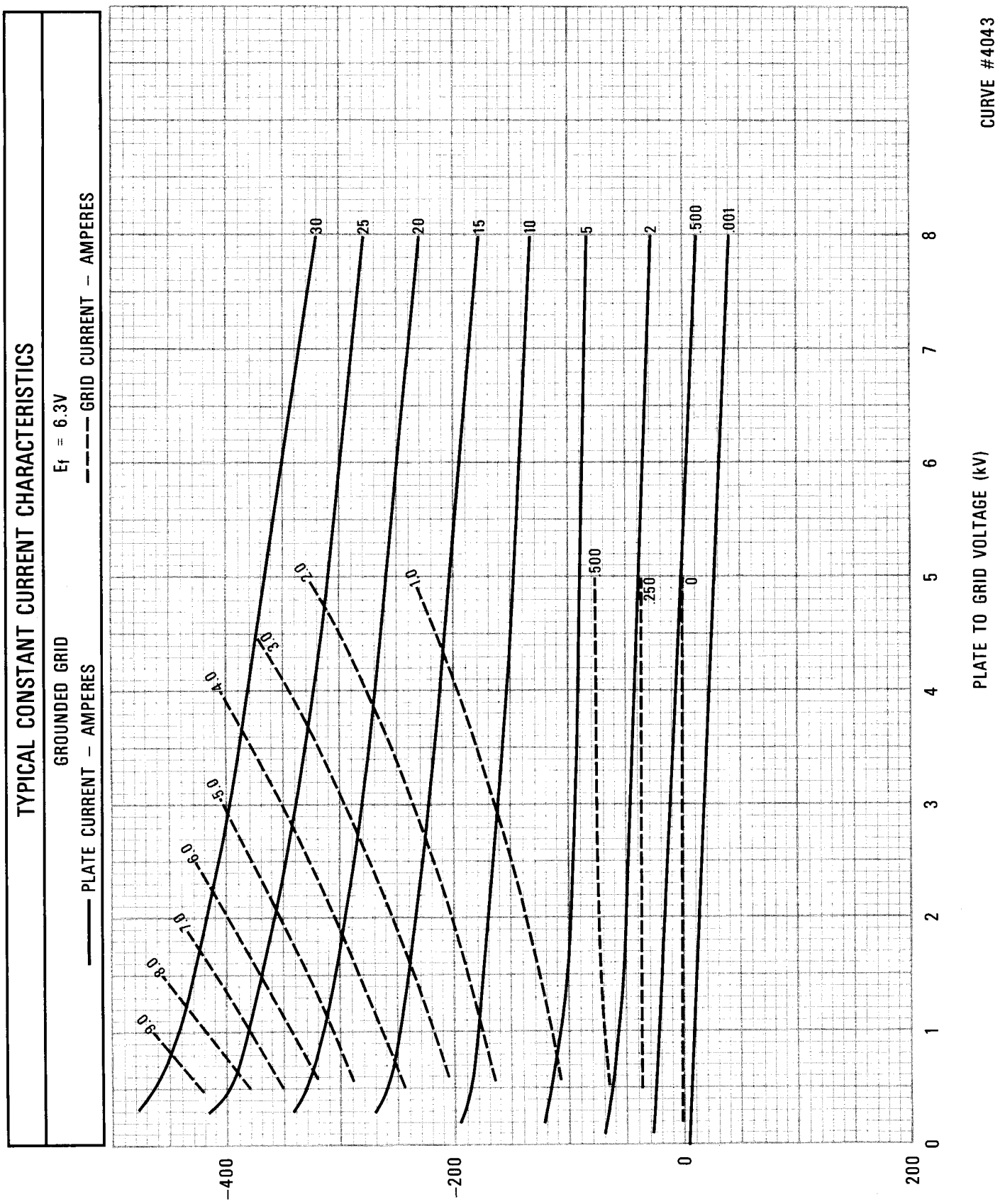
HIGH VOLTAGE - The 3CX20,000A7 operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, CA 94070, for information and recommendations.

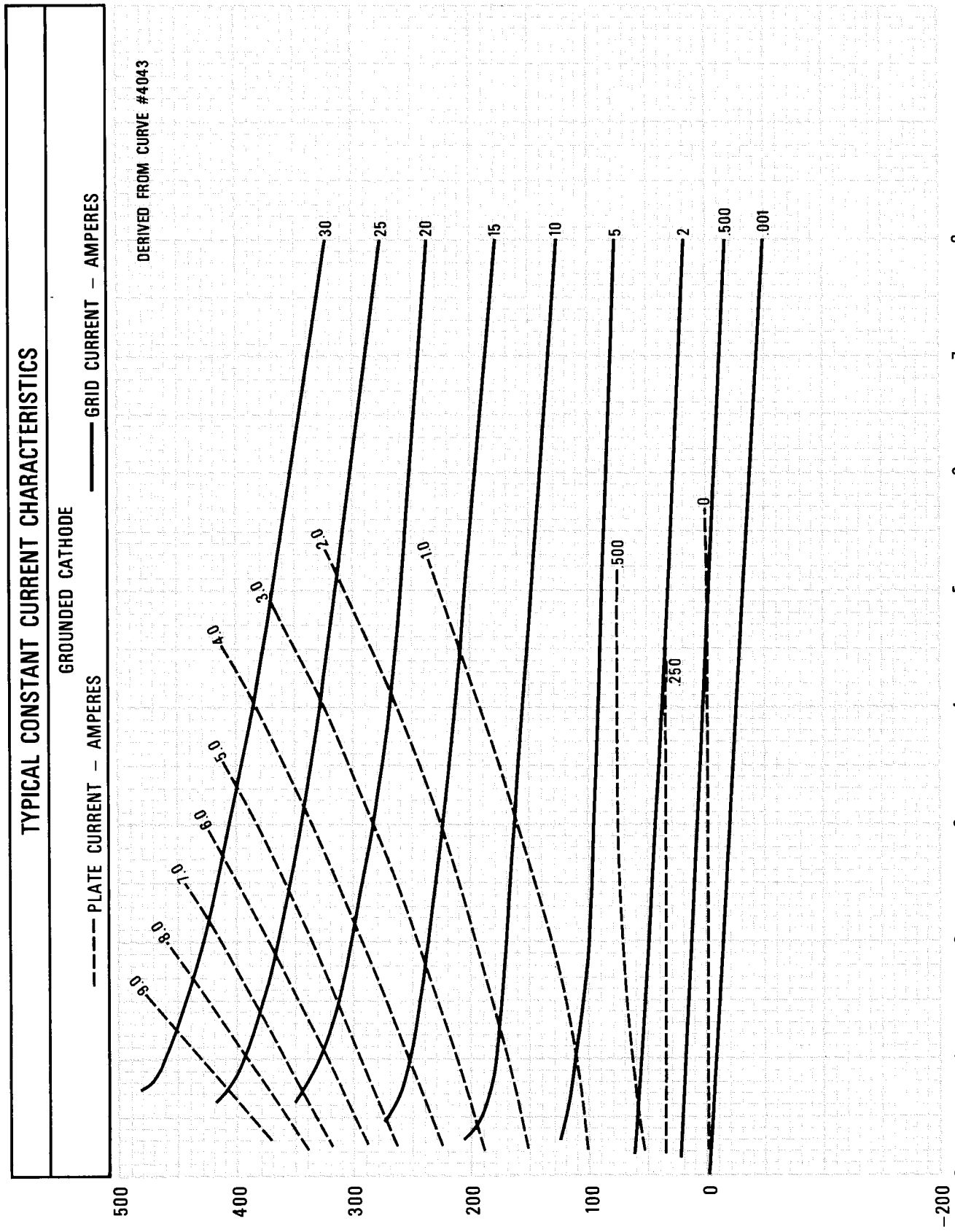
DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	8.190	8.310	- -	208.03	211.07	- -
B	0.855	0.895	- -	21.72	22.73	- -
C	0.720	0.760	- -	18.29	19.30	- -
D	1.896	1.936	- -	48.16	49.17	- -
E	3.133	3.173	- -	79.58	80.59	- -
F	3.792	3.832	- -	96.32	97.33	- -
H	0.188	- -	- -	4.77	- -	- -
J	0.188	- -	- -	4.77	- -	- -
M	4.125	4.375	- -	104.77	111.12	- -
N	1.775	1.850	- -	45.08	46.99	- -
P	8.250	8.750	- -	209.55	222.25	- -
R	0.986	1.050	- -	25.04	26.67	- -
S	3.450	3.750	- -	87.63	95.25	- -
T	0.375	- -	- -	9.52	- -	- -

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (✱) CONTACT SURFACES




TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED GRID
Ef = 6.3V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
30
25
20
15
10
5
2
.500
.001
0
.250
.500
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
0
1
2
3
4
5
6
7
8
PLATE TO GRID VOLTAGE (kV)
CATHODE TO GRID VOLTAGE (V)
200
0
−200
−400

CURVE #4043

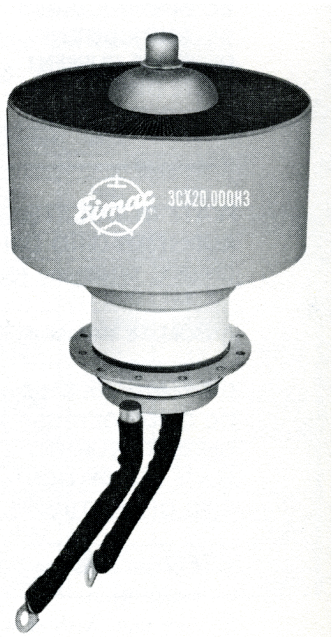

TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
DERIVED FROM CURVE #4043
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #4282
500
400
300
200
100
0
−200
0
1
2
3
4
5
6
7
8
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.500
.250
0
30
25
20
15
10
5
2
.500
.001

3CX20,000H3

TECHNICAL DATA

MEDIUM-MU
INDUSTRIAL TRIODE

The 3CX20,000H3 is a ceramic insulated medium-mu power triode with terminals arranged for direct mounting in industrial heating equipment without the use of a socket. The 3CX20,000H3 is recommended for use as an industrial oscillator in the LF to lower VHF range (30 KHz to 90 MHz). This triode is also recommended for the AM broadcast service as a modulator, modulated rf stage, or as a linear amplifier.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	10.0 ± 0.5	V
Current, at 10.0 volts	160	A
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	70.0	pF
Cout	2.3	pF
Cgp	43.0	pF
Frequency of Maximum Rating:		
CW	90	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Overall Dimensions:	
Length (Not including filament leads)	10.60 in: 269.2 mm
Diameter	8.00 in; 203.2 mm
Net Weight	20.0 lb; 9.1 kg
Operating Position	Vertical, anode up or down
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Forced air
Base	Flexible filament leads

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RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy, or Industrial Oscillator
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	12,000	VOLTS
DC GRID VOLTAGE	-2000	VOLTS
DC GRID CURRENT	1.5	AMPERES
DC PLATE CURRENT	8.0	AMPERES
PLATE DISSIPATION	20.0	KILOWATTS
GRID DISSIPATION	750	WATTS

TYPICAL OPERATION

Plate Voltage	7500	10,000	Vdc
Grid Voltage	-800	-900	Vdc
Plate Current	8.0	7.9	Adc
Grid Current[1]	1.4	.75	Adc
Peak rf Grid Voltage[1]	1200	1270	v
Calculated Driving Power[1]	1670	960	W
Plate Input Power	60	78	kW
Plate Dissipation	9.0	14.0	kW
Plate Output Power	51.0	64.0	kW
Resonant Load Impedance	480	640	Ω

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	6500	VOLTS
DC GRID VOLTAGE	-2000	VOLTS
DC PLATE CURRENT	5.5	AMPERES
PLATE DISSIPATION[1]	13.0	KILOWATTS
GRID DISSIPATION[2]	750	WATTS

1. Corresponds to 20,000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION

Plate Voltage	6500	Vdc
Grid Voltage	-1300	Vdc
Plate Current	5.0	mAdc
Grid Current[1]	900	mAdc
Peak rf Grid Voltage[1]	1660	v
Calculated Driving Power	1500	W
Plate Input Power	32.5	kW
Plate Dissipation	5.0	kW
Plate Output Power	27.5	kW
Resonant Load Impedance	610	Ω

1. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE[1]	8000	VOLTS
DC PLATE CURRENT	8.0	AMPERES
PLATE DISSIPATION	20.0	KILOWATTS
GRID DISSIPATION	750	WATTS

1. Approximate value.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	7500	Vdc
Grid Voltage[1/3]	-380	Vdc
Zero-Signal Plate Current	2.0	Adc
Max. Signal Plate Current	14.8	Adc
Max. Signal Grid Current[1]	1.26	Adc
Peak af Grid Voltage[2]	640	v
Driving Power[1]	800	W
Max. Signal Plate Dissipation	30.2	kW
Plate Output Power	80.0	kW
Load Resistance (plate to plate)	1140	Ω

2. Per Tube.
3. Adjust to give stated zero-signal plate current

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 10.0 volts	152	168	A
Interelectrode Capacitances[1] (grounded cathode connection)			
Cin	65.0	75.0	pF
Cout	2.00	2.60	pF
Cgp	38.0	48.0	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 3CX20,000H3 is intended for direct mounting in the equipment. It may be supported by the anode cooler or by the grid terminal flange. It must be mounted vertically, base up, or base down. The filament terminals are flexible leads approximately eight and three quarter inches in length. At higher operating frequencies it is suggested that the RF return to the filament be made to one or both of the heavy filament rings by suitable clamps. In circuits where circulating current may be large it is possible to make the grid connection through a wide strap bolted to one or more of the ¼ inch holes in the grid flange.

COOLING - The maximum temperature rating for the external surfaces of the 3CX20,000H3 is 250°C. Sufficient forced-air flow must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air flow requirements to maintain core temperature at 225°C in 50°C ambient air are tabulated below. These data are for air flowing in the base-to-anode direction.

The anode cooling air table assumes that the 3CX20,000H3 will be mounted in an enclosure with cooling air flowing into the enclosure and being exhausted through the anode cooler. If the air flow is reversed, that is, flow from the anode toward the base, approximately 20% additional air flow should be provided as indicated by 33% higher pressure drop across the anode cooler.

Approximately 100 CFM of air should be directed from a 1-½ inch diameter nozzle into the base of the tube to cool the filament terminals.

BASE TO ANODE AIR FLOW				
	Sea Level		10,000 Feet	
Plate * Dissipation (watts)	Air Flow (CFM)	Pressure Drop In. W.C.	Air Flow (CFM)	Pressure Drop In. W.C.
10,000	320	0.9	464	1.1
15,000	625	2.1	910	2.8
20,000	1010	4.3	1475	5.8

* Since the power dissipated by the filament represents about 1680 watts and since the grid dissipation can, under some conditions, represent another 750 watts, allowance has been made in preparing this tabulation for an additional 2430 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures, the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

FILAMENT/CATHODE OPERATION - The filament voltage should be maintained within 5% of the nominal 10.0 V value, and for consistent tube life even closer control is advised. For most services the filament voltage may be less than the nominal 10.0 V for extended life.

The exact value about which to control should be determined by experiment in any given service.

GRID OPERATION - The grid dissipation rating of 750 watts must not be exceeded. For the convenience of industrial heating operators a maximum grid current of 1.5 amperes is specified. This provides reasonable assurance that the 750 watt rating is not exceeded.

PLATE OPERATION - Allowable anode dissipation depends on provision of sufficient cooling air for the temperature and altitude environment.

Anode dissipation will vary widely with load changes in industrial heating service. It is important that the power level be adjusted so that under no condition of the load cycle does the anode dissipation exceed the level established by the available cooling air.

When power tubes are operated in parallel, provision should be made to meter plate and grid currents individually. It is good practice also to provide separate plate current or cathode current overload relays when tubes are operated in parallel.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

HIGH VOLTAGE - Normal operating voltages used with the 3CX20,000H3 are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 3CX20,000H3, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

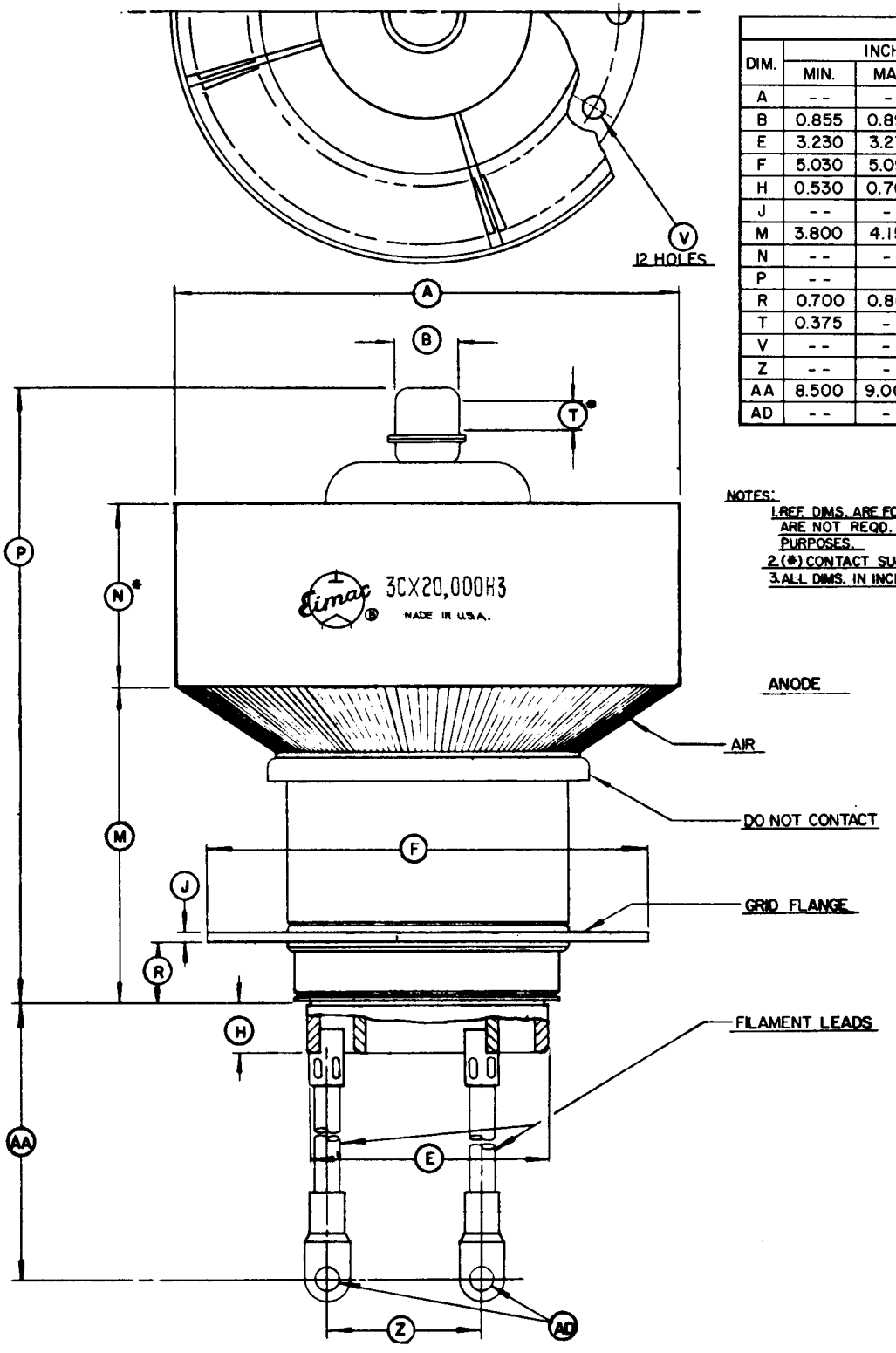
Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at

these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

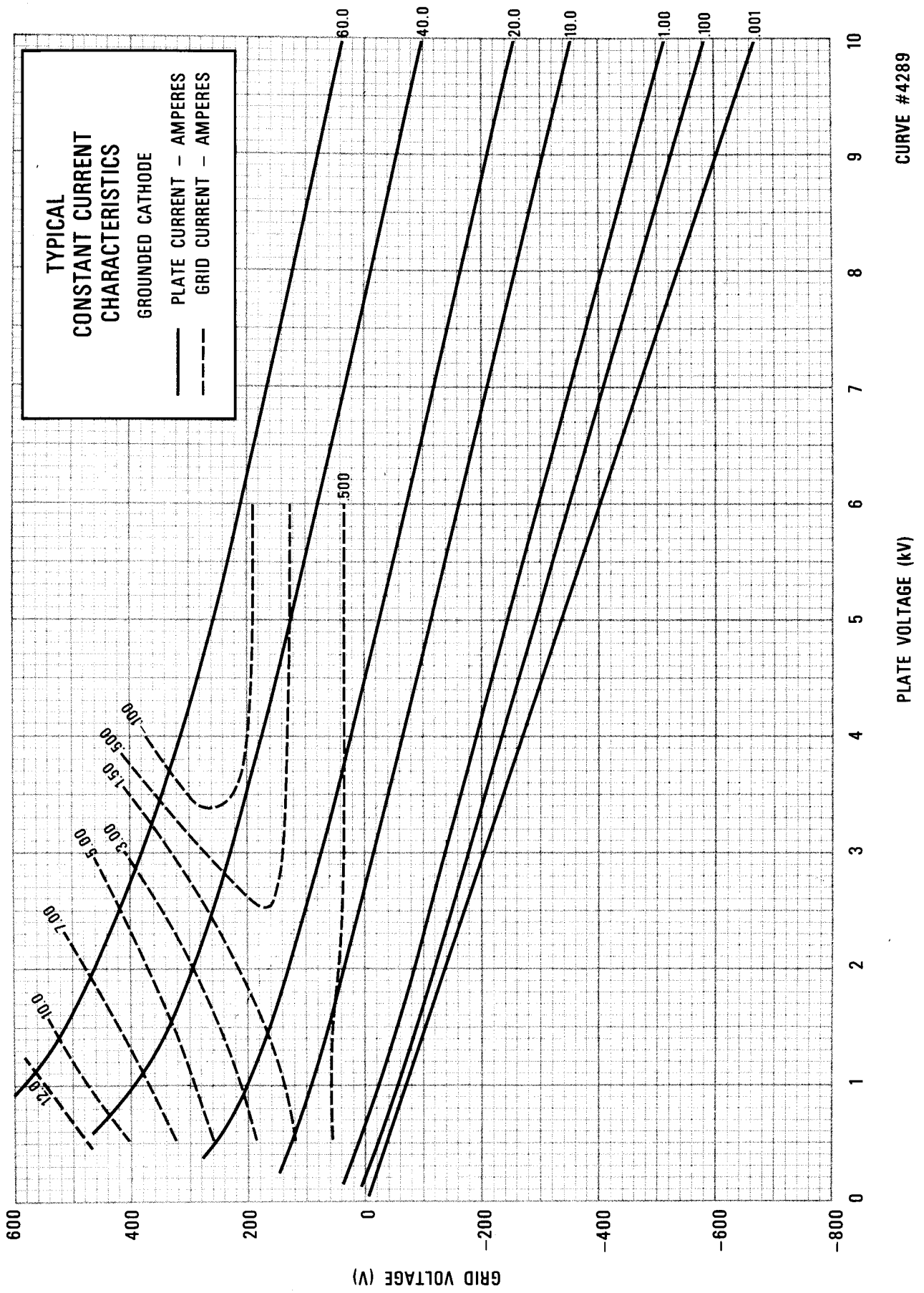
Many EIMAC power tubes, such as the 3CX-20,000H3 are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry --- the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	--	--	8.00	--	--	203.0
B	0.855	0.895	--	21.70	22.70	--
E	3.230	3.270	--	82.00	83.00	--
F	5.030	5.090	--	128.00	128.70	--
H	0.530	0.700	--	13.50	17.70	--
J	--	--	0.125	--	--	3.20
M	3.800	4.150	--	96.50	105.00	--
N	--	--	4.000	--	--	115.00
P	--		10.000	--	--	254.00
R	0.700	0.860	--	17.80	21.80	--
T	0.375	--	--	9.50	--	--
V	--	--	0.265	--	--	6.70
Z	--	--	2.000	--	--	51.00
AA	8.500	9.000	--	215.00	228.00	--
AD	--	--	0.390	--	--	9.90

NOTES:
1. REF. DIMS. ARE FOR INFO. ONLY & ARE NOT REQD. FOR INSPECTION PURPOSES.
2. (#) CONTACT SURFACES
3. ALL DIMS. IN INCHES


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
60.0
40.0
20.0
10.0
1.00
.100
.001
.500
.100
.500
1.50
3.00
5.00
7.00
10.0
12.0
600
400
200
0
-200
-400
-600
-800
0
1
2
3
4
5
6
7
8
9
10
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #4289

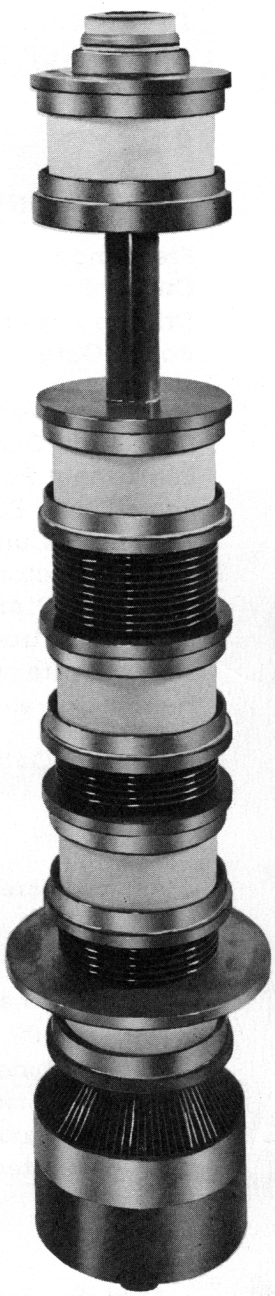
EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

TENTATIVE DATA

3K2500LX

POWER-AMPLIFIER

L-BAND KLYSTRON



The Eimac 3K2500LX is a ceramic and metal, three cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 980 and 1200 megacycles. It will deliver a minimum CW output power of one kilowatt with a power gain of more than 25 db.

The resonant cavities of the 3K2500LX have cylindrical ceramic windows and are completed by tuning boxes external to the tube. This design permits a wide tuning range, and allows repeated tuning cycling without damage to vacuum seals.

An Eimac Klystron Amplifier Circuit Assembly (Catalog Number H-114) has been designed for use with this tube. The klystron must not be operated in any other circuit assembly without design guidance and final approval by Eitel-McCullough, Inc.

CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, Oxide Coated	
	Minimum Heating Time	5 minutes
Heater:	Voltage	7.5 volts
	Current	5.8 amperes
	Maximum Starting Current	15 amperes
Power Gain		25 db
Output Power		1000 watts
Frequency Range		980 to 1200 mc

MECHANICAL

Operating Position*	Axis vertical
R-F Coupling:	
Input	Type "N" coaxial fitting
Output	1 5/8-inch 50-ohm air line
Cooling (See Application)	Forced air
Net Weight	22 pounds
Shipping Weight (Approximate)	80 pounds
Maximum Over-All Dimensions:	
Length	25 7/8 inches
Diameter	5 1/8 inches

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS (Using H-114 Coils)

Prefocus-Coil Voltage	0 to 35	volts
Prefocus-Coil Current	0 to 1.0	ampere
Body-Coil Voltage	0 to 165	volts
Body-Coil Current	0 to 2.5	amperes

*Cathode end up when installed in the Eimac H-114 circuit assembly.

(Effective 9-15-58) Copyright 1958 by Eitel-McCullough, Inc.

MAXIMUM RATINGS

D-C BEAM VOLTAGE	7000	MAX. VOLTS
D-C BEAM CURRENT	600	MAX. MA
D-C BODY CURRENT (CONTINUOUS)	60	MAX. MA
D-C BODY CURRENT (TUNING ONLY)	90	MAX. MA
D-C FOCUS-ELECTRODE VOLTAGE	-100	MAX. VOLTS
COLLECTOR DISSIPATION	2500	MAX. WATTS

TYPICAL OPERATION

NARROW-BAND CW AMPLIFIER (In H-114 Circuit Assembly)

Frequency	1000	1000	megacycles
Output Power	830	1320	watts
Driving Power	2	2	watts
Power Gain	26.1	28.2	db
D-C Beam Voltage	6000	7000	volts
D-C Beam Current	350	455	milliamperes
Beam Input Power	2100	3180	watts
Beam Power Efficiency	39.5	41.4	percent
D-C Body Current	40	30	milliamperes
D-C Collector Current	310	425	milliamperes
Collector Dissipation*	1030	1650	watts
Focus-Electrode Voltage	-100	-100	volts
Heater Voltage	7.5	7.5	volts
Heater Current	5.8	5.8	amperes
Magnetic-Coil Currents:*			
Prefocus	0.5	0.5	ampere
Body	2.0	2.0	amperes

*Approximate values.

APPLICATION

Cooling--When the 3K2500LX is operated at sea level, with an ambient air temperature of less than 30° C (86°F), the cathode will normally require only convection air cooling. At higher altitudes or temperatures, forced-air cooling must be used to maintain the temperature of the metal button at the cathode end of the tube below 150°C.

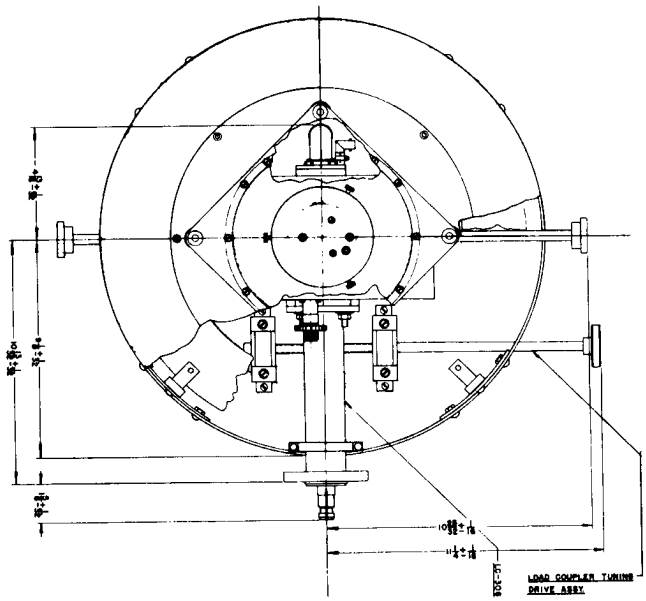
With a maximum ambient temperature of 25° C (77° F) and at sea level, the air-flow rates tabulated below are sufficient for operation at maximum ratings.

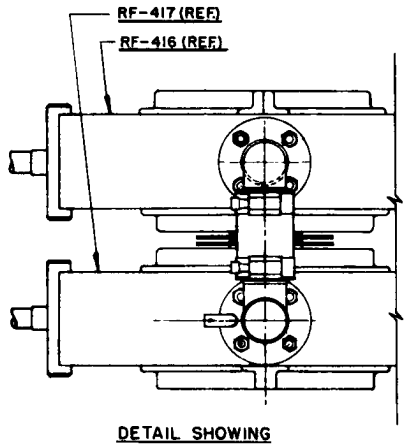
Output and Middle Cavities (Combined)	50 cfm
Collector	150 cfm

At higher temperatures or altitudes, the air-flow rate must be increased to obtain equivalent cooling.

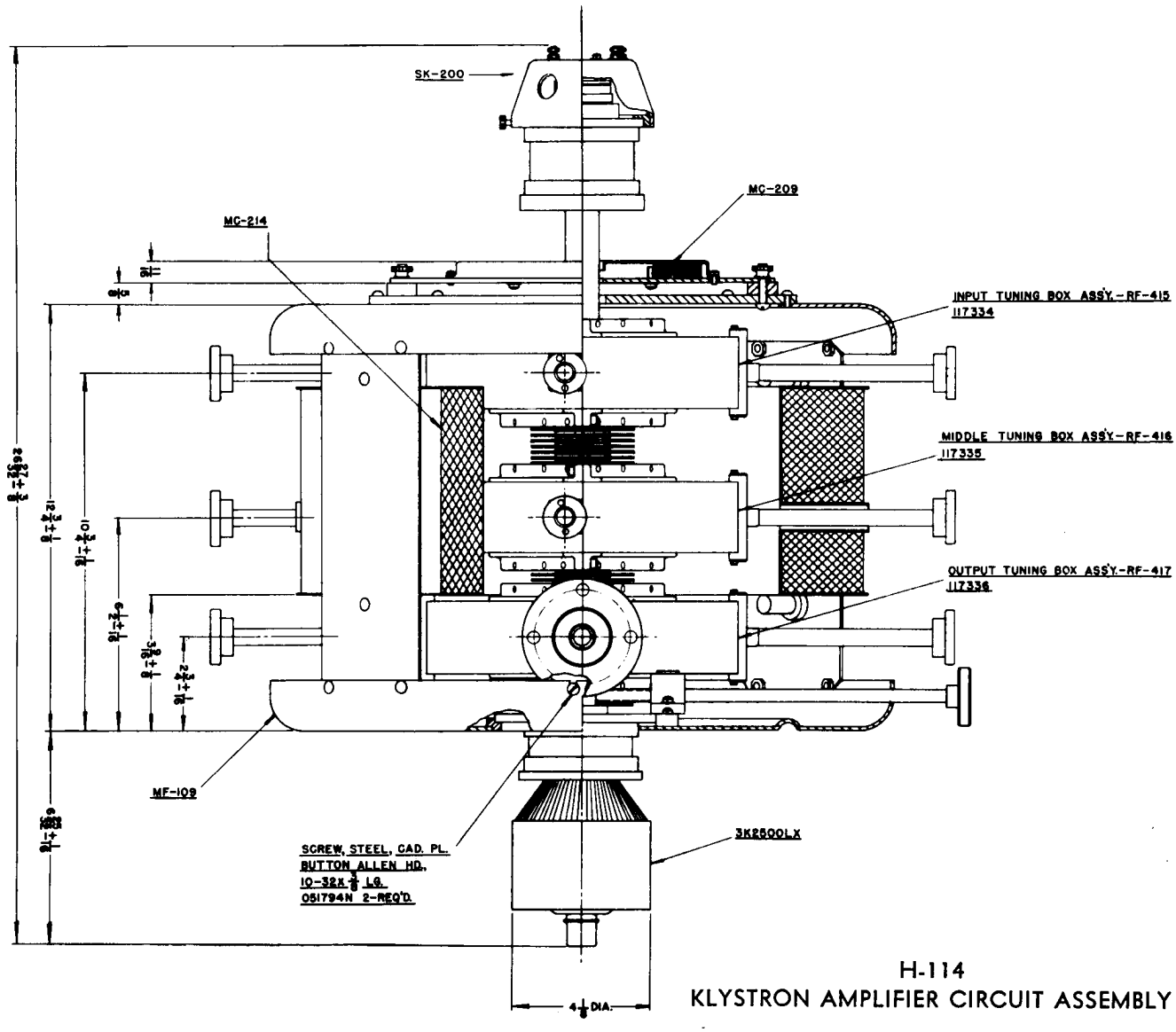
Body cooling is normally provided by the escaping air from the tuning boxes. However, if the ambient air temperature exceeds 30° C, forced air will also be required on the body cooling fins.

Special Applications--If it is desired to operate this tube under conditions not covered by this data sheet or if more information is required, write to the Application Engineering Department, Eitel-McCullough, Inc., San Carlos, California.



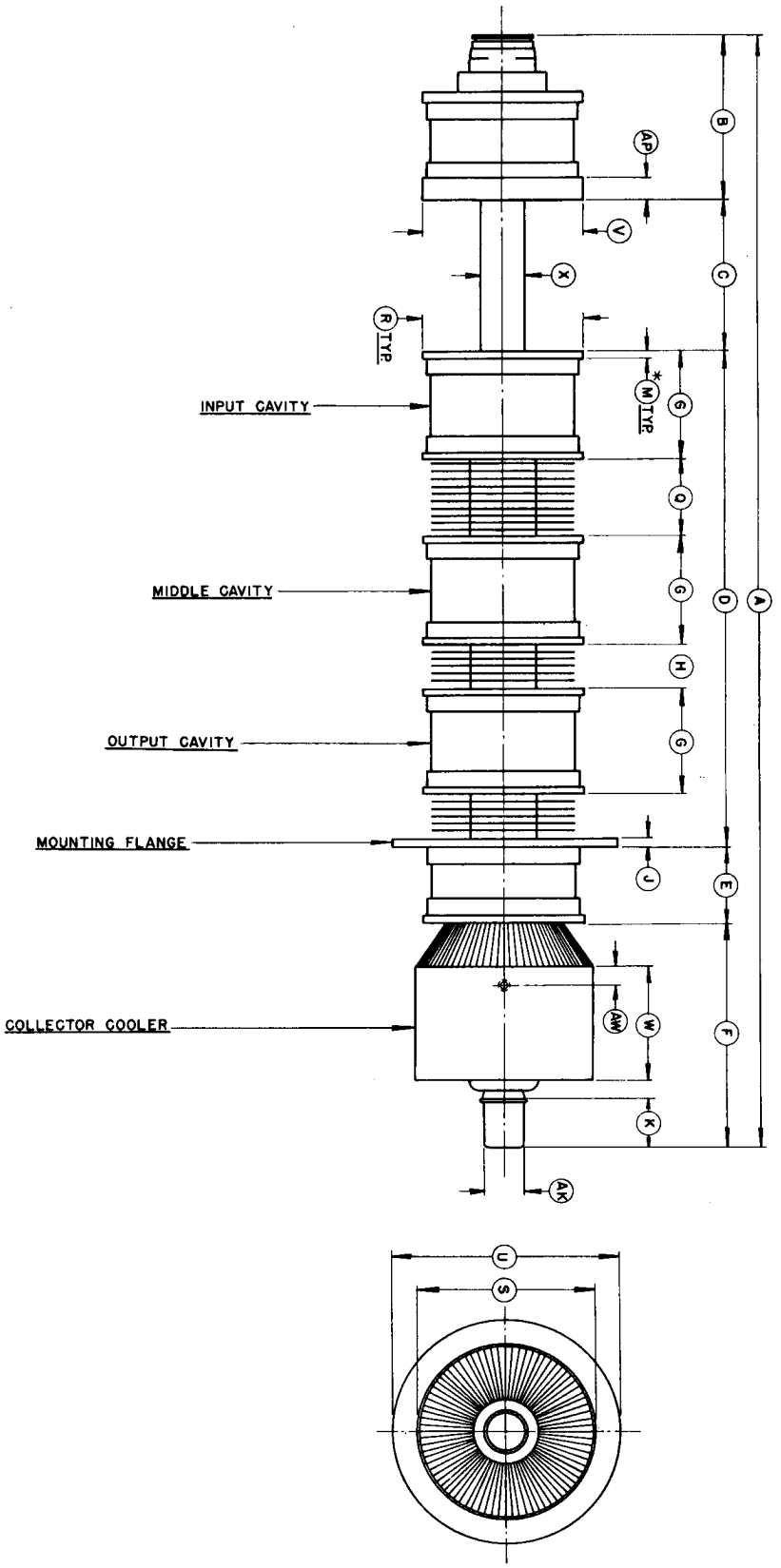


DETAIL SHOWING
COOLING TUBE ASSY.



H-114
KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		25.438	26.188
B		3.730	3.980
C		3.406	3.470
D		11.107	11.357
E	1.976		
F		5.187	5.437
G		2.464	2.528
H		.971	1.033
J		.220	.240
K		1.115	1.135
M		.187	
Q		1.710	1.774
R		3.615 DIA.	3.635 DIA.
S		3.985 DIA.	4.015 DIA.
U		5.118 DIA.	5.148 DIA.
V		3.615 DIA.	3.635 DIA.
W	2.625		
X		.992 DIA.	1.008 DIA.
AK		.865 DIA.	.885 DIA.
AP		.490	.510
AW		.428	.448



NOTES:

1. *MINIMUM CONTACT SURFACES.
2. DIMENSIONS IN INCHES

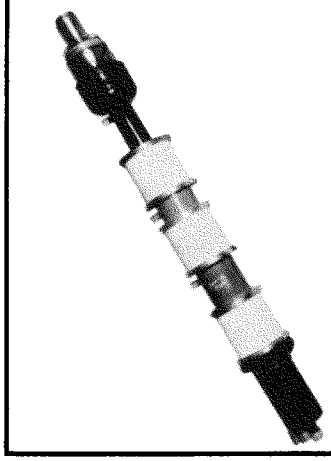
3K2500LX
OUTLINE DRAWING

Printed in U.S.A. 54405

TENTATIVE DATA

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

3K20,000LA
3K20,000LF
3K20,000LK
KLYSTRONS
●
L-BAND AMPLIFIERS



The Eimac 3K20,000LA, 3K20,000LF and 3K20,000LK klystrons are three cavity, magnetically focused power amplifiers intended primarily for UHF television broadcast service. Each klystron type, operating as a television visual r-f amplifier, will deliver 5.5 kW of peak synchronizing power output with a power gain of approximately 20 db. The cavities of the Eimac UHF television klystrons have ceramic windows and are completed by tuning boxes external to the tubes.

NOMINAL TUNING RANGE

The UHF television band (470-890 Mc) is covered by the three tube types as follows:

TUBE TYPE NUMBER	MC.	CHANNEL
3K20,000LA	470-580	14-32
3K20,000LF	580-720	33-55
3K20,000LK	720-890	56-83

GENERAL CHARACTERISTICS

MECHANICAL

Mounting (See Outline Drawing)	Support from Mounting Flange
Mounting Position	Axis Vertical
Cooling	Water & Forced Air
Connections:	
Filament	Flexible Leads
Cathode	Cylindrical Strap
Focus Electrode	Cylindrical Strap
Cavities	Multiple Contact Fingers
Collector	Cylindrical Strap

Klystron Type	"A"	"F"	"K"	
Maximum Overall Dimensions:				
Length	50	45	41	inches
Diameter	5⅛	5⅛	5⅛	inches
Net Weight	42	37	35	pounds
Shipping Weight	160	150	145	pounds

ELECTRICAL

Filament: Pure Tungsten		
Voltage	9.0	volts
Current (with cathode cold)	42	amperes
Current (with cathode at operating temperature)	39	amperes
Maximum Allowable Short Circuit Current of Filament Current Source	84	amperes

Cathode: Unipotential; heated by electron bombardment

MAXIMUM CATHODE RATINGS		
DC VOLTAGE	2300	MAX. VOLTS
DC CURRENT	.75	MAX. AMPERES
DC POWER	1600	MAX. WATTS

Focus Electrode
*Voltage (with respect to cathode) - 0 to —500 volts
Magnetic Field: Axial (See Magnetic Circuit Schematic)
Field Strength (approximately) - 120 gauss
*May be varied over a range of 0 to —500 volts if beam current control is desired.

ULTRA HIGH FREQUENCY POWER AMPLIFIER

MAXIMUM RATINGS

DC BEAM VOLTAGE	14.0 MAX. KILOVOLTS
DC BEAM CURRENT	1.7 MAX. AMPERES
COLLECTOR DISSIPATION	20.0 MAX. KILOWATTS

Note: Maximum beam voltage and beam current should not be applied without r-f excitation.

TYPICAL OPERATION

RF Linear Amplifier—Television Visual Service (In accordance with United States Federal Communications Commission Standards)

DC Cathode Bombarding Power	1400	watts
DC Cathode Bombarding Voltage (approximately)	2100	volts
DC Cathode Bombarding Current (approximately)	.66	amperes
DC Focus Electrode Voltage	0	volts
DC Beam Voltage	13	kilovolts
DC Beam Current	1.4	amperes
DC Collector Current (approximately)[1]	1.2	amperes
Peak Synchronizing Level (80% of saturation power)		
Driving Power (approximately)[2]	55	watts
Power Output	5.5	kilowatts
Efficiency	30	percent
Black Level		
Collector Dissipation (approximately)[1]	12.5	kilowatts
Driving Power (approximately)[2]	33	watts
Power Output	3.3	kilowatts
Efficiency	18	percent

RF Amplifier—Television Aural Service

DC Cathode Bombarding Power	1400	watts
DC Cathode Bombarding Voltage	2100	volts
DC Cathode Bombarding Current	.66	amperes
DC Focus Electrode Voltage	0	volts
DC Beam Voltage	10.0	kilovolts
DC Beam Current	.95	amperes
DC Collector Current[1]	.8	amperes
Driving Power[3]	20	watts
Collector Dissipation (approximately)[1]	5.8	kilowatts
Power Output	2.75	kilowatts
Efficiency	29	percent

[1]Minor tube-to-tube variations may be expected.

[2]Total driving power includes losses inserted for broadband operation. The output power is useful power measured in a load circuit.

[3]The driving power is the total power required by the tube and a resonant circuit.

(Effective 8-17-53) Copyright 1953 by Eitel-McCullough, Inc.

Supersedes 3K20,000LK Data Sheet with Effective Date of 3-10-53.

APPLICATION

Mounting—The klystrons are provided with a mounting flange (See Outline Drawing) which may be used to support the tubes with either end up.

Filament Operation—For maximum tube life, the pure tungsten filament should be operated just above the emission limiting temperature. This temperature will be obtained with a filament voltage, as measured directly at the terminals, of approximately 9 volts.

Cathode Heating Power—The cathode is unipotential and heated by electron bombardment. A dc potential of approximately 2100 volts is applied between the filament and the cathode; and the recommended cathode heating power of 1400 watts is obtained with approximately .66 amperes. The filament is designed to operate under space-charge limited conditions. Cathode temperature is varied by changing the bombarding potential between the filament and the cathode.

Cooling—Forced air is used to cool the Electron Gun Structure and the Middle and Output Cavities. Only clean, well filtered air should be blown on the tube to avoid voltage breakdown due to dust accumulation. The temperature of the metal in the region of the metal-to-glass seals should not exceed 150°C. Tube temperatures may be measured with a temperature-sensitive paint, such as "Tempilaq", manufactured by the Tempil Corporation, 132 West 22nd Street, New York 11, N. Y.

Water is used to cool the Drift Tubes and the Collector Assembly. The cooling water should be of sufficient purity to prevent liming of the water system, and the use of a heat exchanger is recommended. The inlet water pressure of the Drift Tubes and the Collector Assembly should not exceed 40 pounds per square inch. The outlet water temperature must not exceed a maximum of 70°C. under any condition.

Air and water flow should be started before the filament and cathode power are applied and maintained for at least two minutes after the filament and cathode power have been removed.

Klystron Cooling Requirements for Typical Operating Conditions and Correct Magnetic Field Adjustment:

	Cooling Medium	Volume	Pressure Drop	Remarks
Input Drift Tube	*Water	1 gpm	1 psi	Total pressure drop if series connected with 5/16" tubing= 4 psi.
Short Drift Tube Jacket	*Water	1 gpm	1 psi	
Long Drift Tube Jacket	*Water	1 gpm	1 psi	
Output Drift Tube	Water	1 gpm	1 psi	
Collector Assembly	*Water	6 gpm	3 psi	
Electron Gun Structure — Filament Stem	Air		1-2 cfm	See Cooling Diagram
Electron Gun Structure — Cathode Terminal	Air		90 cfm	
Electron Gun Structure — Focus Electrode and Anode Seals	Air		90 cfm	
Input Cavity	None			
Center Cavity	Air		15 cfm	
Output Cavity	Air		50 cfm	

*Cooling water connections should be made as noted on Cooling Diagram.

RF Contact Surfaces—The means by which contact is made between the cavities and the tuning boxes is of great importance. Two requirements which must be met to ensure proper electrical connections are as follows:

(1) Contact to the tube cavities must be made only on the peripheral surface of the 1/4" cavity flanges as shown on the outline drawing.

(2) Each individual finger of the collet or spring stock material must make positive contact to the cavity flange to prevent arcing.

Magnetic Field—An adjustable magnetic field is necessary to control and direct the beam throughout the length of the drift tube. The magnetic field should be capable of variation around the recommended field strength of 120 gauss. Typical magnetic circuit requirements for a 3K20,000LK are shown in the Magnetic Circuit Schematic. The current and adjustsment of the pre-focusing coil are optimized under low beam voltage conditions and will require minor readjustment with changes in beam voltage. The current and location of the focusing coils should be capable of independent adjustment. Readjustment of the current of the focusing coils is necessary with changes in beam voltage. Beam transmission (collector current divided by the beam current as measured in the cathode return to beam power supply) will vary from 75% to 95%. Improper adjustment or misalignment of the magnetic field, as indicated by too low a value of beam transmission, may cause the beam to strike and overheat the drift tube walls.

MAGNETIC FIELD COIL REQUIREMENTS

Number of Coils Required for Field Strength of Approximately 120 Gauss.

	Pre-focusing Coil	Focusing Coils	
Tube Type	375-750 ampere-turns per coil	1600-4800 ampere-turns per coil	0-1600 ampere-turns per coil
3K20,000LA	1	3	1
3K20,000LF	1	3	1
3K20,000LK	1	2	1

CAUTION—It is convenient to operate the r-f and collector portions of the tube at ground potential. Since the cathode and filament are operated at high negative potentials with respect to ground, filament and cathode power supplies and voltmeters must be adequately insulated for these high voltages. Protection must also be afforded to operating personnel.

Protection—It is recommended that the following protective devices be used:

(1) Interlocks in air and water supplies.

(2) Interlocks in magnetic field supply circuits.

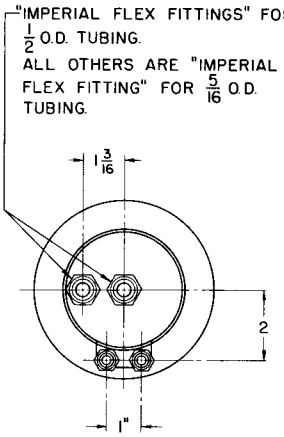
(3) Current overload in cathode bombardment supply circuit.

(4) Current overload in beam current supply circuit.

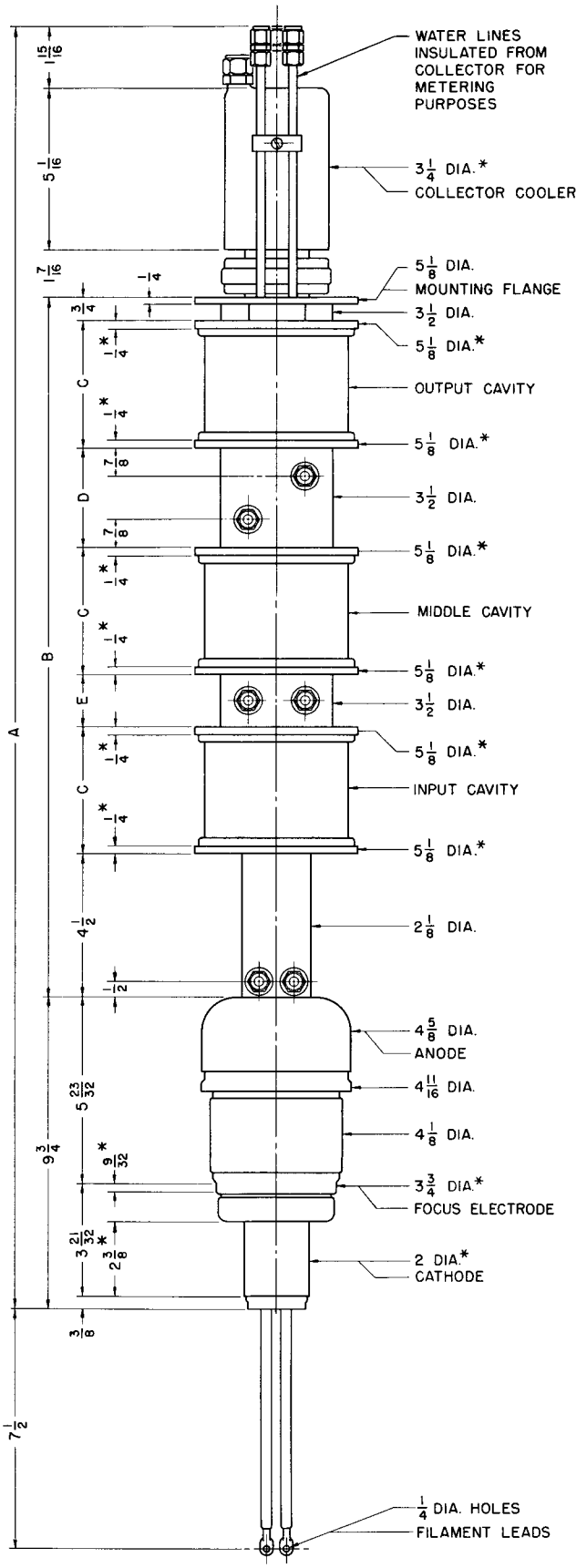
(5) Current overload in cavity current circuit.

(6) Current limiting resistor of approximately 100 ohms in series with beam power supply to isolate tube from final capacitor of supply.

The filament and cathode bombardment voltages will normally be applied before the beam voltage. Cavity tuning or magnetic field adjustment should be made with reduced beam voltage (1/2 to 2/3 normal). Slight retuning and readjustment will be necessary when beam voltage is raised to full value.



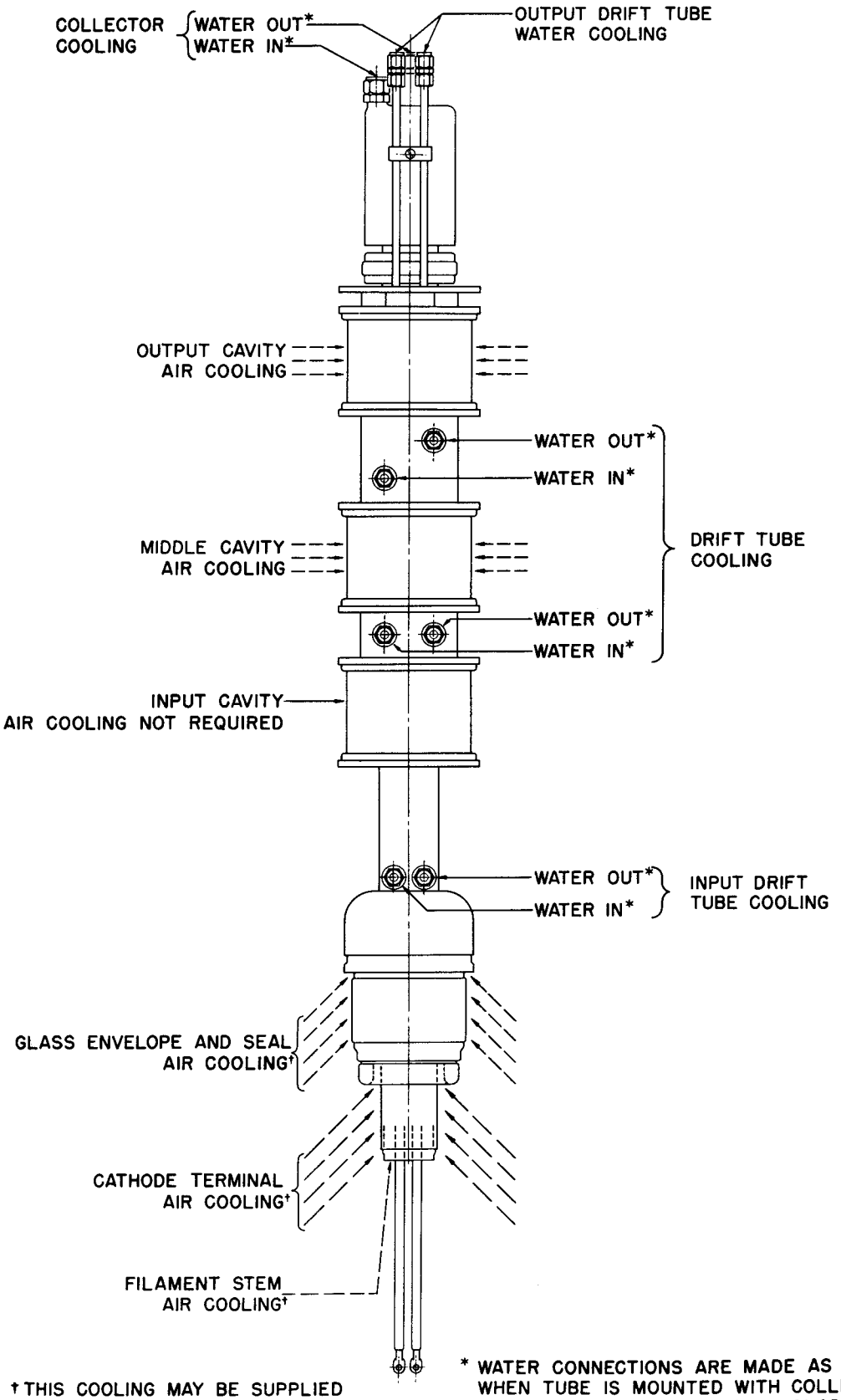
OUTPUT END VIEW



		A	B	C	D	E
3K20,000	LA	48 11/16	30 1/2	6	4 7/8	2 3/8
	LF	44 3/16	26	5	3 3/4	2
	LK	40 3/16	22	4	3 1/8	1 5/8

DIMENSIONS IN INCHES

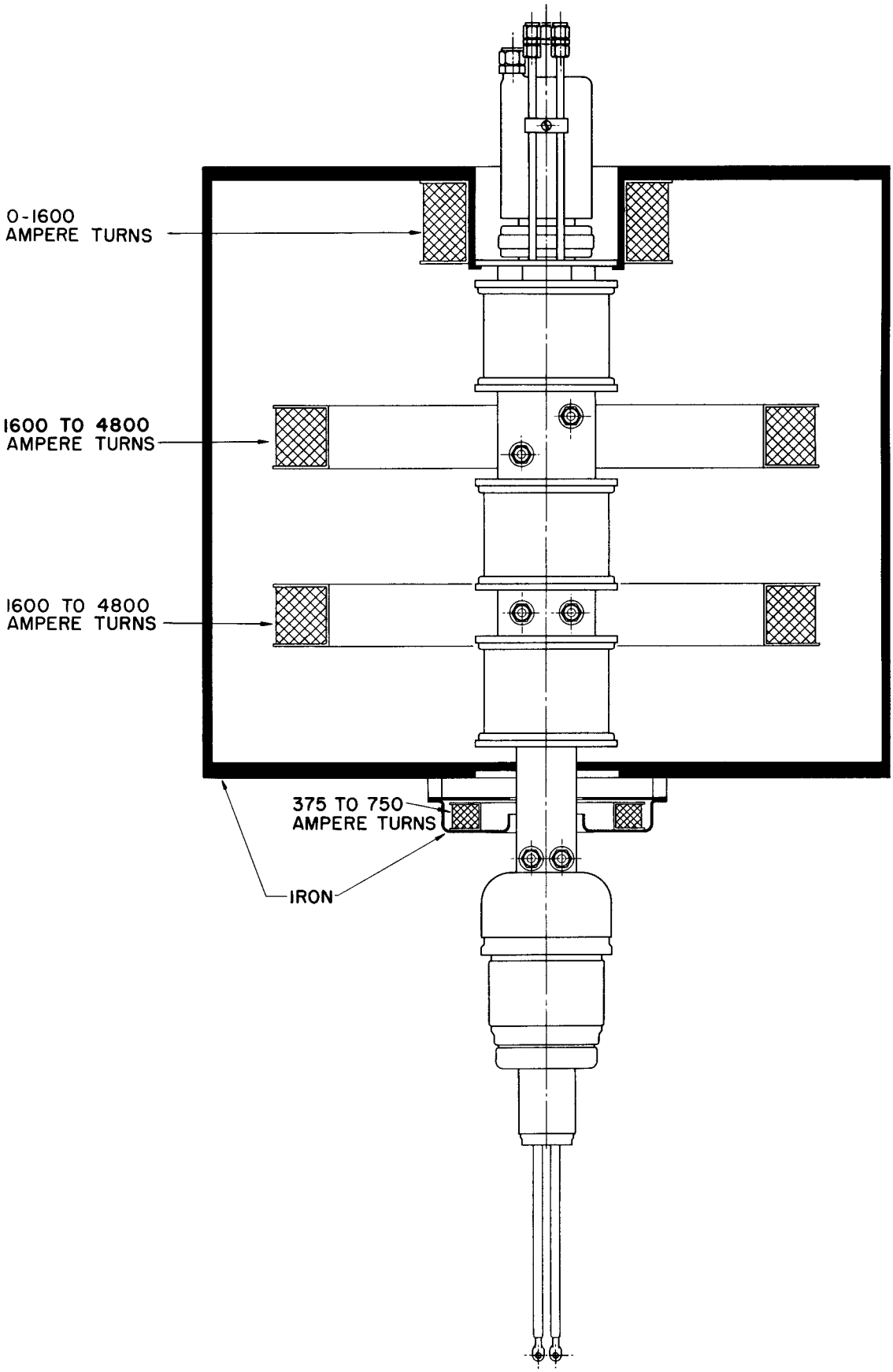
*CONTACT SURFACE



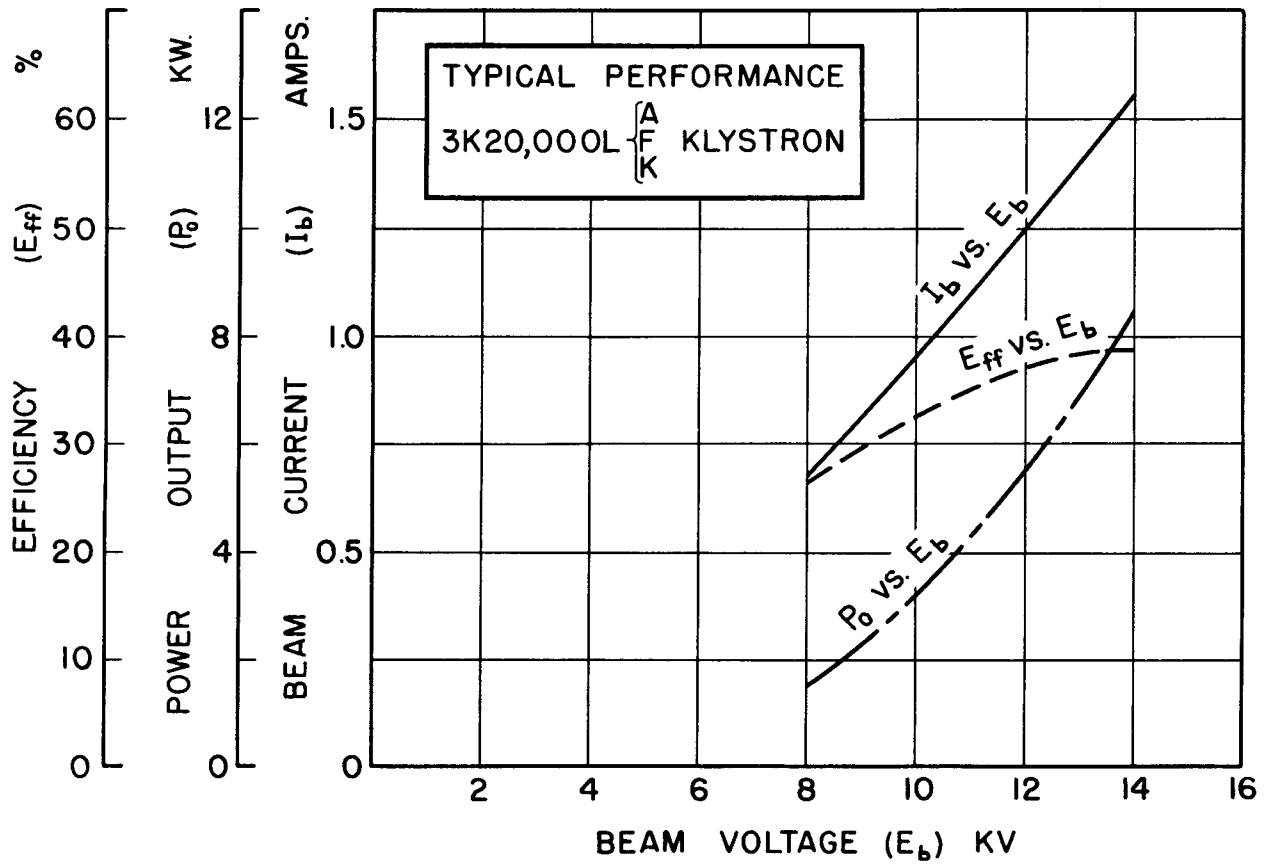
† THIS COOLING MAY BE SUPPLIED BY A SINGLE BLOWER THROUGH SUITABLE MANIFOLD & BAFFLES

* WATER CONNECTIONS ARE MADE AS SHOWN WHEN TUBE IS MOUNTED WITH COLLECTOR UP. WHEN TUBE IS MOUNTED WITH ANODE UP THE WATER CONNECTIONS MUST BE REVERSED.

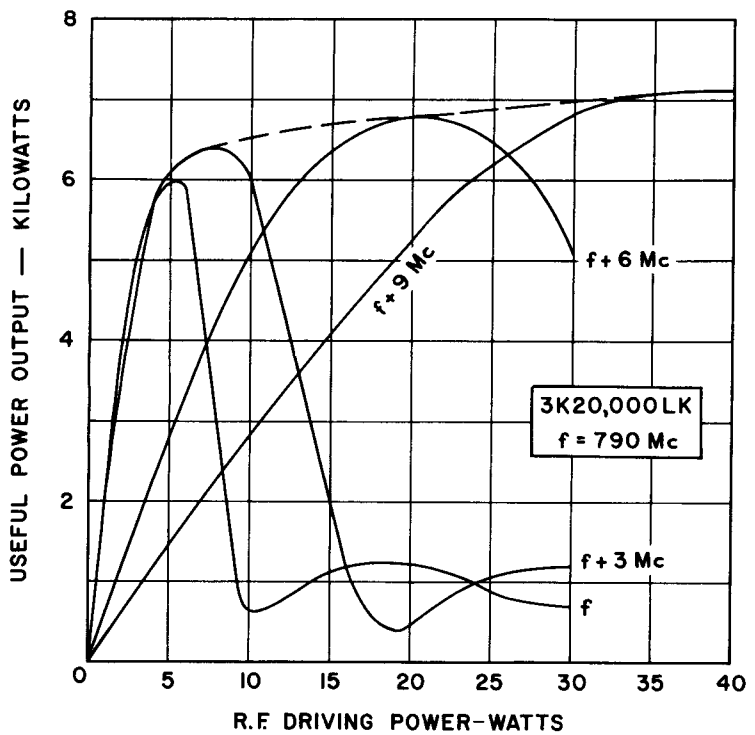
COOLING DIAGRAM



MAGNETIC CIRCUIT SCHEMATIC FOR 3K20,000LK



BEAM CURRENT, POWER OUTPUT AND EFFICIENCY VERSUS BEAM VOLTAGE



USEFUL POWER OUTPUT VS. R.F DRIVING POWER

(MIDDLE CAVITY DETUNED; INPUT & OUTPUT CAVITIES TUNED TO DRIVE FREQUENCY)

2-G3-71963

High-Power Klystrons at UHF*

D. H. PREIST†, MEMBER, IRE, C. E. MURDOCK†, ASSOCIATE, IRE, AND J. J. WOERNER†

Summary—**A brief history of high-power cw klystron development and a classification of types of klystron are followed by a description of the three-cavity, gridless klystron amplifier with magnetic focusing, in general terms, and the Eimac 5-kw klystron for UHF-TV in more detail. This tube has cavities which are partly outside the vacuum system and contain ceramic "windows." The advantages of the klystron over the conventional negative-grid type of tube are reviewed from the standpoint of performance, and the main operational features are noted.**

Introduction

IN VIEW OF the increasing activity above 450 mc for such purposes as television, it may be of value to review the means of generating transmitter power presently available.

Of outstanding interest in this field is the post-World War II development of power amplifier klystrons. Although the klystron principle was discovered as far back as 1939,[1] its application to high-power generation was delayed, largely because of the 1939–1945 war and the need to concentrate on those lines of development which appeared the most promising for military purposes. The ultimate possibilities of the klystron were appreciated by few, and although a great deal of fundamental research on electron beams was carried on in various places, development in the field of high-power cw tubes was confined mainly to one group in California,[2,3] and one group in France.[4,5] As a result of this work the basic principles have been extended, and much progress has been made in techniques of construction, culminating in the recent appearance of high-power klystrons for commercial purposes in the United States,[2,6] and an increasing awareness of the great advantages of this type of tube for stable amplification at high-power levels.

The object of this paper is to review, briefly, from the point of view of the potential user, the performance of a modern high-power klystron, and to describe the special peculiarities and methods of operation of this type of tube. A brief survey will also be made of the factors limiting the performance of a klystron, compared with the factors limiting the performance of conventional negative-grid tubes.

* Decimal classification: R339.2×R583.6. Original manuscript received by the Institute, November 3, 1952.

† Eitel-McCullough, Inc., San Bruno, Calif.

[1] R. H. Varian and S. F. Varian, "A high frequency oscillator and amplifier," *Jour. Appl. Phys.*, vol. 10, p. 321; 1939.

[2] "High Power UHF Klystron," *Tele-Tech*, p. 60; October, 1952.

[3] W. C. Abraham, F. L. Salisbury, S. F. Varian, and M. Chodorow, "Transmitting Tube Suitable for UHF TV," paper presented at IRE National Convention; 1951.

[4] P. Guénard, B. Epsztein, and P. Cahour, "Klystron Amplificateur de 5 KW à large bande passante," *Ann. Radioelect.*, vol. VI, p. 24; 1951.

[5] R. Warnecke and P. Guénard, "Tubes à Modulation de Vitesse," Gauthier-Villards, Paris; 1951.

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Klystron Types

Present-day klystrons fall into three categories:

1. *Reflex Klystron Oscillators*
   Most of these have low efficiency (of the order of 1 per cent) and generate relatively low power, and are suitable for receivers, local oscillators, test equipment, and the like.
2. *2-Cavity Klystrons*
   These may be used as amplifiers, oscillators, or frequency multipliers; as amplifiers they are capable of power gains of about 13 db and efficiencies of about 20 per cent, at frequencies of the order of 1,000 mc.
3. *3-Cavity Klystrons*
   These are useful, principally, as amplifiers, and are capable of power gains of about 20 to 30 db, and efficiencies of 30 to 40 per cent, together with bandwidths of several mc, at frequencies of the order of 1,000 mc. Because of the superior amplifier performance given by this type of klystron, the other two types will not be dealt with further in this paper.

3-Cavity Gridless Klystron Amplifier with Magnetic Focussing

A. Description

This type of tube, sometimes called a "cascade amplifier," is illustrated schematically in Fig. 1. It will be seen to consist of four essential parts:

1. *The Electron Gun*
   This has a source of electrons (the cathode), a means of accelerating the electrons to a high energy level (the anode), and a means of focussing the electrons into a parallel beam of high electron density emerging from the hole in the anode.

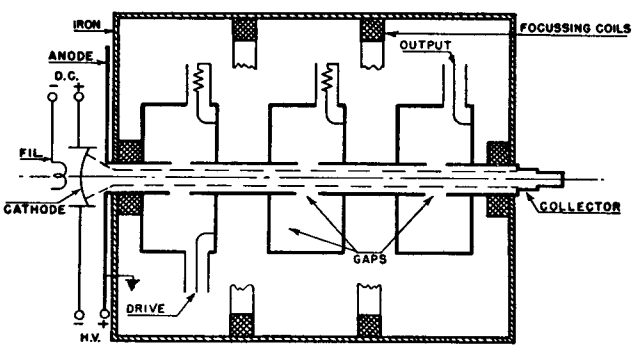


Fig. 1—Schematic diagram of 3-cavity klystron with magnetic focusing.

2. *The RF Resonant Cavities and Drift Tubes*
   The first cavity is fed with RF energy from a driving source at low level. The second cavity is tuned to resonance, or near resonance, but is not fed with energy from outside. The function of these two cavities, in conjunction with the drift tubes, is to velocity-modulate the electron beam so as to produce "bunches" of electrons at the output cavity. The latter is tuned to resonance and coupled to the antenna, or other load, and serves to extract as much RF energy as possible from the "bunched" electron beam. Its function and operation are closely similar to those of the output circuit of a Class "C" amplifier using triodes or tetrodes.
3. *The "Collector" Electrode*
   This collects the electrons after they have passed through the output cavity, and have given up part of their energy to the RF field, and thus to the load; because only about 30 per cent of the energy in the beam is converted to RF energy, this collector has to be capable of dissipating the remaining percentage, that is to say, 70 per cent of the product of the anode-cathode voltage and cathode current, when fully driven. (In practice the collector current is very slightly less than this because some electrons inevitably strike the anode and the drift-tube walls.) If the tube is used as a linear modulated amplifier, the collector will be required to dissipate 100 per cent of the input power under conditions of zero drive and zero output.
4. *External Magnetic Circuit*
   This consists of suitably disposed electromagnets producing an axial magnetic field of controllable strength which tends to keep the beam parallel as it passes along the tube. Without this field the beam would expand because of the mutual repulsion of the electrons. The optimum field strength is fairly critical, and is not necessarily uniform along the length of the tube. It is usually prevented from penetrating the cathode, either by a metallic magnetic shield or by the use of a "bucking" coil, or by a combination of both.

B. Performance and Operational Features of This Type of Klystron

The 3-cavity klystron is a tube capable of generating a much larger power output at uhf than the conventional negative-grid tube. The deterioration of performance as the frequency is raised is slight. The power gain of the klystron is very much larger than that of a tetrode. It may be worthwhile to review briefly the reasons for this.

Considering the factors limiting the power output of a triode or tetrode, aside from external circuit losses, one finds that basically they are the total cathode emission, the anode voltage, the interelectrode spacing, and the RF loss in the materials used to make the electrodes and the envelope. Now the total cathode emission, assuming the best material is used and that a given life is required, depends on its area. This area is limited at uhf because the tube forms part of a resonant transmission line in which large changes of electric and magnetic field occur over distances which are small compared with the wavelength. Since nonuniform potentials between electrodes cause loss of efficiency, it is necessary to keep the electrode dimensions small compared with the wavelength; thus, the cathode area is limited, and has to be reduced as the wavelength is decreased. The anode voltage is limited by internal flash-arcs between electrodes. The electrode spacing must, however, be small enough to give small electron transit times, and must be decreased with the wavelength. The applied voltage must, therefore, be reduced also with the wavelength. Lastly, the RF losses in the tube materials increase as the wavelength decreases. All these factors added together give the well-known result that triodes and tetrodes get rapidly smaller as the wavelength decreases, and so does the power they will generate and the efficiency. In addition, the problem of manufacture becomes more and more serious, and ultimately becomes prohibitive. The two worst problems are caused by the small spacing between electrodes, of the order of 0.001 inch, and the mechanical weakness of the fine wire grids.

Considering now the power gain, this becomes less as the wavelength decreases because the tube requires more and more driving power to overcome the increasing electron transit-time effects, losses in materials, grid current, and (usually) inherent negative feedback.

In a klystron, on the other hand, some of these limitations do not occur at all, and others are less significant. The cathode area is not limited by the wavelength because it is outside the RF field. The anode-to-cathode spacing being of the order of 1 inch, extremely high anode voltages may be applied without internal flash-arcs; also, the cavity gap spacings may be about $\frac{1}{2}$ inch in a 5-kw tube at 1,000 mc. Again, because gridless gaps may be used without serious loss of coupling between the beam and the resonant cavities, there are no problems of fabrication or heating of grid wires. Furthermore, because the collector is outside the RF field, it may be designed solely for the purpose of dissipating heat, and this becomes a minor problem in practice. The losses in the conductive tube materials are small because all the metal parts carrying RF current may be made of high-conductivity metal. (There is no loss comparable to the RF losses in a triode due to RF current flowing through lossy cathode material or fine resistive grid wires.) Therefore, the only limiting factor approached in klystrons giving adequate power for present commercial applications is the loss in the dielectrics. Some dielectrics are inevitable either in the form of windows in the cavities, as in the Eimac tube, or in the other type of tube with integral cavities, the window between the

output cavity and the load. If the power level is raised high enough, these dielectrics will ultimately break down, either by cracking due to heat or by flashing over the outside surface which is at atmospheric pressure; however, this does not occur in a well-designed tube at power levels that are presently interesting.

Considering the power gain of a klystron, this is governed almost entirely by the geometry and is limited only by the small RF losses in the input cavity and the beam loading of the cavity, which is small. The transit-time loading experienced with a triode becomes a factor of minor importance, and the negative feedback disappears since there is no coupling between the input and output cavities.

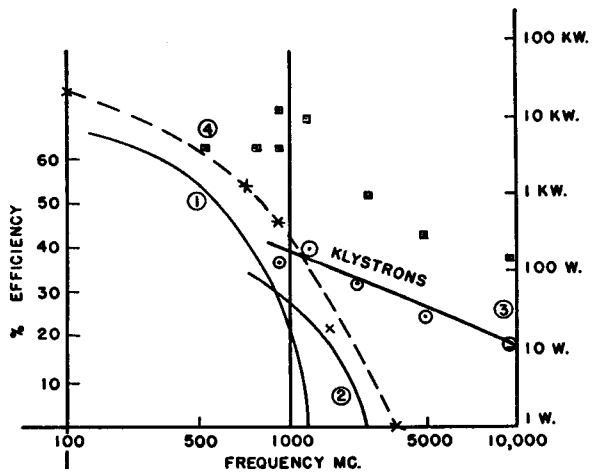


Fig. 2—Curve (1): Efficiency versus frequency for typical uhf tetrode —4X150G. (Plate dissipation 150 watts.)
Curve (2): Efficiency versus frequency for typical uhf triode —2C39. (Plate dissipation 100 watts.)
Curve (3): Typical efficiency of klystrons versus frequency (independent of output power). This is the efficiency at the optimum frequency for each tube.
Curve (4) (dotted): Maximum power output of the largest commercially available negative-grid tube at various frequencies.
Points ⊡ cw power output of various klystrons (not the largest possible).

It is, therefore, apparent that the efficiency and power gain of a klystron will fall off relatively slowly, compared with a triode or tetrode, as the wavelength is reduced. This is illustrated by the curves in Fig. 2. It is also clear that the maximum size and power output of a klystron are not determined by the wavelength. It follows that the klystron is ideally suited to high-power generation at uhf and microwave frequencies, and outclasses the conventional type of tube in every respect, including ease of manufacture.

Turning now to a typical performance obtainable from a 3-cavity klystron, the results given by the Eimac tube may be taken as representative of this type of tube. This tube will generate 5 kw of RF power in the uhf television band with an efficiency of more than 30 per cent when fully driven. The over-all bandwidth is about 5 mc and the power gain, under television conditions, is about 20 db. Salient features of operation are these:

The tuning of each of the 3 cavities is independent of the others since there is no feedback present. This makes for very simple lining-up procedure.

The output cavity is tuned to resonance at the midband frequency, and loaded for optimum performance by means of some variable coupling device external to the tube.

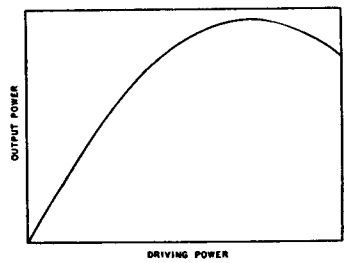


Fig. 3—Output power versus driving power for klystron.

A curve of power output against power input for this type of tube is a Bessel function of the first order and the first kind, and the first part of such a curve is very nearly linear. (See Fig. 3.) In television service, assuming that sync stretching is used in the driving stages, the klystron may be operated in such a way that the sync pulses drive the tube very nearly to the peak of the Bessel curve, so that the efficiency at sync pulse levels is nearly the fully driven efficiency.

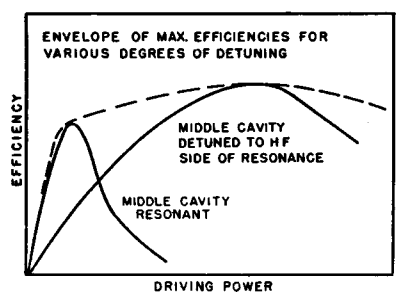


Fig. 4—Efficiency versus driving power, showing the effect of detuning the middle cavity.

The center cavity is detuned to a frequency slightly higher than the midband frequency, since this gives greater efficiency than resonant operation, and helps to broaden the pass band. This cavity may be loaded externally by resistance in some cases. This detuned operation requires greater driving power to the first cavity than resonant operation. (See Fig. 4.)

The input cavity may be either detuned on the low-frequency side of resonance or it may be tuned to resonance and loaded with external resistance in order to achieve the necessary bandwidth.

The relation between efficiency, power output, and anode voltage for a given tube is shown at Fig. 5. There is an optimum voltage for best efficiency because the voltage determines the speed of the electrons along the tube. Now a certain time is required for electron bunching to take place; this depends mainly on the frequency and determines the distance between the cavities. But this distance will be optimum for only one electron speed, and therefore only one voltage. Conversely, for a given voltage the relation between efficiency and frequency will also show a broad peak at a given frequency, and this fall-off at higher and lower frequencies will limit the useful frequency range of a given tube, even if the cavities are tunable over an indefinitely wide range.

The power input from the dc power supply feeding the anode of the tube is constant (about 1.5 amps at 13 kv), and independent of the drive voltage; therefore, the regulation of this power supply may be quite poor without adverse effects. Also, only simple circuits are necessary to reduce the hum to a low level. The filament may be heated by ac.

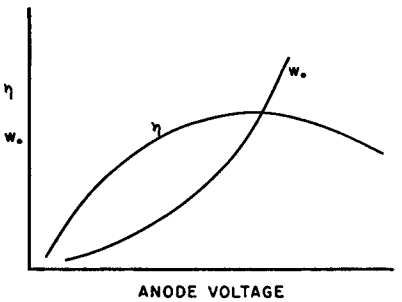


Fig. 5—Power output and efficiency versus anode voltage.

The magnetic field used for focussing the beam is simple to arrange, and relatively low in intensity, and consumes only a small amount of dc power in the coils. It must be made variable since the efficiency of the tube varies fairly rapidly with the field strength and reaches a maximum for an optimum setting of the magnetic field. The RF cavities, the drift tubes, and the anode are all in metallic contact and may be grounded. Thus, there is no problem of by-passing and dc isolation in the output circuit compared to the by-passing problem with a triode or tetrode amplifier. The collector is usually insulated from the main part of the tube in order to facilitate monitoring of the current division between the collector and the drift tubes. The anode voltage supply is grounded on the positive side, and the negative side is connected to the cathode of the tube.

Considering now the over-all problem of design, construction, installation, and operation of a high-power uhf amplifier, and the difference between the problem with a conventional type of tube and with a klystron, it is evident that the klystron scores heavily in all respects. The burden imposed on the transmitter designer is lessened because the klystron with its cavities forms a complete amplifier stage in itself. Because of the absence of feedback in the klystron, the circuit design is greatly simplified, compared with the conventional amplifier design. Also, when using a conventional tube at uhf, the designer is usually faced with the very difficult problem of obtaining the maximum efficiency from a stage in which the tube is run to its limit, and only by very careful design can the desired performance be obtained from it. With klystrons, on the other hand, the problem is easier because there is usually a greater margin of performance, both in respect to output and power gain. Also, the construction of a klystron stage is simpler than the conventional stage, and, as we have seen, the operation is also simpler.

Fig. 1 shows the more or less conventional type of klystron construction involving integral cavities, namely, cavities which are an integral part of the vacuum system. A unique feature of the Eimac tube, hereinafter described, is that part of the cavities are external to the tube envelope so that simple mechanical tuning of the cavities over a wider band of frequencies is possible. The tube itself is also simplified.

C. A Practical Example: Eimac UHF Klystron for TV

The photograph in Fig. 6 shows the Eimac uhf klystron, an example of a 3-cavity klystron in a form suitable for commercial manufacture, and now in produc-

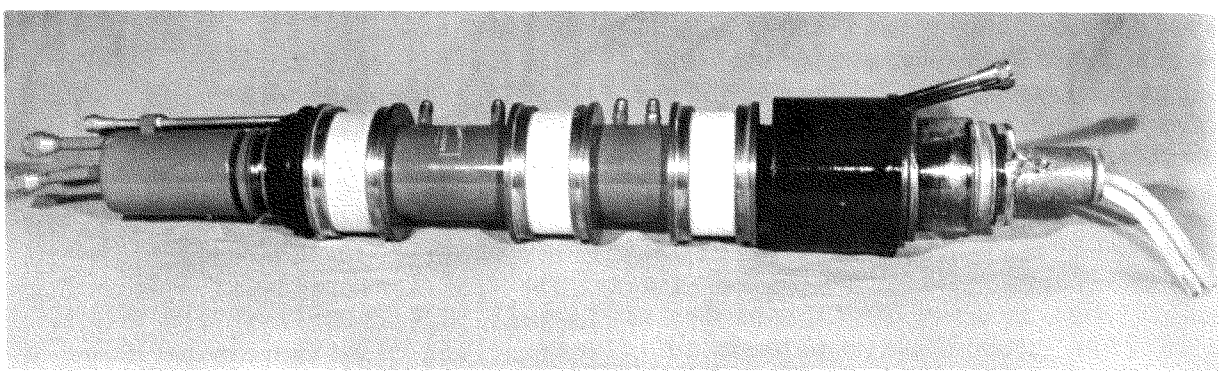


Fig. 6—The Eimac 5-kw uhf klystron for TV.

tion. Tube-cavity parts and drift-tube sections are shown in Fig. 7. Fig. 8 shows the tube and external cavities in a test setup.

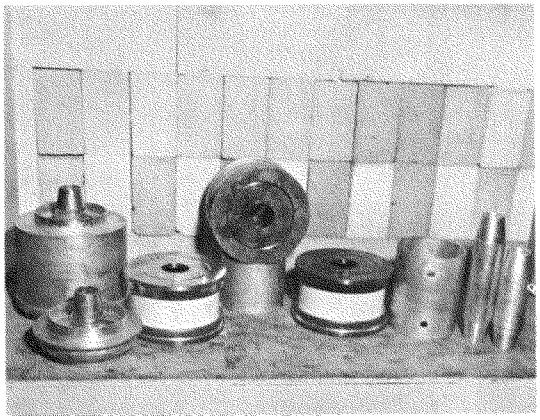


Fig. 7—Tube cavity parts and drift tube sections.



Fig. 8—The 5-kw klystron on test.

A feature of interest is the use of cavities which are tunable by means external to the vacuum system. This is made possible by use of ceramic "windows" which, if designed and fabricated correctly, will produce only a minor deterioration in the over-all performance of the tube because of their finite dielectric loss and high dielectric constant.

This means that part of each cavity is in vacuo and part is in air. The convenience of operating a tube of this type, compared with a tube in which the cavities are entirely in vacuo, is considerable. In the first place, the mechanism for varying the resonant frequency is simple and may involve straightforward shorting bars with sliding contacts with negligible losses. These slidable devices are outside the vacuum system, as shown in Fig. 8. The tuning range of such a cavity is large. With a totally evacuated cavity it has not yet been found possible to use such a means of tuning, because sliding contacts in vacuo are generally unsatisfactory. Therefore, tuning has to be done by distortion of some flexible metallic membrane. Such a membrane introduces mechanical weaknesses into the tube structure which then has to be stiffened by an external frame. Also, the range of tuning is relatively small, and usually the tuning is done by varying the gap spacing, and therefore, its capacitance. This can be done only to a limited extent. If the gap is made too wide, the electron transit time will become an appreciable fraction of 1 RF cycle, causing inefficiency; on the other hand, if the gap is too small, the bandwidth will suffer (bandwidth varies roughly as 1/c). With a ceramic window cavity the tuning is done by varying the inductance of the cavity, the capacitance across the gap is fixed, and the gap can be set for optimum performance over the frequency band.

Another point of difference is that the mechanical forces required to tune a cavity by means external to the vacuum system are small, being determined only by friction, whereas with the other type of cavity the tuning mechanism has to withstand the forces caused by the operation of atmospheric pressure against the flexible metallic membrane.

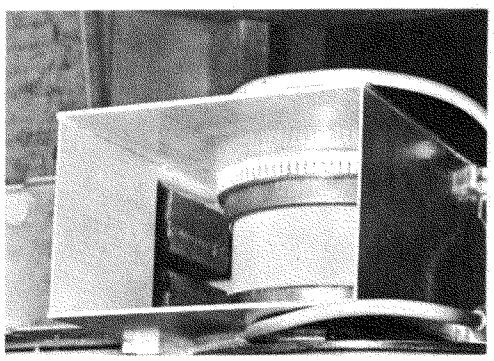


Fig. 9—Output cavity with one tuning plunger removed, showing ceramic and output coupling device.

Another desirable feature obtained with the ceramic windows is that the loading of the cavity may be accomplished outside the vacuum system, either by loops or a waveguide-to-cavity loading device, such as a quarter-wave transformer made from ridge waveguide. (See photograph of output cavity, Fig. 9.) The coupling may, therefore, be varied with ease. With a totally evacuated cavity it is very inconvenient to build in a variable load coupling, and it is common practice to use

a fixed loop; thus the benefit of variable coupling is lost.

Lastly, because of the relatively large frequency band that can be covered by a given klystron with ceramic windows, a smaller number of tube designs is required to cover a given frequency band, such as the uhf TV band. This simplifies the manufacturing problem and reduces the cost of the tube.

Another feature of interest is the use of a tantalum cathode heated by electron bombardment from a tungsten filament of relatively small size by means of a dc power supply (0.6 amps. at 2,000 volts) between the cathode and the filament. This constitutes a flexible system, and is much simpler to design and construct than a radiation-heated cathode.

Conclusions

The 3-cavity externally tunable klystron is excellently suited to high-power generation at uhf (and also at higher frequencies) because

1. it is relatively simple to manufacture,
2. it is easy to use and adjust,
3. the transmitter design and construction is simplified by its use,
4. its performance as an amplifier is greatly superior to other tube types.

It is likely that the future will see more and more such tubes in commercial service for an increasing variety of applications.

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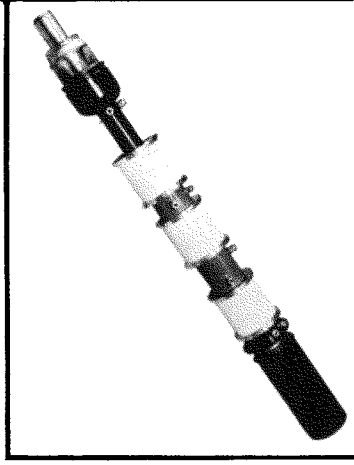
NOTE

The appended reprint from the PROCEEDINGS OF THE INSTITUTE OF RADIO ENGINEERS describes early experimental klystron structures.

TENTATIVE DATA

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

3K50,000LA
3K50,000LF
3K50,000LK
KLYSTRONS
●
L-BAND AMPLIFIERS



The Eimac 3K50,000LA, 3K50,000LF and 3K50,000LK klystrons are three cavity, magnetically focused power amplifiers intended primarily for UHF television broadcast service. Each klystron type, operating as a television visual r-f amplifier, will deliver 12 kW of peak synchronizing power output with a power gain of approximately 20 db. The cavities of the Eimac UHF television klystrons have ceramic windows and are completed by tuning boxes external to the tubes.

NOMINAL TUNING RANGE

The UHF television band (470-890 Mc) is covered by the three tube types as follows:

TUBE TYPE NUMBER	MC.	CHANNEL
3K50,000LA	470-580	14-32
3K50,000LF	580-720	33-55
3K50,000LK	720-890	56-83

GENERAL CHARACTERISTICS

MECHANICAL

Mounting (See Outline Drawing)	Support from Mounting Flange			
Mounting Position	Axis Vertical			
Cooling	Water & Forced Air			
Connections:				
Filament	Flexible Leads			
Cathode	Cylindrical Strap			
Focus Electrode	Cylindrical Strap			
Cavities	Multiple Contact Fingers			
Collector	Cylindrical Strap			
Klystron Type	"A"	"F"	"K"	
Maximum Overall Dimensions:				
Length	54	49	45	inches
Diameter	5⅛	5⅛	5⅛	inches
Net Weight	53	48	46	pounds
Shipping Weight	185	175	170	pounds

ELECTRICAL

Filament: Pure Tungsten		
Voltage	9.0	volts
Current (with cathode cold)	42	amperes
Current (with cathode at operating temperature)	39	amperes
Maximum Allowable Short Circuit Current of Filament Current Source	84	amperes
Cathode: Unipotential; heated by electron bombardment		
MAXIMUM CATHODE RATINGS		
DC VOLTAGE	2300	MAX. VOLTS
DC CURRENT	.75	MAX. AMPERES
DC POWER	1600	MAX. WATTS
Focus Electrode		
*Voltage (with respect to cathode)	0 to —500	volts
Magnetic Field: Axial (See Magnetic Circuit Schematic)		
Field Strength (approximately)	120	gauss

*May be varied over a range of 0 to —500 volts if beam current control is desired.

ULTRA HIGH FREQUENCY POWER AMPLIFIER

MAXIMUM RATINGS

DC BEAM VOLTAGE	19.5 MAX. KILOVOLTS
DC BEAM CURRENT	2.56 MAX. AMPERES
COLLECTOR DISSIPATION	50.0 MAX. KILOWATTS

Note: Maximum beam voltage and beam current should not be applied without r-f excitation.

TYPICAL OPERATION

RF Linear Amplifier—Television Visual Service (In accordance with United States Federal Communications Commission Standards)

DC Cathode Bombarding Power	1400	watts
DC Cathode Bombarding Voltage (approximately)	2100	volts
DC Cathode Bombarding Current (approximately)	.66	amperes
DC Focus Electrode Voltage	0	volts
DC Beam Voltage	17.2	kilovolts
DC Beam Current	2.15	amperes
DC Collector Current (approximately)[1]	1.72	amperes
Peak Synchronizing Level (80% of saturation power)		
Driving Power (approximately)[2]	55	watts
Power Output	12.0	kilowatts
Efficiency	41	percent
Black Level		
Collector Dissipation (approximately)[1]	30	kilowatts
Driving Power (approximately)[2]	33	watts
Power Output	7.2	kilowatts
Efficiency	19	percent

RF Amplifier—Television Aural Service

DC Cathode Bombarding Power	1400	watts
DC Cathode Bombarding Voltage	2100	volts
DC Cathode Bombarding Current	.66	amperes
DC Focus Electrode Voltage	0	volts
DC Beam Voltage	12.3	kilovolts
DC Beam Current	1.33	amperes
DC Collector Current[1]	1.06	amperes
Driving Power[3]	20	watts
Collector Dissipation (approximately)[1]	10	kilowatts
Power Output	6	kilowatts
Efficiency	36	percent

[1]Minor tube-to-tube variations may be expected.

[2]Total driving power includes losses inserted for broadband operation. The output power is useful power measured in a load circuit.

[3]The driving power is the total power required by the tube and a resonant circuit.

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APPLICATION

Mounting—The klystrons are provided with a mounting flange (See Outline Drawing) which may be used to support the tubes with either end up.

Filament Operation—For maximum tube life, the pure tungsten filament should be operated just above the emission limiting temperature. This temperature will be obtained with a filament voltage, as measured directly at the terminals, of approximately 9 volts.

Cathode Heating Power—The cathode is unipotential and heated by electron bombardment. A dc potential of approximately 2100 volts is applied between the filament and the cathode; and the recommended cathode heating power of 1400 watts is obtained with approximately .66 amperes. The filament is designed to operate under space-charge limited conditions. Cathode temperature is varied by changing the bombarding potential between the filament and the cathode.

Cooling—Forced air is used to cool the Electron Gun Structure and the Middle and Output Cavities. Only clean, well filtered air should be blown on the tube to avoid voltage breakdown due to dust accumulation. The temperature of the metal in the region of the metal-to-glass seals should not exceed 150°C. Tube temperatures may be measured with a temperature-sensitive paint, such as "Tempilaq", manufactured by the Tempil Corporation, 132 West 22nd Street, New York 11, N. Y.

Water is used to cool the Drift Tubes and the Collector Assembly. The cooling water should be of sufficient purity to prevent liming of the water system, and the use of a heat exchanger is recommended. The inlet water pressure of the Drift Tubes and the Collector Assembly should not exceed 50 pounds per square inch. The outlet water temperature must not exceed a maximum of 70°C. under any condition.

Air and water flow should be started before the filament and cathode power are applied and maintained for at least two minutes after the filament and cathode power have been removed.

Klystron Cooling Requirements for Typical Operating Conditions and Correct Magnetic Field Adjustment:

	Cooling Medium	Volume	Pressure Drop	Remarks
Input Drift Tube	*Water	1 gpm	1 psi	Total pressure drop if series connected with 5/16" tubing= 4 psi.
Short Drift Tube Jacket	*Water	1 gpm	1 psi	
Long Drift Tube Jacket	*Water	1 gpm	1 psi	
Output Drift Tube	*Water	1 gpm	1 psi	
Collector Assembly	*Water	15 gpm	3 psi	
Electron Gun Structure — Filament Stem	Air	1-2 cfm		See Cooling Diagram
Electron Gun Structure — Cathode Terminal	Air	90 cfm		
Electron Gun Structure — Focus Electrode and Anode Seals	Air	90 cfm		
Input Cavity	None			
Center Cavity	Air	15 cfm		
Output Cavity	Air	50 cfm		

*Cooling water connections should be made as noted on Cooling Diagram.

RF Contact Surfaces—The means by which contact is made between the cavities and the tuning boxes is of great importance. Two requirements which must be met to ensure proper electrical connections are as follows:

(1) Contact to the tube cavities must be made only on the peripheral surface of the 1/4" cavity flanges as shown on the outline drawing.

(2) Each individual finger of the collet or spring stock material must make positive contact to the cavity flange to prevent arcing.

Magnetic Field—An adjustable magnetic field is necessary to control and direct the beam throughout the length of the drift tube. The magnetic field should be capable of variation around the recommended field strength of 120 gauss. Typical magnetic circuit requirements for a 3K50,000LK are shown in the Magnetic Circuit Schematic. The current and adjustment of the pre-focusing coil are optimized under low beam voltage conditions and will require minor readjustment with changes in beam voltage. The current and location of the focusing coils should be capable of independent adjustment. Readjustment of the current of the focusing coils is necessary with changes in beam voltage. Beam transmission (collector current divided by the beam current as measured in the cathode return to beam power supply) will vary from 75% to 95%. Improper adjustment or misalignment of the magnetic field, as indicated by too low a value of beam transmission, may cause the beam to strike and overheat the drift tube walls.

MAGNETIC FIELD COIL REQUIREMENTS

Number of Coils Required for Field Strength of Approximately 120 Gauss.

Tube Type	Pre-focusing Coil: 375-750 ampere-turns per coil	Focusing Coils: 1600-4800 ampere-turns per coil	Focusing Coils: 0-1600 ampere-turns per coil
3K50,000LA	1	3	1
3K50,000LF	1	3	1
3K50,000LK	1	2	1

CAUTION—It is convenient to operate the r-f and collector portions of the tube at ground potential. Since the cathode and filament are operated at high negative potentials with respect to ground, filament and cathode power supplies and voltmeters must be adequately insulated for these high voltages. Protection must also be afforded to operating personnel.

Protection—It is recommended that the following protective devices be used:

(1) Interlocks in air and water supplies.

(2) Interlocks in magnetic field supply circuits.

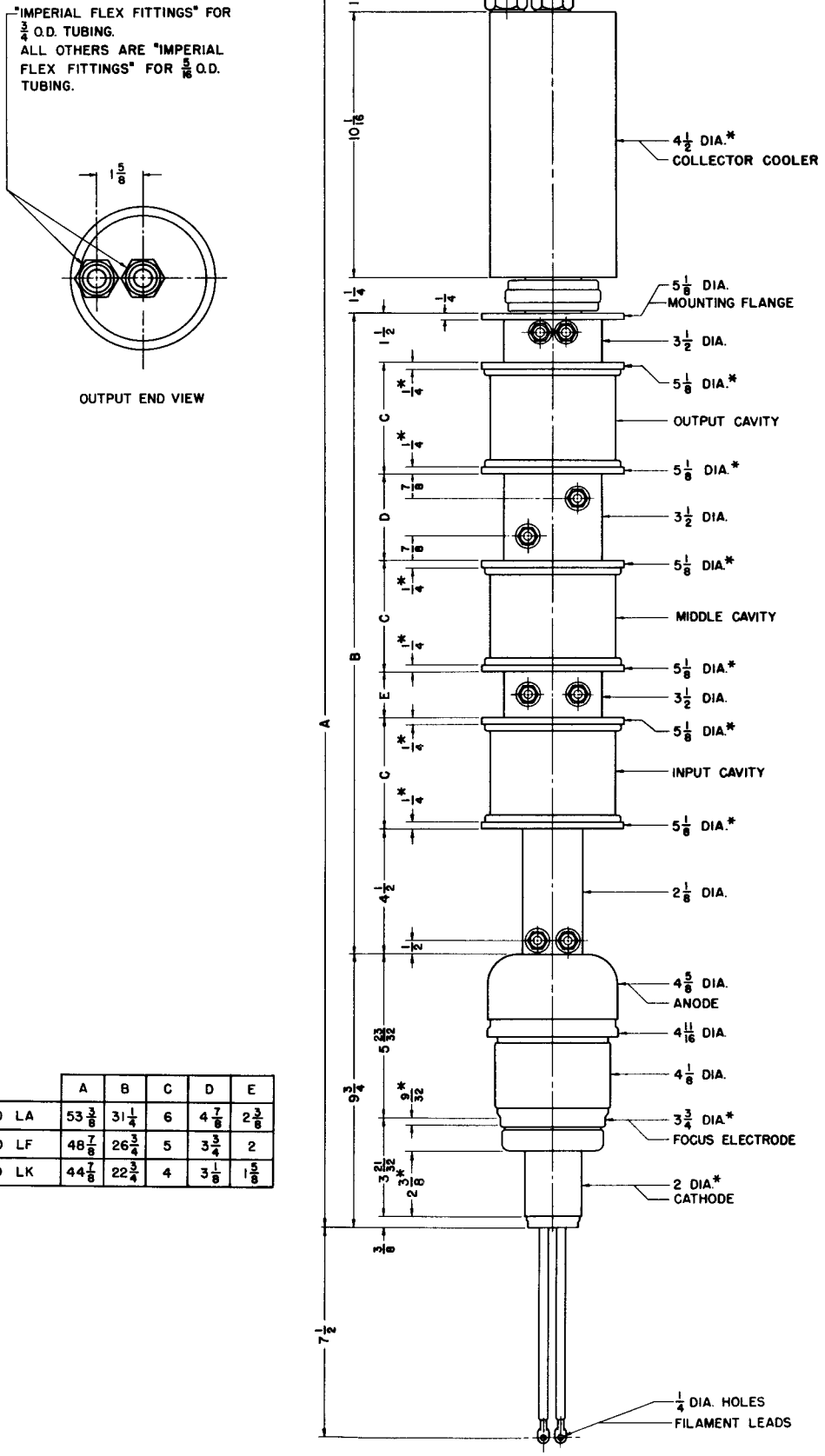
(3) Current overload in cathode bombardment supply circuit.

(4) Current overload in beam current supply circuit.

(5) Current overload in cavity current circuit.

(6) Current limiting resistor of approximately 100 ohms in series with beam power supply to isolate tube from final capacitor of supply.

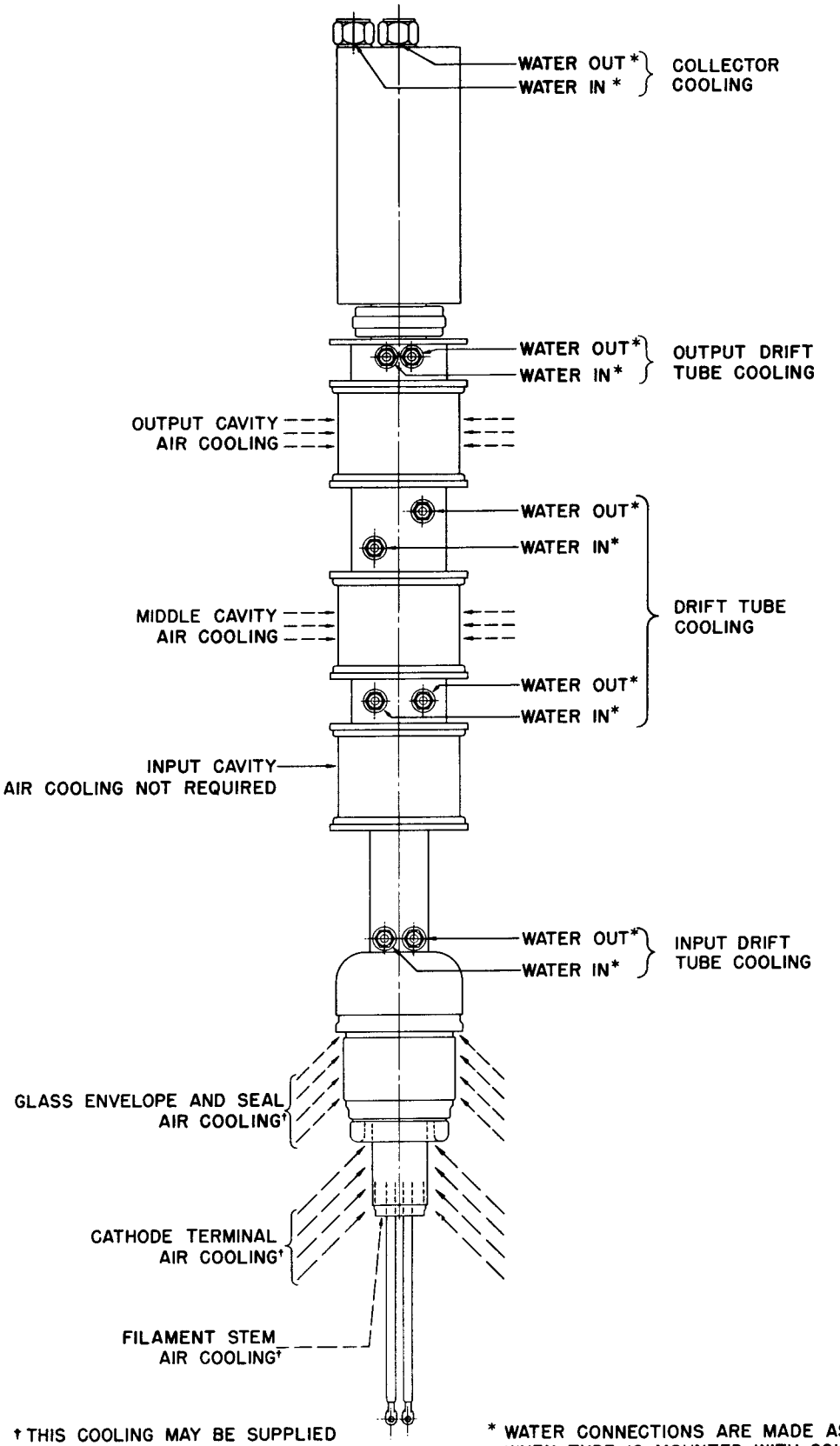
The filament and cathode bombardment voltages will normally be applied before the beam voltage. Cavity tuning or magnetic field adjustment should be made with reduced beam voltage (1/2 to 2/3 normal). Slight retuning and readjustment will be necessary when beam voltage is raised to full value.



	A	B	C	D	E
3K50,000 LA	53 3/8	31 1/4	6	4 7/8	2 3/8
3K50,000 LF	48 7/8	26 3/4	5	3 3/4	2
3K50,000 LK	44 7/8	22 3/4	4	3 1/8	1 15/16

DIMENSIONS IN INCHES

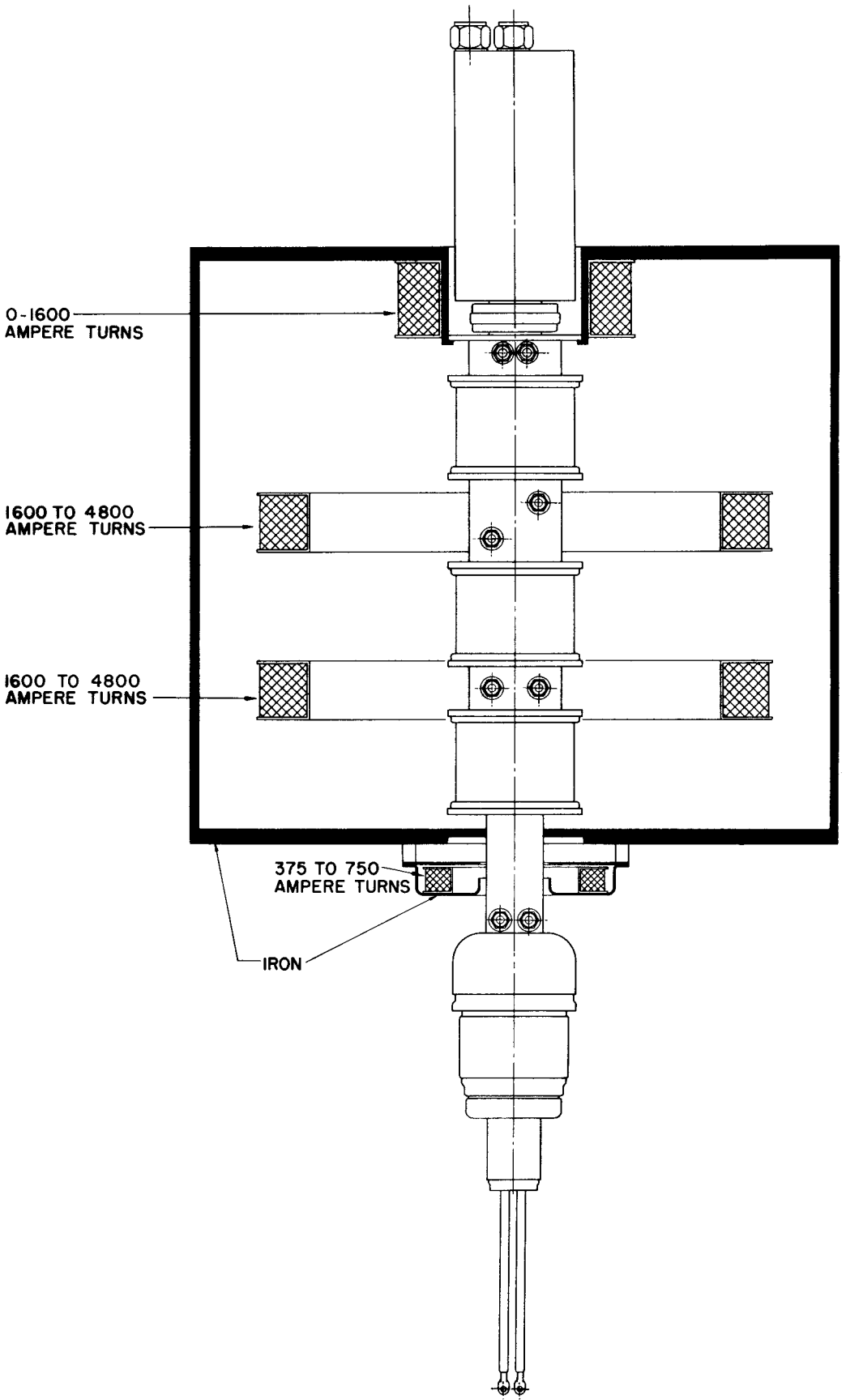
*CONTACT SURFACE



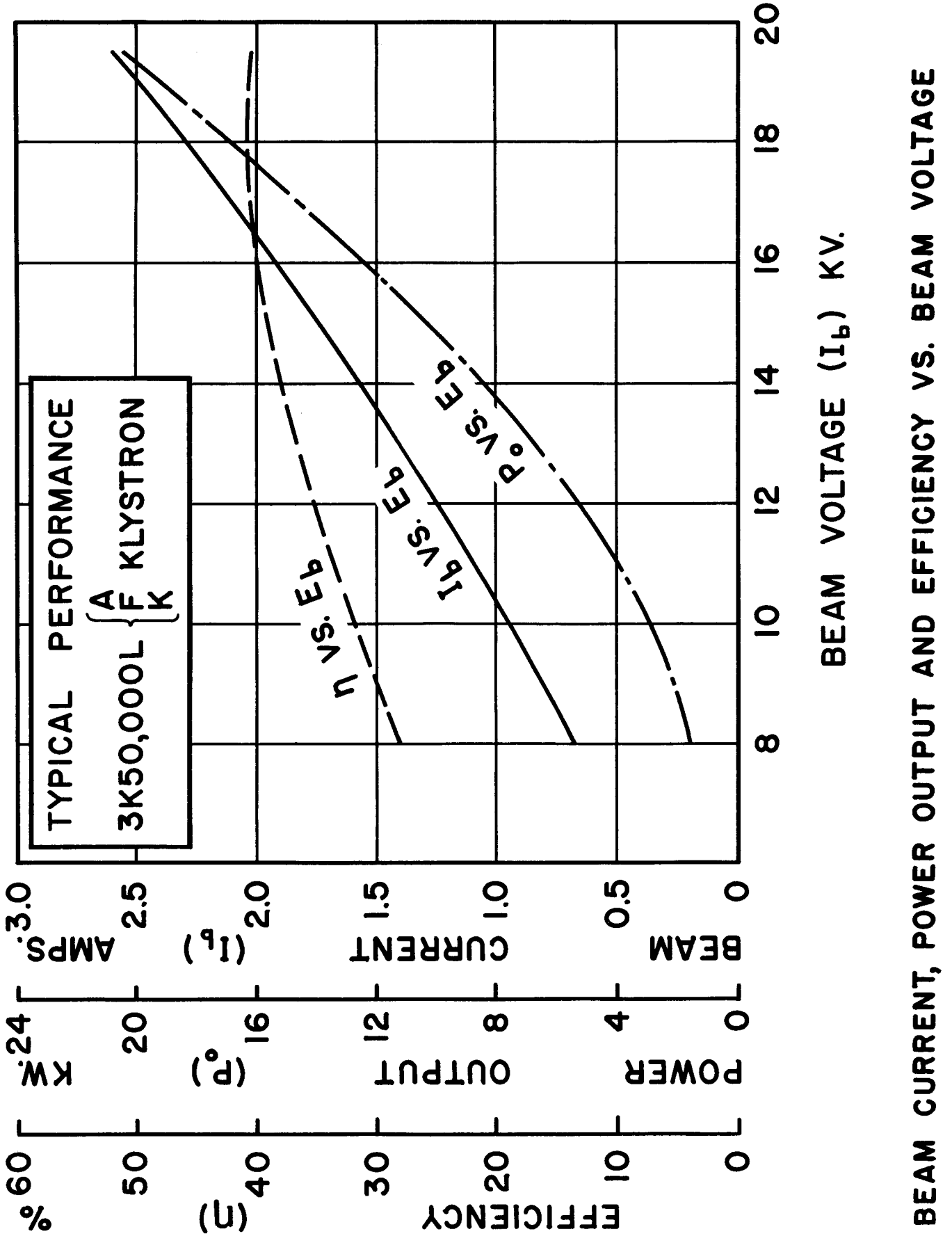
† THIS COOLING MAY BE SUPPLIED BY A SINGLE BLOWER THROUGH SUITABLE MANIFOLD & BAFFLES

* WATER CONNECTIONS ARE MADE AS SHOWN WHEN TUBE IS MOUNTED WITH COLLECTOR UP. WHEN TUBE IS MOUNTED WITH ANODE UP THE WATER CONNECTIONS MUST BE REVERSED.

COOLING DIAGRAM



MAGNETIC CIRCUIT SCHEMATIC FOR 3K50,000LK



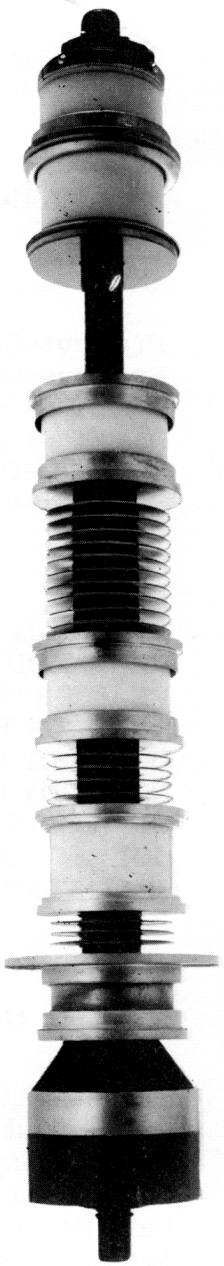
BEAM CURRENT, POWER OUTPUT AND EFFICIENCY VS. BEAM VOLTAGE

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

3KM4000LT

PULSE AMPLIFIER L-BAND KLYSTRON



The Eimac 3KM4000LT is a three-cavity, magnetically focused, pulse-amplifier klystron. It will deliver a peak output power of 40 kilowatts with an average power of one kilowatt at frequencies between 960 and 1215 megacycles. Nominal power gain is 33 db.

This klystron employs the Eimac Modulating Anode which provides an effective means of pulse modulating the output power without changing the beam voltage. A modulating anode voltage of approximately one half the beam voltage is sufficient to realize full rated pulse output power.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design affords a wide tuning range and permits external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-116 has been designed for use with the 3KM4000LT to cover the frequency range of 960 to 1215 megacycles. This assembly includes a klystron supporting structure, focus coils, tuning cavities and an adjustable output load coupler.

CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, Oxide-Coated		
	Minimum Heating Time	5	minutes
Heater:	Voltage	7.5	volts
	Current	5.5	amperes
	Maximum Starting Current	11	amperes
Modulating Anode Capacitance (To all other electrodes)		22	uuf
Power Gain (Nominal)		33	db
Average Output Power		1	kilowatt
Peak Output Power		40	kilowatts
Frequency Range (In H-116 Assembly)		960 to 1215	megacycles

MECHANICAL

Operating Position	Vertical, cathode end up	
RF Input Coupling	50-ohm Type "N"	
RF Output Coupling	1-5/8 inch, 50-ohm line	
Weight (Tube Only)	21	pounds
Approximate Shipping Weight (Klystron only)	120	pounds
Weight (H-116 Circuit Assembly)	240	pounds

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MECHANICAL (Cont'd)

Maximum Dimensions (Tube):

Length	31	inches
Diameter	5.3	inches

Maximum Dimensions (Tube and Circuit Assembly):

Length	31	inches
Diameter	19	inches

Cooling:

Cathode and Drift Tubes - Convection air cooling is adequate at sea level up to 25° C ambient air temperature. Forced-air cooling may be required at higher altitudes or higher temperatures.

Collector - 150 cfm air with pressure drop of 1.85 inches H_2O (25° C inlet air at sea level).

FOCUS COIL POWER-SUPPLY REQUIREMENTS

Prefocus-Coil Voltage	0 to 25	volts
Prefocus-Coil Current	0 to 1.5	amperes
Body-Coil Voltage	0 to 25	volts
Body-Coil Current	0 to 10	amperes
Collector-Coil Voltage	0 to 50	volts
Collector-Coil Current	0 to 2.5	amperes

MAXIMUM RATINGS

DC BEAM VOLTAGE	28	KILOVOLTS
PEAK MODULATING-ANODE VOLTAGE	14	KILOVOLTS
PEAK BEAM CURRENT	6	AMPERES
AVERAGE BEAM CURRENT	500	MILLIAMPERES
DC BODY CURRENT (CONTINUOUS)	20	MILLIAMPERES
DC BODY CURRENT (TUNING ONLY)	40	MILLIAMPERES
DC FOCUS ELECTRODE VOLTAGE	-400	VOLTS
COLLECTOR DISSIPATION	4	KILOWATTS
SEAL TEMPERATURE	175	DEGREES C

TYPICAL OPERATION

(In H-116 Circuit Assembly)

NARROW-BAND PULSE AMPLIFIER, SQUARE PULSE, 0.025 DUTY, MODULATING ANODE PULSED

DC Beam Voltage	24	26	28	kilovolts
Peak Output Power	30	36	40	kilowatts
Peak Driving Power	5	5	5	watts
Power Gain	37.7	38.5	39	db
Peak Beam Current	2.8	3.3	3.7	amperes
Average Beam Current	71	82	90	milliamperes
DC Body Current	13	14	15	milliamperes
Peak Modulating-Anode Voltage	12	13	14	kilovolts
Focus-Electrode Voltage	-75	-75	-75	volts
Focus Coil Currents:				
Prefocus	0.92	1.1	1.2	amperes
Body	6.8	7	7	amperes
Collector	0.95	1.0	1.0	ampere

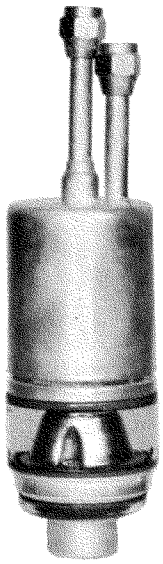
For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California.

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

3W5000A3

MEDIUM MU TRIODE



The Eimac 3W5000A3 is a water-cooled, medium-mu transmitting triode with a maximum plate dissipation rating of 5000 watts. Relatively high power-output as an oscillator, amplifier or modulator may be obtained from this tube at low plate voltages. A single tube will deliver a radio frequency output of 7500 watts at 4000 volts at frequencies up to 110 Mc.

The tube has a rugged, low-inductance cylindrical filament-stem structure, which readily becomes a part of a linear filament-tank circuit for VHF operation. The grid provides thorough shielding between the input and output circuits for grounded-grid applications and is conveniently terminated in a ring between the plate and filament terminals.

NOTE: THE 3W5000A3 IS A WATER-COOLED VERSION OF THE AIR-COOLED 3X2500A3.

The plate dissipation of the 3W5000A3 is 5000 watts. Other ratings are the same as for the 3X2500A3 tube type.

The 3W5000A3 should be used where water cooling is preferred and for industrial applications or installations where reserve anode dissipation is desired.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	7.5 volts
Current	51 amperes
Amplification Factor (Average)	20
Direct Interelectrode Capacitances (Average)	
Grid-Plate	20 $\mu\mu$f
Grid-Filament	36 $\mu\mu$f
Plate-Filament	1.2 $\mu\mu$f
Transconductance (i_b=830 ma., E_b=3000v.)	20,000 umhos
Frequency for Maximum Ratings	75 Mc.

MECHANICAL

Base	see drawing
Mounting	Vertical, base down or up
Maximum Overall Dimensions:	
Length	12.56 inches
Diameter	3.63 inches
Net Weight	3.5 pounds
Shipping Weight (Average)	15 pounds
Cooling	Water and Forced Air

The water-cooled anode requires one gallon of cooling water per minute for the rated plate dissipation of 5 kilowatts. The outlet water temperature must not exceed a maximum of 70°C. under any conditions. The inlet water pressure must not exceed a maximum of 60 pounds per square inch. The pressure drop across the anode is negligible compared to the drop in the associated piping.

The grid-terminal contact surface and adjacent glass must be cooled by forced air. The quantity, velocity and direction must be adjusted to limit the maximum seal temperature to 150°C.

The filament stem structure also requires forced-air cooling. A minimum of 6 cubic feet per minute must be directed into the space between the inner and outer filament contacting surfaces.

Air and water flow must be started before filament power is applied and maintained for at least five minutes after the filament power has been removed.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

(Conventional Neutralized Amplifier—Frequencies below 75 Mc.)

Class-C FM or Telegraphy (Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPS
PLATE DISSIPATION	5000 MAX. WATTS
GRID DISSIPATION*	150 MAX. WATTS

TYPICAL OPERATION (Frequencies below 75 Mc., per tube)

D-C Plate Voltage	4000	5000	6000	Volts
D-C Plate Current	2.5	2.5	2.08	Amps
D-C Grid Voltage	—300	—450	—500	Volts
D-C Grid Current	245	265	180	Ma.
Peak R-F Grid Input Voltage	580	750	765	Volts
Driving Power (approx.)	142	197	136	Watts
Grid Dissipation	68	78	46	Watts
Plate Power Input	10,000	12,500	12,500	Watts
Plate Dissipation	2500	2500	2500	Watts
Plate Power Output	7500	10,000	10,000	Watts

*See application notes.

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RADIO FREQUENCY POWER AMPLIFIER

Grounded-Grid Circuit
Class-C FM Telephony

MAXIMUM RATINGS (Frequencies between 85 and 110 Mc.)

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C PLATE CURRENT	2.0 MAX. AMPS
D-C GRID CURRENT*	200 MAX. MA.
PLATE DISSIPATION	5000 MAX. WATTS
GRID DISSIPATION*	150 MAX. WATTS

*See application notes.

TYPICAL OPERATION (110 Mc., per tube)

D-C Plate Voltage	3700	4000	Volts
D-C Grid Voltage	—450	—500	Volts
D-C Plate Current	1.8	1.85	Amps
D-C Grid Current	190	190	Ma.
Driving Power (approx.)	1600	1900	Watts
Useful Power Output	6850	7500	Watts

PLATE MODULATED RADIO FREQUENCY AMPLIFIER

(Conventional Neutralized Amplifier—Frequencies below 75 Mc.)
Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000 MAX. VOLTS
D-C PLATE CURRENT	2.0 MAX. AMPS
PLATE DISSIPATION	3350 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATIONS (Frequencies below 75 Mc., per tube)

D-C Plate Voltage	4000	4500	5000	Volts
D-C Plate Current	1.67	1.55	1.45	Amps
Total Bias Voltage	—450	—500	—550	Volts
Fixed Bias Voltage	—230	—325	—410	Volts
Grid Resistor	1500	1500	1400	Ohms
D-C Grid Current	150	120	100	Ma.
Peak R-F Grid Input Voltage	680	720	760	Volts
Driving Power (approx.)	102	86	76	Watts
Grid Dissipation	35	26	21	Watts
Plate Power Input	6670	6970	7250	Watts
Plate Dissipation	1670	1670	1670	Watts
Plate Power Output	5000	5300	5580	Watts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
MAX.-SIGNAL D-C PLATE CURRENT, PER TUBE	2.5 MAX. AMPS
PLATE DISSIPATION, PER TUBE	5000 MAX. WATTS

TYPICAL OPERATION CLASS AB_2 (Two tubes)

D-C Plate Voltage	4000	5000	6000	Volts
D-C Grid Voltage (approx.)*	—150	—190	—240	Volts
Zero-Signal D-C Plate Current	0.6	0.5	0.4	Amps
Max-Signal D-C Plate Current	4.0	3.2	3.0	Amps
Effective Load, Plate to Plate	2200	3600	4650	Ohms
Peak A-F Grid Input Voltage (per tube)	340	360	390	Volts
Max.-Signal Peak Driving Power	340	230	225	Watts
Max.-Signal Nominal Driving Power (approx.)	170	115	113	Watts
Max.-Signal Plate Power Output	11,000	11,000	13,000	Watts

*Adjust to give stated zero-signal plate current.

TYPICAL OPERATION CLASS AB_2 (Two tubes)
(Modulator service for 4000 and 5000 volt operation, to modulate one or two tubes, as shown under "Plate Modulated Radio Frequency Amplifier.")

D-C Plate Voltage	4000	5000	4000	5000	Volts
D-C Grid Voltage (approx.)*	—155	—200	—145	—190	Volts
Zero-Signal D-C Plate Current	0.4	0.4	0.6	0.5	Amps
Max.-Signal D-C Plate Current	1.35	1.13	2.70	2.26	Amps
Effective Load, Plate to Plate	6600	10,000	3300	5000	Ohms
Peak A-F Grid Input Voltage (per tube)	240	275	285	310	Volts
Max.-Signal Peak Driving Power	42	40	134	118	Watts
Max.-Signal Nominal Driving Power (approx.)	21	20	67	59	Watts
Max.-Signal Plate Power Output	3700	4000	7400	8000	Watts
Will Modulate R. F. Final Input of	6670	7250	13,340	14,500	Watts

*Adjust to give stated zero-signal plate current.

APPLICATION

Filament Voltage — The filament voltage, as measured directly at the tube, should be 7.5 volts with maximum allowable variations due to line fluctuation of from 7.1 to 7.9 volts.

Bias Voltage—There is little advantage in using bias voltages in excess of those given under "Typical Operation", except in certain very specialized applications. Where bias is obtained from a grid resistor, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Plate Voltage—The plate supply voltage for the 3W5000A3 should not exceed 6000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

In Class-C FM or Telegraphy service, a 0.1 henry choke, shunted by a spark gap, should be series connected between the plates of the amplifier tubes and the high voltage plate supply capacitor to offer protection from transients and surges. In plate modulated service, where a plate modulation transformer is used, the protective choke is not normally required.

Grid Dissipation — The power dissipated by the grid of the 3W5000A3 must never exceed 150 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp}\ I_c$$

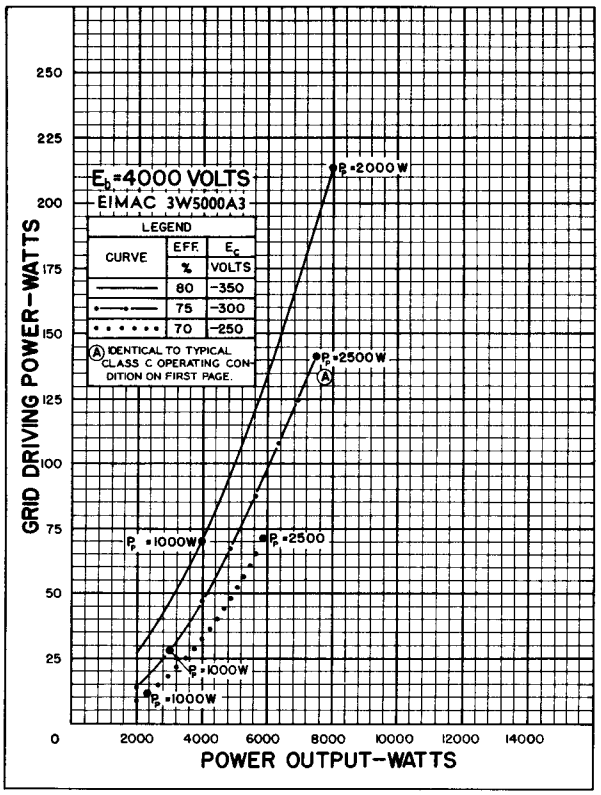
where P_g = Grid dissipation,
e_{cmp} = Peak positive grid voltage, and
I_c = D-C grid current

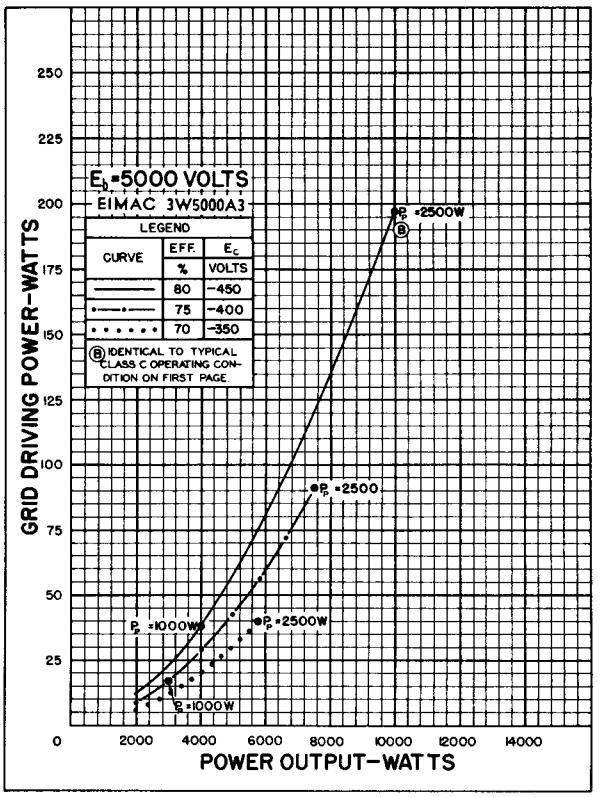
e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid. Any suitable peak v.t.v.m. circuit may be used (one is shown in "Vacuum Tube Ratings", Eimac News, January 1945. This article is available, in reprint form on request).

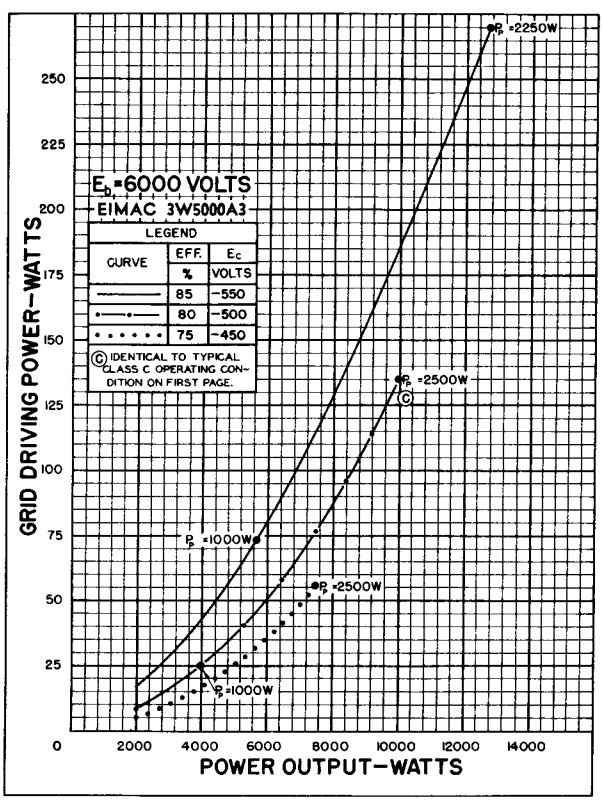
In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

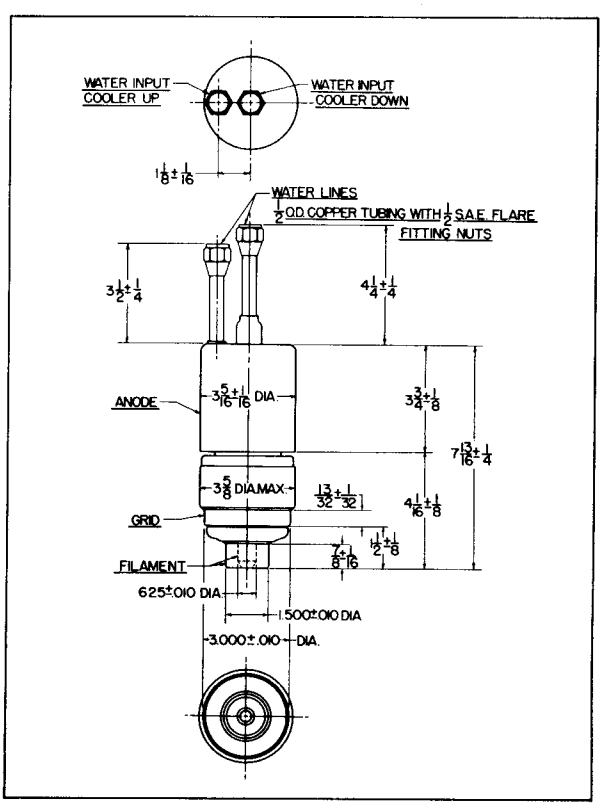
In VHF operation, particularly above 75 Mc., the d-c grid current must not exceed 200 ma. under any conditions of plate loading. With lightly loaded conditions the grid driving-power should be reduced so that the grid current does not exceed one-tenth of the plate current.

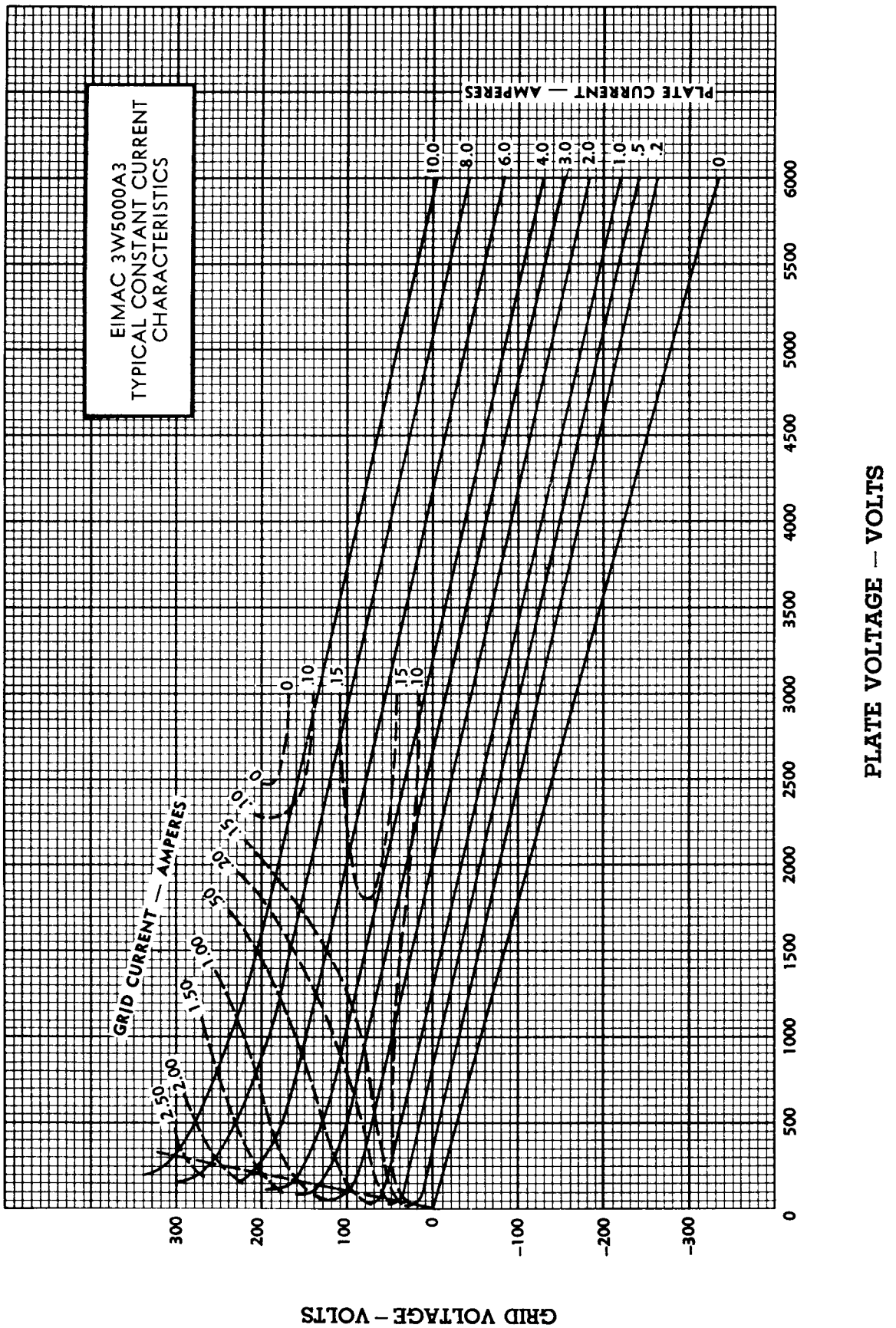
DRIVING POWER vs. POWER OUTPUT—The three charts on this page show the relationship of plate efficiency, power output and grid driving-power at plate voltages of 4000, 5000 and 6000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by Pp. Points A, B, and C are identical to the typical Class-C operating conditions shown on the first page under 4000, 5000 and 6000 volts respectively.











▶Indicates Change from Sheet Dated 3-1-51

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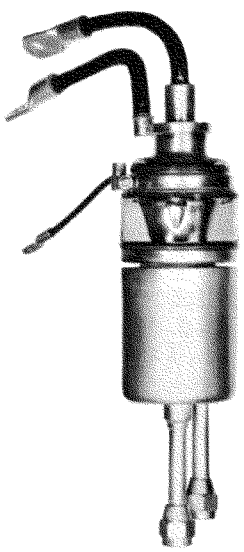
TENTATIVE DATA

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

3W5000F3

MEDIUM MU-TRIODE



The Eimac 3W5000F3 is a water-cooled, medium-mu power triode intended for amplifier, oscillator or modulator service. It has a maximum plate dissipation rating of 5000 watts and is capable of high output at relatively low plate voltages. A single 3W5000F3 will deliver a radio frequency plate power-output of 7500 watts at a plate voltage of 4000 volts.

The tube is equipped with flexible filament and grid leads which simplifies socketing and equipment design for industrial and communication frequencies below 30 Mc.

NOTE: THE 3W5000F3 IS A WATER-COOLED VERSION OF THE AIR-COOLED 3X2500F3.

The plate dissipation of the 3W5000F3 is 5000 watts. Other ratings are the same as for the 3X2500F3 tube type.

The 3W5000F3 should be used where water cooling is preferred and for industrial applications or installations where reserve anode dissipation is desired.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten		
Voltage	7.5	volts
Current	51	amperes
Maximum allowable starting current	100	amperes
Amplification Factor (Average)	20	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	21	$\mu\mu f$
Grid-Filament	36	$\mu\mu f$
Plate-Filament	1.2	$\mu\mu f$
Transconductance (i_b=830 ma., E_b=3000v.)	20,000	μmhos
Frequency for Maximum Ratings	30	Mc.

MECHANICAL

Base	see drawing	
Mounting	Vertical, base down or up.	
Maximum Overall Dimensions:		
Length (Does not include filament connectors)	12.56	inches
Diameter	3.63	inches
Net Weight	4.8	pounds
Shipping Weight (Average)	15	pounds
Cooling	Water and Forced Air	

The water-cooled anode requires one gallon of cooling water per minute for the rated plate dissipation of 5 kilowatts. The outlet water temperature must not exceed a maximum of 70°C. under any conditions. The inlet water pressure must not exceed a maximum of 60 pounds per square inch. The pressure drop across the anode is negligible compared to the drop in the associated piping.

The grid-terminal contact surface and adjacent glass must be cooled by forced air. The quantity, velocity and direction must be adjusted to limit the maximum seal temperature to 150°C.

The filament stem structure also requires forced-air cooling. A minimum of 6 cubic feet per minute must be directed into the space between the inner and outer filament contacting surfaces.

Air and water flow must be started before filament power is applied and maintained for at least five minutes after the filament power has been removed.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

(Frequencies below 30 Mc.)

Class-C FM or Telegraphy

(Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPS
PLATE DISSIPATION	5000 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION

(Frequencies below 30 Mc., per tube)

D-C Plate Voltage	4000	5000	6000	Volts
D-C Plate Current	2.5	2.5	2.08	Amps
D-C Grid Voltage	—300	—450	—500	Volts
D-C Grid Current	245	265	180	Ma.
Peak R. F. Grid Input Voltage	580	750	765	Volts
Driving Power (approx.)	142	197	136	Watts
Grid Dissipation	68	78	46	Watts
Plate Power Input	10,000	12,500	12,500	Watts
Plate Dissipation	2500	2500	2500	Watts
Plate Power Output	7500	10,000	10,000	Watts

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TENTATIVE DATA

PLATE MODULATED RADIO FREQUENCY AMPLIFIER

(Frequencies below 30 Mc.)

Class-C Telephony

(Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000 MAX. VOLTS
D-C PLATE CURRENT	2.0 MAX. AMPS
PLATE DISSIPATION	3350 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION
(Frequencies below 30 Mc., per tube)

D-C Plate Voltage	4000	4500	5000	Volts
D-C Plate Current	1.67	1.55	1.45	Amps
Total Bias Voltage	—450	—500	—550	Volts
Fixed Bias Voltage	—230	—325	—410	Volts
Grid Resistor	1500	1500	1400	Ohms
D-C Grid Current	150	120	100	Ma.
Peak R. F. Grid Input Voltage	680	720	760	Volts
Driving Power (approx.)	102	86	76	Watts
Grid Dissipation	35	26	21	Watts
Plate Power Input	6670	6970	7250	Watts
Plate Dissipation	1670	1670	1670	Watts
Plate Power Output	5000	5300	5580	Watts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
MAX.-SIGNAL D-C PLATE CURRENT, PER TUBE	2.5 MAX. AMPS
PLATE DISSIPATION, PER TUBE	5000 MAX. WATTS

TYPICAL OPERATION CLASS AB_2 (Two Tubes)

D-C Plate Voltage	4000	5000	6000	Volts
D-C Grid Voltage (approx)*	—150	—190	—240	Volts
Zero-Signal D-C Plate Current	0.6	0.5	0.4	Amps
Max.-Signal D-C Plate Current	4.0	3.2	3.0	Amps
Effective Load, Plate to Plate	2200	3600	4650	Ohms
Peak A-F Grid Input Voltage (per tube)	340	360	390	Volts
Max.-Signal Peak Driving Power	340	230	225	Watts
Max.-Signal Nominal Driving Power (approx.)	170	115	113	Watts
Max.-Signal Plate Power Output	11,000	11,000	13,000	Watts

*Adjust to give stated zero-signal plate current.

TYPICAL OPERATION CLASS AB_2 (Two Tubes)

Modulator service for 4000 and 5000 volt operation, to modulate one or two tubes, as shown under "Plate Modulated Radio Frequency Amplifier" (Page 1)

D-C Plate Voltage	4000	5000	4000	5000	Volts
D-C Grid Voltage (approx)*	—155	—200	—145	—190	Volts
Zero-Signal D-C Plate Current	0.4	0.4	0.6	0.5	Amps
Max.-Signal D-C Plate Current	1.35	1.13	2.70	2.26	Amps
Effective Load, Plate to Plate	6600	10,000	3300	5000	Ohms
Peak A-F Grid Input Voltage (per tube)	240	275	285	310	Volts
Max.-Signal Peak Driving Power	42	40	134	118	Watts
Max.-Signal Nominal Driving Power (approx.)	21	20	67	59	Watts
Max.-Signal Plate Power Output	3700	4000	7400	8000	Watts
Will Modulate one Tube R. F. Final Input of	6670	7250			Watts
Will Modulate two tubes R. F. Final Input of			13,340	14,500	Watts

*Adjust to give stated zero-signal plate current.

APPLICATION

Filament Voltage — The filament voltage, as measured directly at the tube, should be 7.5 volts with maximum allowable variations due to line fluctuation of from 7.12 to 7.87 volts.

Bias Voltage—There is little advantage in using bias voltages in excess of those given under "Typical Operation", except in certain very specialized applications. Where bias is obtained from a grid resistor, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Plate Voltage—The plate supply voltage for the 3W5000F3 should not exceed 6000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

In Class-C FM or Telegraphy service, a 0.1 henry choke, shunted by a spark gap, should be series connected between the plates of the amplifier tubes and the high voltage plate supply capacitor to offer protection from transients and surges. In plate modulated service, where a plate modulation transformer is used, the protective choke is not normally required.

Grid Dissipation—The power dissipated by the grid of the 3W5000F3 must never exceed 150 watts. Grid dissipation may be calculated from the following expression

$$P_g = e_{cmp} I_c$$

where P_g = Grid dissipation,
e_{cmp} = Peak positive grid voltage, and
I_c = D-C grid current

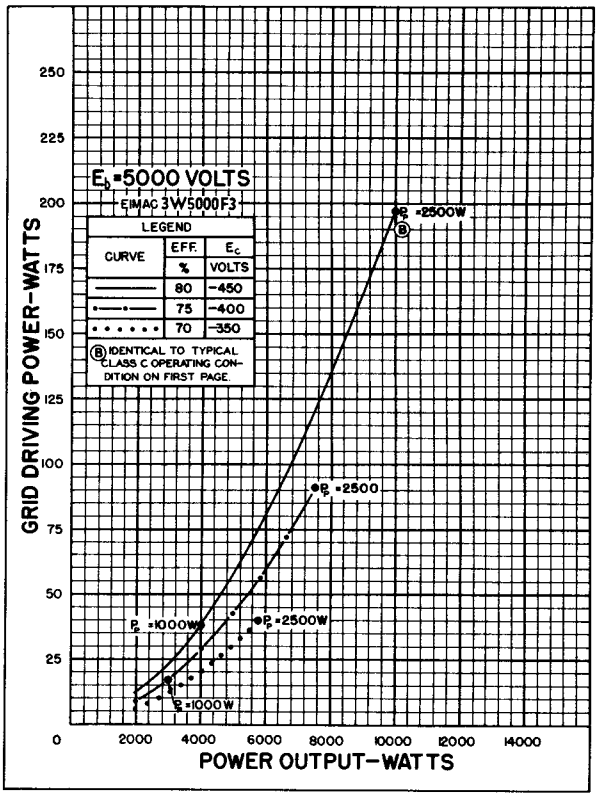
e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid. Any suitable peak v.t.v.m. circuit may be used (one is shown in "Vacuum Tube Ratings", Eimac News, January 1945. This article is available in reprint form on request).

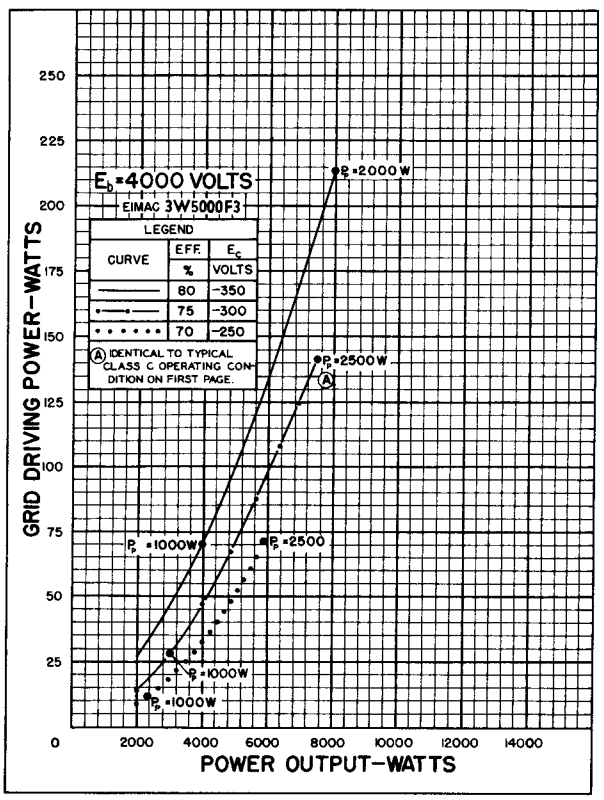
In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

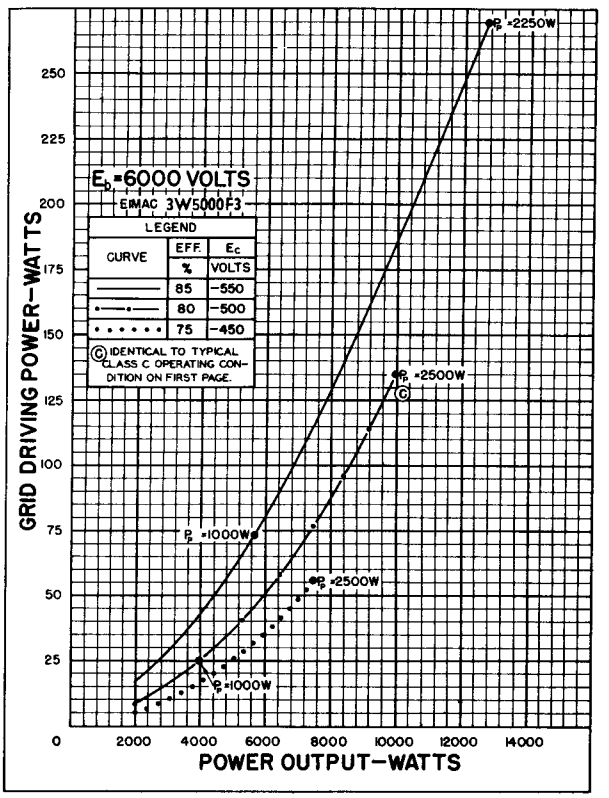
DRIVING POWER vs. POWER OUTPUT

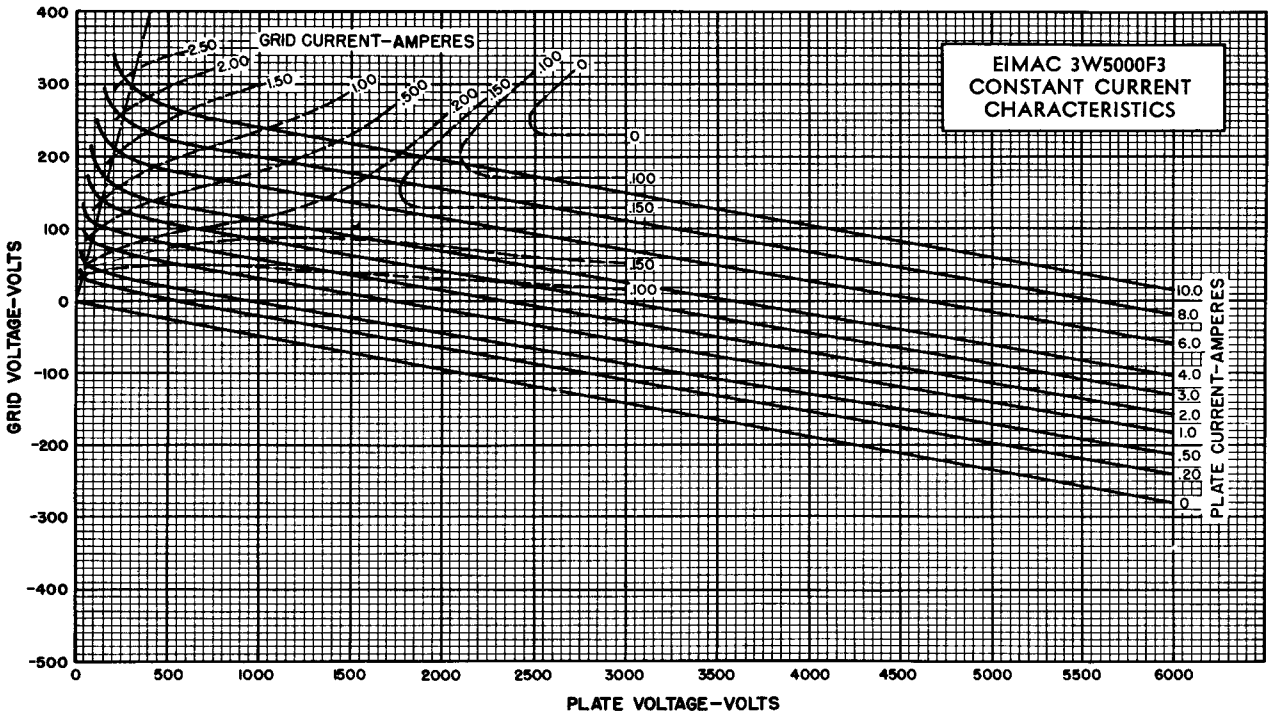
The three charts on this page show the relationship of plate efficiency, power output and grid driving-power at plate voltages of 4000, 5000 and 6000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

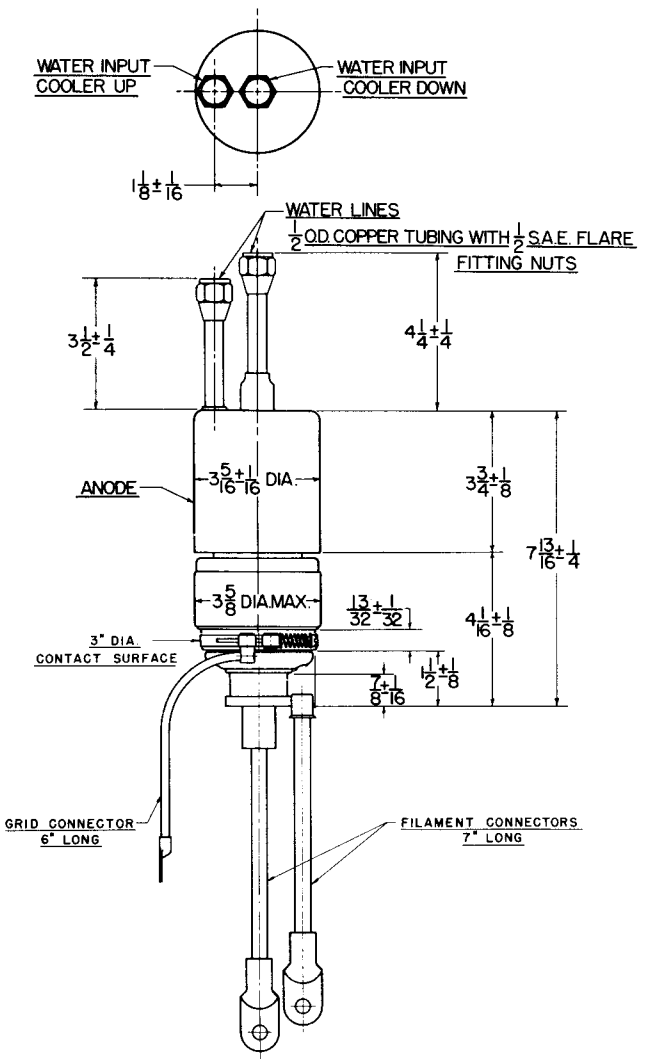
Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 4000, 5000 and 6000 volts respectively.











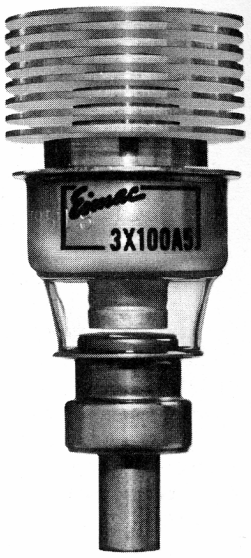
PRINTED IN U. S. A. 2-17-76230

3X100A5

HIGH-MU

TRIODE

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA



The Eimac 3X100A5 is a high-mu transmitting triode of planar construction designed for use as a power amplifier, oscillator, or frequency multiplier in the VHF and UHF ranges. The 3X100A5 is physically and electrically identical to the Eimac 2C39A but additional production tests, including long-pulse cathode evaluation, assure higher quality.

The 3X100A5 will deliver a minimum of 12 watts useful power output as an r-f oscillator at 2500 megacycles and up to 27 watts power output as an amplifier at 500 megacycles.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide-Coated, Unipotential				
Heating Time		60		seconds
Heater: Voltage (See "Applications")		6.3		volts
Current	0.95		1.10	amperes
Amplification Factor		100		
Direct Interelectrode Capacitances:				
Grid-Plate	1.86		2.16	uuf
Grid-Cathode	5.60		7.60	uuf
Plate-Cathode			0.035	uuf
Tranconductance (I_b=70 ma.)	20,000		30,000	umhos
Frequency for Maximum Ratings			2,500	mc

MECHANICAL

Base, Socket and Connections	See drawing
Operating Position	Any
Cooling	Forced Air
Maximum Operating Temperatures:	
Metal-to-Glass Seals	175° C
Anode Core	175° C

Maximum Over-all Dimensions:	
Length	2.75 inches
Diameter	1.27 inches
Net Weight	2.8 ounces
Shipping Weight (Approximate)	7 ounces

RADIO-FREQUENCY POWER AMPLIFIER, OR OSCILLATOR

MAXIMUM RATINGS (Per tube)

D-C PLATE VOLTAGE	1000 MAX. VOLTS
D-C CATHODE CURRENT	125 MAX. MA
D-C GRID VOLTAGE	—150 MAX. VOLTS
D-C GRID CURRENT	50 MAX. MA
HEATER VOLTAGE	SEE APPLICATION NOTES
INSTANTANEOUS PEAK POSITIVE GRID VOLTAGE	30 MAX. VOLTS
INSTANTANEOUS PEAK NEGATIVE GRID VOLTAGE	400 MAX. VOLTS
PLATE DISSIPATION	100 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Key-down conditions, per tube)
(Power-Amplifier Grid-Isolation Circuit, CW Operation, 500 Mc.)

D-C Plate Voltage	800 volts
D-C Grid Voltage	—20 volts
D-C Plate Current	80 ma
D-C Grid Current	32 ma
Driving Power (approx.)[1]	6 watts
Useful Power Output	27 watts

TYPICAL OPERATION
(R-F Oscillator, 2500 Mc.)[2]

D-C Plate Voltage	900 volts
D-C Grid Voltage	—22 volts
D-C Plate Current	90 ma
D-C Grid Current	27 ma
Useful Power Output	12 watts

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS (Carrier conditions, per tube)

D-C PLATE VOLTAGE[3]	600 MAX. VOLTS
D-C GRID VOLTAGE	—150 MAX. VOLTS
D-C GRID CURRENT	50 MAX. MA
D-C CATHODE CURRENT	100 MAX. MA
PEAK INSTANTANEOUS POSITIVE GRID VOLTAGE	30 MAX. VOLTS
PEAK INSTANTANEOUS NEGATIVE GRID VOLTAGE	400 MAX. VOLTS
PLATE DISSIPATION	70 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION
(Plate-Modulated Radio-Frequency Power Amplifier Grid-Isolation Circuit, 500 Mc., Per Tube)

D-C Plate Voltage	600 volts
D-C Grid Voltage	—16 volts
D-C Plate Current	65 ma
D-C Grid Current	35 ma
Driving Power (approx.)[1]	5 watts
Useful Carrier Power Output	16 watts

[1]Driving power listed is the total power which must be supplied to a practical grid circuit at the frequency shown.
[2]These 2500-megacycle conditions conform to the minimum requirements of the MIL-E-1 specifications for the 2C39A.
[3]For less than 100% modulation, higher d-c plate voltage may be used if the sum of the peak positive modulating voltage and the d-c plate voltage does not exceed 1200 volts.

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APPLICATION

MECHANICAL

Mounting—The 3X100A5 may be operated in any position. It should be firmly held in place by spring-finger collets bearing on the terminal surfaces. The tube should seat against the under side of the "anode flange" (see outline drawing). In applications involving severe shock and vibration, the tube may be clamped in place by applying a suitable clamping device to the anode flange. It is recommended that no other portion of the tube be subjected to clamping forces.

Connections—The tube terminals are in the form of concentric cylinders of graduated diameters so that the 3X100A5 may be conveniently used with coaxial tuning devices. Spring-finger collets should be used to make contact with the anode, grid, cathode, and heater terminals. Adequate contact area and spring pressure should be provided to minimize heating and to prevent erratic circuit performance at the higher frequencies. Non-contacting or intermittently-contacting collet fingers will cause troublesome circuit behavior, especially at very-high and ultra-high frequencies. Electrode contact surfaces should be kept clean and free of oxide coatings.

Cooling—Forced air must be supplied to the anode cooler and to the metal-to-glass seals in sufficient quantity to maintain their temperatures below 175° C.

At sea level, with an inlet air temperature of 20° C, 12.5 cubic feet per minute of air flow is required to cool the anode at 100 watts plate dissipation when the illustrated air cowling is used. Operation at higher altitudes or with higher inlet air temperatures will require increased volumes of flow to obtain equivalent cooling. When using the anode cowling as illustrated here, it is necessary to provide air for seal cooling separately.

It should be borne in mind that operating temperature is the sole criterion of cooling effectiveness, regardless of the coolant type, flow rate, or coolant temperature. One method of measuring surface temperatures is by the use of a temperature-sensitive lacquer, such as "Tempilaq." This product can be obtained from the Tempil Corporation, 132-34 West 22nd Street, New York 11, N.Y. or from various chemical or scientific-equipment suppliers. When temperature-sensitive materials are used, extremely thin applications must be used to avoid inaccurate indications and interference with the heat transfer from the tube to the air stream.

ELECTRICAL

Heater Operation—The rated heater voltage for the 3X100A5 is 6.3 volts and the working voltage should be determined from the table below. The heater voltage should be maintained within plus or minus 10% of its intended value to minimize variations in circuit performance and to obtain maximum tube life.

At ultra-high frequencies transit-time effects can influence the cathode temperature. The amount of r-f driving power diverted to heating the cathode by back-bombardment will depend upon the frequency, the plate current, and the r-f driving power being supplied to the tube. The following table is intended as a general guide.

Frequency (Mc.)	E_f (Volts)
Up to 400	6.3
400 to 1000	6.0
1000 to 1500	5.5
1500 to 2000	5.0
2000 and above	4.5

If the conditions of operation result in extreme cathode back-heating, it may be necessary to start dynamic tube operation at normal heater voltage followed by a reduction of heater voltage to the proper value.

Cathode Operation—The oxide-coated unipotential cathode in the 3X100A5 and one side of the heater are connected internally. The absolute maximum rated d-c current is 125 milliamperes.

It is recommended that rated heater voltage be applied for a minimum of 30 seconds before other operating voltages are applied. Tube performance will become stabilized approximately 60 seconds after the heater voltage is applied.

Control-Grid Operation—The maximum rated grid dissipation is 2.0 watts.

At operating frequencies near 500 megacycles, the driving power necessary for maximum output of a typical grounded-grid amplifier is in the order of 6 watts and as the operating frequency is increased, the driving power requirements increase. Most of this additional driving power is absorbed in circuit losses other than grid dissipation, however, and the actual grid dissipation will increase very little.

The grid bias required by various 3X100A5 tubes may vary between limits approximately 50% above and below the nominal value and means should be provided in the equipment to accommodate such variations.

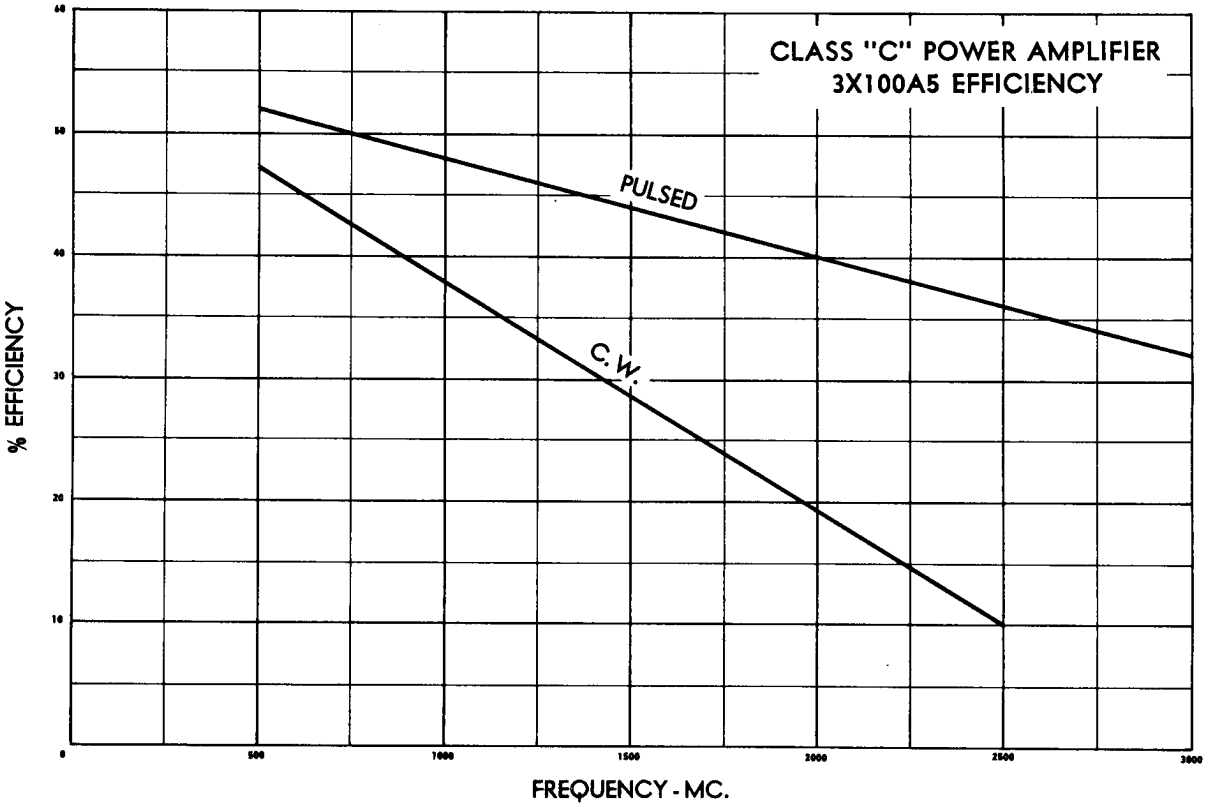
When grid-leak bias is used, suitable means must be provided to protect the tube against loss of excitation at plate voltages above 600 volts and the grid-leak resistor should be made variable to facilitate maintaining the bias voltage and plate current at the desired values when tubes are changed in the equipment.

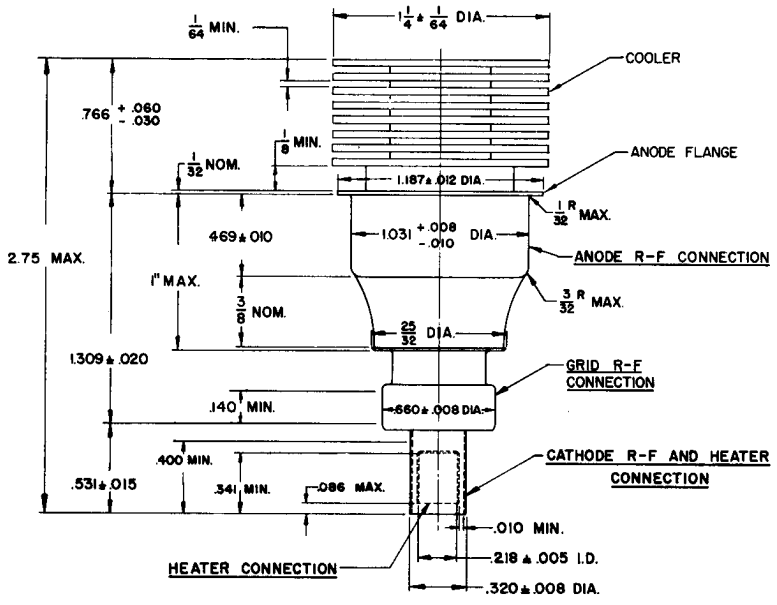
Plate Operation—The maximum rated plate dissipation is 100 watts. In plate-modulated applications, the plate dissipation under carrier conditions must be limited to 70 watts to avoid exceeding the plate-dissipation rating with 100% sine-wave modulation.

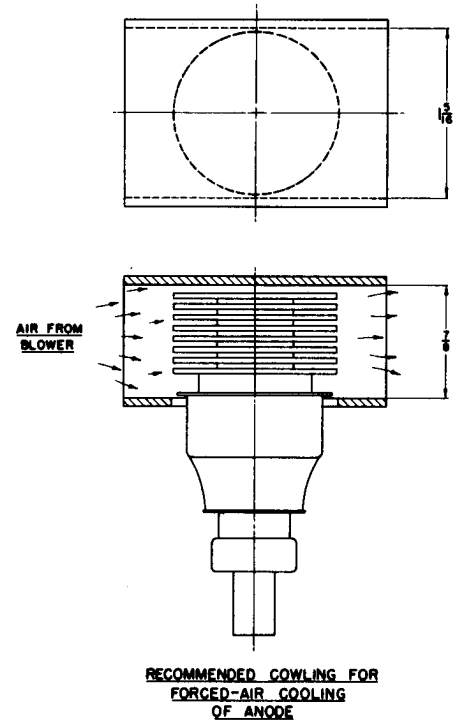
In general, low-voltage high-current operation is preferable to high-voltage low-current operation from the standpoint of optimum life.

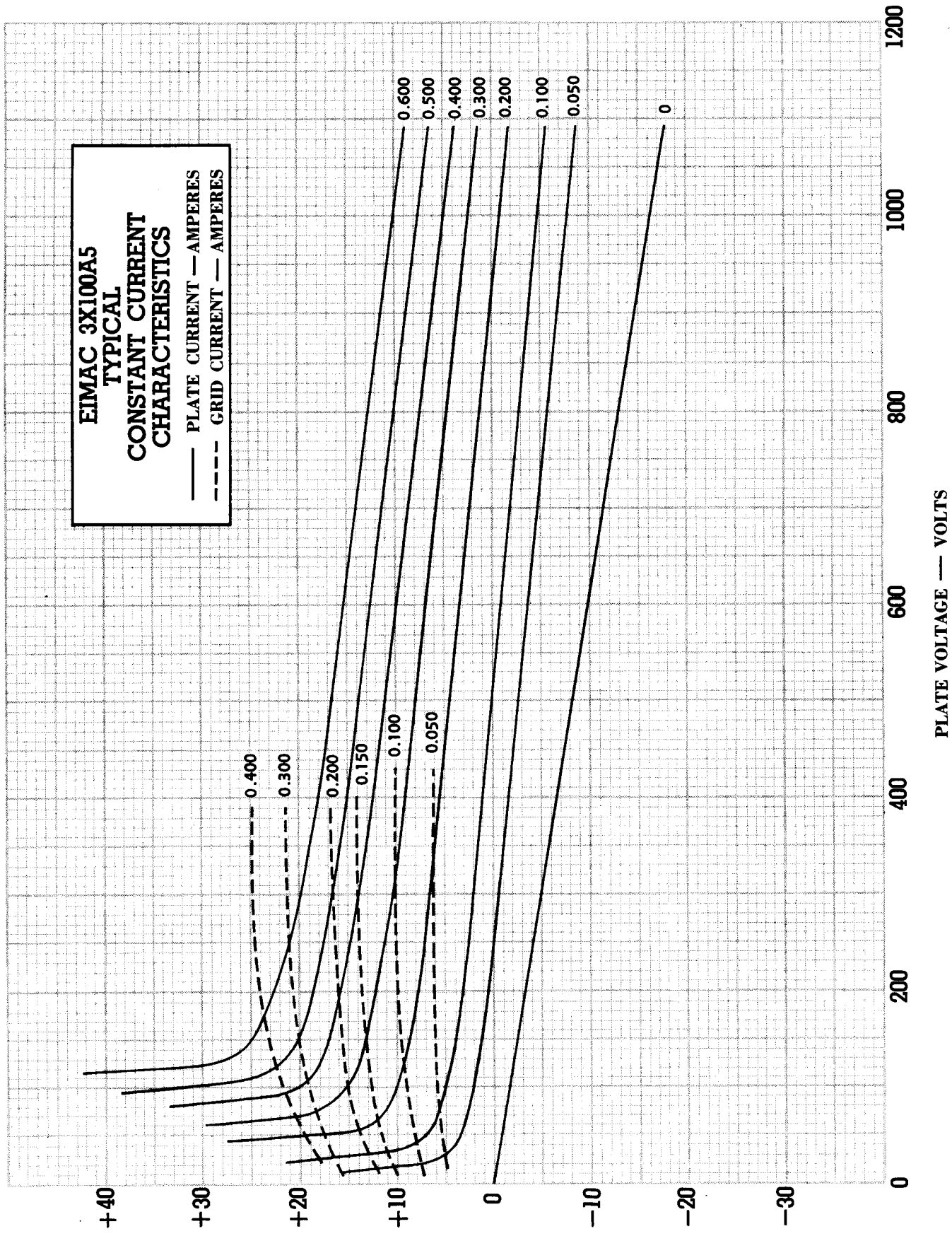
An excellent indication of operating conditions is the ratio of grid current to plate current; when the 3X100A5 is operated with grid-current values greater than half those of the plate current, either the drive is excessive or the plate loading is too light for the excitation present. The tube should never be operated unloaded, even for short periods of time. Drive should be held to the lowest value consistent with reasonable efficiency.

Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to Eitel-McCullough, Inc., San Bruno, California, for information and recommendations.


CLASS "C" POWER AMPLIFIER
3X100A5 EFFICIENCY
PULSED
C.W.
% EFFICIENCY
FREQUENCY - MC.
500
1000
1500
2000
2500
3000


1/64 MIN.
1 1/4 ± 1/64 DIA.
COOLER
.766 +.060 -.030
1/8 MIN.
1/32 NOM.
ANODE FLANGE
1.187 ± .012 DIA.
1/32 R MAX.
.469 ± .010
1.031 +.008 -.010 DIA.
ANODE R-F CONNECTION
2.75 MAX.
1" MAX.
3/32 R MAX.
3/8 NOM.
25/32 DIA.
1.309 ± .020
GRID R-F CONNECTION
.140 MIN.
.660 ± .008 DIA.
.400 MIN.
CATHODE R-F AND HEATER CONNECTION
.531 ± .015
.341 MIN.
.086 MAX.
.010 MIN.
.218 ± .005 I.D.
HEATER CONNECTION
.320 ± .008 DIA.


AIR FROM BLOWER
RECOMMENDED COWLING FOR FORCED-AIR COOLING OF ANODE



Printed in U.S.A. 39409

3X2500F3

MEDIUM-MU

TRIODE

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA



The Eimac 3X2500F3 is a medium-mu, forced-air cooled, external-anode power triode intended for amplifier, oscillator, or modulator service. It has a maximum plate-dissipation rating of 2500 watts and is capable of high output at relatively low plate voltages. A single 3X2500F3 will deliver a radio-frequency plate power output of 7500 watts at a plate voltage of 4000 volts.

The tube is equipped with flexible filament and grid leads which simplify socketing and equipment design for industrial and communication frequencies below 30 megacycles.

The approved Federal Communications Commission rating for the 3X2500F3 is 5000 watts of carrier power when used as a plate-modulated amplifier and 1250 watts of carrier power when used as a grid-modulated or linear amplifier.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	49		54	amperes
Amplification Factor	19		26	
Direct Interelectrode Capacitances:				
Grid-Plate	16.8		23.2	uuf
Grid-Filament	29.2		40.2	uuf
Plate-Filament	0.6		1.2	uuf
Transconductance (I_b=830 ma., E_b=3000 v.)		20,000		umhos
Highest Frequency for Maximum Ratings			30	mc

MECHANICAL

Base	See outline drawing
Mounting	Vertical, base down or up
Maximum Anode Cooler Core and Seal Temperatures	150° C
Cooling	Forced air
Maximum Over-All Dimensions:	
Length (Does not include filament connectors)	8.6 inches
Diameter	4.16 inches
Length of Filament Connectors	7 inches
Net Weight	7.5 pounds
Shipping Weight (Approximate)	17 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Conventional Neutralized Amplifier,
Class-C FM or Telegraphy (Key-Down Conditions)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPS
PLATE DISSIPATION	2500 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION (Frequencies below 30 Mc)

D-C Plate Voltage	4000	5000	6000 volts
D-C Plate Current	2.5	2.5	2.08 amps
D-C Grid Voltage	—300	—450	—500 volts
D-C Grid Current	245	265	180 ma
Peak R-F Grid Input Voltage*	580	750	765 volts
Driving Power*	142	197	136 watts
Grid Dissipation*	68	78	46 watts
Plate Input Power	10,000	12,500	12,500 watts
Plate Dissipation	2500	2500	2500 watts
Plate Output Power	7500	10,000	10,000 watts

*Approximate values.

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Conventional Neutralized Amplifier,
Class-C Telephony (Carrier Conditions)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000 MAX. VOLTS
D-C PLATE CURRENT	2.0 MAX. AMPS
PLATE DISSIPATION	1670 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION (Frequencies below 30 Mc)

D-C Plate Voltage	4000	4500	5000 volts
D-C Plate Current	1.67	1.47	1.25 amps
D-C Grid Voltage	—450	—500	—550 volts
D-C Grid Current*	180	140	150 ma
Peak R-F Grid Input Voltage*	685	715	760 volts
Driving Power*	125	100	115 watts
Grid Dissipation*	43	30	32 watts
Plate Input Power	6670	6615	6250 watts
Plate Dissipation	1670	1315	950 watts
Plate Output Power	5000	5300	5300 watts

*Approximate values.

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AUDIO-FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB or B

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPS
PLATE DISSIPATION	2500 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

D-C Plate Voltage	4000	5000	6000	volts
D-C Grid Voltage[1]	—150	—190	—240	volts
Zero-Signal D-C Plate Current	0.6	0.5	0.4	amps
Max-Signal D-C Plate Current	4.0	3.2	3.0	amps
Effective Load, Plate to Plate	2200	3600	4650	ohms
Peak A-F Grid Input Voltage (per tube)*	340	360	390	volts
Max-Signal Peak Driving Power*	340	230	225	watts
Max-Signal Nominal Driving Power*	170	115	113	watts
Max-Signal Plate Output Power	11,000	11,000	13,000	watts

*Approximate values.

[1]Adjust to give listed zero-signal plate current.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS

APPLICATION

Cooling—Forced-air cooling must be provided to hold the glass-to-metal seals and the anode cooler core below the maximum rated temperature of 150° C. Although the air requirements stated below are sufficient to maintain rated tube temperatures under many conditions, air in excess of the amounts shown will usually result in longer tube life. At ambient temperatures higher than 40° C and at high altitudes additional air flow must be provided. In all cases, tube temperatures are the criteria which govern air requirements. Surface temperatures may be measured conveniently with the aid of temperature-sensitive paints.

The minimum air-flow requirement for the anode cooler at the maximum rated plate dissipation of 2500 watts and with an inlet-air temperature of 20° C is 125 CFM. At sea level the pressure drop across the cooler for this air flow is 2.3 inches.

Under the same conditions, a minimum air-flow rate of 6 CFM directed into the filament-stem structure between the inner and outer filament terminals is required to maintain the base seals at 150° C.

Simultaneous removal of all power and air (as in the case of a power failure) will not ordinarily injure the tube, but it is not recommended as a standard operating practice.

Filament Voltage—The filament voltage, as measured directly at the tube, should be 7.5 volts with maximum allowable variations due to line fluctuation of from 7.12 to 7.87 volts.

Bias Voltage—There is little advantage in using bias voltages in excess of those given under "Typical Operation", except in certain very specialized applications. Where bias is obtained from a grid resistor, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Plate Voltage—The plate-supply voltage for the 3X2500F3 should not exceed 6000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

In Class-C FM or Telegraphy service, a 0.1—henry choke, shunted by a spark gap, should be series connected between the plates of the amplifier tubes and the high-voltage plate-supply capacitor to offer protection from transients and surges. In plate-modulated service, where a plate-modulation transformer is used, the protective choke is not normally required.

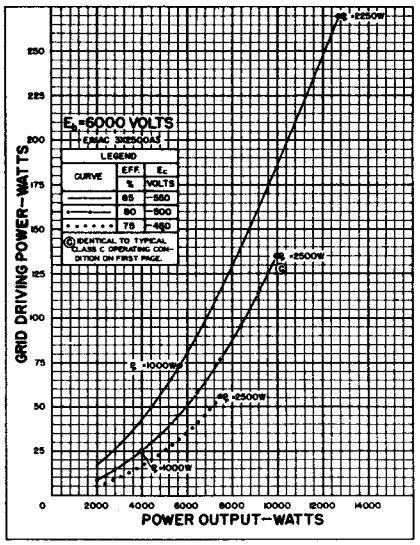
Grid Dissipation—The power dissipated by the grid of the 3X2500F3 must never exceed 150 watts. Grid dissipation may be calculated from the following expression:

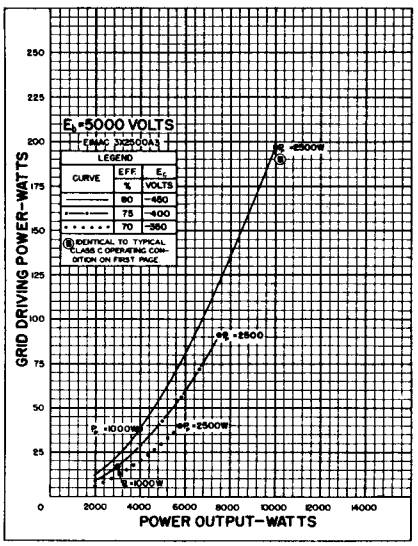
$$P_g = e_{cmp} I_c$$

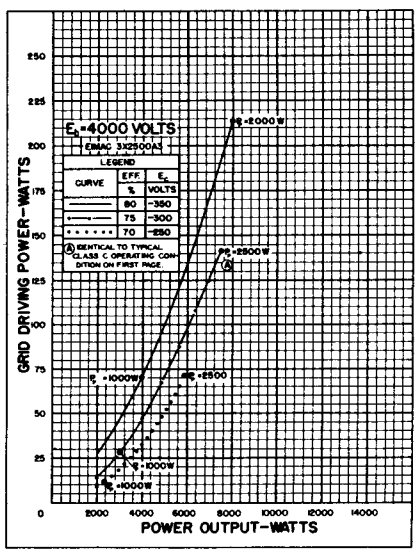
where: P_g = Grid dissipation,
e_{cmp} = Peak positive grid voltage, and
I_c = D-C grid current.

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid. Any suitable peak v.t.v.m. circuit may be used.

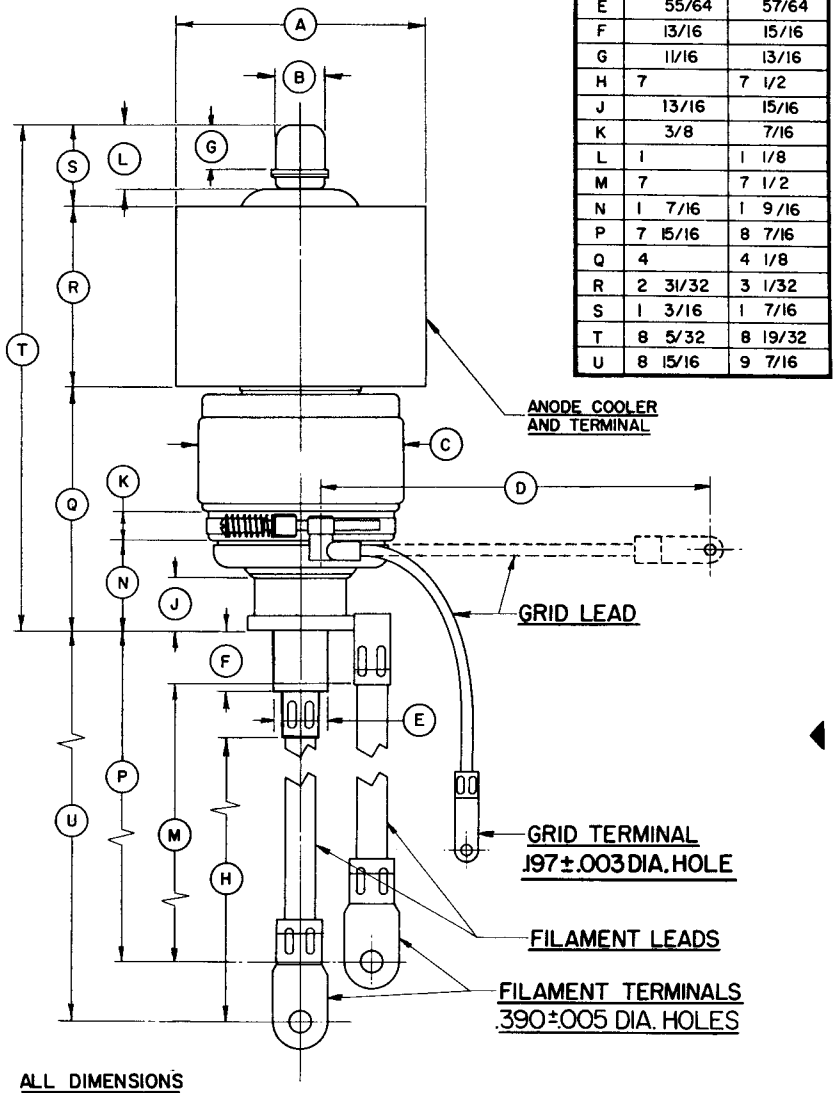
In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading. With lightly loaded conditions the grid driving power should be reduced so that the grid current does not exceed one-tenth of the plate current.







DIMENSION DATA		
REF.	MIN	MAX
A	4 3/32	4 5/32
B	25/32	27/32
C		3 5/8
D	6 3/8	6 5/8
E	55/64	57/64
F	13/16	15/16
G	11/16	13/16
H	7	7 1/2
J	13/16	15/16
K	3/8	7/16
L	1	1 1/8
M	7	7 1/2
N	1 7/16	1 9/16
P	7 15/16	8 7/16
Q	4	4 1/8
R	2 31/32	3 1/32
S	1 3/16	1 7/16
T	8 5/32	8 19/32
U	8 15/16	9 7/16

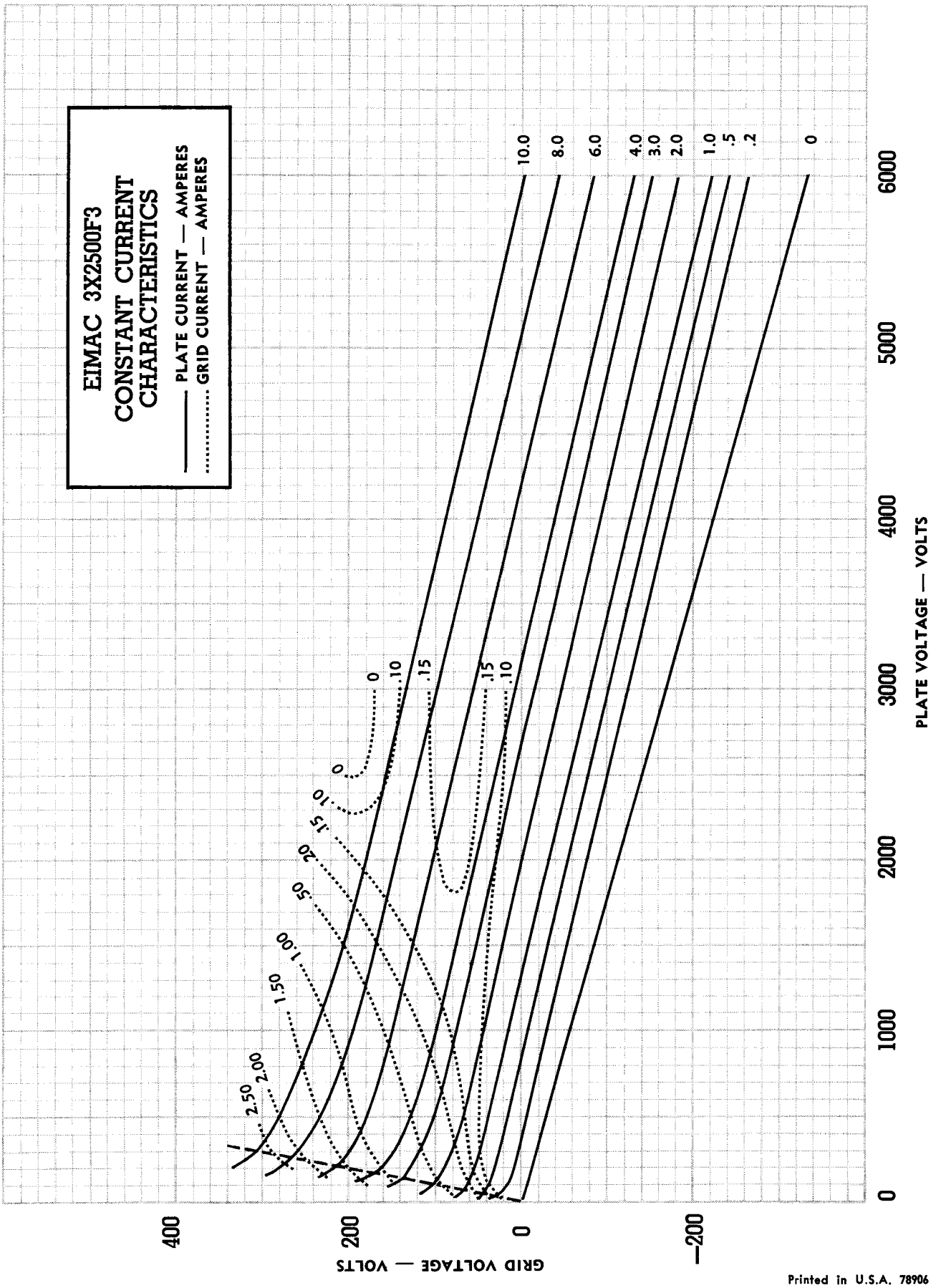


ALL DIMENSIONS IN INCHES

DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and approximate grid driving power at plate voltages of 4000, 5000 and 6000 volts. These charts show combined grid and bias losses only. The driving-power and power-output figures do not include circuit losses. The plate dissipation in watts is indicated by Pp. Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 4000, 5000 and 6000 volts respectively.

▶ Indicates change from sheet dated 1-27-58



Printed in U.S.A. 78906

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

3X3000A1

LOW-MU TRIODE

•

MODULATOR AMPLIFIER

The Eimac 3X3000A1 is a low-mu forced-air-cooled power triode intended for use as an audio amplifier or modulator. The maximum rated plate dissipation is 3000 watts.

Two 3X3000A1's in class-AB_1 audio service will deliver up to 10 kilowatts maximum-signal plate power output at 6000 plate volts without drawing grid current.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	7.5 volts
Current	51 amperes
Amplification Factor (Average)	5
Direct Interelectrode Capacitances (Average)	
Grid-Plate	17 $\mu\mu$fd
Grid-Filament	29 $\mu\mu$fd
Plate-Filament	2.5 $\mu\mu$fd
Transconductance (I_b = 1.0 amp., E_b = 3000v.)	11,000 μmhos

MECHANICAL

Base	See outline drawing
Mounting Position	Vertical, base down or up
Cooling	Forced air
Maximum Temperatures:	
Grid and Filament Seals, Anode Cooler Core	150°C
Maximum Overall Dimensions:	
Length	9.0 inches
Diameter	4.16 inches
Net Weight	6.25 pounds
Shipping Weight (Average)	16 pounds

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per tube)

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPERES
PLATE DISSIPATION	3000 MAX. WATTS
GRID DISSIPATION	50 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	3000	4000	5000	6000	volts
D-C Grid Voltage (approx.)[1]	−600	−860	−1080	−1300	volts
Zero-Signal D-C Plate Current	665	500	400	335	ma
Max-Signal D-C Plate Current	3.35	3.00	2.80	2.65	amps
Effective Load, Plate-to-Plate	1170	2160	3320	4560	ohms
Peak A-F Grid Input Voltage (per tube)	555	760	995	1250	volts
Max-Signal Driving Power (approx.)	0	0	0	0	watts
Max-Signal Plate Power Input	10,000	12,000	14,000	16,000	watts
Max-Signal Plate Dissipation (per tube)	3000	3000	3000	3000	watts
Max-Signal Plate Power Output	4000	6000	8000	10,000	watts
Total Harmonic Distortion[2]	2.7	1.8	2.6	2.1	per cent

[1]Adjust to stated Zero-Signal D-C Plate Current. Effective grid-circuit resistance must not exceed 200,000 ohms.
[2]At maximum signal without negative feedback.

APPLICATION

Filament Voltage—The filament voltage, as measured directly at the tube, should be the rated value of 7.5 volts. Variations should be held within the range of 7.12 to 7.87 volts.

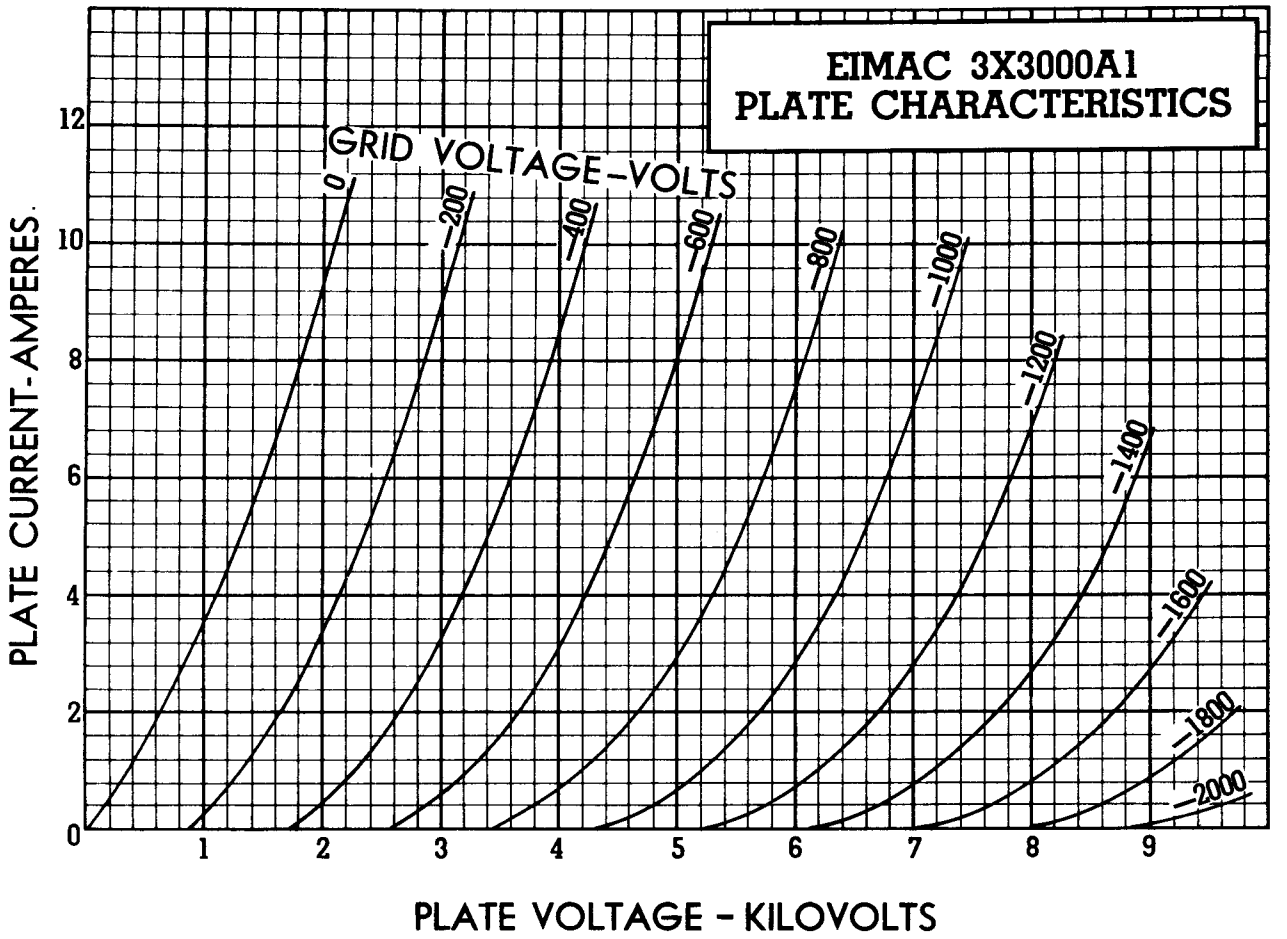
Cooling—The 3X3000A1 requires an air-flow of 150 cubic feet per minute through the anode cooler. This corresponds to a pressure drop across the cooler of 2.2 inches of water. A flow of 6 cubic feet per minute must also be directed into the filament stem structure, between the inner and outer filament conductors.

The air-flow must be started when power is applied to the filament, and must continue without interruption until all electrode voltages have been removed from the tube. It is advisable to permit the air-cooling system to operate for two minutes or more after the removal of power.

These air requirements are based upon operation at an ambient temperature of 20°C and at sea level.

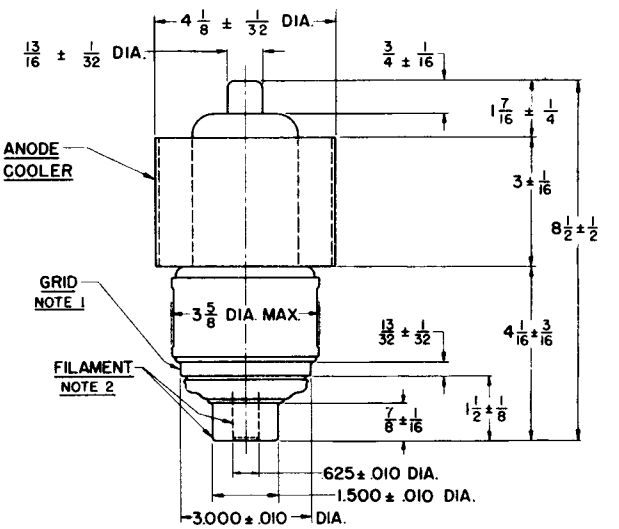
Cooling conditions for the 3X3000A1 may be considered satisfactory if the temperature of the anode cooler core and of the metal parts of the metal-to-glass seals is not allowed to exceed 150°C. A convenient accessory for the measurement of these temperatures is "Tempilaq", a temperature-sensitive lacquer manufactured by the Tempil Corporation, 132 West 22nd St., New York 11, N. Y.

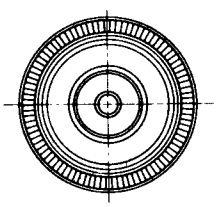
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NOTE 1
.040" MAXIMUM RUNOUT OF GRID CONTACT SURFACE WITH RESPECT TO AXIS DETERMINED BY ANODE AND OUTER FILAMENT CONTACT SURFACE.

NOTE 2
.025" MAXIMUM RUNOUT OF INNER FILAMENT CONTACT SURFACE WITH RESPECT TO TO OUTER FILAMENT CONTACT SURFACE.





BOTTOM VIEW

DIMENSIONS IN INCHES

Printed in U.S.A. 3-EI-76228

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

TENTATIVE DATA

3X3000A7

HIGH-MU POWER TRIODE

The Eimac 3X3000A7 is an external-anode power triode intended to be used as a zero-bias Class-B amplifier in audio or radio-frequency applications. Operation with zero grid bias offers circuit simplicity by eliminating the bias supply. In addition, grounded-grid operation is attractive since a power gain of over twenty times can be obtained with the 3X3000A7.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated-Tungsten	
Voltage	7.5 volts
Current	51 amperes
Amplification Factor	200
Interelectrode Capacitances:	
Grid-Filament	38 uuf
Grid-Plate	24 uuf
Plate-Filament	0.6 uuf
Frequency for Maximum Ratings	75 Mc

MECHANICAL

Base	See outline drawing
Operating Position	Vertical, base up or down
Cooling	Forced air
Maximum Operating Temperatures:	
Anode Core and Seals	175°C
Maximum Dimensions:	
Height	8.6 inches
Diameter	4.16 inches
Net Weight	6.25 pounds

AF AMPLIFIER OR MODULATOR CLASS-B, GRID-DRIVEN

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	5000 VOLTS
DC PLATE CURRENT	2.5 AMPS
PLATE DISSIPATION	3 KW
GRID DISSIPATION	225 WATTS

*Approximate Values

TYPICAL OPERATION, Two Tubes, Sinusoidal Wave

DC Plate Voltage	4000 volts
DC Grid Voltage	0 volts
Zero-Sig DC Plate Current*	0.640 amps
Max-Sig DC Plate Current	4.00 amps
Max-Sig DC Grid Current	0.860 amps
Driving Power	120 watts
Peak AF Driving Voltage (per tube)	185 volts
Load Resistance, Plate-to-Plate	2200 ohms
Max-Sig Plate Output Power	11,000 watts

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RF LINEAR AMPLIFIER
CLASS-B, GROUNDED-GRID

MAXIMUM RATINGS

DC PLATE VOLTAGE	5000 VOLTS
DC PLATE CURRENT	2.5 AMPS
PLATE DISSIPATION	3 KW
GRID DISSIPATION	225 WATTS

*Approximate Value

TYPICAL OPERATION, Single-Tone Conditions

DC Plate Voltage	4000	5000 volts
Zero-Sig DC Plate Current*	0.32	0.44 amps
Max-Sig DC Plate Current	2.00	1.56 amps
Max-Sig DC Grid Current	0.42	0.33 amps
Driving Impedance	50	50 ohms
Resonant Load Impedance	1120	1850 ohms
Max-Sig Driving Power	360	215 watts
Peak Envelope Plate Output Power	5500	5500 watts
Power Gain	15.3	25.6 times

RF LINEAR AMPLIFIER
CARRIER CONDITIONS, GRID-DRIVEN

MAXIMUM RATINGS

DC PLATE VOLTAGE	5000 VOLTS
DC PLATE CURRENT	2.5 AMPS
PLATE DISSIPATION	3 KW
GRID DISSIPATION	225 WATTS

*Approximate Value
†Modulation Crest Conditions

TYPICAL OPERATION

DC Plate Voltage	4000 volts
DC Grid Voltage	0 volts
Zero-Sig DC Plate Current*	0.32 amps
DC Plate Current	0.815 amps
DC Grid Current	0.205 amps
Driving Impedance†	220 ohms
Peak Driving Voltage†	160 volts
Driving Power	15 watts
Plate Output Power	1100 watts

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

APPLICATION

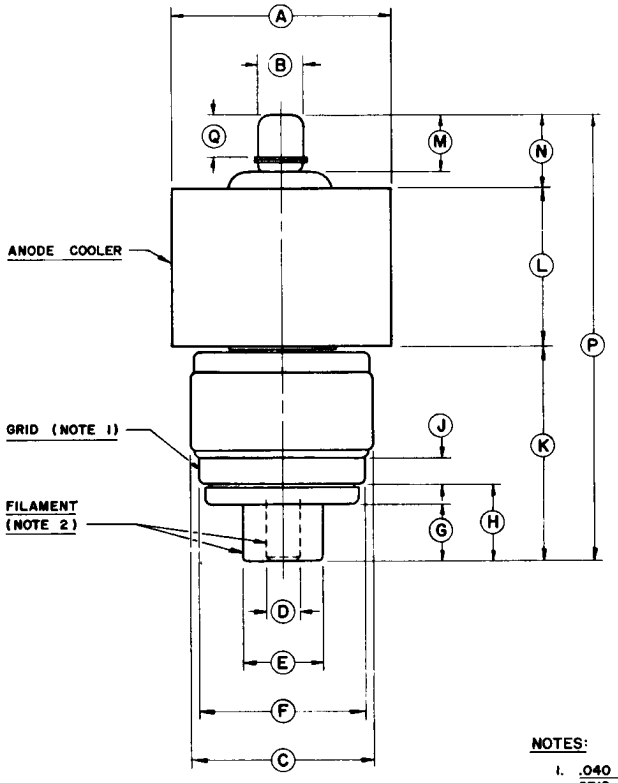
Input Circuit—When the 3X3000A7 is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a "Q" of five or more.

Cooling—The maximum temperature rating for the anode core and seals of the 3X3000A7 is 175°C. Sufficient forced-air cooling must be provided to keep the temperature of the anode core and the temperatures of the glass-to-metal seals below 175°C. Tube life is usually prolonged if these areas are maintained at temperatures below the maximum rating. Minimum air flow requirements to maintain anode-core and seal temperatures below 175°C at sea level with an inlet-air temperature of 50°C are tabulated for air-flow in the anode-to-base and base-to-anode directions. At higher ambient temperatures, frequencies above 30 Mc or at higher altitude, a greater quantity of air will be required. It is suggested that temperatures be monitored in any new installation to insure proper cooling.

In addition, a minimum air flow of 7 cfm must be directed into the filament stem structure, between the inner and outer filament conductors. This rate of air flow provides sufficient stem cooling at ambient temperatures up to 55°C.

Minimum Cooling Air-Flow Requirements				
Plate** Dissipation (Watts)	Anode-To-Base Air-Flow		Base-To-Anode Air Flow	
	Air Flow (CFM)	Pressure Drop (Inches of Water	Air Flow (CFM)	Pressure Drop (Inches of Water)
1000	42	0.4	25	0.15
2000	109	2.25	63	0.75
3000	215	7.8	130	2.6

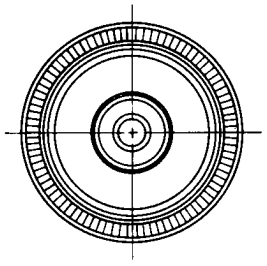
**Since the power dissipated by the filament is about 375 watts and since grid dissipation can, under some circumstances, represent another 225 watts, allowance has been made in preparing this tabulation for an additional 600 watts dissipation.



DIMENSIONS IN INCHES

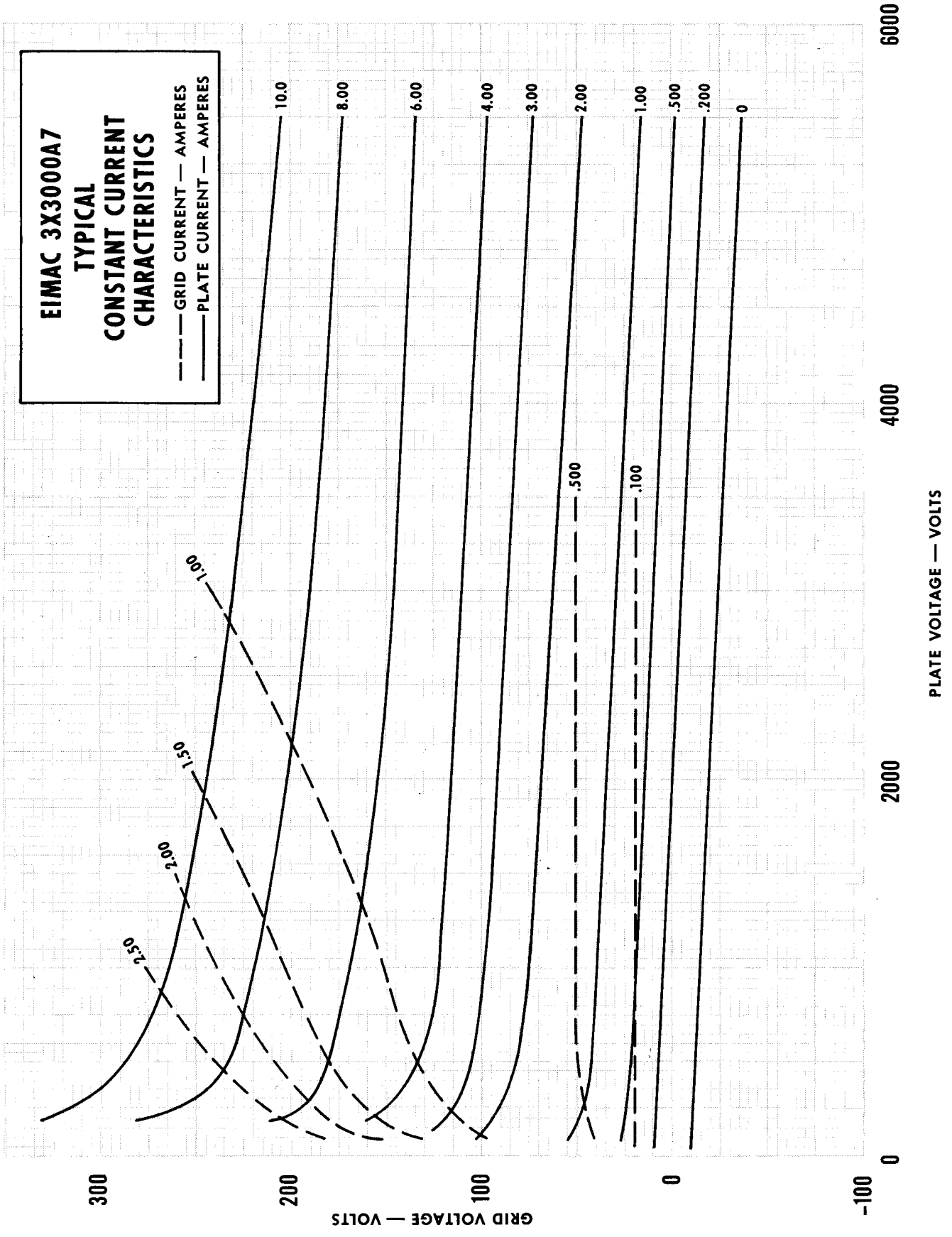
DIMENSIONAL DATA

REF.	MIN.	MAX.	NOM.
A	4.093	4.156	
B	.781	.843	
C		3.625	
D	.615	.635	
E	1.490	1.510	
F	2.990	3.010	
G	.812	.937	
H	1.437	1.562	
J	.375	.437	
K	4.	4.125	
L	2.968	3.031	
M	1.	1.125	
N	1.187	1.437	
P	8.156	8.593	
Q	.687	.812	



NOTES:

1. .040 MAX. RUNOUT OF GRID CONTACT SURFACE WITH RESPECT TO AXIS DETERMINED BY ANODE AND OUTER FILAMENT CONTACT SURFACE.
2. .025 MAX. RUNOUT OF INNER FILAMENT CONTACT SURFACE WITH RESPECT TO OUTER FILAMENT CONTACT SURFACE.


EIMAC 3X3000A7
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GRID CURRENT — AMPERES
PLATE CURRENT — AMPERES
10.0
8.00
6.00
4.00
3.00
2.00
1.00
.500
.200
0
.500
.100
1.00
1.50
2.00
2.50
300
200
100
0
-100
0
2000
4000
6000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

3X3000F1

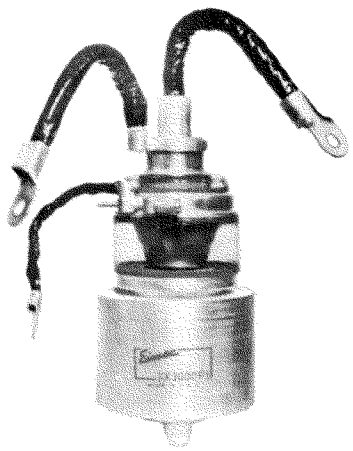
LOW-MU TRIODE

•

MODULATOR
AMPLIFIER

The Eimac 3X3000F1 is a low-mu forced-air-cooled power triode intended for use as an audio amplifier or modulator. The maximum rated plate dissipation is 3000 watts.

Two 3X3000F1's in class-AB$_1$ audio service will deliver up to 10 kilowatts maximum-signal plate power output at 6000 plate volts without drawing grid current.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	7.5	volts
Current	51	amperes
Amplification Factor (Average)	5	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	17	$\mu\mu$fd
Grid-Filament	29	$\mu\mu$fd
Plate-Filament	2.5	$\mu\mu$fd
Transconductance (I_b = 1.0 amp., E_b = 3000v.)	11,000	μmhos

MECHANICAL

Base	See outline drawing	
Mounting Position	Vertical, base down or up	
Cooling	Forced air	
Maximum Temperatures:		
Grid and Filament Seals, Anode Cooler Core	150	°C
Maximum Overall Dimensions:		
Length	9.0	inches
Diameter	4.16	inches
Net Weight	7.5	pounds
Shipping Weight	17	pounds

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB$_1$

MAXIMUM RATINGS (Per tube)

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPERES
PLATE DISSIPATION	3000 MAX. WATTS
GRID DISSIPATION	50 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tube unless otherwise specified)

D-C Plate Voltage	3000	4000	5000	6000 volts
D-C Grid Voltage (approx.)[1]	—600	—860	—1080	—1300 volts
Zero-Signal D-C Plate Current	665	500	400	335 ma
Max-Signal D-C Plate Current	3.35	3.00	2.80	2.65 amps
Effective Load, Plate-to-Plate	1170	2160	3320	4560 ohms
Peak A-F Grid Input Voltage (per tube)	555	760	995	1250 volts
Max-Signal Driving Power (approx.)	0	0	0	0 watts
Max-Signal Plate Power Input	10,000	12,000	14,000	16,000 watts
Max-Signal Plate Dissipation (per tube)	3000	3000	3000	3000 watts
Max-Signal Plate Power Output	4000	6000	8000	10,000 watts
Total Harmonic Distortion[2]	2.7	1.8	2.6	2.1 per cent

[1]Adjust to stated Zero-Signal D-C Plate Current. Can be expected to vary ±15%. Effective grid-circuit resistance must not exceed 200,000 ohms.
[2]At maximum signal without negative feedback.

APPLICATION

Filament Voltage—The filament voltage, as measured directly at the tube, should be the rated value of 7.5 volts. Variations should be held within the range of 7.12 to 7.87 volts.

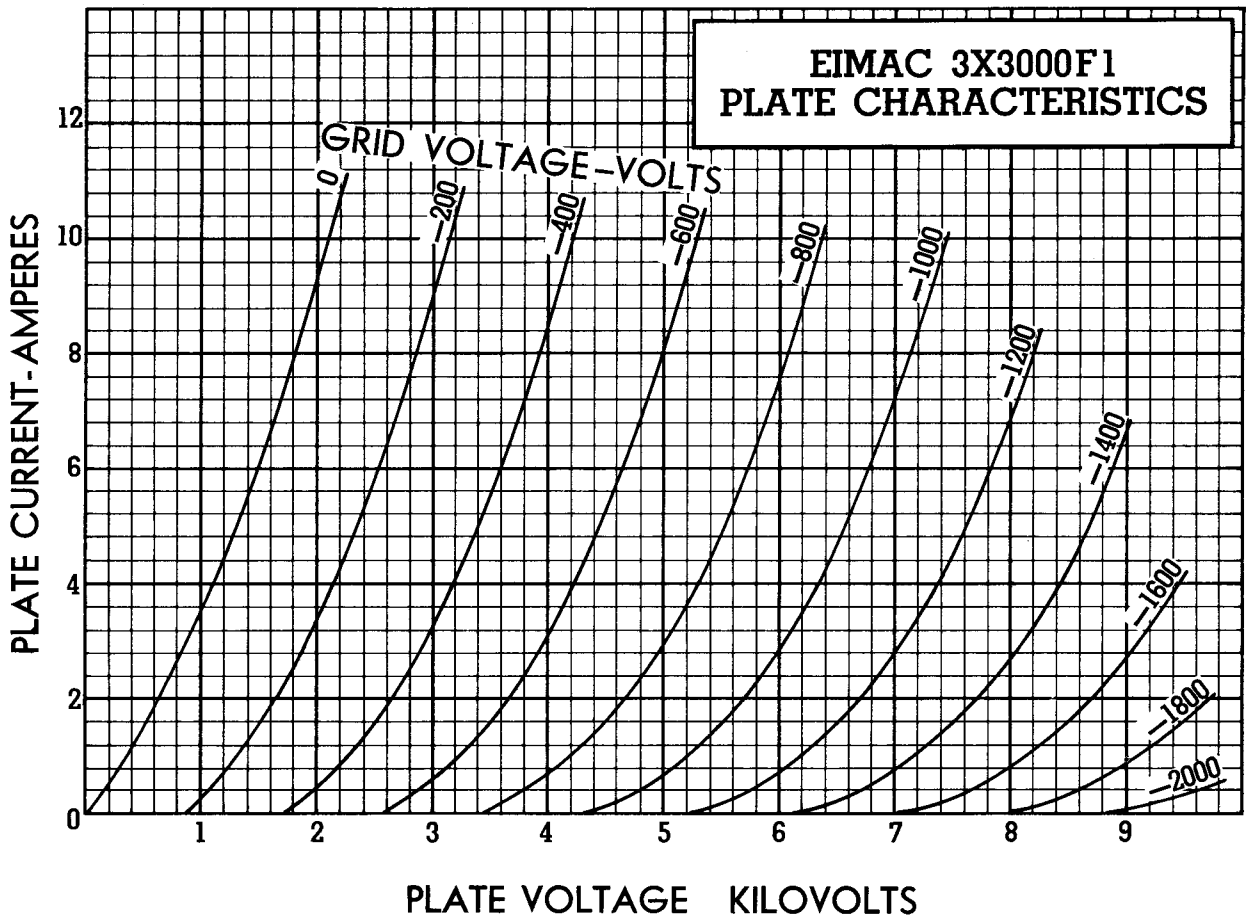
Cooling—The 3X30000F1 requires an air-flow of 150 cubic feet per minute through the anode cooler. This corresponds to a pressure drop across the cooler of 2.2 inches of water. A flow of 6 cubic feet per minute must also be directed into the filament stem structure, between the inner and outer filament conductors.

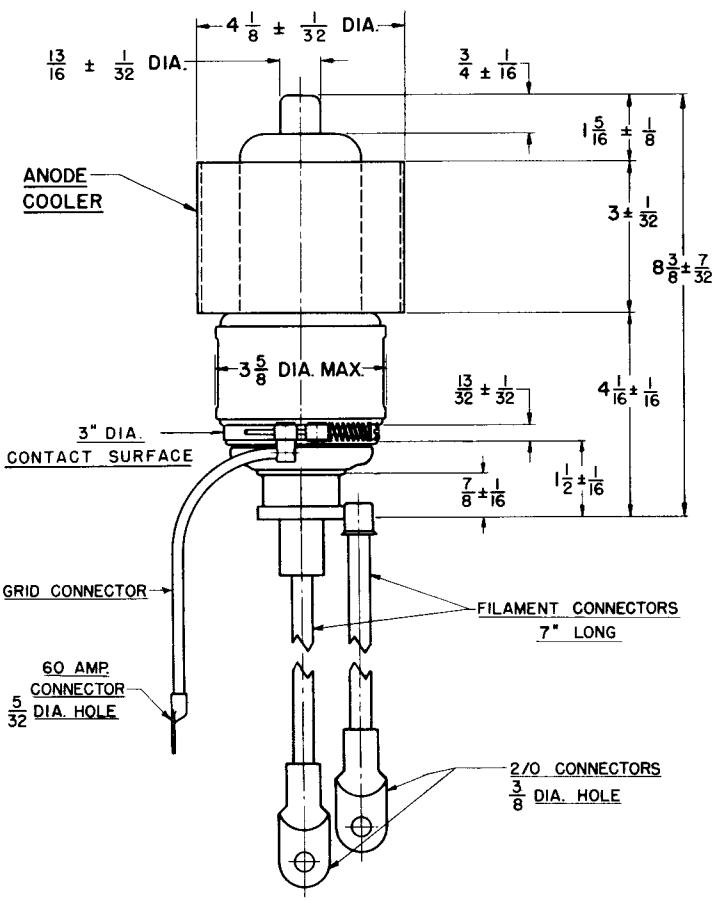
The air-flow must be started when power is applied to the filament, and must continue without interruption until all electrode voltages have been removed from the tube. It is advisable to permit the air-cooling system to operate for two minutes or more after the removal of power.

These air requirements are based upon operation at an ambient temperature of 20°C and at sea level.

Cooling conditions for the 3X3000F1 may be considered satisfactory if the temperature of the anode cooler core and of the metal parts of the metal-to-glass seals is not allowed to exceed 150°C. A convenient accessory for the measurement of these temperatures is "Tempilaq", a temperature-sensitive lacquer manufactured by the Tempil Corporation, 132 West 22nd St., New York 11, N. Y.

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TENTATIVE DATA

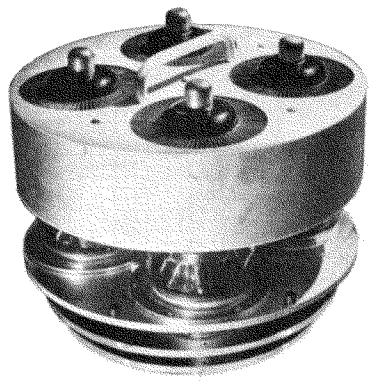
EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

3X12500A3

Medium Mu Triode

The Eimac 3X12500A3 is a medium-mu, forced-air cooled, external anode transmitting triode incorporating features which make it suitable for effective use at frequencies well into the vhf region, as well as at lower frequencies. Close electrode spacings and maximum utilization of electrode areas are made possible through the multi-unit design, which allows the production of high power at exceptionally low plate voltage, thus reducing circuit losses to an insignificant amount.

As a push-pull grounded-grid 110-Mc FM amplifier, a pair of 3X12500A3's will deliver a useful output of over 50 kilowatts at a plate voltage of 3700 volts. As a conventional grounded-filament amplifier, a power output of 30 kilowatts per tube may be obtained in class-C telegraphy service.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten		
Voltage	7.5	volts
Current	192	amperes
Maximum starting current	400	amperes
Amplification Factor (Average)	20	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	95	$\mu\mu$f.
Grid Filament	240	$\mu\mu$f.
Plate Filament	5	$\mu\mu$f.
Transconductance (e_b=3000 v., i_b=4 a.)	80,000	μmhos

MECHANICAL

Cooling	Forced air[1]	
Maximum Overall Dimensions		
Length	9.5	inches
Diameter	11.1	inches
Net Weight	32	pounds
Shipping Weight (Average)	80	pounds

RADIO FREQUENCY POWER AMPLIFIER
Grounded-Grid Circuit

Class-C FM Telephony or Telegraphy

MAXIMUM RATINGS (Frequencies below 110 Mc.)

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C PLATE CURRENT	8 MAX. AMPS.
PLATE DISSIPATION[1]	12,500 MAX. WATTS
GRID DISSIPATION	600 MAX. WATTS

TYPICAL OPERATION (110 Mc., per tube)

D-C Plate Voltage	3700	4000 volts
D-C Grid Voltage	−450	−550 volts
D-C Plate Current	7.2	7.4 amps.
D-C Grid Current	0.9	1.1 amps
Driving Power (approx.)	6.4	7.6 kw
Useful Power Output	27.4	30 kw

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Grounded-Filament Circuit

Class-C Telegraphy (Key-down conditions, per tube)

MAXIMUM RATINGS (Frequencies below 85 Mc.)

D-C PLATE VOLTAGE	5000 MAX. VOLTS
D-C PLATE CURRENT	8 MAX. AMPS.
PLATE DISSIPATION[1]	12,500 MAX. WATTS
GRID DISSIPATION	600 MAX. WATTS

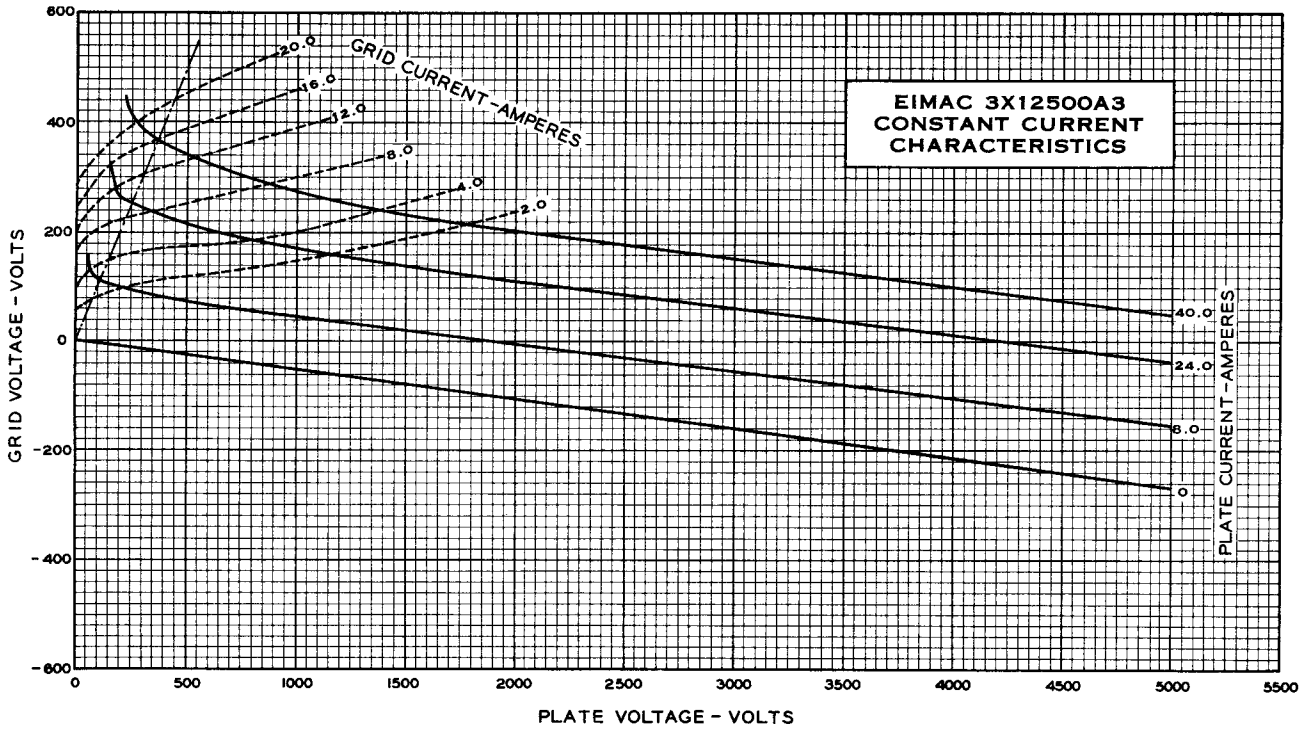
TYPICAL OPERATION (Frequencies below 50 Mc., per tube)

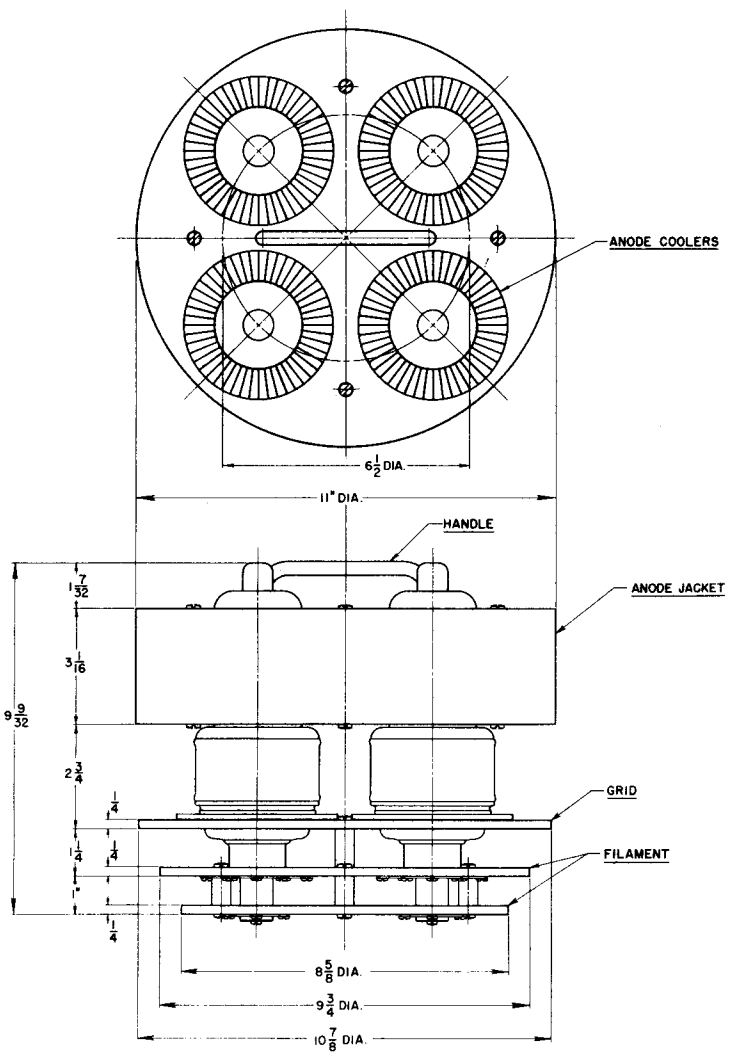
D-C Plate Voltage	3500	4000	5000	volts
D-C Grid Voltage	−420	−360	−400	volts
D-C Plate Current	7.2	6.4	8	amps
D-C Grid Current	2	1.7	1.9	amps
Peak R-F Grid Input Voltage	735	630	710	volts
Driving Power (Approx.)	1.3	0.95	1.35	kw
Grid Dissipation	480	350	590	watts
Plate Input	25.2	25.6	40	kw
Plate Dissipation	5.2	5.6	10	kw
Plate Power Output	20	20	30	kw

[1] A minimum flow of 400 cubic feet of air per minute must be passed through the plate cooler. The pressure drop across the cooler at this flow equals 1.5" of water. A minimum air flow of 200 cubic feet per minute must also be directed toward the filament end of the tube. The pressure required for filament-structure cooling is low, and depends upon the details of the tube mounting. Preference should be given to filament-structure cooling systems which allow air to enter or exhaust through the central hole in the lower filament strapping plate. Cooling air in the above amounts must be applied to both the plate cooler and filament assembly before applying filament voltage and should be continued for five minutes after the filament power is removed.

▶ Indicates change from sheet dated 2-25-47

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EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

4CN15A

CERAMIC POWER TETRODE

The Eimac 4CN15A is a coolerless version of the 4CX300A tetrode intended for use in low duty or pulse service. It is electrically identical to the 4CX300A with the exception of plate dissipation which is rated at 15 watts in air. Where other cooling means are used, such as liquid immersion, plate dissipation is limited only by the maximum allowable anode and seal temperatures.



GENERAL CHARACTERISTICS

ELECTRICAL

		Min.	Nom.	Max.	
Cathode:	Oxide-Coated, Unipotential				
	Heating Time	30	60		seconds
	Cathode-to-Heater Potential			±150	volts
Heater:	Voltage		6.0		volts
	Current	2.6		3.1	amperes
Amplification Factor (Grid to Screen)		4.0		5.6	
Transconductance (I_b = 200 ma)			12,000		umhos
Direct Interelectrode Capacitances, Grounded Cathode:					
	Input	25		33	uuf
	Output	3.5		4.5	uuf
	Feedback			0.06	uuf
Frequency for Maximum Ratings				500	Mc

MECHANICAL

Base	Special, breechblock terminal surfaces
Recommended Socket	Eimac SK-700 series
Operating Position	Any
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250° C
Anode Core	250° C
Cooling	Convection or conduction
Maximum Over-all Dimensions:	
Height	2.5 inches
Diameter	inches
Net Weight	2.5 ounces
Shipping Weight	1 pound

MAXIMUM CW RATINGS

	Class-C FM or Teleg	Class-C Plate Mod	Class-AB		
DC PLATE VOLTAGE	2000	1500	2500*	MAX.	VOLTS
DC PLATE CURRENT	250	200	250	MAX.	MA
DC SCREEN VOLTAGE	300	300	400	MAX.	VOLTS
DC GRID VOLTAGE	-250	-250	---	MAX.	VOLTS
PLATE DISSIPATION	15**	10**	15**	MAX.	WATTS
SCREEN DISSIPATION	12	12	12	MAX.	WATTS
GRID DISSIPATION	2	2	2	MAX.	WATTS

*Up to 250 Mc.

**Rating in air - may be increased with adequate cooling.

(Effective 6-1-68) © 1963, 1968 by Varian

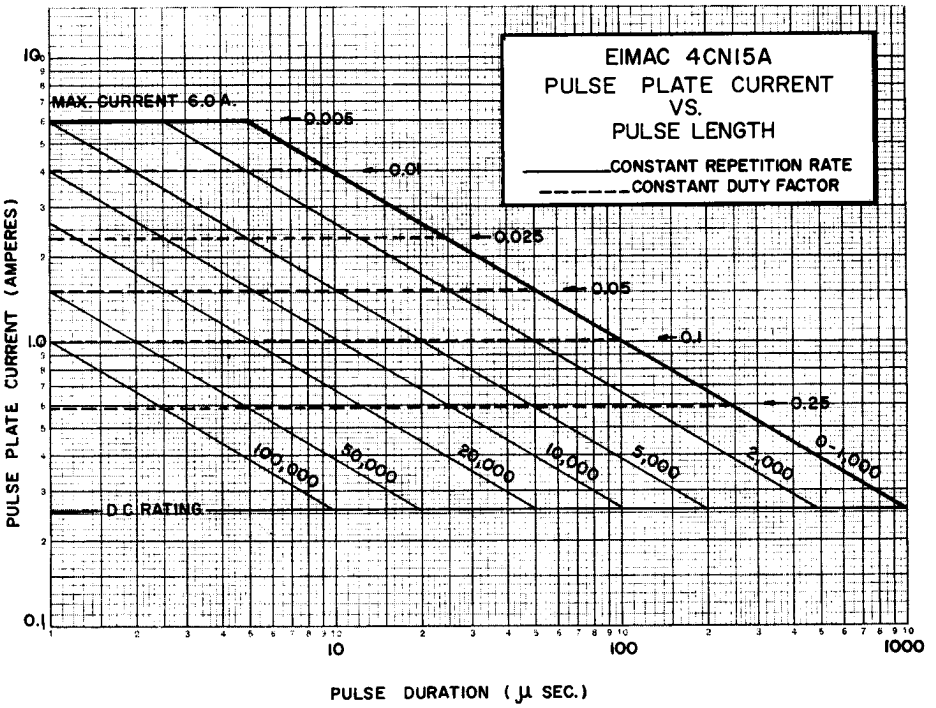
Printed in U.S.A.

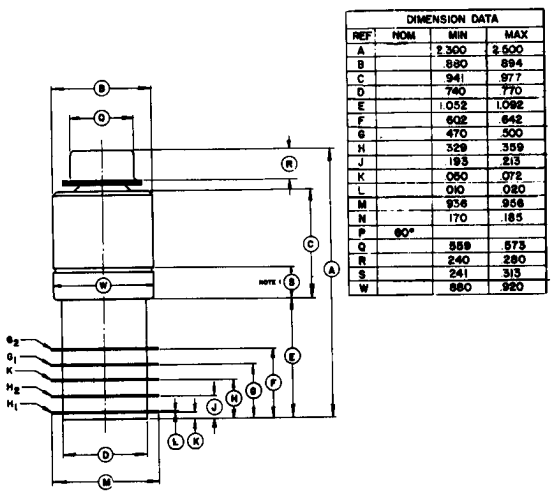
MAXIMUM PULSE RATINGS

	Class-C Grid Pulsed	Class-C Plate Pulsed	Pulse Modulator		
DC PLATE VOLTAGE	2500	7000 (pulsed)	4000	MAX.	VOLTS
PEAK PLATE CURRENT (DC Component)	6.0*	6.0*	6.0*	MAX.	AMPS
DC GRID VOLTAGE	-300	-500	-300	MAX.	VOLTS
DC SCREEN VOLTAGE	750	1500 (pulsed)	750	MAX.	VOLTS
PLATE DISSIPATION (AVG)**	15	15	15	MAX.	WATTS
SCREEN DISSIPATION (AVG)	12	12	12	MAX.	WATTS
GRID DISSIPATION (AVG)	2	2	2	MAX.	WATTS

*According to table below.

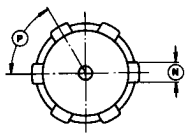
**Depends on cooling method.





DIMENSION DATA			
REF	NOM	MIN	MAX
A		2.300	2.500
B		.880	.894
C		.941	.977
D		.740	.770
E		1.052	1.092
F		.602	.642
G		.470	.500
H		.329	.359
J		.193	.213
K		.060	.072
L		.010	.020
M		.936	.956
N		.170	.185
P	60°		
Q		.559	.575
R		.240	.280
S		.241	.313
W		.880	.920

NOTE: These dimensions reflect standard manufacturing tolerances. Where they are to be made the basis of purchase specifications, they should first be checked with the factory.



NOTES:
1. DO NOT CONTACT THIS SURFACE.
2. DIMENSIONS IN INCHES.

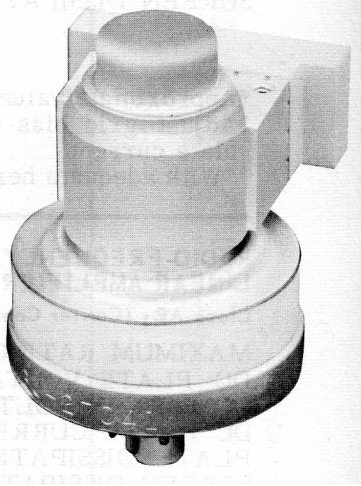
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

4CS100L

QUICK-HEAT POWER TETRODE

The Eimac 4CS100L is a metal-ceramic power tetrode with a quick-heating cylindrical cathode intended for use in portable and mobile transmitters. Power output 3 db down from normal is available within one second after the application of rated heater voltage. Tube operation in approximately 150 milliseconds can be obtained by using a built-in control diode and a minimum amount of additional circuitry.

The conduction cooled 4CS100L has a maximum plate dissipation rating of 100 watts and may be operated at frequencies up to 250 megacycles.



GENERAL CHARACTERISTICS

ELECTRICAL

		Min.	Nom.	Max.	
Cathode:	Oxide-coated, directly heated				
	Heating time (rated filament voltage)	1	2		seconds
	Heating time (at 6.2 volts)		0.15		second
Heater:	Voltage (See "Application")		2.1		volts
	Current (Ef=2.1 volts)	7.15		8.10	amperes
	Absolute Maximum Filament Voltage for fast warm-up (See "Application")		6.2		volts
Amplification Factor (grid to screen)		10	13		
Transconductance (Ib=150 ma)			20,000		umhos

Direct Interelectrode Capacitances, Grounded Cathode:

Input	26.0 pf
Output*	5.2 pf
Feedback	0.05 pf

*When mounted on a metal chassis, approximately 6.0 pf anode-to-ground capacitance is added to this value.

Frequency for Maximum Ratings - 250 Mc

Control Diode Ratings:

Plate Resistance (Id=0.01A, Ec=0v)	1200 ohms
(Id=0.01A, Ec= —40v)	1600 ohms
Plate Dissipation (Maximum)	0.5 watts
DC Plate Voltage (Maximum)	150 volts
DC Plate Current (Maximum)	20 mA

MECHANICAL

Base	Special 9-pin
Recommended Socket	Eimac, SK-660
Operating Position	Any
Maximum Operating Temperatures:	
Ceramic to Metal Seals	250° C
Anode Core	250° C
Cooling	Conduction
Maximum Over-all dimensions:	
Height	2.464 inches
Width	1.728 inches
Net Weight	4 ounces

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RADIO-FREQUENCY LINEAR AMPLIFIER

Class AB_1 (Single Sideband Suppressed-Carrier Operation)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 MAX. VOLTS
DC SCREEN VOLTAGE	400 MAX. VOLTS
DC PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	**100 MAX. WATTS
SCREEN DISSIPATION	8 MAX. WATTS

*Approximate values
1Adjust grid bias to obtain listed zero-signal plate current
**With adequate heat sink contact

TYPICAL OPERATION

DC Plate Voltage	1000	1500	2000 volts
DC Screen Voltage	400	400	400 volts
DC Grid Voltage[1]	—33	—33	—33 volts
Zero-Signal DC Plate Current	30	30	30 mA
DC Plate Current	150	150	140 mA
DC Screen Current*	5	4	8 mA
Peak RF Grid Voltage*	24	24	24 volts
Plate Input Power	145	220	280 watts
Plate Output Power	65	125	185 watts
Two-Tone Average DC Plate Current	96	96	96 mA
Two-Tone Average DC Screen Current	3	3	3 mA

RADIO-FREQUENCY LINEAR AMPLIFIER

Class AB_1 (Carrier Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 MAX. VOLTS
DC SCREEN VOLTAGE	400 MAX. VOLTS
DC PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	**100 MAX. WATTS
SCREEN DISSIPATION	8 MAX. WATTS

*Approximate values
1Adjust grid bias to obtain listed zero-signal plate current
**With adequate heat sink contact

TYPICAL OPERATION

DC Plate Voltage	1000	1500	2000 volts
DC Screen Voltage	400	400	400 volts
DC Grid Voltage[1]	—33	—33	—33 volts
Zero-Signal DC Plate Current	30	30	30 mA
DC Plate Current	55	55	55 mA
DC Screen Current*	0	0	0
Peak RF Grid Voltage*	12	12	12 volts
Plate Output Power	10	17	30 watts

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class AB_1

MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	2000 MAX. VOLTS
DC SCREEN VOLTAGE	400 MAX. VOLTS
DC PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	**100 MAX. WATTS
SCREEN DISSIPATION	8 MAX. WATTS

*Approximate values
1Adjust grid bias to obtain listed zero-signal plate current
**With adequate heat sink contact

TYPICAL OPERATION (Sinusoidal wave, two tubes)

DC Plate Voltage	1000	1500	2000 volts
DC Screen Voltage	400	400	400 volts
DC Grid Voltage[1]	—33	—33	—33 volts
Zero-Signal DC Plate Current	60	60	60 mA
Max. Signal DC Plate Current	300	300	280 mA
Max. Signal DC Screen Current	10	8	16 mA
Effective Load, Plate to Plate	4700	8600	13800 ohms
Peak AF Grid input voltage* (per tube)	24	24	24 volts
Driving Power	0	0	0 watts
Max. Signal Plate Output Power	130	250	370 watts

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance is made for circuit losses of any kind. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf driving voltage is applied.

APPLICATION

MECHANICAL

MOUNTING

The 4CS100L may be mounted in any position provided that the anode beryllium oxide insulator is properly mated to an adequate heat sink. A heat-conducting socket, such as the Eimac SK-660, or a socket having equivalent characteristics, is required. The screen must be by-passed by the Eimac SK-665 capacitor. This capacitor also includes a provision for a dc connection to the tube's screen ring. There is no pin connection on the tube base for a screen connection.

COOLING

Maximum ratings for the 4CS100L depend on adequate conduction cooling to maintain all tube and seal temperatures at 250° C or below. Maximum anode dissipation depends on intimate mating of the BeO anode insulator to an adequate heat-sink. A conductive lubricant is suggested to insure proper seating of the BeO insulator to the heat-sink. Tube temperatures can be expected to run up to 120° C above the beryllia-to-heat-sink surface temperature.

Base cooling is also by conduction through the Eimac SK-660 socket (or equivalent). To insure proper cooling, tube temperatures should be monitored with temperature sensitive lacquer or by some other means in any new installation.

VIBRATION

This tube is capable of satisfactorily withstanding ordinary shock and vibration, such as encountered in normal operation and handling. The tubes will function well in portable, automobile and truck mobile installations or similar environments.

ELECTRICAL

HEATER OPERATION

With the rated heater voltage of 2.1 volts applied, the warm-up time is approximately 1 second for power output 3 db down from normal. Approximately 2 seconds are required for full output power. The heater voltage must be maintained within $\pm 5\%$ of its rated value to minimize variations in performance and to obtain maximum tube life.

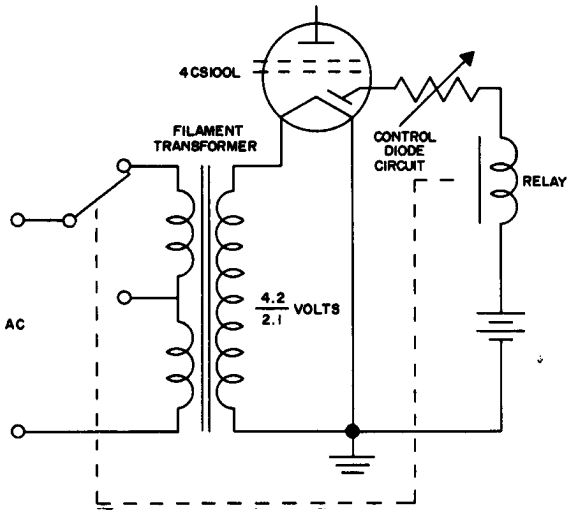
However, the warm-up time may be reduced to approximately 0.15 second by applying overvoltage to the heater for a short period of time, as controlled by the control diode, and then switching to rated heater voltage when the cathode has reached normal operating temperature. Overvoltage must be limited to 3 times nominal (Ef=6.2 volts maximum), for the proper length of time. This feature permits "push-to-talk" operation, of portable and mobile equipment with significant extension of battery life.

CONTROL DIODE OPERATION

Extreme caution must be taken to insure that heater overvoltage is not applied beyond the time at which the cathode reaches operating temperature, since the voltage used is sufficient to destroy the cathode. Proper operation will be insured if overvoltage is removed when control diode anode current reaches 65% of its steady state operating value.

The control diode built into the tube is designed specifically for sensing cathode temperature, and in combination with a properly designed relay circuit will allow overvoltage for a short period followed by a switch to normal voltage. Since the control diode section of the tube is intended for dc switching use only, the control diode anode polarity should not be made negative with respect to the cathode. A typical simplified control circuit is shown; more sophisticated, fail-safe circuits can be used.

In any application, the actual circuit details will depend on such factors as the operating time of the relay used and the degree of overvoltage used initially. It is recommended that the Power Grid Tube Marketing, Eitel-McCullough, Inc., San Carlos, California be contacted for assistance in the use of the Eimac 4CS100L, in applications requiring the use of heater overvoltage.



CONTROL-GRID OPERATION

The grid dissipation rating of the 4CS100L is 0.5 watts and precautions should be observed to avoid exceeding this rating. The 4CS100L is a high transconductance tube requiring low drive voltage for full power output. The design features which make this tube capable of maximum power

operation with low grid drive also make it necessary to avoid drawing significant grid current. Although the tube was designed primarily for Class AB_1 operation, it may be used for Class C applications if the above control grid precautions are carefully observed.

SCREEN-GRID OPERATION

The maximum rated power dissipation for the screen grid is 8 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

Protection for the screen can be provided by an overcurrent relay and by interlocking the screen supply so that the plate voltage must be applied before screen voltage can be applied.

The screen current may reverse under certain conditions, and produce negative current indications on the screen milliameter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind, so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor or shunt regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per connected screen. An electron tube series regulator can be used only when an adequate bleeder resistor is provided.

A screen by-pass capacitor such as the Eimac SK-665 may be used. Connection to the screen is made to the contact on the SK-655 or to the screen ring on the tube.

PLATE OPERATION

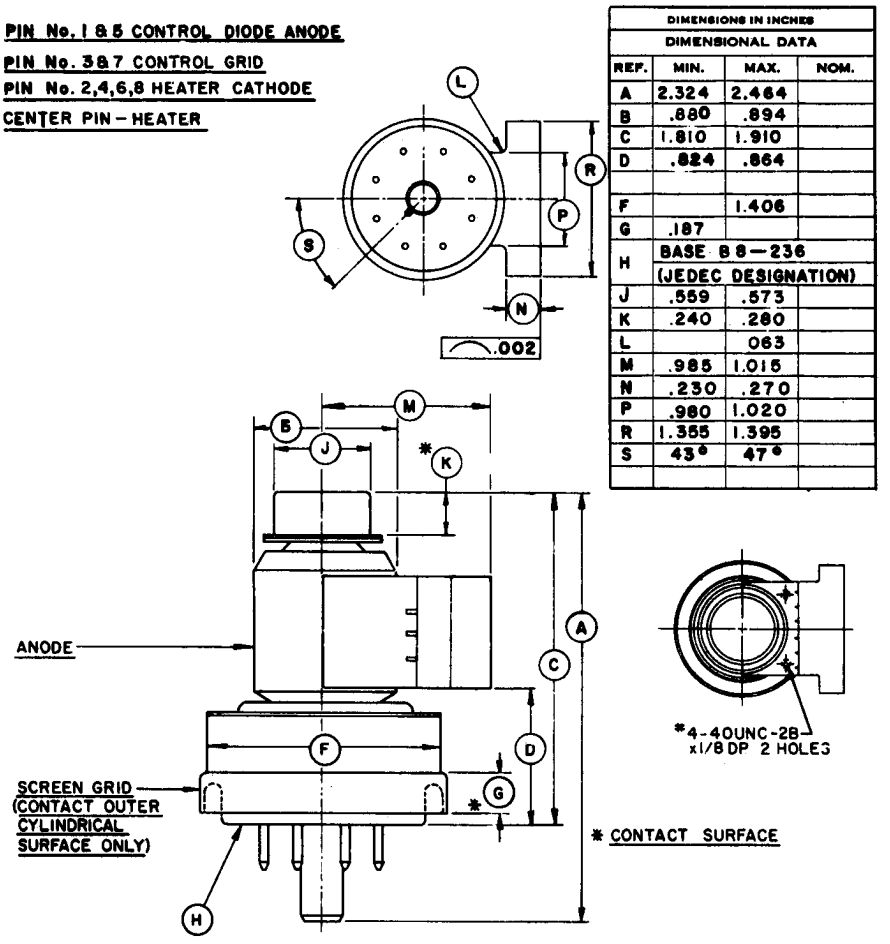
Connection to the anode may be made at the top cap or to the tapped holes on the anode "saddle."

The maximum plate-dissipation rating for the 4CS100L is 100 watts. Plate dissipation may be permitted to exceed the maximum rated value if rated core and seal temperature is maintained.

The maximum rated plate voltage for Class AB_1 operation at frequencies up to 250 megacycles is 2000 volts.

SPECIAL APPLICATIONS

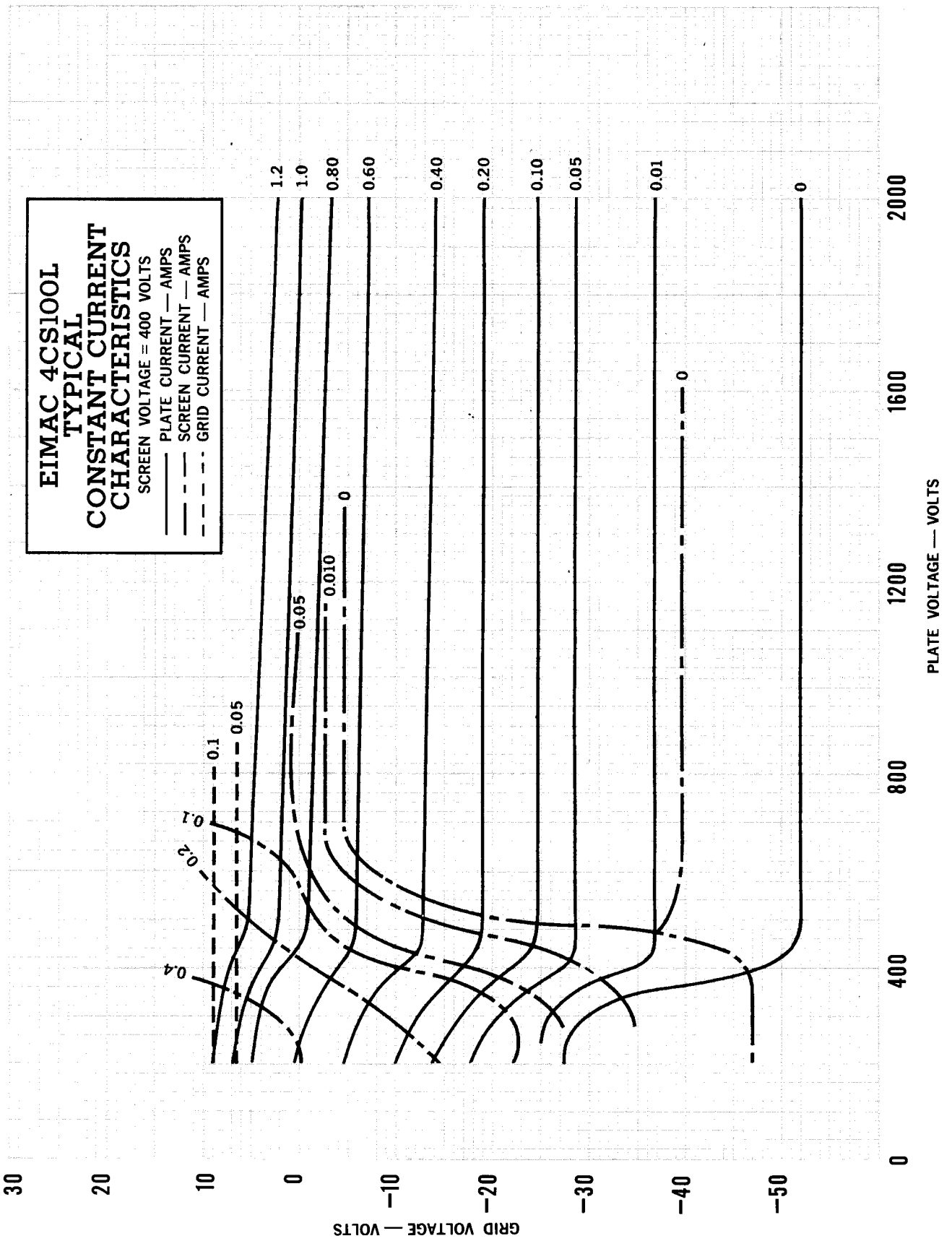
If it is desired to operate this tube under conditions widely different from those given here, write to Eitel-McCullough, Inc. for information and recommendations.

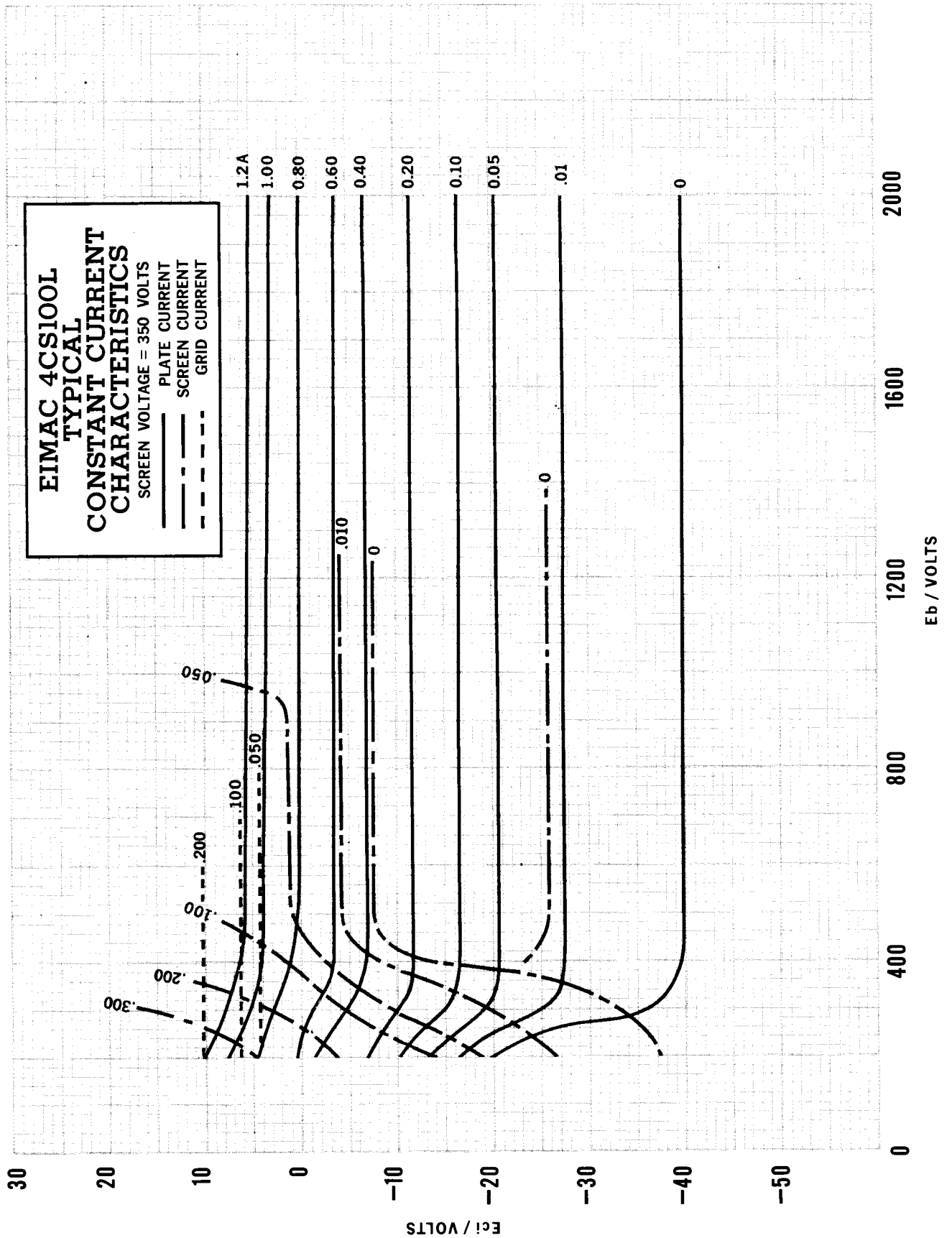


DIMENSIONS IN INCHES

DIMENSIONAL DATA

REF.	MIN.	MAX.	NOM.
A	2.324	2.464	
B	.880	.894	
C	1.810	1.910	
D	.824	.864	
F		1.406	
G	.187		
H	BASE B 8–236 (JEDEC DESIGNATION)		
J	.559	.573	
K	.240	.280	
L		063	
M	.985	1.015	
N	.230	.270	
P	.980	1.020	
R	1.355	1.395	
S	43°	47°	


EIMAC 4CS100L
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 400 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
1.2
1.0
0.80
0.60
0.40
0.20
0.10
0.05
0.01
0
0.05
0.010
0
0.1
0.05
0.1
0.2
0.4
30
20
10
0
−10
−20
−30
−40
−50
GRID VOLTAGE — VOLTS
0
400
800
1200
1600
2000
PLATE VOLTAGE — VOLTS

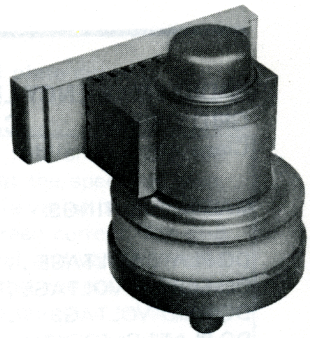

EIMAC 4CS100L
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 350 VOLTS
PLATE CURRENT
SCREEN CURRENT
GRID CURRENT
1.2A
1.00
0.80
0.60
0.40
0.20
0.10
0.05
.01
0
.010
0
.050
.100
.200
.100
.200
.300
30
20
10
0
−10
−20
−30
−40
−50
Ec1 / VOLTS
0
400
800
1200
1600
2000
Eb / VOLTS

4CS250R

TECHNICAL DATA

CONDUCTION COOLED
RADIAL BEAM
TETRODE

The 4CS250R is a compact, conduction cooled, high perveance radial beam tetrode. It is electrically identical to the 4CX250R except that the maximum dissipation of the 4CS250R is limited only by the maximum allowable anode and ceramic/metal seal temperatures. A beryllium oxide (BeO) thermal link is brazed to the anode providing an electrically isolated, low thermal resistance path between the anode and the heat sink. Ruggedized construction allows the 4CS250R to be operated in applications where shock and/or vibration is experienced.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	6.0 ± 0.3 V
Current, at 6.0 volts	2.6 A
Cathode - Heater Potential	±150 V
Direct Interelectrode Capacitances (grounded cathode)[2]	
Input	17 pF
Output [3]	4.7 pF
Feedback	0.04 pF
Frequency of Maximum Rating:	
CW	500 MHz
Plate or Grid-Pulsed	500 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. In Shielded Fixture.
3. See output capacitance.

MECHANICAL

Maximum Overall Dimensions:	
Length	2.46 in; 62.5 mm
Diameter	1.76 in; 44.9 mm
Net Weight	5 oz; 141.7 gm
Operating Position	Any

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Maximum Operating Temperature:

Ceramic/Metal Seals	250°C
Anode Core	250°C
Plate and Base Seals	250°C
Cooling	Conduction
Base	Special 9-pin
Recommended Socket	EIMAC SK-660, SK-661 series

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN CATHODE DRIVEN
Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	500	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.250	AMPERE
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 500 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	1500	2000	Vdc
Screen Voltage	350	400	Vdc
Grid Voltage [1]	-62	-80	Vdc
Zero-Signal Plate Current	133	70	mAdc
Two-Tone Plate Current	250	245	mAdc
Two-Tone Screen Current [2]	-10	+1	mAdc
Peak rf Grid Voltage	56	80	v
Useful Output Power	262	470	w
Resonant Load Impedance	2160	2840	Ω
Intermodulation Distortion Products [3]			
3rd Order	-30	-23	db
5th Order	-35	-27	db

1. Adjust to specified zero-signal dc plate current.
2. Approximate values.
3. The intermodulation distortion products are referenced against one tone of a two equal tone signal.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM Telephony
(Key-Down Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.250	AMPERE
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	250	250	250	Vdc
Grid Voltage	-90	-90	-90	Vdc
Plate Current	227	240	241	mAdc
Screen Current [1]	9	8	8	mAdc
Grid Current [1]	11	10.5	10.5	mAdc
Peak rf Grid Voltage [1]	104	104	104	v
Calculated Driving Power [1]	1.2	1.1	1.1	W
Plate Input Power	170	360	482	W
Plate Dissipation	17	91	103	W
Plate Output Power	153	269	379	W
Resonant Load Impedance	1833	2900	4041	Ω

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN
Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	1500	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.200	AMPERE
SCREEN DISSIPATION [1]	12	WATTS
GRID DISSIPATION [1]	2	WATTS

1. Average, with or without modulation.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR
Class AB_1, Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube):

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	500	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.250	AMPERE
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Two Tubes) (Push-Pull)

Plate Voltage	1500	2000	Vdc
Screen Voltage	300	350	Vdc
Grid Voltage 1/2	-48	-66	Vdc
Zero-Signal Plate Current	200	140	mAdc
Max. Signal Plate Current	490	500	mAdc
Zero-Signal Screen Current[1]	-2	-4	mAdc
Max. Signal Screen Current[1]	0	+4	mAdc
Plate Output Power	390	595	W
Load Resistance (plate to plate)	5920	8016	Ω

1. Approximate value.
2. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	2.3	2.9	A
Cathode Warmup Time	30	---	sec.
Interelectrode Capacitances[1] (grounded cathode connection)			
Input	16.0	18.5	pF
Output	4.2	5.2	pF
Feedback	---	0.06	pF

1. In Shielded Fixture.

APPLICATION

MECHANICAL

MOUNTING & SOCKETING - The 4CS250R may be mounted in any position. EIMAC SK-660 and SK-661 socket series is recommended. The SK-660 (made of alumina) and the SK-661 (made of BeO) will allow the tube base seal heat to be effectively transferred to the heat sink. Other sockets may be used if a means for keeping the ceramic/metal base seals below 250°C is provided. The EIMAC SK-655 and ERIE 2943 and 2929 series screen by-pass capacitor are recommended for use with the 4CS250R. Figure 1 shows the recommended method of mounting the 4CS-250R to the heat sink.

When using natural convection heat sinks, Figure 2 will assist the designer in determining the minimum heat sink surface area required for the given power dissipation. The thermal and electrical characteristics of the BeO used on the 4CS250R are given in Table I and Figure 3.

A good thermally conductive compound (1) should be used in the interface to reduce the thermal resistance of this joint. In addition, the method of fastening the tube to the heat sink should provide reasonable compression to help further reduce this interface thermal resistance.

The effectiveness of any cooling system used with the 4CS250R is determined by the anode and ceramic/metal seal temperatures. These must be held below 250°C for all conditions of expected ambient temperatures and operation. These temperature parameters should be measured in the design stage using accurate thermocouples or thermistors.

(1) Thermal joint compound and supplier.

a) Wakefield 120, Wakefield Engineering Co. Wakefield, Mass.
b) Dow Corning 340, Dow Corning Corp., Midland, Michigan.
c) Astrodyne Thermal Bond 312, Astrodyne, Inc., Burlington, Mass.
d) General Electric Insulgrease – G641, General Electric Co. Cleveland Ohio, 44117.

COOLING - The 4CS250R is designed for conduction cooled systems by using a beryllium oxide (BeO) thermal link brazed to the anode. The BeO is a ceramic material which exhibits high thermal conductance similar to aluminum and high electrical resistance and low loss typical of ceramics. When this BeO thermal link is fastened to a suitable heat sink, it provides a low thermal resistance path allowing the anode heat to be transferred to the heat sink. The BeO also provides electrical isolation between the tube anode and the heat sink.

The heat sink can be cooled by natural (free) convection, forced air convection, liquid cooling or a combination of these methods. The design choice is determined by the tubes application but in all cases the cooling system must maintain the anode and ceramic/metal seal temperatures below 250°C.

In a conduction cooled system, anode temperature and seal temperature are determined by the thermal resistance of the thermal path between the anode and the cooling medium, e.g., air, water. The thermal path consists of the Beryllium oxide thermal link, the interface between the thermal link and heat sink, and the heat sink. The thermal resistance of the BeO thermal link versus its average temperature is given in Figure 3. The tube user must then determine the thermal resistance of the thermal link from the BeO thermal link to the cooling medium for his particular application.

DANGER-BERYLLIUM OXIDE CERAMICS (BeO) BREATHING DUST OR FUMES CAN KILL
Normal use of tubes with Beryllium Oxide ceramics is not hazardous, but the user is cautioned that breathing small quantities of the dust or fumes from Beryllium Oxide can seriously injure or kill. Do not alter, disassemble, grind, lap, fire, chemically clean, or perform any other operation on the Beryllium Oxide block attached to the anode of the 4CS250R, or to the socket used with the tube, which may also contain Beryllium Oxide.

Any tube or accessory part containing Beryllium Oxide ceramics should be returned to EIMAC at the end of its useful life, with authorization for disposal.

SHOCK AND VIBRATION - The 4CS250R is shock and vibration tested with plate and screen voltages applied. Production tubes are randomly sampled and tested under the following conditions.

With a plate voltage of 2000 volts applied, the tubes sampled are subjected to six shocks of 90 G's minimum half-sine-wave motion, with a duration of 11.0 ± 2 milliseconds, in each of the three major axes (X, Y, Z).

With the rated plate and screen voltages applied and the control grid voltage adjusted for a plate current of 100 ma. through a plate load resistance of 4900 ohms, each of the tubes tested is vibrated in the three major axes throughout the range of 28 to 2000 and back to 28 Hz in a

CHARACTERISTICS OF 99.5% BeO

Electrical Resistivity in ohm-cm @250°F	10^{14}	Dielectric Strength in volts/mil	300
Dielectric Constant at 70°F and 1 MHz at 70°F and 8.5 GHz at 250°F and 8.5 GHz	 6.40 6.57 6.64	Thermal Conductivity (K) in Cal./Cm2/Cm/Sec./°C of 99.5% BeO	
Loss Tangent at 70°F and 1 MHz at 70°F and 8.5 GHz at 250°F and 8.5 GHz	 0.0006 0.00044 0.00040	20°C 100°C 400°C	0.60 0.45 0.20
		(From Coors Data Sheet 0001, Aug 1965)	

Table I

minimum time of six minutes per axis. The vibration level is maintained at 10 G's. The noise voltage developed across the plate load resistor may not exceed 30 volts rms.

VOLTAGE BREAKDOWN VERSUS ALTITUDE - Table II shows typical breakdown voltage versus altitude across the BeO thermal link. The measurements were taken with the heat sink plate at ground potential and the anode at the breakdown potential.

Altitude (thousands of feet)	All voltage readings in kVdc (typical)
Sea Level	11.5
5	10.5
10	10.5
15	9.0
20	7.5
25	6.5
30	5.5
35	5.0
40	4.0
45	4.0
50	3.5

Table II

OUTPUT CAPACITANCE - The interelectrode capacitances given in the General Characteristics are measured in a shielded fixture and does not include additional external capacitances. The typical capacitance between the anode and a heat sink plate 4'' x 4'' is 6.7 pF at 25°C. Total output capacitance will be approximately 11.5 pF. The measurement configuration is shown in Figure 1.

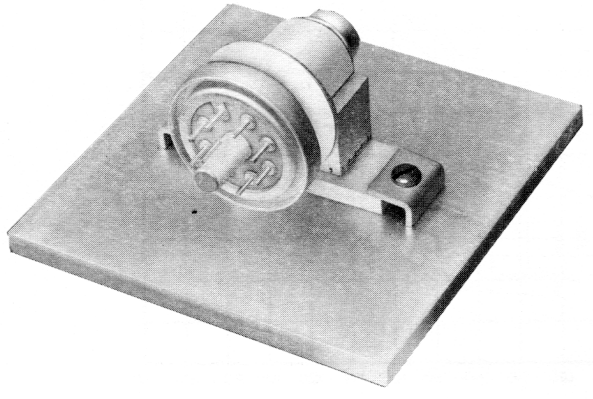


FIG. 1 TYPICAL MOUNTING CONFIGURATION

ELECTRICAL

HEATER/CATHODE OPERATION - For maximum life and uniform performance, the heater voltage should be maintained within plus or minus 5% of the rated 6.0 volts at operating frequencies up to 300 MHz for CW use.Between 300 and 400 MHz, 5.75 volts is recommended and between 400 and 500 MHz 5.5 volts is recommended.

GRID OPERATION - Maximum rated dc bias voltage is -250 volts. D.C. resistance, grid to cathode, should be no more than 100,000 ohms. Maximum grid dissipation allowable is 2 watts.

SCREEN OPERATION - Maximum screen dissipation is 12 watts, normally computed by multiplying dc screen voltage by the average screen current. This computation is essentially correct except in the case of heavy plate loading when secondary emission current may mask the normal screen current.

All tetrodes, under some conditions of loading and drive, will exhibit secondary emission from the screen which changes the net current to the screen and may even cause the screen meter to reverse. Normally, secondary emission is harmless provided the screen voltage is stable. To insure stable screen voltage, it is recommended that a bleeder resistor calculated to pass 15 ma from screen to ground be used.

PLATE OPERATION - The plate dissipation rating of the 4CS250R is limited by anode core and ceramic/metal seal temperature. These are a function of the thermal link and are discussed in the "Cooling" section.

MULTIPLE OPERATION - To obtain maximum power with minimum distortion from tubes operated in multiple it is desirable to adjust individual screen or grid-bias voltages so the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual dc plate currents will be approximately equal for full input signal for class-AB_1 operation.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

ANODE POWER DISSIPATION OF 4CS250R VS HEAT SINK
AREA FOR WAKEFIELD B–1703 (SAFETY FACTOR INCLUDED)

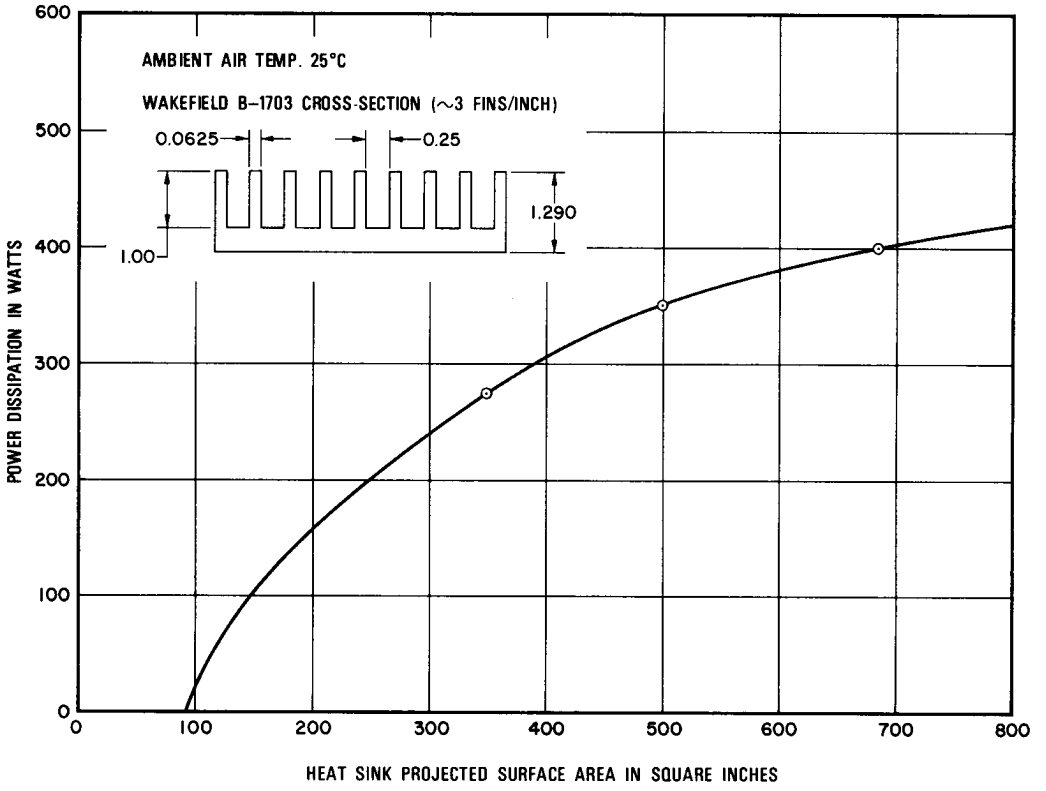


FIG. 2

THERMAL RESISTANCE VS AVERAGE TEMPERATURE OF 4CS250R THERMAL LINK INCLUDING 1 LAYER
OF WAKEFIELD 120 THERMAL COMPOUND BETWEEN B_EO AND HEAT SINK

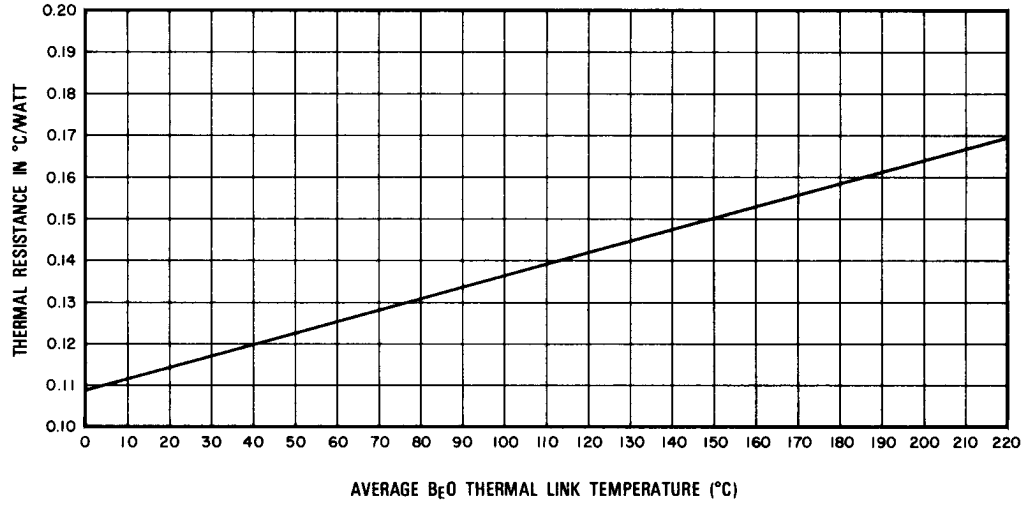
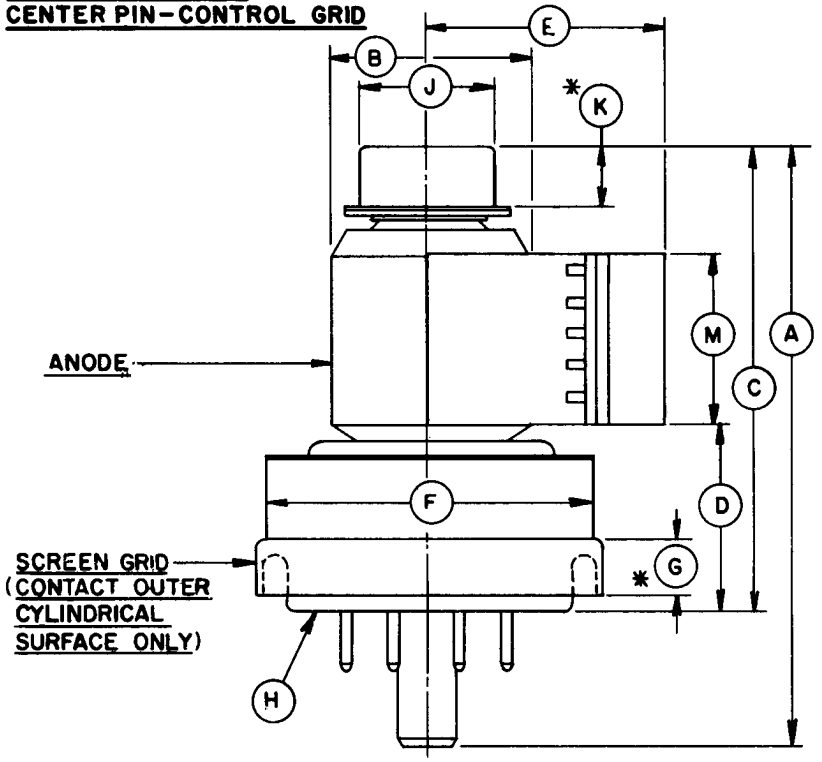
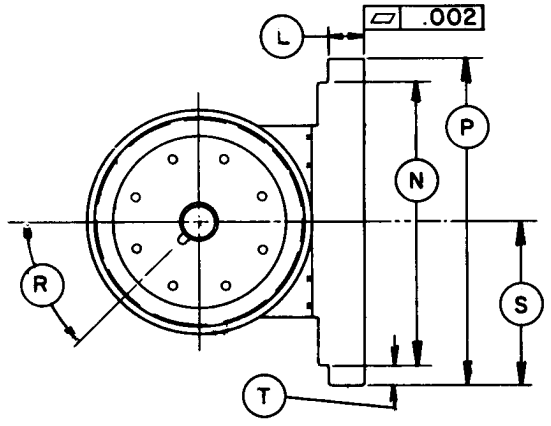
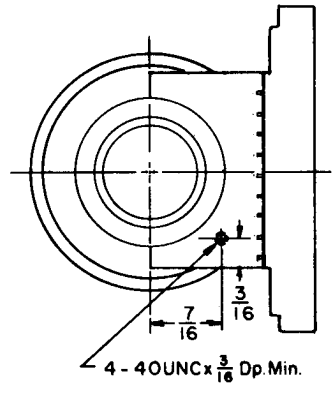


FIG. 3

PIN NO. 1. SCREEN GRID
PIN NO 2 CATHODE
PIN NO. 3. HEATER
PIN NO. 4. CATHODE
PIN NO. 5. I.C. DO NOT USE FOR EXTERNAL CONNECTION
PIN NO. 6. CATHODE
PIN NO. 7. HEATER
PIN NO. 8. CATHODE
CENTER PIN-CONTROL GRID







TOP VIEW

DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	2.324	2.464	- -	59.03	62.59	- -
B	0.880	0.894	- -	22.35	22.71	- -
C	1.810	1.910	- -	45.97	48.51	- -
D	0.760	0.800	- -	19.30	20.32	- -
E	0.985	1.015	- -	25.02	25.78	- -
F	- -	1.406	- -	- -	35.71	- -
G	0.187	- -	- -	4.75	- -	- -
H	BASE B8-236 (JEDEC DESIGNATION)					
J	0.559	0.573	- -	14.20	14.55	- -
K	0.240	- -	- -	6.10	- -	- -
L	0.214	0.228	- -	5.44	5.79	- -
M	0.600	0.640	- -	15.24	16.26	- -
N	1.733	1.767	- -	44.02	44.88	- -
P	19.80	20.30	- -	50.29	51.56	- -
R	43°	47°	- -	43°	47°	- -
S	0.985	1.105	- -	25.02	25.78	- -
T	0.107	0.143	- -	2.72	3.63	- -

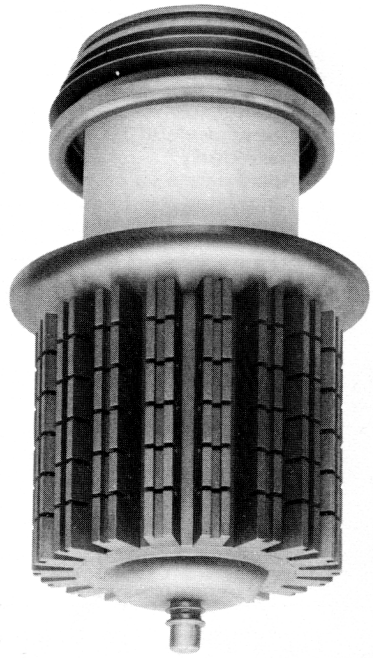
NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8351
4CV100,000C
VAPOR COOLED POWER TETRODE

The EIMAC 8351/4CV100,000C is a ceramic-metal, vapor-cooled power tetrode intended for use at the 100 to 200 kilowatt output power level. It is recommended for use as a Class-C rf amplifier or oscillator, a Class-AB, rf linear amplifier or a Class-AB, push-pull af amplifier or modulator. The 8351/4CV100,000C is also useful as a plate and screen modulated Class-C rf amplifier.

The vapor-cooled anode is rated at 100 kilowatts of plate dissipation when mounted in the EIMAC BR-300 series boiler.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten			
Voltage		10	V
Current		300	A
Amplification Factor (Grid-Screen) (average)		4.5	
Interelectrode Capacitances, Grounded Cathode	*Min.*	*Max.*	
Input	420	500	pF
Output	46	56	pF
Feedback	1.5	3.2	pF
Interelectrode Capacitances, Grounded Grid			
Input	170	210	pF
Output	48	58	pF
Feedback	---	0.6	pF
Frequency for Maximum Ratings		30	MHz

MECHANICAL

Base	Special, graduated rings
Maximum Seal Temperature	250°C
Maximum Anode Flange Temperature	130°C
Recommended Socket	EIMAC SK-1500 Series
Recommended Boiler	EIMAC BR-300 Series
Operating Position	Vertical, base up
Maximum Dimensions:	
Height	17.0 in
Diameter	10.0 in
Cooling	Liquid to vapor and forced air
Net Weight	95 lbs
Shipping Weight (approximate)	150 lbs

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPS
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (Frequencies below 30 megacycles)

DC Plate Voltage	15	17.5	kV
DC Screen Voltage	1.5	1.5	kV
DC Grid Voltage	-1020	-1050	V
DC Plate Current	11.8	11.8	A
DC Screen Current	1.0	1.0	A
DC Grid Current	100	100	mA
Peak RF Grid Voltage	1220	1250	V
Driving Power*	120	125	W
Plate Dissipation	38	38.5	kW
Plate Output Power	139	168	kW
Resonant Load Impedance	600	710	Ω

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Printed in U.S.A.

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER-CATHODE DRIVEN

Class-C Telephony (Carrier conditions except where noted)

MAXIMUM RATINGS		
DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	15.0	AMPS
PLATE DISSIPATION*	66,500	WATTS
SCREEN DISSIPATION‡	1750	WATTS
GRID DISSIPATION‡	500	WATTS

* Corresponds to 100,000 watts at 100 per cent sine wave modulation
** Approximate value
† Calculated low frequency drive power
‡ Average, with or without modulation

TYPICAL OPERATION (Frequencies below 30 megacycles)

DC Plate Voltage	14	16	kV
DC Screen Voltage	750	750	V
Peak AF Screen Voltage (for 100% modulation**	750	750	V
DC Grid Voltage	-700	-700	V
DC Plate Current	9.1	12.0	A
DC Screen Current	2.0	1.75	A
DC Grid Current	1.0	1.20	A
Peak RF Grid Voltage	1000	1050	V
Grid Driving Power†	1000	1260	W
Plate Dissipation	20.4	54.0	kW
Plate Output Power	107	138.5	kW
Resonant Load Impedance	790	620	Ω

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS		
DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPS
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

*Per Tube
**Approximate value

TYPICAL OPERATION (Two Tubes)

DC Plate Voltage	15	18	kV
DC Screen Voltage	1.5	1.5	kV
DC Grid Voltage	-360	-380	V
Max-Signal Plate Current	18.8	20.0	A
Zero-Signal Plate Current	6.0	6.0	A
Max-Signal Screen Current**	0.690	0.700	A
Peak AF Driving Voltage*	350	380	V
Driving Power	0	0	W
Load Resistance, Plate-to-Plate	1800	2080	Ω
Max-Signal Plate Dissipation*	47.3	56.8	kW
Max. Signal Plate Output Power	187.4	246.4	kW

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class-C Telephony (Carrier conditions except where noted)

MAXIMUM RATINGS		
DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	15.0	AMPS
PLATE DISSIPATION	66,500	WATTS
SCREEN DISSIPATION‡	1750	WATTS
GRID DISSIPATION‡	500	WATTS

*Voltages given are referenced to ground
‡Average, with or without modulation

TYPICAL OPERATION (Frequencies below 30 megacycles)

DC Plate Voltage*	12	15	kV
DC Screen Voltage*	560	900	V
DC Grid Voltage*	-440	-600	V
DC Plate Current	12.4	11.6	A
DC Screen Current	1.32	0.72	A
DC Grid Current	0.20	0.10	A
Peak RF Cathode Voltage	655	720	V
Cathode Driving Power	8.1	8.1	kW
Cathode Driving Impedance	27	32	Ω
Plate Dissipation	49.2	47.0	kW
Plate Output Power	112.7	141.0	kW
Resonant Load Impedance	480	650	Ω

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1

MAXIMUM RATINGS		
DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPS
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

*Approximate value

TYPICAL OPERATION, Peak-Envelope or Modulation-Crest Conditions, (Frequencies below 30 megacycles)

DC Plate Voltage	15	18	kV
DC Screen Voltage	1.5	1.5	kV
DC Grid Voltage	-360	-380	V
Max-Signal Plate Current	9.4	10.0	A
Zero-Signal Plate Current	3.0	3.0	A
Max-Signal Screen Current*	0.345	0.350	A
Peak RF Grid Voltage	350	380	V
Driving Power	0	0	W
Plate Dissipation	47.3	56.8	kW
Plate Output Power	93.7	123.2	kW
Resonant Load Impedance	900	1040	Ω

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when the tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf driving voltage is applied.

APPLICATION

MECHANICAL

Mounting: The 4CV100,000C must be mounted vertically, anode down, in an EIMAC BR-300 series boiler. Care must be exercised to insure that the axis of the tube/boiler combination is vertical and that water in the boiler is at the level indicated. The anode flange on the tube must seat securely against the rubber "O" ring, forming a vapor-tight seal between tube and boiler.

Socket: The EIMAC SK-1500 series socket is available for use with the 4CV100,000C. Filament, control grid and screen grid connections are made to this socket. Spring finger contacts on the socket are used to make connections to the concentric rings on the tube base.

Cooling: Cooling is accomplished by immersing the anode of the 4CV100,000C in a "Boiler" filled with distilled water. Energy dissipated by the anode causes the water to boil at the anode surfaces, be converted into steam and be carried away to an external condenser. The condensate is then returned to the boiler, completing the cycle.

This boiling action maintains the anode surfaces at a fairly constant temperature near 100°C. The vapor-cooled tube has good overload capabilities; excess dissipation for moderate periods only causes more water to boil.

The system schematic drawing shown below outlines a vapor-cooling installation. A control box (EIMAC CB-202) is used to sense water level, to signal for make-up water and to shut down the system in case of low water level. In order to perform its function, the control box must be mounted so that its water level mark is at the same elevation as the water level mark on the boiler.

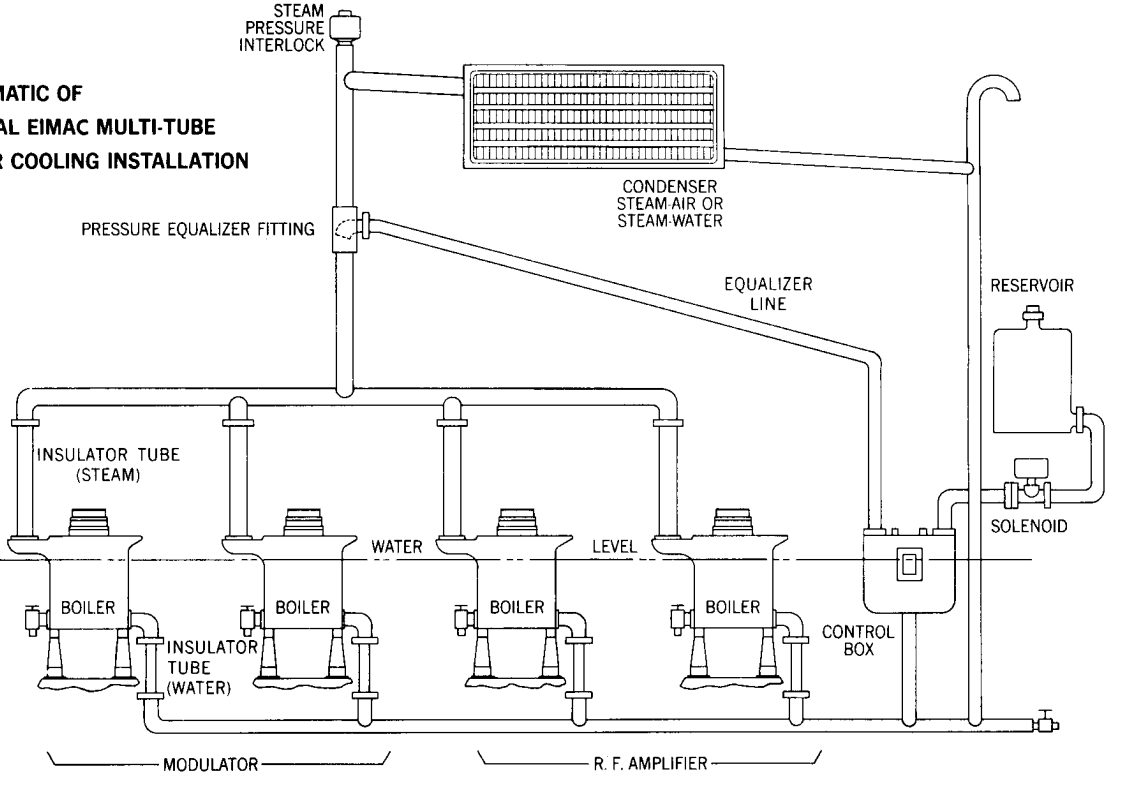
Since the tube anode and boiler are usually at high potential to ground, water and steam connections to the boiler are made through insulating tubing.

A pressure equalizing line is shown between the steam side of the system and the top of the control box. Its function is to provide the same pressure in the control box as in the boiler.

Separate cooling of the tube base is required and is accomplished by directing approximately 120 cfm of air horizontally through the socket from the side. It is preferable to direct this air through three equally spaced ducts.

The well in the center of the baseplate of the tube is a critical area which requires cooling to maintain envelope temperatures less than 250°C. For most applications, 1 to 2 C.F.M. of air directed through the center of the socket is sufficient for this purpose.

SCHEMATIC OF TYPICAL EIMAC MULTI-TUBE VAPOR COOLING INSTALLATION



ELECTRICAL

Filament The rated filament voltage for the 4CV100,000C is 10.0 volts. Filament voltage, as measured at the socket, should be maintained at 10 volts plus or minus five percent to obtain maximum life and consistent performance.

Filament starting current must be limited to a maximum of 900 amperes.

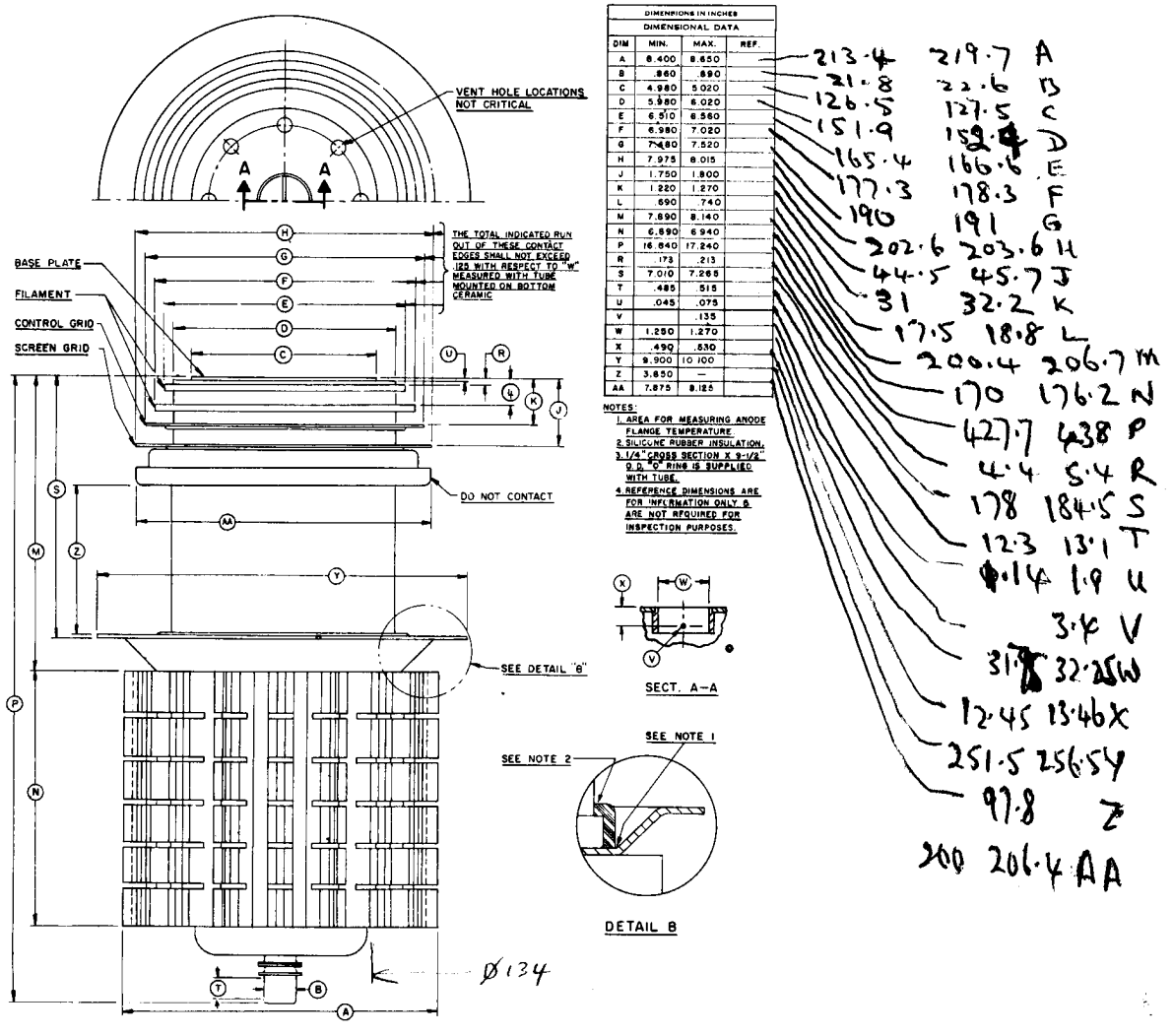
Voltage between filament and the base plates of either tube, or SK-1500 socket, must not exceed 100 volts.

Control-Grid Operation The 4CV100,000C control grid is rated at 500 watts of dissipation. Grid dissipation is the approximate product of grid current and peak positive grid voltage.

Screen Dissipation The power dissipated by the screen grid must not exceed 1750 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is dependent on RMS screen voltage, and RMS screen current. Plate voltage, plate load or bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

Plate Dissipation The plate dissipation of 100 kilowatts attainable through vapor cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CV100,000C is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 66,500 watts.

Special Application Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, for information and recommendations.



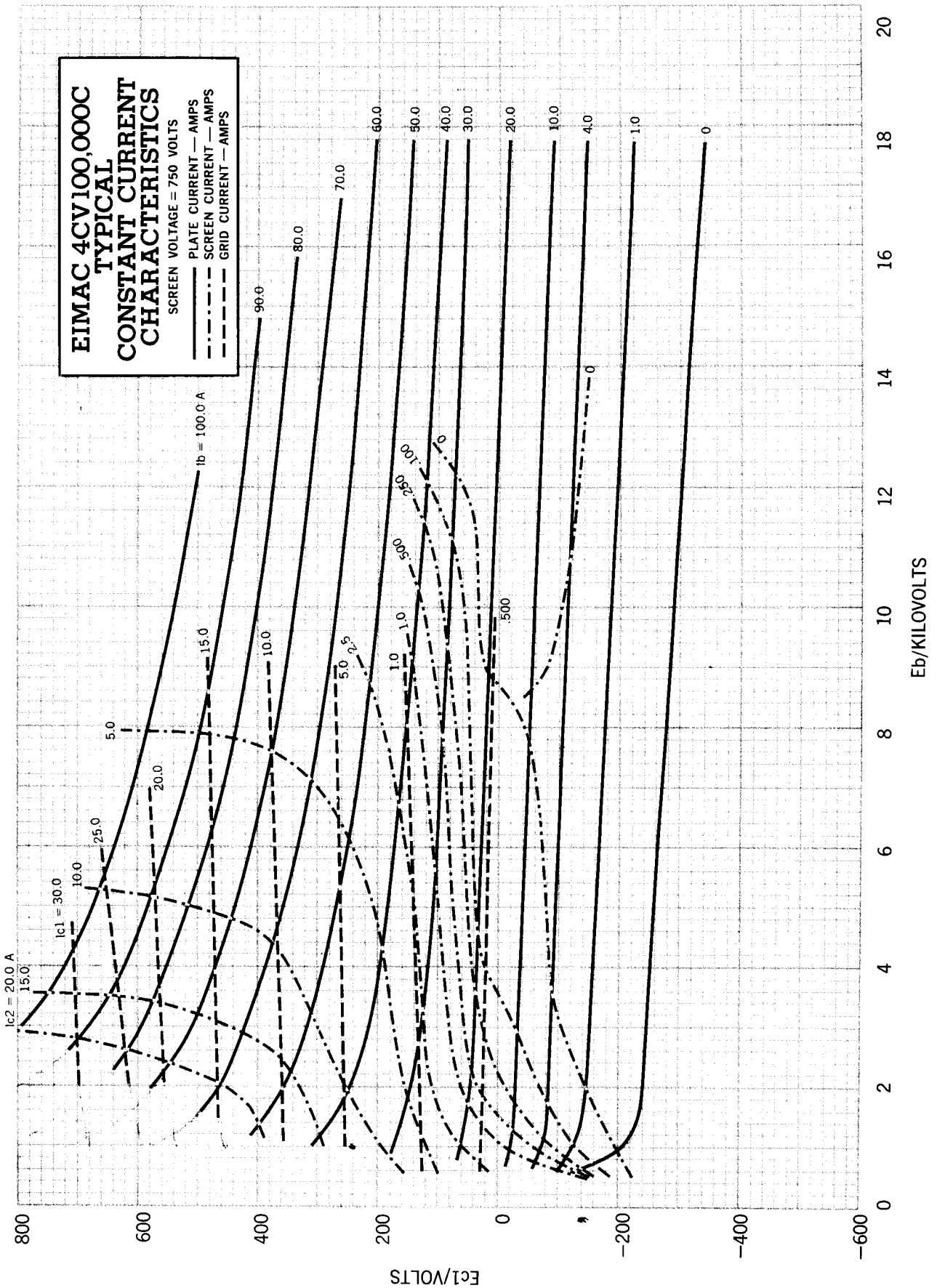
DIMENSIONS IN INCHES

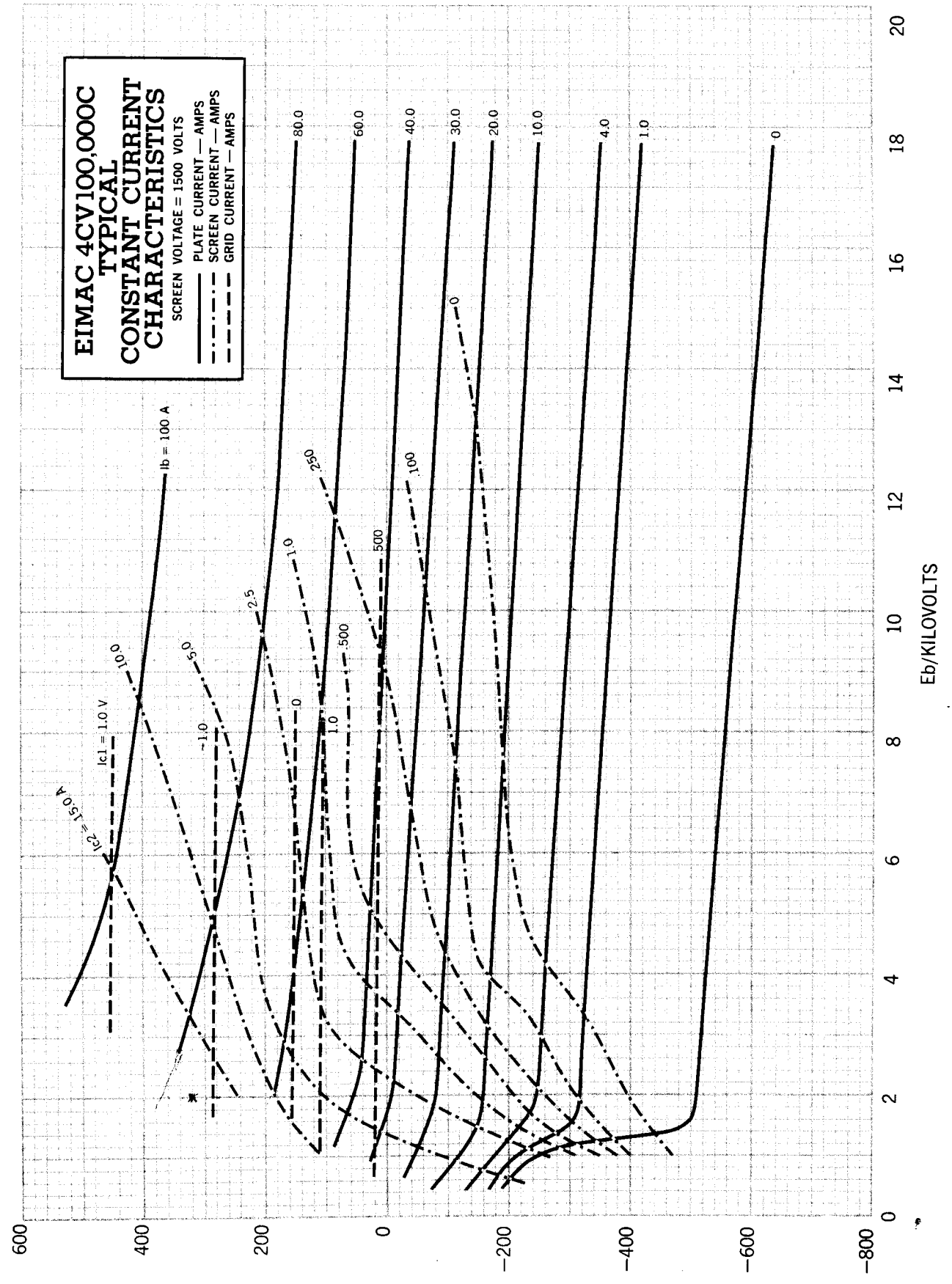
DIMENSIONAL DATA

DIM	MIN.	MAX.	REF.
A	8.400	8.650	
B	.860	.890	
C	4.980	5.020	
D	5.980	6.020	
E	6.510	6.560	
F	6.980	7.020	
G	7.480	7.520	
H	7.975	8.015	
J	1.750	1.800	
K	1.220	1.270	
L	.690	.740	
M	7.890	8.140	
N	6.890	6.940	
P	16.840	17.240	
R	.173	.213	
S	7.010	7.265	
T	.485	.515	
U	.045	.075	
V		.135	
W	1.250	1.270	
X	.490	.530	
Y	9.900	10.100	
Z	3.850	—	
AA	7.875	8.125	

NOTES:
1. AREA FOR MEASURING ANODE FLANGE TEMPERATURE.
2. SILICONE RUBBER INSULATION.
3. 1/4" CROSS SECTION X 9-1/2" O.D. O-RING IS SUPPLIED WITH TUBE.
4. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.

213.4 219.7 A
21.8 22.6 B
126.5 127.5 C
151.9 152.4 D
165.4 166.6 E
177.3 178.3 F
190 191 G
202.6 203.6 H
44.5 45.7 J
31 32.2 K
17.5 18.8 L
200.4 206.7 M
170 176.2 N
427.7 438 P
4.4 5.4 R
178 184.5 S
12.3 13.1 T
1.4 1.9 U
3.4 V
31.8 32.25 W
12.45 13.46 X
251.5 256.54
97.8 Z
200 206.4 AA


EIMAC 4CV100,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 100.0 A
Ic2 = 20.0 A
Ic1 = 30.0
Eb/KILOVOLTS
Ec1/VOLTS


EIMAC 4CV100,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 100 A
Ic1 = 1.0 V
Ic2 = 15.0 A
10.0
5.0
2.5
1.0
0
-1.0
80.0
60.0
40.0
30.0
20.0
10.0
4.0
1.0
0
250
100
500
500
1.0
0
Ec1/VOLTS
600
400
200
0
-200
-400
-600
-800
0
2
4
6
8
10
12
14
16
18
20
Eb/KILOVOLTS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

4CV20,000A

VAPOR-COOLED
RADIAL-BEAM
POWER-TETRODE

The Eimac 4CV20,000A is a vapor-cooled, ceramic-metal, power tetrode designed for use as an oscillator, modulator, or amplifier in audio and radio-frequency applications. The vapor-cooled anode is conservatively rated at 20 kilowatts of plate dissipation when mounted in an Eimac BR-200 boiler.

A pair of these tubes in class AB_1 audio frequency or radio frequency linear amplifier service will deliver 35 kilowatts output. The frequency for maximum ratings is 30 megacycles; operation to 110 megacycles is possible at reduced input.



GENERAL CHARACTERISTICS

ELECTRICAL

		Min.	Nom.	Max.	
Filament:	Thoriated Tungsten				
	Voltage		7.5		V
	Current	73		78	A
Amplification Factor (Grid-Screen)			4.5		
Direct Interelectrode Capacitances, Grounded Cathode:					
	Input	108		122	pF
	Output	18		23	pF
	Feedback			1.0	pF
Direct Interelectrode Capacitances, Grounded Grid:					
	Input	48		58	pF
	Output	18		23	pF
	Feedback			1.0	pF
Frequency for Maximum Ratings				30	MHz

MECHANICAL

Base	Special, Concentric
Recommended Socket	Eimac, SK-300A
Recommended Boiler	Eimac, BR-200
Operating Position	Axis vertical, base up
Cooling	Vapor & Forced air
Maximum Seal Temperature	250° C
Maximum Anode Core Temperature	250° C
Maximum Over-all Dimensions:	
Height	9.13 in
Diameter	7.75 in
Net Weight	21 lbs

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony

MAXIMUM RATINGS

DC PLATE VOLTAGE (to 30 Mc)	7500 VOLTS
(30-60 Mc)	7000 VOLTS
(60-110 Mc)	6500 VOLTS
DC SCREEN VOLTAGE	1500 VOLTS
DC PLATE CURRENT (to 30 Mc)	3.0 AMPS
(30-60 Mc)	2.8 AMPS
(60-110 Mc)	2.6 AMPS
PLATE DISSIPATION	20,000 WATTS
SCREEN DISSIPATION	250 WATTS
GRID DISSIPATION	75 WATTS

TYPICAL OPERATION (Below 30 Mc)

DC Plate Voltage	6000	7500 volts
DC Screen Voltage	500	500 volts
DC Grid Voltage	-290	-300 volts
DC Plate Current	3.0	3.0 amps
DC Screen Current*	500	500 mA
DC Grid Current	290	290 mA
Peak RF Grid Voltage*	520	530 volts
Driving Power	150	155 watts
Plate Output Power	12,900	17,000 watts

*Approximate Values

(Effective 6-1-68) © 1962, 1968 by Varian

Printed in U.S.A.

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier conditions except where noted)

MAXIMUM RATINGS

DC PLATE VOLTAGE	5000 VOLTS
DC SCREEN VOLTAGE	1000 VOLTS
DC PLATE CURRENT	2.5 AMPS
PLATE DISSIPATION*	13,500 WATTS
SCREEN DISSIPATION	250 WATTS
GRID DISSIPATION	75 WATTS

* Corresponds to 20,000 watts at 100-percent sine-wave modulation.

** Approximate values.

TYPICAL OPERATION
(Frequencies below 30 megacycles)

DC Plate Voltage	4000	5000	volts
DC Screen Voltage	500	500	volts
Peak AF Screen Voltage (For 100%) modulation)	470	490	volts
DC Grid Voltage	-320	-340	volts
DC Plate Current	2.2	2.2	amps
DC Screen Current**	335	330	mA
DC Grid Current**	160	150	mA
Peak RF Grid Voltage**	490	510	volts
Grid Driving Power	78.5	76.5	watts
Plate Dissipation	3050	3250	watts
Plate Output Power	5750	7750	watts

RADIO-FREQUENCY LINEAR AMPLIFIER

Class AB_1

MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	7500 VOLTS
DC SCREEN VOLTAGE	1500 VOLTS
DC PLATE CURRENT	4.0 AMPS
PLATE DISSIPATION	20,000 WATTS
SCREEN DISSIPATION	250 WATTS
GRID DISSIPATION	75 WATTS

* Per Tube

**Approximate values.

TYPICAL OPERATION (Peak-Envelope or Modulation-Crest Conditions.

DC Plate Voltage	5000	7500	volts
DC Screen Voltage	1500	1500	volts
DC Grid Voltage	-250	-260	volts
Max-Signal Plate Current	4.0	4.0	amps
Zero-Signal Plate Current	2.0	2.0	amps
Max-Signal Screen Current*	165	150	mA
Peak RF Grid Voltage*	240	250	volts
Driving Power	0	0	watts
Plate Dissipation	9700	12,500	watts
Plate Output Power	10,300	17,500	watts
Resonant Load Impedance	590	1030	ohms

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	7500 VOLTS
DC SCREEN VOLTAGE	1500 VOLTS
DC PLATE CURRENT	4.0 AMPS
PLATE DISSIPATION	20,000 WATTS
SCREEN DISSIPATION	250 WATTS
GRID DISSIPATION	75 WATTS

* Approximate values

TYPICAL OPERATION (Two Tubes)

DC Plate Voltage	5000	7500	volts
DC Screen Voltage	1500	1500	volts
DC Grid Voltage	-250	-260	volts
Max-Signal Plate Current	8.0	8.0	amps
Zero-Signal Plate Current	4.0	4.0	amps
Max-Signal Screen Current**	330	300	mA
Peak RF Driving Voltage**	240	250	volts
Driving Power	0	0	watts
Load Resistance, Plate-to-Plate	1180	2060	ohms
Max-Signal Plate Dissipation*	9700	12,500	watts
Max-Signal Plate Output Power	20,600	35,000	watts

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance is made for circuit losses of any kind. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf driving voltage is applied.

APPLICATION

MECHANICAL

MOUNTING — The 4CV20,000A must be operated with its axis vertical, base up in an Eimac BR-200 boiler. Care must be exercised when installing to insure that the boiler is level, the water is at the proper level and that the flange of the tube makes a vapor tight seal against the rubber "O" ring and boiler. A typical vapor cooling system is shown below.

SOCKET — The Eimac SK-300A socket is available for use with the 4CV20,000A. Filament, control grid and screen grid connections are made to this socket.

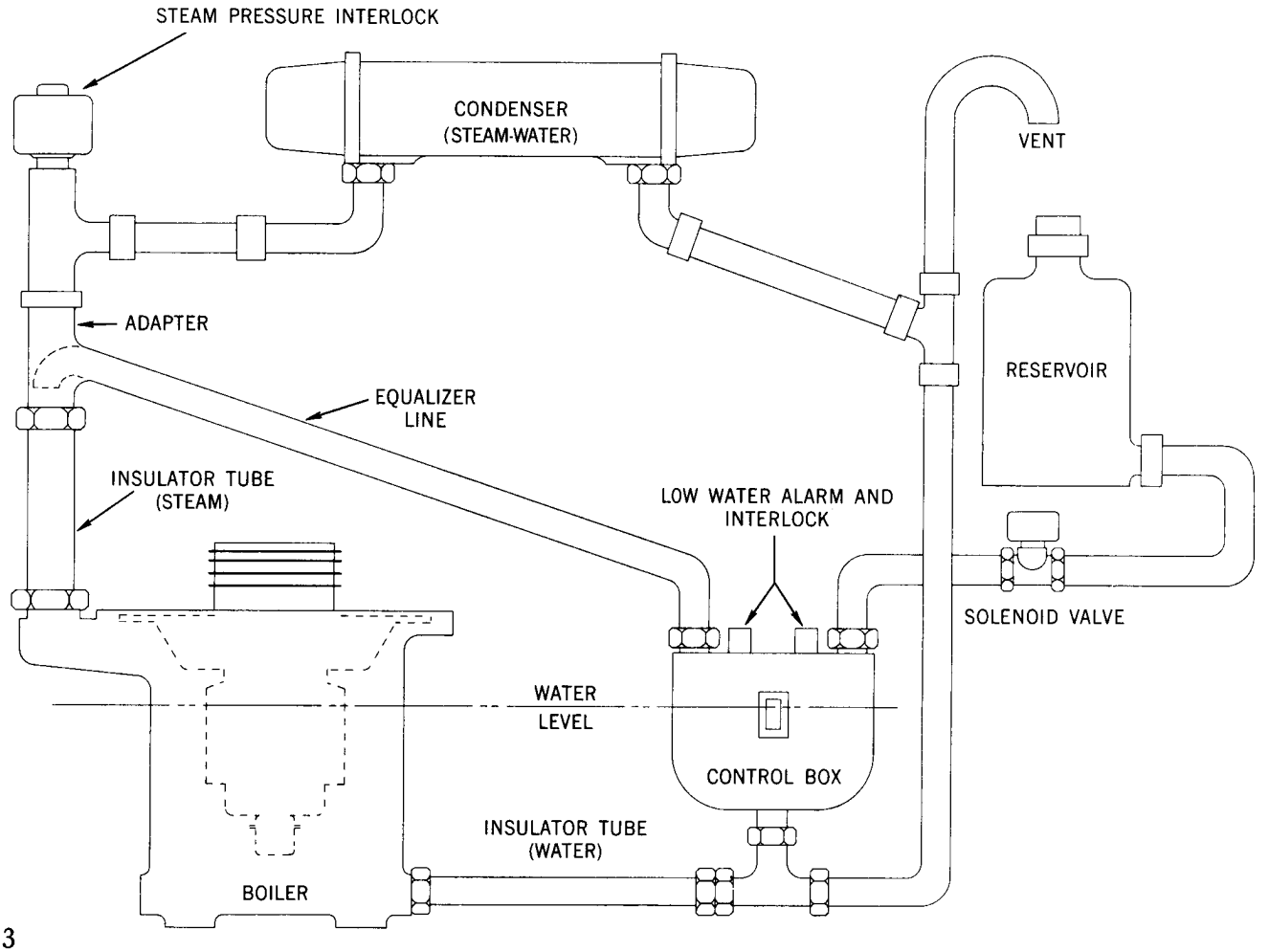
COOLING — Cooling is accomplished by immersing the anode in the distilled water filled BR-200 boiler. The energy dissipated at the anode causes the water to boil at the surfaces of the anode, be converted into steam and be carried away to the condenser. The boiling action keeps the anode surfaces at approximately 100°C. In a properly designed boiler-tube system (such as the 4CV20,000A and BR-200), it is extremely unlikely that the anode surfaces will ever exceed 110°C - well below the 250°C maximum rating - at full dissipation ratings.

The water in the boiler must be maintained at a constant level as indicated by the mark on the boiler, just below the top of the fins on the anode cooler. This is accomplished automatically in the vapor cooling system shown. Condensate from the condenser is returned to the boiler to maintain this constant fluid level. Any losses or drops in liquid level are sensed by the control box, CB-202. A low water level in the control box activates the solenoid water valve, allowing make-up water from the reservoir to enter the boiler. When the proper level is reached, the control box de-energizes the solenoid, stopping the flow from the reservoir. A second switch in the control box is energized if the water level drops to a lower level because of an empty reservoir or a constriction in the line. This switch may be used to shut down the equipment or activate an alarm.

For reliable operation, it is important that the control box and boiler be mounted so that the level sensed by the control box is exactly the same as the level in the boiler.

Cooling of the tube base is accomplished by blowing 25-50 CFM of air into the socket in the area of the filament seals.

VAPOR COOLING SYSTEM



ELECTRICAL

FILAMENT OPERATION — The rated filament voltage for the 4CV20,000A is 7.5 volts. Filament voltage, as measured at the socket, must be maintained at 7.5 volts plus or minus five percent to obtain maximum tube life. The use of a constant voltage filament transformer is recommended.

CONTROL-GRID OPERATION — The 4CV20,000A control grid has a maximum dissipation rating of 75 watts. Precautions should be observed to avoid exceeding this rating. Grid dissipation is the product of the dc grid current and the peak positive grid voltage swing.

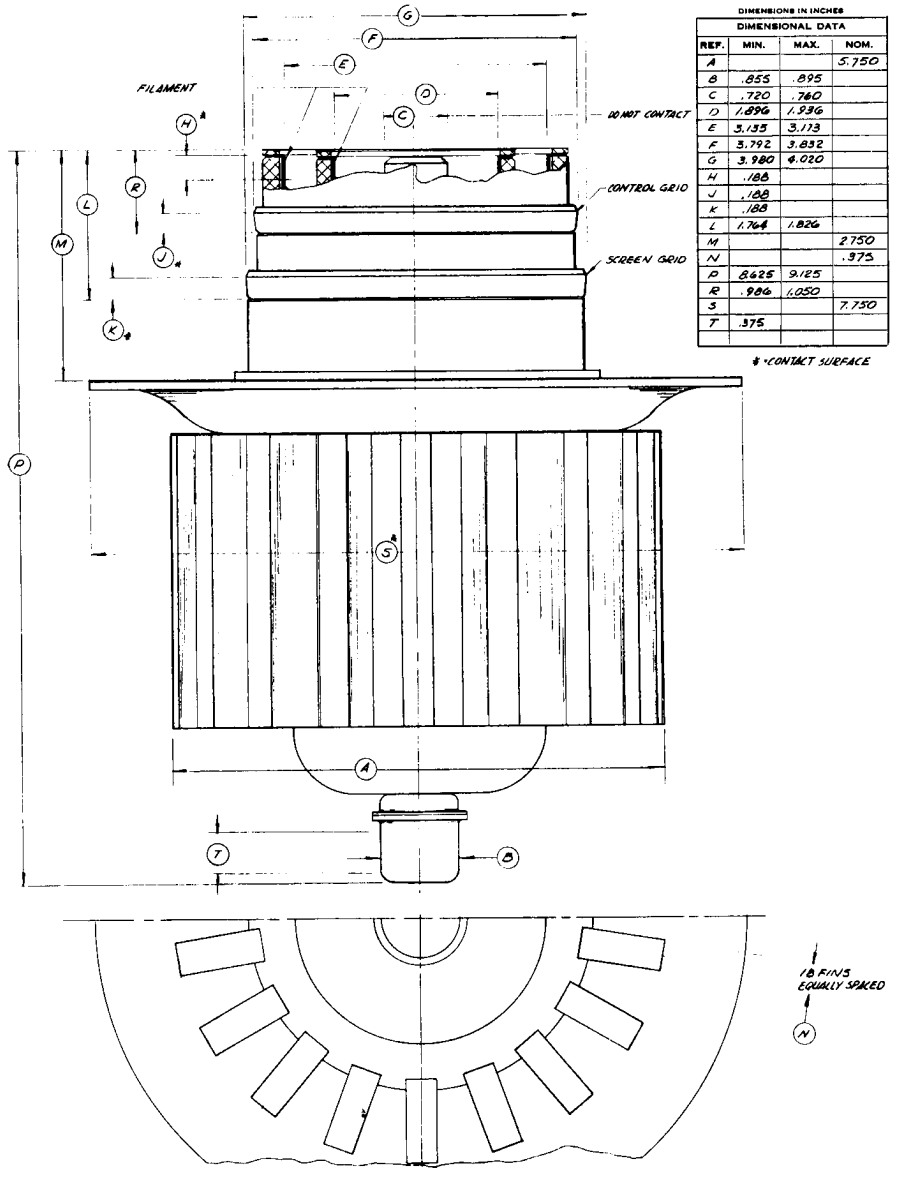
SCREEN-GRID OPERATION — The power dissipated by the screen must not exceed 250 watts. Screen dissipation, in cases where no ac is applied to the screen is the product of screen voltage and screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power and screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation in the event of these failures.

PLATE DISSIPATION — The plate dissipation rating of 20,000 watts attainable through vapor cooling provides a large margin of safety. It is unlikely that this rating will be exceeded, even during tuning periods.

When the 4CV20,000A is used as a plate-modulated rf amplifier, this rating is reduced to 13,500 watts with a reduced plate input rating of 5000 volts and 2.5 amps.

SPECIAL APPLICATIONS — If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing Department, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California for information and recommendations.

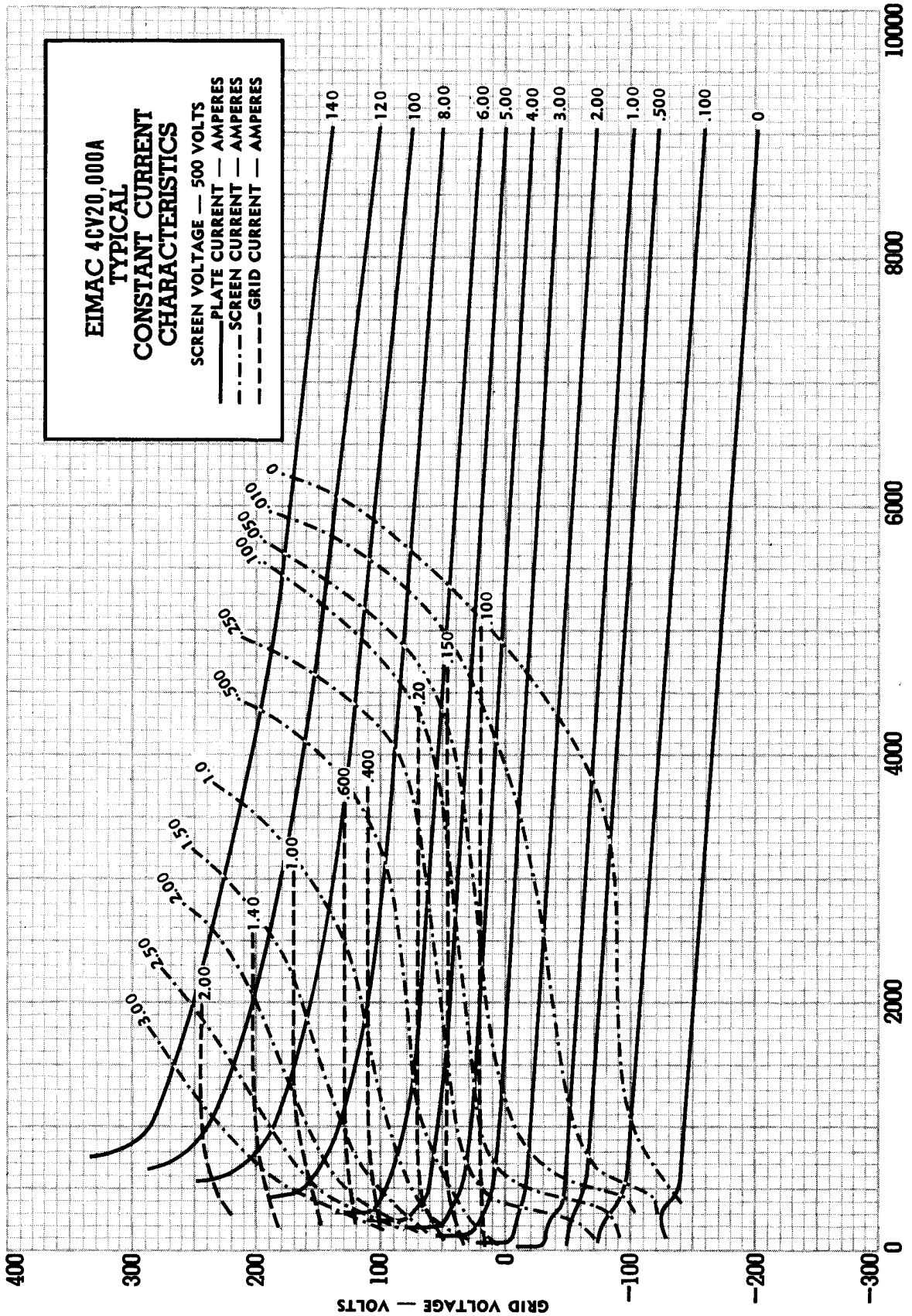


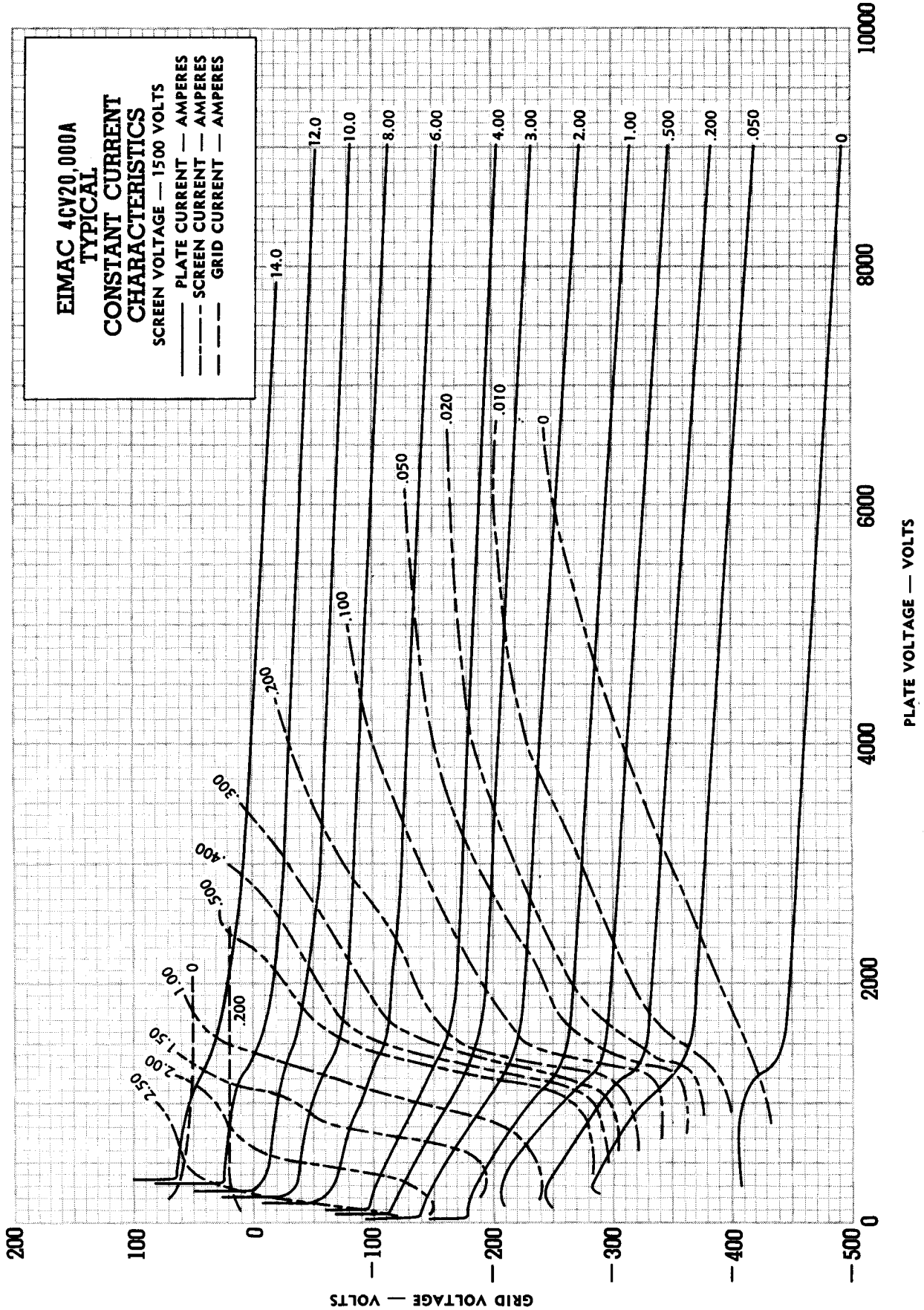
DIMENSIONS IN INCHES

DIMENSIONAL DATA

REF.	MIN.	MAX.	NOM.
A			5.750
B	.855	.895	
C	.720	.760	
D	1.896	1.936	
E	3.135	3.173	
F	3.792	3.832	
G	3.980	4.020	
H	.188		
J	.188		
K	.188		
L	1.764	1.826	
M			2.750
N			.375
P	8.625	9.125	
R	.986	1.050	
S			7.750
T	.375		

CONTACT SURFACE


EIMAC 4CV20,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
140
120
100
8.00
6.00
5.00
4.00
3.00
2.00
1.00
.500
.100
0
.010
.050
.100
.250
.500
1.0
1.50
2.00
2.50
3.00
1.40
.600
.400
.20
.150
.100
400
300
200
100
0
−100
−200
−300
0
2000
4000
6000
8000
10000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS


EIMAC 4CV20,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 1500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
14.0
12.0
10.0
8.00
6.00
4.00
3.00
2.00
1.00
.500
.200
.050
0
.020
.010
.100
.200
.300
.400
.500
1.00
1.50
2.00
2.50
200
100
0
—100
—200
—300
—400
—500
0
2000
4000
6000
8000
10000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

EIMAC
Division of Varian
301 INDUSTRIAL WAY • SAN CARLOS, CALIF. 94070
PHONE: (415) 592-1221 • CABLE: "EIMAC" SAN CARLOS

4CV250000

Vapor Cooled
Power Tetrode
TENTATIVE

The EIMAC 4CV250,000 is a ceramic-metal, vapor-cooled power tetrode intended for use at the 250 to 500 kilowatt output power level. It is recommended for use as a Class-C r-f amplifier or oscillator, a Class-AB r-f linear amplifier or a Class AB push-pull a-f amplifier or modulator. The 4CV250,000 is also useful as a plate and screen modulated Class-C r-f amplifier.

The vapor-cooled anode is rated at 250 kilowatts of plate dissipation when mounted in the EIMAC BR-600 series boiler.

GENERAL CHARACTERISTICS

ELECTRIC

Filament: Thoriated Tungsten		
Voltage	12	volts
Current	640	amps
Amplification Factor (Grid-Screen) (average)	4.5	
Direct Interelectrode Capacitances, Grounded Cathode:		
Input	875	pf
Output	115	pf
Feedback	1.2	pf
Frequency for Maximum Ratings	30	MHz

MECHANICAL

Base		Special
Maximum Seal Temperature	250	°C
Maximum Anode Flange Temperature	130	°C
Recommended Boiler	EIMAC BR-600	Series
Operating Position	Vertical,	base up
Maximum Dimensions:		
Height	27-1/2	inches
Diameter	13	inches
Cooling	Vapor &	water
Net Weight	180	pounds
Shipping Weight (approximate)	300	pounds

eff. date 5-19-66

4CV250,000

Vapor-Cooled, Power Tetrode

Tentative Data

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down Conditions)

MAXIMUM RATINGS

DC Plate Voltage	25,000	Max. Volts
DC Screen Voltage	2,500	Max. Volts
DC Plate Current	50	Max. Amps
Plate Dissipation	250,000	Max. Watts
Screen Dissipation	3,500	Max. Watts
Grid Dissipation	1,500	Max. Watts

TYPICAL OPERATION
(Frequencies below 30 megacycles)

DC Plate Voltage	14	24	kv
DC Screen Voltage	1,200	800	volts
DC Grid Voltage	-800	-900	volts
DC Plate Current	26	30.4	amps
DC Screen Current	2.4	3.1	amps
DC Grid Current	1	1.6	amps
Driving Power	1.3	2.2	kW
Plate Output Power	255	600	kW

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier Conditions Except Where Noted)

MAXIMUM RATINGS

DC Plate Voltage	18,000	Max. Volts
DC Screen Voltage	2,000	Max. Volts
DC Plate Current	40	Max. Amps
Plate Dissipation*	67,000	Max. Watts
Screen Dissipation	3,500	Max. Watts
Grid Dissipation	1,500	Max. Watts

*Corresponds to 250,000 watts at 100 per cent sine wave modulation

4CV250,000

Vapor-Cooled, Power Tetrode

Tentative Data

TYPICAL OPERATION
(Frequencies below 30 Megacycles)

DC Plate Voltage	14	kv
DC Screen Voltage	800	volts
Peak AF Screen Voltage (For 100% Modulation)**	800	volts
DC Grid Voltage	-800	volts
DC Plate Current	29	Amps
DC Screen Current	3.6	Amps
DC Grid Current	1.8	Amps
Peak RF Grid Voltage	1,200	volts
Grid Driving Power	2.5	kW
Plate Output Power	292	kW

**Approximate Value

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class AB_1

MAXIMUM RATINGS (Per Tube)

DC Plate Voltage	25,000	Max. Volts
DC Screen Voltage	2,500	Max. Volts
DC Plate Current	40	Max. Amps
Plate Dissipation	250,000	Max. Watts
Screen Dissipation	3,500	Max. Watts
Grid Dissipation	1,500	Max. Watts

TYPICAL OPERATION (Two Tubes)

DC Plate Voltage	15	22	kv
DC Screen Voltage	1.8	1.8	kv
DC Grid Voltage	-700	-780	volts
Max-Signal Plate Current	37	35	amps
Max-Signal Screen Current**	1.5	1.3	amps
Peak AF Driving Voltage*	700	780	volts
Driving Power	0	0	watts
Max-Signal Plate Output Power	420	615	kW

* Per Tube
**Approximate Value

4CV250,000

Vapor-Cooled, Power Tetrode

Tentative Data

APPLICATION

Mechanical

Mounting

The 4CV250,000 must be mounted vertically, anode down, in an EIMAC BR-600 series boiler. Care must be exercised to insure that the axis of the tube/boiler combination is perfectly vertical and that water in the boiler is at the level indicated. The anode flange on the tube must seat securely against the rubber "O" ring, forming a vapor-tight seal between tube and boiler.

Cooling

Cooling is accomplished by immersing the anode of the 4CV250,000 in a "Boiler" filled with distilled water. Energy dissipated by the anode causes the water to boil at the anode surfaces, be converted into steam and be carried away to an external condenser. The condensate is then returned to the boiler, completing the cycle.

This boiling action maintains the anode surfaces at a fairly constant temperature near 100°C. In a properly designed tube/boiler system (such as the EIMAC BR-600) it is extremely unlikely that anode surface temperature will exceed 110°C - well below the 130°C maximum - at full dissipation ratings. The vapor-cooled tube has good overload capabilities; excess dissipation for moderate periods only causes more water to boil.

Since the tube anode and boiler are usually at high potential to ground, water and steam connections to the boiler are made through insulating tubing. These insulating sections may be rather short - two to three feet is sufficient for most applications.

An equalizer line is needed between the steam side of the system and the top of the control box. Its function is to provide the same pressure characteristics in the control box as those in the boiler. In this way, errors in water level sensing due to pressure differentials are eliminated.

Separate water cooling of the tube base is required. Approximately .8 GPM at 40 psi (series connected) is sufficient to cool the filament and grid terminals.

APPLICATION

Electrical

Filament

The rated filament voltage for the 4CV250,000 is 12 volts. Filament voltage, as measured at the socket, should be maintained at this value, ±2 volts, to obtain maximum life and consistent performance.

Control-Grid Operation

The 4CV250,000 control grid is rated at 1,500 watts of dissipation and protective measures should be included in circuitry to insure that this rating is not exceeded. Grid dissipation is the approximate product of grid current and peak positive grid voltage.

Screen Dissipation

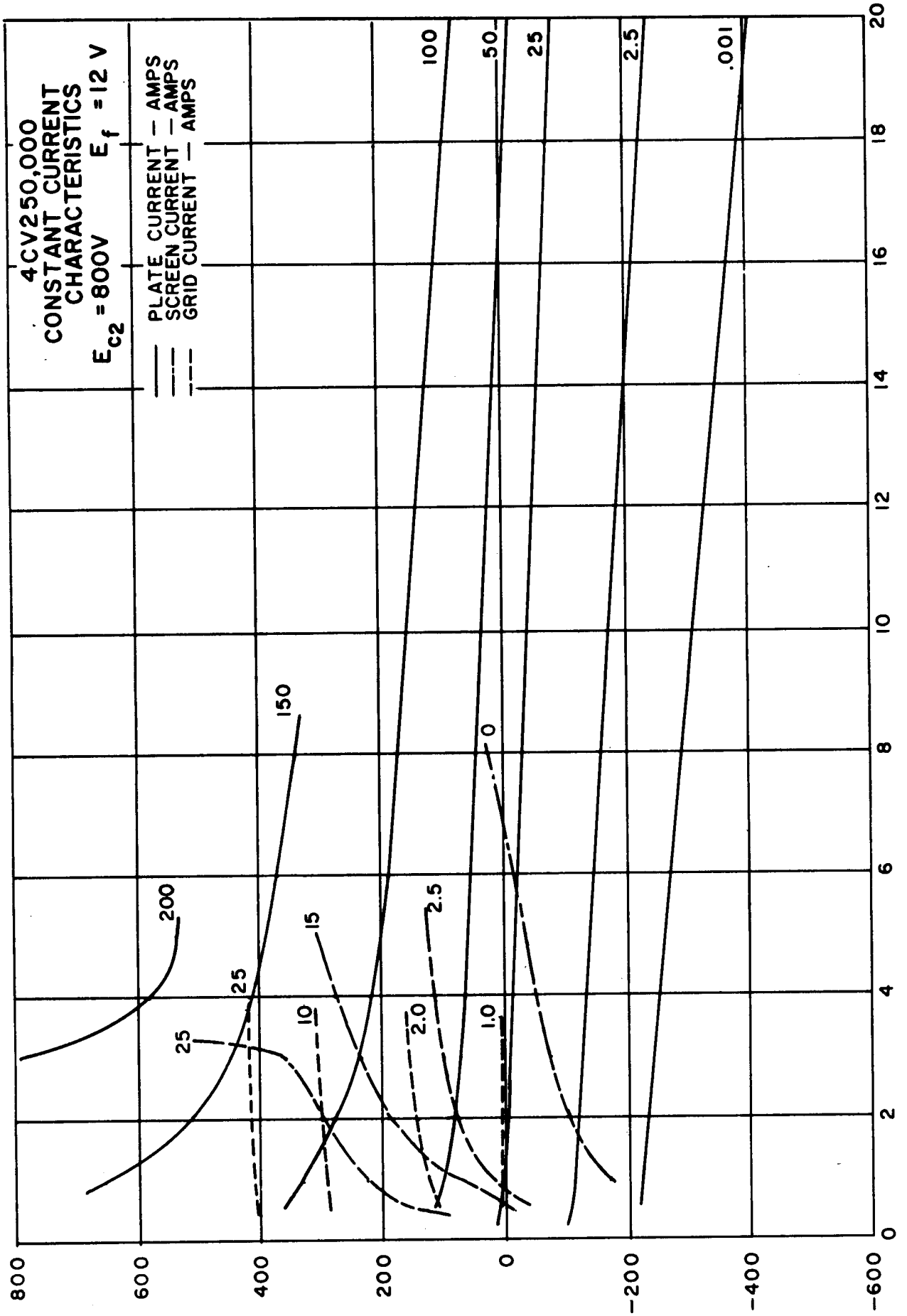
The power applied to the screen grid must not exceed 3,500 watts. Where no a-c is applied to the screen, dissipation is the product of d-c screen voltage and d-c screen current. With screen modulation the dissipation is dependent on loading, driving power, and screen voltages. Plate voltage, plate load or bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

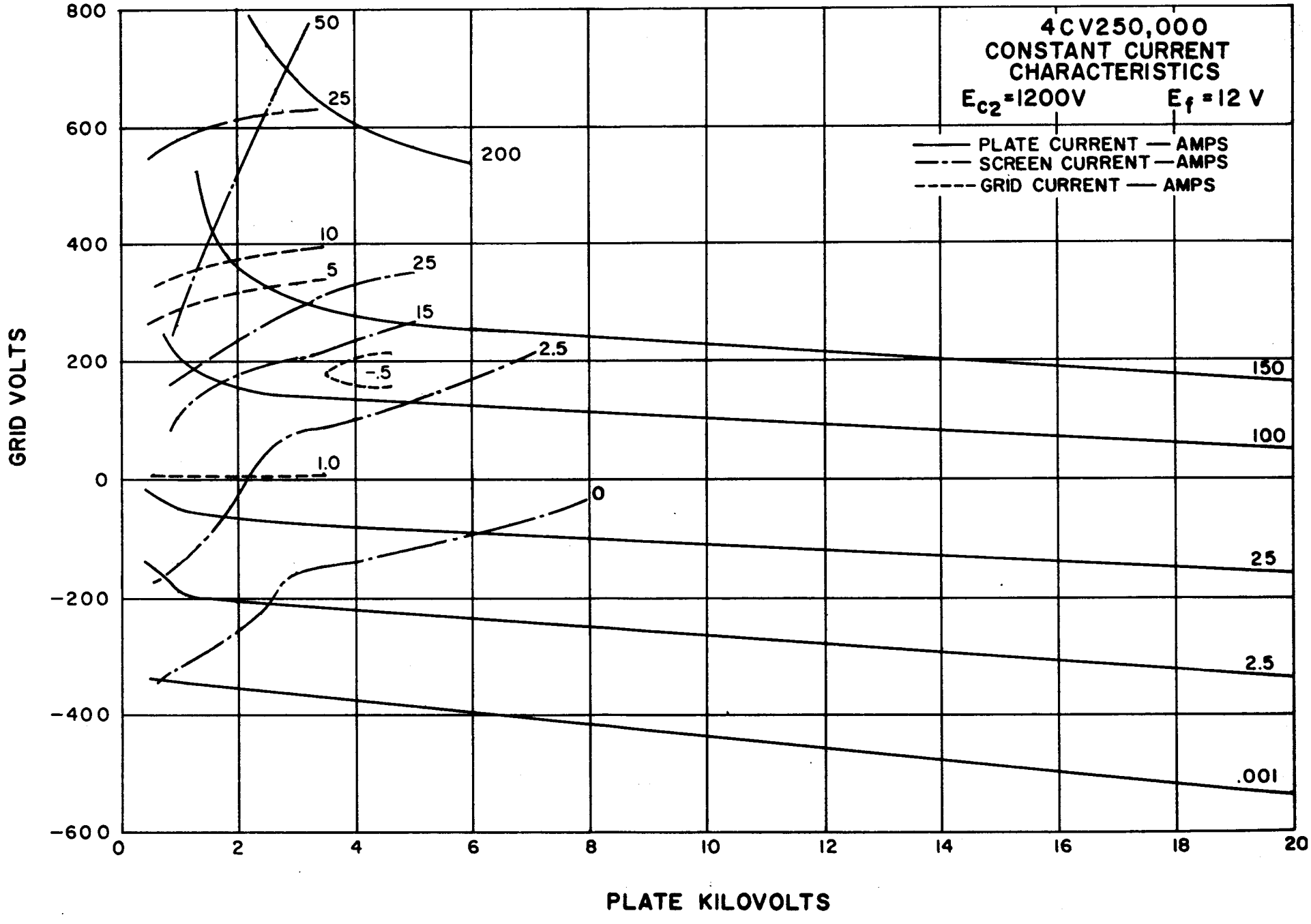
Plate Dissipation

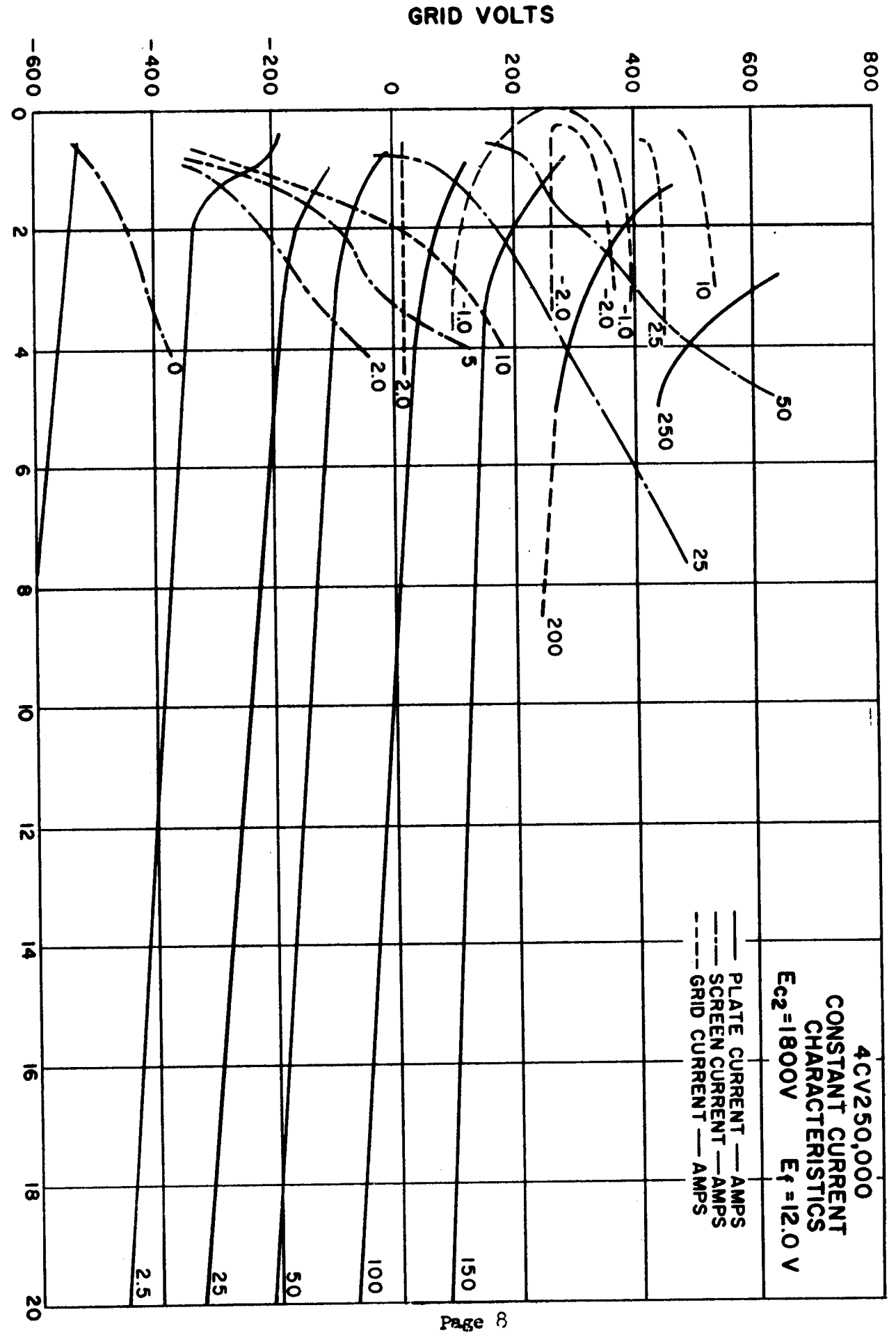
The plate dissipation of 250 kilowatts attainable through vapor cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CV250,000 is used as a plate-modulated r-f amplifier, plate dissipation under carrier conditions is limited to 167,000 watts.

Special Application

Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Product Manager, EIMAC-Division of Varian, 301 Industrial Way, San Carlos, California, for information and recommendations.


4CV250,000
CONSTANT CURRENT
CHARACTERISTICS
E_{c2} = 800V E_f = 12 V
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
100
50
25
2.5
.001
150
0
200
25
15
2.5
25
10
2.0
1.0
800
600
400
200
0
-200
-400
-600
GRID VOLTS
0
2
4
6
8
10
12
14
16
18
20
PLATE KILOVOLTS

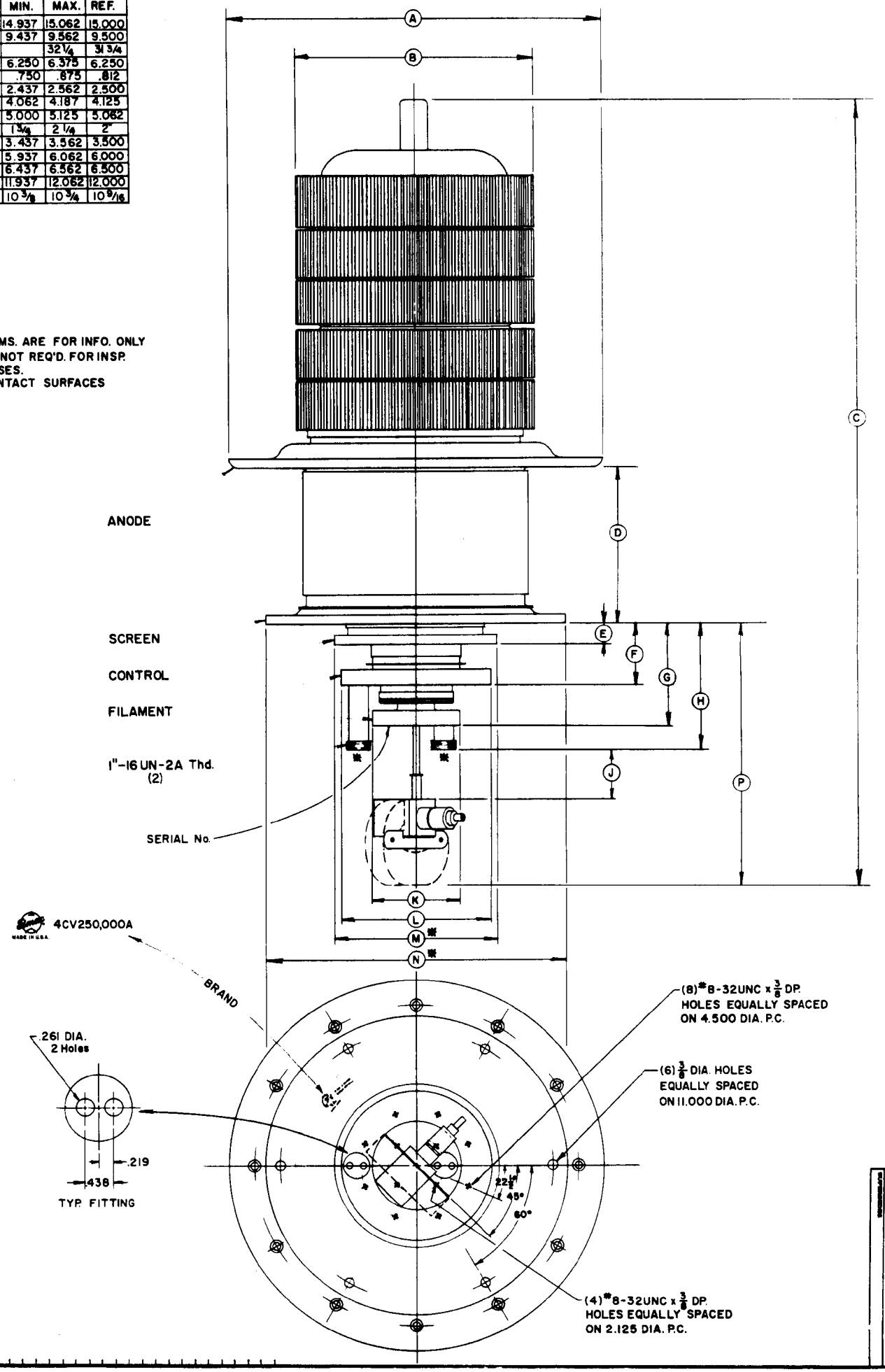

4CV250,000
CONSTANT CURRENT
CHARACTERISTICS
E_{c2}=1200V
E_f=12 V
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
GRID VOLTS
PLATE KILOVOLTS
800
600
400
200
0
-200
-400
-600
0
2
4
6
8
10
12
14
16
18
20
50
25
200
10
5
25
15
2.5
-.5
1.0
0
150
100
25
2.5
.001


4CV250,000
CONSTANT CURRENT
CHARACTERISTICS
Ec2=1800V Ef=12.0 V
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
GRID VOLTS
PLATE KILOVOLTS
-600
-400
-200
0
200
400
600
800
0
2
4
6
8
10
12
14
16
18
20
10
-1.0
-2.0
2.5
50
250
25
200
0
2.0
-2.0
5
10
-1.0
-2.0
2.5
25
50
100
150

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A	14.937	15.062	15.000
B	9.437	9.562	9.500
C		32 1/4	31 3/4
D	6.250	6.375	6.250
E	.750	.875	.812
F	2.437	2.562	2.500
G	4.062	4.187	4.125
H	5.000	5.125	5.062
J	1 3/4	2 1/4	2"
K	3.437	3.562	3.500
L	5.937	6.062	6.000
M	6.437	6.562	6.500
N	11.937	12.062	12.000
P	10 3/8	10 3/4	10 9/16

NOTE:
1. REF. DIMS. ARE FOR INFO. ONLY & ARE NOT REQ'D. FOR INSP. PURPOSES.
2. (*) CONTACT SURFACES



DO NOT SCALE DRAWING
DRAWN D.H. 11-16-66
SCALE NONE
TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS ± 1/64 DECIMALS ± .010 ANGLES ± 1°

CODE IDENT 06980
PART No. 4CV250,000A

ELECTRON TUBE

C 4CV250,000A-60 –

EITEL-McCULLOUGH, INC.
SAN CARLOS CALIFORNIA

4CV250,000A-60

4CV250,000A

TECHNICAL DATA

VAPOR COOLED
POWER TETRODE



The EIMAC 4CV250,000A is a ceramic/metal, vapor-cooled power tetrode intended for use at the 250 to 500 kilowatt output power level. It is recommended for use as a Class C rf amplifier or oscillator, a Class AB rf linear amplifier or a Class AB push-pull af amplifier or modulator. The 4CV250,000A is also useful as a plate and screen modulated Class C rf amplifier.

The vapor cooled anode is rated at 250 kilowatts maximum dissipation when used with the EIMAC Y-585 boiler.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	12.0 ± 0.6	V
Current (at 12.0 volts)	660	A
Amplification Factor (Grid-Screen)(Avg.)	4.5	
Direct Interelectrode Capacitance: (Grounded Cathode)[2]		
Cin	765	pF
Cout	124	pF
Cgp	6.0	pF
Frequency for Maximum Ratings	30	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured without any special shielded fixture.

MECHANICAL

Base	Special
Maximum Seal Temperature	200°C
Recommended Boiler	EIMAC Y-585
Operating Position	Vertical, Anode up
Maximum Dimensions:	
Height	28.02 in; 71.17 cm
Diameter	15.062 in; 38.26 cm
Cooling	Vapor and water
Net Weight	180 lb.; 82 kg
Shipping Weight (approximate)	350 lb.; 159 kg

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RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-down Condition)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	40	AMPERES
PLATE DISSIPATION	250,000	WATTS
SCREEN DISSIPATION	3,500	WATTS
GRID DISSIPATION	1,500	WATTS

TYPICAL OPERATION (Frequencies below 30 MHz)

DC Plate Voltage	16	19	kV
DC Screen Voltage	800	800	V
DC Grid Voltage	-800	-800	V
DC Plate Current	23.5	32.5	A
DC Screen Current	2.4	3.5	A
DC Grid Current	1.15	2.5	A
Driving Power [1]	2.24	3.0	kW
Plate Output Power	275	460	kW
Plate Dissipation	100	155	kW
RF Load Impedance	300	275	Ω
η	63%	63%	

1. Calculated Driving Power neglects input conductance and rf circuit loss.

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class C Telephony (Carrier conditions except where noted)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	30	AMPERES
PLATE DISSIPATION [1]	167,000	WATTS
SCREEN DISSIPATION	3,500	WATTS
GRID DISSIPATION	1,500	WATTS

1. Corresponds to 250,000 watts at 100 per cent sine wave modulation.
2. Approximate Value.

TYPICAL OPERATION (Frequencies below 30 MHz)

DC Plate Voltage	15	kV
DC Screen Voltage	800	V
Peak af Screen Voltage(for 100% Mod.)2.	800	V
DC Grid Voltage	-800	V
DC Plate Current	22.8	A
DC Screen Current	4.1	A
DC Grid Current	1.46	A
Peak rf Grid Voltage	1110	v
Grid Driving Power [3]	1630	W
Plate Output Power	280	kW
RF Load Impedance	323	Ω
Plate Dissipation	63	kW
2	66%	

3. Calculated Driving Power neglects input conductance and rf circuit loss.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class AB

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	40	AMPERES
PLATE DISSIPATION	250,000	WATTS
SCREEN DISSIPATION	3,500	WATTS
GRID DISSIPATION	1,500	WATTS

1. Approximate Value.
2. Per Tube

TYPICAL OPERATION (Two Tubes Class AB_1)

DC Plate Voltage	15	20	kV
DC Screen Voltage	1.8	1.8	kV
DC Grid Voltage	-500	-500	V
Max-Signal Plate Current	40	46	A
Zero Signal Plate Current[2]	0.2	0.2	A
Max-Signal Screen Current [1]	1.1	1.2	A
Peak af Driving Voltage [2]	500	500	v
Driving Power	0	0	W
Load Impedance (plate to plate)	650	870	Ω
Plate Dissipation	160	260	kW
Max-Signal Output Power	440	660	kW
2	73%	71%	

RADIO-FREQUENCY LINEAR AMPLIFIER

Class AB

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	40	AMPERES
PLATE DISSIPATION	250,000	WATTS
SCREEN DISSIPATION	3,500	WATTS
GRID DISSIPATION	1,500	WATTS

1. Approximate Value.
2. Calculated Driving Power neglects input conductance and rf circuit loss.

TYPICAL OPERATION Class AB_1 Peak-Envelope or Modulation Crest Conditions (Frequencies below 30 MHz)

DC Plate Voltage	15	20	kV
DC Screen Voltage	1.8	1.8	kV
DC Grid Voltage	-500	-500	V
Plate Current	20	23	A
Zero Signal Plate Current	0.2	0.2	A
Maximum Signal Screen Current 1.	1.1	1.2	A
Peak rf Grid Voltage	500	500	v
Driving Power 2.	0	0	W
Plate Dissipation	80	130	kW
Resonant Load Impedance	325	435	Ω
Plate Output Power	220	330	kW
η	73%	71%	

PULSE MODULATOR OR REGULATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	40,000 VOLTS
DC SCREEN VOLTAGE	2,500 VOLTS
PEAK CATHODE CURRENT	350 AMPERES
PLATE DISSIPATION	250,000 WATTS
SCREEN DISSIPATION	3,500 WATTS
GRID DISSIPATION	1,500 WATTS

APPLICATION

MECHANICAL

MOUNTING - The 4CV250,000A must be mounted vertically, anode up. The tube may be supported by the anode flange or the screen flange.

Care must be exercised to insure that the axis of the tube/boiler combination is vertical and that water in the boiler is at the level indicated. The anode flange on the tube must seat securely against the rubber "O" ring, forming a vapor-tight seal between tube and boiler.

COOLING - Cooling is accomplished by immersing the anode of the 4CV250,000A in a "Boiler" filled with distilled water. Energy dissipated by the anode causes the water to boil at the anode surfaces, be converted into steam and be carried away to an external condenser. The condensate is then returned to the boiler, completing the cycle.

This boiling action maintains the anode surfaces at a fairly constant temperature near 100°C. The vapor-cooled tube has good overload capabilities; excess dissipation for moderate periods only causes more water to boil.

Since the tube anode and boiler are usually at high potential to ground, water and steam connections to the boiler are made through insulated tubing.

The filament supports of the 4CV250,000A are water cooled. Approximately .5 GPM should circulate through each of the filament connectors with a pressure drop of 20 PSI. Filament connector assemblies, SK-1710, provide electrical and water connections. Two sets of SK-1710 are required.

It is recommended that the water cooled control grid connector, SK-1712, be used. Water flow of approximately .5 GPM should circulate through the grid connector. The pressure drop across the grid connector is low. A convenient way to make water connection is to series connect the grid cooling water with the outer filament cooling water path.

The outer filament water path has a lower pressure drop than the inner filament water path making this connection practical.

ELECTRICAL

FILAMENT OPERATION - The peak emission at rated filament voltage of the EIMAC 4CV-250,000A is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CV250,000A by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appeared to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked.

Filament starting current must be limited to a maximum of 1800 amperes.

CONTROL GRID OPERATION - The 4CV-250,000A control grid is rated at 1,500 watts of dissipation and protective measures should be included in circuitry to insure that this rating is not exceeded. Grid dissipation is the approximate product of dc grid current and peak positive grid voltage.

SCREEN DISSIPATION - The power applied to the screen grid must not exceed 3,500 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is the product of RMS screen current and RMS screen voltage.

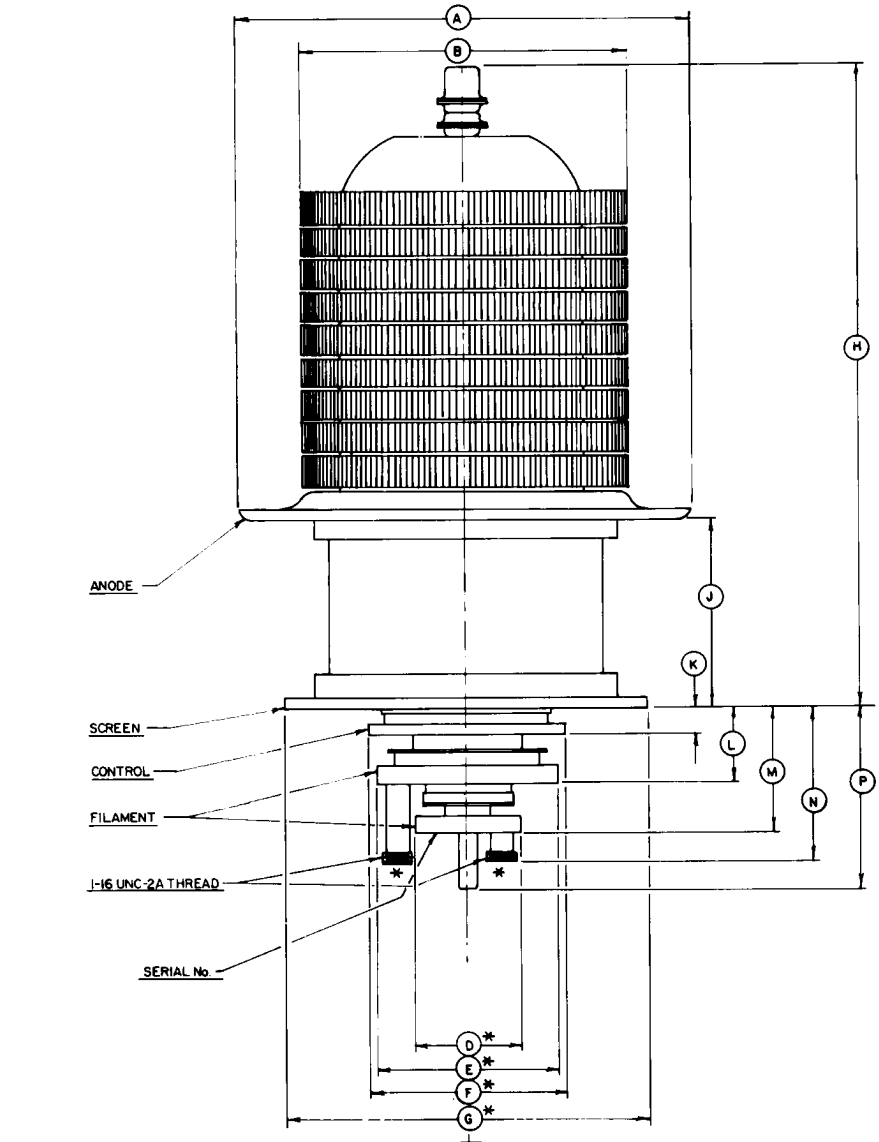
PLATE DISSIPATION - The plate dissipation of 250 kilowatts attainable through vapor cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CV250,000A is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 167,000 watts.

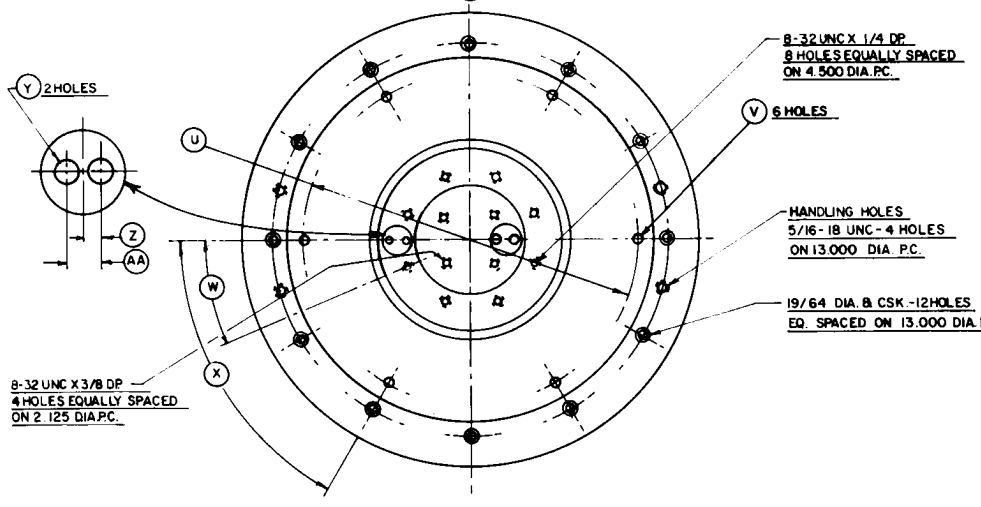
X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CV250,000A, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

HIGH VOLTAGE - Normal operating voltages used with the 4CV250,000A are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

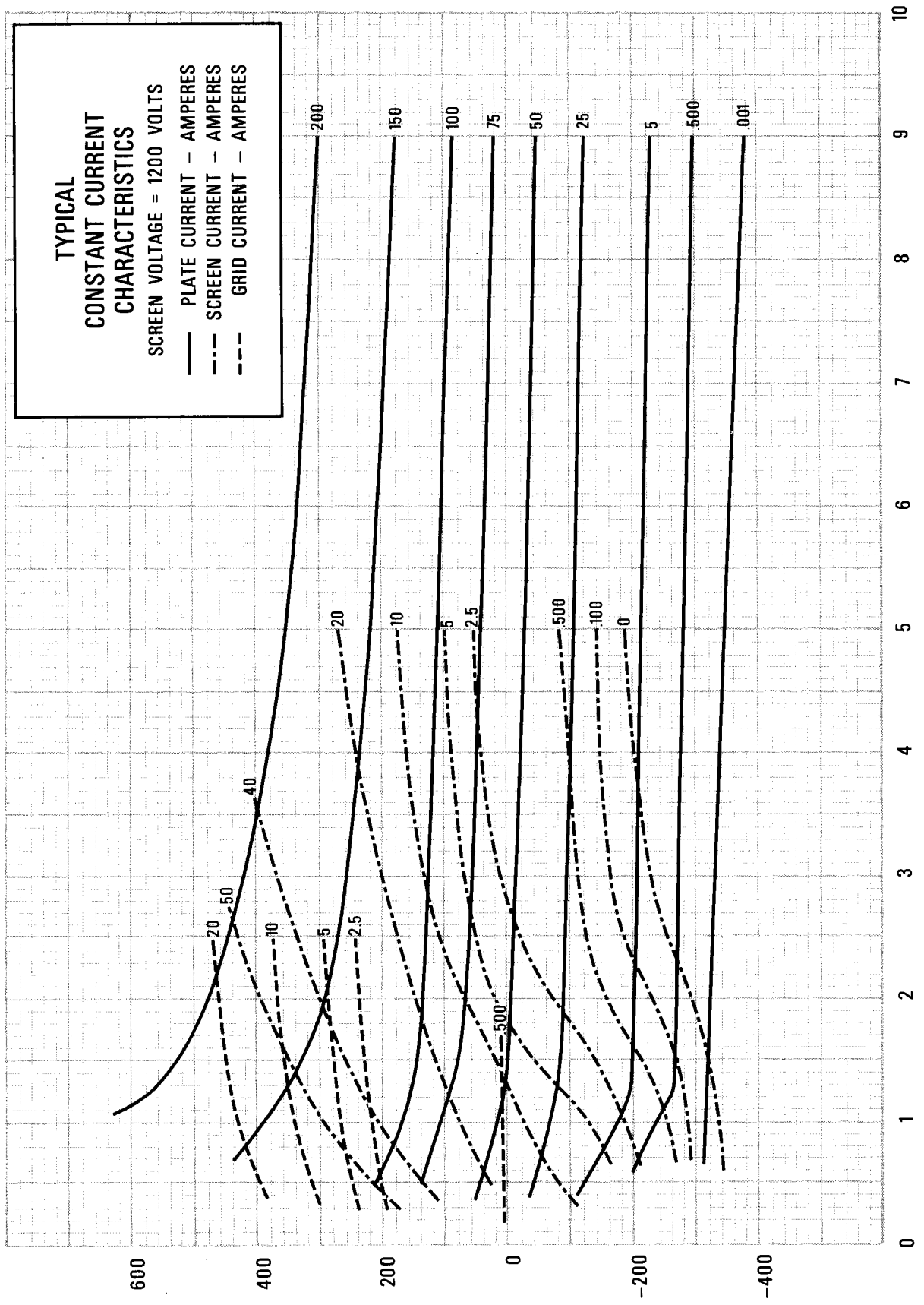


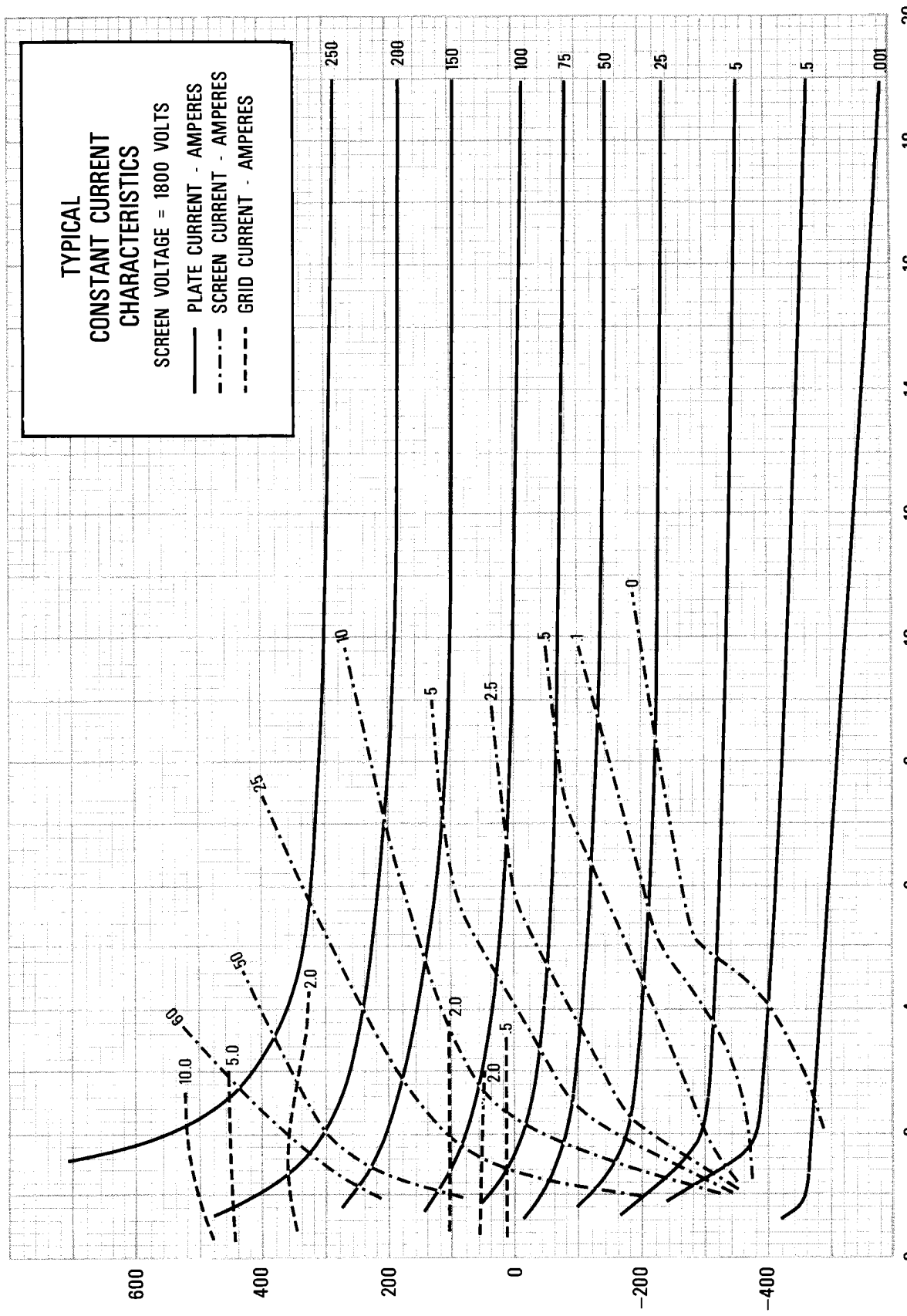


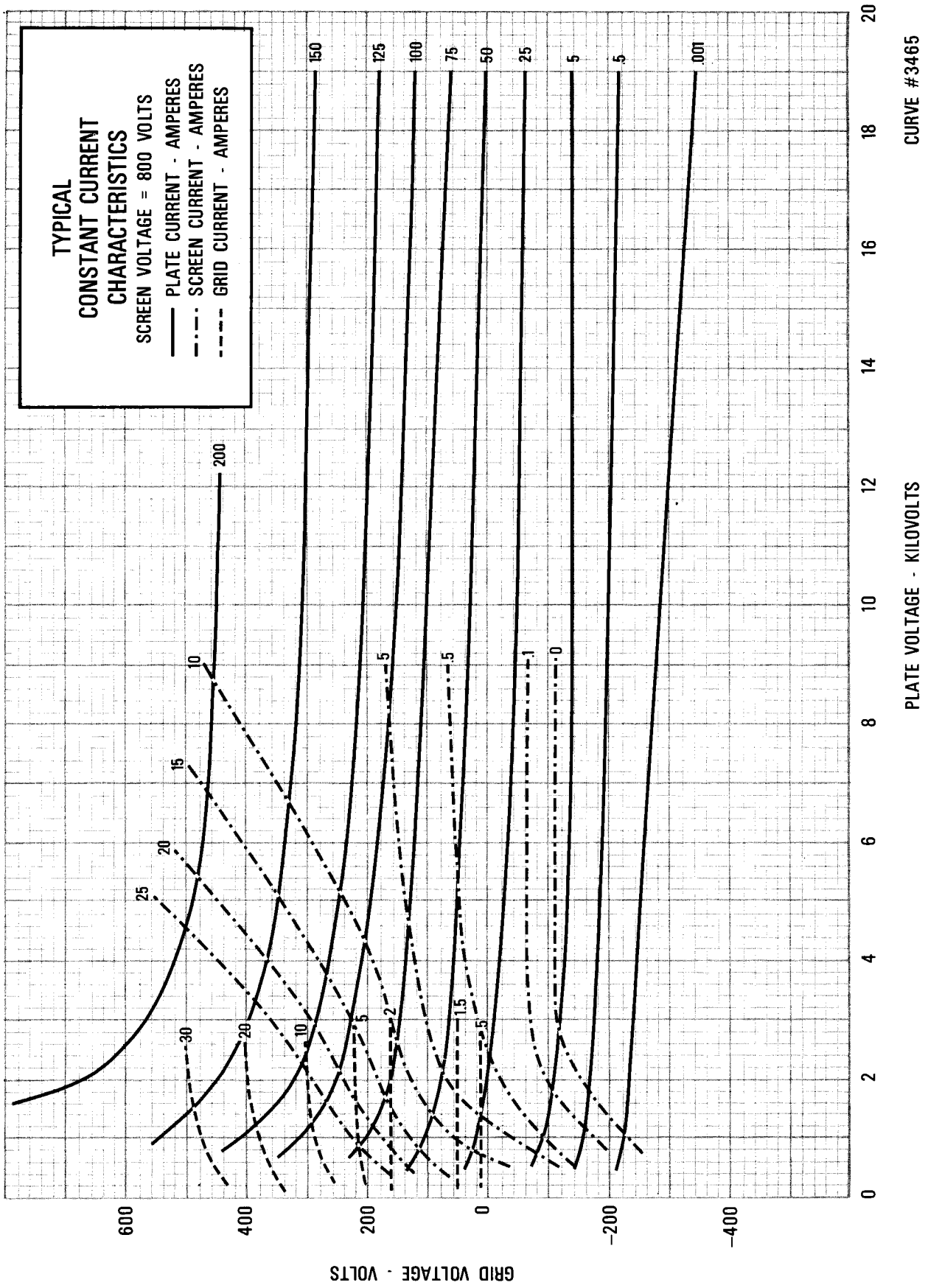
DIM.	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	14.937	15.062	- -	379.40	382.57	- -
B	11.125	11.375	- -	282.57	288.92	- -
D	3.437	3.562	- -	87.30	90.47	- -
E	5.937	6.062	- -	150.80	153.97	- -
F	6.437	6.562	- -	163.50	166.67	- -
G	11.937	12.062	- -	303.20	306.37	- -
H	20.400	21.120	- -	518.16	536.45	- -
J	6.250	6.375	- -	158.75	161.92	- -
K	0.750	0.875	- -	19.05	22.22	- -
L	2.437	2.562	- -	61.90	65.07	- -
M	4.062	4.187	- -	103.17	106.35	- -
N	5.000	5.125	- -	127.00	130.17	- -
U	- -	- -	11.000	- -	- -	279.40
V	- -	- -	0.375	- -	- -	9.52
W	- -	- -	22-1/2°	- -	- -	22-1/2°
X	- -	- -	60°	- -	- -	60°
Y	- -	- -	0.261	- -	- -	6.63
Z	- -	- -	0.219	- -	- -	5.56
AA	- -	- -	0.438	- -	- -	11.12

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.

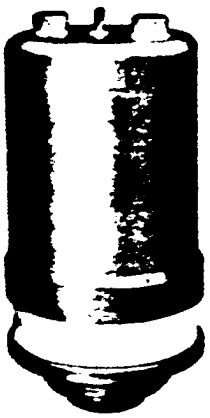
2. (*) CONTACT SURFACES.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1200 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
200
150
100
75
50
25
5
.500
.001
40
20
10
5
2.5
500
20
10
5
2.5
500
100
0
600
400
200
0
−200
−400
GRID VOLTAGE – VOLTS
0
1
2
3
4
5
6
7
8
9
10
PLATE VOLTAGE – KILOVOLTS
CURVE #3285


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1800 VOLTS
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
250
200
150
100
75
50
25
5
.5
.001
10.0
5.0
2.0
.5
25
10
5
2.5
2.0
.5
.5
.1
0
600
400
200
0
-200
-400
0
2
4
6
8
10
12
14
16
18
20
GRID VOLTAGE - VOLTS
PLATE VOLTAGE - KILOVOLTS
CURVE #3464


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 800 VOLTS
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
GRID VOLTAGE - VOLTS
PLATE VOLTAGE - KILOVOLTS
CURVE #3465

4CW100,000G



The 4CW100,000G is a tetrode intended for Class C HF and VHF service. It features high-stability pyrolytic graphite grids and an internal structure which permits high efficiency operation to 250 MHz. The tube is also recommended for FM broadcast service and for VHF-TV linear amplifier service. The anode is rated for 100 kW with water cooling.

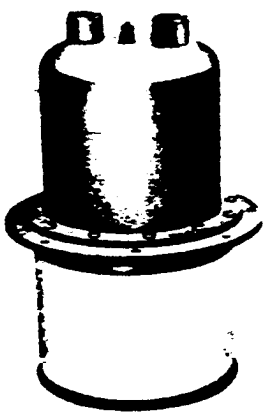
CHARACTERISTICS

Plate Dissipation (Max.)	100,000 watts
Screen Dissipation (Max.)	1,500 watts
Grid Dissipation (Max.)	1,000 watts
Frequency for Max. Ratings (CW)	110 MHz
Cooling	Water and Forced Air
Filament	Thoriated Tungsten mesh
Voltage	15.0 volts
Current	170 amperes
Capacitances (Gnd. Cath. Connection)	
Input	445 pF
Output	37.0 pF
Feed-through	1.8 pF
Capacitances (Gnd. Grid Connection)	
Input	169 pF
Output	39.0 pF
Feed-through	0.17 pF
Amplification Factor (g_1–g_2)	8
Base	Special Coaxial
Recommended Air System Socket	SK-2400
Maximum Seal & Anode Core Temperature	250°C
Maximum Length	12.7 in; 32.3 cm
Maximum Diameter	6.4 in; 16.3 cm
Weight (approximate)	27.2 lb; 12.3 kg
Operating Position	Vertical, base up or down

Class of Operation	Type of Service	MAXIMUM RATINGS: Plate Voltage (volts)	MAXIMUM RATINGS: Plate Current (amps)	TYPICAL OPERATION: Plate Voltage (volts)	TYPICAL OPERATION: Screen Voltage (volts)	TYPICAL OPERATION: Plate Current (amps)	TYPICAL OPERATION: Drive Power (watts)	TYPICAL OPERATION: Output Power (kW)
C	RF Amplifier	14,000	12.5	10,600	800	7.0	250	60
C	RF Amplifier†	14,000	12.5	11,500	550	6.4	1,000	53

†100.5 MHz

4CW150,000E



The 4CW150,000E is intended for use as a Class C RF amplifier or oscillator, a Class AB push-pull AF amplifier or modulator as well as a plate-and screen-modulated Class C RF amplifier. In pulse modulator service, it can deliver a peak output of 4 megawatts. The tube is characterized by low input and feedback capacitances and low internal lead inductance.

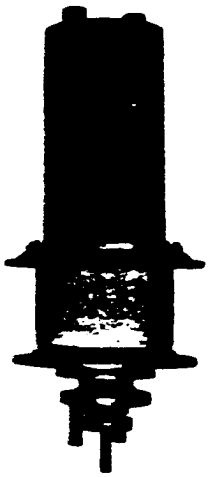
CHARACTERISTICS

Plate Dissipation (Max.)	150,000 watts
Screen Dissipation (Max.)	1,750 watts
Grid Dissipation (Max.)	500 watts
Frequency for Max. Ratings (CW)	110 MHz
Cooling	Water and Forced Air
Filament	Thoriated Tungsten mesh
Voltage	15.5 volts
Current	215 amperes
Capacitances (Gnd. Cath. Connection)	
Input	370 pF
Output	60.0 pF
Feed-through	1.0 pF
Capacitances (Gnd. Grid Connection)	
Input	175 pF
Output	60.0 pF
Feed-through	0.35 pF
Base	Special Coaxial
Recommended Air System Socket	SK-2011A
Maximum Seal & Anode Core Temperature	250°C
Maximum Length	14.3 in; 36.2 cm
Maximum Diameter	9.5 in; 24.2 cm
Weight (approximate)	47 lb; 21.4 kg
Operating Position	Vertical, base up or down

Class of Operation	Type of Service	MAXIMUM RATINGS: Plate Voltage (volts)	MAXIMUM RATINGS: Plate Current (amps)	TYPICAL OPERATION: Plate Voltage (volts)	TYPICAL OPERATION: Screen Voltage (volts)	TYPICAL OPERATION: Plate Current (amps)	TYPICAL OPERATION: Drive Power (watts)	TYPICAL OPERATION: Output Power (kW)
C	RF Amplifier	22,000	20.0	20,000	1,500	15.2	120	220
C	RF Amplifier Plate Modulated	17,500	20.0	15,000	750	11.7	530	140
AB_1	RF Linear Amplifier	22,000	20.0	18,000	1,500	13.5	—	168
—	Pulse Modulator	40,000	200†	40,000	2,500	122†	—	4,100‡

†Cathode current, pulse
‡Pulse value

4CW250,000B



The 4CW250,000B is recommended as a Class C amplifier or oscillator; a Class AB RF linear amplifier; a Class AB push-pull AF linear amplifier or modulator; a plate or screen modulated Class C RF amplifier; or for pulse modulator or regulator service. Water jacket not included.

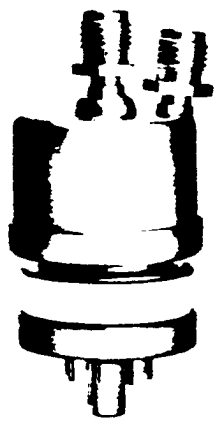
CHARACTERISTICS

Plate Dissipation (Max.)	250,000 watts
Screen Dissipation (Max.)	3,500 watts
Grid Dissipation (Max.)	1,500 watts
Frequency for Max. Ratings (CW)	50 MHz
Cooling	Water and Forced Air
Filament	Thoriated Tungsten
Voltage	12.0 volts
Current	660 amperes
Capacitances (Gnd. Cath. Connection):	
Input	745 pF
Output	124 pF
Feed-through	6.0 pF
Capacitances (Gnd. Grid Connection):	
Input	324 pF
Output	128 pF
Feed-through	1.2 pF
Amplification Factor (g_1–g_2)	4.5
Base	Special
Recommended Filament Connector	SK-1710
Recommended Grid Connector	SK-1712
Recommended Anode Water Jacket	SK-1720
Maximum Seal & Envelope Temperature	200°C
Maximum Length:	27.65 in; 70.23 cm
Maximum Diameter:	13.06 in; 33.17 cm
Weight (approximate) (tube only)	98.0 lb; 44.5 kg.
Operating Position	Vertical, base up or down

Class of Operation	Type of Service	MAXIMUM RATINGS: Plate Voltage (volts)	MAXIMUM RATINGS: Plate Current (amps)	TYPICAL OPERATION: Plate Voltage (volts)	TYPICAL OPERATION: Screen Voltage (volts)	TYPICAL OPERATION: Plate Current (amps)	TYPICAL OPERATION: Drive Power (watts)	TYPICAL OPERATION: Output Power (kW)
C	RF Amplifier	20,000	40.0	19,000	800	32.5	3000	460
C	RF Amplifier Plate Modulated	17,500	30.0	14,000	800	29.0	2320	285
AB_1	RF Linear Amplifier	20,000	40.0	20,000	1800	23.0	—	330
AB_1	AF Amplifier or Modulator	20,000	40.0	20,000	1800	46.0*	—	660*

*Two tubes.

4W300B/8249



The 4W300B/8249 is a water-cooled version of the 4CX250B/7203 having an anode dissipation rating of 300 watts. It is intended for use where water cooling is preferred or when reserve anode dissipation is desired.

CHARACTERISTICS

Plate Dissipation (Max.)	300 watts
Screen Dissipation (Max.)	12 watts
Grid Dissipation (Max.)	2 watts
Frequency for Max. Ratings (CW)	500 MHz
Cooling	Water and Forced Air
Cathode	Oxide-coated Unipotential
Voltage	6.0 volts
Current	2.6 amperes
Capacitances (Gnd. Cath. Connection)	
Input	15.7 pF
Output	4.5 pF
Feed-through	0.04 pF
Capacitances (Gnd. Grid Connection)	
Input	13.0 pF
Output	4.5 pF
Feed-through	0.01 pF
Amplification Factor (g_1–g_2)	5
Base	9-Pin Special
Recommended Air System Socket	SK-600 Series
Maximum Seal & Anode Core Temperature	250°C
Maximum Length	3.4 in; 86.5 mm
Maximum Diameter	1.56 in; 39.7 mm
Weight (approximate)	5.75 oz; 163 gm
Operating Position	Vertical, base up or down

Class of Operation	Type of Service	MAXIMUM RATINGS: Plate Voltage (volts)	MAXIMUM RATINGS: Plate Current (amps)	TYPICAL OPERATION: Plate Voltage (volts)	TYPICAL OPERATION: Screen Voltage (volts)	TYPICAL OPERATION: Plate Current (amps)	TYPICAL OPERATION: Drive Power (watts)	TYPICAL OPERATION: Output Power (watts)
C	RF Amplifier up to 175 MHz	2000	0.25	2000	300	0.25	2.9	390
C	RF Amplifier Plate Modulated up to 175 MHz	1500	0.20	1500	250	0.20	1.7	235
AB_1	RF Linear Amplifier up to 175 MHz	2000	0.25	2000	350	0.25	—	300
AB_1	RF Linear Amplifier (AM Service) up to 175 MHz	2000	0.25	2000	350	0.15	—	65†
AB_1	AF Amplifier or Modulator	2000	0.25	2000	350	0.50*	—	600*

*Two tubes
†Carrier Power

TECHNICAL DATA

4CV250,000B
VAPOR COOLED

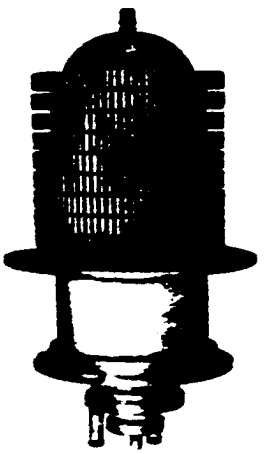
4CW250,000B
WATER COOLED

POWER TETRODES

The EIMAC 4CV250,000B and 4CW250,000 are ceramic/metal (vapor cooled and water cooled, respectively) power tetrodes intended for use at the 250 to 500 kilowatt output power level. They are recommended for use as a Class C amplifier or oscillator, Class AB rf linear amplifier, Class AB push-pull af amplifier or modulator, plate or screen modulated Class C rf amplifier, or for pulse modulator or regulator service.

The 4CV250,000B is operated in the accessory boiler BR-620 (not supplied with the tube); the 4CW250,000B is operated with the accessory water jacket SK-1720 (not supplied with the tube), and both tubes are rated for 250 kilowatts maximum anode dissipation.

4CV250,000B



4CW250,000B



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten

Voltage	12.0 ± 0.6	V
Current @ 12.0 V	660	A
Amplification Factor (average), grid to screen	4.5	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	760	pF
Cout	124	pF
Cgp	6.0	pF
Frequency of Maximum Rating, CW	50	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured without any special shielded fixture.

MECHANICAL

Maximum Overall Dimensions:

Length (4CV250,000B)	26.895 In; 68.31 cm
(4CW250,000B)	26.525 In; 67.37 cm
Diameter (4CV250,000B)	15.062 In; 38.26 cm
(4CW250,000B)	13.062 In; 33.18 cm

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varian, EIMAC division/301 industrial way/san carlos/california 94070

Base (both types) ..... Special

Recommended Base Connectors (both types):

Filament Connector (2 required) ..... EIMAC SK-1710

Control Grid Connector (1 required) ..... EIMAC SK-1712

Recommended Accessories For Anode Cooling (not supplied with tube):

4CV250,000B ..... EIMAC Boiler BR-620

4CW250,000B ..... EIMAC Jacket SK-1720

Operating Position: 4CV250,000B ..... Vertical, Anode Up

4CW250,000B ..... Vertical, Base Up or Down

Maximum Ceramic/Metal Seal or Envelope Temperature ..... 200°C

Cooling: 4CV250,000B ..... Vapor and Water

4CW250,000B ..... Water

Net Weight: 4CV250,000B (w/o boiler) ..... 180 Lb; 81.8 kg

4CW250,000B (w/o jacket) ..... 98 Lb; 44.5 kg

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM
(Key-down Condition)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000 VOLTS
DC SCREEN VOLTAGE	2,500 VOLTS
DC PLATE CURRENT	40 AMPERES
PLATE DISSIPATION	250,000 WATTS
SCREEN DISSIPATION	3,500 WATTS
GRID DISSIPATION	1,500 WATTS

TYPICAL OPERATION (Frequencies below 30 MHz)

DC Plate Voltage	16	19 kV
DC Screen Voltage	800	800 V
DC Grid Voltage	-800	-800 V
DC Plate Current	23.5	32.5 A
DC Screen Current	2.4	3.5 A
DC Grid Current	1.15	2.5 A
Driving Power[1]	2.24	3.0 kW
Plate Output Power	275	460 kW
Plate Dissipation	100	155 kW
RF Load Impedance	300	275 Ω

1. Calculated Driving Power neglects input conductance and rf circuit loss.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER

Class C Telephony
(Carrier conditions except where noted)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500 VOLTS
DC SCREEN VOLTAGE	2,000 VOLTS
DC PLATE CURRENT	30 AMPERES
PLATE DISSIPATION[1]	167,000 WATTS
SCREEN DISSIPATION	3,500 WATTS
GRID DISSIPATION	1,500 WATTS

1. Corresponds to 250,000 watts at 100 per cent sine wave modulation.
2. Approximate Value.

TYPICAL OPERATION (Frequencies below 30 MHz)

DC Plate Voltage	15 kV
DC Screen Voltage	800 V
Peak af Screen Voltage (for 100% Mod.)[2]	800 v
DC Grid Voltage	-800 V
DC Plate Current	22.8 A
DC Screen Current	4.1 A
DC Grid Current	1.46 A
Peak rf Grid Voltage	1110 v
Grid Driving Power[3]	1630 W
Plate Output Power	280 kW
RF Load Impedance	323 Ω
Plate Dissipation	63 kW

3. Calculated Driving Power neglects input conductance and rf circuit loss.

AUDIO FREQUENCY AMPLIFIER OR MODULATOR
Class AB

ABSOLUTE MAXIMUM RATINGS: (Per Tube)

DC PLATE VOLTAGE	20,000 VOLTS
DC SCREEN VOLTAGE	2,500 VOLTS
DC PLATE CURRENT	40 AMPERES
PLATE DISSIPATION	250,000 WATTS
SCREEN DISSIPATION	3,500 WATTS
GRID DISSIPATION	1,500 WATTS

1. Approximate Value.
2. Per Tube

TYPICAL OPERATION (Two Tubes)
Class AB 1

DC Plate Voltage	15	20 kV
DC Screen Voltage	1.8	1.8 kV
DC Grid Voltage	-500	-500 V
Max-Signal Plate Current	40	46 A
Zero Signal Plate Current[2]	0.2	0.2 A
Max-Signal Screen Current[1]	1.1	1.2 A
Peak af Driving Voltage[2]	500	500 v
Driving Power	0	0 W
Load Impedance (plate to plate)	650	870 Ω
Plate Dissipation	160	260 kW
Max-Signal Output Power	440	660 kW

RADIO FREQUENCY LINEAR AMPLIFIER
Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20.000 VOLTS
DC SCREEN VOLTAGE	2.500 VOLTS
DC PLATE CURRENT	40 AMPERES
PLATE DISSIPATION	250.000 WATTS
SCREEN DISSIPATION	3.500 WATTS
GRID DISSIPATION	1.500 WATTS

1. Approximate Value
2. Calculated Driving Power neglects input conductance and rf circuit loss.

TYPICAL OPERATION (Frequencies below 30 MHz)
Class AB 1, Peak-Envelope or Modulation Crest Conditions

DC Plate Voltage	15	20 kV
DC Screen Voltage	1.8	1.8 kV
DC Grid Voltage	-500	-500 V
Plate Current	20	23 A
Zero Signal Plate Current	0.2	0.2 A
Max-Signal Screen Current[1]	1.1	1.2 A
Peak rf Grid Voltage	500	500 v
Driving Power[2]	0	0 W
Plate Dissipation	80	130 kW
Resonant Load Impedance	325	435 Ω
Plate Output Power	220	330 kW

PULSE MODULATOR OR REGULATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	40.000 VOLTS
DC SCREEN VOLTAGE	2.500 VOLTS
PEAK CATHODE CURRENT	350 AMPERES
PLATE DISSIPATION	250.000 WATTS
SCREEN DISSIPATION	3.500 WATTS
GRID DISSIPATION	1.500 WATTS

APPLICATION

MECHANICAL

MOUNTING (4CV250,000B) - The tube must be mounted vertically, anode up. The tube may be supported by the anode flange or the screen flange.

Care must be exercised to insure that the axis of the tube/boiler combination is vertical and that the water in the boiler is at the correct level. The anode flange on the tube must seal securely against the "O" ring, forming a vapor-tight seal between the tube and boiler.

MOUNTING (4CW250,000B) - The tube must be mounted vertically, anode up or down. The tube may be supported by the anode flange or the screen flange.

ANODE COOLING (4CV250,000B) - Cooling is accomplished by immersing the anode of the 4CV250,000B in a "Boiler" filled with distilled water. Energy dissipated by the anode causes the water to boil at the anode surfaces, be converted into steam and be carried away to an external condenser. The condensate is then returned to the boiler, completing the cycle.

This boiling action maintains the anode surfaces at a fairly constant temperature near 100°C. The vapor-cooled tube has good overload capabilities; excess dissipation for moderate periods only causes more water to boil.

Since the tube anode and boiler are usually at high potential to ground, water and steam connections to the boiler are made through insulated tubing.

ANODE COOLING (4CW250,000B) - Minimum cooling water requirements for the anode are shown in the table for an outlet water temperature not to exceed 70°C and an inlet water temperature of 50°C. High-purity water must be used to minimize power loss, corrosion of metal fittings, and loss of anode dissipation capability. Water resistivity must be maintained at 1 megohm/cm³ or better for long term operation.

Anode Dissipation (kW)	Water Flow (gpm)	Approx. Jacket Press. Drop (psi)
150	37.5	3.5
200	50.0	9.0
250	60.0	10.0

EIMAC Application Bulletin #16 titled, "WATER PURITY REQUIREMENTS IN LIQUID COOLING SYSTEMS" is available on request, and should be consulted for details on maintenance of water quality standards and use of a water purification loop in the installation. Since the anode is normally at high potential to

ground, water connections to the anode are made through insulating tubing, with long enough sections that column resistance is above 4 megohms per 1000 plate supply volts, or 10 megohms total, whichever is less.

BASE COOLING (Both Types) - The filament supports of both tubes are water cooled. Approximately .5 GPM should circulate through each of the filament connectors with a pressure drop of 20 PSI. Filament connector assemblies, SK-1710, provide electrical and water connections. Two sets of SK-1710 are required.

It is recommended that the water cooled control grid connector, SK-1712, be used. Water flow of approximately .5 GPM should circulate through the grid connector. The pressure drop across the grid connector is low. A convenient way to make water connection is to series connect the grid cooling water with the outer filament cooling water path.

The outer filament water path has a lower pressure drop than the inner filament water path making this connection practical.

ALL COOLING MUST BE APPLIED BEFORE OR SIMULTANEOUSLY WITH THE APPLICATION OF ELECTRODE VOLTAGES, INCLUDING FILAMENT, AND SHOULD NORMALLY BE MAINTAINED FOR SEVERAL MINUTES AFTER ALL VOLTAGES ARE REMOVED TO ALLOW FOR TUBE COOLDOWN.

ELECTRICAL

FILAMENT OPERATION - The peak emission at rated filament voltage is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase life by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appeared to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked.

Filament starting current must be limited to a maximum of 1800 amperes.

CONTROL GRID OPERATION - The control grid is rated at 1,500 watts of dissipation and protective measures should be included in circuitry to insure that this rating is not exceeded. Grid dissipation is the approximate product of dc grid current and peak positive grid voltage.

SCREEN DISSIPATION - The power applied to the screen grid must not exceed 3,500 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is the product of RMS screen current and RMS screen voltage.

PLATE DISSIPATION - The plate dissipation of 250 kilowatts provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 167,000 watts.

LOAD VSWR - The load VSWR should be monitored and the detected signal used to operate the interlock system to remove the plate voltage within 20 milliseconds after a fault occurs. In the case of high stored energy in the load system, care must be taken to avoid excessive return energy from damaging the tube and associated circuit components.

FAULT PROTECTION - To assure nondestruction of tube elements from high-energy power supplies, during a fault condition, all supplies must be checked for proper operation of their protective circuits. An approved method to meet the tube protection criteria would be the use foil, solder wire, or small diameter wire to produce a controlled short on the power supply. The simplest technique is to short the plate to cathode, screen grid to cathode, control grid to cathode, and screen grid to anode (individually, one at a time) using

a vacuum relay through a section of #30 AWG copper wire. The wire will remain intact if the power supply protective circuitry is operating properly. An electronic crowbar will be required on the anode supply, and may be required on the other electrode supplies if the test outlined above is not passed. See EIMAC Application Bulletin #17 for further details.

Properly rated spark gaps must also be located between the screen grid and cathode and between the control grid and cathode to meet over-voltage protection criteria. A series resistance of 10 to 50 ohms is recommended in the screen and control grid power supply leads.

X-RADIATION - High-vacuum tubes operating at voltages higher than 15 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. These tubes, operating at rated voltages and currents, are a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 15 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

HIGH VOLTAGE - Normal operating voltages used with these tubes are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, 94070, For information and recommendations.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of power tubes involves one or more of the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. *HIGH VOLTAGE* - Normal operating voltages can be deadly.

b. *RF RADIATION* - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE AFFECTED.

c. *X-RAY RADIATION* - High voltage tubes can produce dangerous and possibly fatal x-rays.

d. *BERYLLIUM OXIDE POISONING* - Dust or fumes from BeO ceramics used as thermal links with some conduction-cooled power tubes are highly toxic and can cause serious injury or death.

e. *GLASS EXPLOSION* - Many electron tubes have glass envelopes. Breaking the glass can cause an implosion, which will result in an explosive scattering of glass particles. Handle glass tubes carefully.

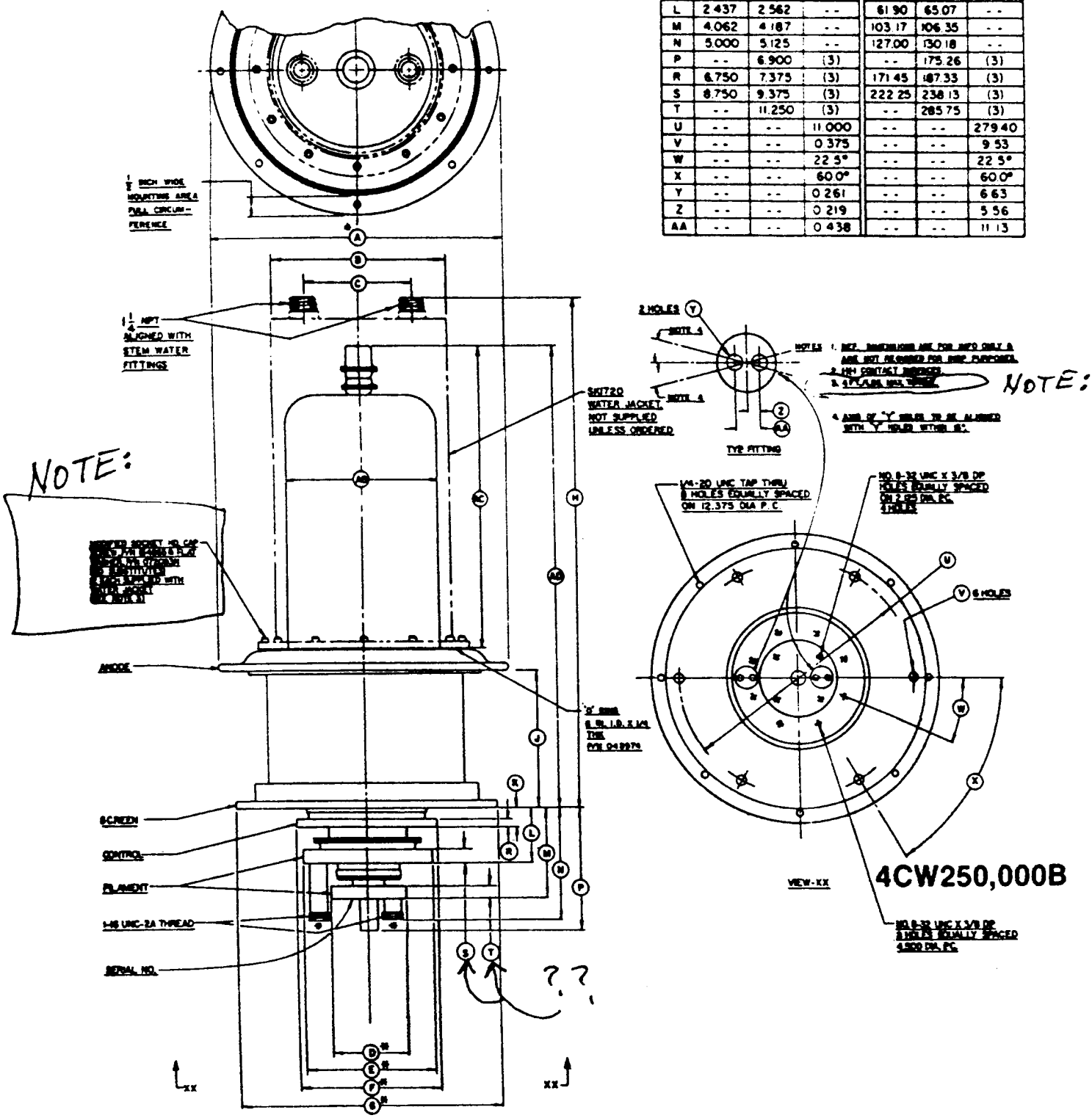
f. *HOT WATER* - Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

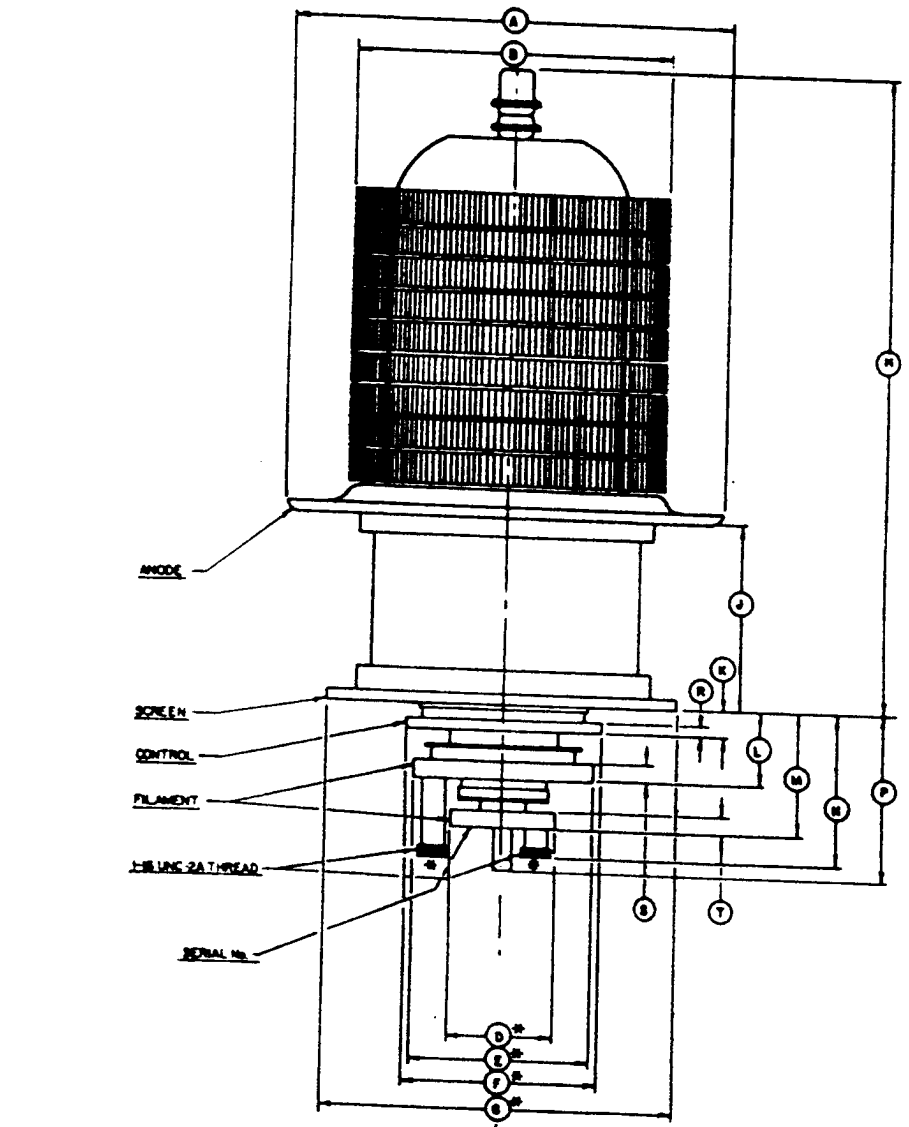
g. *HOT SURFACES* - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred degrees centigrade and cause serious burns if touched.

Please review the detailed operating hazards sheet enclosed with each tube or request a copy from the address shown below: Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070.

DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	12.937	13.062	--	328.60	331.77	--
B	7.937	8.062	--	201.60	204.77	--
C	4.437	4.562	--	112.70	115.87	--
D	3.437	3.562	--	87.30	90.47	--
E	5.937	6.062	--	150.80	153.97	--
F	6.437	6.562	--	163.50	166.67	--
G	11.937	12.062	--	303.20	306.37	--
H	23.437	23.562	--	595.30	598.47	--
J	6.250	6.375	--	158.75	161.93	--
K	0.750	0.875	--	19.05	22.23	--
L	2.437	2.562	--	61.90	65.07	--
M	4.062	4.187	--	103.17	106.35	--
N	5.000	5.125	--	127.00	130.18	--
P	--	6.900	(3)	--	175.26	(3)
R	6.750	7.375	(3)	171.45	187.33	(3)
S	8.750	9.375	(3)	222.25	238.13	(3)
T	--	11.250	(3)	--	285.75	(3)
U	--	--	11.000	--	--	279.40
V	--	--	0.375	--	--	9.53
W	--	--	22.5°	--	--	22.5°
X	--	--	60.0°	--	--	60.0°
Y	--	--	0.261	--	--	6.63
Z	--	--	0.219	--	--	5.56
AA	--	--	0.438	--	--	11.13

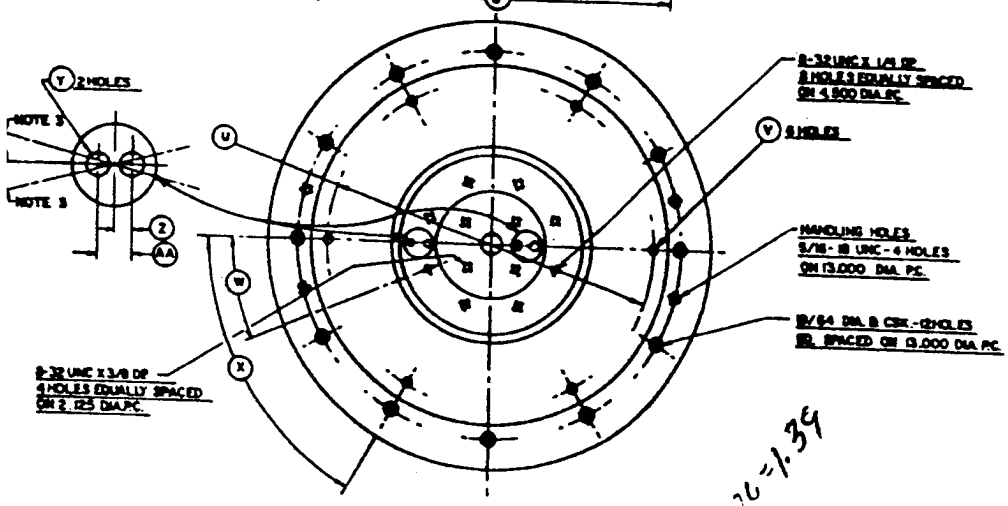


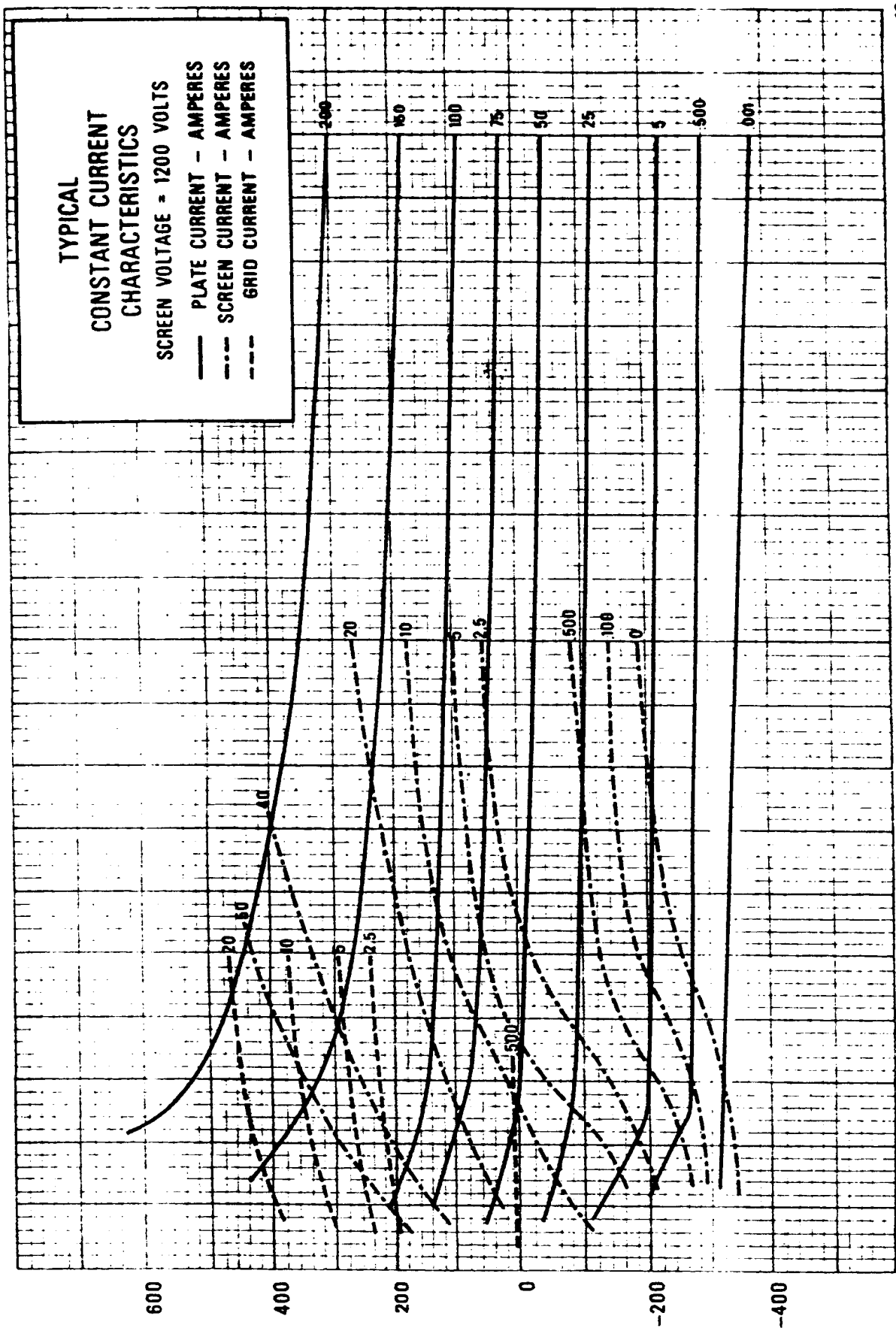


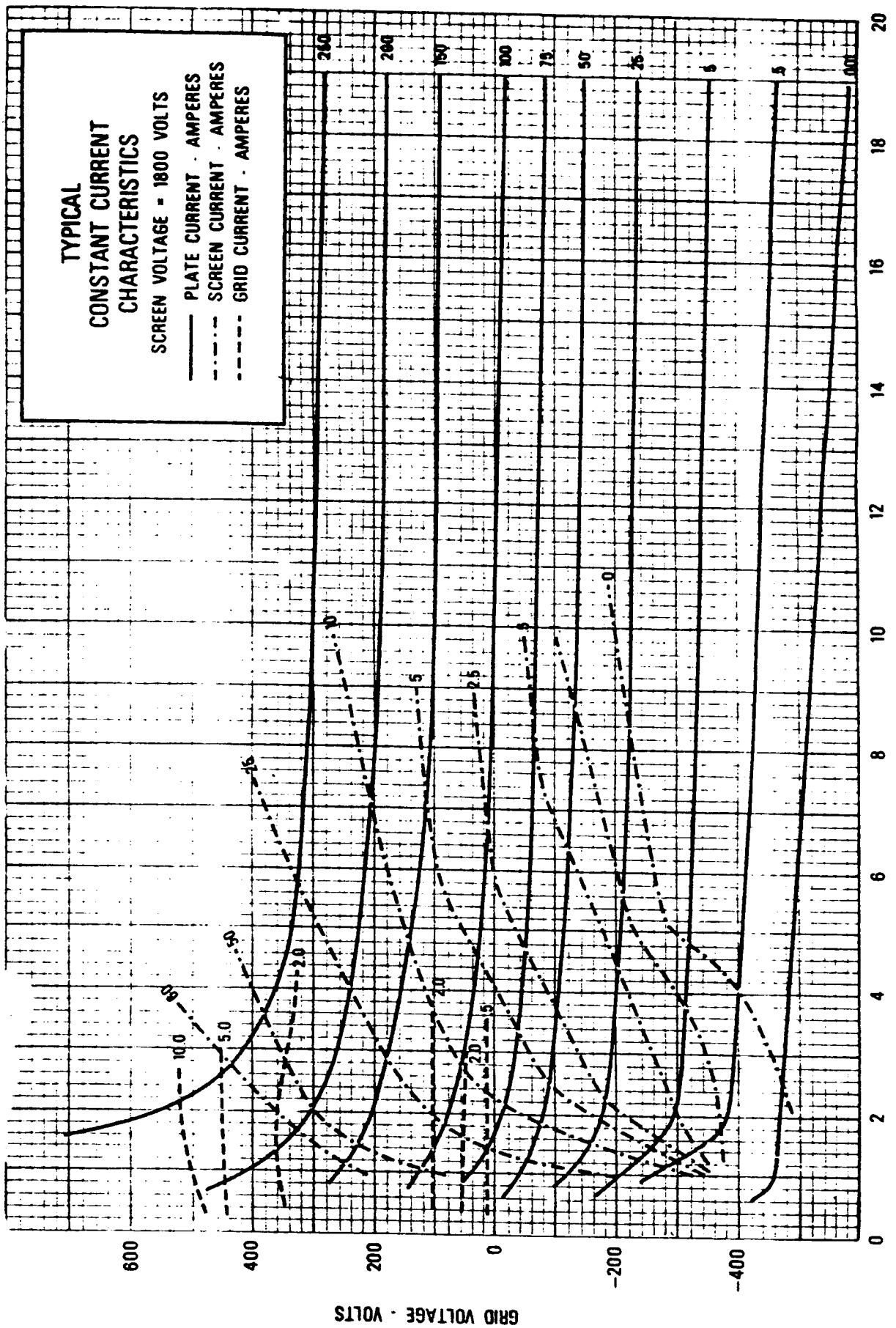
DIM.	INCHES		REF	MILLIMETRES		REF
	MIN.	MAX.		MIN.	MAX.	
A	14.937	15.062	- -	379.40	382.57	- -
B	11.433	11.375	- -	288.37	289.48	- -
C	3.497	3.562	- -	87.38	90.47	- -
D	5.497	5.622	- -	139.60	142.77	- -
E	6.497	6.562	- -	165.00	166.67	- -
F	12.497	12.562	- -	317.40	319.07	- -
G	7.900	8.100	- -	200.66	205.74	- -
J	0.250	0.375	- -	6.35	9.52	- -
K	0.750	0.875	- -	19.05	22.22	- -
L	2.497	2.562	- -	61.90	65.07	- -
M	4.062	4.187	- -	103.17	106.38	- -
N	5.000	5.125	- -	127.00	130.17	- -
U	- -	- -	11.000	- -	- -	279.40
V	- -	- -	0.375	- -	- -	9.52
W	- -	- -	28°-4"	- -	- -	28°-4"
X	- -	- -	60°	- -	- -	60°
Y	- -	- -	0.281	- -	- -	7.14
Z	- -	- -	0.219	- -	- -	5.56
AA	- -	- -	0.438	- -	- -	11.12

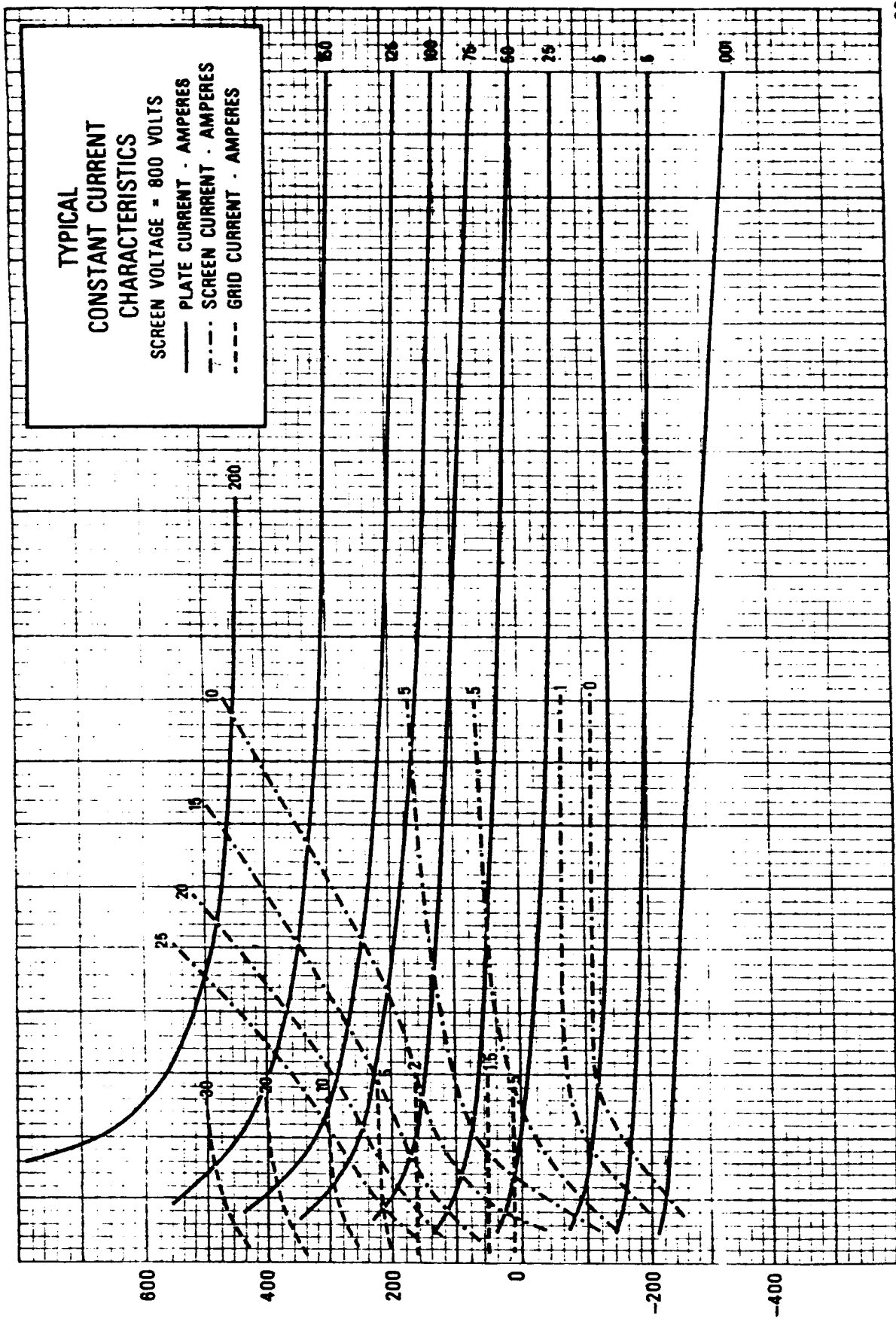
NOTES
1. ALL DIMENSIONS ARE FOR REFERENCE ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. IN CONTACT SURFACES.
3. AXIS OF "Y" HOLES TO BE ALIGNED WITH "Y" HOLES WITHIN 30°
4. "O" RING P/N 049172 N, 12 I.D. x 3/16 WALL, SUPPLIED WITH TUBE

4CV250,000B




TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1200 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS
CURVE #3285
NEW


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1800 VOLTS
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
PLATE VOLTAGE - KILOVOLTS
GRID VOLTAGE - VOLTS
CURVE #3464

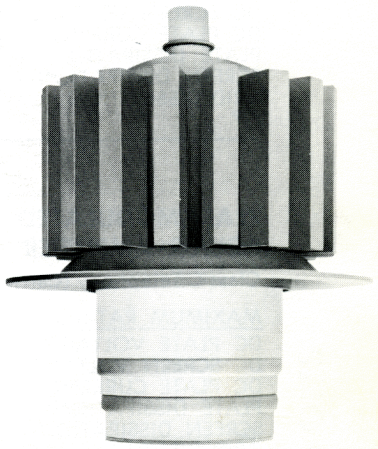

TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 800 VOLTS
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
CURVE #3465
PLATE VOLTAGE - KILOVOLTS
GRID VOLTAGE - VOLTS
0
2
4
6
8
10
12
14
16
18
20
600
400
200
0
-200
-400

TECHNICAL DATA

4CV35,000A

VAPOR-COOLED RADIAL-BEAM POWER-TETRODE

The EIMAC 4CV35,000A is a ceramic-metal power tetrode intended for use as a Class-C amplifier in radio-frequency applications. It features a new type of internal mechanical structure which results in higher RF operating efficiency. Low RF losses in this mechanical structure permit operation of the 4CV35,000A at full ratings up to 110 megahertz. The 4CV35,000A is also recommended for Class-AB audio-frequency and radio-frequency linear power amplifier service. The vapor-cooled anode is rated at 35 kilowatts of plate dissipation, making the tube attractive for low efficiency applications.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		6.3		volts
Current	152		168	amps
Amplification Factor (Grid-Screen) (average)		4.5		

	Min.	Max.	
Direct Interelectrode Capacitances, Grounded Cathode:			
Input	152	172	μμf
Output	22.0	27.0	μμf
Feedback		2.0	μμf
Direct Interelectrode Capacitances, Grounded Grid and Screen:			
Input	63.0	78.0	μμf
Output	23.0	28.0	μμf
Feedback		0.3	μμf

MECHANICAL

Base	Special, concentric
Maximum Seal Temperature	250°C
Maximum Anode Flange Temperature (See Outline Drawing)	110°C
Recommended Socket	EIMAC, SK-310
Boiler	EIMAC, BR-200
Operating Position	Axis vertical, base up or down
Maximum Dimensions:	
Height	9.44 inches
Diameter	7.75 inches
Base Cooling	Forced Air
Net Weight	20 pounds
Shipping Weight (Approximate)	35 pounds

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

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RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	5.0	AMPS
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION

DC Plate Voltage	7500	10,000	volts
DC Screen Voltage	750	750	volts
DC Grid Voltage	—515	—540	volts
DC Plate Current	4.95	4.8	amps
DC Screen Current	.580	.585	amp
DC Grid Current	.360	.320	amp
Peak RF Grid Voltage	675	700	volts
Driving Power	240	225	watts
Plate Dissipation	9000	10,000	watts
Plate Output Power	27,000	38,000	watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier conditions unless noted)

MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	4.0	AMPS
PLATE DISSIPATION*	23,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

*Corresponds to 35,000 watts at 100 percent sine-wave modulation.

TYPICAL OPERATION

DC Plate Voltage	6000	8000	volts
DC Screen Voltage	750	750	volts
Peak AF Screen Voltage (For 100% modulation)	—740	710	volts
DC Grid Voltage	—600	—640	volts
DC Plate Current	3.75	3.65	amps
DC Screen Current	.450	.430	mA
DC Grid Current	.185	.180	mA
Peak RF Grid Voltage	800	840	volts
Grid Driving Power	150	150	watts
Plate Dissipation	5100	5800	watts
Plate Output Power	17,400	23,500	watts

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	6.0	AMPS
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

*Per Tube
**Approximate Values

TYPICAL OPERATION (Two Tubes)

DC Plate Voltage	8000	10,000	volts
DC Screen Voltage	1500	1500	volts
DC Grid Voltage	—290	—300	volts
Max-Signal Plate Current	10.7	10.7	amps
Zero-Signal Plate Current*	5.0	5.0	amps
Max-Signal Screen Current**	.390	.340	mA
Zero-Signal Screen Current	0	0	amps
Peak AF Driving Voltage*	280	290	volts
Driving Power	0	0	watts
Load Resistance, Plate-to-Plate	1680	2200	ohms
Max-Signal Plate Dissipation*	16,800	20,500	watts
Max-Signal Plate Output Power	50,000	66,000	watts

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	6.0	AMPS
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

*Approximate Values

TYPICAL OPERATION, Peak-Envelope or Modulation-Crest Conditions

DC Plate Voltage	8000	10,000	volts
DC Screen Voltage	1500	1500	volts
DC Grid Voltage	—290	—300	volts
Max-Signal Plate Current	5.35	5.35	amps
Zero-Signal Plate Current	2.5	2.5	amps
Max-Signal Screen Current*	.195	.170	mA
Peak RF Grid Voltage	280	290	volts
Driving Power	0	0	watts
Plate Dissipation	16,800	20,500	watts
Plate Output Power	25,000	33,000	watts
Resonant Load Impedance	840	1100	ohms

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance is made for circuit losses of any kind. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf driving voltage is applied.

APPLICATION

MECHANICAL

Mounting — The 4CV35,000A must be operated with its axis vertical, base up in an EIMAC BR-200 boiler. Care must be exercised when installing to insure that the boiler is level, the water is at the proper level and that the flange of the tube makes a vapor tight seal against the the rubber O-ring and boiler. A typical vapor cooling system is shown on the opposite page.

Socket — The EIMAC SK-310 socket is available for use with the 4CV35,000A. Filament, control grid and screen grid connections are made to this socket.

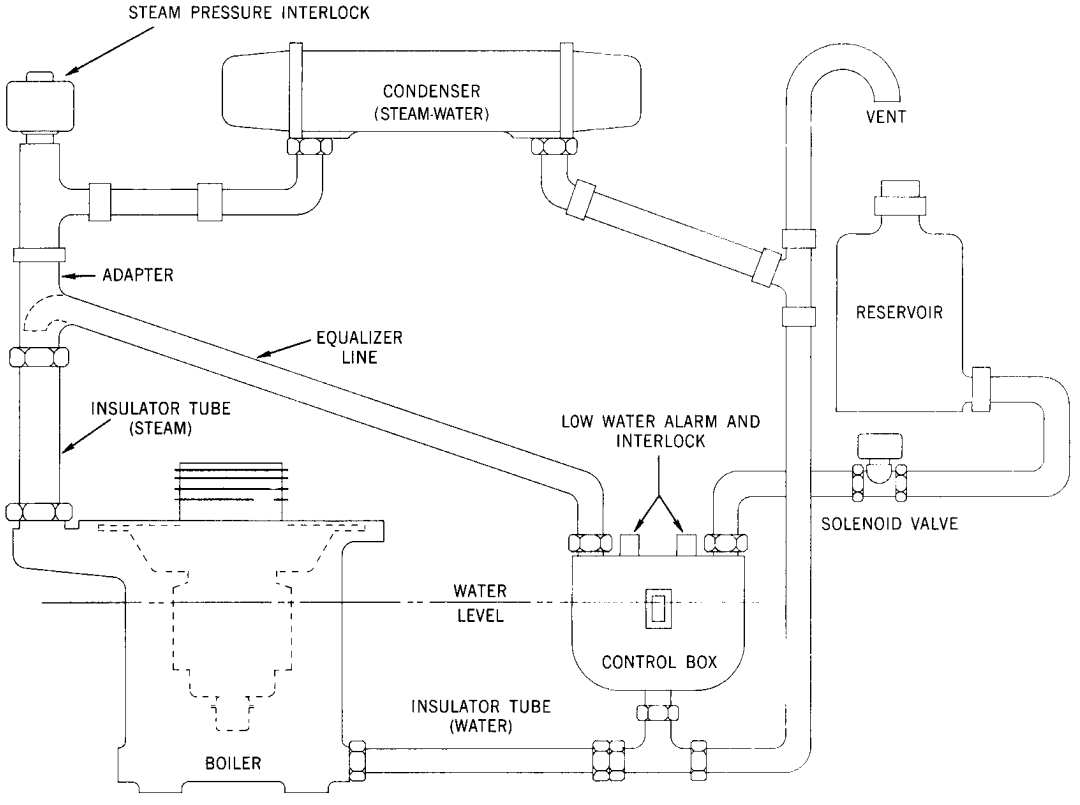
Cooling — Cooling is accomplished by immersing the anode in the distilled water filled BR-200 boiler. The energy dissipated at the anode causes the water to boil at the surfaces of the anode, be converted into steam and be carried away to the condenser. The boiling action keeps the anode surfaces at approximately 100°C. In a properly designed boiler-tube system (such as the 4CV35,000A and BR-200), it is extremely unlikely that the anode surfaces will ever exceed 110°C — well below the 250°C maximum rating — at full dissipation ratings.

The water in the boiler must be maintained at a constant level. Just below the top of the fins on the anode cooler. This is accomplished automatically in the vapor cooling system shown. Condensate from the condenser is returned to the boiler to maintain this constant fluid level. Any losses or drops in liquid level are sensed by the control box CB-202. A low water level in the control box activates the solenoid water valve, allowing make-up water from the reservoir to enter the boiler. When the proper level is reached, the control box de-energizes the solenoid, stopping the flow from the reservoir. A second switch in the control box is energized if the water level drops to a lower level because of an empty reservoir or a constriction in the line. This switch may be used to shut down the equipment or activate an alarm.

For reliable operation, it is important that the control box and boiler be mounted so that the level sensed by the control box is exactly the same as the level in the boiler.

Air cooling of the tube base is required. 100 CFM minimum should be directed straight down toward the center of the SK-310 socket from a blower or duct, not more than 5½ inches from the socket.

VAPOR COOLING SYSTEM



ELECTRICAL

Filament Operation — The rated filament voltage for the 4CV35,000A is 6.3 volts. Filament voltage, as measured at the socket, must be maintained at 6.3 volts plus or minus five percent to obtain maximum tube life. The use of a constant voltage filament transformer is recommended.

Control-Grid Operation — The 4CV35,000A control grid has a maximum dissipation rating of 200 watts. Precautions should be observed to avoid exceeding this rating. Grid dissipation is the product of the dc grid current and the peak positive grid voltage swing.

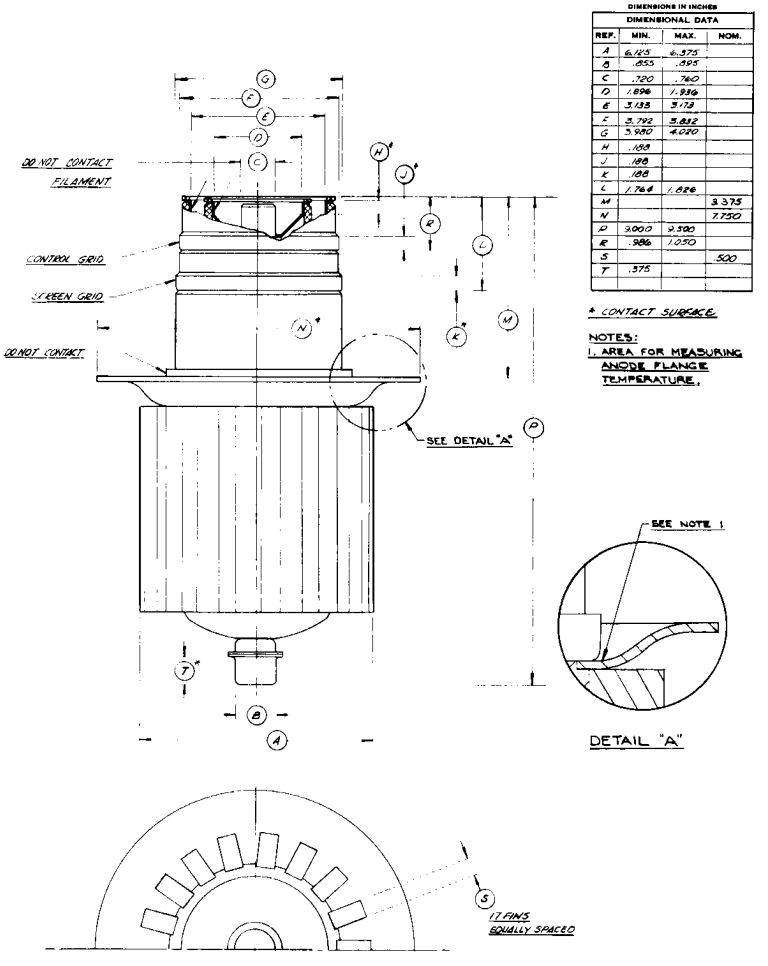
Screen-Grid Operation — The power dissipated by the screen must not exceed 450 watts. Screen dissipation, in cases where no ac is applied to the screen is the product of screen voltage and screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power and screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation in the event of these failures.

Plate Dissipation — The plate dissipation rating of 35,000 watts attainable through vapor cooling provides a large margin of safety. It is unlikely that this rating will be exceeded, even during tuning periods.

When the 4CV35,000A is used as a plate-modulated rf amplifier, this rating is reduced to 23,000 watts with a reduced plate input rating of 8000 volts and 4.0 amps.

Special Applications — If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing Department, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California for information and recommendations.



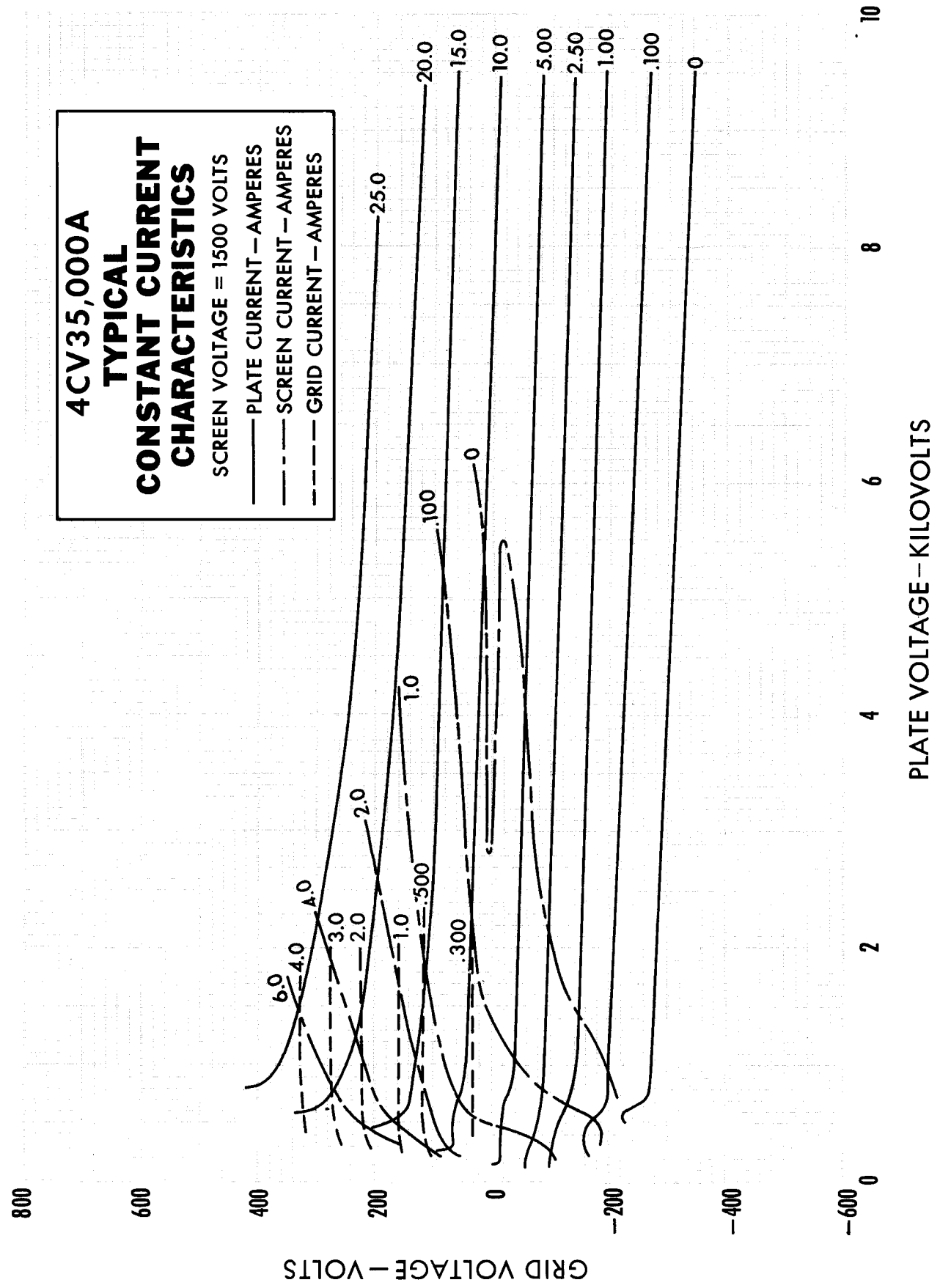
DIMENSIONS IN INCHES

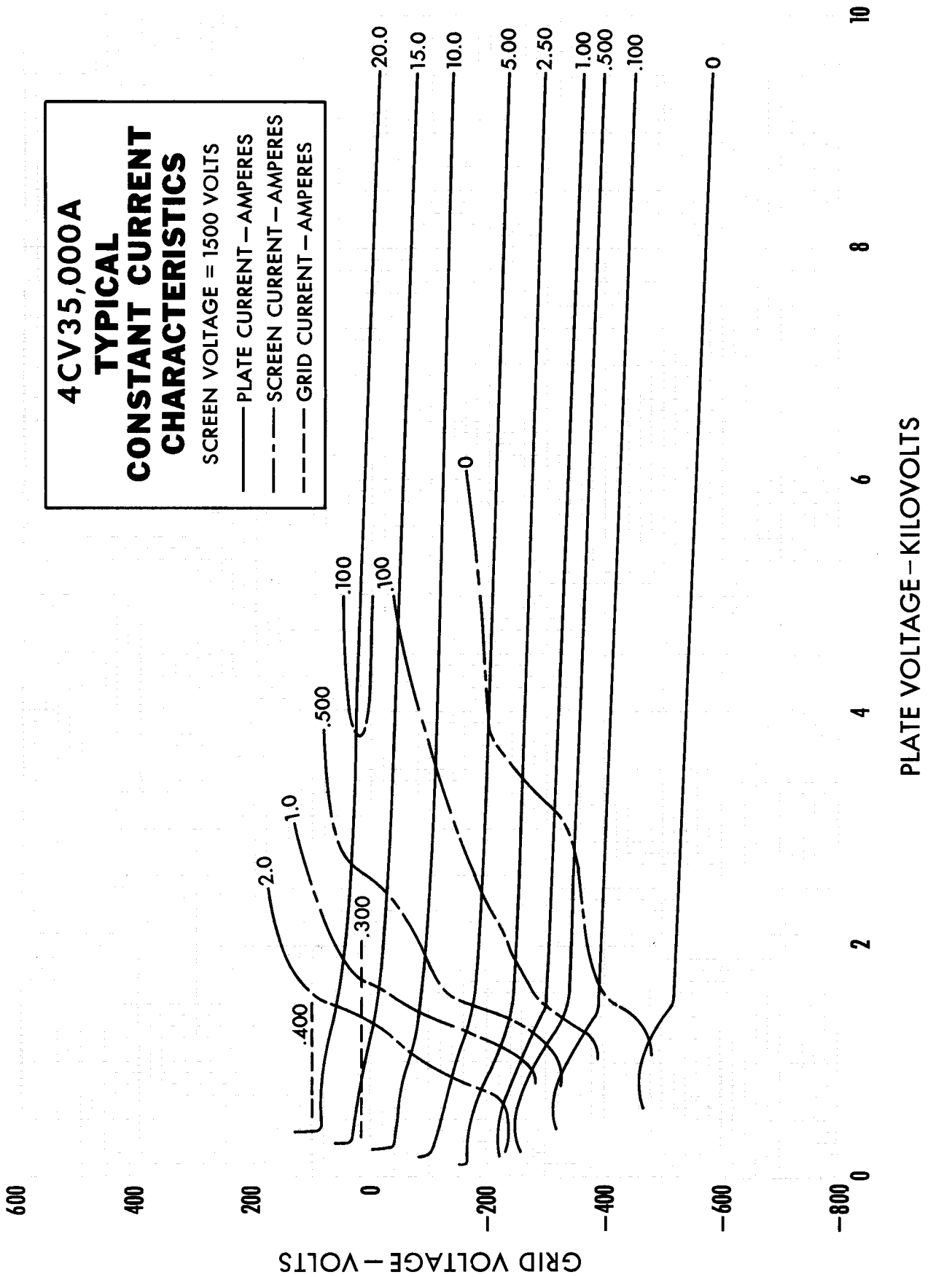
DIMENSIONAL DATA

REF.	MIN.	MAX.	NOM.
A	6.125	6.375	
B	.855	.895	
C	.720	.760	
D	1.898	1.938	
E	3.138	3.178	
F	5.792	5.832	
G	3.990	4.020	
H	.198		
J	.188		
K	.188		
L	1.764	1.826	
M			3.375
N			7.750
P	2.000	2.500	
R	.986	1.050	
S			.500
T	.375		

* CONTACT SURFACE.

NOTES:
1. AREA FOR MEASURING ANODE FLANGE TEMPERATURE.


4CV35,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
25.0
20.0
15.0
10.0
5.00
2.50
1.00
.100
0
6.0
4.0
4.0
3.0
2.0
2.0
1.0
1.0
.500
.300
.100
0
800
600
400
200
0
−200
−400
−600
0
2
4
6
8
10
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—KILOVOLTS

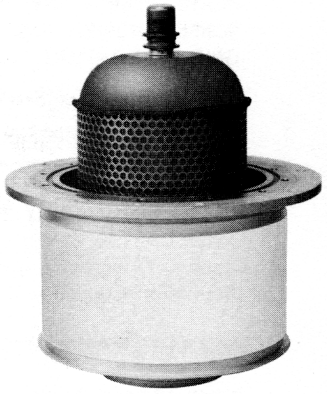

4CV35,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
20.0
15.0
10.0
5.00
2.50
1.00
.500
.100
0
.100
.500
1.0
2.0
.400
.300
600
400
200
0
−200
−400
−600
−800
0
2
4
6
8
10
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

4CV50,000E

VAPOR COOLED POWER TETRODE

The EIMAC 4CV50,000E is a ceramic/metal, vapor-cooled power tetrode intended for use at the 50 to 100 kilowatt output power level. This tube is characterized by low input and feedback capacitances and low internal lead inductances. A rugged mesh thoriated tungsten filament provides adequate emission over the long operating life. It is recommended for use as a class C rf amplifier or oscillator, a class AB rf linear amplifier or a class AB push-pull af amplifier or modulator. The 4CV50,000E is also useful as a plate and screen modulated class C rf amplifier. The vapor cooled anode is rated at 50 kilowatts dissipation.



Shown with boiler removed.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Mesh Thoriated Tungsten		
Voltage	12 ± 0.6	V
Current, at 12.0 volts	220	A
Amplification Factor (Average)		
Grid to Screen	4.5	
Direct Interelectrode Capacitances (grounded cathode)		
Input	310	pF
Output	53	pF
Feedback	0.7	pF
Frequency of Maximum Rating:		
CW	110	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

MECHANICAL

Maximum Overall Dimensions:	
Length (less boiler)	11.500 in; (292.1 mm)
Diameter	9.531 in; (241.0 mm)
Net Weight (less boiler)	31.5 lb; (14.3 kg)
Operating Position	Vertical, base down
Maximum Operating Temperature:	
Ceramic/Metal Seals and terminals	250°C
Cooling	Vapor and Forced Air
Base	Special
Recommended Air System Socket	EIMAC SK-2000 Series
Recommended Boiler	EIMAC BR-700 Series

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RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions.

Plate Voltage	10.0	kVdc
Screen Voltage	1.8	kVdc
Grid Voltage [1]	-260	Vdc
Zero-Signal Plate Current	3.4	Adc
Single Tone Plate Current	9.14	Adc
Peak rf Grid Voltage 2	230	v
Resonant Load Impedance	600	Ω
Plate Dissipation	35	kW
Plate Output Power	57	kW

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	15.0	15.0	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage	-800	-800	Vdc
Plate Current	9.0	11.5	Adc
Screen Current [1]	0.9	0.83	Adc
Grid Current [1]	125	160	mAdc
Peak rf Grid Voltage [1]	880	925	v
Calculated Driving Power [1]	110	150	W
Plate Dissipation	25	36	kW
Plate Output Power	110	137	kW
Resonant Load Impedance	820	615	Ω

1. Approximate value

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	15,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION [1]	33,000	WATTS
SCREEN DISSIPATION [2]	1,500	WATTS
GRID DISSIPATION [2]	400	WATTS

1. Corresponds to 50,000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	9.0	14.0	kVdc
Screen Voltage	750	750	Vdc
Grid Voltage	-600	-600	Vdc
Plate Current	7.41	9.25	Adc
Screen Current [3]	0.69	1.15	Adc
Grid Current	0.333	0.833	Adc
Peak af Screen Voltage 3 (100% modulation)	750	750	v
Peak rf Grid Voltage 3	750	820	v
Calculated Driving Power	250	685	W
Plate Dissipation	12.5	21.5	kW
Plate Output Power	54.2	110	kW

3. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_1, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

TYPICAL OPERATION (Two Tubes)

Plate Voltage	15.0	kVdc
Screen Voltage	1.25	kVdc
Grid Voltage [1/3]	-280	Vdc
Zero-Signal Plate Current	5.0	Adc
Max. Signal Plate Current	18.6	Adc
Max. Signal Screen Current [1]	0.6	Adc
Peak af Grid Voltage 2	275	v
Peak Driving Power	0	w
Max. Signal Plate Dissipation 2	41.7	kW
Plate Output Power	195	kW
Load Resistance (plate to plate)	1870	Ω

1. Approximate value.
2. Per tube.
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Heater: Current at 12.0 volts	200	230	A
Interelectrode Capacitances (grounded cathode connection)			
Input	290	330	pF
Output	47.0	57.0	pF
Feedback	---	1.0	pF
Interelectrode Capacitances (grounded grid connection)			
Input	130	150	pF
Output	47.0	57.0	pF
Feedback	---	0.5	pF

APPLICATION

MECHANICAL

MOUNTING - The 4CV50,000E must be operated with its axis vertical. The base of the tube must be down.

SOCKET - The EIMAC sockets type SK-2000 series are recommended for use with the 4CV-50,000E.

COOLING - Cooling is accomplished by immersing the anode in the distilled water filled EIMAC boiler. The energy dissipated at the anode causes the water to boil at the surfaces of the anode, to be converted into steam and be carried away to the condenser. The boiling action keeps the anode surfaces at approximately 100°C. In a properly designed boiler-tube system, it is extremely unlikely that the anode surfaces will ever exceed 110°C at full dissipation ratings.

The water in the boiler must be maintained at a constant level which may be accomplished automatically in an EIMAC vapor cooling system. Condensate from the condenser is returned to the boiler to maintain a constant coolant level. Any losses or drops in coolant level are sensed and makeup water enters the boiler from the reservoir. When the proper level is reached the flow from the reservoir is stopped automatically. A switch is energized when the reservoir water level drops to a low level. This switch may be used to shut down the equipment or activate an alarm.

Air cooling of the tube base is required whenever filament voltage is applied. A minimum air flow of 100 cfm should be ducted toward the center of the EIMAC SK-2000 socket from a blower or fan. Pressure drop through the SK-2000 socket is approximately 0.5 inches of water. The air system must be capable of supplying 100 cfm into this head.

The water used as a coolant in the vapor phase cooling system is continuously distilled. It is imperative that the resistivity of the water be maintained above 200,000 ohms/cm^3. The entry of any contaminator to the system must be prevented. The use of any lead bearing alloys such as brass or soft/solder in fabrication of the cooling system must be avoided since steam leaches out the lead, contaminating the coolant.

Suitable materials for a cooling system are copper, hard solder, and polypropylene. Any contamination of the water causes leakage current to flow through the water supply lines to ground. When the resistivity is low this leakage current power will cause boiling in the lines, interfering with the proper operation of the system.

The user must be prepared to flush the system on initial startup to purge any contamination which may have entered the components during shipment or assembly.

ELECTRICAL

FILAMENT OPERATION - Filament voltage should be measured at the socket with a 1 percent rms responding meter. The peak emission at rated filament voltage of the EIMAC 4CV-50,000E is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CV50,000E by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CV50,000E. At some point in filament voltage there will be noticeable reduction in plate current, or power output, or an increase in age slightly higher than the point at which performance appears to deteriorate. This point should be periodically checked to maintain proper operation.

GRID OPERATION - The 4CV50,000E control grid is rated at 400 watts of dissipation. Grid dissipation is the approximate product of grid current and peak positive grid voltage.

SCREEN OPERATION - The power dissipated by the screen grid must not exceed 1500 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate load or bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

The 4CV50,000E may exhibit reversed screen current to a greater or lesser degree depending on operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, or an electron-tube regulator circuit may be employed in the screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed.

PLATE DISSIPATION - The plate dissipation of 50 kilowatts attainable through vapor cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CV50,000E is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 33,300 watts.

HIGH VOLTAGE - Normal operating voltages used with the 4CV50,000E are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all e-equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CV50,000E, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

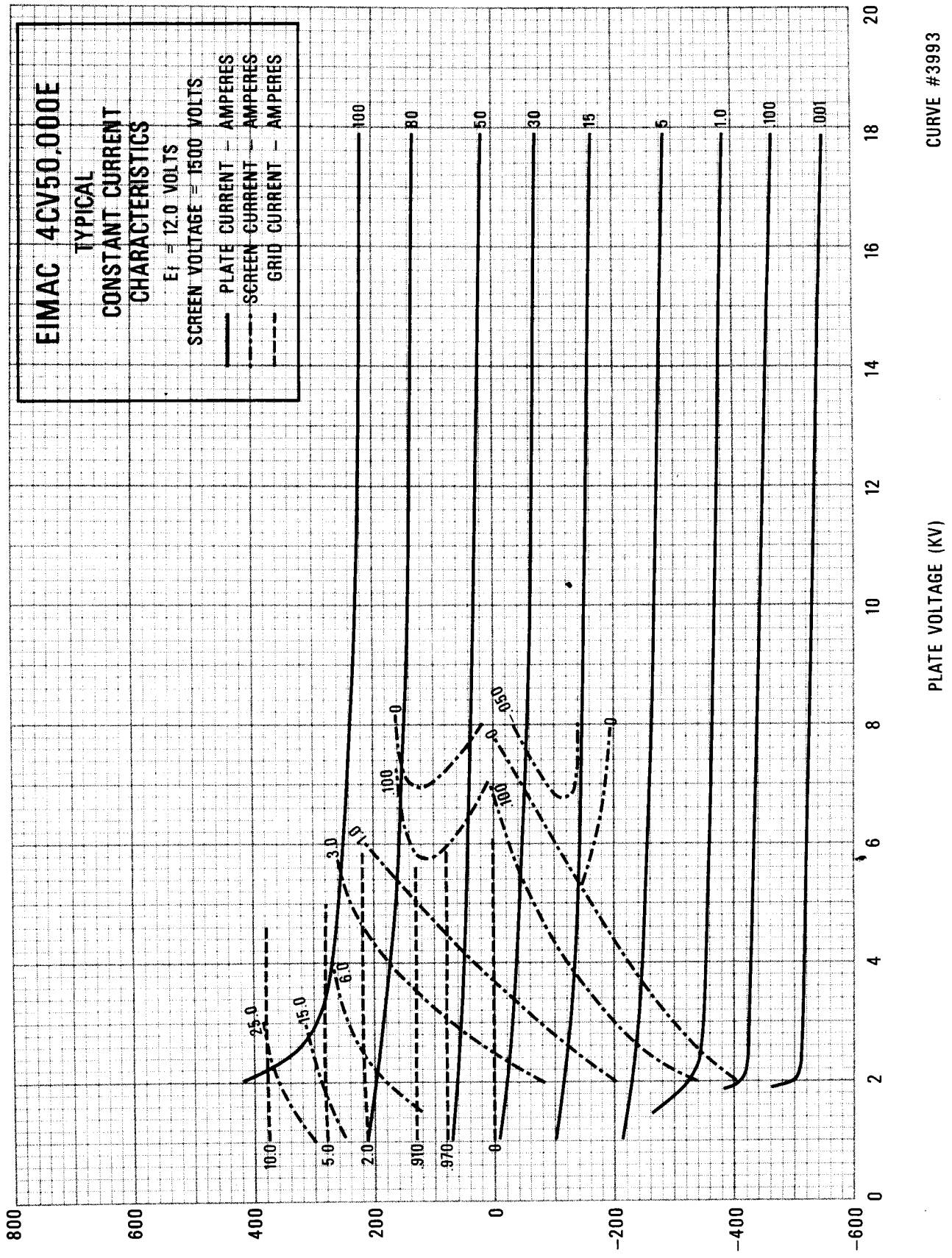
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as the 4CV-50,000E, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry---the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal plate overcurrent interlock, screen current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltages.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc is recommended.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Application Engineering, Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

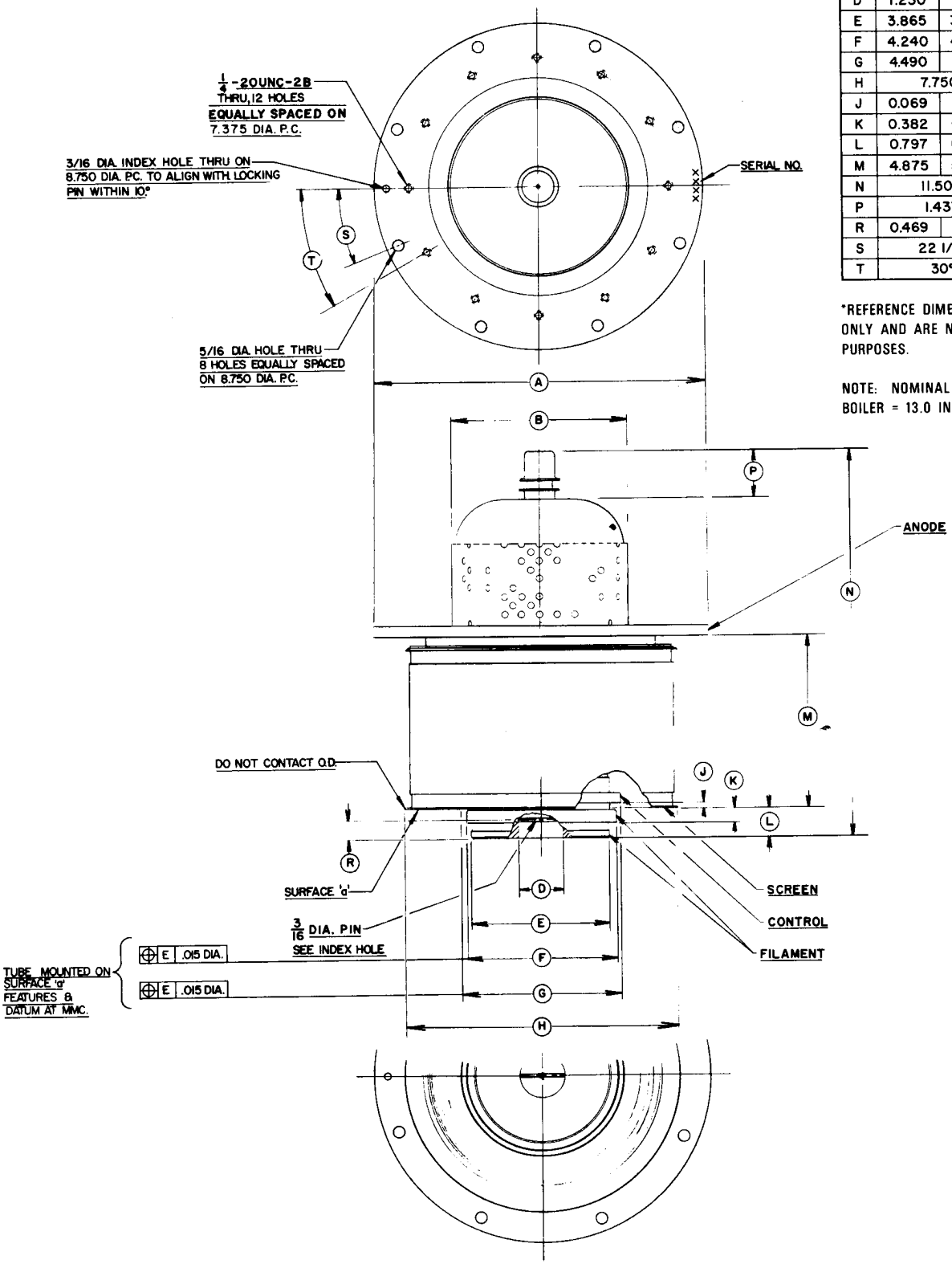

EIMAC 4CV50,000E
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
Ef = 12.0 VOLTS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
100
80
50
30
15
5
1.0
.100
.001
25.0
15.0
10.0
6.0
5.0
3.0
2.0
1.0
.910
.970
0
.050
.100
GRID VOLTAGE (V)
800
600
400
200
0
-200
-400
-600
0
2
4
6
8
10
12
14
16
18
20
PLATE VOLTAGE (KV)

CURVE #3993

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	9.468	9.531	240.49	242.09
B	5.000	5.250	127.00	133.35
C	--	--	--	--
D	1.230	1.270	31.24	32.26
E	3.865	3.885	98.17	98.68
F	4.240	4.260	107.70	108.20
G	4.490	4.510	114.05	114.55
H	7.750*		196.85*	
J	0.069	0.149	1.75	3.78
K	0.382	0.462	9.70	11.73
L	0.797	0.922	20.24	23.42
M	4.875	5.000	123.83	127.00
N	11.500*		292.10*	
P	1.437*		36.50*	
R	0.469	0.531	11.91	13.49
S	22 1/2°*		22 1/2°*	
T	30°*		30°*	

*REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.

NOTE: NOMINAL OVERALL HEIGHT WITH BOILER = 13.0 INCHES (330.2 mm).



4CV50,000J

TECHNICAL DATA

VAPOR COOLED
POWER TETRODE

The EIMAC 4CV50,000J is a ceramic/metal, vapor-cooled power tetrode intended for use at the 50 to 100 kilowatt output power level. This tube is characterized by low input and feedback capacitances and low internal lead inductances. A rugged mesh thoriated tungsten filament provides adequate emission over the long operating life. It is recommended for use as a class AB_1 rf linear amplifier. The vapor cooled anode is rated at 50 kilowatts dissipation.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Mesh Thoriated Tungsten	
Voltage	12 ± 0.6 V
Current, at 12.0 volts	220 A
Amplification Factor (Average)	
Grid to Screen	4.5
Direct Interelectrode Capacitances (grounded cathode)	
Cin	310 pF
Cout	48 pF
Cgp	1.0 pF
Frequency of Maximum Rating:	
CW	110 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

MECHANICAL

Overall Dimensions:	
Length (less boiler)	11.500 in; 292.1 mm
Diameter	9.531 in; 241.0 mm
Net Weight (less boiler)	31.5 lb; 14.3 kg
Operating Position	Vertical, base down
Maximum Operating Temperature:	
Ceramic/Metal Seals and terminals	250°C
Cooling	Vapor and Forced Air
Base	Special
Recommended Air System Socket	EIMAC SK-2000 Series
Recommended Boiler	EIMAC BR-710, 720

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RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.
3. The IMD products are referenced against one tone of a two-equal tone signal.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven Peak Envelope or Modulation Crest Conditions

Plate Voltage	8.3	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage 1	-250	Vdc
Zero-Signal Plate Current	3.6	Adc
Single-Tone Plate Current	9.8	Adc
Peak rf Grid Voltage 2	250	v
Resonant Load Impedance	413	Ω
Plate Dissipation	35	kW
Plate Output Power	45	kW
Intermod. Distortion Products 3		
3rd Order	-46	dB
5th Order	-60	dB

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Heater: Current at 12.0 volts	200	230	A
Interelectrode Capacitances (grounded cathode connection)			
Cin	290	330	pF
Cout	42.0	53.0	pF
Cgp	---	1.5	pF
Interelectrode Capacitances (grounded grid connection)			
Cin	113	137	pF
Cout	45.0	55.0	pF
Cgk	---	0.5	pF

APPLICATION

MECHANICAL

MOUNTING - The 4CV50,000J must be operated with its axis vertical. The base of the tube must be down.

SOCKET - The EIMAC sockets type SK-2000 series are recommended for use with the 4CV-50,000J.

COOLING - Cooling is accomplished by immersing the anode in the distilled water filled EIMAC boiler. The energy dissipated at the anode causes the water to boil at the surfaces of the anode, to be converted into steam and be carried away to the condenser. The boiling action keeps the anode surfaces at approximately 100°C. In a properly designed boiler-tube system, it is extremely unlikely that the anode surfaces will ever exceed 110°C at full dissipation ratings.

The water in the boiler must be maintained at a constant level which may be accomplished automatically in an EIMAC vapor cooling system. Condensate from the condenser is returned to the boiler to maintain a constant coolant level. Any losses or drops in coolant level are sensed and makeup water enters the boiler from the reservoir. When the proper level is reached the flow from the reservoir is stopped automatically. A switch is energized when the reservoir water level drops to a low level. This switch may be used to shut down the equipment or activate an alarm.

Air cooling of the tube base is required whenever filament voltage is applied. A minimum air

flow of 100 cfm should be ducted toward the center of the EIMAC SK-2000 socket from a blower or fan. Pressure drop through the SK-2000 socket is approximately 0.5 inches of water. The air system must be capable of supplying 100 cfm into this head.

The water used as a coolant in the vapor phase cooling system is continuously distilled. It is imperative that the resistivity of the water be maintained above 200,000 ohms/cm . The entry of any contaminator to the system must be prevented. The use of any lead bearing alloys such as brass or soft/solder in fabrication of the cooling system must be avoided since steam leaches out the lead, contaminating the coolant.

Suitable materials for a cooling system are copper, hard solder, and polypropylene. Any contamination of the water causes leakage current to flow through the water supply lines to ground. When the resistivity is low this leakage current power will cause boiling in the lines, interfering with the proper operation of the system.

The user must be prepared to flush the system on initial startup to purge any contamination which may have entered the components during shipment or assembly.

ELECTRICAL

FILAMENT OPERATION - Filament voltage should be measured at the socket with a 1 percent rms responding meter. The peak emission at rated filament voltage of the EIMAC 4CV-50,000J is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CV50,000J by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CV50,000J. At some point in filament voltage there will be noticeable reduction in plate current, or power output, or an increase in distortion. Operation must be at a filament voltage slightly higher than the point at which performance appears to deteriorate. This point should be periodically checked to maintain proper operation.

GRID OPERATION - The 4CV50,000J control grid is rated at 400 watts of dissipation. Grid dissipation is the approximate product of grid current and peak positive grid voltage.

SCREEN OPERATION - The power dissipated by the screen grid must not exceed 1500 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate load or bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

The 4CV50,000J may exhibit reversed screen current to a greater or lesser degree depending on operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, or an electron-tube regulator circuit may be employed in the screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed.

PLATE DISSIPATION - The plate dissipation of 50 kilowatts attainable through vapor cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CV50,000J is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 33,300 watts.

HIGH VOLTAGE - Normal operating voltages used with the 4CV50,000J are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CV50,000J, operating at its rated voltages and currents, is a potential

X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

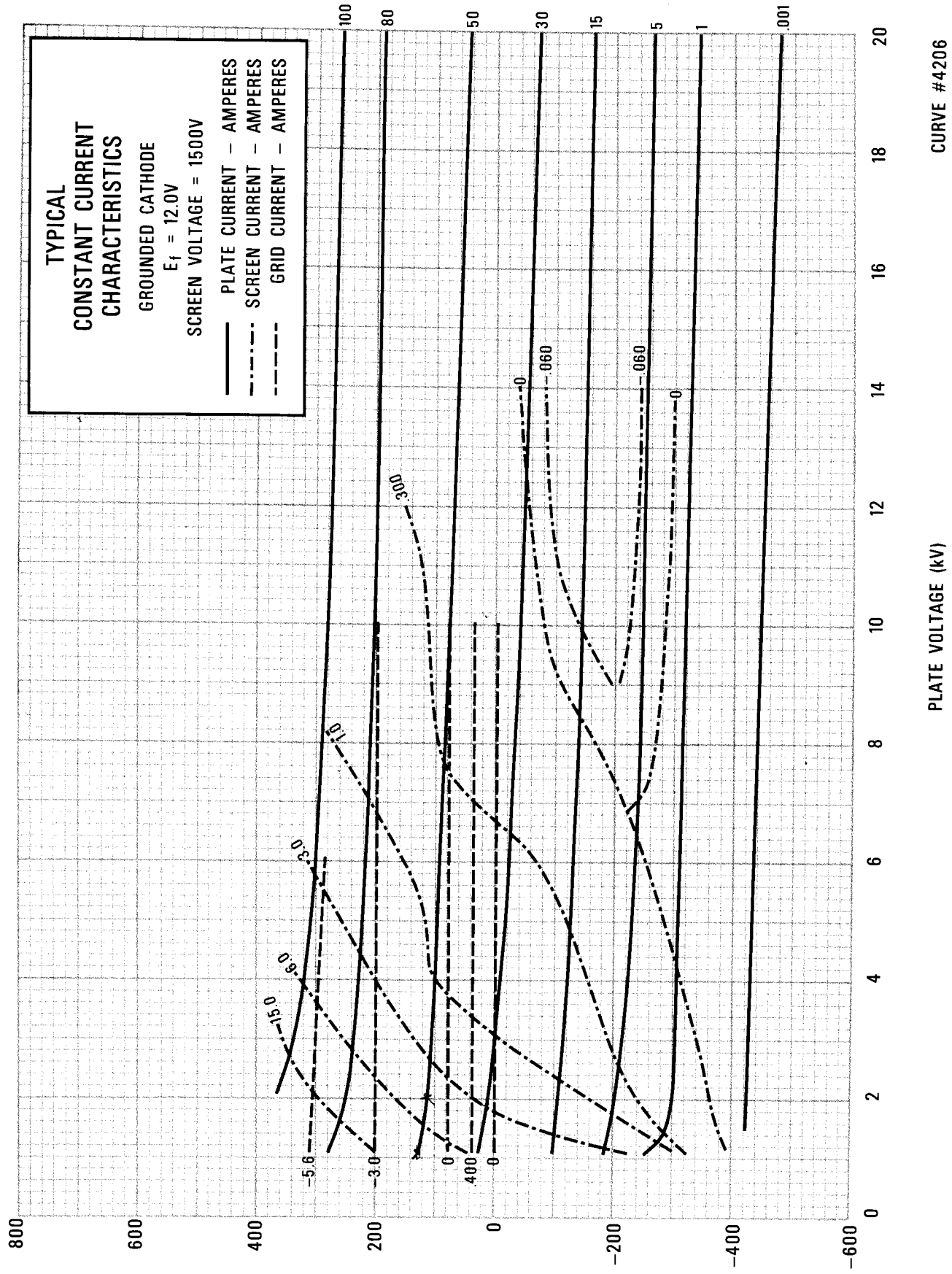
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as the 4CV-50,000J, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry---the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal plate overcurrent interlock, screen current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltages.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc is recommended.

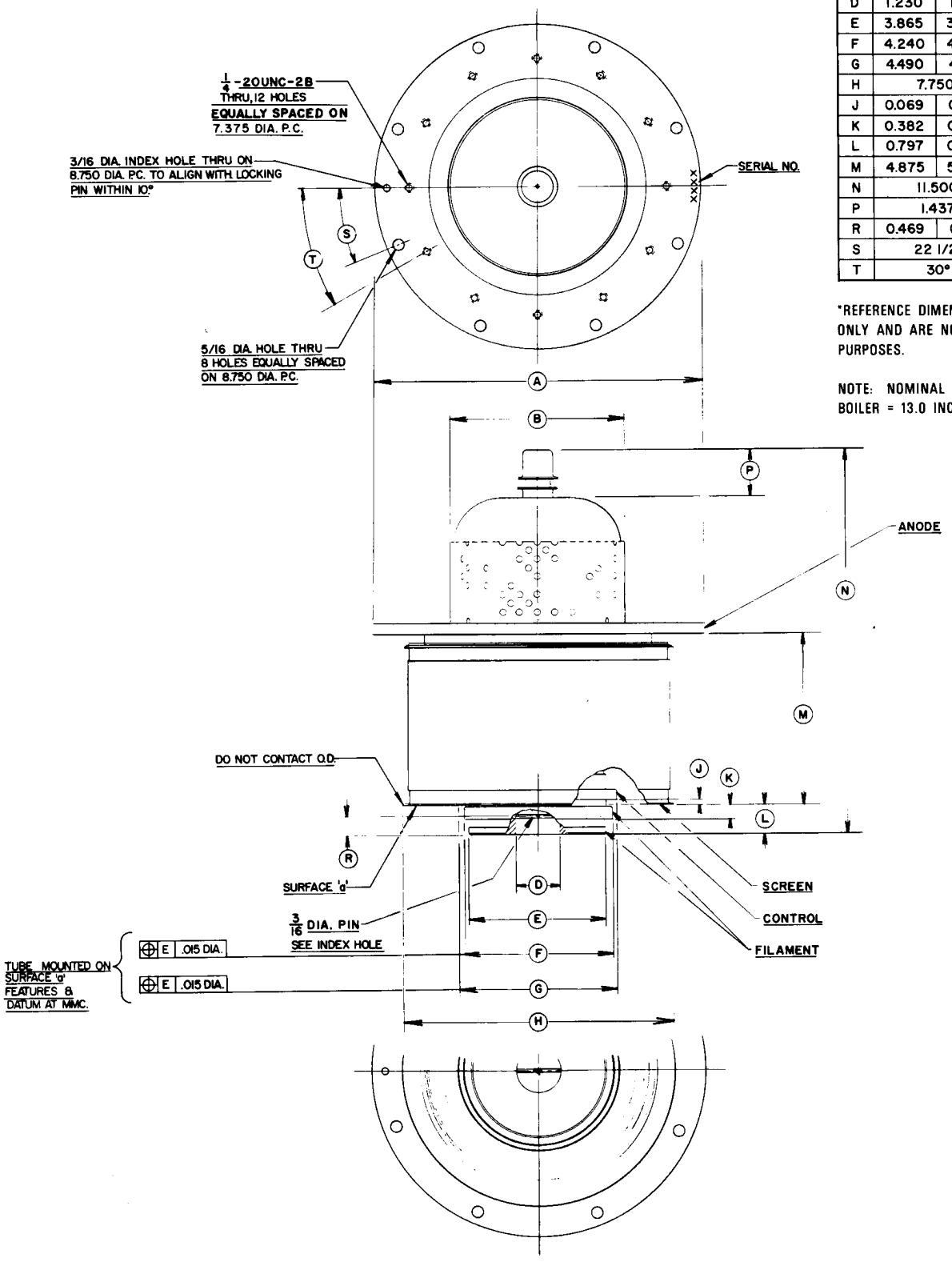
SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Application Engineering, Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 12.0V
SCREEN VOLTAGE = 1500V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
100
80
50
30
15
5
1
.001
.060
.300
-15.0
-9.0
-6.0
-3.0
-5.6
-3.0
0
.400
0
800
600
400
200
0
-200
-400
-600
0
2
4
6
8
10
12
14
16
18
20
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #4206

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	9.468	9.531	240.49	242.09
B	5.000	5.250	127.00	133.35
C	--	--	--	--
D	1.230	1.270	31.24	32.26
E	3.865	3.885	98.17	98.68
F	4.240	4.260	107.70	108.20
G	4.490	4.510	114.05	114.55
H	7.750*		196.85*	
J	0.069	0.149	1.75	3.78
K	0.382	0.462	9.70	11.73
L	0.797	0.922	20.24	23.42
M	4.875	5.000	123.83	127.00
N	11.500*		292.10*	
P	1.437*		36.50*	
R	0.469	0.531	11.91	13.49
S	22 1/2°*		22 1/2°*	
T	30°*		30°*	

*REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.

NOTE: NOMINAL OVERALL HEIGHT WITH BOILER = 13.0 INCHES (330.2 mm).



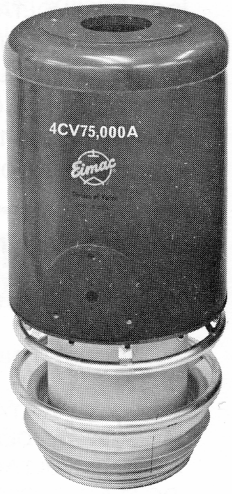
4CV75,000A

TECHNICAL DATA

VAPOR COOLED
POWER TETRODE

The EIMAC 4CV75,000A is a ceramic/metal, vapor-cooled power tetrode intended for use at the 50 to 80 kilowatt output power level. It is recommended for use as a Class C rf amplifier or oscillator, a Class AB rf linear amplifier, or a Class AB push-pull af amplifier or modulator. The 4CV-75,000A is also useful as a plate and screen modulated Class C rf amplifier.

The vapor-cooled anode is rated at 75 kilowatts of dissipation when mounted in the EIMAC BR-320 boiler assembly.



BR-320 Boiler installed

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	10 ± 0.5	V
Current, at 10.0 volts	300	A
Amplification Factor (Grid-Screen, average)	4.5	
Direct Interelectrode Capacitances (grounded filament)		
Cin	440	pF
Cout	55	pF
Cgp	2.3	pF
Direct Interelectrode Capacitances (grounded grid)		
Cin	175	pF
Cout	57	pF
Cpk	0.4	pF
Frequency for Maximum Ratings:		
CW	30	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as a result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

MECHANICAL

Maximum Overall Dimensions: (without boiler)	
Length	17.450 in; 443.2 mm
Diameter	9.300 in; 236.2 mm
Net Weight	60 lb; 27.3 kg
Operating Position	Vertical, base down
Maximum Operating Temperature:	
Base and Anode Seals	250°C
Recommended Socket	EIMAC SK-1500 Series
Recommended Boiler	EIMAC BR-320
Cooling	Vapor and Forced Air

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RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE	15,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15	AMPERES
PLATE DISSIPATION	75,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	10.0	15.0	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage [1]	-290	-340	Vdc
Zero-Signal Plate Current	2.0	1.0	Adc
Single Tone Plate Current	8.7	7.55	Adc
Single-Tone Screen Current[2]	0.385	0.310	Adc
Peak rf Grid Voltage [2]	270	310	v
Plate Dissipation	32	30.5	W
Plate Output Power	55	82.5	kW

1. Adjust to specified zero-signal dc plate current.
2. Approximate value .

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy or FM Telephony (Key-Down Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	15,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC GRID VOLTAGE	-2000	VOLTS
DC PLATE CURRENT	15	AMPERES
PLATE DISSIPATION	75	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	10.0	15.0	15.0	kVdc
Screen Voltage	750	750	1500	Vdc
Grid Voltage	-425	-480	-1020	Vdc
Plate Current	6.7	6.45	11.8	Adc
Screen Current[1]	0.925	0.810	1.0	Adc
Grid Current [1]	0.320	0.355	0.100	Adc
Peak rf Grid Voltage[1]	575	640	1220	v
Calculated Driving Power	185	225	120	W
Plate Input Power	67	96.5	177	kW
Plate Dissipation	12	14	38	kW
Plate Output Power	55	82.5	139	kW

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	12,500	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC GRID VOLTAGE	-2000	VOLTS
DC PLATE CURRENT	15	AMPERES
PLATE DISSIPATION [1]	50,000	WATTS
SCREEN DISSIPATION [2]	1750	WATTS
GRID DISSIPATION [2]	500	WATTS

1. Corresponds to 75,000 watts at 10% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	7.5	10.0	kVdc
Screen Voltage	750	750	Vdc
Grid Voltage	-460	-520	Vdc
Plate Current	7.0	6.6	Adc
Screen Current[1]	1.2	0.985	Adc
Grid Current [1]	0.375	0.370	mAdc
Peak af Screen Voltage 1 (100% modulation)	640	675	v
Peak rf Grid Voltage[1]	630	680	v
Calculated Driving Power	235	250	W
Plate Input Power	52.5	66	kW
Plate Dissipation	10.5	11	kW
Plate Output Power	42	55	kW

1. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB_1, Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	15,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15	AMPERES
PLATE DISSIPATION	75,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.
2. Per Tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	10.0	15.0	kVdc
Screen Voltage	1.5	1.5	Vdc
Grid Voltage [1/3]	-290	-340	Vdc
Zero-Signal Plate Current	4.0	2.0	Adc
Max. Signal Plate Current	17.4	15.1	Adc
Zero-Signal Screen Current[1]	0	0	Adc
Max. Signal Screen Current[1]	0.77	0.62	Adc
Max. Signal Grid Current[1]	0	0	Adc
Peak af Grid Voltage [2]	270	310	v
Peak Driving Power	0	0	w
Plate Input Power	143	195.0	kW
Max. Signal Plate Dissipation	33	30.5	kW
Plate Output Power	110	165	kW
Load Resistance(plate to plate)	1150	2560	Ω

3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 10.0 volts	280	310	A
Cathode Warmup Time	10	---	sec.
Interelectrode Capacitances (grounded filament connection)			
Cin	410	470	pF
Cout	50	60	pF
Cgp	1.5	3.2	pF
Interelectrode Capacitances (grounded grid connection)			
Cin	155	195	pF
Cout	52	62	pF
Cpk	---	0.6	pF

APPLICATION

MECHANICAL

MOUNTING - The 4CV75,000A must be mounted vertically, anode up, in an EIMAC BR-320 boiler. Care must be exercised to insure that the axis of the tube/boiler combination is vertical and that the water in the boiler is at the level indicated on the outline drawing of the tube and boiler The anode flange on the tube must seat securely against the rubber "O" ring, forming a liquid-tight seal between the tube and boiler.

SOCKETING - The EIMAC SK-1500 series is available for use with the 4CV75,000A. Filament, control grid, and screen grid connections are made to this socket. Springfinger contacts on the socket are used to make connections to the concentric rings on the tube base.

COOLING - Anode cooling is accomplished by immersion in a "boiler" filled with distilled water. Energy dissipated by the anode causes the water to boil at the anode surface, be converted into steam, and carried away to an external condenser. The condensate is then returned to the boiler, completing the cycle.

This boiling action maintains the anode surface at a fairly constant temperature near 100°C. The vapor-cooled tube has good overload capabilities; excess dissipation for moderate periods only causes more water to boil.

A control box (EIMAC CB-202) is used to sense water level in the boiler and signal for make-up water from a reservoir, and also to shut down the system in case of low water level. In order to perform its function, the control box must be mounted so that its water level mark is at the same elevation as the water level mark on the boiler.

Since the tube anode and boiler are usually at high potential to ground, water and steam connections to the boiler are made through insulated tubing.

A pressure equalizing line is required between the steam side of the system and the top of the control box. Its function is to provide the same pressure in the control box as in the boiler.

Separate cooling of the tube base is required and is accomplished by directing a minimum of 60 cfm of air at 25°C maximum at sea level (rising to 100 cfm of air at 50°C maximum at sea level) into

the socket from the side, in the area of the filament seals. In addition, a minimum of 2 cfm of air should be directed into the base well of the tube, to maintain a safe temperature in this area. Base air cooling should be applied before or simultaneously with the application of electrode voltages, including the filament, and should be maintained for a short period after all voltages are removed to allow for tube cool-down.

ELECTRICAL

FILAMENT - The rated filament voltage for the 4CV75,000A is 10.0 volts and, as measured at the socket or the base of the tube, should be maintained within plus or minus five percent to obtain maximum tube life and consistent performance.

Filament starting (inrush) current should be limited to a maximum of 900 amperes.

Voltage between filament and the base plates of either tube or the SK-1500 socket should not exceed 100 volts.

CONTROL GRID OPERATION - The 4CV75,000A control grid is rated at 500 watts of dissipation. Grid dissipation is the approximate product of a grid current and peak positive grid voltage.

SCREEN DISSIPATION - The power dissipated by the screen grid must not exceed 1750 watts. Where no ac voltage is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the the dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate load, or bias voltage must never be removed while filament and screen voltages are present on the tube since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

The 4CV75,000A may exhibit reverse screen current, depending on operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, or an electron-tube regulator circuit may be used in the screen supply. A bleeder resistor must be used if a series regulator is employed.

PLATE DISSIPATION - The plate dissipation of 75 kilowatts attainable with vapor cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CV75,000A is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 50 kilowatts.

FAULT PROTECTION - In addition to the normal plate-overcurrent interlock, screen-current interlock, and vapor-cooling control box interlock, it is good practice to protect the tube from internal damage caused by an internal plate arc which may occur at high plate voltages.

A protective resistance of 5 to 25 ohms should always be connected in series with the tube anode, to absorb power-supply stored energy if a plate arc should occur. An electronic crowbar, which will discharge power-supply capacitors in a few microseconds after the start of a plate arc, is recommended.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CV75,000A, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

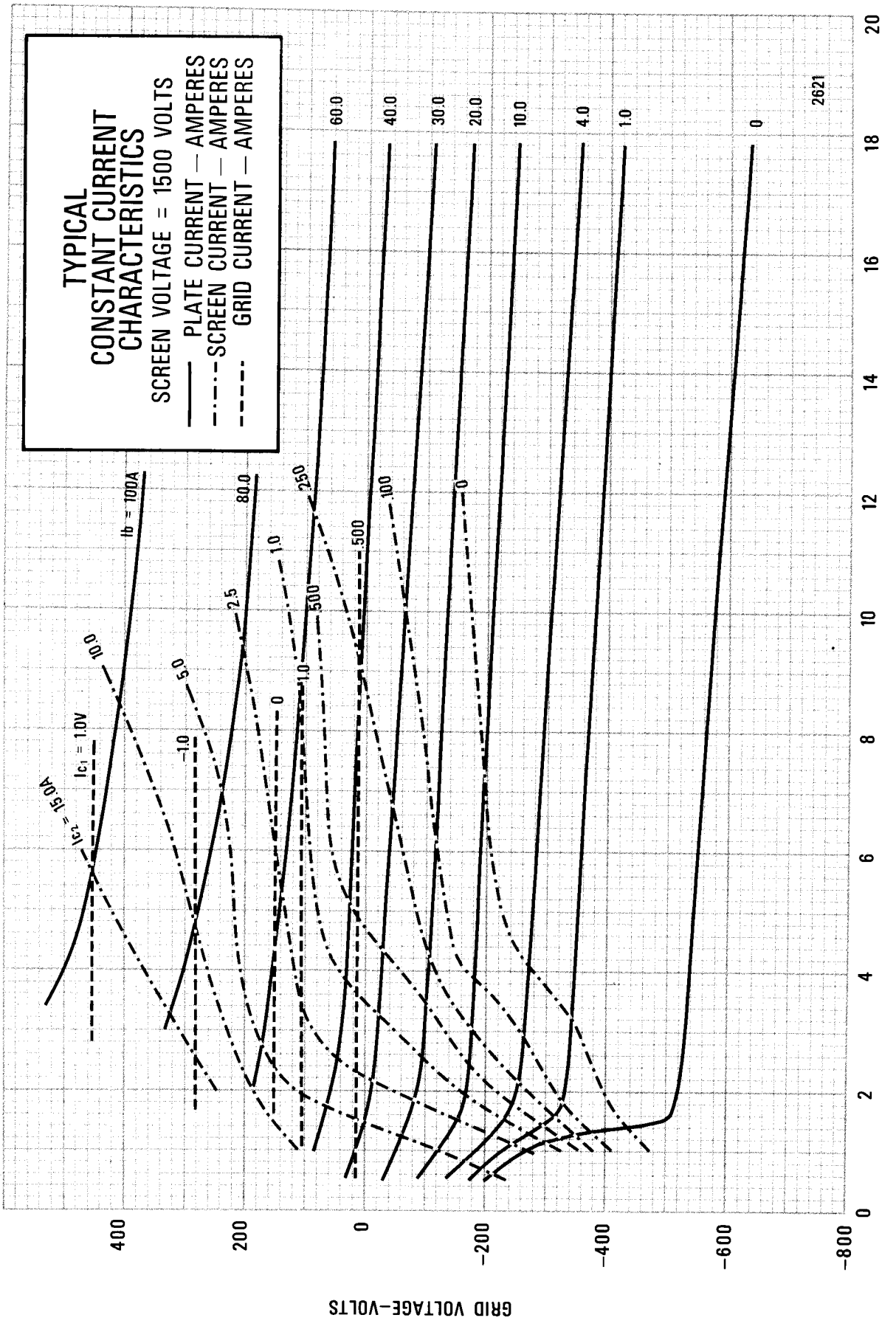
Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

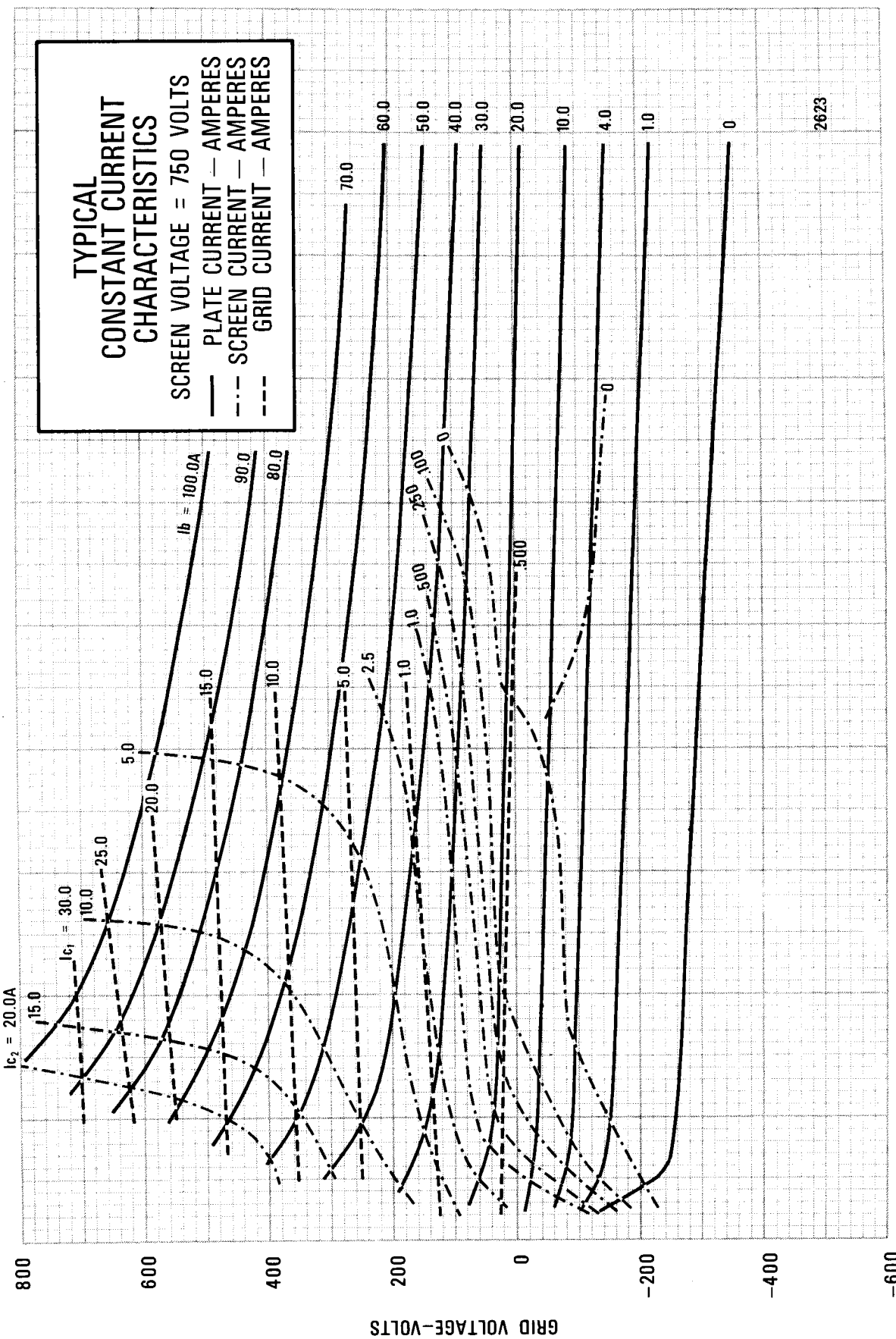
HIGH VOLTAGE - Normal operating voltages used with the 4CV75,000A are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to dis-

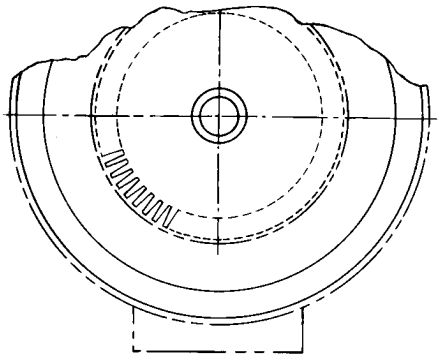
charge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation of heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

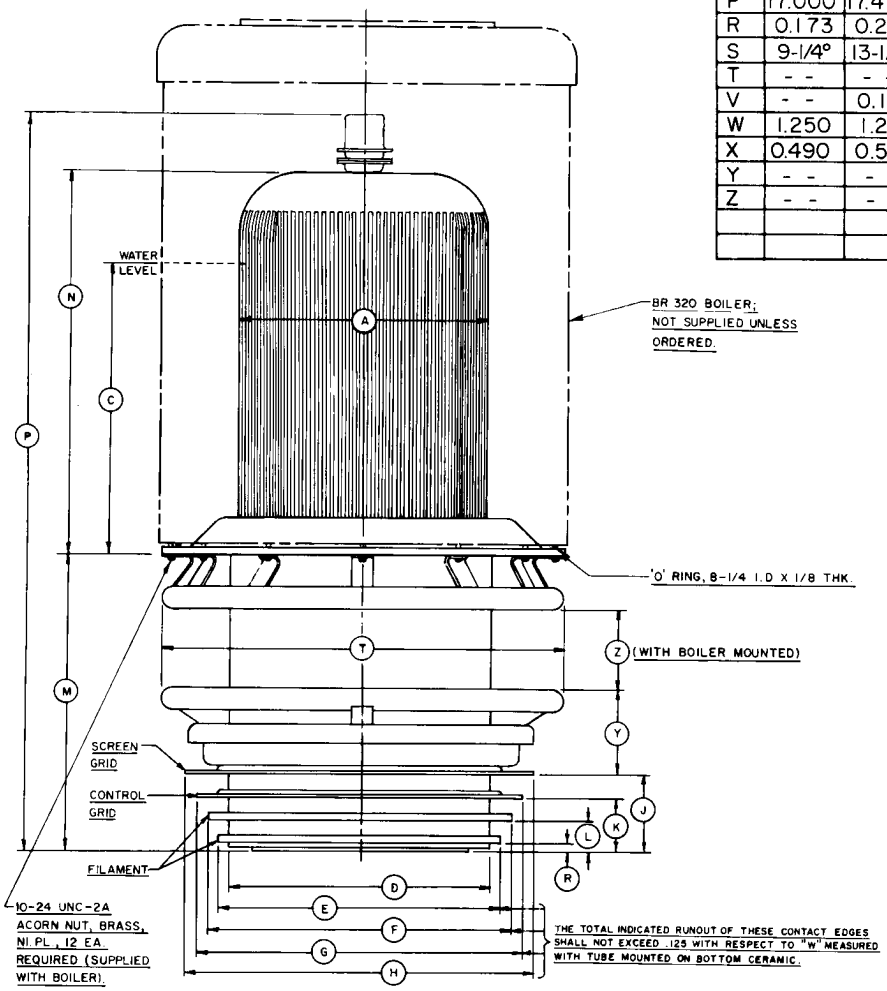

TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
I_{c1} = 15.0A
I_{c1} = 1.0V
I_b = 100A
10.0
5.0
2.5
1.0
0
-1.0
80.0
250
500
1.0
500
100
0
60.0
40.0
30.0
20.0
10.0
4.0
1.0
0
2621
400
200
0
-200
-400
-600
-800
0
2
4
6
8
10
12
14
16
18
20
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—KILOVOLTS

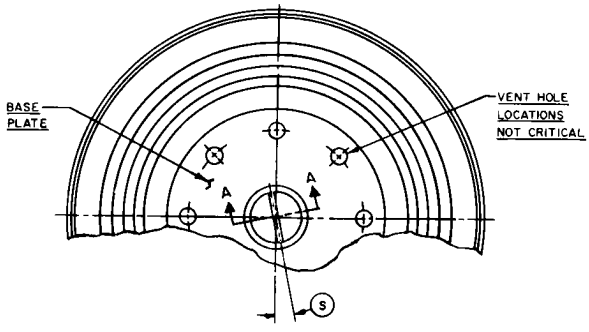

TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
I_b = 100.0A
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
4.0
1.0
0
2623
I_{c_2} = 20.0A
15.0
I_{c_1} = 30.0
10.0
25.0
5.0
20.0
15.0
10.0
5.0
2.5
1.0
.500
.250
.100
0
500
0
GRID VOLTAGE—VOLTS
800
600
400
200
0
−200
−400
−600
0
2
4
6
8
10
12
14
16
18
20
PLATE VOLTAGE—KILOVOLTS

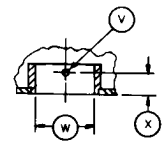


DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	5.562	5.812	- -	141.28	147.63	- -
C	4.500	7.000	- -	114.30	177.80	- -
D	5.980	6.020	- -	151.89	152.91	- -
E	6.510	6.560	- -	165.35	166.62	- -
F	6.980	7.020	- -	177.29	178.30	- -
G	7.480	7.520	- -	189.99	191.00	- -
H	7.975	8.015	- -	202.56	203.58	- -
J	1.750	1.800	- -	44.45	45.72	- -
K	1.220	1.270	- -	30.99	32.26	- -
L	0.690	0.740	- -	17.53	18.80	- -
M	6.942	7.192	- -	176.33	182.68	- -
N	8.725	8.950	- -	221.62	227.33	- -
P	17.000	17.450	- -	431.80	443.23	- -
R	0.173	0.213	- -	4.39	5.41	- -
S	9-1/4°	13-1/4°	- -	- -	- -	- -
T	- -	- -	9.250	- -	- -	234.95
V	- -	0.135	- -	- -	3.43	- -
W	1.250	1.270	- -	31.75	32.26	- -
X	0.490	0.530	- -	12.45	13.46	- -
Y	- -	- -	2.000	- -	- -	50.80
Z	- -	- -	2.000	- -	- -	50.80

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.







SECTION A-A (ROTATED 11¼°)

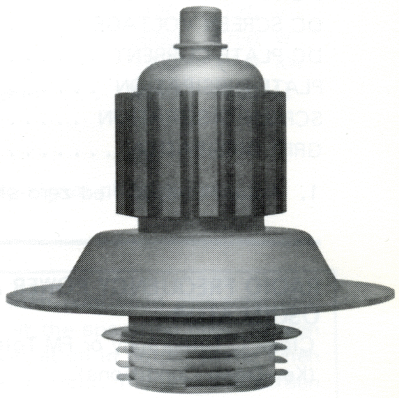
4CV8000A

TECHNICAL DATA

VAPOR-COOLED
RADIAL-BEAM
POWER-TETRODE

The EIMAC 4CV8000A is a ceramic/metal vapor-cooled power tetrode designed to be used as a Class-AB1 linear amplifier in audio or radio-frequency applications. Its characteristic of low intermodulation distortion makes it specially suitable for single-sideband service. The vapor-cooled anode has a dissipation rating of 8000 watts when mounted in an EIMAC BR-101 broiler.

The 4CV8000A is also recommended for Class-C radio-frequency power amplifier and plate-modulated radio-frequency power amplifier service.



GENERAL CHARACTERISTICS[1]

Filament: Thoriated Tungsten	
Voltage	9.0 ± 0.45 V
Current, at 9.0 volts	41.5 A
Amplification Factor (Average):	
Grid to Screen	5.5
Direct Interelectrode Capacitance (grounded cathode)[2]	
Cin	130 pF
Cout	12.5 pF
Cpk	1.0 pF
Frequency of Maximum Rating:	
CW	150 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accorcance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	7.98 in; 202.69 mm
Diameter	7.87 in; 199.90 mm
Net Weight	7.0 lb; 3.2 kg
Operating Position	Axis vertical, base up
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Flange	110°C
Cooling	Vapor and Forced Air
Base	Special, ring and breach-block terminal surfaces
Recommended Air System Socket	SK-1490
Recommended Boiler	BR-101

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Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN, Class AB1

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	7000	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC PLATE CURRENT	2.0	AMPERES
PLATE DISSIPATION	8000	WATTS
SCREEN DISSIPATION	175	WATTS
GRID DISSIPATION	50	WATTS

1. Adjust to specified zero-signal dc plate current.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions.

Plate Voltage	5000	6000	Vdc
Screen Voltage	850	850	Vdc
Grid Voltage [1]	-130	-135	Vdc
Zero-Signal Plate Current	1.0	1.0	Adc
Single-Tone Plate Current	1.95	2.0	Adc
Single-Tone Screen Current [2]	130	125	mAdc
Peak rf Grid Voltage [2]	120	125	v
Plate Dissipation	3650	4750	W
Plate Output Power	6000	7250	W
Resonant Load Impedance	2170	1825	Ω

2. Approximate value .

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	7000	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC PLATE CURRENT	2.0	AMPERES
PLATE DISSIPATION	8000	WATTS
SCREEN DISSIPATION	175	WATTS
GRID DISSIPATION	50	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	6000	7000	Vdc
Screen Voltage	500	500	Vdc
Grid Voltage	-240	-265	Vdc
Plate Current	1.95	1.90	Adc
Screen Current [1]	315	295	mAdc
Grid Current [1]	135	125	mAdc
Peak rf Grid Voltage [1]	345	370	v
Calculated Driving Power	47	47	W
Plate Output Power	9.2	11.0	kW

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	5000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC PLATE CURRENT	1.4	AMPERES
PLATE DISSIPATION [1]	5500	WATTS
SCREEN DISSIPATION [2]	175	WATTS
GRID DISSIPATION [2]	50	WATTS

1. Corresponds to 8000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	4000	5000	Vdc
Screen Voltage	400	400	Vdc
Grid Voltage	-250	-250	Vdc
Plate Current	1.4	1.35	Adc
Screen Current [1]	225	235	mAdc
Grid Current [1]	115	125	mAdc
Peak af Screen Voltage [1] (100% modulation)	365	365	v
Peak rf Grid Voltage [1]	335	330	v
Calculated Driving Power	39	42	W
Plate Dissipation	1200	1250	W
Plate Output Power	4400	5500	W

1. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB , Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	7000	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC PLATE CURRENT	2.0	AMPERES
PLATE DISSIPATION	8000	WATTS
SCREEN DISSIPATION	175	WATTS
GRID DISSIPATION	50	WATTS

TYPICAL OPERATION (Two Tubes)

Plate Voltage	5000	6000	Vdc
Screen Voltage	850	850	Vdc
Grid Voltage [1/3]	-130	-135	Vdc
Zero-Signal Plate Current	2.0	2.0	Adc
Max. Signal Plate Current	3.9	4.0	Adc
Max. Signal Screen Current[1]	260	250	mAdc
Peak af Grid Voltage[2]	120	125	v
Max. Signal Plate Dissipation[2]	3650	4750	W
Plate Output Power	12.0	14.5	kW
Load Resistance (plate to plate)	4340	3650	Ω

1. Approximate value.
2. Per Tube.
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In Class C service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 9.0 volts	39.5	43.5	A
Interelectrode Capacitances[1] (grounded cathode connection)			
Cin	120	140	pF
Cout	10.5	14.5	pF
Cgp	---	1.4	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CV8000A must be operated with its axis vertical, base up in an EIMAC BR-101 boiler. Care must be exercised when installing to insure that the boiler is level, the water is at the proper level and that the flange of the tube makes a vapor tight seal against the rubber "O" ring and boiler. A typical vapor cooling system is shown in this data sheet.

SOCKET - The EIMAC SK-1490 socket is available for use with the 4CV8000A. Filament, control-grid, and screen-grid connections are made to this socket.

COOLING - Cooling is accomplished by immersing the anode in the distilled water filled BR-101 boiler. The energy dissipated at the anode causes the water to boil at the surfaces of the anode, be converted into steam and be carried away to the condenser. The boiling action keeps the anode surfaces at approximately 100°C. In a properly designed boiler-tube system (such as the 4CV8000A and BR-101), it is extremely unlikely that the anode surfaces will ever exceed 110°C - well below the 250°C maximum rating - at full dissipation ratings.

The water in the boiler must be maintained at

a constant level, just below the top of the fins on the anode cooler. This is accomplished automatically in the vapor cooling system shown. Condensate from the condenser is returned to the boiler to maintain this constant fluid level. Any decrease in liquid level is sensed by the control box, CB-102. A low water level in the control box activates the solenoid water valve, allowing make-up water from the reservoir to enter the boiler. When the proper level is reached, the control box de-energizes the solenoid, stopping the flow from the reservoir. A second switch in the control box is energized if the water level drops to a lower level because of an empty reservoir or a constriction in the line. This switch may be used to shut down the equipment or activate an alarm.

For reliable operation, it is important that the control box and boiler be mounted so that the level sensed by the control box is exactly the same as the level in the boiler.

Cooling of the tube base is accomplished by blowing 25-50 CFM of air through the socket from the sides.

ELECTRICAL

HIGH VOLTAGE - Normal operating voltages used with the 4CV8000A are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

FILAMENT OPERATION - The rated filament voltage for the 4CV8000A is 9.0 volts. Filament voltage, as measured at the socket, must be maintained at 9.0 volts plus or minus five percent to obtain maximum tube life. The use of a constant voltage filament transformer is recommended.

GRID OPERATION - The 4CV8000A grid has a maximum dissipation rating of 50 watts. Precautions should be observed to avoid exceeding this rating. Grid dissipation is the product of the dc grid current and the peak positive grid voltage swing.

SCREEN OPERATION - The power dissipated by the screen must not exceed 175 watts. Screen dissipation, in cases where no ac is applied to the screen, is the product of screen voltage and screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power and screen voltage.

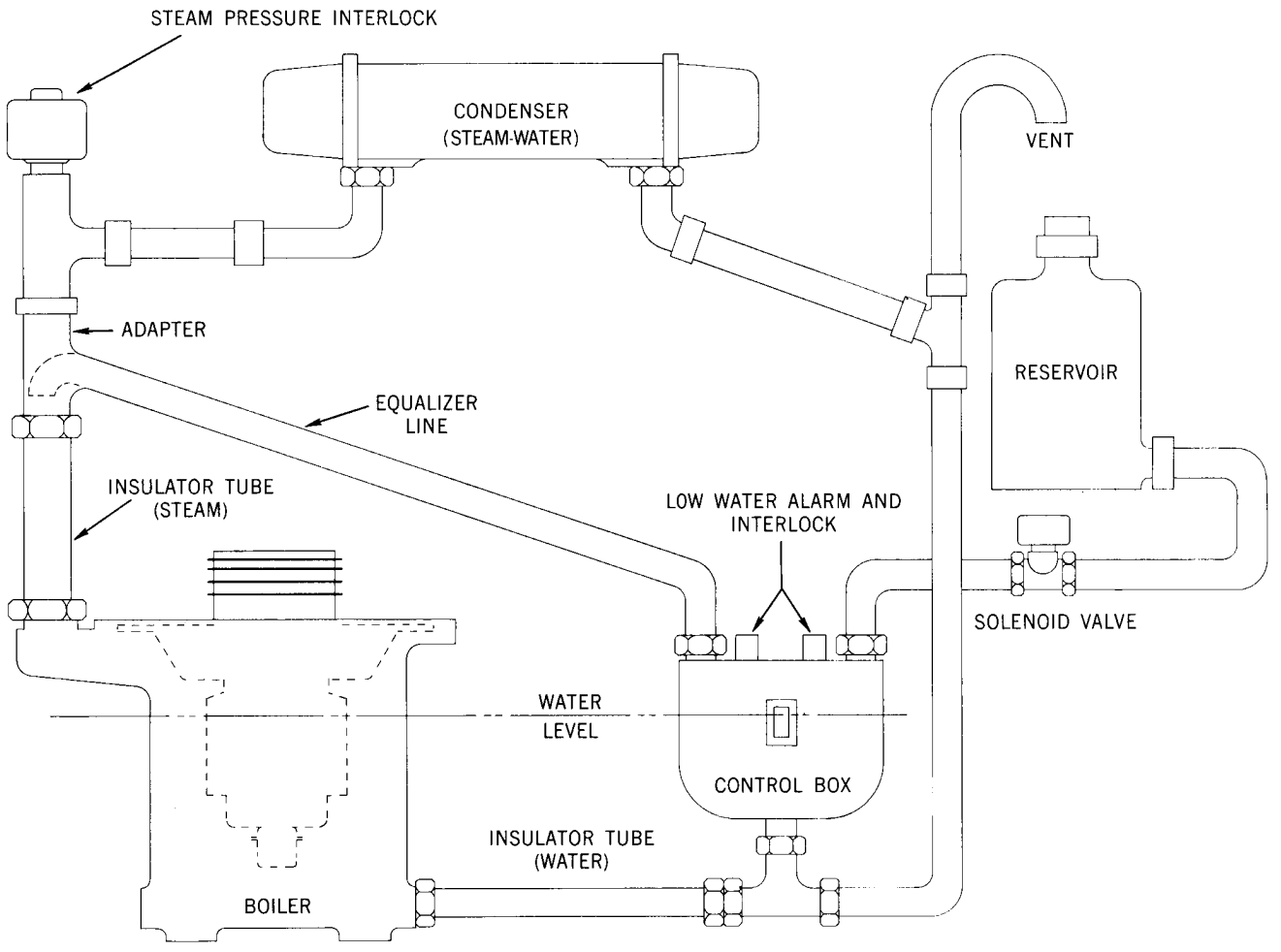
Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation in the event of these failures.

PLATE DISSIPATION - The plate dissipation rating of 8000 watts attainable through vapor cooling provides a large margin of safety. It is unlikely that this rating will be exceeded, even during tuning periods.

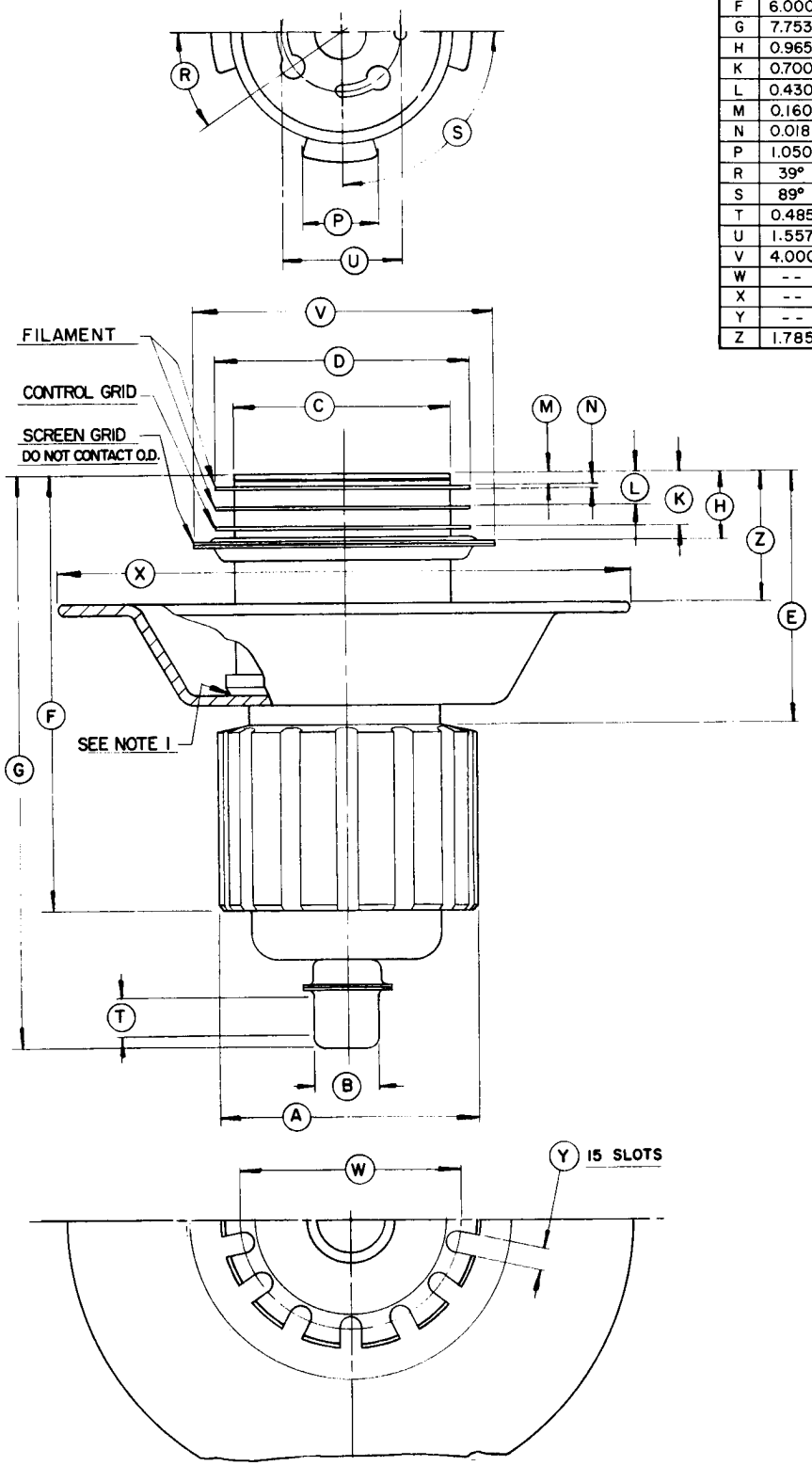
When the 4CV8000A is used as a plate-modulated rf amplifier, this rating is reduced to 5500 watts with a reduced plate input rating of 5000 volts and 1.4 amps.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

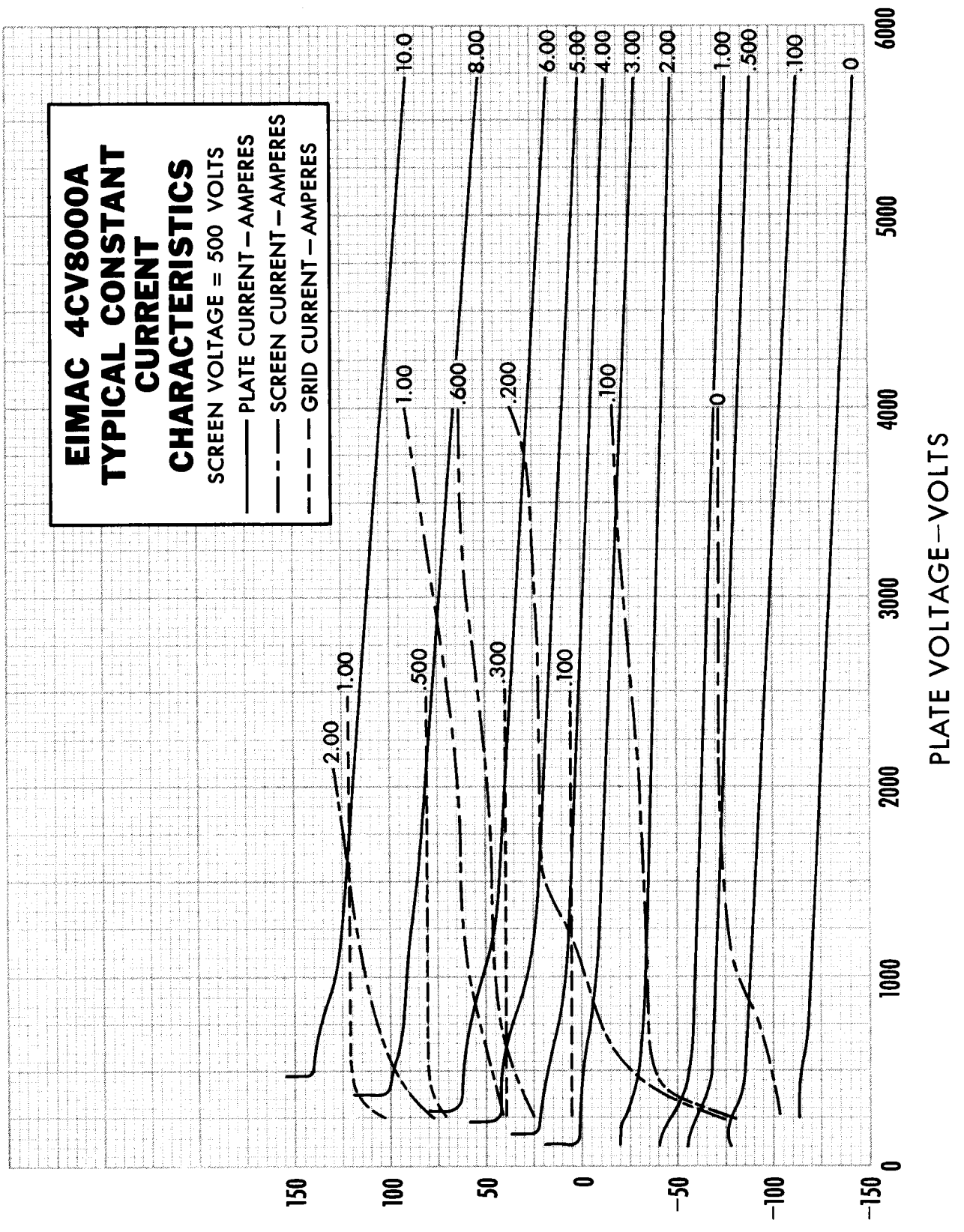
VAPOR COOLING SYSTEM

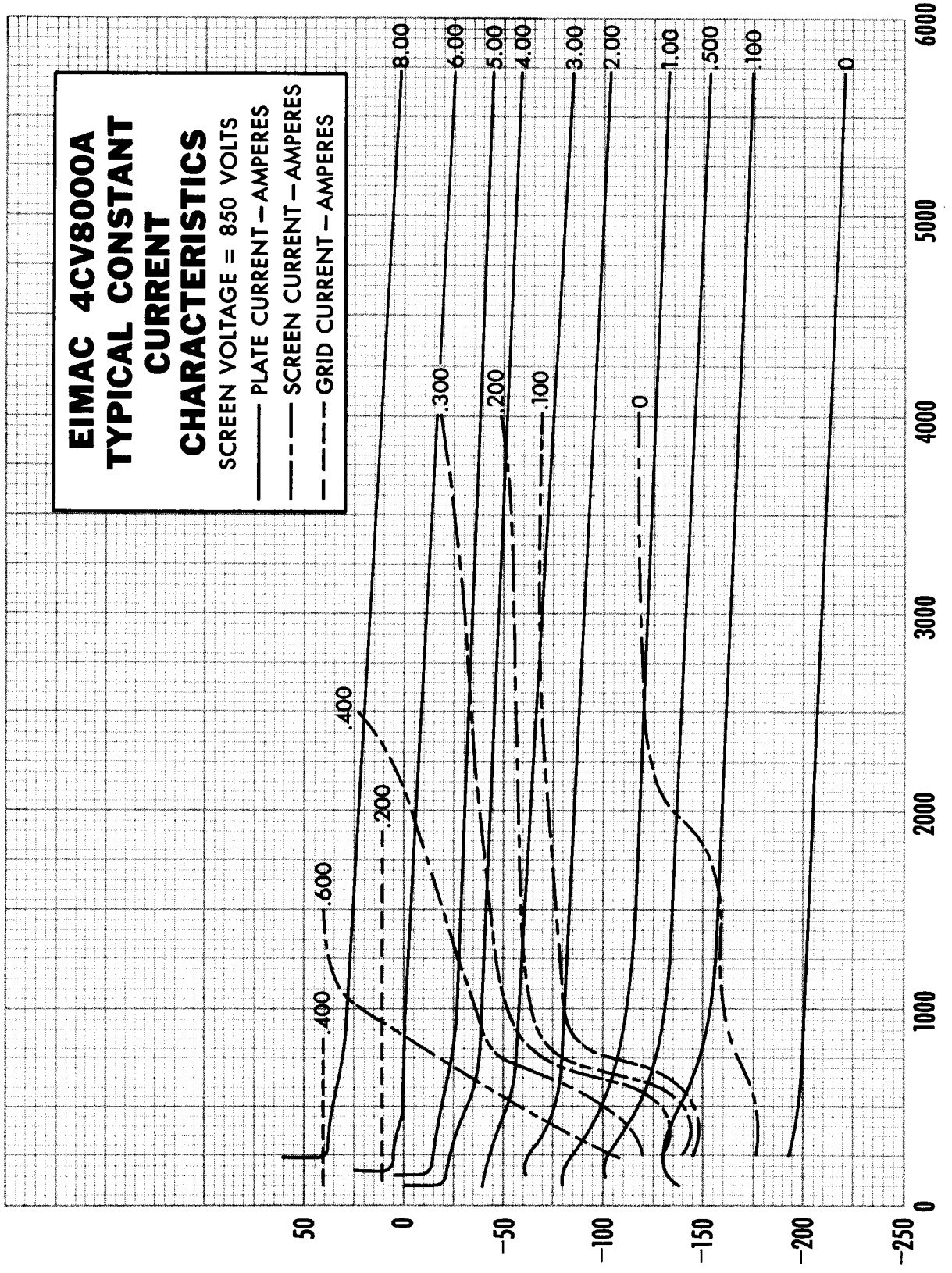


DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.475	3.525		88.27	89.53	--
B	0.860	0.890		21.84	22.61	--
C	2.985	3.025		75.82	76.84	--
D	3.490	3.525		88.65	89.54	--
E	3.472	3.602		88.19	91.49	--
F	6.000	6.200		152.40	157.48	--
G	7.753	7.983		196.93	202.77	--
H	0.965	1.005		24.51	25.53	--
K	0.700	0.730		17.78	18.54	--
L	0.430	0.460		10.92	11.68	--
M	0.160	0.180		4.06	4.57	--
N	0.018	0.025		0.46	0.64	--
P	1.050	1.100		26.67	27.94	--
R	39°	41°		39°	41°	--
S	89°	91°		89°	91°	--
T	0.485	0.515		12.32	13.08	--
U	1.557	1.567		39.55	39.80	--
V	4.000	4.175		101.60	106.05	--
W	--	--	2.968	--	--	75.39
X	--	--	7.875	--	--	200.03
Y	--	--	0.344	--	--	8.74
Z	1.785	1.915	--	45.34	48.64	--



NOTES:
1. AREA FOR MEASURING ANODE FLANGE TEMPERATURE.
2. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.


EIMAC 4CV8000A
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
10.0
8.00
6.00
5.00
4.00
3.00
2.00
1.00
.500
.100
0
2.00
1.00
.500
.600
.200
.300
.100
0
1.00
.500
.100
0
150
100
50
0
−50
−100
−150
0
1000
2000
3000
4000
5000
6000
GRID VOLTAGE–VOLTS
PLATE VOLTAGE–VOLTS


EIMAC 4CV8000A
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 850 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
8.00
6.00
5.00
4.00
3.00
2.00
1.00
.500
.100
0
.300
.200
.100
0
.400
.200
.600
.400
50
0
-50
-100
-150
-200
-250
0
1000
2000
3000
4000
5000
6000
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—VOLTS

4CW100,000D

TECHNICAL DATA

LIQUID COOLED
POWER TETRODE

The EIMAC 4CW100,000D is a ceramic/metal, liquid-cooled power tetrode intended for use at the 100 to 200 kilowatt output power level. It is recommended for use as a Class-C rf amplifier or oscillator, a Class-AB, rf linear amplifier or a Class-AB, push-pull af amplifier or modulator. The 4CW100,000D is also useful as a plate and screen modulated Class-C rf amplifier, and in pulse modulator-regulator service.

The liquid-cooled anode is rated at 100 kilowatts maximum plate dissipation.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	10.0	V
Current	295	A
Amplification Factor (Grid-Screen)(average)	4.5	
Interelectrode Capacitances, Grounded Cathode: [2]		
Cin	440	pF
Cout	55	pF
Cgp	2.4	pF
Interelectrode Capacitances, Grounded Grid: [2]		
Cin	175	pF
Cout	57	pF
Cpk	0.5	pF
Frequency for Maximum Ratings	30	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special, graduated rings
Maximum Seal Temperature	250°C
Maximum Envelope Temperature	250°C
Recommended Socket	EIMAC SK-1500 Series
Operating Position	Vertical, base up or down

(Effective 9-1-75) © 1967, 1975 by Varian

Printed in U.S.A.

Maximum Dimensions:

Height	18.0 In.; 457.2 mm
Diameter	8.0 In.; 203.2 mm
Cooling	Liquid and forced air
Net Weight (Approximate)	60 lbs; 27.3 kg
Shipping Weight (Approximate)	85 lbs; 38.6 kg

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class-C Telegraphy or FM

(Key-down conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Calculated low frequency drive power.

TYPICAL OPERATION (Frequencies below 30 MHz)

Plate Voltage	15.0	17.0	19.0	kVdc
Screen Voltage	750	750	750	Vdc
Grid Voltage	-700	-700	-700	Vdc
Plate Current	9.0	9.8	10.6	Adc
Screen Current	1.6	1.67	1.83	Adc
Grid Current	0.8	1.0	1.12	Adc
Peak RF Grid Voltage	1000	1020	1040	v
Driving Power 1.	790	1020	1165	W
Plate Dissipation	24.0	30.0	35	kW
Plate Output Power	110	137.5	165	kW
Resonant Load Impedance	825	845	980	Ω

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class-C Telephony

(Carrier conditions except where noted)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION[1]	66,500	WATTS
SCREEN DISSIPATION[4]	1750	WATTS
GRID DISSIPATION[4]	500	WATTS

1. Corresponds to 100,000 watts at 100% sine wave modulation.
2. Approximate value, depends on degree of driver modulation.

TYPICAL OPERATION (Frequencies below 30 MHz)

Plate Voltage	14	16	kVdc
Screen Voltage	750	750	Vdc
Peak AF Screen Voltage (For 100% modulation)[2]	750	750	v
Grid Voltage	-700	-700	Vdc
Plate Current	9.1	12.0	Adc
Screen Current	2.0	1.75	Adc
Grid Current	1.0	1.20	Adc
Peak RF Grid Voltage	1000	1050	v
Grid Driving Power[3]	1000	1260	W
Plate Dissipation	20.4	54.0	kW
Plate Output Power	107	138.5	kW
Resonant Load Impedance	790	620	Ω

3. Calculated low frequency drive power.
4. Average, with or without modulation.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB

ABSOLUTE MAXIMUM RATINGS (per tube):

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Per Tube.
2. Approximate value.

TYPICAL OPERATION (Two Tubes) Class-AB1

Plate Voltage	15	18	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage	-360	-380	Vdc
Max-Signal Plate Current	18.8	20.0	Adc
Zero-Signal Plate Current	6.0	6.0	Adc
Max-Signal Screen Current[2]	0.690	0.700	Adc
Peak AF Driving Voltage[1]	350	380	v
Driving Power	0	0	W
Load Resistance, Plate-to-Plate	1800	2080	Ω
Max-Signal Plate Dissipation[1]	47.3	56.8	kW
Max-Signal Plate Output Power	187.4	246.4	kW

RADIO-FREQUENCY LINEAR AMPLIFIER
Class-AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.

TYPICAL OPERATION, Peak-Envelope or Modulation-Crest Conditions, (Frequencies below 30 MHz)
Class-AB

Plate Voltage	15	18	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage	-360	-380	Vdc
Max-Signal Plate Current	9.4	10.0	Adc
Zero-Signal Plate Current	3.0	3.0	Adc
Max-Signal Screen Current[1]	0.345	0.350	Adc
Peak RF Grid Voltage	350	380	v
Driving Power	0	0	W
Plate Dissipation	47.3	56.8	kW
Plate Output Power	93.7	123.2	kW
Resonant Load Impedance	900	1040	Ω

PULSE MODULATOR SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	40	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
PEAK CATHODE CURRENT	200	AMPERES
PLATE DISSIPATION(average)	100	KILOWATTS
SCREEN DISSIPATION (average)	1750	WATTS
GRID DISSIPATION (average)	500	WATTS

1. Approximate value.
Note: The power dissipated during rise and fall time is considered negligible.

TYPICAL OPERATION

Plate Voltage	38	kVdc
Pulse Plate Current	112	a
Screen Voltage	1.5	kVdc
Pulse Screen Current [1]	18.0	a
Grid Voltage	-1.2	kVdc
Pulse Grid Current[1]	10.0	a
Pulse Positive Grid Voltage	480	v
Duty	5	%
Pulse Output Voltage	32	kv
Pulse Input Power	4.25	Mw
Pulse Output Power	3.58	Mw
Pulse Cathode Current	140	a

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 10.0 volts	280	310	A
Interelectrode Capacitances (grounded cathode connection)[2]			
Cin	410	470	pF
Cout	50	60	pF
Cgp	1.5	3.2	pF

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CW100,000D must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the circuit designer.

SOCKET - The EIMAC sockets, type SK-1500 and SK-1510 are recommended for use with the 4CW100,000D.

COOLING - Anode cooling is accomplished by circulating water through the integral anode water jacket. The table below lists minimum cooling water requirements at various dissipation levels.

Plate Dissipation * (kilowatts)	Water Flow (GPM)	Pressure Drop (PSI)
50	10	10
75	15	25
100	20	40

* Since the power dissipated by the filament represents about 3000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 2250 watts, allowance has been made in preparing this tabulation for an additional 5250 watts dissipation.

The cooling table above assumes a water temperature rise of 20°C. Under no circumstances should the outlet water temperature exceed 70°C. Inlet water pressure should not exceed 80 PSI.

A major factor effecting long life of water cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 K ohms/cm3, and preferably above 250 K ohms/cm3. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of the insulating hose column if metal nipples or fittings are used as electrodes.

Separate cooling of the tube base is required and is accomplished by directing approximately 120 cfm of air horizontally through the socket from the side. It is preferable to direct this air through three equally spaced ducts.

The well in the center of the baseplate of the tube is a critical area which requires cooling to maintain envelope temperatures less than 250°C. For most applications, 1 to 2 cfm of air directed through the center of the socket is sufficient for this purpose.

ELECTRICAL

FILAMENT OPERATION - The peak emission at rated filament voltage of the EIMAC 4CW100,000D is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CW100,000D by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CW100,000D. At some point in filament voltage there will be noticeable reduction in plate current, or power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appeared to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked to maintain proper operation.

Filament starting current must be limited to a maximum of 900 amperes.

Voltage between filament and the base plates of the tube, and SK-1500 socket, must not exceed 100 volts.

CONTROL-GRID OPERATION - The 4CW-100,000D control grid is rated at 500 watts of dissipation. Grid dissipation is the approximate product of grid current and peak positive grid voltage.

SCREEN DISSIPATION - The power dissipated by the screen grid must not exceed 1750 watts.

Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is dependent on RMS screen voltage, and RMS screen current. Plate voltage, plate load or bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

PLATE DISSIPATION - The plate dissipation of 100 kilowatts attainable through water cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CW100,000D is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 66,500 watts.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

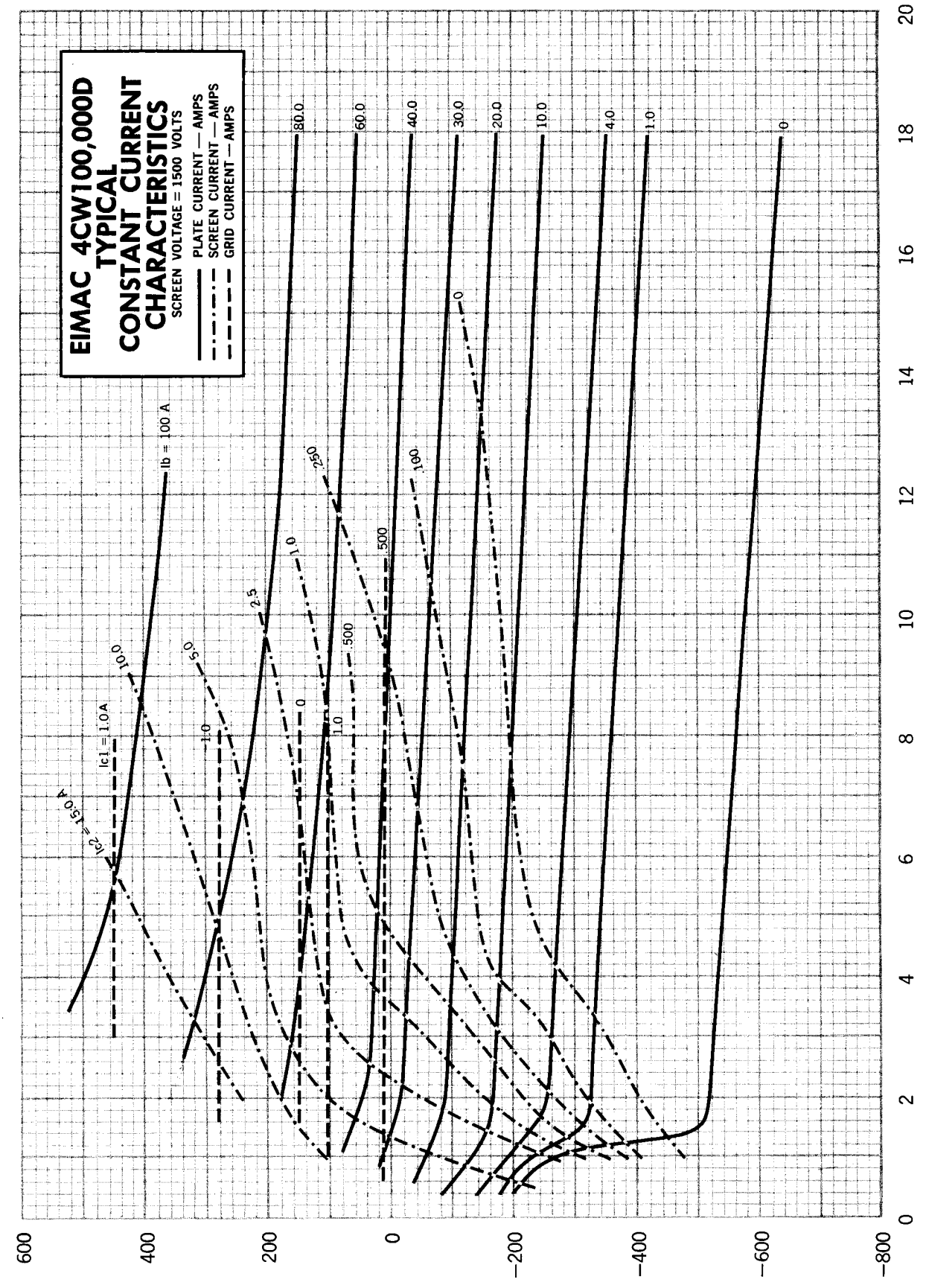
X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

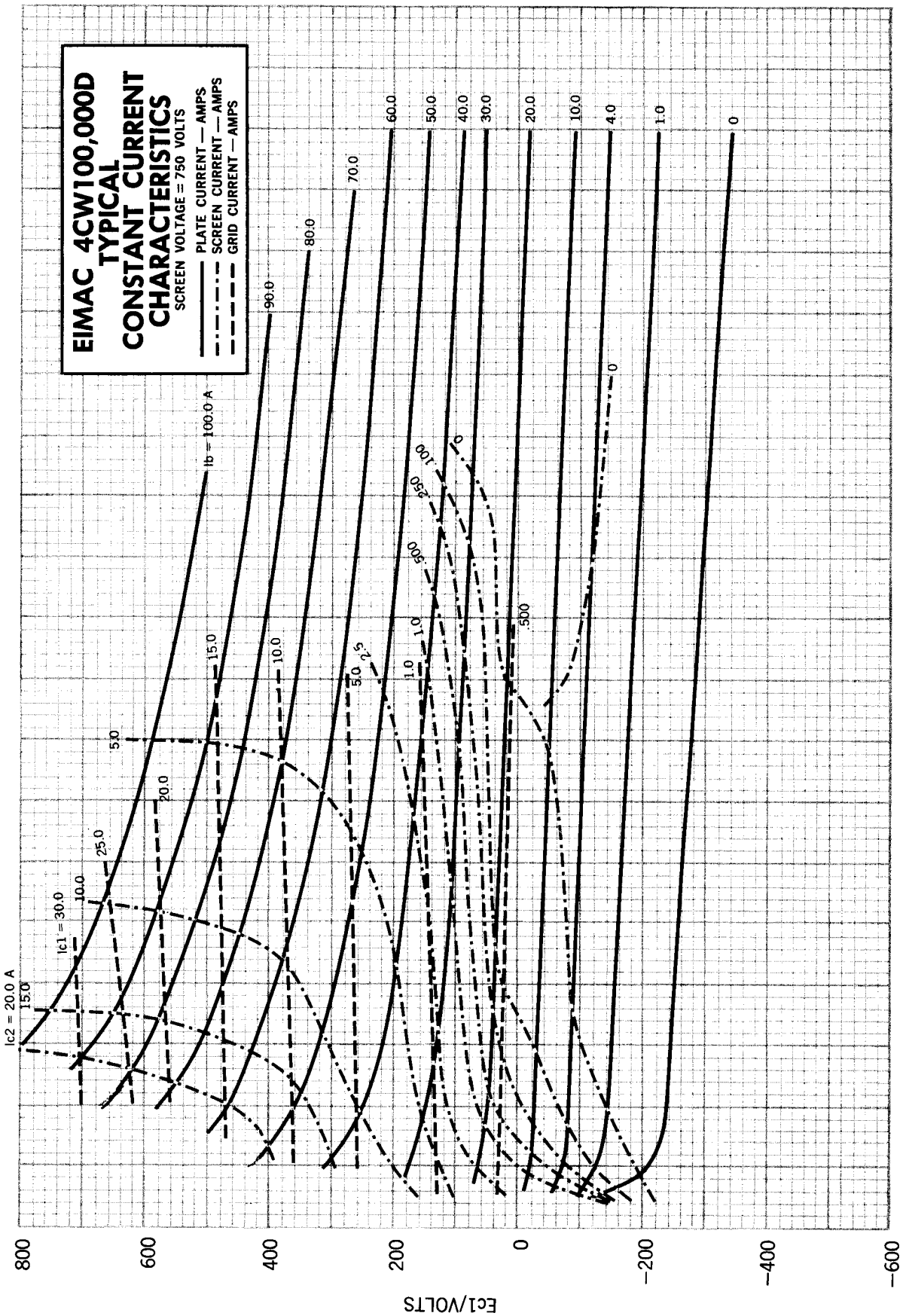
FAULT PROTECTION - In addition to normal plate overcurrent interlock, screen current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltage.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with each tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, we strongly recommend use of some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc.

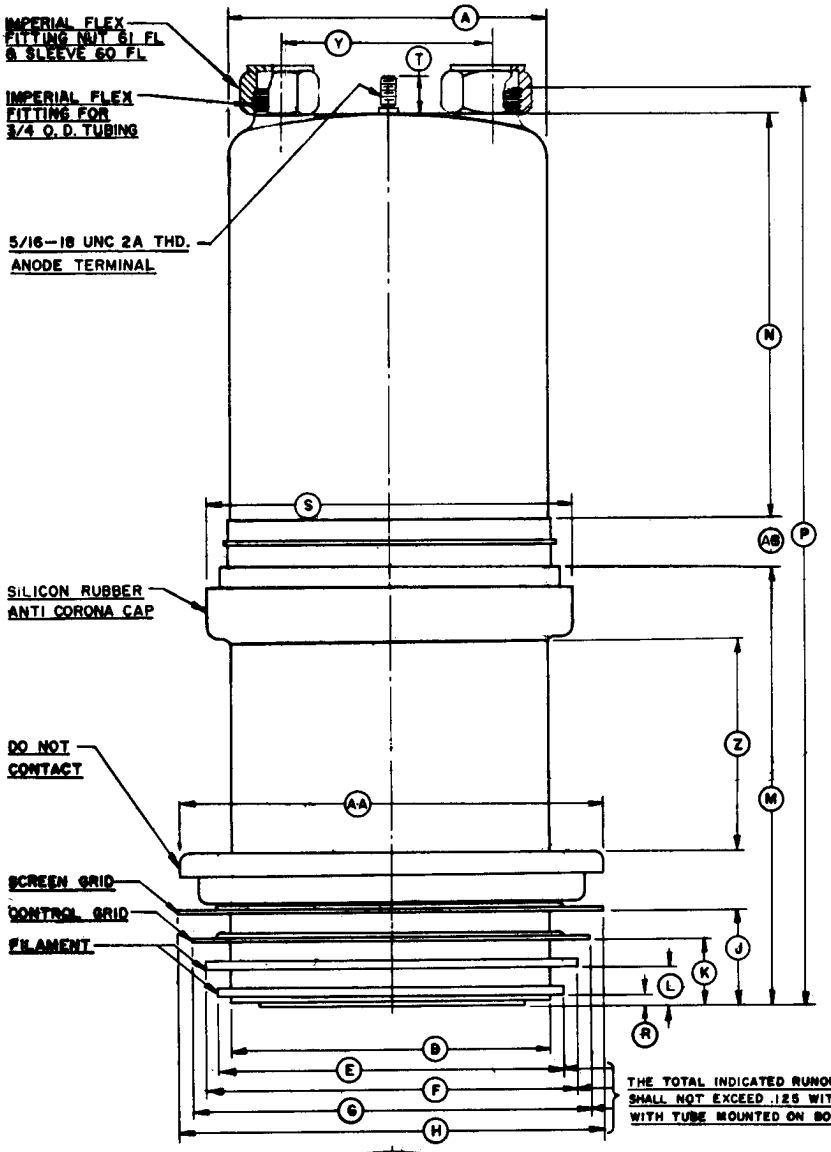
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


EIMAC 4CW100,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 100 A
Ic1 = 1.0 A
80.0
60.0
40.0
30.0
20.0
10.0
4.0
1.0
0
250
100
50
25
10
5.0
2.5
1.0
0.5
0
Eb/KILOVOLTS
Ec1/VOLTS
0
2
4
6
8
10
12
14
16
18
20
600
400
200
0
−200
−400
−600
−800

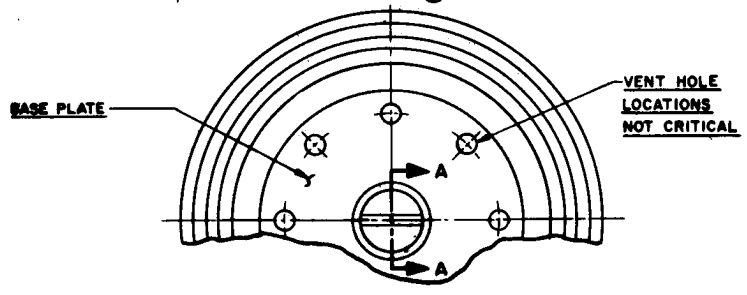
CURVE #2621

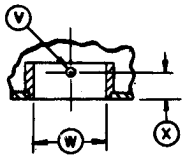

EIMAC 4CW100,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 100.0 A
Ic2 = 20.0 A
Ic1 = 30.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
15.0
10.0
5.0
4.0
1.0
0
25.0
20.0
15.0
10.0
5.0
2.5
1.0
.500
.250
.100
0
Ec1/VOLTS
800
600
400
200
0
−200
−400
−600
0
2
4
6
8
10
12
14
16
18
20
Eb/KILOVOLTS

CURVE #2623



THE TOTAL INDICATED RUNOUT OF THESE CONTACT EDGES SHALL NOT EXCEED .125 WITH RESPECT TO "W" MEASURED WITH TUBE MOUNTED ON BOTTOM CERAMIC





SECTION A-A
ROTATED 180°

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	5.875	6.125	- -	149.2	155.6	- -
D	5.980	6.020	- -	151.9	152.9	- -
E	6.510	6.560	- -	165.3	166.6	- -
F	6.980	7.020	- -	177.3	178.3	- -
G	7.480	7.520	- -	190.0	191.0	- -
H	7.975	8.015	- -	202.6	203.6	- -
J	1.750	1.800	- -	44.4	45.7	- -
K	1.220	1.270	- -	31.0	32.3	- -
L	0.690	0.740	- -	17.5	18.8	- -
M	8.600	8.800	- -	218.4	223.5	- -
N	7.000	7.500	- -	177.8	190.5	- -
P	17.250	18.000	- -	438.1	457.2	- -
R	0.173	0.213	- -	4.39	5.41	- -
S	- -	- -	6.950	- -	- -	176.5
T	- -	- -	0.718	- -	- -	18.2
V	- -	0.135	- -	- -	3.43	- -
W	1.250	1.270	- -	31.7	32.2	- -
X	0.490	0.530	- -	12.4	13.5	- -
Y	3.940	4.060	- -	100.1	103.1	- -
Z	- -	- -	4.200	- -	- -	106.7
AA	- -	- -	8.000	- -	- -	203.2
AB	- -	- -	1.080	- -	- -	27.4

NOTES:
1. THE LATERAL AXES OF THE WATER FITTINGS & BASE LOCKING PIN ARE TO BE WITHIN 10°
2. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.

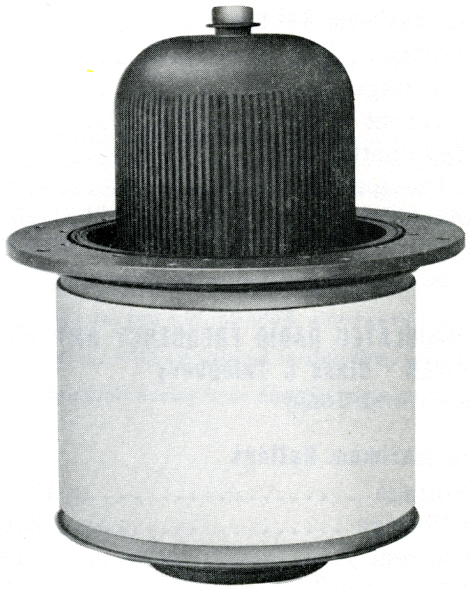
TECHNICAL DATA

4CW100,000E

HIGH-POWER
WATER-COOLED
TETRODE

DESCRIPTION

The 4CW100,000E is a ceramic/metal, high-power tetrode for applications requiring tube outputs from 100 to 250 kilowatts. It is ideal for use as a Class C rf amplifier or oscillator, a Class AB rf linear amplifier, or a Class AB push-pull af amplifier or modulator as well as a plate- and screen-modulated Class C rf amplifier. In pulse-modulator service, it can deliver a peak output of 4 megawatts. The tube is characterized by low input and feedback capacitances and low internal lead inductances. Its rugged mesh thoriated-tungsten filament provides ample emission for long operating life. The water-cooled anode dissipates 100 kilowatts when used with the EIMAC SK-2100 water jacket.



4CW100,000E without SK-2100 Water Jacket

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament	Thoriated Tungsten
Voltage	15.5 ± 0.75 V
Current, at 15.5 V	215 A
Direct Interelectrode Capacitances,	
Cathode grounded	
Input	370 pF
Output	60 pF
Feedback	1.0 pF
Grid grounded	
Input	175 pF
Output	60 pF
Feedback	0.35 pF
Maximum Frequency,	
for maximum CW ratings	108 MHz

PHYSICAL

Dimensions	See Outline Drawing
Net Weight	
Tube only	38.5 lb; 17.5 kg
Tube and water jacket	47.0 lb; 21.4 kg
Operating Position	Vertical, base up or down
Anode Cooling	Water
Base Cooling	Forced Air
Operating Temperature, maximum	
Ceramic/metal seals and envelope	250 °C
Anode Water Jacket,	
required	EIMAC SK-2100
Air System Socket,	
recommended	EIMAC SK-2000 Series
Base	Special

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

RADIO FREQUENCY LINEAR AMPLIFIER, Class AB

Absolute Maximum Ratings

Plate Voltage	20 kVdc
Screen Voltage	2.5 kVdc
Plate Current	16 Adc
Plate Dissipation	100 kW
Screen Dissipation	1750 W
Grid Dissipation	500 W

Typical Operation, Class AB_1, Grid Driven

Peak Envelope or Modulation Crest Conditions

Plate Voltage	18 kVdc
Screen Voltage	1.5 kVdc
Grid Voltage[2]	-320 Vdc
Zero-Signal Plate Current	4 Adc
Single-Tone Plate Current	13.5 Adc
Peak rf Grid Voltage, approx	300 v
Plate Dissipation	75 kW
Plate Output Power	168 kW
Resonant Load Impedance	697 Ω

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MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM Telephony
(Key-down Conditions)

Absolute Maximum Ratings

Plate Voltage	20	kVdc
Screen Voltage	2.5	kVdc
Plate Current	16	Adc
Plate Dissipation	100	kW
Screen Dissipation	1750	W
Grid Dissipation	500	W

Typical Operation

Plate Voltage	20	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage	-800	Vdc
Plate Current	15.2	Adc
Screen Current, approx	567	mAdc
Grid Current, approx	125	mAdc
Peak rf Grid Voltage, approx	900	v
Driving Power, calculated, approx	120	W
Plate Dissipation	54	kW
Plate Output Power	220	kW
Resonant Load Impedance	575	Ω

PLATE MODULATED RADIO FREQUENCY AMPLIFIER
GRID DRIVEN - Class C Telephony
(Carrier Conditions)

Absolute Maximum Ratings

Plate Voltage	17.5	kVdc
Screen Voltage	2.0	kVdc
Plate Current	16	Adc
Plate Dissipation[3]	67	kW
Screen Dissipation[4]	1750	W
Grid Dissipation[4]	500	W

Typical Operation

Plate Voltage	15	kVdc
Screen Voltage	750	Vdc
Grid Voltage	-600	Vdc
Plate Current	11.7	Adc
Screen Current, approx	875	mAdc
Grid Current, approx	660	mAdc
Peak af Screen Voltage, 100% mod., approx	750	v
Peak rf Grid Voltage, approx	800	v
Driving Power, calculated	530	W
Plate Dissipation	35	kW
Plate Output Power	140	kW
Resonant Load Impedance	620	Ω

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR
GRID DRIVEN - Class AB_1, Sinusoidal Wave

Absolute Maximum Ratings, per tube

Plate Voltage	20	kVdc
Screen Voltage	2.5	kVdc
Plate Current	16	Adc
Plate Dissipation	100	kW
Screen Dissipation	1750	W
Grid Dissipation	500	W

Typical Operation, two tubes

Plate Voltage	15	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage, approx[2]	-345	Vdc
Zero-Signal Plate Current	6	Adc
Maximum-Signal Plate Current	19.5	Adc
Maximum-Signal Screen Current, approx	830	mAdc
Peak af Grid Voltage, per tube	275	v
Maximum-Signal Plate Dissipation, per tube	46	kW
Plate Output Power	200	kW
Load Resistance, plate to plate	1825	Ω

PULSE MODULATOR SERVICE

Absolute Maximum Ratings

Plate Voltage	40	kVdc
Screen Voltage	2.5	kVdc
Grid Voltage	-2.0	kVdc
Peak Cathode Current	200	a
Plate Dissipation, during the pulse[5]	1.0	MW
Plate Dissipation, average	100	kW
Screen Dissipation, average	1750	W
Grid Dissipation, average	500	W
Pulse Length	10	ms

Typical Operation

Plate Voltage	40	kVdc
Plate Current, pulse	110	a
Screen Voltage	2.5	kVdc
Screen Current, pulse, approx	12	a
Grid Voltage	-1.2	kVdc
Grid Current, pulse, approx	400	ma
Positive Grid Voltage, pulse	110	v
Duty	6	%
Output Voltage, pulse	37	kv
Input Power, pulse	4.4	Mw
Output Power, pulse	4.1	Mw
Cathode Current, pulse, approx	122	a

TYPICAL OPERATION values are obtained by calculations from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to produce the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min	Max	
Filament Current, at 15.5 V ...	200	230	A
Cutoff Bias, at Eb = 25 kVdc, Ec2 = 1500 Vdc, Ib = 10 mAdc	---	-650	Vdc
Interelectrode Capacitances, Cathode grounded			
Input	350	390	pF
Output	55	65	pF
Feedback	---	1.2	pF
Grid grounded			
Input	160	190	pF
Output	55	65	pF
Feedback	---	0.5	pF

NOTES:

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. The EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Adjust to give specified zero-signal plate current.
3. Corresponds to 100 kW at 100% sine-wave modulation.
4. Average value, with or without modulation.
5. Power dissipated during rise and fall time neglected.

APPLICATION NOTES

MOUNTING — The 4CW100,000E must be mounted with its major axis vertical. The tube base may be either up or down, at the discretion of the circuit designer.

SOCKETING — An EIMAC SK-2000 series Socket, or equivalent, is recommended.

ANODE WATER JACKET — The EIMAC SK-2100 Water Jacket must be used to provide anode cooling. To achieve an anode dissipation of 100 kilowatts, the water jacket must be installed over the tube anode and adequate water flow provided.

COOLING — Anode cooling is accomplished by circulating water through the SK-2100 Water Jacket. Insufficient water flow will cause the anode temperature to rise to levels which will shorten tube life. Also, if the coolant lines become clogged, enough steam pressure may be generated to rupture the water jacket and destroy the tube. The following table lists the minimum cooling water requirements at various dissipation levels with a maximum inlet water temperature of 50 °C.

Anode Dissipation (kW)	Minimum Water Flow (gpm)	Approximate Pressure Drop (psi)
20	5.0	2.8
40	9.0	5.8
60	12.5	9.3
80	16.5	14.2
100	20.0	19.2

Note: Since the filament dissipates about 3500 watts, and the grid-plus-screen can, under some conditions, dissipate another 2250 watts, the table allows for an additional dissipation of 5750 watts.

Outlet water temperature must never exceed 70 °C and inlet water pressure should be limited to 100 psi. Direction of water flow is optional.

Tube life can be seriously affected by the condition of the cooling water. If it becomes ionized, copper-oxide deposits form on the inside of the water jacket causing localized anode heating and eventual tube failure.

To insure minimum electrolysis, and power loss, the water resistance at 20 °C should be greater than 50,000 ohms/cm^3, preferably 250,000 ohms/cm^3 or higher. The relative water resistance can be continuously monitored by measuring the leakage current through a short section of the insulating hose, using metal nipples or fittings as electrodes.

Auxiliary forced-air cooling, of the tube base is required to maintain filament- and grid-seal temperatures below 250 °C. An air flow of approximately 120 ft^3/min at 50 °C maximum and sea level should be directed, through an EIMAC SK-2000 series socket or equivalent, toward the filament- and grid-seal areas.

Both anode and base cooling should be applied before or simultaneously with the application of electrode voltages, including the filament. Base cooling should continue for about three minutes after the removal of electrode voltages to allow the tube to cool properly.

FILAMENT OPERATION — At rated filament voltage, the peak emission of a 4CW100,000E is many times greater than the amount needed for communication service. Reducing the filament voltage decreases the filament temperature. A small decrease in filament temperature substantially increases filament life. The correct value of filament-voltage should be determined for the particular applications. First, gradually reduce the filament voltage to the point where there is a noticeable reduction in plate current or power output, or an increase in distortion. Then increase the voltage several tenths of a volt above the value where performance degradation occurred; this is the proper operating voltage. Filament voltage should always be measured at the tube base or socket using an rms responding meter. The above procedure should be performed periodically to assure optimum tube life.

GRID OPERATION — The maximum control-grid dissipation is 500 watts, determined approximately by the product of grid current and peak positive grid voltage.

Under some operating conditions, the control grid may exhibit a negative-resistance characteristic. This may occur when, with high screen-grid voltage, increasing the drive voltage decreases the grid current. As a result, large values of instantaneous negative grid current can be produced, causing the amplifier to become regenerative. Because this may happen, the driver stage must be designed to tolerate this condition. One technique is to swamp the driver so that the change in load, due to secondary grid emission, is a small percentage of the total driver load.

SCREEN OPERATION — The maximum screen-grid dissipation is 1750 watts. With no ac applied to the screen, dissipation is simply the product of dc screen voltage and dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since the screen dissipation rating will be exceeded. Suitable protective circuitry should be provided.

The 4CW100,000E may exhibit reverse screen current to a greater or lesser degree depending on operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, or an electron-tube regulator circuit may be employed in the screen supply. A bleeder resistor must be used if a series electron-tube regulator is employed.

PLATE DISSIPATION — The rated plate dissipation of 100 kilowatts, attainable with water cooling, provides a large margin of safety in most applications. This rating may be exceeded briefly during tuning. When the 4CW100,000E is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions should be limited to 67 kilowatts.

FAULT PROTECTION — In addition to the normal plate-overcurrent interlock, screen-current interlock, and coolant-flow interlock, it is good practice to protect the tube from internal damage caused by an internal plate arc which may occur at high plate voltages.

A protective resistance of 5 to 25 ohms should always be connected in series with each tube anode, to absorb power-supply stored energy if a plate arc should occur. An electronic crowbar, which will discharge power-supply capacitors in a few microseconds after the start of a plate arc, is recommended.

OPERATING HAZARDS

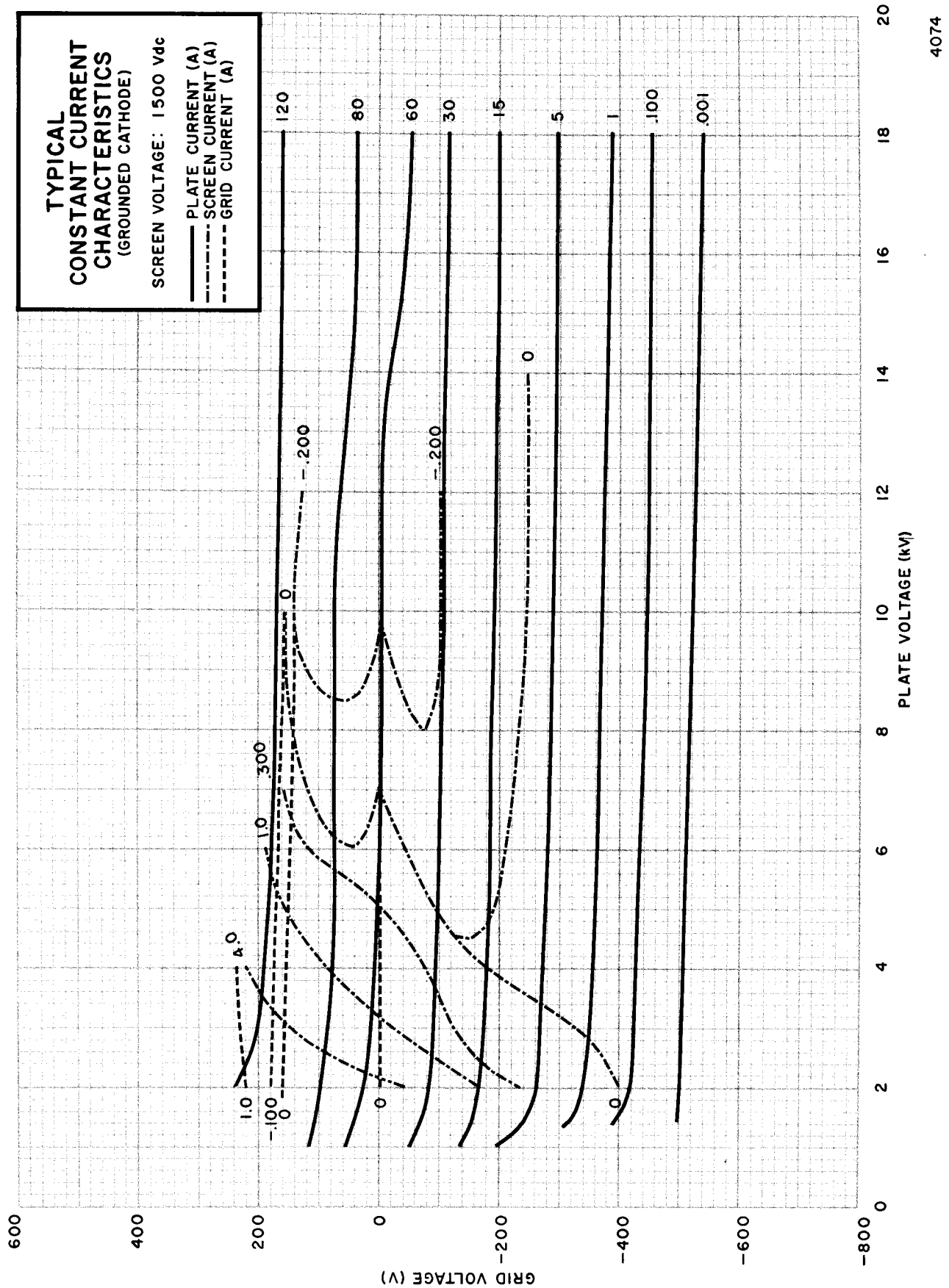
Read the following and take all necessary precautions to safeguard personnel. Safe operating conditions are the responsibility of the equipment designer and the user.

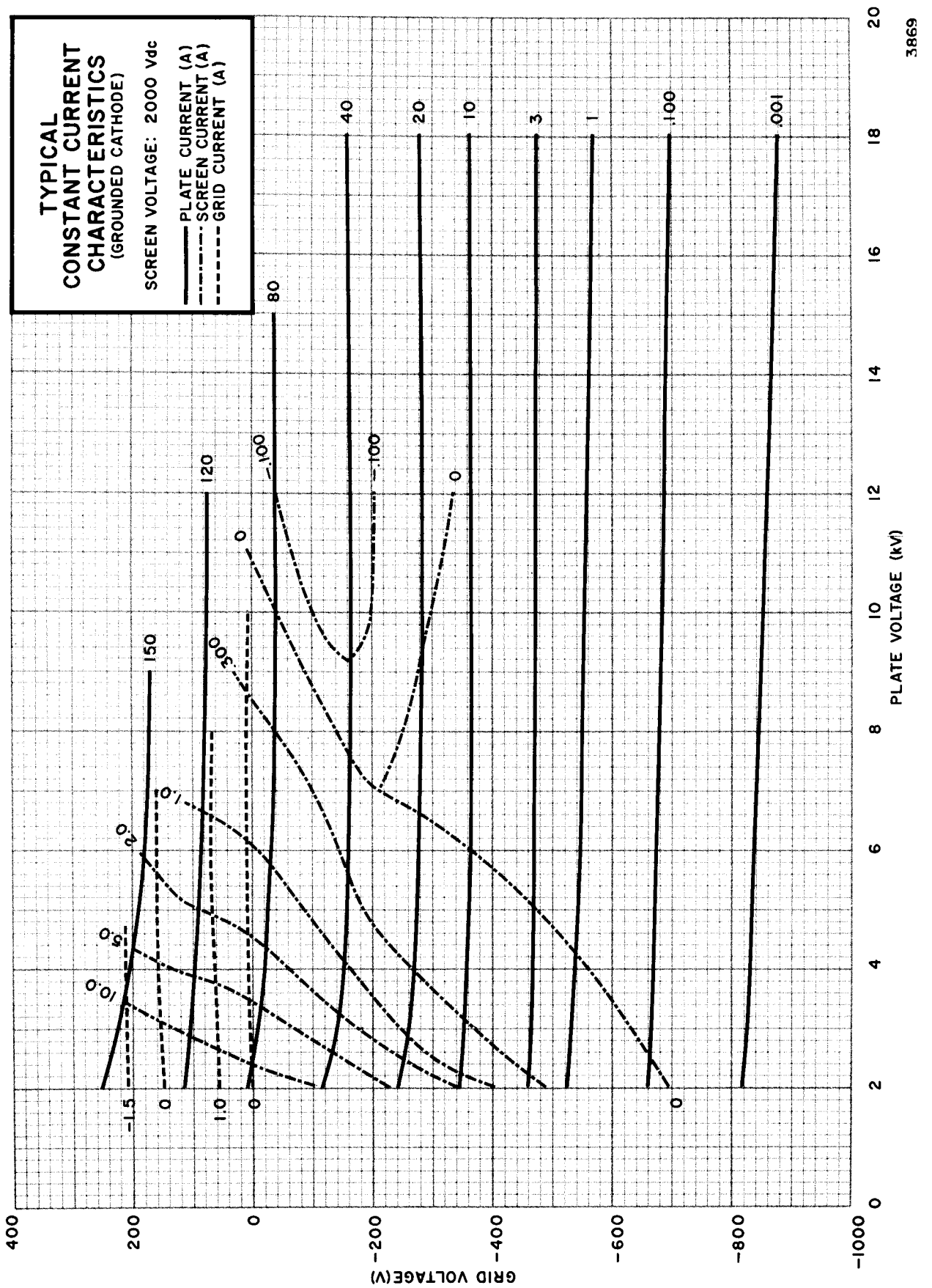
HIGH VOLTAGE — This tube operates at voltages which can be deadly. Equipment must be designed so personnel cannot come in contact with operating voltages. Enclose high-voltage circuits and terminals and provide fail-safe interlocking switch circuits to open the primary circuits of the power supply and to discharge high-voltage condensers whenever access into the enclosure is required.

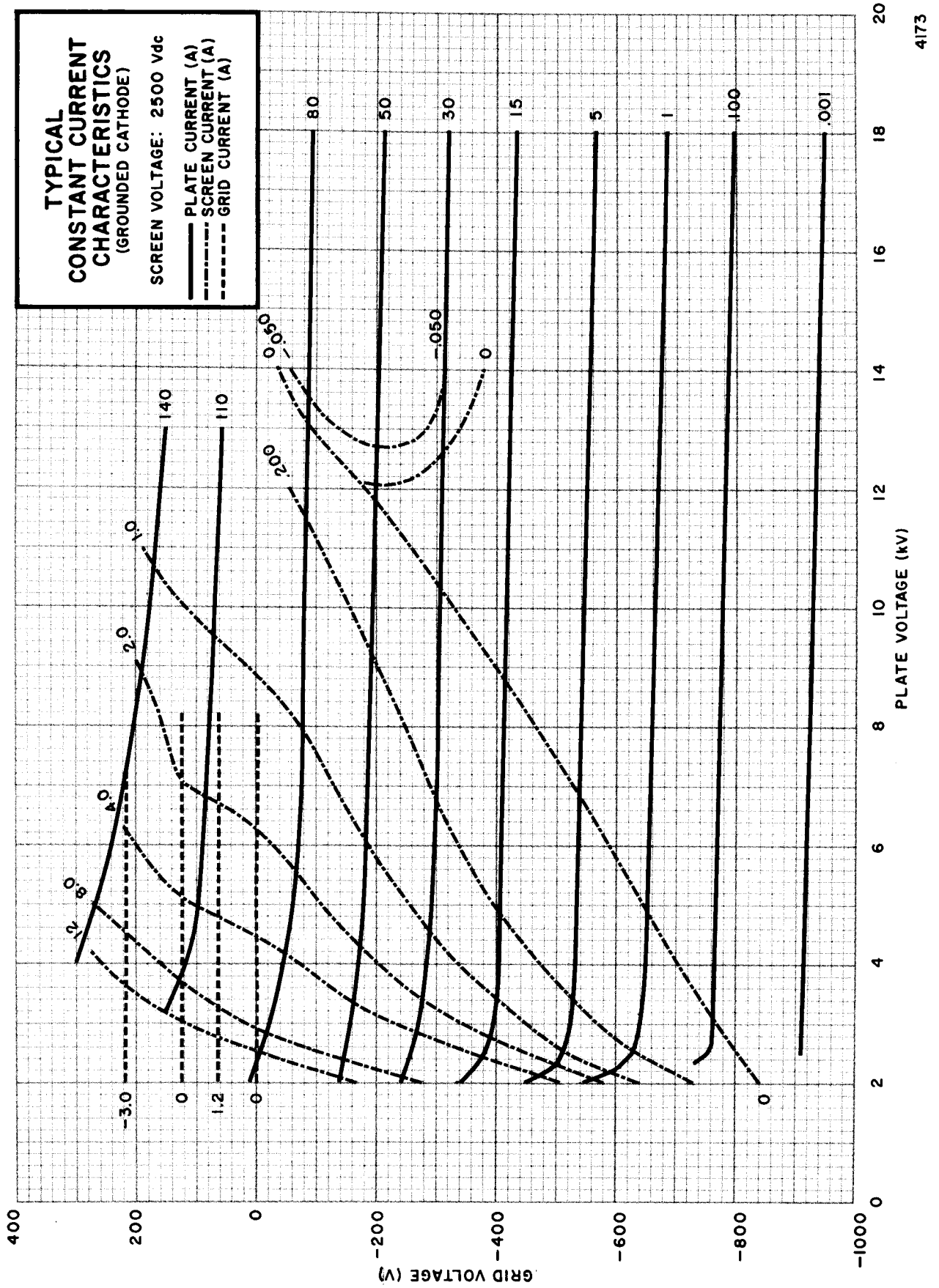
X-RAY RADIATION — The 4CW100,000E, operating at its rated voltages and currents, is a potential X-ray hazard. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to changes in leakage paths or emission characteristics as they are affected by high voltage. Only limited shielding is afforded by the tube envelope. Additional X-ray shielding must be provided on all sides of the tube to provide adequate protection to operating personnel throughout the tube's life. When this tube is used as a pulse modulator, shielding of the pulse transformer may also be necessary. X-ray caution signs or labels must be permanently attached to equipment using this tube directing operating personnel never to operate this device without X-ray shielding in place.

RADIO FREQUENCY RADIATION — Exposure of the human body to rf radiation becomes increasingly more hazardous as the power level and/or frequency are increased. Exposure to high-power rf radiation must be strictly prevented at any frequency.

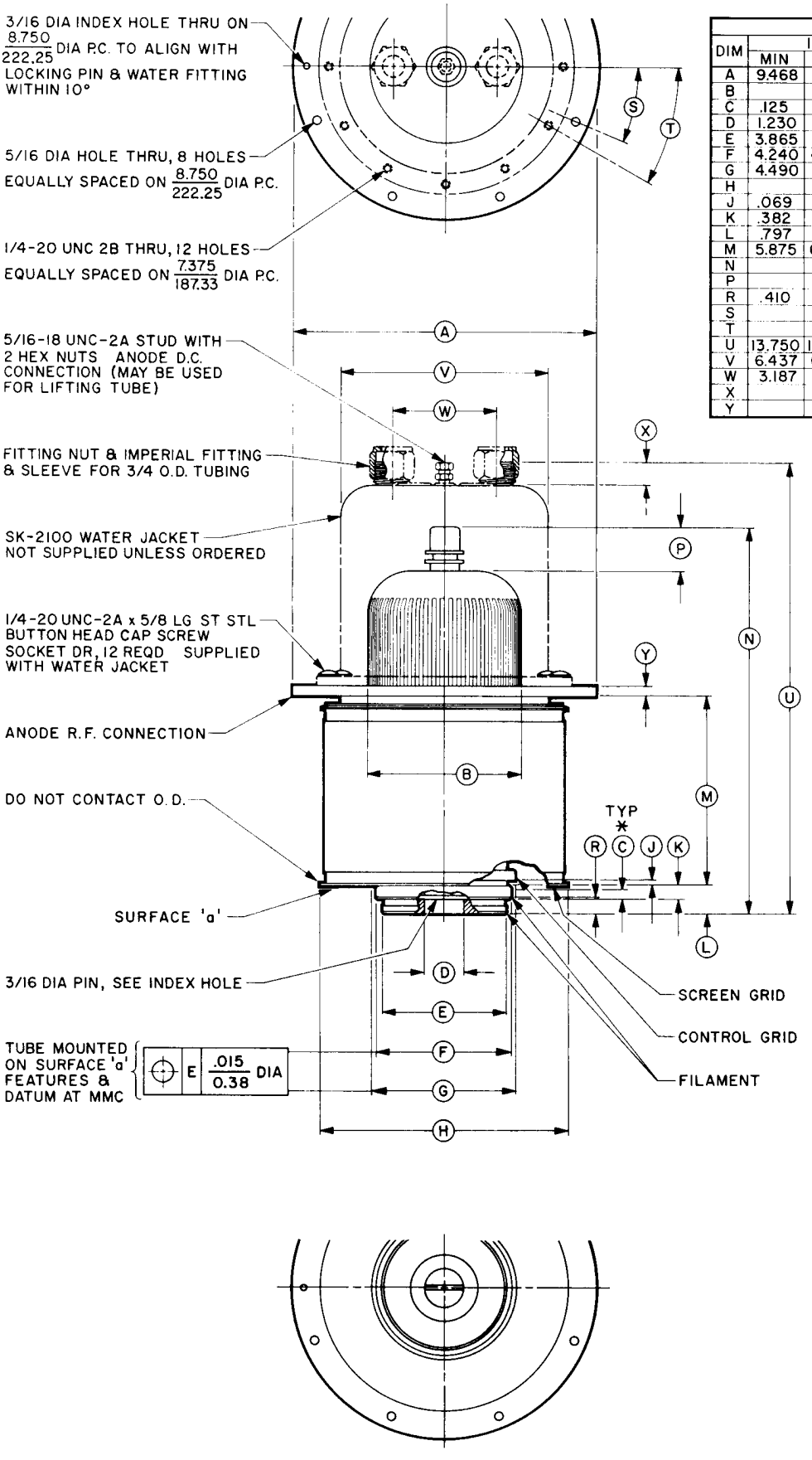
Equipment must be designed to fully safeguard all personnel from these hazards. Labels and caution notices must be provided on equipment and in manuals clearly warning of these hazards.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
(GROUNDED CATHODE)
SCREEN VOLTAGE: 1500 Vdc
PLATE CURRENT (A)
SCREEN CURRENT (A)
GRID CURRENT (A)
120
80
60
30
15
5
1
.100
.001
4.0
1.0
.300
.100
0
-.100
-.200
-.200
0
0
0
0
0
GRID VOLTAGE (V)
600
400
200
0
-200
-400
-600
-800
0
2
4
6
8
10
12
14
16
18
20
PLATE VOLTAGE (kV)
4074


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
(GROUNDED CATHODE)
SCREEN VOLTAGE: 2000 Vdc
PLATE CURRENT (A)
SCREEN CURRENT (A)
GRID CURRENT (A)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
3869


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
(GROUNDED CATHODE)
SCREEN VOLTAGE: 2500 Vdc
PLATE CURRENT (A)
SCREEN CURRENT (A)
GRID CURRENT (A)
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
4173

OUTLINE DRAWING



DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN	MAX	REF	MIN	MAX	REF
A	9.468	9.531		240.49	242.09	
B			5.000			127
C	.125			3.18		
D	1.230	1.270		31.24	32.26	
E	3.865	3.885		98.17	98.68	
F	4.240	4.260		107.7	108.2	
G	4.490	4.510		114.05	114.55	
H			7.750			196.85
J	.069	.149		1.75	3.79	
K	.382	.462		9.70	11.74	
L	.797	.922		20.24	23.42	
M	5.875	6.000		149.23	152.6	
N			11.500			292.1
P			1.375			34.93
R	.410	.475		10.41	12.07	
S			22 1/2°			—
T			30°			—
U	13.750	14.250		349.25	361.95	
V	6.437	6.562		163.7	166.88	
W	3.187	3.313		80.95	84.15	
X			.562			14.28
Y			.312			7.93

REF DIMENSIONS ARE FOR INFORMATION ONLY

(*) MINIMUM CONTACT SURFACE

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

4CW10,000A

RADIAL-BEAM POWER TETRODE

The Eimac 4CW10,000A is a water-cooled, ceramic-metal power tetrode which is electrically identical to the 8171/4CX10,000D (and 8170/4CX5000A, except for plate dissipation). The water-cooled anode is equipped with an integral water jacket and is rated at 12 kilowatts dissipation.

The 4CW10,000A is useful as an oscillator, amplifier or modulator at frequencies up to 110 megacycles, and is particularly suited for use as a linear rf amplifier or or class-AB audio amplifier.

A pair of these tubes operating class AB will deliver more than 30 kilowatts of audio-frequency or radio-frequency plate output power.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	73		78	amperes
Amplification Factor (Grid-Screen)		4.5		
Frequency for Maximum Ratings			30	Mc

Direct Interelectrode Capacitances, Grounded Cathode:	Min.	Max.	
Input	108	122	uuf
Output	18	23	uuf
Feedback		1.0	uuf

Direct Interelectrode Capacitances, Grounded Grid and Screen:	Min.	Max.	
Input	48	58	uuf
Output	18	23	uuf
Feedback		0.16	uuf

MECHANICAL

Base	Special concentric
Maximum Seal Temperature	250° C
Maximum Anode-Core Temperature	250° C
Recommended Socket	Eimac SK-300A
Operating Position	Axis vertical, base up or down

Maximum Dimensions:

Height	11.44 inches
Diameter	4.66 inches
Cooling	Water and Forced air
Net Weight	7.5 pounds
Shipping Weight (Approximate)	17 pounds

(Effective 4-15-63) 1963, 1967 by VARIAN Printed in U.S.A.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR (Up to 110 megacycles)

Class-C Telegraphy or FM Telephony (Key-down conditions)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	up to 30 megacycles	7500 MAX.	VOLTS
	30 to 60 megacycles	7000 MAX.	VOLTS
	60 to 110 megacycles	6500 MAX.	VOLTS
D-C SCREEN VOLTAGE		1500 MAX.	VOLTS
D-C PLATE CURRENT	up to 30 megacycles	3 MAX.	AMPERES
	30 to 60 megacycles	2.8 MAX.	AMPERES
	60 to 110 megacycles	2.6 MAX.	AMPERES
PLATE DISSIPATION		10,000 MAX.	WATTS
SCREEN DISSIPATION		250 MAX.	WATTS
GRID DISSIPATION		75 MAX.	WATTS

TYPICAL OPERATION
(Frequencies below 30 megacycles)

D-C Plate Voltage	7500	volts
D-C Screen Voltage	500	volts
D-C Grid Voltage	—350	volts
D-C Plate Current	2.8	amperes
D-C Screen Current	0.5	ampere
D-C Grid Current	0.25	ampere
Peak R-F Grid Voltage	590	volts
Driving Power	150	watts
Plate Dissipation	5000	watts
Plate Output Power	16,000	watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier conditions except where noted)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000 MAX.	VOLTS
D-C SCREEN VOLTAGE	1000 MAX.	VOLTS
D-C PLATE CURRENT	2.5 MAX.	AMPERES
PLATE DISSIPATION*	6650 MAX.	WATTS
SCREEN DISSIPATION	250 MAX.	WATTS
GRID DISSIPATION	75 MAX.	WATTS

*Corresponds to 10,000 watts at 100-percent sine-wave modulation.

TYPICAL OPERATION (Frequencies below 30 megacycles)

D-C Plate Voltage	5000	volts
D-C Screen Voltage	500	volts
Peak A-F Screen Voltage (For 100-percent modulation)	500	volts
D-C Grid Voltage	—350	volts
D-C Plate Current	2.4	amperes
D-C Screen Current	0.4	ampere
D-C Grid Current	0.22	ampere
Peak R-F Grid Voltage	550	volts
Grid Driving Power	120	watts
Plate Dissipation	3500	watts
Plate Output Power	8.5	kilowatts

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7500 MAX.	VOLTS
D-C SCREEN VOLTAGE	1500 MAX.	VOLTS
D-C PLATE CURRENT	4.0 MAX.	AMPERES
PLATE DISSIPATION	12,000 MAX.	WATTS
SCREEN DISSIPATION	250 MAX.	WATTS
GRID DISSIPATION	75 MAX.	WATTS

TYPICAL OPERATION, two tubes

D-C Plate Voltage	4000	5000	6000	7500	volts
D-C Screen Voltage	1500	1500	1500	1500	volts
D-C Grid Voltage	—315	—320	—330	—340	volts
Max.-Signal Plate Current	6.66	6.66	6.66	6.66	ampere
Zero-Signal Plate Current*	0.50	0.50	0.50	0.50	ampere
Max.-Signal Screen Current	0.33	0.32	0.30	0.25	ampere
Zero-Signal Screen Current	0	0	0	0	ampere
Peak A-F Driving Voltage	305	310	320	330	volts
Driving Power	0	0	0	0	watts
Load Resistance, Plate-to-Plate	940	1320	1700	2280	ohms
Max.-Signal Plate Dissipation*	6,670	7,950	8,100	9,050	watts
Max.-Signal Plate Output Power	13,300	17,500	23,800	31,900	watts

*Per Tube

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7500 MAX.	VOLTS
D-C SCREEN VOLTAGE	1500 MAX.	VOLTS
D-C PLATE CURRENT	4.0 MAX.	AMPERES
PLATE DISSIPATION	12,000 MAX.	WATTS
SCREEN DISSIPATION	250 MAX.	WATTS
GRID DISSIPATION	75 MAX.	WATTS

TYPICAL OPERATION, Peak-Envelope or Modulation-Crest Conditions, (Frequencies below 30 megacycles)

D-C Plate Voltage	7500	volts
D-C Screen Voltage	1500	volts
D-C Grid Voltage*	—340	volts
Max.-Signal Plate Current	3.33	amperes
Zero-Signal Plate Current	0.50	ampere
Max.-Signal Screen Current	0.125	ampere
Peak R-F Grid Voltage	330	volts
Driving Power	0	watts
Plate Dissipation	9050	watts
Plate Output Power**	15,950	watts

*Adjust grid voltage to obtain specified Zero-Signal plate current.
**PEP output or r-f output power at crest of modulation envelope.

NOTE: In most cases, "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses, either input or output, has been made.

APPLICATION

MECHANICAL

Mounting—The 4CW10,000A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

Socket—The Eimac SK-300A air-system socket may be used with the 4CW10,000A. The socket has provision for directing cooling air through the socket and over the base seals.

Cooling—Base terminal cooling is accomplished by directing air through the socket and over the filament and grid seals. Anode cooling is accomplished by circulating water through the integral water jacket. The table below lists minimum water flow rates for proper cooling at various plate dissipation levels.

Minimum Cooling Water Requirement		
Plate Dissipation (kw)	Quantity (gpm)	Pressure Drop (psi)
6	4.0	2.2
8	5.1	3.1
10	6.3	4.3
12	7.4	5.5

Note: Since power dissipated by the filaments represented about 560 watts and grid plus screen dissipation can represent another 325 watts, an extra 900 watts has been added to plate dissipation in preparing this tabulation.

Maximum outlet-water temperature must never exceed 70°C and inlet-water pressure should be limited to 50 psi.

When the tube is mounted with its anode up, the water inlet is on the outer connector; when the anode is down, the inlet is the center connector. Water and air flow should start whenever filament voltage is applied. There is no danger in removing cooling water and air simultaneously with power removal.

Base cooling may be accomplished by directing approximately 30 cfm of air through the socket and over the seals. Pressure drop will be approximately 0.1 inch of water. An alternate method for frequencies below 30 Mc is to direct approximately 10 cfm through a ¾" ID tube directly at the center stud. The jet should be no more than two inches from the stud.

ELECTRICAL

Filament Operation—The rated filament voltage for the 4CW10,000A is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than plus or minus 5 percent from the rated value.

Electrode Dissipation Ratings—The maximum dissipation ratings for the 4CW10,000A must be respected to avoid damage to the tube. An exception is the plate dissipation, which may be permitted to rise above the rated maximum during brief periods, such as may occur during tuning.

Control Grid Operation—The 4CW10,000A control grid has a maximum dissipation rating of 75 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible.

Screen-Grid Operation—The power dissipated by the screen of the 4CW10,000A must not exceed 250 watts.

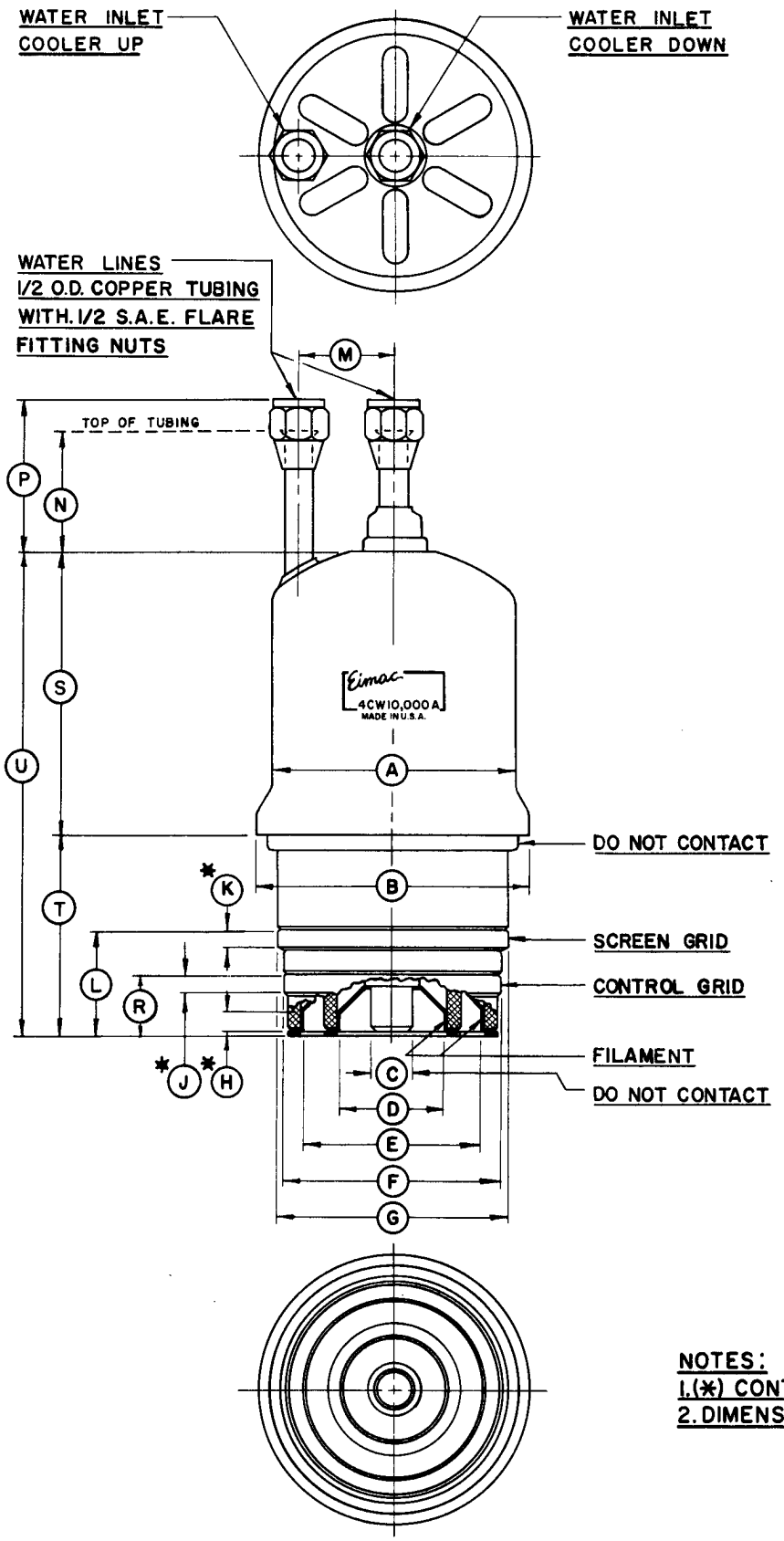
Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 250 watts in the event of circuit failure.

Plate Dissipation—The plate-dissipation rating for the 4CW10,000A is 10,000 watts for most applications, but for audio and SSB amplifier applications, the maximum allowable dissipation is 12,000 watts.

When the 4CW10,000A is operated as a plate-modulated r f power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 6650-watt maximum plate dissipation rating will be exceeded.

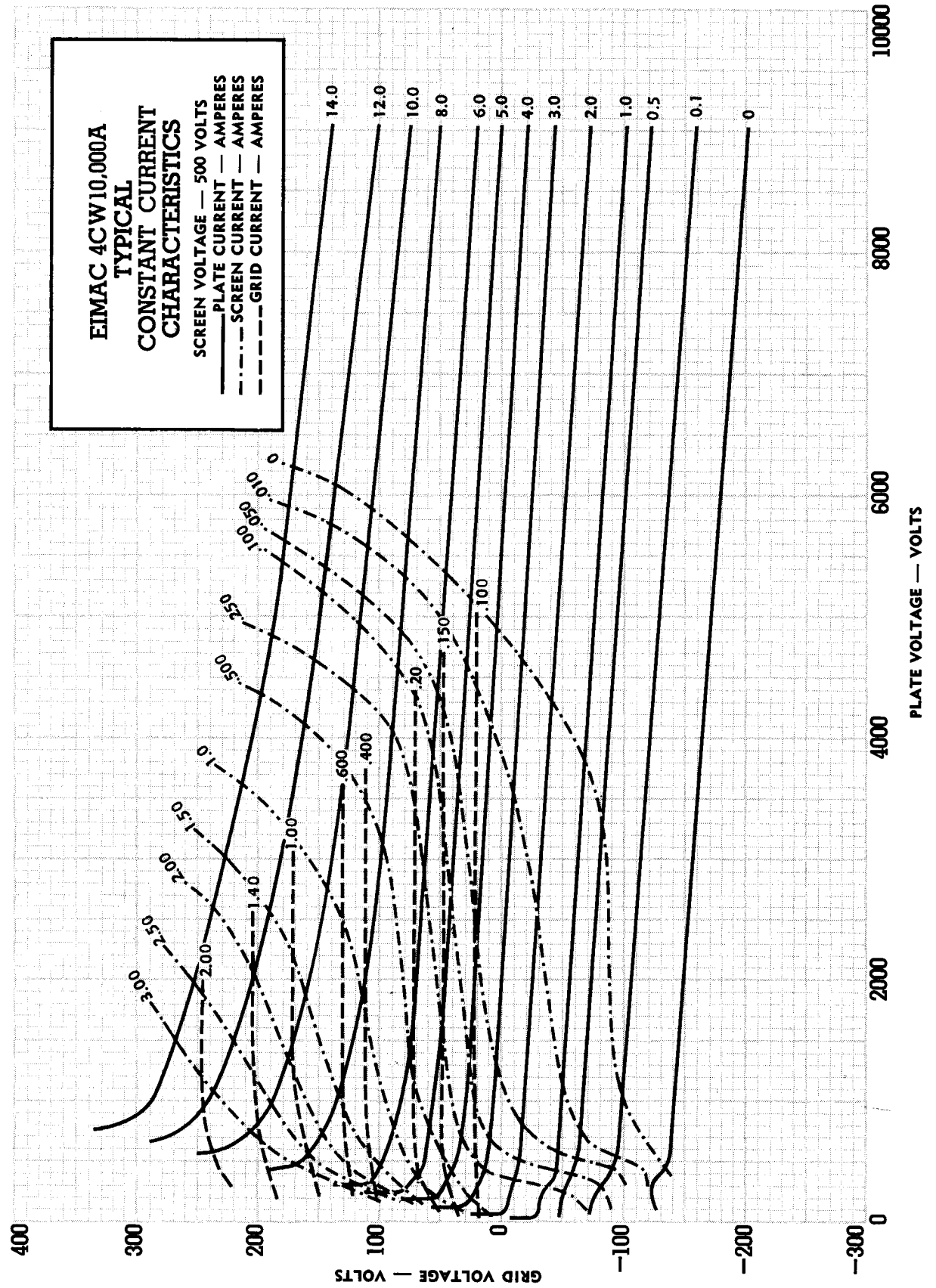
Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to the Power Grid Tube Marketing Department, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.

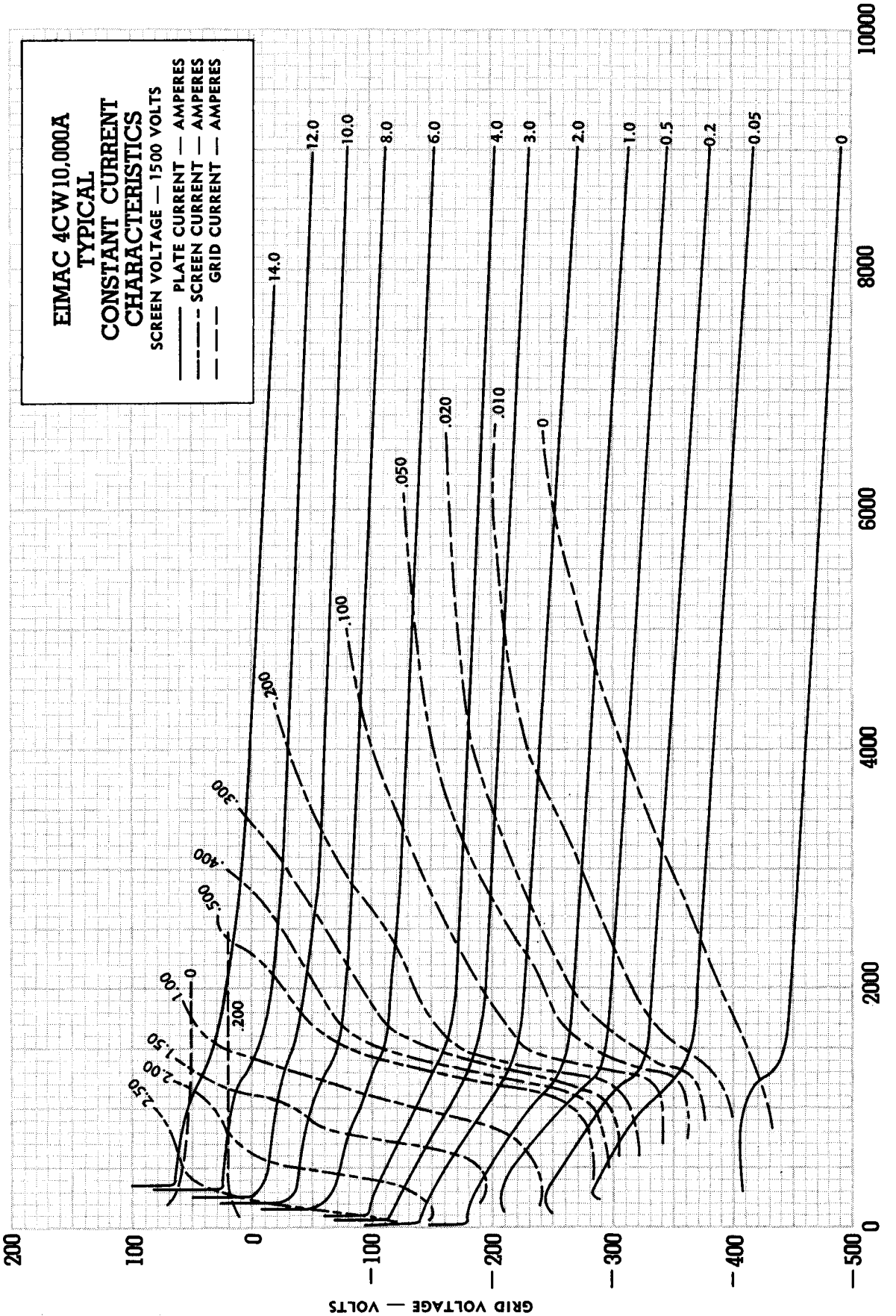


DIMENSION DATA			
REF	NOM.	MIN.	MAX.
A		4.094	4.156
B		4.594	4.656
C		.720	.760
D		1.896	1.936
E		3.133	3.173
F		3.792	3.832
G		3.980	4.020
H		.188	
J		.188	
K		.188	
L		1.764	1.826
M		1.500	1.750
N		1.937	2.187
P		2.312	2.812
R		.986	1.050
S		4.780	5.025
T		3.350	3.650
U		8.125	8.625

These dimensions reflect standard manufacturing tolerances. They should not be used as the basis for purchase specifications unless checked with Eitel-McCullough, Inc.

NOTES:
1.(*) CONTACT SURFACE.
2. DIMENSIONS IN INCHES.


EIMAC 4CW10,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
14.0
12.0
10.0
8.0
6.0
5.0
4.0
3.0
2.0
1.0
0.5
0.1
0
.010
.050
.100
.250
.500
1.0
1.50
2.00
2.50
3.00
1.40
.600
.400
.200
.150
.100
400
300
200
100
0
−100
−200
−300
0
2000
4000
6000
8000
10000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

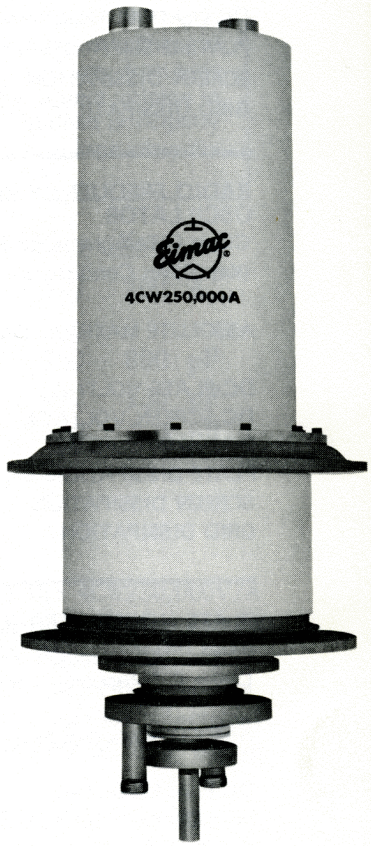

EIMAC 4CW10,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 1500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
14.0
12.0
10.0
8.0
6.0
4.0
3.0
2.0
1.0
0.5
0.2
0.05
0
.050
.020
.010
.100
200
300
400
500
1.00
1.50
2.00
2.50
200
100
0
—100
—200
—300
—400
—500
0
2000
4000
6000
8000
10000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

TECHNICAL DATA

4CW250,000V
4CW250,000A

WATER-COOLED
POWER TETRODE

The EIMAC 4CW250,000V/A is a ceramic/metal, water-cooled, power tetrode intended for use at the 250 to 500 kilowatt output power level. It is recommended as a Class C amplifier or oscillator; a Class AB rf linear amplifier; a Class AB push-pull af amplifier or modulator; a plate or screen modulated Class C rf amplifier; or for pulse modulator or regulator service. The 4CW250,000V is supplied with a Vaclon® pump attached. On the 4CW-250,000A, no Vaclon pump is attached.



Shown with anode water jacket.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	12.0 ± 0.6	V
Current, at 12.0 volts	660	A
Amplification Factor (Average):		
Grid to Screen	4.5	
Direct Interelectrode Capacitance (grounded cathode) [2]		
Cin	765	pF
Cout	124	pF
Cgp	6.0	pF
Frequency or Maximum Rating:		
CW	50	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube.

MECHANICAL

Maximum Overall Dimensions:	
Length (4CW250,000V)	32.93 in; 837.0 mm
(4CW250,000A)	30.46 in; 774.0 mm
Diameter	13.06 in; 330.0 mm
Net Weight	98 lb; 44.5 kg
Operating Position	Vertical, base up or down
Maximum Operating Temperature:	
Ceramic/Metal Seals	200°C
Cooling	Liquid
Base	Special
Recommended Anode Water Jacket (not supplied)	SK-1720

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RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	40	AMPERES
PLATE DISSIPATION	250,000	WATTS
SCREEN DISSIPATION	3,500	WATTS
GRID DISSIPATION	1,500	WATTS

TYPICAL OPERATION (Frequencies to 50 MHz)
Class AB, Peak Envelope or Modulation Crest Conditions

Plate Voltage	15	20	kVdc
Screen Voltage	1.8	1.8	kVdc
Grid Voltage [1/2]	-500	-500	Vdc
Zero-Signal Plate Current	0.20	0.20	Adc
Single-Tone Plate Current	20	23	Adc
Single-Tone Screen Current[2]	1.1	1.2	Adc
Peak rf Grid Voltage [2]	500	500	v
Plate Dissipation	80	130	kW
Plate Output Power	220	330	kW
Resonant Load Impedance	325	435	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	40	AMPERES
PLATE DISSIPATION	250,000	WATTS
SCREEN DISSIPATION	3,500	WATTS
GRID DISSIPATION	1,500	WATTS

TYPICAL OPERATION (Frequencies to 50 MHz)

Plate Voltage	16.0	19.0	kVdc
Screen Voltage	800	800	Vdc
Grid Voltage	-800	-800	Vdc
Plate Current	23.5	32.5	Adc
Screen Current[1]	2.4	3.5	Adc
Grid Current [1]	1.15	2.5	Adc
Calculated Driving Power	2.24	3.00	kW
Plate Dissipation	100.0	155.0	kW
Plate Output Power	275.0	460.0	kW
Resonant Load Impedance	300	275	Ω

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	30	AMPERES
PLATE DISSIPATION [1]	167,000	WATTS
SCREEN DISSIPATION [2]	3,500	WATTS
GRID DISSIPATION [2]	1,500	WATTS

1. Corresponds to 250,000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 50 MHz)

Plate Voltage	14.0	kVdc
Screen Voltage	800	Vdc
Grid Voltage	-800	Vdc
Plate Current	29.0	Adc
Screen Current[1]	3.5	Adc
Grid Current [1]	2.0	Adc
Peak af Screen Voltage[1](100% modulation)	800	v
Peak rf Grid Voltage[1]	1160	v
Calculated Driving Power	2320	W
Plate Dissipation	119.0	kW
Plate Output Power	285.0	kW
Resonant Load Impedance	210	Ω

1. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	40	AMPERES
PLATE DISSIPATION	250,000	WATTS
SCREEN DISSIPATION	3,500	WATTS
GRID DISSIPATION	1,500	WATTS

1. Approximate value.

TYPICAL OPERATION (Two Tubes), Sinusoidal Wave

Plate Voltage	15.0	20.0	kVdc
Screen Voltage	1.8	1.8	kVdc
Grid Voltage [1/3]	-500	-500	Vdc
Zero-Signal Plate Current	0.20	0.20	Adc
Max. Signal Plate Current	40.0	46.0	Adc
Max. Signal Screen Current [1]	1.1	1.2	Adc
Peak af Grid Voltage [2]	500	500	v
Max. Signal Plate Dissipation	160.0	260.0	kW
Plate Output Power	440.0	660.0	kW
Load Resistance (plate to plate)	650	870	Ω

2. Per Tube.
3. Adjust to give stated zero-signal plate current.

PULSE MODULATOR OR REGULATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	40,000 VOLTS	PLATE DISSIPATION	250,000 WATTS
DC SCREEN VOLTAGE	2,500 VOLTS	SCREEN DISSIPATION	3,500 WATTS
PEAK CATHODE CURRENT	350 AMPERES	GRID DISSIPATION	1,500 WATTS

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Filament: Current at 12 volts	620	700	A
Interelectrode Capacitances[1] (grounded cathode connection)			
Cin	730	800	pF
Cout	112	136	pF
Cgp	4.0	8.0	pF

1. Capacitance values are for a cold tube.

APPLICATION

MECHANICAL

MOUNTING - The 4CW250,000V/A must be mounted vertically, anode up or down. The tube may be supported by the anode flange or the screen flange.

COOLING - The EIMAC SK-1720 water jacket is available for use with the 4CW250,000A and V. Because of the small size of this cooler, high frequency operation is possible. It is essential that high purity water be used to minimize power loss and corrosion of metal fittings. Good distilled or de-ionized water will have a resistance of 1 to 2 megohms per cm^3. Water should be discarded if resistivity falls to 50,000 ohms cm^3.

Since the tube anode is usually at high potential to ground, water connections to the anode are made through insulating tubing. These insulating sections should be long enough so that column resistance is above 100,000 ohms per 1000 plate supply volts.

The table below lists minimum cooling water requirements at various plate dissipation levels.

Plate Dissipation (kilowatts)	Water Flow (GPM)	Pressure Drop (PSI)
100	25.0	3.5
150	37.5	3.7
200	50.0	4.0
250	60.0	6.0
300	73.0	9.0

The filament supports of the 4CW250,000V/A are water cooled. Approximately 0.5 GPM should circulate through each of the filament connectors with a pressure drop of 20 PSI. Filament connector assemblies, SK-1710, provide electrical and water connections. Two sets of SK-1710 are required.

It is recommended that the water cooled control grid connector, SK-1712, be used. Water flow of approximately 0.5 GPM should circulate through the grid connector. The pressure drop across the grid connector is low. A convenient way to make water connection is to series connect the grid cooling water with the outer filament cooling water path.

The outer filament water path has a lower pressure drop than the inner filament water path making this connection practical.

VacIon ® High Vacuum Pump –
Model 913-0011

This pump is included as standard equipment on the 4CW250,000V. It permits periodic checking of the vacuum condition of tubes in storage. It may be used to restore the vacuum of a tube which has been accidentally damaged by overheating in service.

Accessories required for VacIon ® pump operation but not supplied with the tube are:
Permanent magnet, Model 913-0011.
Control unit, Model 921-0006 for 60 Hz power.
Control unit, Model 921-0026 for 50 Hz power.

ELECTRICAL

FILAMENT OPERATION - The peak emission at rated filament voltage of the EIMAC 4CW-250,000V/A is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CW250,000V/A by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CW250,000V/A. At some value of filament voltage there will be a noticeable reduction in plate current or power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appeared to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked.

Filament starting current must be limited to a maximum of 1800 amperes.

GRID OPERATION - The 4CW250,000V/A grid is rated at 1,500 watts of dissipation and protective measures should be included in circuitry to insure that this rating is not exceeded. Grid dissipation is the approximate product of dc grid current and peak positive grid voltage.

SCREEN DISSIPATION - The power applied to the screen grid must not exceed 3,500 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is the product of RMS screen current and RMS screen voltage.

Plate voltage, plate load and bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to remove screen power at the occurrence of any such conditions.

PLATE DISSIPATION - The plate dissipation of 250 kilowatts attainable through water cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CW250,000V/A is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 167,000 watts.

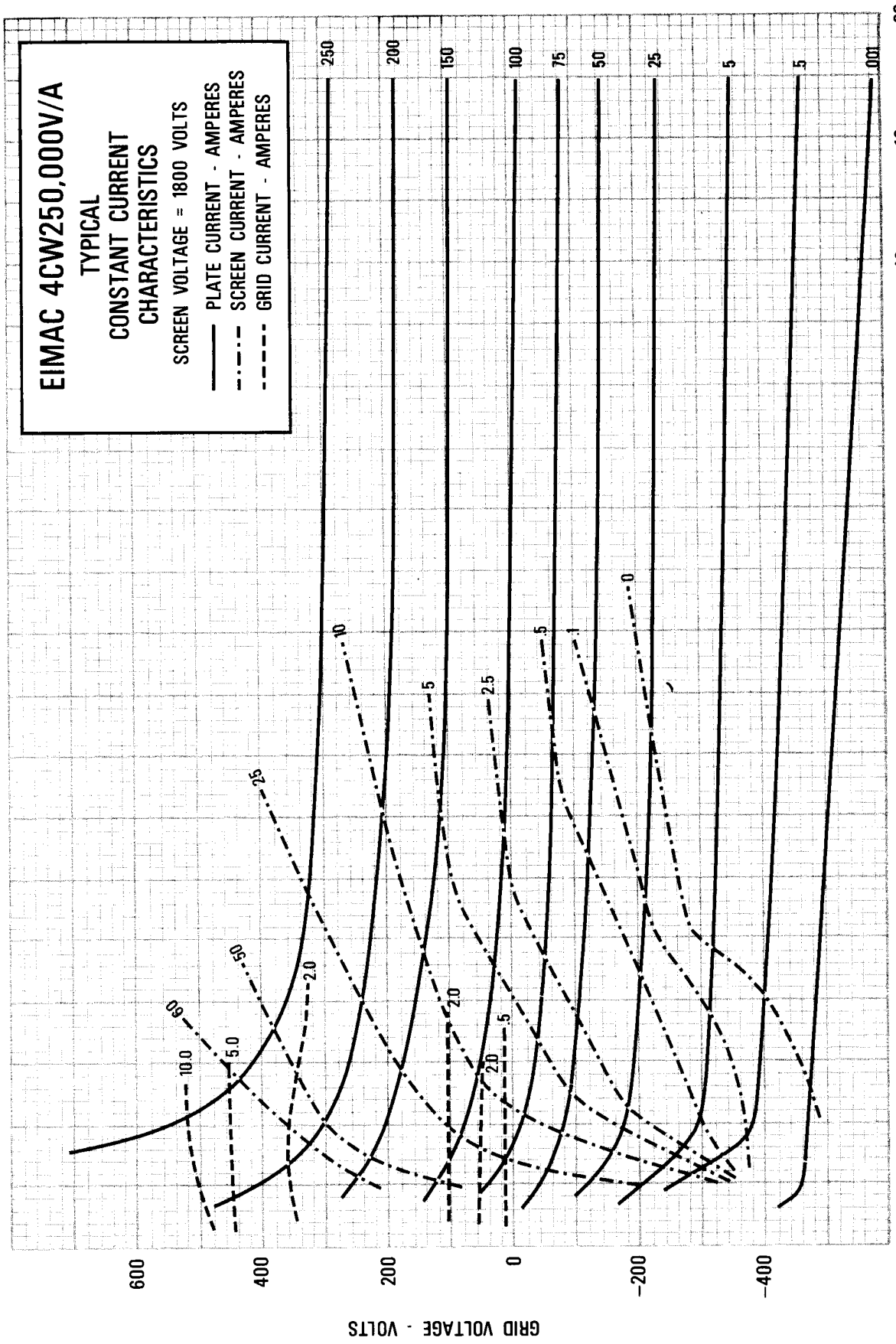
HIGH VOLTAGE - Normal operating voltages used with the 4CW250,000V/A are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

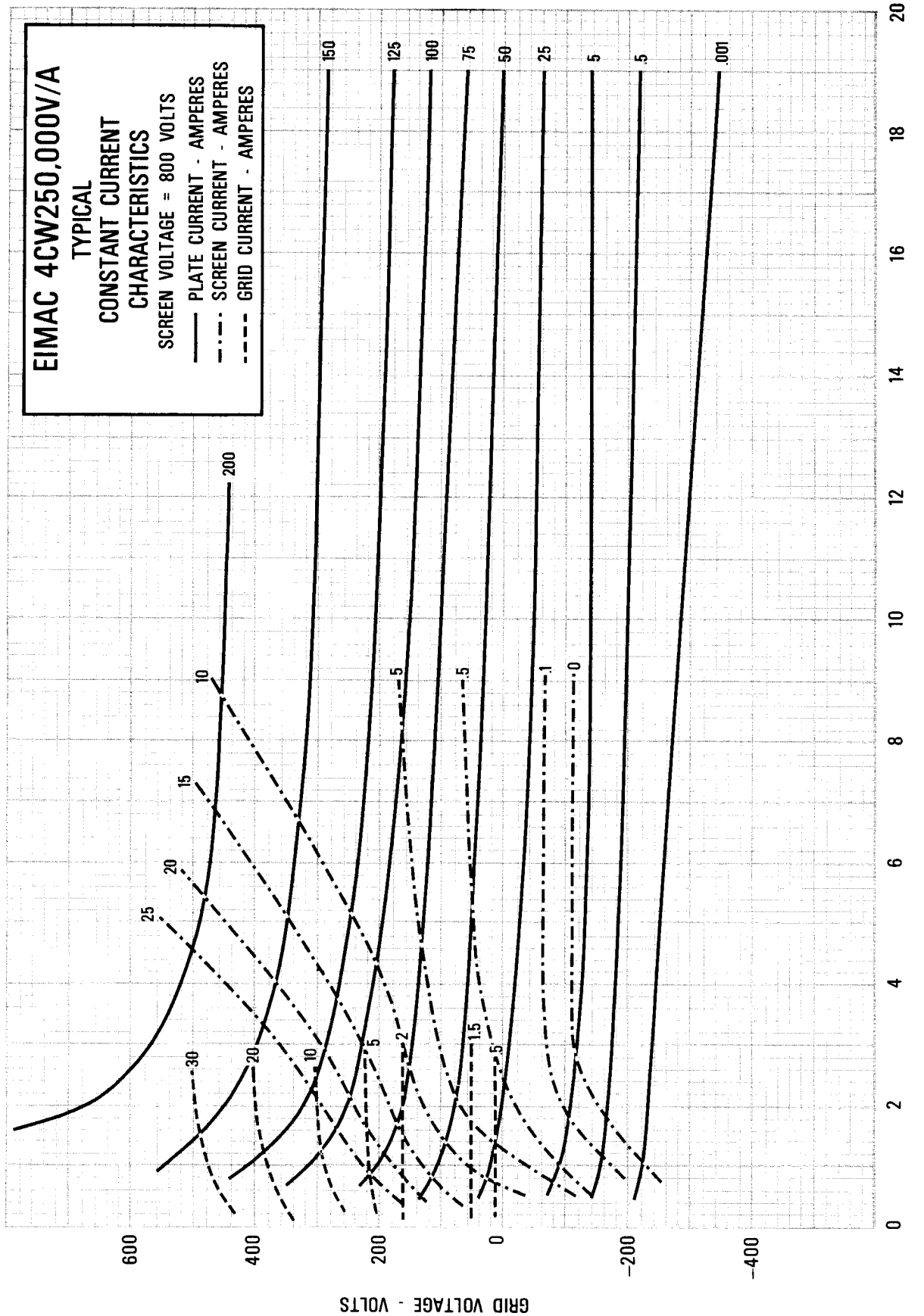
X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CW250,000V/A, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

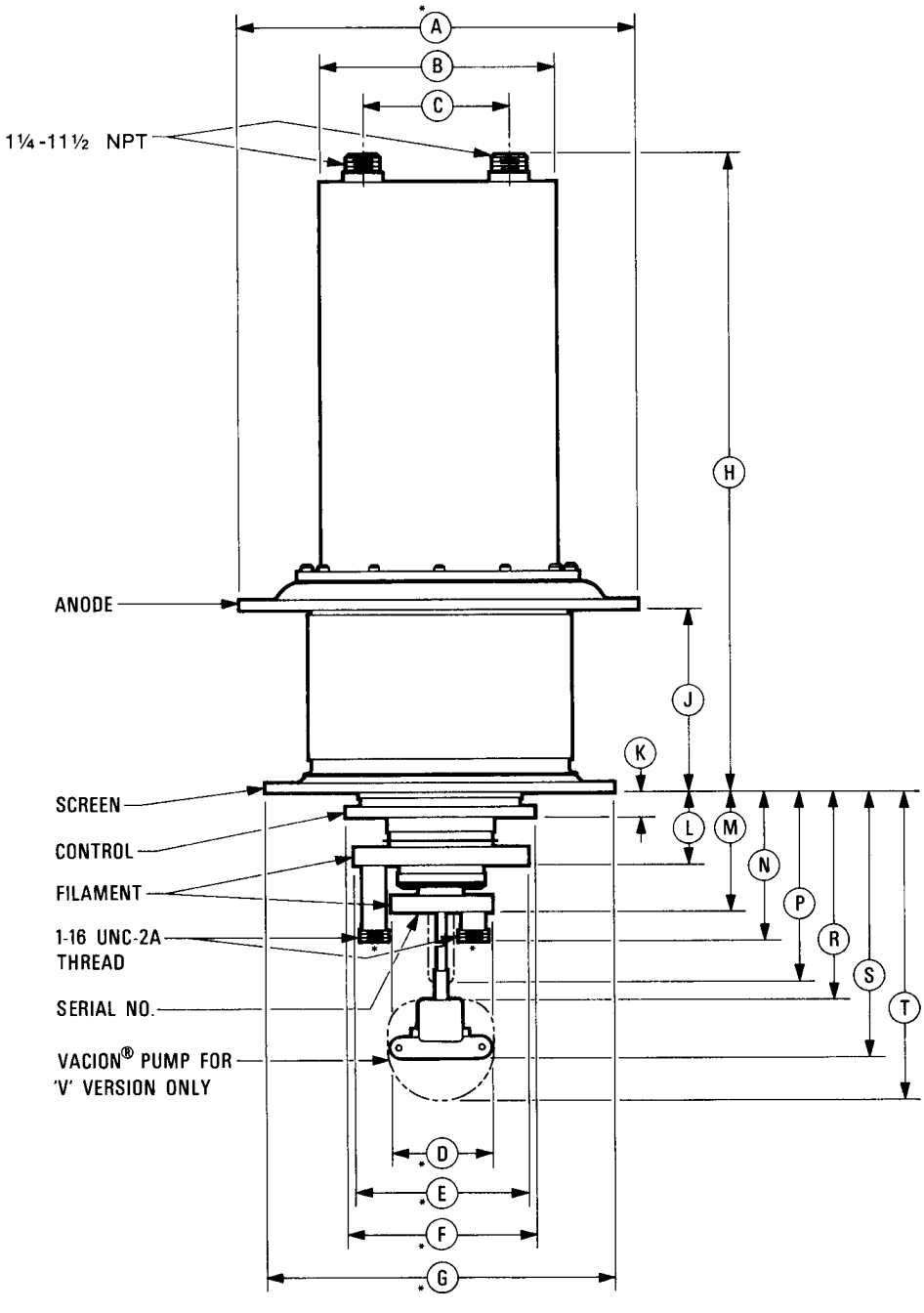
SPECIAL APPLICATION - Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, 94070, for information and recommendations.

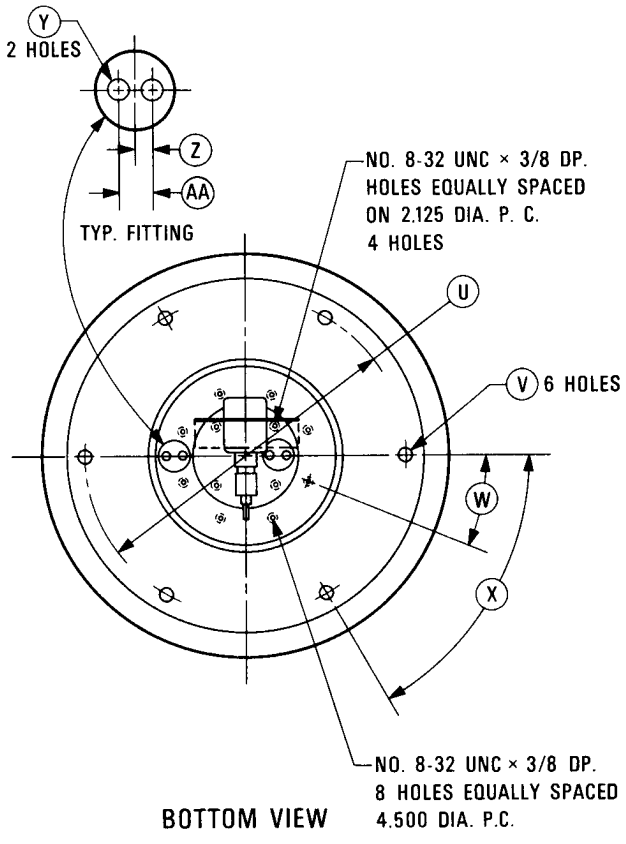

EIMAC 4CW250,000V/A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1800 VOLTS
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
GRID VOLTAGE - VOLTS
600
400
200
0
-200
-400
PLATE VOLTAGE - KILOVOLTS
0
2
4
6
8
10
12
14
16
18
20
CURVE #3464


EIMAC 4CW250,000V/A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 800 VOLTS
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
150
125
100
75
50
25
5
.5
.001
200
30
25
20
15
10
20
10
5
2
1.5
.5
5
.5
1
0
600
400
200
0
−200
−400
0
2
4
6
8
10
12
14
16
18
20
GRID VOLTAGE - VOLTS
PLATE VOLTAGE - KILOVOLTS
CURVE #3465

DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	12.937	13.062	--	328.60	331.77	--
B	7.937	8.062	--	201.60	204.77	--
C	4.437	4.562	--	112.70	115.87	--
D	3.437	3.562	--	87.30	90.47	--
E	5.937	6.062	--	150.80	153.97	--
F	6.437	6.562	--	163.50	166.67	--
G	11.937	12.062	--	303.20	306.37	--
H	23.437	23.562	--	595.30	598.47	--
J	6.250	6.375	--	158.75	161.93	--
K	0.750	0.875	--	19.05	22.23	--
L	2.437	2.562	--	61.90	65.07	--
M	4.062	4.187	--	103.17	106.35	--
N	5.000	5.125	--	127.00	130.18	--
P	--	6.900	(3)	--	175.26	(3)
R	6.750	7.375	(3)	171.45	187.33	(3)
S	8.750	9.375	(3)	222.25	238.13	(3)
T	--	11.250	(3)	--	285.75	(3)
U	--	--	11.000	--	--	279.40
V	--	--	0.375	--	--	9.53
W	--	--	22.5°	--	--	22.5°
X	--	--	60.0°	--	--	60.0°
Y	--	--	0.261	--	--	6.63
Z	--	--	0.219	--	--	5.56
AA	--	--	0.438	--	--	11.13

NOTES:
1. REF. DIMS. ARE FOR INFO.ONLY AND ARE NOT REQ'D. FOR INSP. PURPOSES.
2. (*) CONTACT SURFACES.
3. 'P' DIM. APPLIES TO 'A' VERSION ONLY. R, S & T DIMS. APPLY TO 'V' VERSION ONLY.



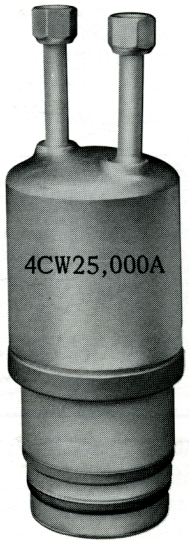


BOTTOM VIEW

4CW25,000A

TECHNICAL DATA

RADIAL BEAM
POWER TETRODE



The EIMAC 4CW25,000A is a ceramic/metal power tetrode intended for use in audio or radio frequency applications. It features a new type of internal mechanical structure which results in higher rf operating efficiency. Low rf losses in this mechanical structure permit operation of the 4CW25,000A at full ratings up to 110 MHz, and at reduced ratings, to 225 MHz.

The 4CW25,000A is recommended for radio-frequency linear power amplifier service, for television linear amplifier service, and as a switch tube for pulsed regulator service.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	6.3 ± 0.3 V
Current, at 6.3 volts	160 A
Amplification Factor, average	
Grid to Screen	4.5
Direct Interelectrode Capacitances (cathode grounded): [2]	
Cin	160.0 pF
Cout	24.5 pF
Cgp	1.5 pF
Direct Interelectrode Capacitances (grid and screen grounded): [2]	
Cin	67.0 pF
Cout	25.5 pF
Cpk	0.2 pF
Maximum Frequency Ratings	
CW	110 MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	12.69 in; 322.33 mm
Diameter	4.750 in; 120.65 mm
Net Weight	13.5 lb; 6.10 kg
Operating Position	Axis vertical, base up or down
Cooling	Water and Forced Air

(Effective 2-1-72) © by Varian Printed in U.S.A.

Operating Temperature, maximum
Ceramic/Metal Seals and Anode Core ..... 250° C
Base ..... Special, concentric
Recommended Air System Socket SK-300A

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN, Class AB_1

ABSOLUTE MAXIMUM RATINGS:

PLATE VOLTAGE	10.0 kVdc
SCREEN VOLTAGE	2.0 kVdc
PLATE CURRENT	6.0 Adc
PLATE DISSIPATION	25.0 kW
SCREEN DISSIPATION	450 W
GRID DISSIPATION	200 W

1. Adjust for specified zero-signal plate current.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 110 MHz)
Peak Envelope or Modulation Crest Conditions

Plate Voltage	7,500	10,000 Vdc
Screen Voltage	1,500	1,500 Vdc
Grid Voltage [1]	-350	-370 Vdc
Zero-Signal Plate Current	1.0	1.0 Adc
Single-Tone Plate Current	4.0	4.25 Adc
Single-Tone Screen Current [2]	170	150 mAdc
Peak rf Grid Voltage [2]	330	340 v
Plate Dissipation	12.2	14.0 kW
Single-Tone Plate Output Power	20.8	28.5 kW
Resonant Load Impedance	865	1,260 Ω

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy of FM Telephony
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

PLATE VOLTAGE	10.0 kVdc
SCREEN VOLTAGE	2.0 kVdc
PLATE CURRENT	5.0 Adc
PLATE DISSIPATION	25.0 kW
SCREEN DISSIPATION	450 W
GRID DISSIPATION	200 W

TYPICAL OPERATION (Frequencies to 110 MHz)

Plate Voltage	7,500	10,000 Vdc
Screen Voltage	750	750 Vdc
Grid Voltage	-510	-550 Vdc
Plate Current	4.65	4.55 Adc
Screen Current [1]	0.59	0.54 Adc
Grid Current [1]	0.30	0.27 Adc
Peak rf Grid Voltage [1]	730	790 v
Calculated Driving Power	220	220 W
Plate Dissipation	8.1	9.0 kW
Plate Output Power	26.7	36.5 kW

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER, GRID DRIVEN, Class C Telephony

(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

PLATE VOLTAGE	8.0 kVdc
SCREEN VOLTAGE	1.5 kVdc
PLATE CURRENT	4.0 Adc
PLATE DISSIPATION	16.4 kW
SCREEN DISSIPATION	450 W
GRID DISSIPATION	200 W

1. Approximate value.

TYPICAL OPERATION (Frequencies to 110 MHz)

Plate Voltage	6,000	8,000 Vdc
Screen Voltage	750	750 Vdc
Grid Voltage	-600	-640 Vdc
Plate Current	3.75	3.65 Adc
Screen Current [1]	0.45	0.43 Adc
Grid Current [1]	0.18	0.18 Adc
Peak af Screen Voltage [1]		
100% modulation	740	710 v
Peak rf Grid Voltage [1]	800	840 v
Calculated Driving Power	150	150 W
Plate Dissipation	5.1	5.8 kW
Plate Output Power	17.4	23.5 kW

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR, GRID DRIVEN, Class AB_1

(Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

PLATE VOLTAGE	10.0 kVdc
SCREEN VOLTAGE	2.0 kVdc
PLATE CURRENT	6.0 Adc
PLATE DISSIPATION	25.0 kW
SCREEN DISSIPATION	450 W
GRID DISSIPATION	200 W

1. Adjust for specified zero-signal plate current.

TYPICAL OPERATION (Two tubes)

Plate Voltage	7,500	10,000 Vdc
Screen Voltage	1,500	1,500 Vdc
Grid Voltage [1]	-350	-370 Vdc
Zero-Signal Plate Current	1.00	1.00 Adc
Maximum Signal Plate Current	8.80	8.50 Adc
Maximum Signal Screen Current [2]	0.34	0.30 Adc
Peak af Grid Voltage [2]	330	340 v
Maximum Signal Plate Dissipation	12.2	14.0 kW
Plate Output Power	41.6	57.0 kW
Load Resistance		
(plate to plate)	1.730	2.520 Ω

2. Approximate value.

SWITCH TUBE OR PULSED REGULATOR SERVICE

ABSOLUTE MAXIMUM RATINGS:

PLATE VOLTAGE	20.0	kVdc
SCREEN VOLTAGE	3.0	kVdc
GRID VOLTAGE	-1.5	kVdc
PEAK CATHODE CURRENT	80	a
PEAK ANODE CURRENT	60	a
GRID DISSIPATION [1]	200	W
SCREEN DISSIPATION [1]	450	W
PLATE DISSIPATION [1]	25.0	kW
PULSE LENGTH	See Note 2	
DUTY FACTOR	See Note 2	

1. Dissipation values shown are average.

2. Duty must be maintained at a low enough level that average tube dissipation ratings are not exceeded. For pulse lengths in excess of 0.1 second, some reduction of electrode dissipation ratings will be required.

TYPICAL OPERATION values are obtained by calculations from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to produce the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater Current, at 6.3 volts	152	168	A
Interelectrode Capacitances, cathode grounded [1]			
Cin	154.0	167.0	pF
Cout	22.0	27.0	pF
Cgp	----	2.0	pF
Interelectrode Capacitances, grid and screen grounded [1]			
Cin	62.0	72.0	pF
Cout	23.0	28.0	pF
Cpk	----	0.3	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CW25,000A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC Air-System Socket Type SK-300A is designed especially for the concentric base terminals of the 4CW25,000A. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube base seal areas.

COOLING - Anode cooling is accomplished by circulating water through the integral anode water jacket. The table below lists the minimum cooling water requirements at various dissipation levels.

Plate *Dissipation (kilowatts)	Water Flow GPM	Approx. Pressure Drop PSI
10	2.2	3.3
15	3.0	5.0
20	4.0	8.0
25	5.0	11.5

*Since the power dissipated by the filament represents about 1000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 600 watts, allowance has been made in preparing this tabulation for an additional 1600 watts dissipation.

The cooling table assumes a water temperature rise of 20°C. Under no circumstances should the outlet water temperature exceed 70°C. Inlet water pressure should not exceed 50 PSI.

A major factor effecting long life of water cooled tubes is the condition of the cooling water.

A simple method of determing the condition of the water is to measure the resistance across a measured amount. This can be accomplished by inserting two electrodes into the water through an insulted section of water line and measuring the resistance between the two electrodes with a sensitive meter. The resistance of the water should be maintained above 50 kohms/cm^3.

Separate cooling of the tube base is required and is accomplished by directing approximately 50 cfm of air at sea level through the socket.

ELECTRICAL

FILAMENT OPERATION - The rated filament voltage for the 4CW25,000A is 6.3 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than plus or minus five percent from the rated value.

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings for the 4CW25,000A must be respected to avoid damage to the tube. An exception is the plate dissipation which may be permitted to rise above the rated maximum during brief periods, such as may occur during tuning.

GRID OPERATION - The 4CW25,000A control grid has a maximum dissipation rating of 200 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible. The maximum grid circuit resistance should not exceed 100,000 ohms per tube.

SCREEN OPERATION - The power dissipated by the screen of the 4CW25,000A must not exceed 450 watts.

Screen dissipation, in cases where there is no AC applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 450 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CW25,000A is 25,000 watts.

When the 4CW25,000A is operated as a plate-modulated rf power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 25,000 watt maximum plate dissipation rating will be exceeded.

HIGH VOLTAGE - Normal operating voltages used with the 4CW25,000A are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CW25,000A, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

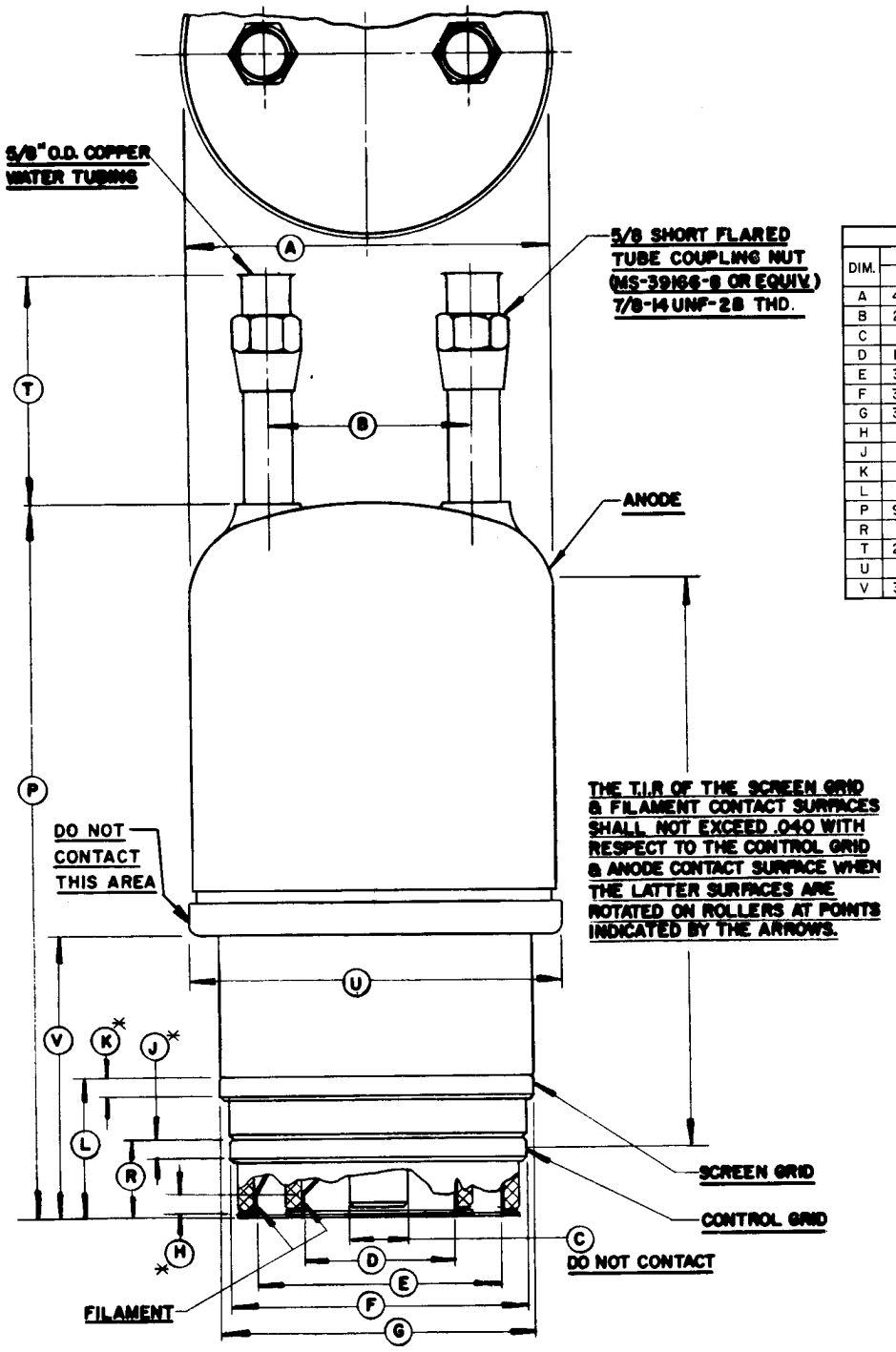
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as the 4CW-25,000A, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry---the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

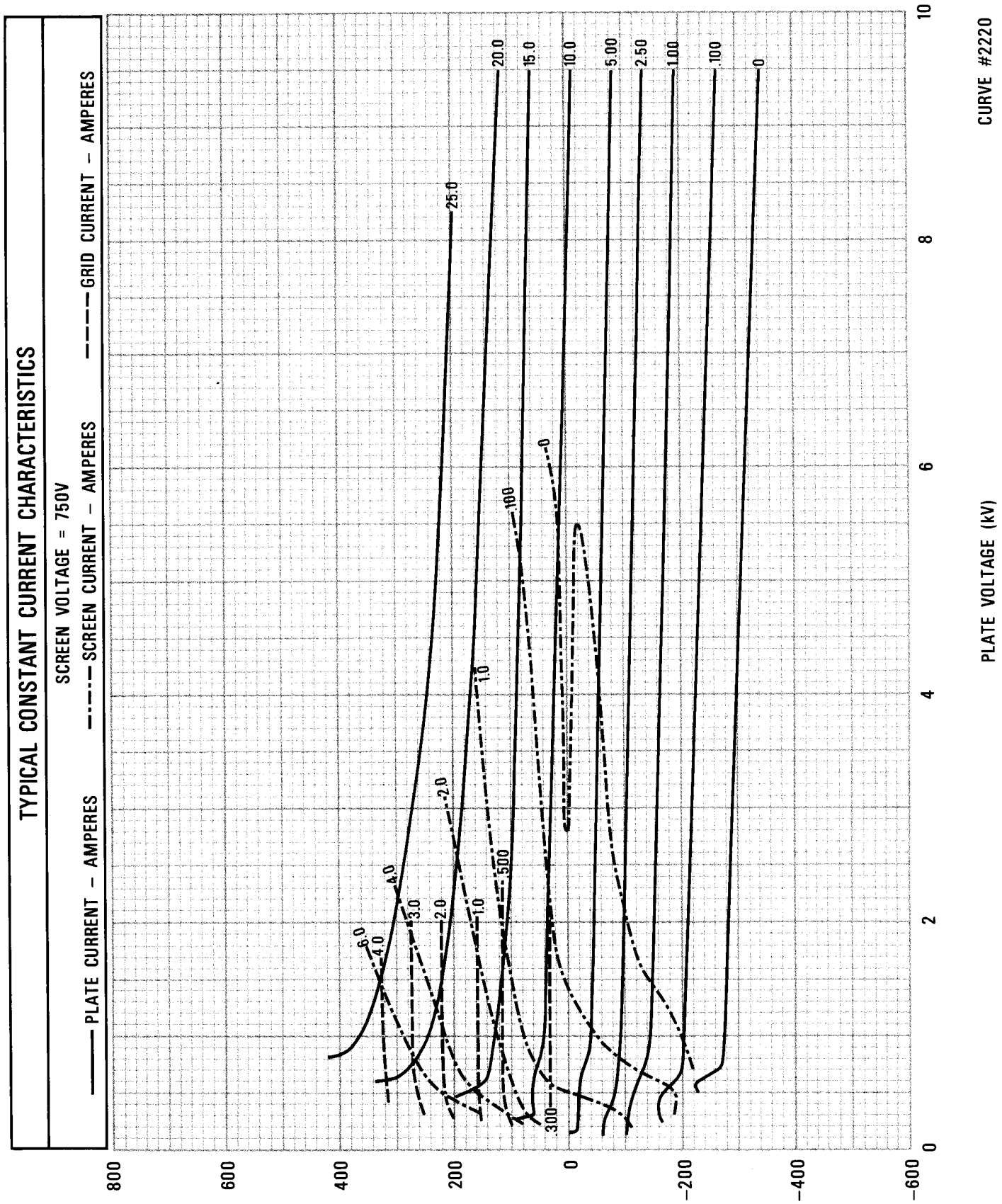
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to the Application Engineering Dept., Power Grid Tube Division, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California, 94070 for information and recommendations.



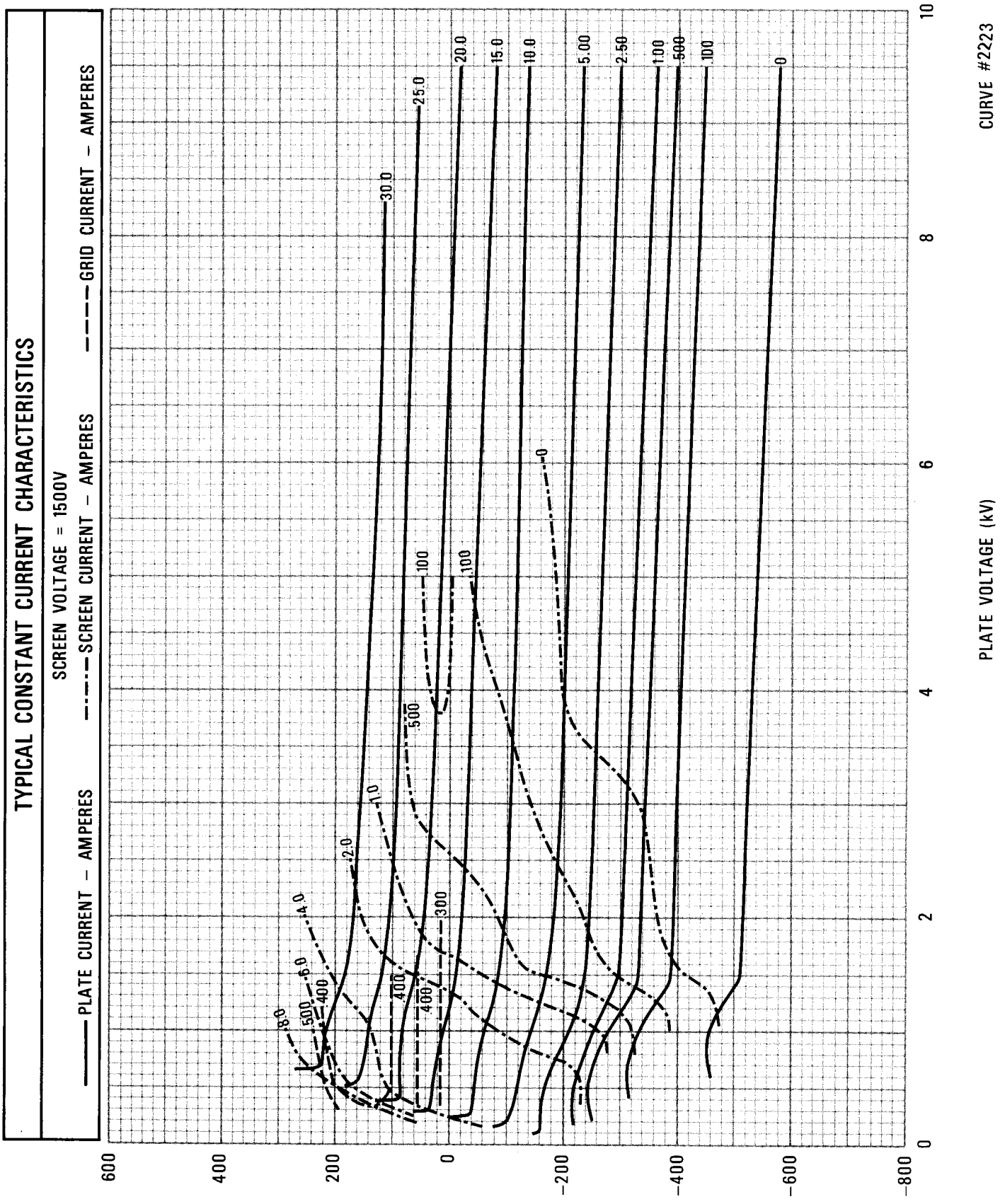
DIM.	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.570	4.630	--	116.08	117.60	--
B	2.625	2.875	--	66.67	73.02	--
C	.720	.760	--	18.29	19.30	--
D	1.896	1.936	--	48.16	49.17	--
E	3.133	3.173	--	79.58	80.59	--
F	3.792	3.832	--	96.32	97.33	--
G	3.980	4.020	--	101.09	102.11	--
H	.188	--	--	4.77	--	--
J	.188	--	--	4.77	--	--
K	.188	--	--	4.77	--	--
L	1.764	1.826	--	44.80	46.38	--
P	9.065	9.565	--	230.25	242.95	--
R	.986	1.050	--	25.04	26.67	--
T	2.875	3.125	--	73.02	79.37	--
U	--	4.750	--	--	120.65	--
V	3.625	3.675	--	92.07	93.34	--

NOTES:

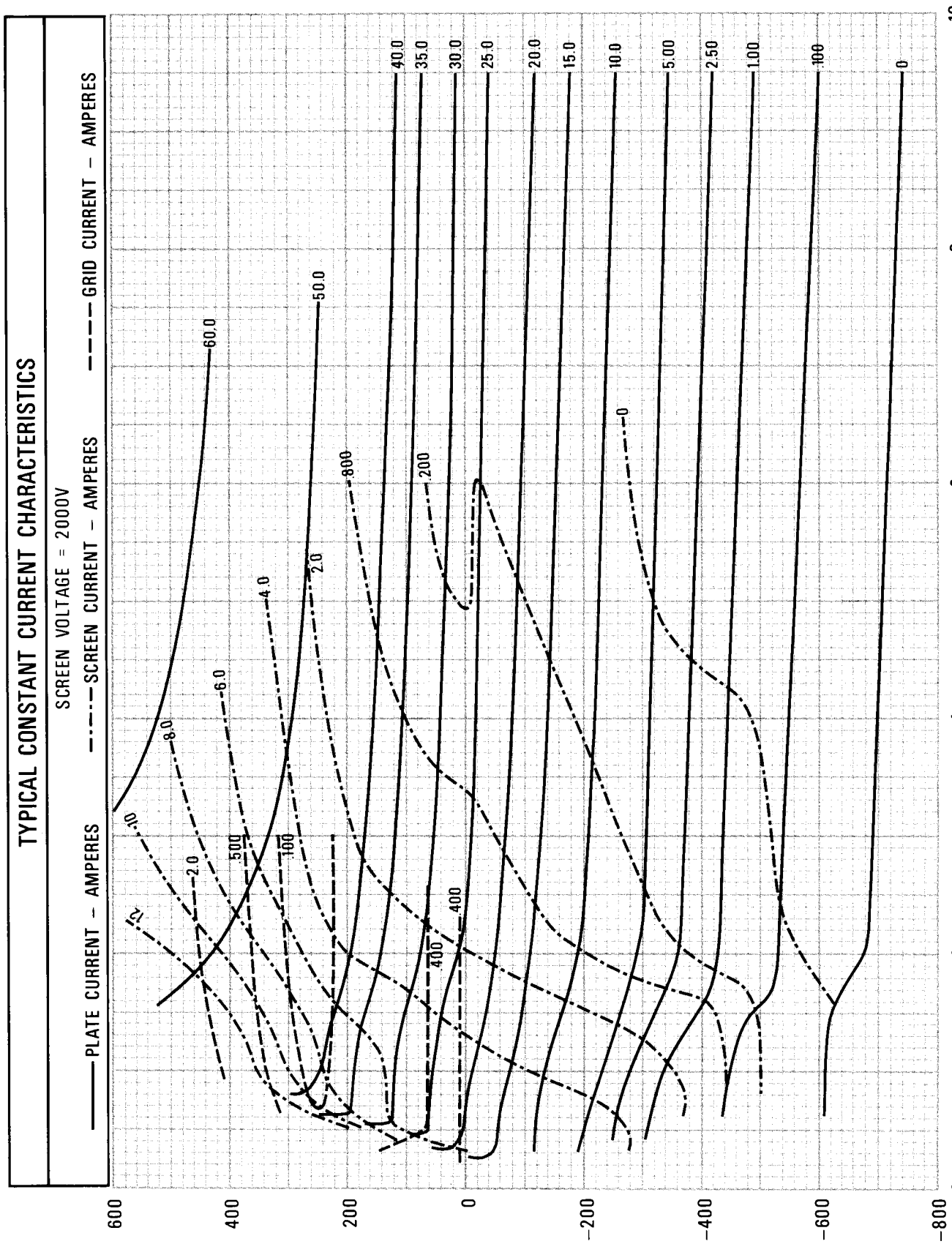
1. (*) CONTACT SURFACE
2. REF. DIMENSIONS ARE FOR INFORMATION ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.

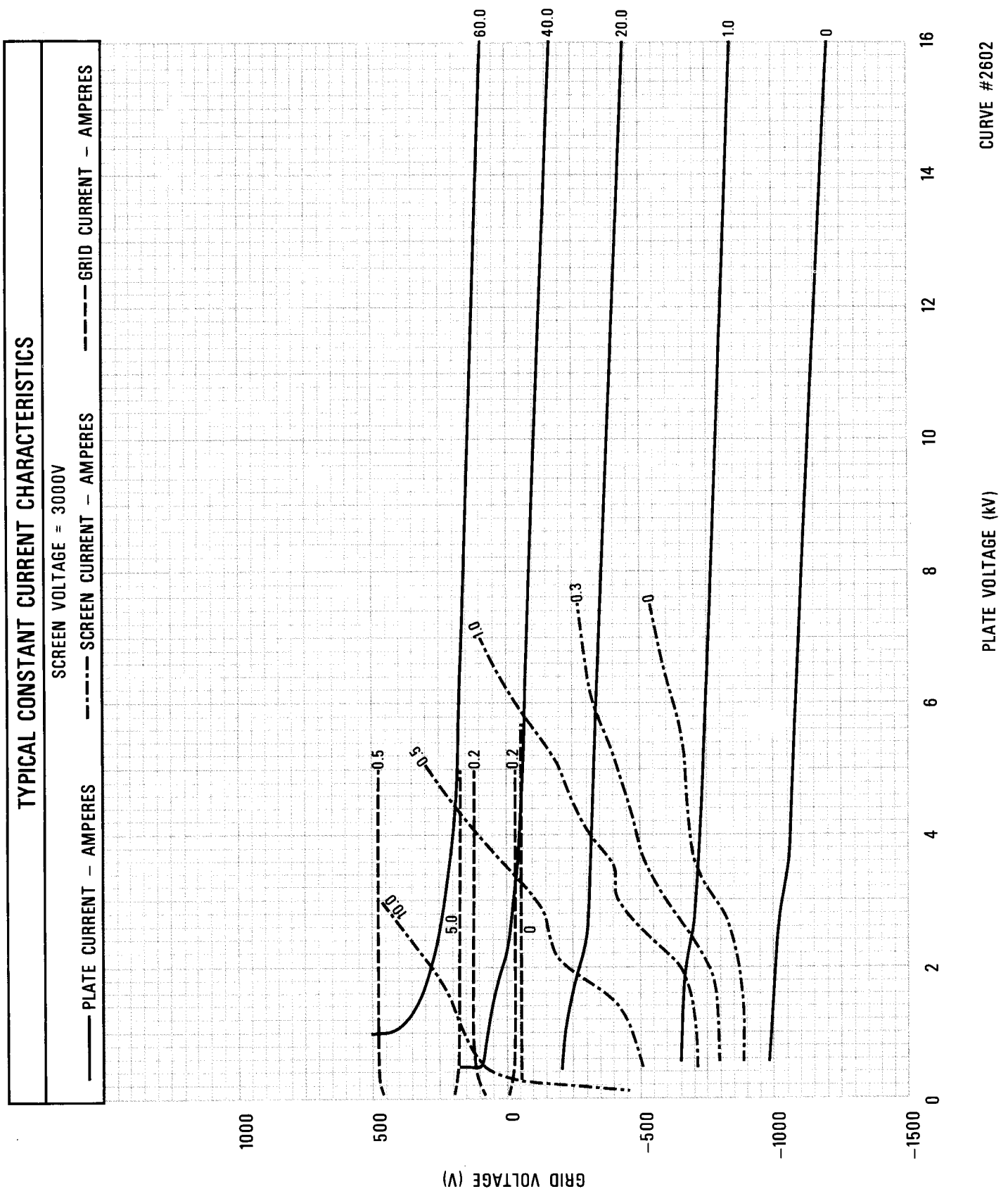

TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 750V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
800
600
400
200
0
-200
-400
-600
0
2
4
6
8
10
PLATE VOLTAGE (kV)
6.0
4.0
3.0
2.0
1.0
.500
.300
4.0
2.0
1.0
.100
0
25.0
20.0
15.0
10.0
5.00
2.50
1.00
.100
0

CURVE #2220


TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 1500V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
600
400
200
0
-200
-400
-600
-800
0
2
4
6
8
10
PLATE VOLTAGE (kV)
30.0
25.0
20.0
15.0
10.0
5.00
2.50
1.00
.500
.100
0
8.0
6.0
4.0
2.0
1.0
.500
.400
.300
.100
.400
.500

CURVE #2223


TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 2000V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #2224
600
400
200
0
-200
-400
-600
-800
0
2
4
6
8
10
60.0
50.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
8.0
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1.00
.10
.02
800
500
400
200
100
0

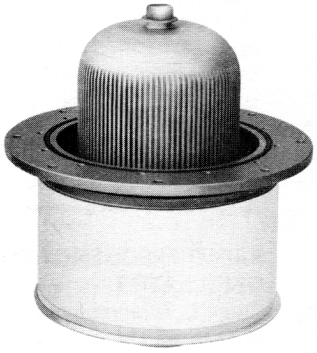

TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 3000V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
60.0
40.0
20.0
1.0
0
-0.5
-0.2
-0.2
-0.3
-0
10.0
5.0
0
1000
500
0
-500
-1000
-1500
0
2
4
6
8
10
12
14
16
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #2602

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

4CW50,000E

WATER COOLED POWER TETRODE

The EIMAC 4CW50,000E is a ceramic/metal, liquid-cooled power tetrode intended for use at the 50 to 100 kilowatt output power level. This tube is characterized by low input and feedback capacitances and low internal lead inductances. A rugged mesh thoriated tungsten filament provides adequate emission over the long operating life. It is recommended for use as a Class C rf amplifier or oscillator, a Class AB rf linear amplifier or a Class AB push-pull af amplifier or modulator. The 4CW50,000E is also useful as a plate and screen modulated Class C rf amplifier. The liquid-cooled anode is rated at 50 kilowatts plate dissipation.



Shown with SK-2050 water jacket removed.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Mesh Thoriated Tungsten		
Voltage	12.0 ± 0.6	V
Current, at 12.0 volts	220	A
Amplification Factor (Average);		
Grid to Screen	4.5	
Direct Interelectrode Capacitances (grounded cathode)		
Input	310	pF
Output	53	pF
Feedback	0.7	pF
Frequency of Maximum Rating;		
CW	110	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

MECHANICAL

Maximum Overall Dimensions:	
Length (with water jacket)	12.75 in; (324 mm)
Diameter	9.53 in; (242 mm)
Net Weight (less water jacket)	35 lb; (15.9 kg)
Operating Position	Vertical, base up or down
Maximum Operating Temperature:	
Ceramic/Metal Seals and terminals	250°C
Cooling	Liquid and Forced air
Base	Special
Recommended Socket	EIMAC SK-2000 Series
Recommended Water Jacket	EIMAC SK-2050

(Effective 7-1-70) © 1970 Varian Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions.

Plate Voltage	10.0	kVdc
Screen Voltage	1.8	kVdc
Grid Voltage [1]	-260	Vdc
Zero-Signal Plate Current	3.4	Adc
Single Tone Plate Current	9.14	Adc
Peak rf Grid Voltage 2	230	v
Resonant Load Impedance	600	Ω
Plate Dissipation	35	kW
Plate Output Power	57	kW

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	15.0	15.0	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage	-800	-800	Vdc
Plate Current	9.0	11.5	Adc
Screen Current [1]	0.9	0.83	Adc
Grid Current [1]	125	160	mAdc
Peak rf Grid Voltage [1]	880	925	v
Calculated Driving Power [1]	110	150	W
Plate Dissipation	25	36	kW
Plate Output Power	110	137	kW
Resonant Load Impedance	820	615	Ω

1. Approximate value

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	15,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION [1]	33,000	WATTS
SCREEN DISSIPATION [2]	1,500	WATTS
GRID DISSIPATION [2]	400	WATTS

1. Corresponds to 50,000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	9.0	14.0	kVdc
Screen Voltage	750	750	Vdc
Grid Voltage	-600	-600	Vdc
Plate Current	7.41	9.25	Adc
Screen Current [3]	0.69	1.15	Adc
Grid Current	.0.333	0.833	Adc
Peak af Screen Voltage [3] (100% modulation)	750	750	v
Peak rf Grid Voltage [3]	750	820	v
Calculated Driving Power	250	685	W
Plate Dissipation	12.5	21.5	kW
Plate Output Power	54.2	110	kW

3. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_1, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

TYPICAL OPERATION (Two Tubes)

Plate Voltage	15.0	kVdc
Screen Voltage	1.25	kVdc
Grid Voltage [1/3]	-280	Vdc
Zero-Signal Plate Current	5.0	Adc
Max. Signal Plate Current	18.6	Adc
Max. Signal Screen Current [1]	0.6	Adc
Peak af Grid Voltage [2]	275	v
Peak Driving Power	0	w
Max. Signal Plate Dissipation [2]	41.7	kW
Plate Output Power	195	kW
Load Resistance (plate to plate)	1870	Ω

1. Approximate value.
2. Per tube.
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Filament: Current at 12.0 volts	200	230	A
Interelectrode Capacitances (grounded cathode connection)			
Input	290	330	pF
Output	45	58	pF
Feedback	---	1.0	pF
Interelectrode Capacitances (grounded grid connection)			
Input	130	150	pF
Output	47	57	pF
Feedback	---	0.5	pF

APPLICATION

MECHANICAL

MOUNTING - The 4CW50,000E must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the circuit designer.

SOCKET - The EIMAC socket type SK-2000 is recommended for use with the 4CW50,000E.

COOLING - Anode cooling is accomplished by circulating water through the SK-2050 water jacket. The table below lists minimum cooling water requirements at various dissipation levels.

Plate Dissipation* (kilowatts)	Water Flow (GPM)	Pressure Drop (PSI)
10	3.0	2.0
20	5.0	3.0
30	6.5	4.0
40	8.5	5.2
50	10.5	6.5

*Since the power dissipated by the filament represents about 2500 watts and since grid-plus-screen dissipation can, under some conditions, represent another 1900 watts, allowance has been made in preparing this tabulation for an additional 4400 watts dissipation.

The cooling table above assumes a water temperature rise of 20°C. Under no circumstances should the outlet water temperature exceed 70°C. Inlet water pressure should not exceed 100 psi.

A major factor affecting long life of water cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 K ohms/cm^3, and preferably above 250 K ohms/cm^3. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of the insulating hose column if metal nipples or fittings are used as electrodes.

Separate cooling of the tube base is required and is accomplished by directing approximately 200 cfm of air through the socket.

ELECTRICAL

FILAMENT OPERATION - Filament voltage should be measured at the socket with a 1 percent rms responding meter. The peak emission at rated filament voltage of the EIMAC 4CW50,000E is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CW50,000E by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is

done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CW50,000E. At some point in filament voltage there will be noticeable reduction in plate current, or power output, or an increase in distortion. Operation must be at a filament voltage slightly higher than the point at which performance appears to deteriorate. This point should be periodically checked to maintain proper operation.

GRID OPERATION - The 4CW50,000E control grid is rated at 400 watts of dissipation. Grid dissipation is the approximate product of grid current and peak positive grid voltage.

SCREEN DISSIPATION - The power dissipated by the screen grid must not exceed 1500 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is dependent on rms screen voltage, and rms screen current. Plate voltage, plate load or bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

The 4CW50,000E may exhibit reversed screen current to a greater or lesser degree depending on operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, or an electron-tube regulator circuit may be employed in the screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed.

PLATE DISSIPATION - The plate dissipation of 50 kilowatts attainable through water cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CW50,000E is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 33,300 watts.

STANDBY OPERATION - Coolant must be circulated through the anode water jacket whenever filament power is applied even though no other voltages are present. Sixty to eighty percent of the filament power appears as heat in the anode. In the absence of coolant, flow temperatures will rise to levels which are detrimental to long life. If the coolant lines are obstructed the coolant jacket may rupture from the generated steam pressure.

HIGH VOLTAGE - Normal operating voltages used with the 4CW50,000E are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CW50,000E, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

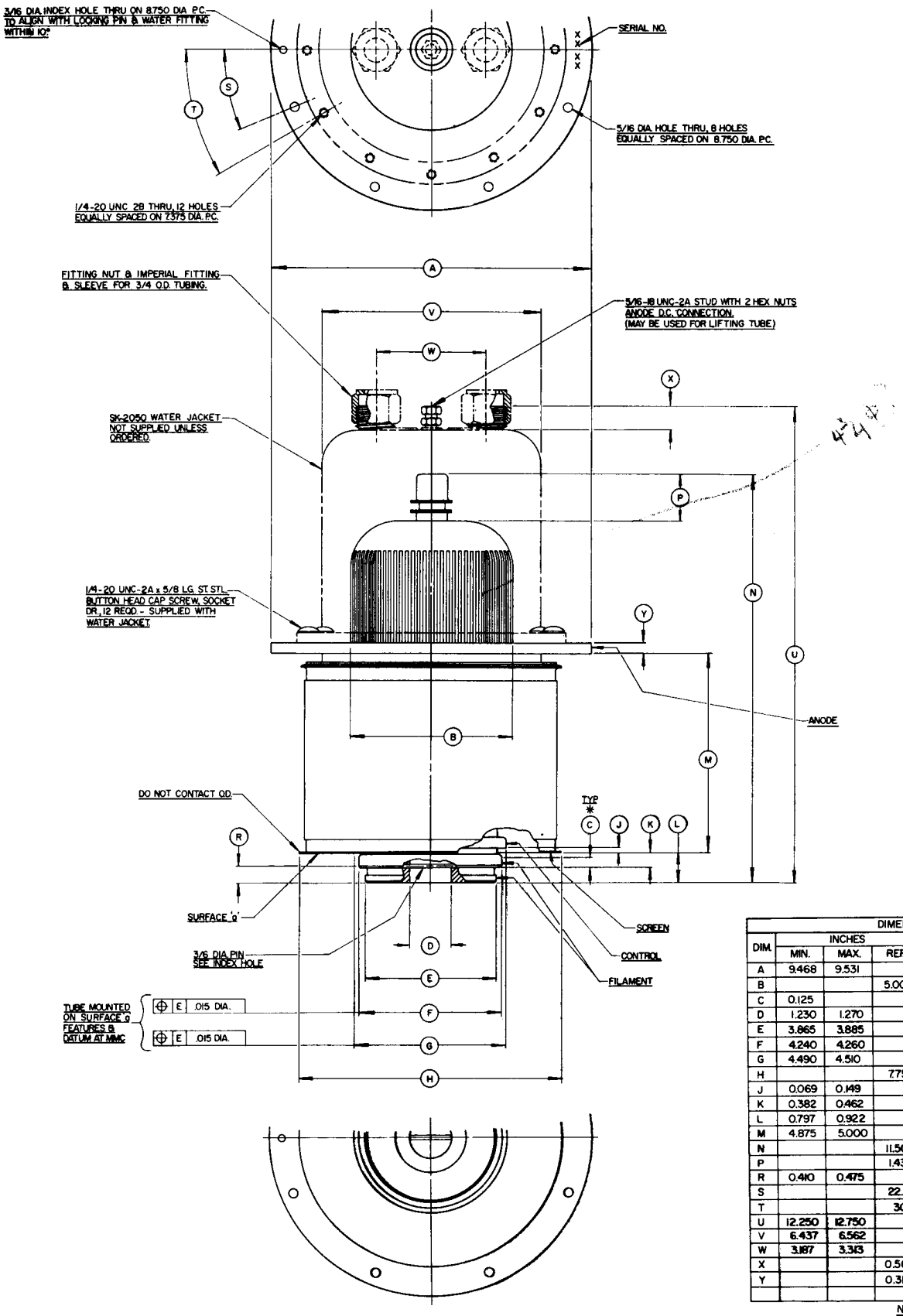
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as the 4CW-50,000E, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry---the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal plate over-current interlock, screen current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltage.

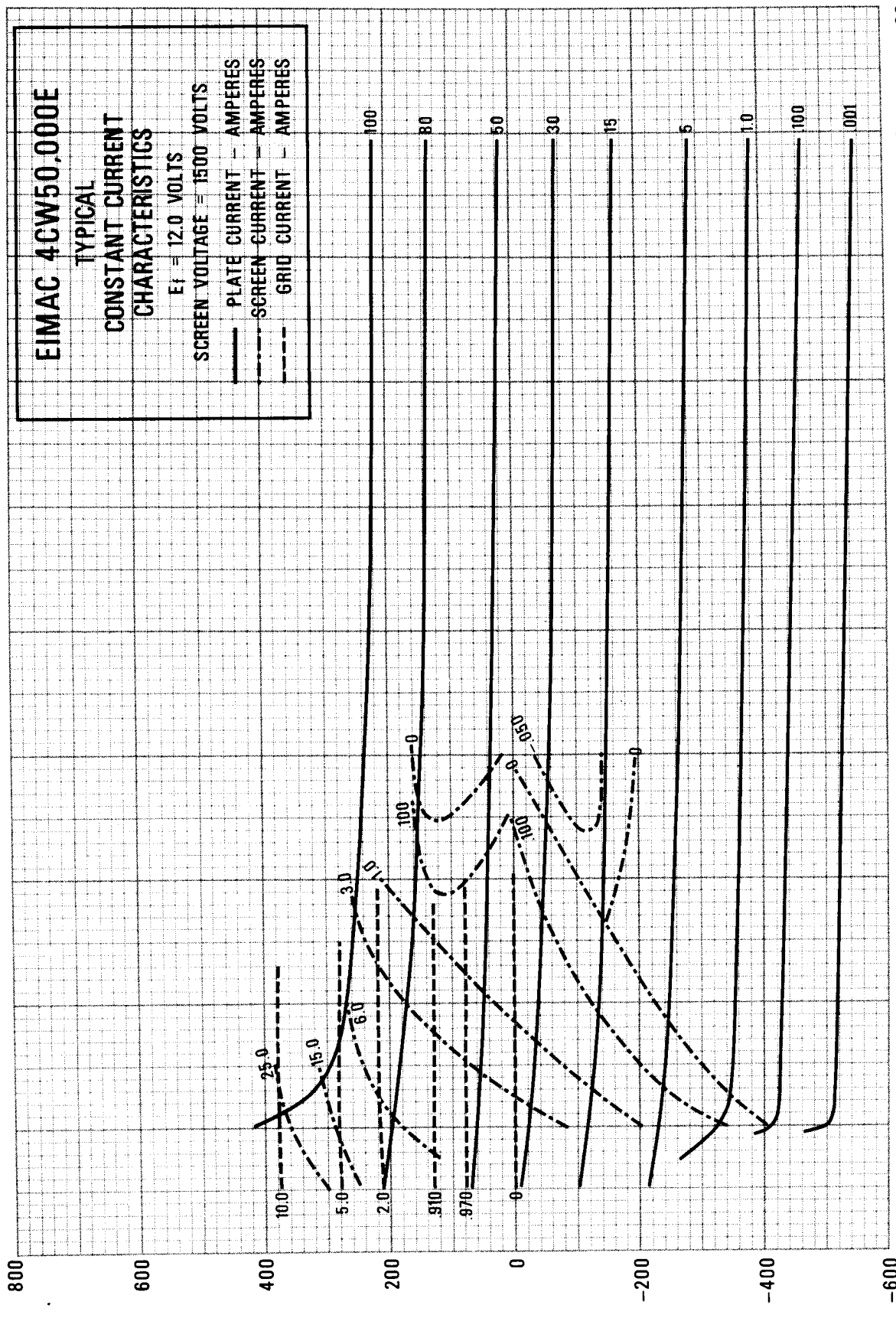
In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with each tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, we strongly recommend use of some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc.

SPECIAL APPLICATION - Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.



DIM.	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
	MIN.	MAX.	REF	MIN.	MAX.	REF
A	9.468	9.531		240.49	242.09	
B			5.000			127.00
C	0.125			3.18		
D	1.230	1.270		31.24	32.26	
E	3.865	3.885		98.17	98.68	
F	4.240	4.260		107.70	108.20	
G	4.490	4.510		114.05	114.55	
H			7.750			196.85
J	0.069	0.149		1.75	3.78	
K	0.382	0.462		9.70	11.73	
L	0.797	0.922		20.24	23.42	
M	4.875	5.000		123.83	127.00	
N			11.500			292.10
P			1.437			36.50
R	0.410	0.475		10.41	12.07	
S			22.5°			22.5°
T			30°			30°
U	12.250	12.750		311.15	323.85	
V	6.437	6.562		163.50	166.67	
W	3.187	3.313		80.95	84.15	
X			0.562			14.27
Y			0.312			7.92

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.

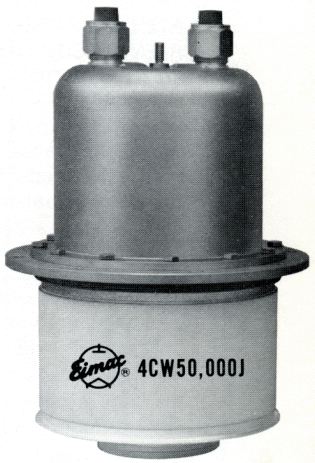

EIMAC 4CW50,000E
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
Ef = 12.0 VOLTS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
800
600
400
200
0
-200
-400
-600
0
2
4
6
8
10
12
14
16
18
20
PLATE VOLTAGE (KV)
CURVE #3993

4CW50,000J

TECHNICAL DATA

WATER COOLED
POWER TETRODE

The EIMAC 4CW50,000J is a ceramic/metal, liquid-cooled power tetrode intended for use at the 50 to 100 kilowatt output power level. This tube is characterized by low input and feedback capacitances and low internal lead inductances. A rugged mesh thoriated tungsten filament provides adequate emission over the long operating life. It is recommended for use as a Class AB_1 rf linear amplifier. The liquid-cooled anode is rated at 50 kilowatts plate dissipation.



Shown with SK-2050 Jacket (order separately)

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Mesh Thoriated Tungsten	
Voltage	12.0 ± 0.6 V
Current, at 12.0 volts	220 A
Amplification Factor (Average):	
Grid to Screen	4.5
Direct Interelectrode Capacitances (grounded cathode):	
Cin	310 pF
Cout	48 pF
Cgp	1.0 pF
Frequency of Maximum Rating:	
CW	110 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

MECHANICAL

Maximum Overall Dimensions:	
Length (with water jacket)	12.75 in; 324 mm
Diameter	9.53 in; 242 mm
Net Weight (less water jacket)	35 lb; 15.9 kg
Operating Position	Vertical, base up or down
Maximum Operating Temperature:	
Ceramic/Metal Seals and terminals	250°C
Cooling	Liquid and Forced Air
Base	Special
Recommended Socket	EIMAC SK-2000 Series
Recommended Water Jacket	EIMAC SK-2050

(Effective 7-15-71) © 1971 Varian Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	12.0	AMPERES
PLATE DISSIPATION	50,000	WATTS
SCREEN DISSIPATION	1,500	WATTS
GRID DISSIPATION	400	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.
3. The IMD products are referenced against one tone of a two-equal tone signal.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB1, Grid Driven
Peak Envelope or Modulation Crest Conditions

Plate Voltage	8.3	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage [1]	-250	Vdc
Zero-Signal Plate Current	3.6	Adc
Single-Tone Plate Current	9.8	Adc
Peak rf Grid Voltage[2]	250	v
Resonant Load Impedance	413	Ω
Plate Dissipation	35	kW
Plate Output Power	45	kW
Intermod. Distortion Products [3]		
3rd Order	-46	dB
5th Order	-60	dB

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 12.0 volts	200	230	A
Interlectrode Capacitances (grounded cathode connection)			
Cin	290	330	pF
Cout	42.0	53.0	pF
Cgp	---	1.5	pF
Interelectrode Capacitances (grounded grid connection)			
Cin	113	137	pF
Cout	45.0	55.0	pF
Cgk	---	0.5	pF

APPLICATION

MECHANICAL

MOUNTING - The 4CW50,000J must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the circuit designer.

SOCKET - The EIMAC socket type SK-2000 is recommended for use with the 4CW50,000J.

COOLING - Anode cooling is accomplished by circulating water through the SK-2050 water jacket. The table below lists minimum cooling water requirements at various dissipation levels.

Plate Dissipation* (kilowatts)	Water Flow (GPM)	Pressure Drop (PSI)
10	3.0	2.0
20	5.0	3.0
30	6.5	4.0
40	8.5	5.2
50	10.5	6.5

*Since the power dissipated by the filament represents about 2500 watts and since grid-plus-screen dissipation can, under some conditions, represent another 1900 watts, allowance has been made in preparing this tabulation for an additional 4400 watts dissipation.

The cooling table above assumes a water temperature rise of 20°C. Under no circumstances should the outlet water temperature exceed 70°C. Inlet water pressure should not exceed 100 psi.

A major factor affecting long life of water cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 K ohms/cm^3, and preferably above 250 K ohms/cm^3. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of the insulating hose column if metal nipples or fittings are used as electrodes.

Separate cooling of the tube base is required and is accomplished by directing approximately 200 cfm of air through the socket.

ELECTRICAL

FILAMENT OPERATION - Filament voltage should be measured at the socket with a 1 percent rms responding meter. The peak emission at rated filament voltage of the EIMAC 4CW50,000J is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CW50,000J by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CW50,000J. At some point in filament voltage there will be noticeable reduction in plate current, or power output, or an increase in distortion. Operation must be at a filament voltage slightly higher than the point at which performance appears to deteriorate. This point should be periodically checked to maintain proper operation.

GRID OPERATION - The 4CW50,000J control grid is rated at 400 watts of dissipation. Grid dissipation is the approximate product of grid current and peak positive grid voltage.

SCREEN DISSIPATION - The power dissipated by the screen grid must not exceed 1500 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is dependent on rms screen voltage, and rms screen current. Plate voltage, plate load or bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

The 4CW50,000J may exhibit reversed screen current to a greater or lesser degree depending on operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, or an electron-tube regulator circuit may be employed in the screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed.

PLATE DISSIPATION - The plate dissipation of 50 kilowatts attainable through water cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CW50,000J is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 33,300 watts.

STANDBY OPERATION - Coolant must be circulated through the anode water jacket whenever filament power is applied even though no other voltages are present. Sixty to eighty percent of the filament power appears as heat in the anode. In the absence of coolant flow, temperatures will rise to levels which are detrimental to long life. If the coolant lines are obstructed the coolant jacket may rupture from the generated steam pressure.

HIGH VOLTAGE - Normal operating voltages used with the 4CW50,000J are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher that 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CW50,000J, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

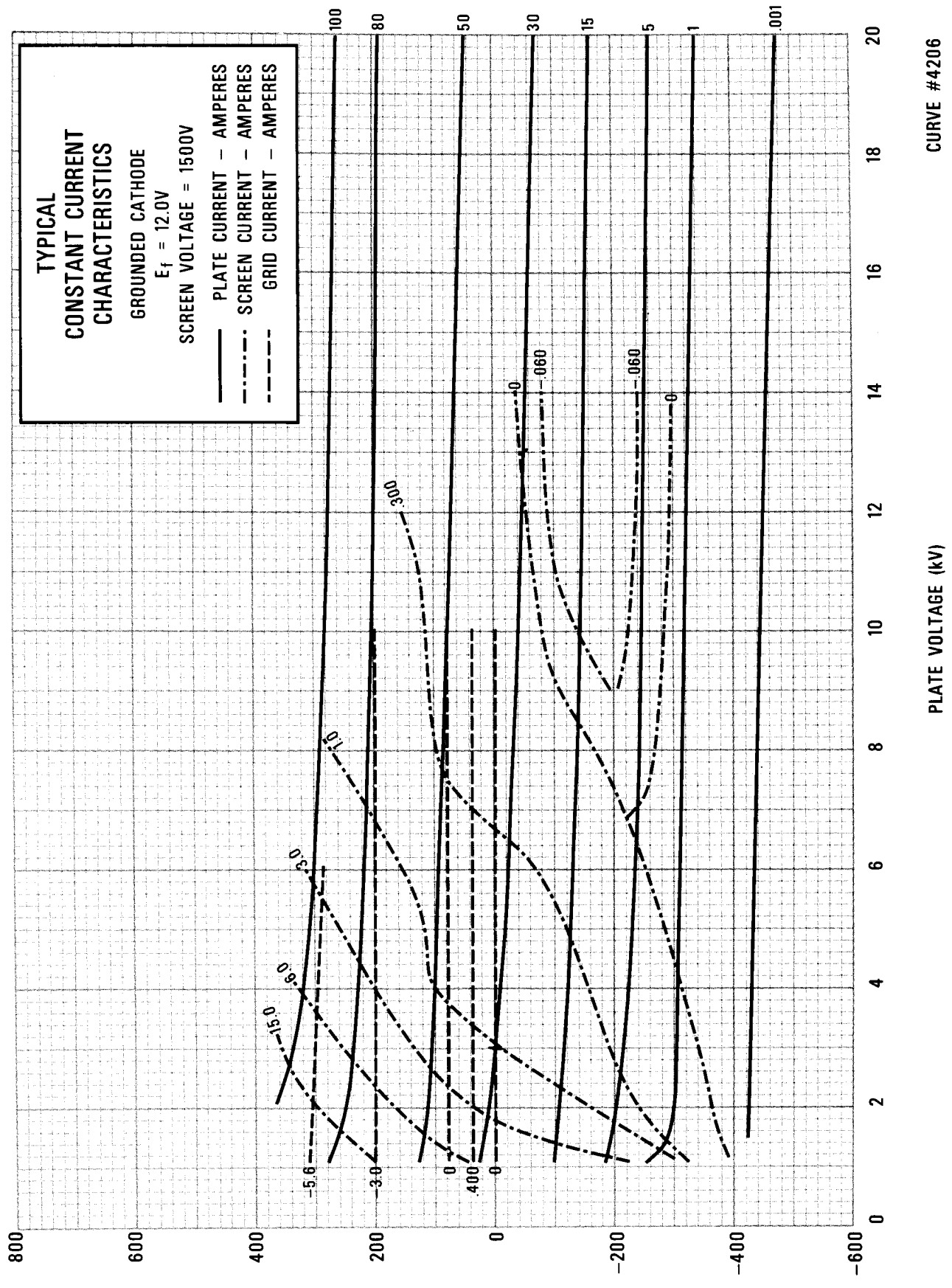
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

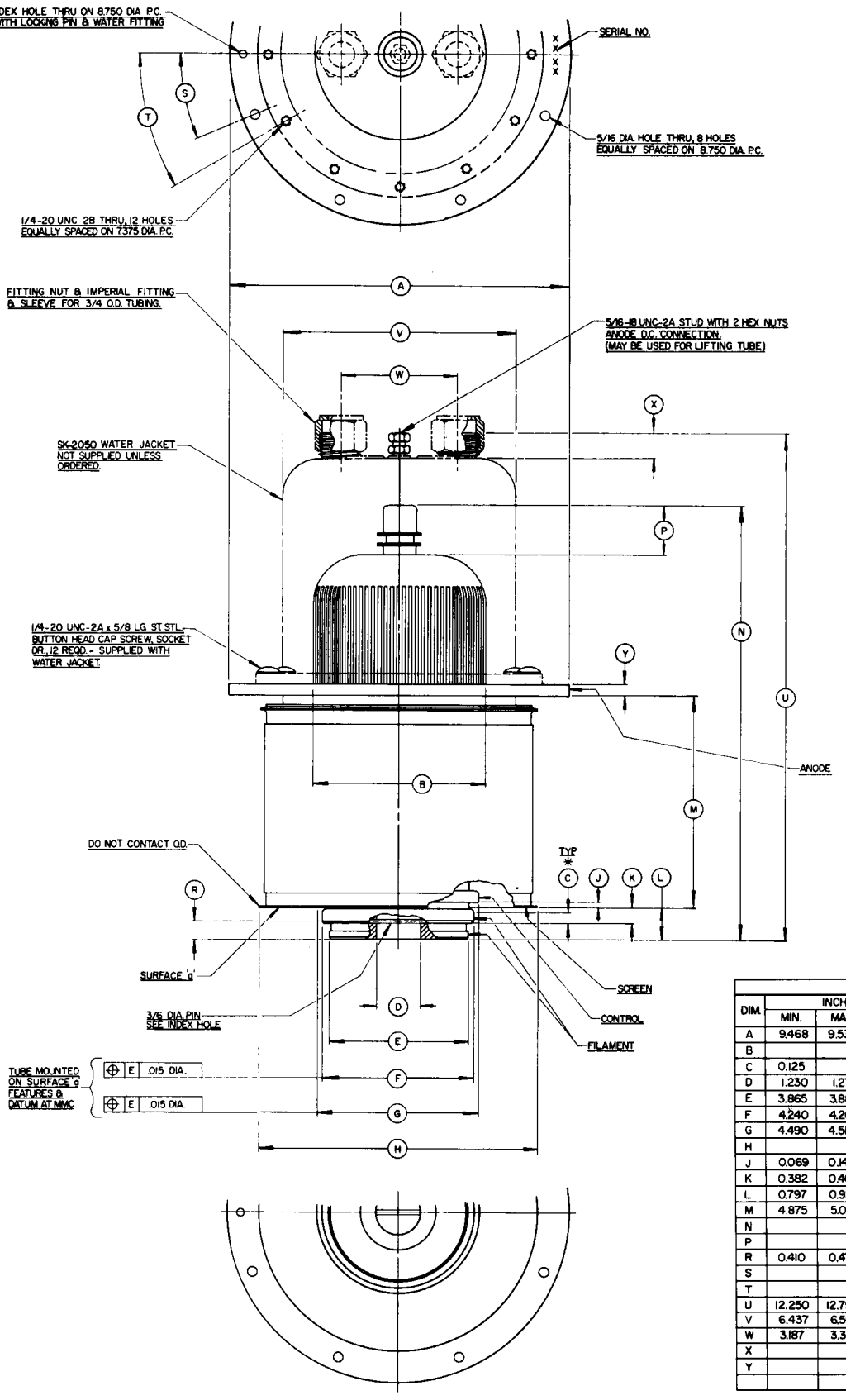
Many EIMAC power tubes, such as the 4CW-50,000J, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry---the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION - In addition to normal plate over-current interlock, screen current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltage.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with each tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, we strongly recommend use of some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc.

SPECIAL APPLICATION - Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 12.0V
SCREEN VOLTAGE = 1500V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #4206



DIM.	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
	MIN.	MAX.	REF	MIN.	MAX.	REF
A	9.468	9.531		240.49	242.09	
B			5.000			127.00
C	0.125			3.18		
D	1.230	1.270		31.24	32.26	
E	3.865	3.885		98.17	98.68	
F	4.240	4.260		107.70	108.20	
G	4.490	4.510		114.05	114.55	
H			7.750			196.85
J	0.069	0.149		1.75	3.78	
K	0.382	0.462		9.70	11.73	
L	0.797	0.922		20.24	23.42	
M	4.875	5.000		123.83	127.00	
N			11.500			292.10
P			1.437			36.50
R	0.410	0.475		10.41	12.07	
S			22.5°			22.5°
T			30°			30°
U	12.250	12.750		311.15	323.85	
V	6.437	6.562		163.50	166.67	
W	3.187	3.313		80.95	84.15	
X			0.562			14.27
Y			0.312			7.92

NOTES:
1. REF DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.

TECHNICAL DATA

4CW800B
4CW800F

RADIAL BEAM
POWER TETRODE

The EIMAC 4CW800B and 4CW800F are ceramic/metal, liquid cooled radial-beam tetrodes designed for use in distributed amplifiers and VHF/UHF power amplifiers.

The mechanical and electrical features of these tubes are compatible with distributed amplifier circuit requirements, i.e., low lead inductance, low input and output capacitance and small size.

Ruggedized construction consisting of a unitized electrode structure and direct mounting to the chassis, combine to make the 4CW800B and 4CW800F suitable for environments of severe shock and vibration.

The maximum rated plate dissipation is 800 watts for both types.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential

Heater: 4CW800B

Voltage	6.0 V
Current	4.4 A

Heater: 4CW800F

Voltage	26.5 V
Current	1.1 A
Transconductance: (I_b = 600 mAdc)	40,000 μmhos
Input Conductance: (I_b = 600 mAdc) (F = 30 MHz)	0.1×10^{-3} mhos
Frequency for Maximum Ratings	800 MHz
Direct Interelectrode Capacitance: (Grounded Cathode)[2]	
Cin	45 pF
Cout	5.8 pF
Cgp	0.15 pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture.

MECHANICAL

Base	Special
Operating Position	Any
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250°C
Base Plate	150°C
Cooling	Liquid

(Revised 11-1-73) © 1968, 1973 by Varian Printed in U.S.A.

Maximum Over-all Dimensions:

Length	3.00 In; 76.20 mm
Diameter	2.03 In; 51.56 mm
Net Weight	7 oz; 198 gm

RANGE VALUES FOR EQUIPMENT DESIGN

Heater: 4CW800B - Current at 6.0 volts	4.0	4.7	A
4CW800F - Current at 26.5 volts	0.85	1.25	A
Cathode Warmup Time - both types	180	---	sec.
Interelectrode Capacitances (grounded cathode circuit)[1]			
Cin	42.0	48.0	pF
Cout	5.3	6.3	pF
Cgp	---	0.20	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

BROADBAND RF LINEAR AMPLIFIER

Class AB, Grid Driven

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000 VOLTS
DC SCREEN VOLTAGE	500 VOLTS
DC PLATE CURRENT	0.6 AMPERE
PLATE DISSIPATION	800 WATTS
SCREEN DISSIPATION	15 WATTS
GRID DISSIPATION	3 WATTS

1. Adjust for specified zero-signal plate current.
2. Approximate value.

TYPICAL OPERATION

Plate Voltage	1000	1500	2500	Vdc
Screen Voltage	275	275	275	Vdc
Grid Voltage[1]	-40	-40	-40	Vdc
Zero Signal Plate Current	100	100	100	mAdc
Plate Current	570	580	585	mAdc
Screen Current[2]	32	29	17	mAdc
Peak rf Grid Voltage[2]	44	43	42	v
Plate Output Power[2]	320	590	1000	W
Plate Dissipation[2]	250	280	460	W
rf Load Impedance	765	1225	2325	Ω

RADIO FREQUENCY POWER AMPLIFIER

Class B, Grid Driven

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000 VOLTS
DC SCREEN VOLTAGE	500 VOLTS
DC PLATE CURRENT	0.6 AMPERE
PLATE DISSIPATION	800 WATTS
SCREEN DISSIPATION	15 WATTS
GRID DISSIPATION	3 WATTS

1. Adjust for specified zero-signal plate current.
2. Approximate value.
3. Delivered to the load.

TYPICAL OPERATION	140-250 MHz Strip-line amp			432 MHz Cavity	865 MHz Cavity	
Plate Voltage	1650	1950	2500	2000	2000	Vdc
Screen Voltage	400	300	300	300	300	Vdc
Grid Voltage[1]	-75	-60	-60	-54	-60	Vdc
Zero Signal Plate Current	15	15	15	20	15	mAdc
Maximum Signal Plate Current	600	530	600	600	600	mAdc
Screen Current[2]	14	11	11	7	8	mAdc
Grid Current[2]	-6	-2	+8	+14	0	mAdc
Useful Power Output[3]	540	555	820	770	550	W
Bandwith (3dB) of Amplifier	6	6	4.5	---	9	MHz
Power Gain[2]	---	---	---	15.3	10.4	dB

APPLICATION

MECHANICAL

MOUNTING - These tubes may be mounted in any position. No socket is required. The tube may be mounted directly on the SK-680 Screen Bypass Capacitor which in turn is mounted to the chassis with four 6-32 screws. The chassis thickness should be 0.062 inch to insure adequate space for connections to the base of the tube and care should be exercised to insure a flat mounting surface to minimize cathode lead inductance.

COOLING - Sufficient cooling must be provided for the anode and ceramic-to-metal seals to maintain operating temperatures below the rated maximum values:

Ceramic-to-metal seals	250°C
Base and flanges	150°C

Anode cooling is accomplished by circulating liquid through the integral water jacket.

At ambient temperatures of 25°C or less, no base cooling is required.

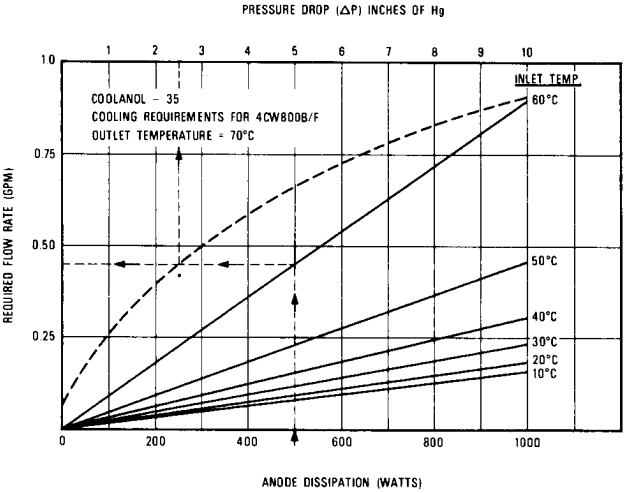
At higher temperatures, base cooling may be required to maintain base temperatures below 150°C. This can be accomplished by mounting the tube to a cold plate cooled by the inlet liquid.

WATER COOLING - The tabulation below lists the minimum water flow requirements for 25°C inlet water temperature with a temperature rise of 15°C from inlet to outlet.

Plate Dissipation (Watts)	Water Flow (GPM)	Pressure Drop (psi)
200	.050	.025
400	.100	.050
600	.156	.075
800	.202	.100

Water pressure should never exceed 200 psi and outlet temperature must be limited to 70°C.

OIL COOLING - The cooling jacket was specifically designed for oil coolant such as Coolanol 35. The minimum flow requirement and pressure drop can be derived from the following graph:



* Sample Calculation: For an inlet temperature of 60°C at 500 watts anode dissipation, the required flow rate is .45 GPM. The pressure drop will be .25 inches of Hg.

In cases where there is any doubt regarding the adequacy of the supplied cooling, it should be borne in mind that operating temperature is the sole criterion of cooling effectiveness.

ELECTRICAL

HEATER - The rated heater voltage is 6.0 volts for the 4CW800B and 26.5 volts for the 4CW800F. The voltage, as measured at the socket, should be maintained at this value to minimize variations in operation and to obtain maximum tube life. In no case should the voltage be allowed to exceed 5% above or below the rated value.

The cathode and one side of the heater are internally connected.

It is recommended that the heater voltage be applied for a period of not less than three minutes before current is drawn from the cathode. Tube operation will stabilize after a period of approximately five minutes from a cold start.

CONTROL-GRID OPERATION - The control-grid has a maximum dissipation of 3.0 watts and precautions should be observed to avoid exceeding this rating. Derating of the control grid dissipation will be necessary if the base flange temperature exceeds 150°C.

There are four threaded grid pins on the base of the tube. These pins can be used separately or in parallel to control the amount of grid lead in-

ductance to suit the requirements of the circuit. The grid lead inductance for one pin is 2.4 nanohenries.

SCREEN GRID OPERATION - The maximum rated screen dissipation for the 4CW800B or 4CW800F is 15 watts.

Under certain operating conditions the screen current of a tetrode may reverse as indicated on the screen current meter. This condition is the result of secondary emission from the screen and is normal for a power tetrode. If the impedance of the screen power supply is high, negative screen current will cause the screen voltage to approach the anode voltage, and the results will be a runaway condition which could lead to a catastrophic failure. This condition can be avoided if sufficient bleeder current is drawn from the screen supply by an appropriate bleeder or regulator tube. The recommended bleeder current for these tubes is 20 mA for each tube connected to a common screen power supply.

A low inductance screen bypass capacitor, EIMAC SK-680, is available for either tube. This capacitor is easily installed with six 0-80 screws. With the SK-680 capacitor installed, the screen self-resonant frequency of either tube is in excess of 900 MHz.

PLATE OPERATION - The maximum rated plate dissipation power for either tube is 800 watts. Except for brief periods during circuit adjustments, this maximum value should not be exceeded. Connection to the anode is accomplished by a clamp around the anode.

DISTRIBUTED AMPLIFIER SERVICE - The mechanical and electrical features of the 4CW800B and 4CW800F are compatible with distributed amplifier circuit requirements, combining the qualities of low lead inductance, low input and output capacitances, high transconductance, and small size. Connection is made to the control grid by means of four threaded studs. By using the correct number of connections, the designer has available a choice of several values of grid lead inductance. This feature is quite useful in design of VHF/UHF distributed amplifiers. In addition, rugged internal tube construction, consisting of a unitized electrode structure and a solid direct-chassis flange mount, are features which make these tubes suitable for environments exhibiting severe shock and vibration, such as encountered in mobile or airborne service.

A distributed amplifier is a wideband, cascade device, employing vacuum tubes placed along an artificial transmission line, the tube capacitances appearing as the shunt elements of the line. In a properly designed distributed amplifier, the driving impedance is virtually independent of the number of tubes. The amplifier may make use of the characteristics of the low pass, the band pass, or the high pass filter configuration.

The 4CW800B and 4CW800F are ideal tubes for distributed amplifier service, as anode heat may be readily disposed of by a compact, external cooling system. An amplifier using one of these types is an advantage in instantaneous bandwidth rf systems as it eliminates the need of complex and slow tuning and tracking equipment necessary for a tuned amplifier.

EIMAC APPLICATION BULLETIN NUMBER FOURTEEN - This 23-page booklet is available from EIMAC and contains additional information on the use of these tubes (or similar types of the same tube family), including some constructional details, in strip-line amplifier circuitry in the 140-250 MHz range, distributed amplifier service, and cavity amplifier operation at 432 MHz and 865 MHz.

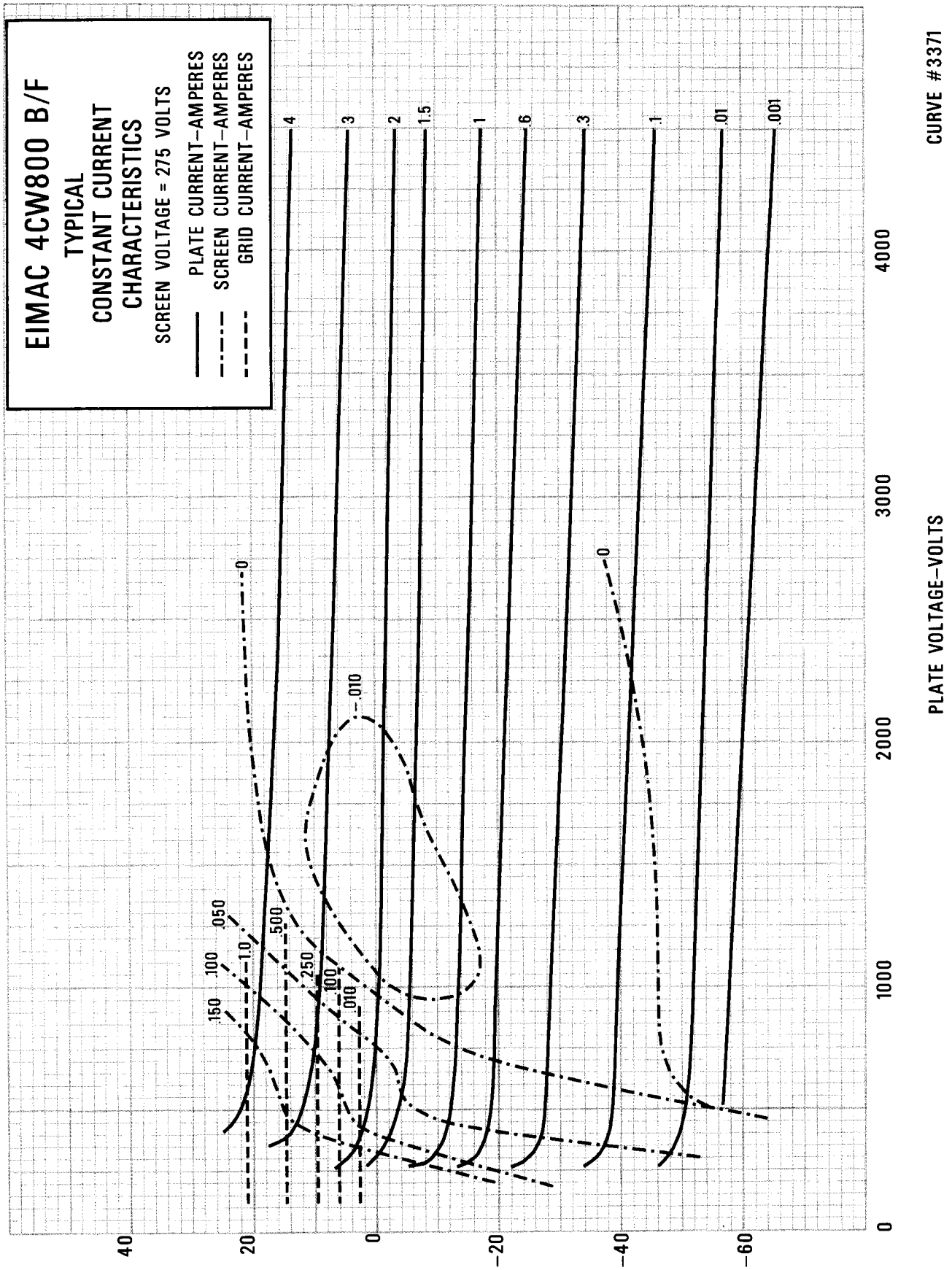
HIGH VOLTAGE - The 4CW800B and 4CW800F operate at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

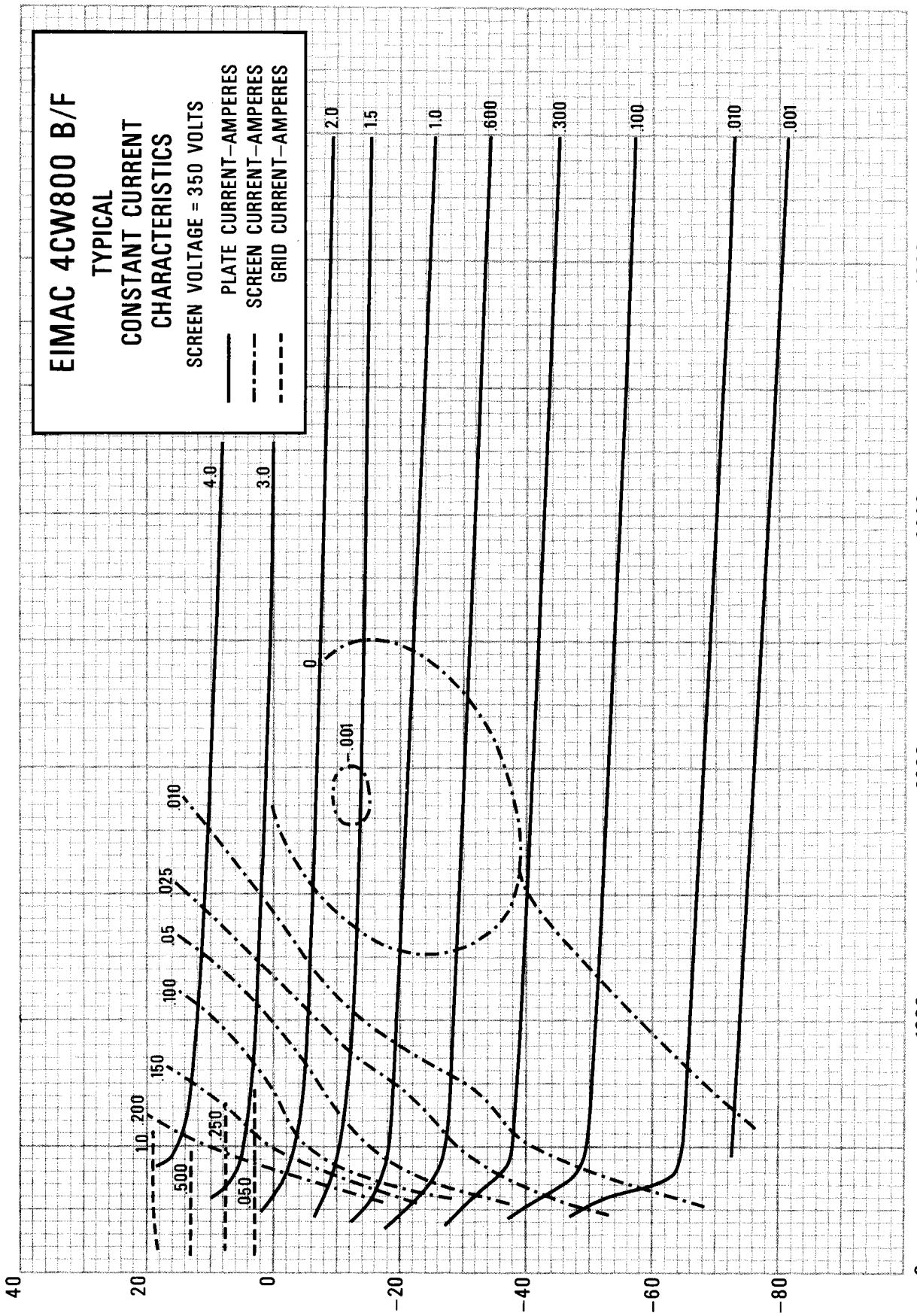
INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

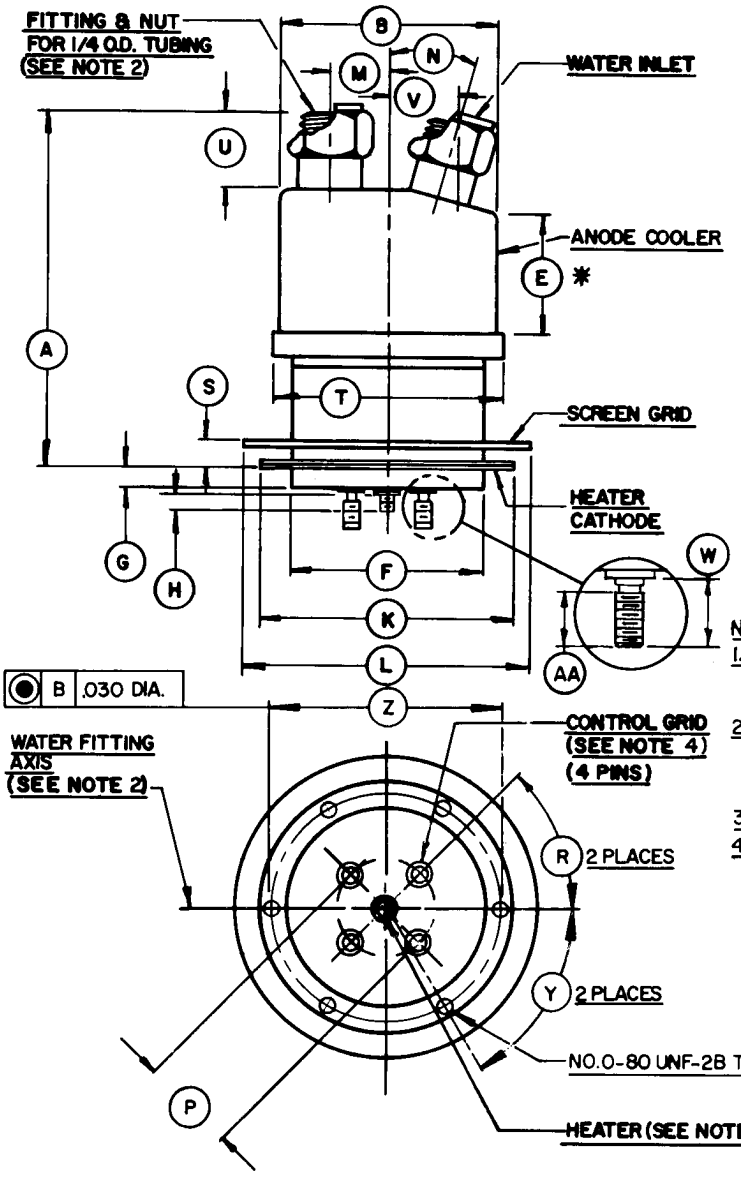
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


EIMAC 4CW800 B/F
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 275 VOLTS
PLATE CURRENT–AMPERES
SCREEN CURRENT–AMPERES
GRID CURRENT–AMPERES
4
3
2
1.5
1
.6
.3
.1
.01
.001
0
.010
.150
.100
.050
1.0
.500
.250
.100
.010
0
PLATE VOLTAGE–VOLTS
0
1000
2000
3000
4000
GRID VOLTAGE–VOLTS
40
20
0
–20
–40
–60

CURVE #3371


EIMAC 4CW800 B/F
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 350 VOLTS
PLATE CURRENT–AMPERES
SCREEN CURRENT–AMPERES
GRID CURRENT–AMPERES
4.0
3.0
2.0
1.5
1.0
.600
.300
.100
.010
.001
0
.001
.010
.025
.05
.100
.150
.200
1.0
.500
.250
.050
40
20
0
-20
-40
-60
-80
0
1000
2000
3000
4000
GRID VOLTAGE–VOLTS
PLATE VOLTAGE–VOLTS
CURVE #3342



DIM	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	- -	2.515	- -	- -	63.88	- -
B	1.485	1.515	- -	37.35	38.10	- -
E	0.650	- -	- -	16.35	- -	- -
F	1.305	1.325	- -	32.82	33.32	- -
G	0.130	0.155	- -	3.27	3.90	- -
H	0.130	0.180	- -	3.27	4.53	- -
K	1.710	1.750	- -	43.01	44.01	- -
L	1.930	2.025	- -	48.54	50.93	- -
M	0.435	0.475	- -	10.94	11.95	- -
N	15°	25°	- -	15°	25°	- -
P	0.550	0.600	- -	13.97	15.24	- -
R	44°	46°	- -	44°	46°	- -
S	0.180	0.220	- -	4.53	5.53	- -
T	1.550	1.610	- -	38.98	40.48	- -
U	0.400	- -	- -	10.06	- -	- -
V	0.440	0.520	- -	11.07	13.08	- -
W	0.250	0.300	- -	6.29	7.54	- -
Y	59°	61°	- -	59°	61°	- -
Z	1.608	1.628	- -	40.84	41.35	- -

NOTES:
1. REF. DIMS. ARE FOR INFO. ONLY AND ARE NOT REQD FOR INSP. PURPOSES.
2. WATER FITTINGS ARE DIAMETRICALLY OPPOSED & AXIS IS LOCATED BETWEEN AXES OF PINS.
3. (*) CONTACT SURFACE.
4. 2-56 UNC-2A.

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

4CX10000D

RADIAL-BEAM POWER TETRODE



The Eimac 4CX10,000D is a metal-ceramic tetrode which is identical electrically to the 4CX5000A except for its rated plate dissipation of ten kilowatts. This increased dissipation capability, resulting from a larger cooler, is most useful in linear applications where plate dissipation is generally the limiting factor. Accordingly, more output power can be obtained in r-f or a-f linear service and "Typical" operating conditions have been modified to reflect this change in tube capability.

The improved cooler also allows the 4CX10,000D to be used in place of the 4CX5000A with less cooling for any given plate dissipation or results in cooler operation at any given air-flow rate.

The 4CX10,000D is useful as an oscillator, amplifier, or modulator at frequencies up to 110 megacycles and is particularly suited for use as a linear r-f amplifier or class-AB_1 audio amplifier.

A pair of these tubes, operating class-AB_1 will deliver more than 30 kilowatts of audio-frequency or radio-frequency plate output power.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	73		78	amperes
Amplification Factor (Grid-Screen)	4.25		5.0	amperes
Direct Interelectrode Capacitances, Grounded Cathode:				
Input	108		122	uuf
Output	18		23	uuf
Feedback			1.0	uuf

Direct Interelectrode Capacitances, Grounded Grid and Screen:	Min.	Max.	
Input	48	58	uuf
Output	18	23	uuf
Feedback		0.14	uuf

MECHANICAL

Base	Special concentric
Maximum Seal Temperature	250° C
Maximum Anode-Core Temperature	250° C
Recommended Socket	Eimac SK-300A
Recommended Air Chimney	Eimac SK-1306
Operating Position	Axis vertical, base up or down
Maximum Dimensions:	
Height	9.13 inches
Diameter	7.05 inches
Cooling	Forced air
Net Weight	12.2 pounds
Shipping Weight (Approximate)	23 pounds

(Effective 3-1-61) Copyright 1961 by Eitel-McCullough, Inc.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR (Up to 110 megacycles)

Class-C Telegraphy or FM Telephony (Key-down conditions)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	up to 30 megacycles	7500 MAX.	VOLTS
	30 to 60 megacycles	7000 MAX.	VOLTS
	60 to 110 megacycles	6500 MAX.	VOLTS
D-C SCREEN VOLTAGE		1500 MAX.	VOLTS
D-C PLATE CURRENT	up to 30 megacycles	3 MAX.	AMPERES
	30 to 60 megacycles	2.8 MAX.	AMPERES
	60 to 110 megacycles	2.6 MAX.	AMPERES
PLATE DISSIPATION		10,000 MAX.	WATTS
SCREEN DISSIPATION		250 MAX.	WATTS
GRID DISSIPATION		75 MAX.	WATTS

TYPICAL OPERATION
(Frequencies below 30 megacycles)

D-C Plate Voltage	7500	volts
D-C Screen Voltage	500	volts
D-C Grid Voltage	—350	volts
D-C Plate Current	2.8	amperes
D-C Screen Current	0.5	ampere
D-C Grid Current	0.25	ampere
Peak R-F Grid Voltage	590	volts
Driving Power	150	watts
Plate Dissipation	5000	watts
Plate Output Power	16,000	watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier conditions except where noted)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000 MAX.	VOLTS
D-C SCREEN VOLTAGE	1000 MAX.	VOLTS
D-C PLATE CURRENT	2.5 MAX.	AMPERES
PLATE DISSIPATION*	6650 MAX.	WATTS
SCREEN DISSIPATION	250 MAX.	VOLTS
GRID DISSIPATION	75 MAX.	WATTS

*Corresponds to 10,000 watts at 100-percent sine-wave modulation.

TYPICAL OPERATION (Frequencies below 30 megacycles)

D-C Plate Voltage	5000	volts
D-C Screen Voltage	500	volts
Peak A-F Screen Voltage (For 100-percent modulation)	450	Volts
D-C Grid Voltage	—400	volts
D-C Plate Current	1.4	amperes
D-C Screen Current	0.26	ampere
D-C Grid Current	0.05	ampere
Peak R-F Grid Voltage	520	volts
Grid Driving Power	25	watts
Plate Dissipation	1100	watts
Plate Output Power	5.8	kilowatts

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7500 MAX.	VOLTS
D-C SCREEN VOLTAGE	1500 MAX.	VOLTS
D-C PLATE CURRENT	4.0 MAX.	AMPERES
PLATE DISSIPATION	10,000 MAX.	WATTS
SCREEN DISSIPATION	250 MAX.	WATTS
GRID DISSIPATION	75 MAX.	WATTS

TYPICAL OPERATION, two tubes

D-C Plate Voltage	4000	5000	6000	7500	volts
D-C Screen Voltage	1500	1500	1500	1500	volts
D-C Grid Voltage	—315	—320	—330	—340	volts
Max.-Signal Plate Current	6.66	6.66	6.66	6.66	ampere
Zero-Signal Plate Current*	0.50	0.50	0.50	0.50	ampere
Max.-Signal Screen Current	0.33	0.32	0.30	0.25	ampere
Zero-Signal Screen Current	0	0	0	0	ampere
Peak A-F Driving Voltage	305	310	320	330	volts
Driving Power	0	0	0	0	watts
Load Resistance, Plate-to-Plate	940	1320	1700	2280	ohms
Max.-Signal Plate Dissipation	6,670	7,950	8,100	9,050	watts
Max.-Signal Plate Output Power	13,300	17,500	23,800	31,900	watts

*Per Tube

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7500 MAX.	VOLTS
D-C SCREEN VOLTAGE	1500 MAX.	VOLTS
D-C PLATE CURRENT	4.0 MAX.	AMPERES
PLATE DISSIPATION	10,000 MAX.	WATTS
SCREEN DISSIPATION	250 MAX.	WATTS
GRID DISSIPATION	75 MAX.	WATTS

TYPICAL OPERATION, Peak-Envelope or Modulation-Crest Conditions,
(Frequencies below 30 megacycles)

D-C Plate Voltage	7500	volts
D-C Screen Voltage	1500	volts
D-C Grid Voltage*	—340	volts
Max.-Signal Plate Current	3.33	amperes
Zero-Signal Plate Current	0.50	ampere
Max.-Signal Screen Current	.125	ampere
Peak R-F Grid Voltage	330	volts
Driving Power	0	watts
Plate Dissipation	9050	watts
Plate Output Power**	15,950	watts

*Adjust grid voltage to obtain specified Zero-Signal plate current.
**PEP output or r-f output power at crest of modulation envelope.

NOTE: In most cases, "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made. Exceptions are distinguished by a listing of "Useful" output power as opposed to "Plate" output power. Values appearing in these groups have been obtained from existing equipment(s) and the output power is that measured at the load.

APPLICATION

MECHANICAL

Mounting—The 4CX10000D must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

Socket—A new, more efficient Eimac Air-System Socket Type SK-300A has been designed especially for the concentric base terminals of the 4CX10000D. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through an Air Chimney, the SK-1306, into the anode cooling fins.

Cooling—The maximum temperature rating for the external surfaces of the 4CX10000D is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic-metal seals below 250°C. Air-flow requirements to maintain seal temperatures at 200°C in 50°C ambient air are tabulated below.

	SEA LEVEL		10,000 FEET	
Plate Dissipation* (Watts)	Air Flow (CFM)	Pressure Drop (Inches of water)	Air Flow	Pressure Drop (Inches of water)
4000	100	0.3	145	.4
6000	190	0.8	275	1.2
8000	290	1.5	420	2.2
10000	400	2.5	580	3.6

*Since the power dissipated by the filament represents about 560 watts and since grid-plus-screen dissipation can, under some conditions, represent another 200 to 300 watts, allowance has been made in preparing this tabulation for an additional 1000 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

Filament Operation—The rated filament voltage for the 4CX10000D is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than 5 percent from the rated value.

Electrode Dissipation Ratings—The maximum dissipation ratings for the 4CX10000D must be respected to avoid damage to the tube. An exception is the plate dissipation, which may be permitted to rise above the rated maximum during brief periods, such as may occur during tuning.

Control-Grid Operation— The 4CX10000D control grid has a maximum dissipation rating of 75 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible.

Screen-Grid Operation—The power dissipated by the screen of the 4CX10000D must not exceed 250 watts.

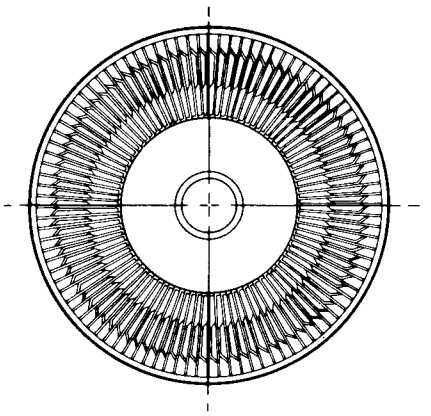
Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

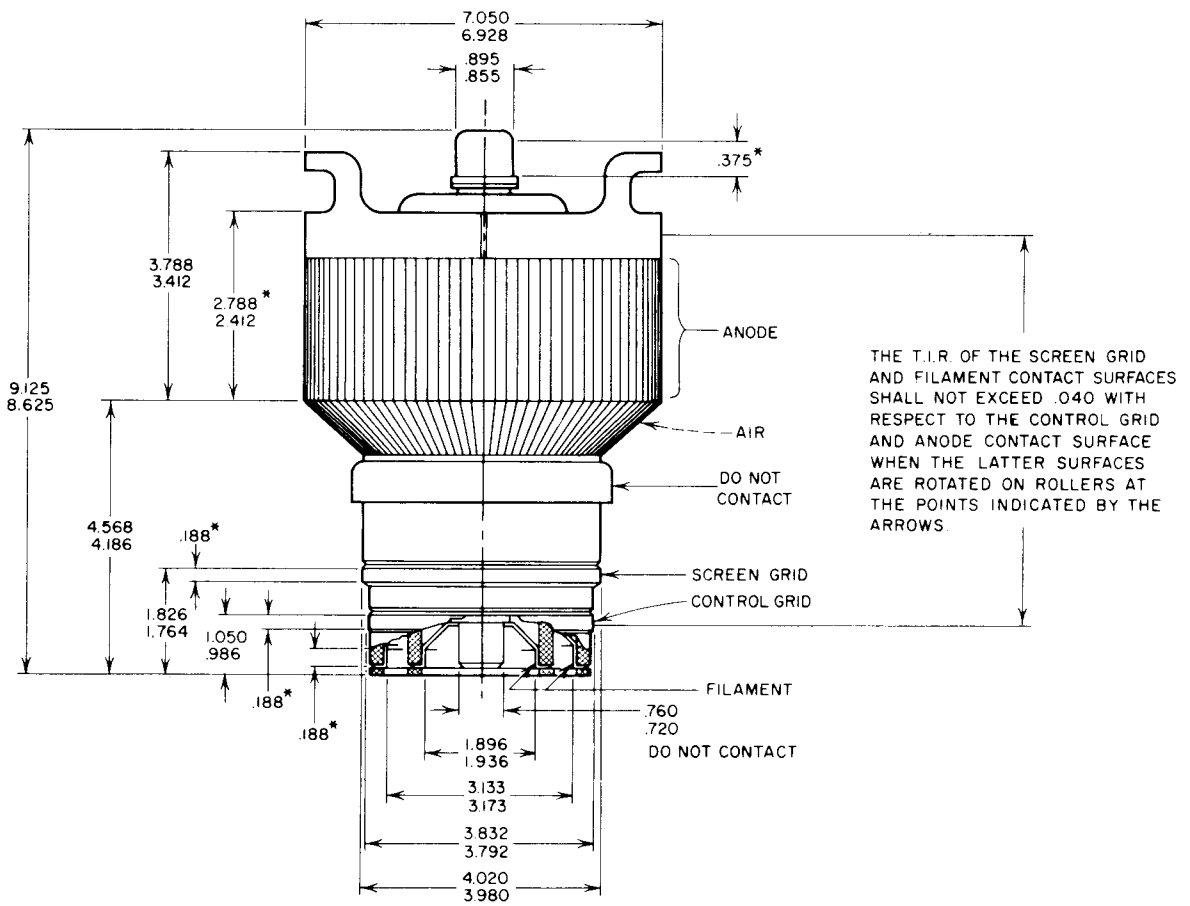
Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 250 watts in the event of circuit failure.

Plate Dissipation—The plate-dissipation rating for the 4CX10000D is 10,000 watts.

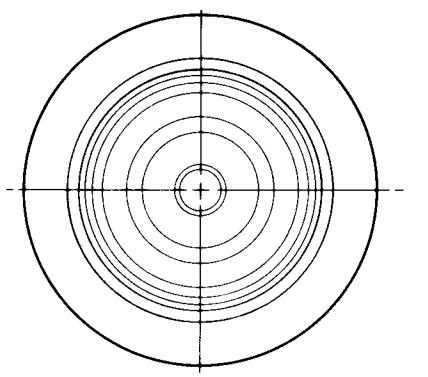
When the 4CX10000D is operated as a plate-modulated r-f power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 6650-watt maximum plate dissipation rating will be exceeded.

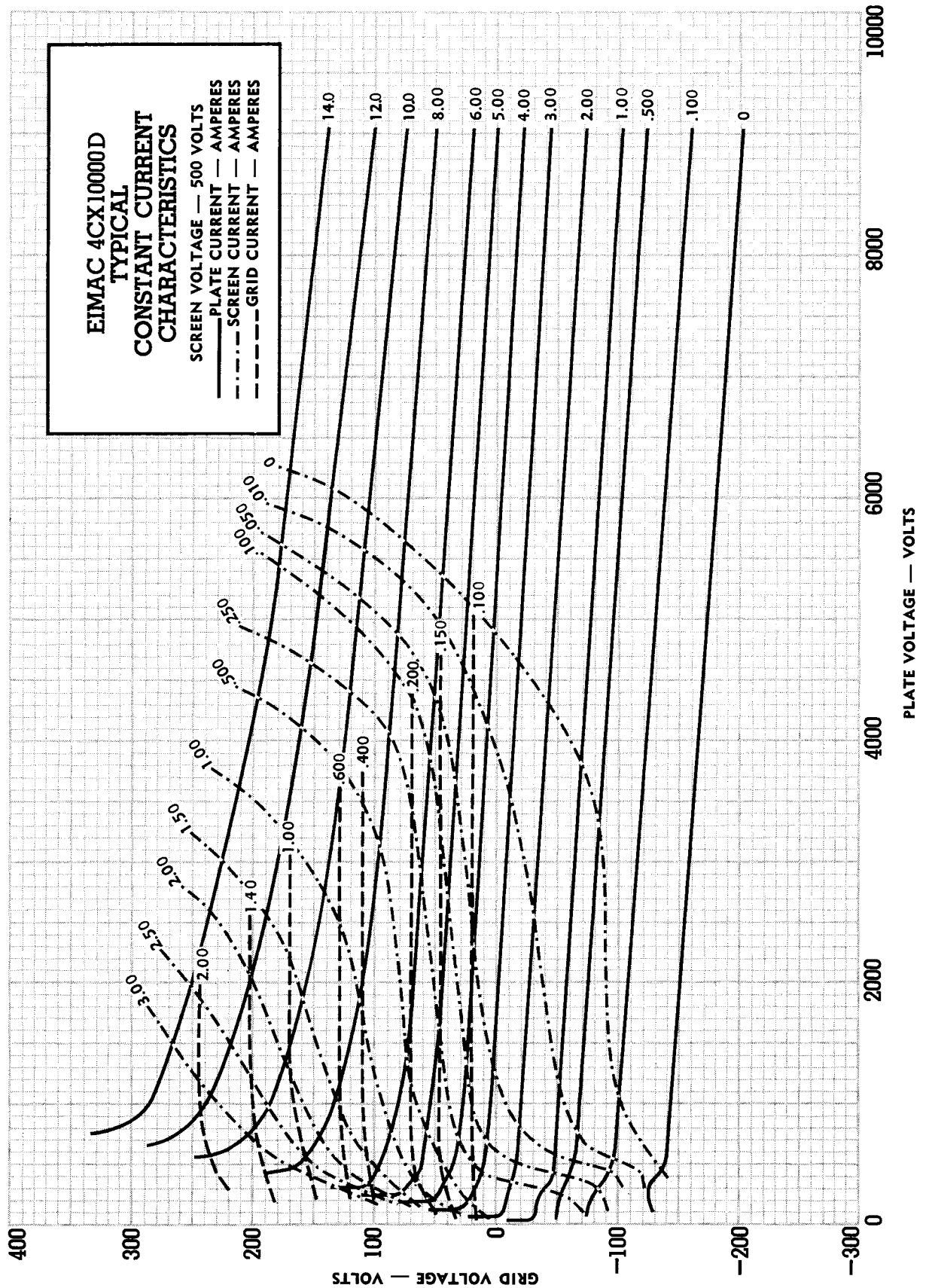
Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to the Power Grid Tube Marketing Department, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.

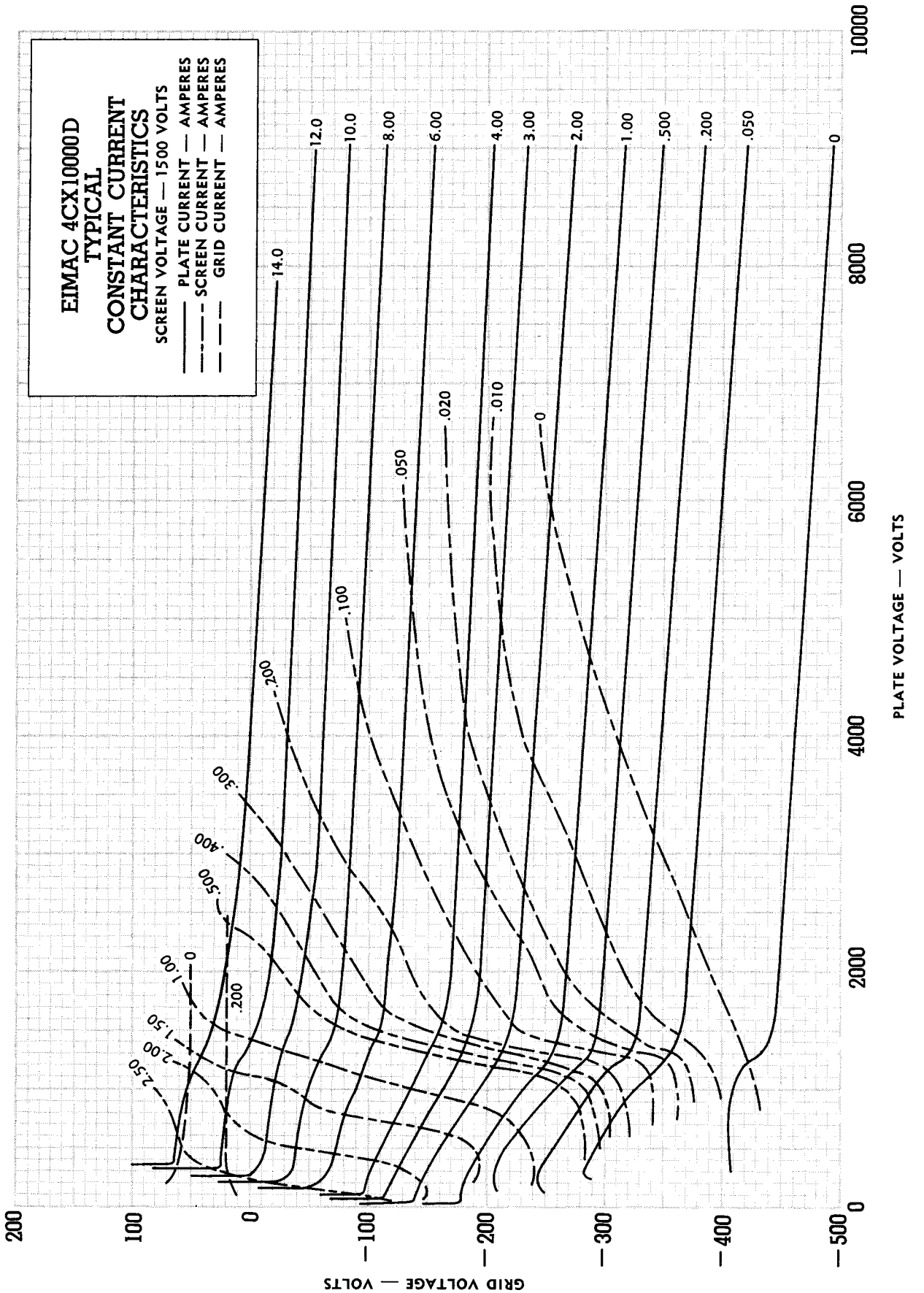




*CONTACT SURFACE
ALL DIMENSIONS IN INCHES




EIMAC 4CX10000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
14.0
12.0
10.0
8.00
6.00
5.00
4.00
3.00
2.00
1.00
.500
.100
0
.010
.050
.100
.250
.500
1.00
1.50
2.00
2.50
3.00
1.40
.600
.400
.200
.150
.100
400
300
200
100
0
−100
−200
−300
0
2000
4000
6000
8000
10000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS



Printed in U.S.A. 973

4CX10,000J

TECHNICAL DATA

RADIAL-BEAM
POWER TETRODE

The EIMAC 4CX10,000J is a compact, high-power, ceramic/metal, forced-air cooled tetrode with a rated maximum plate dissipation of 12,000 watts. It incorporates rugged internal construction features, including a mesh filament/cathode.

The 4CX10,000J is specifically designed for exceptionally low intermodulation distortion in radio-frequency linear amplifier service.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	7.5 ± 0.37	V
Current, at 7.5 volts	103	A
Amplification Factor (Average):		
Grid to Screen	4.5	
Direct Interelectrode Capacitance (grounded filament)[2]		
Cin	120	pF
Cout	20.5	pF
Cgp	0.7	pF
Direct Interelectrode Capacitance (grounded grid) [2]		
Cin	56	pF
Cout	21.5	pF
Cpk	0.10	pF
Frequency of Maximum Rating:		
CW	100	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	9.125 in: 231.77 mm
Diameter	7.050 in; 179.07 mm
Net Weight	12.2 lb; 5.55 kg
Operating Position	Axis vertical, base up or down

(Effective 2-1-72) © by Varian Printed in U.S.A.

Maximum Operating Temperature:	
Ceramic/Metal Seals or Anode Core	250°C
Cooling	Forced Air
Base	Special concentric
Recommended Air System Socket	SK-300A
Recommended (Air) Chimney	SK-1306

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN
Class AB1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1600	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	12,000	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.
3. Useful power is that delivered to the load.
4. Referenced against one tone of a two equal-tone signal.

TYPICAL OPERATION
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	7500	Vdc
Screen Voltage	1600	Vdc
Grid Voltage [1]	-400	Vdc
Zero-Signal Plate Current	300	mAdc
Single-Tone Plate Current	2.2	Adc
Single-Tone Screen Current [2]	30	mAdc
Peak rf Grid Voltage [2]	400	v
Single-Tone Plate Dissipation	8500	W
Useful Power Output (PEP) [3]	10	kW
Load Impedance	1650	Ω
Intermodulation Distortion Products [4]:		
3rd Order	-35	dB
5th Order	-40	dB

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in screen current. The screen current which results when the desired plate current is obtained is incidental and varies from tube to tube. This current variation causes no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 7.5 volts	98	108	A
Interelectrode Capacitances[1](grounded filament connection)			
Cin	113	127	pF
Cout	18	23	pF
Cgp	---	1.0	pF
Interelectrode Capacitances[1](grounded grid connection)			
Cin	51	61	pF
Cout	19	24	pF
Cpk	---	0.16	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX10,000J must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC SK-300A Air-System Socket is designed especially for the concentric base terminals of the 4CX10,000J. The use of recommended air-flow rates through this socket pro-

vides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through an Air Chimney, the SK-1316, into the anode cooling fins.

COOLING - The maximum temperature rating for the external surfaces of the 4CX10,000J is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air-flow requirements to maintain seal temperatures at 200°C in 50°C ambient air are tabulated below (for operation below 30 megahertz). The pressure drop values shown are for the Tube/Socket/Chimney combination.

	SEA LEVEL		10,000 FEET	
Plate * Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (In. of water)	Air Flow (CFM)	Pressure Drop (In. of water)
4000	110	0.4	160	0.6
6000	200	0.8	290	1.2
8000	315	1.7	460	2.5
10000	445	2.8	645	4.1
12000	600	4.4	870	6.4

* Since the power dissipated by the filament represents about 770 watts and since grid-plus screen dissipation can, under some conditions, represent another 200 to 300 watts, allowance has been made in preparing this tabulation for an additional 1200 watts dissipation.

At higher altitudes, higher frequencies, or higher ambient temperatures the flow rate must be increased to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using maximum rated temperatures as the criteria for satisfactory cooling.

IMPACT AND VIBRATION - The 4CX10,000J is designed to operate under shock and vibration conditions which might disable a less rugged tube. Production tubes are subjected to testing to insure ability to withstand 15 G impact at 11 milliseconds duration and 2 G vibratory acceleration over the range of 5 to 55 Hz.

ELECTRICAL

FILAMENT VOLTAGE - The rated filament voltage for the 4CX10,000J is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than 5 percent from the rated value.

GRID DISSIPATION - The 4CX10,000J control grid has a maximum dissipation rating of 75 watts. Precautions should be observed to avoid exceeding this rating. Grid dissipation is approximately the product of dc grid current and peak positive grid voltage. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible.

SCREEN DISSIPATION - The power dissipated by the screen of the 4CX10,000J must not exceed 250 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 250 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX10,000J is 12,000 watts. Plate dissipation may be permitted to rise above the maximum rating during brief periods, such as may occur during tuning.

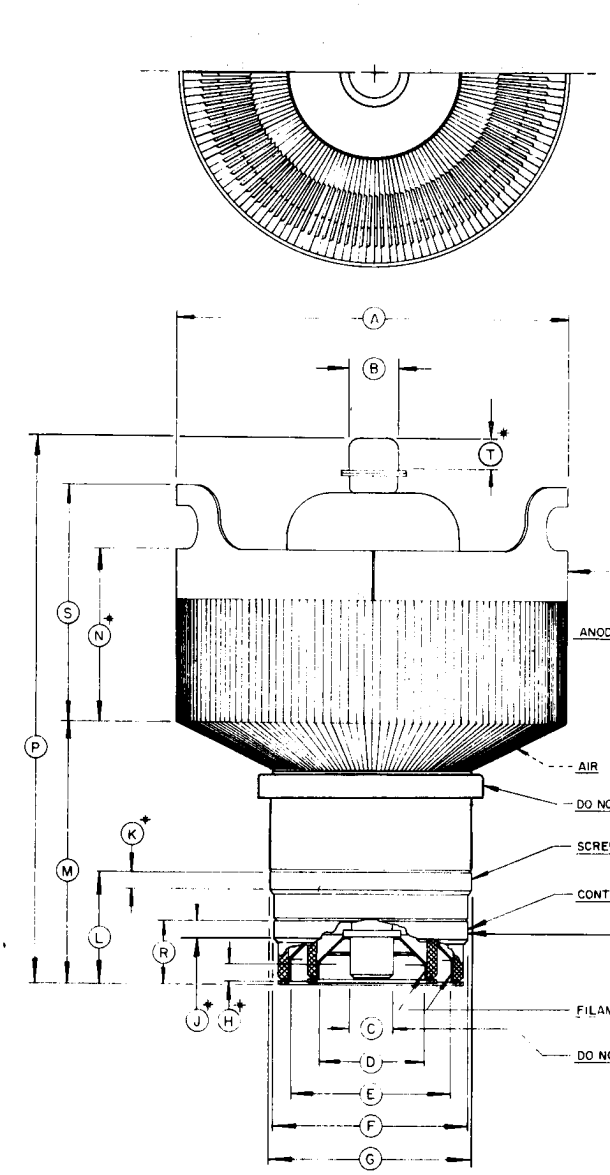
HIGH VOLTAGE - The 4CX10,000J operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard

RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

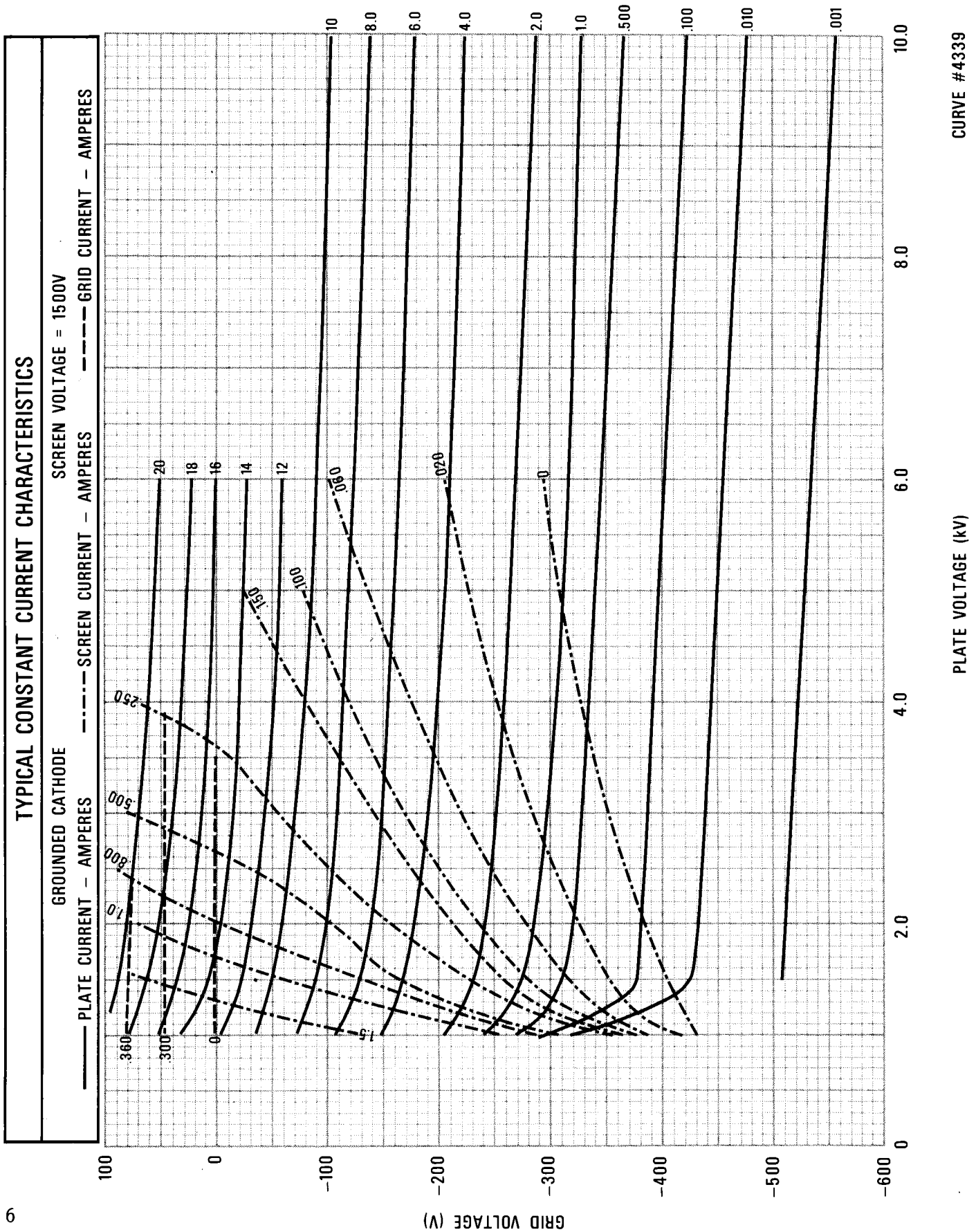
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	6.928	7.050	- -	175.97	179.07	- -
B	0.855	0.895	- -	21.72	22.73	- -
C	0.720	0.760	- -	18.29	19.30	- -
D	1.896	1.936	- -	48.16	49.17	- -
E	3.133	3.173	- -	79.58	80.59	- -
F	3.792	3.832	- -	96.32	97.33	- -
G	3.980	4.020	- -	101.09	102.11	- -
H	0.188	- -	- -	4.77	- -	- -
J	0.188	- -	- -	4.77	- -	- -
K	0.188	- -	- -	4.77	- -	- -
L	1.764	1.826	- -	44.80	46.38	- -
M	4.186	4.568	- -	106.32	116.03	- -
N	2.412	2.788	- -	61.26	70.81	- -
P	8.812	9.062	- -	223.82	230.17	- -
R	0.986	1.050	- -	25.04	26.67	- -
S	3.412	3.788	- -	86.66	96.21	- -
T	0.375	- -	- -	9.52	- -	- -

NOTES:
1. (✱) CONTACT SURFACE.
2. ALL DIMENSIONS IN INCHES.
3. REF. DIMENSION ARE FOR INFO ONLY AND ARE NOT REQD. FOR INSPECTION PURPOSES.

THE T.I.R. OF THE SCREEN GRID AND FILAMENT CONTACT SURFACES SHALL NOT EXCEED .040 WITH RESPECT TO THE CONTROL GRID AND ANODE CONTACT SURFACE WHEN THE LATTER SURFACES ARE ROTATED ON ROLLERS AT THE POINTS INDICATED BY THE ARROWS.

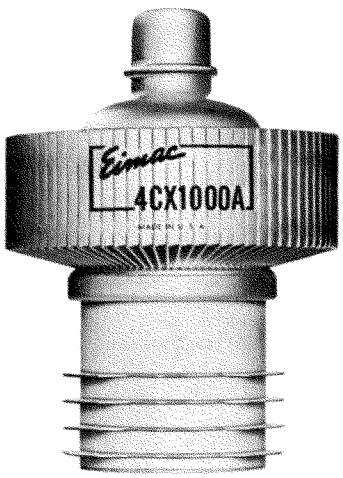

TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 1500V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #4339

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

TENTATIVE DATA

4CX1000A

CERAMIC POWER TETRODE



The Eimac 4CX1000A is a ceramic and metal, forced-air cooled, radial-beam tetrode with a rated maximum plate dissipation of 1000 watts. It is a low-voltage, high-current tube specifically designed for Class-AB_1 r-f linear-amplifier or audio-amplifier applications where its high gain and low distortion characteristics may be used to advantage. At its rated maximum plate voltage of 3000 volts, it is capable of producing 1680 watts of peak-envelope output power. Two 4CX1000As operating in Class-AB_1 will produce 3360 watts of audio power.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide Coated, Unipotential				
Heating Time	3			minutes
Heater: Voltage		6.0		volts
Current	9.5		11.5	amperes
Transconductance (I_b=1.0 ampere)		37,000		umhos
Direct Interelectrode Capacitances, Grounded Cathode:*				
Input	77		90	uuf
Output	11		13	uuf
Feedback			0.02	uuf

	Min.	Nom.	Max.	
Direct Interelectrode Capacitances, Grounded Grid and Screen:*				
Input		35		uuf
Output	11		13	uuf
Feedback			0.005	uuf
Frequency for Maximum Ratings			30	mc

*In shielded fixture.

MECHANICAL

Base	Special, breechblock terminal surfaces
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	200° C
Anode Core	250° C
Recommended Socket	Eimac SK-800 Series
Operating Position	Any
Maximum Over-All Dimensions:	
Height	4.75 inches
Diameter	3.36 inches
Net Weight	27 ounces
Shipping Weight (Approximate)	3 pounds

CLASS-AB_1 RADIO-FREQUENCY LINEAR AMPLIFIER

(Single Side-Band Suppressed-Carrier Operation)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. WATTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C PLATE CURRENT	1.0 MAX. AMP
PLATE DISSIPATION	1000 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	0 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	2000	2500	3000	volts
D-C Screen Voltage	325	325	325	volts
D-C Grid Voltage[1]	—60	—60	—60	volts
Zero-Signal D-C Plate Current	250	250	250	ma
Single-Tone D-C Plate Current	1.0	1.0	0.9	amp
Two-Tone Average D-C Plate Current	700	700	640	ma
Zero-Signal D-C Screen Current*	—2	—2	—2	ma
Single-Tone D-C Screen Current*	35	35	35	ma
Two-Tone Average D-C Screen Current*	11	10	9	ma
Plate Output Power	1020	1450	1680	watts

*Approximate values.

[1]Adjust grid bias to obtain listed zero-signal plate current.

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Supersedes sheet dated 8-15-57

CLASS-AB$_1$ AUDIO AMPLIFIER OR MODULATOR

MAXIMUM RATINGS	
D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C PLATE CURRENT	1.0 MAX. AMP
PLATE DISSIPATION	1000 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	0 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

D-C Plate Voltage	2000	2500	3000	volts
D-C Screen Voltage	325	325	325	volts
D-C Grid Voltage[1]	—60	—60	—60	volts
Zero-Signal D-C Plate Current	500	500	500	ma
Max.-Signal D-C Plate Current	2.0	2.0	1.8	amps
Zero-Signal D-C Screen Current*	—4	—4	—4	ma
Max-Signal D-C Screen Current*	70	70	70	ma
Effective Load, Plate to Plate	1650	2400	3450	ohms
Driving Power	0	0	0	watts
Max-Signal Plate Output Power	2040	2900	3360	watts

*Approximate values.

[1]Adjust grid bias to obtain listed zero-signal plate current.

NOTE: "TYPICAL OPERATION" data are obtained by calculation from the published characteristic curves and confirmed by direct tests. Adjustment of the grid bias to obtain the specified zero-signal plate current is assumed. When grid drive is applied, the screen voltage required to obtain the specified value of plate current without drawing grid current may vary somewhat from the typical values shown.

APPLICATION

MECHANICAL

Cooling—Sufficient cooling must be provided for the anode and ceramic-to-metal seals to maintain operating temperatures below the rated maximum values:

Ceramic-to-Metal Seals	200°C
Anode Core	250°C

A flow rate of 28 cubic feet per minute will be adequate for operation at maximum rated plate dissipation at sea level and with inlet air temperatures up to 40°C. Under these conditions, 28 cfm of air flow corresponds to a pressure difference across the tube and socket of 0.25 inch of water column. Experience has shown that if reliable long-life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube.

At higher altitudes increased air flow will be required. For example, at an altitude of 10,000 feet, a flow rate of 40 cfm will be required and will be obtained with a pressure drop across tube and socket of 0.35 inch of water column. In selecting a blower for use at high altitudes, care must be taken to assure that the blower is designed to deliver the desired volume of air at the corresponding pressure drop and *at the particular altitude.*

In cases where there is any doubt regarding the adequacy of the supplied cooling, it should be borne in mind that operating temperature is the sole criterion of cooling effectiveness. Surface temperatures may be easily and effectively measured by using one of the several temperature-sensitive paints or sticks available from various chemical or scientific-equipment suppliers. When these materials are used, extremely thin applications must be made to avoid interference with the transfer of heat from the tube to the air stream, which would cause inaccurate indications.

ELECTRICAL

Heater—The rated heater voltage for the 4CX1000A is 6.0 volts. The voltage, as measured at the socket, should be maintained at this value to minimize variations in operation and to obtain maximum tube life. In no case should the voltage be allowed to exceed 5% above or below the rated value.

The cathode and one side of the heater are internally connected.

It is recommended that the heater voltage be applied for a period of not less than 3 minutes before other operating voltages are applied. From an initial cold condition, tube operation will stabilize after a period of approximately 5 minutes.

Control-Grid Operation—The grid dissipation rating of the 4CX1000A is zero watts. The design features which make the tube capable of maximum power operation without driving the grid into the positive region also make it necessary to avoid positive-grid operation.

Although the average grid-current rating is zero, peak grid currents of less than one milliampere as read on a one-milliampere meter may be permitted to flow for peak-signal monitoring purposes.

Screen-Grid Operation—Tetrode tubes may exhibit reversed screen current to a greater or lesser degree depending on individual tube design. This characteristic is prominent in the 4CX1000A and, under some operating conditions, indicated negative screen currents in the order of 25 milliamperes may be encountered.

The maximum rated power dissipation for the screen grid in the 4CX1000A is 12 watts and the screen power should be kept below this level. The product of the peak screen voltage and the indicated d-c screen current approximates the screen input power except when the screen current indication is near zero or negative. In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the d-c screen voltage. Experience has shown that the screen will operate within the limits established for this tube if the indicated screen current, plate voltage and drive voltage approximate the 'Typical Operation" values.

The screen supply voltage must be maintained constant for any values of negative and positive screen currents that may be encountered. Dangerously high plate currents may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished in several different ways. A bleeder resistor may be connected from screen to cathode; a combination of VR tubes may be connected from screen to cathode; or an electron-tube regulator circuit may be used in the

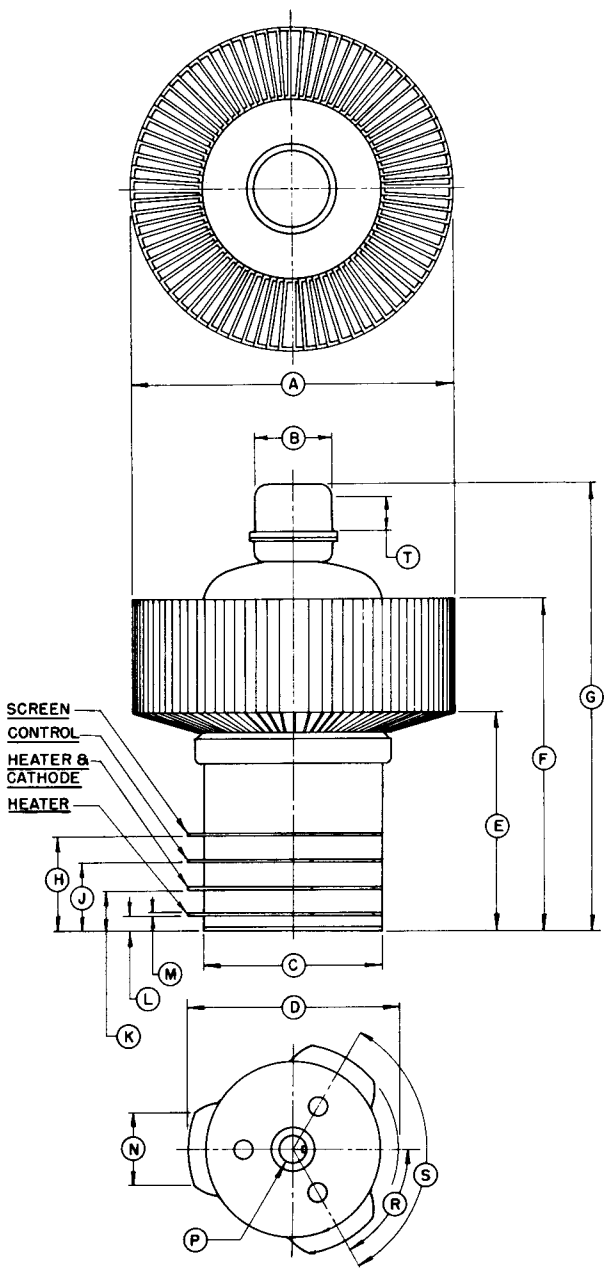
screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed. The screen bleeder current should approximate 70 milliamperes to adequately stabilize the screen voltage. It should be observed that this bleeder power may be usefully employed to energize low-power stages of the transmitter.

Plate Operation—The maximum rated plate dissipation power is 1000 watts. Except for brief periods during circuit adjustments, this maximum value should not be exceeded.

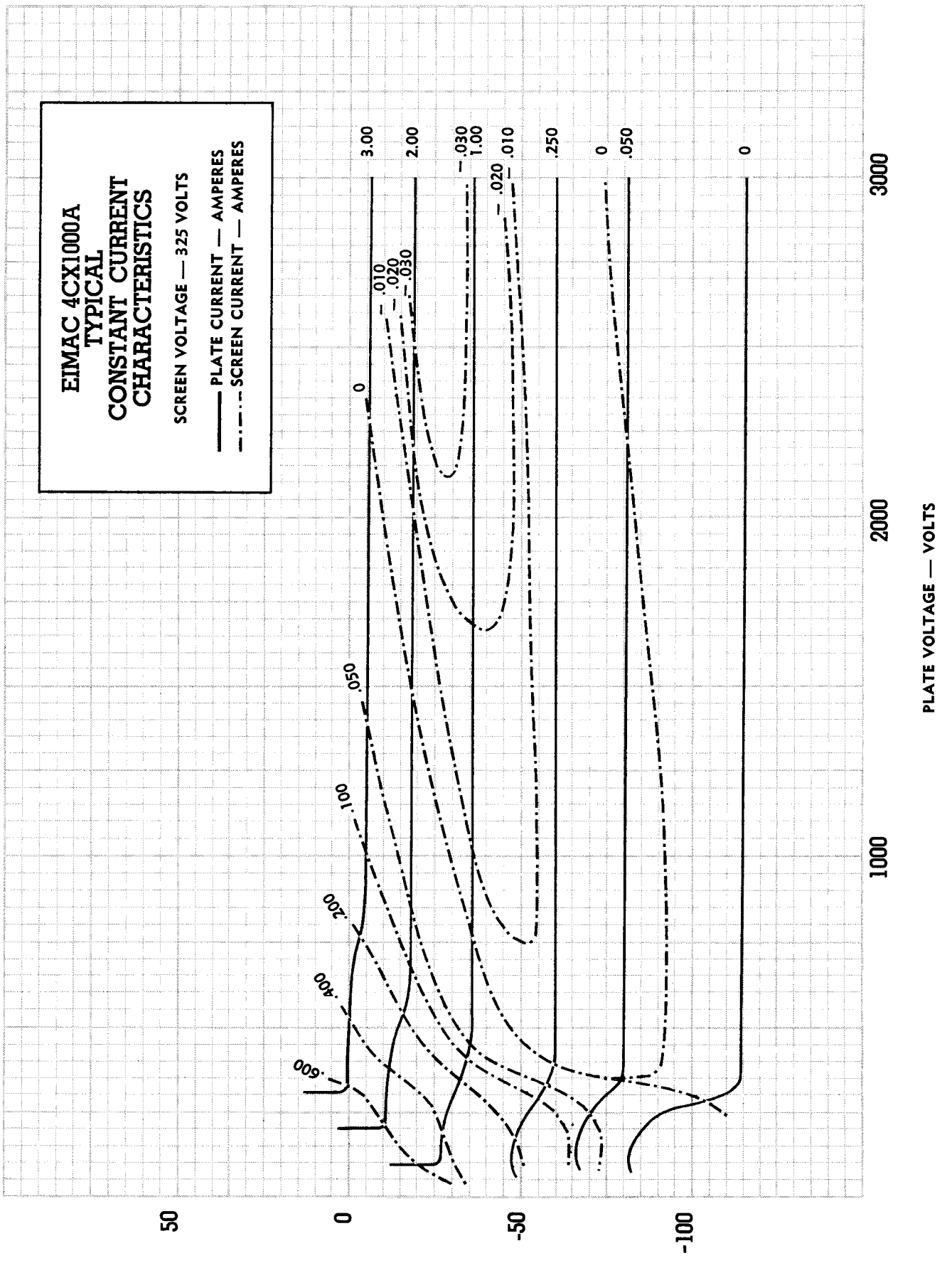
The top cap on the anode cooler may be used as a plate terminal or a circular clamp or spring-finger collet encircling the cylindrical outer surface of the anode cooler may be used.

Points of electrical contact with the anode cooler should be kept clean and free of oxide to minimize radio-frequency losses. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

Special Applications—If it is desired to operate this tube under conditions different from those given here, write to the Application Engineering Department, Eitel-McCullough, Inc., San Carlos, California, for information and recommendations.



DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A	3.350	3.340	3.360
B	.8125	.810	.815
C	1.875	1.870	1.890
D	2.265 DIA.	2.254 DIA.	2.278 DIA.
E	2.234	2.195	2.380
F	3.500	3.410	3.550
G	4.720	4.690	4.750
H	.980	.950	1.000
J	.705	.695	.720
K	.425	.400	.450
L	.155	.145	.170
M	.023	.019	.026
N	.750	.700	.800
P	.321 DIA.	.316 DIA.	.326 DIA.
R	60°		
S	120°		
T	.410	.360	.460



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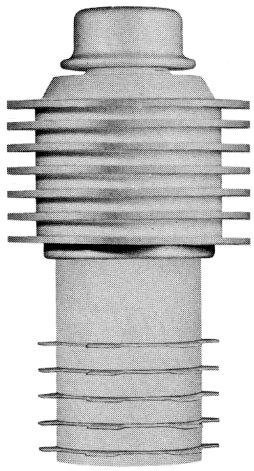
EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

4CX125C
4CX125F

RADIAL-BEAM POWER TETRODES

The EIMAC 4CX125C and 4CX125F are horizontally-finned versions of the 4CX300A. These tubes possess the same rugged internal features of the 4CX300A and are quite free of mechanical noise under severe shock and vibration conditions.

The horizontal fins used on these tubes result in a lighter and smaller tube than the 4CX300A. Transverse cooling air-flow is required to attain the 125 watt nominal plate dissipation rating.



GENERAL CHARACTERISTICS

ELECTRICAL

		Min.	Nom.	Max.	
Cathode:	Oxide-coated, Unipotential				
	Heating Time	30	60		seconds
	Cathode-to-heater Potential			± 150	volts
Heater:	Voltage: 4CX125C		6.0		volts
	4CX125F		26.5		volts
	Current: 4CX125C	2.6		3.1	amperes
	4CX125F	0.6		0.7	amperes
Amplification Factor (Grid–Screen)		4.0		5.6	
Transconductance (I_b = 200 Ma)			12,000		umhos
Frequency for Maximum Ratings				500	MHz

Interelectrode Capacitances, Grounded Cathode:	Min.	Max.	
Input	25.0	33.0	pF
Output	3.5	4.5	pF
Feedback		0.06	pF

MECHANICAL

Base	Special, breechblock, terminal surfaces
Socket	EIMAC SK-700 series
Maximum Operating Temperatures:	
Anode Core	250° C
Ceramic-to-Metal Seals	250° C
Operating Position	Any
Cooling	Forced air
Net Weight	3.5 ounces
Shipping Weight (Approximate)	1 pound

MAXIMUM RATINGS

	Class–C Plate Mod	Class–C Teleg or FM	Class–AB Audio or SSB	
DC Plate Voltage	1500	2000	2000	volts
DC Screen Voltage	300	300	400	volts
DC Grid Voltage	− 250	− 250	. . .	volts
DC Plate Current	200	250	250	ma
Plate Dissipation	83	125	125	watts
Screen Dissipation	12	12	12	watts
Grid Dissipation	2	2	2	watts

Note: See 4CX300A data sheet for characteristic curves and typical operating conditions.

TYPICAL OPERATION

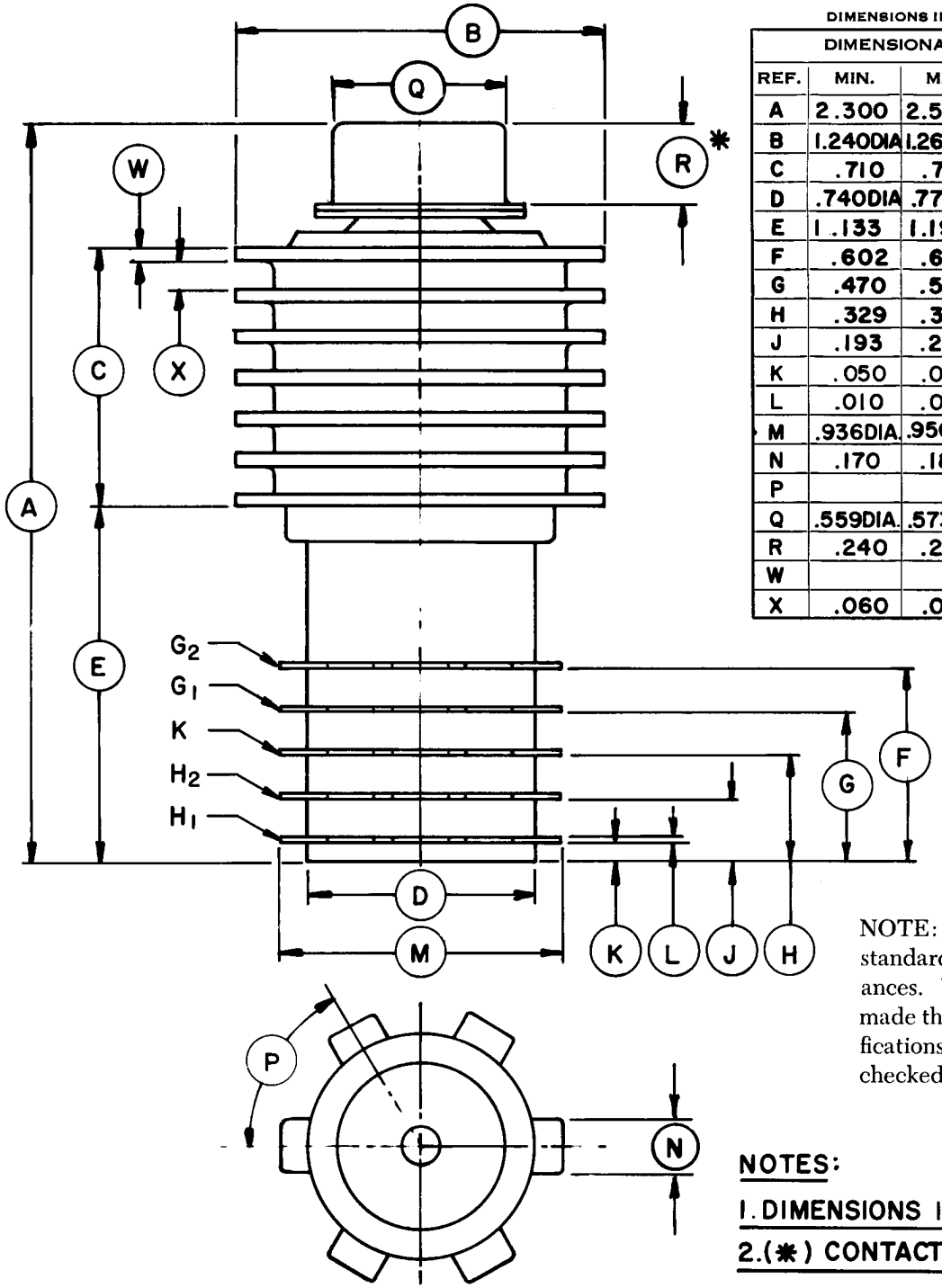
RF Amplifier (excluding circuit losses)	DC Plate Voltage (Volts)	Driving Power (Watts)	Input Power (Watts)	Output Power (Watts)
Class–C Telegraphy or FM Telephony	2000	3.0	500	390
Plate–Modulated Telephony (Carrier)	1500	2.0	300	235
Class–AB_1 Linear Amplifier	2000	0	315	205

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APPLICATION

Cooling: The 4CX125C and 4CX125F are intended for use where transverse cooling air is desired. With the anode cooler installed in a duct of 1" x 1½" cross section, approximately 8 cfm of air is required to maintain seal temperatures below 250° C. This presumes sea level operation with an ambient temperature of 25 ° or less. Sufficient air must be circulated around the base terminals to maintain the rated seal temperatures.



DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	2.300	2.500	
B	1.240DIA	1.265DIA.	
C	.710	.790	
D	.740DIA	.770DIA	
E	1.133	1.195	
F	.602	.642	
G	.470	.500	
H	.329	.359	
J	.193	.213	
K	.050	.072	
L	.010	.020	
M	.936DIA	.956DIA.	
N	.170	.185	
P			60°
Q	.559DIA	.573DIA.	
R	.240	.280	
W			.040
X	.060	.090	

NOTE: These dimensions reflect standard manufacturing tolerances. Where they are to be made the basis of purchase specifications, they should first be checked with the factory.

NOTES:

1. DIMENSIONS IN INCHES.

2.(*) CONTACT SURFACE

4CX1500A

RADIAL BEAM TETRODE

The EIMAC 4CX1500A is a general purpose tetrode for use up to and through VHF. Insulation is ceramic and the thoriated tungsten filament is a rugged mesh design. The screen terminal is a continuous ring which allows good isolation between the plate circuit and the control grid circuit.



The 4CX1500A is recommended for use as a class C power amplifier, class B, or class AB_1 linear amplifier, as a regulator, and in pulse modulator service.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament Voltage	5.0	volts
Filament Current	38.5	amps
Amplification Factor (Grid Screen)	5.5	
Transconductance (I_b = 1 ampere)		
E_{c_2} = 500 volts, E_b = 200 volts)	26,000	μmho
Frequency for Maximum Ratings	150	MHz
Direct Interelectrode Capacitances (Grounded Cathode) [2]		
Cin	78.0	pF
Cout	10.5	pF
Cgp	0.25	pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special ring and breechblock terminal surfaces
Recommended Socket	EIMAC SK-831
Recommended Air Chimney	EIMAC SK-806
Operating Position	Axis Vertical
Maximum Anode Core Temperature	250°C
Maximum Seal Temperature	250°C
Cooling	Forced Air

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Maximum Dimensions	
Height	4.90 in; 124.5 mm
Diameter	3.37 in; 85.6 mm
Net Weight	30 oz; 850 gm
Shipping Weight (Approximately)	3 lb; 1.21 kg

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament Current, E_f = 5.0 V	36.5	40.5	A
Interelectrode Capacitance (grounded cathode circuit) [1]			
Cin	73.0	83.0	pF
Cout	8.5	12.5	pF
Cgp	---	0.4	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class AB

MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	750	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
SCREEN DISSIPATION	75	WATTS
CONTROL GRID DISSIPATION	25	WATTS

TYPICAL OPERATION Class AB_1

DC Plate Voltage	2500	3900 V
DC Screen Voltage	600	600 V
DC Grid Voltage [1]	-105	-110 V
Zero-Signal Plate Current	250	200 mA
Max-Signal Plate Current	765	750 mA
Max-Signal Screen Current [2]	46	40 mA
Peak RF Driving Voltage	95	100 v
Resonant Plate Load Resistance	1670	2900 Ω
Max-Signal Plate Power Out	1080	1850 W

1. Adjust to specified zero-signal dc plate current.
2. Approximate values.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM
(Continuous Operating Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC SCREEN VOLTAGE	750	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
SCREEN DISSIPATION	75	WATTS
CONTROL GRID DISSIPATION	25	WATTS

TYPICAL OPERATION

	Low Freq. Calculated		220 MHz Measured
DC Plate Voltage	3000	4000	3000 V
DC Screen Voltage	500	500	500 V
DC Grid Voltage	-200	-200	-116 V
DC Plate Current	800	800	1000 mA
DC Screen Current [2]	36	37	35 mA
DC Grid Current [2]	17	15	0 mA
Peak RF Grid Voltage	240	240	--- v
Driving Power	4.1	3.6	31.5 W
Resonant Load Resistance	1720	2570	--- Ω
Plate Dissipation	600	700	--- W
Power Output	1800	2500	1500 W [1]

1. Useful Power Output
2. Approximate values.

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class C Telephony
(Carrier Conditions unless noted)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	3500	VOLTS
DC SCREEN VOLTAGE	550	VOLTS
DC PLATE CURRENT	.8	AMPERE
PLATE DISSIPATION [1]	1000	WATTS
SCREEN DISSIPATION	75	WATTS
CONTROL GRID DISSIPATION	25	WATTS

1. Corresponds to 1500 watts at 100% sine-wave modulation.

TYPICAL OPERATION

	Low Frequency Calculated		
DC Plate Voltage	2500	3400	V
DC Screen Voltage	500	500	V
DC Grid Voltage	-300	-300	V
Peak Audio Screen Voltage (For 100% mod. approx.)	500	500	v
DC Plate Current	800	900	mA
DC Screen Current [2]	46	28	mA
DC Grid Current [2]	27	28	mA
Peak RF Grid Voltage	365	365	v
Grid Driving Power	10	10	W
Resonant Load Resonant	3200	1940	Ω
Plate Dissipation	620	780	W
Plate Power Out	1600	2320	W

2. Approximate value.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class AB

MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	750	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
SCREEN DISSIPATION	75	WATTS
CONTROL GRID DISSIPATION	25	WATTS

TYPICAL OPERATION (Two Tubes) Class AB_1

DC Plate Voltage	2500	3900	V
DC Screen Voltage	600	600	V
DC Grid Voltage	-105	-110	V
Zero-Signal Plate Current	500	400	mA
Max-Signal Plate Current	1.530	1.500	A
Max-Signal Screen Current [2]	90	80	mA
Peak AF Driving Voltage	95	100	v
Load Resistance Plate to Plate	3340	5800	Ω
Max-Signal Plate Dissipation [1]	820	1070	W
Max-Signal Plate Power Out	2160	3700	W

1. Per Tube
2. Approximate value.

NOTE: TYPICAL OPERATION data is obtained by direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias screen and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In Class C service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

APPLICATION

MECHANICAL

MOUNTING - The 4CX1500A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC SK-831 socket and SK-806 chimney have been designed especially for the 4CX1500A. The use of recommended air-flow rates through these sockets provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals through the Air Chimney, and through the anode cooling fins.

COOLING - The maximum temperature rating for the anode core of the 4CX1500A is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air-flow requirements to maintain seal temperature at 225°C in 50°C ambient air are tabulated on page 4 (for operation below 30 MHz).

	SEA LEVEL		6000 FEET	
Plate Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
1000	27	0.33	33	0.40
1500	47	0.76	58	0.95

*Since the power dissipated by the filament represents about 200 watts and since grid-plus-screen dissipation can, under some conditions, represent another 100 watts, allowance has been made in preparing this tabulation for an additional 300 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

FILAMENT OPERATION - The rated filament voltage for the 4CX1500A is 5.0 volts. Filament voltage, as measured at the socket, should be maintained at this value or below to obtain maximum tube life.

CONTROL GRID OPERATION - The rated dissipation of the grid is 25 watts. This is approximately the product of dc grid current and peak positive grid voltage. Operation at bias and drive levels near those listed will insure safe operation.

SCREEN GRID OPERATION - The power dissipated by the screen of the 4CX1500A must not exceed 75 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon RMS screen current and voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 75 watts in the event of circuit failure.

HIGH VOLTAGE - Normal operating voltages used with the 4CX1500A are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

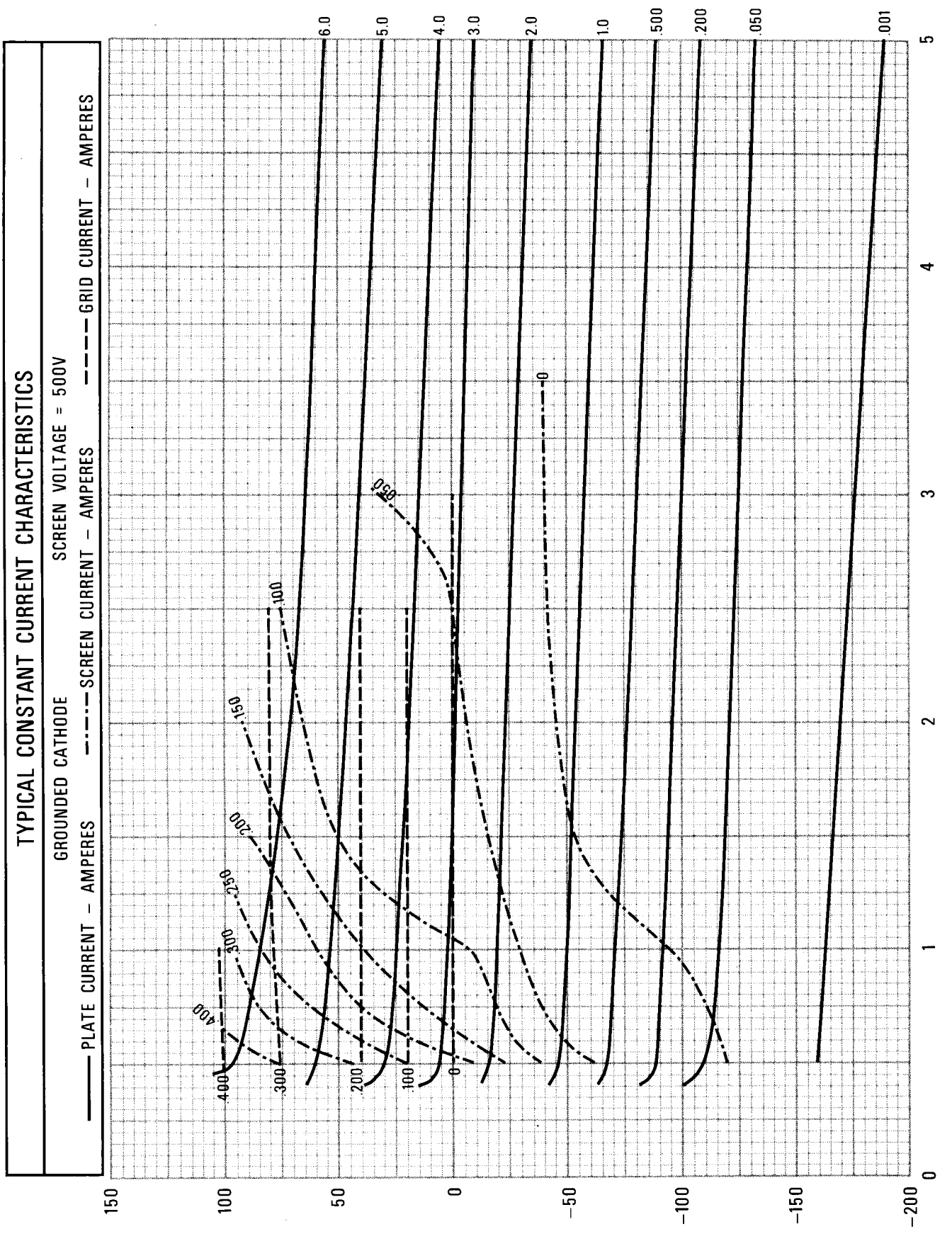
INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground".

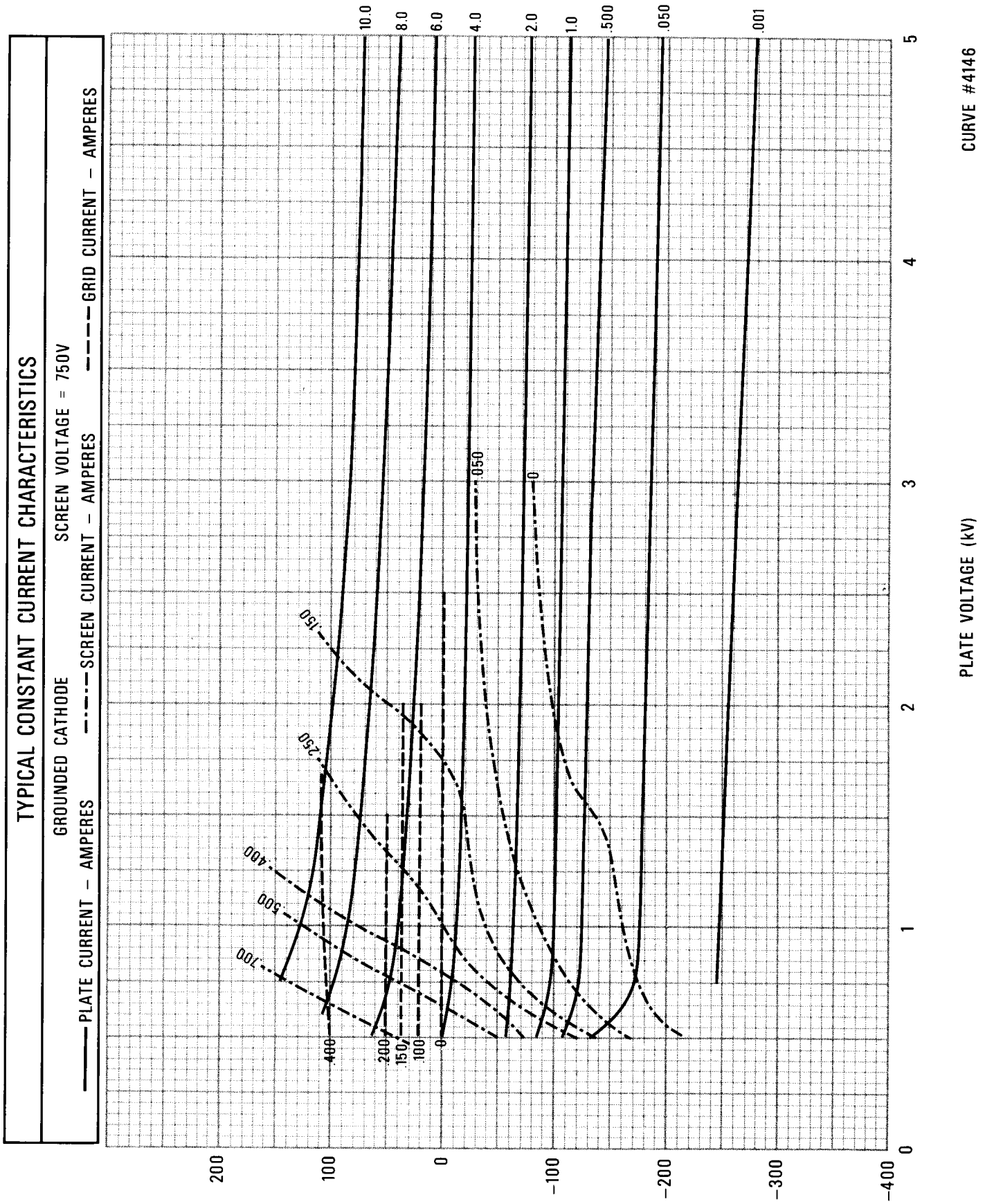
The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

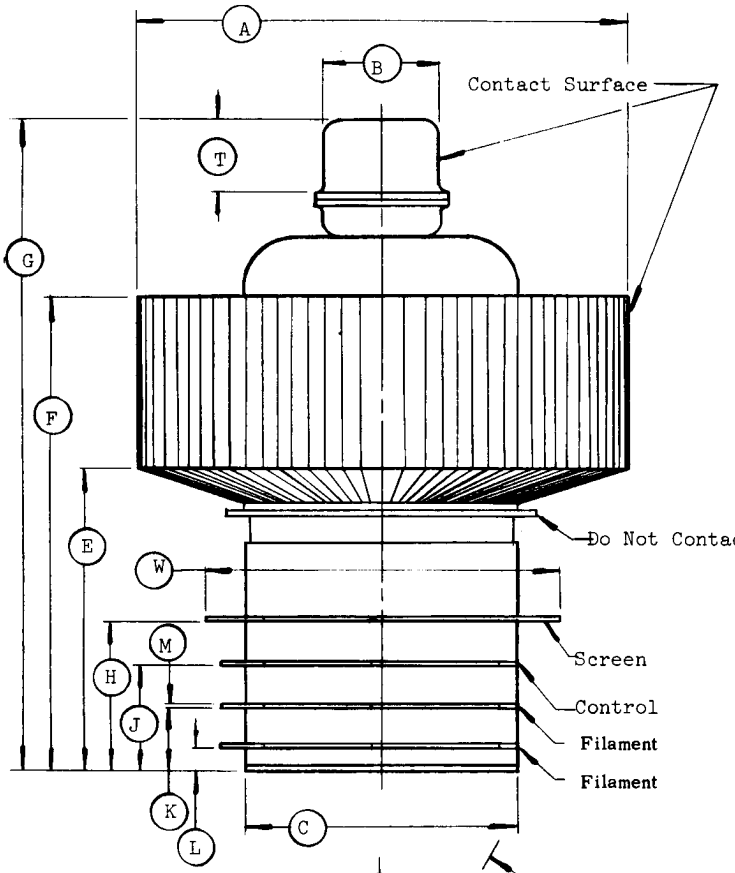
MULTIPLE OPERATION - To obtain maximum power output with minimum distortion from tubes operated in multiple, it is desirable to adjust individual screen or grid bias voltages so that the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual dc plate currents will be approximately equal for full input signal.

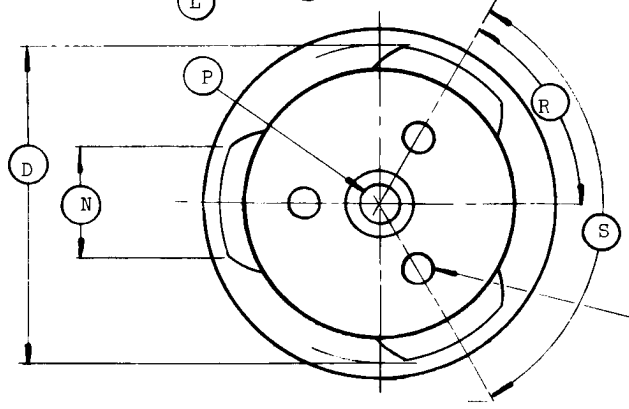
SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 500V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #4145
150
100
50
0
–50
–100
–150
–200
0
1
2
3
4
5
6.0
5.0
4.0
3.0
2.0
1.0
.500
.200
.050
.001
650
400
300
250
200
150
100
0


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 750V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
10.0
8.0
6.0
4.0
2.0
1.0
.500
.050
.001
.050
0
150
250
400
500
700
400
200
150
100
0
200
100
0
-100
-200
-300
-400
0
1
2
3
4
5
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #4146

4CX1500A





DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.335	3.370	- -	84.71	85.60	- -
B	0.807	0.820	- -	20.50	20.83	- -
C	1.865	1.900	- -	47.37	48.26	- -
D	2.250	2.300	- -	57.15	58.42	- -
E	2.265	2.465	- -	57.53	62.61	- -
F	3.454	3.654	- -	87.73	92.81	- -
G	4.675	4.900	- -	118.74	124.46	- -
H	0.965	0.988	- -	24.51	25.09	- -
J	0.690	0.710	- -	17.53	18.03	- -
K	0.415	0.435	- -	10.54	11.05	- -
L	0.140	0.165	- -	3.56	4.19	- -
M	0.018	0.030	- -	00.46	0.76	- -
N	0.700	0.800	- -	17.78	20.32	- -
P	0.314	0.326	- -	7.97	8.28	- -
R	55°	65°	- -	55°	65°	- -
S	115°	125°	- -	115°	125°	- -
T	0.470	0.530	- -	11.94	13.46	- -
W	2.468	2.531	- -	62.69	64.29	- -

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

4CX1500B
RADIAL BEAM POWER TETRODE

JEDEC DESIGNATION
8660



The EIMAC 4CX1500B is ceramic and metal, forced-air cooled, radial beam tetrode with a rated maximum plate dissipation of 1500 watts. It is a low-voltage, high-current tube specifically designed for exceptionally low intermodulation distortion and low grid interception. The low distortion characteristics make the 4CX1500B especially suitable for radio-frequency and audio-frequency linear amplifier service.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide Coated, Unipotential				
Heating Time	3			min
Heater: Voltage		6.0		V
Current	9.0		11.0	A
Transconductance:				
(I_b=0.5 amperes, E_{c2}=225 volts)		30,000		umhos

Direct Interelectrode Capacitances, Grounded Cathode:*	Min.	Nom.	Max.	
Input	75		88	pF
Output	10.8		12.8	pF
Feedback			.03	pF
Direct Interelectrode Capacitances, Grounded Grid and Screen:*				
Input		38		pF
Output		12		pF
Feedback			0.005	pF

*In Shielded Fixture

MECHANICAL

Base	Special, breechblock terminal surfaces
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250°C
Anode Core	250°C
Recommended Socket	EIMAC SK-800 Series
Operating Position	Any
Maximum Over-All Dimensions:	
Height	4.8 in
Diameter	3.37 in
Net Weight	27 oz
Shipping Weight (Approximate)	3 lbs

RADIO-FREQUENCY LINEAR AMPLIFIER

Class AB

MAXIMUM RATINGS

DC PLATE VOLTAGE	3000 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC PLATE CURRENT	.900 AMP
PLATE DISSIPATION	1500 WATTS
SCREEN DISSIPATION	12 WATTS
CONTROL GRID DISSIPATION	1 WATT

*Adjust to the specified Zero-Signal Plate Current.
**The driving power specified includes the power dissipated in a 1000 ohm swamping resistor between the control grid and the cathode.
***The intermodulation distortion products will be as specified or better for all levels from zero-signal to maximum output power and are referenced against one tone of a two equal tone signal.

TYPICAL OPERATION (Frequencies below 30 MHz)

Class AB_2, Grid Driven, Peak Envelope or Modulation Crest Conditions

DC Plate Voltage	2500	2750	2900	Volts
DC Screen Voltage	225	225	225	Volts
DC Grid Voltage*	—34	—34	—34	Volts
Zero-Signal DC Plate Current	300	300	300	mA
Single-Tone DC Plate Current	720	755	710	mA
Two-Tone DC Plate Current	530	555	542	mA
Single-Tone DC Grid Current	1.3	0.95	0.53	mA
Two-Tone DC Grid Current	0.06	0.20	0.06	mA
Single-Tone DC Screen Current	—7	—14	—15	mA
Two-Tone DC Screen Current	—11	—11	—11	mA
Peak RF Grid Voltage	46	45	41	Volts
Driving Power**	1.5	1.5	1.5	Watts
Useful Output Power	900	1100	1100	Watts
Resonant Load Impedance	1900	1900	2200	Ohms
Intermodulation Distortion Products***— 3rd order	—38	—40	—43	dB
5th order	—47	—48	—47	dB

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Printed in U.S.A.

AUDIO AMPLIFIER OR MODULATOR

Class AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	3000 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC PLATE CURRENT	.900 AMP
PLATE DISSIPATION	1500 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	1.0 WATTS

*Approximate values.
**Adjust grid bias to obtain listed zero-signal plate current.

TYPICAL OPERATION (Sinusoidal wave, 2 tubes unless noted)

DC Plate Voltage	2000	2500	2900	Volts
DC Screen Voltage	325	325	325	Volts
DC Grid Voltage**	—60	—60	—60	Volts
Zero-Signal DC Plate Current	500	500	500	mA
Max.-Signal DC Plate Current	1.68	1.69	1.69	Amps
Zero-Signal DC Screen Current*	—30	—25	—20	mA
Max.-Signal DC Screen Current*	—27	—33	—32	mA
Effective Load, Plate to Plate	1948	2715	3333	Ohms
Driving Power	0	0	0	Watts
Max.-Signal Plate Output Power	1604	2258	2774	Watts

NOTE: "TYPICAL OPERATION" data are obtained by calculation from the published characteristic curves and confirmed by direct tests. Adjustment of the grid bias to obtain the specified zero-signal plate current is assumed. When grid drive is applied, the screen voltage required to obtain the specified value of plate current without drawing grid current may vary somewhat from the typical values shown.

APPLICATION

Cooling — The maximum temperature rating for the anode core of the 4CX1500B is 250°C. Sufficient forced air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic-to-metal seals to below 250°C. Air flow requirements to maintain seal temperature at 225°C in 50°C ambient air are tabulated below (for operation below 30 megahertz). Tube mounted in recommended socket and chimney.

	Sea Level		10,000 feet	
Plate Dissipation watts	Air Flow CFM	Pressure Drop inches water	Air Flow CFM	Pressure Drop inches water
1000	18	.23	24	.31
1500	34	.60	45	.80

*Since the power dissipated by the heater represents about 60 watts and since grid plus screen dissipation can, under some conditions, represent another 13 watts, allowance has been made in preparing this tabulation for an additional 73 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

Heater — The rated heater voltage for the 4CX1500B is 6.0 volts. The voltage, as measured at the socket, should be maintained at this value to minimize variations in operation and to obtain maximum tube life. In no case should the voltage be allowed to exceed 5% above or below the rated value.

The cathode and one side of the heater are internally connected.

It is recommended that the heater voltage be applied for a period of not less than 3 minutes before other operating voltages are applied. From an initial cold condition, tube operation will stabilize after a period of approximately 5 minutes.

Intermodulation Distortion — The Radio Frequency Linear Amplifier operating conditions including the distortion data are the results of actual operation in a neutralized grid-driven amplifier. Plots of IM distortion versus power output under two-tone conditions, as a function of zero-signal plate current, are included to illustrate the effect of this parameter upon distortion. Because the 4CX1500B has very low grid interception it is possible to drive the grid positive without any adverse effects upon the distortion level or upon the driver. Class AB_2 linear amplifier operation is therefore possible and recommended. It is also recommended that a low impedance driver be used and that the input of the 4CX1500B be swamped with a 1000 ohm resistor from grid to cathode so as to provide an almost constant load to the driver.

Control-Grid Operation — The control grid dissipation rating of the 4CX1500B is 1 watt. The design features which make the 4CX1500B such an extremely linear tube also contribute to very low grid interception. It will be found that the grid will be driven into the positive grid region in the typical operation of the tube. The grid current will usually be less than 1.0 milliampere.

Screen-Grid Operation — Tetrode tubes may exhibit reversed screen current to a greater or lesser degree depending on individual tube design. This characteristic is prominent in the 4CX1500B and, under some operating conditions, indicated negative screen currents in the order of 35 milliamperes may be encountered.

The maximum rated power dissipation for the screen grid in the 4CX1500B is 12 watts and

the screen power should be kept below this level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative. In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage. Experience has shown that the screen will operate within the limits established for this tube if the indicated screen current, plate voltage and drive voltage approximate the "Typical Operation" values.

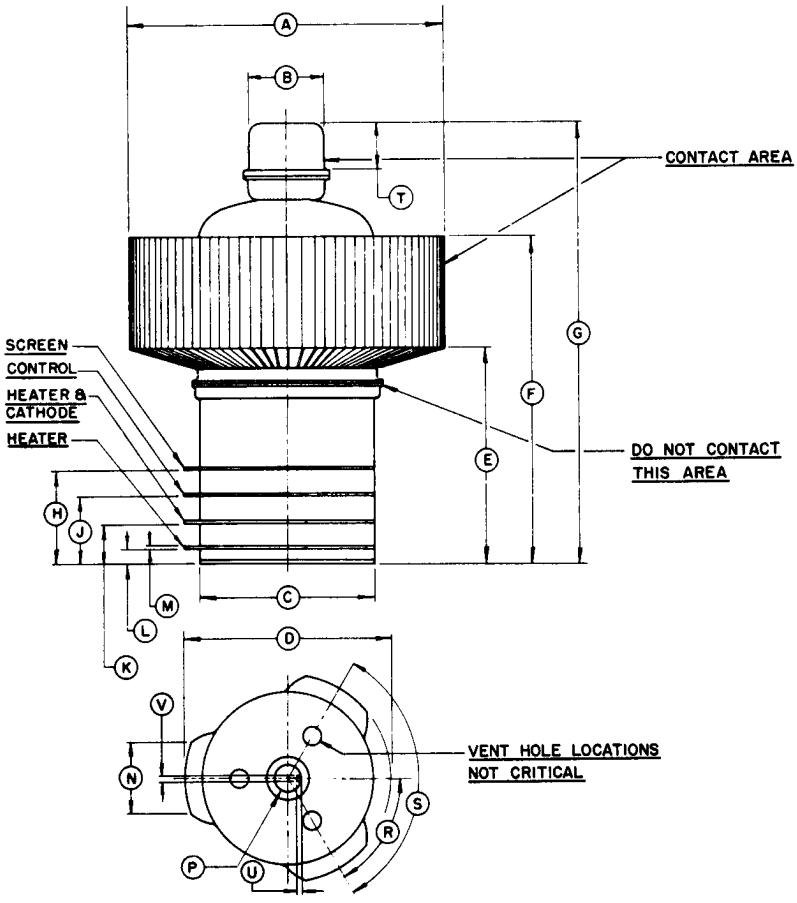
The screen supply voltage must be maintained constant for any values of negative and positive screen currents that may be encountered. Dangerously high plate currents may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished in several different ways. A bleeder resistor may be connected from screen to cathode; a combination of VR tubes may be connected from screen to cathode; or an electron-tube regulator circuit may be used in the screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed. The screen bleeder current should approximate 70 milliamperes to adequately stabilize the screen voltage. It should be observed that this bleeder power may be usefully employed to energize low-power stages of the transmitter.

Plate Operation — The maximum rated plate dissipation power is 1500 watts. Except for brief periods during circuit adjustments, this maximum value should not be exceeded.

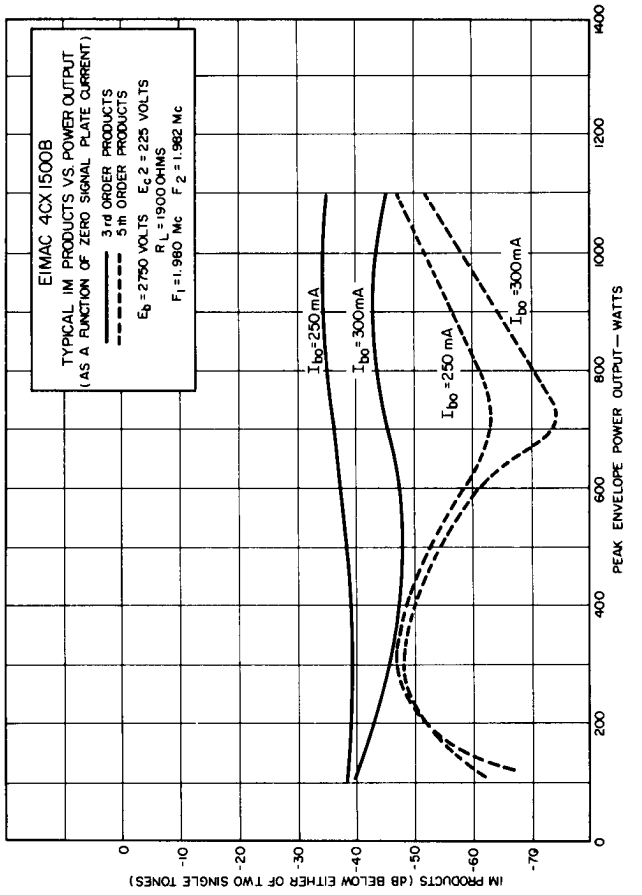
The top cap on the anode cooler may be used as a plate terminal at low frequencies or a circular clamp or spring-finger collet encircling the cylindrical outer surface of the anode cooler may be used at high frequencies.

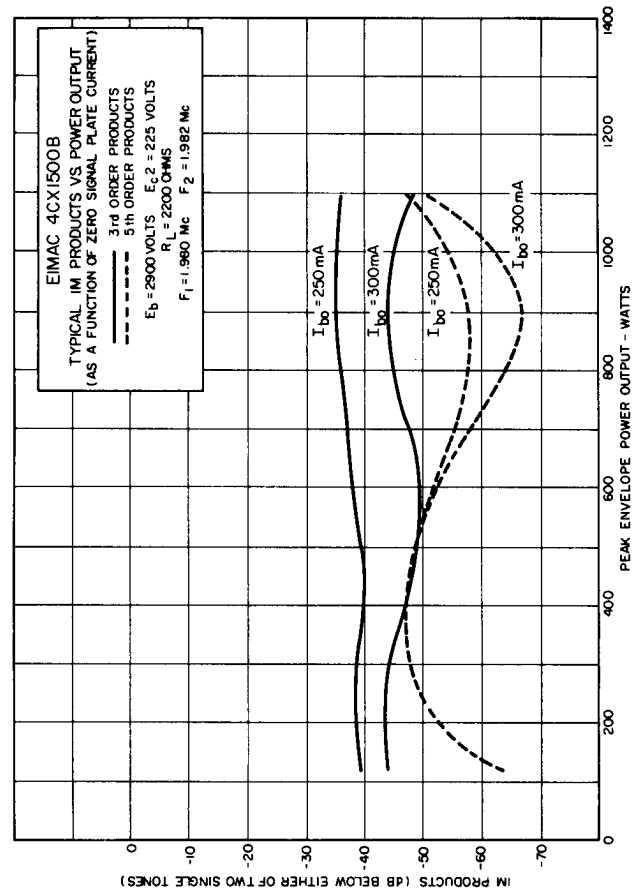
Points of electrical contact with the anode cooler should be kept clean and free of oxide to minimize radio-frequency losses. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

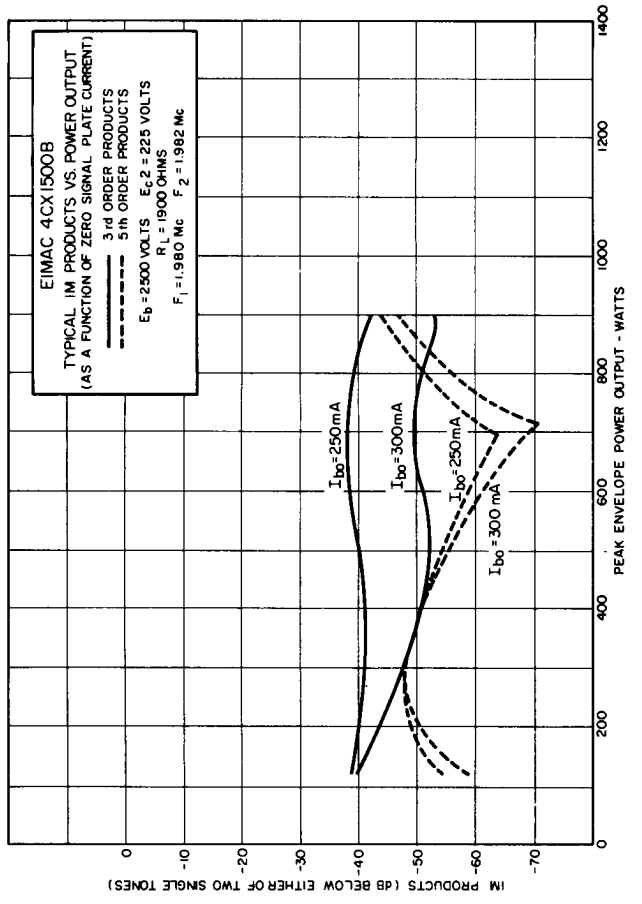
Special Applications — If it is desired to operate this tube under conditions different from those given here, write to the Power Grid Product Manager, EIMAC Division of Varian Associates, San Carlos, California, for information and recommendations.

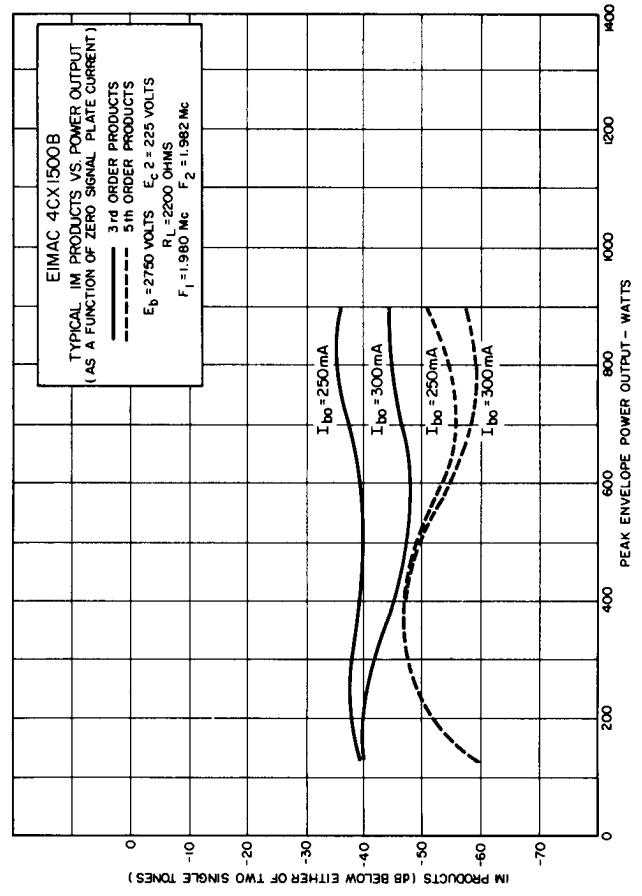


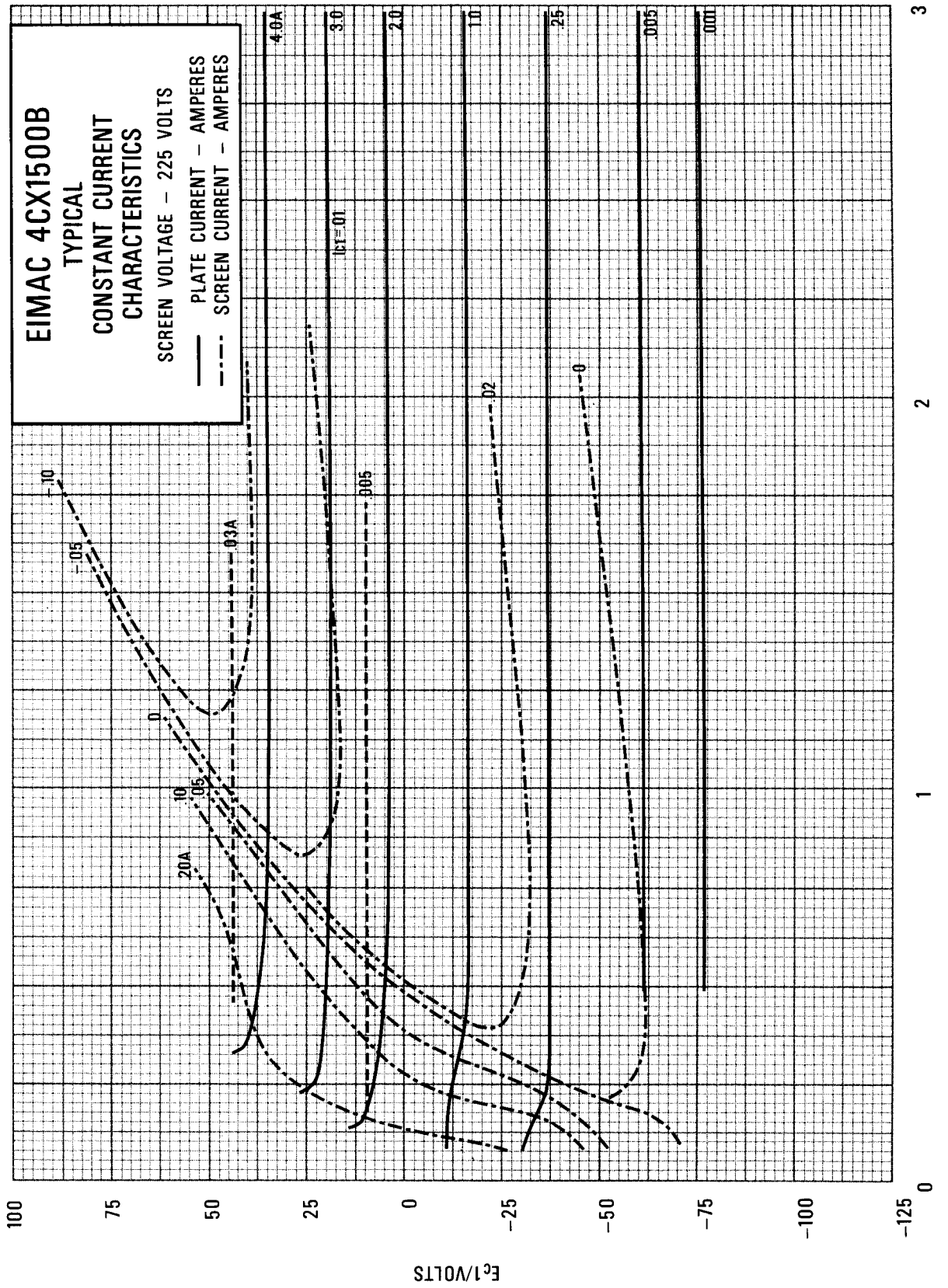
DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		3.335	3.365
B		.807	.817
C		1.870	1.900
D		2.250 DIA.	2.300 DIA.
E		2.195	2.380
F		3.410	3.550
G		4.600	4.800
H		.950	1.000
J		.675	.725
K		.400	.450
L		.140	.170
M		.020	.030
N		.700	.800
P		.314 DIA.	.326 DIA.
R		55°	65°
S		115°	125°
T		.470	.530
U		.023	.043
V		.057 DIA.	.073 DIA.

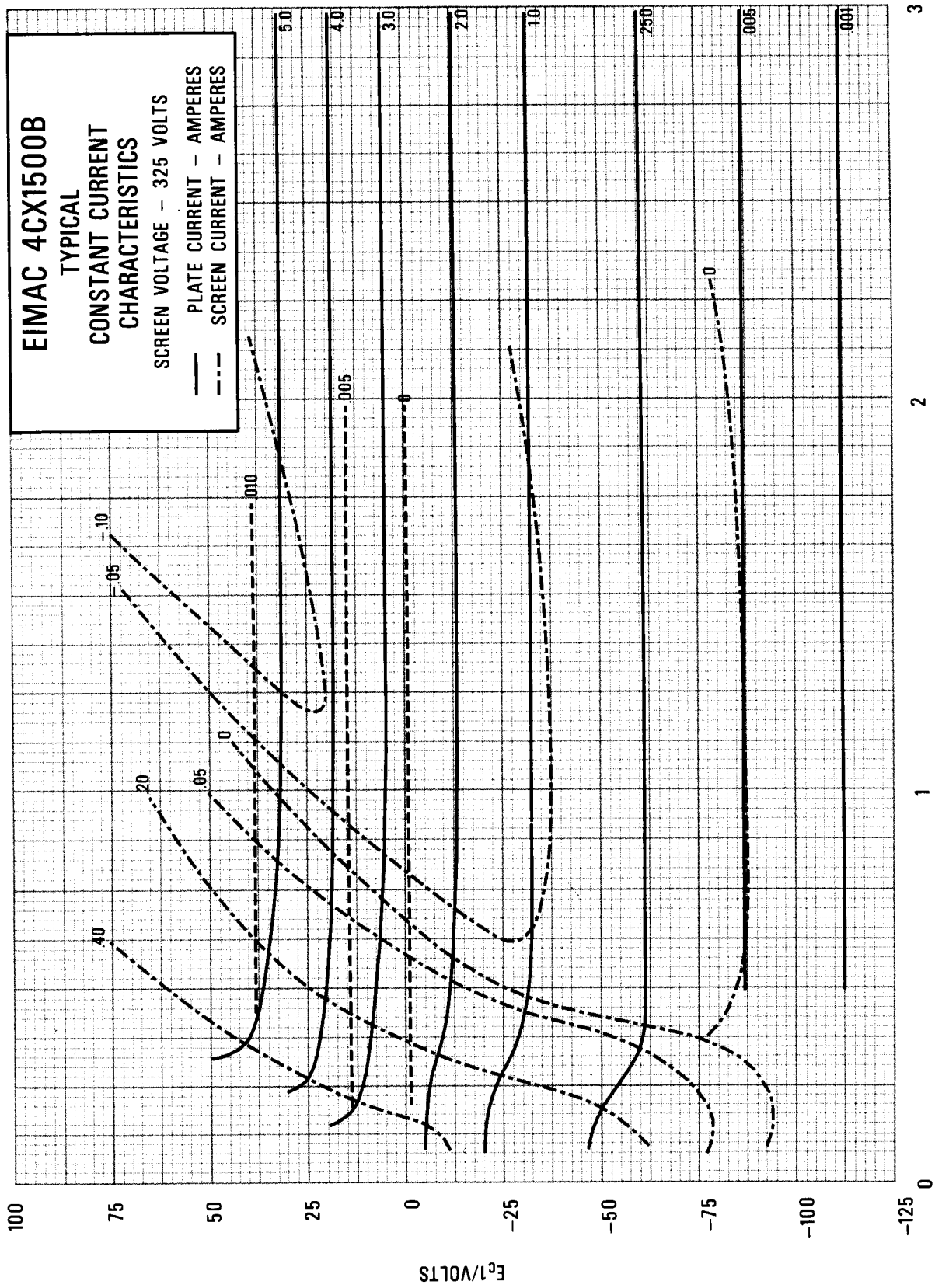

EIMAC 4CX1500B
TYPICAL IM PRODUCTS VS. POWER OUTPUT
(AS A FUNCTION OF ZERO SIGNAL PLATE CURRENT)
3rd ORDER PRODUCTS
5th ORDER PRODUCTS
Eb = 2750 VOLTS Ec2 = 225 VOLTS
RL = 1900 OHMS
F1 = 1.980 Mc F2 = 1.982 Mc
Ibo=250mA
Ibo=300mA
Ibo=250 mA
Ibo=300mA
IM PRODUCTS (dB BELOW EITHER OF TWO SINGLE TONES)
PEAK ENVELOPE POWER OUTPUT - WATTS


EIMAC 4CX1500B
TYPICAL IM PRODUCTS VS. POWER OUTPUT
(AS A FUNCTION OF ZERO SIGNAL PLATE CURRENT)
3rd ORDER PRODUCTS
5th ORDER PRODUCTS
Eb = 2900 VOLTS Ec2 = 225 VOLTS
RL = 2200 OHMS
F1 = 1.980 Mc F2 = 1.982 Mc
Ibo=250mA
Ibo=300mA
Ibo=250mA
Ibo=300mA
IM PRODUCTS (dB BELOW EITHER OF TWO SINGLE TONES)
PEAK ENVELOPE POWER OUTPUT - WATTS


EIMAC 4CX1500B
TYPICAL IM PRODUCTS VS. POWER OUTPUT
(AS A FUNCTION OF ZERO SIGNAL PLATE CURRENT)
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IM PRODUCTS (dB BELOW EITHER OF TWO SINGLE TONES)
PEAK ENVELOPE POWER OUTPUT - WATTS


EIMAC 4CX1500B
TYPICAL IM PRODUCTS VS. POWER OUTPUT
(AS A FUNCTION OF ZERO SIGNAL PLATE CURRENT)
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Ibo=300mA
IM PRODUCTS (dB BELOW EITHER OF TWO SINGLE TONES)
PEAK ENVELOPE POWER OUTPUT - WATTS


EIMAC 4CX1500B
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE – 225 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
4.0A
3.0
2.0
1.0
.25
.05
.01
.005
.001
.10
.05
0
.10
.06
.20A
.03A
.02
0
.005
100
75
50
25
0
–25
–50
–75
–100
–125
0
1
2
3
EC1/VOLTS
EB/KILOVOLTS


EIMAC 4CX1500B
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE – 325 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
5.0
4.0
3.0
2.0
1.0
250
005
001
010
005
0
-10
-05
0
05
20
40
100
75
50
25
0
-25
-50
-75
-100
-125
0
1
2
3
EC1/VOLTS
EB/KILOVOLTS

ADVANCE PRODUCT ANNOUNCEMENT

4CX25,000A VHF POWER TETRODE

The EIMAC 4CX25,000A is a ceramic/metal power tetrode intended for use in VHF-TV linear amplifier service. It features a type of internal mechanical structure which results in high rf operating efficiency. Low rf losses in this structure permit operation at full ratings to 230 MHz in TV linear amplifier service.

The anode is rated for 25 kW dissipation with forced-air cooling and uses a highly efficient cooler.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh	
Voltage	9.5 ± 0.5 V
Current, at 10.0 volts	150 A
Maximum Cold Start Inrush Current	300 A
Amplification Factor (Average) Grid to Screen	6.7
Direct Interelectrode Capacitances (cathode grounded) [2]	
Cin	171 pF
Cout	18.4 pF
Cgp	0.57 pF
Direct Interelectrode Capacitances (grids grounded) [2]	
Cin	79 pF
Cout	19 pF
Cpk	0.06 pF
Maximum Frequency for Full Ratings (CW)	230 MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	9.15 In; 23.24 cm
Diameter	8.85 In; 22.50 cm
Net Weight (approximate)	26.4 Lbs; 12.0 kg
Operating Position	Axis Vertical, Base Up or Down
Cooling	Forced Air
Operating Temperature, Absolute Maximum	
Ceramic/Metal Seals and Anode Core	250°C
Base	Special, Coaxial
Recommended Air-System Socket (for grid-driven dc or LF/HF applications)	EIMAC SK-320
Recommended Air Chimney (for use with SK-360 Socket)	EIMAC SK-326
Recommended Air-System Socket (for grid-driven VHF applications)	EIMAC SK-360
Available Screen Grid Bypass Capacitor Kit for SK-360 (8000 pF @ DCWV = 5000)	EIMAC SK-355
Available Anode Contact Connector	EIMAC ACC-3

TELEVISION LINEAR AMPLIFIER
CHANNELS 7-13 - Cathode Driven

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10.0	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-1.0	KILOVOLT
DC PLATE CURRENT	8.0	AMPERES
PLATE DISSIPATION	25	KILOWATTS
SCREEN DISSIPATION	300	WATTS
GRID DISSIPATION	180	WATTS

* Approximate; will vary tube-to-tube.
\# Calculated; including circuit losses gain will be 1 to 2 dB lower.

TYPICAL OPERATION, Composite Signal Black Level unless otherwise stated

Plate Voltage	7800	Vdc
Screen Voltage	1400	Vdc
Grid Bias Voltage *	-107	Vdc
Zero-Signal Plate Current	1.6	Adc
Plate Current	5.3	Adc
Grid Current *	100	mAdc
Screen Current *	120	mAdc
Peak Cathode Voltage (peak sync)	173	v
Cathode Driving Power (peak sync) *	1000	w
Plate Output Power (peak sync)	34.7	kw
Plate Load Resistance	634	Ohms
Cathode Load Resistance	15	Ohms
Gain #	15.4	dB
Plate Dissipation	21	kW

395090(Effective March 1986)
VA4857

Printed In U.S.A.

VHF CLASS B CW RF AMPLIFIER
Cathode Driven

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE . . .	10.0	KILOVOLTS
DC SCREEN VOLTAGE . .	2.0	KILOVOLTS
DC GRID VOLTAGE . . .	-1.0	KILOVOLT
DC PLATE CURRENT . . .	8.0	AMPERES
PLATE DISSIPATION . .	25	KILOWATTS
SCREEN DISSIPATION . .	300	WATTS
GRID DISSIPATION . . .	180	WATTS

* Approximate; will vary tube-to-tube.
\# Adjust for zero-signal plate current.

TYPICAL OPERATION:

Plate Voltage	6400	7000	Vdc
Screen Voltage	1200	1200	Vdc
Grid Bias Voltage #	-95	-110	Vdc
Zero-Signal Plate Current	1.0	0.5	Adc
Plate Current	4.05	3.4	Adc
Grid Current *	77	40	mAdc
Screen Current *	200	200	mAdc
Plate Output Power	16.5	16.5	kW
Plate Dissipation	9.8	7.8	kW
Plate Load Resistance	820	1090	Ohms
Cathode Load Resistance	18	22	Ohms
Cathode Drive Power *	420	380	W

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in ouput power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

APPLICATION

MECHANICAL

STORAGE - If a tube is to be stored as a spare it should be kept in its original shipping carton, with the original packing material, to minimize the possibility of handling damage.

Before storage a new tube should be operated in the equipment for 100 to 200 hours to establish it has not been damaged and operates properly (See FILAMENT OPERATION for recommendations on initial value of filament voltage during this operation period). If the tube is still in storage 6 months later it again should be operated in the equipment for 100 to 200 hours to make sure there has been no degradation. If operation is satisfactory the tube can again be stored with great assurance of being a known-good spare.

MOUNTING - The 4CX25,000A must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the designer.

SOCKET & CHIMNEY - The EIMAC air-system socket SK-320 and air chimney SK-326 are designed for use with the 4CX25,000A in dc or LF/HF applications. For VHF applications the SK-360 air-system socket is recommended. The use of the recommended air flow through an air-system socket will provide effective forced-air cooling of the base, with air then guided through the anode cooling fins by the air chimney.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250 Deg.C, and sufficient forced-air cooling must be used in all applications to keep the temperature of the anode (at the base of the cooling fins) and the temperature of the ceramic/metal seals comfortably below this rated maximum.

It is considered good engineering practice to design for a maximum anode core temperature of 225°C and temperature-sensitive paints are available for checking base and seal temperatures before any design is finalized. EIMAC Application Bulletin #20 titled "TEMPERATURE MEASUREMENTS WITH EIMAC TUBES" is available on request.

It is also good practice to allow for variables such as dirty air filters, rf seal heating, and the fact that the anode cooling fins may not be clean if the tube has been in service for some length of time. Special attention is required in cooling the center of the stem (base), by means of special directors or some other provision. An air interlock system should be incorporated in the design to automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.

It should be noted the contact fingers used in the contact collet assemblies (inner and outer filament, control grid and screen grid) are made of beryllium copper. If operated above 150°C for any appreciable length of time this material will loose its temper (or springy characteristic) and then will no longer make good contact to the base contact areas of the tube. This can lead to arcing which can melt metal in a contact area (primarily the inner or outer filament contacts) and the tube's vacuum integrity is then destroyed.

If all cooling air is not passed around the base of the tube and through the socket, then arrangements must be made to assure adequate cooling of the tube base and the socket contacts. Movement of cooling air around the base of the tube accomplishes a double purpose in keeping the tube base and the socket contact fingers at a safe operating temperature.

Minimum air flow requirements for a maximum anode temperature of 225°C for various altitudes and dissipation levels are listed. The pressure drop values shown are approximate and are for the tube anode cooler only. Pressure drop in a typical installation will be higher because of system loss.

Inlet Air Temperature = 25°C

Sea Level	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
	10	150	0.3
	15	320	0.9
	20	550	2.2
	25	840	4.6
5000 Feet	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
	10	190	0.3
	15	390	1.0
	20	660	2.5
	25	1010	5.2
10,000 Feet	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
	10	230	0.4
	15	470	1.1
	20	800	2.8
	25	1230	5.9

Inlet Air Temperature = 35°C

Sea Level	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
	10	180	0.4
	15	370	1.1
	20	630	2.7
	25	960	5.6
5000 Feet	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
	10	210	0.4
	15	440	1.2
	20	590	2.0
	25	1170	6.4
10,000 Feet	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
	10	260	0.4
	15	540	1.4
	20	920	3.4
	25	1410	7.3

Inlet Air Temperature = 50°C

Sea Level	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
	10	220	0.5
	15	460	1.5
	20	780	3.6
	25	1200	7.7
5000 Feet	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
	10	270	0.5
	15	550	1.6
	20	950	4.1
	25	1450	8.9
10,000 Feet	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
	10	320	0.6
	15	670	1.8
	20	1140	4.7
	25	1760	10.3

When long life and consistent performance are factors cooling in excess of minimum requirements is normally beneficial.

Air flow must be applied before or simultaneously with the application of power, including the tube filament, and should normally be maintained for a short period of time after all power is removed to allow for tube cooldown.

ELECTRICAL

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

FILAMENT OPERATION - This tube is designed for commercial service, with no more than one normal off/on filament cycle per day. If additional cycling is anticipated it is recommended the user contact Application Engineering at Varian EIMAC for additional information.

Filament inrush current should be limited to twice normal current. A suitable step-start procedure can accomplish this, with full operating temperature reached in as little as four seconds.

With a new tube, or one which has been in storage for some period of time, operation with filament voltage only applied for a period of 30 to 60 minutes is recommended before full operation begins. This allows the active getter material mounted within the filament structure to absorb any residual gas molecules which have accumulated during storage. Once normal operation has been established a minimum filament warmup time of four seconds is normally sufficient. (See current inrush limitation and step-start comment above.)

At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The voltage should then be increased a few tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked after 24 hours.

Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations.

Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. Periodically throughout the life of the tube the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best tube life.

EIMAC Application Bulletin #18 titled "EXTENDING TRANSMITTER TUBE LIFE" contains valuable information and is available on request.

DISSIPATION RATINGS - Maximum dissipation ratings for the 4CX25,000A must be respected to avoid damage to the tube. An exception is plate dissipation which may be permitted to rise above the rated maximum during brief periods (10 seconds maximum) such as may occur during tuning.

GRID OPERATION - The maximum control grid dissipation is 180 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. A protective spark-gap device should be connected between the control grid and the cathode to guard against excessive voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 300 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. Energy limiting circuitry (which will activate if there is a fault condition) and spark gap over-voltage protection are recommended as good engineering practice.

The tube may exhibit reversed (negative) screen current under some operating conditions. Screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, to assure that net screen supply current is always positive. This is essential if a series electronic regulator is employed.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and coolant interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with the tube anode (in the B+ line, to absorb power supply stored energy if an internal arc should occur. If power supply stored energy is high an electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, is recommended. The protection criteria for each electrode supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-inch section of #30 AWG copper wire. The wire will remain intact if protection is adequate.

EIMAC's Application Bulletin #17 FAULT PROTECTION contains considerable detail, and is available on request.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of a specially constructed test fixture which shields all external tube leads or contacts from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown in the technical data are taken in accordance with Standard RS-191. The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in the appliction. Measurements should be taken with the mounting which represents approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn: Product Manager; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

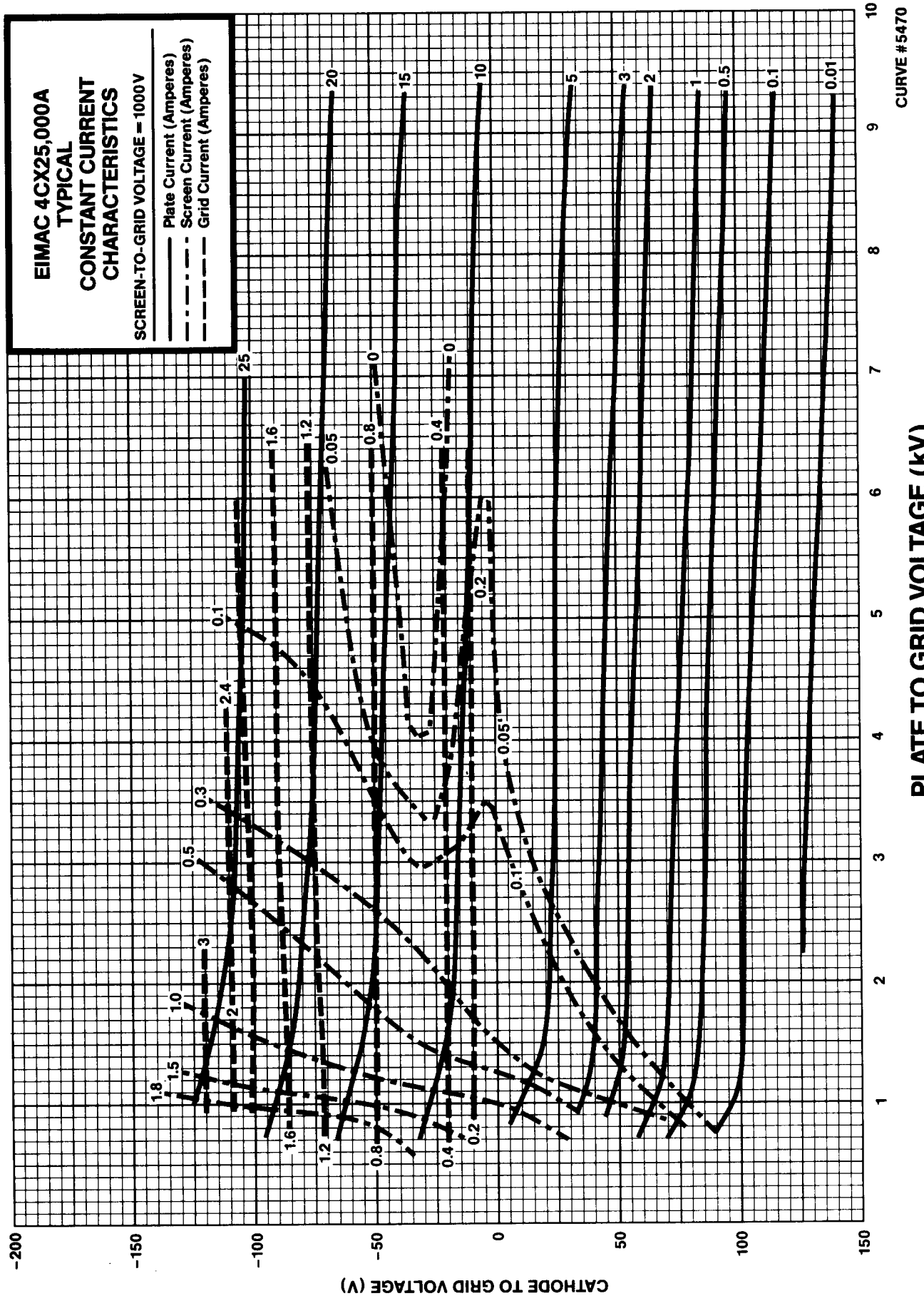
a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

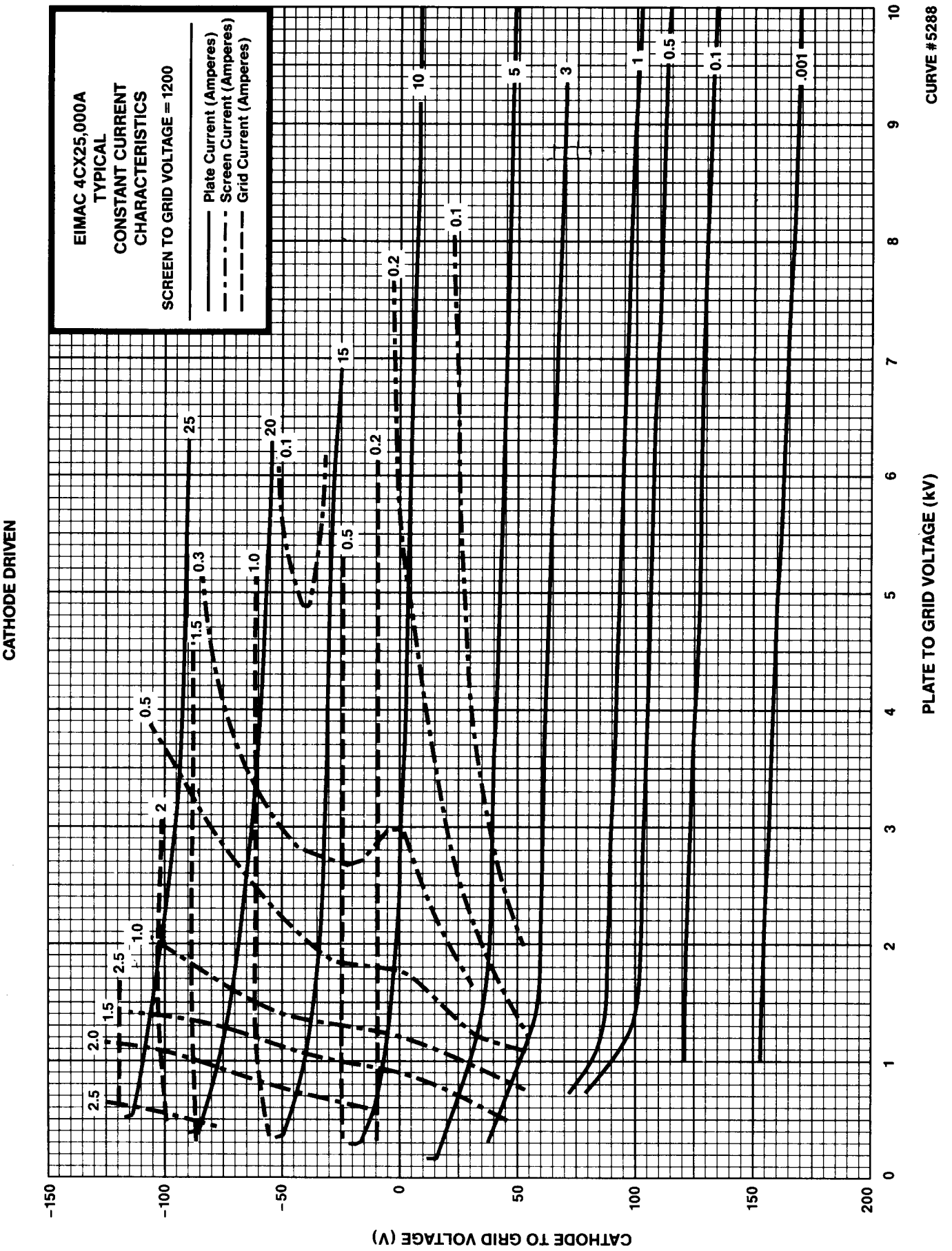
b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

c. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

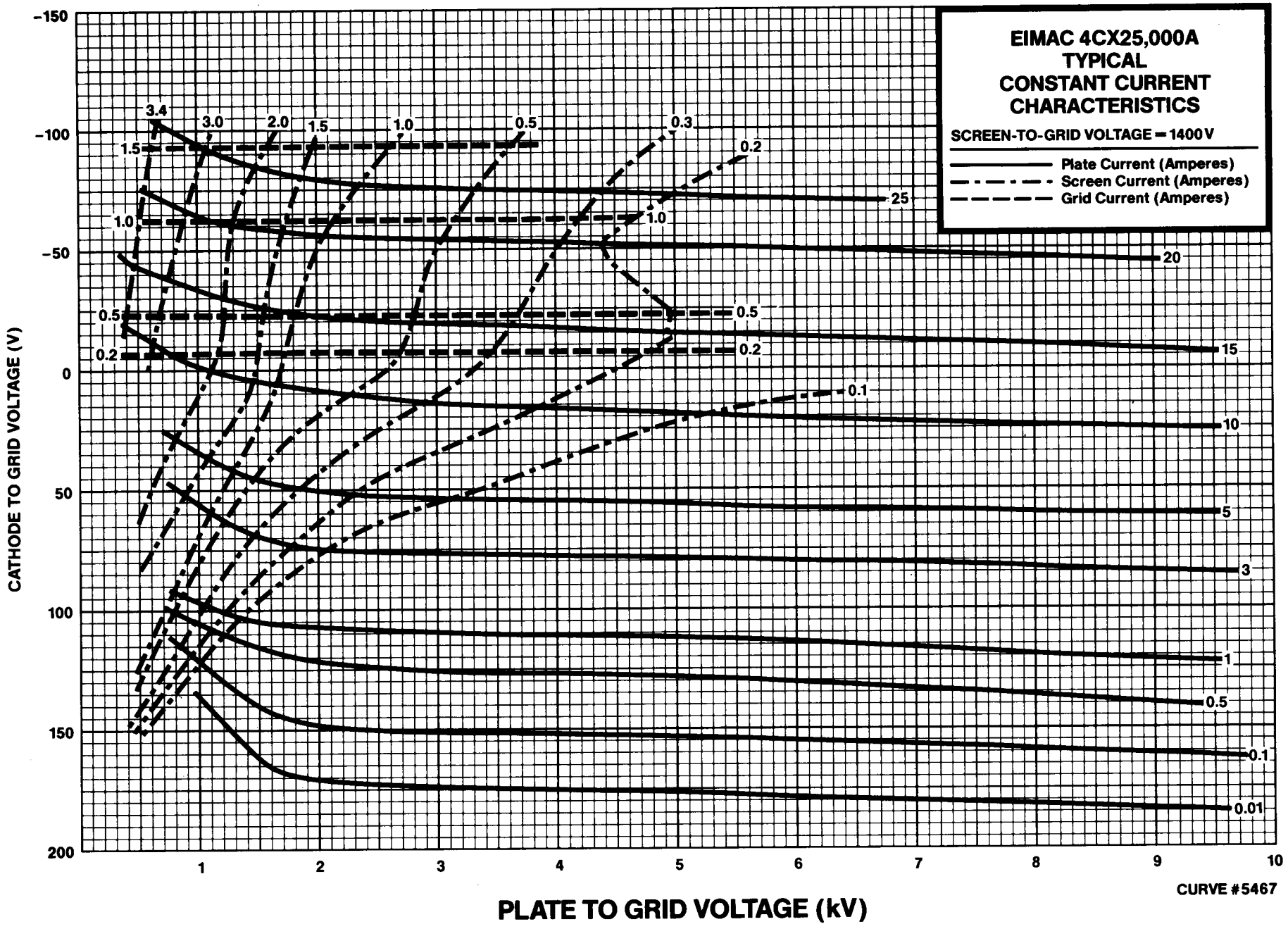
d. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.


EIMAC 4CX25,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN-TO-GRID VOLTAGE = 1000 V
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
CATHODE DRIVEN
CATHODE TO GRID VOLTAGE (V)
PLATE TO GRID VOLTAGE (kV)
CURVE #5470


EIMAC 4CX25,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN TO GRID VOLTAGE = 1200
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
CATHODE DRIVEN
CATHODE TO GRID VOLTAGE (V)
PLATE TO GRID VOLTAGE (kV)
CURVE #5288
-150
-100
-50
0
50
100
150
200
0
1
2
3
4
5
6
7
8
9
10
25
2.5
2.0
1.5
1.0
0.5
20
0.1
15
0.2
0.5
1.0
0.3
1.5
2
2.5
1.0
10
0.1
0.2
5
3
1
0.5
0.1
.001

CATHODE DRIVEN

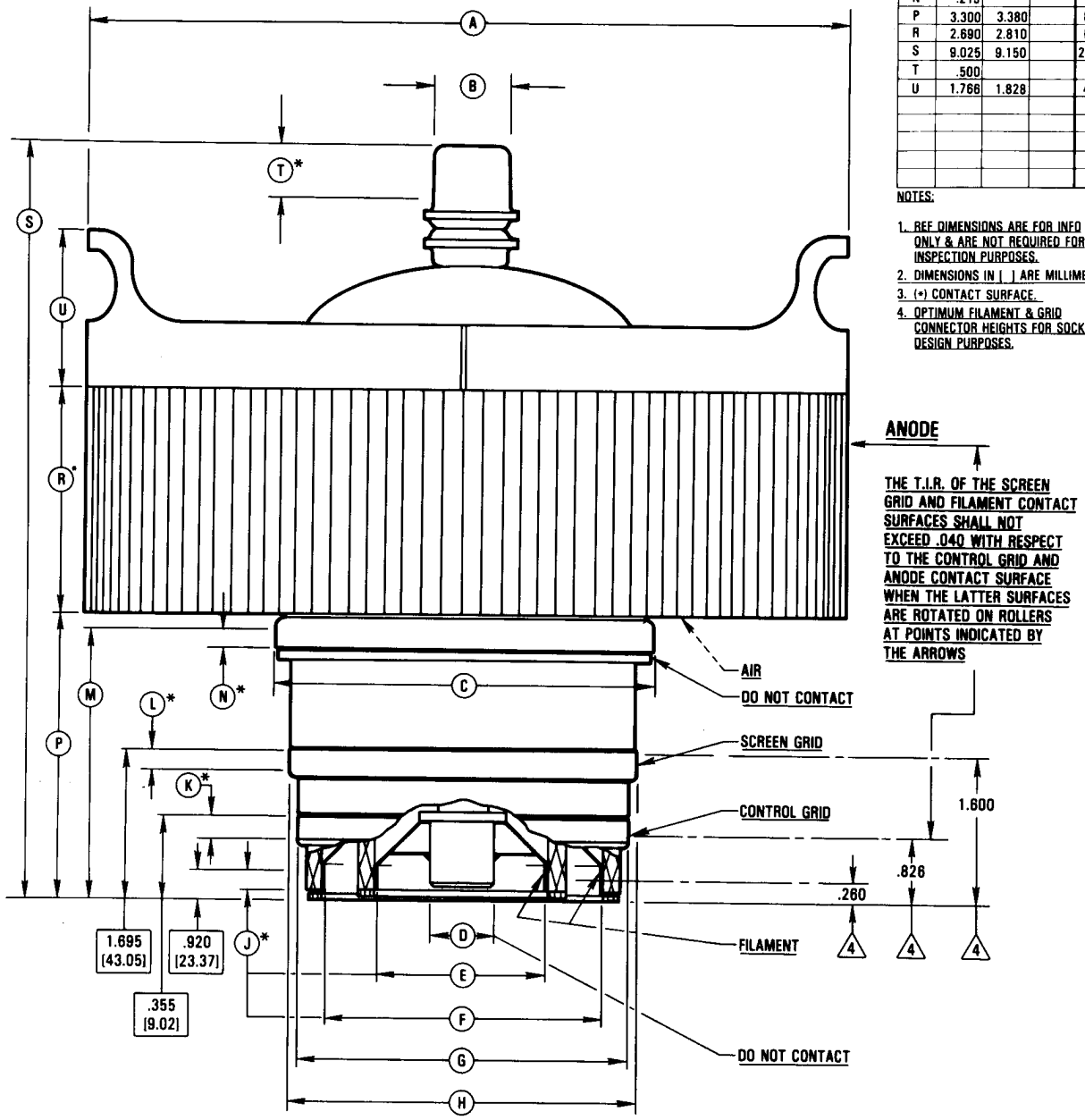


CURVE #5467

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM	MIN	MAX	REF	MIN	MAX	REF
A	8.730	8.860		221.74	225.04	
B	.855	.895		21.72	22.73	
C	4.406	4.468		111.91	113.49	
D	.600	.760		15.24	19.30	
E	1.896	1.936		48.16	49.17	
F	3.133	3.173		79.58	80.59	
G	3.792	3.832		96.32	97.33	
H	3.980	4.020		101.09	102.11	
J	.188			4.78		
K	.188			4.78		
L	.188			4.78		
M	3.160	3.220		80.26	81.79	
N	.219			5.56		
P	3.300	3.380		83.82	85.85	
R	2.690	2.810		68.32	71.37	
S	9.025	9.150		229.24	232.41	
T	.500			12.70		
U	1.766	1.828		44.86	46.43	

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. DIMENSIONS IN [ ] ARE MILLIMETERS.
3. (*) CONTACT SURFACE.
4. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES.



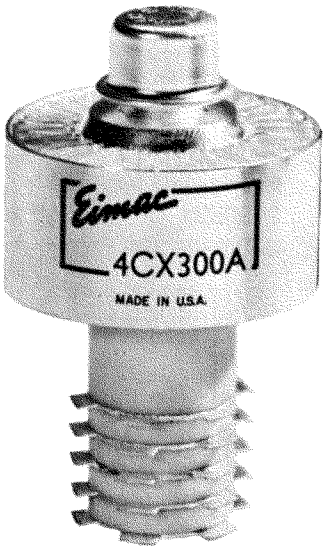
TENTATIVE DATA

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

4CX300A

CERAMIC POWER TETRODE

The Eimac 4CX300A is an integral-finned external-anode miniature power tetrode having a plate dissipation rating of 300 watts. The 4CX300A may be operated at full ratings at frequencies up to 500 megacycles. The all-ceramic-and-metal construction and the internally-unitized electrode structure combine to make the 4CX300A especially durable and free of mechanically-induced noise under conditions of severe acceleration caused by shock or vibration.



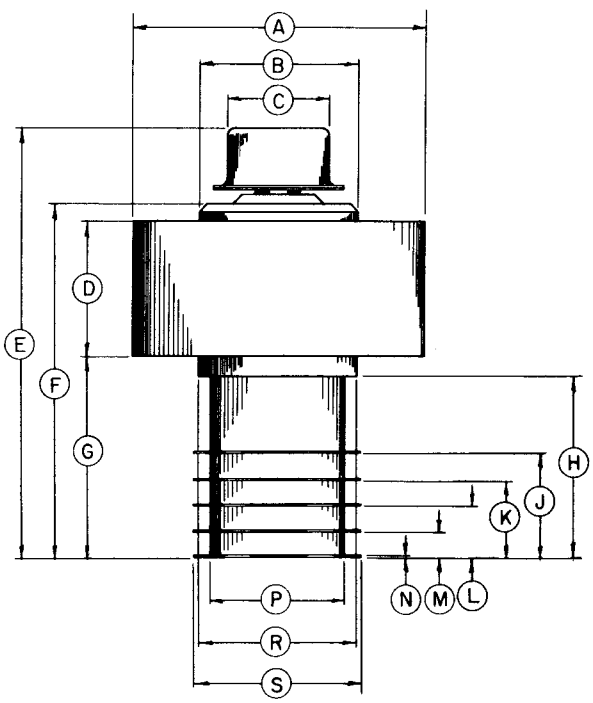
GENERAL CHARACTERISTICS

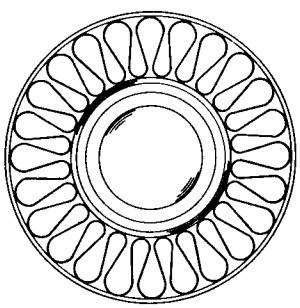
ELECTRICAL

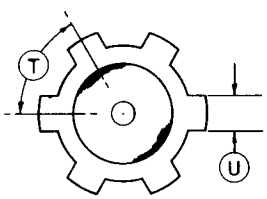
Cathode: Unipotential, Oxide-coated		
Heater Voltage	6.0	volts
Heater Current	2.75	amperes
Heating Time (Minimum)	30	seconds
Grid-Screen Amplification Factor	5.0	
Transconductance (at I_b=0.20 ampere)	12,000	u-mhos
Direct Interelectrode Capacitances:		
Input	29.5	uufds
Output	4.8	uufds
Feedback	0.04	uufds
Highest Frequency for Maximum Ratings	500	megacycles

MECHANICAL

Base	Special, breechlock terminal surfaces
Recommended Socket	Eimac X-648
Operating Position	Any
Max Rated Body Temperature	250°C.
Cooling	Forced Air
Maximum Over-all Dimensions:	
Height	2.4 inches
Diameter	1.65 inches
Net Weight	3.75 ounces
Shipping Weight	1.5 pounds







REF.	NOM.
A	1.625 Dia.
B	.883 Dia.
C	.566 Dia.
D	¾
E	2⅜
F	1.961
G	1.116
H	1.021
J	.564
K	.423
L	.282
M	.141
N	.010 (Typ.)
P	.750 Dia.
R	.883 Dia.
S	.938 Dia.
T	60°
U	.200

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RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	300 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 175 Mc, per tube)

D-C Plate Voltage	500	1000	1500	2000	volts
D-C Screen Voltage	250	250	250	250	volts
D-C Grid Voltage	—90	—90	—90	—90	volts
D-C Plate Current	250	250	250	250	ma
D-C Screen Current	45	35	30	25	ma
D-C Grid Current	32	28	28	27	ma
Peak R-F Grid Voltage (approx.)	118	116	116	115	volts
Driving Power	3.6	3.2	3.2	2.8	watts
Plate Power Input	125	250	375	500	watts
Plate Power Output	85	195	300	410	watts

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	1500 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	200 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 175Mc, per tube)

D-C Plate Voltage	500	1000	1500	volts
D-C Screen Voltage	250	250	250	volts
D-C Grid Voltage	—100	—100	—100	volts
D-C Plate Current	200	200	200	ma
D-C Screen Current	45	35	25	ma
D-C Grid Current	22	19	17	ma
Peak R-F Grid Input Voltage	124	122	121	volts
Driving Power	2.7	2.3	2.1	watts
Plate Power Input	100	200	300	watts
Plate Power Output	75	160	250	watts

CLASS-AB POWER AMPLIFIER OR MODULATOR

MAXIMUM RATINGS (Per tube)

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	300 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION
Class-AB_1 Audio Amplifier (Sinusoidal wave, two tubes unless otherwise noted)

D-C Plate Voltage	1000	1500	2000	volts,
D-C Screen Voltage	350	350	350	volts
D-C Grid Voltage (approx.)*	—50	—50	—50	volts
Zero-Signal D-C Plate Current	200	200	200	ma
Max-Signal D-C Plate Current	500	500	500	ma
Max-Signal D-C Screen Current	50	40	30	ma
Effective Load, Plate-to-Plate	3260	5760	8260	ohms
Peak A-F Grid Input Voltage (per tube)	50	50	50	volts
Driving Power	0	0	0	watts
Max-Signal Plate Dissipation (per tube)	125	150	175	watts
Max-Signal Plate Power Output	250	450	650	watts
Third-Harmonic Distortion	4.5	4.5	4.5	pct

*Adjust grid voltage to obtain specified zero-signal plate current

TYPICAL OPERATION
Class-AB_1 R-F Linear Amplifier (Frequencies to 175 Mc, per tube)

D-C Plate Voltage	1000	1500	2000	volts
D-C Screen Voltage	350	350	350	volts
D-C Grid Voltage (approx.)*	—50	—50	—50	volts
Zero-Signal D-C Plate Current	100	100	100	ma
Max-Signal D-C Plate Current	250	250	250	ma
Max-Signal D-C Screen Current	25	20	15	ma
Peak R-F Grid Voltage	50	50	50	volts
Driving Power	0	0	0	watts
Max-Signal Plate Dissipation	125	150	175	watts
Max-Signal Plate Power Output	125	225	325	watts

*Adjust grid voltage to obtain specified zero-signal plate current

Note: Typical operation data are based on conditions of adjusting the r-f grid drive to a specified plate current, maintaining fixed conditions of grid bias and screen voltage. It will be found that if this procedure is followed, there will be little variation in power output between tubes even though there may be some variation in grid and screen currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

APPLICATION

MECHANICAL

Mounting—The 4CX300A may be operated in any position. The recommended socket for the 4CX300A is the Eimac Air-System Socket type X-648. This socket provides low-inductance connections to all the external circuits except the plate circuit, and incorporates a screen by-pass capacitor in its structure. The breech-block terminal arrangement provides firm mechanical retention of the tube when subjected to shock or vibration.

Cooling—The maximum rated surface temperature for any part of the 4CX300A is 250°C. Adequate forced-air cooling facilities must be provided to assure that this maximum temperature rating is not exceeded. At sea level with an ambient temperature of 20°C adequate cooling for 300 watts plate dissipation can be obtained with an air flow rate of 6.5 CFM, corresponding to a pressure drop of 0.35 inches of water column across the X-648 socket and the cooling-fin assembly of the tube. (Air flow rate in CFM is approximately eleven times the square root of the pressure differential across tube and socket.)

At high altitudes and high ambient temperatures the flow rates must be increased to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using the maximum rated temperature as the criterion for satisfactory cooling.

Cooling effectiveness should also be determined on an individual basis if the 4CX300A is operated immersed in an insulating fluid such as silicone oil, again using the maximum rated temperature as the criterion.

Impact and Vibration—The 4CX300A is designed to operate without failure under impact or vibration conditions capable of disabling a conventional tube of similar power capabilities. Impact forces up to 50g with 11 milli-sec duration time, or vibratory accelerations up to 20g at frequencies from 20 to 2000 cycles per second, will not cause a normal 4CX300A to malfunction.

It is not suggested that the 4CX300A be subjected to abusive treatment unneccessarily, but in applications where operation under severe environmental conditions is unavoidable the 4CX300A will provide more reliable service than will conventional tubes.

ELECTRICAL

Heater Operation—The rated heater voltage for the 4CX300A is 6.0 volts, and the corresponding heater current is 2.75 amperes. At frequencies higher than 300 megacycles the heater voltage should be reduced according to the following schedule:

Frequency (Mc.)	Heater Voltage (Volts)
Up to 300	6.00
300 to 400	5.75
400 to 500	5.50

The heater voltage must be maintained within ±5% of the selected operating voltage if variations in circuit performance are to be minimized and best tube life obtained.

Cathode Operation—The 4CX300A employs a cylindrical indirectly-heated oxide-coated unipotential cathode. The minimum warm-up time is 30 seconds when rated heater voltage is applied.

Grid Operation—The 4CX300A control grid has a maximum dissipation rating of 2.0 watts, and precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the Typical Operation sections of the data sheet whenever possible.

At frequencies higher than 300 Mc., the driving power required by the circuits associated with the tube begins to increase, until at 500 Mc., as much as 30 watts driving power may be required. The power dissipated by the control grid increases only slightly, however, in spite of the greatly increased driving power required by the circuit.

In stable amplifiers, where the bias is not unnecessarily high, d-c grid current values below approximately 15 milliamperes indicate safe grid operation. In class-A and class AB_1 amplifiers, where no grid current flows, the grid bias voltage may be applied through a resistor. The maximum permissible series resistance per tube is 100,000 ohms.

Screen Operation—The maximum rated screen dissipation for the 4CX300A is 12 watts. The maximum rated d-c screen supply voltage rating is 300 volts when the tube is operated in class-C amplifier or oscillator service, and 400 volts when the tube is operated in class-AB or class-B amplifier service.

Under certain operating conditions the screen current of a tetrode may reverse. This makes it dangerous to rely on a screen dropping resistor or a series regulator to supply the screen voltage unless a bleeder or regulator tube is connected from screen to cathode. This bleeder should draw at least 15 milliamperes per tube connected to the screen supply.

The power input to the screen can be calculated from the voltage and current whenever the screen to cathode potential does not vary. Screen modulation or cathode driving of tetrode amplifiers can lead to errors in measurement of screen input when the effective voltage and current exceed the indicated d-c values. When there is reason to suspect that the screen input exceeds the indicated power, it is advisable to maintain the indicated screen power input below approximately 75% of the rated screen dissipation.

An 1100-uufd screen by-pass capacitance is incorporated into the body of the recommended Eimac Air-System Socket for the 4CX300A, adequate for normal amplifier operation at high- and ultra-high radio frequencies. Operation at low radio frequencies and at audio frequency may require additional capacitance to be connected externally. In the latter case, the screen by-pass capacitance within the socket helps to eliminate the high-frequency parasitic oscillations occasionally encountered in tetrode amplifiers.

The self-neutralizing frequency of the 4CX300A is above the useful high frequency limit for the tube when the recommended socket is used.

Plate Operation—The 4CX300A has a finned external anode for forced-air cooling. Connection to the anode may be made to the 9/16-inch diameter top cap or to the 1-5/8-inch diameter cylindrical cooler shell. The latter is usually used when the tube is installed in coaxial lines or cavities.

The absolute maximum plate dissipation rating for the 4CX300A is 300 watts, which is also the rated maximum dissipation for class-C amplifier or oscillator applications and for class-B or class-AB amplifier applications. When the 4CX300A is used in plate-modulated amplifier applications, the plate dissipation rating is 200 watts under carrier conditions, rising to 300 watts under 100% sine-wave modulation. Plate dissipation may be permitted to exceed the maximum rated value for brief periods, such as may occur while tuning.

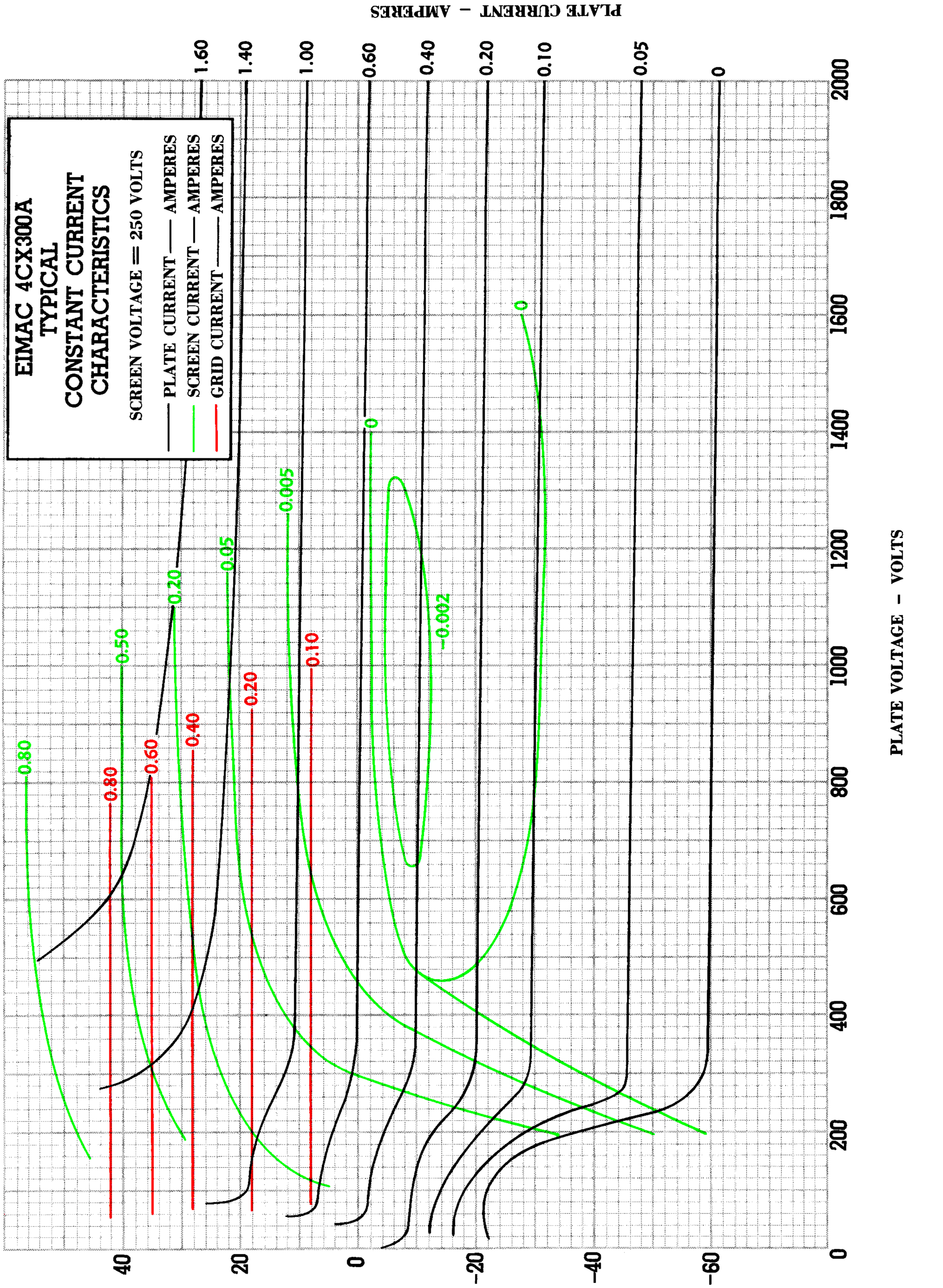
The absolute maximum rated plate voltage is 2000 volts for all except plate modulated amplifier applications, for which the rated maximum is 1500 volts.

Modulation—The 4CX300A can be modulated by any of the methods commonly used with tetrode tubes. Its large reserve plate dissipation makes it especially suited for use in screen-modulated and linear amplifiers in which the plate efficiency is low.

Plate modulation can be applied to the 4CX300A when it is operated as a class-C amplifier. To obtain 100% modulation with minimum distortion the screen voltage supply should be modulated in phase with the modulation applied to the plate supply voltage. Screen voltage modulation factors between 0.75 and 1.00 may be used.

"Self-modulation" of the screen by means of a resistor or reactance in series with the screen supply line is not recommended, because of the effects which require a bleeder from screen to cathode as described under "Screen Operation," above.

Special Applications—If it is desired to operate this tube under conditions widely different than those given here, write to Eitel-McCullough, Inc., San Bruno, California, for information and recommendations.



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EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

4CX300Y

CERAMIC POWER TETRODE

The EIMAC 4CX300Y is a compact integral-finned external-anode power tetrode having a maximum plate-dissipation rating of 400 watts. The 4CX300Y may be operated at maximum ratings to 110 MHz.

The all-ceramic-and-metal construction and the internally-unitized electrode structure combine to make the 4CX300Y especially durable and free from mechanically-induced noise under conditions of severe acceleration caused by shock or vibration.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide-Coated, Unipotential				
Heating Time	30	60		S
Cathode-to-Heater Potential			±150	V
Heater: Voltage (See "Application")		6.0		V
Current (E_f=6.0 volts)	3.0		3.85	A
Amplification Factor (Grid to Screen)	4.0		5.6	
Transconductance (I_b=200 ma.)		12,000		μmhos

Direct Interelectrode Capacitances, Grounded Cathode:	Min.	Nom.	Max.	
Input	30		38	pF
Output	3.9		5.0	pF
Feedback			0.07	pF
Direct Interelectrode Capacitances, Grounded Grid and Screen:				
Input		18		pF
Output	3.9		5.0	pF
Feedback		0.01		pF
Frequency for Maximum Ratings			110	MHz

MECHANICAL

Base	Special, breechblock terminal surfaces	
Recommended Socket	EIMAC SK-700 Series	
Operating Position	Any	
Maximum Operating Temperatures:		
Ceramic-to-Metal Seals	250°C	
Anode Core	250°C	
Cooling	Forced Air	
Maximum Over-All Dimensions:		
Height	2.5	in
Diameter	1.65	in
Net Weight	4	oz
Shipping Weight (Approximate)	1	lb

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Printed in U.S.A.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 VOLTS
DC SCREEN VOLTAGE	300 VOLTS
DC GRID VOLTAGE	—250 VOLTS
DC PLATE CURRENT	400 MA
PLATE DISSIPATION	400 WATTS
SCREEN DISSIPATION	8 WATTS
GRID DISSIPATION	1 WATT

TYPICAL OPERATION

DC Plate Voltage	1000	1500	2000 volts
DC Screen Voltage	250	250	250 volts
DC Grid Voltage	—90	—90	—90 volts
DC Plate Current	0.38	0.4	0.4 amps
DC Screen Current*	31	26	26 mA
DC Grid Current*	32	33	33 mA
Peak RF Grid Voltage*	110	110	110 volts
Driving Power*	3.5	3.8	3.8 watts
Plate Input Power	380	600	800 watts
Plate Output Power	240	425	600 watts

*Approximate values

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	2000 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC PLATE CURRENT	400 MA
PLATE DISSIPATION	400 WATTS
SCREEN DISSIPATION	8 WATTS
GRID DISSIPATION	1 WATT

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

DC Plate Voltage	1000	1500	2000 volts
DC Screen Voltage	400	400	400 volts
DC Grid Voltage[1]	—60	—70	—70 volts
Zero-Signal DC Plate Current	400	200	200 mA
Max-Signal DC Plate Current	800	790	750 mA
Max-Signal DC Screen Current	24	16	4 mA
Effective Load, Plate to Plate	2060	3000	5100 ohms
Peak AF Grid Input Voltage (per tube)*	55	65	60 volts
Driving Power	0	0	0 watts
Max-Signal Plate Output Power	340	800	890 watts

*Approximate values
[1]Adjust grid bias to obtain listed zero-signal plate current.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1 (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC PLATE CURRENT	400 MA
PLATE DISSIPATION	400 WATTS
SCREEN DISSIPATION	8 WATTS
GRID DISSIPATION	1 WATT

TYPICAL OPERATION

DC Plate Voltage	1000	1500	2000 volts
DC Screen Voltage	400	400	400 volts
DC Grid Voltage[1]	—60	—70	—70 volts
Zero-Signal DC Plate Current	200	100	100 mA
DC Plate Current	280	210	205 mA
DC Screen Current*	—5	—5	—5 mA
Peak RF Grid Voltage*	28	33	30 volts
Plate Output Power	52	110	115 watts

*Approximate values.
[1]Adjust grid bias to obtain listed zero-signal plate current.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1 (Single-Sideband Suppressed-Carrier Operation)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC PLATE CURRENT	400 MA
PLATE DISSIPATION	400 WATTS
SCREEN DISSIPATION	8 WATTS
GRID DISSIPATION	1 WATT

TYPICAL OPERATION (Peak-envelope conditions except where noted)

DC Plate Voltage	1000	1500	2000 volts
DC Screen Voltage	400	400	400 volts
DC Grid Voltage[1]	—60	—70	—70 volts
Zero-Signal DC Plate Current	200	100	100 mA
Peak RF Grid Voltage*	55	65	60 volts
DC Plate Current	400	395	375 mA
DC Screen Current*	12	8	2 mA
Plate Input Power	400	590	750 watts
Plate Output Power	170	400	415 watts
Two-Tone Average DC Plate Current			
Two-Tone Average DC Screen Current			

*Approximate values.
[1]Adjust grid bias to obtain listed zero-signal plate current.

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	1500 VOLTS
DC SCREEN VOLTAGE	300 VOLTS
DC GRID VOLTAGE	—250 VOLTS
DC PLATE CURRENT	300 MA
PLATE DISSIPATION	250 WATTS
SCREEN DISSIPATION	8 WATTS
GRID DISSIPATION	1 WATT

TYPICAL OPERATION

DC Plate Voltage	1000	1500	volts
DC Screen Voltage	250	250	volts
DC Grid Voltage	—130	—130	volts
DC Plate Current	285	300	mA
DC Screen Current*	24	18	mA
DC Grid Current*	17	17	mA
Peak RF Grid Input Voltage*	148	148	volts
Driving Power*	1.7	1.7	watts
Plate Input Power	285	500	watts
Plate Output Power	165	300	watts

*Approximate values.

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance has been made for circuit losses. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variation in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf driving voltage is applied.

APPLICATION

MECHANICAL

Mounting — The 4CX300Y may be operated in any position. Recommended sockets for the 4CX300Y are the EIMAC Air-System Sockets type SK-700 (ungrounded cathode) or type SK-710 (cathode and one heater contact grounded). Both sockets provide connections to all electrodes except the anode and each incorporates a screen by-pass capacitor of approximately 1100 pF. The SK-606 chimney is recommended for use with the SK-700 and SK-710 sockets.

Other sockets suitable for use with the 4CX300Y include the SK-740, SK-760, and SK-770. These sockets do not incorporate screen by-pass capacitors. The SK-760 and SK-770 incorporate integral air chimneys. Screen contacts are connected to the mounting flange in the SK-770 and are, therefore, grounded when the socket is installed in the usual manner.

Cooling — The maximum rated ceramic-to-metal seal temperature for the 4CX300Y is 250°C. Adequate forced-air cooling must be provided to assure that this maximum temperature rating is not exceeded. Air-flow requirements to maintain seal temperatures at 200°C in 50°C ambient air are tabulated below.

Plate Dissipation (Watts)	SEA LEVEL		10,000 FEET	
	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
100	2.2	0.065	3.2	0.095
150	3.4	0.14	4.9	0.21
200	4.6	0.26	6.7	0.37
250	5.9	0.40	8.6	0.58
300	7.2	0.58	10.5	0.85
350	8.7	0.82	12.7	1.2
400	10.3	1.12	15.0	1.6

A new, more efficient cooling fin design is incorporated in the 4CX300Y which results in lower air-flow requirements. This is reflected in the table above (which assumes the use of an EIMAC SK-700 or SK-710 socket and SK-606 chimney).

At high altitudes and high ambient temperatures the flow rate must be increased to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using the maximum rated temperature as the criterion for satisfactory cooling.

Cooling effectiveness should also be determined on an individual basis if the 4CX300Y is operated immersed in an insulating fluid such as silicone oil, again using the maximum rated temperature as the criterion.

ELECTRICAL

Heater Operation — The rated heater voltage for the 4CX300Y is 6.0 volts.

The heater voltage must be maintained within ±5% of the selected operating voltage if variations in circuit performance are to be minimized and best tube life obtained.

Cathode Operation — The 4CX300Y employs a cylindrical indirectly-heated oxide-coated unipotential cathode. The minimum warm-up time is 30 seconds when rated heater voltage is applied.

Grid Operation — The 4CX300Y control grid has a maximum dissipation rating of 1.0 watt, and precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the Typical Operation sections of the data sheet whenever possible.

In class-A and class AB_1 amplifiers, where no grid current flows, the grid bias voltage may be applied through a resistor. The maximum permissible series resistance per tube is 100,000 ohms.

Screen Operation — The maximum rated screen dissipation for the 4CX300Y is 8 watts. The maximum rated dc screen supply voltage is 300 volts when the tube is operated in class-C amplifier or oscillator service, and 400 volts when the tube is operated in class-AB_1 or class-B amplifier service.

Under certain operating conditions the screen current of a tetrode may reverse. This makes it dangerous to rely on a screen-dropping resistor or a series regulator to supply the screen voltage unless a bleeder or regulator tube is connected from screen to cathode. This bleeder should draw at least 15 milliamperes for each tube connected to the screen supply.

The power input to the screen can be calculated from the voltage and current whenever the screen-to-cathode potential does not vary. Screen modulation or cathode driving of tetrode amplifiers can lead to errors in measurement of screen input when the effective voltage and current exceed the indicated dc values. When there is reason to suspect that the screen input exceeds the indicated power, it is advisable to maintain the indicated screen power input below approximately 75% of the rated screen dissipation.

A screen by-pass capacitor of approximately 1100 $\mu\mu$f is incorporated in the body of the EIMAC SK-700 and SK-710 Air-System Sockets and is adequate for normal amplifier operation at high and ultra-high radio frequencies. Operation at low radio frequencies or audio frequencies may require that additional capacitance be connected externally. In the latter case, the screen by-pass capacitance within the socket helps to eliminate the high-frequency parasitic oscillations occasionally encountered in tetrode amplifiers.

The self-neutralizing frequency of the 4CX300Y is above the useful high-frequency limit for the tube when either of the sockets with integral screen by-pass capacitors is used.

Plate Operation—The 4CX300Y has a finned external anode for forced-air cooling. Connection to the anode may be made at the top cap or cylindrical cooler shell. The latter is usually used

when the tube is installed in coaxial lines or cavities.

The absolute maximum plate-dissipation rating for the 4CX300Y is 400 watts, which is also the rated maximum dissipation for class-C amplifier or oscillator applications and for class-B or class-AB_1 amplifier applications. When the 4CX300Y is used in plate-modulated amplifier applications, the plate-dissipation rating is 250 watts under carrier conditions, rising to 400 watts under 100% sine-wave modulation. Plate dissipation may be permitted to exceed the maximum rated value for brief periods, such as may occur while tuning.

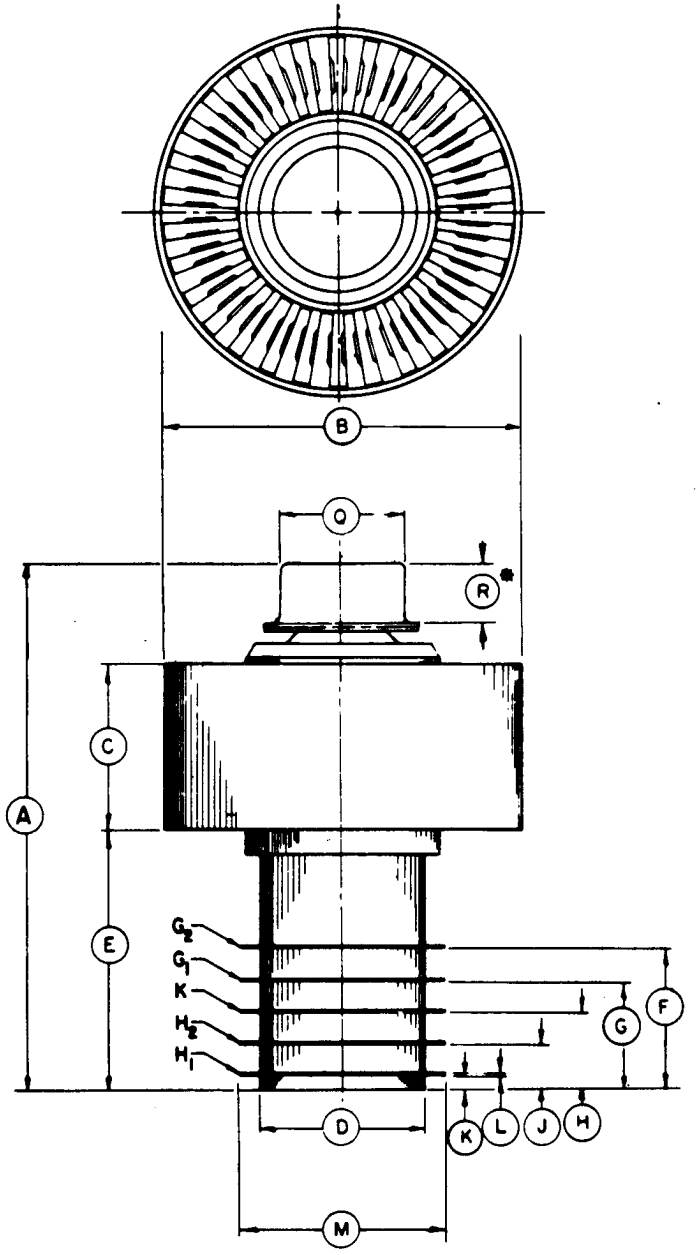
The maximum rated plate voltage for class-AB_1 operation is 2000 volts. In class-C telegraphy and plate-modulated service the maximum rated plate voltage is 2000 and 1500 volts respectively.

Modulation — The 4CX300Y can be modulated by any of the methods commonly used with tetrode tubes. Its large reserve plate dissipation makes it especially suited for use in screen-modulated and linear amplifiers in which the plate efficiency is low.

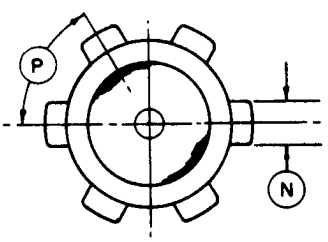
Plate modulation can be applied to the 4CX300Y when it is operated as a class-C amplifier. To obtain 100% modulation with minimum distortion the screen supply voltage should be modulated in phase with the modulation applied to the plate supply voltage. Screen voltage modulation factors between 0.75 and 1.00 may be used.

"Self-modulation" of the screen by means of a resistor in series with the screen supply line is not recommended because of the effects which require a bleeder from screen to cathode as described under "Screen Operation" above.

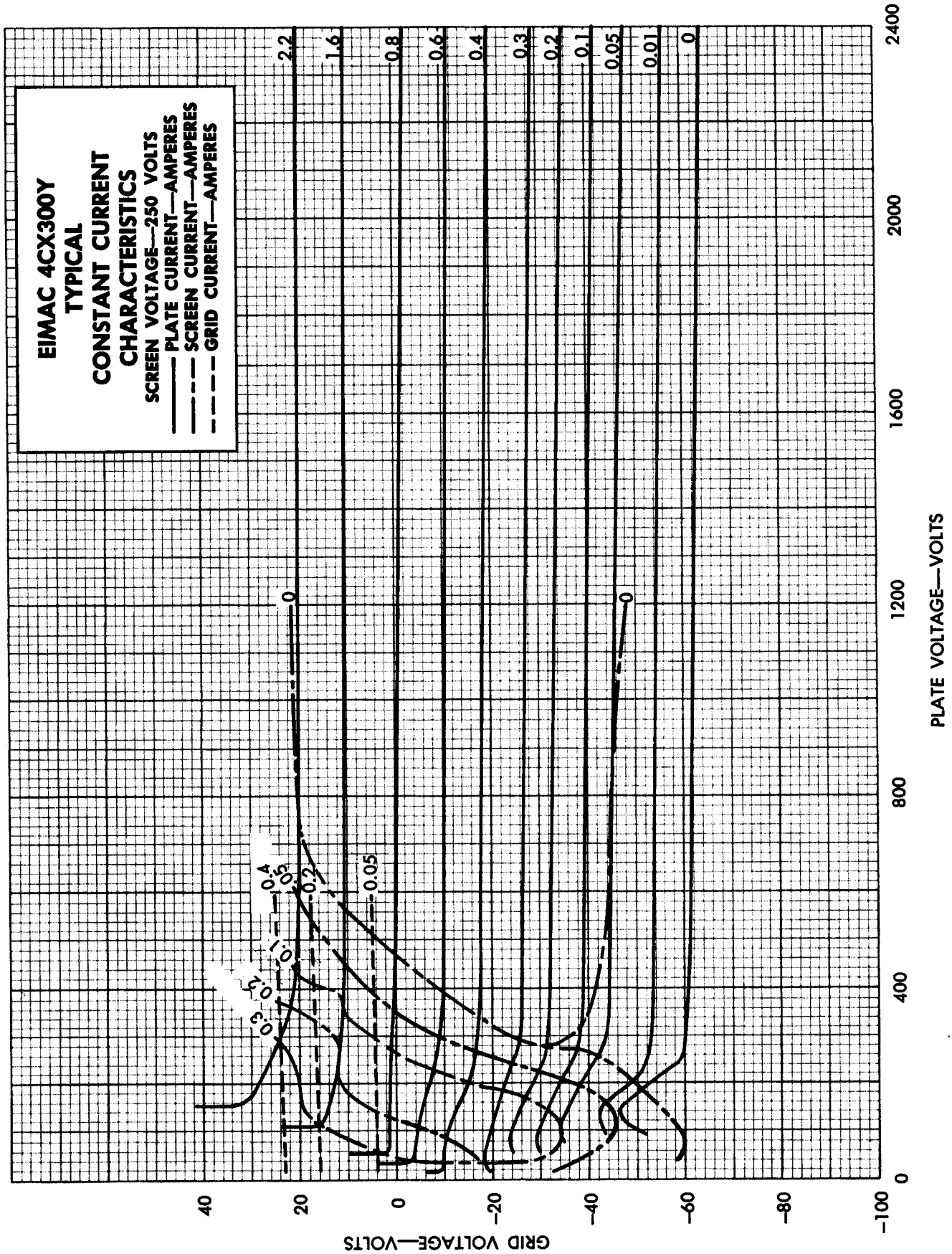
Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California, for information and recommendations.

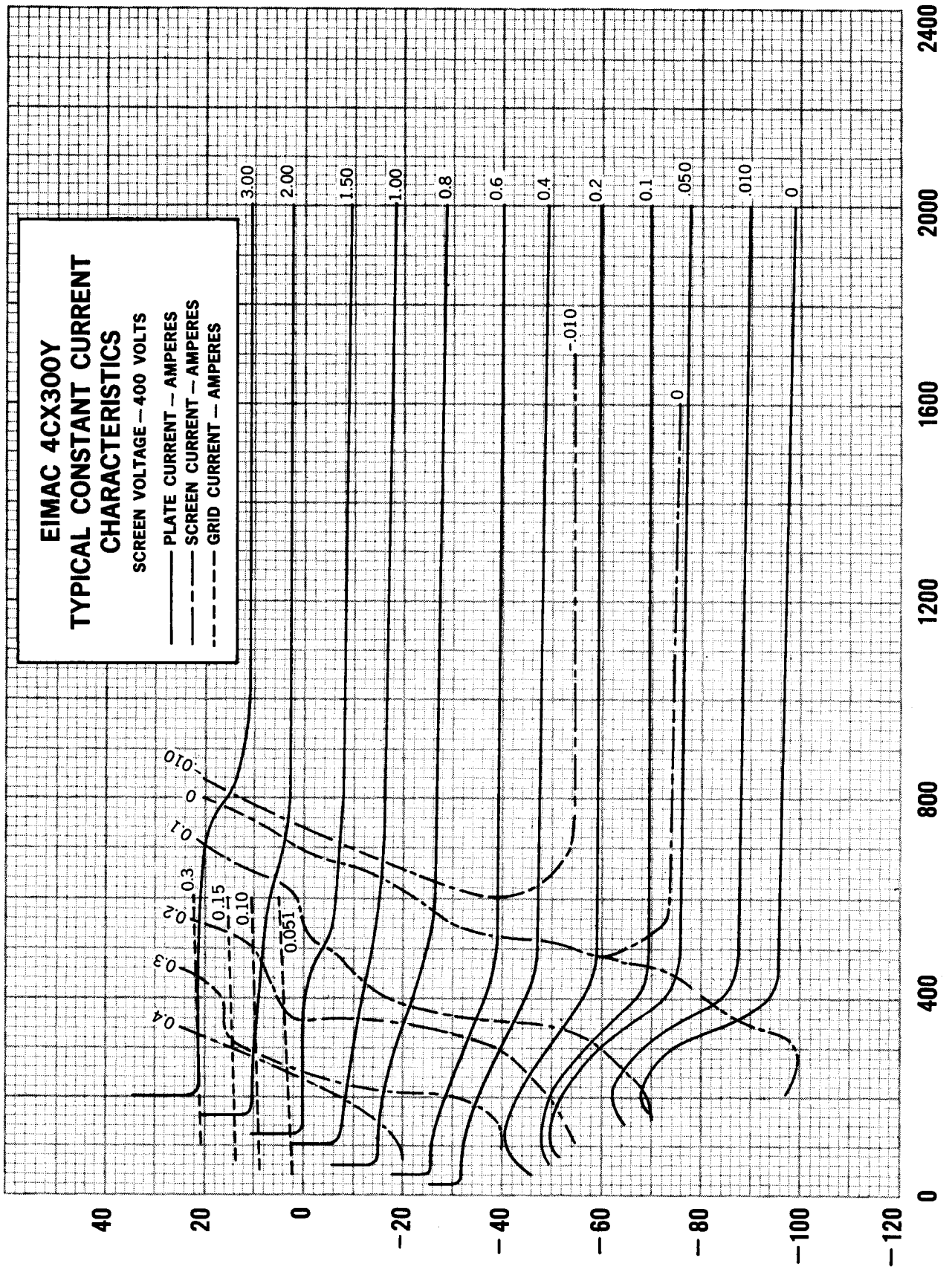


DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		2.300	2.500
B		1.610	1.640
C		.710	.790
D		.740	.770
E		1.133	1.195
F		.602	.642
G		.470	.500
H		.329	.359
J		.193	.213
K		.050	.072
L		.010	.020
M		.936	.956
N		.170	.185
P	60°		
Q		.559	.573
R		.240	.280



*CONTACT SURFACE


EIMAC 4CX300Y
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE—250 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
2.2
1.6
0.8
0.6
0.4
0.3
0.2
0.1
0.05
0.01
0
0.4
0.5
0.2
0.1
0.3
0.05
40
20
0
−20
−40
−60
−80
−100
0
400
800
1200
1600
2000
2400
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—VOLTS


EIMAC 4CX300Y
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE — 400 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
3.00
2.00
1.50
1.00
0.8
0.6
0.4
0.2
0.1
.050
.010
0
-.010
0.4
0.3
0.2
0.15
0.10
0.051
0.1
0
-.010
40
20
0
−20
−40
−60
−80
−100
−120
0
400
800
1200
1600
2000
2400
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4CX35,000A/ 4CX35,000C

Radial-Beam

Power Tetrodes

The Eimac 4CX35,000A and 4CX35,000C ceramic-metal power tetrodes are intended for use at the fifty kilowatt output power level. The 4CX35,000A is recommended for use as a Class-C r-f amplifier or oscillator, Class-AB_1 r-f amplifier, or Class-AB_1 push-pull a-f amplifier or modulator. The 4CX35,000C is a special version with a longer screen-anode insulator intended specifically for use as a plate-and screen-modulated Class-C r-f amplifier. Both types carry full ratings to 110 megacycles.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten			
Voltage		10.0	Volts
Current		300	Amperes
Amplification Factor (Grid-Screen) (Average)		5.5	
Direct Interelectrode Capacitances, Grounded Cathode (Average):			
Tube Type:	4CX35,000A	4CX35,000C	
Input	415	445	μμf
Output	45	45	μμf
Feedback	2.3	2.3	μμf
Frequency for Maximum Ratings		110	Megacycles

MECHANICAL

Base		Special, graduated rings	
Recommended Socket		Eimac SK-1500	
Operating Position		Axis-vertical, base up or down	
Cooling		Forced air	
Maximum Seal Temperature		250°C	
Maximum Anode Core Temperature		250°C	
Maximum Over-all Dimensions:			
Tube Type:	4CX35,000A	4CX35,000C	
Height	13.5	15.5	Inches
Diameter	9.75	9.75	Inches
Net Weight	48	50	Pounds

March 15, 1962

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony

MAXIMUM RATINGS

D-C PLATE VOLTAGE	10,000	VOLTS
D-C SCREEN VOLTAGE	2500	VOLTS
D-C PLATE CURRENT	10.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1500	WATTS
GRID DISSIPATION	450	WATTS

TYPICAL OPERATION

D-C Plate Voltage	10,000	Volts
D-C Screen Voltage	750	Volts
D-C Grid Voltage	-425	Volts
D-C Plate Current	6.80	Amperes
D-C Screen Current	925	Ma
D-C Grid Current	320	Ma
Peak R-F Grid Voltage	575	Volts
Driving Power	185	Watts
Plate Dissipation	11,700	Watts
Plate Output Power	56,500	Watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

(Applies Only to 4CX35,000C)

Class-C Telephony (Carrier conditions except where noted)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	10,000	VOLTS
D-C SCREEN VOLTAGE	1250	VOLTS
D-C PLATE CURRENT	10.0	AMPERES
PLATE DISSIPATION	23,500	WATTS
SCREEN DISSIPATION	1500	WATTS
GRID DISSIPATION	450	WATTS

TYPICAL OPERATION

D-C Plate Voltage	10,000	Volts
D-C Screen Voltage	750	Volts
Peak A-F Screen Voltage (for 100-percent modulation)*	705	Volts
D-C Grid Voltage	-525	Volts
D-C Plate Current	6.70	Amperes
D-C Screen Current	1.05	Amperes
D-C Grid Current	315	Ma
Peak R-F Grid Voltage	680	Volts
Driving Power	215	Watts
Plate Dissipation (at 100% Modulation)*	17,100	Watts
Plate Output Power	55,600	Watts

* Approximate Value

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1, Grid-Driven

MAXIMUM RATINGS (Single-Tone Conditions)

D-C PLATE VOLTAGE	10,000	VOLTS
D-C SCREEN VOLTAGE	2500	VOLTS
D-C PLATE CURRENT	10.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1500	WATTS
GRID DISSIPATION	450	WATTS

TYPICAL OPERATION

D-C Plate Voltage	10,000	Volts
D-C Screen Voltage	1500	Volts
D-C Grid Voltage *	-290	Volts
Zero-Sig D-C Plate Current	2.00	Amperes
Max-Sig D-C Plate Current	8.75	Amperes
Max-Sig D-C Screen Current	270	Ma
Peak R-F Grid Voltage	265	Volts
Driving Power	0	Watts
Plate Dissipation	32,500	Watts
Max-Sig Plate Output Power	55,000	Watts
Resonant Load Impedance	590	Ohms

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per Tube)

D-C PLATE VOLTAGE	10,000	VOLTS
D-C SCREEN VOLTAGE	2500	VOLTS
D-C PLATE CURRENT	10.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1500	WATTS
GRID DISSIPATION	450	WATTS

TYPICAL OPERATION (Two Tubes, Sinusoidal Wave)

D-C Plate Voltage	10,000	Volts
D-C Screen Voltage	1500	Volts
D-C Grid Voltage *	-290	Volts
Zero-Sig D-C Plate Current	4.00	Amperes
Max-Sig D-C Plate Current	17.5	Amperes
Max-Sig D-C Screen Current	540	Ma
Peak A-F Driving Voltage (Per Tube)	265	Volts
Driving Power	0	Watts
Load Resistance, Plate-to-Plate	1180	Ohms
Plate Dissipation (Per Tube)	32,500	Watts
Max-Sig Plate Output Power	110,000	Watts

* Adjust grid voltage to obtain specified zero-signal plate current.

NOTE: In most cases, "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made. Exceptions are distinquished by a listing of "Useful" output power as opposed to "Plate" output power. Values appearing in these groups have been obtained from existing equipment and the output power is that measured at the load.

APPLICATION

MECHANICAL

MOUNTING - The 4CX35,000A or 4CX35,000C must be operated with its axis vertical. The base of the tube be down or up.

SOCKET - The Eimac SK-1500 Socket is recommended for use with the 4CX35,000A and 4CX35,000C. The SK-1500 is not an air-system socket.*

COOLING - The maximum temperature rating for the external surfaces of the 4CX35,000A and the 4CX35,000C is 250°C. Sufficient forced-air cooling must be provided to keep the temperature of the anode core and the temperature of the ceramic-metal seals below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below this maximum rating. Estimated air-flow requirements to maintain anode-core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated below for operation below 30 Mc. These data are for air flowing in the anode-to-base direction. At higher altitudes, higher frequencies, or higher ambient temperatures the flow rate must be increased to obtain equivalent cooling.

	SEA LEVEL		10,000 FEET	
Plate Dissipation** (Watts)	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
15,000	545	1.5	795	2.2
20,000	800	2.5	1170	3.6
35,000	1760	7.0	2560	10.2

** Since the power dissipated by the filament represents about 3000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 1950 watts, allowance has been made in preparing this tabulation for an additional 5000 watts dissipation.

ELECTRICAL

FILAMENT OPERATION - The rated filament voltage for the 4CX35,000A and the 4CX35,000C is 10.0 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate from the rated value by more than ± 5%.

SPECIAL APPLICATIONS - For additional data, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

* Separate base cooling is required.

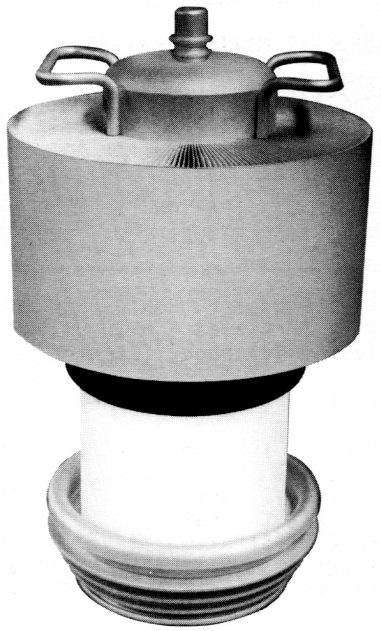
TECHNICAL DATA

4CX35,000D HF POWER TETRODE

The EIMAC 4CX35,000D is a ceramic/metal forced-air cooled power tetrode intended for use at the 50 to 150 kW output power level. It is recommended for use as a Class-C rf amplifier, a Class-AB rf linear amplifier, or a Class-AB push-pull audio amplifier or modulator. It is also useful as a plate and screen modulated Class-C rf amplifier.

The tube utilizes a rugged thoriated tungsten mesh cathode. It is interchangeable with the 8349/4CX35,000C and provides improved performance in many applications.

The forced-air cooled anode is rated at 35 kW maximum dissipation.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	10.0 ± 0.5	V
Current, at 10.0 volts	275	A
Amplification Factor (average)	4.5	
Direct Interelectrode Capacitance (grounded cathode) [2]		
Cin	445	pF
Cout	51	pF
Cgp	2.3	pF
Direct Interelectrode Capacitance (grounded grid) [2]		
Cin	195	pF
Cout	55	pF
Cpk	0.5	pF
Maximum Frequency for Full Ratings (CW)	30	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	17.34 In; 44.04 cm
Diameter	9.75 In; 24.77 cm
Net Weight	50 lb; 22.7 kg
Operating	Vertical, base up or down
Maximum Operating Temperature, Anode Core or Ceramic/Metal Seals	250°C
Cooling	Forced Air
Base	Special, graduated rings
Recommended Air-System Socket	EIMAC SK-1500A or SK-1510A
Available Screen Grid Bypass Capacitor Components	2300 pF - EIMAC P/N 149089
	1100 PF - EIMAC P/N 149090
	Required Set of Insulator Bushings - EIMAC P/N 149088
Available Anode Connector Clip	EIMAC ACC-3

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN
Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20 KILOVOLTS
DC SCREEN VOLTAGE	2.5 KILOVOLTS
DC GRID VOLTAGE	-2.0 KILOVOLTS
DC PLATE CURRENT	15 AMPERES
PLATE DISSIPATION	35 KILOWATTS
SCREEN DISSIPATION	1750 WATTS
GRID DISSIPATION	500 WATTS

* Approximate; will vary tube to tube.
\# Adjust to specified zero-signal dc plate current.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	10.00	15.0	kVdc
Screen Voltage	1500	1500	Vdc
Grid Voltage #	-350	-400	Vdc
Zero-Signal Plate Current	2.0	0.91	Adc
Single-Tone Plate Current	8.7	7.9	Adc
Single-Tone Screen Current *	0.23	0.16	Adc
Peak rf Grid Driving Voltage *	287	335	v
Peak Driving Power *	0	0	w
Plate Dissipation *	30	33	kW
Plate Output Power *	56.5	85	kW
Resonant Load Impedance	593	1019	Ohms

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VA4898

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RADIO FREQUENCY POWER AMPLIFIER
Class C Telegraphy or FM
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	15	AMPERES
PLATE DISSIPATION	35	KILOWATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	10.0	15.0	19.0	kVdc
Screen Voltage	750	750	750	Vdc
Grid Voltage	-425	-480	-550	Vdc
Plate Current	7.1	6.6	8.7	Adc
Screen Current *	0.35	0.39	0.25	Adc
Grid Current *	0.17	0.14	0.30	Adc
Peak rf Grid Driving Voltage *	528	570	690	v
Calculated Driving Power *	88	77	197	W
Plate Dissipation *	14.7	15	25	kW
Plate Output Power *	56.6	85	140	kW

* Approximate; will vary tube to tube.

PLATE MODULATED RADIO-FREQUENCY
POWER AMPLIFIER - GRID DRIVEN
Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17.5	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	15	AMPERES
PLATE DISSIPATION **	23	KILOWATTS
SCREEN DISSIPATION #	1750	WATTS
GRID DISSIPATION #	500	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	10	15	kVdc
Screen Voltage	750	750	Vdc
Grid Voltage	-520	-540	Vdc
Plate Current	7.1	6.9	Adc
Screen Current *	0.22	0.21	Adc
Grid Current *	0.18	0.19	Adc
Peak af Screen Voltage (100% modulation)##	540	530	v
Peak rf Grid Driving Voltage *	640	655	v
Calculated Driving Power *	130	120	W
Plate Dissipation *	10.6	13.6	kW
Plate Output Power *	60	90	kW
Resonant Load Impedance	705	1110	Ohms

* Approximate; will vary tube to tube.
** Corresponds to 35 kilowatts at 100% sine-wave modulation.
\# Average, with or without modulation.
Approximate, depending on degree of driver modulation.

AUDIO FREQUENCY POWER AMPLIFIER
OR MODULATOR
Class AB, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	15	AMPERES
PLATE DISSIPATION	35	KILOWATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

* Approximate; will vary tube to tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	10	15	kVdc
Screen Voltage	1500	1500	Vdc
Grid Voltage * #	-350	-410	Vdc
Zero-Signal Plate Current	4.0	1.8	Adc
Max.Signal Plate Current	17.4	15.8	Adc
Max.Signal Screen Current *	0.46	0.32	Adc
Peak af Grid Driving Voltage * ##	287	335	v
Max.Signal Plate Dissipation * ##	30.3	33	kW
Plate Output Power *	113	170	kW
Load Resistance (plate to plate)	1190	2040	Ohms

\# Adjust to give stated zero-signal plate current.
Per tube.

TYPICAL OPERATION values are obtained by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

RANGE VALUES FOR EQUIPMENT DESIGN:	MIN.	MAX.	
Filament Current, at 10.0 Volts[1]	260	290	A
Interelectrode Capacitance (grounded cathode connection)[1]			
Cin	410	480	pF
Cout	46	56	pF
Cgp	1.5	3.2	pF
Interelectrode Capacitance (grounded grid connection)[1]			
Cin	185	215	pF
Cout	50	60	pF
Cpk	---	0.6	pF

1 Measured in a specially shielded fixture in accordance with EIA Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX35,000D must be operated with its axis vertical, base up or down at the option of the equipment designer.

SOCKET - Air-system sockets SK-1500A and SK-1510A have been designed especially for the concentric base terminals of the 4CX35,000D. The SK-1510A includes a tube seating & locking device. Special screen bypass capacitor dielectrics are available and the EIMAC part numbers are shown on Page 1.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250°C. Sufficient forced-air cooling must be provided to maintain the anode at the base of the cooling fins, and the ceramic/metal seals, below 250°C.

Air flow requirements to maintain anode core temperature at 225°C with 40°C ambient cooling air are tabulated below (for operation below 30 MHz). This data is for flow in the base-to-anode direction; pressure drop figures are in inches of water, are for the anode cooler only, and are approximate.

	SEA LEVEL		10,000 FEET	
Plate Diss. (watts)	Air Flow (cfm)	Press. Drop	Air Flow (cfm)	Press. Drop
15,000	440	1.0	635	1.5
20,000	650	2.0	935	2.9
25,000	975	3.8	1400	5.5
30,000	1300	6.0	1870	8.6
35,000	1760	9.6	2535	13.8

The blower selected in any given application must be able to supply the desired air flow at a back pressure equal to the pressure drop shown above plus any drop(s) encountered in ducts and filters.

Separate cooling of the tube base is required and is accomplished by directing approximately 120 cfm of air horizontally through the socket from the side. It is preferable to direct this air through three equally spaced ducts. Temperature of spring contacts in the socket should not exceed 150°C to provide proper socket life.

The well in the center of the baseplate of the tube is a critical area which requires cooling to maintain envelope temperatures less than 250°C. For most applications, 1 to 2 cfm of air directed through the center of the socket is sufficient.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases. The designer is reminded that it is considered good engineering practice to allow some safety factor so the tube is not operated at the absolute maximum temperature rating. Temperature sensitive paints are available for testing before any equipment design is finalized, and Application Bulletin #20 titled TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES is available on request.

Air flow must be applied before or simultaneously with the application of power, including the tube filament, and should normally be maintained for a short period of time after power is removed to allow for tube cooldown.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

FILAMENT OPERATION - During turn-on the filament inrush current should be limited to 600 amperes.

At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The filament voltage should then be increased a few tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked in 24 hours. Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations.

Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. Periodically throughout the life of the tube the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best tube life.

Where hum is an important system consideration it is permissible to operate the filaments with dc rather than ac power. Contact Varian EIMAC Application Engineering for special precautions when using a dc filament supply.

This tube is designed for commercial service, with only one off/on filament cycle per day. If addi-

tional cycling is anticipated it is recommended the user contact Application Engineering at EIMAC.

BASE PLATE VOLTAGE - Any difference in potential between the base plate and the tube filament must be limited to 100 volts (peak).

GRID OPERATION - The maximum control grid dissipation is 500 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. A protective spark-gap device should be connected between the grid and the cathode to guard against excessive voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 1750 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

The screen current may reverse under certain conditions and produce negative indictions on the screen current meter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind, so that the correct operating voltage will be maintained on the screen under all conditions. A current path from the screen to cathode in the form of a bleeder resistor or a shunt regulator, connected between screen and cathode, may be required. A series regulated power supply can be used only when an adequate bleeder resistor is provided.

PLATE OPERATION - The rated maximum dissipation for the tube is 35,000 watts. When operated as a plate-modulated rf amplifier, under carrier conditions the maximum dissipation rating is 23,000 watts, which corresponds to 35,000 watts at 100% sine-wave modulation.

Operation with significant plate current under some conditions of high instantaneous anode voltage (such as regulator service or low power and low impedance "tuning" conditions) can, as a result of the screen and grid voltages chosen, lead to anode damage and subsequent failure. If operation under such conditions is necessary EIMAC Application Engineering should be contacted for assistance in selection of operating parameters.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and coolant interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each tube anode, to help absorb power supply stored energy if an internal arc should occur. An electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, is recommended. The protection criteria for each electrode supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-inch length of #30 AWG copper wire. The wire will remain intact if the protection is adequate.

EIMAC Application Bulletin #17 titled FAULT PROTECTION contains considerable detail; it is available on request.

X-RADIATION HAZARD - High-vacuum tubes operating at voltages higher than 15 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential X-ray source. Only limited shielding is afforded by the tube envelope. Moreover, the X-radiation level may increase significantly with tube aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by the high voltage. X-ray shielding may be required on all sides of tubes operating at these voltages to provide adequate protection throughout the life of the tube. Periodic checks on the X-ray level should be made, and the tube should never be operated without required shielding in place. If there is any question as to the need for or the adequacy of shielding, an expert in this field should be contacted to perform an equipment X-ray survey.

In cases where shielding has been found to be required operation of high voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube [as the key component involved] the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires use of a specially constructed test fixture which shields all external tube leads or contacts from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown in the technical data are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in the application. Measurements should be taken with the mounting which represents approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn: Applications Engineering; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE - Normal operating voltages can be deadly. Always remember that HIGH VOLTAGE CAN KILL.

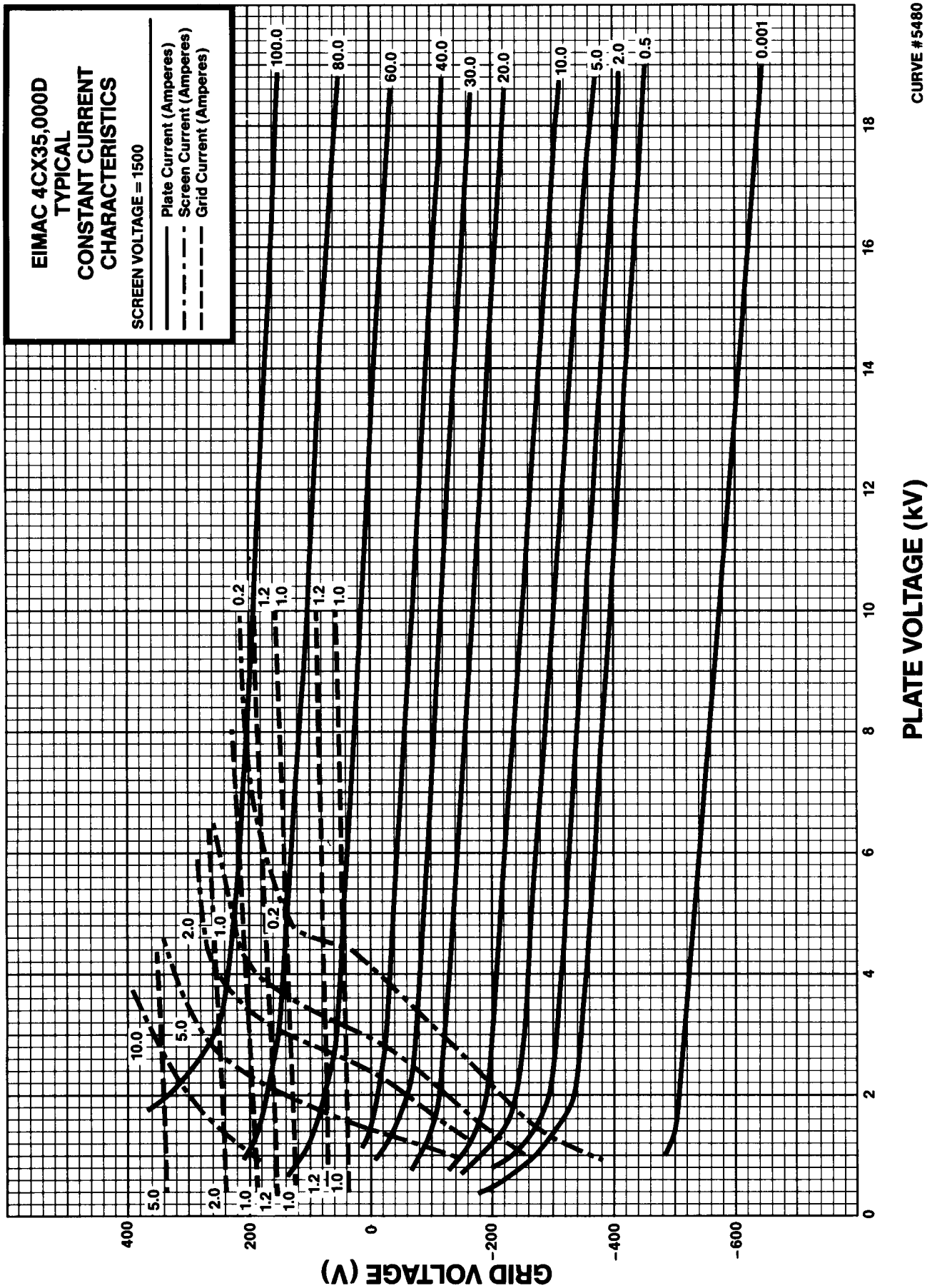
b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - Personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

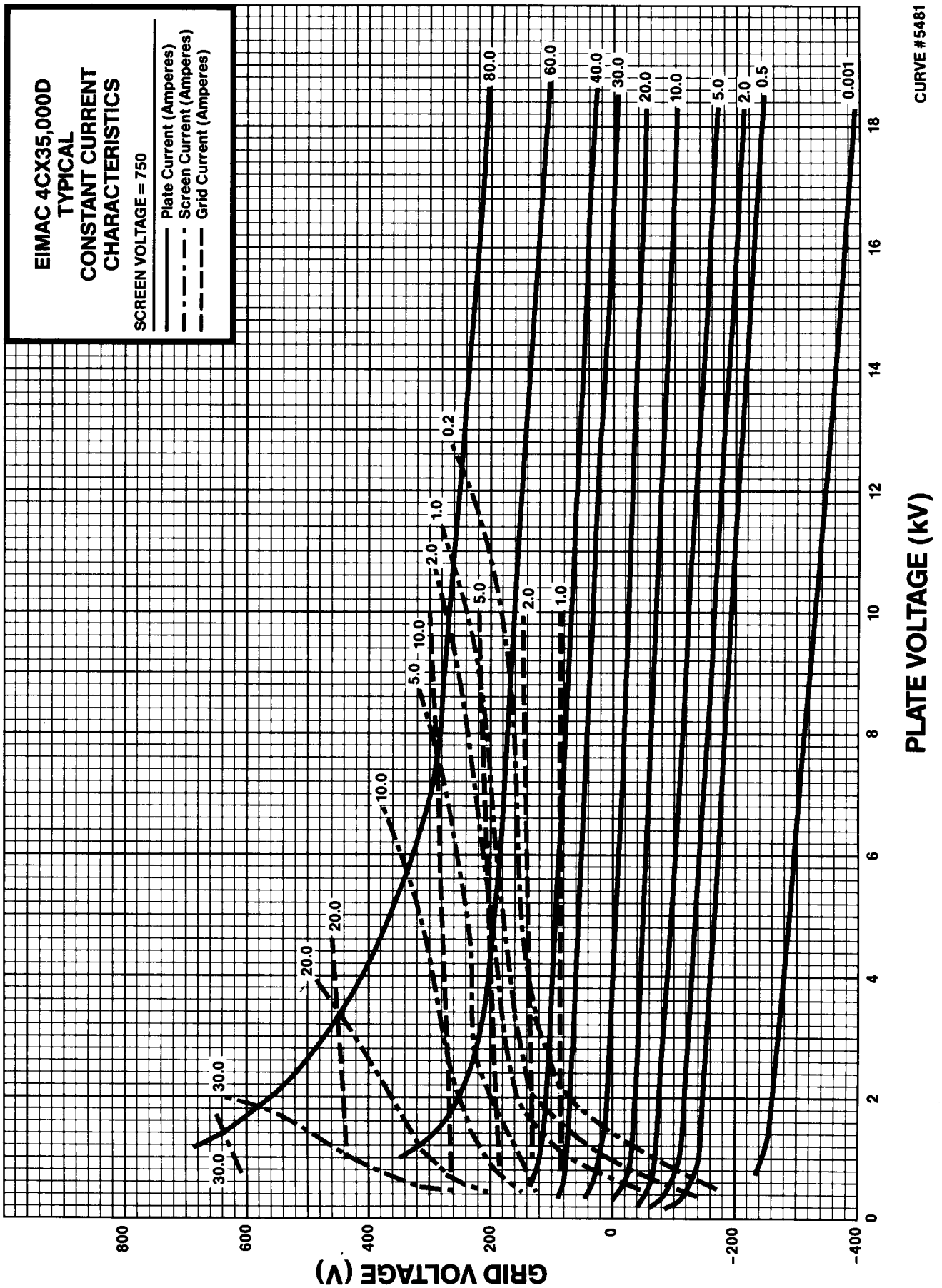
c. X-RAY RADIATION - High-voltage pulse modulator tubes are a potential source of dangerous X-Ray radiation and shielding may be required on all sides of the tube. A survey may be required by an expert in this field.

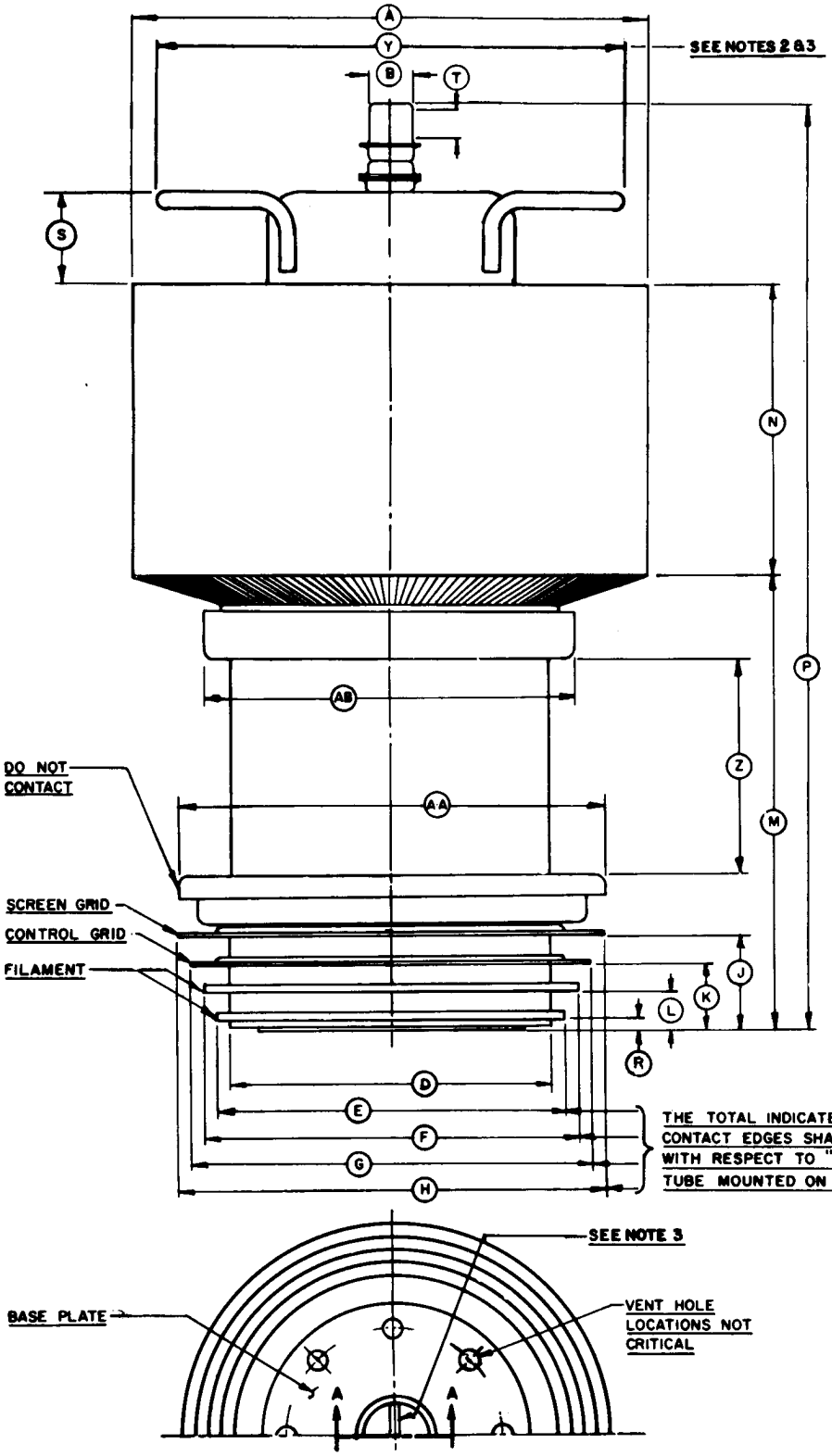
d. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

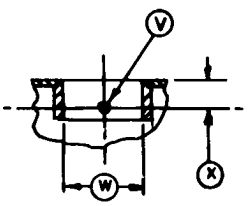
e. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.


EIMAC 4CX35,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
100.0
80.0
60.0
40.0
30.0
20.0
10.0
5.0
2.0
0.5
0.001
0.2
1.2
1.0
GRID VOLTAGE (V)
400
200
0
-200
-400
-600
0
2
4
6
8
10
12
14
16
18
PLATE VOLTAGE (kV)
CURVE #5480


EIMAC 4CX35,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #5481
800
600
400
200
0
-200
-400
0
2
4
6
8
10
12
14
16
18
80.0
60.0
40.0
30.0
20.0
10.0
5.0
2.0
0.5
0.001
0.2
1.0
2.0
5.0
10.0
20.0
30.0





DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	9.500	9.750	241.30	247.65
B	0.860	0.890	21.84	22.60
D	5.980	6.020	151.89	152.91
E	6.510	6.560	165.35	166.62
F	6.980	7.020	177.29	178.31
G	7.480	7.520	189.99	191.01
H	7.975	8.015	202.57	203.58
J	1.750	1.800	44.45	45.72
K	1.220	1.270	30.99	32.26
L	0.690	0.740	17.53	18.80
M	8.442	8.692	214.43	220.78
N	5.375	5.625	136.52	142.88
P	17.070	17.340	433.58	440.44
R	0.173	0.213	4.40	5.41
S	1.750		44.45	
T	0.485	0.515	12.32	13.08
V	— —	0.135	— —	3.43
W	1.250	1.270	31.75	32.26
X	0.490	0.530	12.45	13.46
Y	— —	8.750	— —	222.25
Z	3.750		95.25	
AA	8.000		203.20	
AB	6.875		174.63	

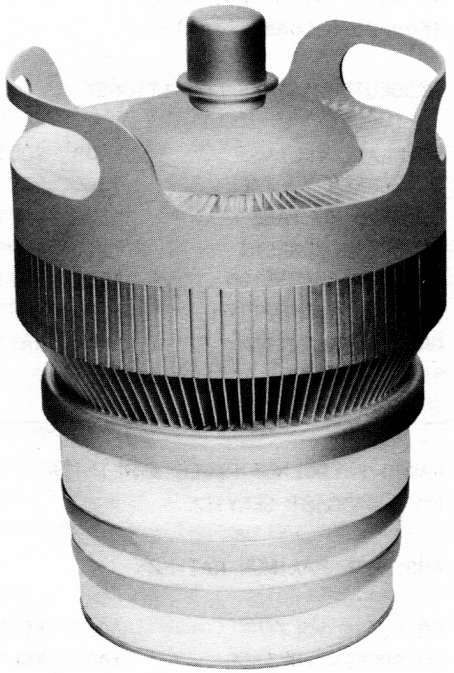
NOTES:
1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. DIM. Y IS MAXIMUM DIA. ACROSS CORNERS
3. HANDLE LATERAL AXIS ORIENTATION WITH BASE LOCK PIN IS AS SHOWN.

TECHNICAL DATA

4CX3500A VHF RADIAL BEAM POWER TETRODE

The EIMAC 4CX3500A is a compact ceramic/metal radial beam power tetrode intended for use in VHF power amplifier applications. It features a type of internal mechanical structure which results in high rf operating efficiency. Low rf losses in this structure permit operation at full ratings to 220 MHz.

The 4CX3500A has a gain of over 18 dB in FM broadcast service, and is also recommended for rf linear power amplifier service and for VHF-TV linear amplifier service. The anode is rated for 3500 watts of dissipation with forced-air cooling.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh		
Voltage	5.0 ± 0.25	V
Current, at 5.0 volts	90	A
Amplification Factor, average		
Grid to Screen	4.5	
Direct Interelectrode Capacitances (cathode grounded)[2]		
Cin	111	pF
Cout	12	pF
Cgp	0.5	pF
Direct Interelectrode Capacitances (grids grounded)[2]		
Cin	58.5	pF
Cout	10	pF
Cpk	0.4	pF
Maximum Frequency for Full Ratings (CW)	220	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	7.25 in; 18.42 cm
Diameter	4.94 in; 12.55 cm
Net Weight (approximate)	5.5 Lbs; 2.5 kg
Operating Position	Axis Vertical, Base Up or Down
Cooling	Forced Air
Maximum Operating Temperature, Ceramic/Metal Seals & Anode Core	250 Deg.C
Base	Special, Coaxial
Recommended Air-System Socket	HF: EIMAC SK-340
	VHF: EIMAC SK-350
Recommended Air-System Chimney	HF: EIMAC SK-306
	VHF: EIMAC SK-356

394350 (Effective 16 Jan 84 - supersedes 30 Mar 82)
VA4520

Printed in U.S.A.

RADIO FREQUENCY POWER AMPLIFIER

Class C Telegraphy or FM
(Key-down Conditions)

ABSOLUTE MAXIMUM CONDITIONS

DC PLATE VOLTAGE	6000	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	2.0	AMPERES
PLATE DISSIPATION	3500	WATTS
SCREEN DISSIPATION	165	WATTS
GRID DISSIPATION	50	WATTS

TYPICAL OPERATION (frequencies to 30 MHz)

Plate Voltage	5.0	5.0	kVdc
Screen Voltage	500	500	
Grid Voltage	-200	-250	Vdc
Plate Current	1.32	0.80	Adc
Screen Current *	75	43	mAdc
Grid Current *	59	21	mAdc
Peak rf Grid Voltage *	335	290	v
Calculated Driving Power	25	7	W
Plate Dissipation *	1320	640	W
Plate Output Power *	5280	3360	W
Load Impedance	1700	2700	Ohms

* Approximate value

RADIO FREQUENCY POWER AMPLIFIER
FM BROADCAST SERVICE

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	6000	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	2.0	AMPERES
PLATE DISSIPATION	3500	WATTS
SCREEN DISSIPATION	165	WATTS
GRID DISSIPATION	50	WATTS

MEASURED DATA AT 100.5 MHZ

Plate Voltage	4000	4300	Vdc
Plate Current	1.5	1.9	Adc
Screen Voltage	500	700	Vdc
Screen Current *	140	123	mAdc
Grid Voltage	-300	-400	Vdc
Grid Current *	84	63	mAdc
Useful Power Out * #	3838	5531	W
Efficiency *	64	68	%
Driving Power *	56	66	W
Power Gain *	18.4	19.2	dB

* Approximate; will vary from tube to tube
\# Delivered to the load

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in ouput power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjusted to produce the required bias voltage when the correct rf grid voltage is applied.

APPLICATION

MECHANICAL

MOUNTING - The 4CX3500A must be mounted with its axis vertical, base up or down at the convenience of the circuit designer.

AIR-SYSTEM SOCKET & CHIMNEY - The EIMAC sockets type SK-340 and SK-350 are designed especially for the concentric base terminals of the 4CX3500A. The SK-340 is intended for use at HF, while the SK-350 is recommended for VHF applications. The SK-306 chimney should be used with the SK340 socket for the lower frequencies, while the SK-356 chimney is intended for use with the SK-350 socket. Use of the recommended air flow rates through either socket will provide effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through the chimney and into the anode cooling fins.

COOLING - At full rated anode dissipation, at sea level and with cooling air at 50 Deg.C maximum, for frequencies below 110 MHz, and with the tube mounted in either an SK-340 or SK-350 socket with a chimney in place, a minimum of 241 CFM of air must be passed through the socket and the tube anode cooling fins. Air flow should be in the base-to-anode direction. The pressure drop across the tube/ socket/chimney combination with this air flow rate will be approximately 1.87 inches of water.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to that shown, plus any drop encounted in ducts and filters.

Air flow must be applied before or simultaneously with the application of power, including the tube filament, and may be removed simultaneously with filament voltage. An air interlock system should be incorporated in the design to automatically remove all voltages from the tube in case of even a partial failure of the tube cooling air.
It is considered good engineering practice to supply more than the minimum required cooling air, to allow for variables such as dirty air filters, rf seal heating, and the fact that the anode cooling fins may not be clean if the tube has been in service for some time.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - The values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply voltage variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

FILAMENT OPERATION - At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The filament voltage should then be increased a few tenths of a volt above the value where performance degradation was noted. The operating point should be rechecked after 24 hours. Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations.

Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. Periodically the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best life.

GRID OPERATION - The maximum control grid dissipation is 50 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 165 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

SCREEN CURRENT - The screen current may reverse under certain conditions and produce negative indictions on the screen current meter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind, so that the correct operating voltage will be maintained on the screen under all conditions. A current path from the screen to cathode must be provided by a bleeder resistor or a shunt regulator connected between screen and cathode and arranged to pass approximately 10% of the average screen current per connected tube. A series regulated power supply can be used only when an adequate bleeder resistor is provided.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and air-flow interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each tube anode, to absorb power supply stored energy if an internal arc should occur. EIMAC's Application Bulletin #17 titled FAULT PROTECTION contains considerable detail, and is available on request.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the Industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown here are taken in accordance with Standard RS-191. The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal appliction. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn:Applications Engineering; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

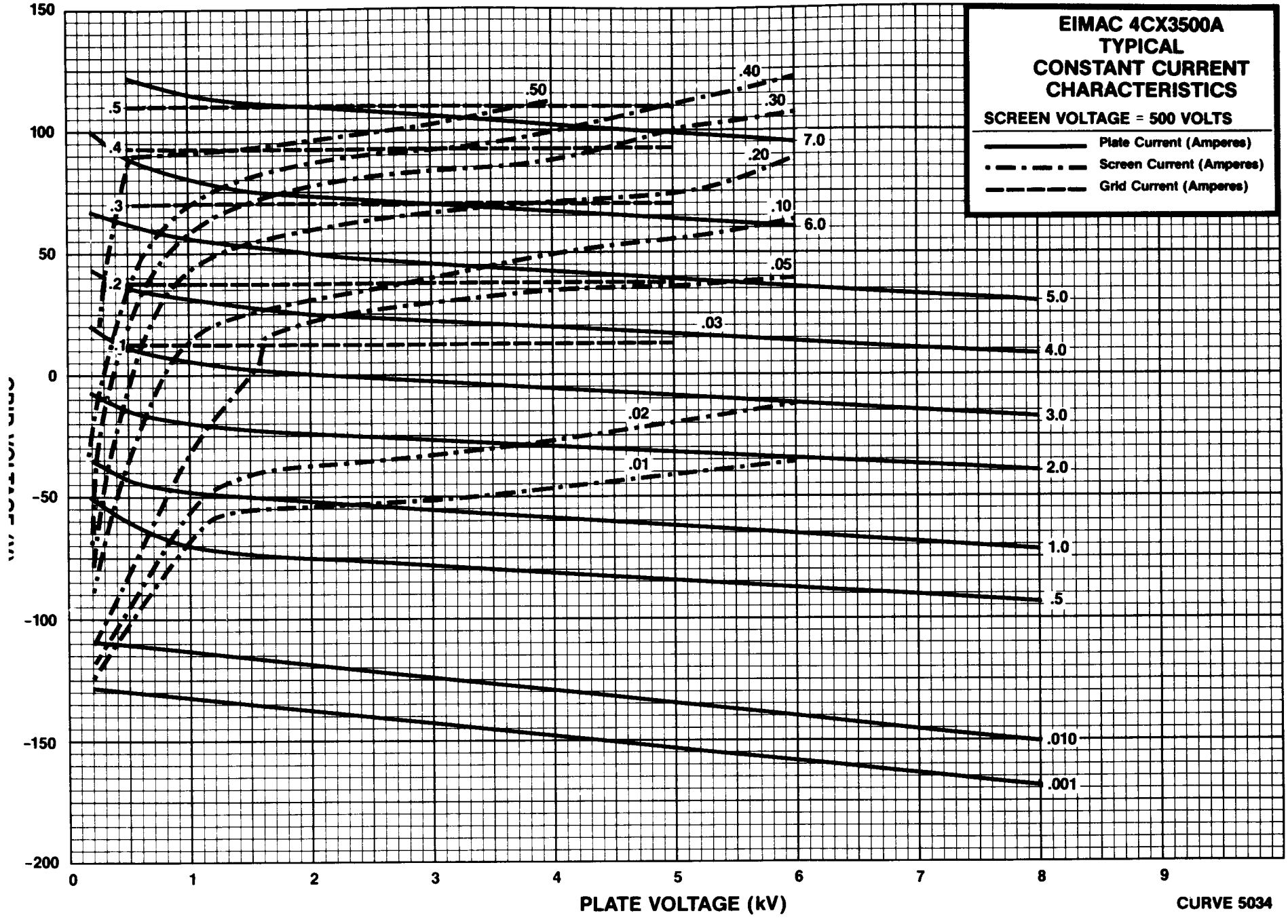
The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE - Normal operating voltages can be deadly. Always remember that HIGH VOLTAGE CAN KILL.

b. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

c. HOT SURFACES - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred Degrees C and cause serious burns if touched for several minutes after all power is removed.

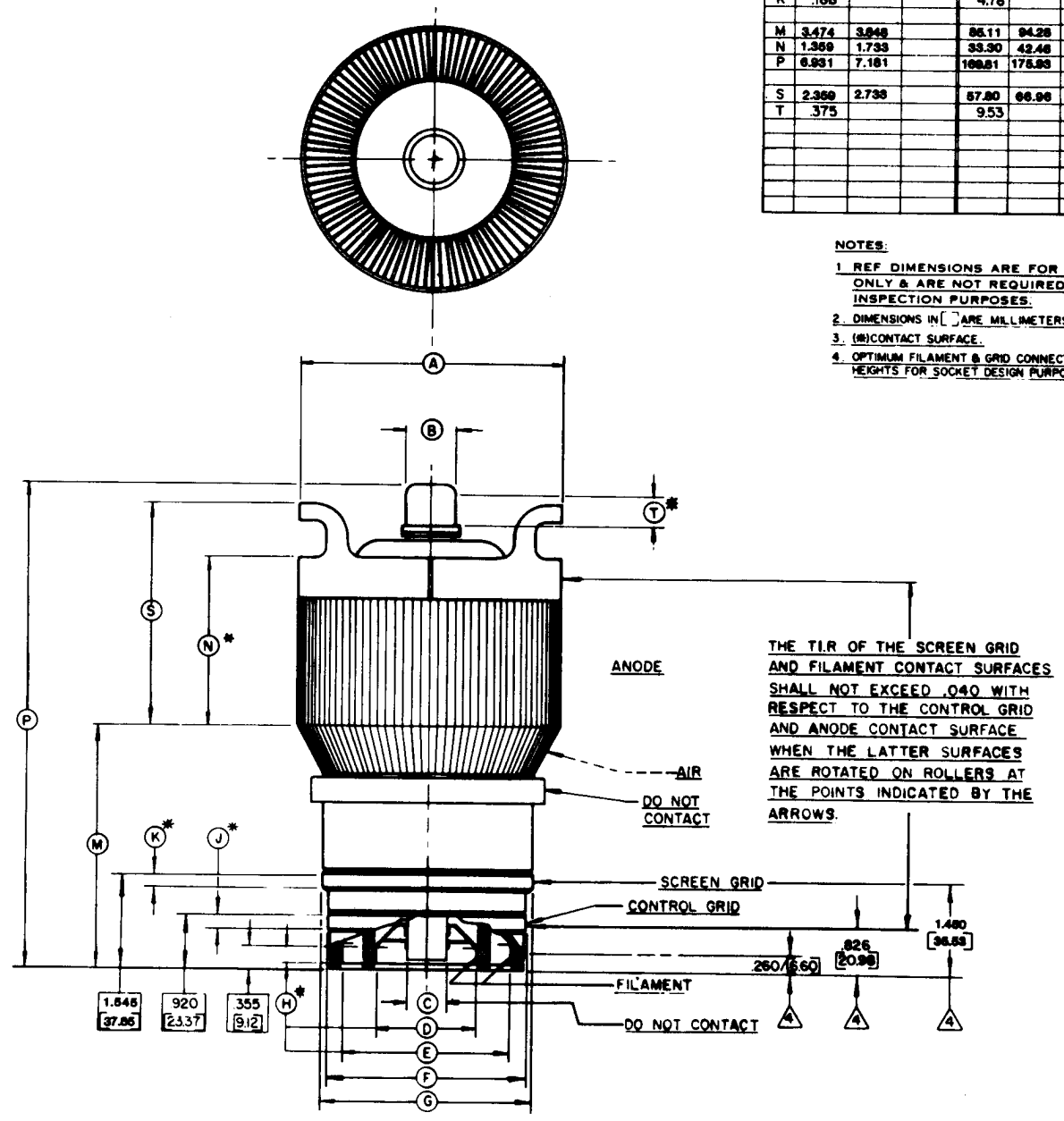
Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Tube Division, 301 Industrial Way, San Carlos CA 94070.


EIMAC 4CX3500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
150
100
50
0
-50
-100
-150
-200
0
1
2
3
4
5
6
7
8
9
PLATE VOLTAGE (kV)
.5
.4
.3
.2
.1
.50
.40
.30
.20
.10
.05
.03
.02
.01
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.5
.010
.001
CURVE 5034

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM	MIN	MAX	REF	MIN	MAX	REF
A	4.812	4.938		122.22	125.43	
B	.855	.895		21.72	22.73	
C	.600	.760		15.24	19.30	
D	1.896	1.936		48.16	49.17	
E	3.133	3.173		79.58	80.59	
F	3.792	3.832		96.32	97.33	
G	3.980	4.020		101.09	102.11	
H	.188			4.78		
J	.188			4.78		
K	.188			4.78		
M	3.474	3.848		88.11	94.28	
N	1.369	1.733		33.30	42.46	
P	6.931	7.181		169.81	175.93	
S	2.369	2.738		57.80	66.96	
T	.375			9.53		

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. DIMENSIONS IN [ ] ARE MILLIMETERS.
3. (##)CONTACT SURFACE.
4. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES.



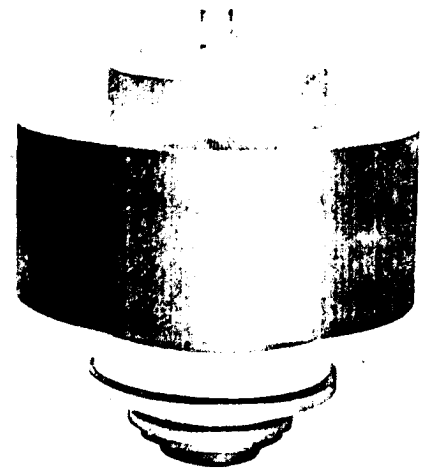
TENTATIVE
TECHNICAL DATA

4CX40,000G

VHF RADIAL BEAM POWER TETRODE

The EIMAC 4CX40,000G is a ceramic/metal power tetrode intended for use in audio or radio-frequency applications. It features a high-stability pyrolytic graphite grid and a type of internal mechanical structure which results in high rf operating efficiency. Low rf losses in this structure permit operation of the tube at full ratings up to 220 MHz.

The 4CX40,000G is recommended for FM broadcast service, rf linear power amplifier service, and for VHF-TV linear amplifier service. The anode is rated for 40 kW of dissipation with forced-air cooling, and incorporates a highly efficient cooler of new design.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated-tungsten Mesh		
Voltage	15.0 ± 0.75	V
Current, @ 15.0 volts	170	A
Warmup: see FILAMENT WARMUP RECOMMENDATION		
Amplification Factor, average at Ib = 10 Adc		
Grid to screen	8	
Direct Interelectrode Capacitances (cathode grounded)		
Cin	447	pF
Cout	33	pF
Cgp	1.8	pF
Direct Interelectrode Capacitances (grid & screen grounded)		
Cin	155	pF
Cout	35	pF
Cfp	0.15	pF
Frequency of Maximum Ratings (CW)	220	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

Effective: September 1979

MECHANICAL

Maximum Length	11.85 In; 30.10 Cm
Maximum Diameter	10.08 In; 25.60 Cm
Net Weight (approximate)	55 lbs ; 25 kg
Operating Position	Axis Vertical, Base Up or Down
Cooling	Forced Air
Operating Temperature, Maximum	
Ceramic/Metal Seals and Anode Core	250 °C
Base	Special, Coaxial
Recommended Air-System Socket	EIMAC SK-2400
Recommended Air-System Chimney	EIMAC SK-2406

RADIO FREQUENCY POWER AMPLIFIER
OR OSCILLATOR

Class C Telegraph or FM

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	14.	KILOVOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC GRID VOLTAGE	-1000	VOLTS
DC PLATE CURRENT	10	AMPERES
PLATE DISSIPATION	40	KILOWATTS
SCREEN DISSIPATION	1500	WATTS
GRID DISSIPATION	1000	WATTS

TYPICAL OPERATION

Class C rf Amplifier

Plate Voltage	10.6	kVdc
Screen Voltage	800	Vdc
Grid Voltage	-300	Vdc
Plate Current	7.0	Adc
Screen Current [1]	440	mAdc
Grid Current [1]	700	mAdc
Load Impedance	800	Ω
Driving Power [1]	250	W
Useful Power Output [2]	60	kW

1 Approximate value

2 Measured at the load

TYPICAL OPERATION values are obtained by calculations from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to produce the required bias voltage when the correct rf grid voltage is applied.

APPLICATION

MECHANICAL

MOUNTING - The tube must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the designer.

SOCKET & CHIMNEY - The EIMAC air-system socket SK-2400 and air chimney SK-2406 are designed especially for use with the 4CX40,000G. The use of the recommended air flow through this socket provides effective forced-air cooling of the base, with air then guided through the anode cooling fins by the air chimney.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250°C, and sufficient forced-air cooling must be used in all applications to keep the temperature of the anode (at the base of the cooling fins) and the temperature of the ceramic/metal seals comfortably below the rated maximum.

The cooling characteristics of the anode are shown in the attached graphs, for power levels (anode dissipation) from 20 to 40 kW and for sea level, 5000 feet, and 10,000 feet. The designer is cautioned to keep in mind this is ABSOLUTE data, with pure dc power, with no safety factors added, and the pressure drop figures make no allowance for losses in filters, ducting, and the like.

It is considered good engineering practice to design for a maximum anode core temperature of 225 °C, and temperature-sensitive paints are available for checking base and seal temperatures before any design is finalized. It is also considered good practice to add a 15% safety factor to the indicated air flow, and allow for variables such as dirty air filters, rf seal heating at VHF, and the fact that the anode cooling fins may not be clean if the tube has been in service for some length of time. Special attention may be required in cooling the center of the stem (base), by means of special directors or some other provision. An air interlock system should be incorporated into the design to automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.

Air flow must be applied before or simultaneously with the application of power, including the tube filament, and should normally be maintained for a short period of time after all power is removed to allow for tube cooldown.

ELECTRICAL

FILAMENT WARMUP RECOMMENDATION - Filament inrush surge current must be limited to two times rated current. The filament should be brought to rated voltage over a two-minute period. If a step-start sequence is used the initial voltage applied should be 1/3 to 1/2 the nominal rated filament voltage. After two minutes the voltage may then be increased to the rated value. In the event of power failure which does not exceed 60 seconds the full filament voltage may be applied to the tube instantaneously. If the power failure exceeds 60 seconds, the programmed warmup procedure should be used.

FILAMENT OPERATION - The rated nominal filament voltage for the tube is 15.0 volts, as measured at the socket or tube base. Variation in voltage should be maintained within plus or minus five percent, and the filament warmup procedure should be adhered to.

The peak emission capability at nominal filament voltage is normally more than that required for communication service. A small decrease in filament temperature due to a reduction in filament voltage can increase tube life by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is done by measuring some important parameter of performance (such as plate current, power output, or distortion) while filament voltage is reduced. At some point in filament voltage there will be a noticeable change in the operating parameter being monitored, and the operating filament voltage must be slightly higher than the level at which deterioration was noted. When filament voltage is to be reduced in this manner it should be regulated and held to plus or minus one percent, and the actual operating value should be checked periodically to maintain proper operation.

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings of the tube must be respected to avoid damage. An exception is the plate dissipation which may be permitted to rise above the rated maximum during brief periods (10 seconds maximum) such as may occur during tuning.

GRID OPERATION - The control grid has a maximum dissipation rating of 1000 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should normally be kept near the values shown in the TYPICAL OPERATION section of the data sheet whenever possible.

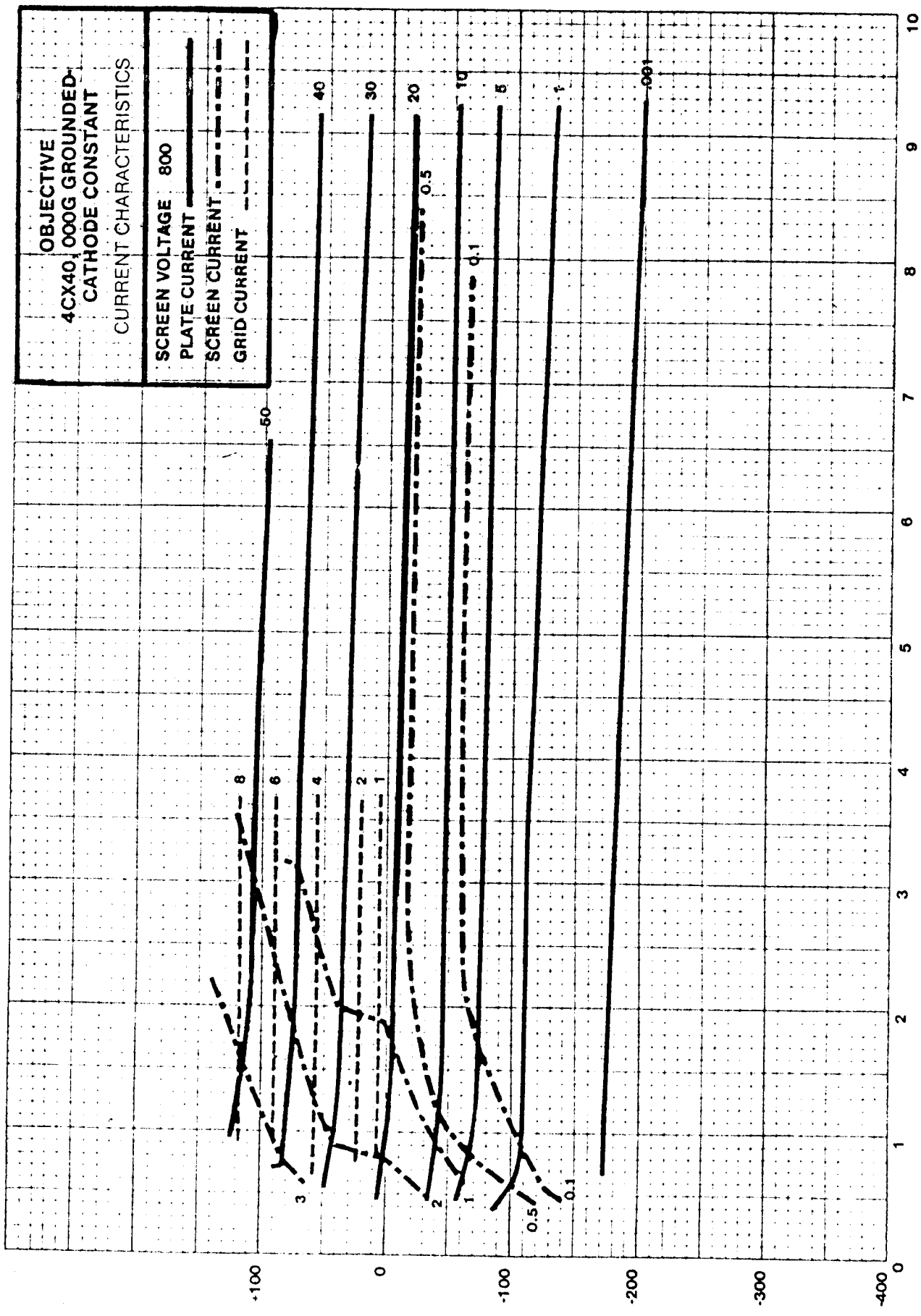
SCREEN OPERATION - The power dissipated by the screen grid must not exceed 1500 watts. Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with the filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation in the event of circuit failure. Energy limiting circuitry (which will activate if there is a fault condiition) and spark gap over-voltage protection are recommended as good engineering proactice.

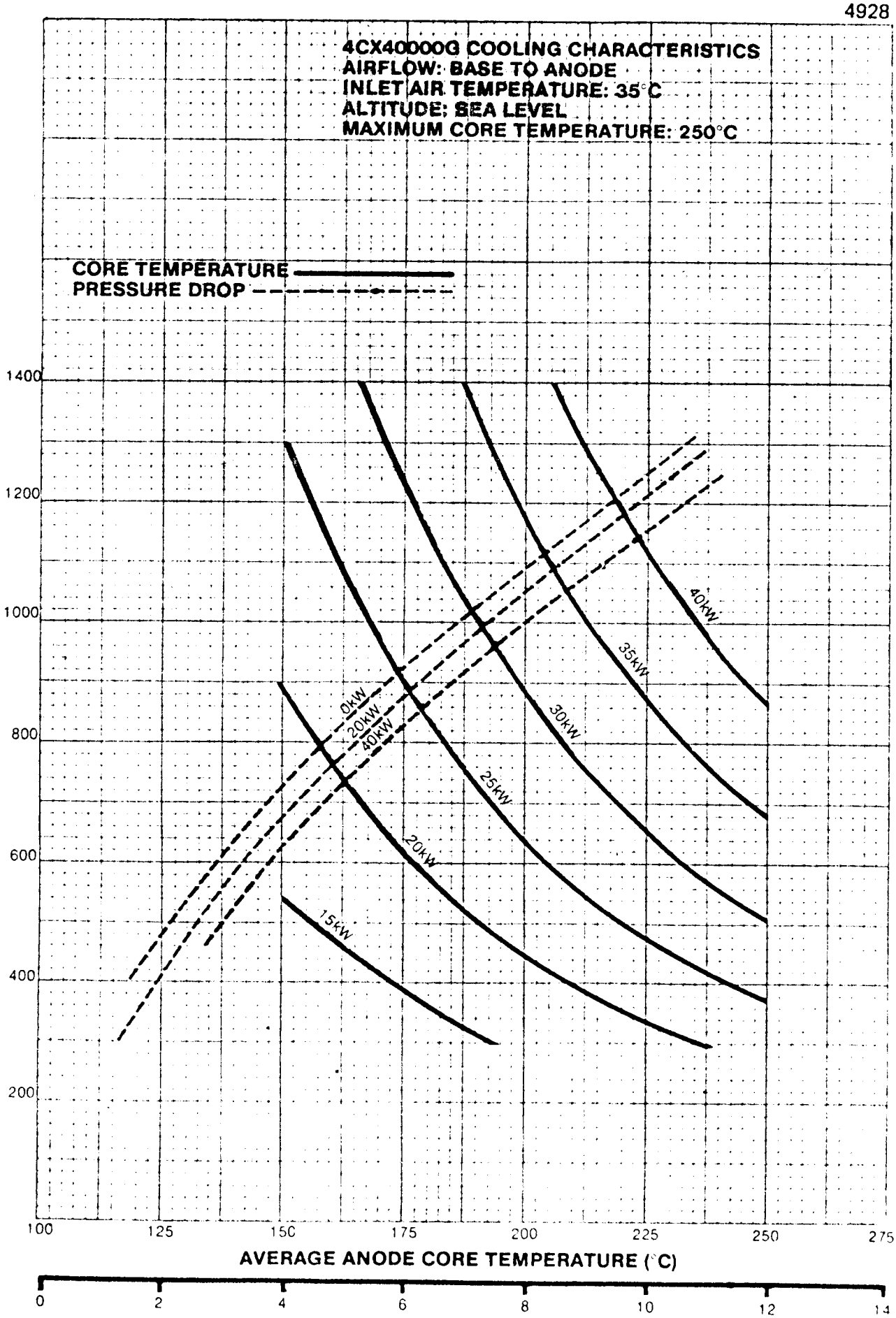
HIGH VOLTAGE - Normal operating voltages used with the 4CX40,000G are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

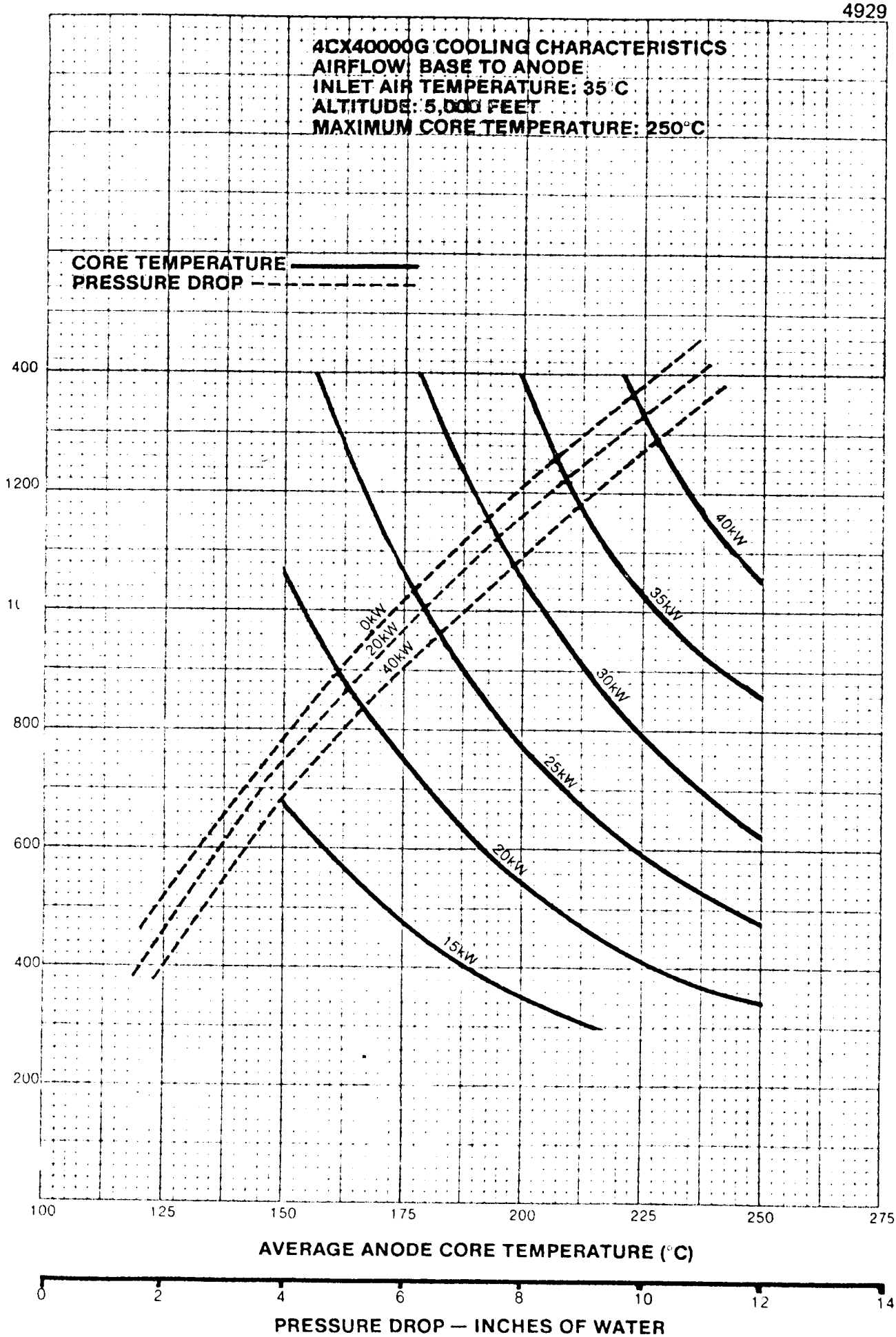
FAULT PROTECTION - In addition to normal cooling airflow interlock and plate and screen over-current interlocks, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high voltage.

In all cases some protective resistance, at least one or two ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur. When stored energy is high, it is recommended that some form of electronic crowbar be used which will discharge power supply capacitors in as short a time as possible following indication of start of a plate arc.

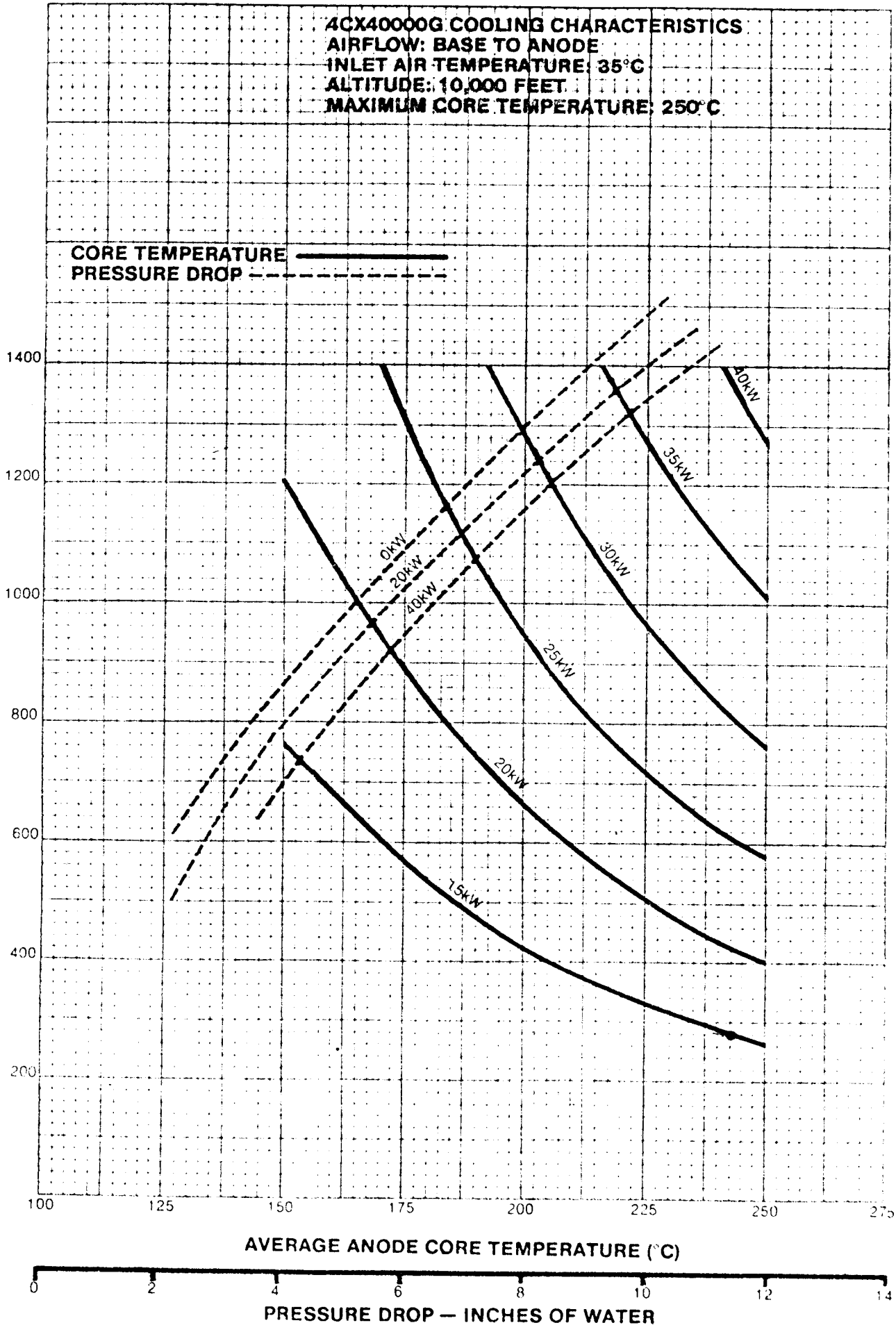

OBJECTIVE
4CX40,000G GROUNDED-CATHODE CONSTANT
CURRENT CHARACTERISTICS
SCREEN VOLTAGE 800
PLATE CURRENT
SCREEN CURRENT
GRID CURRENT
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — KILOVOLTS

4928

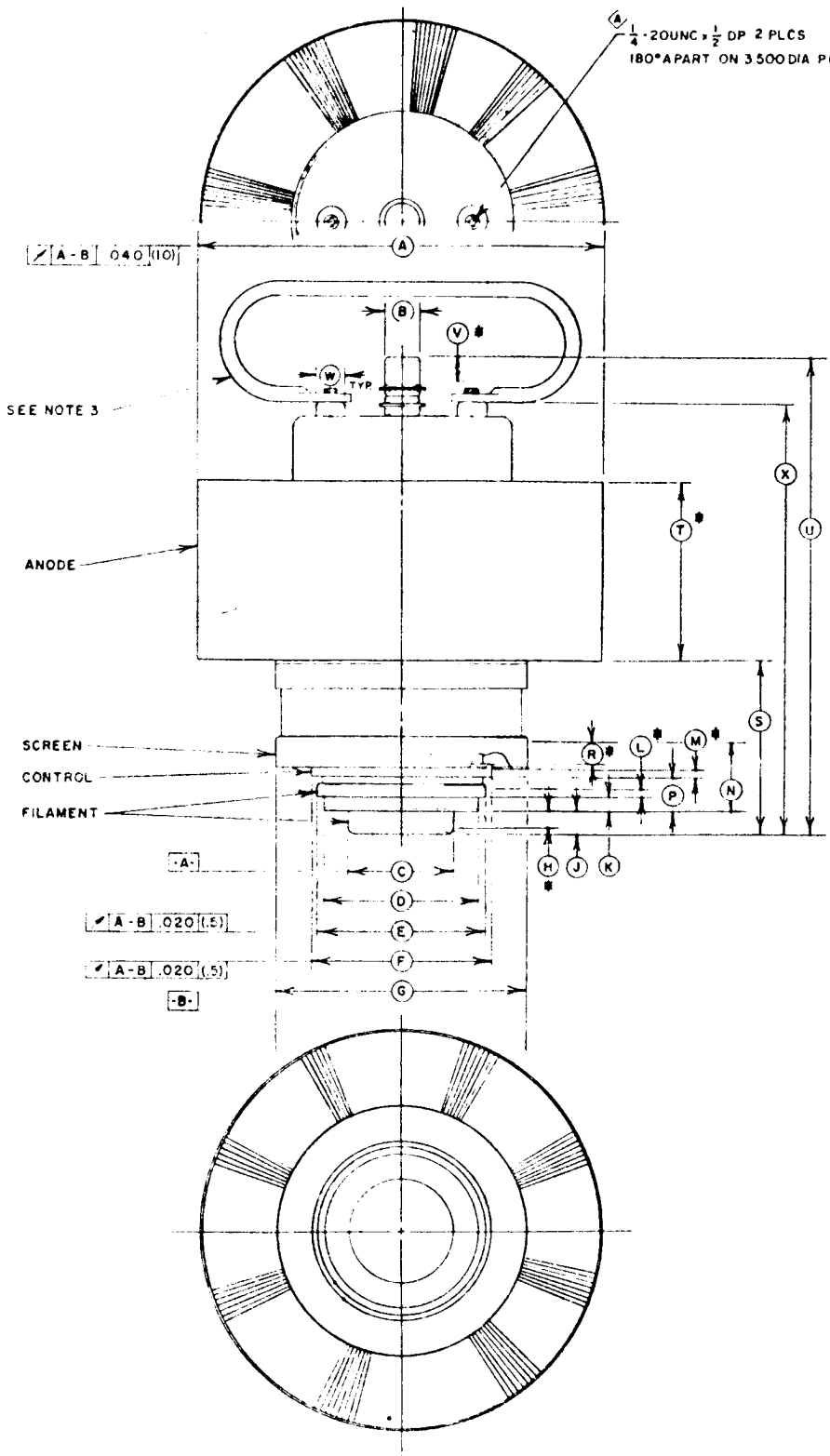

4CX40000G COOLING CHARACTERISTICS
AIRFLOW: BASE TO ANODE
INLET AIR TEMPERATURE: 35°C
ALTITUDE: SEA LEVEL
MAXIMUM CORE TEMPERATURE: 250°C
CORE TEMPERATURE
PRESSURE DROP
1400
1200
1000
800
600
400
200
40kW
35kW
30kW
25kW
20kW
15kW
0kW
20kW
40kW
100
125
150
175
200
225
250
275
AVERAGE ANODE CORE TEMPERATURE (°C)
0
2
4
6
8
10
12
14
PRESSURE DROP — INCHES OF WATER


4929
4CX40000G COOLING CHARACTERISTICS
AIRFLOW: BASE TO ANODE
INLET AIR TEMPERATURE: 35°C
ALTITUDE: 5,000 FEET
MAXIMUM CORE TEMPERATURE: 250°C
CORE TEMPERATURE
PRESSURE DROP
400
1200
800
600
400
200
0kW
20kW
40kW
40kW
35kW
30kW
25kW
20kW
15kW
100
125
150
175
200
225
250
275
AVERAGE ANODE CORE TEMPERATURE (°C)
0
2
4
6
8
10
12
14
PRESSURE DROP — INCHES OF WATER

4930


4CX40000G COOLING CHARACTERISTICS
AIRFLOW: BASE TO ANODE
INLET AIR TEMPERATURE: 35°C
ALTITUDE: 10,000 FEET
MAXIMUM CORE TEMPERATURE: 250°C
CORE TEMPERATURE
PRESSURE DROP
1400
1200
1000
800
600
400
200
100
125
150
175
200
225
250
275
0kW
20kW
40kW
35kW
30kW
25kW
20kW
15kW
AVERAGE ANODE CORE TEMPERATURE (°C)
0
2
4
6
8
10
12
14
PRESSURE DROP — INCHES OF WATER

4CX40,000G



DIM	INCHES MIN	INCHES MAX	INCHES REF	MILLIMETERS MIN	MILLIMETERS MAX	MILLIMETERS REF
A	9.960	10.080		253.0	256.0	
B	.860	.890		21.8	22.6	
C	2.615	2.625		66.42	66.68	
D			3.825			97.2
E	4.245	4.265		107.80	108.30	
F	4.490	4.520		114.05	114.81	
G	6.360	6.405		161.5	162.7	
H	.440			11.2		
J	.640	.680		16.2	17.3	
K	.260	.290		6.6	7.4	
L	.250			6.3		
M	.150			3.8		
N	1.600			40.6		
P	.790	.830		20.1	21.1	
R	.350			8.9		
S	4.170	4.400		106.0	111.8	
T	4.400	4.600		112.0	117.0	
U	11.550	11.850		293.0	301.0	
V	.500			12.7		
W			.750			19.1
X	10.500	10.850		267.0	276.0	

NOTES.

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. # CONTACT SURFACE
3. SHIPPED WITH HANDLE ATTACHED REMOVE BEFORE OPERATION

2nd Draft 17 Aug 83

Varian EIMAC
San Carlos, California

Issue Date Here

TEST SPECIFICATION

ELECTRON TUBE, TRANSMITTING TETRODE
EXTERNAL ANODE, FORCED-AIR COOLED

TYPE 4CX40,000GM

F1 = 110 MHz

ABSOLUTE MAXIMUM RATINGS: (See Note 1)

Parameter:	Ef	Eb	Ec2	Ec1	Ib	Pg1	Pg2	Pp	Anode Core & Seal T	Cooling	Alt.
Units:	Vac	kVdc	kVdc	kVdc	Adc	W	W	kW	°C	---	Ft.
	Note 2								Note 3	Note 4	Note 5
Class AB1 (audio or rf) :	15.0±5%	14.0	2.0	-1.0	10	500	1500	40	250	---	10,000
TEST COND :	15.0	---	1.4	---	---	---	---	---	---	Note 6	---

METHOD OR PAR. references: MIL-E-1 or MIL-STD-1311 — Mounting: See Note 7

Recommended Air-System Socket: EIMAC SK-2400 — Envelope: Ceramic & Metal

Fault Protection: See Note 8 — rf Radiation Hazard: See Note 9

METHOD OR PAR.	REQUIREMENT OR TEST	CONDITIONS	AQL%	INSP. LEVEL	SYMB.	LIMITS Min	LIMITS Max	UNITS
	General							
---	Cathode	Thoriated-tungsten filament	---	---	---	---	---	---
4.8.5	Holding Period		---	---	t:	72	---	hrs

METHOD OR PAR.	REQUIREMENT OR TEST	CONDITIONS	AQL%	INSP. LEVEL	SYMB.	LIMITS Min	LIMITS Max	UNITS
	Quality Conformance Inspection - Part 1 (Production) Note 10							
D-30(a), 40, 60	Visual & Mechanical Inspection Criteria		---	---	---	---	---	---
1301	Filament Current	t = 5 minutes minimum; See Note 11	0.65	II	If:	168	182	Aac
1261	Grid Voltage (1)	Eb = 10.5 ± 0.5 kVdc; Ec1/Ib = 2.5 Adc	0.65	II	-Ec1:	160	230	Vdc
					-Ic1:	---	1.0	mAdc
1266	Primary Grid Emission (control)	Pg1 = 500 W; t = 120 minimum; Ec2 = 0 Vdc; anode = -500 to -1000 Vdc	0.65	II	-Isg1:	---	1.0	mAdc
1266	Primary Grid Emission (screen)	Ec1 = 0 Vdc; t = 120 minimum; Pg2 = 2000 W; anode = -500 to -1000 Vdc	0.65	II	-Isg2:	---	6.0	mAdc
---	Ion Current	Ec1 = 0 Vdc; Ec2 = 75 Vdc; Eb = -45 Vdc; t = 180; Ef/Ic2 = 25 mAdc	0.65	II	Iz:	---	1.0	uAdc
1261	Grid Voltage (2) (cut-off)	Eb = 16 kVdc; Eco = Ec1/Ib = 20 mAdc	0.65	II	-Eco:	---	350	Vdc
1372	Current Division (1)	Eb = 5000 Vdc; Ec1 = -400 Vdc; egk/Ib = 17 a; See Note 12	0.65	II	egk:	---	0	v
					Ic2:	---	2.0	a
1372	Current Division (2)	Eb = Ec2 = 2000 Vdc; Ec1 = -400 Vdc; egk/Ib = 27 a; See Note 12	0.65	II	egk:	---	0	v
					Ic2:	---	5.0	a
1231	Pulsing Emission	eb = ec2 = ec1 = 1000 v etd/Ib = 100 a	0.65	II	Is:	200	---	a
---	rf Operation	To Be Specified	0.65	II	---	---	---	---

METHOD OR PAR.	REQUIREMENT OR TEST	CONDITIONS	AQL%	INSP. LEVEL	SYMB.	LIMITS Min	LIMITS Max	UNITS
	Quality Conformance Inspection - Part 2 (Design) - Note 13							
D-30(b)	Dimensions	Per Outline Drawing	6.5	S3	---	---	---	---
1331	Direct Interelectrode Capacitance (gnd.cath.connection)		6.5	S3	Cin:	420	480	pF
					Cout:	33	43	pF
					Cgp:	---	2.0	pF
1331	Direct Interelectrode Capacitance (gnd.grid connection)		6.5	S3	Cin:	150	180	pF
					Cout:	35	45	pF
					Cpk:	---	0.5	pF

NOTES

1. The values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply voltage variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

2. Filament inrush surge current must be limited to 300 amperes. For best reliability experience has shown that the filament and its internal supporting structure should be raised to operating temperature over a two-minute period. This should be accomplished by a linear increase in voltage to the operating value over 120 seconds. This can be accomplished by a motor-driven variable transformer or an equivalent solid-state device. A step-start sequence can be used with equivalent reliability, as follow:

   1) Turn on at 40% to 50% of operating voltage and maintain this value for 120 seconds.
   2) Increase voltage to full operating value.

   In the event of a power failure not exceeding 60 seconds the full operating voltage may be reapplied instantaneously. If the power failure exceeds 60 seconds, the programmed warmup procedure should be used. In case of emergency the turn-on program may be bypassed with no serious effect on reliability but normal startup should be programmed.

   Filament voltage should be measured at the tube base or socket, using an known-accurate rms-responding meter.

3. Under all operating conditions the specified maximum temperature should not be exceeded for the anode core or surface, the seals, and the envelope. Where long life and consistent performance are factors, maintaing temperature well below the rated maximum is normally beneficial.

4. In all cases of operation forced-air cooling of the anode and base is required. Minimum air flow requirements for the anode are shown, based on a maximum tube temperature of 225°C and a cooling air temperature of 35°C, with air flow through the anode cooler in a base-to-anode direction. The pressure drop values shown are in inches of water for the anode cooler and are approximate.

	SEA LEVEL		10,000 FEET	
Anode Diss. (kW)	Air Flow (cfm)	Press. Drop	Air Flow (cfm)	Press. Drop
20	340	1.6	510	2.2
30	660	4.2	970	6.3
40	1110	9.4	1600	13.6

Cooling of the base requires a minimum of 100 cfm of air (at a maximum temperature of 35°C) be directed horizontally through the socket from the sides. It is preferable to direct this air through three equally-spaced ducts.

Particular care should be taken to insure that the blower selected for anode cooling is capable of supplying the desired air flow at a back pressure equal to the pressure drop shown in the table plus any drop built up in ducts and/or filters. At higher altitudes or ambient temperatures the amount of cooling air must be modified to obtain equivalent cooling. Both base and anode cooling must be applied before or simultaneously with the application of electrode voltages (including the filament) and should normally be maintained for approximately 2 minutes after all electrode voltages are removed.

5. Operation at altitudes significantly above sea level may require that electrode voltages be set lower than the maximum values shown. Normally only the anode would require reduction.

6. In all electrical tests involving the application of filament voltage, the use of an air-system socket is permissible and forced-air cooling of the anode and base is permissible.

7. The tube must be mounted vertically, base up or down.

8. In addition to the normal plate over-current interlock, screen current interlock, and air-flow interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each tube anode, to absorb power supply stored energy if an internal arc should occur. An electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, is recommended. The protection criteria for each electrode supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a section of #30 AWG copper wire. The wire will remain intact if the criteria is met.

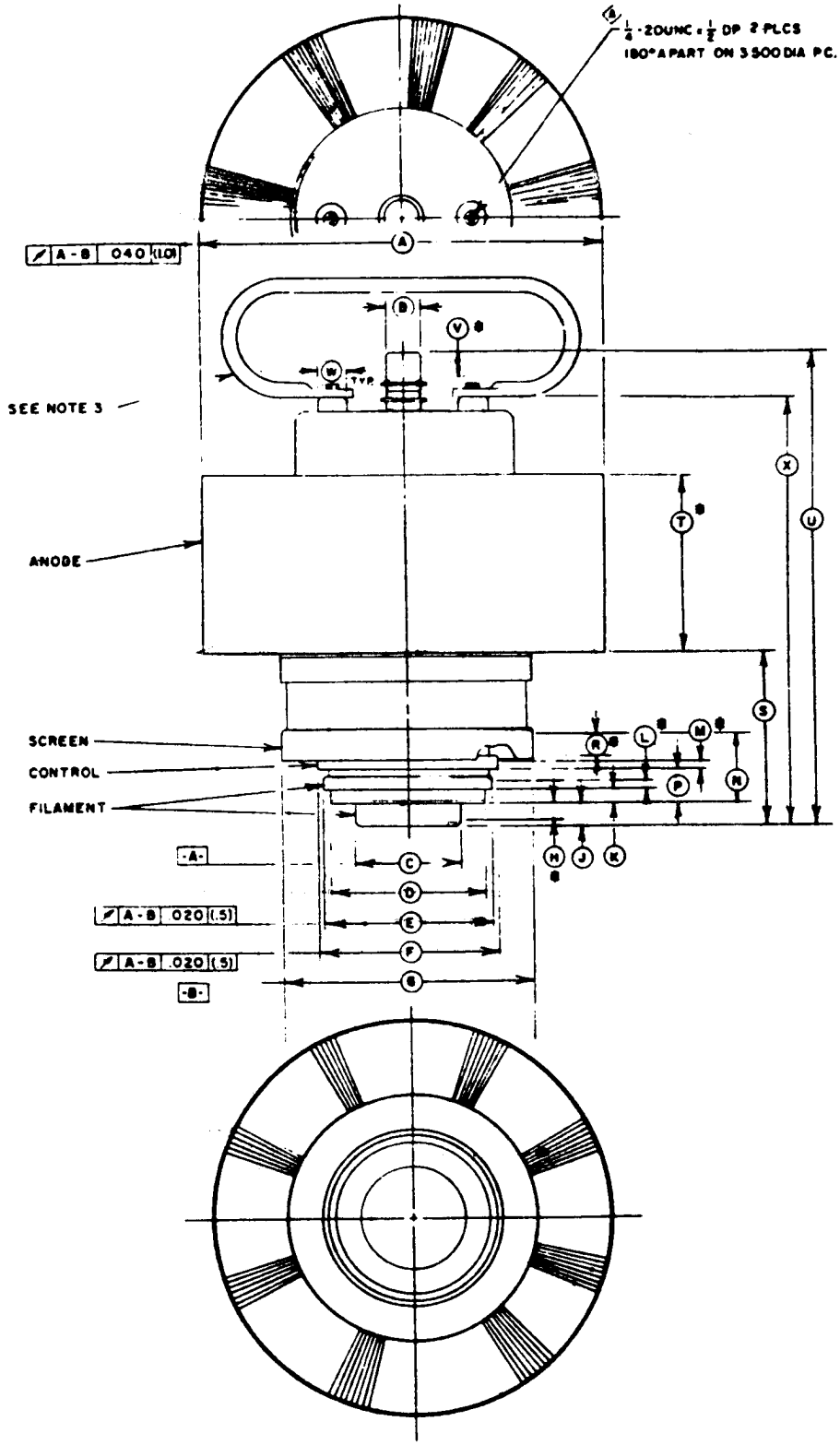
9. Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. A widely accepted standard is that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

10. These tests are carried out 100% by the manufacturer as standard production tests. On final acceptance testing, sampling in accord with MIL-STD-105 may be used. The AQL for the combined defectives for attributes, excluding mechanical, shall be 1%. A tube having 1 or more defects shall be counted as 1 defective.

11. Filament voltage shall be maintained at the specified value for a minimum of 5 minutes before the filament current is read.

12. The symbol egk represents peak positive voltage between the control grid and the cathode.

13. Sampling shall be in accord with MIL-STD-105.



DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM	MIN	MAX	REF	MIN	MAX	REF
A	9.940	10.060		253.0	256.0	
B	.860	.890		21.8	22.6	
C	2.615	2.625		66.42	66.68	
D			3.825			97.2
E	4.245	4.265		107.80	108.30	
F	4.490	4.520		114.05	114.81	
G	6.360	6.405		161.5	162.7	
H	.440			11.2		
J	.660	.680		16.2	17.3	
K	.260	.280		6.6	7.6	
L	.240			6.1		
M	.150			3.8		
N	1.600			40.6		
P	.790	.830		20.1	21.1	
R	.350			8.9		
S	4.170	4.400		106.0	111.8	
T	4.400	4.600		112.0	117.0	
U	11.550	11.850		293.0	301.0	
V	.500			12.7		
W			.750			19.1
X	10.300	10.650		261.6	270.4	

NOTES

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES
2. Ⓑ CONTACT SURFACE
3. SHIPPED WITH HANDLE ATTACHED. REMOVE BEFORE OPERATION

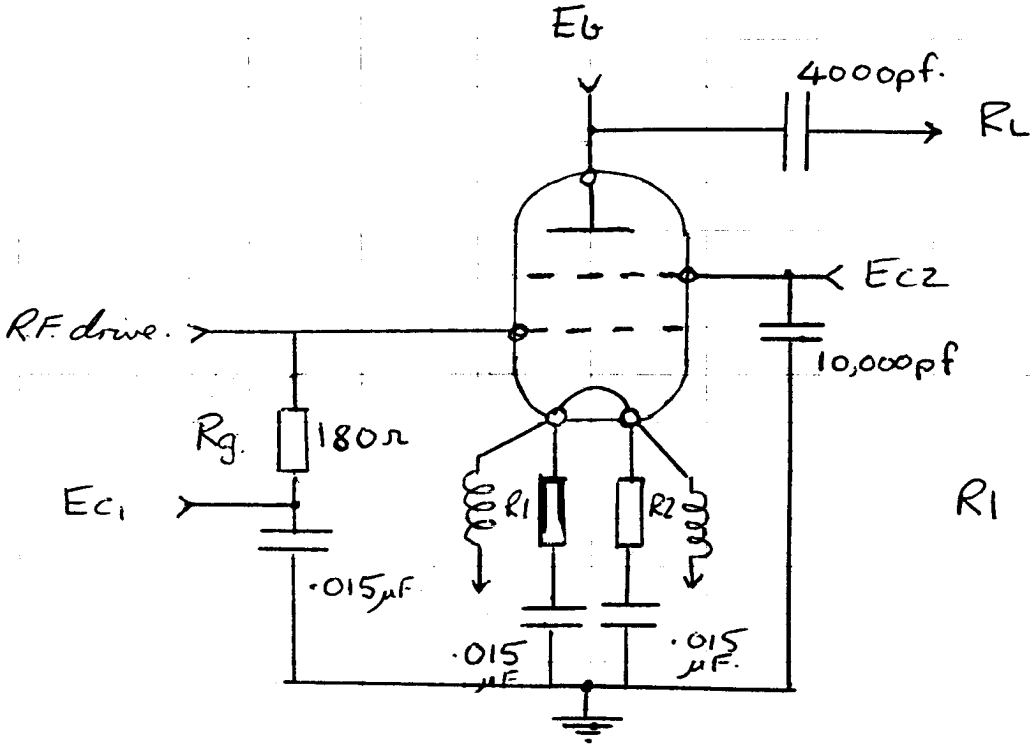
EIMAC TEST SPECIFICATION.

RE 2ND DRAFT 17/8/83 15/3/84.

4CX 40,000 G M.

RF operation

1. Test circuit



R1 = R2 = 6·5Ω.

2. Class AB Amplifier.

3. E_b = 10·5 KV d.c.

4. E_{c2} = 1400 V d.c.

5. R_L = 650Ω ± 5%

Anode loaded tank Q = 10 to 15

6. R_g = 180Ω ± 5%

7. I_{b0} < 2·5A d.c (after adjustment for optimum I.M.D.)

8. Power Out and Intermodulation distortion.

8.1 The power out measured at the anode to be at least 56 KW PEP at 3 MHz with two equal tones spaced at 600 Hz.

8.2. Peak R.F. grid voltage < 260 V at 56 KW PEP

8.3 I_{C2} < 400 ma dc. at 56 KW PEP.

8.4. I.M.D. - measured relative to each tone at any level up to 56 KW P.E.P.

3RD I.M.D. < −41 db.

5TH IMD < −46 db.

The drive signal I.M.D and Harmonics < −55 db.

COMPARISON OF I.M.D. PERFORMANCE OF V1, V3, V4 & V5

WITH TEST CIRCUIT AS SHOWN.

0dB = 56 KW PEP. AT ANODE.

V1	I_{BO} = 2.0A				I_{BO} = 2.2A				I_{BO} = 2.6A			
dB	5th	3rd	3rd	5th	5th	3rd	3rd	5th	5th	3rd	3rd	5th
0	45	49	45	45	47	53	46	48	50	41	39	50
−1	50	42	42	50	53	47	46	53	60	47	45	60
−3	60	41	41	60	60	46	46	60	54	52	52	54
−6	58	50	50	58	57	59	59	57	53	48	47	53
−10	60	60	60	60	60	53	53	60	58	46	46	58

Bk1/95

V3	I_{BO} = 2.8A				I_{BO} = 3.2A				I_{BO} =			
dB	5	3	3	5	5	3	3	5	5	3	3	5
0	48	39	39	47	52	47	46	51				
−1	56	38	38	56	57	43	43	57				
−3	57	40	40	56	53	45	45	53				
−6	54	51	52	56	55	56	56	57				
−10	60	54	54	60	60	52	53	60				

Bk2/164

V4	I_{BO} = 1·7A				I_{BO} = 2·0A				I_{BO} = 2·6A			
dB	5	3	3	5	5	3	3	5	5	3	3	5
0	49	39	38	49	58	47	43	58	51	44	42	52
−1	54	39	38	54	53	44	44	54	46	44	43	46
−3	56	42	42	54	50	56	56	50	46	40	40	46
−6	56	58	58	56	52	45	45	52	50	38	38	52
−10	60	49	49	60	60	44	46	60	60	42	42	60

BK2/213

V5	I_{BO} = 1·8A				I_{BO} = 2·0A				I_{BO} = 2·4A			
dB	5	3	3	5	5	3	3	5	5	3	3	5
0	58	38	38	58	52	42	41	52	46	51	46	46
−1	56	38	38	58	48	44	43	48	44	50	46	44
−3	52	44	44	52	48	52	50	48	46	42	42	46
−6	52	54	52	50	52	44	43	52	58	38	38	52
−10	55	44	44	55	58	43	43	56	62	42	42	62

BK3/51

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

4CX5000A

RADIAL-BEAM POWER TETRODE



The Eimac 4CX5000A is a compact high-power ceramic and metal tetrode cooled by forced air. It is useful as an oscillator, amplifier, or modulator at frequencies up to 110 megacycles and is particularly suited for use as a linear single-sideband amplifier, class-AB_1 audio amplifier, or as a screen-modulated radio-frequency amplifier.

A pair of these tubes will deliver 17.5 kilowatts of audio-frequency or radio-frequency power with zero driving power. The rated plate dissipation is five kilowatts for most classes of service and six kilowatts for class-AB operation.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	73		78	amperes
Amplification Factor (Grid-Screen)	4.25		5.0	
Direct Interelectrode Capacitances, Grounded Cathode:				
Input		106		uuf
Output		18		uuf
Feedback		0.75		uuf

	Nom.	
Direct Interelectrode Capacitances, Grounded Grid and Screen:		
Input	47	uuf
Output	18	uuf
Feedback	0.14	uuf

MECHANICAL

Base	Special concentric
Maximum Seal Temperature	250° C
Maximum Anode-Core Temperature	250° C
Recommended Socket	Eimac SK-300
Operating Position	Axis vertical, base up or down
Maximum Dimensions:	
Height	9.13 inches
Diameter	4.94 inches
Cooling	Forced air
Net Weight	9.5 pounds
Shipping Weight (Approximate)	22 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR (Up to 30 megacycles)

Class-C Telegraphy (Key-down conditions)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7500 MAX. VOLTS
D-C SCREEN VOLTAGE	1500 MAX. VOLTS
D-C PLATE CURRENT	3 MAX. AMPERES
PLATE DISSIPATION	5000 MAX. WATTS
SCREEN DISSIPATION	250 MAX. WATTS
GRID DISSIPATION	75 MAX. WATTS

TYPICAL OPERATION
(Frequencies below 30 megacycles)

D-C Plate Voltage	7500	volts
D-C Screen Voltage	500	volts
D-C Grid Voltage	—350	volts
D-C Plate Current	2.8	amperes
D-C Screen Current	0.5	ampere
D-C Grid Current	0.25	ampere
Peak R-F Grid Voltage	590	volts
Driving Power	150	watts
Plate Dissipation	5000	watts
Plate Output Power	16,000	watts

(Effective 3-15-60) Copyright, 1956 by Eitel-McCullough, Inc.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR (From 30 to 110 megacycles)

Class-C Telegraphy or FM Telephony (Key-down conditions)

MAXIMUM RATINGS

D-C PLATE VOLTAGE:	
30 to 60 megacycles	7000 MAX. VOLTS
60 to 110 megacycles	6500 MAX. VOLTS
D-C SCREEN VOLTAGE	1500 MAX. VOLTS
D-C PLATE CURRENT:	
30 to 60 megacycles	2.8 MAX. AMPERES
60 to 110 megacycles	2.6 MAX. AMPERES
PLATE DISSIPATION	5000 MAX. WATTS
SCREEN DISSIPATION	250 MAX. WATTS
GRID DISSSIPATION	75 MAX. WATTS

TYPICAL OPERATION (Frequencies between 88 and 108 megacycles)

D-C Plate Voltage	6500	volts
D-C Screen Voltage	750	volts
D-C Grid Voltage	—350	volts
D-C Plate Current	2.3	amperes
D-C Screen Current	0.2	ampere
D-C Grid Current	0.05	ampere
Driving Power	25	watts
Useful Output Power	10,000	watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier conditions except where noted)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000 MAX. VOLTS
D-C SCREEN VOLTAGE	1000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPERES
PLATE DISSIPATION*	3500 MAX. WATTS
SCREEN DISSIPATION	250 MAX. VOLTS
GRID DISSIPATION	75 MAX. WATTS

*Corresponds to 5000 watts at 100-percent sine-wave modulation.

TYPICAL OPERATION (Frequencies below 30 megacycles)

D-C Plate Voltage	5000	volts
D-C Screen Voltage	500	volts
Peak A-F Screen Voltage (For 100-percent modulation)	450	Volts
D-C Grid Voltage	—400	volts
D-C Plate Current	1.4	amperes
D-C Screen Current	0.26	ampere
D-C Grid Current	0.05	ampere
Peak R-F Grid Voltage	520	volts
Grid Driving Power	25	watts
Plate Dissipation	1100	watts
Plate Output Power	5.8	kilowatts

SCREEN-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

(Carrier conditions except where noted)

MAXIMUM RATINGS, Class-C Telephony (Per Tube)

D-C PLATE VOLTAGE	7500 MAX. VOLTS
D-C SCREEN VOLTAGE	750 MAX. VOLTS
D-C PLATE CURRENT	3.0 MAX. AMPERES
PLATE DISSIPATION	5000 MAX. WATTS
GRID DISSIPATION	75 MAX. WATTS

TYPICAL OPERATION (Frequencies below 30 megacycles, per tube)

D-C Plate Voltage	7500	7500	volts
D-C Screen Voltage	350	350	volts
Peak A-F Screen Voltage (For 100-percent modulation)	550	550	volts
D-C Grid Voltage	—300	—300	volts
D-C Plate Current	0.9	1.14	amperes
D-C Screen Current*	—0.01	—0.01	amperes
D-C Grid Current	0.015	0.03	amperes
Peak R-F Grid Voltage	350	375	volts
Grid Driving Power	7	11	watts
R-F Load Impedance	2000	1600	ohms
Plate Dissipation	4000	5000	watts
Useful Output Power	2750	3550	watts

*D-C Screen Current is a function of loading; values of plus or minus 20 milliamperes may be considered typical at carrier level.

NOTE: Two tubes can be employed under conditions listed in the first column to obtain more than five kilowatts plate output power. Likewise, three tubes can be utilized at conditions listed in the second column to obtain better than ten kilowatts output power.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per Tube)

D-C PLATE VOLTAGE	7500 MAX. VOLTS
D-C SCREEN VOLTAGE	1500 MAX. VOLTS
D-C PLATE CURRENT	4.0 MAX. AMPERES
PLATE DISSIPATION	6000 MAX. WATTS
SCREEN DISSIPATION	250 MAX. WATTS
GRID DISSIPATION	75 MAX. WATTS

TYPICAL OPERATION, two tubes

D-C Plate Voltage	4000	5000	6000	7000	volts
D-C Screen Voltage	1250	1250	1250	1250	volts
D-C Grid Voltage	—270	—280	—310	—325	volts
Max.-Signal Plate Current	5.10	4.40	4.25	3.65	amperes
Zero-Signal Plate Current	1.25	1.00	0.83	0.70	amperes
Max-Signal Screen Current	0.35	0.33	0.30	0.24	amperes
Zero-Signal Screen Current	0	0	0	0	amperes
Peak A-F Driving Voltage	250	240	270	235	volts
Driving Power	0	0	0	0	watts
Load Resistance, Plate-to-Plate	1500	2370	2940	4100	ohms
Max.-Signal Plate Dissipation	4200	4200	4200	4200	watts
Max.-Signal Plate Output Power	11,500	13,500	17,000	17,500	watts

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7500 MAX. VOLTS
D-C SCREEN VOLTAGE	1500 MAX. VOLTS
D-C PLATE CURRENT	4.0 MAX. AMPERES
PLATE DISSIPATION	6000 MAX. WATTS
SCREEN DISSIPATION	250 MAX. WATTS
GRID DISSIPATION	75 MAX. WATTS

TYPICAL OPERATION, Peak-Envelope or Modulation-Crest Conditions, (Frequencies below 30 megacycles)

D-C Plate Voltage	7500	volts
D-C Screen Voltage	1250	volts
D-C Grid Voltage*	—300	volts
Max.-Signal Plate Current	1.9	amperes
Zero-Signal Plate Current	0.50	ampere
Max.-Signal Screen Current	0.20	ampere
Peak R-F Grid Voltage	300	volts
Driving Power	0	watts
Plate Dissipation	4200	watts
Plate Output Power**	10,000	watts

*Adjust grid voltage to obtain specified Zero-Signal plate current.
**PEP output or r-f output power at crest of modulation envelope.

NOTE: In most cases, "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made. Exceptions are distinguished by a listing of "Useful" output power as opposed to "Plate" output power. Values appearing in these groups have been obtained from existing equipment(s) and the output power is that measured at the load.

APPLICATION

MECHANICAL

Mounting—The 4CX5000A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

Socket—The Eimac Air-System Socket Type SK-300 is designed especially for the concentric base terminals of the 4CX5OOOA. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through an Air Chimney, the SK-306, into the anode cooling fins.

Cooling—The maximum temperature rating for the external surfaces of the 4CX5OOOA is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic-metal seals below 250°C. Air-flow requirements to maintain seal temperatures at 200°C in 50°C ambient air are tabulated below.

	SEA LEVEL		10,000 FEET	
Plate Dissipation* (Watts)	Air Flow (CFM)	Pressure Drop (Inches of water)	Air Flow (CFM)	Pressure Drop (Inches of water)
2000	100	0.6	146	0.9
3000	160	1.4	230	2.0
4000	230	2.8	330	4.0
5000	310	4.0	450	5.8
6000	400	5.1	580	7.4

*Since the power dissipated by the filament represents about 560 watts and since grid-plus-screen dissipation can, under some conditions, represent another 200 to 300 watts, allowance has been made in preparing this tabulation for an additional 1000 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be increased to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using maximum rated temperatures as the criteria for satisfactory cooling.

ELECTRICAL

Filament Operation—The rated filament voltage for the 4CX5000A is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than 5 percent from the rated value.

Electrode Dissipation Ratings—The maximum dissipation ratings for the 4CX5000A must be respected to avoid damage to the tube. An exception is the plate dissipation, which may be permitted to rise above the maximum rating during brief periods, such as may occur during tuning.

Control Grid Operation—The 4CX5000A control grid has a maximum dissipation rating of 75 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible.

Screen-Grid Operation—The power dissipated by the screen of the 4CX5000A must not exceed 250 watts.

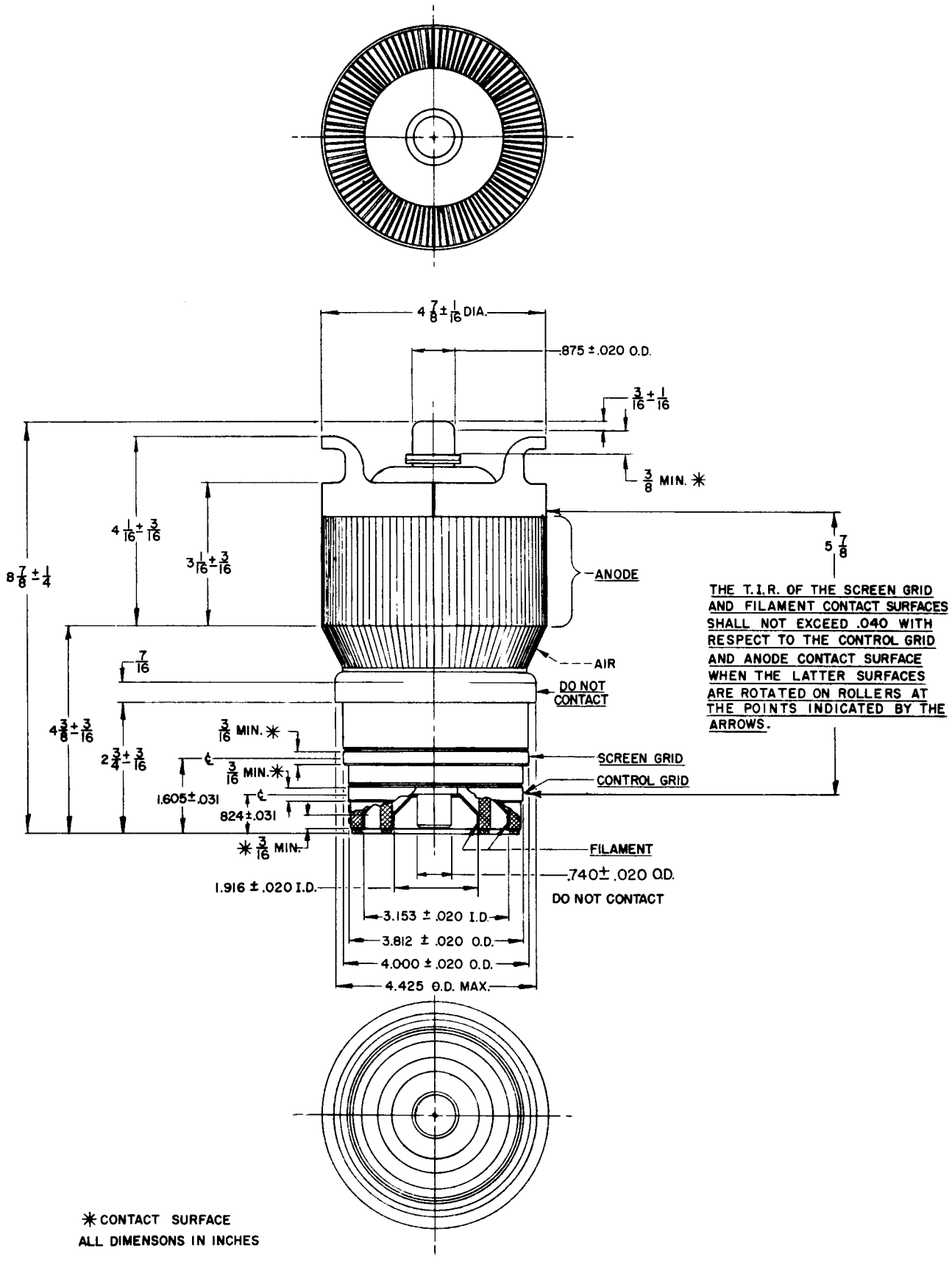
Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

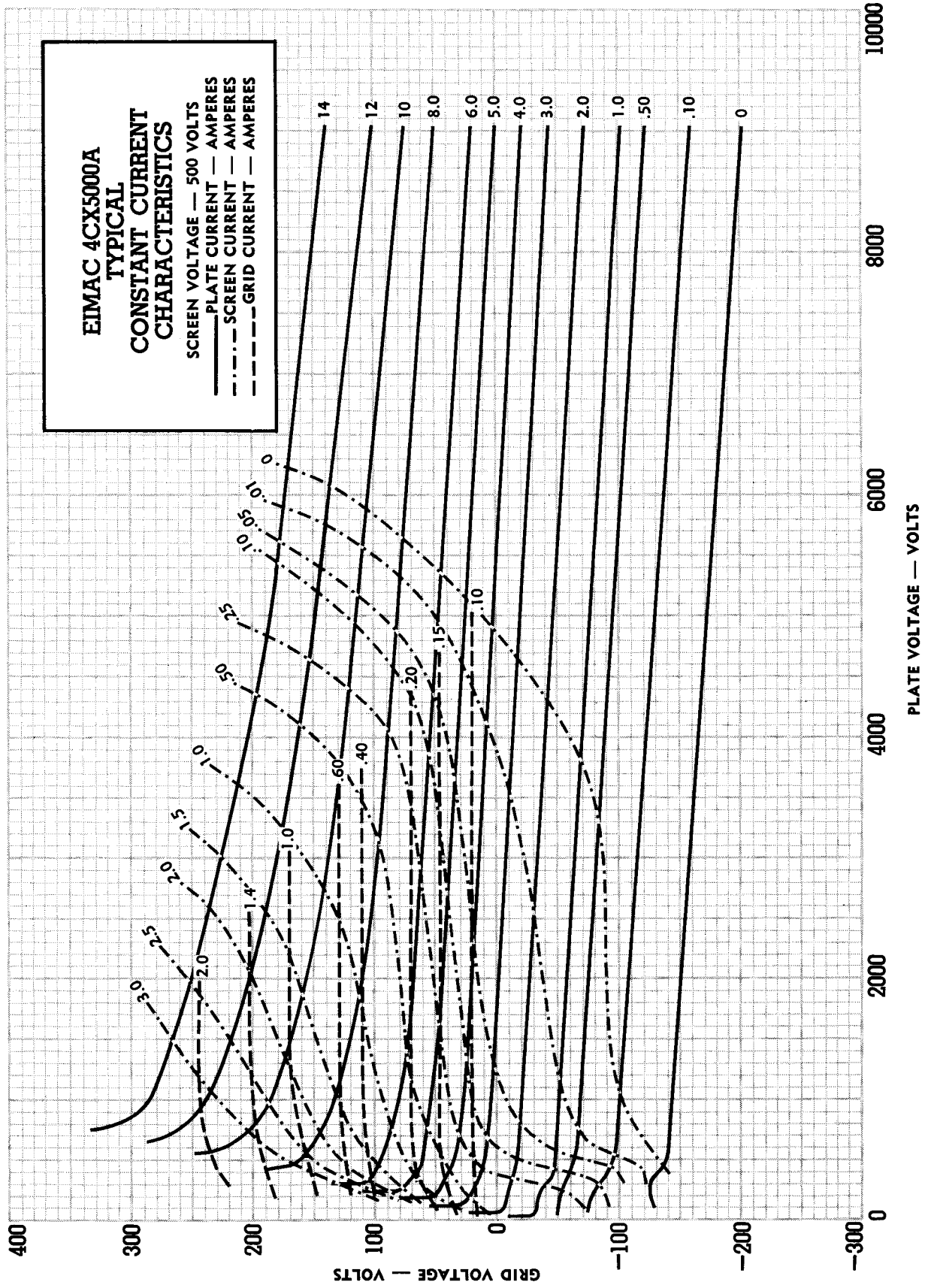
Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 250 watts in the event of circuit failure.

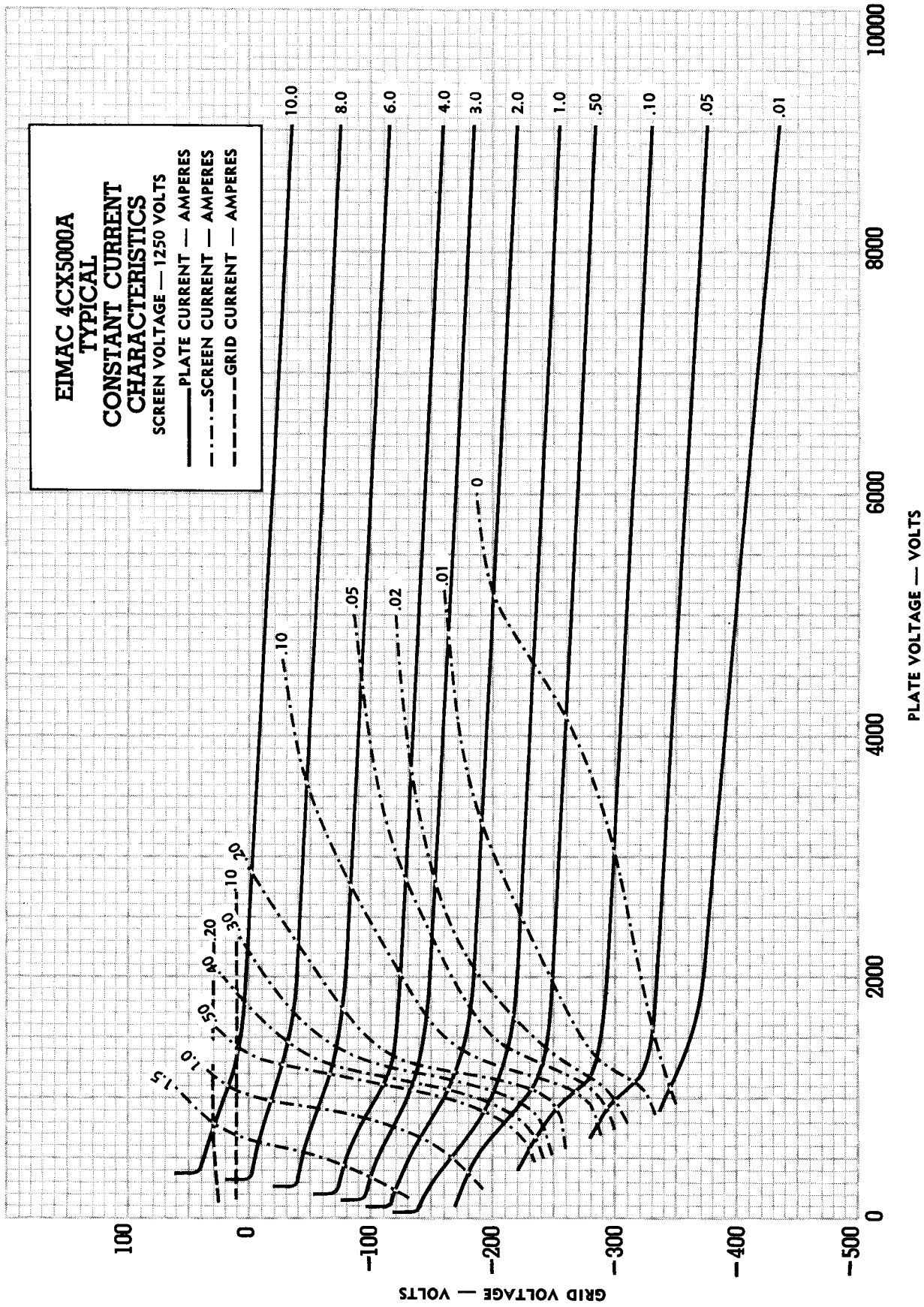
Plate Dissipation—The plate-dissipation rating for the 4CX5000A is 5000 watts for most applications but for audio and SSB amplifier applications, the maximum allowable dissipation is 6000 watts.

When the 4CX5000A is operated as a plate-modulated r-f power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 3500-watt maximum plate dissipation rating will be exceeded.

Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to the Application Engineering Department, Eitel-McCullough, Inc., 301 Industrial Road, San Carlos, California, for information and recommendations.


4 7/8 ± 1/16 DIA.
.875 ± .020 O.D.
3/16 ± 1/16
3/8 MIN. ✳
5 7/8
8 7/8 ± 1/4
4 1/16 ± 3/16
3 1/16 ± 3/16
ANODE
AIR
7/16
DO NOT CONTACT
4 3/8 ± 3/16
2 3/4 ± 3/16
3/16 MIN. ✳
3/16 MIN. ✳
1.605 ± .031
824 ± .031
✳ 3/16 MIN.
SCREEN GRID
CONTROL GRID
FILAMENT
.740 ± .020 O.D.
DO NOT CONTACT
1.916 ± .020 I.D.
3.153 ± .020 I.D.
3.812 ± .020 O.D.
4.000 ± .020 O.D.
4.425 O.D. MAX.
THE T.I.R. OF THE SCREEN GRID AND FILAMENT CONTACT SURFACES SHALL NOT EXCEED .040 WITH RESPECT TO THE CONTROL GRID AND ANODE CONTACT SURFACE WHEN THE LATTER SURFACES ARE ROTATED ON ROLLERS AT THE POINTS INDICATED BY THE ARROWS.
✳ CONTACT SURFACE
ALL DIMENSONS IN INCHES


EIMAC 4CX5000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
14
12
10
8.0
6.0
5.0
4.0
3.0
2.0
1.0
.50
.10
0
.01
.05
.10
.25
.50
1.0
1.5
2.0
2.5
3.0
1.4
.60
.40
.20
.15
.10
400
300
200
100
0
−100
−200
−300
0
2000
4000
6000
8000
10000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS



Printed in U.S.A. 5415

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4CX600A

(formerly X2009)

The 4CX600A is a compact radial-beam tetrode with low lead inductances and low interelectrode capacitances, designed for use in distributed amplifiers and in UHF service up to 1300 Mc. Maximum plate dissipation is 600 watts.

A feature of this tube is the integral screen-cathode by-pass capacitor. One side of the heater is terminated in a "deck" attached to this capacitor while the other heater contact is brought out on a pin on the tube base. The control grid is brought out to four threaded pins on the base.

GENERAL CHARACTERISTICS

ELECTRICAL

Heater Voltage	6.0	Volts
Current (average)	4.8	Amperes
Cathode: Oxide-coated, Unipotential		
Amplification Factor	8	
Transconductance (I_b = 300 mA)	25,000	umhos
Frequency for maximum ratings	1300	Mc
Interelectrode capacitances:		
Input	42	uuf
Output	10	uuf
Screen-cathode	110	uuf

MECHANICAL

Base	5	Pin, Special
Maximum operating temperatures:		
Anode core		250° C
Ceramic-metal seals		250° C
Cooling		Forced air

MAXIMUM RATINGS Class-C Amplifier

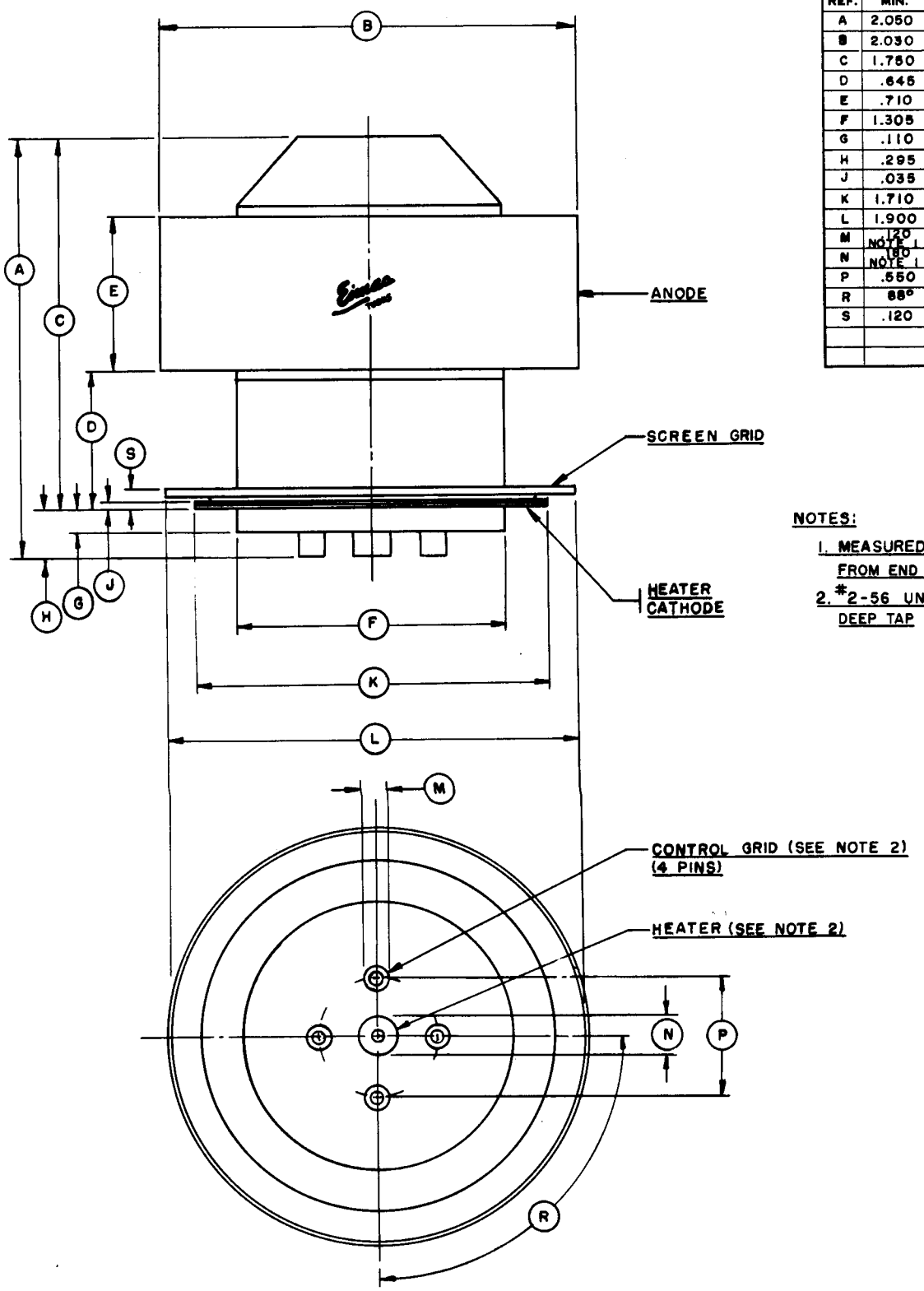
DC Plate Voltage	3000	Max. Volts
DC Screen Voltage	400	Max. Volts
DC Grid Voltage	-150	Max. Volts
DC Plate Current	500	Max. mA
Plate Dissipation	600	Max. Watts
Screen Dissipation	15	Max. Watts
Grid Dissipation	3	Max. Watts

This information applies to a tentative tube design and is subject to change. Further application information is available from Power Grid Tube Marketing, Eitel-McCullough, Inc., San Carlos, California.

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DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	2.050	2.200	
B	2.030	2.080	
C	1.750	1.900	
D	.645	.780	
E	.710	.790	
F	1.305	1.325	
G	.110	.135	
H	.295	.350	
J	.035	.050	
K	1.710	1.750	
L	1.900	2.025	
M	.120 NOTE 1	.135 NOTE 1	
N	.180 NOTE 1	.210 NOTE 1	
P	.550	.600	
R	88°	92°	
S	.120	.160	



NOTES:

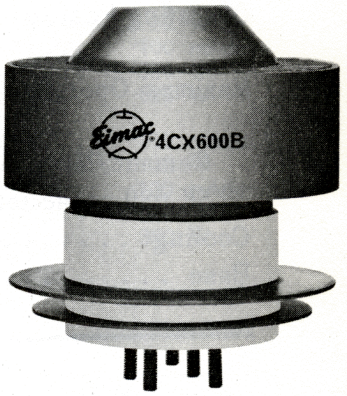
1. MEASURED .100 INCHES FROM END OF PIN
2. #2-56 UNC-2B X 3/16 DEEP TAP

TECHNICAL DATA

4CX600B
4CX600F

RADIAL BEAM POWER TETRODE

The EIMAC 4CX600B and 4CX600F are ceramic/metal, air cooled radial beam tetrodes designed for use in wideband amplifiers, particularly distributed amplifiers.



The mechanical and electrical features of these tubes are compatible with wideband amplifier circuit requirements; i.e., low lead inductance, low input and output capacitances, small size and high transconductance.

Rugged construction consisting of a unitized electrode structure and direct mounting to the chassis combine to make the 4CX600B and 4CX600F suitable for environments of severe shock and vibration.

The maximum rated plate dissipation of either type is 600 watts.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: (4CX600B) Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3	V
Current, at 6.0 volts	4.3	A
Cathode: (4CX600F) Oxide Coated, Unipotential		
Heater: Voltage	26.5 ± 1.3	V
Current, at 26.5 volts	1.05	A
Transconductance (Average):		
I_b = 0.6 Adc	41,000	μmhos
Input Conductance:		
I_b = 0.6 Adc (F = 30 MHz)	0.1×10^{-3}	mhos
Direct Interelectrode Capacitances (grounded cathode)[2]		
Input	45	pF
Output	5.8	pF
Feedback	0.10	pF
Frequency of Maximum Rating:		
CW	500	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. In Shielded Fixture.

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MECHANICAL

Maximum Overall Dimensions:

Length	2.45 in; 62.23 mm
Diameter	2.08 in; 52.83 mm
Net Weight	7.0 oz; 198 gm
Operating Position	Any

Maximum Operating Temperature:

Ceramic/Metal Seals and Anode Core	250°C
SK-680 capacitor when used	150°C
Cooling	Air
Base	Special

BROADBAND LINEAR AMPLIFIER

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-150	VOLTS
DC PLATE CURRENT	0.6	AMPERE
PLATE DISSIPATION	600	WATTS
SCREEN DISSIPATION	15	WATTS
GRID DISSIPATION	3	WATTS

TYPICAL OPERATION

Plate Voltage	1000	1500	2500	Vdc
Screen Voltage	275	275	275	Vdc
Grid Voltage [1]	-40	-40	-40	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Single Tone Plate Current	570	580	585	mAdc
Single-Tone Screen Current [2]	32	29	17	mAdc
Peak rf Grid Voltage	44	43	42	v
Screen Dissipation	8.8	8.0	4.7	W
Plate Input Power	570	870	1460	W
Plate Dissipation	250	280	460	W
Plate Output Power	320	590	1000	W
Rf Load Impedance	765	1225	2325	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER

Class AB

(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS (890 MHz):

DC PLATE VOLTAGE	2500	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-150	VOLTS
DC PLATE CURRENT	0.6	AMPERE
PLATE DISSIPATION	600	WATTS
SCREEN DISSIPATION	15	WATTS
GRID DISSIPATION	3	WATTS

1. Approximate value

2. Grid driven. Grounded screen, rf grounded cathode.

3. For CW operation on 865 MHz heater voltage is reduced 15%. Inquire for voltage recommended for other UHF conditions.

4CX600F TYPICAL OPERATION	NOTE 2	NOTE 4	
Frequency	432	865	MHz
Plate to Cathode Voltage	1830	2000	Vdc
Screen to Cathode Voltage	300	300	Vdc
Grid Voltage	-54	-53	Vdc
Plate Current	600	600	mAdc
Screen Current [1]	7.5	8	mAdc
Grid Current [1]	12	-1.0	mAdc
Zero-Signal dc Plate Current [1]	20	15	mAdc
Measured Driving Power [1]	25	52	W
Plate Input Power	1 100	1200	W
Plate Dissipation	350	550	W
Useful Output Power	700	585	W
Heater Voltage [3]	22.0	22.0	V
Gain	15.0	10.4	db
Efficiency	65	48	%
Bandwidth (3db) output circuit	10.7	13.5	MHz

4. Grid driven. Neutralized cavity. Grounded screen.

RADIO-FREQUENCY POWER AMPLIFIER
Class-B, Television Service (Frequencies to 890 MHz)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	2500	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC PLATE CURRENT	0.6	AMPERE
PLATE DISSIPATION	600	WATTS
SCREEN DISSIPATION	15	WATTS
GRID DISSIPATION	3	WATTS
DC GRID VOLTAGE	-150	VOLTS

TYPICAL OPERATION (865 MHz)
Grid driven, neutralized cavity, grounded screen. Rf grounded cathode, single tuned input and output circuits. Output circuit efficiency 80%.

Plate to Cathode Voltage	2000	Vdc
Screen to Cathode Voltage	300	Vdc
Grid Voltage[1]	-54	Vdc
Heater voltage (See note 3 page 2)		
Bandwidth at 3 db points	9	MHz
Zero-Signal dc Plate Current	100	mAdc
During Sync-Pulse		
dc Plate Current	600	mAdc
Pulse Screen Current[1]	8	mAdc
Drive Power [1]	52	W
Zero-Signal dc Plate Current	100	mAdc
Plate Dissipation	550	W
Useful Power Output	585	W
Black Level:		
dc Plate Current	450	mAdc
Drive Power [1]	25	W
Zero-Signal dc Plate Current	100	mAdc
Plate Dissipation	550	W
Useful Power Output	350	W

1. Approximate

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
4CX600B			
Heater: Current at 6.0 volts	4.0	4.7	A
Cathode Warmup Time	180	--	sec.
4CX600F			
Heater: Current at 26.5 volts	0.85	1.25	A
Cathode Warmup Time	180	--	sec.
Interelectrode Capacitances [1] (grounded cathode connection)			
Input	42	48	pF
Output	5.3	6.3	pF
Feedback	---	0.2	pF

APPLICATION

MECHANICAL

MOUNTING - The 4CX600B and 4CX600F may be mounted in any position. No socket is required. The tube may be mounted directly on the SK-680 Screen Bypass Capacitor which in turn is mounted to the chassis with four screws. The chassis thickness should be 0.062 inches to insure adequate space for connections to the base of the tube and care should be exercised to insure a flat mounting surface to minimize cathode lead inductance.

COOLING - Sufficient forced-air cooling must be provided to maintain the anode core and seal temperatures below 250°C. The tabulation (page 4) lists the minimum cooling requirements at sea level and 10,000 feet with 50°C ambient air. At VHF and UHF, additional cooling air will be required due to circuit loss, a portion of which is chargeable to the tube.

Air cooling of the tube base is required. 10 CFM minimum should be directed straight up toward the center of tube base from a duct or blower, not more than 2-1/2 inches from the tube.

PLATE DISSIPATION (WATTS)	SEA LEVEL		10,000 FEET	
	AIR FLOW (CFM)	STATIC PRESSURE (W.C.)	AIR FLOW (CFM)	STATIC PRESSURE (W.C.)
300	5.5	0.14	8.0	0.20
450	11.4	0.47	16.6	0.68
600	14.1	0.65	20.6	0.94

The following diagram illustrates a typical cooling installation.

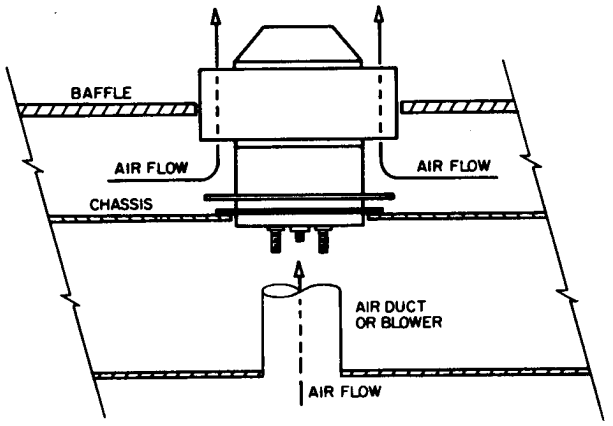


FIG. I

In cases where there is any doubt regarding the adequacy of the supplied cooling, it should be borne in mind that operating temperature is the sole criterion of cooling effectiveness.

ELECTRICAL

HEATER - The rated heater voltage is 6.0 volts for the 4CX600B and 26.5 volts for the 4CX600F. The voltage, as measured at the tube, should be maintained at this value to minimize variations in operation and to obtain maximum tube life. In no case should the voltage be allowed to exceed 5% above the rated value. (See note 3 page 2).

The cathode and one side of the heater are internally connected.

It is recommended that the heater voltage be applied for a period of not less than three minutes before current is drawn from the cathode. Tube operation will stabilize after a period of approximately five minutes from a cold start.

GRID OPERATION - The 4CX600B and 4CX600F control grid has a maximum dissipation of 3.0 watts and precautions should be observed to avoid exceeding this rating. Derating of the control grid dissipation will be necessary if the base flange temperature exceeds 150°C.

The 4CX600B and 4CX600F have four threaded grid pins on the base of the tube. These pins can be used separately or in parallel to control the amount of grid lead inductance to suit the requirements of the circuit. The grid lead inductance for one pin is 2.4 nanohenries.

Caution should be excercised when tightening the nuts on the control grid pins. Maximum torque of three inch-pounds is sufficient for good electrical connection and should not be exceeded due to possible damage to the vacuum seal.

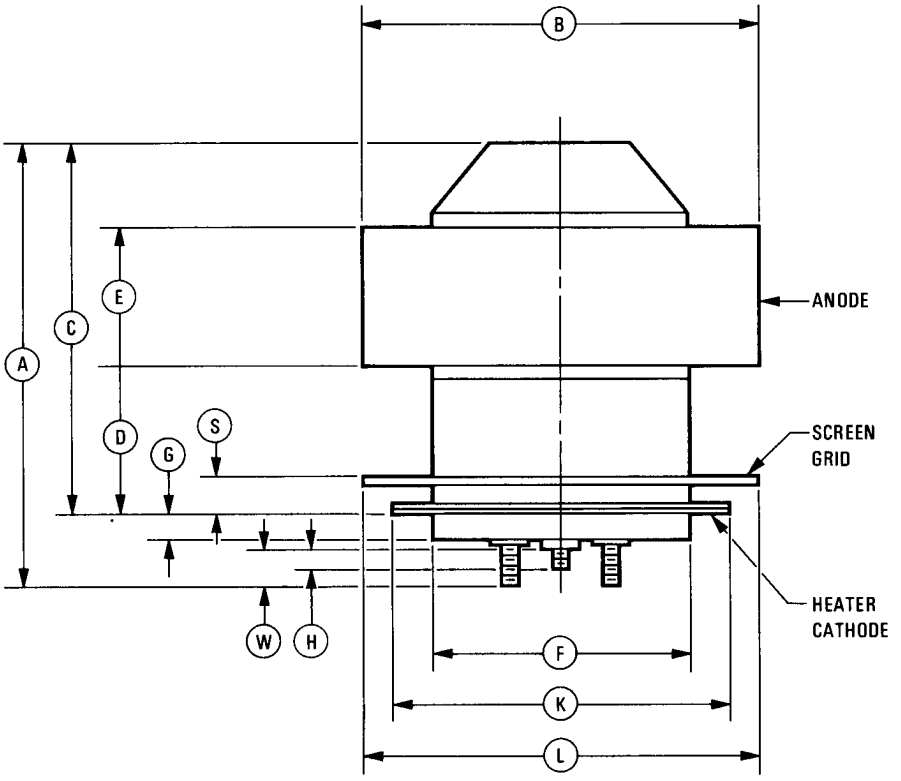
SCREEN OPERATION - The maximum rated screen dissipation for the 4CX600B and 4CX600F is 15 watts.

Under certain operating conditions the screen current of a tetrode may reverse as indicated on the screen current meter. This condition is the result of secondary emission from the screen and is normal for a power tetrode. If the impedance of the screen power supply is high, negative screen current will cause the screen voltage to approach the anode voltage, and the results will be a runaway condition which could lead to a catastrophic failure. This condition can be avoided if sufficient bleeder current is drawn from the screen supply by an appropriate bleeder or regulator tube. The recommended bleeder current for the 4CX600B and 4CX600F is 20 mA for each tube connected to a common screen power supply.

A low inductance screen bypass capacitor, Eimac SK-680, is available for the 4CX600B and 4CX600F. This capacitor is easily installed with six 0-80 screws. With the SK-680 capacitor installed, the screen self-resonant frequency of the 4CX600B or 4CX600F is in excess of 900 MHz.

PLATE OPERATION - The maximum rated plate dissipation power for the 4CX600B and 4CX600F is 600 watts. Except for brief periods during circuit adjustments, this maximum value should not be exceeded. Connection to the anode is accomplished by a clamp around the anode.

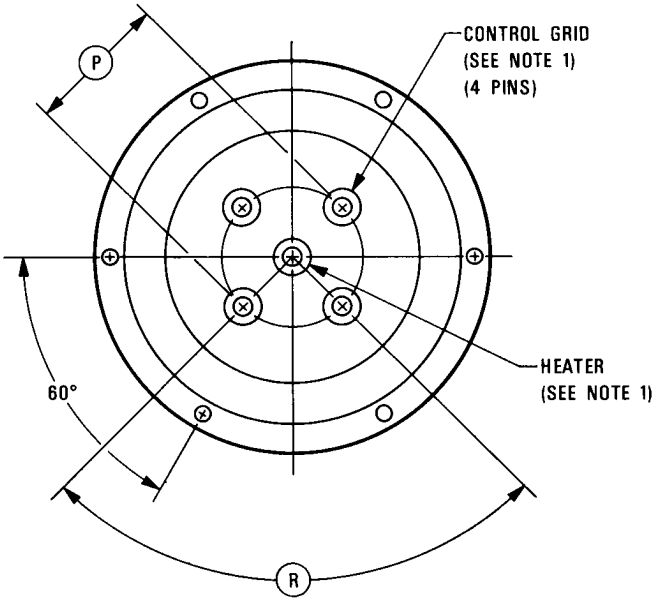
SPECIAL APPLICATIONS - If it is desired to operate the tube under conditions different from those given here, contact the Power Grid Division, EIMAC Division of Varian, San Carlos, California, 94070, for information and recommendations.

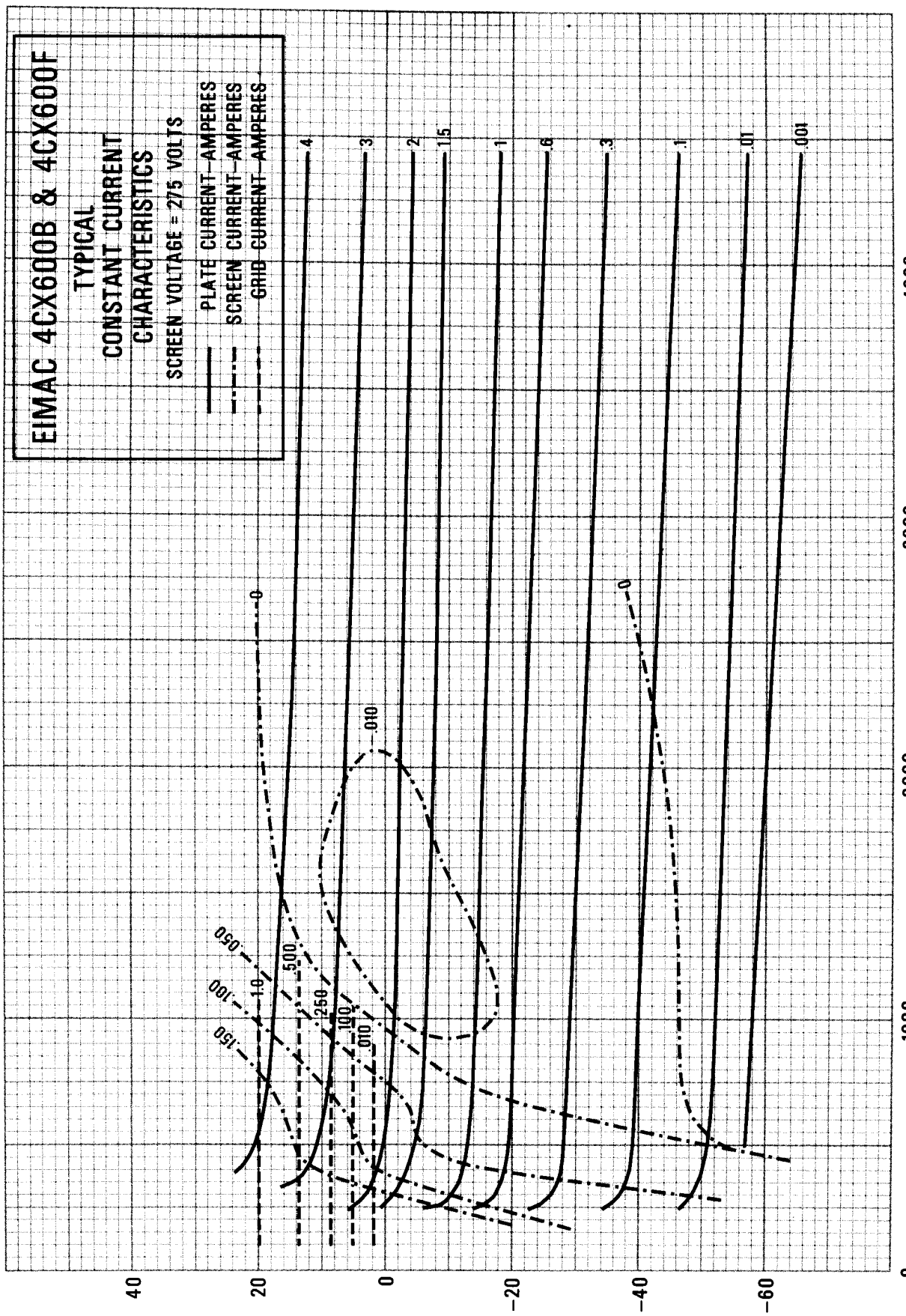


DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	--	2.450	--	62.23
B	2.040	2.080	51.82	52.83
C	1.825	1.975	46.35	50.16
D	.675	.810	17.14	20.57
E	.720	.800	18.29	20.32
F	1.305	1.325	33.15	33.65
G	.130	.155	3.30	3.94
H	.130	.180	3.30	4.57
K	1.710	1.750	43.43	44.45
L	1.930	2.025	49.02	51.43
P	.550	.600	13.97	15.24
R	88°	92°	88°	92°
S	.180	.210	4.57	5.33
W	.250	.300	6.35	7.62

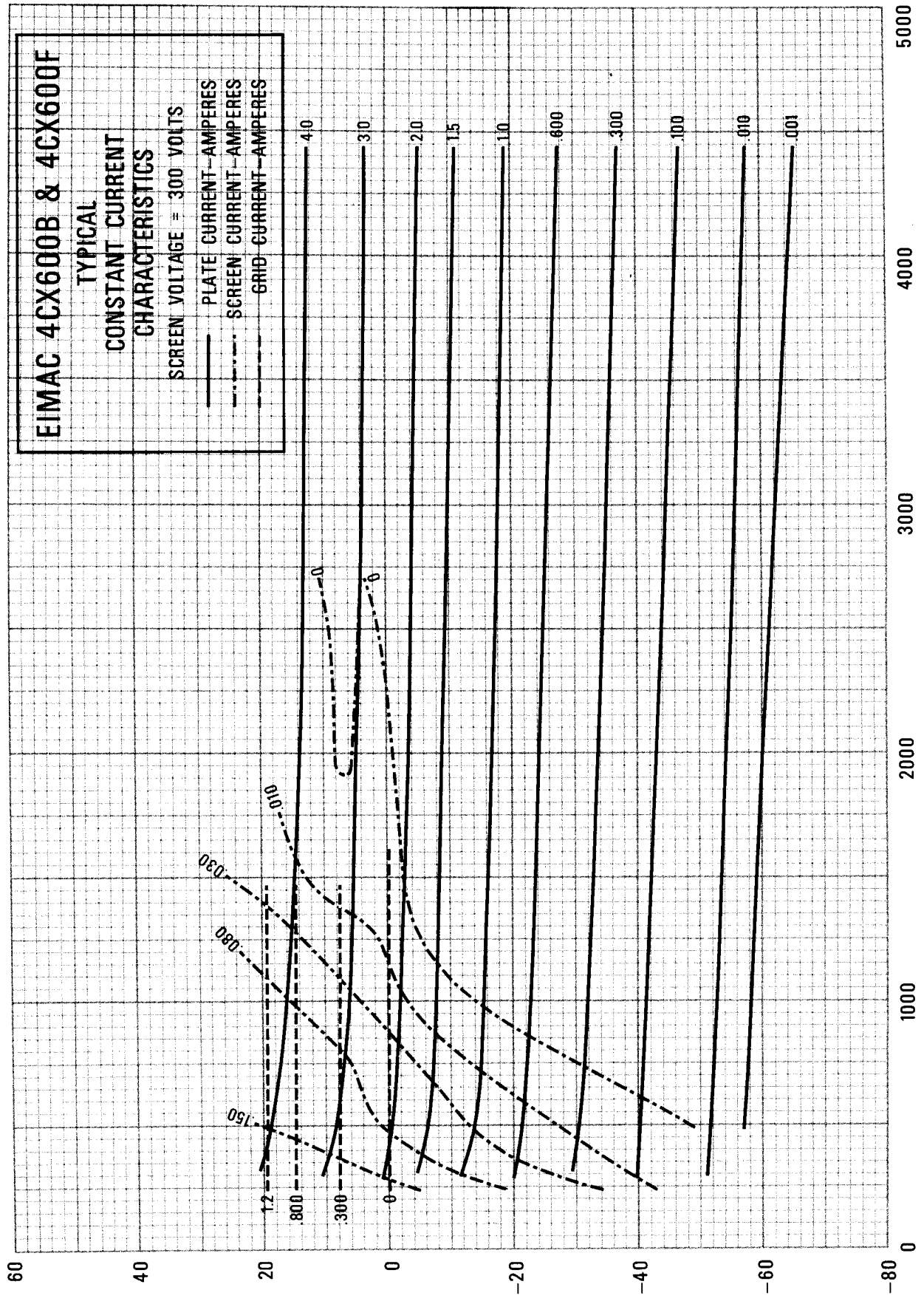
NOTES:

1. 2–56 UNC–2A
2. REF. DIM. ARE FOR INFO. ONLY AND ARE NOT REQ'D. FOR INSPECTION PURPOSES.

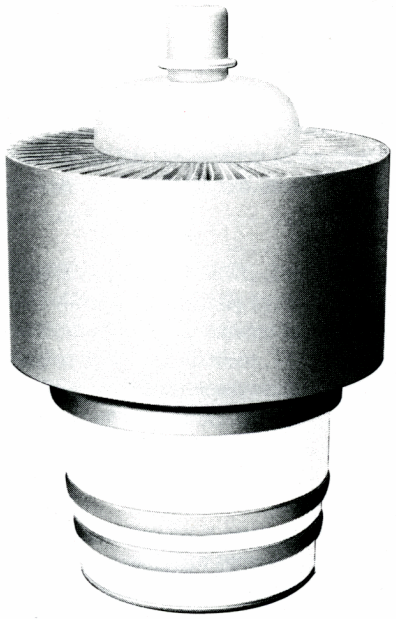



EIMAC 4CX600B & 4CX600F
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 275 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
4
3
2
1.5
1
.6
.3
.1
.01
.001
0
.010
.050
.100
.150
1.0
.500
.250
.100
.010
0
0
1000
2000
3000
4000
PLATE VOLTAGE (V)
40
20
0
−20
−40
−60
GRID VOLTAGE (V)

CURVE #3371


EIMAC 4CX600B & 4CX600F
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 300 VOLTS
PLATE CURRENT-AMPERES
SCREEN CURRENT-AMPERES
GRID CURRENT-AMPERES
4.0
3.0
2.0
1.5
1.0
.600
.300
.100
.010
.001
0
.010
.030
.080
.150
1.2
.800
.300
0
60
40
20
0
-20
-40
-60
-80
0
1000
2000
3000
4000
5000
GRID VOLTAGE (V)
PLATE VOLTAGE (V)

CURVE #3988



TECHNICAL DATA

4CX7500A
VHF RADIAL BEAM POWER TETRODE

The EIMAC 4CX7500A is a compact ceramic/metal radial beam power tetrode intended for use in VHF power amplifier applications. It features a type of internal mechanical structure which results in high rf operating efficiency. Low rf losses in this structure permit operation at full ratings to 220 MHz. A dense mesh filament is used which contributes to the high performance capability.

The 4CX7500A has a gain of over 20 dB in FM broadcast service, and is also recommended for rf linear power amplifier service and for VHF-TV linear amplifier service. The anode is rated for 7500 watts of dissipation with forced air cooling.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh		
Voltage	7.0 ± 0.35	V
Current, at 7.0 volts	110	A
Amplification Factor, average		
Grid to Screen	4.5	
Direct Interelectrode Capacitances (cathode grounded)[2]		
Cin	145	pF
Cout	20	pF
Cgp	0.5	pF
Direct Interelectrode Capacitances (grids grounded)[2]		
Cin	74.1	pF
Cout	20.6	pF
Cpk	0.065	pF
Maximum Frequency for Full Ratings (CW)	220	MHz

[1]Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Varian Power Grid & X-Ray Tube Products should be consulted before using this information for final equipment design.

[2]Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

394625 (Effective April 1985) VA4807 2216

Printed in U.S.A.

varian

power grid & x-ray tube products

301 Industrial Way / San Carlos, CA 94070 / U.S.A. / (415) 592-1221

MECHANICAL

Maximum Overall Dimensions:	
Length	8.72 In; 21. 5 cm
Diameter	5.66 In; 14.4 cm
Net Weight (approximate)	7.7 Lbs; 3.5 kg
Operating Position	Axis Vertical, Base Up or Down
Cooling	Forced Air
Maximum Operating Temperature, Ceramic/Metal Seals & Anode Core	250°C
Base	Special, Coaxial
Recommended Air-System Socket	HF: EIMAC SK-340
	VHF: EIMAC SK-350
Available Screen Grid Bypass Capacitor Kit for SK-350 or SK-360 (8000 pF @ 5000 DCWV)	EIMAC SK-355
Recommended Air-System Chimney (for SK-350 or SK-360)	EIMAC SK-346
Recommended EIMAC Cavity Assembly for FM Broadcast Service	CV-2228
Available Anode Connector Clip	EIMAC ACC-3

RADIO FREQUENCY POWER AMPLIFIER
Class C Telegraphy or FM
(Key-down Conditions)

ABSOLUTE MAXIMUM CONDITIONS

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	3.0	AMPERES
PLATE DISSIPATION	7500	WATTS
SCREEN DISSIPATION	165	WATTS
GRID DISSIPATION	50	WATTS

TYPICAL OPERATION
(Measured data in EIMAC CV2228 FM cavity at 100.5 MHz)

Plate Voltage	6.5	6.5	6.5	kVdc
Screen Voltage	635	750	750	Vdc
Grid Voltage	-460	-275	-400	Vdc
Plate Current	2.1	2.2	2.4	Adc
Screen Current	195	128	140	mAdc
Grid Current	185	90	95	mAdc
Driving Power	247	100	130	W
Efficiency	79.3	77.6	77.0	%
Useful Output Power	10.8	11.1	12.1	kW
Power Gain	16	20	19.7	dB

RADIO FREQUENCY LINEAR AMPLIFIER
Class AB1

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	3.0	AMPERES
PLATE DISSIPATION	7500	WATTS
SCREEN DISSIPATION	165	WATTS
GRID DISSIPATION	50	WATTS

* Approximate Value
** Adjust to specified zero-signal plate current
# PEP output or rf power at crest of modulation envelope
§ Referenced against one tone of a two equal-tone signal

Typical Operation, Peak Envelope or Modulation Crest Conditions (frequencies below 30 MHz)

Plate Voltage	7500	Vdc
Zero Signal Plate Current	750	mAdc
Max. Signal Plate Current	2.2	Adc
Screen Voltage	1250	Vdc
Screen Current*	95	mAdc
Grid Bias Voltage**	-190	Vdc
Grid Current*	0	mAdc
Useful Power Out#,##	10	kW
Driving Power*	0	W
Intermodulation Distortion Products§		
3rd Order Products	-32	dB
5th Order Products	-44	dB

##Delivered to the load

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

APPLICATION

MECHANICAL

MOUNTING - The 4CX7500A must be mounted with its axis vertical, base up or down at the convenience of the equipment designer, and should be protected from shock and vibration which could damage the internal structure of the tube.

AIR-SYSTEM SOCKET & CHIMNEY - The EIMAC sockets type SK-340 and SK-350 are designed especially for the concentric base terminals of the 4CX7500A. The SK-340 is intended for use at HF, while the SK-350 is recommended for VHF applications. The SK-346 chimney is intended for use with either. Use of the recommended air flow rates through either socket will provide effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through the chimney and into the anode cooling fins.

COOLING - Forced-air cooling is required in all applications. The blower selected in a given application must be capable of supplying the desired air flow at a back pressure sufficient for the tube, plus any drop caused by ducts and filters. Air flow must be applied before or simultaneously with filament voltage.

Minimum air flow requirements for a maximum anode temperature of 225°C for various altitudes and dissipation levels are listed. The pressure drop values shown are approximate and are for the SK-340/tube/SK-346 combination. If an SK-350 is used air passages in addition to those in the socket may be required for low pressure drop.

Inlet Air Temperature = 25°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	5000	192	1.0
	7500	414	4.3
5000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	5000	232	1.2
	7500	501	5.1
10,000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	5000	281	1.4
	7500	607	6.1

Inlet Air Temperature = 35°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	5000	220	1.25
	7500	476	5.42
5000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	5000	268	1.5
	7500	576	6.5
10,000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	5000	324	1.75
	7500	6.98	7.75

Inlet Air Temperature = 50°C

Sea Level	Plate Diss. Watts	Flow Rate CFM	Press Drop In. Water
	5000	280	1.8
	7500	592	7.9
5000 Feet	Plate Diss. Watts	Flow Rate CFM	Press Drop In. Water
	5000	332	2.1
	7500	717	9.4
10,000 Feet	Plate Diss. Watts	Flow Rate CFM	Press. Drop In. Water
	5000	402	2.5
	7500	868	11.3

With operation at plate dissipation below 5.0 kW and lower air flow inherent with that operation, special attention is required for cooling the center of the stem (base), by means of special directors or some other provision. Temperature measurements in this area should be made, as well as the anode seal areas, during development of the equipment. Temperature-sensitive paints are available for this purpose, and Application Bulletin #20 titled TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES is available from Varian Power Grid & X-Ray Tube Products on request.

An air interlock system should be incorporated in the design to automatically remove all voltages from the tube in case of even a partial failure of the tube cooling air.

It is considered good engineering practice to supply more than the minimum required cooling air, to allow for variables such as dirty air filters, rf seal heating, and dirty anode cooling fins if the tube has been in service for some time.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside

which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

FILAMENT OPERATION - At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The filament voltage should then be increased a few tenths of a volt above the value where performance degradation was noted. The operating point should be rechecked after 24 hours. Filament voltage should be closely regulated when voltage is to be reduced in this manner, to avoid any adverse influence by normal line voltage variations. Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. Periodically the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best life.

GRID OPERATION - The maximum control grid dissipation is 50 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 165 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

SCREEN CURRENT - The screen current may reverse under certain conditions and produce negative indications on the screen current meter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind, so that the correct operating voltage will be maintained on the screen under all conditions. A current path from the screen to cathode must be provided by a bleeder resistor or a shunt regulator connected between screen and cathode and arranged to pass approximately 10% of the average screen current per connected tube. A series regulated power supply can be used only when an adequate bleeder resistor is provided.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and air-flow interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each tube anode, to absorb power supply stored energy if an internal arc should occur. EIMAC's Application Bulletin #17 titled FAULT PROTECTION contains considerable detail, and is available on request.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that **HIGH VOLTAGE CAN KILL.**

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground." The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown here are taken in accordance with Standard RS-191. The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian Power Grid & X-Ray Tube.Products, Attn: Product Manager; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

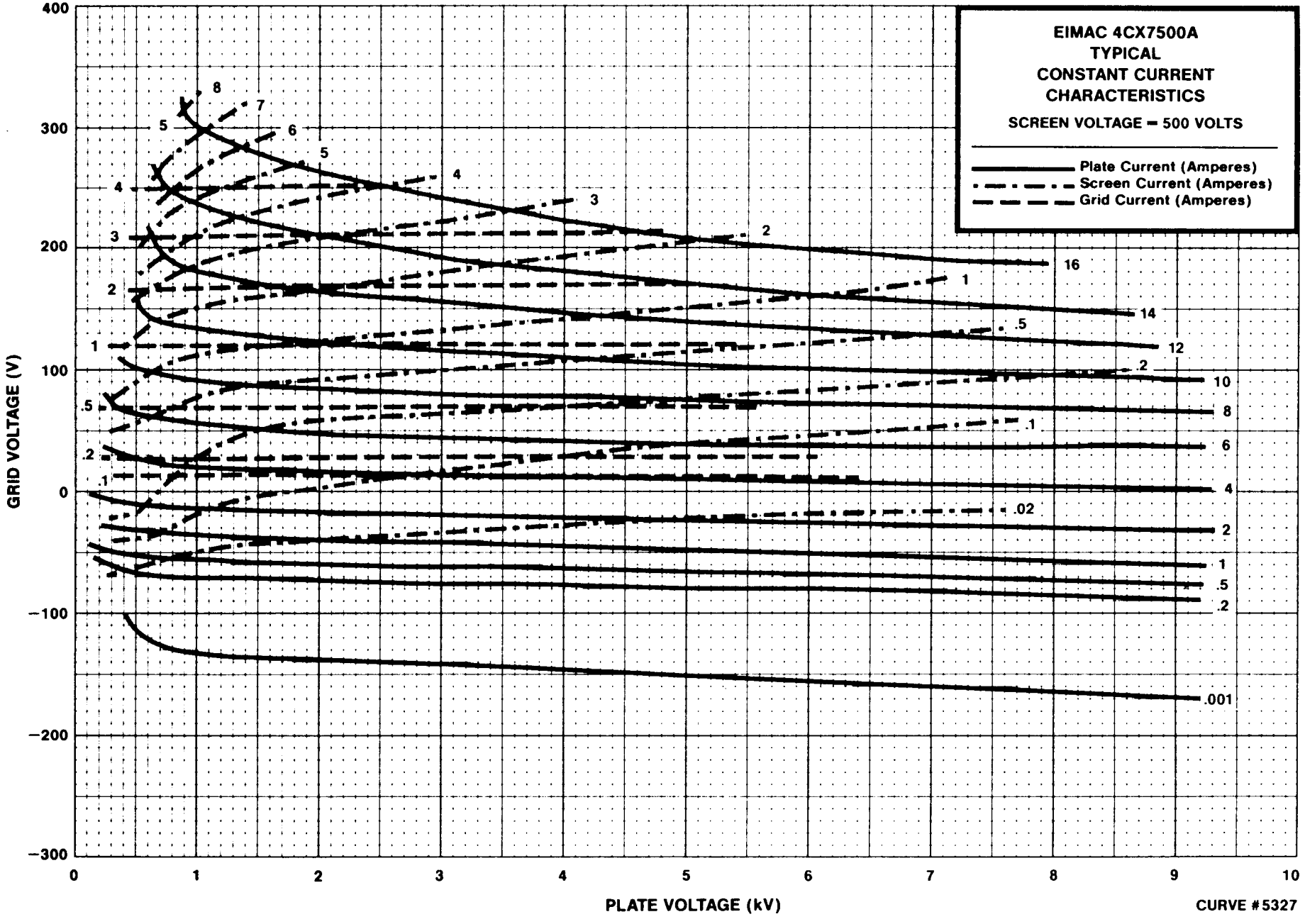
a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

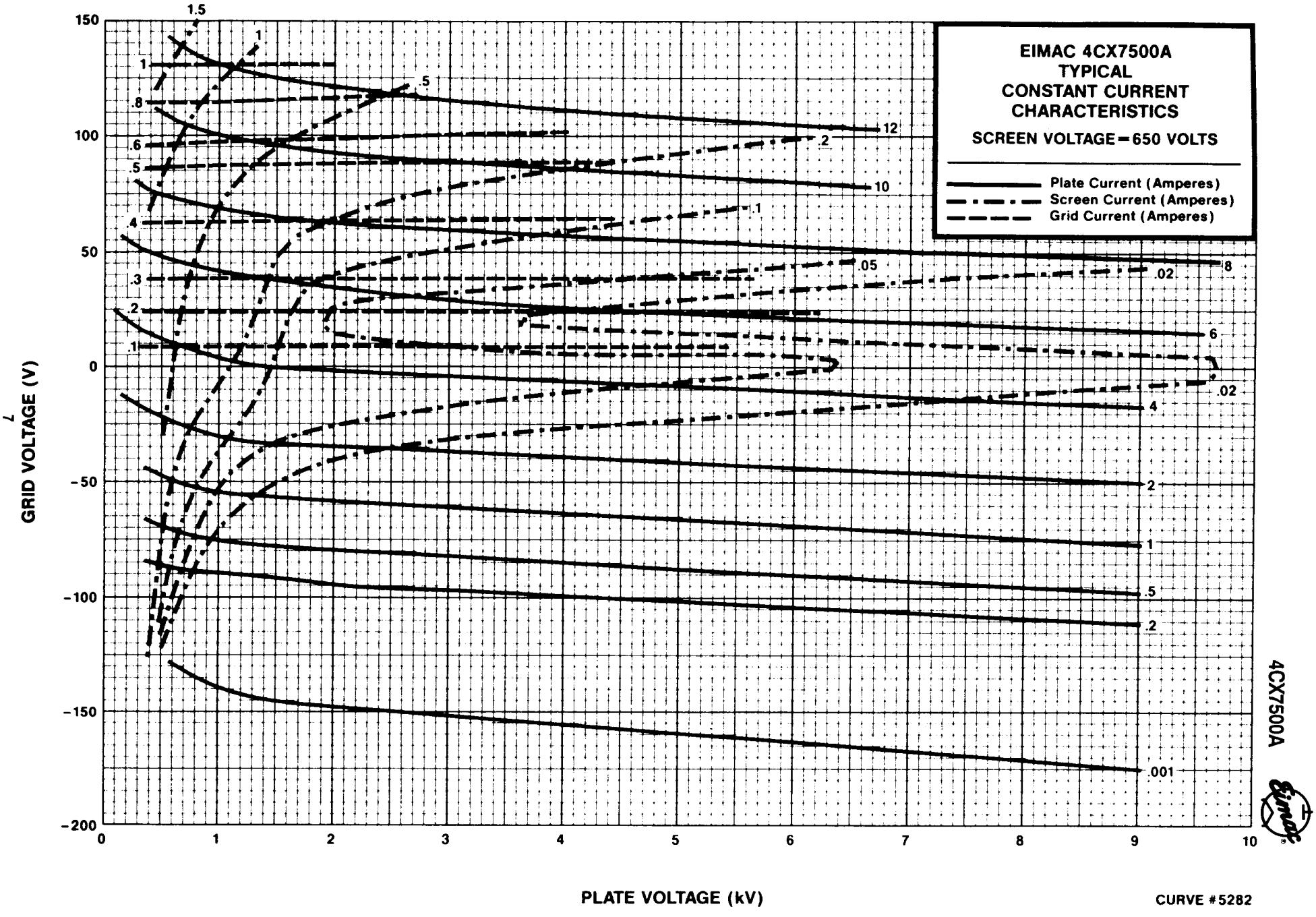
b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

c. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE AFFECTED.

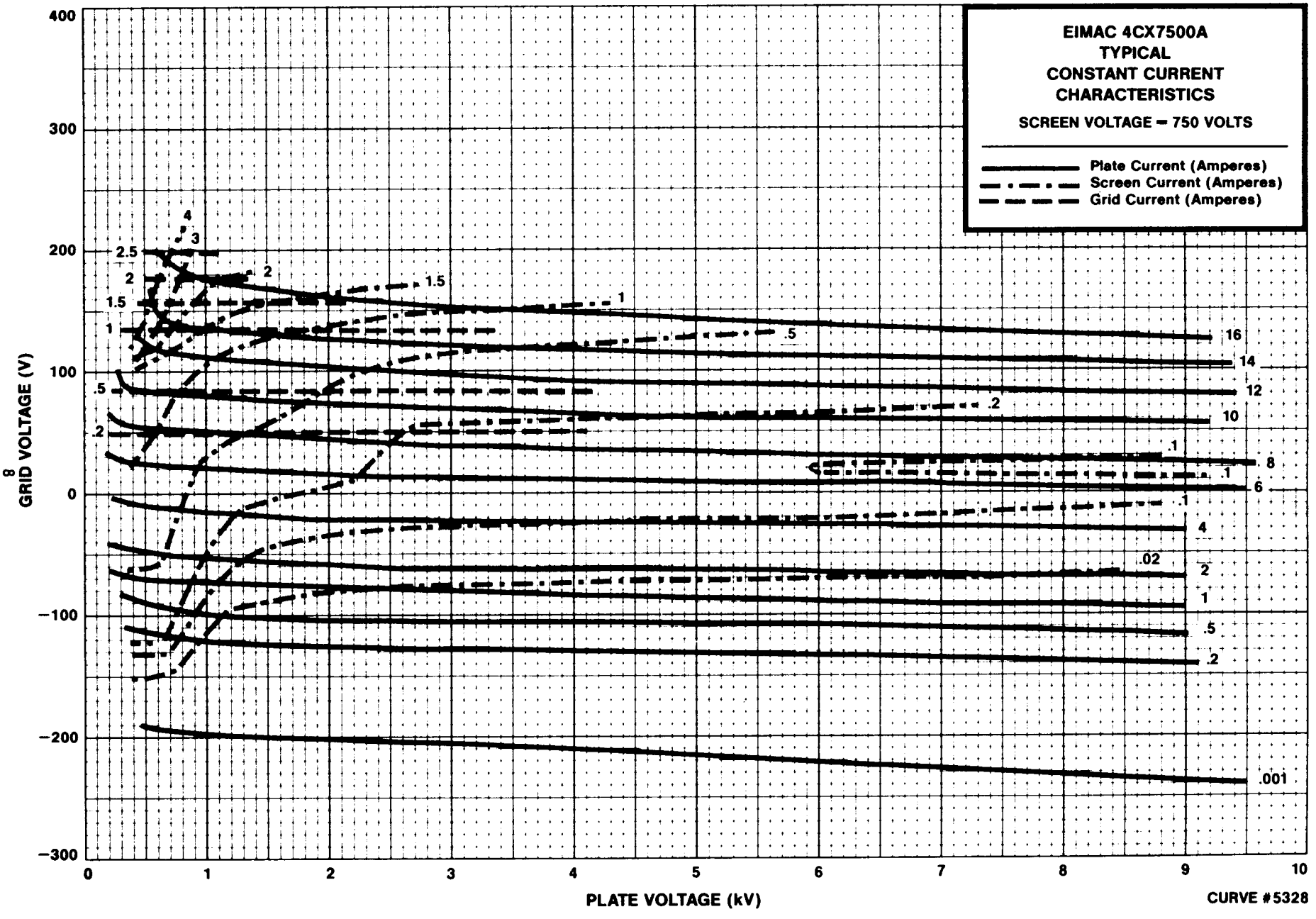
d. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

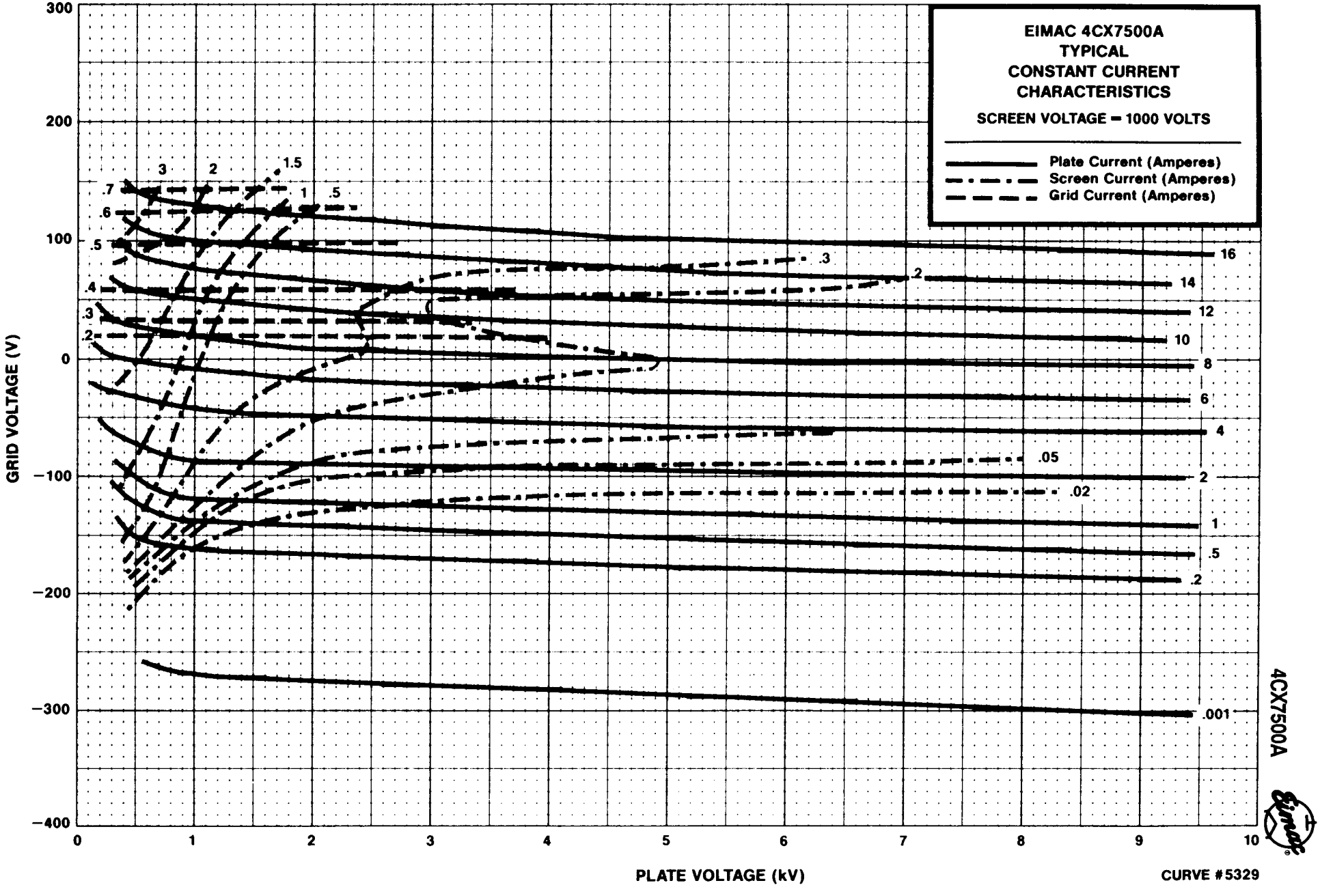
Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian Power Grid & X-Ray Tube Products, Power Grid Application Engineering, 301 Industrial Way, San Carlos, CA 94070.


EIMAC 4CX7500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
400
300
200
100
0
−100
−200
−300
0
1
2
3
4
5
6
7
8
9
10
16
14
12
10
8
6
4
2
1
.5
.2
.1
.02
.001
CURVE #5327


EIMAC 4CX7500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 650 VOLTS
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
150
100
50
0
-50
-100
-150
-200
0
1
2
3
4
5
6
7
8
9
10
1.5
1
.8
.6
.5
.4
.3
.2
.1
.05
.02
.001
12
10
8
6
4
2
1
.5
.2
4CX7500A
Eimac

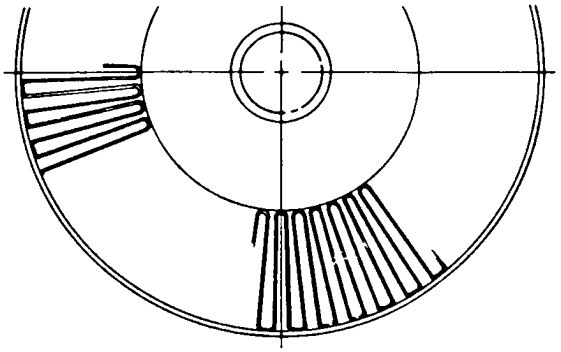
CURVE #5282


EIMAC 4CX7500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
400
300
200
100
0
−100
−200
−300
0
1
2
3
4
5
6
7
8
9
10
16
14
12
10
8
6
4
2
1
.5
.2
.1
.02
.001
2.5
1.5
CURVE #5328



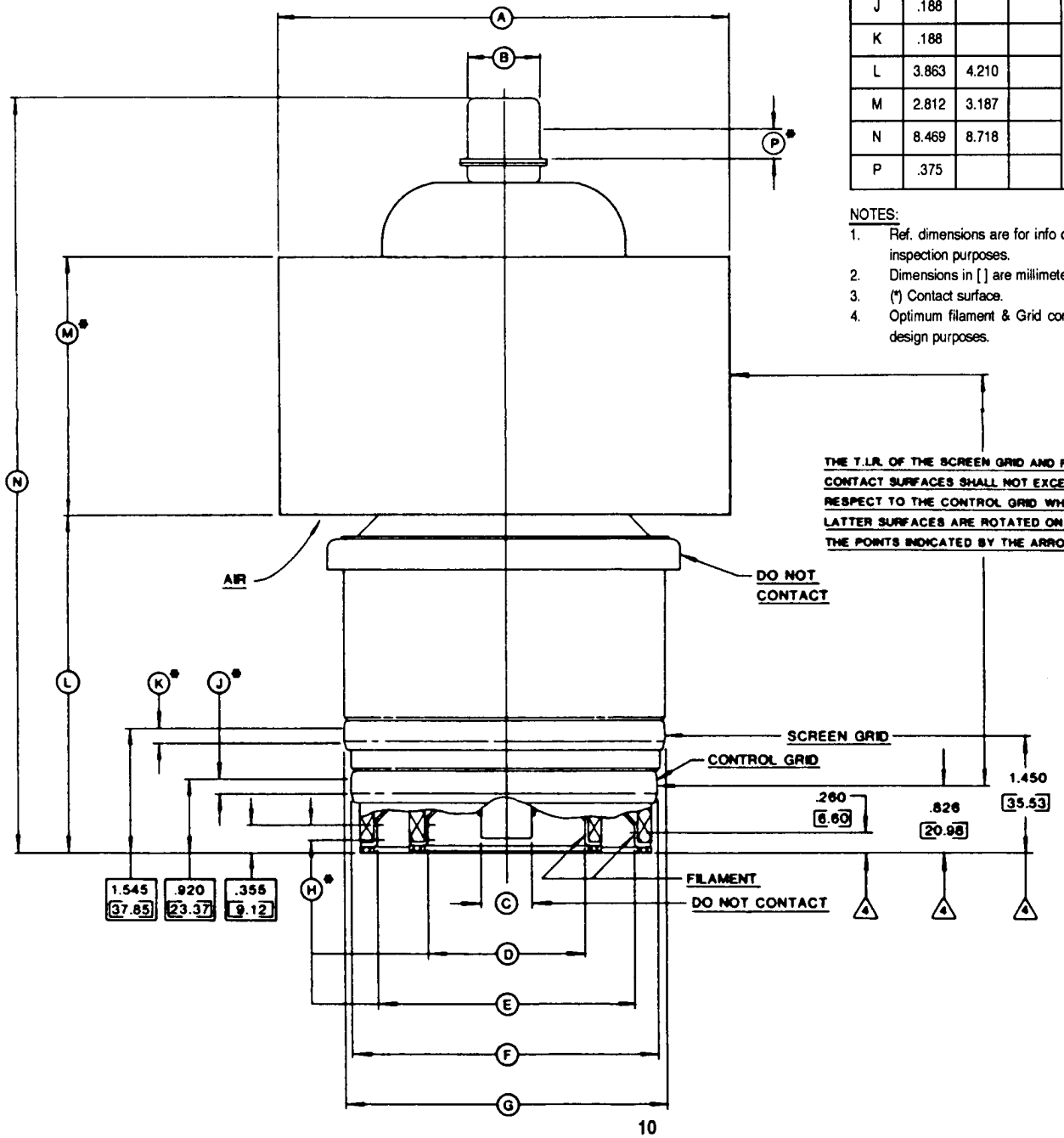
4CX7500A

CURVE #5329



DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	5.539	5.663		140.69	143.84	
B	.855	.895		21.72	22.73	
C	.600	.760		15.24	19.30	
D	1.896	1.936		48.16	49.17	
E	3.133	3.173		79.58	80.59	
F	3.792	3.832		96.32	97.32	
G	3.980	4.020		101.09	102.11	
H	.188			4.78		
J	.188			4.78		
K	.188			4.78		
L	3.863	4.210		97.43	106.93	
M	2.812	3.187		71.42	80.95	
N	8.469	8.718		215.11	246.86	
P	.375			9.53		

NOTES:
1. Ref. dimensions are for info only & are not required for inspection purposes.
2. Dimensions in [ ] are millimeters.
3. (*) Contact surface.
4. Optimum filament & Grid connector heights for socket design purposes.



EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

4E27A/5-125B

RADIAL-BEAM POWER PENTODE

•

MODULATOR
OSCILLATOR
AMPLIFIER

The Eimac 4E27A/5-125B is a power pentode intended for use as a modulator, oscillator or amplifier. The driving-power requirement is very low, and neutralization problems are simplified or eliminated entirely. The tube has a maximum plate-dissipation rating of 125 watts and a maximum plate voltage rating of 4000 volts at frequencies up to 75 Mc. Cooling is by convection and radiation. Type 4E27A/5-125B unilaterally replaces type 4E27.

The 4E27A/5-125B in class-C r-f service will deliver up to 375 watts plate power output with less than 2 watts driving power. It will deliver up to 75 watts of carrier for suppressor modulation.

Two 4E27A/5-125B's will deliver up to 300 watts maximum-signal plate power output in class AB_1 modulator service, 400 watts in class AB_2 with less than 1 watt driving power.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	5.0 volts
Current	7.5 amperes
Grid-Screen Amplification Factor (Average)	5.0
Direct Interelectrode Capacitances (Average)	
Grid-Plate	0.08 $\mu\mu$fd
Input	10.5 $\mu\mu$fd
Output	4.7 $\mu\mu$fd
Transconductance (I_b=50ma., E_b=2500v., E_{c2}=500v., E_{c1}= 0v.)	2150 μmhos
Highest Frequencies for Maximum Ratings	75 Mc.

MECHANICAL

Base	7-pin, metal shell
Connections	See drawing
Socket*	E. F. Johnson Co. No. 122-237, or equivalent
Mounting Position	Vertical, base down or up
Cooling	Convection and radiation
Recommended Heat Dissipating Plate Connector	Eimac HR-5
Maximum Over-All Dimensions:	
Length	6.19 inches
Diameter	2.75 inches
Net Weight (Average)	6.0 ounces
Shipping Weight	2.0 pounds

*See "Cooling" under Application Notes.

Note: Typical operation data are based on conditions of adjusting the r-f grid drive to specified plate current, maintaining fixed conditions of grid bias, screen voltage and suppressor voltage. It will be found that if this procedure is followed, there will be little variation in power output between tubes even though there may be some variation in grid, screen and suppressor currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony, Frequencies up to 75 Mc.
(Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	750 MAX. VOLTS
D-C GRID VOLTAGE	−500 MAX. VOLTS
D-C PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	125 MAX. WATTS
SUPPRESSOR DISSIPATION	20 MAX. WATTS
SCREEN DISSIPATION	20 MAX. WATTS
GRID DISSIPATION	5 MAX. WATTS

TYPICAL OPERATION
60 Suppressor Volts, 500 Screen Volts

D-C Plate Voltage	1000	1500	2000	2500	3000	volts
D-C Grid Voltage	−120	−130	−150	−170	−200	volts
D-C Plate Current	167	200	200	186	167	ma
D-C Suppressor Current*	6	5	4	3	3	ma
D-C Screen Current*	11	11	11	7	5	ma
D-C Grid Current*	6	8	8	7	6	ma
Peak R-F Grid Input Voltage	170	200	222	240	260	volts
Driving Power*	1.0	1.6	1.8	1.7	1.6	watts
Grid Dissipation*	.3	.6	.6	.5	.6	watts
Screen Dissipation*	5.5	5.5	5.5	3.5	2.5	watts
Plate Dissipation	47	85	100	115	125	watts
Plate Power Input	167	300	400	465	500	watts
Plate Power Output	120	215	300	350	375	watts

TYPICAL OPERATION
Zero Suppressor Volts, 500 Screen Volts

D-C Plate Voltage	1000	1500	2000	2500	3000	volts
D-C Grid Voltage	−120	−130	−150	−170	−200	volts
D-C Plate Current	145	180	200	184	167	ma
D-C Screen Current*	17	20	23	18	12	ma
D-C Grid Current*	6	8	11	9	7	ma
Peak R-F Grid Input Voltage	170	200	240	250	270	volts
Driving Power*	1.0	1.6	2.6	2.3	1.9	watts
Grid Dissipation*	.3	.6	1.0	.8	.5	watts
Screen Dissipation*	8.5	10	12	9	6	watts
Plate Dissipation	55	95	125	125	125	watts
Plate Power Input	145	270	400	460	500	watts
Plate Power Output	90	175	275	335	375	watts

TYPICAL OPERATION
Zero Suppressor Volts, 750 Screen Volts

D-C Plate Voltage	1000	1500	2000	2500	3000	volts
D-C Grid Voltage	−170	−180	−200	−225	−250	volts
D-C Plate Current	160	200	200	186	167	ma
D-C Screen Current*	21	24	22	12	9	ma
D-C Grid Current*	3	6	6	4	3	ma
Peak R-F Grid Input Voltage	205	235	257	270	290	volts
Driving Power*	.6	1.4	1.5	1.1	.9	watts
Grid Dissipation*	.1	.4	.3	.2	.2	watts
Screen Dissipation*	16	18	17	9	7	watts
Plate Dissipation	45	85	100	115	125	watts
Plate Power Input	160	300	400	465	500	watts
Plate Power Output	115	215	300	350	375	watts

*Approximate Values

(Effective 8-15-52) c 1968 by Varian

Printed in U.S.A.

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony, Frequencies up to 75 Mc.
(Carrier conditions, per tube, unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3200 MAX. VOLTS
D-C SCREEN VOLTAGE	750 MAX. VOLTS
D-C GRID VOLTAGE	-500 MAX. VOLTS
D-C PLATE CURRENT	160 MAX. MA
PLATE DISSIPATION	85 MAX. WATTS
SUPPRESSOR DISSIPATION	20 MAX. WATTS
SCREEN DISSIPATION	20 MAX. WATTS
GRID DISSIPATION	5 MAX. WATTS

TYPICAL OPERATION
Zero Suppressor Volts, 500 Screen Volts

D-C Plate Voltage	1000	1500	2000	2500	volts
D-C Grid Voltage	-190	-195	-200	-205	volts
D-C Plate Current	149	150	151	152	ma
D-C Screen Current*	20	18	17	16	ma
D-C Grid Current*	7	7	8	8	ma
Peak A-F Screen Voltage (100% Modulation)	350	350	350	350	volts
Peak R-F Grid Input Voltage	260	265	270	275	volts
Driving Power*	2	2	2	2	watts
Grid Dissipation*	0.5	0.5	0.5	0.5	watts
Screen Dissipation*	10	9	8.5	8	watts
Plate Dissipation	64	72	80	85	watts
Plate Power Input	149	225	300	380	watts
Plate Power Output	85	153	220	295	watts

SUPPRESSOR-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony, Frequencies up to 75 Mc.
(Carrier conditions, per tube, unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	750 MAX. VOLTS
D-C GRID VOLTAGE	-500 MAX. VOLTS
D-C PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	125 MAX. WATTS
SUPPRESSOR DISSIPATION	20 MAX. WATTS
SCREEN DISSIPATION	20 MAX. WATTS
GRID DISSIPATION	5 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	1500	2000	2500	3000	volts
D-C Suppressor Voltage	-220	-260	-305	-350	volts
Peak A-F Suppressor Voltage (100% Modulation)	220	260	305	350	volts
D-C Screen Voltage	400	400	400	400	volts
Fixed D-C Screen Voltage	610	645	650	610	volts
Screen Dropping Resistor[1]	5500	9100	10,000	8300	ohms
D-C Grid Voltage	-170	-180	-190	-200	volts
D-C Plate Current	59	59	59	60	ma
D-C Screen Current*	38	27	25	25	ma
D-C Grid Current*	6	5	5	4	ma
Peak R-F Grid Input Voltage	230	235	245	250	volts
Driving Power*	1.4	1.3	1.2	1.2	watts
Grid Dissipation*	.35	.25	.25	.20	watts
Screen Dissipation*	15	11	10	10	watts
Plate Dissipation	54	68	87	105	watts
Plate Power Input	89	118	148	180	watts
Plate Power Output	35	50	61	75	watts

[1]Adjust to stated d-c screen voltage.

AUDIO-FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB, Sinusoidal Wave

MAXIMUM RATINGS (Per Tube)

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	750 MAX. VOLTS
D-C GRID VOLTAGE	-500 MAX. VOLTS
D-C PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	125 MAX. WATTS
SUPPRESSOR DISSIPATION	20 MAX. WATTS
SCREEN DISSIPATION	20 MAX. WATTS
GRID DISSIPATION	5 MAX. WATTS

TYPICAL OPERATION (Two tubes unless otherwise specified)
Class-AB_1

D-C Plate Voltage	1500	2000	2500	volts
D-C Suppressor Voltage	0	0	0	volts
D-C Screen Voltage	500	500	500	volts
D-C Grid Voltage[1]	-70	-80	-85	volts
Zero-Signal D-C Plate Current	110	85	65	ma
Max-Signal D-C Plate Current	205	210	220	ma
Zero-Signal D-C Screen Current*	0	0	0	ma
Max-Signal D-C Screen Current*	15	13	8	ma
Effective Plate-to-Plate Load	13,700	18,000	20,000	ohms
Peak A-F Grid Voltage (per tube)	70	80	85	volts
Max-Signal Driving Power*	0	0	0	watts
Max-Signal Plate Power Input	310	420	550	watts
Max-Signal Plate Power Output	200	250	300	watts

[1]Adjust to stated zero-signal d-c plate current. The effective grid circuit resistance for each tube must not exceed 250,000 ohms.

TYPICAL OPERATION (Two tubes unless otherwise specified)
Class-AB_2

D-C Plate Voltage	1500	2000	2500	volts
D-C Suppressor Voltage	60	0	0	volts
D-C Screen Voltage	500	500	500	volts
D-C Grid Voltage[1]	-70	-80	-85	volts
Zero-Signal D-C Plate Current	110	85	65	ma
Max-Signal D-C Plate Current	365	295	250	ma
Zero-Signal D-C Screen Current*	0	0	0	ma
Max-Signal D-C Screen Current*	11	16	13	ma
Effective Plate-to-Plate Load	7300	13,000	20,000	ohms
Peak A-F Grid Input Voltage (per tube)	100	100	95	volts
Max-Signal Driving Power*	0.5	0.3	0.2	watts
Max-Signal Plate Power Input	550	590	625	watts
Max-Signal Plate Power Output	300	350	400	watts

[1]Adjust to stated zero-signal d-c plate current.
*Approximate values.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION" POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EIMAC, DIVISION OF VARIAN, FOR INFORMATION AND RECOMMENDATIONS.

APPLICATION

MECHANICAL

Mounting—The 4E27A/5-125B must be mounted vertically, base down or up. The plate lead should be flexible, and the tube must be protected from vibration and shock.

Cooling—A heat dissipating connector (Eimac HR-5 or equivalent) is required at the plate terminal, and provision must be made for the free circulation of air through the socket and through the holes in the base. If the E. F Johnson Co. 122-237 socket recommended under "General Characteristics" is to be used, the model incorporating a ventilating hole should be specified.

At high ambient temperatures, at frequencies above 75 Mc., or when the flow of air is restricted, it may become necessary to provide forced air circulation in sufficient quantity to prevent the temperature of the plate and base seals from exceeding 225°C. Forced movement of air across the tube seals and envelope is always beneficial, though not necessarily required.

Tube temperatures may be measured with the aid of "Tempilaq," a temperature-sensitive lacquer manufactured by the Tempil Corporation, 132 West 22nd Street, New York 11, N. Y.

ELECTRICAL

Filament Voltage—For maximum tube life the filament voltage, as measured directly at the base pins, should be the rated value of 5.0 volts. Variations should be held within the range of 4.75 to 5.25 volts.

Grid Voltage—Although a maximum of —500 volts bias may be applied to the grid, there is little advantage in using bias voltages in excess of those listed under "Typical Operation," except in certain specialized applications.

When grid-leak bias is used, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation, and the grid-leak resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired value from tube to tube.

In class-C operation, particularly at high frequency, both grid bias and grid drive should be only great enough to provide satisfactory operation at good plate efficiency.

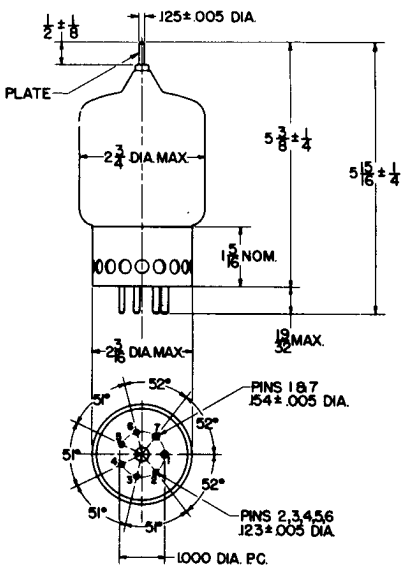
Screen Dissipation—Decrease or removal of plate load, plate voltage or bias voltage may result in screen dissipation in excess of the 20 watt maximum rating. The tube may be protected by an overload relay in the screen circuit set to remove the screen voltage when the dissipation exceeds 20 watts.

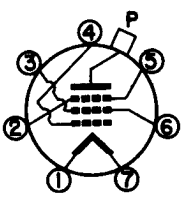
Resistors placed in the screen circuit for the purpose of developing an audio modulating voltage on the screen in modulated radio-frequency amplifiers should be made variable to permit adjustment when replacing tubes.

Plate Dissipation—Plate dissipation in excess of the 125-watt maximum rating is permissible for short periods of time, such as during tuning procedures.

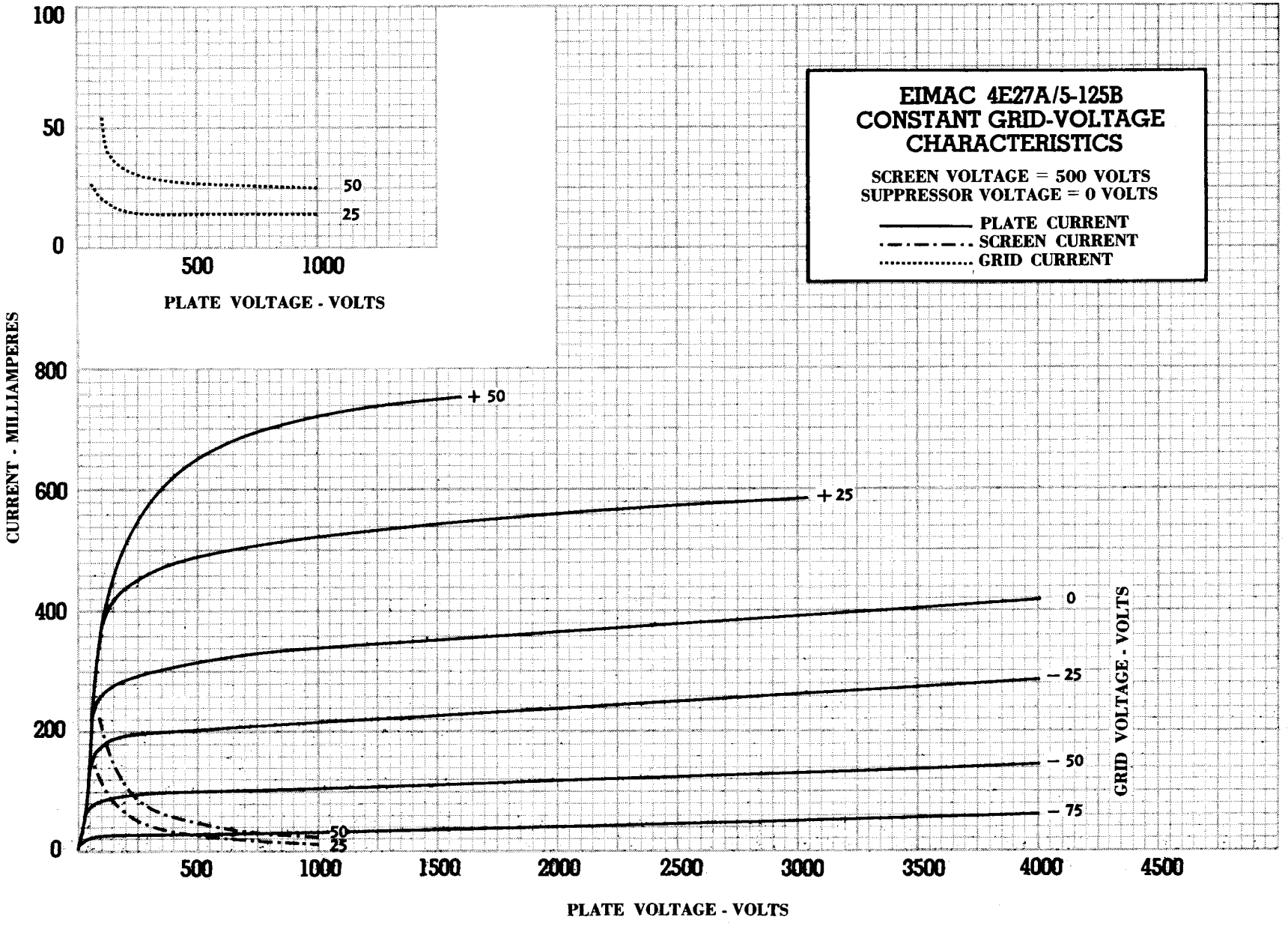
Operation—If reasonable precautions are taken to prevent coupling between the input and output circuits, the 4E27A/5-125B may usually be operated at frequencies up to 75 Mc. without neutralization. A conventional method of obtaining the necessary shielding between the grid and plate circuits is to use a suitable metal chassis with the grid circuit mounted below the deck and the plate circuit above. The tube socket should be mounted flush with the under side of the chassis deck, and spring fingers mounted around the socket opening should make contact between the chassis and the metal base shell of the tube. Power-supply leads entering the amplifier should be by-passed to ground and properly shielded. The output circuit and antenna feeders should be arranged so as to preclude any possibility of feedback to other circuits.

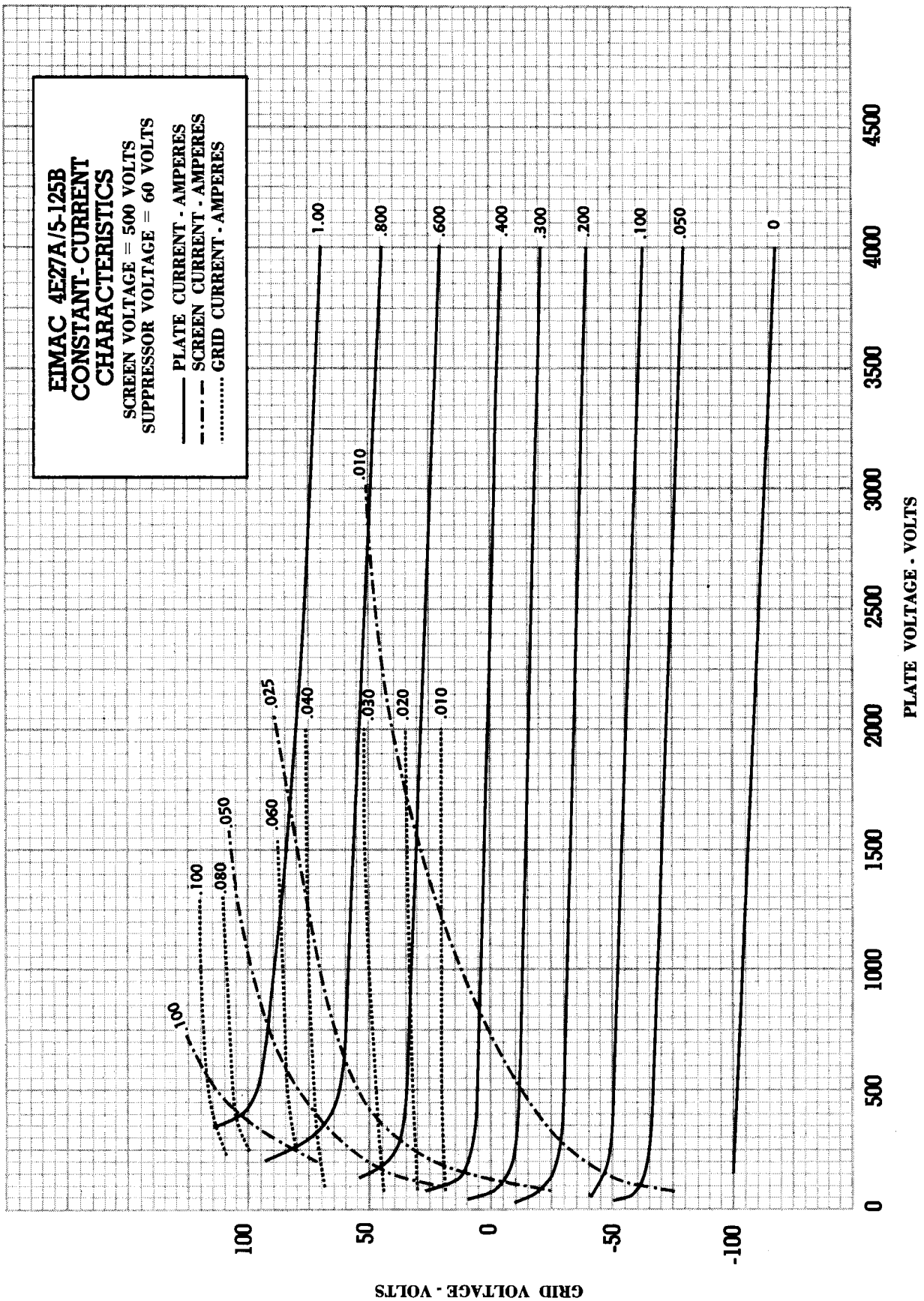
Feedback at high frequencies may be due to the inductance of leads, particularly those of the screen and suppressor-grids. By-passing methods and means of placing these grids at r-f ground potential are discussed in Application Bulletin Number Eight, "The Care and Feeding of Power Tetrodes," available from Eimac, Division of Varian. Much of the material contained in this bulletin may be applied to pentodes.

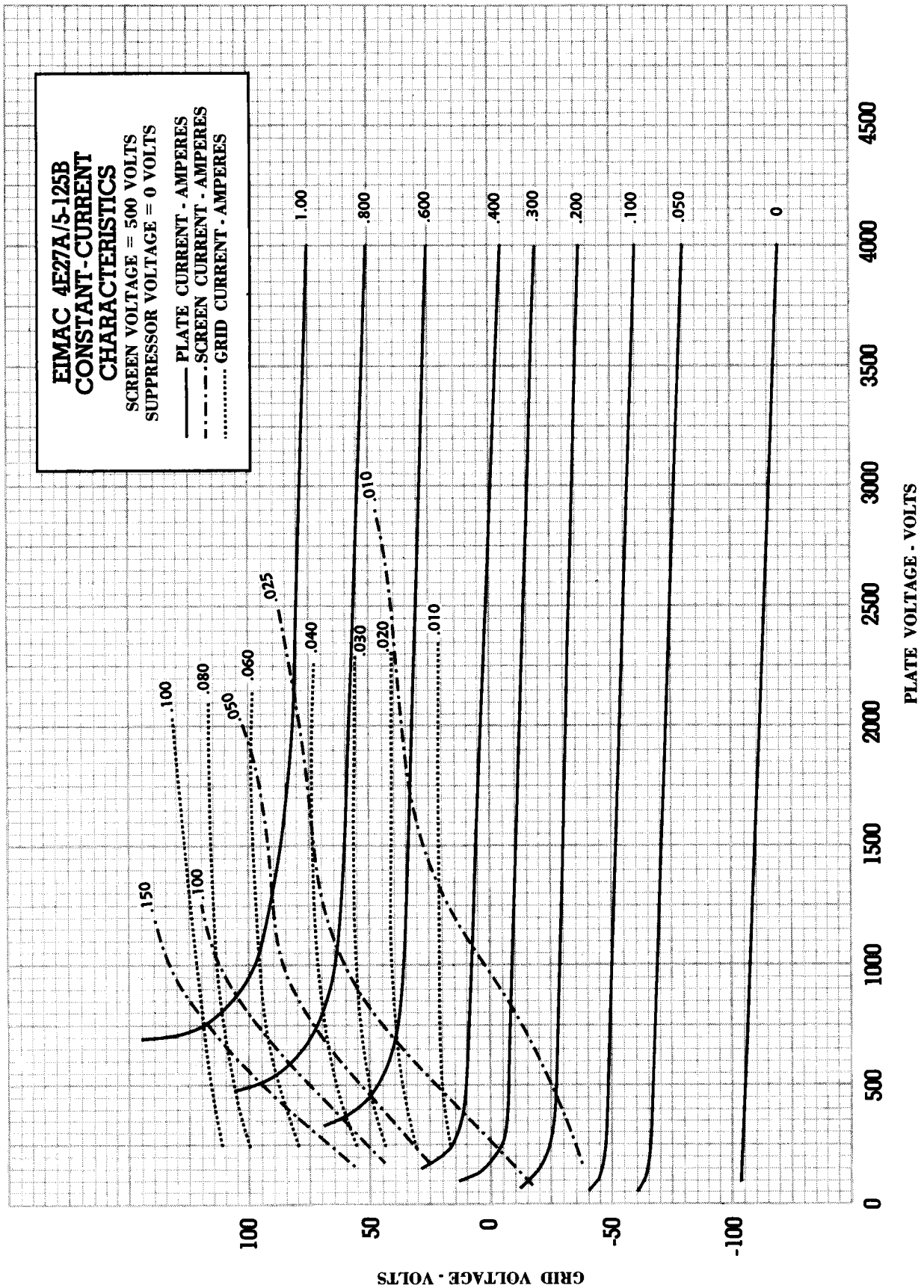




7BM


EIMAC 4E27A/5-125B
CONSTANT GRID-VOLTAGE
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
SUPPRESSOR VOLTAGE = 0 VOLTS
PLATE CURRENT
SCREEN CURRENT
GRID CURRENT
CURRENT - MILLIAMPERES
PLATE VOLTAGE - VOLTS
GRID VOLTAGE - VOLTS
+ 50
+ 25
0
– 25
– 50
– 75
50
25
100
50
0
800
600
400
200
0
500
1000
1500
2000
2500
3000
3500
4000
4500


EIMAC 4E27A/5-125B
CONSTANT-CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
SUPPRESSOR VOLTAGE = 60 VOLTS
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
1.00
.800
.600
.400
.300
.200
.100
.050
0
.010
.025
.040
.030
.020
.010
.100
.080
.050
.060
.100
100
50
0
-50
-100
0
500
1000
1500
2000
2500
3000
3500
4000
4500
GRID VOLTAGE - VOLTS
PLATE VOLTAGE - VOLTS


EIMAC 4E27A/5-125B
CONSTANT-CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
SUPPRESSOR VOLTAGE = 0 VOLTS
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
1.00
.800
.600
.400
.300
.200
.100
.050
0
.150
.100
.080
.060
.050
.040
.030
.025
.020
.010
.010
100
50
0
-50
-100
0
500
1000
1500
2000
2500
3000
3500
4000
4500
GRID VOLTAGE - VOLTS
PLATE VOLTAGE - VOLTS

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4K3CB

POWER AMPLIFIER C-BAND KLYSTRON

The Eimac 4K3CB is an air cooled, permanent magnet focused, power amplifier klystron. It will deliver a minimum CW output power of one kilowatt at frequencies from 4.4 to 5.0 kMc, with a minimum power gain of 43 db. The 4K3CB is designed for use in transmitters where compactness and light weight are essential.

FEATURES

FREQUENCY.	4.4-5.0	kMc
MINIMUM OUTPUT POWER	1	kW
HALF POWER BANDWIDTH	7.5	Mc
MINIMUM POWER GAIN. .	43	db

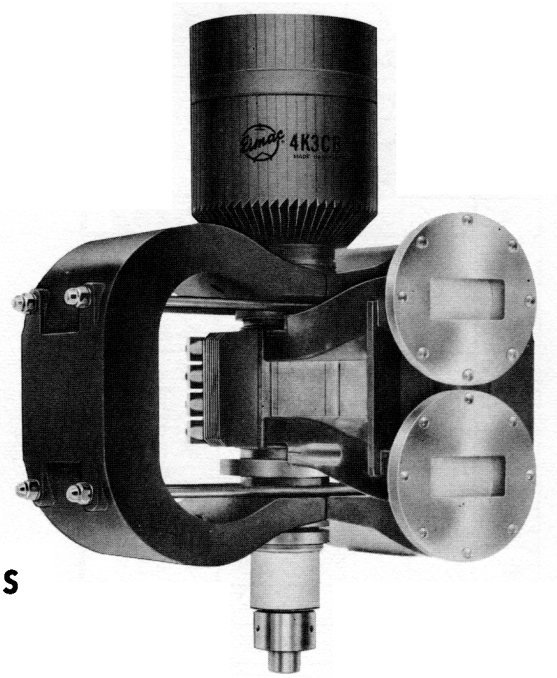
AIR COOLING

PERMANENT MAGNET FOCUSING

FOUR INTEGRAL CAVITIES

FIXED INPUT AND OUTPUT COUPLING

INSTANT FAULT RECYCLING



CHARACTERISTICS

ELECTRICAL

Cathode:	Impregnated, Unipotential		
	Heating Time.	3	minutes
Heater:	Voltage.	6.5	volts
	Current	7.5	amperes
	Maximum Starting Current	15	amperes

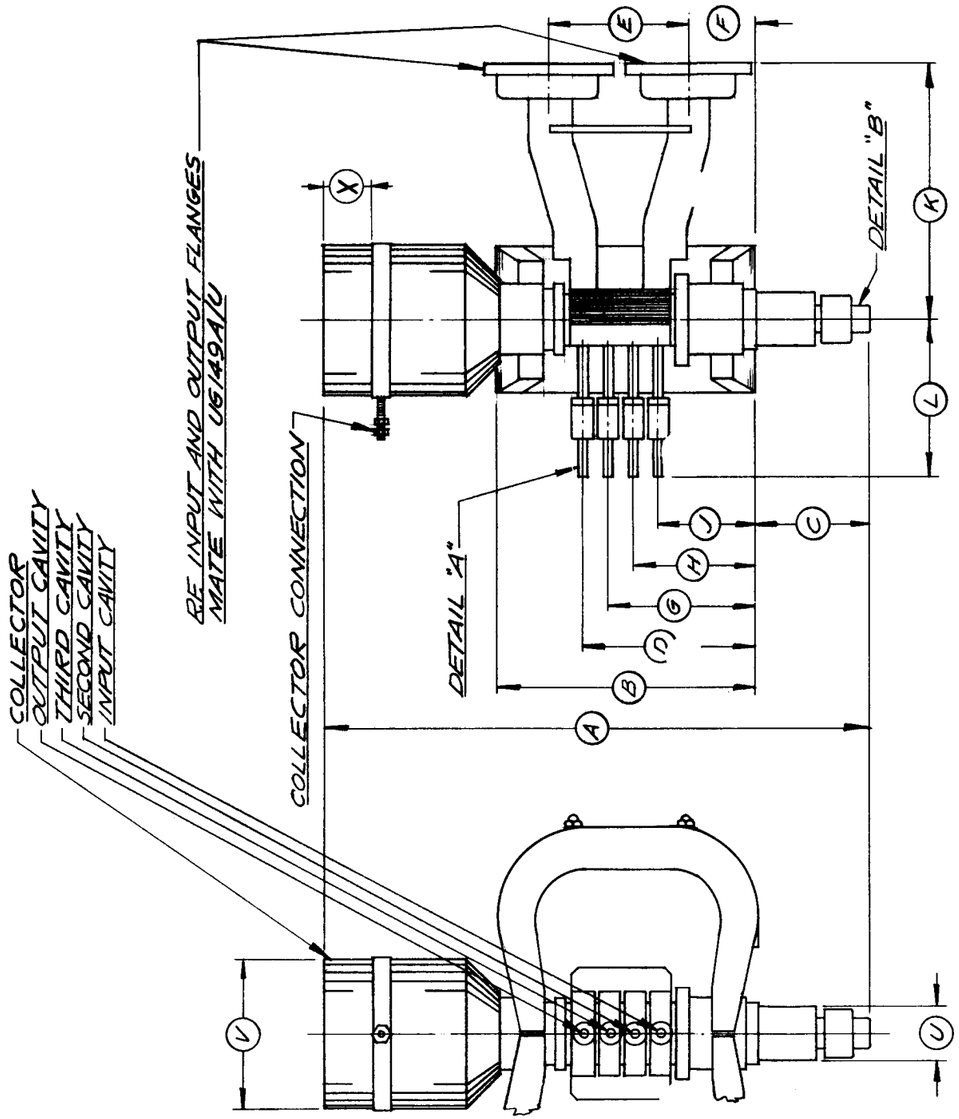
MECHANICAL

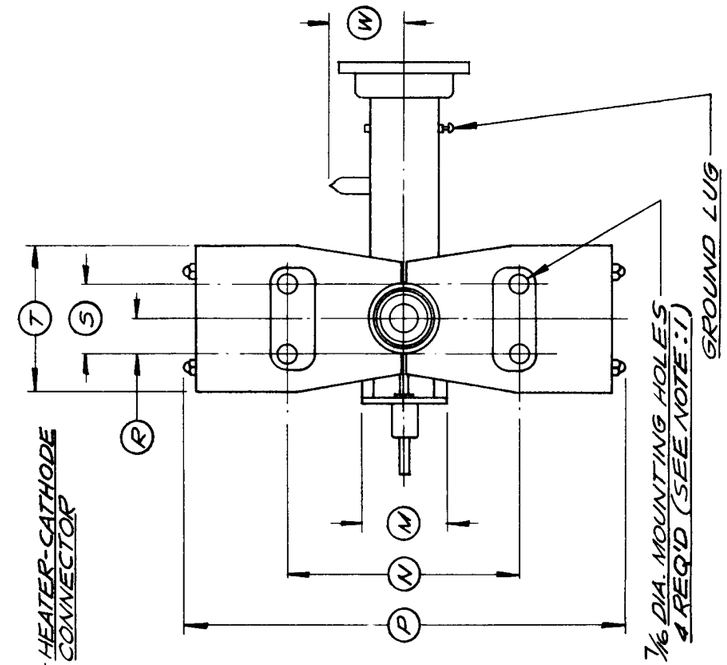
Maximum Dimensions:		
Length	15-1/2	inches
Width	12-13/16	inches
Depth	11-15/16	inches
Maximum Weight (Tube and Magnet)	60	pounds
Input Coupling.	UG149A/U	waveguide
Output Coupling	UG149A/U	waveguide
Maximum Tuner Torque.	30	in-oz
Mounting Position Preferred	Vertical, cathode down	

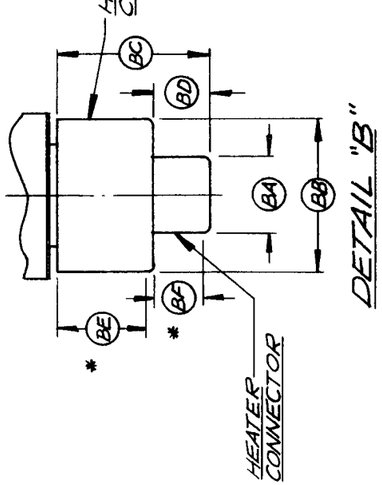
(Effective 10-16-62) Copyright 1962 by Eitel-McCullough, Inc. Printed in U.S.A.

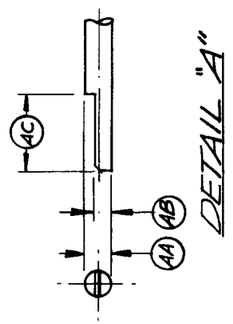
4K3CB

DIMENSIONAL DATA			
REF.	NOM.	MIN.	MAX.
A			15.500
B			7.500
C	2.723		
D	5.104		
E		3.629	3.879
F	2.281		
G	4.409		
H	3.714		
J	3.019		
K		7.038	7.288
L		4.481	4.605
M		2.328	2.359
N		6.500	6.625
P			12.812
R		.937	1.000
S		1.969	2.031
T			4.600
U			1.627
V		4.333	4.433
W			2.750
X		.875	1.125
AA		.248	.250
AB		.170	.180
AC		.740	.760
BA		.740	.760
BB		1.485	1.505
BC		1.450	1.490
BD		.530	
BE		.830	
BF		.450	









NOTES:
1. KEEP MAGNETIC MATERIAL AT LEAST SIX INCHES AWAY FROM MAGNETS; OTHER MAGNETS SHOULD BE AT LEAST TWELVE INCHES DISTANT.
2. DIMENSIONS ARE IN INCHES.
3. (*) MINIMUM CONTACT SURFACES.

4K3CB KLYSTRON

MECHANICAL (continued)

Cooling: Forced Air (20° C at Sea Level)

	Flow Rate	Pressure Drop
Tuner (Ducted)	60 cfm	0.25 inches H_2O
Body	60 cfm	free
Collecter (Ducted)	200 cfm	2 inches H_2O

MAXIMUM RATINGS

DC BEAM VOLTAGE	8.0	KILOVOLTS
DC BEAM CURRENT	0.6	AMPERE
DC BEAM INPUT POWER	4	KILOWATTS
DC BODY CURRENT	60	MILLIAMPS
COLLECTOR DISSIPATION	4	KILOWATTS
LOAD VSWR	2:1	
TEMPERATURE OF COLLECTOR, BODY AND TUNER FINS	150° C	

TYPICAL OPERATION - TUNED FOR MAXIMUM EFFICIENCY

Frequency	4.4	4.7	5.0	kilomegacycles
Output Power	1.42	1.32	1.22	kilowatts
Driving Power	40	40	40	milliwatts
Gain	45.5	45	44.8	decibels
DC Beam Voltage	7.5	7.5	7.5	kilovolts
DC Beam Current	0.465	0.465	0.465	ampere
Beam Power Efficiency	40.7	37.8	35	percent
Half Power Bandwidth	7.5	8	9	megacycles
DC Body Current	21	21	18	milliamperes

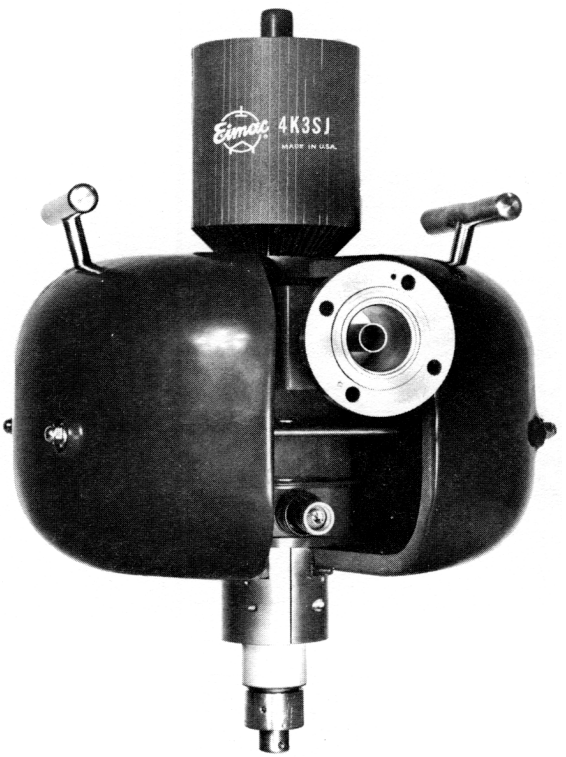
For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

4K3SJ

POWER AMPLIFIER
S-BAND KLYSTRON

The EIMAC 4K3SJ is an air cooled, permanent magnet focused, power-amplifier klystron designed to operate at frequencies from 1700 to 2400 MHz. It will deliver a minimum output power of 1 kilowatt with minimum power gain of 40 decibels. The 4K3SJ is intended for use in applications where light weight and compactness are essential.



FEATURES

- PERMANENT MAGNET FOCUSING
- FOUR INTEGRAL CAVITIES
- LOW NOISE LEVEL
- FIXED INPUT AND OUTPUT COUPLING
- TWO LIFTING HANDLES FOR EASE OF HANDLING
- INSTANT FAULT RECYCLING

CHARACTERISTICS

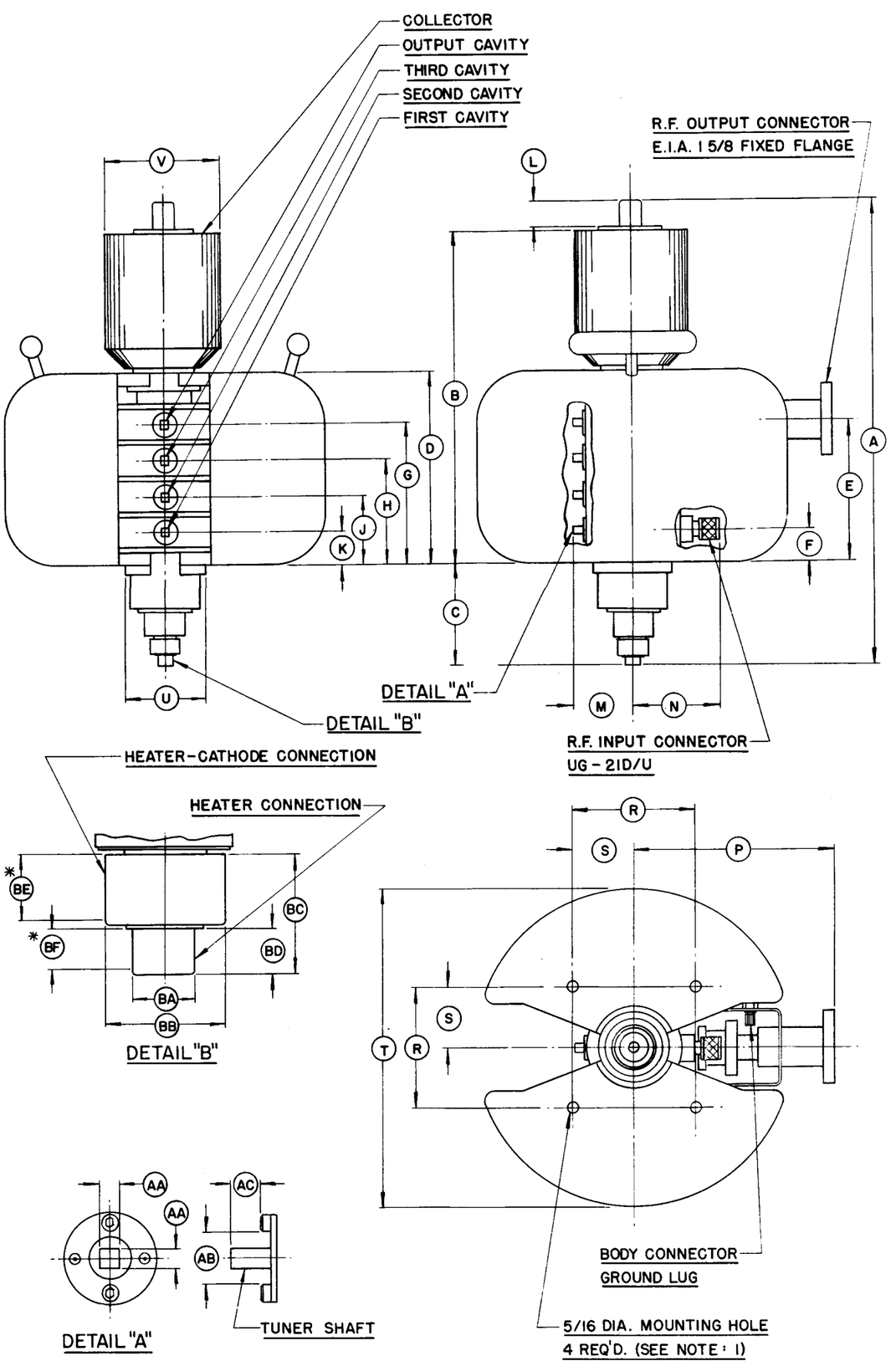
ELECTRICAL

Frequency	1700-2400	MHz
Minimum Output Power	1	kW
Minimum Power Gain	40	db
Cathode: Impregnated Unipotential		
Starting Time	3	minutes
Heater: Voltage	6	volts
Current	4.5	amperes
Maximum Starting Current	9	amperes

(Revised 7-1-66) © 1962, 1966 Varian

Printed in U.S.A.

DIMENSIONAL DATA			
REF.	NOM.	MIN.	MAX.
A			19.000
B	13.475		
C	4.544		
D			7.874
E	5.820		
F	1.470		
G	5.820		
H	4.370		
J	2.920		
K	1.470		
L			.750
M	2.472		
N	3.475		
P	7.910		
R		4.888	5.012
S		2.444	2.506
T		13.196	
U		3.042	
V	4.383		
AA		.248	.252
AB		.647	
AC		.340	
BA		.740	.760
BB		1.485	1.505
BC		1.450	1.490
BD		.530	
BE		.830	
BF		.450	



NOTES:

1. KEEP MAGNETIC MATERIALS AT LEAST SIX INCHES AWAY FROM MAGNET: OTHER MAGNETS SHOULD BE AT LEAST TWELVE INCHES DISTANT.
2. DIMENSIONS ARE IN INCHES.
3. (*) MINIMUM CONTACT.

4K3SJ KLYSTRON

4K3SJ Eimac

MECHANICAL

Operating Position (preferred)	Vertical, cathode down
Cavity Tuning Torque (maximum)	12 inch pounds
Cooling	Forced Air (20°C at sea level)
Collector Flow	200 cfm
Collector Pressure Drop	1.5 inches H_2O

Body and cathode seals require cooling only at higher temperatures or lower pressures.

Maximum Dimensions:

Length	18.4 inches
Width	13.25 inches
Depth	14 inches

RF Input Coupling	UG-21 D/U Connector
RF Output Coupling	1⅝ inch, 50-ohm line
Weight (Klystron and Magnet)	85 pounds

MAXIMUM RATINGS

DC BEAM VOLTAGE	7.0 KILOVOLTS
DC BEAM CURRENT	0.6 AMPERE
DC BEAM INPUT POWER	4 KILOWATTS
COLLECTOR DISSIPATION	4 KILOWATTS
CATHODE SEAL TEMPERATURE	150 DEGREES C
LOAD VSWR	2:1

TYPICAL OPERATION — TUNED FOR MAXIMUM EFFICIENCY

Frequency	1700	2000	2400	megahertz
Output Power	1.17	1.08	1.03	kilowatts
Driving Power	20	25	30	milliwatts
Gain	47.6	46.3	45.3	decibels
DC Beam Voltage	6	6	6.2	kilovolts
DC Beam Current	0.54	0.54	0.56	ampere
Beam Power Efficiency	36.2	33.4	31.8	percent
3 db Bandwidth	4	4.5	6	megahertz

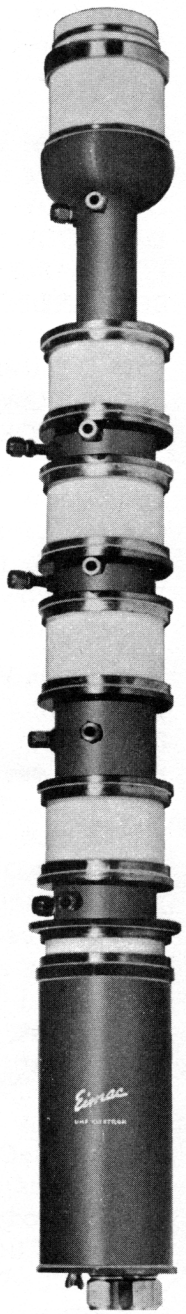
For additional data or information regarding a specific application, write to EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California.

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

TENTATIVE DATA

4K50,000LQ

POWER AMPLIFIER L-BAND KLYSTRON



The Eimac 4K50,000LQ is a ceramic and metal, four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 600 and 985 megacycles. It will deliver a minimum CW output power of 10 kilowatts with a power gain of more than 55 db. In applications requiring a 6-megacycle bandwidth at the 0.5-db power points, the 4K50,000LQ will deliver 10 kilowatts output power with a power gain of 30 db.

The resonant cavities for the 4K50,000LQ are completed through the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows repeated tuning cycling without damage to vacuum seals.

An Eimac Klystron Amplifier Circuit Assembly (Catalog Number H-101A) has been designed for use with this tube and covers the frequency range of 720 to 985 megacycles. Other frequency ranges can be provided if required. This assembly includes an electromagnetic frame and coils, external tuning boxes, an adjustable output coupler, and an Eimac SK-110 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

Filament: Pure Tungsten		
Voltage	8.0	volts
Current	40	amperes
Maximum Starting Current	80	amperes
Cathode: Unipotential, Bombardment Heated		
Voltage	2250	volts
Current	0.71	ampere
Power	1600	watts
Power Gain:		
Narrow Band	55	db
Broad Band (6 mc at 0.5-db points)*	30	db
Output Power	10,000	watts
Frequency Range (In H-101A Assembly)	720 to 985	mc

*(9 mc at 3-db points)

MECHANICAL

Operating Position	Vertical, cathode end up	
R-F Input Coupling	Type "N" coaxial fitting	
R-F Output Coupling	3 1/8-inch 50-ohm air line	
Net Weight	53	pounds
Shipping Weight (approximate)	135	pounds

Cooling: Water and Forced Air	Flow Rate	Pressure Drop
Cathode (With SK-110)	52 cfm air	5 inches H_2O
Output Cavity	50 cfm air	1.5 inches H_2O
Body	1 gpm water	8 psi
Collector	25 gpm water	28 psi

(Effective 5-28-58) Copyright 1958 by Eitel-McCullough, Inc.

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus-Coil Voltage	0 to 25	volts
Prefocus-Coil Current	0 to 1	ampere
Each of Three Body Coils:		
Voltage	0 to 175	volts
Current	0 to 3	amperes
Collector-Coil Voltage	0 to 50	volts
Collector-Coil Current	0 to 1.5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	20 MAX.	KILOVOLTS
D-C BEAM CURRENT	2.5 MAX.	AMPERES
D-C BODY CURRENT (CONTINUOUS)	0.1 MAX.	AMPERE
D-C BODY CURRENT (TUNING ONLY)	0.15 MAX.	AMPERE
FOCUS-ELECTRODE VOLTAGE	-500 MAX.	VOLTS
BOMBARDED CATHODE:		
D-C VOLTAGE	2.4 MAX.	KILOVOLTS
D-C CURRENT	0.75 MAX.	AMPERE
D-C POWER	1.6 MAX.	KILOWATTS
COLLECTOR DISSIPATION	50 MAX.	KILOWATTS

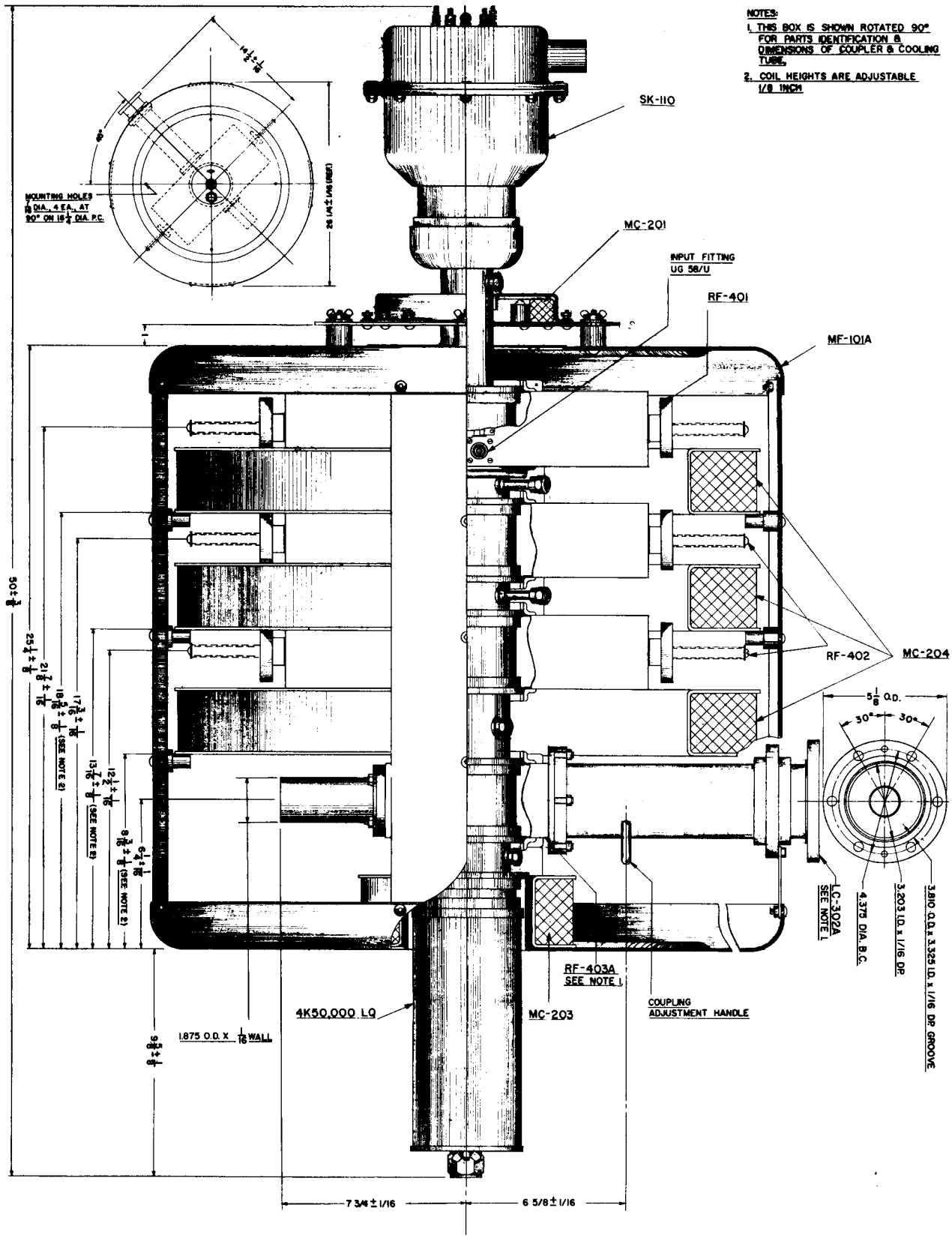
TYPICAL OPERATION

Frequency	900	900	megacycles
Output Power	10.15	11.2	kilowatts
Bandwidth (0.5-db power points)	6.85	1.05	megacycles
Driving Power	5	0.02	watts
Power Gain	33	57.5	db
D-C Beam Voltage	17	16	kilovolts
D-C Beam Current	1.78	1.59	amperes
Beam Input Power	30.2	25.4	kilowatts
Beam Power Efficiency	33.6	44.1	percent
D-C Body Current	80	80	milliamperes
D-C Collector Current	1.7	1.51	amperes
Collector Dissipation*	11.51	12.92	kilowatts
Focus-Electrode Voltage	-200	-200	volts
Filament Voltage	8.0	8.0	volts
Filament Current	40	40	amperes
Bombarded Cathode:			
Voltage*	2250	2250	volts
Current*	0.71	0.71	ampere
Power	1600	1600	watts
Magnetic-Coil Currents:* (Using H-101A Components)			
Prefocus	0.8	0.75	ampere
First Body	1.2	1.2	amperes
Second Body	1.9	1.8	amperes
Third Body	2.5	2.3	amperes
Collector	0.85	0.85	ampere

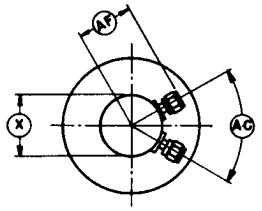
*Approximate values.

APPLICATION

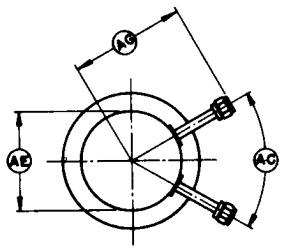
For additional information or information regarding any specific application, write to the Application Engineering Department, Eitel-McCullough, Inc., San Bruno, California. All such requests will be handled confidentially and without charge.



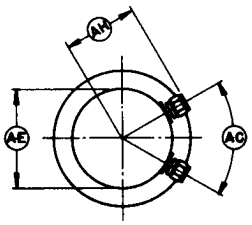
H-101A
KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY



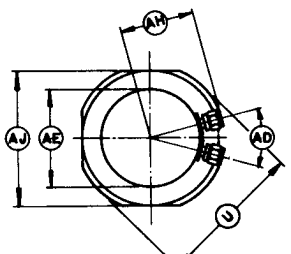
SECTION A-A



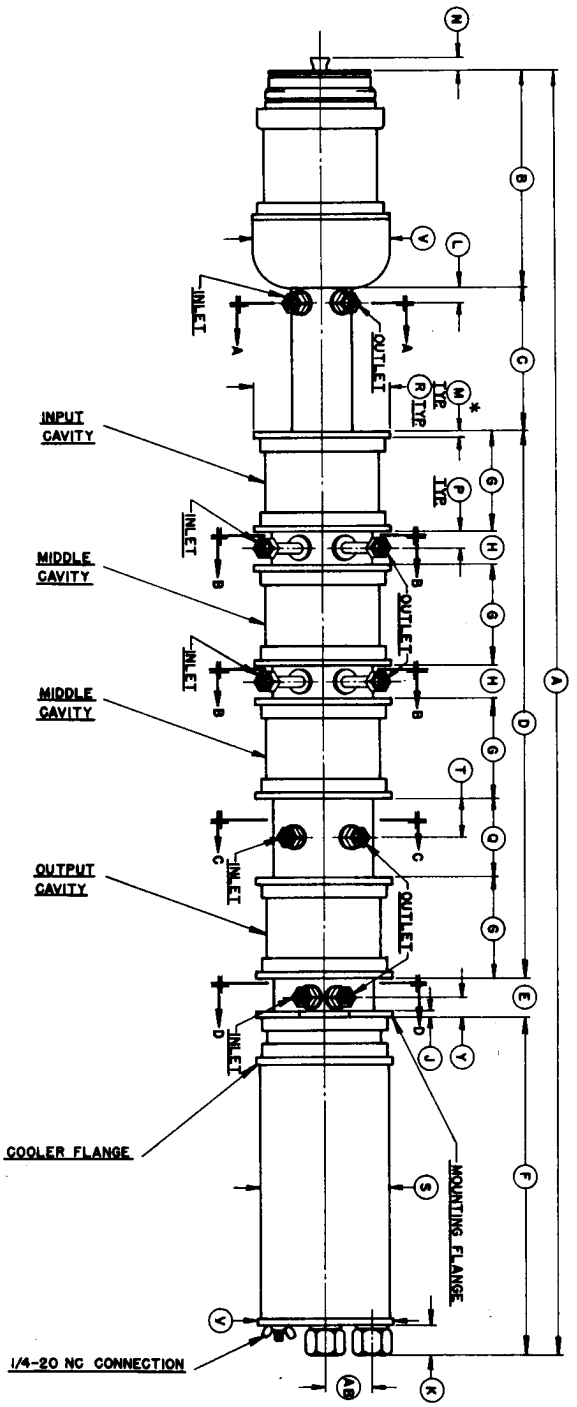
SECTION B-B



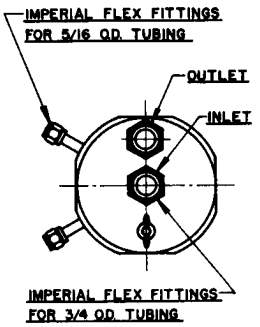
SECTION C-C



SECTION D-D



DIMENSION DATA			
REF	NOM.	MIN.	MAX.
A		44.560	44.690
B		7.470	7.510
C		4.985	5.040
D		19.994	20.064
E	.626		
F		12.515	12.620
G		3.495	3.530
H		1.170	1.205
J		.230	.255
K		1.030	1.100
L		.515	.645
M		.187	
N		.750	
P		.560	.650
Q		2.735	2.770
R		4.610 D	4.630 D
S		4.490 D	4.510 D
T		1.320	1.425
U		5.115 D	5.130 D
V		4.610 D	4.640 D
X		2.120	2.140
Y		.645	.705
AB		1.585	1.630
AC	60°		
AD	30°		
AE		3.485	3.510
AF	1.875		
AG	4.000		
AH	2.563		
AJ		4.615	4.635



NOTES:
1. *MINIMUM CONTACT SURFACES FOR ALL CAVITY PLATES.
2. DIMENSIONS IN INCHES.
3. FOR ELECTRICAL CONTACT SURFACE DIMENSIONS SEE GUN NO. 2 OUTLINE, DRWG. NO. GUN NO. 2-6001.

4K50,000LQ
OUTLINE DRAWING

Printed in U.S.A. 46915

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

TENTATIVE DATA

4KM100LA

POWER AMPLIFIER

L-BAND KLYSTRON

The Eimac 4KM100LA is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies from 470 to 610 megacycles. Intended primarily for television visual service, it is also suitable for aural TV, or for tropospheric-scatter communications service.

When adjusted for narrow-band CW operation the 4KM100LA will deliver a minimum output power of 35 kilowatts with a power gain of 45 decibels. In television visual service it will provide more than 25 kilowatts of peak synchronizing power, with a power gain of 30 decibels, and 1db bandwidth of 8 megacycles. Random AM noise is more than 60db below black level.

The electron gun of this klystron utilizes a semi-confined flow field which minimizes focusing adjustments and produces a very stable beam. The cathode loading of only 100 milliamperes per square centimeter, at a beam voltage of 18 kilovolts, is ultra conservative in the interest of long life. Effective protection from internal arcs is provided by the Eimac Modulating Anode.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. Load couplers are provided to permit external loading of these cavities for extreme wide-band operation. However, external cavity loading is not ordinarily required in TV visual service.

The 4KM100LA incorporates a built-in vacuum pump in the form of a titanium getter. This getter should be energized whenever heater power is applied. Its normal operating voltage is 3.7 volts at approximately 20 amperes. When a new tube is first placed in operation the getter should be flashed for 5 minutes at a voltage of 7.5 volts (±5%) which produces a current of approximately 33 amperes. The getter should also be flashed whenever a tube exhibits symptoms of high gas pressure.

Eimac Klystron Amplifier Circuit Assembly H133 has been designed for use with the 4KM100LA to cover the specified frequency range. This assembly includes a klystron supporting structure, magnetic focusing coils, tuning cavities, and adjustable load couplers for each cavity.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage - - -	26.0	volts
	Current - - -	11.5	amperes
	Maximum Starting Current -	23	amperes
Cathode:	EMA, Unipotential		
	Heating Time - - -	5	minutes
Getter	(Operating):		
	A-C Voltage (±5%) - -	3.7	volts
	A-C Current - -	20	amperes
Getter	(Flash):		
	A-C Voltage (±5%) - -	7.5	volts
	A-C Current - -	33	amperes
Power Gain:	Narrow Band - -	45	decibels
	Television Visual Service -	30	decibels
Output Power:	Narrow Band - -	35	kilowatts
	Television Visual Service -	25	kilowatts
Frequency Range (H133 Assembly)	-	470 to 610	megacycles

MECHANICAL

Operating Position	Axis vertical, cathode up
RF Coupling:	
Input	Type "N" coaxial fitting
Output	3-1/8 inch, 50-ohm line
Input and 2nd Cavity Loading	Type "N" coaxial fitting
3rd Cavity Loading	1-5/8 inch, 50-ohm line
Shipping Weights:	
Klystron Only	119 lbs (Net)
H-133 RF Circuit Assembly	1188 lbs (Net)

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode	*5 cfm	-------
Cavity	50 cfm	TBS
Klystron Body (5 drift-tube sections, in series)	2 gpm	35 psi
Klystron Collector	30 gpm	7.5 psi

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Each of Four Body Coils and Collector Coil:

Voltage	0 to 50	volts
Current	0 to 10	amperes

MAXIMUM RATINGS

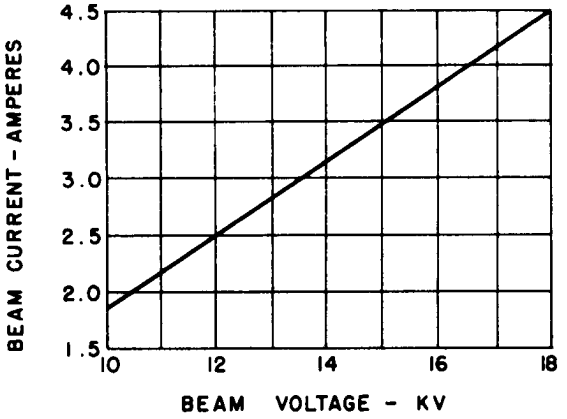
D-C BEAM VOLTAGE	20	KILOVOLTS
D-C BEAM CURRENT	6.0	AMPERES
D-C BODY CURRENT	150	MILLIAMPERES
COLLECTOR DISSIPATION	100	KILOWATTS
INLET WATER PRESSURE	100	PSI

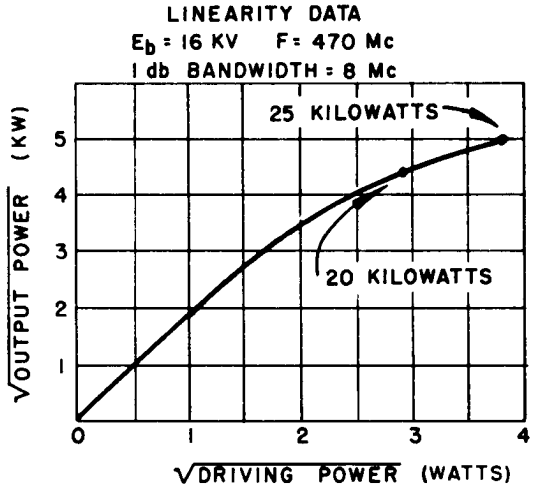
TYPICAL OPERATION

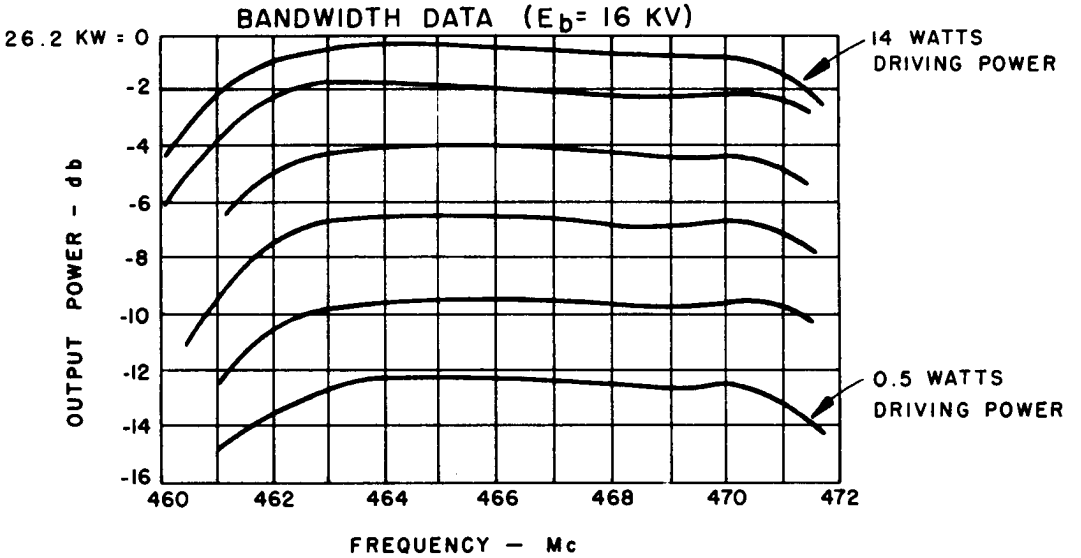
	TV Visual Amplifier	Narrow Band CW	
Frequency	550	550	megacycles
Output Power	26.4 (peak sync.)	35.4	kilowatts
Driving Power	20 " "	1.0	watts
Power Gain	31 " "	45	decibels
D-C Beam Voltage	16	18	kilovolts
D-C Beam Current	3.82	4.54	amperes
Beam Power Efficiency	43 (peak sync.)	43.3	percent
D-C Body Current	--	90	milliamperes
1 db Bandwidth	8	--	megacycles
Magnetic Coil Currents:			
First Body Coil	9.0	9.0	amperes
Second Body Coil	9.0	9.2	amperes
Third Body Coil	8.6	9.8	amperes
Fourth Body Coil	7.1	6.0	amperes
Collector Coil	3.3	6.3	amperes

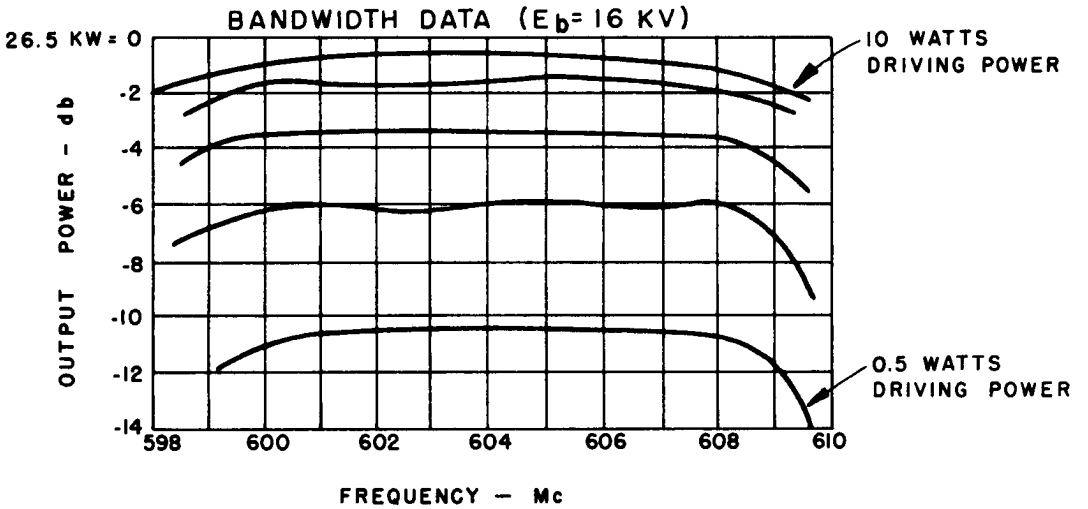
* Required only if ambient air temperature exceeds 25° C.

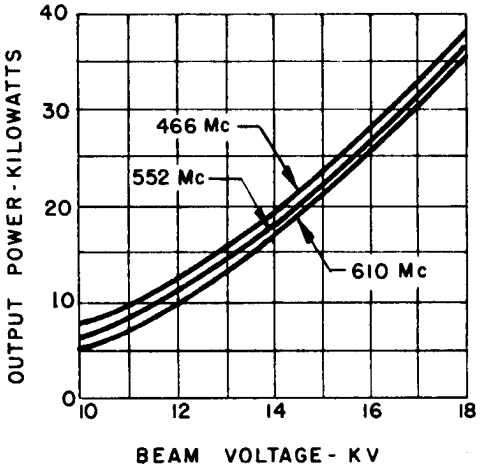
For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Bruno, California.

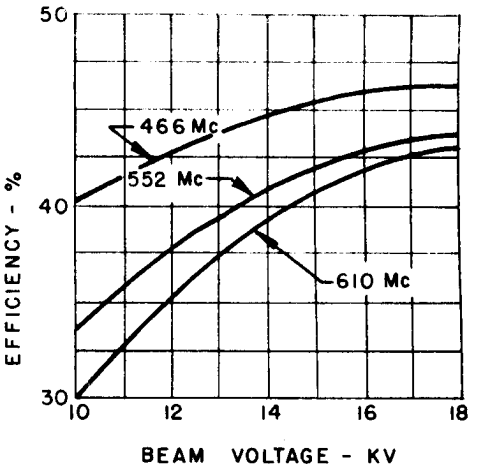

BEAM CURRENT - AMPERES
4.5
4.0
3.5
3.0
2.5
2.0
1.5
10
12
14
16
18
BEAM VOLTAGE - KV

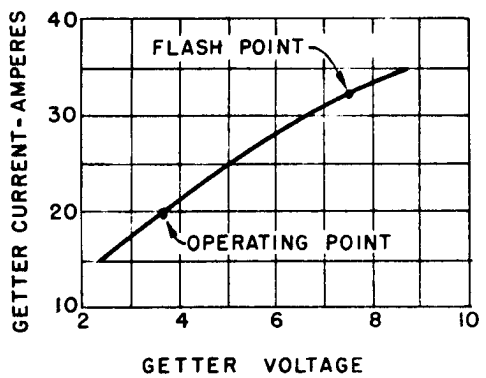

LINEARITY DATA
E_b = 16 KV F = 470 Mc
1 db BANDWIDTH = 8 Mc
25 KILOWATTS
20 KILOWATTS
√OUTPUT POWER (KW)
5
4
3
2
1
0
1
2
3
4
√DRIVING POWER (WATTS)

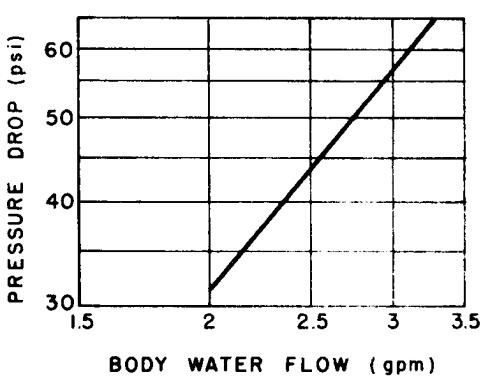

BANDWIDTH DATA (E_b= 16 KV)
26.2 KW = 0
-2
-4
-6
-8
-10
-12
-14
-16
OUTPUT POWER - db
460
462
464
466
468
470
472
FREQUENCY — Mc
14 WATTS
DRIVING POWER
0.5 WATTS
DRIVING POWER

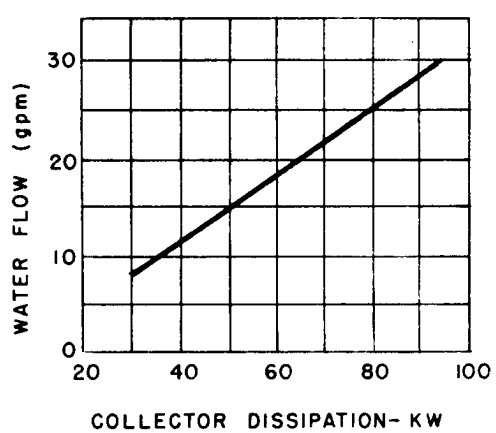

BANDWIDTH DATA (E_b= 16 KV)
26.5 KW = 0
-2
-4
-6
-8
-10
-12
-14
OUTPUT POWER - db
598
600
602
604
606
608
610
FREQUENCY — Mc
10 WATTS
DRIVING POWER
0.5 WATTS
DRIVING POWER

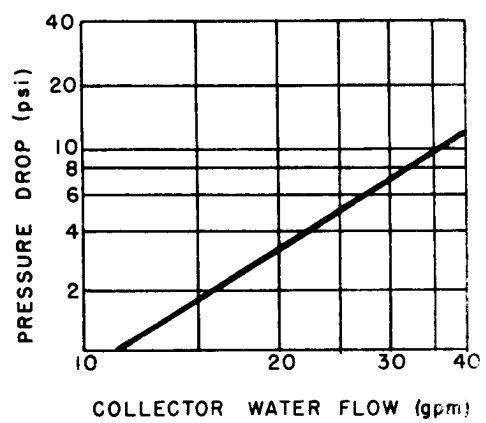

OUTPUT POWER - KILOWATTS
40
30
20
10
0
466 Mc
552 Mc
610 Mc
10
12
14
16
18
BEAM VOLTAGE - KV

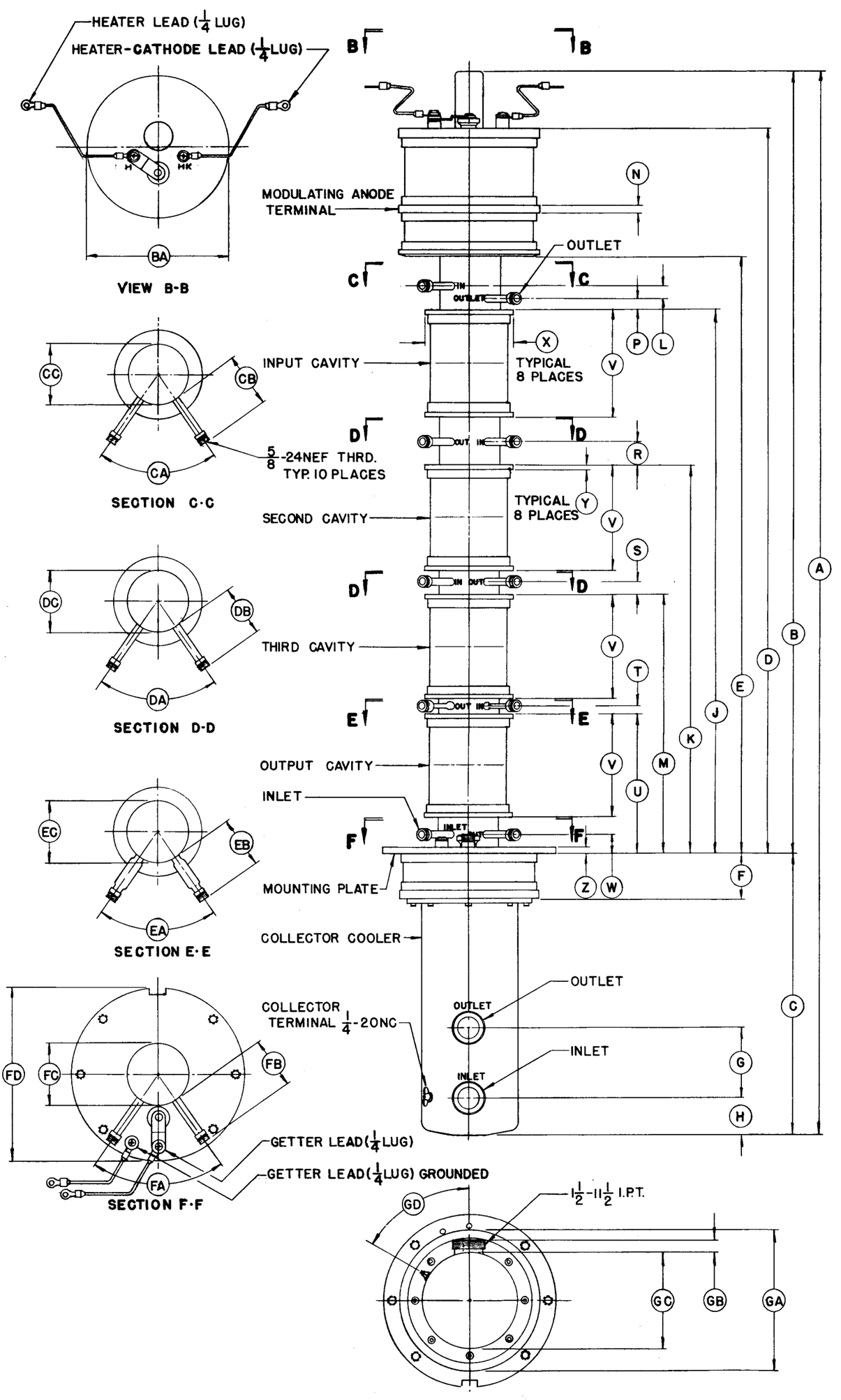

EFFICIENCY - %
50
40
30
466 Mc
552 Mc
610 Mc
10
12
14
16
18
BEAM VOLTAGE - KV


GETTER CURRENT - AMPERES
40
30
20
10
FLASH POINT
OPERATING POINT
2
4
6
8
10
GETTER VOLTAGE


PRESSURE DROP (psi)
60
50
40
30
1.5
2
2.5
3
3.5
BODY WATER FLOW (gpm)

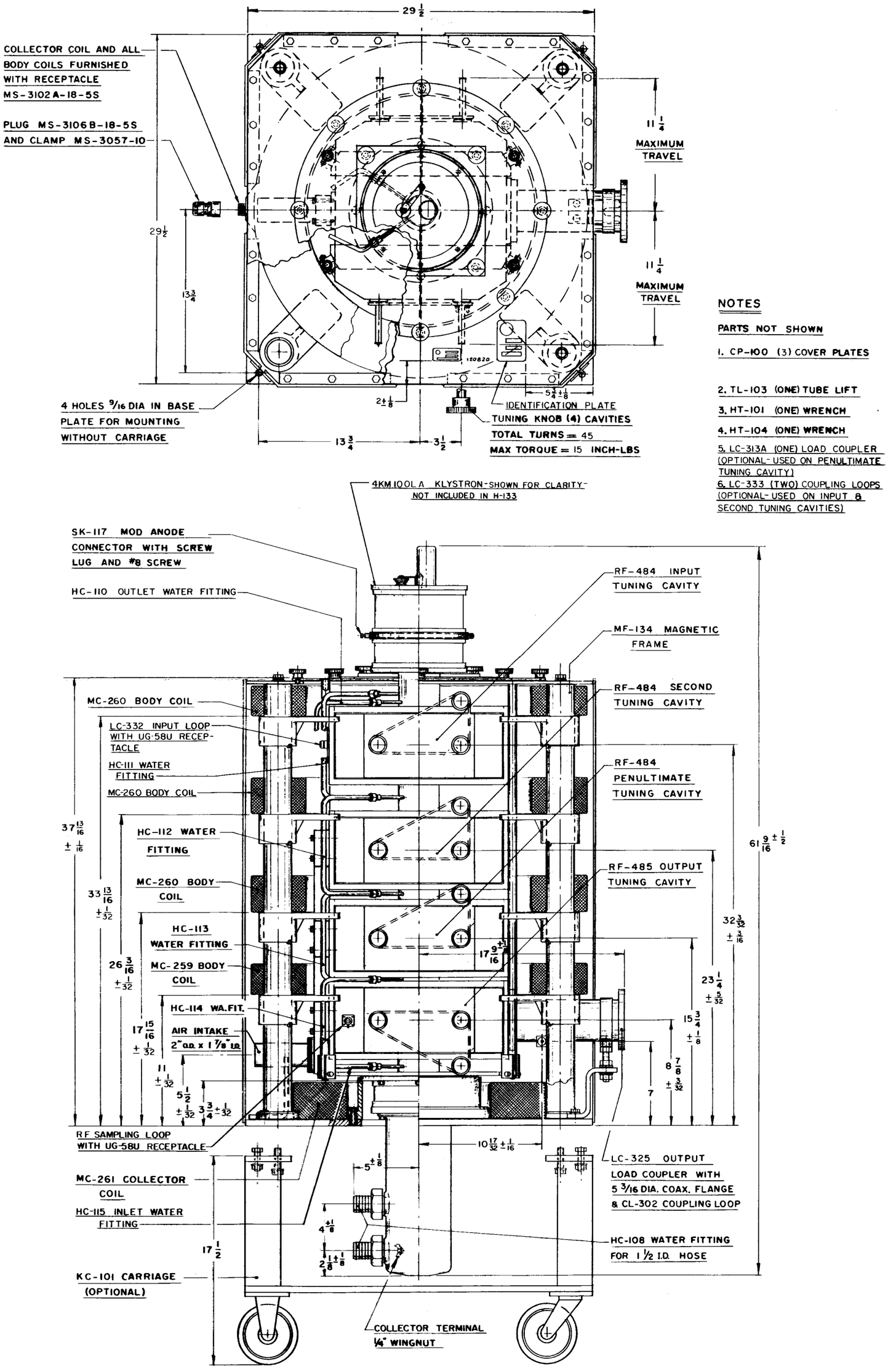

WATER FLOW (gpm)
30
20
10
0
20
40
60
80
100
COLLECTOR DISSIPATION - KW


PRESSURE DROP (psi)
40
20
10
8
6
4
2
10
20
30
40
COLLECTOR WATER FLOW (gpm)



DIMENSION DATA			
REF.	NOMINAL	MINIMUM	MAXIMUM
A	61.625		
B	45.150		
C	16.475		
D	41.900		
E	34.467		
F	2.600		
G	4.000		
H	2.125		
J	31.341		
K	22.499		
L	.625		
M	14.999		
N	.375		
P	.636		
R	1.433		
S	.875		
T	.453		
U	8.124		
V	6.000		
W	1.124		
X	5.125		
Y	.250		
Z	.375		
BA	8.125 DIA		
CA	70°		
CB	3.000		
CC	3.500 DIA		
DA	70°		
DB	3.000		
DC	3.500 DIA		
EA	70°		
EB	3.000		
EC	3.500 DIA		
FA	70°		
FB	3.000		
FC	3.500 DIA		
FD	10.000 DIA		
GA	8.125 DIA		
GB	.843		
GC	5.500 DIA		
GD	60°		

4KM100LA KLYSTRON



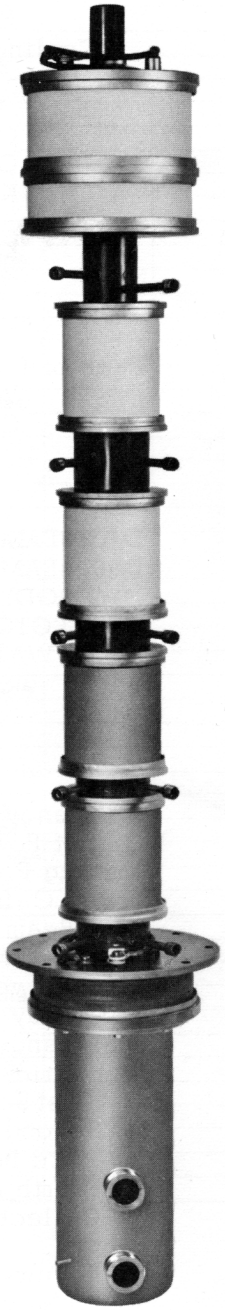
H-133 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4KM100LA

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 4KM100LA is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies from 470 to 610 megacycles. Intended primarily for television visual service, it is also suitable for aural TV, or for tropospheric-scatter communications service.

When adjusted for narrow-band CW operation the 4KM100LA will deliver a minimum output power of 35 kilowatts with a power gain of 45 decibels. In television visual service it will provide more than 25 kilowatts of peak synchronizing power, with a power gain of 30 decibels, and 1db bandwidth of 8 megacycles. Random AM noise is more than 60db below black level.

The electron gun of this klystron utilizes a semi-confined flow field which minimizes focusing adjustments and produces a very stable beam. The cathode loading of only 100 milliamperes per square centimeter, at a beam voltage of 18 kilovolts, is ultra conservative in the interest of long life. Effective protection from internal arcs is provided by the Eimac Modulating Anode.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. Load couplers are provided to permit external loading of these cavities for extreme wideband operation. However, external cavity loading is not ordinarily required in TV visual service.

The 4KM100LA incorporates a built-in vacuum pump in the form of a titanium getter. This getter should be energized whenever heater power is applied. Its normal operating voltage is 3.7 volts at approximately 20 amperes. When a new tube is first placed in operation the getter should be flashed for 5 minutes at a voltage of 7.5 volts (±5%) which produces a current of approximately 33 amperes. The getter should also be flashed whenever a tube exhibits symptoms of high gas pressure.

Eimac Klystron Amplifier Circuit Assembly H-133 has been designed for use with the 4KM100LA to cover the specified frequency range. This assembly includes a klystron supporting structure, magnetic focusing coils, tuning cavities, and adjustable load couplers for each cavity.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage	26.0	volts
	Current	11.5	amperes
	Maximum Starting Current	23	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter (Operating):			
	A-C Voltage (±5%)	3.7	volts
	A-C Current	20	amperes
Getter (Flash):			
	A-C Voltage (±5%)	7.5	volts
	A-C Current	33	amperes
Power Gain:	Narrow Band	45	decibels
	Television Visual Service	30	decibels
Output Power:	Narrow Band	35	kilowatts
	Television Visual Service	25	kilowatts
Frequency Range (H-133 Assembly)		470 to 610	megacycles

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MECHANICAL

Maximum Height of Klystron and H-133 Assembly including KC-101 Carriage	67 inches
Operating Position	Axis vertical, cathode up
R-F Coupling:	
Input	Type "N" coaxial fitting
Output	3-1/8 inch, 50-ohm line
Input and 2nd Cavity Loading	Type "N" coaxial fitting
3rd Cavity Loading	1-5/8 inch, 50-ohm line
Weights:	
Klystron Only	119 pounds
H-133 RF Circuit Assembly	1188 pounds

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode	*5 cfm	-------
Cavity	50 cfm	TBS
Klystron Body (5 drift-tube sections, in series)	2 gpm	35 psi
Klystron Collector	30 gpm	7.5 psi

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Each of Four Body Coils and Collector Coil:

Voltage	0 to 50	volts
Current	0 to 10	amperes

MAXIMUM RATINGS

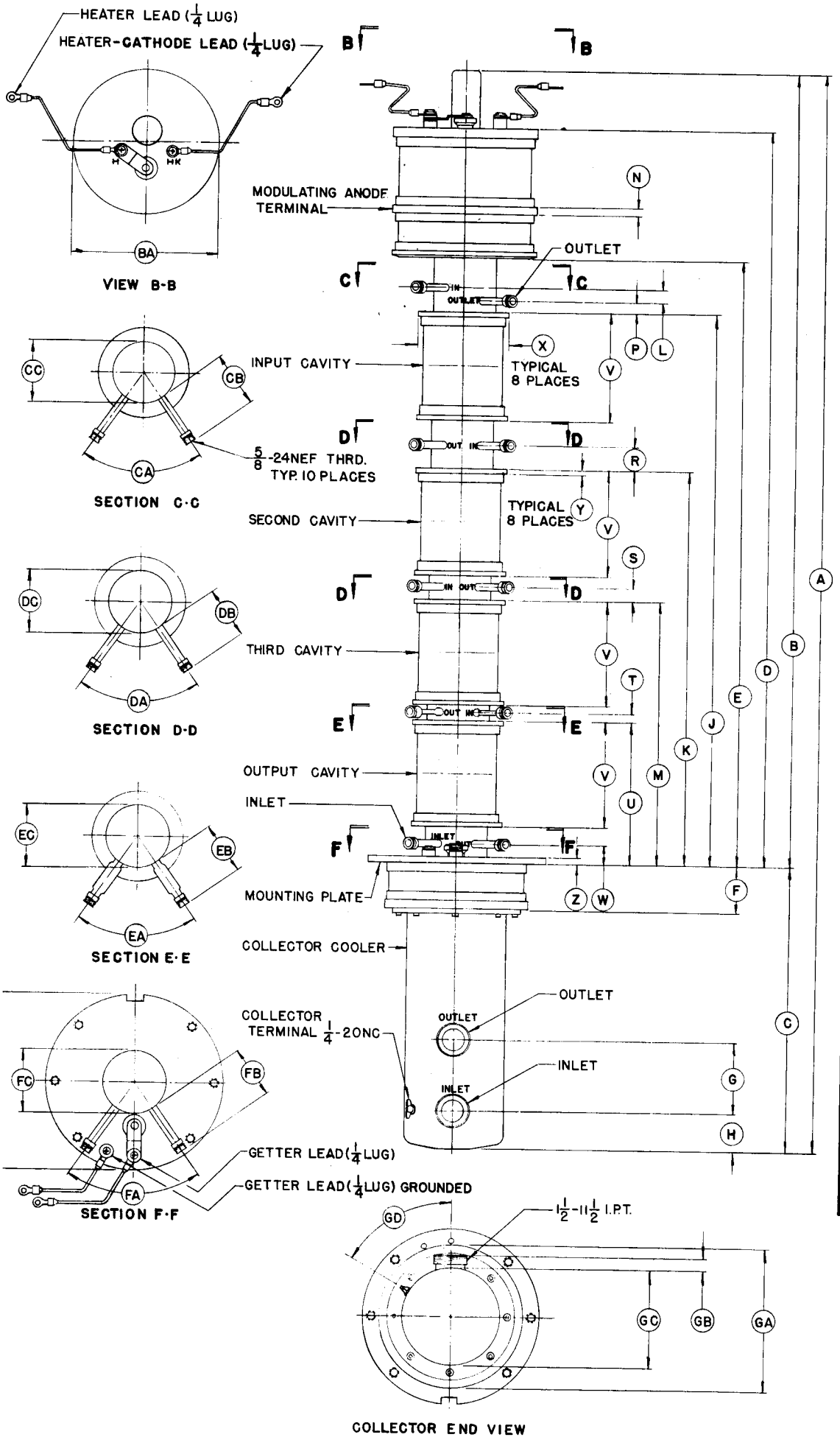
D-C BEAM VOLTAGE	20	KILOVOLTS
D-C BEAM CURRENT	6.0	AMPERES
D-C BODY CURRENT	150	MILLIAMPERES
COLLECTOR DISSIPATION	100	KILOWATTS
INLET WATER PRESSURE	100	PSI

TYPICAL OPERATION

	TV Visual Amplifier	Narrow Band CW	
Frequency	550	550	megacycles
Output Power	26.4(peak sync.)	35.4	kilowatts
Driving Power	20 " "	1.0	watts
Power Gain	31 " "	45	decibels
D-C Beam Voltage	16	18	kilovolts
D-C Beam Current	3.82	4.54	amperes
Beam Power Efficiency	43(peak sync.)	43.3	percent
D-C Body Current	--	90	milliamperes
1 db Bandwidth	8	--	megacycles
Magnetic-Coil Currents:			
First Body Coil	9.0	9.0	amperes
Second Body Coil	9.0	9.2	amperes
Third Body Coil	8.6	9.8	amperes
Fourth Body Coil	7.1	6.0	amperes
Collector Coil	3.3	6.3	amperes

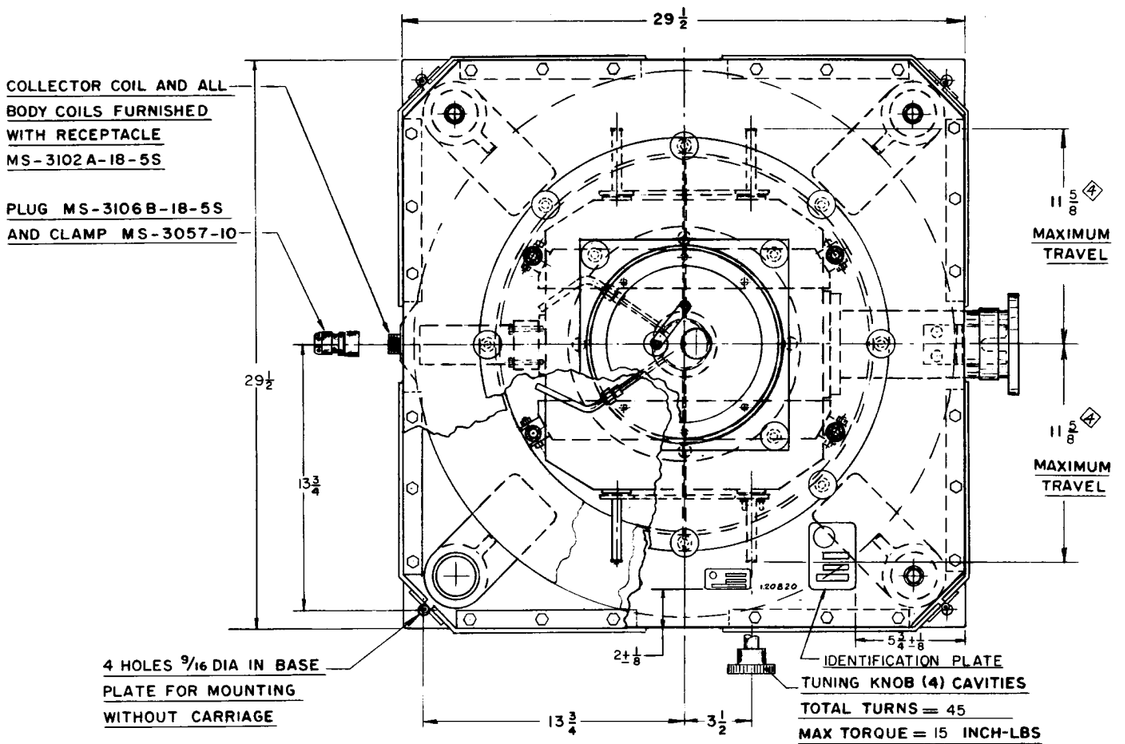
* Required only if ambient air temperature exceeds 25°C.

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.



DIMENSION DATA			
REF.	NOMINAL	MINIMUM	MAXIMUM
A	61.625		
B	45.150		
C	16.475		
D	41.900		
E	34.467		
F	2.600		
G	4.000		
H	2.125		
J	31.341		
K	22.499		
L	.625		
M	14.999		
N	.375		
P	.636		
R	1.433		
S	.875		
T	.453		
U	8.124		
V	6.000		
W	1.124		
X	5.125		
Y	.250		
Z	.375		
BA	8.125 DIA		
CA	70°		
CB	3.000		
CC	3.500 DIA		
DA	70°		
DB	3.000		
DC	3.500 DIA		
EA	70°		
EB	3.000		
EC	3.500 DIA		
FA	70°		
FB	3.000		
FC	3.500 DIA		
FD	10.000 DIA		
GA	8.125 DIA		
GB	.843		
GC	5.500 DIA		
GD	60°		

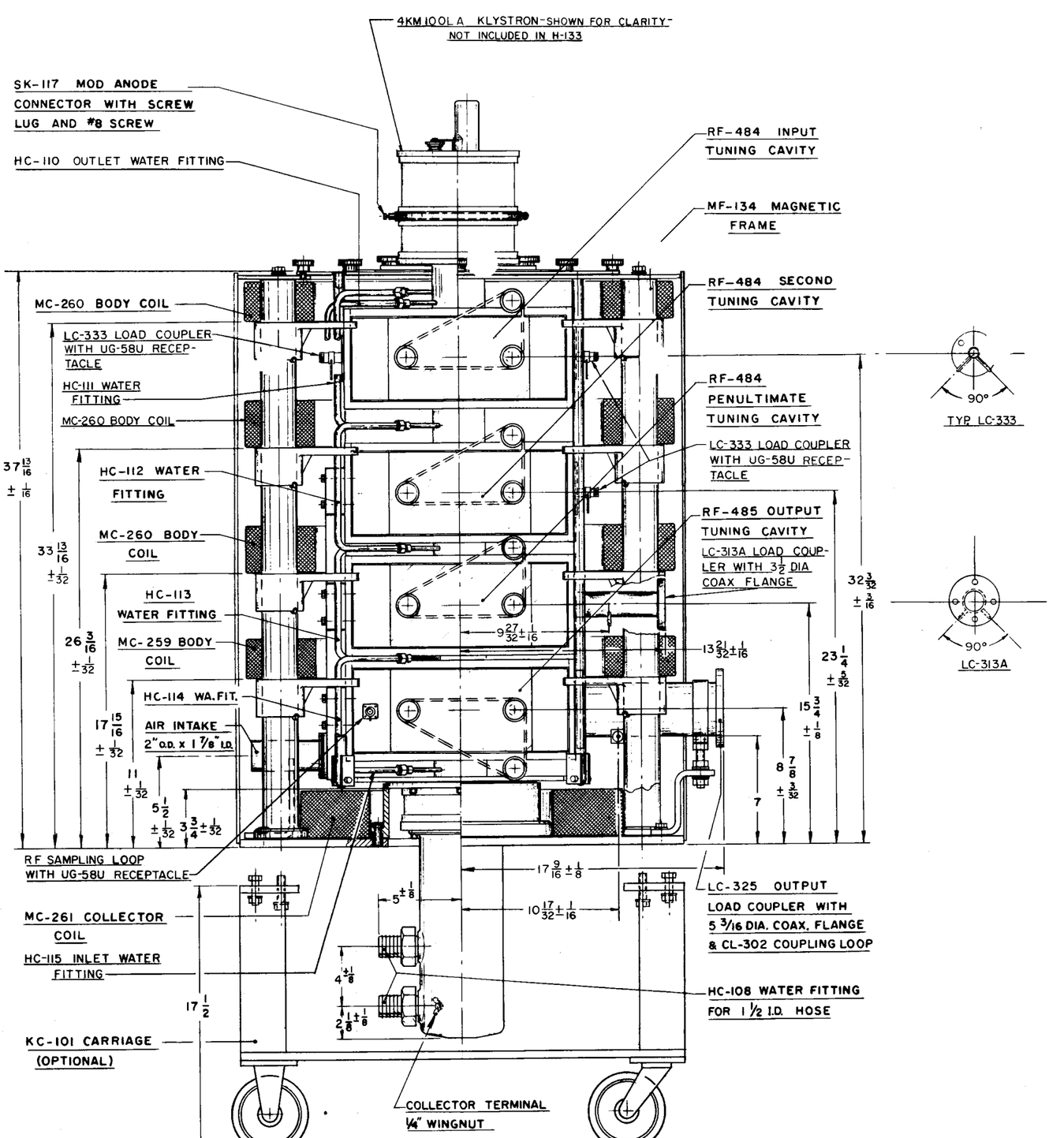
4KM100LA KLYSTRON



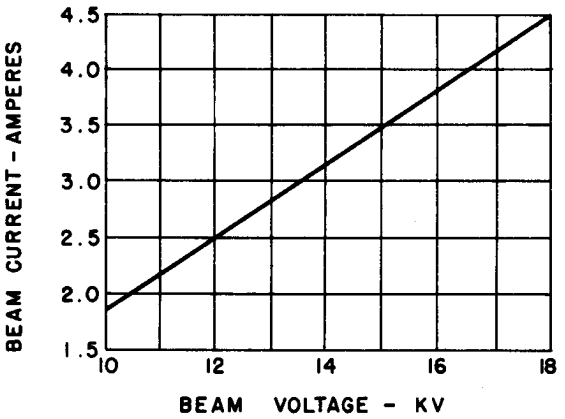
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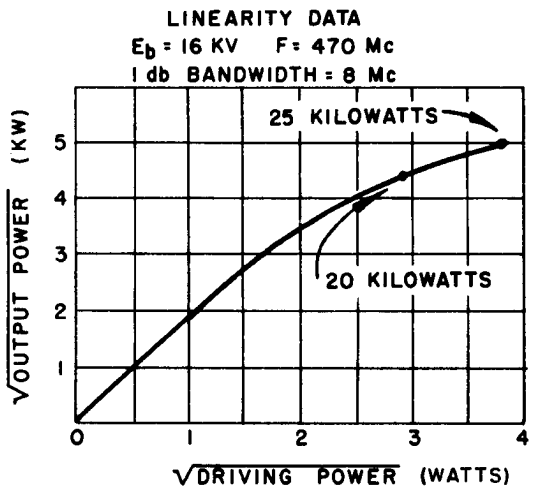
PARTS NOT SHOWN

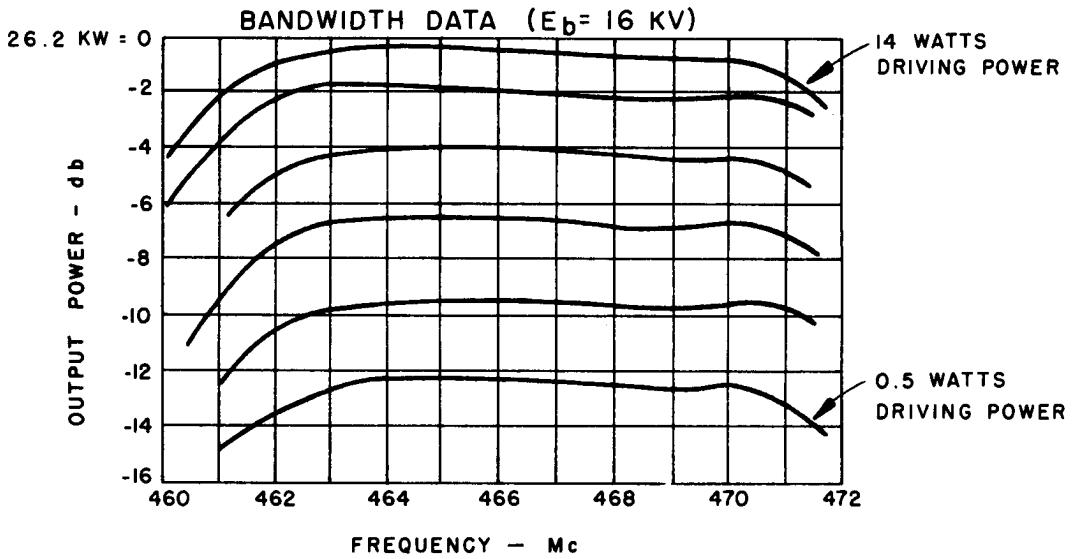
1. CP-100 (3) COVER PLATES — TO REPLACE LC-313A OR LC-335 IF NOT USED
2. TL-103 (ONE) TUBE LIFT
3. HT-101 (ONE) WRENCH
4. HT-104 (ONE) WRENCH

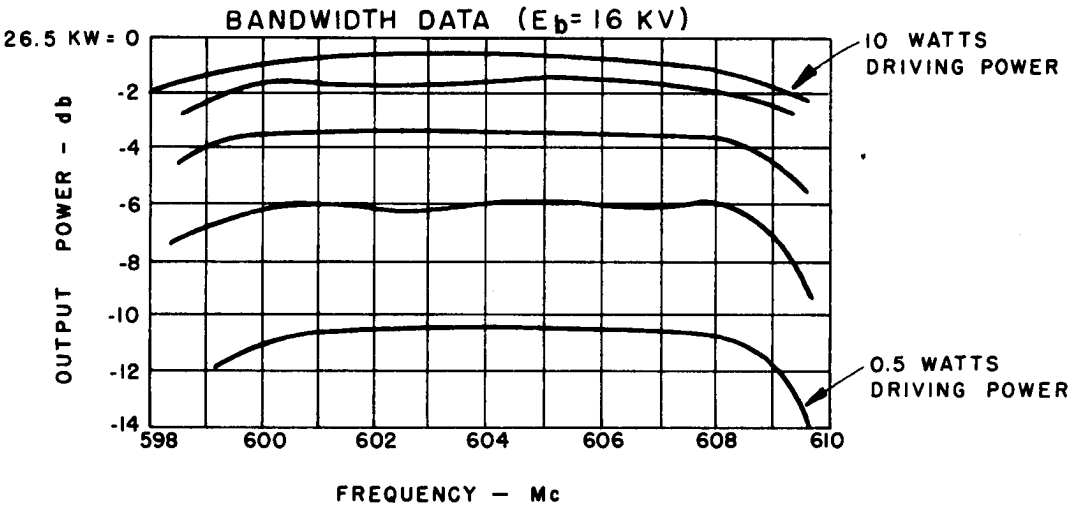


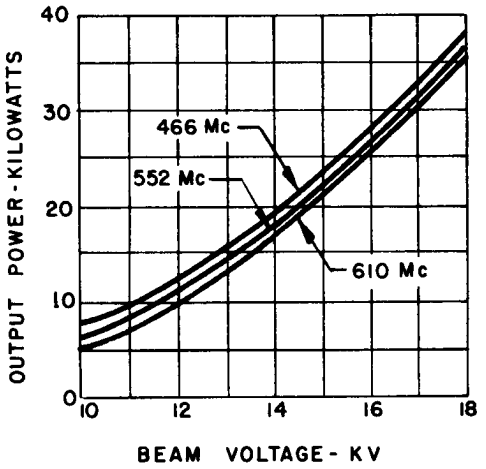
H-133 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

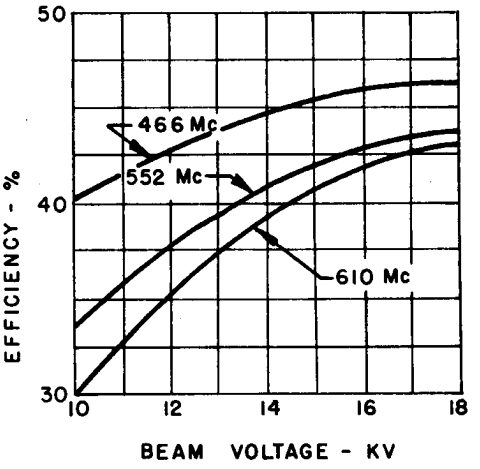

BEAM CURRENT - AMPERES
4.5
4.0
3.5
3.0
2.5
2.0
1.5
10
12
14
16
18
BEAM VOLTAGE - KV

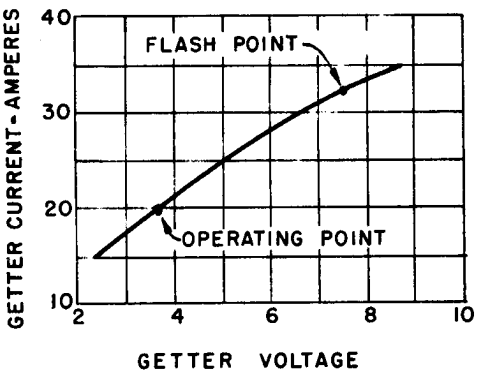

LINEARITY DATA
Eb = 16 KV F = 470 Mc
1 db BANDWIDTH = 8 Mc
25 KILOWATTS
20 KILOWATTS
√OUTPUT POWER (KW)
5
4
3
2
1
0
1
2
3
4
√DRIVING POWER (WATTS)

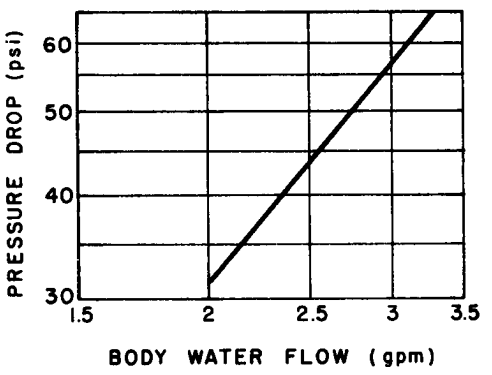

BANDWIDTH DATA (Eb= 16 KV)
26.2 KW = 0
-2
-4
-6
-8
-10
-12
-14
-16
OUTPUT POWER - db
460
462
464
466
468
470
472
FREQUENCY — Mc
14 WATTS
DRIVING POWER
0.5 WATTS
DRIVING POWER

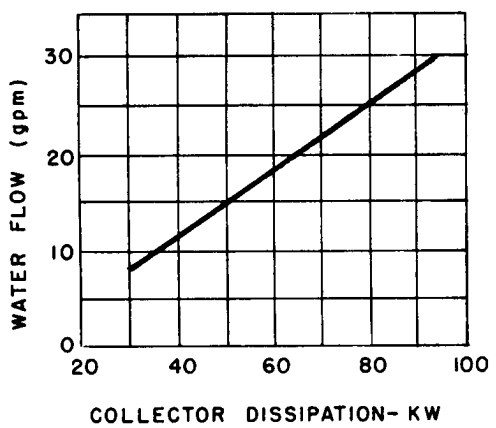

BANDWIDTH DATA (Eb= 16 KV)
26.5 KW = 0
-2
-4
-6
-8
-10
-12
-14
OUTPUT POWER - db
598
600
602
604
606
608
610
FREQUENCY — Mc
10 WATTS
DRIVING POWER
0.5 WATTS
DRIVING POWER

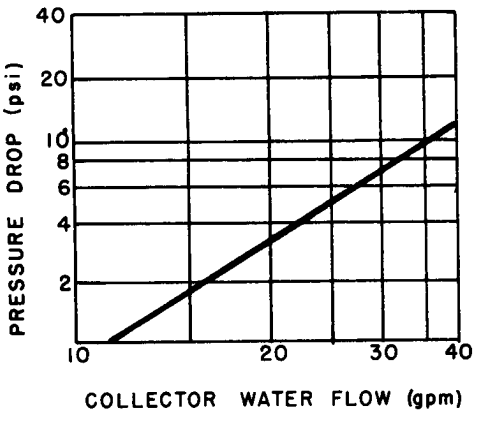

OUTPUT POWER - KILOWATTS
40
30
20
10
0
466 Mc
552 Mc
610 Mc
10
12
14
16
18
BEAM VOLTAGE - KV


EFFICIENCY - %
50
40
30
466 Mc
552 Mc
610 Mc
10
12
14
16
18
BEAM VOLTAGE - KV


GETTER CURRENT - AMPERES
40
30
20
10
FLASH POINT
OPERATING POINT
2
4
6
8
10
GETTER VOLTAGE


PRESSURE DROP (psi)
60
50
40
30
1.5
2
2.5
3
3.5
BODY WATER FLOW (gpm)


WATER FLOW (gpm)
30
20
10
0
20
40
60
80
100
COLLECTOR DISSIPATION - KW


PRESSURE DROP (psi)
40
20
10
8
6
4
2
10
20
30
40
COLLECTOR WATER FLOW (gpm)

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4KM100LA 25KW

POWER-AMPLIFIER L-BAND KLYSTRON

The Eimac 4KM100LA is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies from 470 to 610 megacycles. Intended primarily for television visual service, it is also suitable for aural TV, or for tropospheric-scatter communications service.

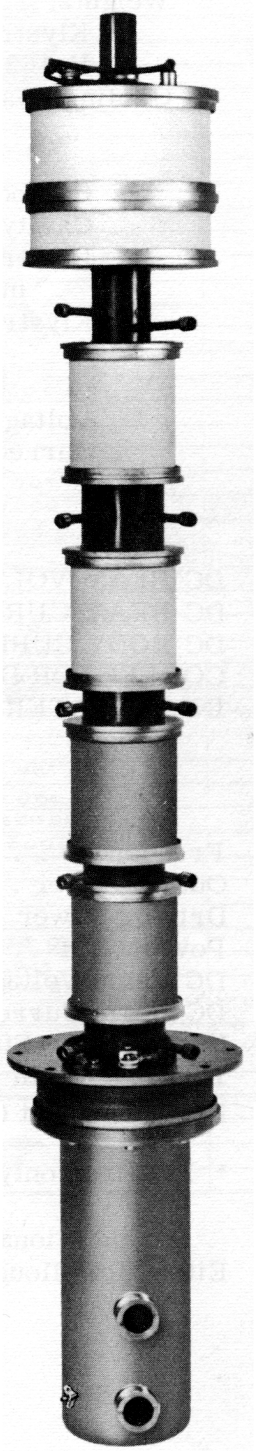
In television visual service the 4KM100LA will provide more than 25 kilowatts of peak synchronizing power, with a power gain of 30 decibels, and ldb bandwidth of 8 megacycles. Random AM noise is more than 60db below black level.

The electron gun of this klystron utilizes a semi-confined flow field which minimizes focusing adjustments and produces a very stable beam. The cathode loading of only 100 milliamperes per square centimeter, at a beam voltage of 18 kilovolts, is ultra conservative in the interest of long life. Effective protection from internal arcs is provided by the Eimac Modulating Anode.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. Load couplers are provided to permit external loading of these cavities for extreme wideband operation.

The 4KM100LA incorporates a built-in vacuum pump in the form of a titanium getter. This getter should be energized whenever heater power is applied. Its normal operating voltage is 3.7 volts at approximately 20 amperes.

Eimac Klystron Amplifier Circuit Assembly H-163 has been designed for use with the 4KM100LA to cover the specified frequency range. This assembly includes a klystron supporting structure, focusing electromagnet, tuning cavities, and adjustable load couplers for each cavity.



CHARACTERISTICS

ELECTRICAL

Heater:	DC Voltage	26.0	volts
	DC Current	11.5	amperes
	Maximum Starting Current	23	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter (Operating):			
	AC Voltage (±5%)	3.7	volts
	AC Current	20	amperes
Power Gain:			
	Television Visual Service	30	decibels
Output Power:			
	Television Visual Service	25	kilowatts
Frequency Range (H-163 Assembly)		470 to 610	megacycles

(Effective 9-25-62) Copyright 1962 by Eitel-McCullough, Inc. Printed in U.S.A.

MECHANICAL

Maximum Height of Klystron and H-163 Assembly including KC-102 Carriage . . . . . 67 inches

Operating Position . . . . . .Axis vertical, cathode up

R-F Coupling:

Input. . . . . .Type "N" coaxial fitting

Output . . . . . .3-1/8 inch, 50-ohm line

Input and 2nd Cavity Loading . . . . . .Type "N" coaxial fitting

3rd Cavity Loading . . . . . .1-5/8 inch, 50-ohm line

Weights:

Klystron Only . . . . . 119 pounds

H-163 RF Circuit Assembly . . . . . .1800 pounds

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode	*5 cfm	-------
Cavity	50 cfm	TBS
Klystron Body and Electromagnet in Series	2 gpm	45 psi
Klystron Collector	30 gpm	7.5 psi

ELECTROMAGNET POWER-SUPPLY REQUIREMENTS

Voltage	0 to 150	volts
Current	0 to 12	amperes

MAXIMUM RATINGS

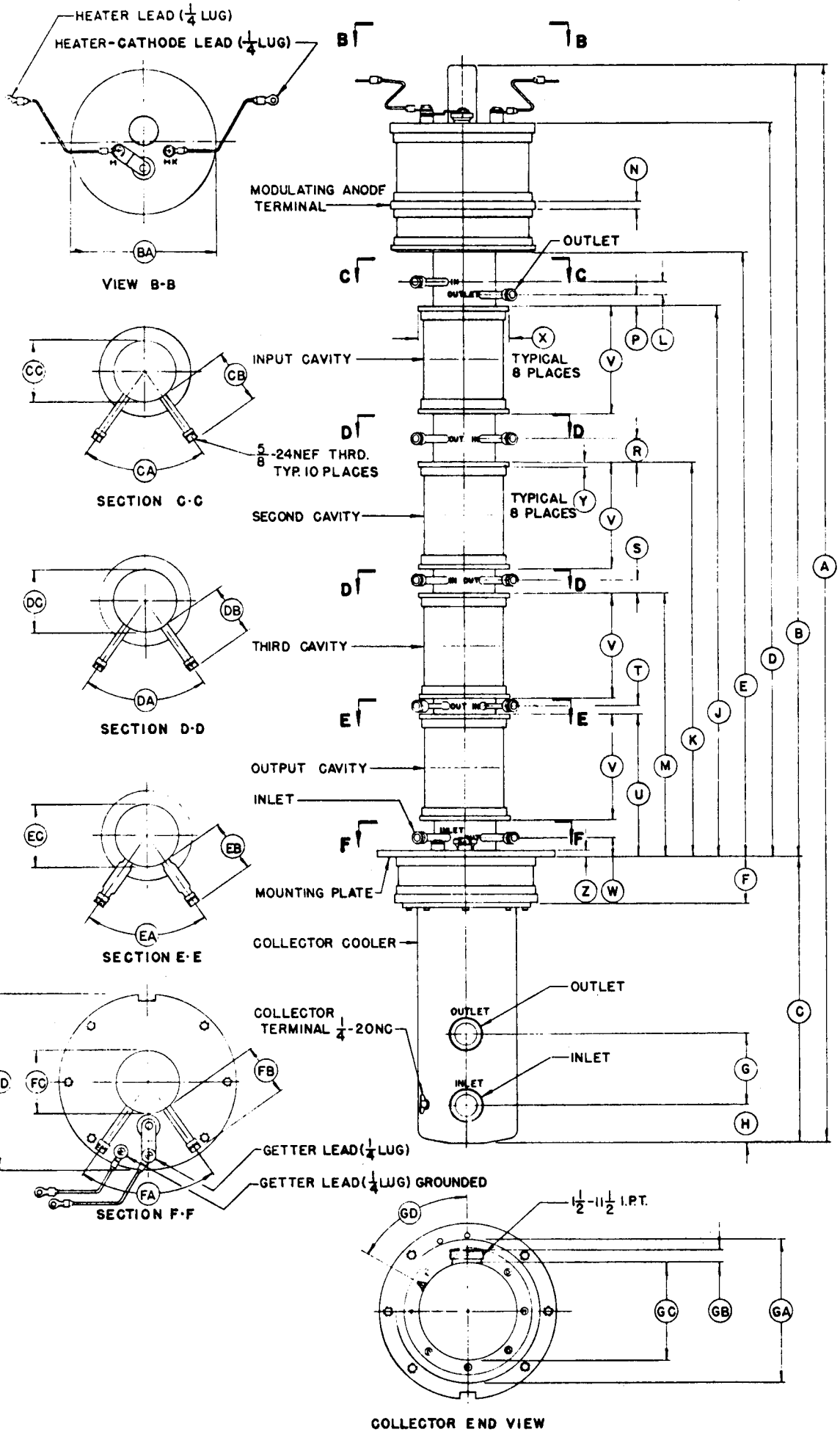
DC BEAM VOLTAGE	20	KILOVOLTS
DC BEAM CURRENT	6.0	AMPERES
DC BODY CURRENT	150	MILLIAMPERES
COLLECTOR DISSIPATION	100	KILOWATTS
INLET WATER PRESSURE	100	PSI

TYPICAL OPERATION

	TV Visual Amplifier	
Frequency	550	megacycles
Output Power	26.4 (peak sync.)	kilowatts
Driving Power	20 " "	watts
Power Gain	31 " "	decibels
DC Beam Voltage	16	kilovolts
DC Beam Current	3.82	amperes
Beam Power Efficiency	43 (peak sync.)	percent
1 db Bandwidth	8	megacycles
Electromagnet Current	8.9	amperes

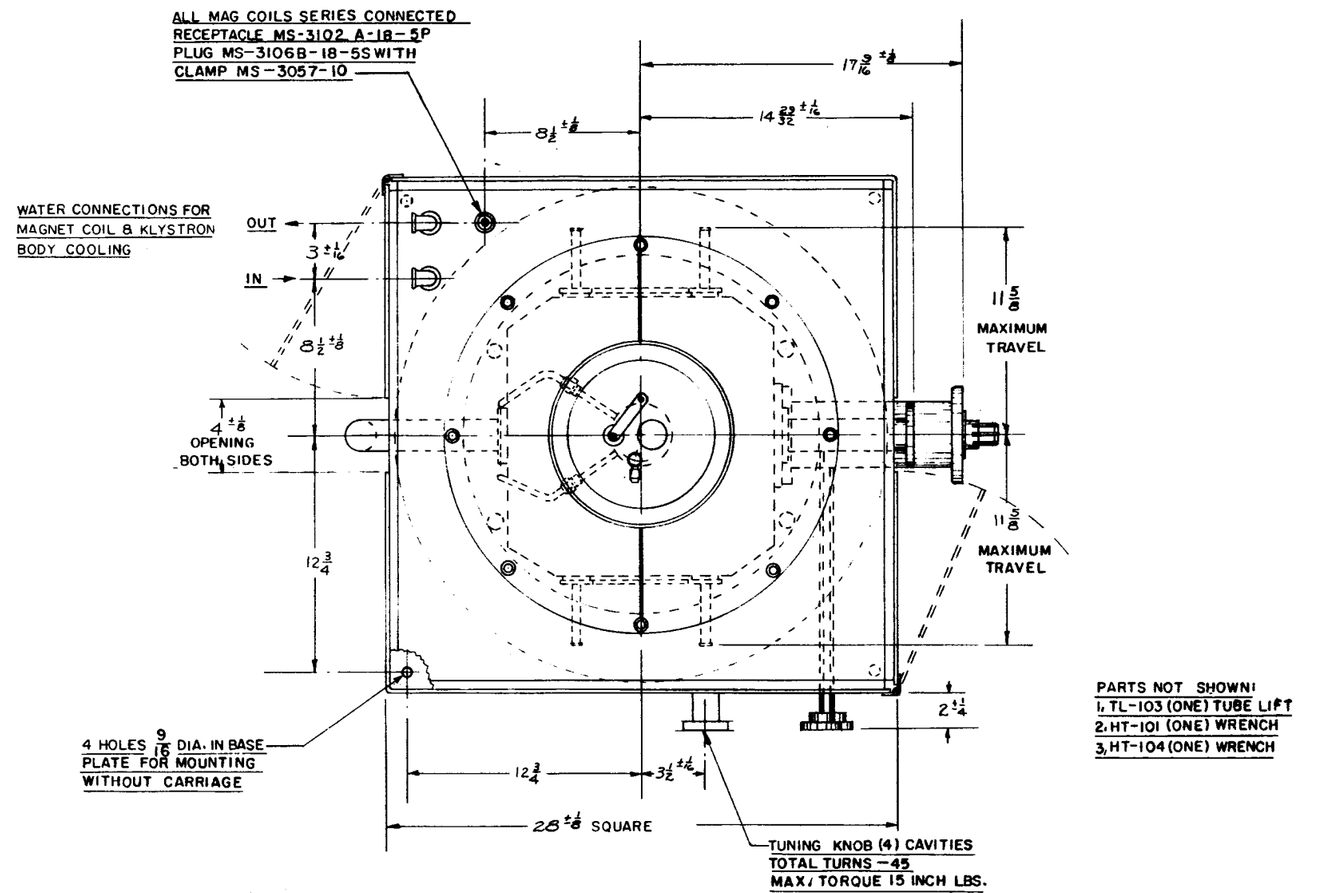
* Required only if ambient air temperature exceeds 25° C.

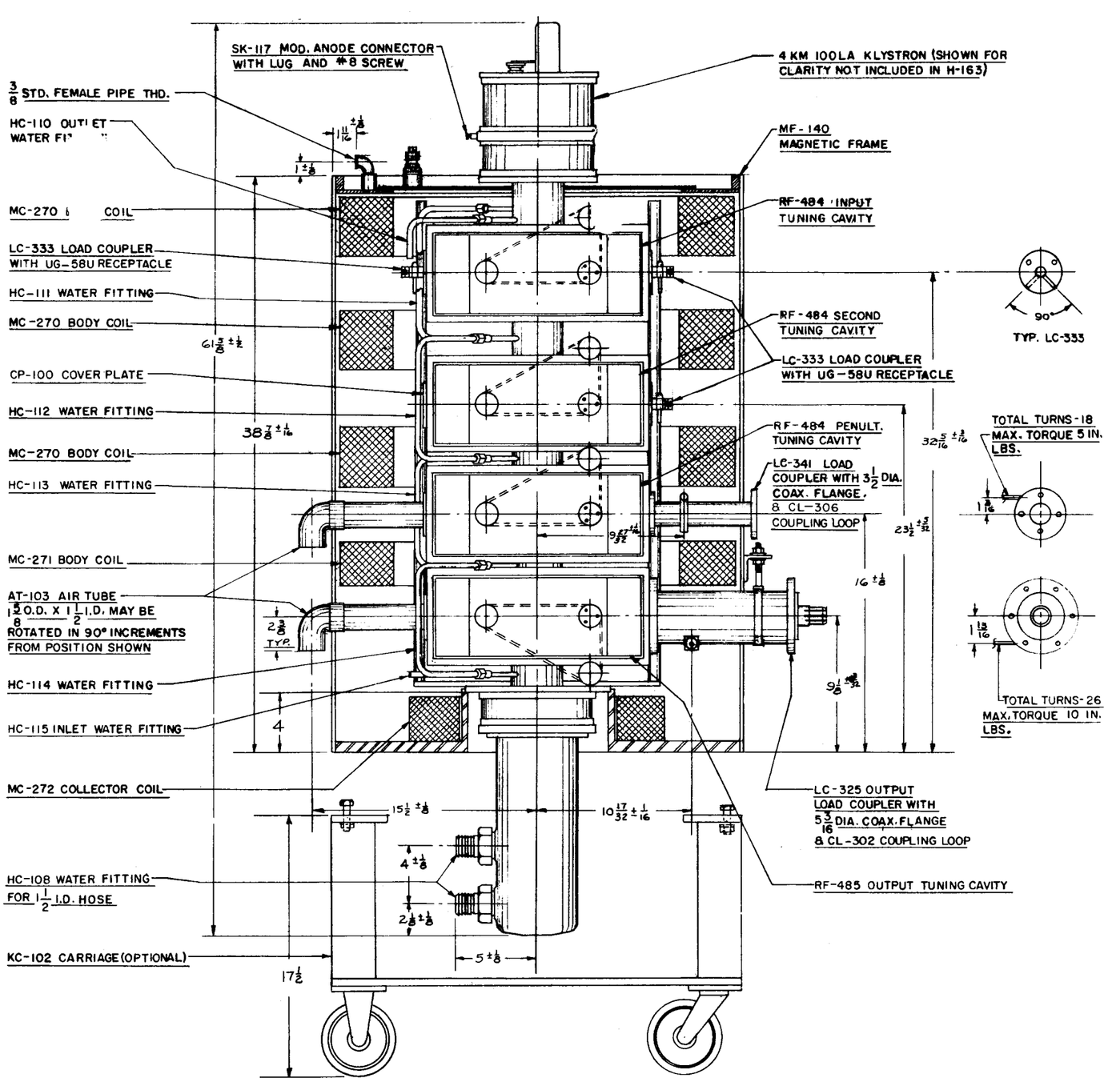
For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.



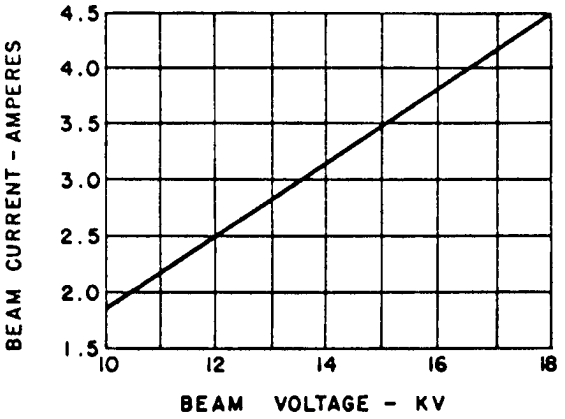
DIMENSION DATA			
REF.	NOMINAL	MINIMUM	MAXIMUM
A	61.625		
B	45.150		
C	16.475		
D	41.900		
E	34.467		
F	2.600		
G	4.000		
H	2.126		
J	31.341		
K	22.499		
L	.625		
M	14.999		
N	.375		
P	.636		
R	1.433		
S	.875		
T	.453		
U	8.124		
V	6.000		
W	1.124		
X	5.125		
Y	.250		
Z	.375		
BA	8.125 DIA		
CA	70°		
CB	3.000		
CC	3.500 DIA		
DA	70°		
DB	3.000		
DC	3.500 DIA		
EA	70°		
EB	3.000		
EC	3.500 DIA		
FA	70°		
FB	3.000		
FC	3.500 DIA		
FD	10.000 DIA		
GA	8.125 DIA		
GB	.843		
GC	5.500 DIA		
GD	60°		

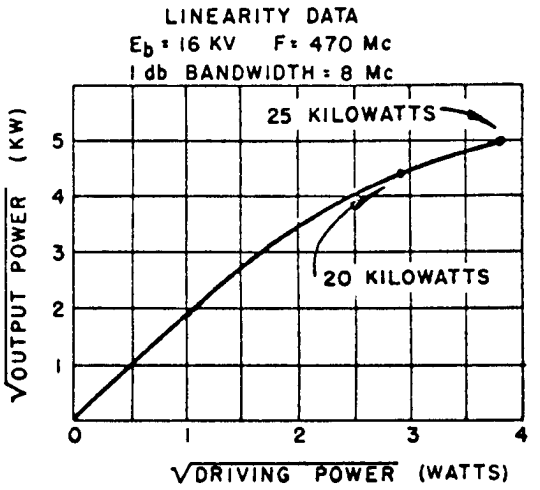
4KM100LA KLYSTRON

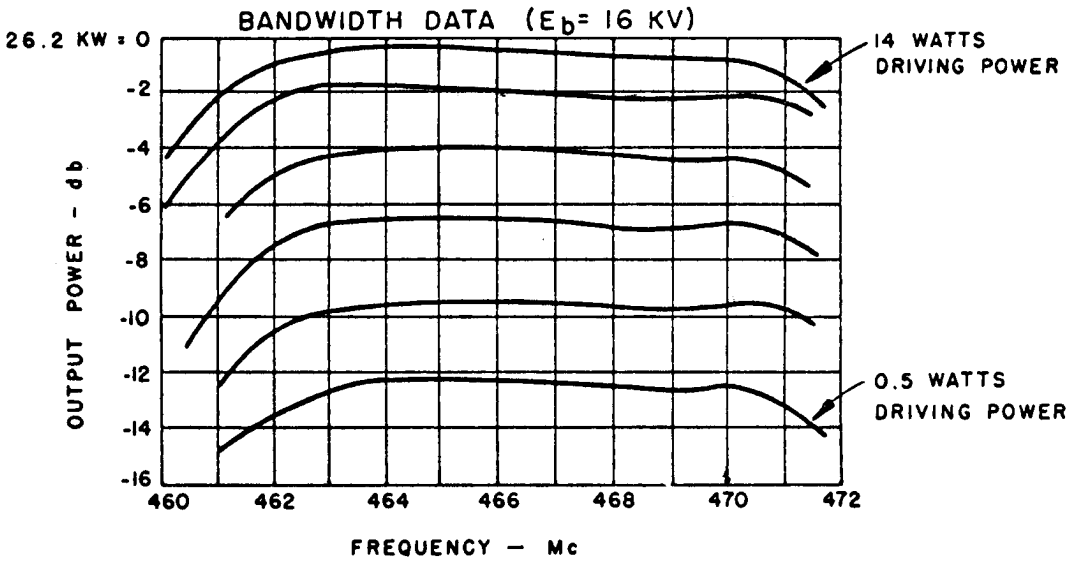


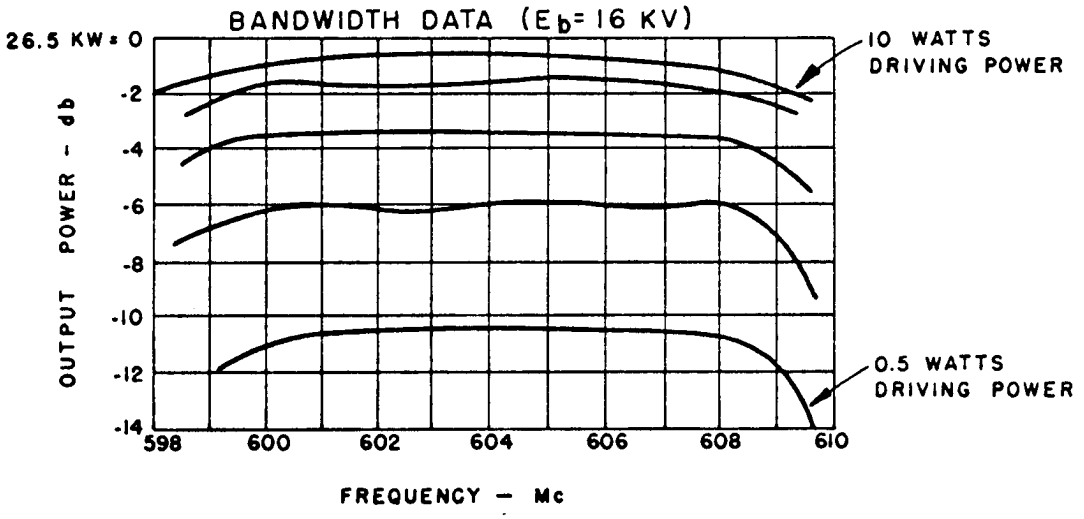


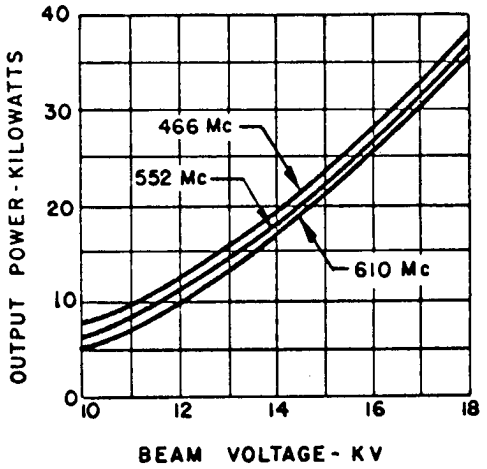
H-163 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

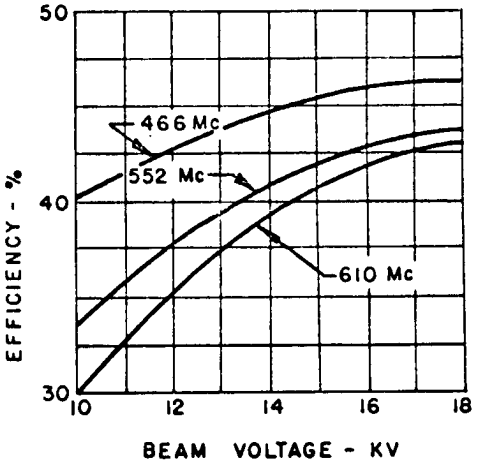

BEAM CURRENT - AMPERES
4.5
4.0
3.5
3.0
2.5
2.0
1.5
10
12
14
16
18
BEAM VOLTAGE - KV

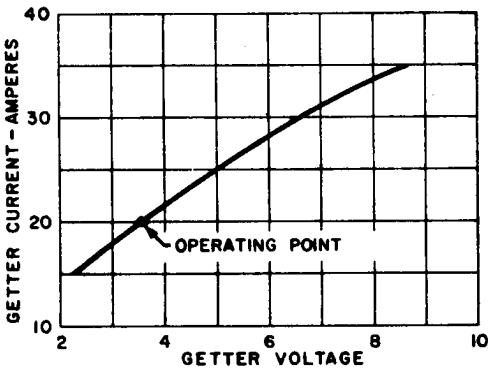

LINEARITY DATA
Eb = 16 KV F = 470 Mc
1 db BANDWIDTH = 8 Mc
25 KILOWATTS
20 KILOWATTS
√OUTPUT POWER (KW)
5
4
3
2
1
0
1
2
3
4
√DRIVING POWER (WATTS)

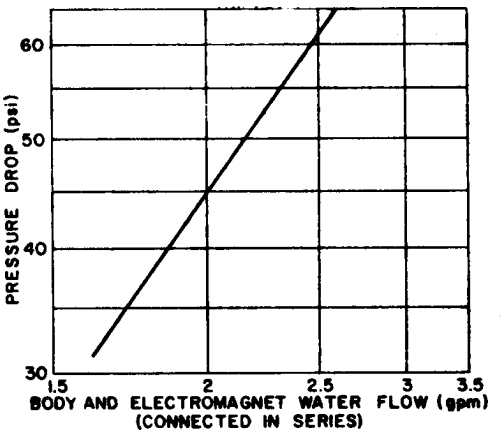

BANDWIDTH DATA (Eb= 16 KV)
26.2 KW = 0
-2
-4
-6
-8
-10
-12
-14
-16
OUTPUT POWER - db
14 WATTS
DRIVING POWER
0.5 WATTS
DRIVING POWER
460
462
464
466
468
470
472
FREQUENCY — Mc

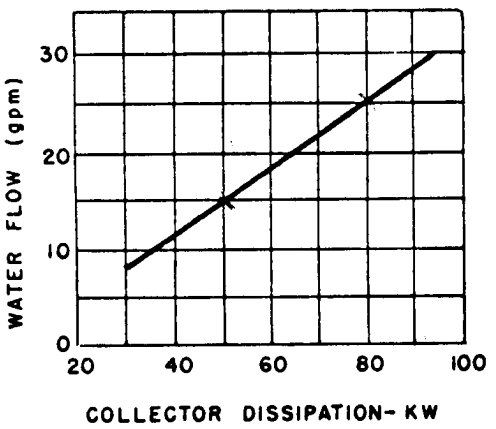

BANDWIDTH DATA (Eb= 16 KV)
26.5 KW = 0
-2
-4
-6
-8
-10
-12
-14
OUTPUT POWER - db
10 WATTS
DRIVING POWER
0.5 WATTS
DRIVING POWER
598
600
602
604
606
608
610
FREQUENCY — Mc

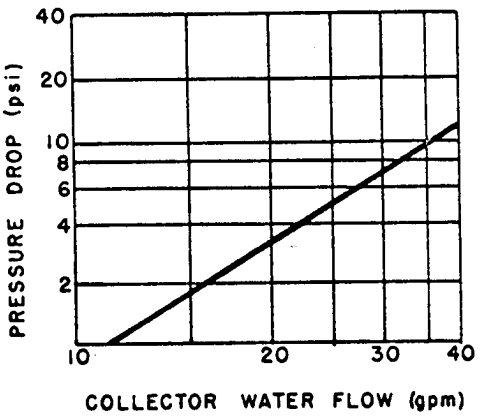

OUTPUT POWER - KILOWATTS
40
30
20
10
0
466 Mc
552 Mc
610 Mc
10
12
14
16
18
BEAM VOLTAGE - KV


EFFICIENCY - %
50
40
30
466 Mc
552 Mc
610 Mc
10
12
14
16
18
BEAM VOLTAGE - KV


GETTER CURRENT - AMPERES
40
30
20
10
OPERATING POINT
2
4
6
8
10
GETTER VOLTAGE


PRESSURE DROP (psi)
60
50
40
30
1.5
2
2.5
3
3.5
BODY AND ELECTROMAGNET WATER FLOW (gpm)
(CONNECTED IN SERIES)


WATER FLOW (gpm)
30
20
10
0
20
40
60
80
100
COLLECTOR DISSIPATION - KW


PRESSURE DROP (psi)
40
20
10
8
6
4
2
10
20
30
40
COLLECTOR WATER FLOW (gpm)

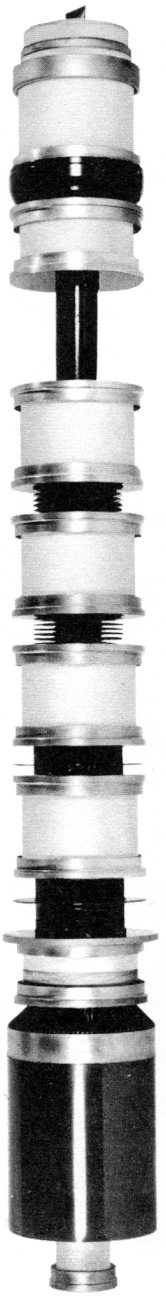
EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

TENTATIVE DATA

4KM3000LQ

POWER-AMPLIFIER

L-BAND KLYSTRON



The Eimac 4KM3000LQ is a four-cavity, magnetically focused, power-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 710 and 985 megacycles and will deliver a minimum CW output power of two kilowatts with a minimum power gain of 25 decibels when operated at 50% collector depression.

The collector is designed to operate at less than the cathode to anode voltage, thereby realizing an improvement in efficiency.

This klystron employs the Eimac Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage. It is also useful as a protective device, either in conjunction with external circuits, or when grounded through a resistor.

The resonant cavities for the 4KM3000LQ are completed by tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows external cavity loading for broad-band applications. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

Eimac Klystron Amplifier Circuit Assembly H-118, for use with the 4KM3000LQ, covers the frequency range of 710 to 985 megacycles. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, output r-f load coupler and an Eimac SK-100 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

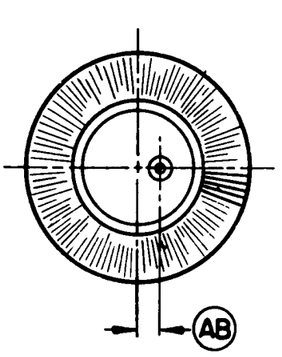
Cathode, Unipotential, Oxide Coated				
Minimum Heating Time	-	-	5	minutes
Heater: Voltage	-	-	5	volts
Current	-	-	33	amperes
Maximum Starting Current			65	amperes
Modulating Anode Capacitance (To other electrodes)	-	-	21	uuf
Power Gain (Narrow Band CW)		-	25	decibels
Output Power (Narrow Band CW)		-	2000	watts
Frequency Range (In H-118 Circuit Assembly)	-		710 to 985	megacycles

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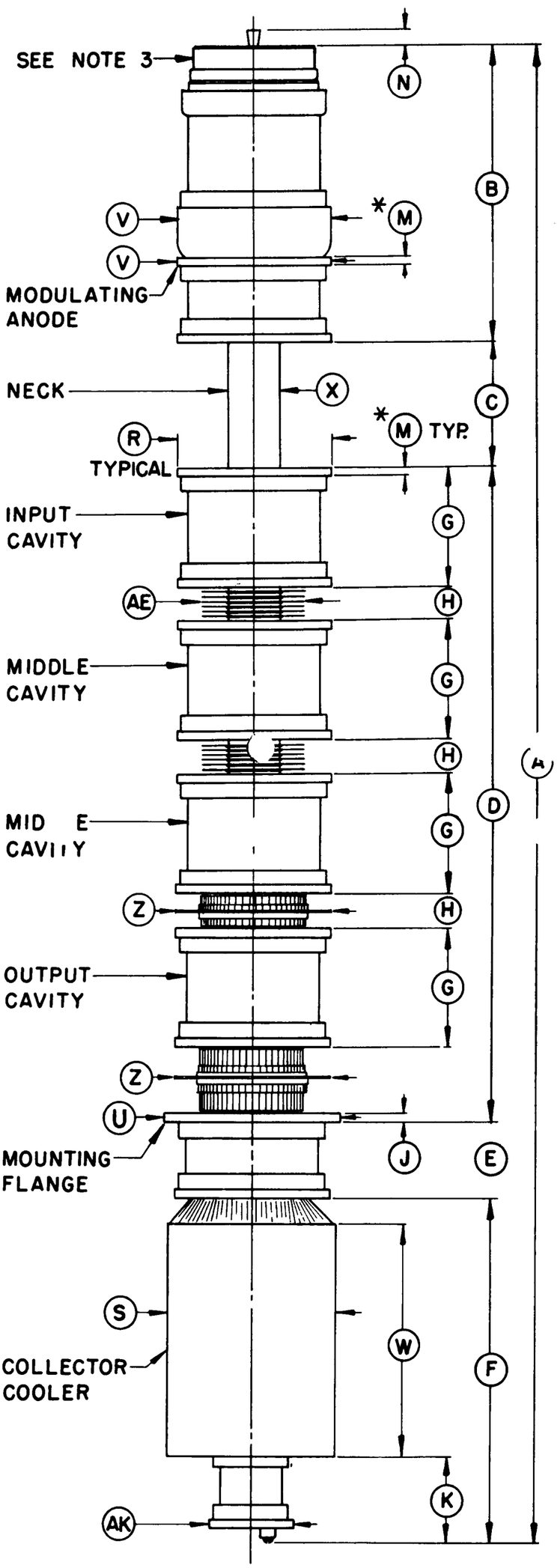
DIMENSIONS			
REF.	NOM.	MIN.	MAX.
A	44.187		
B	8.781		
C	3.750		
D	19.250		
E	2.125		
F	10.265		
G	3.500		
H	1.000		
J	.250		
K	2.578		
M		.187	
N		.650	1.000
R	4.625 DIA.		
S	5.135 DIA.		
U	5.375 DIA.		
V	4.625 DIA.		
W	6.937		
X	1.500 DIA.		
Z	4.625 DIA.		
AB	.500		
AE	3.078 DIA.		
AK	2.500 DIA.		

NOTES

1. *MINUMUM CONTACT SURFACE.
2. DIMENSIONS IN INCHES.
3. FOR ELECTRICAL CONTACT SURFACE DIMENSIONS SEE GUN NO. 1 OUTLINE, DRWG. NO. GUN NO. 1 – 6001.



COLLECTOR COOLER
END VIEW



4KM3000LQ OUTLINE DRAWING

4KM3000LQ

MECHANICAL

Operating Position	Axis vertical, cathode up
R-F Coupling	
Input	Type "N" coaxial fitting
Output	1-5/8 inch 50-ohm line
Shipping Weights:	
Klystron Only	49 lbs (Net); 138 lbs (Gross)
H-118 R-F Amplifier Circuit Assembly	327 lbs (Net); 473 lbs (Gross)

Cooling:

The 4KM3000LQ is cooled by forced air. At sea level and with inlet air temperature of 20°C (68°F) the flow rates tabulated below are sufficient for operation at maximum ratings and at maximum collector depression of 50%.

Cathode (with SK-100 Air-System Socket)	5 cfm
Penultimate Cavity	50 cfm
Output Cavity	75 cfm
Collector	150 cfm

Operation at higher altitudes or with higher inlet temperatures requires increased volumes of air flow to obtain equivalent cooling.

MAGNETIC-COIL POWER SUPPLY-REQUIREMENTS

Prefocus Coil Voltage	0 to 50	volts
Prefocus Coil Current	2.0	amperes
Each of Three Body Coils		
Voltage	0 to 100	volts
Current	3.0	amperes
Collector Coil Voltage	0 to 50	volts
Collector Coil Current	0 to 1.5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	10,000	VOLTS
D-C BEAM CURRENT	0.750	AMPERE
D-C FOCUS ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	3000	WATTS
SEAL TEMPERATURES	175	DEGREES C

TYPICAL OPERATION - NARROW BAND CW AMPLIFIER - COLLECTOR DEPRESSED

Frequency	900	megacycles
Output Power	2150	watts
Driving Power	4.0	watts
Power Gain	27	decibels
D-C Beam Voltage	9000	volts
D-C Beam Current	0.580	amperes
D-C Collector Voltage (from Cathode)	4500	volts
D-C Collector Current	0.210	amperes
D-C Body Current	0.370	amperes
Focus Electrode Voltage	-200	volts
Efficiency	50.0	percent

For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California. All such requests will be handled confidentially.

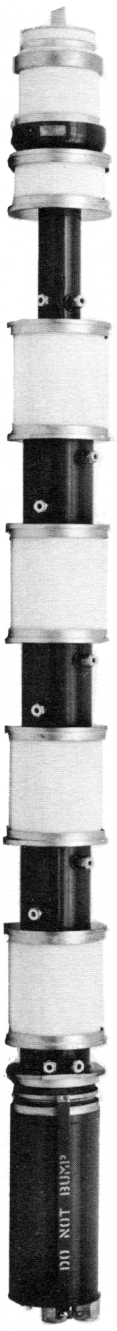
Printed in U.S.A. 890

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4KM50,000LA

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 4KM50,000LA is a four-cavity, magnetically focused, power-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 400 and 610 megacycles and will deliver a minimum CW output power of 10 kilowatts with a minimum power gain of 50 decibels.

This klystron employs the Eimac Modulating Anode which provides an effective means of amplitude or pulse modulating the output power without changing the beam voltage. It is also useful as a protective device, either in conjunction with external circuits or when grounded through a resistor.

The resonant cavities for the 4KM50,000LA are completed by tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range and allows external cavity loading for broad-band applications. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

Eimac Klystron Amplifier Circuit Assembly H-121, for use with the 4KM50,000LA, covers the frequency range of 400 to 610 megacycles. This assembly includes a klystron supporting structure, electro-magnetic focusing coils, tuning boxes, adjustable load couplers for the second, third and output cavities, and an Eimac SK-110 Air-System Socket.

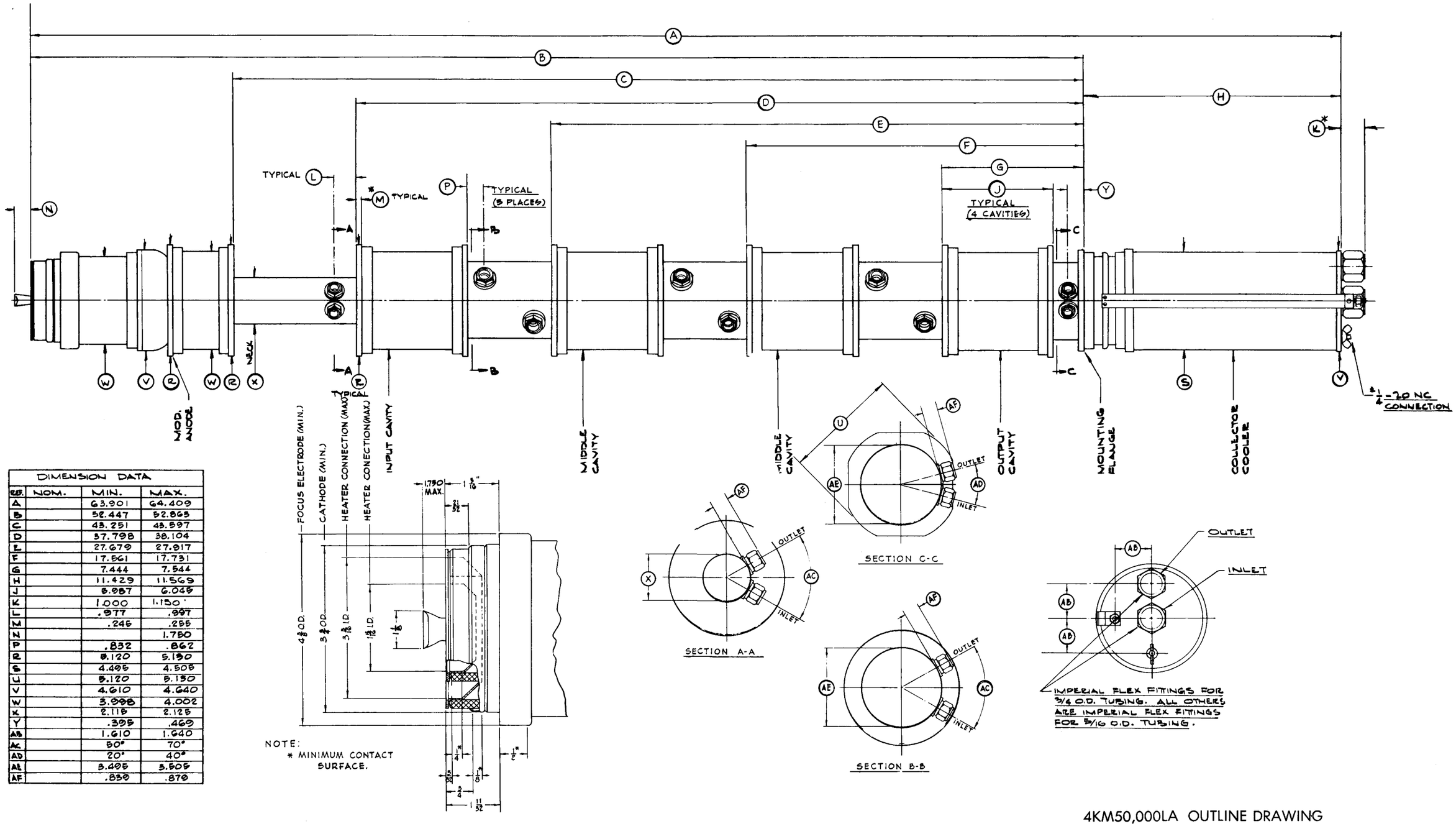
CHARACTERISTICS

ELECTRICAL

Heater:	Voltage	7.5	volts
	Current	40.0	amperes
	Maximum Starting Current	80.0	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter (Operating):			
	Voltage	2.0	volts
	Current	36.0	amperes
Power Gain: (Narrow Band)		50	decibels
Output Power		10	kilowatts
Frequency Range (H-121 Assembly)		400 to 610	megacycles

(Effective 8-15-60) Copywrite, 1960 Eitel-McCullough, Inc.

4KM50,000LA



DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		63.901	64.409
B		52.447	52.865
C		43.251	43.597
D		37.798	38.104
E		27.679	27.817
F		17.561	17.731
G		7.444	7.544
H		11.429	11.569
J		5.957	6.045
K		1.000	1.150
L		.977	.997
M		.246	.255
N			1.750
P		.832	.862
R		5.120	5.190
S		4.495	4.505
U		5.120	5.150
V		4.610	4.640
W		3.998	4.002
X		2.115	2.125
Y		.395	.469
AB		1.610	1.640
AC		50°	70°
AD		20°	40°
AE		5.495	5.505
AF		.850	.870

SECTION A-A

SECTION C-C

SECTION B-B

IMPERIAL FLEX FITINGS FOR 3/4 O.D. TUBING. ALL OTHERS ARE IMPERIAL FLEX FITINGS FOR 5/16 O.D. TUBING.

4KM50,000LA OUTLINE DRAWING

MECHANICAL

Operating Position	Axis vertical, cathode up
R-F Coupling:	
Input	Type "N" coaxial fitting
Output	3 1/8 inch 50 ohm line
Input Cavity Loading	Type "N" coaxial fitting
2nd and 3rd Cavity Loading	1 5/8 inch 50 ohm line
Shipping Weights:	
4KM50, 000LA Klystron Only	64 lbs (Net) 155 lbs (Gross)
H-121 R-F Circuit Assembly	767 lbs (Net) 1084 lbs (Gross)

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode (with SK-110 Air-System Socket)	*25 cfm	1 inch H_2O
Output Cavity	*50 cfm	1.5 inches H_2O
Klystron Body (5 drift-tube sections, in series)	1 gpm	28 psia
Klystron Collector	25 gpm	28 psia

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus-Coil: Voltage	0 to 50	volts
Current	0 to 1.5	amperes
Three Body Coils and Collector Coil in Series:		
Voltage	0 to 500	volts
Current	0 to 2.5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	20	KILOVOLTS
D-C Beam Current	2.5	AMPERES
D-C BODY CURRENT (CONTINUOUS)	100	MILLIAMPERES
D-C BODY CURRENT (TUNING ONLY)	150	MILLIAMPERES
A-C GETTER CURRENT	50	AMPERES
FOCUS ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	50	KILOWATTS

TYPICAL OPERATION, NARROW BAND, CW AMPLIFIER

Frequency	400	610	megacycles
Output Power	13.1	12.0	kilowatts
Driving Power	.050	.050	watts
Power Gain	54	53.8	decibels
D-C Beam Voltage	17	17	kilovolts
D-C Beam Current	1.8	1.8	amperes
Beam Power Efficiency	42.8	39.2	percent
D-C Body Current	90	80	milliamperes
D-C Collector Current	1.71	1.72	amperes
Focus-Electrode Voltage	-201	-211	volts
Magnetic-Coil Currents (H-121 Components):			
Prefocus Coil	1.0	0.97	ampere
Three Body Coils and Collector Coil in Series	2.0	2.0	amperes

* At Sea level with 20° C inlet air temperature.

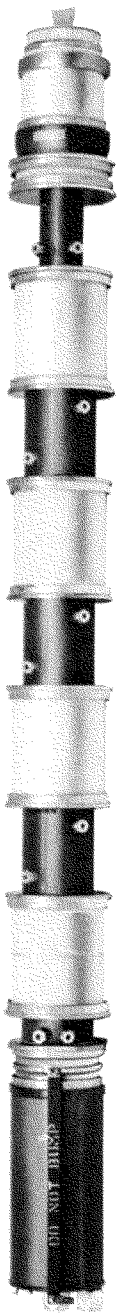
For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Carlos, California. All such requests will be handled confidentially.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4KM50,000LA3

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 4KM50,000LA3 is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies from 400 to 610 megacycles. It is suitable for use in UHF television visual service and may also be used for FM, for aural TV, or for tropospheric-scatter communications service.

When adjusted for narrow-band CW operation this klystron will deliver a minimum output power of 10 kilowatts with a power gain of 50 decibels. In television visual service it will provide more than 10 kilowatts of peak synchronizing power with a power gain of 30 decibels. The random AM noise is more than 50 decibels below black level.

The 4KM50,000LA3 employs the Eimac Modulating Anode which provides an effective means of protecting the tube from internal arcs when connected to the beam supply through a resistor.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design affords a wide tuning range and permits external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-143 has been designed for use with the 4KM50,000LA3 to cover the specific frequency range. This assembly includes a klystron supporting structure, magnetic focusing coils, tuning cavities, adjustable load couplers for the second, third and output cavities and an Eimac SK-110 Air System Socket.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage	7.5	volts
	Current	40.0	amperes
	Maximum Starting Current	80.0	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter (Operating):			
	Voltage	2.0	volts
	Current	36.0	amperes
Power Gain: (Narrow Band)		50	decibels
Output Power		10	kilowatts
Frequency Range (H-143 Assembly)		400 to 610	megacycles

MECHANICAL

Operating Position	Axis vertical, cathode up
R-F Coupling:	
Input	Type "N" coaxial fitting
Output	3 1/8 inch, 50-ohm line
Input Cavity Loading	Type "N" coaxial fitting
2nd and 3rd Cavity Loading	1 5/8 inch, 50-ohm line

(Effective 10-20-61) Copyright 1961 by Eitel-McCullough, Inc. Printed in U.S.A.

MECHANICAL (cont'd)

Weights:

4KM50,000LA3 Klystron only	64 lbs (Net)
	155 lbs (Gross)
H-143 RF Circuit Assembly	767 lbs (Net)
	1084 lbs (Gross)

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode (with SK-110 Air-System Socket)	*25 cfm	1 inch H_2O
Output Cavity	*50 cfm	1.5 inches H_2O
Klystron Body (5 drift-tube sections, in series)	1 gpm	28 psi
Klystron Collector	25 gpm	28 psi

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus-Coil:	Voltage	0 to 50	volts
	Current	0 to 1.5	amperes
Three Body Coils and Collector Coil in Series:			
	Voltage	0 to 500	volts
	Current	0 to 2.5	amperes

MAXIMUM RATINGS

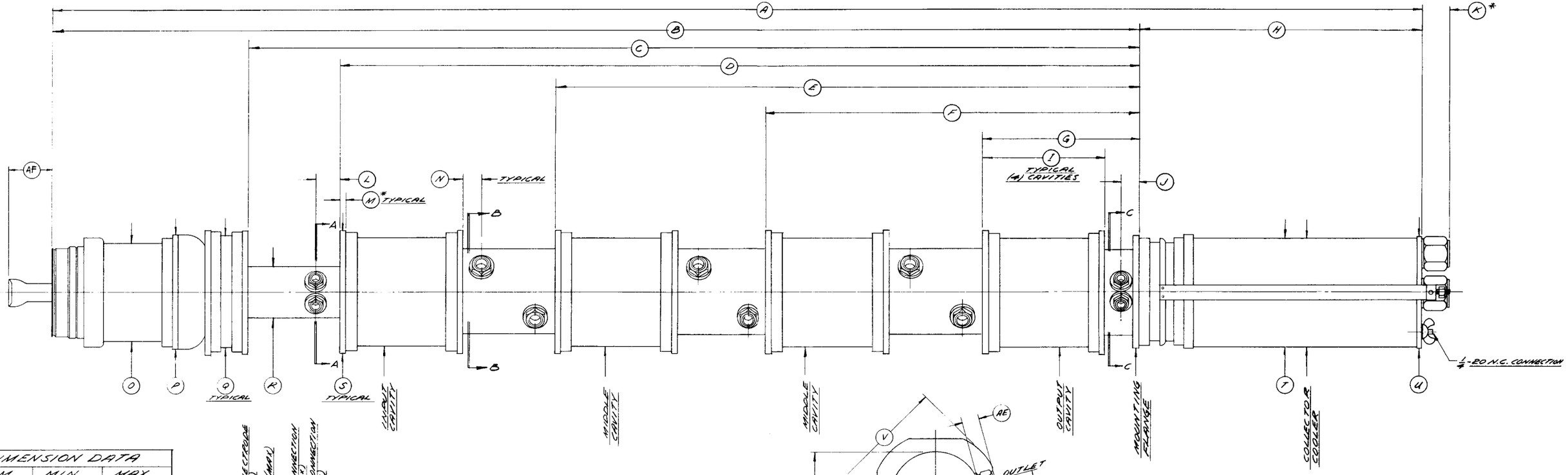
D-C BEAM VOLTAGE	20	KILOVOLTS
D-C BEAM CURRENT	2.5	AMPERES
D-C BODY CURRENT (CONTINUOUS)	100	MILLIAMPERES
D-C BODY CURRENT (TUNING ONLY)	150	MILLIAMPERES
A-C GETTER CURRENT	50	AMPERES
FOCUS-ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	50	KILOWATTS
INLET WATER PRESSURE	50	PSI

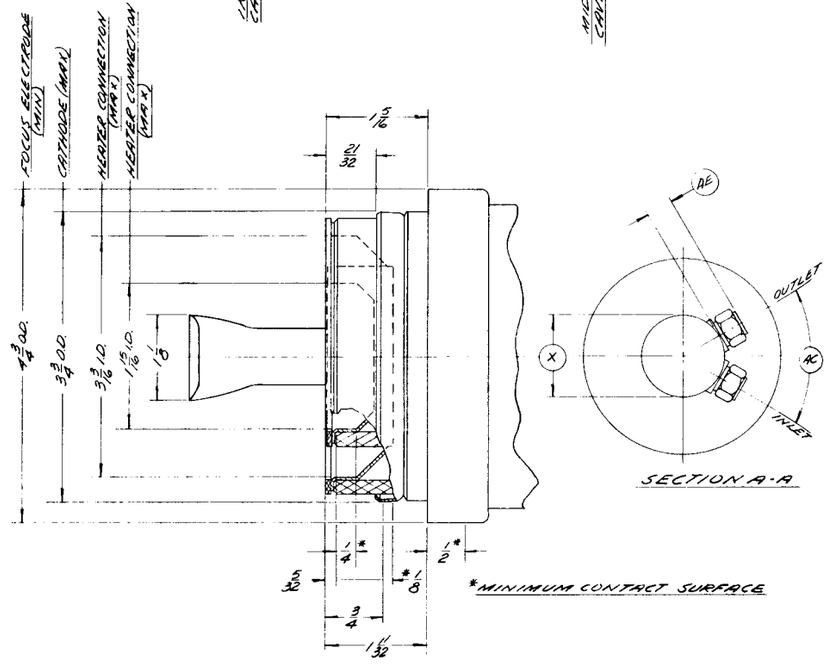
TYPICAL OPERATION, NARROW BAND, CW AMPLIFIER

Frequency	400	610	megacycles
Output Power	13.1	12.0	kilowatts
Driving Power	.050	.050	watt
Power Gain	54	53.8	decibels
D-C Beam Voltage	17	17	kilovolts
D-C Beam Current	1.8	1.8	amperes
Beam Power Efficiency	42.8	39.2	percent
D-C Body Current	90	80	milliamperes
D-C Collector Current	1.71	1.72	amperes
Focus-Electrode Voltage	-201	-211	volts
Magnetic-Coil Currents (H-143 Components):			
Prefocus Coil	1.0	0.97	ampere
Three Body Coils and Collector Coil in Series	2.0	2.0	amperes

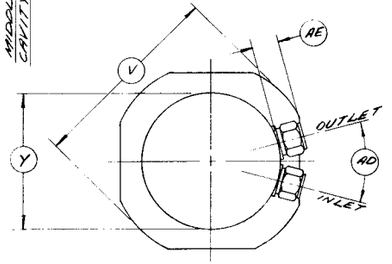
* At Sea level with 20° C inlet air temperature.

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California

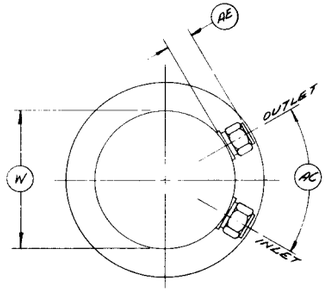




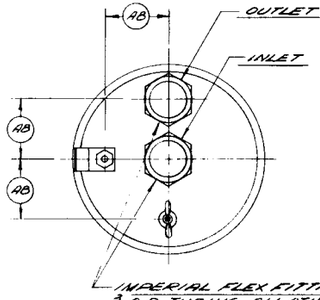
SECTION A-A



SECTION C-C



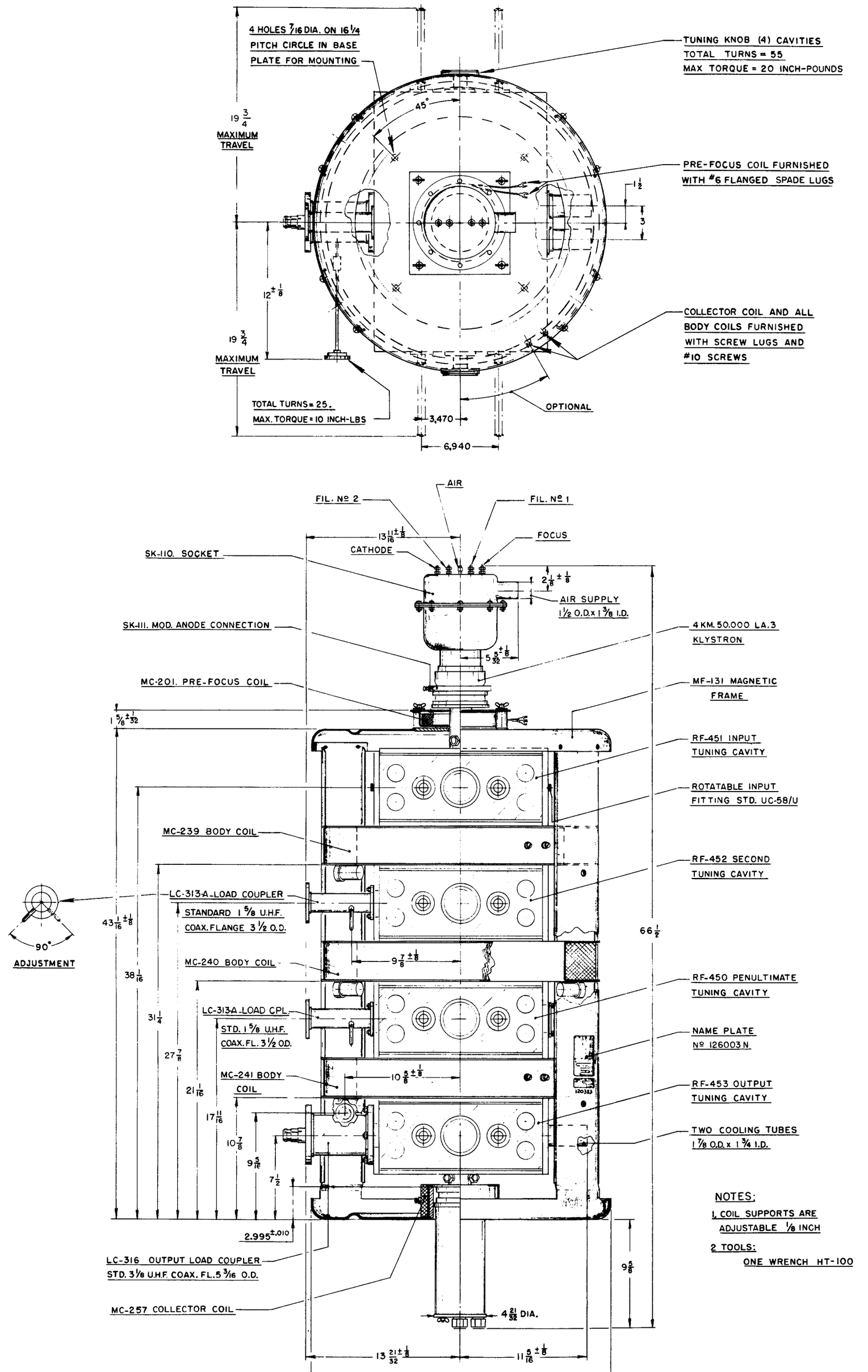
SECTION B-B



IMPERIAL FLEX FITTINGS FOR 3/4 O.D. TUBING. ALL OTHERS ARE IMPERIAL FLEX FITTINGS FOR 5/8 O.D.

DIMENSION DATA			
NO	NOM.	MIN.	MAX.
A		61.125.	61.635.
B		49.695	50.065.
C		41.788	42.038.
D		37.990.	38.210
E		27.824	27.984
F		17.652	17.762
G		7.485	7.535.
H		11.429	11.569
I		5.995.	6.025
J		.335	.469
K		1.000	1.150
L		.977	.977
M		.245	.255
N		.832	.862
O		3.998	4.002
P		4.615	4.645
Q		4.498	4.502
R		2.115	2.125
S		5.120	5.130
T		4.445	4.505
U		4.610	4.640
V		5.120	5.130
W		3.495	3.505
X		2.115	2.125
Y		3.495	3.505
AB		1.610	1.640
AC		50°	70°
AD		20°	40°
AE		.833	.379
AF			1.750

4KM50,000LA3 KLYSTRON



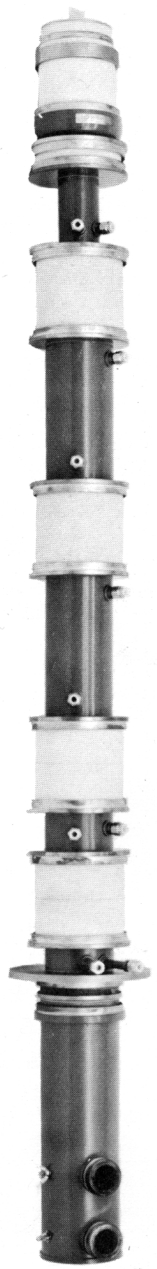
H-143 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4KM50,000LF

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 4KM50,000LF is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies from 610 to 790 megacycles. Although intended primarily for UHF television visual service this klystron may also be used for FM, for aural TV, or for tropospheric-scatter communications service.

When tuned for narrow band CW operation this klystron will deliver a minimum output power of 10 kilowatts with a power gain of 45 db. In television visual service it will provide more than 10 kilowatts of peak synchronizing output power with a power gain of 30 db. The AM random noise is more than 50 db below black level. Minimum bandwidth at the 3 db power level is 8 megacycles with a minimum of 7 megacycles at the 1 db level.

The 4KM50,000LF employs the Eimac Modulating Anode which provides an effective means of protecting the tube from internal arcs.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design permits a wide tuning range and allows external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-139 has been designed for use with the 4KM50,000LF to cover the specified frequency range. This assembly includes a klystron supporting structure, magnetic focusing coils, tuning cavities, adjustable load couplers for the second, third and output cavities and an Eimac SK-110 Air System Socket.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage	7.5	volts
	Current	40.0	amperes
	Maximum Starting Current	80.0	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter (Operating):			
	Voltage	2.0	volts
	Current	36.0	amperes
Power Gain:	Narrow Band	45	decibels
	Television Visual Service	30	decibels
Output Power:	Television Visual Service	10	kilowatts
Frequency Range (H-139 Assembly)		610 to 790	megacycles

MECHANICAL

Operating Position	Axis vertical, cathode up
R-F Coupling:	
Input	Type "N" coaxial fitting
Output	3 1/8 inch, 50-ohm line
Input Cavity Loading	Type "N" coaxial fitting
2nd and 3rd Cavity Loading	1 5/8 inch, 50-ohm line

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MECHANICAL (cont'd)

Shipping Weights:

4KM50,000LF Klystron only	64	pounds
H-139 RF Circuit Assembly	767	pounds

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode (with SK-110 Air System Socket)	*25 cfm	1 inch H_2O
Output Cavity	*50 cfm	1.5 inches H_2O
Klystron Body (5 drift-tube sections, in series)	1 gpm	28 psi
Klystron Collector	(See collector cooling curves)	

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil: Voltage	0 to 50	volts
Current	0 to 1.5	amperes
Three Body Coils and Collector Coil in Series:		
Voltage	0 to 500	volts
Current	0 to 2.5	amperes

MAXIMUM RATINGS

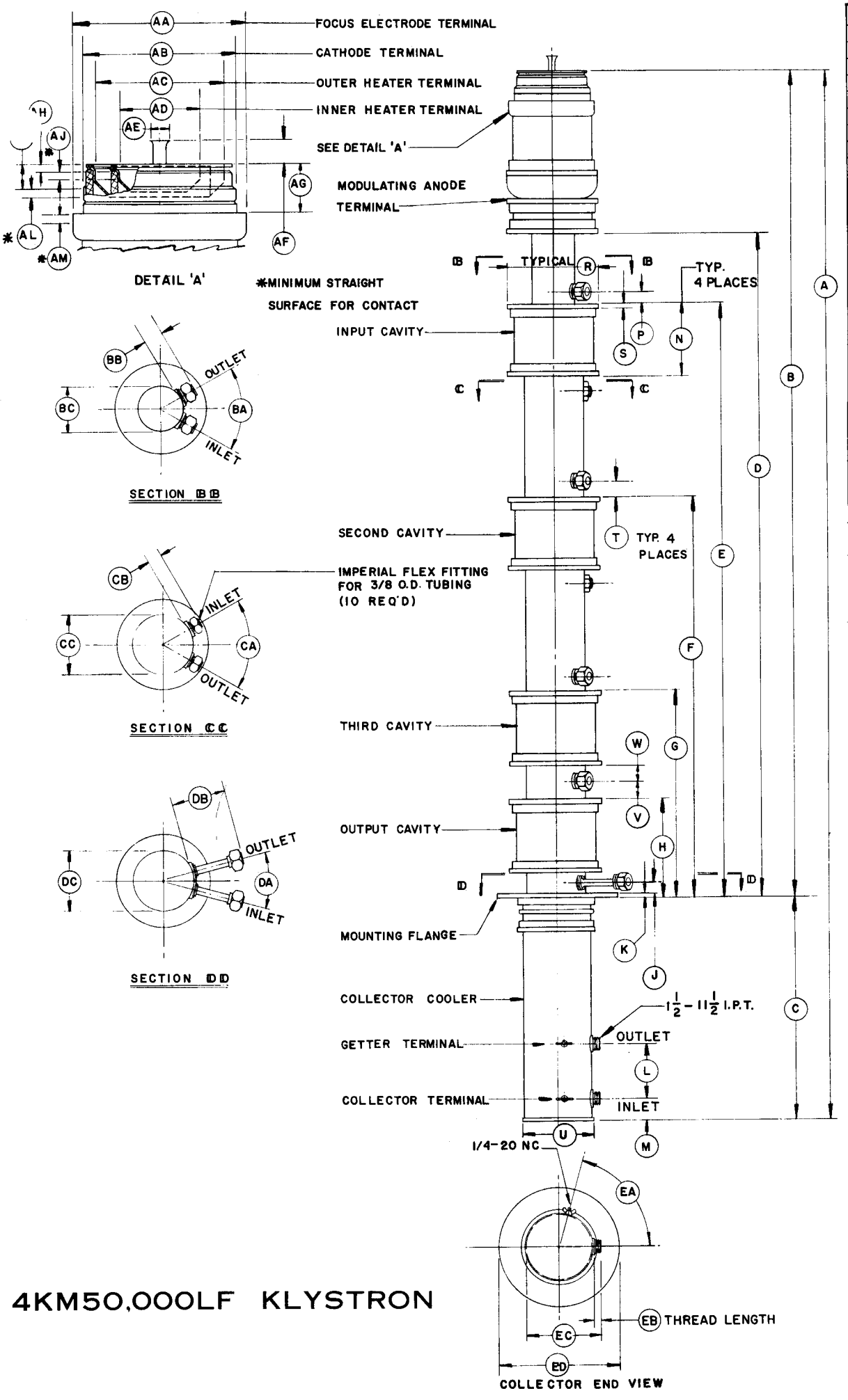
D-C BEAM VOLTAGE	20	KILOVOLTS
D-C BEAM CURRENT	2.5	AMPERES
D-C BODY CURRENT	150	MILLIAMPERES
A-C GETTER CURRENT	50	AMPERES
FOCUS-ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	60	KILOWATTS
INLET WATER PRESSURE	50	PSI

TYPICAL OPERATION

	TV Visual Service	Narrow Band	
Frequency	610	735	megacycles
Output Power	12.6	15.6	kilowatts
Driving Power	10	0.30	watts
Power Gain	30.3	47.2	decibels
D-C Beam Voltage	18	18	kilovolts
D-C Beam Current	2.03	2.03	amperes
Beam Power Efficiency	34.5	43	percent
D-C Body Current	75	45	milliamperes
Focus-Electrode Voltage	-200	-200	volts
Cavity Loading:			
1st Cavity	0.47	--	watts
2nd Cavity	116	--	watts
3rd Cavity	390	--	watts
Magnetic-Coil Currents:			
Prefocus Coil	1.15	1.15	amperes
Three Body Coils and Collector Coil in Series	2.3	2.3	amperes

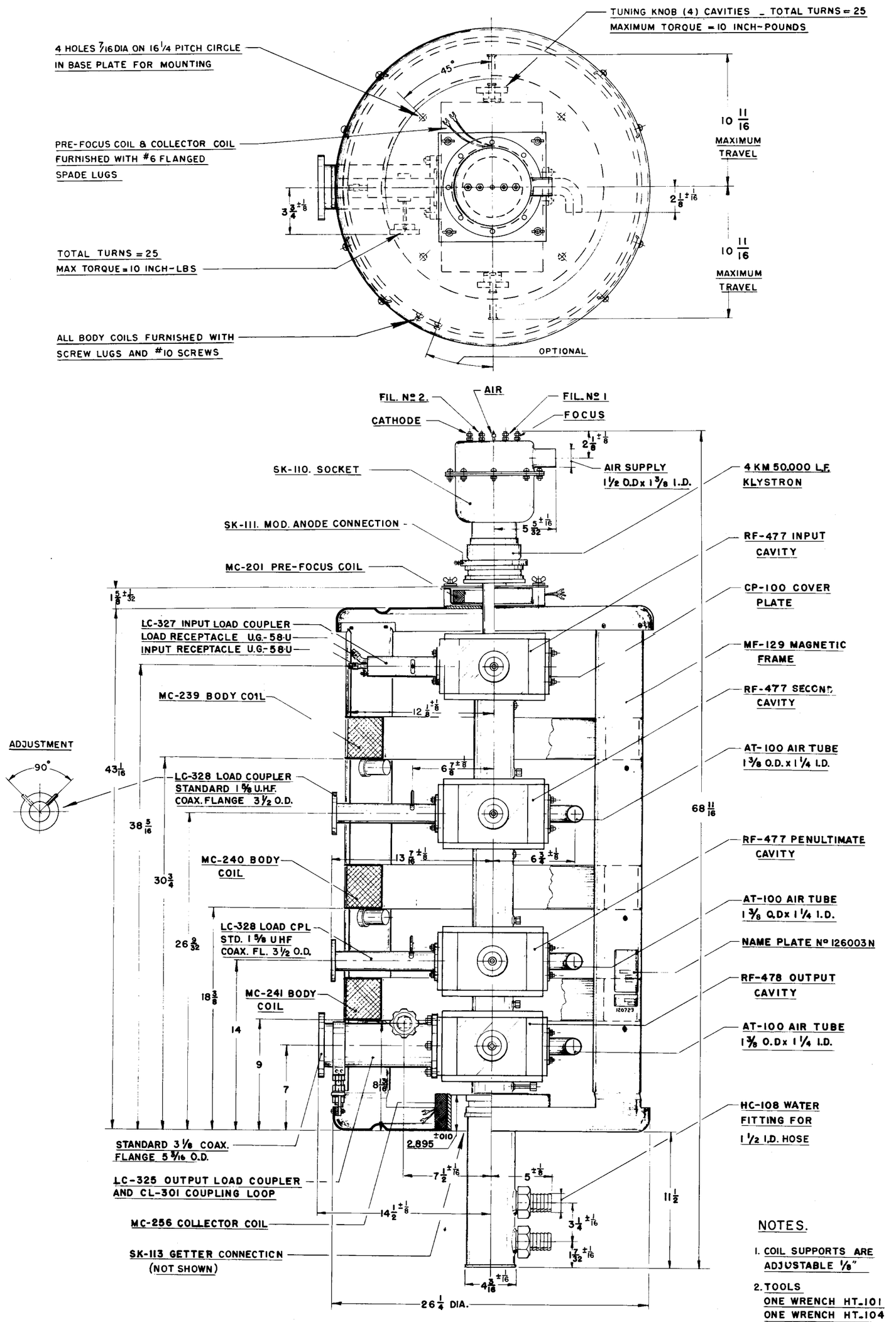
* At sea level with 20° C inlet air temperature.

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.



ITEM	DIMENSION DATA NOM.	MIN.	MAX.
A		63.700	65.200
B		49.600	50.300
C		14.250	14.750
D		41.600	42.100
E		37.800	38.325
F		25.600	26.000
G		13.400	13.700
H		6.490	6.650
J		0.400	0.500
K		0.335	0.365
L		3.200	3.300
M		1.100	1.300
N		4.950	5.040
P		0.840	1.100
R		5.105	5.145
S		0.230	0.270
T		0.840	
U		4.165	4.215
V		0.840	
W		0.840	
AA		4.300 DIA.	4.450 DIA.
AB		3.750 "	3.835 "
AC		3.100 "	3.200 "
AD		1.865 "	1.950 "
AE			1.188
AF			1.750
AG		1.000	1.500
AH		.125	.175
AJ		.100	
AK		.670	.775
AL		.100	
AM		.500	
BA		55°	65°
BB		0.800	1.000
BC		2.100	2.140
CA		55°	65°
CB		0.800	1.000
CC		3.480	3.520
DA		25°	35°
DB		2.430	2.630
DC		3.480	3.520
EA		75°	85°
EB		0.600	
EC		4.875	5.125
ED		7.140	7.165

4KM50,000LF KLYSTRON

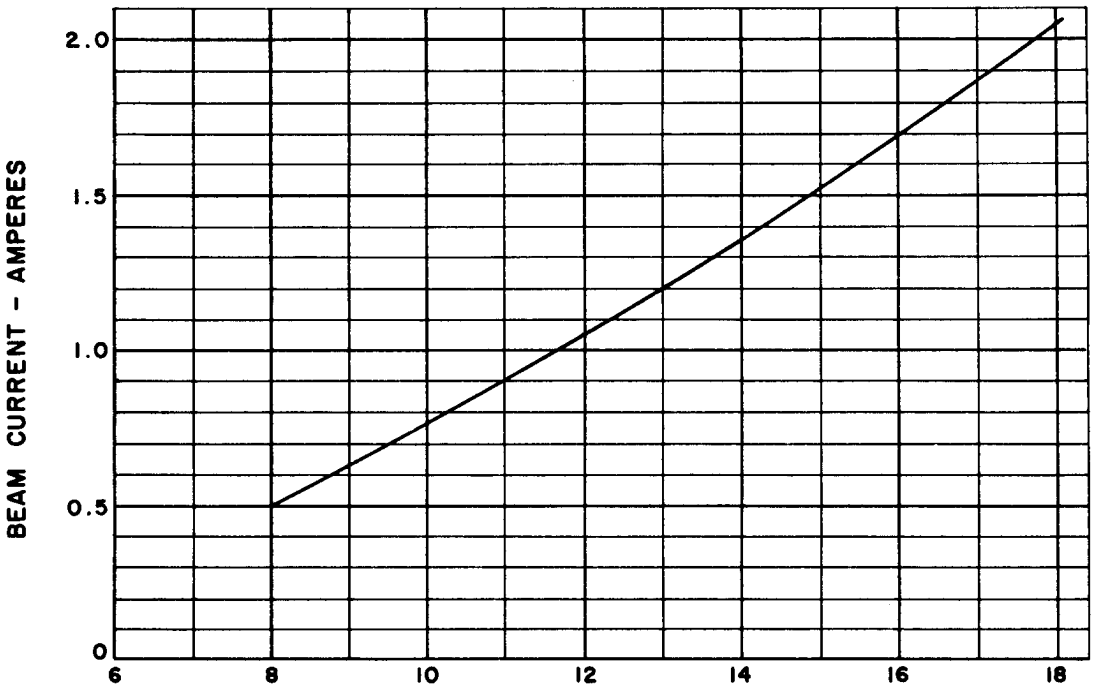


H-139 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

EIMAC 4KM50,000LF

BEAM VOLTAGE vs BEAM CURRENT

E_{foc} = -200 VOLTS



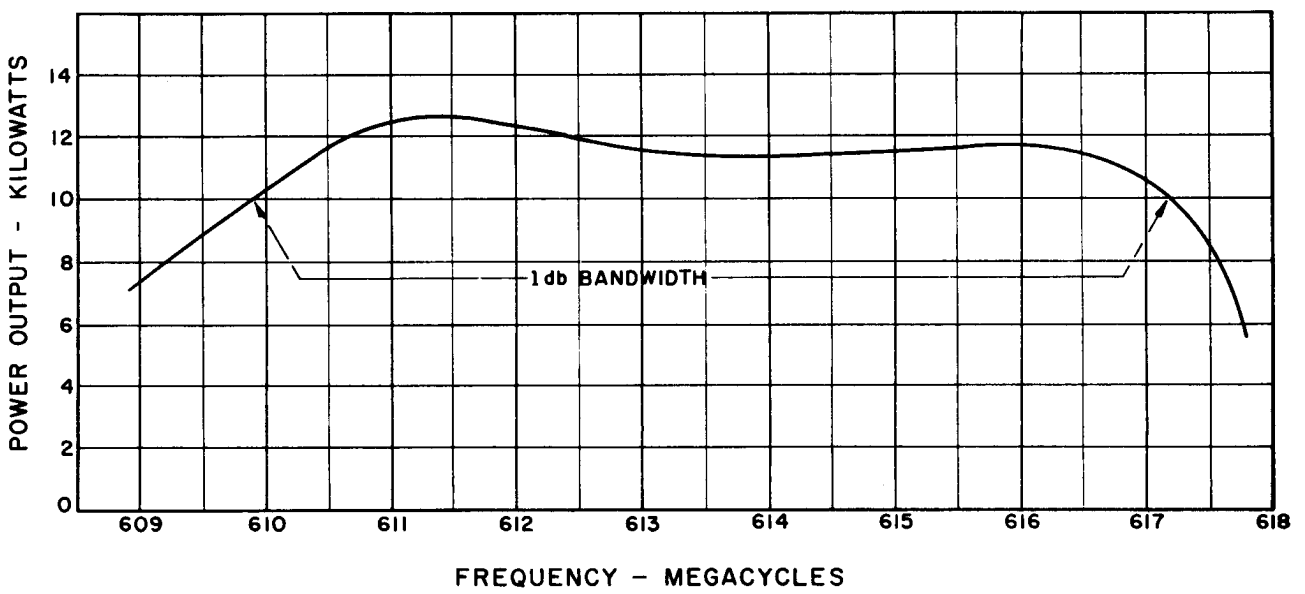
EIMAC 4KM50,000LF

BANDWIDTH DATA

E_b = 18 KILOVOLTS

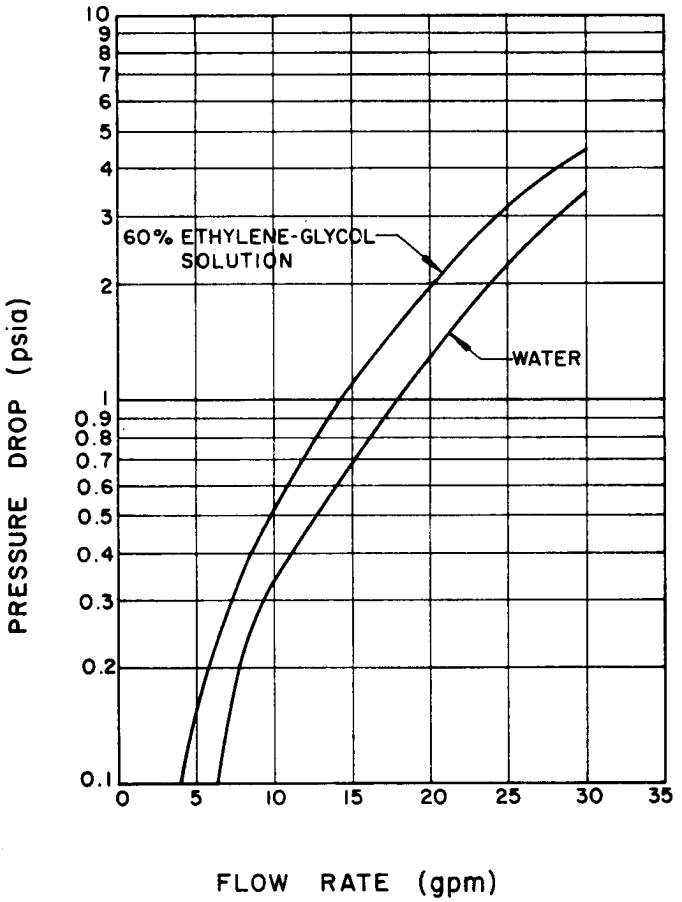
I_b = 2.03 AMPERES

P_D = 10 WATTS



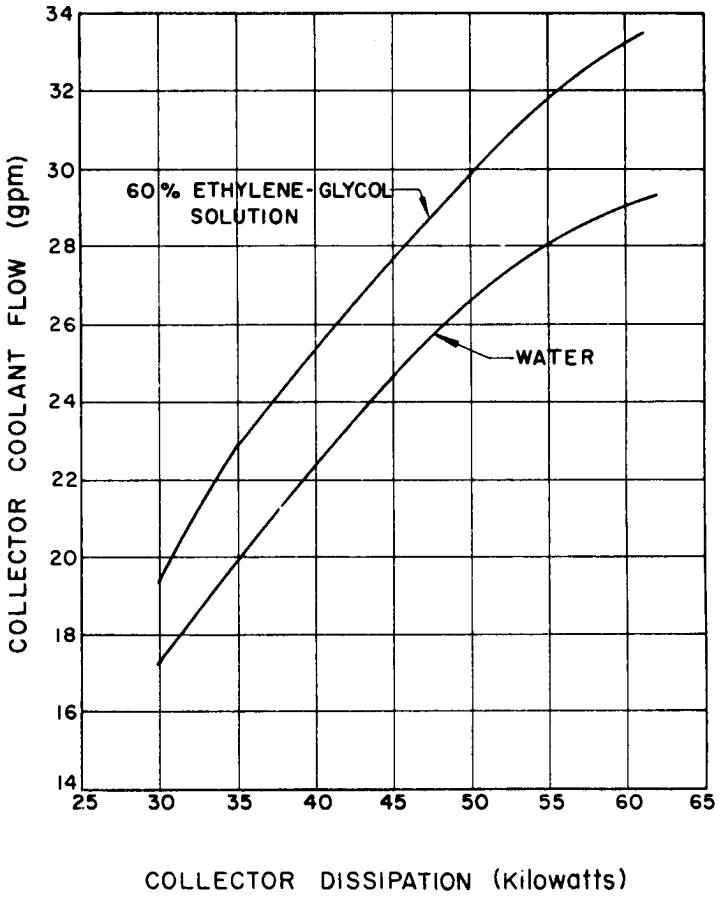
EIMAC 4KM50,000LF

PRESSURE DROP vs COOLANT FLOW RATE
ACROSS COLLECTOR



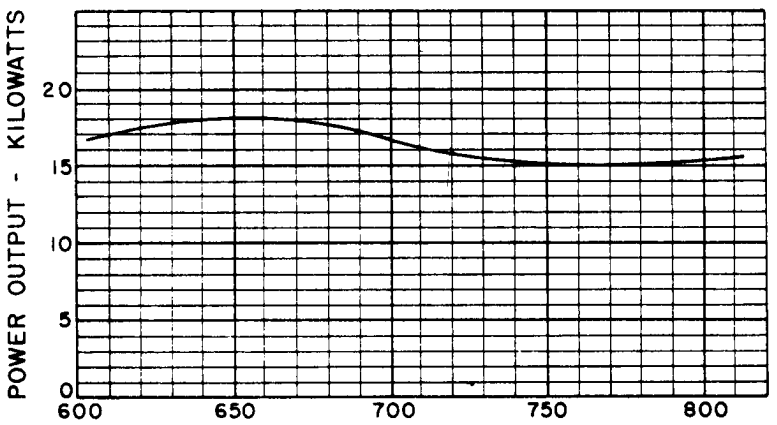
EIMAC 4KM50,000LF

COLLECTOR DISSIPATION vs COOLANT FLOW
COOLANT INLET TEMPERATURE 25°C



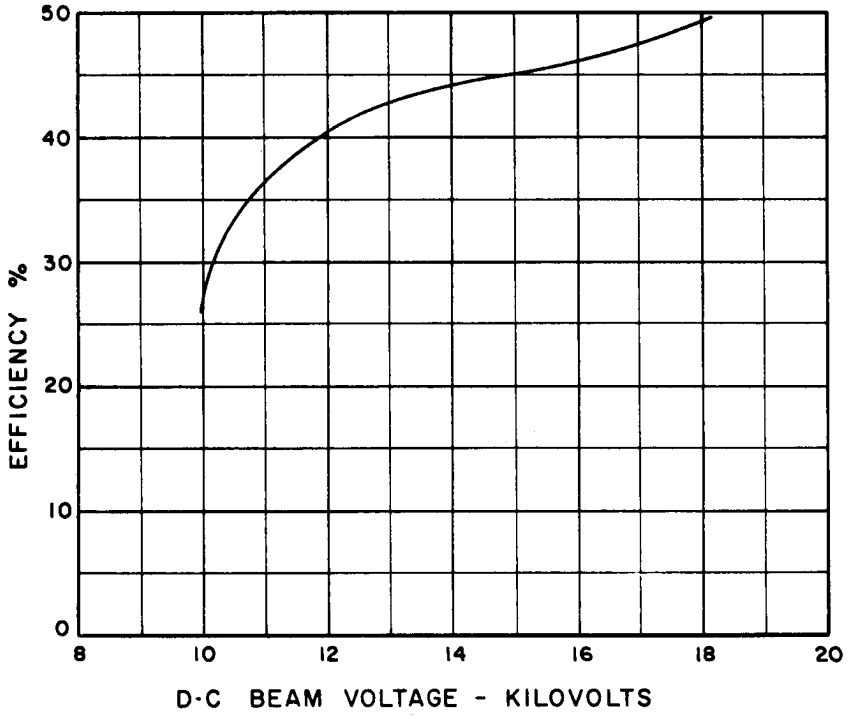
EIMAC 4KM50,000LF

POWER OUTPUT vs FREQUENCY
NARROW BAND
I_b = 2.03 AMPERES
P_d = 0.3 WATTS
E_{foc} = -200 VOLTS
E_b = 18 KILOVOLTS



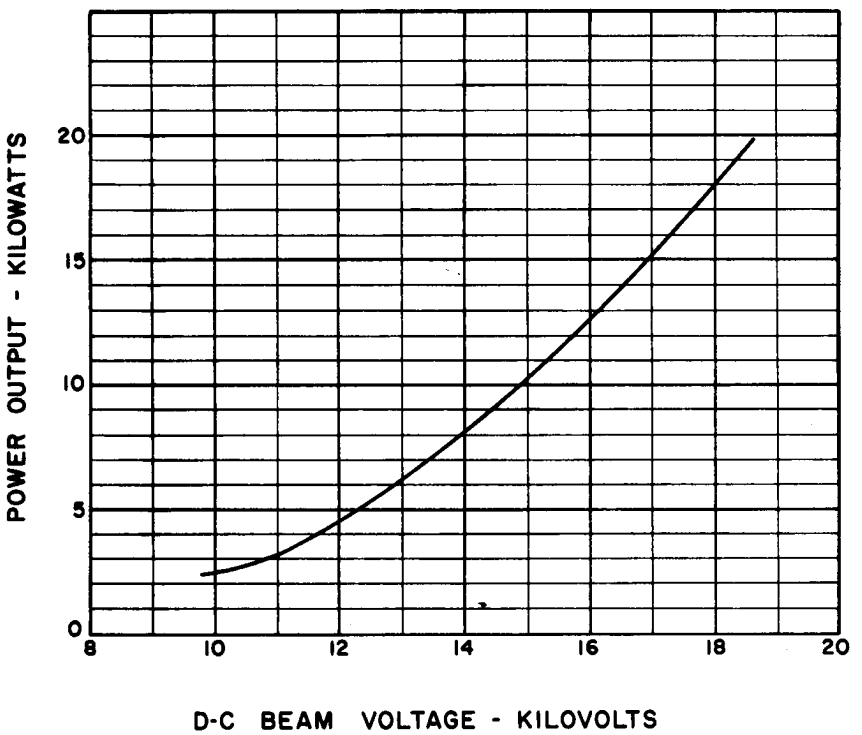
EIMAC 4KM50,000LF

EFFICIENCY vs BEAM VOLTAGE
NARROW BAND
FREQUENCY = 700 MEGACYCLES



EIMAC 4KM50,000LF

POWER OUTPUT vs BEAM VOLTAGE
NARROW BAND
FREQUENCY = 700 MEGACYCLES

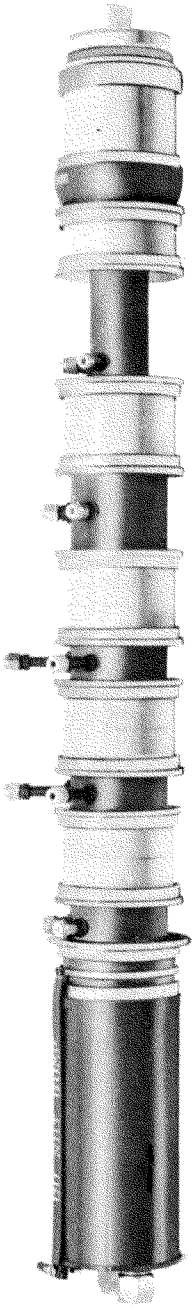


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

4KM50,000LR

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 4KM50,000LR is a four-cavity, magnetically focused, power-amplifier klystron designed for use at frequencies between 755 and 985 megacycles. This klystron will deliver a narrow-band CW output power of 10 kilowatts with a minimum power gain of 50 decibels. When adjusted for wide-band operation the 4KM50,000LR will deliver an output power of 10 kilowatts with a half-power bandwidth of 7 megacycles and a power gain of 30 decibels.

This klystron employs the Eimac Modulating Anode which provides an effective means for protecting the tube against internal arcs when connected to the beam supply through a resistor.

All tuning is accomplished outside of the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design affords a wide tuning range and permits external cavity loading for broadband applications. For spares or replacements, only the basic vacuum tube, without cavities, need be purchased.

Eimac Klystron Amplifier Circuit Assembly H-141 has been designed for use with the 4KM50,000LR to cover the specified frequency range. This assembly includes a klystron supporting structure, magnetic focusing coils, tuning cavities, adjustable load couplers for each cavity, and an Eimac SK-110 Air-System Socket.

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage	7.5	volts
	Current	40.0	amperes
	Maximum Starting Current	80.0	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter	(Operating) :		
	Voltage	2.0	volts
	Current	36.0	amperes
Power Gain: (Narrow Band)		50	decibels
Output Power		10	kilowatts
Frequency Range (H-141 Assembly)		755 to 985	megacycles

MECHANICAL

Operating Position	Axis vertical, cathode up
RF Coupling:	
Input	Type "N" coaxial fitting
Output	3 1/8 inch, 50-ohm line
Input Cavity Loading	Type "N" coaxial fitting
2nd and 3rd Cavity Loading	Type "N" coaxial fitting

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MECHANICAL (cont'd)

Weights:

4KM50,000LR Klystron only	55 lbs (Net), 140 lbs (Gross)
H-141 RF Circuit Assembly	349 lbs (Net), 601 lbs (Gross)

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode (with SK-110 Air-System Socket)	*25 cfm	1 inch H_2O
Output Cavity	*50 cfm	1.5 inches H_2O
Klystron Body (5 drift-tube sections in series)	1 gpm	28 psi
Klystron Collector	25 gpm	28 psi

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil:	Voltage	0 to 25	volts
	Current	0 to 1.25	amperes
Three Body Coils and Collector Coil in Series:			
	Voltage	0 to 400	volts
	Current	0 to 4.0	amperes

MAXIMUM RATINGS

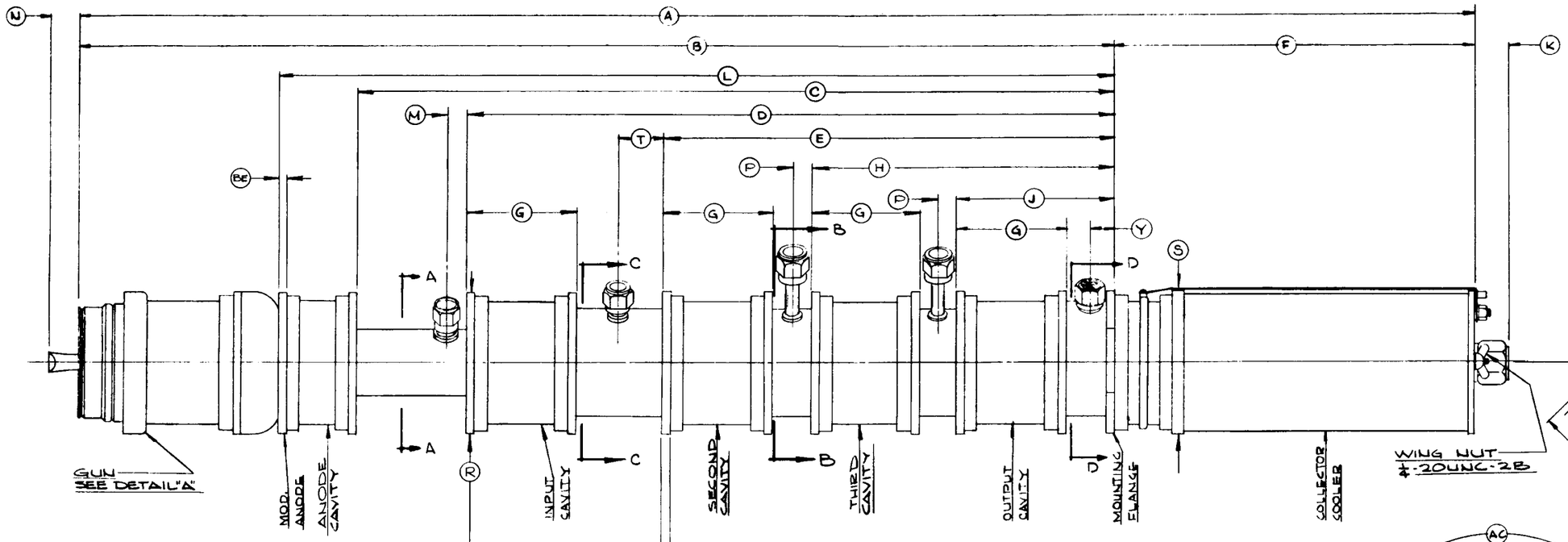
D-C BEAM VOLTAGE	20	KILOVOLTS
D-C BEAM CURRENT	2.5	AMPERES
D-C BODY CURRENT (CONTINUOUS)	100	MILLIAMPERES
D-C BODY CURRENT (TUNING ONLY)	150	MILLIAMPERES
A-C GETTER CURRENT	50	AMPERES
FOCUS-ELECTRODE VOLTAGE	-500	VOLTS
COLLECTOR DISSIPATION	50	KILOWATTS
INLET WATER PRESSURE	50	PSI

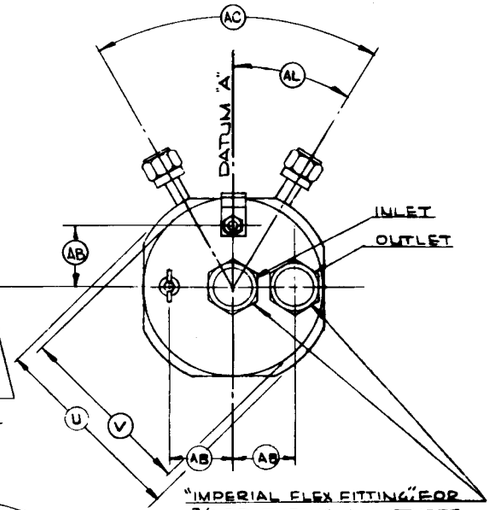
TYPICAL OPERATION

	Narrow Band		Wide Band	
Frequency	755	985	762	megacycles
Output Power	12.1	11.5	10	kilowatts
Driving Power	0.05	0.05	10	watts
Power Gain	53.8	53.6	30	decibels
D-C Beam Voltage	17	17	17	kilovolts
D-C Beam Current	1.76	1.76	1.9	amperes
Beam Power Efficiency	45.7	43.7	31	percent
D-C Body Current	30	40	90	milliamperes
Focus-Electrode Voltage	-245	-245	-175	volts
Half Power Bandwidth	- -	- -	7	megacycles
Cavity Loading:				
1st Cavity	- -	- -	8	watts
2nd Cavity	- -	- -	70	watts
3rd Cavity	- -	- -	400	watts
Magnetic-Coil Currents:				
Prefocus Coil	1.06	1.03	1.1	amperes
Three Body Coils and Collector Coil in Series	3.0	3.0	3.0	amperes

* At sea level with 20° C inlet air temperature.

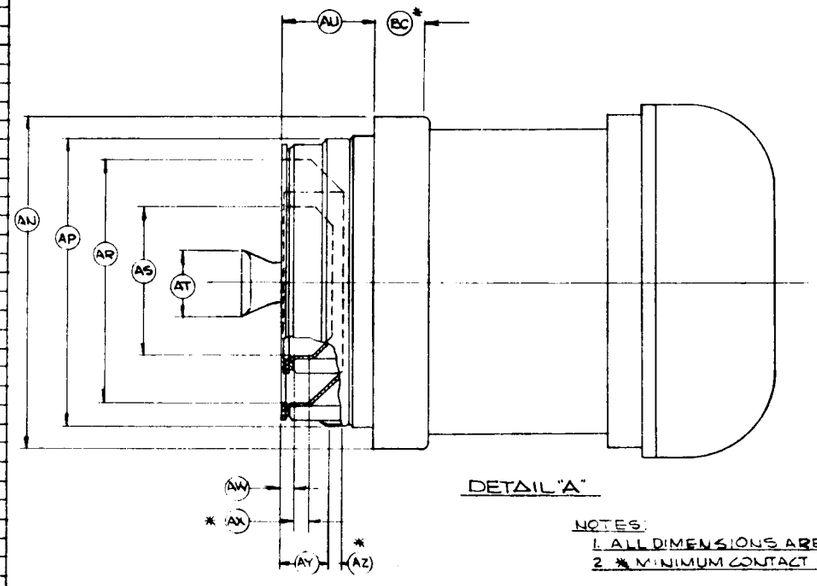
For additional information or information regarding a specific application write to Eitel-McCullough, Inc., San Carlos, California.

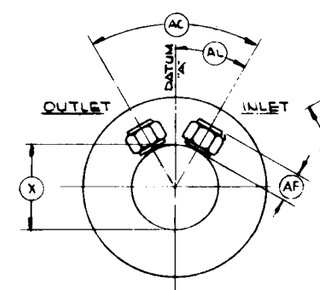


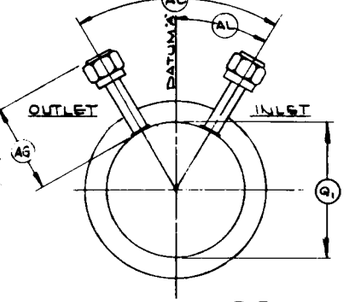


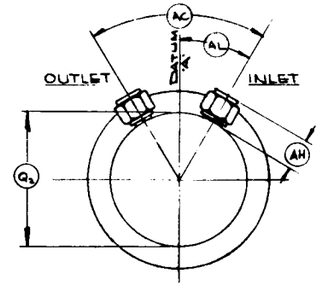
"IMPERIAL FLEX FITTING" FOR 3/4 O.D. TUBING, ALL OTHERS ARE "IMPERIAL FLEX FITTING" FOR 5/16 O.D. TUBING.

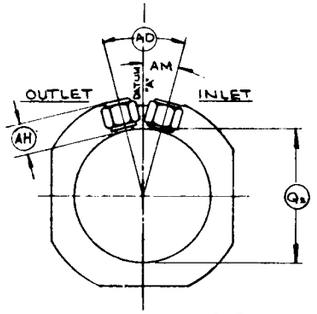
DIMENSIONAL DATA							
NO	NOM	MIN.	MAX.	AS		1.865	1.950
A	44.640			AT			1.190
B	33.127			AU		1.000	1.500
C	24.392			AV			
D	20.662			AW		.125	.175
E	14.388			AX		.100	
F	11.818			AY		.670	.775
G	3.504			AZ		.100	
H	9.696			BA			
J	5.004			BC		.100	
K	1.062			BD			
L	26.875			BE	0.250		
M	.562						
N			1.750				
P	.593						
Q	3.500						
R	4.625	4.610	4.640				
S	4.720						
T	1.375						
U	3.122						
V	4.625						
W							
X	2.180						
Y	0.696						
AB	1 5/8						
AC	60°						
AD	30°						
AE							
AF	.850						
AG	2.250						
AH	0.850						
AJ							
AK							
AL	30°						
AM	15°						
AN		4.300	4.450				
AP		3.750	3.835				
AQ							
AR		3.100	3.200				





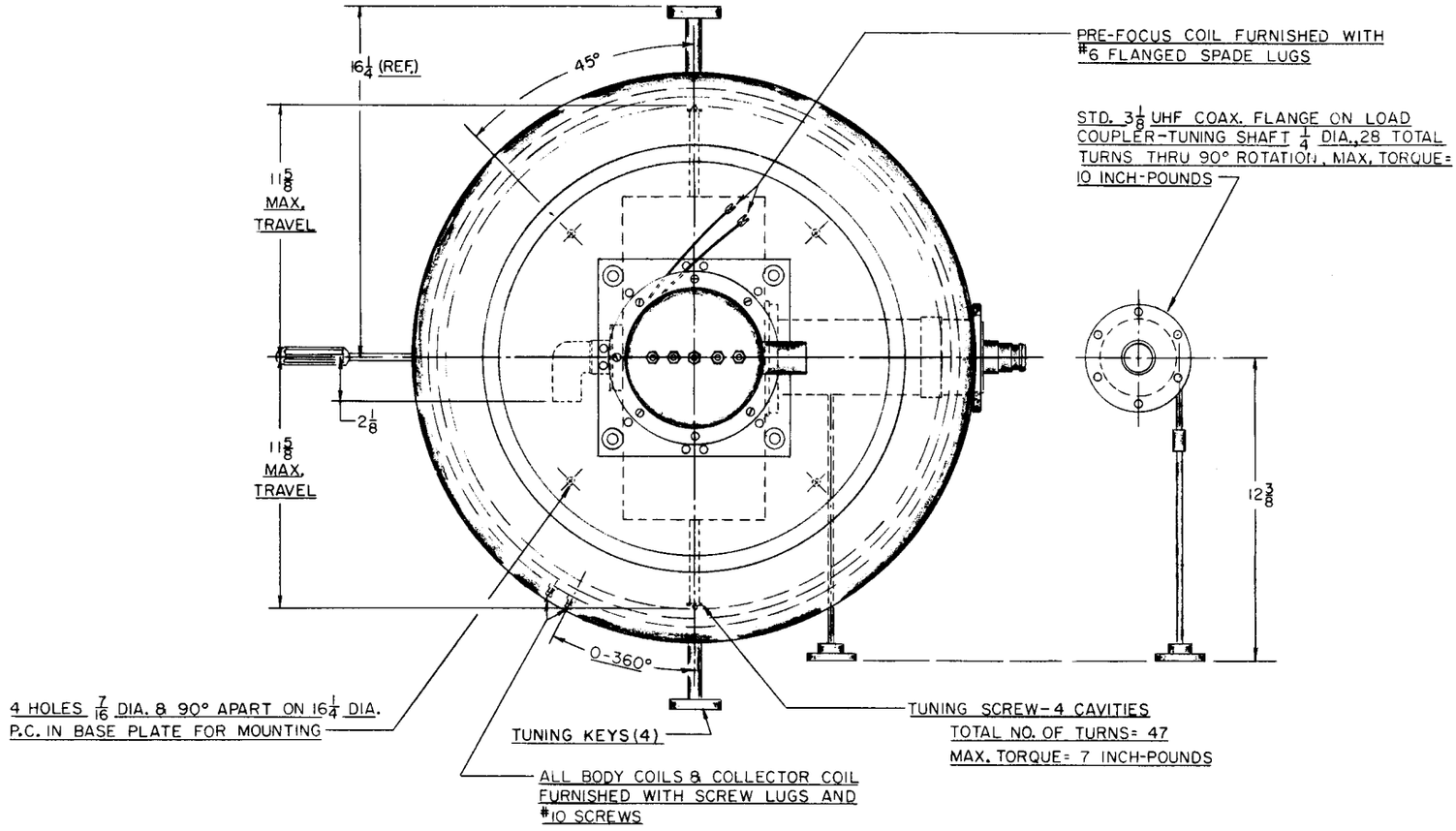


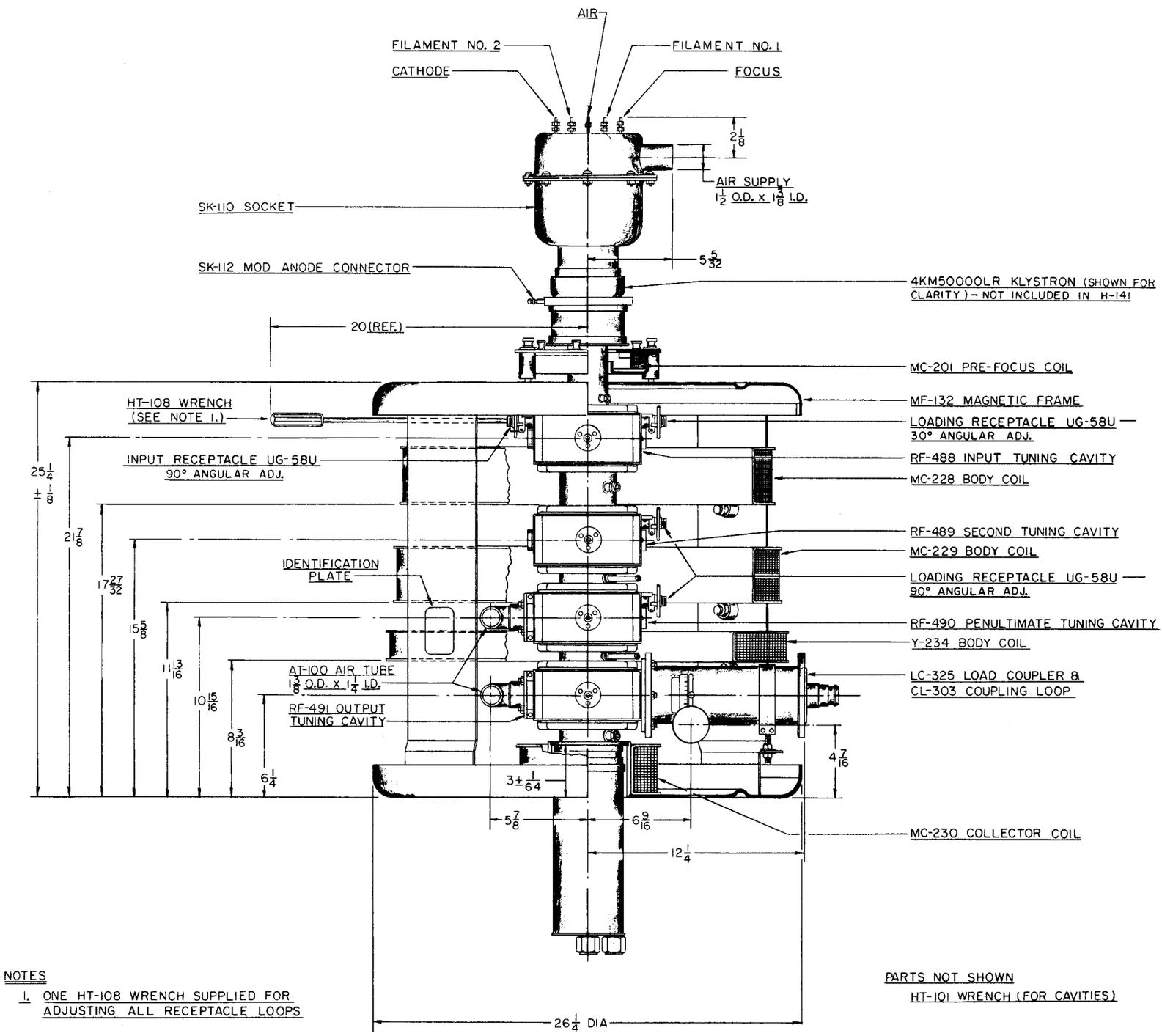




NOTES:
1. ALL DIMENSIONS ARE IN INCHES
2. * MINIMUM CONTACT SURFACE

4KM50,000LR KLYSTRON





NOTES

1. ONE HT-108 WRENCH SUPPLIED FOR ADJUSTING ALL RECEPTACLE LOOPS

PARTS NOT SHOWN

HT-101 WRENCH (FOR CAVITIES)

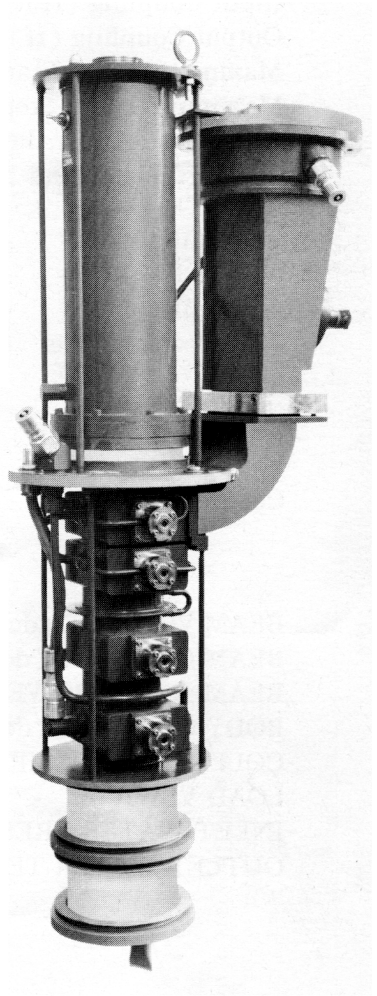
H-141 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

4KM50SJ

POWER AMPLIFIER KLYSTRON

12 kW
1.7 - 2.4 Gc



The 4KM50SJ is a four-cavity, power amplifier klystron intended primarily for use in tropospheric scatter communications systems. When tuned for maximum efficiency, it produces a minimum output power of 12 kilowatts, at frequencies from 1.7 to 2.4 gigacycles, with a minimum gain of 40 decibels.

The electron gun of this klystron has a confined flow configuration which minimizes focusing adjustments and produces a stable beam. The current of the focusing electromagnet can be varied over a wide range without appreciably affecting rf output or body current. Only one electromagnet power supply is required. Cathode current loading is less than 200 milliamperes per square centimeter. This light cathode loading contributes to long life.

Both input and output couplings of the 4KM50SJ are fixed. The only adjustments required are therefore the tuning of the four integral cavities. The output window is a thick beryllium oxide disc which is protected by a photo-cell arc detector.

The 4KM50SJ incorporates a built-in vacuum pump in the form of a titanium getter which should be energized whenever heater power is applied. Effective protection against internal arcs is provided by the Eimac Modulating Anode.

A focusing electromagnet and klystron supporting structure, Catalog Number H-158, has been designed for use with the 4KM50SJ.

Eimac Water Load WL-202 is recommended for use with the 4KM50SJ.

CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential	
Heating time	5 minutes
Heater: Voltage (±5%)	7.5 volts
Current	12 amperes
Getter: Voltage	4 volts ac
Amperes	24 amperes ac
Power Gain	40 decibels
Output Power	12 kilowatts
Frequency Range	1.7-2.4 gigacycles
Phase sensitivity to beam voltage	0.058 degrees/volt

(Effective 10-5-64) Copyright 1964 by Eitel-McCullough, Inc.

MECHANICAL

Maximum Dimensions (4KM50SJ and H-158 Electromagnet)	
Length	33 inches
Diameter	18 inches
Weight (4KM50SJ)	90 pounds
Weight (H-158 Electromagnet)	170 pounds
Input Coupling (rf)	Type N Coaxial
Output Coupling (rf)	UG435A/U Flange
Maximum Tuner Start Torque	70 in-oz
Maximum Tuner Stop Torque	30 in-lbs
Mounting Position Preferred	vertical, cathode down

Cooling: Water and Forced Air

	Flow Rate	*Pressure Drop*
Cathode	20 cfm	free
Body	1.2 gpm	50 psi
Collector	18 gpm	30 psi
Electromagnet	1.5 gpm	15 psi

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage	150 volts
Current	15 amperes

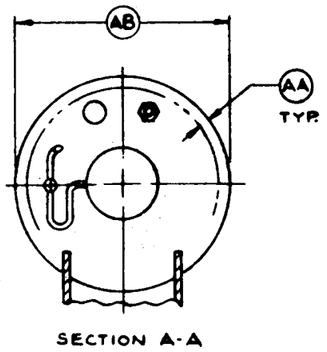
MAXIMUM RATINGS

BEAM VOLTAGE (dc)	20 KILOVOLTS
BEAM CURRENT (dc)	3 AMPERES
BEAM INPUT POWER	50 KILOWATTS
BODY CURRENT (dc)	75 MILLIAMPERES
COLLECTOR DISSIPATION	50 KILOWATTS
LOAD VSWR	1.5:1
INLET WATER PRESSURE	80 PSIG
OUTLET WATER TEMPERATURE	80 DEGREES C

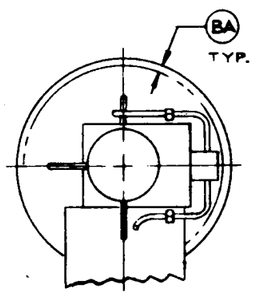
TYPICAL OPERATION

	High Eff. Tuned		*Broadband Tuned*	
Frequency	1.7	2.4	1.7	2.4 gigacycles
Output Power	14.5	12.3	12.1	10.5 kilowatts
Driving Power	1	1	1	1 watt
Gain	41.6	40.9	40.8	40.2 decibels
Beam Voltage	18	18	18	18 kilovolts dc
Beam Current	1.8	1.8	1.8	1.8 amperes dc
Modulating Anode Voltage (to cathode)	10.4	10.4	10.4	10.4 kilovolts dc
Beam Power Efficiency	44.5	38.0	37.2	32.4 percent
Half Power Bandwidth	5	8	10	12 megacycles
Body Current	65	50	55	35 milliamperes dc
Electromagnet Current	12.5	12.5	12.5	12.5 amperes

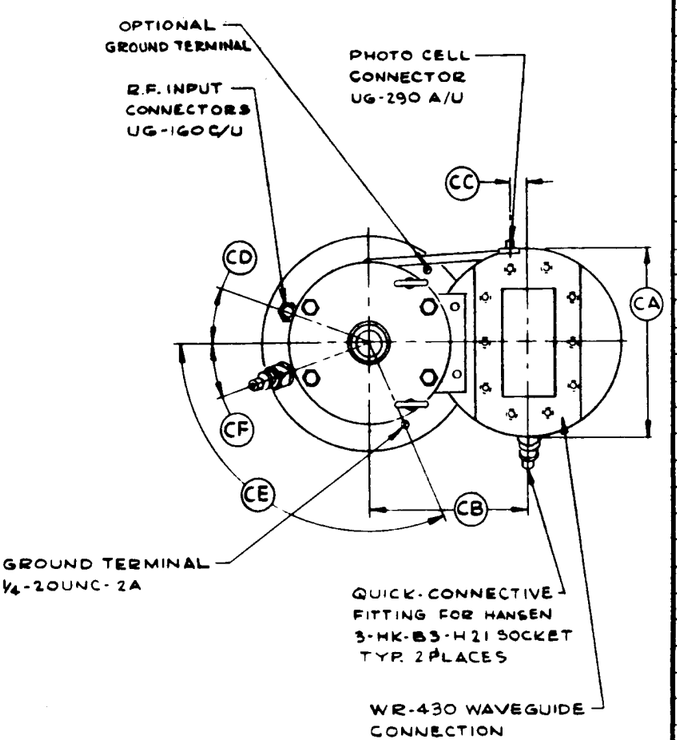
For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.



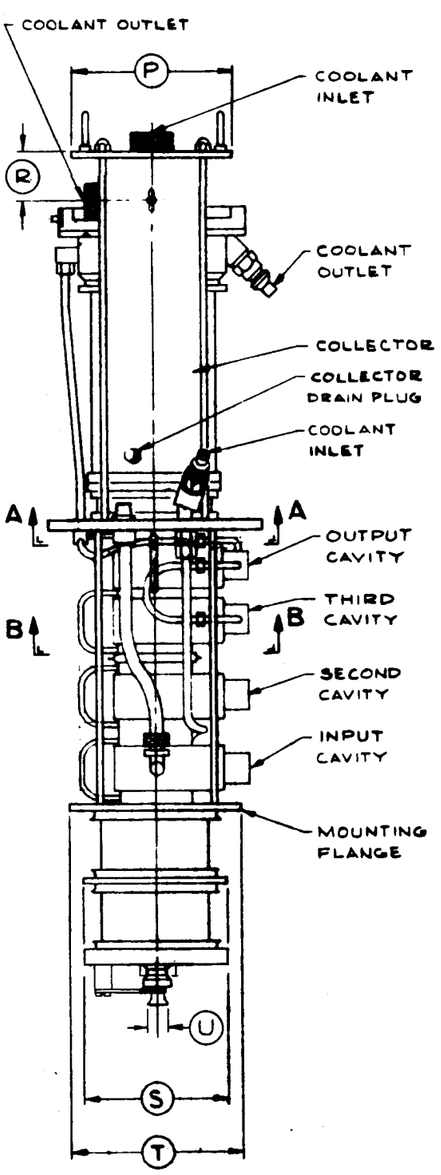
SECTION A-A

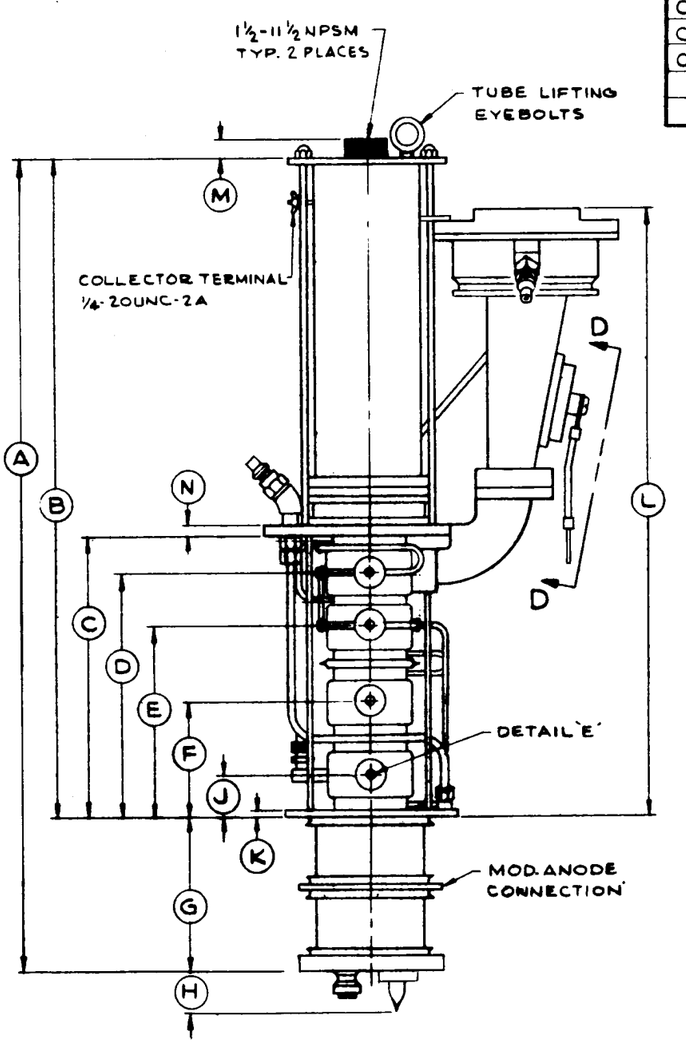


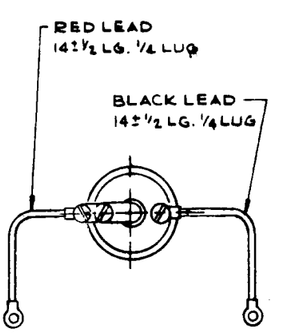
SECTION B-B
TUNER EXTENDED
TO MAX. LIMIT



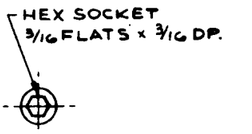
DIMENSIONAL DATA			
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B	24.670		
C		10.325	10.525
D	9.125		
E	7.375		
F	4.388		
G	5.696		
H	2.188		
J	1.638		
K		.230	.270
L		23.600	24.000
M			1.000
N		.345	.405
P		5.950	6.050
R		1.470	1.720
S			5.280
T		6.490	6.500
U			1.188
AA		.437	
AB		7.990	8.000
BA		.380	
CA		6.970	7.030
CB		5.750	6.250
CC		.510	.610
CD		15°	25°
CE		110°	120°
CF		15°	25°



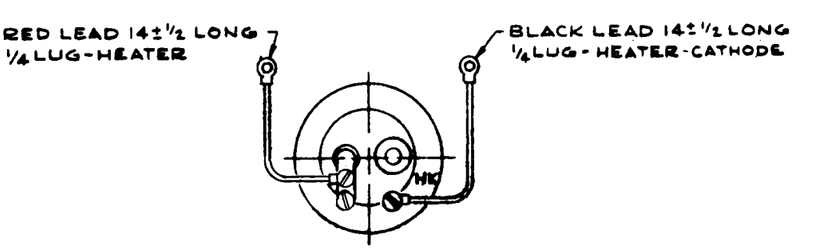




VIEW D-D
GETTER CONNECTIONS

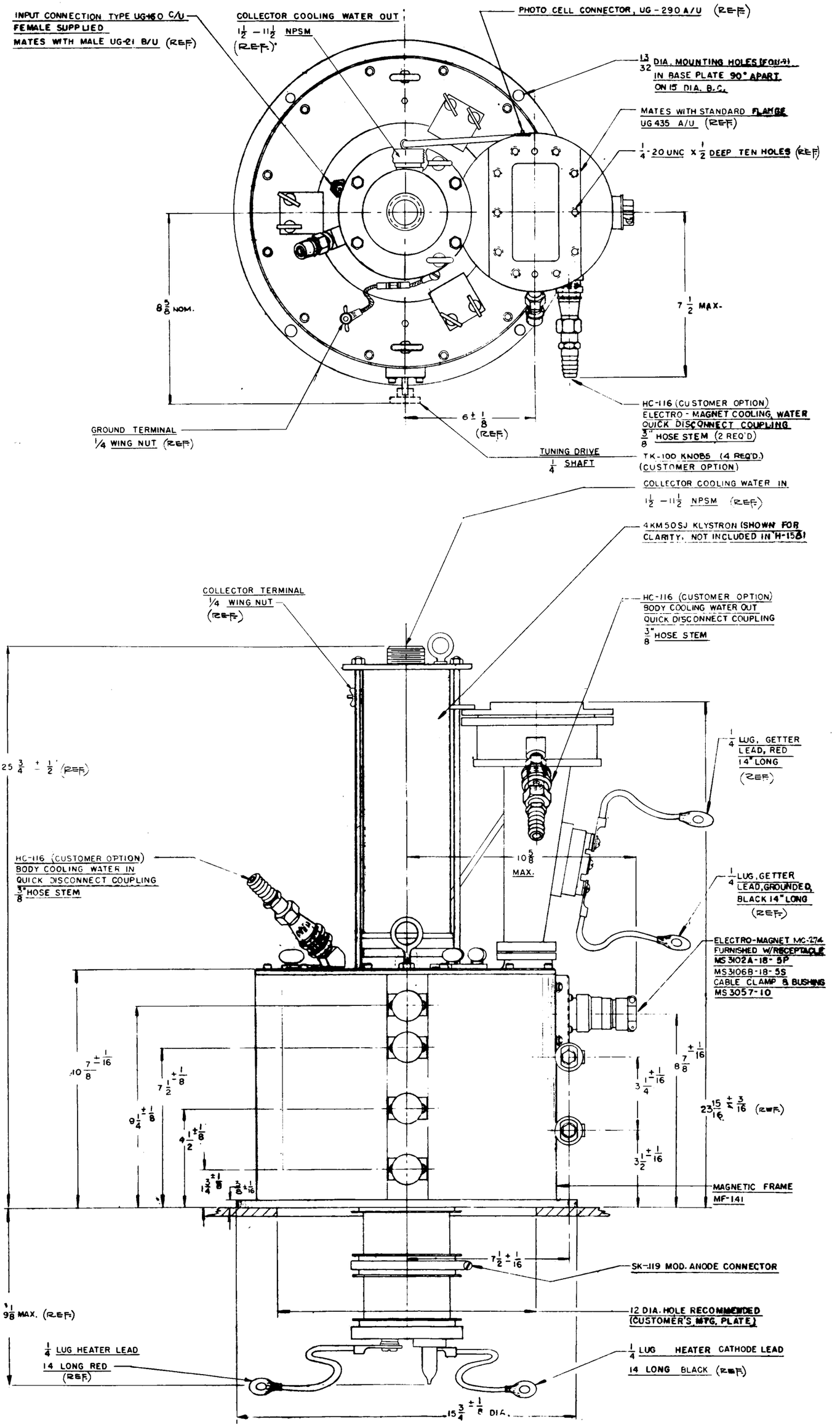


DETAIL E
TUNER SOCKET
TYP. 4 PLACES



FILAMENT CONNECTIONS

4KM50SJ KLYSTRON



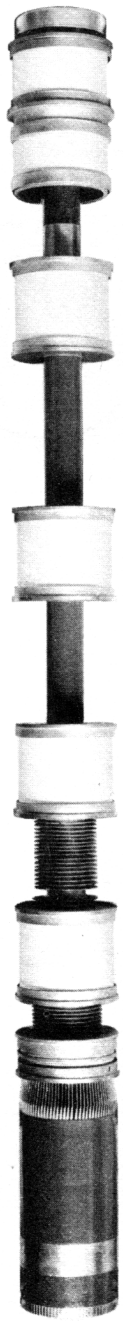
H-158 ELECTROMAGNET AND KLYSTRON SUPPORTING STRUCTURE

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

TENTATIVE DATA

4KMP10,000LF

PULSE AMPLIFIER L-BAND KLYSTRON



The Eimac 4KMP10,000LF is a four-cavity, magnetically focused, pulse-amplifier klystron of ceramic and metal. It is designed for use at frequencies between 570 and 630 megacycles and will deliver a minimum pulse output power of 200 kilowatts at two percent duty, or 400 kilowatts at one percent duty, with an average power of four kilowatts. Nominal power gain is 57 db.

This klystron employs the Eimac Modulating Anode which provides an effective means of pulse modulating the output power without changing the beam voltage. A modulating anode voltage of approximately one half the beam voltage is sufficient to realize full rated pulse output power.

The resonant cavities for the 4KMP10,000LF are completed through tuning boxes which enclose the cylindrical ceramic windows of the klystron and all tuning is accomplished outside the vacuum envelope. This design permits a wide tuning range, and allows external cavity loading for broad-band operation. It also permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

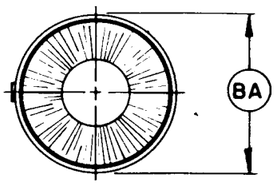
Eimac Klystron Amplifier Circuit Assembly H-127, for use with the 4KMP10,000LF, covers the frequency range of 570 to 630 megacycles. This assembly includes a klystron supporting structure, electromagnetic focusing coils, tuning boxes, adjustable output load coupler, and an Eimac SK-1200 socket.

CHARACTERISTICS

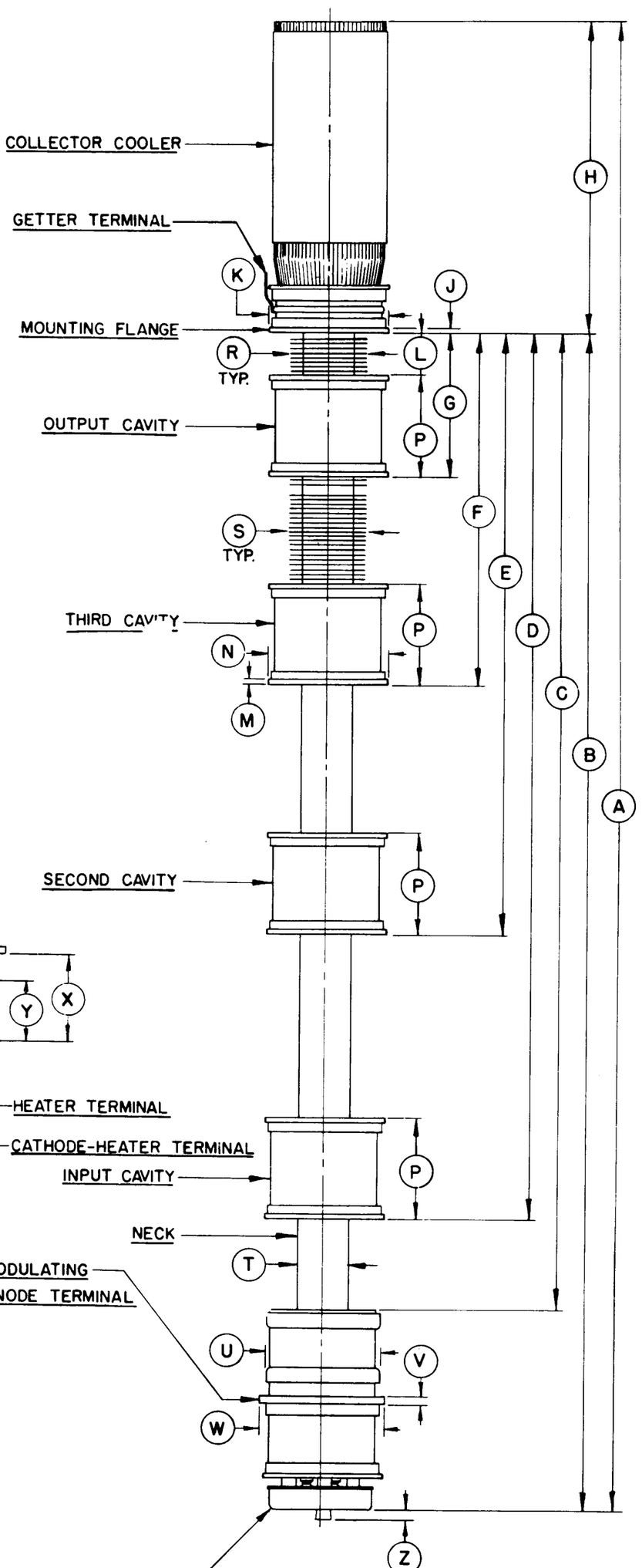
ELECTRICAL			
Heater:	Voltage (±5%)	11	volts
	Current (Normal)	22	amperes
	Maximum Starting Current	50	amperes
Cathode:	Unipotential, Oxide Coated		
	Heating Time	10	minutes
Getter (Operating):	Voltage (Nominal)	5.1	volts
	Current	36	amperes
	Maximum Starting Current	50	amperes
Power Gain:	(Narrow Band)	57	decibels
Output Power:			
	2% Duty	200	kilowatts
	1% Duty	400	kilowatts
	Average	4	kilowatts
Frequency Range		570 to 630	megacycles
Capacitance between Modulating Anode and all other Tube Elements:			
	Maximum	60	micromicrofarads
	Typical	37	micromicrofarads

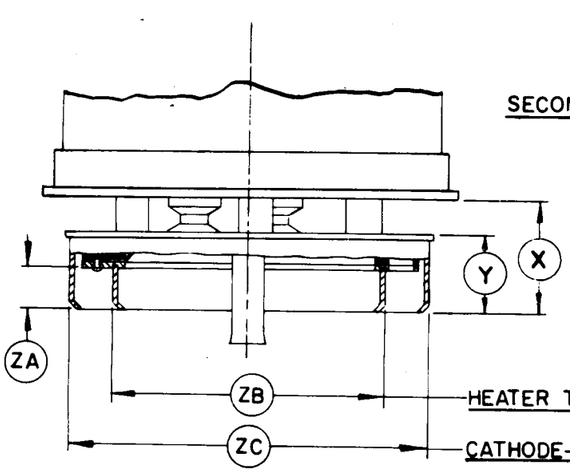
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DIMENSIONAL DATA	
REF.	NOM.
A	84
B	66 1/4
C	54 7/8
D	50 5/32
E	34 3/16
F	20 1/4
G	10 1/2
H	17 13/16
J	1/4
K	6 5/8
L	2 1/4
M	1/4
N	6 5/8
P	6 1/64
R	4 7/16
S	4
T	2 1/2
U	6 5/8
V	3/8
W	6 7/8
X	1 3/4
Y	1 9/32
Z	1
ZA	1/2
ZB	4 3/8
ZC	5 3/4
BA	6 11/32



COLLECTOR COOLER
END VIEW





DETAIL "A"

4KMP10,000LF OUTLINE DRAWING

Eimac 4KMP10,000LF

MECHANICAL

Operating Position	Axis Vertical Cathode down (in oil)
R-F Input Coupling	Type N Coaxial Fitting
R-F Output Coupling	WR1500 Waveguide
Weight (Tube only)	140 pounds

Cooling: Forced Air and Oil

Cathode (With SK-1200 socket) - oil

	Flow Rate	Pressure Drop
Body	*100 cfm air	1 inch H_2O
Output Cavity	*50 cfm air	1 inch H_2O
Collector	*400 cfm air	2.5 inches H_2O

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS
(Eimac H-127 Klystron Amplifier Circuit Assembly)

	Min.	Max.	
Prefocus Coil: Voltage (dc)	0	40	volts
Current (dc)	0	2.5	amperes
Each of Five Body Coils:			
Voltage (dc)	0	40	volts
Current (dc)	0	12.5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	70	KILOVOLTS
PEAK D-C BEAM CURRENT	22.5	AMPERES
PEAK MODULATING ANODE VOLTAGE	44	KILOVOLTS
AVERAGE D-C BODY CURRENT	15	MILLIAMPERES
COLLECTOR DISSIPATION	10	KILOWATTS
PULSE LENGTH	60	MICROSECONDS
SEAL TEMPERATURES	175	DEGREES C
A-C GETTER CURRENT	50	AMPERES

TYPICAL OPERATION, NARROW BAND PULSE AMPLIFIER

Frequency	600	megacycles
Peak Output Power	466	kilowatts
Average Output Power	4.66	kilowatts
Peak Driving Power	0.8	watts
Power Gain	57.4	decibels
D-C Beam Voltage	65	kilovolts
Average D-C Beam Current	165	milliamperes
Peak D-C Beam Current	16.5	amperes
Peak Modulating Anode Voltage	32	kilovolts
D-C Body Current (Average)	9.5	milliamperes
D-C Collector Current (Average)	156	milliamperes
Beam Input Efficiency (Average)	43.4	percent

MAGNETIC-COIL CURRENTS (H-127 Circuit Assembly)

Prefocus Coil	1.9	amperes
First Body Coil	6.3	amperes
Second Body Coil	7.5	amperes
Third Body Coil	7.5	amperes
Fourth Body Coil	8.5	amperes
Fifth Body Coil	8.5	amperes

*At Sea Level with 20° C inlet air temperature.

For additional information or information regarding any specific application, write to Eitel-McCullough, Inc., San Bruno, California. All such requests will be handled confidentially.

Printed in U.S.A. 585

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

4PR60A

RADIAL-BEAM PULSE TETRODE • MODULATOR AMPLIFIER



The Eimac 4PR60A is a high-vacuum tetrode intended for pulse-modulator service in circuits employing inductive or resistive loads. This tube unilaterally replaces the 715C and the 5D21.

▶ The 4PR60A has a maximum plate dissipation rating of 60 watts, is cooled by radiation and convection, and delivers pulse power output in the range of 300 kilowatts with one kilowatt of pulse driving power.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Oxide-coated, Unipotential		
Heater Voltage	26.0	volts
Heater Current	2.25	amperes
Minimum Heating Time	3	minutes
Direct Interelectrode Capacitances (Average)		
Grid-Plate (without shielding)	0.3	μμf
Input	43.0	μμf
Output	9.0	μμf

MECHANICAL

Minimum Shock Test	200g
Base	Fits E. F. Johnson Co. Socket Number 122-234 or equivalent
Mounting Position	Any
Cooling	Radiation and Convection
Recommended Heat Dissipating Plate Connector	Eimac HR-8
Maximum Over-All Dimensions	
Length	6 inches
Diameter	3 1/8 inches
Net Weight	12 ounces
Shipping Weight	1.75 pounds

RATINGS

MAXIMUM RATINGS—Pulse Modulator Service (Per Tube)

D-C PLATE VOLTAGE	20 MAX. KILOVOLTS
D-C SCREEN VOLTAGE[1]	1.5 MAX. KILOVOLTS
D-C GRID VOLTAGE[2]	—1.0 MAX. KILOVOLT
PEAK POSITIVE GRID VOLTAGE	300 MAX. VOLTS
PEAK PLATE CURRENT	18 MAX. AMPERES
PEAK POSITIVE PLATE VOLTAGE	25 MAX. KILOVOLTS
PLATE DISSIPATION (AVERAGE)	60 MAX. WATTS
SCREEN DISSIPATION (AVERAGE)	8 MAX. WATTS
SEAL TEMPERATURES	200 MAX. DEG. C

DUTY

For peak plate currents in excess of 5 amperes, the duty shall not exceed 0.001, and the product of peak current in amperes and pulse duration in microseconds shall not exceed 40. The tube shall not be operated for longer than 5 microseconds in any 100 microsecond interval.

For peak plate current values of less than 5 amperes, the pulse duration-current factor of 40 applies, and the plate dissipation rating of 60 watts determines the maximum permissible duty.

TYPICAL OPERATION
Pulse Modulator (Per Tube)

D-C Plate Voltage	15.8	20.0	kilovolts
Pulse Plate Current	14.0	16.0	amperes
D-C Screen Voltage	1.25	1.25	kilovolts
Pulse Screen Current*	4.0	3.0	amperes
D-C Grid Voltage	-600	-600	volts
Pulse Grid Current*	1.1	1.1	amperes
Pulse Positive Grid Voltage	100	100	volts
Duty	.001	.001	
Pulse Length	2	2	μsec
Peak Positive Plate Voltage	25	25	kilovolts
Peak Plate Current	16	18	amperes
Pulse Power Input	220	320	kilowatts
Pulse Power Output	210	305	kilowatts
Plate Output Voltage	15.0	19.0	kilovolts

[1]Screen grid series protective resistance shall be 20,000 ohms, minimum.

▶ [2]Control grid series resistance shall be 100,000 ohms, maximum.

*Approximate values.

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▶ Indicates change from sheet dated 8-15-52.

APPLICATION

MECHANICAL

Mounting—The 4PR60A may be mounted and operated in any position. A flexible connecting strap should be provided between the plate terminal and the external plate circuit.

The 4PR60A is designed to withstand 200g shocks of short duration transferred to the tube through clamps on the metal skirt. Such clamps must be shaped to fit the contour of the skirt and must be fastened to the tube before being tightened to the chassis in order that no distorting force will be applied. No lateral pressure or clamping action should be applied to the base pins or to any part of the tube other than the skirt. The skirt is internally connected to the cathode.

Adequate ventilation must be provided so that the seals and envelope under operating conditions do not exceed 200°C.

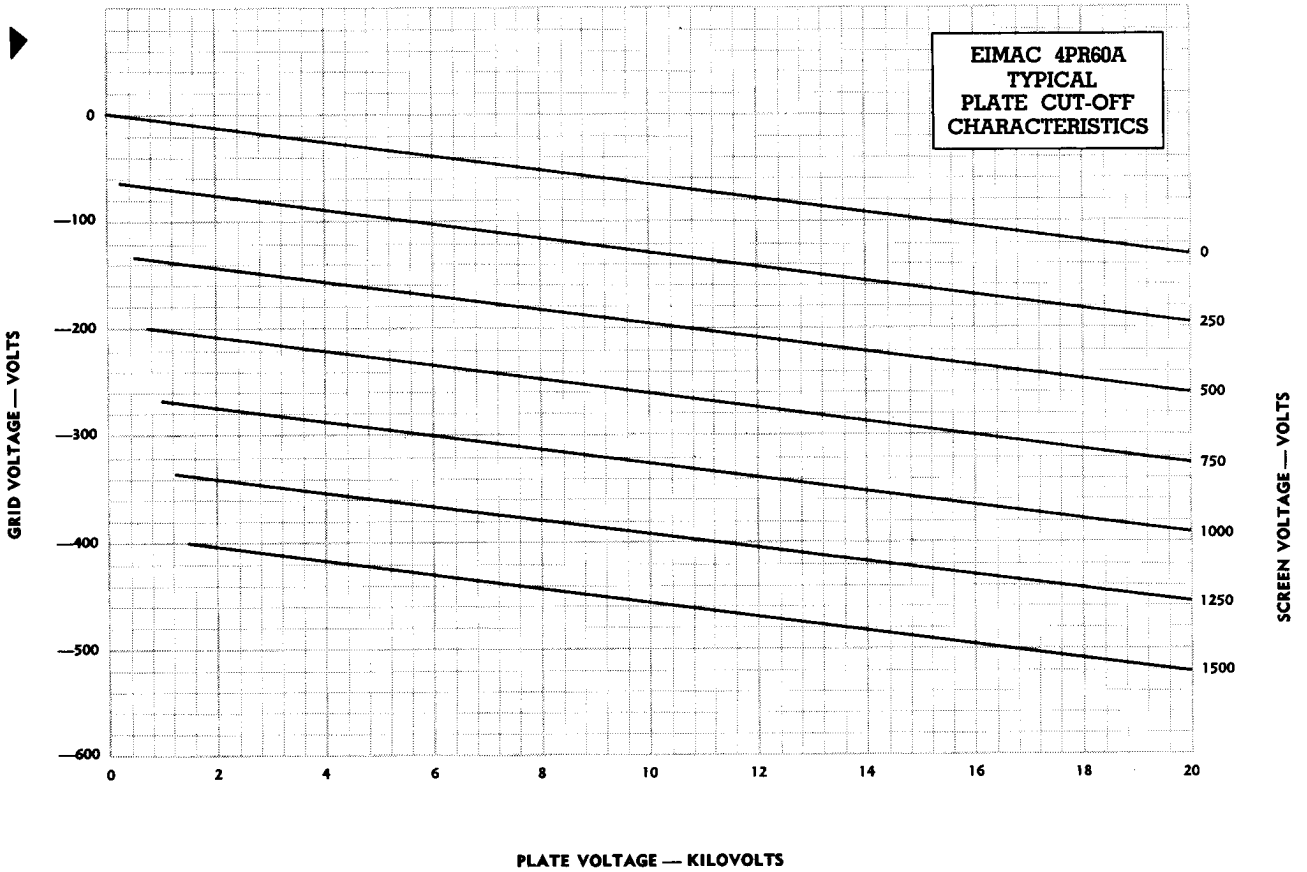
ELECTRICAL

Heater Voltage—The heater voltage, as measured directly at the heater pins, should be the rated value of 26.0 volts. Variations in heater voltage must be kept within the range from 23.4 to 28.6 volts.

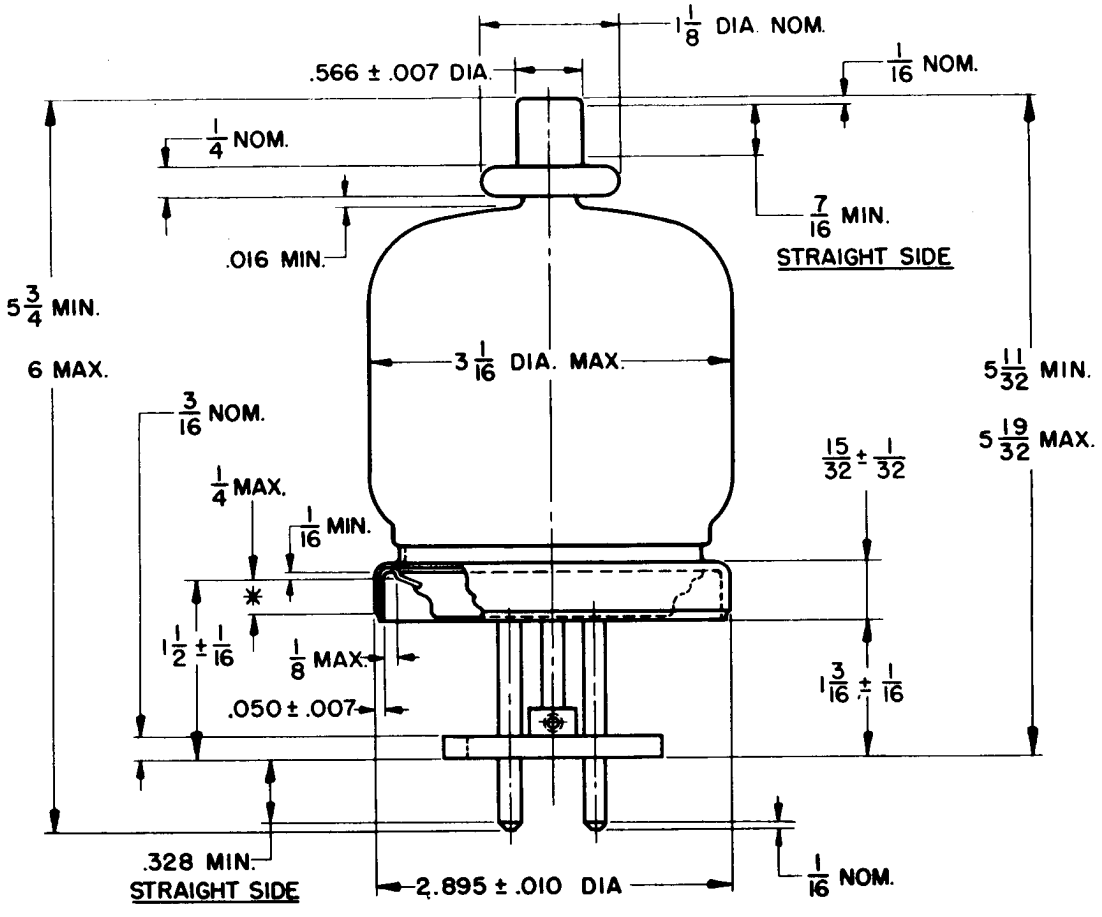
Screen Dissipation—The average power dissipated by the screen of the 4PR60A must not exceed eight watts. A protective series resistance of not less than 20,000 ohms must be inserted in the screen - voltage supply circuit and the screen should be adequately by-passed directly to the cathode by means of a suitable capacitor.

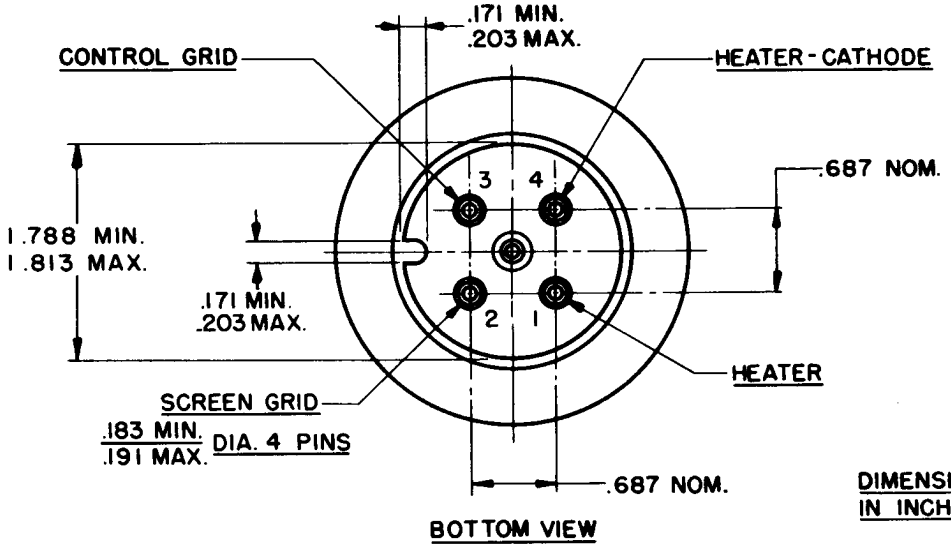
Plate Voltage—The plate-supply voltage for the 4PR60A should not exceed 20 kilovolts. In circuits employing inductive loading, the peak instantaneous plate voltage should not exceed 25 kilovolts.

Plate Dissipation—Under normal operating conditions, the plate dissipation of the 4PR60A should not be allowed to exceed 60 watts. Plate dissipation in excess of maximum rating is permissible for short periods of time, such as during adjustment procedures. The 4PR60A should not be operated without a heat dissipating plate connector such as the recommended Eimac HR-8.



▶ Indicates change from sheet dated 8-15-52.



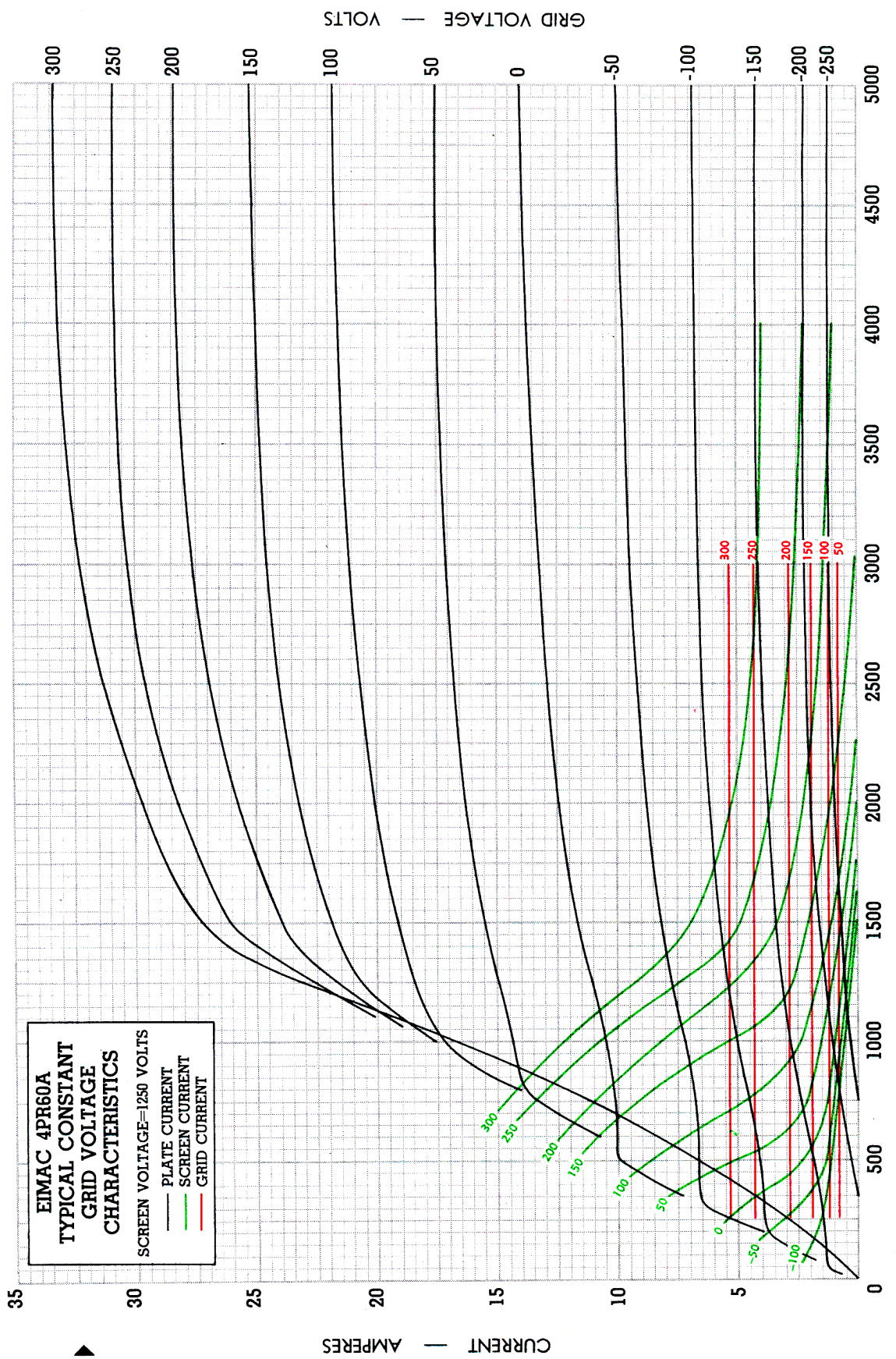


BOTTOM VIEW

DIMENSIONS IN INCHES

THE BASE SHALL BE CAPABLE OF ENTERING A GAUGE 1/4" THICK HAVING 4 HOLES WHOSE DIA'S ARE .214" AND WHICH ARE LOCATED ON 11/16" CENTERS AND A CENTER HOLE OF .250" DIA.

*CYLINDRICAL SURFACE AVAILABLE FOR CLAMPING MUST NOT BE DEFORMED BY ACTION OF CLAMPS



▲ Indicates change from sheet dated 8-15-52.

Printed in U. S. A. 3-J3-74167

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

4W20,000A

RADIAL-BEAM POWER TETRODE



The Eimac 4W20,000A is a high-power, water-cooled transmitting tetrode having a maximum plate dissipation rating of 20 kilowatts. This tube will operate efficiently as a power-amplifier at frequencies up to 250 Mc. A single 4W20,000A operating as a television visual r-f amplifier will deliver a synchronizing power output of 26 kilowatts at 216 Mc., with a 5-Mc. bandwidth.

The coaxial terminal arrangement of the tube is ideally suited for use in cavity circuits. The cathode is a unipotential thoriated tungsten cylinder of rugged construction, heated by electron bombardment.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, thoriated tungsten. Heated by electron bombardment.	
	D-C Voltage (Approx.)	1400 volts
	D-C Current (Approx.)	1.8 amperes
Filament:	Thoriated Tungsten, Helical	
	Voltage	10 volts
	Current (without cathode bombardment)	30 amperes
	Current (with cathode bombardment)	25 amperes
	Maximum allowable starting current	50 amperes
Direct Interelectrode Capacitances (Average)		
	Grid-Plate	0.5 $\mu\mu$f
	Input	125 $\mu\mu$f
	Output	23 $\mu\mu$f
Screen-Grid Amplification Factor (Average)		5.5
Transconductance (I_b=6.6 A.,E_b=3.0 kV., E_{c2}=1200 V.)		75,000 μmhos

MECHANICAL

Base	Special, Concentric
Mounting Position	Vertical, base down or up
Cooling	Water and Forced Air
Maximum Over-all Dimensions	
Length	15.2 inches
Diameter	5.0 inches
Net Weight	7.6 pounds
Shipping Weight	40 pounds

RADIO FREQUENCY POWER AMPLIFIER MAXIMUM RATINGS (per tube)

D-C PLATE VOLTAGE	8 MAX. KV
D-C PLATE CURRENT	15 MAX. AMP
PLATE DISSIPATION	20 MAX. KW
SCREEN DISSIPATION	200 MAX. WATTS
GRID DISSIPATION	60 MAX. WATTS

TYPICAL OPERATION

Class-C Telegraphy or FM Telephony (Per tube—220 Mc.)

D-C Plate Voltage	5000	6000	7000	volts
D-C Screen Voltage	1200	1200	1200	volts
D-C Grid Voltage	—350	—370	—400	volts
D-C Plate Current	3.6	3.6	3.4	amps
D-C Screen Current (approx.)*	167	167	167	ma
D-C Grid Current (approx.)	50	50	50	ma
Peak R-F Input Voltage	455	475	505	volts
Driving Power (approx.)*	750	780	830	watts
Screen Dissipation	200	200	200	watts
Plate Power Input	18	21.6	23.8	kw
Plate Dissipation	7.0	8.6	8.0	kw
Useful Power Output	9.2	11.5	13.0	kw

*The performance figures listed above are obtained by calculation from the characteristic tube curves and confirmed by direct tests. The driving power and output power allow for losses associated with practical resonant circuits.

TYPICAL OPERATION

Class-B Linear Amplifier—Television Visual Service
(Per tube, 5-Mc. Bandwidth up to 216 Mc.)

Peak Synchronizing Level		
Load Impedance	650	ohms
Effective Length of Plate Line	¼	wave
D-C Plate Voltage	7000	volts
D-C Screen Voltage	1200	volts
D-C Control Grid Voltage	—150	volts
D-C Plate Current	6.0	amps
D-C Screen Current (approx.)	230	ma
D-C Control Grid Current (approx.)	90	ma
Peak R-F Grid Input Voltage	280	volts
Driving Power (approx.)	500	watts
Plate Power Input	42	kw
Plate Dissipation	16	kw
Useful Plate Power Output	26	kw
Black Level		
D-C Plate Current	4.5	amps
D-C Screen Current	100	ma
D-C Control Grid Current (approx.)	45	ma
Peak R-F Grid Input Voltage	220	volts
Driving Power (approx.)	300	watts
Plate Power Input	32	kw
Plate Dissipation	16.5	kw
Useful Power Output	15.5	kw

These 216 Mc. typical performance figures were obtained by direct measurement in test equipment. The output power is useful power measured in a load circuit. The driving power is that taken by the tube and a practical resonant grid circuit. These figures are subject to variation and in many cases, with further refinement and improved techniques, better performance might be obtained.

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Note: Typical operation data are based on conditions of adjusting to a specificied plate current, maintaining fixed conditions of grid bias, screen voltage, suppressor voltage and r-f grid voltage. It will be found that if this procedure is followed, there will be little variation in power output between tubes even though there may be some variation in grid, screen and suppressor currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

APPLICATION

Mounting—The 4W20,000A must be mounted vertically. Base-down or base-up mounting is optional.

The co-axial contact surfaces provided for connection to the filament, cathode, grid, screen, and anode are of successively larger diameters to facilitate removal and replacement of tubes.

Cavity circuits may be designed around the dimensions shown in the outline drawing. At very high frequencies the points of contact between the tube and the external circuit will be required to carry high values of charging current. It is, therefore, essential that the contactors make firm and uniform contact between the terminal surfaces of the tube and the external circuit. Particular care should be taken that the contactors are not inadvertently forced out of shape, and that all contact surfaces are maintained free from dust or other foreign matter which would prevent uniform electrical connection. At VHF, poor contact by one finger of a multi-finger collet can result in local overheating which may damage the tube seals.

Although contact fingers or slotted collets are often made an integral part of cavity circuits, there is some advantage to reversing the plan by providing contact-finger assemblies which are designed to be clamped firmly to the terminal surfaces of the tube itself and to make sliding contact with the cavity as the tube is inserted. This arrangement facilitates replacement of worn or damaged contactors and tends to remove incidental local heating from the vicinity of the tube seals. Tubes held in reserve for emergency replacement may be fitted with contact finger assemblies and water-line extensions to minimize lost time in making changes.

▶**Cathode Heating Power** — The cathode of the 4W20,000A is a unipotential, thoriated tungsten cylinder, heated by electron bombardment of its inner surface. Bombardment is obtained by using the cylindrical cathode as the anode of a diode. A helical filament is mounted on the axis of the cathode cylinder to supply the bombarding electrons. A d-c potential of approximately 1400 volts is applied between the filament and the cathode cylinder, and the recommended cathode heating power of 2500 watts is obtained with approximately 1.8 amperes.

The inner filament is designed to operate under space-charge limited conditions so that the cathode temperature may be varied by changing the voltage applied between the inner filament and the cathode cylinder.

For maximum tube life the filament voltage, as measured directly at the filament terminals, must be reduced after the cathode has reached operating temperature. The proper filament voltage for a given cathode bombardment power may be found in the table below. The filament voltage should remain at the 10.0-volt value until the cathode has reached operating temperature, an interval of approximately thirty seconds. The filament voltage should be maintained to within 5% of the proper operating value and the cathode bombardment power should be held within plus or minus 100 watts of the recommended value.

Cathode Bombardment Power	2000	2250	2500	2750	3000
Filament Voltage	6.0	5.2	4.3	3.2	2.0

A cathode bombardment power of 2250 watts is normal for average CW conditions. In applications requiring peak values of cathode current in excess of 75 amperes the cathode bombardment power may be increased to a value between 2250 and 3000 watts as required.

Further increases in cathode efficiency will result in a decrease in the cathode bombardment power requirements. The cathode bombardment power supply should, therefore, be capable of providing a minimum of approximately 2000 watts.

Caution: It must be kept in mind that the filament is at a potential of 1400 volts d-c with respect to ground. The filament transformer and voltmeter must be adequately insulated for this voltage.

Grid Voltage Regulation—The practice of designing grid voltage supplies to maintain adequate regulation under conditions of varying grid current is particularly desirable with the 4W20,000A. Because the cathode of the 4W20,000A is a complete cylinder, grid temperatures run higher than usual. For this reason, even with no excitation, control grid current reversal might conceivably be several milliamperes and safe design should allow for possible peaks on the order of 100 milliamperes.

▶**Anode Cooling**—The water-cooled anode requires 8 gallons per minute of cooling water for the rated 20 kilowatts of plate dissipation. This corresponds to a pressure drop of 7 pounds per square inch across the water jacket. The inlet water pressure must not exceed a maximum of 50 pounds per square inch.

The outlet water temperature must not exceed a maximum of 70°C under any conditions.

▶**Seal Cooling**—The grid and screen tube contact surfaces and adjacent glass and ceramic must be cooled by high-velocity air which may be accomplished by means of ring manifolds. The quantity, velocity and direction of air must be adjusted to limit the maximum seal temperatures to 150°C.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.

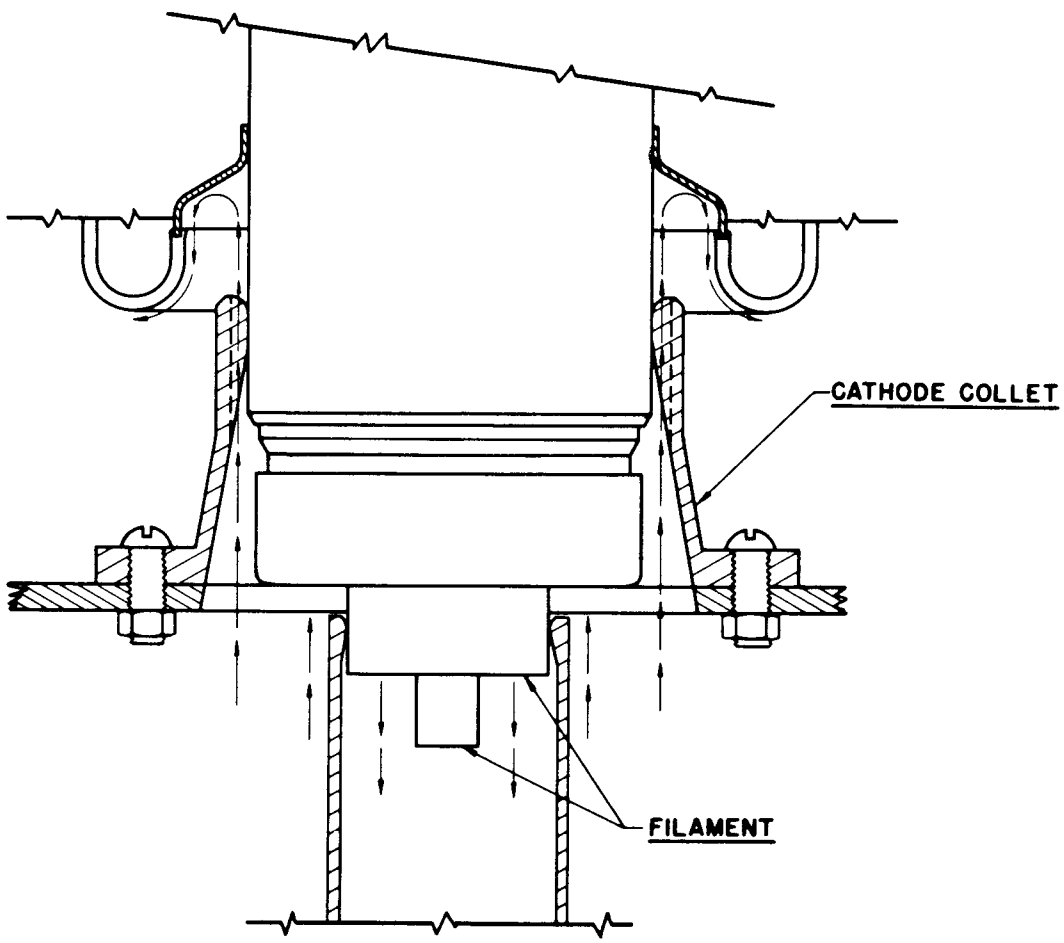
▶ Indicates change from sheet dated 2-27-54

The cathode and filament stem also require forced-air cooling in sufficient quantity so that the region on the cathode terminal opposite the glass of the grid terminal seal does not exceed a maximum of 150°C. The major portion of this air must be guided along the surface of the terminal sleeve. The remaining air flows through the nine holes inside the terminal sleeve, cools the filament stem and vents through the three holes in the tube base enclosed by the outer filament spring collet connection.

By employing a cathode collet such as is shown in the accompanying drawings, the recommended cooling requirements will be fulfilled with an air flow of 60 cubic feet per minute at a static manifold pressure of 2 inches of water column.

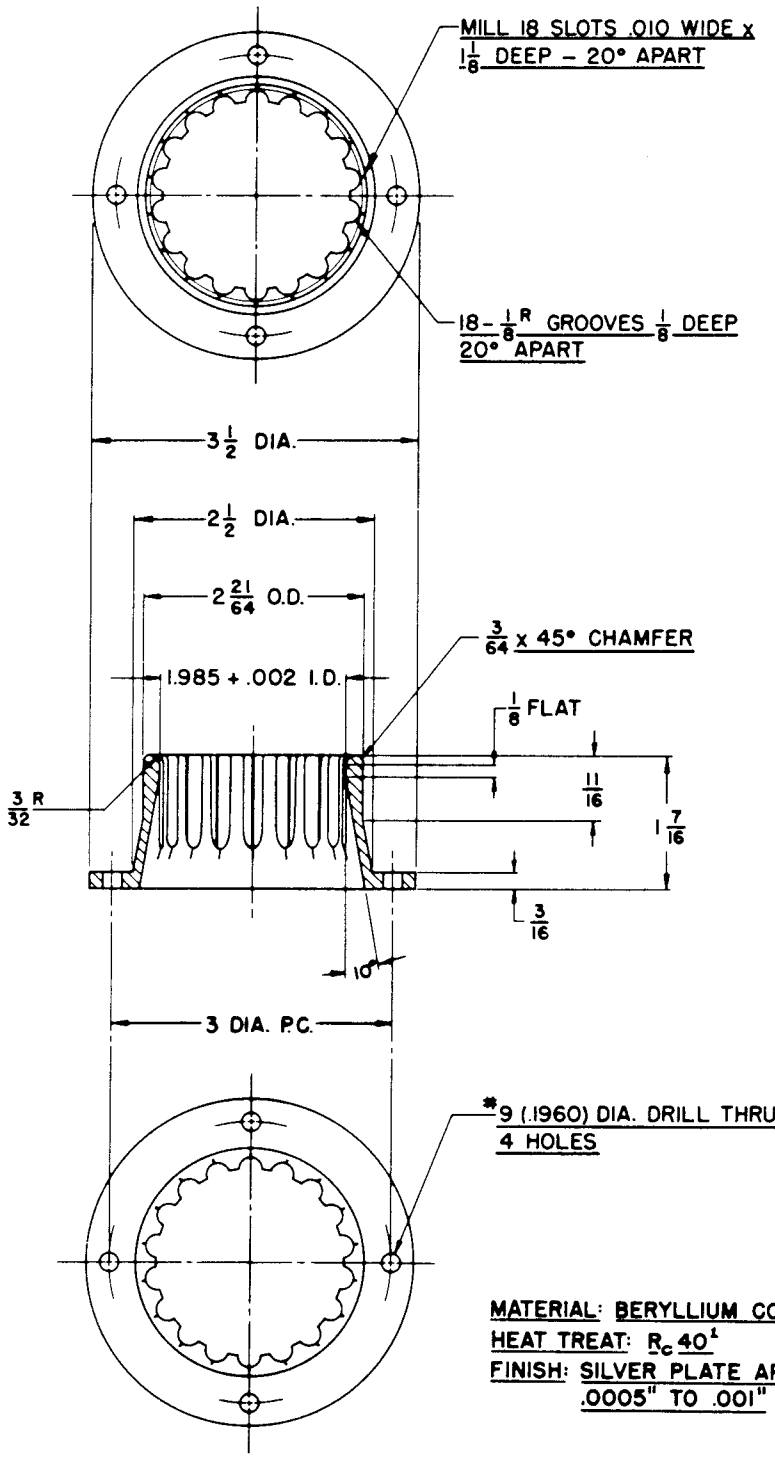
Air and water flow must be started before filament and cathode power are applied and maintained for at least two minutes after the filament and cathode power have been removed.

4W20,000A
SUGGESTED STEM AIR COOLING



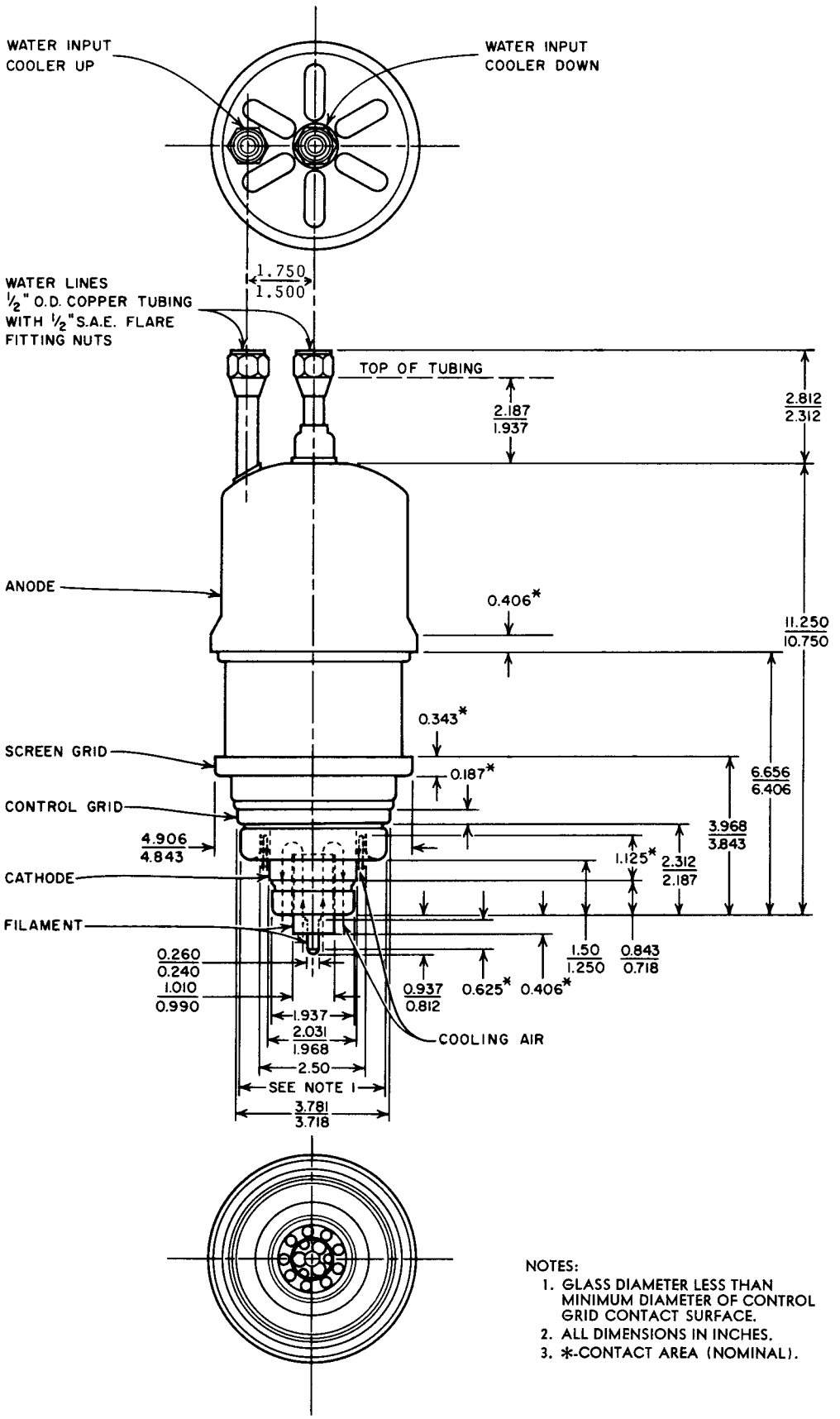
4W20,000A

CATHODE COLLET



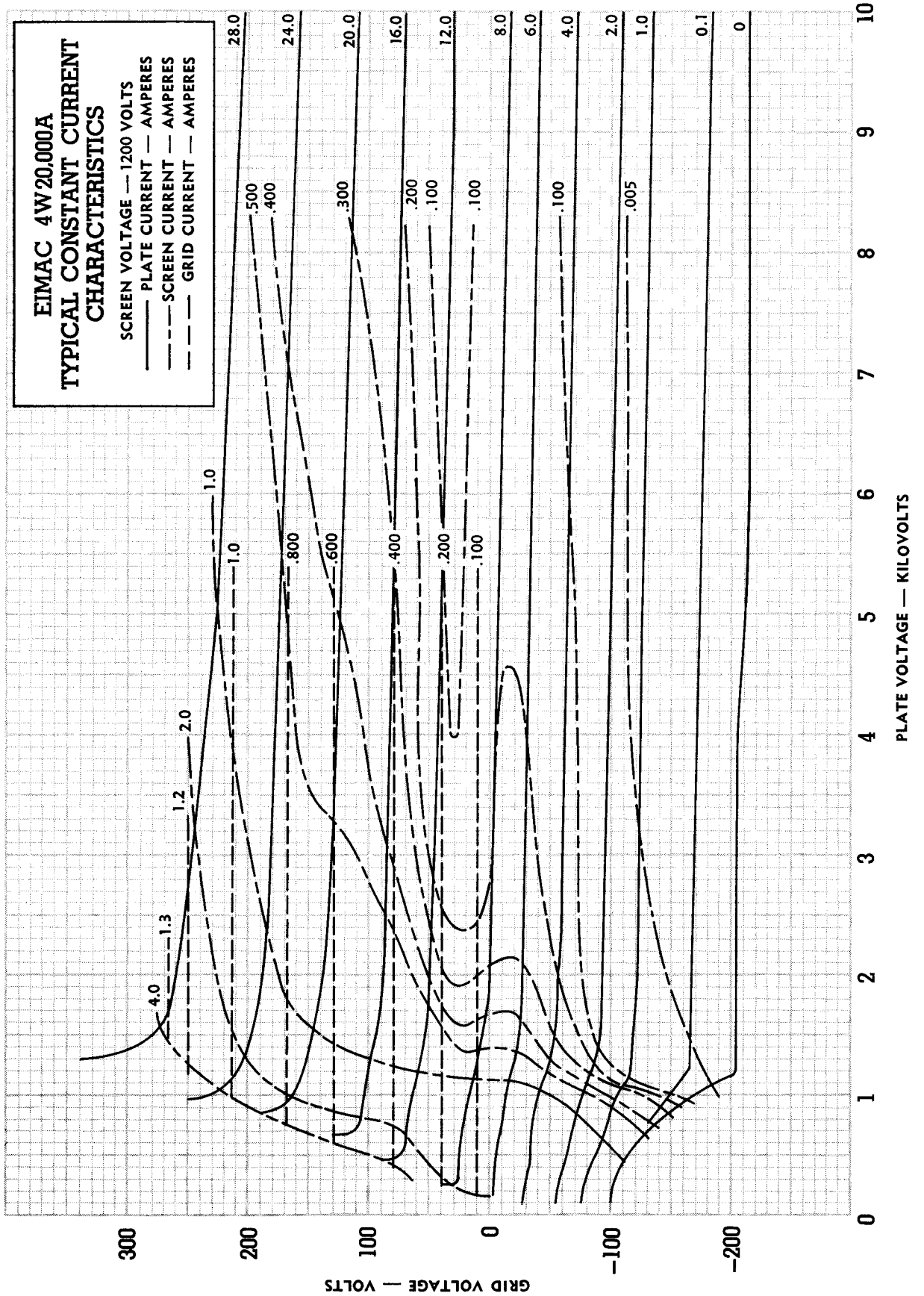
MATERIAL: BERYLLIUM COPPER
HEAT TREAT: R_C 40[1]
FINISH: SILVER PLATE APPROX. .0005" TO .001"

[1] 385°C FOR APPROX. 5–6 HRS. IN NON-REDUCING ATMOSPHERE



NOTES:
1. GLASS DIAMETER LESS THAN MINIMUM DIAMETER OF CONTROL GRID CONTACT SURFACE.
2. ALL DIMENSIONS IN INCHES.
3. *-CONTACT AREA (NOMINAL).

▶ Indicates change from sheet dated 2-27-54



▶ Indicates change from sheet dated 2-27-54

Printed in U.S.A. 194A

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

4X150A

RADIAL-BEAM POWER TETRODE

These Data apply to type 4X150D which is identical to 4X150A except for the heater rating of 26.5 volts 0.57 ampere.



The Eimac 4X150A is a compact power tetrode intended for use as an amplifier, oscillator or frequency multiplier over a wide range of frequencies extending into the UHF region. It is cooled by forced air.

A single 4X150A operating in a coaxial-cavity amplifier circuit will deliver up to 140 watts of useful power output at 500 megacycles.

The maximum rated plate voltage for the 4X150A is 1250 volts, and the tube is capable of good performance with plate voltages as low as 400 volts. Its high ratio of transconductance to capacitance and its 150-watt plate dissipation rating make the 4X150A useful for wide-band amplifier applications.

The use of the Eimac 4X150A Air-System Socket, or a socket providing equivalent air-cooling facilities, is required.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Minimum Heating Time	30	seconds
Cathode-to-Heater Voltage	150	max. volts
Heater: Voltage	6.0	volts
Current	2.6	amperes
Grid-Screen Amplification Factor (Average)	5	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	0.03	$\mu\mu$f
Input	15.5	$\mu\mu$f
Output	4.5	$\mu\mu$f
Transconductance (E_b=500v., E_{c2}=250v., I_b=200 ma)	12,000	μmhos
Frequency for Maximum Ratings	500	Mc

MECHANICAL

Base	9-pin, special	
Recommended Socket	Eimac 4X150A Air-System Socket	
Base Connections	See outline drawing	
Mounting	Any position	
Cooling	Forced air	
Maximum Overall Dimensions:		
Length	2.47	inches
Diameter	1.65	inches
Seated Height	1.91	inches
Net Weight	5.2	ounces
Shipping Weight	1.6	pounds

Note: Typical operation data are based on conditions of adjusting the r-f grid drive to a specified plate current, maintaining fixed conditions of grid bias and screen voltage. It will be found that if this procedure is followed, there will be little variation in power output between tubes even though there may be some variation in grid and screen currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	1250 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	-250 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	150 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 165 Mc., per tube)

D-C Plate Voltage	600	750	1000	1250	volts
D-C Screen Voltage	250	250	250	250	volts
D-C Grid Voltage	-75	-80	-80	-90	volts
D-C Plate Current	200	200	200	200	ma
D-C Screen Current	37	37	30	20	ma
D-C Grid Current	10	10	10	10	ma
Peak R-F Grid Voltage (approx.)	90	95	95	105	volts
Driving Power (approx.)	1	1	1	1.2	watts
Plate Power Input	120	150	200	250	watts
Plate Power Output	85	110	150	195	watts

The performance figures for frequencies up to 165 Mc. are obtained by calculation from the tube characteristic curves and confirmed by direct tests. The driving power includes only power taken by the tube grid and the bias circuit. The driving power and output power do not allow for losses in the associated resonant circuits.

TYPICAL OPERATION (Single tube, 500-Mc| coaxial ,cavity)

D-C Plate Voltage	600	800	1000	1250	volts
D-C Screen Voltage	250	250	250	280	volts
D-C Grid Voltage	-110	-110	-110	-115	volts
D-C Plate Current	170	200	200	200	ma
D-C Screen Current	6	7	7	5	ma
D-C Grid Current	6	10	10	10	ma
Driver Output Power (approx.)	15	20	25	30	watts
Power Input	102	160	200	250	watts
Useful Power Output	50	95	120	140	watts

These typical performance figures were obtained by direct measurement in operating equipment. The output power is useful power measured in a load circuit. The driving power is the total power taken by the tube and a practical resonant circuit. In many cases with further refinement and improved techniques better performance might be obtained.

(Effective 8-15-52) Copyright 1952 by Eitel-McCullough, Inc.

Supersedes Sheet Dated 2-15-52

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	1000 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	100 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 165 Mc.)

D-C Plate Voltage	400	600	800	1000	volts
D-C Screen Voltage	250	250	250	250	volts
D-C Grid Voltage	—90	—95	—100	—105	volts
D-C Plate Current	200	200	200	200	ma
D-C Screen Current	40	35	25	20	ma
D-C Grid Current	7	8	10	15	ma
Peak A-F Screen Voltage at crest of 100% Modulation	140	150	160	170	volts
Peak R-F Grid Input Voltage (approx.)	110	120	120	125	volts
Driving Power (approx.)	1	1	1.5	2	watts
Plate Dissipation	25	40	60	60	watts
Plate Power Input	80	120	160	200	watts
Plate Power Output	55	80	100	140	watts

RADIO-FREQUENCY POWER AMPLIFIER

Class-B Linear, Television Visual Service (per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	1250 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT (AVERAGE)	250 MAX. MA
PLATE DISSIPATION	150 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 216 Mc., 5-Mc. bandwidth)

D-C Plate Voltage	750	1000	1250	volts
D-C Screen Voltage	300	300	300	volts
D-C Grid Voltage	—60	—65	—70	volts
During Sync-Pulse Peak:				
D-C Plate Current	335	330	305	ma
D-C Screen Current	50	45	45	ma
D-C Grid Current	15	20	25	ma
Peak R-F Grid Voltage	85	95	100	volts
R-F Driver Power (approx.)	7	8	9	watts
Useful Power Output	135	200	250	watts
Black Level:				
D-C Plate Current	245	240	230	ma
D-C Screen Current	20	15	10	ma
D-C Grid Current	4	4	4	ma
Peak R-F Grid Voltage (approx.)	65	70	75	volts
R-F Driver Power (approx.)	4.25	4.7	5.5	watts
Plate Power Input	185	240	290	watts
Useful Power Output	75	110	140	watts

CLASS-AB OR -B POWER AMPLIFIER OR MODULATOR

MAXIMUM RATINGS (Per tube)

D-C PLATE VOLTAGE	1250 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	150 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION

Class AB (Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	600	800	1000	1250	volts
D-C Screen Voltage	300	300	300	300	volts
D-C Grid Voltage (approx.)*	—44	—47	—47	—48	volts
Zero-Signal D-C Plate Current	160	120	120	115	ma
Max-Signal D-C Plate Current	380	380	380	390	ma
Zero-Signal D-C Screen Current	0	0	0	0	ma
Max-Signal D-C Screen Current	65	65	60	40	ma
Effective Load, Plate-to-Plate	3550	4625	5850	7200	ohms
Peak A-F Grid Input Voltage (per tube)	44	47	47	48	volts
Driving Power	0	0	0	0	watts
Max-Signal Plate Dissipation (per tube)	45	55	70	90	watts
Max-Signal Plate Power Output	140	195	240	310	watts

*Adjust grid voltage to obtain specified zero-signal plate current. Maximum permissible grid circuit series resistance 100,000 ohms per tube.

TYPICAL OPERATION

Class AB_2 (Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	600	800	1000	1250	volts
D-C Screen Voltage	300	300	300	300	volts
D-C Grid Voltage**	—41	—43	—43	—44	volts
Zero-Signal D-C Plate Current	185	160	165	180	ma
Max-Signal D-C Plate Current	485	490	495	475	ma
Zero-Signal D-C Screen Current	0	0	0	0	ma
Max-Signal D-C Screen Current	85	75	70	65	ma
Effective Load, Plate-to-Plate	2600	3500	4600	5600	ohms
Peak A-F Grid Input Voltage (per tube)	47	48	49	50	volts
Max-Signal Peak Driving Power	0.15	0.15	0.15	0.15	watts
Max-Signal Nominal Driving Power (approx.)	75	75	75	75	mw
Max-Signal Plate Dissipation (per tube)	60	75	90	85	watts
Max-Signal Plate Power Output	170	240	315	425	watts

**Adjust grid voltage to obtain specified zero-signal plate current.

APPLICATION

MECHANICAL

Mounting—The 4X150A may be mounted in any position. Use of the Eimac 4X150A Air-System Socket, or its equivalent, is required.

The tube will fit a standard "loktal" socket, but the use of such a socket prevents adequate air-cooling of the base of the tube. Use of the "loktal" socket is not recommended.

Connections to the terminals of all the electrodes except the plate are provided by the Air-System Socket. The anode-cooler assembly provides a terminal surface for the plate connection. For high-frequency applications a metal band or a spring-finger collet should be used to make good electrical contact with the cylindrical outer surface of the anode cooler. Points of electrical contact should be kept clean and free of oxidation to minimize r-f losses.

Cooling—The 4X150A requires sufficient forced-air cooling to keep the cooler core and the metal parts of the metal-to-glass seals from exceeding a maximum temperature of 150°C. The air flow must be started when power is applied to the heater, and must continue without interruption until all electrode voltages have been removed from the tube.

The Eimac Air-System Socket directs the air over the surfaces of the tube base, and through the anode cooler to provide effective cooling with a minimum air flow. Seven and one-half cubic feet of cooling air per minute must flow through the Air-System Socket and the anode cooler for adequate cooling. This corresponds to a total pressure drop of 0.6 inches of water through the socket and the anode cooler.

The air requirements stated above are based on operation at sea level and an ambient temperature of 20°C. Operation at high altitude or at high ambient temperatures requires a greater volume of air flow. The necessary design information for such conditions is contained in an article entitled "Blower Selection for Forced-Air-Cooled Tubes", by A. G. Nekut, in the August, 1950, issue of "Electronics."

One method of measuring temperature is provided by the use of the "Tempilaq", a temperature-sensitive lacquer, which melts when a given temperature is reached. Where forced-air cooling is employed, very thin applications of the lacquer must be used. This product is obtainable from the Tempil Corporation, 132 West 22nd St., New York 11, N. Y.

ELECTRICAL

Heater—The heater should be operated as close to 6.0 volts as possible, but it will withstand heater-voltage variations as great as 10% without injury. Some variation in power output must be expected to occur with variations of the heater voltage.

Cathode—The cathode is internally connected to the four even-numbered base pins. All four corresponding socket terminals should be used for connection to the external circuit. The leads should be of large cross-section and as short and direct as possible to minimize cathode-lead inductance.

Grid Dissipation—Grid-circuit driving-power requirements increase with increasing frequency because of circuit losses other than grid dissipation. This becomes noticeable at frequencies near 30 Mc., and increases until at 500 Mc. as much as 30 watts driving power may be required in ordinary circuits.

Despite the increased driving power required by the circuit as a whole at higher frequencies, the power actually consumed by the tube grid does not increase greatly. Satisfactory operation in stable amplifier circuits is indicated by d-c grid-current values below approximately 15 milliamperes.

Screen Dissipation—Bias- or plate-supply failure or unloaded-plate-circuit operation can cause the screen current and dissipation to rise to excessive values. Protection for the screen can be provided by an overload relay in the screen circuit, in addition to the usual plate-overload relay. Use of a screen-current milliammeter is advisable.

Plate Dissipation—The maximum-rated plate dissipation is 150 watts. The maximum-rated plate dissipation for plate-modulated applications is 100 watts under carrier conditions, which permits the plate dissipation to rise to 150 watts under 100% sinusoidal modulation.

Plate dissipation may be permitted to exceed the maximum rating momentarily, as, for instance, during tuning.

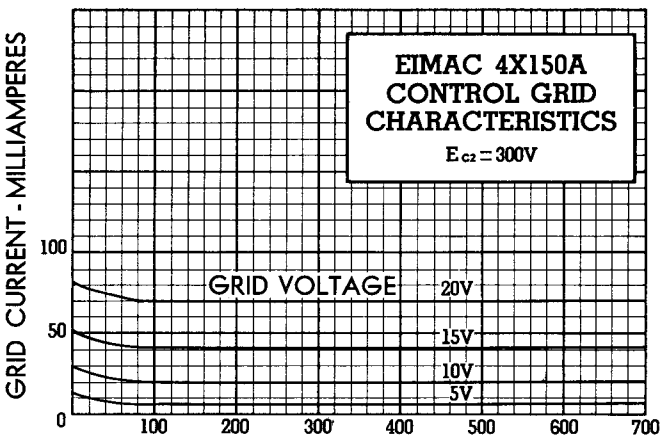
UHF Operation—Transit time effects, which occur at ultra-high frequencies in the 4X150A, can be minimized by adherence to the operating conditions suggested below:

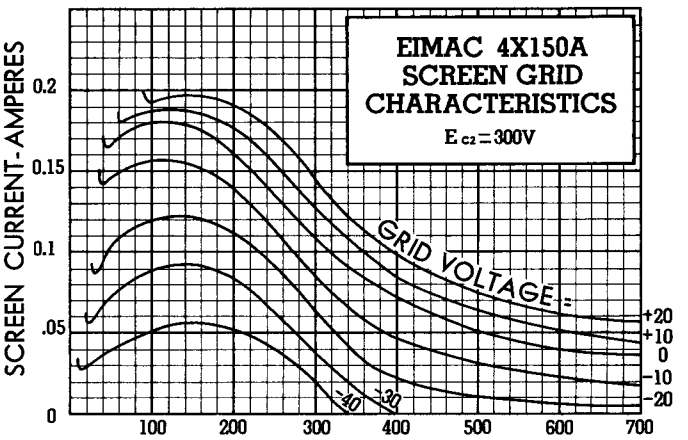
1. Use a minimum d-c bias voltage, not over twice cut-off.
2. Apply only enough drive to obtain satisfactory plate efficiency.
3. Operate the screen at reasonably high voltage, but do not exceed the screen-dissipation rating. The circuit should be loaded to obtain screen-current values close to those given under "Typical Operation" at 500 Mc.
4. Fairly heavy plate loading is required. In general, low-voltage, high-current operation is preferable to operation at high voltage and low current. If conditions require a change to lighter plate loading, the drive should also be reduced to the minimum value for satisfactory operation at the new output level.
5. Parasitic oscillations are usually associated with excessive grid and screen current and are injurious to vacuum tubes. Similarly, tuned-plate circuits which accidentally become simultaneously resonant to harmonics and the fundamental frequency may also cause low efficiency and damage tubes.

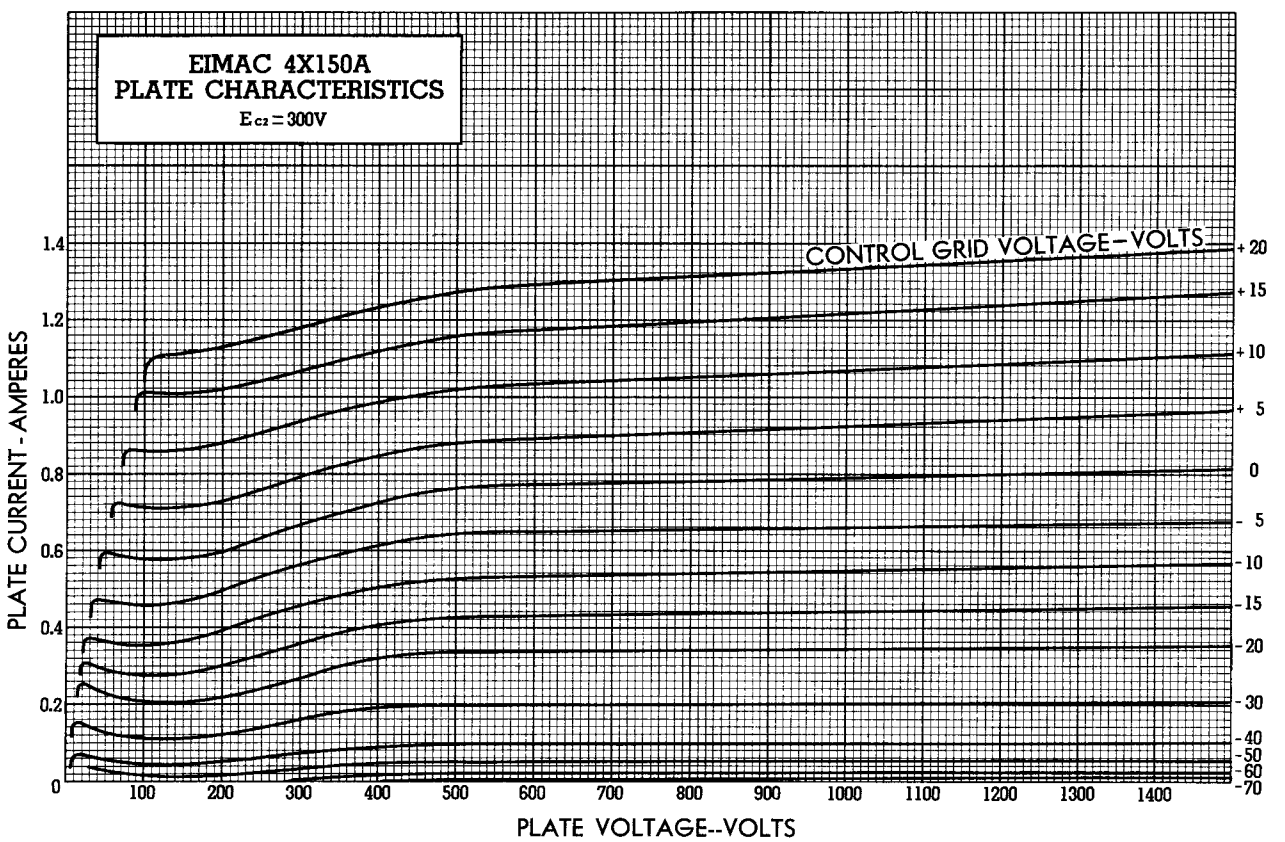
Plate Modulation—Plate modulation can be applied to the 4X150A when it is operated as a class-C radio-frequency amplifier. To obtain 100% modulation, the d-c screen voltage must be modulated approximately 55%, in phase with the plate modulation. Self-modulation of the screen by means of a series resistor or reactor may not be satisfactory in this particular tetrode due to the screen-voltage, screen-current characteristics.

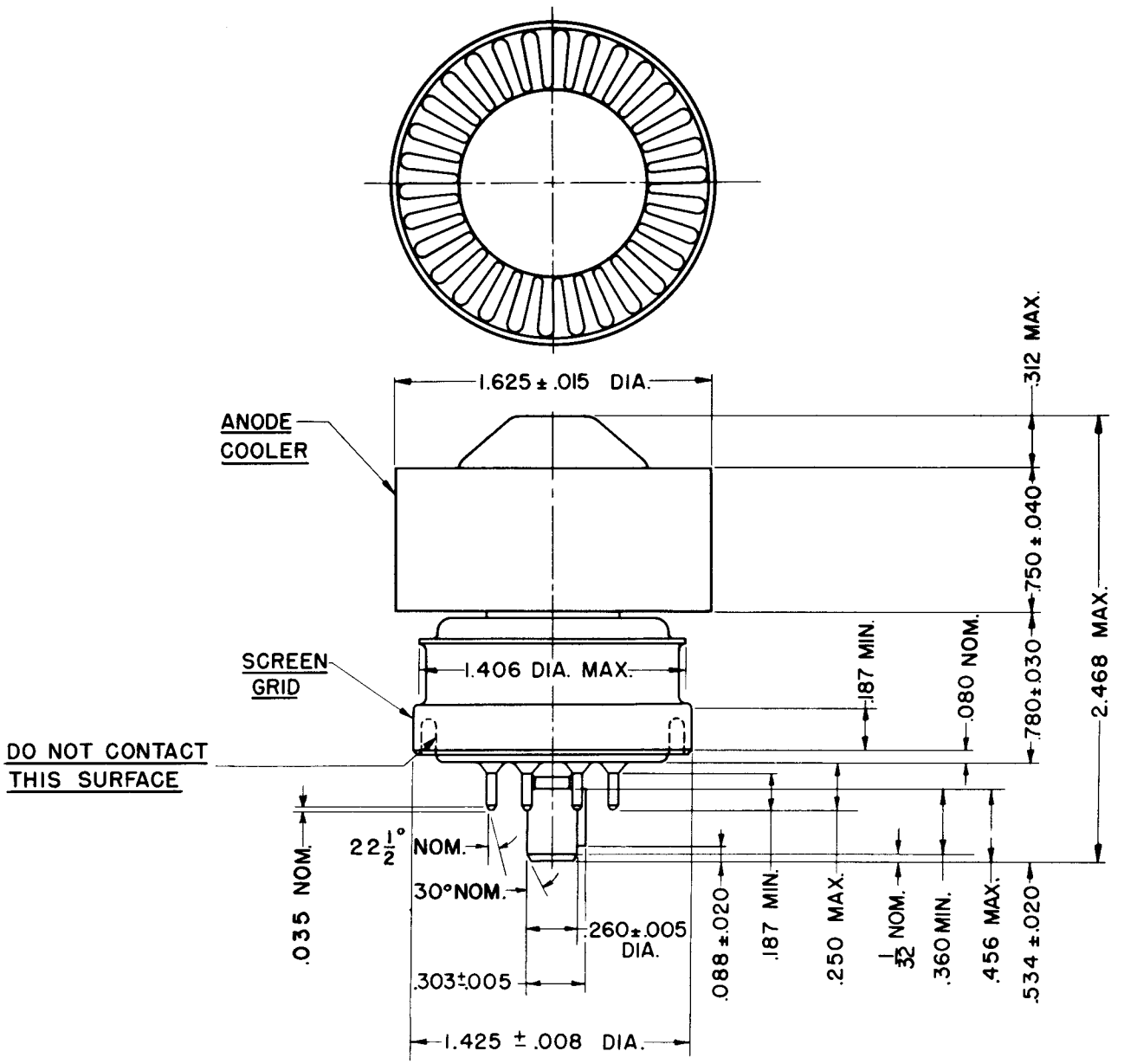
Grid Resistance—In class-A and -AB_1 amplifiers, where no grid current flows, the grid-bias voltage may be applied through a resistor. The maximum permissible series resistance per tube is 100,000 ohms.

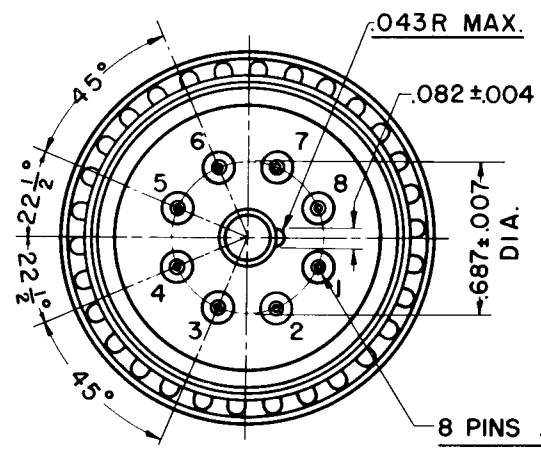
Special Applications—If it is desired to operate this tube under conditions widely different than those given here, write to Eitel-McCullough, Inc., San Bruno, California, for information and recommendations.


EIMAC 4X150A
CONTROL GRID
CHARACTERISTICS
Ec2 = 300V
GRID CURRENT - MILLIAMPERES
GRID VOLTAGE
20V
15V
10V
5V
100
50
0
100
200
300
400
500
600
700
PLATE VOLTAGE--VOLTS


EIMAC 4X150A
SCREEN GRID
CHARACTERISTICS
Ec2 = 300V
SCREEN CURRENT-AMPERES
0.2
0.15
0.1
.05
0
GRID VOLTAGE
+20
+10
0
-10
-20
-40
-30
100
200
300
400
500
600
700
PLATE VOLTAGE--VOLTS


EIMAC 4X150A
PLATE CHARACTERISTICS
Ec2 = 300V
PLATE CURRENT - AMPERES
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
CONTROL GRID VOLTAGE-VOLTS
+20
+15
+10
+ 5
0
- 5
-10
-15
-20
-30
-40
-50
-60
-70
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
PLATE VOLTAGE--VOLTS

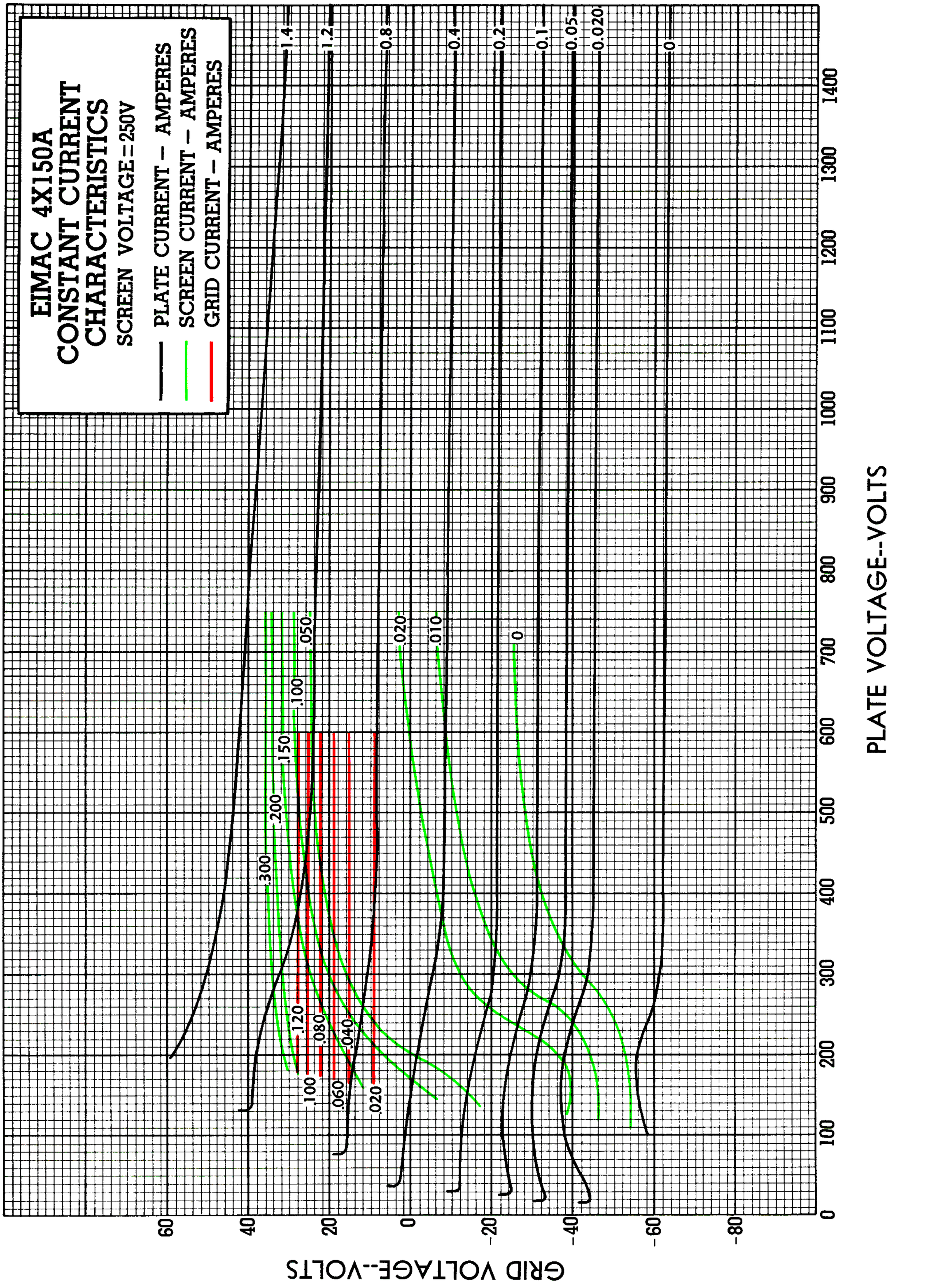




PIN NO. 1 SCREEN GRID
PIN NO. 2 CATHODE
PIN NO. 3 HEATER
PIN NO. 4 CATHODE
PIN NO. 5 I.C. DO NOT USE FOR EXTERNAL CONNECTION
PIN NO. 6 CATHODE
PIN NO. 7 HEATER
PIN NO. 8 CATHODE
CENTER PIN-CONTROL GRID

DIMENSIONS IN INCHES

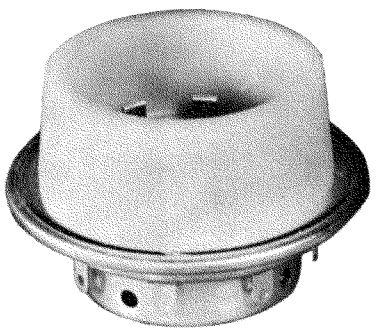
BOTTOM VIEW



Printed in U.S.A. 3-AI-70322

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

4X150A/4000 AND 4X150A/4010 AIR-SYSTEM SOCKETS



The Eimac 4X150A/4000 and 4X150A/4010 Air-System Sockets are designed to provide adequate air cooling and an efficient high-frequency circuit arrangement for the Eimac 4X150A and 4X150D tetrodes. The insulating materials used in their construction have very low r-f losses to well above 800 Mc., and are mechanically strong, non-porous, non-hygroscopic and substantially unaffected by temperatures up to 180° Centigrade. The contact fingers are of spring alloy and all metal parts are silver plated to reduce r-f losses.

The 4X150A/4000 Air-System Socket is characterized by having all connecting tabs insulated from the socket flange and skirt. This type socket is intended for use in circuits where the cathode of the tube is not at chassis potential.

The 4X150A/4010 Air-System Socket is characterized by having the four cathode connecting tabs (Numbers 2, 4, 6 and 8) riveted permanently to the socket skirt. This type socket is intended for use in circuits where the cathode of the tube is at chassis potential.

MOUNTING—If the tube and socket are to be used in a coaxial-line circuit, the Air-System Socket may be mounted directly on the end of the coaxial input line. The skirt of the socket fits over a cylinder of 1 5/8" outside diameter, and four mounting holes are provided (See Outline Drawings).

For chassis mounting, a 2¼" diameter hole should be cut into the deck and the socket secured by the three toe clamps provided.

DO NOT DRILL THROUGH THE SOCKET FLANGE.

CONNECTIONS—The control grid connection is on the axis of the socket and is provided with a No. 6-32 threaded hole for direct connection to a coaxial line or a terminal lug.

A low impedance path between screen grid and ground is provided by a bypass capacitor of from 2750 $\mu\mu$f $\pm$500 $\mu\mu$f built into the socket flange.

COOLING—A pressurized chamber should be provided to introduce an air stream into the socket from the under side to cool the grid, cathode and screen seals. A heat-resistant chimney is provided to direct the air stream over the tube envelope and through the anode radiator.

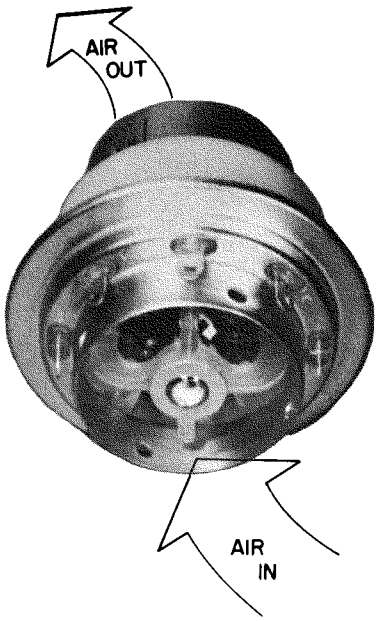
If a coaxial-line circuit is used, the input line should be pressurized, while the output cavity should be made air tight to direct the air through the anode radiator of the tube.

For the specific cooling requirements of the 4X150A and 4X150D, see the paragraph on "Cooling" in the 4X150A Data Sheet.

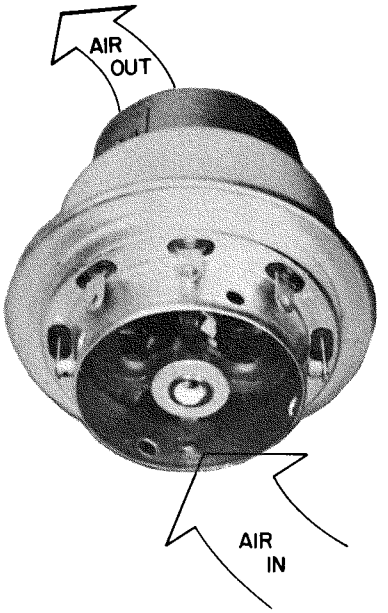
SOCKET IDENTIFICATION

TYPE NUMBER	DESCRIPTION
4X150A/4000	4X150A Air-System Socket with Chimney
4X150A/4001	4X150A Air-System Socket less Chimney
4X150A/4006	4X150A Air-System Chimney Only
4X150A/4010	4X150A Air-System Socket—Grounded Cathode—with Chimney
4X150A/4011	4X150A Air-System Socket—Grounded Cathode—less Chimney

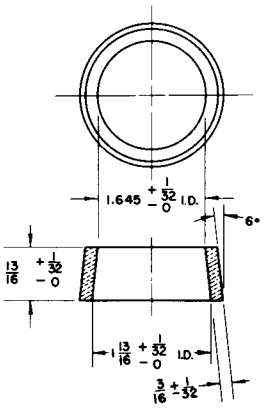
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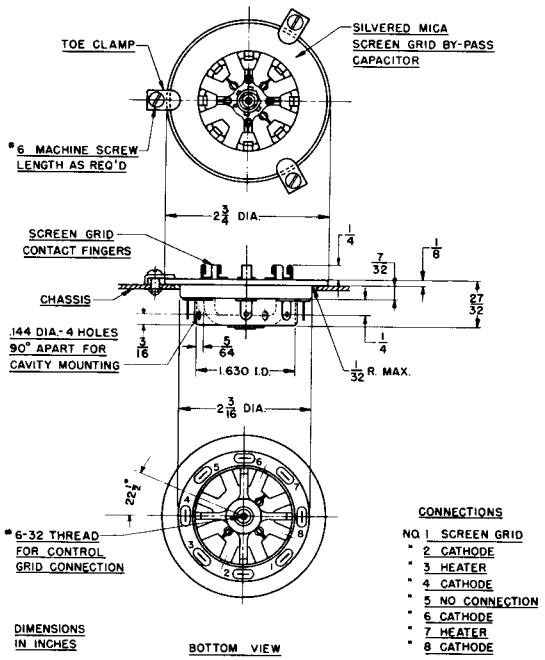
4X150A/4000
with 4X150A



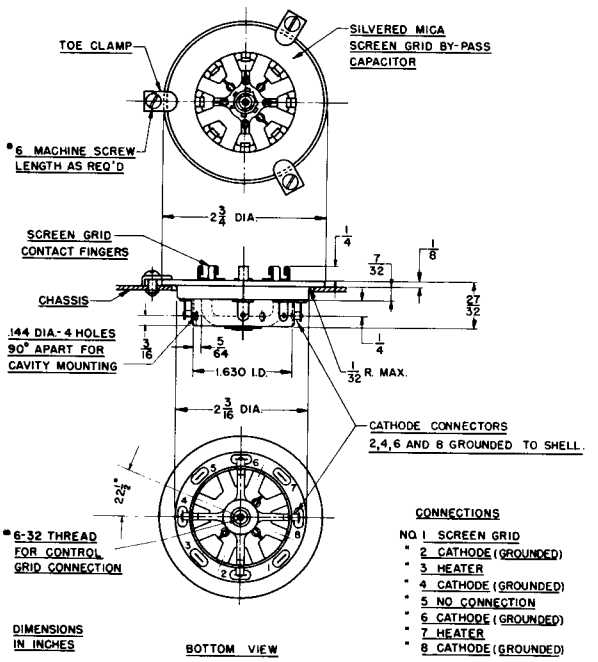
4X150A/4010
with 4X150A



4X150A/4006



4X150A/4001



4X150A/4011

Printed in U.S.A. 1-70322

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

4X150D

RADIAL-BEAM POWER TETRODE

The Eimac 4X150D is the 26.5 volt version of the 4X150A. The 4X150D differs from the 4X150A only in the construction of its package-type heater which is integral with the cathode. The material in the 4X150A data sheet applies exactly to the 4X150D, except for its heater rating of 26.5 volts at 0.57 amperes.

Because of its package-type heater, wherein an insulating material encloses the heater and is bonded to the inner cathode surface, the Eimac 4X150D is suited for use in airborne or vehicular service having 28 volt electrical systems.

As with the 4X150A, the use of the Eimac 4X150A Air-System Socket, or a socket providing equivalent air-cooling facilities, is required for the 4X150D.



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EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

4X150G
RADIAL-BEAM POWER TETRODE

The Eimac 4X150G is an extremely compact external-anode tetrode intended for use as a radio-frequency amplifier, frequency multiplier, or oscillator at frequencies well into the UHF region or as an amplifier in any service requiring a high-gain tube capable of delivering high power-output at low plate-voltage. The combination of a high ratio of transductance to capacitance and a plate dissipation capability of 150 watts make the tube an excellent wide-band amplifier for video applications.

The cathode, grid and screen electrodes are mounted on conical and cylindrical supports giving a minimum of circuit discontinuities and lead inductance. The rugged cylindrical terminals, progressively larger in size, allow the tube to be inserted in coaxial line cavities. The screen support and terminal provide maximum isolation between the grid-cathode terminals and the plate circuit.

In amplifier service at 500 megacycles, output power of 140 watts per tube, with a stage power-gain of 14, can be obtained. At 1000 megacycles an output power of 50 watts per tube is obtained with a power-gain of five.



GENERAL CHARACTERISTICS

ELECTRICAL			
Cathode: Coated Unipotential			
Heater Voltage		2.5	volts
Heater Current		6.25	amperes
Minimum Heating Time		45	seconds
Screen-Grid Amplification Factor (Average)		5.0	
Direct Interelectrode Capacitances (Average)	Grounded Grid	Grounded Cathode	
Feedback (without shielding)	less than 0.005	0.035	μμfd
Input	17.	27	μμfd
Output	4.5	4.5	μμfd
Transconductance (I_b=250 ma., E_b=500v., E_{c_2}=250 V.)		12,000	μmhos
MECHANICAL			
Cooling		Forced Air	
Mounting position		Any	
Maximum Over-all Dimensions			
Length		2¾	inches
Diameter		1.635	inches
Maximum Seated Height		1-27/32	inches
Net Weight		6	ounces
Shipping Weight (Average)		1.6	pounds

Note: Typical operation data are based on conditions of adjusting the r-f grid drive to a specified plate current, maintaining fixed conditions of grid bias and screen voltage. It will be found that if this procedure is followed, there will be little variation in power output between tubes even though there may be some variation in grid and screen currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	1250 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	150 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 165 Mc., per tube)

D-C Plate Voltage	600	750	1000	1250	volts
D-C Screen Voltage	250	250	250	250	volts
D-C Grid Voltage	—75	—80	—80	—90	volts
D-C Plate Current	200	200	200	200	ma
D-C Screen Current	37	37	30	20	ma
D-C Grid Current	10	10	10	10	ma
Peak R-F Grid Voltage (approx.)	90	95	95	105	volts
Driving Power	0.7	0.7	0.7	0.8	watts
Plate Power Input	120	150	200	250	watts
Plate Power Output	85	110	150	195	watts

The performance figures for frequencies up to 165 Mc. are obtained by calculation from the tube characteristic curves and confirmed by direct tests. The driving power includes only power taken by the tube grid and the bias circuit. The driving power and output power do not allow for losses in the associated resonant circuits.

TYPICAL OPERATION (Single tube, 500 Mc., coaxial cavity)

D-C Plate Voltage	600	800	1000	1250	volts
D-C Screen Voltage	250	250	250	250	volts
D-C Grid Voltage	—80	—80	—80	—80	volts
D-C Plate Current	200	200	200	200	ma
D-C Screen Current	7	7	7	7	ma
D-C Grid Current	10	10	10	10	ma
Driver Output Power (approx.)	10	10	10	10	watts
Power Input	120	160	200	250	watts
Useful Power Output	65	90	110	140	watts

These typical performance figures were obtained by direct measurement in operating equipment. The output power is useful power measured in a load circuit. The driving power is the total power taken by the tube and a practical resonant circuit. In many cases with further refinement and improved techniques better performance might be obtained.

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PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	1000 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	100 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 165 Mc.)

D-C Plate Voltage	400	600	800	1000	volts
D-C Screen Voltage	250	250	250	250	volts
D-C Grid Voltage	—90	—95	—100	—105	volts
D-C Plate Current	200	200	200	200	ma
D-C Screen Current	40	35	25	20	ma
D-C Grid Current	7	8	10	15	ma
Peak A-F Screen Voltage at crest of 100% Modulation	140	150	160	170	volts
Peak R-F Grid Input Voltage (approx.)	110	120	120	125	volts
Driving Power (approx.)	1	1	1.5	2	watts
Plate Dissipation	25	40	60	60	watts
Plate Power Input	80	120	160	200	watts
Plate Power Output	55	80	100	140	watts

RADIO-FREQUENCY POWER AMPLIFIER

Class-B Linear, Television Visual Service (per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	1250 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT (AVERAGE)	250 MAX. MA
PLATE DISSIPATION	150 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 216 Mc., 5-Mc. bandwidth)

D-C Plate Voltage	750	1000	1250	volts
D-C Screen Voltage	300	300	300	volts
D-C Grid Voltage	—60	—65	—70	volts
During Sync-Pulse Peak:				
D-C Plate Current	335	330	305	ma
D-C Screen Current	50	45	45	ma
D-C Grid Current	15	20	25	ma
Peak R-F Grid Voltage	85	95	100	volts
R-F Driver Power (approx.)	7	8	9	watts
Useful Power Output	135	200	250	watts
Black Level:				
D-C Plate Current	245	240	230	ma
D-C Screen Current	20	15	10	ma
D-C Grid Current	4	4	4	ma
Peak R-F Grid Voltage (approx.)	65	70	75	volts
R-F Driver Power (approx.)	4.25	4.7	5.5	watts
Plate Power Input	185	240	290	watts
Useful Power Output	75	110	140	watts

PLATE PULSED RADIO FREQUENCY AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS

PULSED PLATE VOLTAGE	7000 MAX. VOLTS
PULSED SCREEN VOLTAGE	1500 MAX. VOLTS
D-C GRID VOLTAGE	—500 MAX. VOLTS
MAXIMUM PULSE DURATION	5 MICROSECONDS
PULSED CATHODE CURRENT	7 MAX. AMPS
AVERAGE POWER INPUT	250 MAX. WATTS
PLATE DISSIPATION	150 MAX. WATTS
SCREEN DISSIPATION	15 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL PULSE OPERATION

Single tube oscillator, 1200-Mc.

Pulsed Plate Voltage	5	7	Kilovolts
Pulsed Plate Current	4.0	6.0	Amps.
Pulsed Screen Voltage	800	1000	Volts
Pulsed Screen Current	0.3	0.4	Amps.
D-C Grid Voltage	—200	—250	Volts
Pulsed Grid Current	0.5	0.6	Amps.
Pulse Duration	4	4	Microseconds
Pulse Repetition Rate	2500	1250	Per second
Peak Power Output	7	17	Kilowatts

APPLICATION

MECHANICAL

Mounting—The 4X150G may be mounted in any position. The concentric arrangement of the electrode terminals permits the use of the 4X150G in coaxial line type circuits to advantage.

Connections to the contact surfaces should be made by means of spring-finger collets which have sufficient pressure to maintain a good electrical contact at all fingers. The presence of non-contacting, or intermittently-contacting, fingers may result in erratic circuit operation, particularly at very-high- or ultra-high-frequencies. Points of electrical contact should be kept clean and free of oxidation to minimize r-f losses.

Cooling—The 4X150G requires sufficient forced-air cooling to keep the cooler core and the metal parts of the metal-to-glass seals from exceeding a maximum temperature of 150°C. The air flow must be started when power is applied to the heater, and must continue without interruption until all electrode voltages have been removed from the tube.

Effective cooling of the anode is accomplished by directing six cubic feet per minute of air through the anode cooler. This flow is obtained at a pressure drop across the cooler of approximately 0.25 inch of water column. The grid, cathode and heater terminals are cooled by high velocity air directed at the terminals and the connecting collets which aid in the removal of heat from the terminals by conduction. The volume required will depend upon the socket arrangement and should be adequate to keep the metal-to-glass seals below 150°C and the center heater terminal below 200°C.

The air requirements stated above are based on op-

eration at sea level and an ambient temperature of 20°C. Operation at high altitudes or at high ambient temperatures requires a greater volume of air flow. The necessary design information for such conditions is contained in an article entitled "Blower Selection for Forced-Air-Cooled Tubes," by A. G. Nekut, in the August, 1950, issue of "Electronics."

Temperature of the external parts of a tube may be measured with the aid of "Tempilaq," a temperature-sensitive lacquer manufactured by the Tempil Corporation, 11 West 25th Street, New York 10, N. Y.

ELECTRICAL

Heater—The heater should be operated as close to 2.5 volts as possible, but it will withstand heater-voltage variations as great as 10% without injury. Some variation in power output must be expected to occur with variations of the heater voltage. In UHF operation of the 4X150G some advantage can be gained by operation of the heater at reduced voltages to compensate for cathode back-heating. Under conditions of operation for maximum power output at frequencies between 500 and 1000 Mc the heater voltage may be reduced to 2.4 volts. 2.3 volts is usually adequate for similar conditions at frequencies from 1000 to 1500 Mc.

Grid Dissipation—Grid-circuit driving-power requirements increase with increasing frequency because of losses other than grid dissipation. This becomes noticeable at frequencies above 150 megacycles and increases until at 500 Mc the required driving power may be as much as 15 watts in an ordinary circuit.

Despite the increased driving power required by the circuit as a whole at higher frequencies, the power actually dissipated at the tube grid does not increase greatly. Satisfactory operation in stable amplifier circuits is indicated by d-c grid-current values below approximately 15 milliamperes.

Screen Dissipation—Bias- or plate-supply failure or unloaded-plate-circuit operation can cause the screen current and dissipation to rise to excessive values. Protection for the screen can be provided by an overload relay in the screen circuit, in addition to the usual plate-overload relay. Use of a screen-current milliammeter is advisable.

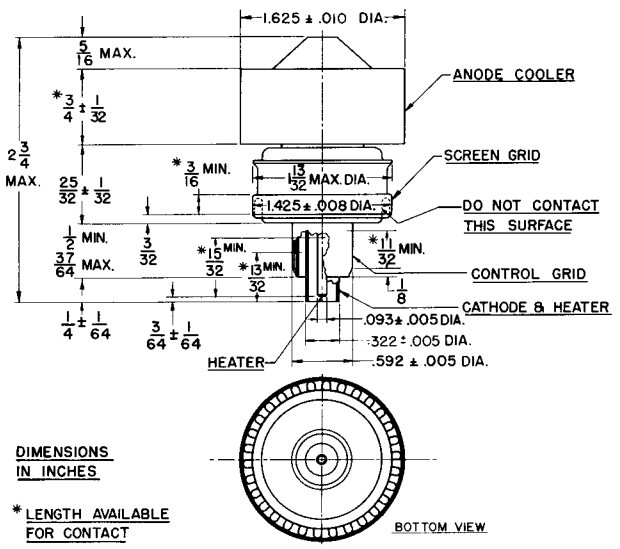
Plate Dissipation—The maximum-rated plate dissipation is 150 watts. The maximum-rated plate dissipation for plate-modulated applications is 100 watts under carrier conditions, which permits the plate dissipation to rise to 150 watts under 100% sinusoidal modulation. Plate dissipation may be permitted to exceed the maximum rating momentarily, as, for instance, during tuning procedures.

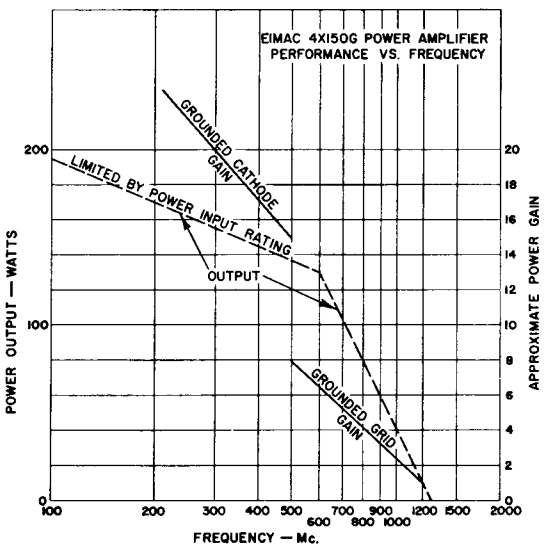
UHF Operation—Transit-time effects, which occur at ultra-high frequencies in the 4X150G, can be minimized by adherence to the operating practices suggested below:

1. Use a minimum d-c bias voltage, not over twice cut-off.
2. Apply only enough drive to obtain satisfactory plate efficiency.
3. Operate the screen at reasonably high voltage, but do not exceed the screen-dissipation rating. The circuit should be loaded to obtain screen-current values close to those given under "Typical Operation" at 500 Mc.
4. Fairly heavy plate loading is required. In general, low-voltage, high-current operation is preferable to operation at high voltages and low currents. If conditions require a change to lighter plate loading, the drive should also be reduced to the minimum value for satisfactory operation at the new output level.
5. Parasitic oscillations are usually associated with excessive grid and screen currents and are injurious to vacuum tubes. Similarly, tuned-plate circuits which accidentally become simultaneously resonant to harmonics and the fundamental frequency may also cause low efficiency and resultant tube damage.

Plate Modulation—Plate modulation can be applied to the 4X150G when it is operated as a class-C radio-frequency amplifier. To obtain 100% modulation, the d-c screen voltage must be modulated in phase with the plate modulation. Self-modulation of the screen by means of a series resistor or reactor may not be satisfactory in this particular tetrode due the screen-voltage, screen-current characteristic.

Grid Resistance—In class-A and -AB_1 amplifiers, where no grid current flows, the grid-bias voltage may be applied through a resistor. The maximum permissible series resistance per tube is 100,000 ohms.

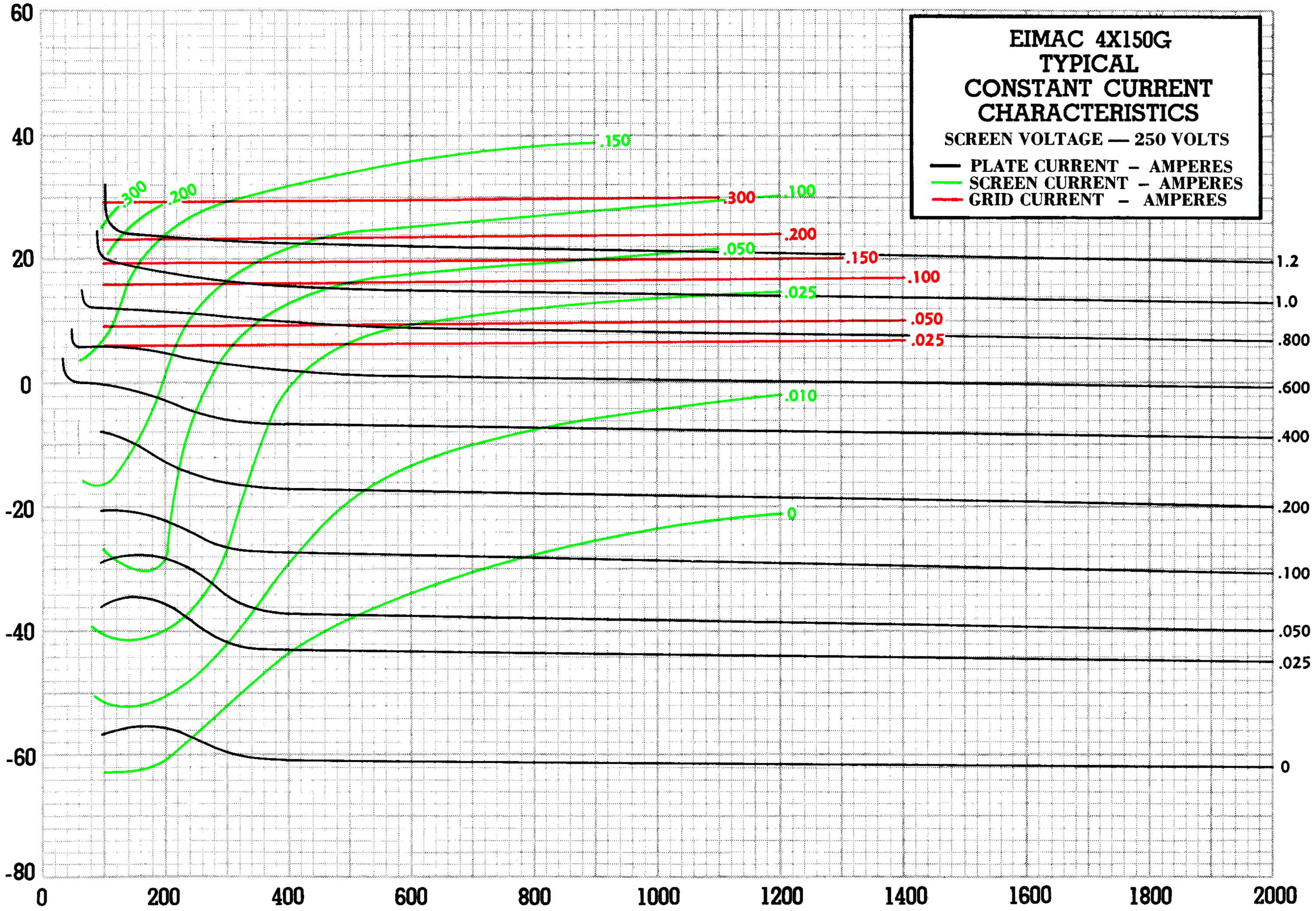




EIMAC 4X150G
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS

SCREEN VOLTAGE — 250 VOLTS

— PLATE CURRENT – AMPERES
— SCREEN CURRENT – AMPERES
— GRID CURRENT – AMPERES

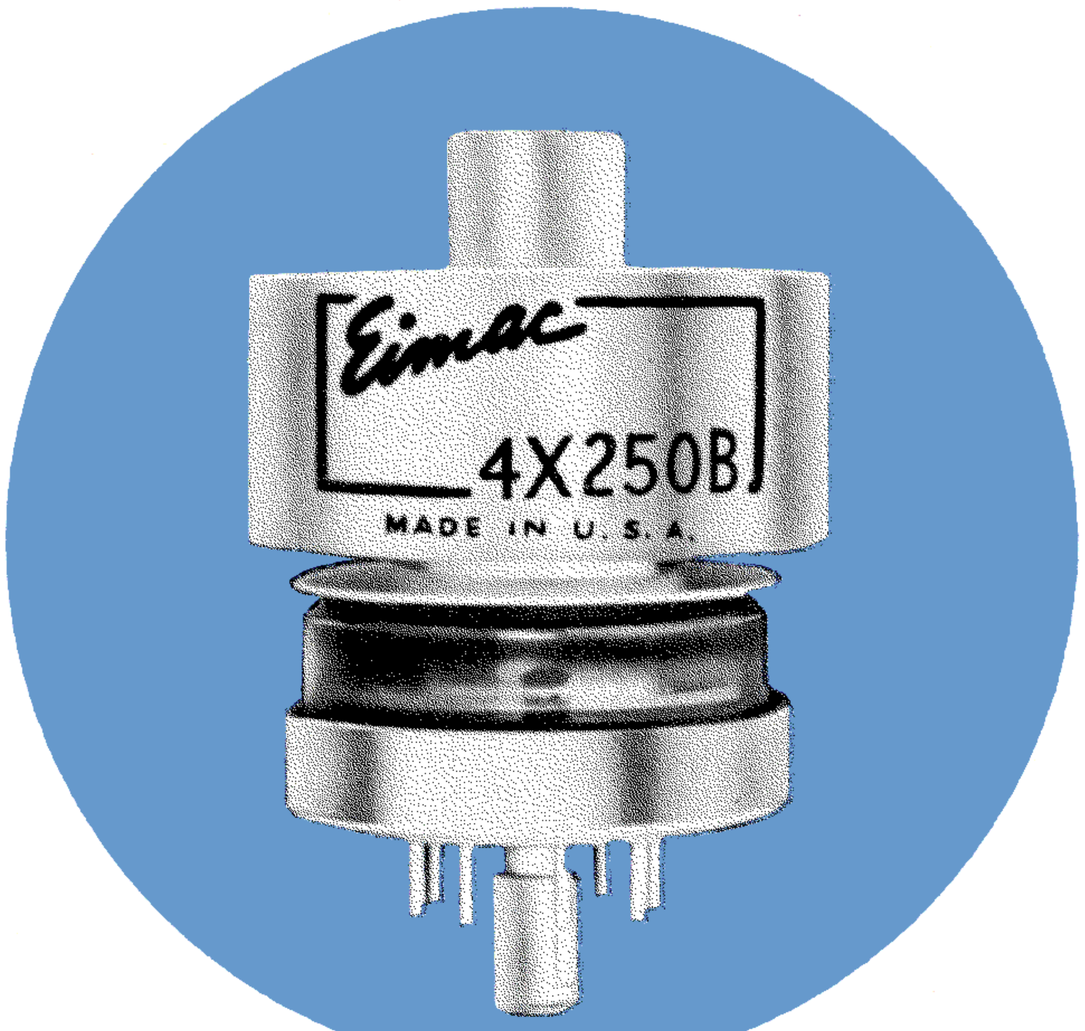


GRID VOLTAGE – VOLTS

PLATE VOLTAGE – VOLTS

Eimac
4X150G

Printed in U.S.A. 6-89047



Introducing the Eimac

4X250B

A superior radial-beam power tetrode unilaterally interchangeable with the Eimac 4X150A

HIGHER POWER • EASIER COOLING • LONGER LIFE

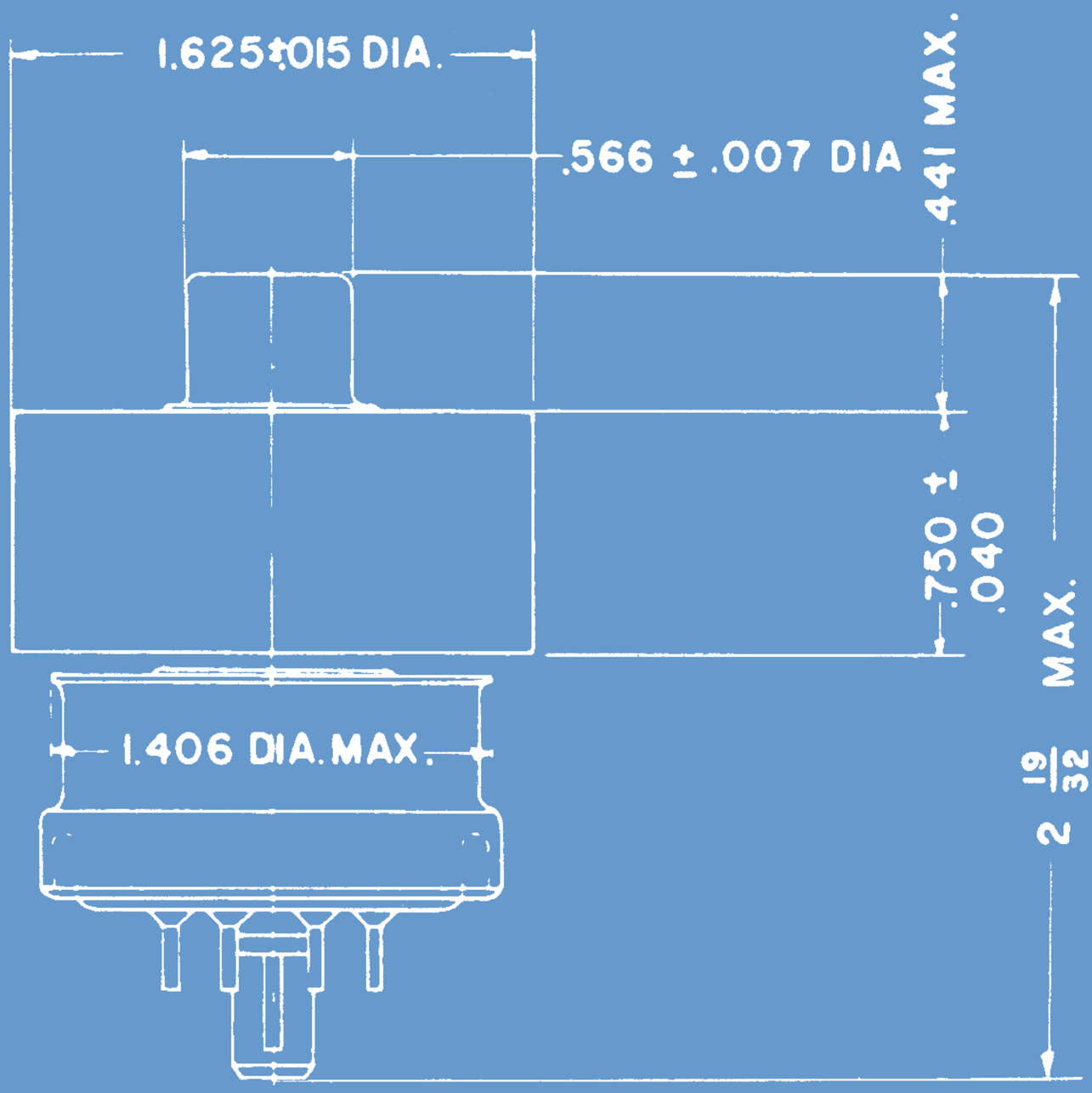
4X250B, a new, superior radial-beam power tetrode by Eimac—originators of the famous 4X150A—is now available. This amazing new bantam is intended for modulator, oscillator, amplifier or frequency multiplier use at all frequencies into UHF. It is unilaterally interchangeable with the 4X150A in nearly all cases, but offers higher power, easier cooling and longer life.

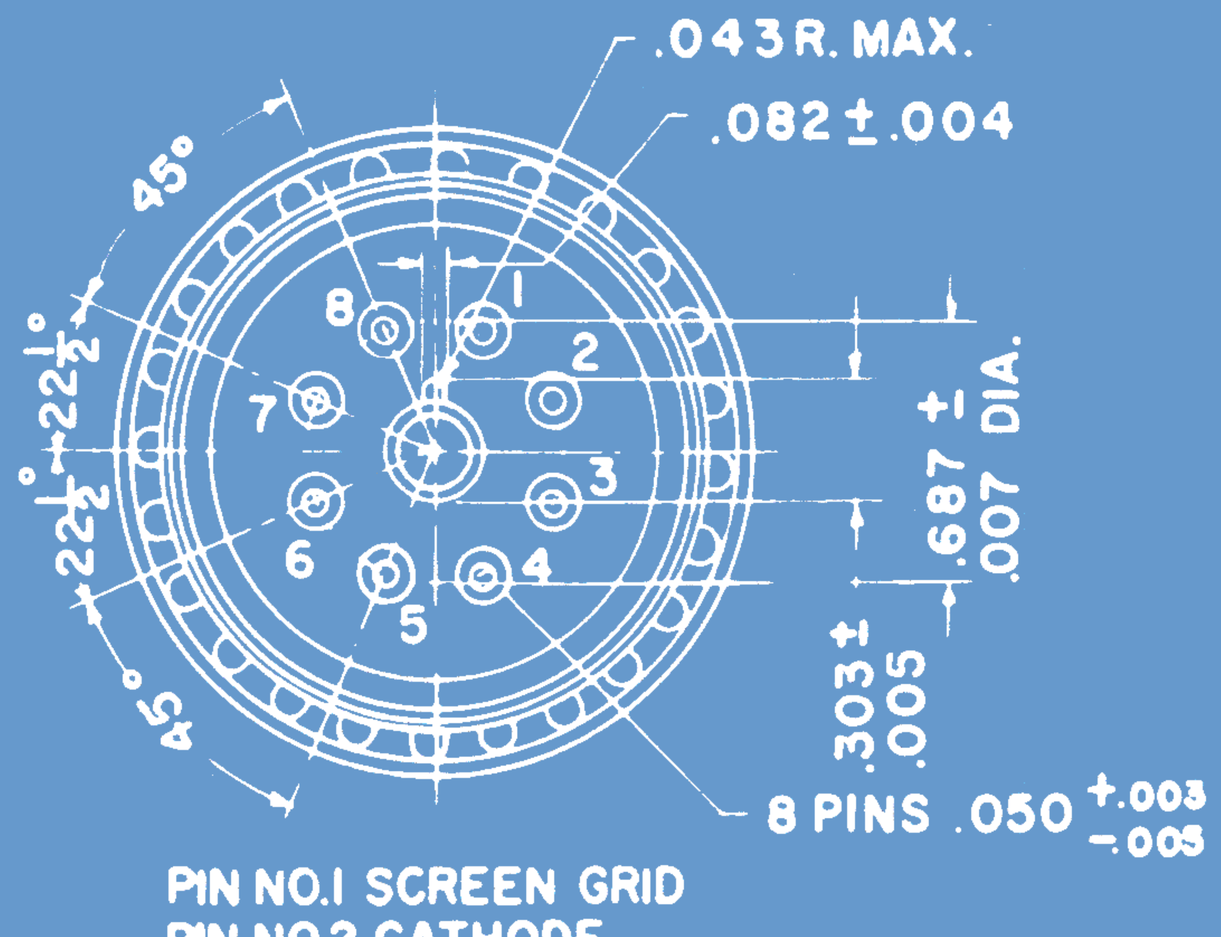
HIGHER POWER—Design advancements permit increased plate dissipation capabilities of 250 watts, compared to 150 watts for the 4X150A. Plate voltage ratings have been increased to 2000 volts and plate power input has been doubled to 500 watts.

EASIER COOLING—The new Eimac integral-finned anode, plus other design improvements, make the 4X250B considerably easier to cool than the 4X150A. Seal temperatures are lower, the anode temperature tolerance is higher and the cooler is more efficient. At equal plate dissipations, the blower horsepower requirement of the 4X250B is one-half that of the 4X150A. Standby forced-air cooling of the 4X250B is eliminated if convection air is properly provided. The table on page four gives a cooling requirement comparison between the 4X250B and 4X150A.

LONGER LIFE—A newly designed, highly efficient oxide cathode, plus the lower seal temperatures, increased anode temperature tolerance and the more efficient cooler, enable the 4X250B to meet the most critical standards and assure longer life. New techniques in grid production, high vacuum outgassing and product evaluation are additional Eimac features that insure uniform quality and more hours of top performance.

Eimac





PIN NO.1 SCREEN GRID
PIN NO.2 CATHODE
PIN NO.3 HEATER
PIN NO.4 CATHODE
PIN NO.5 I.C. DO NOT USE FOR EXTERNAL CONN.
PIN NO.6 CATHODE
PIN NO.7 HEATER
PIN NO.8 CATHODE
PIN NO.9 PIN CONTROL GRID

DIMENSIONS IN INCHES

The Eimac 4X250B is a compact, oxide-cathode, external-anode power tetrode, unilaterally interchangeable with the 4X150A in nearly all cases, and is intended for use as an amplifier, oscillator or frequency multiplier over a wide range of frequencies extending into the UHF region. It is cooled by convection and forced air.

A single 4X250B in a coaxial-cavity amplifier circuit will deliver up to 300 watts of useful power output at 400mc, although this is not the upper frequency limit of the tube.

The high transconductance of the 4X250B makes the tube useful at relatively low plate voltages. High ratio of transconductance to inter-electrode capacitance and a 250 watt plate dissipation rating make the tube ideal for wide-band amplifier applications.

The use of the Eimac 4X150A Air-System Socket or a socket providing equivalent air cooling and RF by-passing characteristics is required.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Minimum Heating Time	30 seconds
Cathode-to-Heater Voltage	150 max. volts
Heater: Voltage	6.0 volts
Current	2.1 amperes
Grid-Screen Amplification Factor (Average)	5
Direct Inter-electrode Capacitances (Average)	
Grid-Plate	0.04 $\mu\mu$f
Input	18.5 $\mu\mu$f
Output	4.7 $\mu\mu$f
Transconductance (E_b=500v., E_{C2}=250v., I_b=200ma)	12,000 μmhos
Frequency for Maximum Plate Voltage Ratings	400 Mc

(All other Maximum Ratings applicable to 500 Mc)

MECHANICAL

Base	9-pin, special
Recommended Socket	Eimac 4X150A Air-System Socket
Base Connections	See outline drawing
Mounting	Any position
Cooling	Convection and Forced air
Maximum Over-All Dimensions	
Length	2.59 inches
Diameter	1.65 inches
Seated Height	2.03 inches
Net Weight	4.0 ounces
Shipping Weight	1.6 pounds

OPERATIONAL CHARACTERISTICS

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

(Class-C Telegraphy or FM Telephony)
(Key-Down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	−250 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 175Mc, per tube)

D-C Plate Voltage	500	1000	1500	2000 volts
D-C Screen Voltage	250	250	250	250 volts
D-C Grid Voltage	−90	−90	−90	−90 volts
D-C Plate Current	250	250	250	250 ma
D-C Screen Current	45	35	30	25 ma
D-C Grid Current	32	28	28	27 ma
Peak R-F Grid Voltage (approx.)	118	116	116	115 volts
Driving Power	3.6	3.2	3.2	2.8 watts
Plate Power Input	125	250	375	500 watts
Plate Power Output	85	195	300	410 watts

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	1500 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	−250 MAX. VOLTS
D-C PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	165 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 175Mc, per tube)

D-C Plate Voltage	500	1000	1500 volts
D-C Screen Voltage	250	250	250 volts
D-C Grid Voltage	−100	−100	−100 volts
D-C Plate Current	200	200	200 ma
D-C Screen Current	45	35	25 ma
D-C Grid Current	22	19	17 ma
Peak R-F Grid Input Voltage	124	122	121 volts
Driving Power	2.7	2.3	2.1 watts
Plate Power Input	100	200	300 watts
Plate Power Output	75	160	250 watts

CLASS-AB POWER AMPLIFIER OR MODULATOR

MAXIMUM RATINGS (Per Tube)

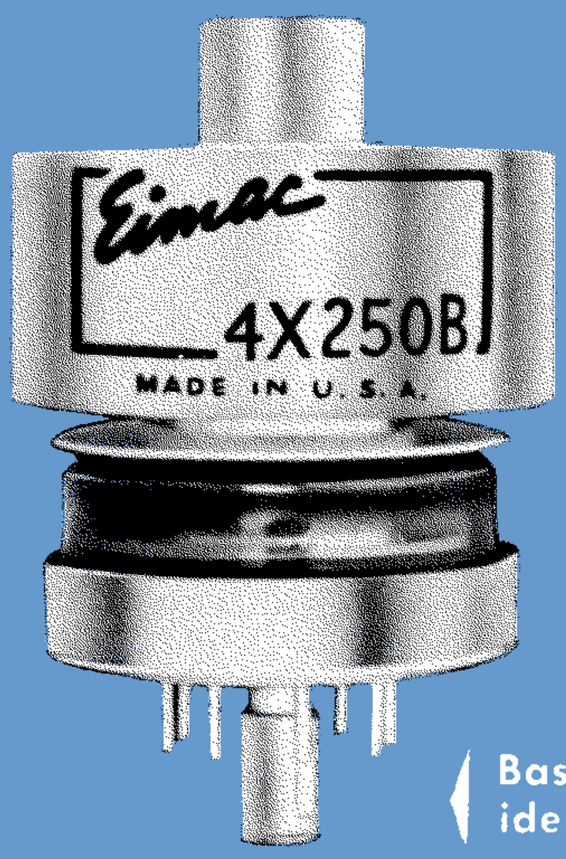
D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION

Class-AB$_1$ R-F Linear Amplifier (Frequencies to 175 Mc, per tube)

D-C Plate Voltage	1000	1500	2000 volts
D-C Screen Voltage	350	350	350 volts
D-C Grid Voltage (Approx.)*	−50	−50	−50 volts
Zero-Signal D-C Plate Current	100	100	100 ma
Max-Signal D-C Plate Current	250	250	250 ma
Max-Signal D-C Screen Current	25	20	15 ma
Peak R-F Grid Voltage	50	50	50 volts
Driving Power	0	0	0 watts
Max-Signal Plate Dissipation	125	150	175 watts
Max-Signal Power Output	125	225	325 watts

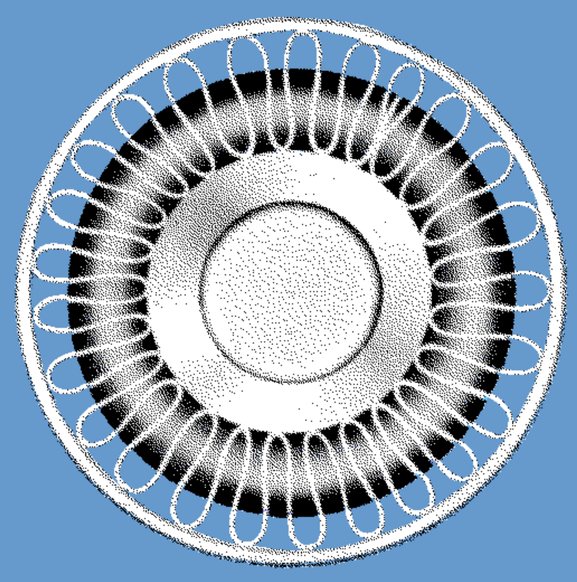
*Adjust grid voltage to obtain specified zero-signal plate current.



A New unitized integral-finned anode makes cooling easier

B New, improved oxide cathode

C Basing arrangement identical to 4X150A



ACTUAL SIZE

SIDE AND TOP VIEW OF 4X250B SHOWING STRUCTURAL FEATURES

A The Eimac integral-finned anode, plus other new design and production techniques, permit higher power ratings for the 4X250B over the 4X150A and make it much easier to cool. The anode-cooler is now one unit, allowing a more efficient anode-to-fin heat transfer and creating an enlarged air-flow area without increasing anode dimensions. Improvements make cooling of the 4X250B easier than the 4X150A by: 1) Eliminating forced-air cooling during stand-by periods if convection air is properly provided, and 2) reducing air pressure and air volume requirements.

B A new improved oxide cathode adds extra hours of tube life.

C Basing arrangement identical to the 4X150A has been maintained, permitting use of the 4X250B in Eimac 4X150A air-system sockets and chimneys. For optimum cooling, the 4X250B should be used with Eimac air-system socket and chimney combinations.

Priced at only $42.50, the 4X250B gives more watt-hours per dollar in all types of commercial, military and amateur operation.

When designing new equipment or replacing 4X150A's, consider the Eimac 4X250B — for higher power, longer life and easier cooling.

FORCED-AIR COOLING REQUIREMENTS

4X250B vs 4X150A

(with Eimac Air-System Socket at normal room temperatures)

CONDITIONS	4X250B	4X150A
Below 175mc		
150w plate dissipation		
volume	1.8 cfm	2.3 cfm
pressure	0.05 in.	0.11 in.
250w plate dissipation		
volume	3.6 cfm	———
pressure	0.23 in.	———
500mc		
volume	3.8 cfm	7.5 cfm
pressure	0.25 in.	0.6 in.
Standby	none required*	required

*if convection air is properly provided

EITEL-McCULLOUGH, INC.

SAN BRUNO • CALIFORNIA

TENTATIVE DATA

EIMAC

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

4X250F

RADIAL-BEAM POWER TETRODE



The Eimac 4X250F is a compact, oxide-cathode, external-anode power tetrode, unilaterally interchangeable with the 4X150D in most applications, and is intended for use as an amplifier, oscillator or frequency multiplier over a wide range of frequencies extending into the UHF region. It is cooled by convection and forced air.

A single 4X250F in a coaxial-cavity amplifier circuit will deliver up to 300 watts of useful power output at 400 megacycles although this is not the upper frequency limit of the tube.

Outstanding features of the 4X250F are: 1. Simple air-cooling requirements. 2. A maximum plate dissipation rating of 250 watts available for low-efficiency applications. 3. A maximum d-c plate voltage rating of 2000 volts at frequencies up to 400 Mc. The high transconductance of the 4X250F makes the tube useful at relatively low plate voltages. The high ratio of transconductance to inter-electrode capacitance and the 250-watt plate dissipation make the tube very useful for wide-band amplifier applications.

The use of an Eimac Air-System Socket or a socket providing equivalent air cooling characteristics, is required.

GENERAL CHARACTERISTICS

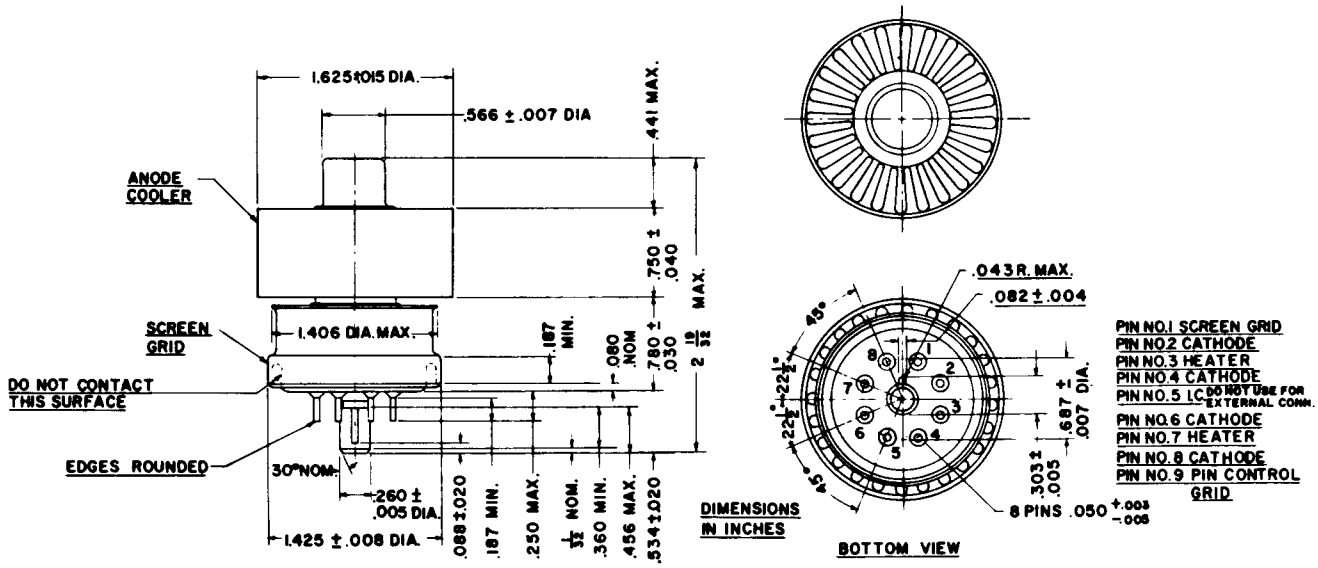
ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Minimum Heating Time	30	seconds
Cathode-to-Heater Voltage	150	max. volts
Heater: Voltage	26.5	volts
Current	0.50	amperes
Grid-Screen Amplification Factor (Average)	5	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	0.04	μμf
Input	18.5	μμf
Output	4.7	μμf
Transconductance (E_b=500v., E_{c2}=250v., I_b=200 ma)	12,000	μmhos
Frequency for Maximum Plate Voltage Ratings	400	Mc

(All other Maximum Ratings applicable to 500 Mc)

MECHANICAL

Base	9-pin, special	
Recommended Socket	Eimac Air-System Socket	
Base Connections	See outline drawing	
Mounting	Any position	
Cooling	Convection and Forced air	
Maximum Over-all Dimensions		
Length	2.59	inches
Diameter	1.65	inches
Seated Height	2.03	inches
Net Weight	4.0	ounces
Shipping Weight	1.6	pounds



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RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 175 Mc, per tube)

D-C Plate Voltage	500	1000	1500	2000	volts
D-C Screen Voltage	250	250	250	250	volts
D-C Grid Voltage	—90	—90	—90	—90	volts
D-C Plate Current	250	250	250	250	ma
D-C Screen Current	45	35	30	25	ma
D-C Grid Current	32	28	28	27	ma
Peak R-F Grid Voltage (approx.)	118	116	116	115	volts
Driving Power	3.6	3.2	3.2	2.8	watts
Plate Power Input	125	250	375	500	watts
Plate Power Output	85	195	300	410	watts

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	1500 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	165 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 175Mc, per tube)

D-C Plate Voltage	500	1000	1500	volts
D-C Screen Voltage	250	250	250	volts
D-C Grid Voltage	—100	—100	—100	volts
D-C Plate Current	200	200	200	ma
D-C Screen Current	45	35	25	ma
D-C Grid Current	22	19	17	ma
Peak R-F Grid Input Voltage	124	122	121	volts
Driving Power	2.7	2.3	2.1	watts
Plate Power Input	100	200	300	watts
Plate Power Output	75	160	250	watts

CLASS-AB POWER AMPLIFIER OR MODULATOR

MAXIMUM RATINGS (Per tube)

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION
Class-AB_1 Audio Amplifier (Sinusoidal wave, two tubes unless otherwise noted)

D-C Plate Voltage	1000	1500	2000	volts,
D-C Screen Voltage	350	350	350	volts
D-C Grid Voltage (approx.)*	—50	—50	—50	volts
Zero-Signal D-C Plate Current	200	200	200	ma
Max-Signal D-C Plate Current	500	500	500	ma
Max-Signal D-C Screen Current	50	40	30	ma
Effective Load, Plate-to-Plate	3260	5760	8260	ohms
Peak A-F Grid Input Voltage (per tube)	50	50	50	volts
Driving Power	0	0	0	watts
Max-Signal Plate Dissipation (per tube)	125	150	175	watts
Max-Signal Plate Power Output	250	450	650	watts
Third-Harmonic Distortion	4.5	4.5	4.5	pct

*Adjust grid voltage to obtain specified zero-signal plate current

TYPICAL OPERATION
Class-AB_1 R-F Linear Amplifier (Frequencies to 175 Mc, per tube)

D-C Plate Voltage	1000	1500	2000	volts
D-C Screen Voltage	350	350	350	volts
D-C Grid Voltage (approx.)*	—50	—50	—50	volts
Zero-Signal D-C Plate Current	100	100	100	ma
Max-Signal D-C Plate Current	250	250	250	ma
Max-Signal D-C Screen Current	25	20	15	ma
Peak R-F Grid Voltage	50	50	50	volts
Driving Power	0	0	0	watts
Max-Signal Plate Dissipation	125	150	175	watts
Max-Signal Plate Power Output	125	225	325	watts

*Adjust grid voltage to obtain specified zero-signal plate current

Note: Typical operation data are based on conditions of adjusting the r-f grid drive to a specified plate current, maintaining fixed conditions of grid bias and screen voltage. It will be found that if this procedure is followed, there will be little variation in power output between tubes even though there may be some variation in grid and screen currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

APPLICATION

MECHANICAL

Mounting—The 4X250F may be mounted in any position. Use of an Eimac Air-System Socket, or its equivalent, is recommended.

The tube will fit a standard "loktal" socket, but the use of such a socket in the usual way prevents adequate air-cooling of the base of the tube. Use of the "loktal" socket is not recommended.

Connections to the terminals of all the electrodes except the plate are provided by the Air-System Socket. The anode-cooler assembly provides a terminal surface for the plate connection. For high-frequency applications a metal band or a spring-finger collet should be used to make good electrical contact with the cylindrical outer surface of the anode cooler. Points of electrical contact should be kept clean and free of oxidation to minimize r-f losses.

Cooling—The 4X250F requires sufficient cooling air to prevent the temperature of the metal part of the metal-to-glass seals exceeding a maximum of 175°C. The temperature of the anode as measured at the base of the cooling fins must be maintained below its maximum of 250°C.

Under conditions of normal room temperatures and installation in the Eimac Air-System Socket, the 4X250F requires no forced air during stand-by periods where only the heater power is on. Anode cooling air may be started and stopped simultaneously with the power on the anode. A quantity of 3.8 cubic feet per minute is required to cool the tube when operating at maximum-rated plate dissipation at 500 Mc. At this quantity of air the pressure drop across the cooler and the Air-System Socket is equal to approximately 0.25 inches of water column. At frequencies below 175 Mc and at 250 watts plate dissipation the quantity of air flow may be reduced to 3.6 cubic feet per minute, at which quantity the pressure drop is 0.23 inches of water column.

The air requirements stated above are based on operation at sea level and an ambient temperature of 20°C. Operation at high altitude or at high ambient temperatures requires a greater volume of air flow. The necessary design information for such conditions is contained in an article entitled "Blower Selection for Forced-Air-Cooled Tubes," by A. G. Nekut, in the August, 1950, issue of "Electronics."

One method of measuring temperature is provided by the use of "Tempilaq", a temperature-sensitive lacquer, which melts when a given temperature is reached. Where forced-air cooling is employed, very thin applications of the lacquer must be used. This product is obtainable from the Tempil Corporation, 11 West 25th St. New York 10, N. Y.

ELECTRICAL

Heater—The heater should be operated as close to 26.5 volts as possible, but it will withstand heater-voltage variations as great as 10% for short durations without injury. Some variations in power output must be expected to occur with variations of the heater voltage.

Cathode—The cathode is internally connected to the four even-numbered base pins. All four corresponding socket terminals should be used for connection to the external circuit. The leads should be of large cross-section and as short and direct as possible to minimize cathode-lead inductance.

Grid Dissipation—Grid-circuit driving-power requirements increase with frequency because of circuit losses other than grid dissipation. This becomes noticeable at frequencies near 100 Mc., and increases until at 500 Mc. as much as 20-25 watts driving power may be required in ordinary circuits.

Despite the increased driving power required by the circuit as a whole at higher frequencies, the power actually dissipated at the tube grid does not increase greatly. Satisfactory operation in stable amplifier circuits is indicated by d-c grid-current values below approximately 20 milliamperes.

Screen Dissipation—Bias- or plate-supply failure or unloaded-plate-circuit operation can cause the screen current and dissipation to rise to excessive values. Protection for the screen can be provided by an overload relay in the screen circuit, in addition to the usual plate-circuit overload relay. Use of a screen-current milliammeter is recommended.

Plate Dissipation—The maximum-rated plate dissipation is 250 watts. The maximum-rated plate dissipation for plate modulated applications is 165 watts under carrier conditions, which permits the plate dissipation to rise to 250 watts under 100% sinusoidal modulation.

Plate dissipation may be permitted to exceed the maximum rating momentarily, as, for instance, during tuning.

UHF Operation—Transit time and other effects, which occur at ultra-high-frequencies in the 4X250F, can be reduced to minimum values by compliance with the following suggested operating conditions:

1. Use a minimum value of d-c grid bias voltage.
2. Apply only enough grid drive to obtain satisfactory plate efficiency.
3. Operate the screen at reasonably high voltage, but do not exceed the screen dissipation rating.
4. Fairly heavy plate loading is required. In general, low-voltage, high-current operation is preferable to operation at high voltage and low current. If conditions require a change to lighter plate loading, the drive should also be reduced to the minimum value for satisfactory operation at the new output level.
5. Parasitic oscillations are usually associated with excessive grid and screen current and are injurious to vacuum tubes. Similarly, tuned-plate circuits which accidentally become simultaneously resonant to harmonics and the fundamental frequency may also cause low efficiency and damage tubes.

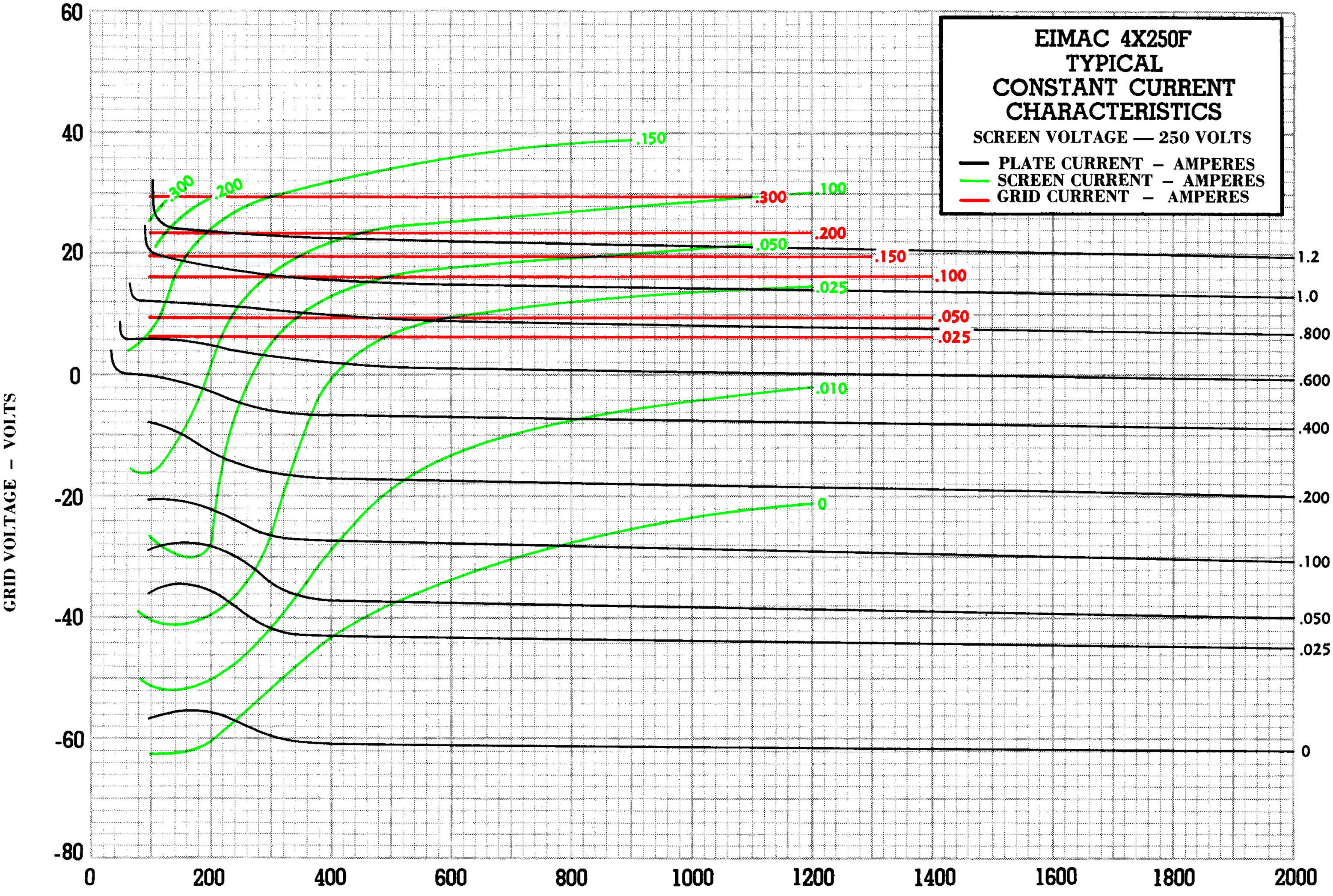
Plate Modulation—Plate modulation can be applied to the 4X250F when it is operated as a class-C radio-frequency amplifier. To obtain 100% modulation, the d-c screen voltage must be modulated in phase with the plate modulation. Self-modulation of the screen by means of a series resistor or reactor may not be satisfactory in this particular tetrode due to the screen-voltage, screen-current characteristics.

Special Applications—If it is desired to operate this tube under conditions widely different than those given here, write to Eitel-McCullough, Inc., San Bruno, California, for information and recommendations.

EIMAC 4X250F
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS

SCREEN VOLTAGE — 250 VOLTS

— PLATE CURRENT – AMPERES
— SCREEN CURRENT – AMPERES
— GRID CURRENT – AMPERES



GRID VOLTAGE – VOLTS

PLATE VOLTAGE – VOLTS

Eimac 4X250F

Printed in U.S.A. 1-C-8628

TENTATIVE DATA

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

4X5000A

RADIAL-BEAM POWER TETRODE

The Eimac 4X5000A is a compact high power forced-air-cooled tetrode of metal and ceramic construction. The 4X5000A is useful as an oscillator, amplifier or modulator at frequencies up to 30 megacycles at full ratings. Its characteristics make it particularly useful as a linear single-sideband amplifier, class AB_1 audio amplifier or as a screen-modulated radio-frequency amplifier.

A pair of these tubes will deliver 17.5 kilowatts of audio-frequency or radio-frequency power with zero driving power. The plate dissipation is rated at five kilowatts for most applications, and six kilowatts for Class-AB operation.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	7.5 volts
Current	75 amperes
Grid-Screen Amplification Factor (Average)	5

Direct Interelectrode Capacitances (Average)	Grounded Cathode	Grounded Grid
Feedback	0.75 uuf	0.14 uuf
Input	106 uuf	47 uuf
Output	18 uuf	18 uuf
Highest Frequency for Maximum Ratings		30 mc

MECHANICAL

Base	Special, Concentric
Recommended Socket	Eimac SK-300
Mounting	Axis vertical, base down or up
Cooling	Forced Air
Maximum Over-all Dimensions:	
Length	9-1/8 inches
Diameter	4-15/16 inches
Net Weight	9½ pounds
Shipping Weight (Approx.)	22 pounds

Note: Typical operation data are based on conditions of adjusting the r-f drive to a specified plate current, maintaining fixed conditions of grid bias and screen voltage. It will be found that if this procedure is followed, there will be little variation in power output between tubes even though there may be some variation in grid and screen currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C, Key-down conditions, per tube:

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7500 MAX. VOLTS
D-C SCREEN VOLTAGE	1500 MAX. VOLTS
D-C PLATE CURRENT	3.0 MAX. AMPERES
PLATE DISSIPATION	5000 MAX. WATTS
SCREEN DISSIPATION	250 MAX. WATTS
GRID DISSIPATION	75 MAX. WATTS

TYPICAL OPERATION (Frequencies below 30 mc.)

D-C Plate Voltage	7500 volts
D-C Screen Voltage	500 volts
D-C Grid Voltage	-350 volts
D-C Plate Current	2.8 amperes
D-C Screen Current	0.5 amperes
D-C Grid Current	0.25 amperes
Peak R-F Grid Voltage	590 volts
Driving Power	150 watts
Grid Dissipation	60 watts
Screen Dissipation	250 watts
Plate Dissipation	5000 watts
Plate Power Output	16,000 watts

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PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony, Carrier Conditions unless otherwise specified, one tube:

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000	MAX. VOLTS
D-C SCREEN VOLTAGE	1000	MAX. VOLTS
D-C PLATE CURRENT	2.5	MAX. AMPERES
PLATE DISSIPATION*	3500	MAX. WATTS
SCREEN DISSIPATION	250	MAX. VOLTS
GRID DISSIPATION	75	MAX. WATTS

TYPICAL OPERATION, Frequencies below 30 mc.:

D-C Plate Voltage	5000 volts
D-C Screen Voltage	500 volts
D-C Grid Voltage	-400 volts
D-C Plate Current	1.4 amperes
D-C Screen Current	0.26 amperes
D-C Grid Current	0.050 amperes
Peak R-F Grid Voltage	520 volts
Grid Driving Power	25 watts
Grid Dissipation	6 watts
Screen Dissipation	130 watts
Plate Dissipation	1100 watts
Peak A-F Screen Voltage for 100% modulation	450 volts
Plate Power Output	5.8 kilowatts

*Corresponds to 5 kw at 100%, sine-wave modulation.

CLASS-AB RADIO-FREQUENCY OR AUDIO POWER AMPLIFIER

MAXIMUM RATINGS per tube:

D-C PLATE VOLTAGE	7500	MAX. VOLTS
D-C SCREEN VOLTAGE	1500	MAX. VOLTS
D-C PLATE CURRENT	4.0	MAX. AMPERES
PLATE DISSIPATION	6000	MAX. WATTS
SCREEN DISSIPATION	250	MAX. WATTS
GRID DISSIPATION	75	MAX. WATTS

TYPICAL OPERATION, Class-AB_1 R-F Linear Amplifier, one tube, Peak Envelope or Modulation Crest Conditions, Frequencies below 30 mc.:

D-C Plate Voltage	7500 volts
D-C Screen Voltage	1250 volts
D-C Grid Voltage*	-300 volts
D-C Plate Current	1.9 amperes
Zero-Signal Plate Current	0.50 amperes
D-C Screen Current	0.20 amperes
D-C Grid Current	0 amperes
Driving Power	0 watts
Peak R-F Grid Voltage	300 volts
Screen Dissipation	250 watts
Plate Dissipation	4200 watts
Plate Power Output**	10,000 watts

*Adjust grid voltage to obtain specified Zero-signal plate current.
**Peak envelope Power Output or R-F Power Output at crest of modulation envelope.

TYPICAL OPERATION, Class-AB_1 Audio Amplifier, two tubes unless otherwise specified:

D-C Plate Voltage	4000	5000	6000	7000 volts
D-C Screen Voltage	1250	1250	1250	1250 volts
D-C Grid Voltage	-270	-280	-310	-325 volts
D-C Zero-Signal Plate Current	1.25	1.00	0.83	0.70 amperes
D-C Max.-Signal Plate Current	5.10	4.40	4.25	3.65 amperes
D-C Zero-Signal Screen Current	0	0	0	0 amperes
D-C Max.-Signal Screen Current	0.35	0.33	0.30	0.24 amperes
Load Resistance, P-to-P	1500	2370	2940	4100 ohms
Peak A-F Driving Voltage	250	240	270	235 volts
Driving Power	0	0	0	0 watts
Max.-Signal Plate Dissipation	4200	4200	4200	4200 watts
Max.-Signal Power Output	11,500	13,500	17,000	17,500 watts

APPLICATION

MECHANICAL

Mounting—The 4X5000A must be mounted with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

Socket—The Eimac Air-System Socket Type SK-300 is designed especially for the concentric base terminals of the 4X5000A. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals, after which a duct guides it into the anode cooling fins.

Cooling—The maximum temperature rating for the external surfaces of the 4X5000A is 200°C. Sufficient forced air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic stem surfaces below 200°C.

When the tube is mounted in the Eimac SK-300 Socket, plate dissipation power of 5,000 watts requires 175 CFM air flow, corresponding to a pressure differential across tube and socket of 1.5 inches water column. Cooling at the 6,000-watt dissipation power level requires 210 CFM air flow, corresponding to a pressure differential of 2.25 inches water column across the tube and socket.

The flow rates and pressure differentials specified above apply to air at sea level pressure and at 20°C ambient temperature.

If the 4X5000A is operated in a socket of a design different from that of the SK-300, the air-flow rates must be determined independently for each design, using the maximum rated temperature as the criterion for satisfactory cooling.

A convenient method of measuring temperatures is the use of a temperature-sensitive paint, applied sparingly to the tube surfaces. When heavy coats are applied, the air-cooled surface of the paint may not reach the tube temperature because the paint conducts heat poorly and errors can occur. One type of temperature-sensitive paint can be obtained from the Tempil Corporation, 11 West 25th Street, New York, 10, N.Y.

The air inlet to the cooling system should be equipped with an effective air filter, which should be inspected periodically to assure adequate air flow into the system.

ELECTRICAL

Filament Operation—The rated filament voltage for the 4X5000A is 7.5 volts. The actual operating voltage should be maintained within the range from 7.15 to 7.85 volts, as measured at the base of the tube.

Electrode Dissipation Ratings—The maximum dissipation ratings for the 4X5000A must be respected to avoid damage to the tube. An exception is the plate dissipation, which may be permitted to rise above the maximum rating during brief periods, such as may occur during tuning.

Grid Dissipation—The grid dissipation can be determined approximately by use of the expression:

$$P_{g1} = e_{cmp}\ I_c$$

where: P_{g1} = Grid dissipation, watts;
e_{cmp} = Peak grid-filament positive voltage, volts;
I_c = D-C grid current, amperes.

The value of the peak positive grid voltage can be measured by means of a suitable peak-reading vacuum tube voltmeter.

Screen Dissipation—The screen dissipation, in cases where there is no a-c applied to the screen, is the simple product of the screen voltage and the screen current.

In case the screen voltage is modulated, the screen dissipation will depend strongly on the loading, driving power, and carrier screen voltage.

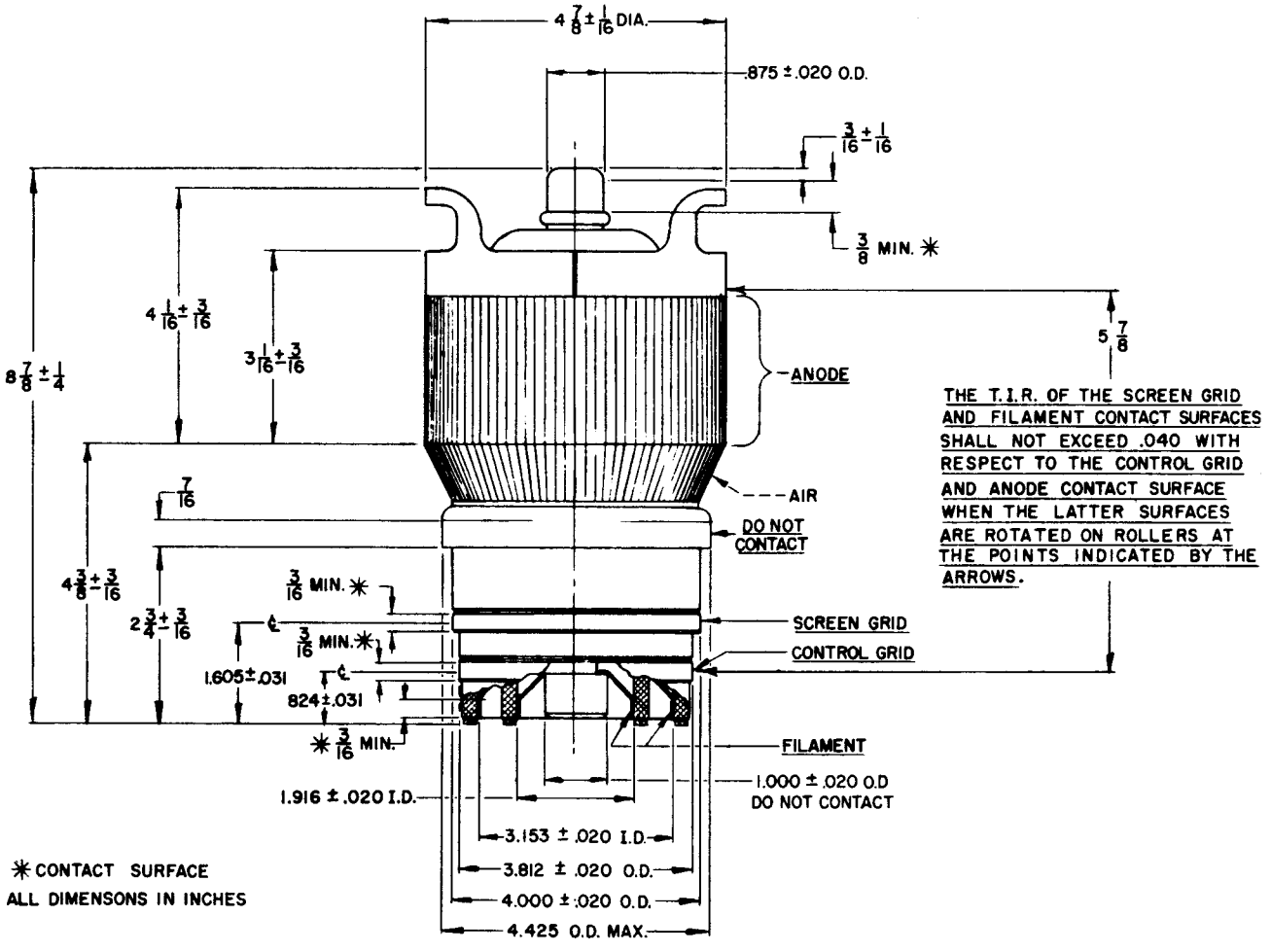
Plate Dissipation—The plate dissipation rating for the 4X5000A is 5000 watts for most applications, but for audio and SSB amplifier applications, the maximum dissipation rating is 6000 watts.

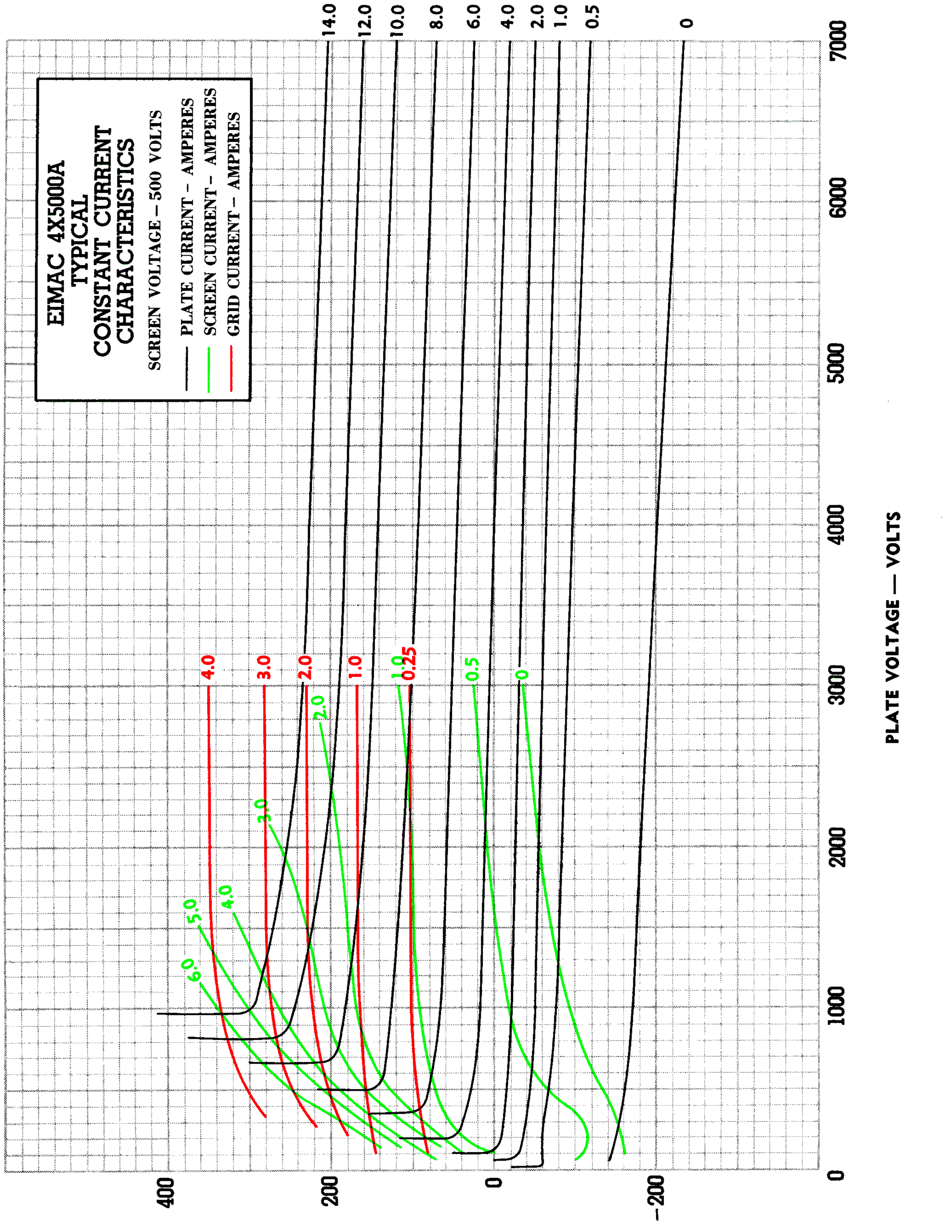
In class-AB and class-B amplifiers, the maximum plate dissipation does not coincide with maximum power output, but occurs at some lower power level determined jointly by the bias voltage and the driving voltage applied to the tube. Accordingly, it is advisable to limit the plate dissipation under full power conditions to approximately 70% of the maximum rated plate dissipation of the tubes used.

Screen modulated operation produces maximum plate dissipation under carrier conditions. The dissipation diminishes as the modulation increases.

When the 4X5000A is operated as a plate-modulated r-f power amplifier, the power input is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 3500-watt maximum plate dissipation rating will be exceeded.

Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to Eitel-McCullough, Inc., San Bruno, California, for information and recommendations.





Printed in U.S.A. 13859

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

4X500A

RADIAL-BEAM POWER TETRODE

The Eimac 4X500A is an external-anode tetrode having a maximum plate dissipation rating of 500 watts. Its small size and low-inductance leads permit efficient operation at relatively large outputs well into the VHF region. The screen grid is mounted on a disc which terminates in a connector ring located between grid and plate, thus making possible effective shielding between the grid and plate circuits. The grid terminal is located at the center of the glass base to facilitate single-tube operation in coaxial circuits.

The combination of low grid-plate capacitance, low screen-lead inductance and functionally located terminals contributes to the stable operation of the 4X500A at high frequencies, making neutralization unnecessary in most cases and greatly simplifying it in others.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		5		volts
Current	12.2		13.7	amperes
Amplification Factor (Grid-to-Screen)	4.5		6.5	
Transconductance (I_b = 200 ma., E_b = 2500v., E_{c2} = 500v.)		5200		umhos
Direct Interelectrode Capacitances Grounded Cathode:				
Input	10.6		14.4	uuf
Output	4.9		6.9	uuf
Feedback			0.1	uuf
Frequency for Maximum Ratings			120	mc.

MECHANICAL

Base	Special 4 pin
Maximum Operating Temperatures:	
Glass-to-Metal Seals	175° C
Anode Core	175° C
Recommended Socket	Eimac SK900
Operating Position	Vertical, base up or down
Maximum Dimension:	
Height	4.75 inches
Diameter	2.625 inches
Cooling (See following page)	Forced Air
Net Weight	1.7 pounds
Shipping Weight (Approximate)	6 pounds

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C FM or Telegraphy (Key-down conditions, 1 tube)
MAXIMUM RATINGS (Frequencies up to 120 Mc.)

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	500 MAX. VOLTS
D-C GRID VOLTAGE	—500 MAX. VOLTS
D-C PLATE CURRENT	350 MAX. MA.
PLATE DISSIPATION	500 MAX. WATTS
SCREEN DISSIPATION	30 MAX. WATTS
GRID DISSIPATION	10 MAX. WATTS

TYPICAL OPERATION (Per tube, at 110 Mc.)

D-C Plate Voltage	2500	3000	4000	Volts
D-C Plate Current	310	310	315	Ma.
D-C Screen Voltage	500	500	500	Volts
D-C Screen Current	26	24	22	Ma.
D-C Grid Voltage	—150	—150	—150	Volts
D-C Grid Current	15	16	16	Ma.
Driving Power (approx.)	5	5	5	Watts
Useful Power Output (approx.)	475	600	835	Watts

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Printed in U.S.A.

RADIO FREQUENCY POWER AMPLIFIER

Class-B Linear Amplifier,

Television Visual Service

MAXIMUM RATINGS (Frequencies below 220 mc.)

D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C PLATE CURRENT	350 MAX. MA.
D-C SCREEN VOLTAGE	500 MAX. VOLTS
D-C GRID VOLTAGE	—500 MAX. VOLTS
PLATE DISSIPATION	500 MAX. WATTS
SCREEN DISSIPATION	30 MAX. WATTS
GRID DISSIPATION	10 MAX. WATTS

TYPICAL OPERATION

(Per tube at peak synchronizing level, 5-Mc. bandwidth, assumed load resistance 3,000 ohms per tube.)[1]

D-C Plate Voltage	1850	2400	Volts
D-C Screen Voltage	500	500	Volts
D-C Grid Voltage	—100	—100	Volts
D-C Plate Current	285	400[1]	Ma.
D-C Screen Current (approx.)	20	35	Ma.
D-C Grid Current (approx.)	10	15	Ma.
Peak R-F Grid Voltage	140	185	Volts
Driving Power, 220 Mc. (approx.)	15	25	Watts
Plate Power Input	525	960	Watts
Power Output	300	600	Watts
BLACK LEVEL			
D-C Plate Current	215	300	Ma.
D-C Screen Current	2	3	Ma.
D-C Grid Current	2	5	Ma.
Plate Power Input	400	720	Watts
Plate Dissipation	230	380	Watts
Power Output	170	340	Watts

[1] Operating conditions at peak synchronizing level may be permitted to exceed maximum ratings of the tube because of the low duty factor. Maximum ratings apply to black level conditions.

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. Adjustment of the r-f grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct r-f driving voltage is applied.

APPLICATION

MECHANICAL

Mounting—The 4X500A must be operated vertically. The base may be down or up. The recommended socket for this tube is the SK-900 Air-System Socket.

Cooling—Forced-air cooling must be provided to hold the glass-to-metal seals and the anode cooler core below the maximum rated temperature of 150°C.

A flow rate of 20 cfm will be adequate for operation at sea level and with an inlet air temperature up to 50°C. Under these conditions, 20 cfm of air flow corresponds to a pressure difference across the tube and SK-900 socket of 2.25 inch of water column. Experience has shown that if reliable long-life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube.

At higher altitudes increased air flow will be required. For example, at an altitude of 10,000 feet, a flow-rate of 29 cfm will be required and will be obtained with a pressure drop across tube and socket of 3.25 inch of water column. In selecting a blower for use at high altitudes, care must be taken to assure that the blower is designed to deliver the desired volume of air at the corresponding pressure drop and at the particular altitude.

The pressure drop figures indicated above are those measured directly at the air gage hole in the SK-900 air system socket. In the event that a socket is not used, and a plenum pressure drop measurement is required, this plenum pressure drop rating must equal the pressure drop figures indicated above multiplied by 1.5 for the specific application.

ELECTRICAL

Filament Operation—For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated voltage of 5.0 volts. Variations in filament voltage must be kept within the range from 4.75 to 5.25 volts.

Control Grid Operation—The d-c voltage for the 4X500A should not exceed 500 volts. If grid leak bias is used, suitable means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation, and the grid-leak resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In operation above 50 Mc., it is advisable to keep the bias voltage as low as is practicable.

Screen Grid Operation—Power dissipated by the screen of the 4X500A must not exceed 30 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 30 watts in event of circuit failure.

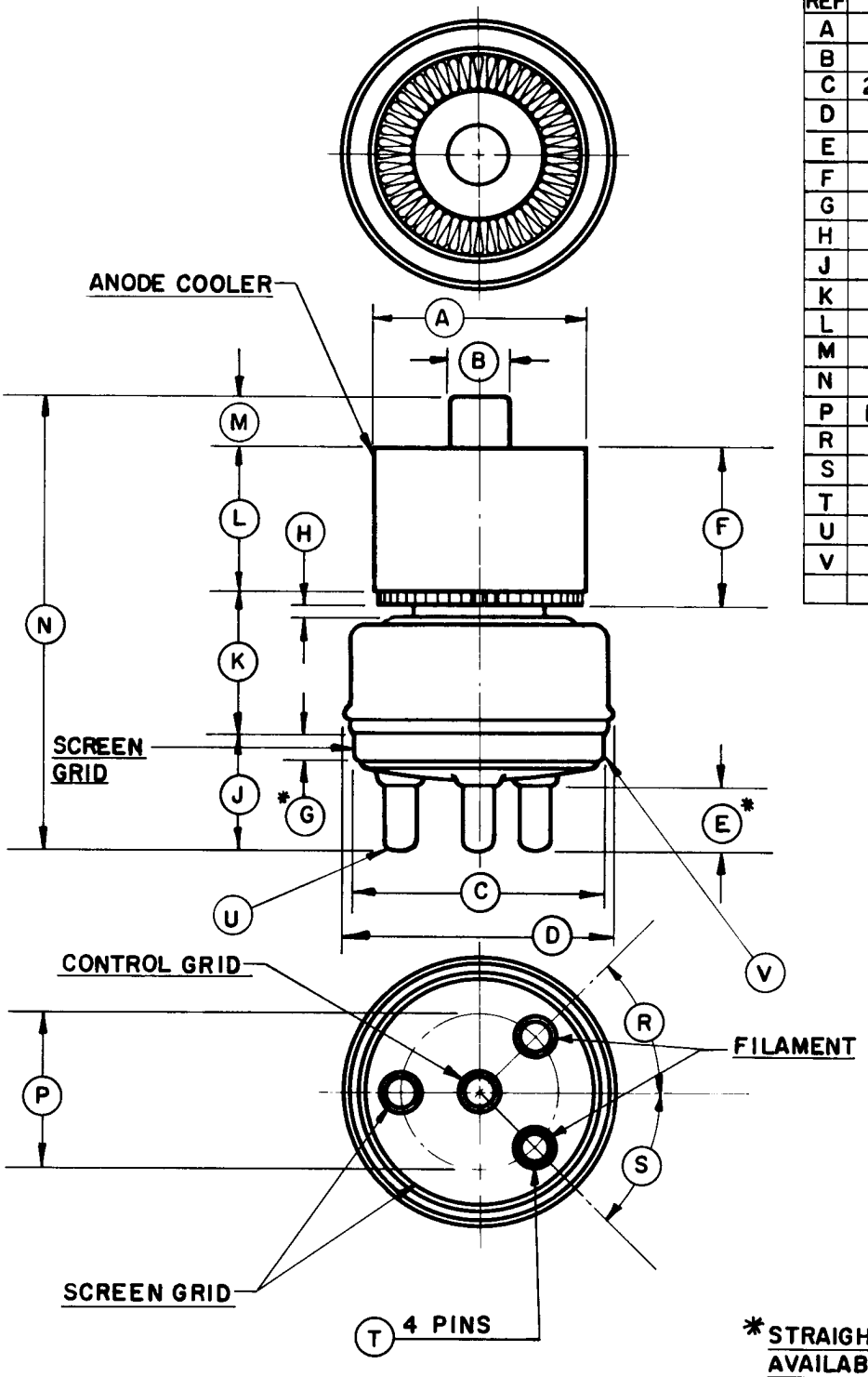
Plate Operation—The maximum rated plate-dissipation power is 500 watts. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

Multiple Operation—Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide for individual metering and individual adjustment of the bias or screen voltage to equalize the inputs.

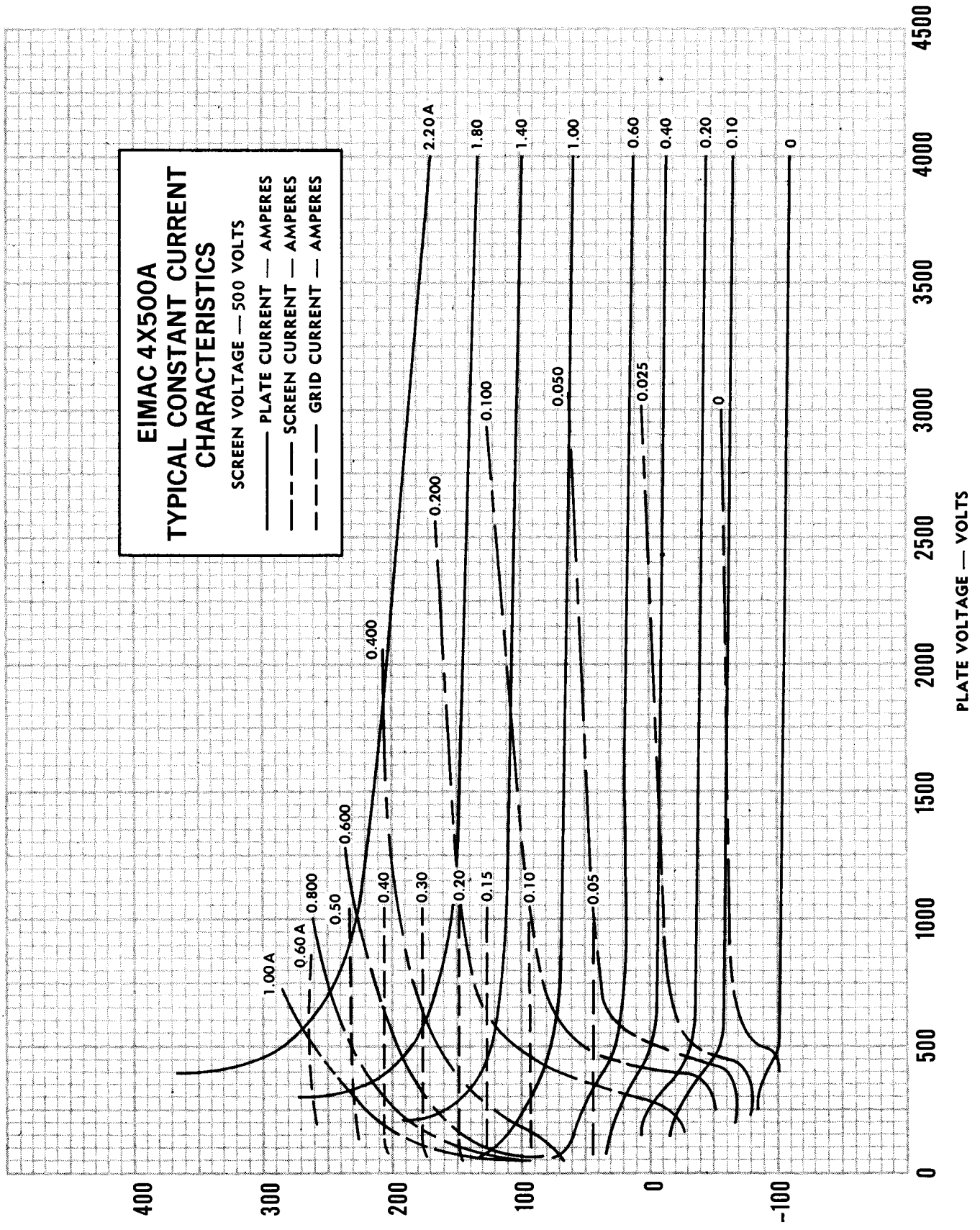
Where overload protection is provided, it should be capable of protecting the surviving tube/s in the event that one tube should fail.

Special Applications— If it is desired to operate this tube under conditions widely different from those given here, write to Application Engineering Department, Eimac Division of Varian, San Carlos, California for information and recommendations.

DIMENSIONS IN INCHES		
REF	MIN.	MAX.
A	1.980	2.020
B	.559	.573
C	2.365	2.385
D		2.625
E	.500	
F	1.438	1.562
G	.156	
H	.062	
J	1	1.125
K	1.406	1.594
L	1.344	1.406
M	.438	.562
N	4.250	4.750
P	1.490	1.510
R	44°	46°
S	44°	46°
T	.308	.318
U	.031R	
V	.094R	



*STRAIGHT SIDE AVAILABLE FOR CONTACT


EIMAC 4X500A
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
——— PLATE CURRENT — AMPERES
— — — SCREEN CURRENT — AMPERES
— — — — GRID CURRENT — AMPERES
2.20 A
1.80
1.40
1.00
0.60
0.40
0.20
0.10
0
0.100
0.050
0.025
0.400
0.200
1.00 A
0.60 A
0.800
0.50
0.600
0.40
0.30
0.20
0.15
0.10
0.05
400
300
200
100
0
-100
0
500
1000
1500
2000
2500
3000
3500
4000
4500
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

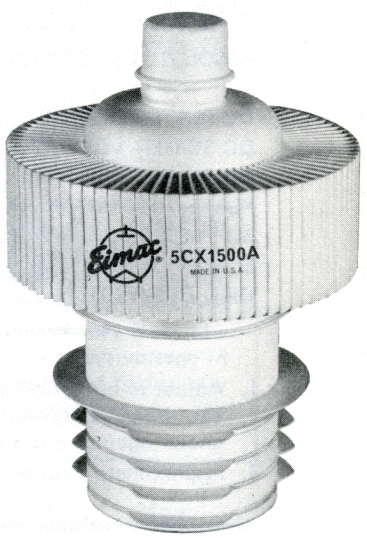
TECHNICAL DATA

5CX1500A

RADIAL BEAM POWER PENTODE

The EIMAC 5CX1500A is a ceramic/metal power pentode designed for use as a Class AB_1 linear amplifier in audio or radio frequency applications. Its characteristic low intermodulation distortion makes it especially suitable for single sideband service. The filament is a rugged mesh type.

The tube is also recommended for use as a Class C rf power amplifier in CW, FM and AM service.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	5.0 ± 0.25	V
Current, at 5.0 volts	40	A
Transconductance (Average):		
I_b = 1.0 Adc, E_{c2} = 500 Vdc	24,000	μmhos
Amplification Factor (Average):		
Grid to Screen	5.5	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Input	75	pF
Output	16.5	pF
Feedback	0.20	pF
Frequency of Maximum Rating:		
CW	110	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length	4.950 in; 125.73 mm
Diameter	3.370 in; 85.60 mm
Net Weight	30 oz; 850.5 gm
Operating Position	Axis vertical, base down or up
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C

(Effective 6-6-70) © 1965,1967,1970 Varian Printed in U.S.A.

Cooling	Forced Air
Base	Special ring and breechblock terminal surfaces
Recommended Air System Socket	EIMAC SK-840 series
Recommended (Air) Chimney	EIMAC SK-806

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	750	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
SUPPRESSOR DISSIPATION	25	WATTS
SCREEN DISSIPATION	75	WATTS
GRID DISSIPATION	25	WATTS

1. Adjust to specified zero-signal dc plate current.
2. The intermodulation distortion products are referenced against one tone of a two equal tone signal.
3. Approximate values.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	2500	3000	4000	Vdc
Suppressor Voltage	0	0	0	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage[1]	-87	-89	-90	Vdc
Zero-Signal Plate Current	250	250	250	mAdc
Single-Tone Plate Current	660	690	690	mAdc
Two-Tone Plate Current	470	480	485	mAdc
Single-Tone Screen Current[3]	79	71	59	mAdc
Two-Tone Screen Current[3]	36	32	25	mAdc
Peak rf Grid Voltage[3]	87	89	90	v
Peak Driving Power[3]	0	0	0	w
Single-Tone Useful Output Power	1090	1330	1785	W
Resonant Load Impedance	2340	2680	3500	Ω
Intermodulation Distortion Products[2]				
3rd Order	-38	-36	-33	db
5th Order	-39	-41	-42	db

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony (Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	5000	VOLTS
DC SCREEN VOLTAGE	750	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
SUPPRESSOR DISSIPATION	25	WATTS
SCREEN DISSIPATION	75	WATTS
GRID DISSIPATION	25	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	3000	4000	4500	Vdc
Suppressor Voltage	0	0	0	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-200	-200	-200	Vdc
Plate Current	900	800	900	mAdc
Screen Current[1]	94	66	88	mAdc
Grid Current[1]	35	25	34	mAdc
Peak rf Grid Voltage[1]	255	245	255	v
Calculated Driving Power	9.0	6.5	9.0	W
Plate Input Power	2700	3200	4050	W
Plate Dissipation	720	850	870	W
Plate Output Power	1980	2350	3180	W
Resonant Load Impedance	1570	2240	2520	Ω

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	3500	VOLTS
DC SCREEN VOLTAGE	550	VOLTS
DC PLATE CURRENT	0.8	AMPERE
PLATE DISSIPATION[1]	1000	WATTS
SUPPRESSOR DISSIPATION	25	WATTS
SCREEN DISSIPATION[2]	75	WATTS
GRID DISSIPATION[2]	25	WATTS

1. Corresponds to 1500 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	2500	3200	Vdc
Suppressor Voltage	0	0	Vdc
Screen Voltage	500	500	Vdc
Grid Voltage	-260	-260	Vdc
Plate Current	800	800	mAdc
Screen Current[1]	90	86	mAdc
Grid Current[1]	32	32	mAdc
Peak af Screen Voltage[1] (100% modulation)	500	500	v
Peak rf Grid Voltage[1]	315	315	v
Calculated Driving Power	10	10	W
Plate Input Power	2000	2560	W
Plate Dissipation	530	576	W
Plate Output Power	1470	1958	W
Resonant Load Impedance	1360	1863	Ω

1. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	750	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
SUPPRESSOR DISSIPATION	25	WATTS
SCREEN DISSIPATION	75	WATTS
GRID DISSIPATION	25	WATTS

TYPICAL OPERATION (Two Tubes)

Plate Voltage	2800	3800	Vdc
Suppressor Voltage	0	0	Vdc
Screen Voltage	500	500	Vdc
Grid Voltage	-81	-83	Vdc
Zero-Signal Plate Current	0.50	1.50	Adc
Max. Signal Plate Current	1.30	1.33	Adc
Zero-Signal Plate Current	20	20	mAdc
Max. Signal Screen Current	110	106	mAdc
Peak af Grid Voltage	81	83	v
Peak Driving Power	0	0	w
Max. Signal Plate Dissipation	720	1130	W
Plate Output Power	2200	3220	W
Load Resistance(plate to plate)	4800	6720	Ω

1. Approximate value.
2. Per tube .
3. Nominal drive power is one-half peak power.
4. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Filament: Current at 5.0 volts	38	43	A
Interelectrode Capacitances[1] (grounded cathode connection)			
Input	70	80	pF
Output	14.5	18.5	pF
Feedback	---	0.25	pF
Interelectrode Capacitances[1] (grounded grid connection)			
Input	32	37	pF
Output	14.5	18.5	pF
Feedback	---	0.05	pF

APPLICATION

MECHANICAL

MOUNTING - The 5CX1500A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC SK-840 socket and SK-806 chimney have been designed especially for the 5CX1500A. The use of recommended airflow rates through these sockets provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals through the Air Chimney, and exits through the anode cooling fins.

COOLING - The maximum temperature rating for the anode core of the 5CX1500A is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air-flow requirements to maintain seal temperature at 225°C in 50°C ambient air are tabulated below (for operation below 30 MHz).

	SEA LEVEL		6000 FEET	
PLATE DISSIPATION (WATTS)	AIR FLOW (CFM)	PRESSURE DROP (INCHES of WATER)	AIR FLOW (CFM)	PRESSURE DROP (INCHES of WATER)
1000	27	.33	33	.40
1500	47	.76	58	.95

* Since the power dissipated by the filament represents about 200 watts and since grid-plus-screen-plus-suppressor dissipation can, under some conditions, represent another 125 watts, allowance has been made in preparing this tabulation for an additional 325 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

FILAMENT OPERATION - The rated filament voltage for the 5CX1500A is 5.0 volts. Filament voltage, as measured at the socket, should be maintained within ±5% of this value or below to obtain maximum tube life.

INTERMODULATION DISTORTION - The Radio Frequency Linear Amplifier operating conditions including distortion data are the results of operation in a neutralized, grid-driven amplifier. Plots of IM distortion versus power output under two-tone condition for a typical tube are shown on next page.

GRID OPERATION - The rated dissipation of the grid is 25 watts. This is approximately the product of dc grid current and peak positive grid voltage. Operation at bias and drive levels near those listed will insure safe operation.

SCREEN OPERATION - The power dissipated by the screen of the 5CX1500A must not exceed 75 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon rms screen current and voltage.

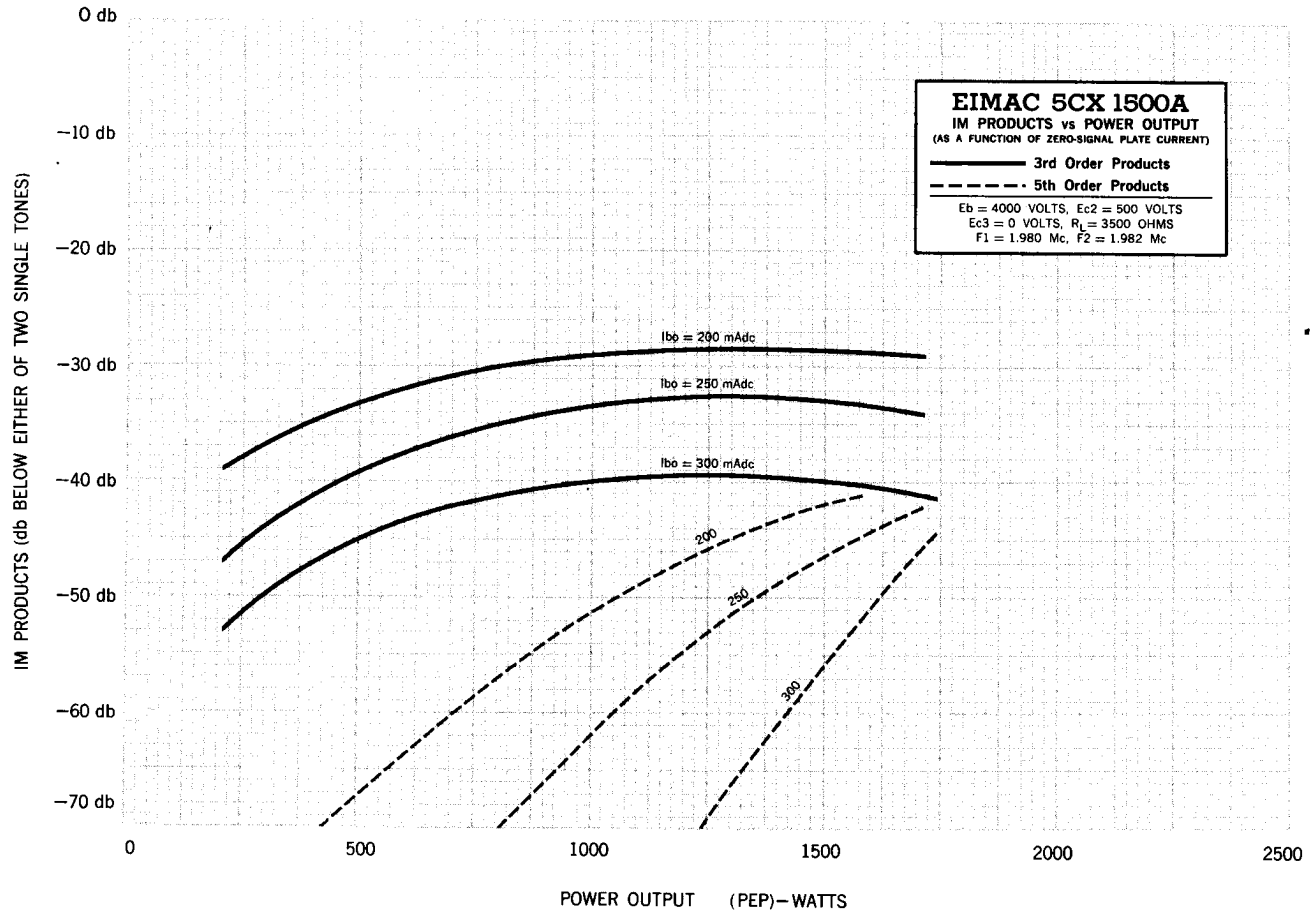
Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 75 watts in the event of circuit failure.

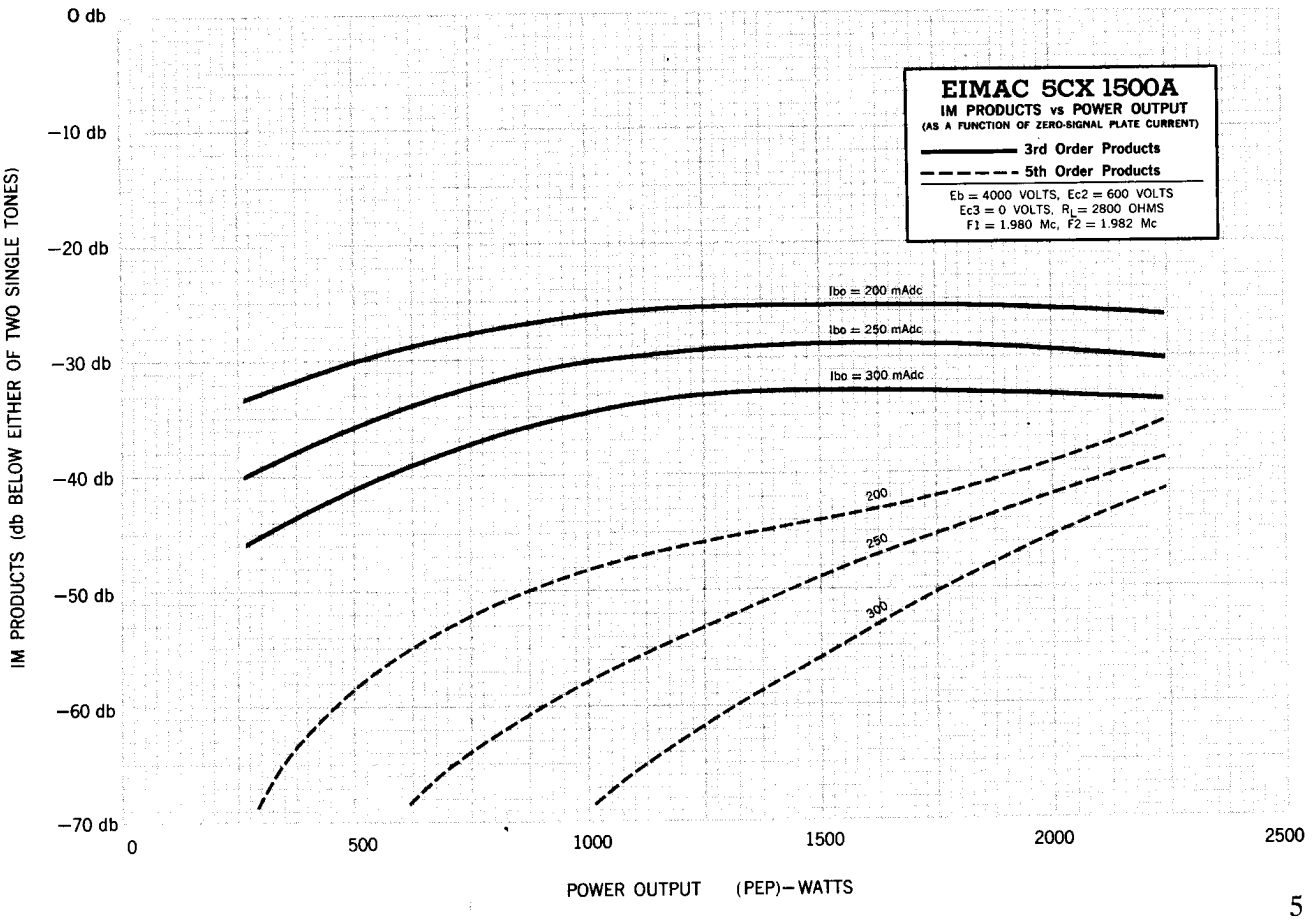
SUPPRESSOR OPERATION - The rated dissipation of the suppressor is 25 watts. Suppressor current will be zero or very nearly zero for all typical operating conditions specified. The 5CX1500A has been designed for zero voltage operation of the suppressor grid for most applications.

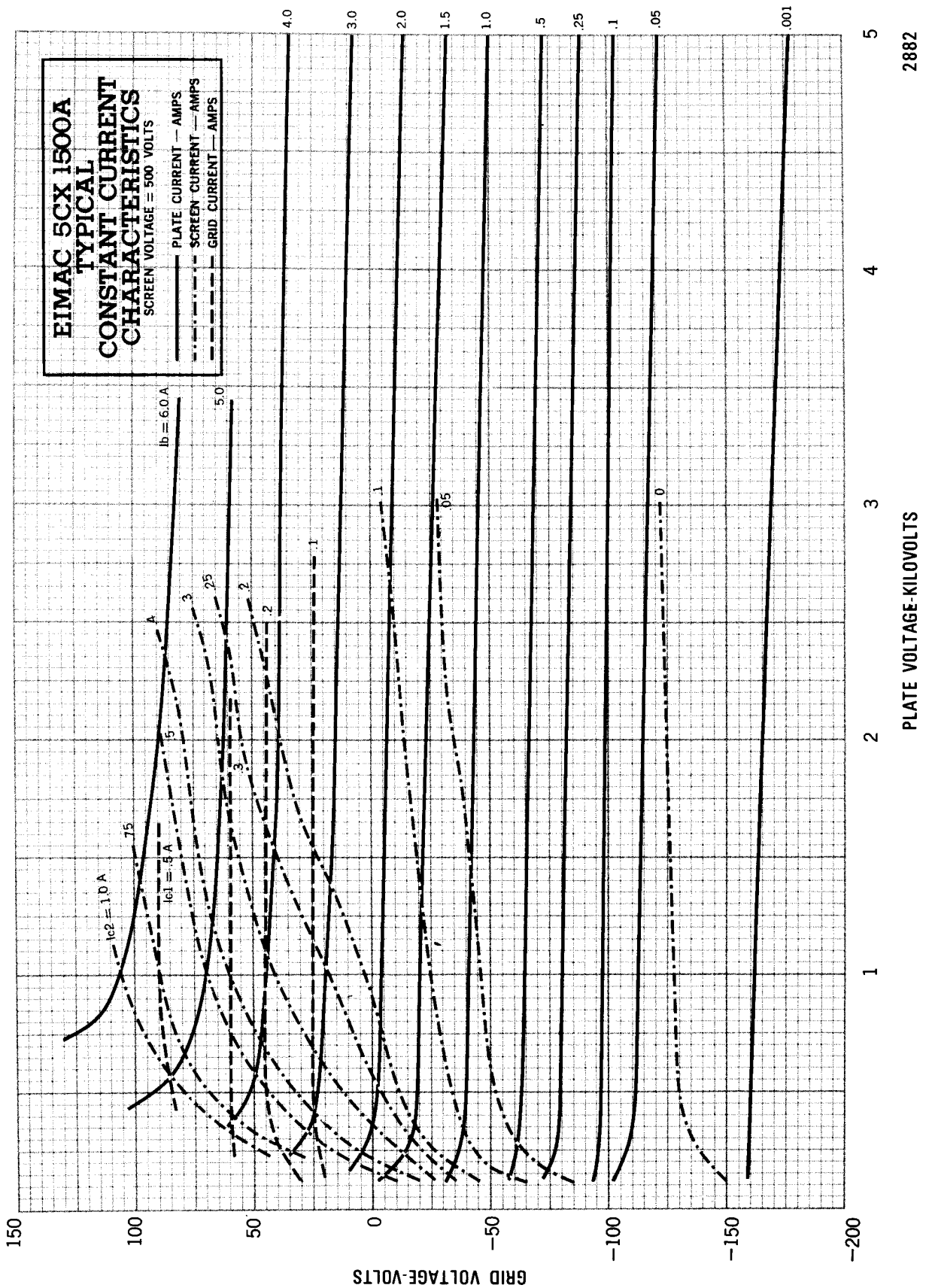
PLATE DISSIPATION - The plate-dissipation ratings for the 5CX1500A is 1000 watts for Class-C plate-modulated service and 1500 watts for Class-C telegraphy. In Class-AB service the plate dissipation rating is 1500 watts.

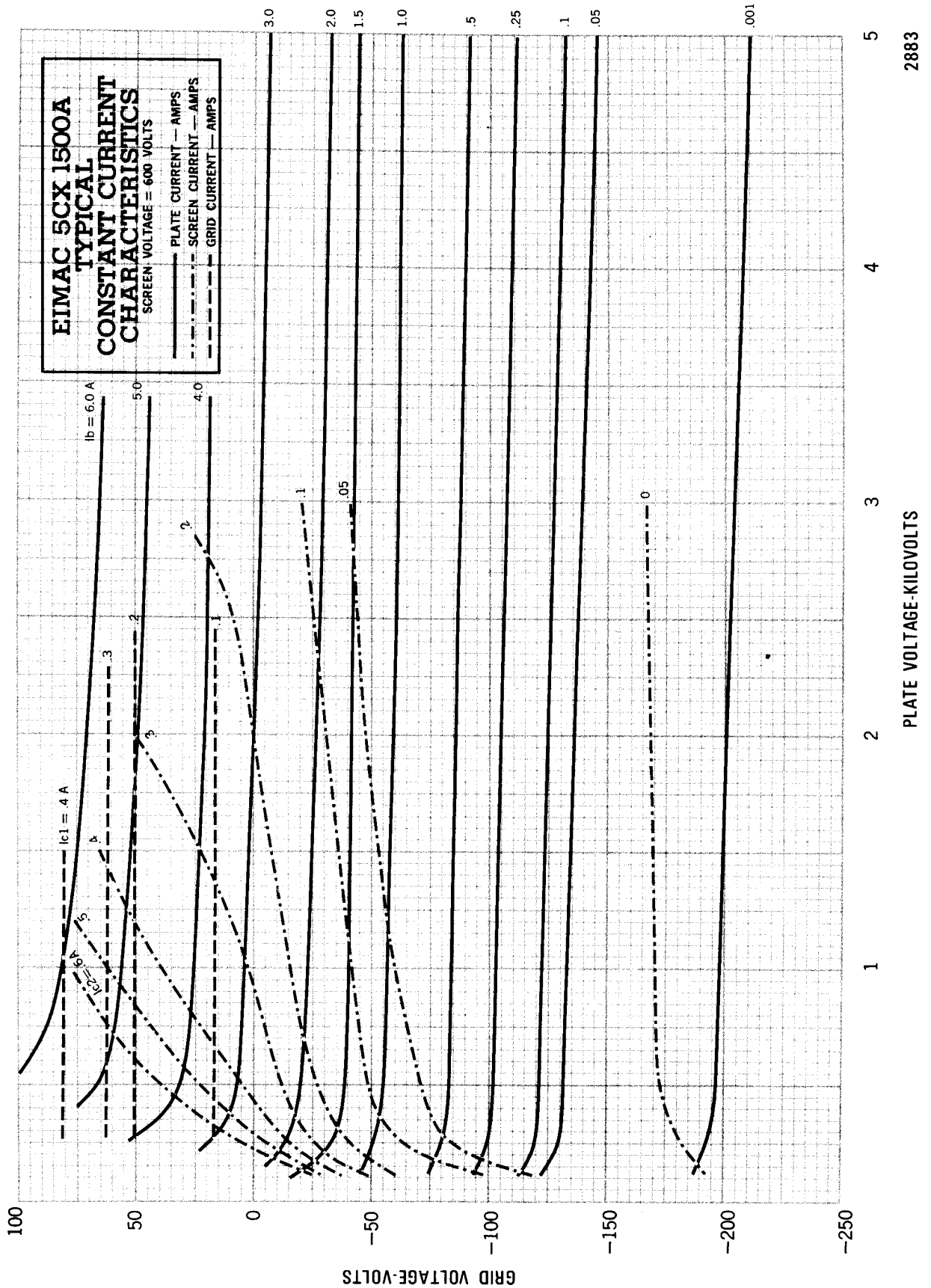
HIGH VOLTAGE - The 5CX1500A operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

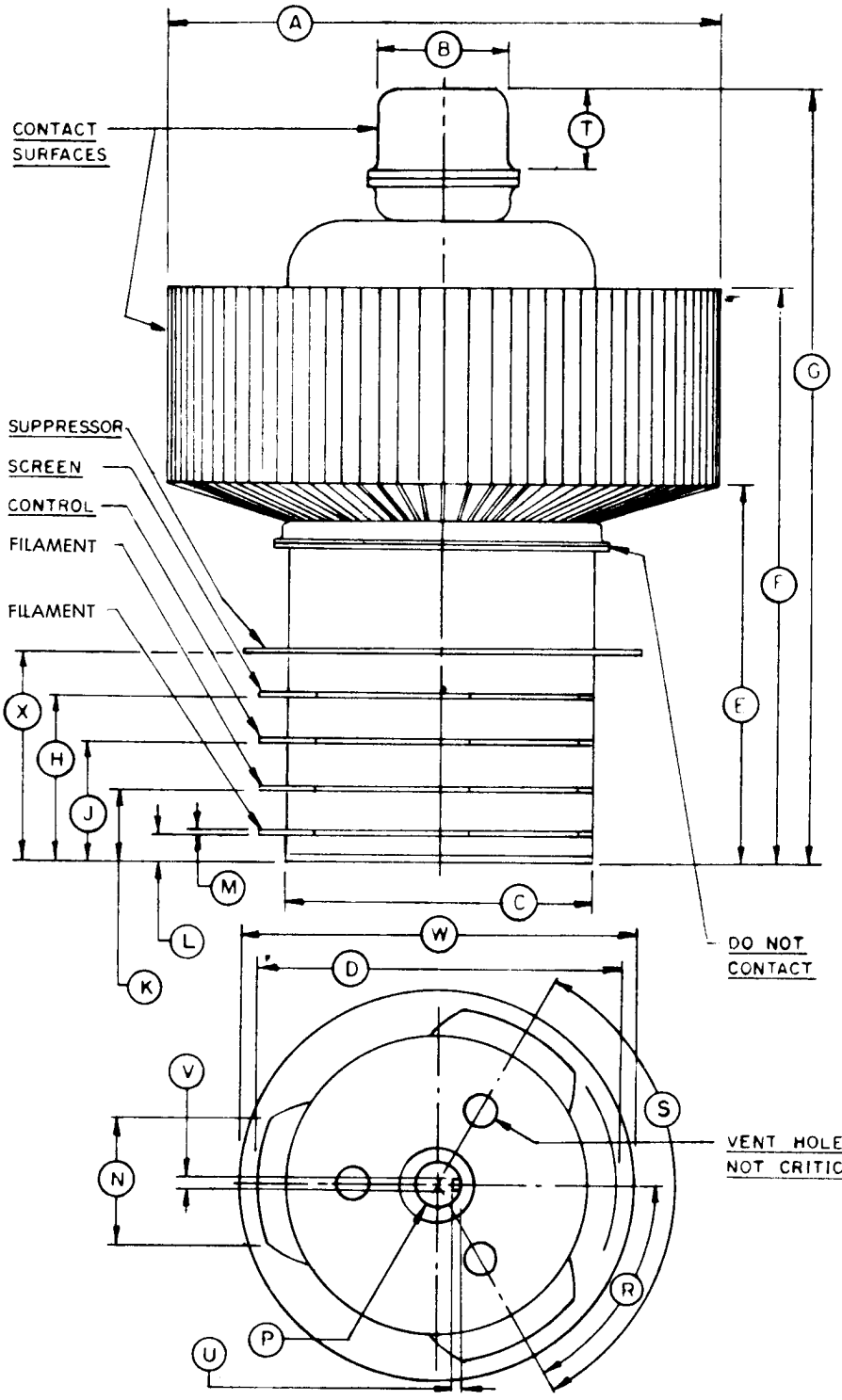
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here write to the Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.


EIMAC 5CX 1500A
IM PRODUCTS vs POWER OUTPUT
(AS A FUNCTION OF ZERO-SIGNAL PLATE CURRENT)
3rd Order Products
5th Order Products
Eb = 4000 VOLTS, Ec2 = 500 VOLTS
Ec3 = 0 VOLTS, RL = 3500 OHMS
F1 = 1.980 Mc, F2 = 1.982 Mc
Ibo = 200 mAdc
Ibo = 250 mAdc
Ibo = 300 mAdc
200
250
300
0 db
−10 db
−20 db
−30 db
−40 db
−50 db
−60 db
−70 db
0
500
1000
1500
2000
2500
IM PRODUCTS (db BELOW EITHER OF TWO SINGLE TONES)
POWER OUTPUT (PEP)—WATTS


EIMAC 5CX 1500A
IM PRODUCTS vs POWER OUTPUT
(AS A FUNCTION OF ZERO-SIGNAL PLATE CURRENT)
3rd Order Products
5th Order Products
Eb = 4000 VOLTS, Ec2 = 600 VOLTS
Ec3 = 0 VOLTS, RL = 2800 OHMS
F1 = 1.980 Mc, F2 = 1.982 Mc
Ibo = 200 mAdc
Ibo = 250 mAdc
Ibo = 300 mAdc
200
250
300
0 db
−10 db
−20 db
−30 db
−40 db
−50 db
−60 db
−70 db
0
500
1000
1500
2000
2500
IM PRODUCTS (db BELOW EITHER OF TWO SINGLE TONES)
POWER OUTPUT (PEP)—WATTS


EIMAC 5CX 1500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
PLATE CURRENT — AMPS.
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 6.0 A
Ic2 = 1.0 A
Ic1 = 5 A
5.0
4.0
3.0
2.0
1.5
1.0
.5
.25
.1
.05
.001
0
GRID VOLTAGE-VOLTS
150
100
50
0
−50
−100
−150
−200
1
2
3
4
5
PLATE VOLTAGE-KILOVOLTS
2882


EIMAC 5CX 1500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 600 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 6.0 A
Ic1 = .4 A
Ic2=.6A
5.0
4.0
3.0
2.0
1.5
1.0
.5
.25
.1
.05
.001
0
GRID VOLTAGE-VOLTS
100
50
0
−50
−100
−150
−200
−250
1
2
3
4
5
PLATE VOLTAGE-KILOVOLTS
2883



DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	3.335	3.370	84.71	85.60
B	0.807	0.820	20.50	20.83
C	1.870	1.900	47.50	48.26
D	2.250D	2.300D	57.15D	58.42D
E	2.335	2.535	59.31	64.39
F	3.530	3.730	89.66	94.74
G	4.800	4.950	121.92	125.73
H	0.950	1.000	24.13	25.40
J	0.675	0.725	17.15	18.42
K	0.400	0.450	10.16	11.43
L	0.140	0.170	3.56	4.32
M	0.020	0.030	0.51	0.76
N	0.700	0.800	17.78	20.32
P	0.314D	0.326D	7.98D	8.28D
R	55°	65°	55°	65°
S	115°	125°	115°	125°
T	0.470	0.530	11.94	13.46
U	0.025	0.048	0.63	1.22
V	0.045D	0.070D	1.14D	1.78D
W	2.468	2.531	62.69	64.29
X	1.225	1.275	31.12	32.39

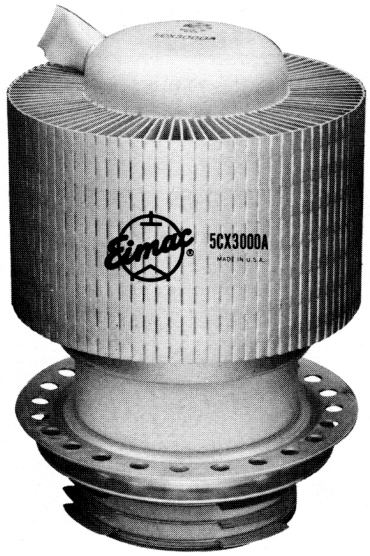
NOTE:
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EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

5CX3000A

RADIAL-BEAM POWER PENTODE

The EIMAC 5CX3000A is a ceramic and metal power pentode designed to be used as a Class-AB_1 linear amplifier in audio or radio-frequency applications. Its characteristics of low intermodulation distortion make it especially suitable for single side-band service.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated Tungsten				
Voltage		9.0		volts
Current	39.5		43.5	amps
Amplification Factor (Grid Screen)		5.5		
Frequency for Maximum Ratings			150	MHz
Direct Interelectrode Capacitances, Grounded Cathode:				
Input	125		145	pF
Output	18		24	pF
Feedback			.60	pF
Direct Interelectrode Capacitances, Grounded Grid and Screen:				
Input	55		67	pF
Output	18		24	pF

MECHANICAL

Base	Special ring and breechblock terminal surfaces
Maximum Seal Temperature	250°C
Maximum Anode Core Temperature	250°C
Recommended Socket	EIMAC SK-1420 series
Recommended Air Chimney	EIMAC SK-1426
Operating Position	Axis vertical, base up or down
Maximum Dimensions:	
Height	6.8 inches
Diameter	4.6 inches
Cooling	Forced air
Net Weight	5.5 pounds
Shipping Weight (Approximate)	10 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	7000 VOLTS
DC SCREEN VOLTAGE	1000 VOLTS
DC PLATE CURRENT	2.0 AMPS
PLATE DISSIPATION	4000 WATTS
SCREEN DISSIPATION	175 WATTS
GRID DISSIPATION	50 WATTS
SUPPRESSOR DISSIPATION	100 WATTS

TYPICAL OPERATION

DC Plate Voltage	6800 volts
DC Screen Voltage	500 volts
DC Grid Voltage	–200 volts
Suppressor Grid	0 volts
DC Plate Current	1.64 amps
DC Screen Current	276 mA
DC Grid Current	72 mA
Peak RF Grid Voltage	300 volts
Driving Power	52 watts
Plate Dissipation	2600 watts
Plate Output Power	8500 watts

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AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	7000 VOLTS
DC SCREEN VOLTAGE	1000 VOLTS
DC PLATE CURRENT	2.0 AMPS
PLATE DISSIPATION	4000 WATTS
SCREEN DISSIPATION	175 WATTS
GRID DISSIPATION	50 WATTS
SUPPRESSOR GRID	100 WATTS

*Per Tube
**Approximate Values

TYPICAL OPERATION (Two Tubes), Class AB_1

DC Plate Voltage	6000 volts
DC Screen Voltage	850 volts
DC Grid Voltage*	-147 volts
DC Suppressor Grid Voltage	0 volts
Max-Signal Plate Current	2.9 amps
Zero-Signal Plate Current	1.0 amp
Max-Signal Screen Current**	200 mA
Zero-Signal Screen Current	0 mA
Peak AF Driving Voltage*	138 volts
Driving Power	0 watts
Load Resistance, Plate-to-Plate	4700 ohms
Max-Signal Plate Dissipation*	3000 watts
Max-Signal Plate Output Power	11,000 watts

Note: In Class AB operation, maximum plate voltage and plate current must not be applied simultaneously, as plate dissipation will be exceeded.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB

MAXIMUM RATINGS

DC PLATE VOLTAGE	7000 VOLTS
DC SCREEN VOLTAGE	1000 VOLTS
DC PLATE CURRENT	2.0 AMPS
PLATE DISSIPATION	4000 WATTS
SCREEN DISSIPATION	175 WATTS
GRID DISSIPATION	50 WATTS
SUPPRESSOR DISSIPATION	100 WATTS

*Adjust to the specified Zero-Signal Ib
**The intermodultaion distortion products will be as specified or better for all levels from zero-signal to maximum output power and are referenced against one tone of a two equal tone signal.

TYPICAL OPERATION Class AB_1 Grid Driven

DC Plate Voltage	3800	6000 volts
DC Screen Voltage	800	850 volts
DC Grid Voltage*	-128	-147 volts
DC Suppressor Voltage	0	0 volts
Zero-Signal DC Plate Current	.600	.500 amps
Single-Tone DC Plate Current	1.510	1.445 amps
Single-Tone DC Screen Current	.136	.092 mA
Two-Tone DC Plate Current	1.770	1.010 amps
Two-Tone DC Screen Current	.072	.041 mA
Peak RF Grid Voltage	116	128 volts
Peak Envelope Useful Output Power	3300	5500 watts
Resonant Load Impedance	1300	2350 ohms
Intermodulation Distortion Products** (no negative feedback)		
3rd Order	-46	-41 dB
5th Order	-50	-53 dB

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance is made for circuit losses. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed.

APPLICATION

MECHANICAL

Mounting — The 5CX3000A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

Socket — The EIMAC SK-1420 socket and SK-1426 chimney have been designed especially for the 5CX3000A. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals through an Air Chimney, the SK-1426, and through the anode cooling fins.

Cooling — The maximum temperature rating for the 5CX3000A is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic-metal seals below 250°C. Air-flow requirements to maintain seal temperature at 200°C in 50°C ambient air are tabulated below (for operation below 30 MHz).

Plate Dissipation* (Watts)	SEA LEVEL		5,000 FEET	
	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
2500	67	1.24	80	1.5
3500	100	2.4	121	3.2
4000	117	3.1	140	4.3

***Since the power dissipated by the filament represents about 450 watts and since grid-plus-screen dissipation can, under some conditions, represent another 225 watts, allowance has been made in preparing this tabulation for an additional 675 watts dissipation.**

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

Filament Operation — The rated filament voltage for the 5CX3000A is 9 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than plus or minus five percent from the rated value.

Intermodulation Distortion — The operating conditions including distortion data are the results of actual operation in a neutralized, grid-driven amplifier. A plot of IM distortion versus power output under two-tone condition for a typical tube is shown on the next page.

Control Grid Operation—The rated dissipation of the grid is 50 watts. This is approximately the product of dc grid current and peak positive grid voltage. Operation at bias and drive levels near those listed will insure safe operation.

Screen-Grid Operation—The power dissipated by the screen of the 5CX3000A must not exceed 175 watts.

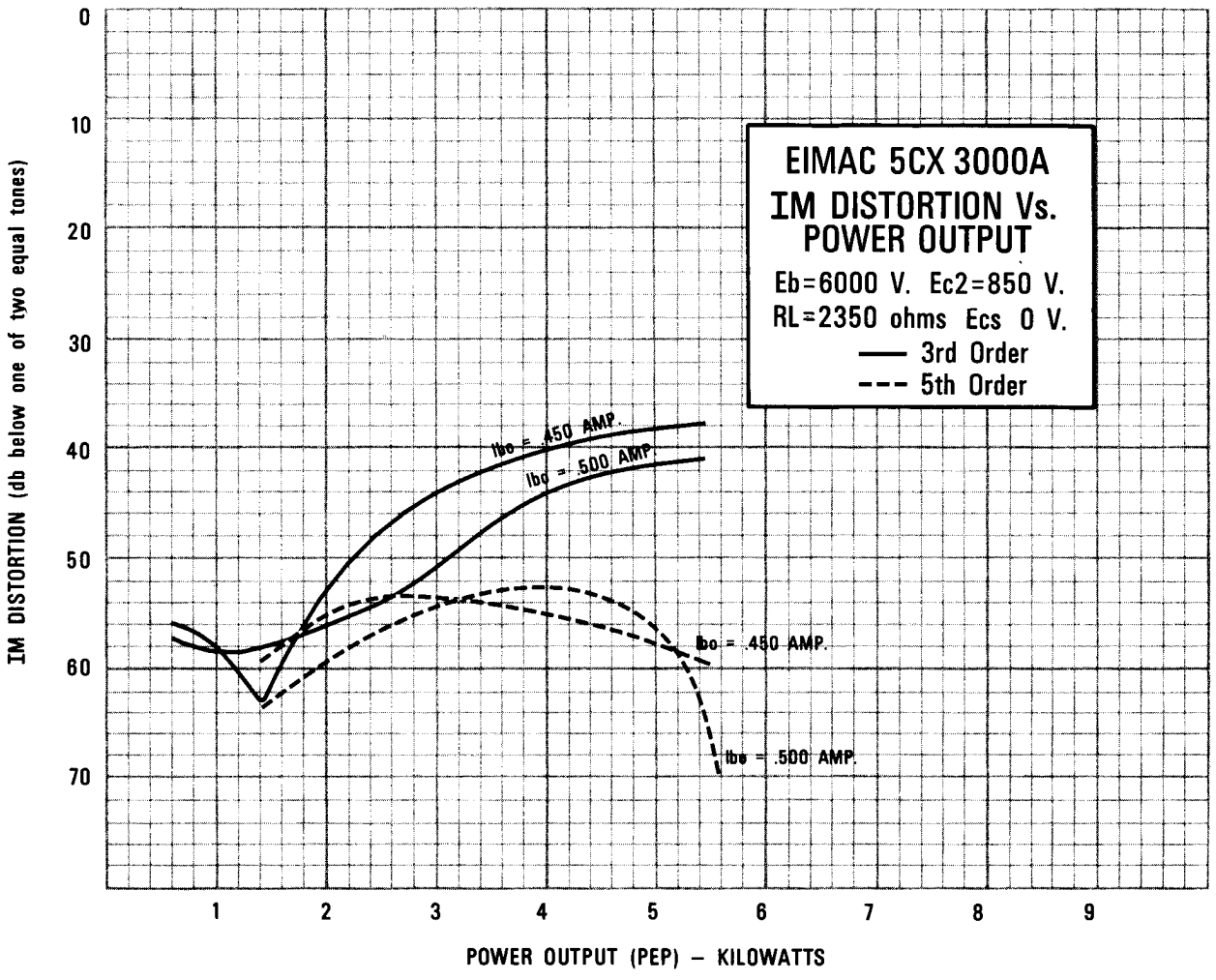
Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

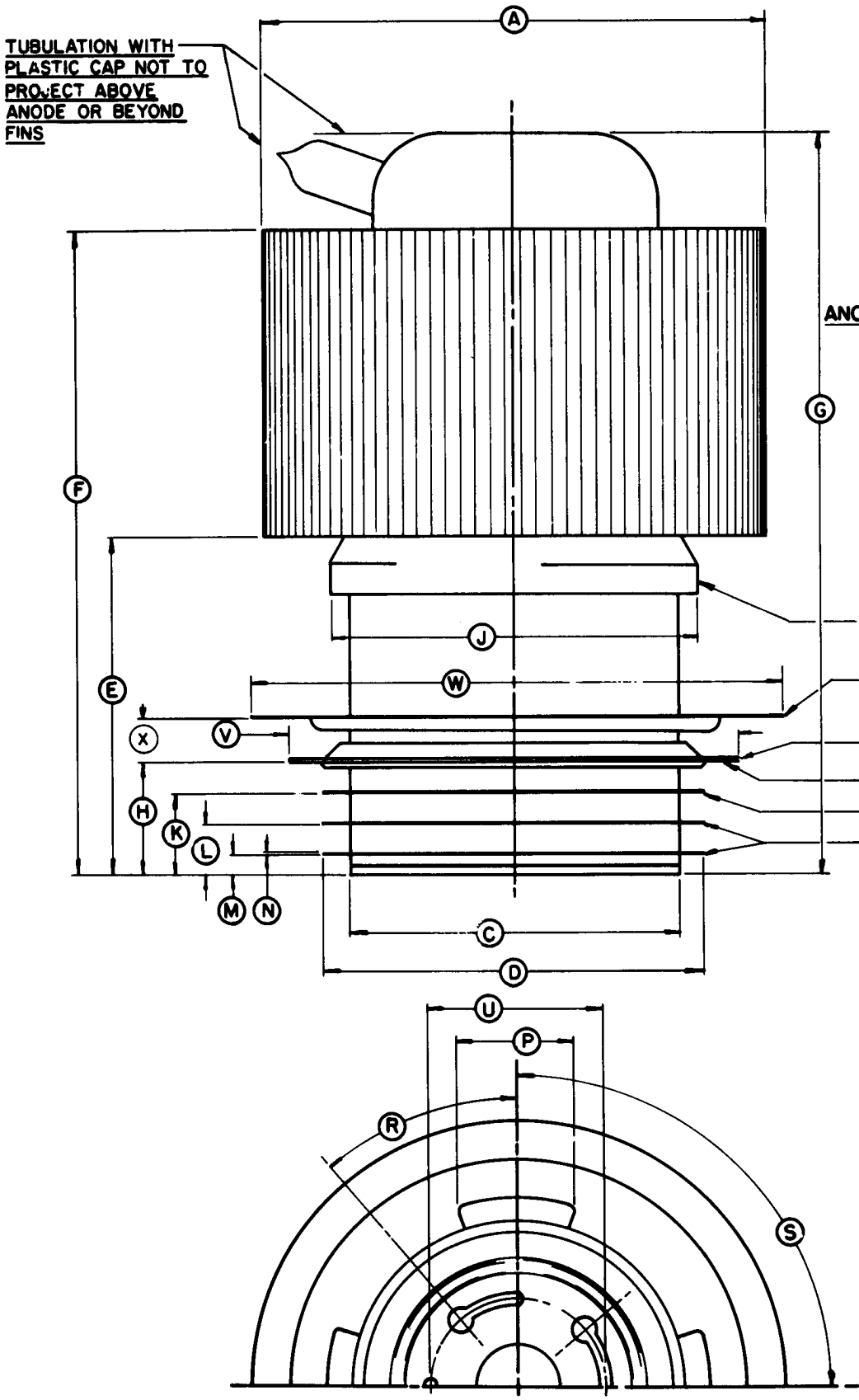
Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 175 watts in the event of circuit failure.

Suppressor Grid — The rated dissipation of the suppressor grid is 100 watts. Suppressor current will be zero or very nearly zero for all typical operating conditions specified. The 5CX-3000A has been designed for zero voltage operation of the suppressor grid for most applications.

Plate Dissipation — The plate-dissipation ratings for the 5CX3000A are 2650 watts for Class-C plate-modulated service and 4000 watts for Class-C telegraphy and Class-AB operation. In any Class-AB application maximum plate current and maximum plate voltage should not be applied simultaneously as the plate-dissipation rating would be exceeded.

Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to the Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, for information and recommendations.

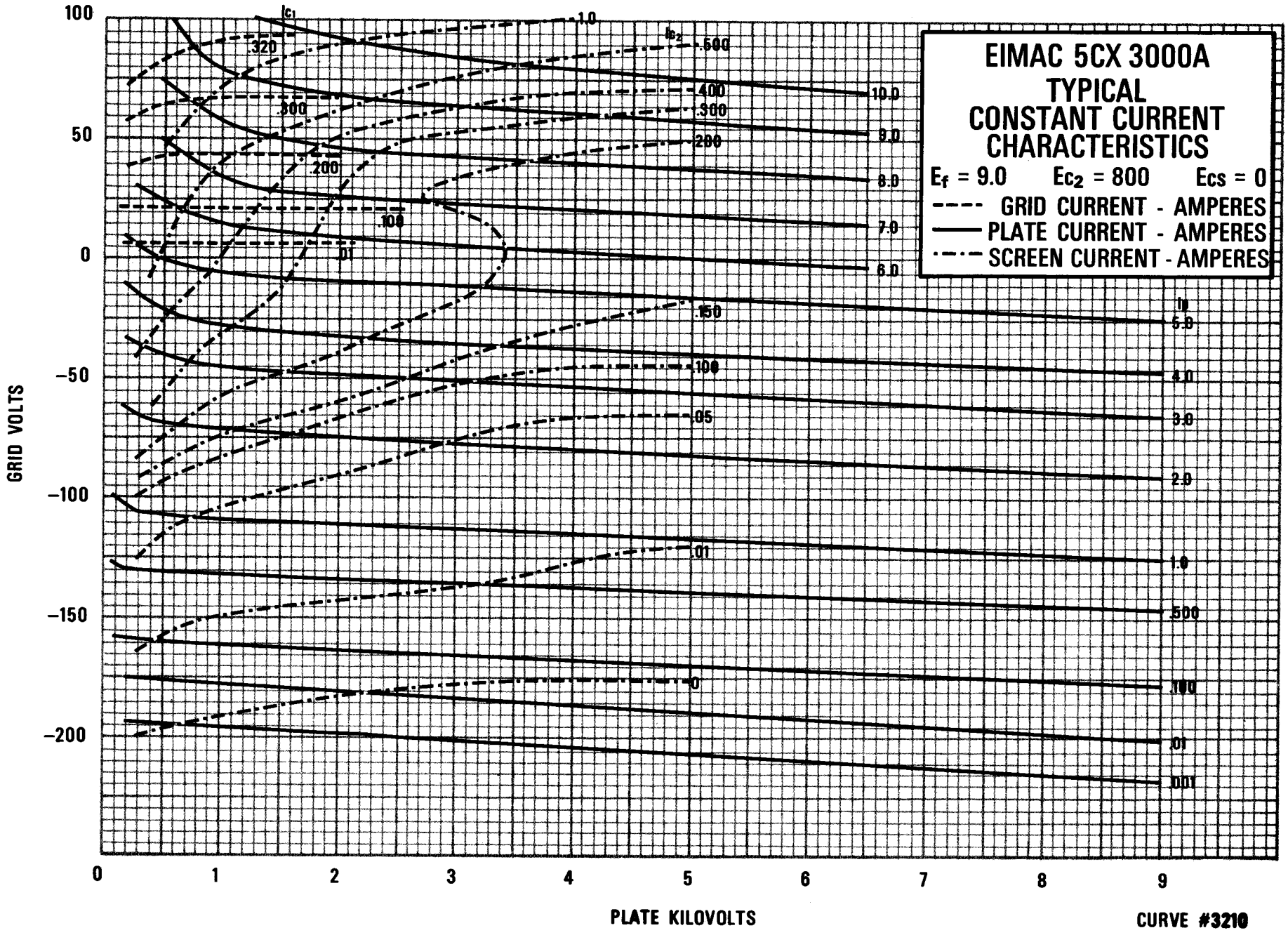


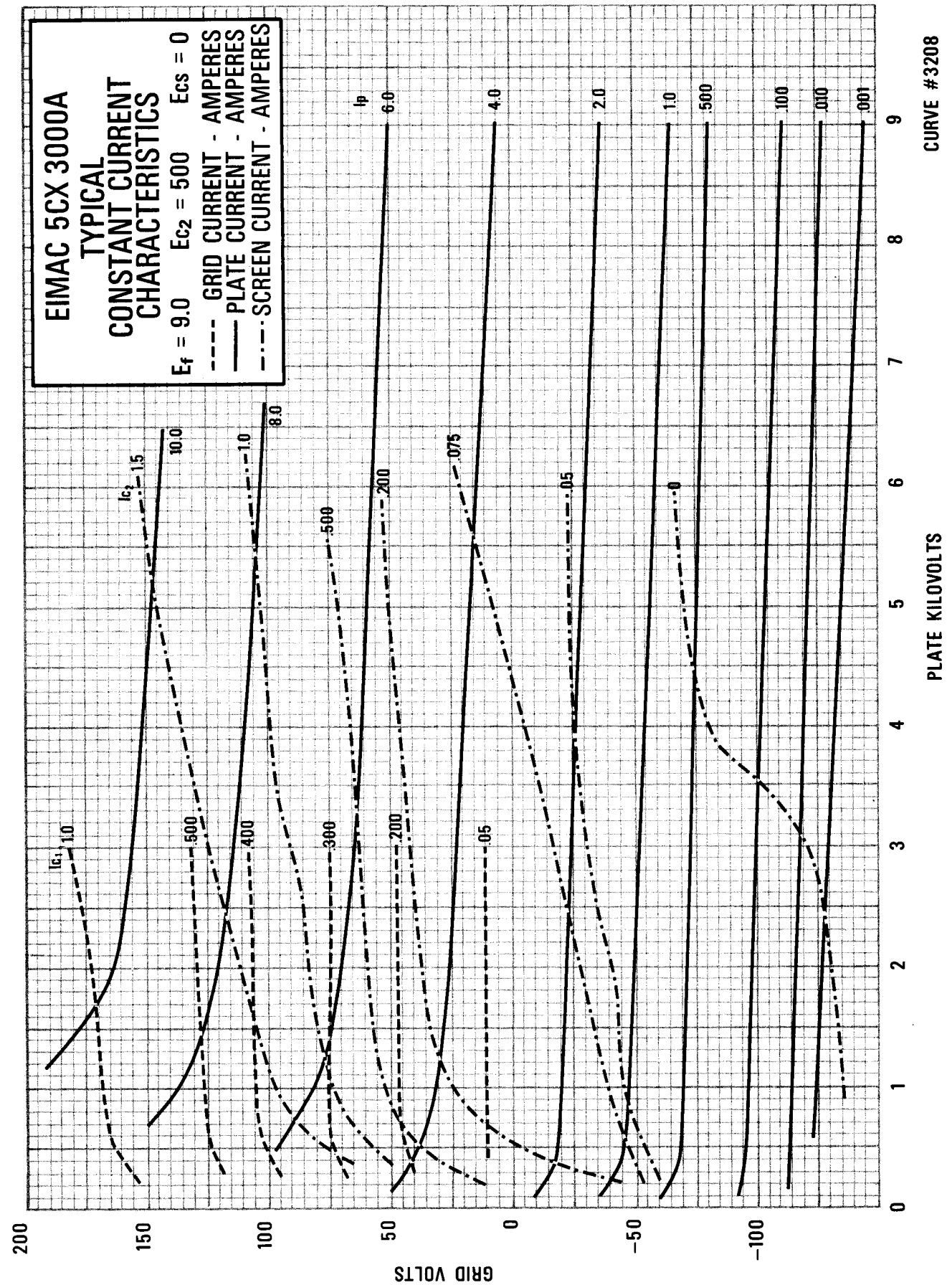


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A	4.585	4.625	
C	2.985	3.025	
D	3.490	3.525	
E	3.050	3.150	
F	5.900	6.100	
G	6.638	6.838	
H	.965	1.005	
J	3.380	3.450	
K	.700	.730	
L	.430	.460	
M	.160	.180	
N	.018	.025	
P	1.050	1.100	
R	39°	41°	
S	89°	91°	
U	1.557	1.567	
V	4.000	4.175	
W	4.615	4.635	
X			.375

NOTE 1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.


EIMAC 5CX 3000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
Ef = 9.0 Ec2 = 800 Ecs = 0
GRID CURRENT - AMPERES
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID VOLTS
PLATE KILOVOLTS
CURVE #3210
100
50
0
−50
−100
−150
−200
0
1
2
3
4
5
6
7
8
9
Ic1
Ic2
1.0
.500
.400
.300
.200
.100
.01
.320
.300
.200
.150
.100
.05
.01
0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.500
.100
.01
.001


EIMAC 5CX 3000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
Ef = 9.0 Ec2 = 500 Ecs = 0
---- GRID CURRENT - AMPERES
—— PLATE CURRENT - AMPERES
-·-·- SCREEN CURRENT - AMPERES
Ip
6.0
4.0
2.0
1.0
.500
.100
.010
.001
Ic2
1.5
10.0
1.0
8.0
Ic1
1.0
.500
.400
.300
.200
.500
.200
.075
.05
.05
0
GRID VOLTS
200
150
100
50
0
−50
−100
0
1
2
3
4
5
6
7
8
9
PLATE KILOVOLTS
CURVE #3208

5D22
4-250A

TECHNICAL DATA

RADIAL BEAM
POWER TETRODE

The EIMAC 5D22/4-250A is a compact, ruggedly constructed power tetrode having a maximum plate dissipation rating of 250 watts. It is intended for use as an amplifier, oscillator or modulator. The low grid-plate capacitance of this tetrode coupled with its low driving-power requirement allows considerable simplification of the associated circuit and driver stage.

The 5D22/4-250A is cooled by radiation from the plate and by circulation of forced-air through the base, around the envelope, and over the plate seal.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	5.0 ± 0.25	V
Current, at 5.0 volts	14.5	A
Transconductance (Average):		
I_b = 100 mA, E_{c2} = 500 Vdc	4000	μmhos
Amplification Factor (Average):		
Grid to Screen	5.1	
Direct Interelectrode Capacitance (grounded filament)[2]		
Input	12.7	pF
Output	4.5	pF
Feedback	0.12	pF
Frequency of Maximum Rating:		
CW	110	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length	6.375 in; 161.93 mm
Diameter	3.563 in; 90.50 mm
Net Weight	8 oz; 226.8 gm
Operating Position	Vertical, base down or up
Maximum Operating Temperature:	
Plate Seal	200°C
Base Seals	170°C

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Cooling	Radiation and forced air
Base	Special 5-pin
Recommended Air System Socket	EIMAC SK-400 Series
Recommended Chimney	EIMAC SK-406
Recommended Heat-Dissipating Connector:	
Plate	HR-6

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_1

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC PLATE CURRENT	0.35	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	2500	3000	Vdc
Screen Voltage	600	600	Vdc
Grid Voltage[1]	-110	-116	Vdc
Zero-Signal Plate Current	60	60	mAdc
Single-Tone Plate Current	215	205	mAdc
Zero-Signal Screen Current[2]	-0.10	-0.10	mAdc
Single-Tone Screen Current[2]	7	6	mAdc
Peak rf Grid Voltage[2]	90	93	v
Plate Dissipation	225	250	W
Single-Tone Plate Output Power	312	350	W
Resonant Load Impedance	5800	7300	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy or FM Telephony (Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	0.35	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Frequencies to 110 MHz)

Plate Voltage	2500	3000	4000	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-150	-180	-225	Vdc
Plate Current	300	345	312	mAdc
Screen Current[2]	60	60	45	mAdc
Grid Current[2]	9	10	9	mAdc
Peak rf Grid Voltage[2]	220	265	303	v
Calculated Driving Power[2/3]	1.7	2.6	2.5	W
Plate Input Power	750	1035	1250	W
Plate Dissipation	175	235	250	W
Plate Output Power	575	800	1000	W

1. Above 110 MHz, the maximum plate voltage rating depends upon frequency. See Application (Electrical) section.
2. Approximate value.
3. Driving power increases above 40 MHz. See Application (Electrical) section.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE[1]	3200	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	0.275	AMPERE
PLATE DISSIPATION[2]	165	WATTS
SCREEN DISSIPATION[3]	35	WATTS
GRID DISSIPATION[3]	10	WATTS

1. Above 110 MHz, the maximum plate voltage rating depends upon frequency. See Application(Electrical)section.
2. Corresponds to 250 watts at 100% sine-wave modulation.
3. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 110 MHz)

Plate Voltage	2500	3000	Vdc
Screen Voltage	400	400	Vdc
Grid Voltage	-200	-310	Vdc
Plate Current	200	225	mAdc
Screen Current[4]	30	30	mAdc
Grid Current[4]	9	9	mAdc
Peak af Screen Voltage (100% modulation)[4]	350	350	v
Peak rf Grid Voltage[4]	255	365	v
Calculated Driving Power[4/5]	2.2	3.2	W
Plate Input Power	500	675	W
Plate Dissipation	125	165	W
Plate Output Power	375	510	W

4. Approximate Value.
5. Driving power increases above 110 MHz. See Application (Electrical) section.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB, Grid Driven

(Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC PLATE CURRENT	0.35	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Two Tubes), Class AB_1

Plate Voltage	1500	2000	2500	3000	Vdc
Screen Voltage	600	600	600	600	Vdc
Grid Voltage1/3	-95	-104	-110	-116	Vdc
Zero-Signal Plate Current	120	110	120	120	mAdc
Max. Signal Plate Current	400	405	430	417	mAdc
Zero-Signal Screen Current[1]	-0.40	-0.30	-0.30	-0.20	mAdc
Max. Signal Screen Current[1]	23	22	13	11	mAdc
Peak af Grid Voltage[2]	64	88	90	93	v
Peak Driving Power	0	0	0	0	w
Max. Signal Plate Dissipation[2]	145	175	225	250	W
Plate Output Power	310	460	625	750	W
Load Resistance (plate to plate)	6250	9170	11,400	15,000	Ω

TYPICAL OPERATION (Two Tubes), Class AB_2

Plate Voltage	1500	2000	2500	3000	Vdc
Screen Voltage	300	300	300	300	Vdc
Grid Voltage1/3	-48	-48	-51	-53	Vdc
Zero-Signal Plate Current	100	120	120	125	mAdc
Max. Signal Plate Current	485	510	500	473	mAdc
Zero-Signal Screen Current[1]	0	0	0	0	mAdc
Max. Signal Screen Current[1]	34	26	23	33	mAdc
Peak af Grid Voltage[2]	96	99	100	99	v
Peak Driving Power[4]	4.7	5.5	4.8	4.6	w
Max. Signal Plate Dissipation[2]	150	185	205	190	W
Plate Output Power	428	650	840	1040	W
Load Resistance (plate to plate)	5400	8000	10,900	16,000	Ω

1. Approximate value.
2. Per tube.
3. Adjust to give stated zero-signal plate current.
4. Nominal drive power is one-half peak drive power.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 5.0 volts	13.5	14.7	A
Interelectrode Capacitances[1] (grounded filament connection)			
Input	10.7	14.5	pF
Output	3.7	5.1	pF
Feedback	---	0.14	pF

1. In Shielded Fixture.

APPLICATION

MECHANICAL

MOUNTING - The 4-250A must be mounted vertically, base up or down. The socket must be constructed so as to allow an unimpeded flow of air through the holes in the base of the tube and must also provide clearance for the glass tip-off which extends from the center of the base. The metal tube-base shell should be grounded by means of suitable spring fingers. The above requirements are met by the EIMAC SK-400 and SK-410 Air-System Sockets. A flexible connecting strap should be provided between the EIMAC HR-6 connector on the plate terminal and the external plate circuit. The tube must be protected from severe vibration and shock.

COOLING - Adequate forced-air cooling must be provided to maintain the base seals at a temperature below 170°C, and the plate seal at a temperature below 200°C.

When the EIMAC SK-400 or SK-410 Air-System Socket is used, a minimum air flow of 5 cubic feet per minute at a static pressure of 0.25 inches of water or less, as measured in the socket or plenum chamber at sea level, is required to provide adequate cooling under all conditions of operation. Seal temperature limitations may require that cooling air be supplied to the tube even when the filament alone is on during stand-by periods.

In the event an Air-System Socket is not used, provision must be made to supply equivalent cooling of the base, the envelope, and the plate lead.

Intermittent-service applications where the "on" time does not exceed a total of five minutes in any ten-minute period, plate-seal temperatures as high as 220°C, are permissible. When the ambient temperature does not exceed 30°C, it will not ordinarily be necessary to provide forced cooling of the bulb and plate seal to hold the temperature below this maximum at frequencies below 30 MHz, provided that a heat-radiating plate connector is used, and the tube is so located that normal circulation of air past the envelope is not impeded. The five cubic feet per minute base-cooling requirement must be observed in intermittent service.

Tube temperatures may be measured with a temperature sensitive paint, spray or crayon, such as manufactured by Tempil Division, Big Three Industrial Gas & Equipment Co., Hamilton Blvd., So. Plainfield, N.J. 07080.

ELECTRICAL

FILAMENT VOLTAGE - For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated voltage of 5.0 volts. Variations in filament voltage must be kept within the range from 4.75 to 5.25 volts.

BIAS VOLTAGE - The dc bias voltage for the 4-250A should not exceed 500 volts. If grid resistor bias is used, suitable means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation, and the grid resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In operation above 50 MHz, it is advisable to keep the bias voltage as low as is practicable.

SCREEN VOLTAGE - The dc screen voltage for the 4-250A should not exceed 600 volts. The screen voltages shown under Typical Operation are representative voltages for the type of operation involved.

PLATE VOLTAGE - The plate-supply voltage for the 4-250A should not exceed 4000 volts in CW and audio applications. In plate-modulated telephony service the dc plate supply voltage should not exceed 3200 volts, except below 110 MHz, intermittent service, where 4000 volts may be used.

GRID DISSIPATION - Grid dissipation for the 4-250A should not be allowed to exceed 10 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{gk} \times I_c$$

where P_g = Grid dissipation

e_{gk} = Peak positive grid to cathode voltage, and

I_c = dc grid current

e_{gk} may be measured by means of a suitable peak voltmeter connected between filament and grid.

SCREEN DISSIPATION - The power dissipated by the screen of the 4-250A must not exceed 35 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 35 watts in event of circuit failure.

PLATE DISSIPATION - Under normal operating conditions, the plate dissipation of the 4-250A should not be allowed to exceed 250 watts. The anode of the 4-250A operates at a visibly red color at its maximum rated dissipation of 250 watts.

In plate modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 165 watts. The plate dissipation will rise to 250 watts under 100% sinusoidal modulation.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

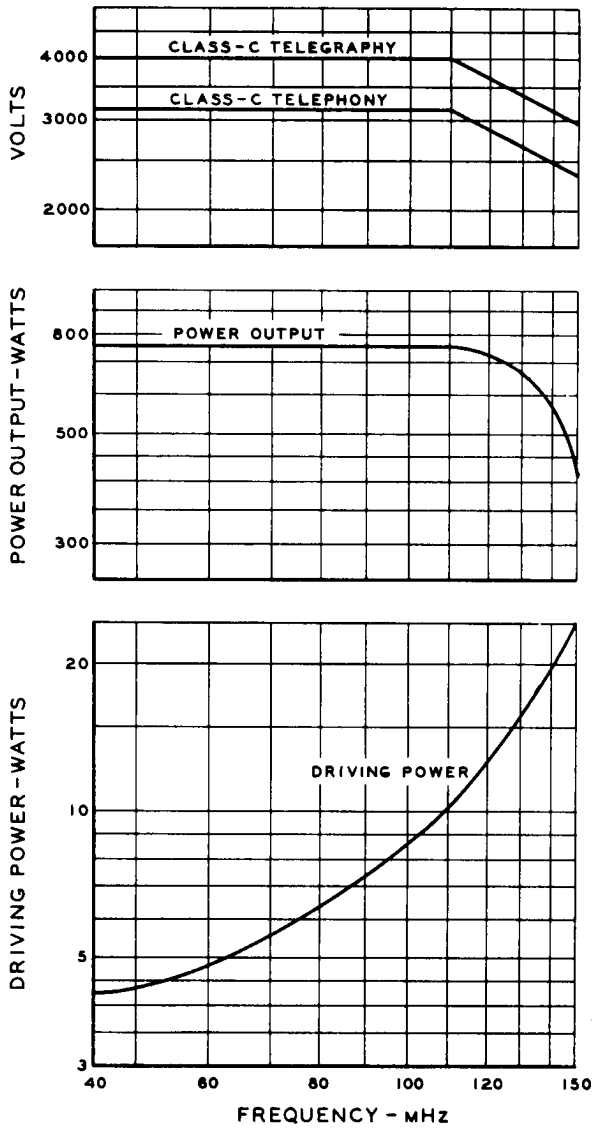
PULSE SERVICE - For pulse service, the EIMAC 4PR400A should be used.

MULTIPLE OPERATION - To obtain maximum power output with minimum distortion from tubes operated in multiple, it is desirable to adjust individual screen or grid bias voltages so that the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual dc plate currents will be approximately equal for full input signal for class AB_1 operation.

CAUTION-GLASS IMPLOSION - The EIMAC 4-250A is pumped to a very high vacuum, which is contained by a glass envelope. When handling a glass tube, remember that glass is a relatively fragile material, and accidental breakage can result at any time. Breakage will result in flying glass fragments, so safety glasses, heavy clothing, and leather gloves are recommended for protection.

CAUTION-HIGH VOLTAGE - Operating voltage for the 4-250A can be deadly, so the equipment must be designed properly and operation precautions must be followed. Design equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high voltage circuits and terminals, with interlock switches to open the primary circuits of the power supply and to discharge high voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

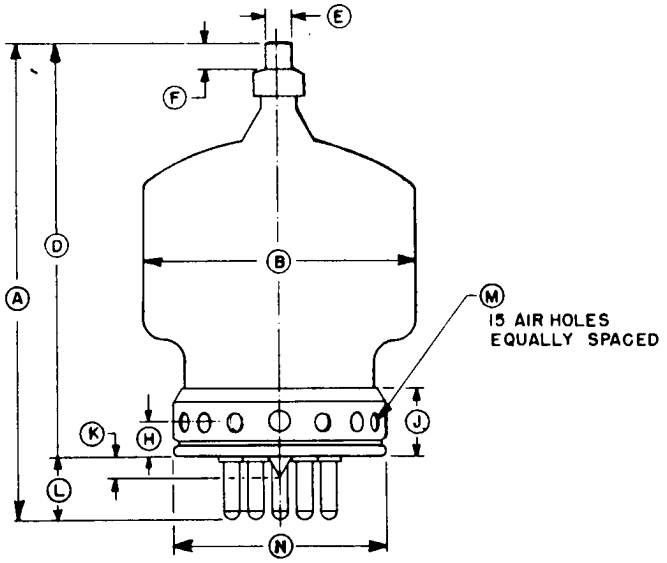


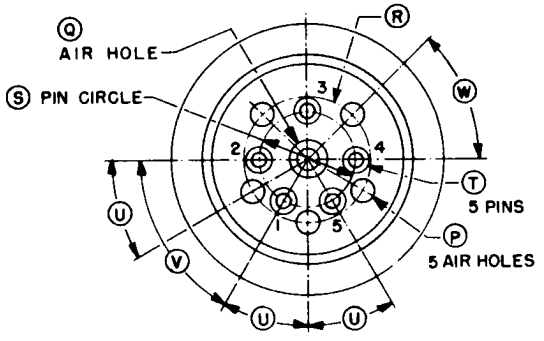
OPERATING CHARACTERISTICS ABOVE 40 MHz

DIMENSIONAL DATA

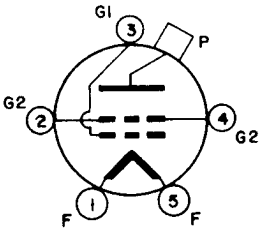
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	5.875	6.375	--	149.23	161.93	--
B	--	3.563	--	--	90.50	--
D	5.125	5.625	--	130.18	142.88	--
E	0.350	0.365	--	8.89	9.27	--
F	0.328	--	--	8.33	--	--
H	--	--	0.438	--	--	11.13
J	--	0.969	--	--	24.61	--
K	--	0.250	--	--	6.35	--
L	--	--	0.750	--	--	19.05
M	--	--	0.250	--	--	6.35
N	--	2.750	--	--	69.85	--
P	--	--	0.312	--	--	7.92
Q	--	--	0.500	--	--	12.70
R	--	--	1.625	--	--	41.28
S	--	--	1.250	--	--	31.75
T	0.185	0.191	--	4.70	4.85	--
U	--	--	30°	--	--	30°
V	--	--	60°	--	--	60°
W	--	--	45°	--	--	45°

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.

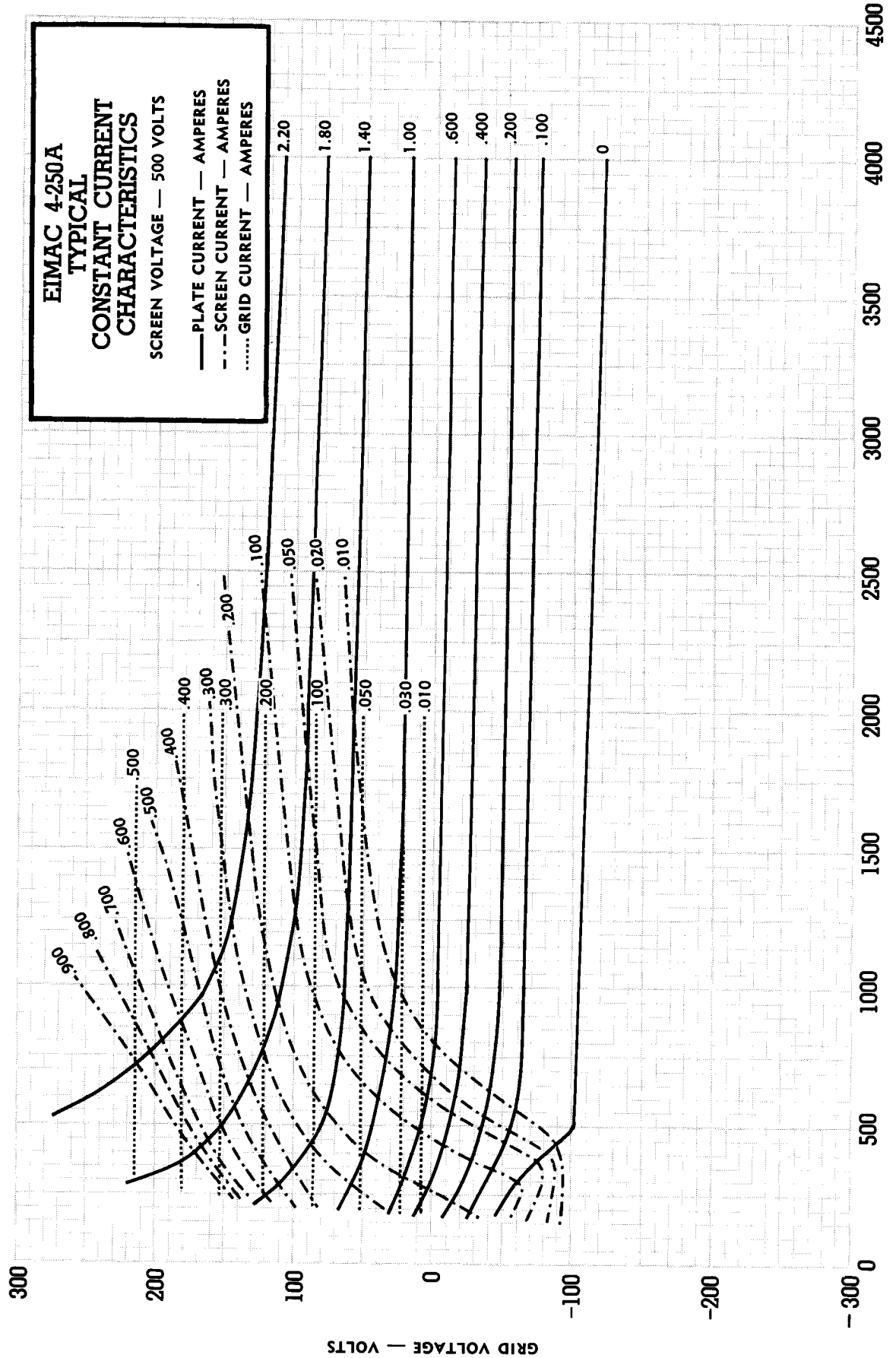




BOTTOM VIEW



NOTE:
Base pins T and tubulation K are so alined that they can be freely inserted in a gage ¼ inch (6.35 mm) thick with hole diameters of .204 (5.18 mm) and .500 (12.70 mm), respectively, located on the true centers by the given dimensions S, U, V.


EIMAC 4-250A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
——PLATE CURRENT — AMPERES
- - -SCREEN CURRENT — AMPERES
.....GRID CURRENT — AMPERES
2.20
1.80
1.40
1.00
.600
.400
.200
.100
0
.900
.800
.700
.600
.500
.500
.400
.400
.300
.300
.200
.200
.100
.050
.020
.010
.100
.050
.030
.010
300
200
100
0
-100
-200
-300
0
500
1000
1500
2000
2500
3000
3500
4000
4500
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

EIMAC
A Division of Varian Associates
SAN CARLOS, CALIFORNIA

Tentative Data

5K50CB

10 KW CW
POWER AMPLIFIER
C-BAND KLYSTRON

The Eimac 5K50CB power-amplifier klystron operates at frequencies from 4.4-5.0 kilomegacycles with a rated output power of 10 kilowatts and a minimum gain of 60 decibels. This klystron is intended primarily for use in tropospheric scatter communications systems.

A confined flow configuration is used in the electron gun of the 5K50CB to minimize focusing adjustments and to provide a thoroughly stable beam.

This electron gun is completely enclosed in a metal shield with integral shielded connecting leads to reduce the high voltage hazard to a minimum.

The small size and light weight of the 5K50CB make it suitable, where necessary, for mounting on the antenna structure of the system in which it is used.

Five integral cavities are used in the 5K50CB. Both input and output couplings are fixed. Unusual stability, for this power and frequency, is achieved through the use of improved body cooling.

The 5K50CB incorporates a built-in vacuum pump in the form of a titanium getter which should be energized whenever heater power is applied.

A focusing electromagnet and klystron supporting structure, Catalog Number H-175, has been designed for use with the 5K50CB.



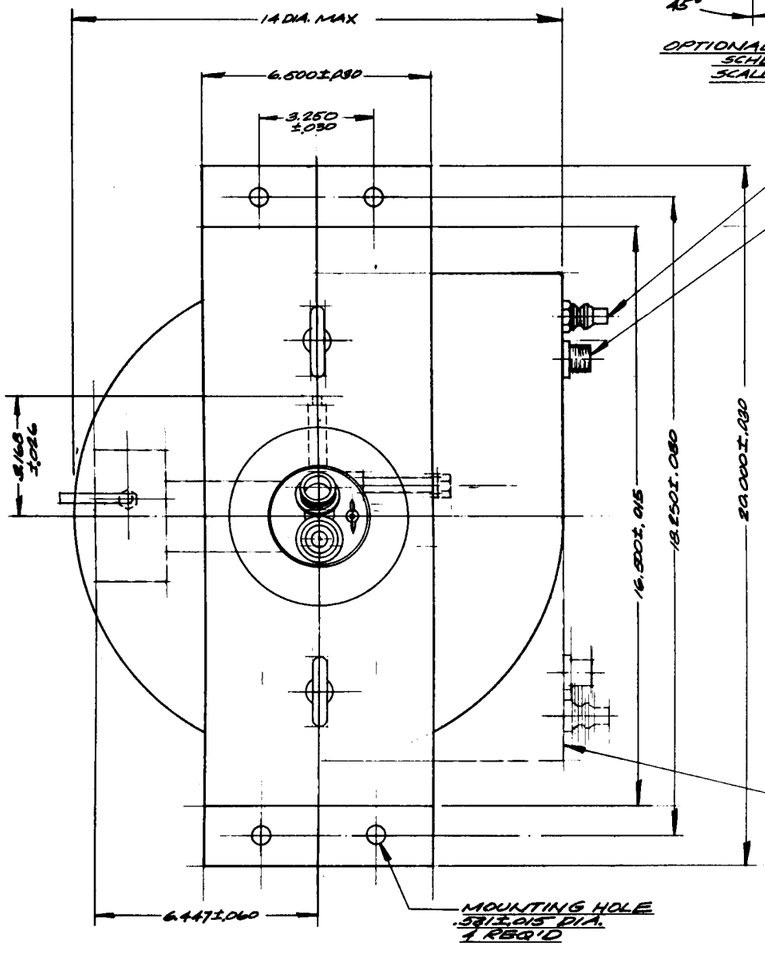
CHARACTERISTICS

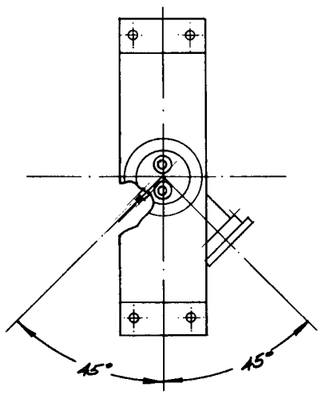
ELECTRICAL

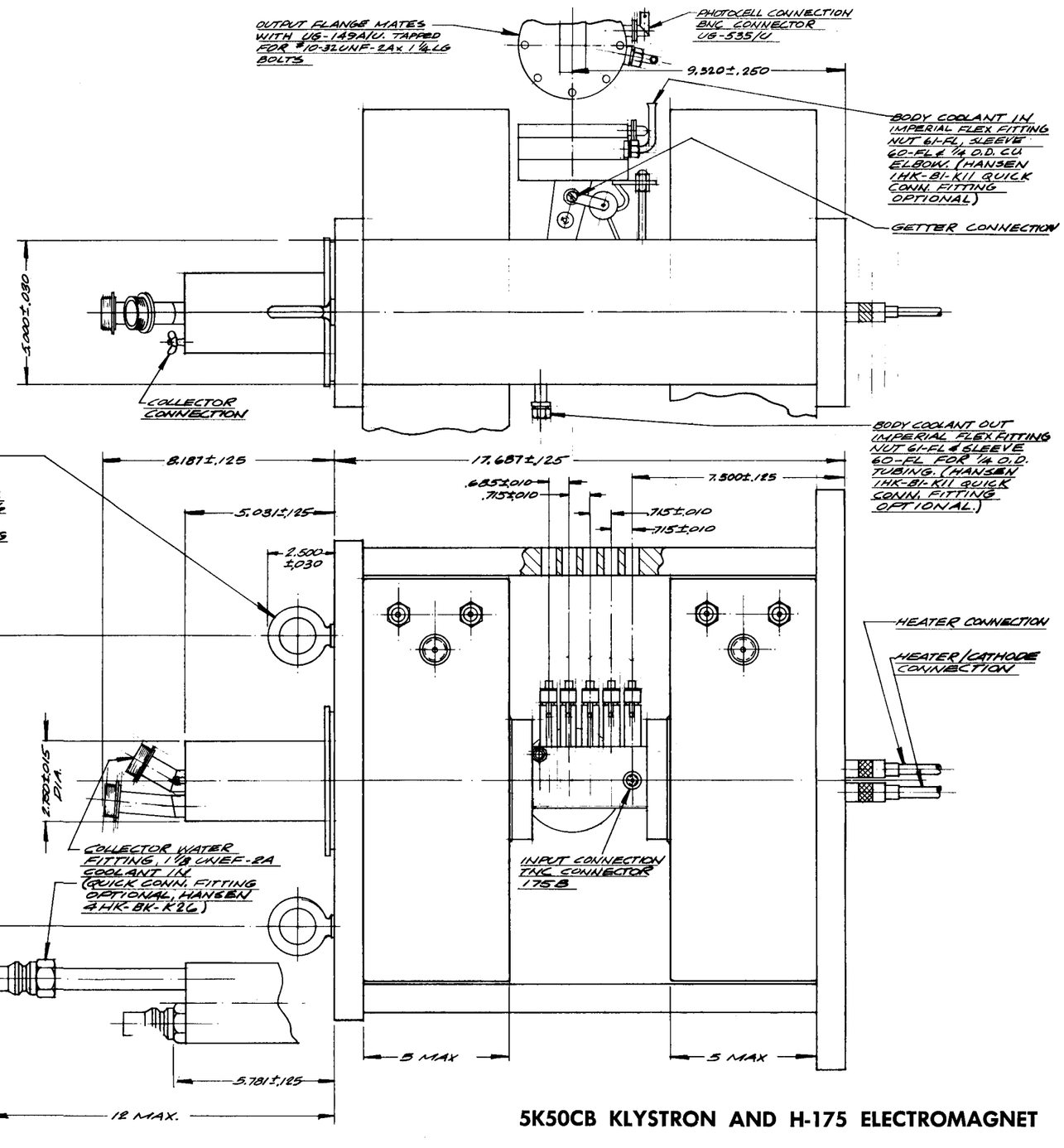
Heater: Voltage	10 volts
Current	3.0 amperes
Cathode: Impregnated, Unipotential	
Heating Time	5 minutes
Getter: Voltage	4.0 volts
Current	25 amperes
Power Gain	60 decibels
Output Power	10 kilowatts
Frequency Range	4.4-5.0 kilomegacycles
Phase sensitivity to beam voltage	0.06 degrees/volt

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5K50CB







5K50CB KLYSTRON AND H-175 ELECTROMAGNET

MECHANICAL

Operating Position	Axis Vertical, Cathode Down
Output rf Coupling	RG49/U Waveguide
Input rf Coupling	TNC
Dimensions: Klystron only	6 x 7 x 26½ inches
Electromagnet:	
Height	18.5 inches
Width	15.5 inches
Depth	20 inches
Weight: Klystron only	30 lbs
Electromagnet	270 lbs

Cooling: 52.5/47.5 Solution, Ethylene Glycol and Water	*Flow Rate*	*Pressure Drop*
Body	1.5 gpm	50 psi
Collector	9 gpm	50 psi
Electromagnet	2 gpm	50 psi

ELECTROMAGNET POWER-SUPPLY REQUIREMENTS

Voltage	170 volts
Current	10 amperes

MAXIMUM RATINGS

DC BEAM VOLTAGE	17.5 KILOVOLTS
DC BEAM CURRENT	2.5 AMPERES
DC BEAM INPUT POWER	50 KILOWATTS
DC BODY CURRENT (with rf drive)	80 MILLIAMPERES
COLLECTOR DISSIPATION	50 KILOWATTS
INLET WATER PRESSURE	120 PSI
OUTLET WATER TEMPERATURE	80 DEGREES C
LOAD VSWR	1.2:1

TYPICAL OPERATION — TUNED FOR HIGH EFFICIENCY

Frequency	4700 megacycles
Output Power	10 kilowatts
Driving Power	10 milliwatts
Power Gain	60 decibels
DC Beam Voltage	15 kilovolts
DC Beam Current	2.0 amperes
Beam Power Efficiency	33 percent
DC Body Current	40 milliamperes
3 db Bandwidth	15 megacycles
Electromagnet Current	9.5 amperes

For additional information or information regarding a specific application, write to Eimac Division, Varian Associates, 301 Industrial Way, San Carlos, California

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

5K70SH

S-BAND

30 KW CW

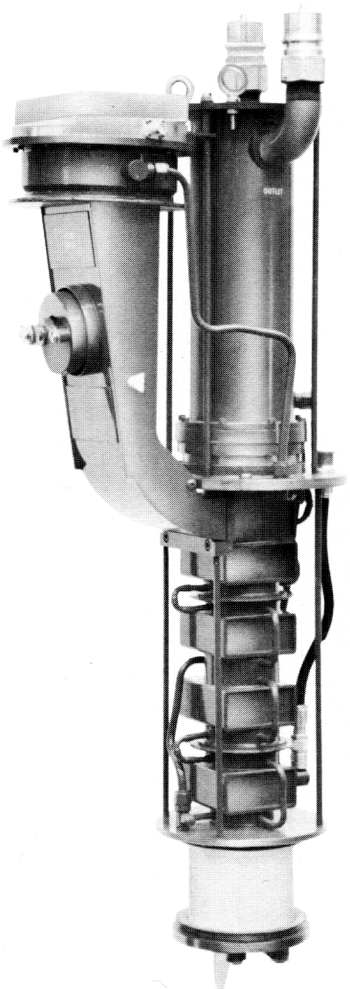
POWER AMPLIFIER KLYSTRON

The EIMAC 5K70SH power amplifier klystron was designed specifically for industrial heating applications. The outstanding characteristic of this klystron is its high efficiency at full power. The 5K70SH delivers 30 kilowatts output power at better than 50% efficiency at 2450 MHz with a minimum gain of 50 db.

An extra large cathode is used in the 5K70SH to assure long life. Five integral cavities are employed for high gain, and all are pre-tuned at the factory. Also, input and output couplings are factory adjusted. In short, no tuning of any kind is required.

The output "window," where microwave power is transferred from the vacuum within the klystron to the external waveguide, is made of beryllium oxide. This insulating material has extremely good heat-transfer and mechanical characteristics. It is virtually indestructible in this application.

A focusing electromagnet, Catalog Number H-226, has been designed for use with the 5K70SH. EIMAC Water Load WL-204 is recommended for use with this klystron.



CHARACTERISTICS

ELECTRICAL

Heater: Voltage (±5%)	7.5	Vac
Current (nominal)	11.5	Aac
Cathode: Oxide Coated		
Heating Time	5	Min
Getter: Voltage	4	Vac
Current	24	Aac
Power Gain	50	db
Output Power	30	kW
Frequency	2450	MHz
Phase Shift as a Function of Beam Voltage	0.0935	°/V

MECHANICAL

Operating Position	Any
Input rf Coupling	Type N Coaxial Fitting
Output rf Coupling	UG435A/U Flange
Weights: 5K70SH	100 lbs
H-226 Electromagnet	186 lbs

Cooling: Forced Air and Water	*Flow Rate*	*Pressure Drop*
Cathode	20 cfm	Free
Klystron Body	0.8 gpm	50 psi
Klystron Collector	18 gpm	30 psi
Electromagnet	2 gpm	30 psi

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage, Adjustable to	150 Vdc
Current, Adjustable to	25 Adc

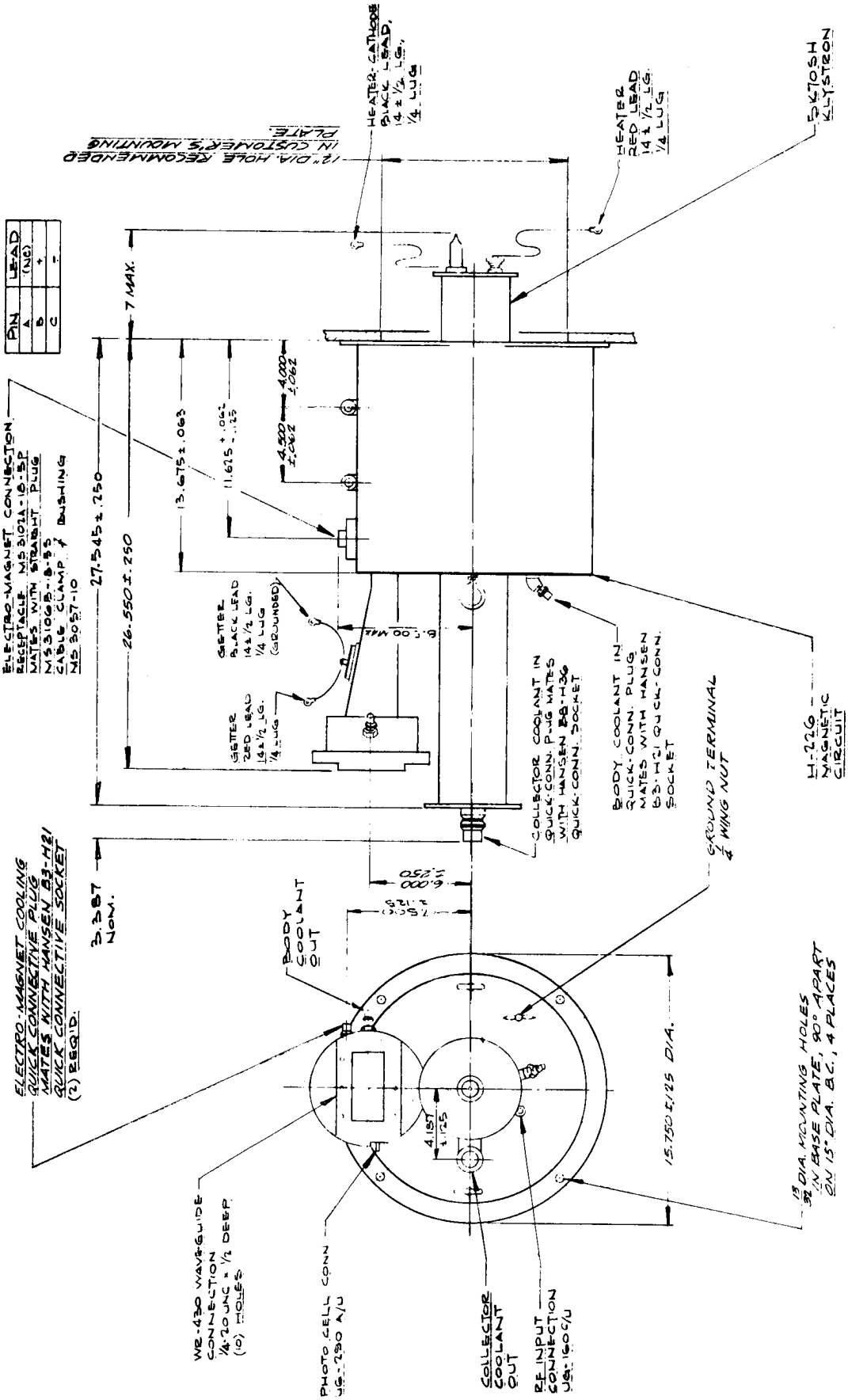
MAXIMUM RATINGS

BEAM VOLTAGE	23 kVdc
BEAM CURRENT	3 Adc
BEAM INPUT POWER	70 kW
BODY CURRENT	100 mAdc
COLLECTOR DISSIPATION	70 kW
INLET COOLANT PRESSURE	125 psig
COOLANT OUTLET TEMPERATURE	80 °C
LOAD VSWR (NON DESTRUCTIVE)	3:1

TYPICAL OPERATION

Frequency	2450 MHz
Output Power	31.5 kW
Driving Power	100 mW
Power Gain	55 db
Beam Voltage	22.5 kVdc
Beam Current	2.66 Adc
Body Current	50 mAdc
Efficiency	52.5 %
Electromagnet Current	16.5 Adc

For additional data or information regarding a specific application, write to EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California.



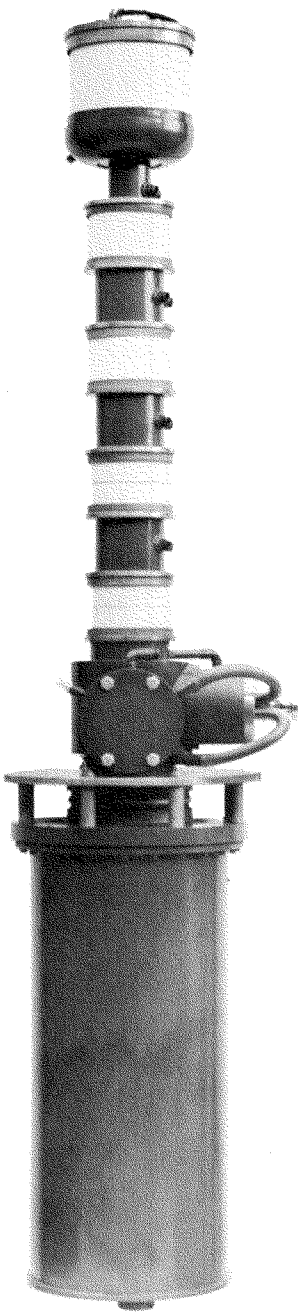
5K70SH and H-226

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

5K210,000LQ

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 5K210,000LQ is a high-gain, power-amplifier klystron designed for wide-band, tropospheric-scatter, communications service at frequencies from 755 to 985 megacycles. This klystron will deliver a CW output power of 75 kilowatts, with a minimum power gain of 42 decibels, and half-power band-width of 10 megacycles.

Five resonant cavities are used in the 5K210,000LQ. Four are external and one, the output cavity, is integral. Output coupling is achieved by means of a fixed loop and a quarter-wave, variable-impedance, coaxial coupling section which terminates in a waveguide transition.

The 5K210,000LQ has a beam microperveance of 2 which makes it possible to achieve adequate bandwidth for tropo-scatter applications without external loading of the intermediate cavities.

Eimac Klystron Amplifier Circuit Assembly H-132 has been designed for use with the 5K210,000LQ to cover the specified frequency range. This assembly includes a supporting structure, magnetic focusing coils, tuning cavities, adjustable load couplers for the input and output cavities, and a coaxial-to-waveguide transition.

CHARACTERISTICS

ELECTRICAL

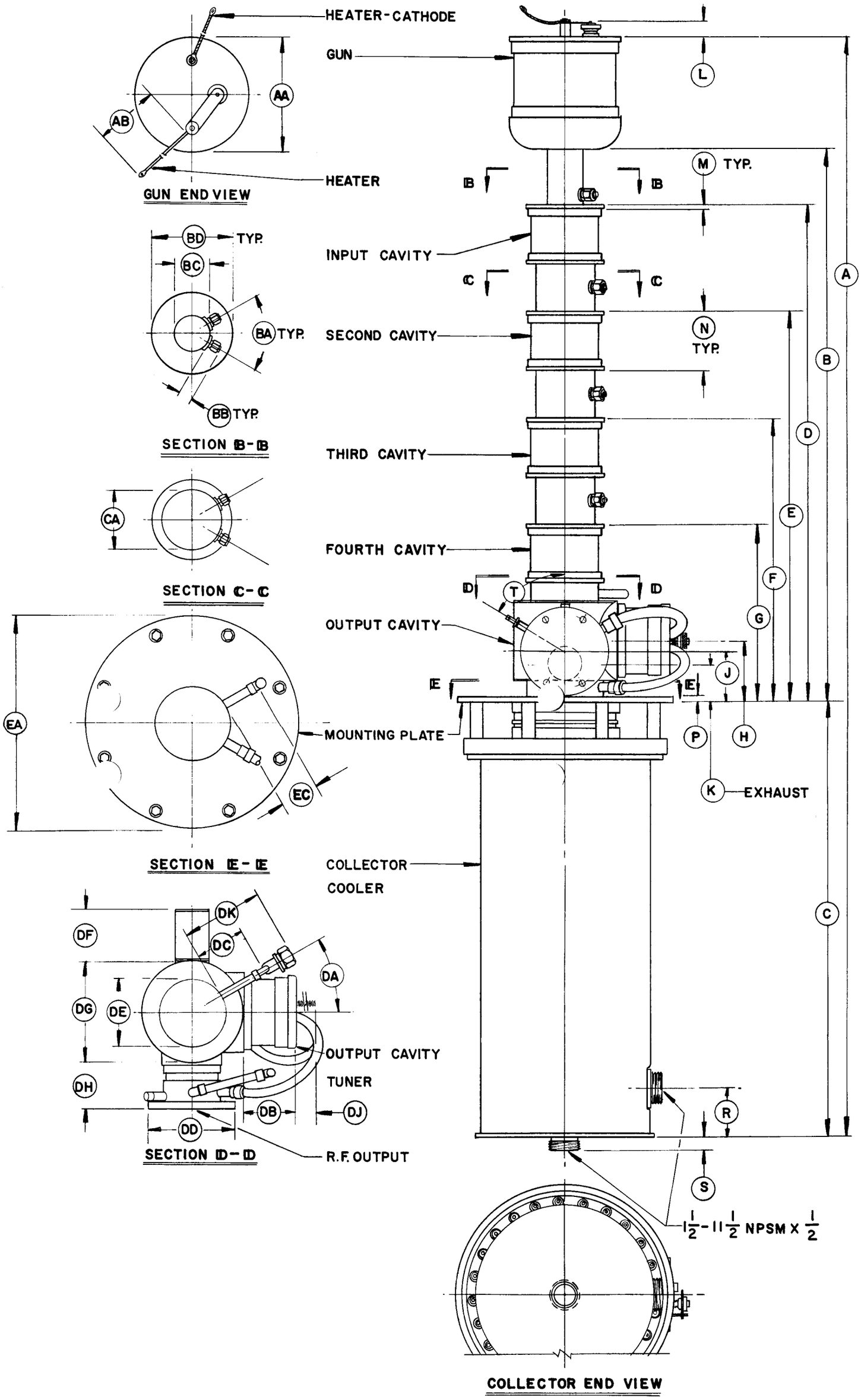
Heater:	Voltage	15	volts
	Current	18	amperes
	Maximum Starting Current	36	amperes
Cathode:	EMA, Unipotential		
	Heating Time	5	minutes
Getter:	Voltage	5.2	volts
	Current	36	amperes
Power Gain (Wide Band)		42	decibels
Output Power		75	kilowatts
Frequency Range (H-132 Circuit Assembly)		755 to 985	megacycles

MECHANICAL

Operating Position	Axis vertical, cathode up
R-F Coupling:	
Input	Type "N" coaxial fitting
Output	WR-975 Waveguide
Weight (5K210,000LQ Klystron)	380 pounds
Weight (H-132 Circuit Assembly)	1530 pounds
Cooling:	Water and Forced Air

	Flow Rate	Pressure Drop
Second, Third and Penultimate Cavities (each)	25 cfm	1 inch H_2O
Body and Output Section	6 gpm	25 psi
Collector	50 gpm	25 psi

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DIMENSIONAL DATA			
ITEM	NOM.	MIN.	MAX.
A	64.787		
B		32.244	32.786
C		25.361	25.613
D		29.066	29.544
E		22.854	23.252
F		16.642	16.960
G		10.430	10.668
H		3.576	3.728
J		2.951	3.103
K		2.206	2.348
L		29/32	1 3/32
M		.245	.255
N		3.481	3.523
P		23/64	25/64
R		2 53/64	2 59/64
S		21/32	23/32
T			
AA		6.620 DIA.	6.630 DIA.
AB		8	9
BA	60°		
BB	39/64		
BC	2.125 DIA.		
BD		4.620 DIA.	4.630 DIA.
CA	3.500 DIA.		
DA	30°		
DB		3	3 5/32
DC	2 15/32		
DD		5 11/64 DIA.	5 13/64 DIA.
DE	4.000 DIA.		
DF	4		
DG		6.000 DIA.	6.010 DIA.
DH		2 35/64	2 43/64
DJ		1.152	1.222
DK			
EA		12.748 DIA.	12.752 DIA.
EB			
EC			
ED			

5K210,000LQ KLYSTRON

MECHANICAL cont.

Maximum Dimensions of Klystron:		
Length	66.6	inches
Diameter	14	inches
Maximum Dimensions (Klystron and Circuit Assembly):		
Height	75	inches
Width	32	inches
Depth	47	inches

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil:	Voltage	0 to 25	volts
	Current	0 to 2	amperes
Each of Four Body Coils:			
	Voltage	0 to 100	volts
	Current	0 to 12	amperes
Collector Coil:	Voltage	0 to 40	volts
	Current	0 to 5	amperes

MAXIMUM RATINGS

D-C BEAM VOLTAGE	30	KILOVOLTS
D-C BEAM CURRENT	10	AMPERES
D-C BODY CURRENT	300	MILLIAMPERES
A-C GETTER CURRENT	50	AMPERES
COLLECTOR DISSIPATION	210	KILOWATTS

TYPICAL OPERATION, WIDE-BAND, CW AMPLIFIER

RF Frequency	860	megacycles
Output Power	81	kilowatts
Driving Power	3	watts
Power Gain	44.3	decibels
D-C Beam Voltage	25	kilovolts
D-C Beam Current	7.52	amperes
Efficiency	43	percent
D-C Body Current	120	milliamperes
Half-Power Bandwidth	10.9	megacycles
Magnetic-Coil Currents:		
Prefocus coil	0.97	ampere
Body Coil #1	8.7	amperes
Body Coil #2	8.2	amperes
Body Coil #3	8.5	amperes
Body Coil #4	7.6	amperes
Collector Coil	3.6	amperes

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.

EIMAC

A Division of Varian Associates

SAN CARLOS, CALIFORNIA

Tentative Data

5KM300SI

S-BAND

100 KW CW

POWER AMPLIFIER KLYSTRON

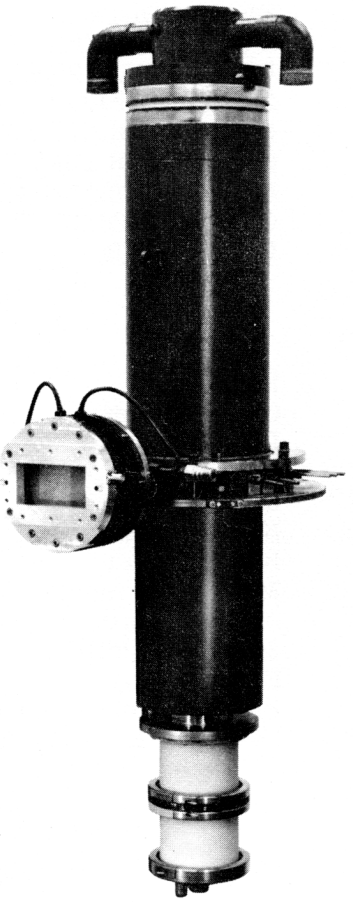
The Eimac 5KM300SI power amplifier klystron was designed specifically for use in the ground transmitters of spacecraft communications systems. The 5KM300SI has a rated output power of 100 kilowatts at frequencies from 2100 to 2400 megacycles with a 3 db bandwidth of 15 megacycles and a minimum gain of 55 decibels.

Five integral cavities are used in the 5KM300SI. Both input and output couplings are fixed. The output window is a thick beryllium oxide disc which will withstand severe abuse. An arc detector is provided to protect this window.

The electron gun of this klystron provides an exceptionally uniform beam which contributes greatly to stability and high efficiency. This gun incorporates the Eimac Modulating Anode which provides a versatile means for controlling the beam.

The 5KM300SI incorporates an ion pump which maintains a low gas pressure in the klystron and also provides a continuous indication of this pressure during operation.

A focusing electromagnet, Catalog Number H-225, has been designed for use with the 5KM300SI.



CHARACTERISTICS

ELECTRICAL

Heater: Voltage (±5%)	13 Vac
Current (Nominal)	5.4 Aac
Cathode: Impregnated, Unipotential	
Heating Time	5 Min
Ion Pump Supply	
Voltage	3 to 4 kVdc
Current	1 mAdc
Power Gain	55 db
Output Power	100 kW
Frequency Range	2100 to 2400 Mc
Phase shift as a function of beam voltage	0.026 °/V

MECHANICAL

Operating Position			any
Input Coupling (rf)			UG-23 D/U
Output Coupling (rf)			WR-430 Waveguide
Weights: 5KM300SI			235 lbs
H-225 Electromagnet			180 lbs
Tuner Starting Torque (max)			50 in-oz
Tuner Stop Torque			6 in-lbs
Cooling: Forced Air and Water		*Flow Rate*	*Pressure Drop*
Cathode		25 cfm	Free
Klystron Body		2.3 gpm	60 psi
Klystron Collector		65 gpm	23 psi
Electromagnet		2.5 gpm	45 psi

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ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Voltage, adjustable to	160 Vdc
Current, adjustable to	20 Adc

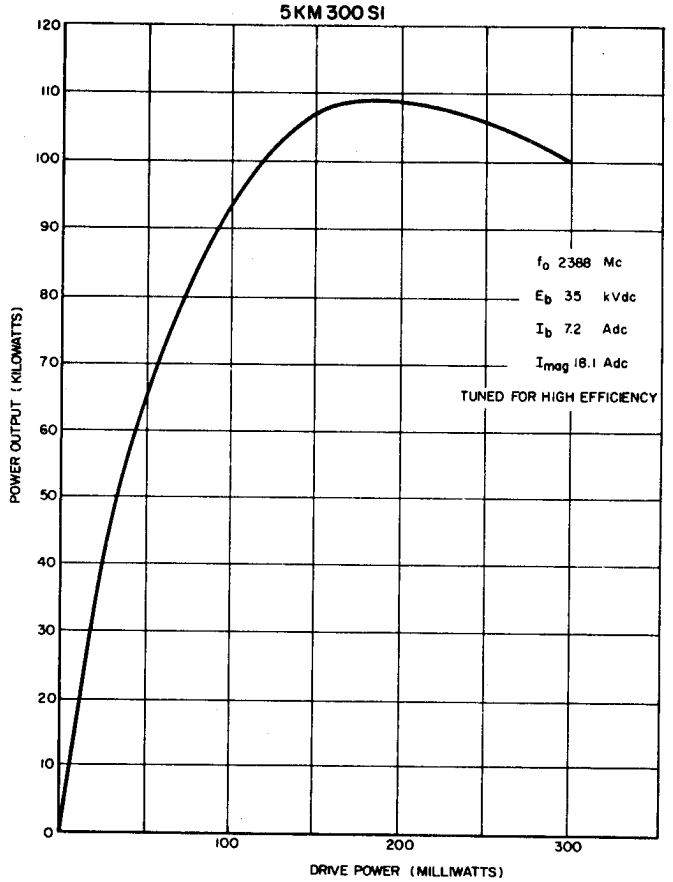
MAXIMUM RATINGS

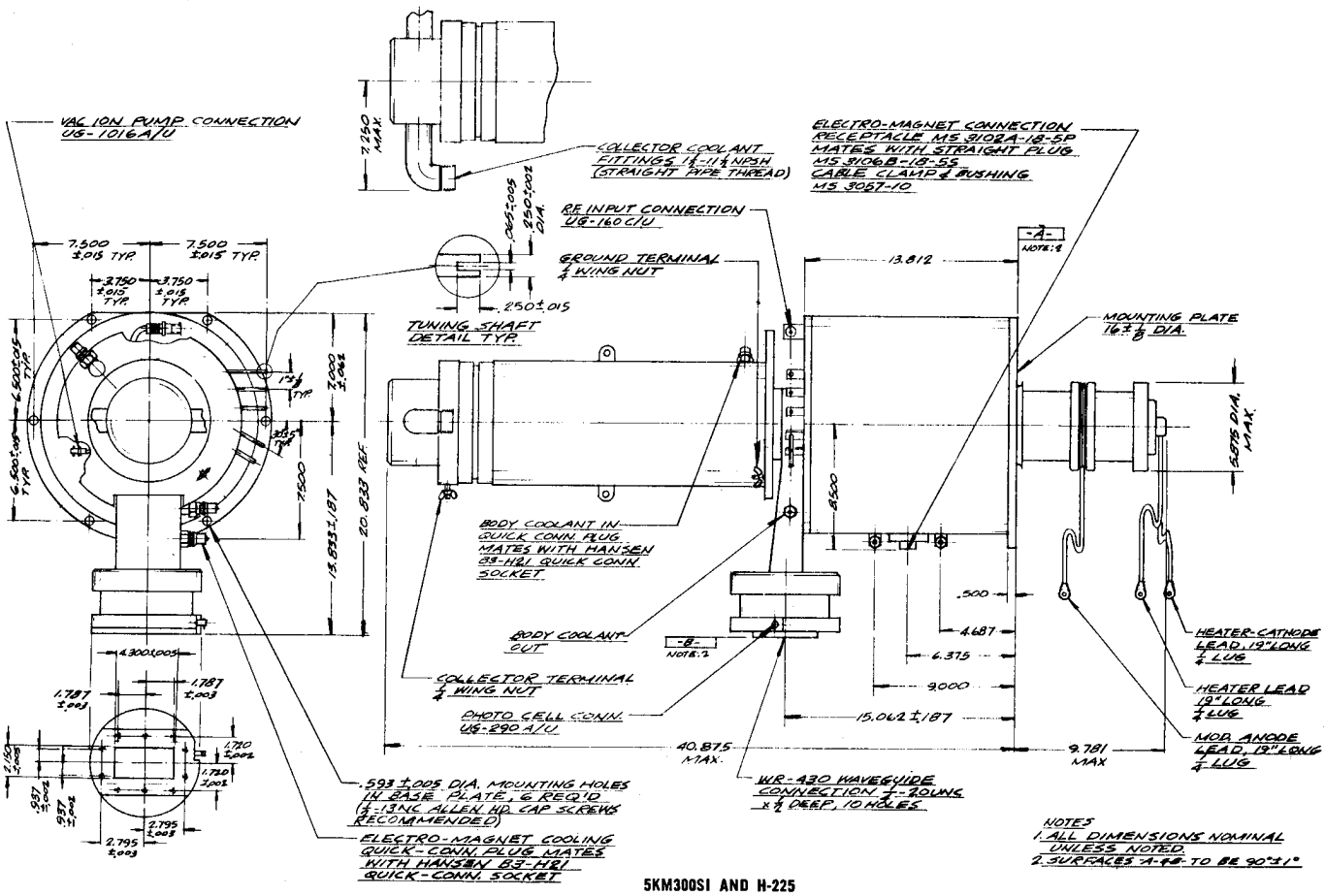
BEAM VOLTAGE	38 kVdc
BEAM CURRENT	7.9 Adc
BEAM INPUT POWER	300 kW
BODY CURRENT (WITHOUT DRIVE)	50 mAdc
BODY CURRENT (WITH DRIVE)	350 mAdc
COLLECTOR DISSIPATION	300 kW
INLET COOLANT PRESSURE	125 psig
COOLANT OUTLET TEMPERATURE	80 °C
LOAD VSWR	1.2:1

TYPICAL OPERATION

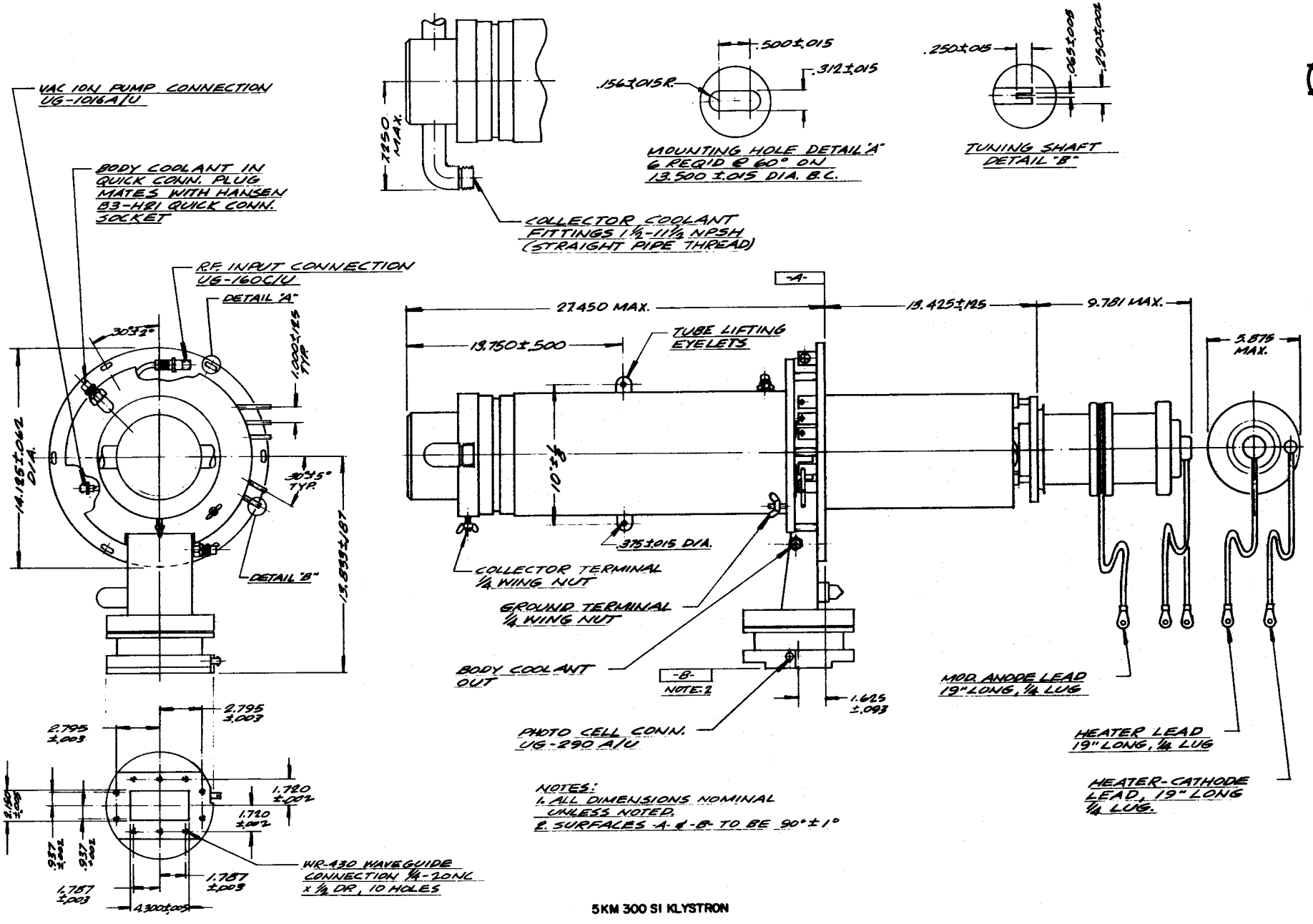
	Synchronously Tuned		*High Efficiency Tuned*		
Frequency	2115	2388	2115	2388	Mc
Output Power	74	79	104	109	kW
Driving Power	1	1.15	215	190	mW
Power Gain	78	78	57	57.3	db
Beam Voltage	35	35	35	35	kVdc
Beam Current	7.2	7.2	7.2	7.2	Adc
Body Current	135	85	340	190	mAdc
Modulating Anode Voltage (with respect to cathode)	35	35	35	35	kVdc
3 db Bandwidth	3.5	4	15	15	Mc
Efficiency	29.4	31.5	41.3	45.3	%
Electromagnet Current	18.1	18.1	18.1	18.1	Adc
Load VSWR	1.1:1	1.1:1	1.1:1	1.1:1	







5KM300SI AND H-225



5KM 300 SI KLYSTRON

EIMAC

A Division of Varian Associates

SAN CARLOS, CALIFORNIA

6C21

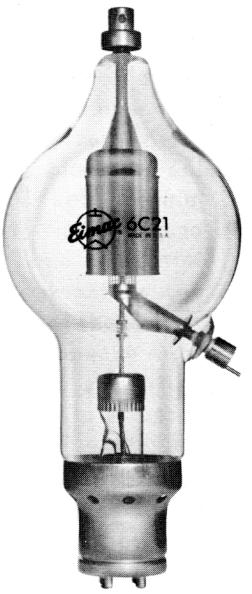
PULSE TRIODE

•

MODULATOR AMPLIFIER

The Eimac 6C21 is a high-vacuum power triode designed for pulse-modulator service at d-c plate voltages up to 30 kilovolts and peak plate currents as high as 15 amperes.

The 6C21 is forced-air and radiation cooled, has a maximum plate-dissipation rating of 300 watts, and, in pulse modulator service, will deliver up to 375 kilowatts to a resistive load with 7.5 kilowatts of driving power.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	8.2 volts
Current	17.0 amperes
Amplification Factor (Average)	30
Direct Interelectrode Capacitances (Average)	
Grid-Plate	4.3 $\mu\mu$f
Input	9.5 $\mu\mu$f
Output	0.7 $\mu\mu$f
Transconductance (I_b=100 ma., E_b=2000v.)	6100 μmhos

MECHANICAL

Base	50-watt jumbo 4-pin
Connections	See drawing
Socket	E. F. Johnson Co. 123-211, National Co. XM-50 or equivalent.
Mounting Position	Vertical, base down or up
Cooling	Forced Air and Radiation
Maximum Temperature of Grid & Plate Seals	225° C.
Recommended Heat Dissipating Plate and Grid Connectors	Eimac HR-8
Maximum Overall Dimensions:	
Length	12-⅝ inches
Diameter	5-⅛ inches
Net Weight	1.3 pounds
Shipping Weight	5.8 pounds

MAXIMUM RATINGS

Pulse Modulator Service (Per Tube)

D-C PLATE VOLTAGE	30 MAX. KILOVOLTS
D-C GRID VOLTAGE	-2.0 MAX. KILOVOLTS
PEAK POSITIVE PLATE VOLTAGE	35 MAX. KILOVOLTS
PEAK POSITIVE GRID VOLTAGE	1.6 MAX. KILOVOLTS
PEAK PLATE CURRENT	15 MAX. AMPERES
AVERAGE GRID DISSIPATION	50 MAX. WATTS
AVERAGE PLATE DISSIPATON	300 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	28 kilovolts
D-C Grid Voltage	-1.5 kilovolts
Pulse Plate Current	15 amperes
Pulse Grid Current*	3.0 amperes
Pulse Positive Grid Voltage	1000 volts
Pulse Grid Driving Power*	7.5 kilowatts
Load: Resistive	1650 ohms
Duty	.002
Pulse Voltage Output	25 kilovolts
Pulse Power Input	420 kilowatts
Pulse Plate Dissipation	45 kilowatts
Pulse Power Output	375 kilowatts

*Approximate values.

(Revised 12-15-65) Copyright 1954, 1965 by Varian Associates

APPLICATION

Mounting—The 6C21 must be mounted vertically, base down or up. The leads to the plate and grid terminals should be flexible, and the tube must be protected from vibration and shock.

Cooling—Forced-air cooling of the filament stem structure is required. Base cooling requires a minimum air flow of 2½ cubic feet per minute directed through the tube base toward the filament press. If the hole in the socket is at least 1 inch in diameter and the manifold is the same diameter, a static pressure of ¼ inch of water is required at the manifold to provide the 2½ cubic feet per minute. Heat Dissipating Connectors (Eimac HR-8 or equivalent) must be used at the plate and grid terminals and unobstructed circulation of air around the tube is required in sufficient quantity to prevent the temperatures of grid and plate seals from exceeding 225°C. Forced ventilation of compartments or equipment in which the tube is located is always beneficial, though not necessarily required.

Tube temperatures may be measured with the aid of "Tempilaq", a temperature-sensitive lacquer manufactured by the Tempil Corporation, 132 West 22nd Street, New York 11, N. Y. For satisfactory results, Tempilaq must be sprayed on the surface to be measured in a thin coat, covering as small an area as will serve the purpose.

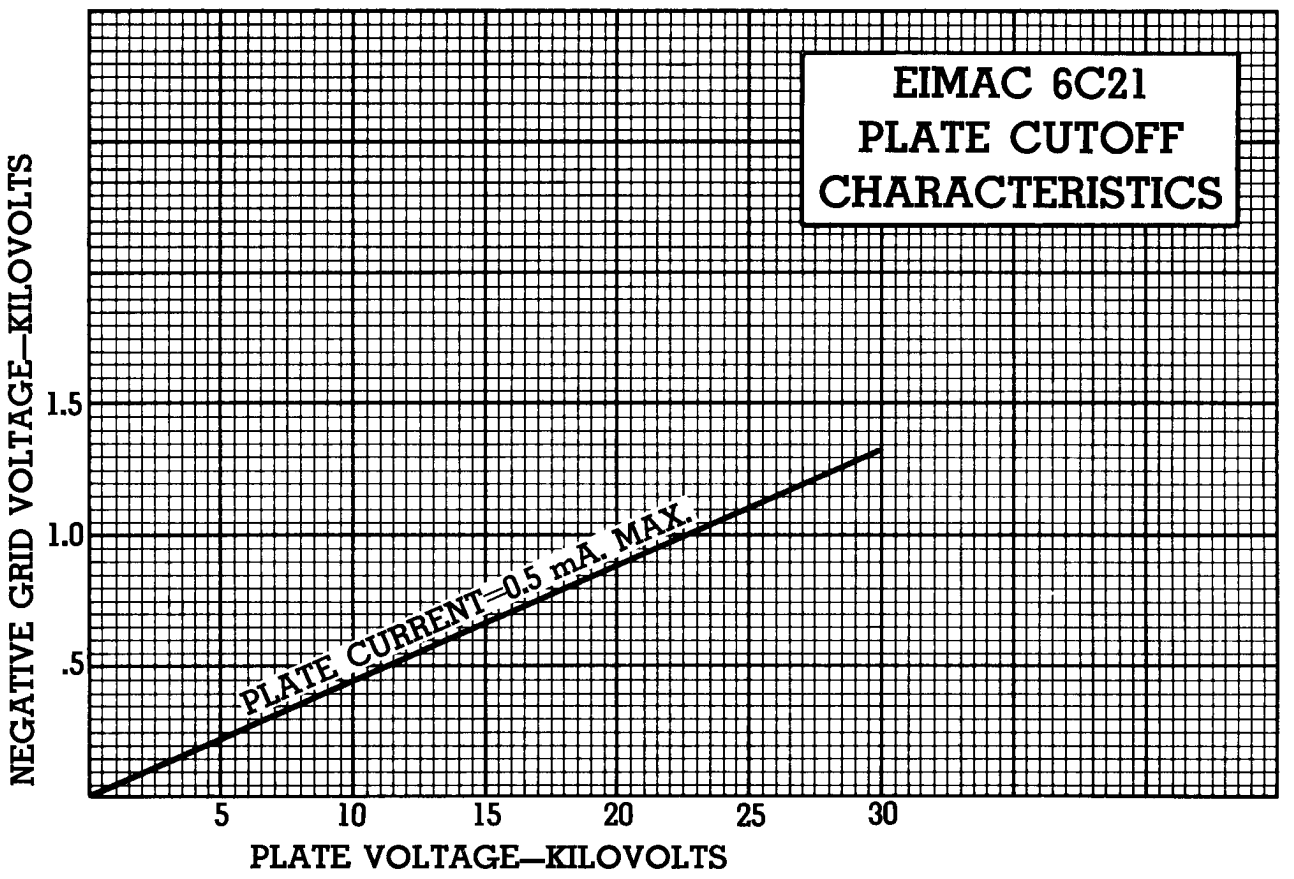
ELECTRICAL

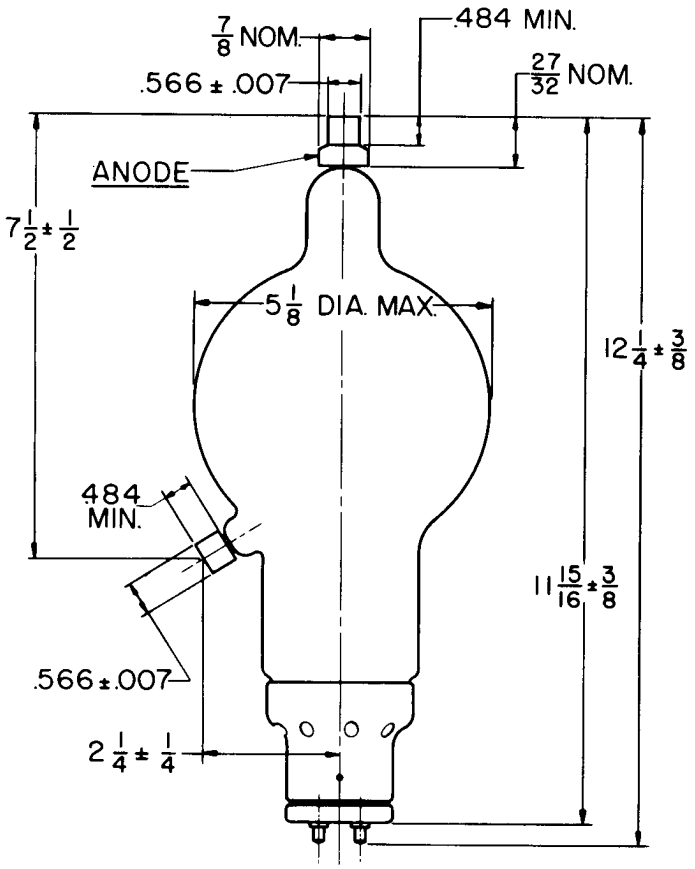
Filament Voltage—For optimum tube life the filament voltage, as measured directly at the base pins, should be the rated value of 8.2 volts. Variations should be kept within the range of 7.9 to 8.5 volts. All four socket terminals should be used, with two placed in parallel for each filament connection.

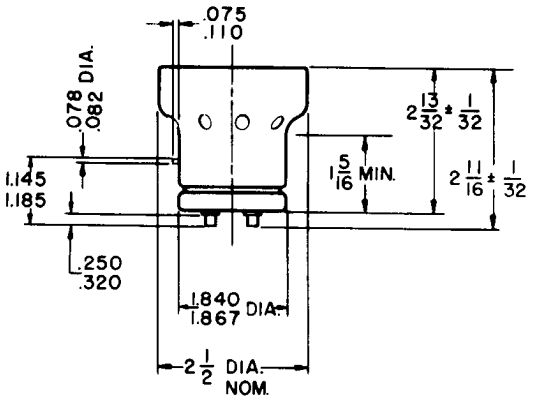
Plate Dissipation—Under normal operating conditions, the plate dissipation should not be allowed to exceed the maximum rating of 300 watts. Plate dissipation in excess of the maximum rating is permissable for short periods of time, such as during adjustment procedures.

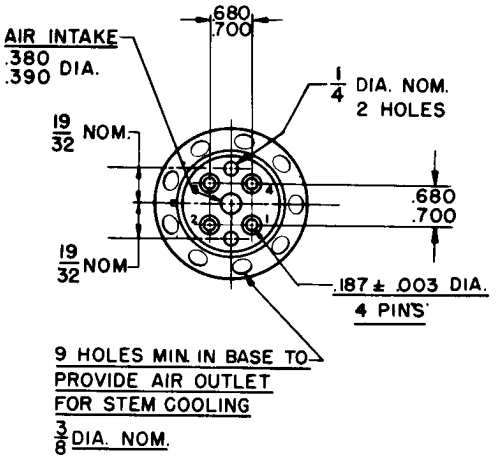
Operation—The 6C21 may be operated with inductive or resistive loads, provided only that the maximum ratings are not exceeded. The ratings listed for pulse modulator service are for operation at peak plate currents of 15 amperes and pulse lengths up to 100 milliseconds. Further information on pulse operation, such as tube limitations under long (100 milliseconds or more) pulse conditions, is contained in "Pulse Service Notes" obtainable from Eimac Division of Varian on request. If it is desired to operate the 6C21 under conditions widely different from those given for pulse modulator service, write Eimac Division of Varian for information and recommendations.

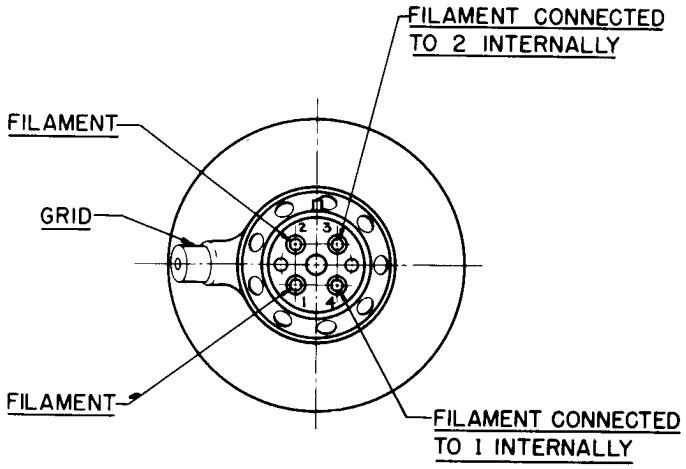
Useful information about pulse circuits may be obtained from such publications as "Pulse Generators," volume 5 of the MIT Radiation Laboratory Series, by McGraw-Hill, 1948.









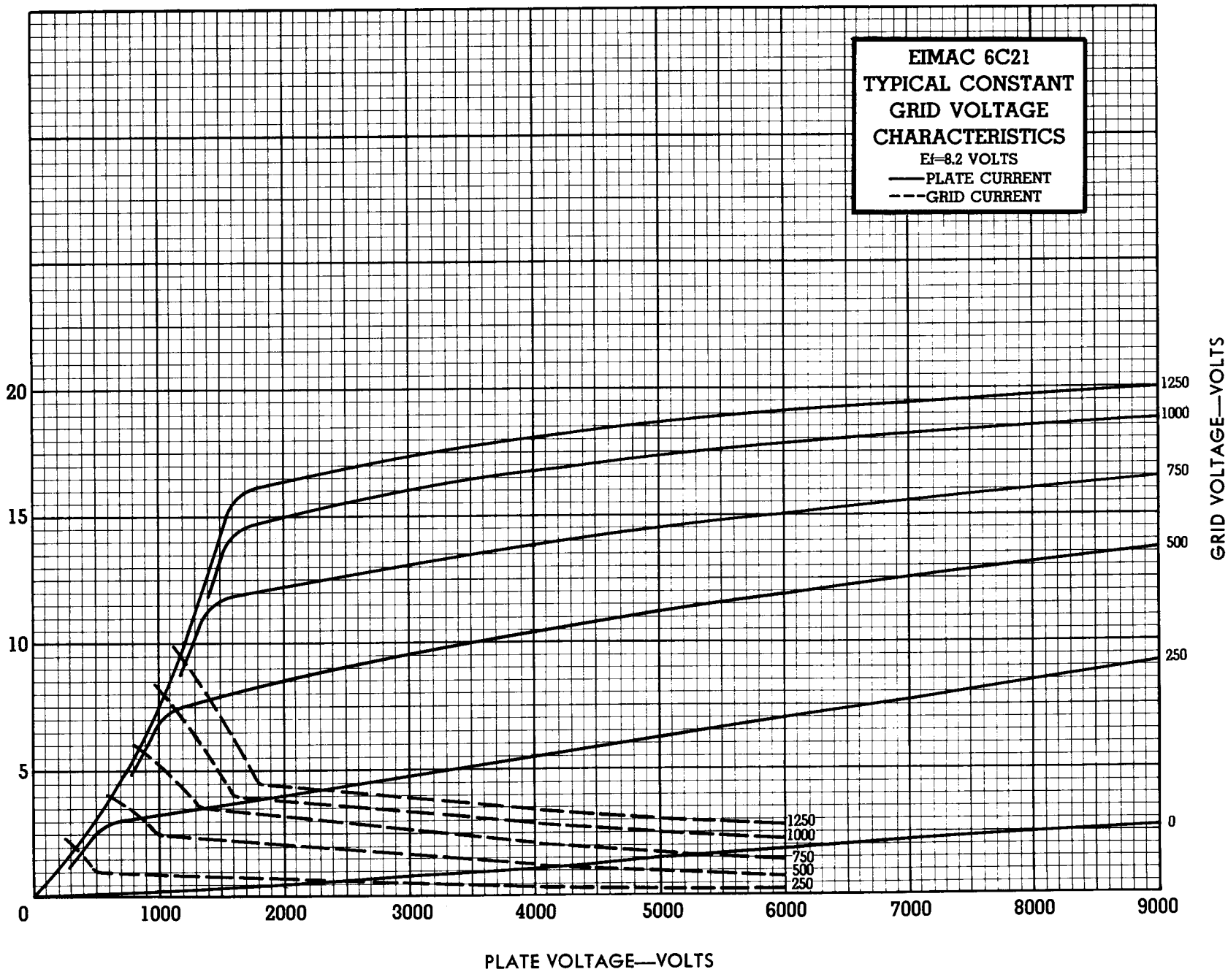


ON FINISHED TUBE ADD .060 MAX. FOR SOLDER

BOTTOM VIEW

BASE DETAIL

DIMENSIONS IN INCHES



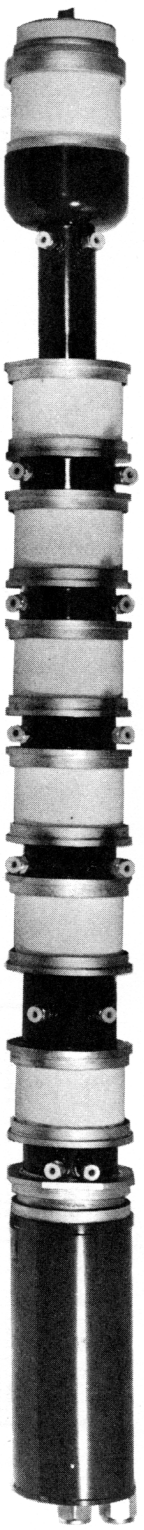
Printed in U.S.A. 917

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

TENTATIVE DATA

6K50,000LQ

POWER-AMPLIFIER L-BAND KLYSTRON



The Eimac 6K50,000LQ is a six-resonant-cavity, magnetically focused, cascade amplifier klystron designed primarily for CW high-power, broad-band communication service in the frequency range of 720 to 980 megacycles.

When tuned for narrow-band operation, this tube type will provide 10 kilowatts of CW r-f output power with a power gain of more than 50 db. When tuned for broad-band operation, this tube type will provide more than 6 kilowatts of CW r-f output power with a power gain of more than 30 db and bandwidths of 15 to 20 megacycles between the 3-db power points

The resonant cavities of the Eimac 6K50,000LQ have cylindrical ceramic windows and are completed by tuning boxes external to the tube. Klystron amplifier circuit assemblies designed for use with this tube provide the required external tuning boxes, magnetic focusing frame, and magnetic focusing coils. Such circuit assemblies also provide both input and output coaxial-type radio-frequency fittings. In addition, these circuit assemblies include an air-system socket which provides for cooling and making connections to the electron-gun portion of the tube.

CHARACTERISTICS

ELECTRICAL

Filament:	Tungsten	
Voltage	8.0	volts
Current	40	amperes
Maximum Starting Current	80	amperes
Minimum Warm-Up Time	30	seconds
Cathode:	Unipotential, Bombardment Heated	
Voltage	2280	volts
Current	0.7	ampere
Power	1596	watts
▶ Frequency Range	720 to 985	mc

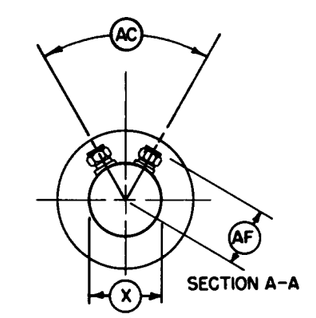
MECHANICAL

Operating Position	Vertical, cathode end up
Recommended Socket	Eimac SK-110
R-F Coupling:	
Input	Type "N" coaxial fitting
Output	3 1/8-inch coaxial line
Approximate Weights:	
Net	63 pounds
Shipping	390 pounds

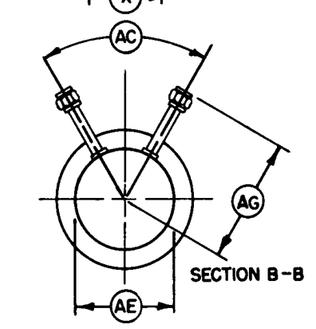
(Effective 5-2-58) Copyright 1958 by Eitel-McCullough, Inc.

▶ Indicates change from sheet dated 2-10-58

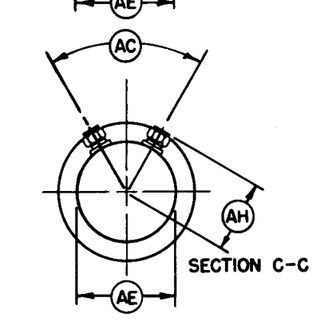
DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		54.750	55.500
B		7.437	7.687
C		4.968	5.031
D		29.875	30.125
E	1.625		
F		10.812	11.062
G		3.468	3.531
H		1.156	1.218
J	.250		
K	1.062		
L	.562		
M		.187	
N	.500		
P	.593		
Q		2.718	2.781
R		4.615 DIA.	4.635 DIA.
S	4.500 DIA.		
T	1.375		
U	5.125 DIA.		
V	4.625 DIA.		
X	2.125 DIA.		
Y	.687		
AB	1.625		
AC	60°		
AD	30°		
AE	3.500 DIA.		
AF	1.875		
AG	4.000		
AH	2.565		
AJ	4.625		



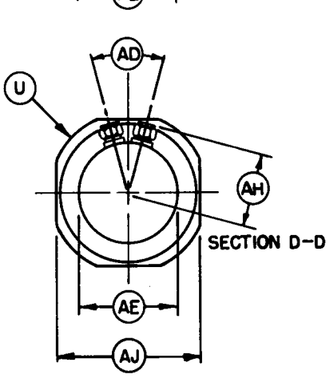
SECTION A-A



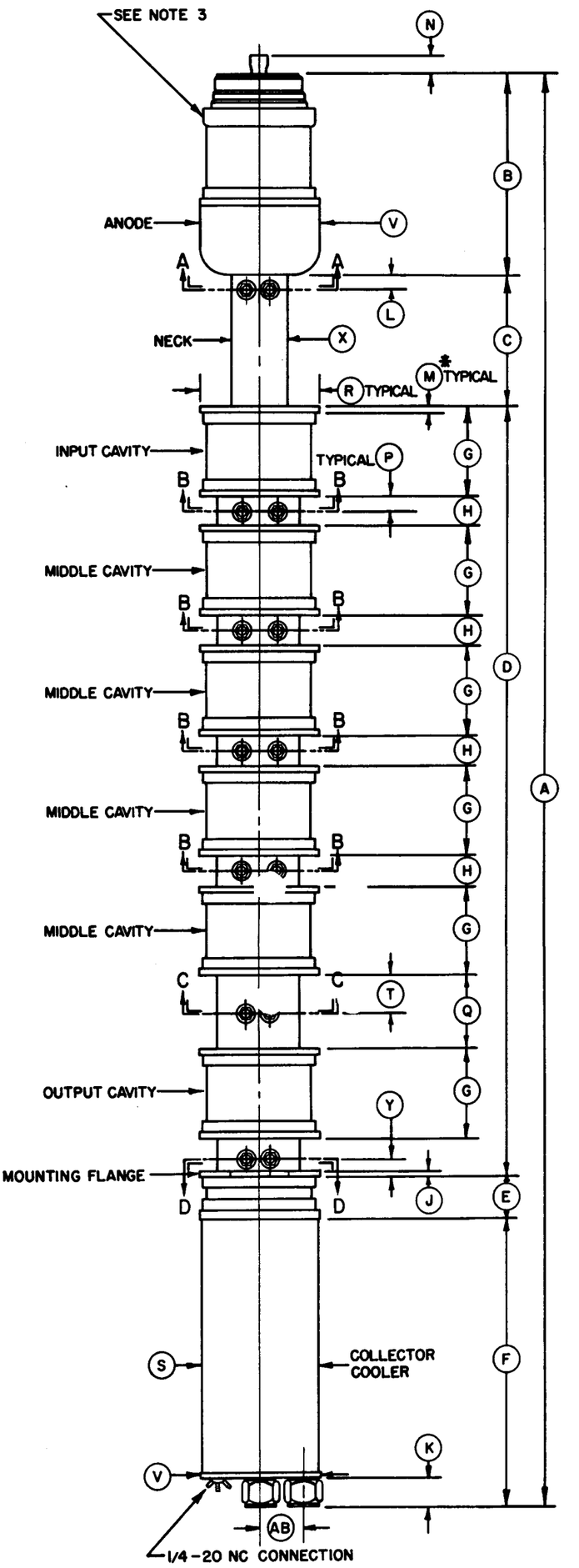
SECTION B-B

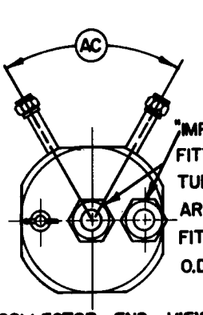


SECTION C-C



SECTION D-D





COLLECTOR END VIEW

"IMPERIAL FLEX FITTING" FOR 3/4 O.D. TUBING ALL OTHERS ARE "IMPERIAL FLEX FITTING" FOR 5/16 O.D. TUBING.

NOTES:

1. * MINIMUM CONTACT SURFACES FOR ALL CAVITY PLATES.
2. DIMENSIONS IN INCHES.
3. FOR ELECTRICAL CONTACT SURFACE DIMENSIONS SEE GUN NO. 2 OUTLINE, DRWG. NO. GUN NO. 2 – 6001.

Eimac 6K50.000LQ

▶COOLING REQUIREMENTS

	Volume	Pressure Drop
Cathode (With Eimac SK-110)	52 cfm air	5 inches H_2O
Fifth Cavity (Broad-Band Applications Only)	50 cfm air	1.5 inches H_2O
Output Cavity	50 cfm air	1.5 inches H_2O
Drift-Tube Jackets (Series Connected)	1 gpm water	11 psi
Collector Assembly	25 gpm water	28 psi

MAXIMUM RATINGS

D-C BEAM VOLTAGE	20 MAX. KILOVOLTS
D-C BEAM CURRENT	2.5 MAX. AMPERES
D-C BODY CURRENT (CONTINUOUS)	0.1 MAX. AMPERE
D-C BODY CURRENT (TUNING ONLY)	0.15 MAX. AMPERE
D-C FOCUS-ELECTRODE VOLTAGE	-500 MAX. VOLTS
BOMBARDED CATHODE:	
▶ VOLTAGE	2400 MAX. VOLTS
CURRENT	0.75 MAX. AMPERE
POWER	1600 MAX. WATTS
COLLECTOR DISSIPATION	50 MAX. KILOWATTS

TYPICAL OPERATION

Frequency	880	880	megacycles
Output Power	6.4	9	kilowatts
Bandwidth (3-db power points)	20	15	megacycles
Driving Power	1.7	2.3	watts
Power Gain	35.6	35.9	db
D-C Beam Voltage	17	19.5	kilovolts
D-C Beam Current	1.88	2.30	amperes
Beam Input Power	31.96	44.85	kilowatts
Beam-Power Efficiency	20	20	percent
D-C Body Current	50	50	milliamperes
D-C Collector Current	1.83	2.25	amperes
D-C Focus-Electrode Voltage	-175	-200	volts
Filament Voltage	8	8	volts
Filament Current	40	40	amperes
Bombarded Cathode:			
Voltage	2280	2280	volts
Current	0.7	0.7	ampere
Power	1596	1596	watts
▶ Collector Dissipation	24.71	34.88	kilowatts

APPLICATION

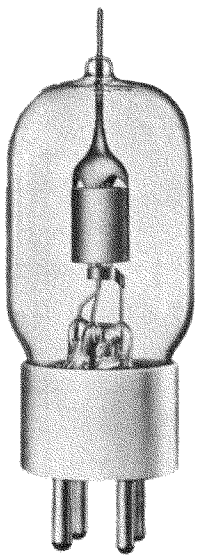
For additional information or information regarding a specific application, write to the Application Engineering Department, Eitel-McCullough, Inc., San Bruno, California. All such requests will be handled confidentially and without charge.

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EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

25T

MEDIUM-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten		
Voltage	▶6.3	volts
Current	3.0	amperes
Amplification Factor (Average)	24	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	1.5	μμf
Grid-Filament	2.7	μμf
Plate-Filament	0.3	μμf
Transconductance (I_b=25 ma., E_b=1000, e_c=–15)	2500	μmhos

MECHANICAL

Base (Small 4-pin bayonet, ceramic)	RMA type M8-071	
Basing	RMA type 3G	
Maximum Overall Dimensions:		
Length	4.50	inches
Diameter	1.44	inches
Net weight	1.00	ounce
Shipping weight (Average)	1.25	pounds

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR
Class B

	TYPICAL OPERATION—2 TUBES				MAX. RATING	
D-C Plate Voltage	750	1000	1500	2000	2000	volts
Max.-Signal D-C Plate Current, per tube*	•	•	•	•	75	ma.
Plate Dissipation, per tube*	•	•	•	•	25	watts
D-C Grid Voltage (approx.)	–20	–30	–55	–80		volts
Peak A-F Grid Input Voltage	205	210	230	270		volts
Zero-Signal D-C Plate Current	43	32	21	16		ma.
Max.-Signal D-C Plate Current	133	120	94	80		ma.
Max.-Signal Driving Power (approx.)	1.4	1.2	0.8	0.7		watts
Effective Load, Plate-to-Plate	9200	15800	33700	55500		ohms
Max.-Signal Plate Power Output	50	70	90	110		watts

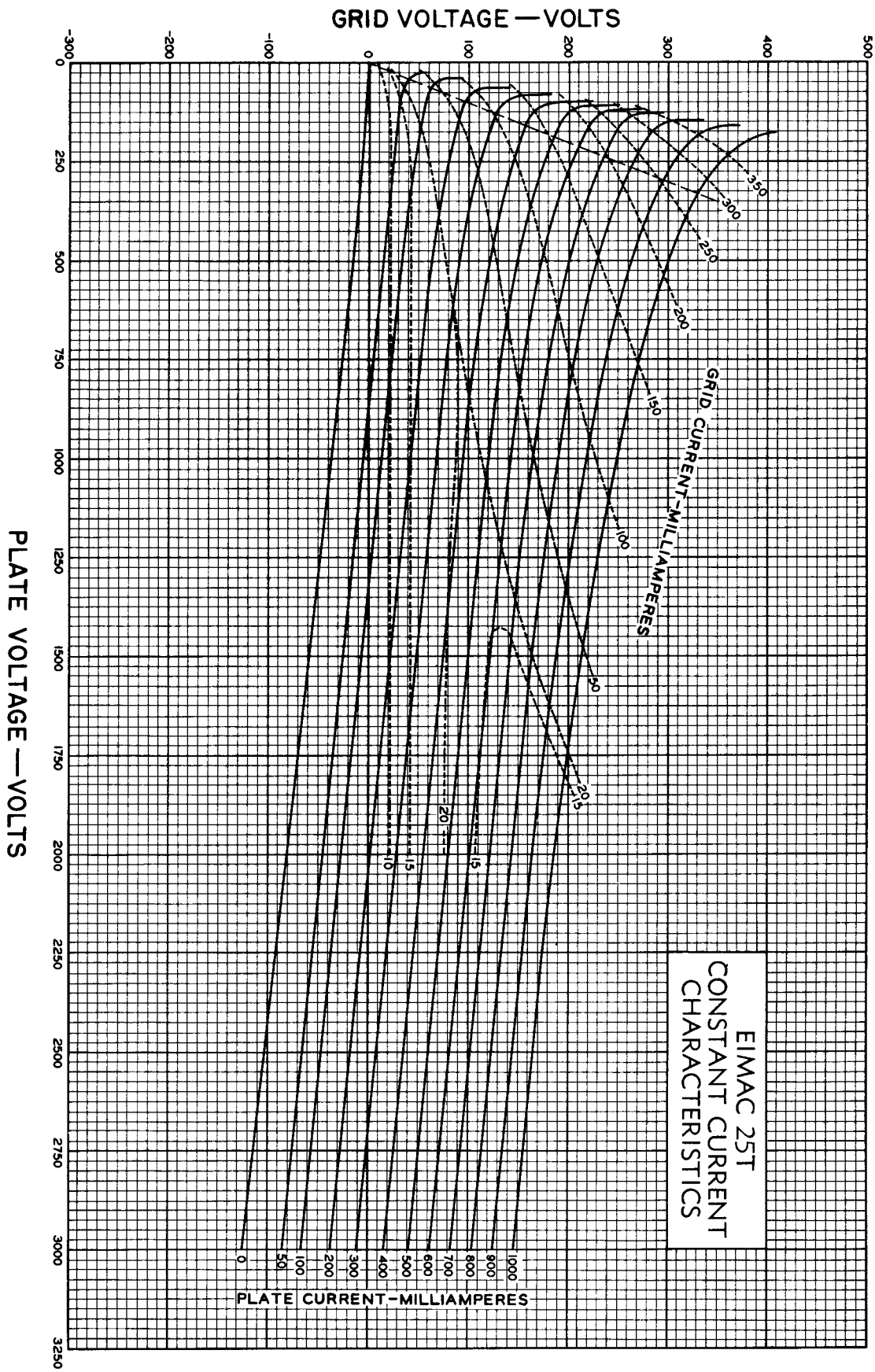
*Averaged over any sinusoidal audio frequency cycle.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR
Class-C *Telegraphy
(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage	1000	1500	2000	2000	volts
D-C Plate Current	72	67	63	75	ma.
D-C Grid Current	9	13	18	25	ma.
D-C Grid Voltage	–70	–95	–130		volts
Plate Power Output	47	75	100		watts
Plate Input	72	100	125		watts
Plate Dissipation	25	25	25	25	watts
Peak R. F. Grid Input Voltage, (approx.)	170	195	245		volts
Driving Power, (approx.)	1.3	2.2	4.0		watts

*The above figures show actual measured tube performance, and do not allow for variation in circuit losses.
▶Corrects typographical error on sheet dated 8-15-44.

(Effective 10-15-44) Copyright, 1946 by Eitel-McCullough, Inc.


GRID VOLTAGE — VOLTS
-300
-200
-100
0
100
200
300
400
500
PLATE VOLTAGE — VOLTS
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
3250
GRID CURRENT-MILLIAMPERES
350
300
250
200
150
100
50
20
15
10
15
20
15
PLATE CURRENT-MILLIAMPERES
0
50
100
200
300
400
500
600
700
800
900
1000
EIMAC 25T
CONSTANT CURRENT
CHARACTERISTICS

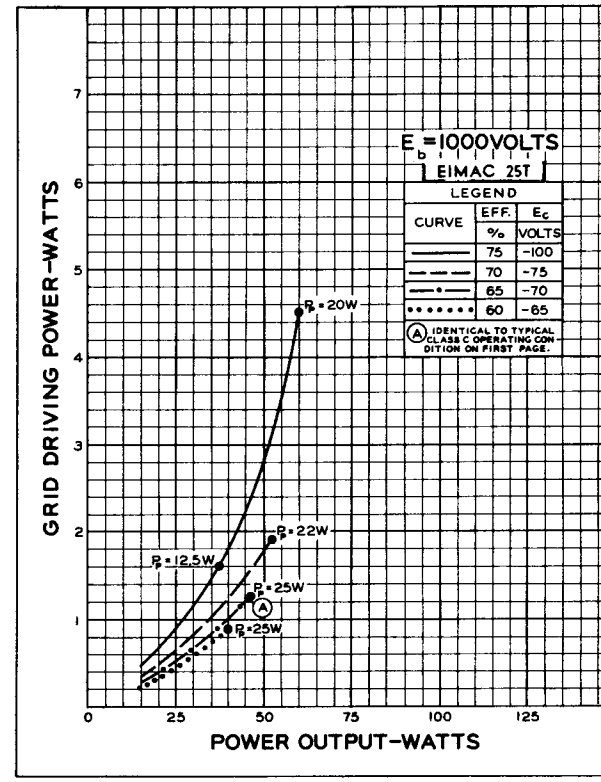
DRIVING POWER vs. POWER OUTPUT

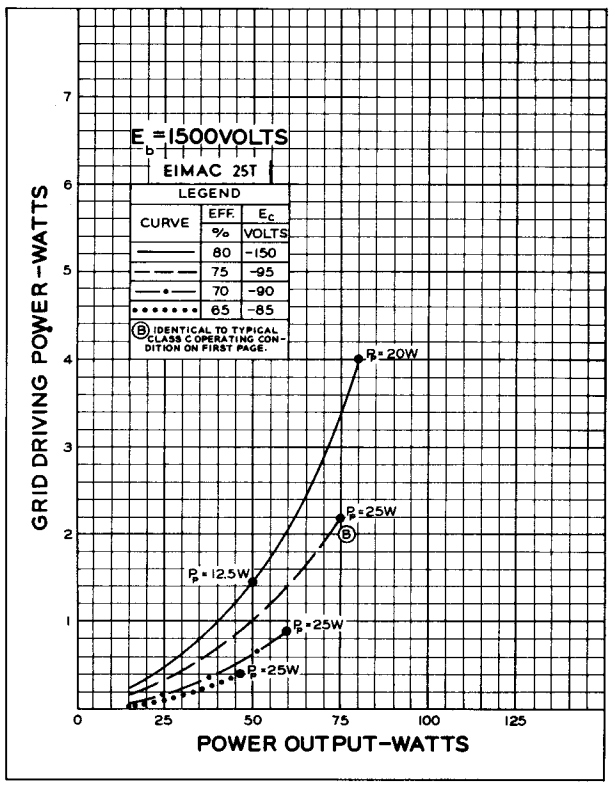
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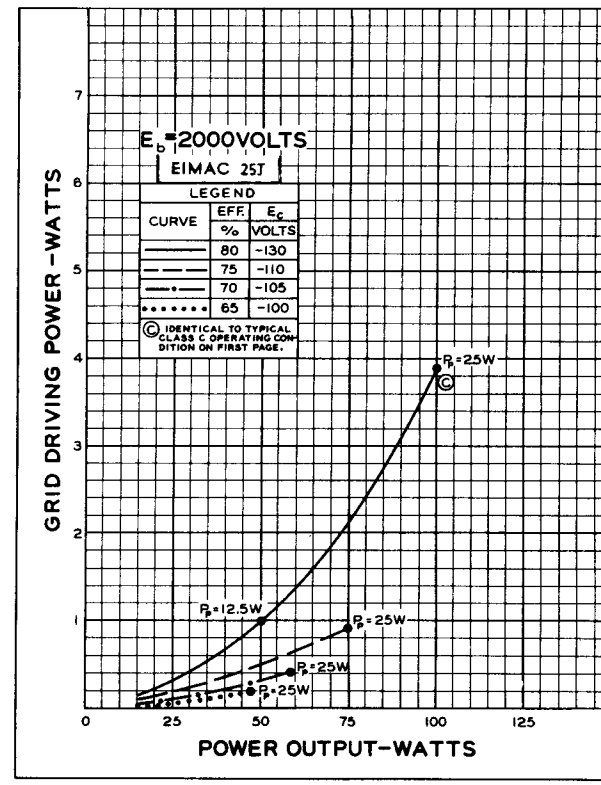
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.

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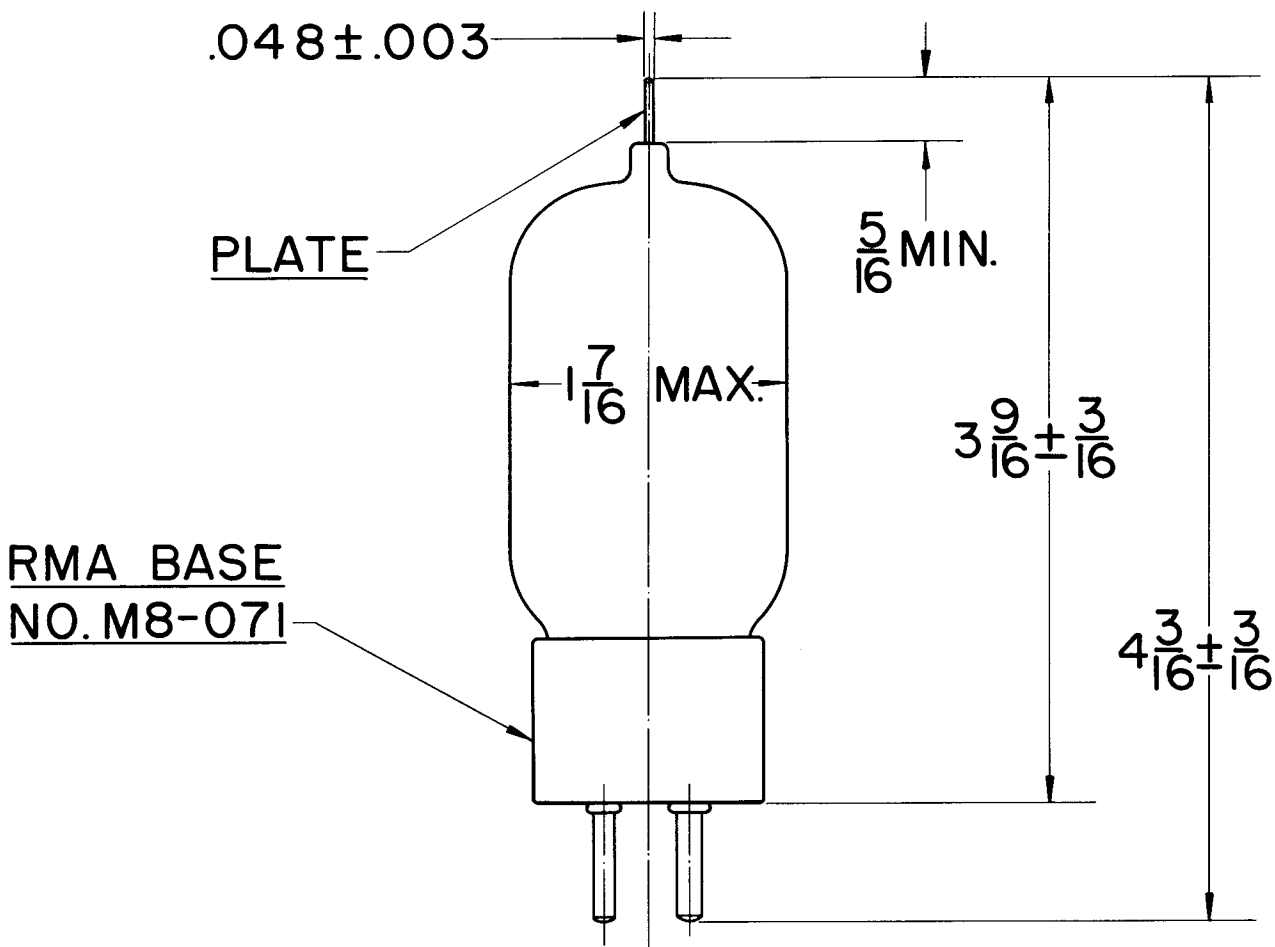


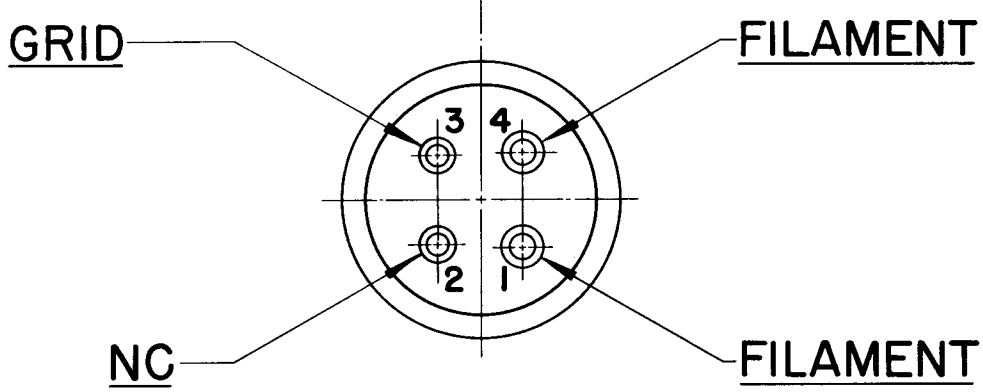




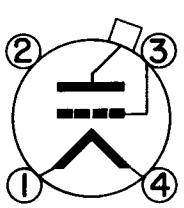
Eimac

25T


.048±.003
PLATE
5/16 MIN.
1 7/16 MAX.
3 9/16 ± 3/16
RMA BASE
NO. M8-071
4 3/16 ± 3/16


GRID
FILAMENT
3
4
2
1
NC
FILAMENT

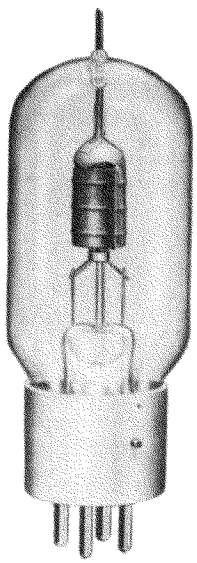
3G


2
3
1
4

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

35T

HIGH-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten		
Voltage	5.0	volts
Current	4.0	amperes
Amplification Factor (Average)	39	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	1.8	$\mu\mu$f
Grid-Filament	4.1	$\mu\mu$f
Plate-Filament	0.3	$\mu\mu$f
Transconductance (I_b=100 ma., E_b=2000, e_c=–30)	2850	μmhos
Frequency for Maximum Ratings	100	mc.

MECHANICAL

Base (Medium 4-pin bayonet, ceramic)	RMA type M8-078
Basing	RMA type 3G
Maximum Overall Dimensions:	
Length	5.5 inches
Diameter	1.81 inches
Net weight	2.5 ounces
Shipping weight (Average)	1.25 pounds

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR
Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage	1000	1500	2000	2000	volts
Max.-Signal D-C Plate Current, per tube*	•	•	•	150	ma.
Plate Dissipation, per tube*	•	•	•	50	watts
D-C Grid Voltage (approx.)	–8	–25	–40		volts
Peak A-F Grid Input Voltage	240	250	255		volts
Zero-Signal D-C Plate Current	67	45	34		ma.
Max.-Signal D-C Plate Current	240	200	167		ma.
Max.-Signal Driving Power (approx.)	7	5	4		watts
Effective Load, Plate-to-Plate	7900	16200	27500		ohms
Max.-Signal Plate Power Output	140	200	235		watts

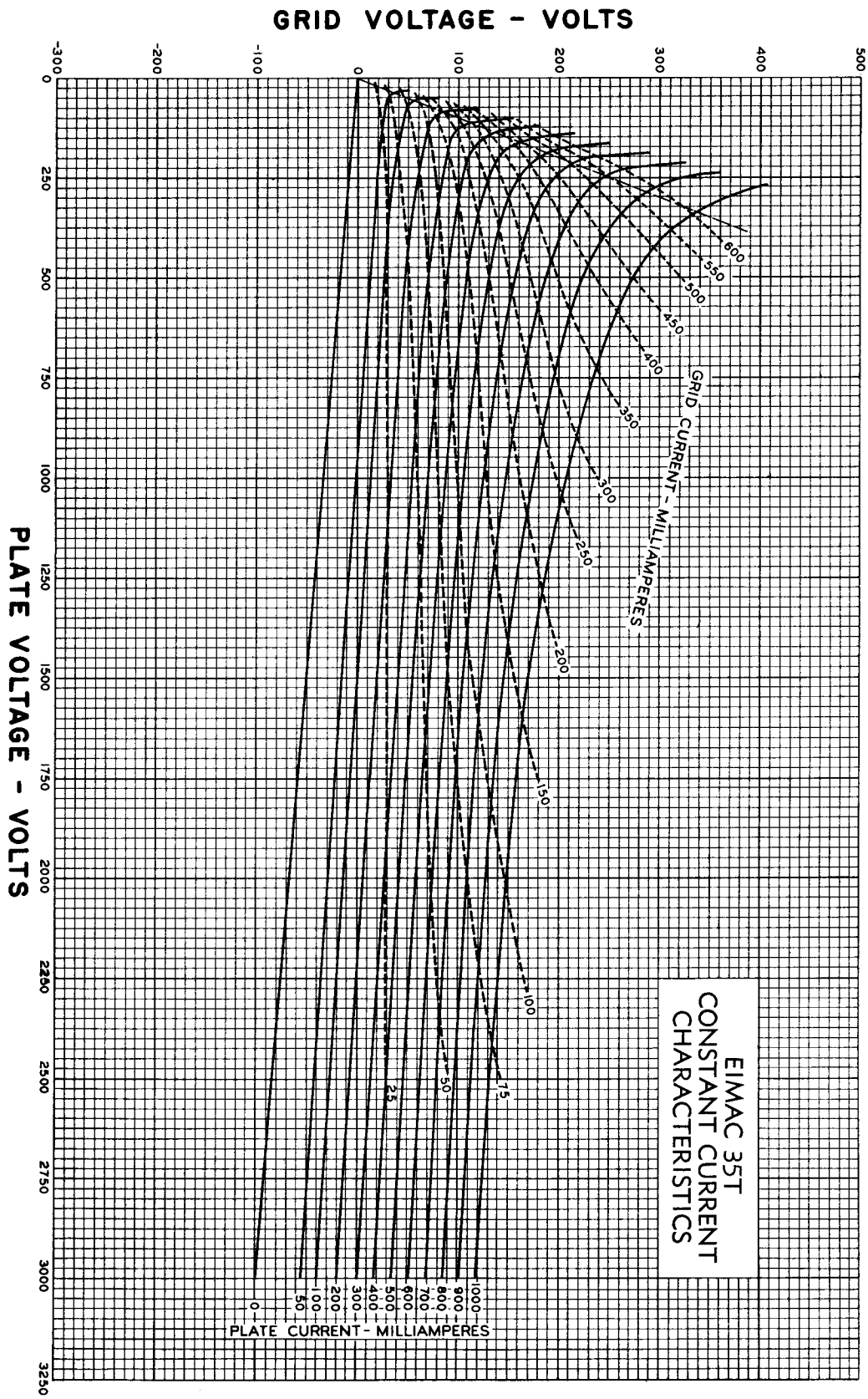
*Averaged over any sinusoidal audio frequency cycle.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR
Class-C *Telegraphy
(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage	1000	1500	2000	2000	volts
D-C Plate Current	125	125	125	150	ma.
D-C Grid Current	40	40	45	50	ma.
D-C Grid Voltage	–60	–120	–135		volts
Plate Power Output	87	141	200		watts
Plate Input	125	188	250		watts
Plate Dissipation	38	47	50	50	watts
Peak R. F. Grid Input Voltage, (approx.)	165	250	285		volts
Driving Power, (approx.)	7	9	13		watts

*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

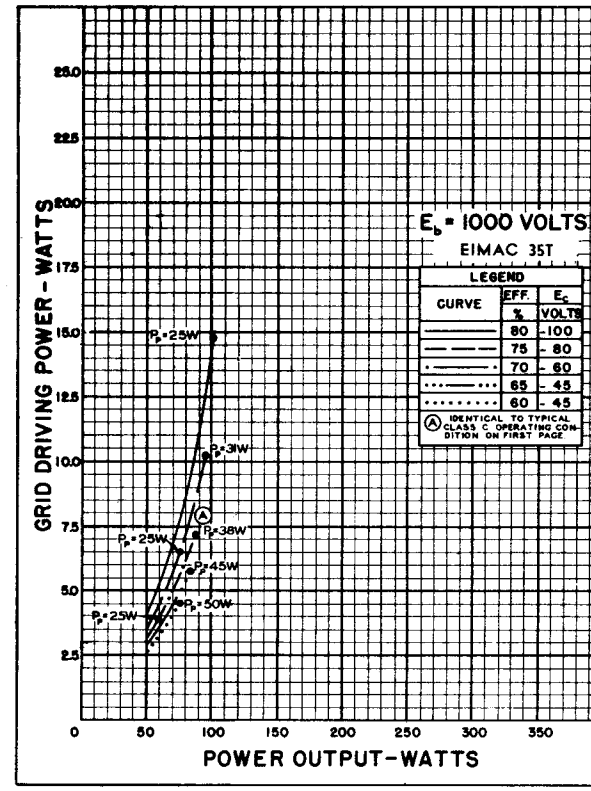
(Effective 5-1-45) Copyright, 1946 by Eitel-McCullough, Inc.

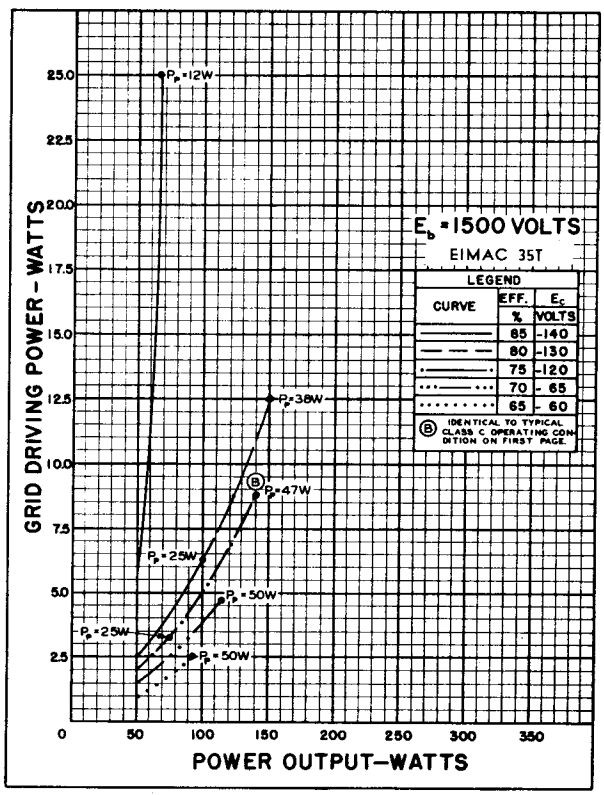

GRID VOLTAGE - VOLTS
-300
-200
-100
0
100
200
300
400
500
PLATE VOLTAGE - VOLTS
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
3250
GRID CURRENT - MILLIAMPERES
600
550
500
450
400
350
300
250
200
150
100
75
50
25
PLATE CURRENT - MILLIAMPERES
0
50
100
200
300
400
500
600
700
800
900
1000
EIMAC 35T
CONSTANT CURRENT
CHARACTERISTICS

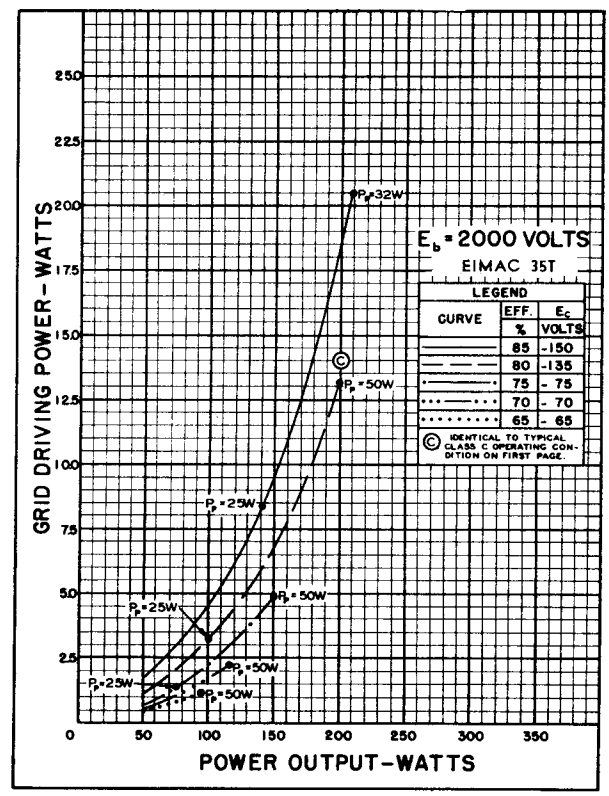
DRIVING POWER vs. POWER OUTPUT

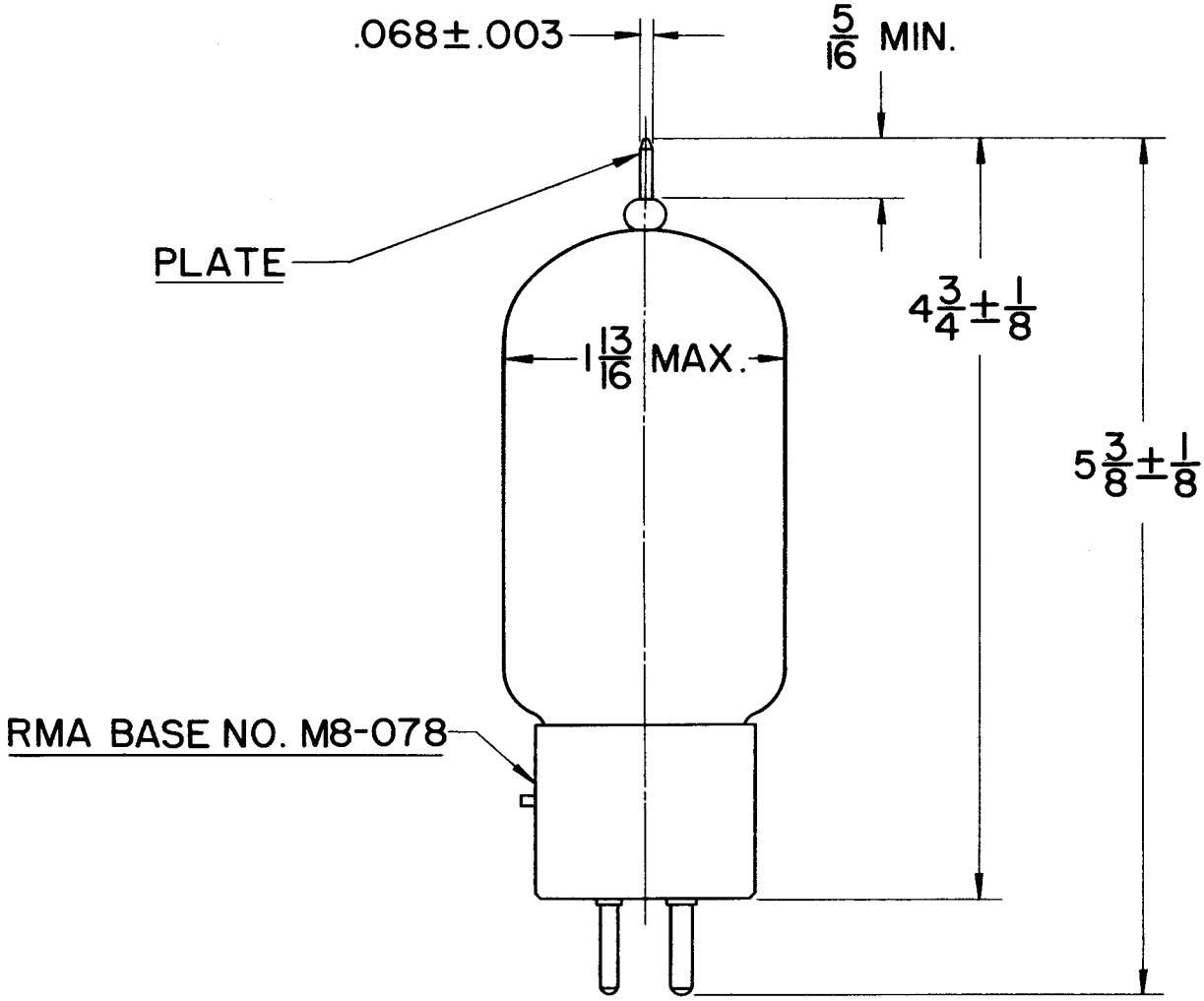
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

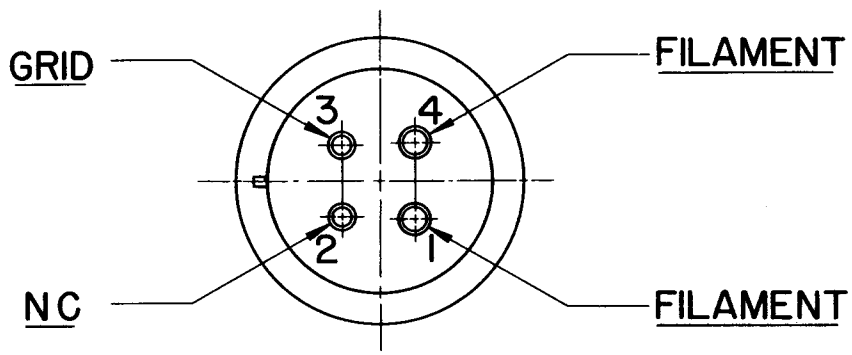
Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.



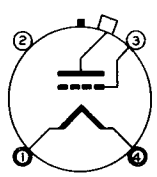





.068±.003
5/16 MIN.
PLATE
4 3/4 ± 1/8
1 13/16 MAX.
5 3/8 ± 1/8
RMA BASE NO. M8-078


GRID
FILAMENT
3
4
2
1
NC
FILAMENT

3G


2
3
1
4

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

35TG

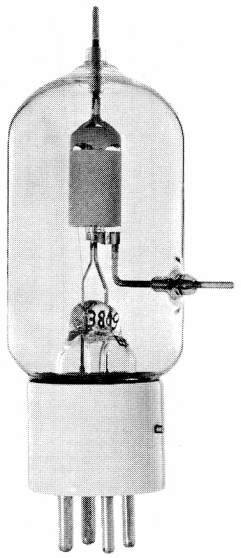
HIGH-MU TRIODE

●

MODULATOR
OSCILLATOR
AMPLIFIER

The EIMAC 35TG is a high-mu triode having a maximum plate dissipation of 50 watts. It is intended for use as an amplifier, oscillator or modulator, and can be used at its maximum ratings at frequencies up to 100 MHz. It is basically the same as the EIMAC 35T except that the grid terminal is located at the side of the bulb.

The 35TG is cooled by radiation and by free circulation of air around the envelope.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		5.0		volts
Current	3.6		4.2	amps
Amplification Factor	35		43	
Direct Interelectrode Capacitances:				
Grid-Plate	1.25		2.05	pF
Grid-Filament	2.00		3.20	pF
Plate-Filament	0.10		0.35	pF
Transconductance (I_b = 100 mA)		2850		umhos
Frequency for Maximum Ratings			100	MHz

MECHANICAL

Base: UX Medium 4-pin. Fits E. F. Johnson Co. 122-124, or National XC-4 or CIR-4 sockets.

Basing	See outline drawing
Mounting	Vertical, base down or up
Cooling	Convection and radiation
Recommended Heat Dissipating Plate Connector	EIMAC HR-3
Maximum Overall Dimensions:	
Length	5.5 inches
Diameter	1.8 inches
Net weight	2.5 ounces
Shipping weight (Average)	1.25 pounds

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR

Class AB (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

DC Plate Voltage	2000	volts
DC Plate Current	150	mA
Plate Dissipation	50	watts
Grid Dissipation	15	watts

TYPICAL OPERATION

DC Plate Voltage	600	1000	1500	2000	volts
DC Grid Voltage (approx.)*	0	−8	−25	−40	volts
Zero-signal DC Plate Current	90	67	45	34	mA
Max-signal DC Plate Current	300	240	200	167	mA
Effective Load Plate-to-Plate	4250	7900	16,200	27,500	ohms
Peak AF Input Voltage (per tube)	130	240	250	255	volts
Peak Driving Power (approx.)	18	14	10	8	watts
Nominal Driving Power (app.)	9	7	5	4	watts
Max-signal Plate Power Output	95	140	200	235	watts

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions, per tube)[1]

MAXIMUM RATINGS

DC Plate Voltage	2000	volts
DC Plate Current	150	mA
Plate Dissipation	50	watts
Grid Dissipation	15	watts

TYPICAL OPERATION

DC Plate Voltage	1000	1500	2000	volts
DC Grid Voltage	−60	−120	−135	volts
DC Plate Current	125	125	125	mA
DC Grid Current	40	40	45	mA
Peak RF Grid Input Voltage	165	250	285	volts
Driving Power (approx.)	7	9	13	watts
Grid Dissipation	4.2	5.0	6.8	watts
Plate Power Input	125	188	250	watts
Plate Dissipation	38	47	50	watts
Plate Power Output	87	141	200	watts

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)[1]

MAXIMUM RATINGS

DC Plate Voltage	1600	volts
DC Plate Current	120	mA
Plate Dissipation	33	watts
Grid Dissipation	15	watts

TYPICAL OPERATION

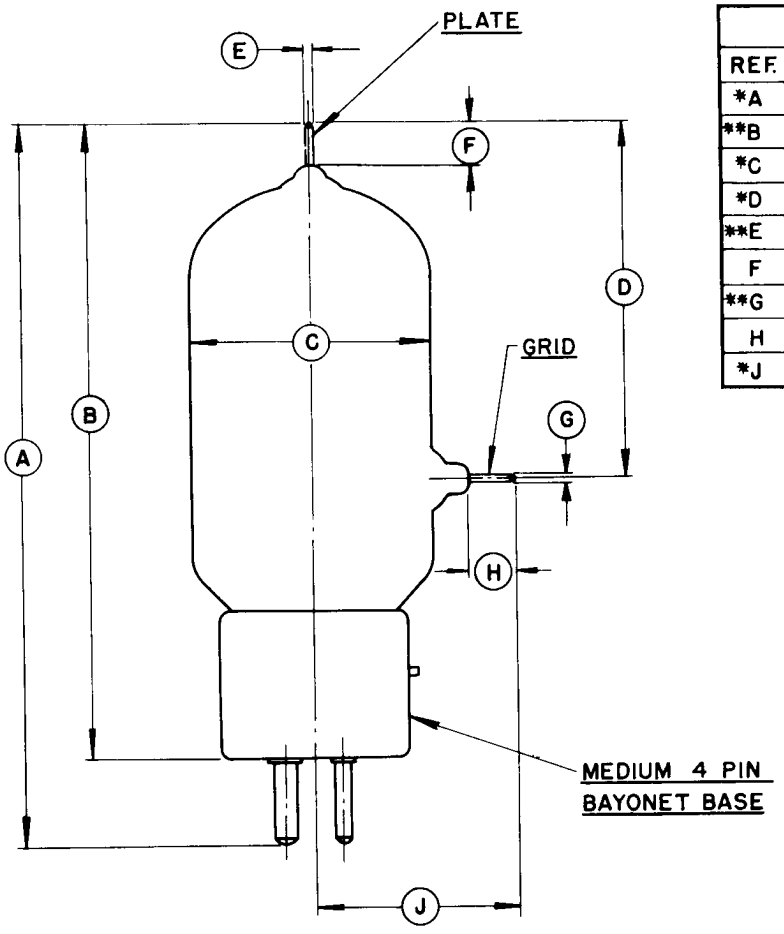
DC Plate Voltage	750	1000	1500	volts
DC Grid Voltage	−100	−125	−150	volts
DC Plate Current	95	100	90	mA
DC Grid Current	40	40	40	mA
Peak RF Driving Voltage (approx.)	210	240	270	volts
Driving Power (approx.)	9	10	11	watts
Plate Dissipation	20	25	30	watts
Plate Input	70	100	135	watts
Plate Power Output	50	75	105	watts

*Adjust for stated zero-signal plate current.

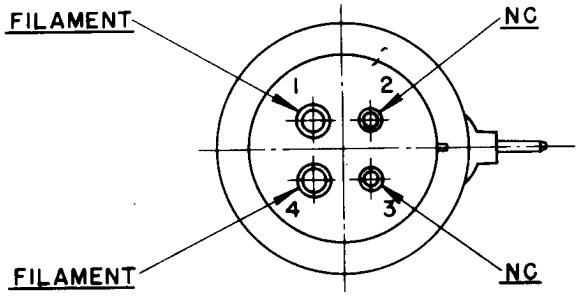
[1] The performance figures listed under Typical Operation are for radio frequencies up to the VHF region and are obtained by calculation from the characteristic tube curves and confirmed by direct tests. The driving power given includes power taken by the tube grid and the bias circuit. The driving power and output power do not allow for losses in the associated resonant circuits. These losses are not included because they depend principally upon the design and choice of the circuit components.

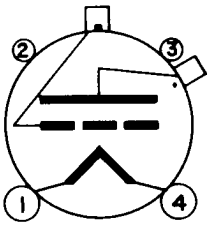
(Revised 6-1-67) © 1958, 1967 by Varian

Printed in U.S.A.



DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
*A		5 3/8	5 3/4
**B		4 3/4	5 1/8
*C			1.813
*D		2.060	2.680
**E		.065	.071
F		.312	
**G		.065	.071
H		.312	
*J		1.370	1.630





NOTES:

1. DIMENSIONS IN INCHES.
2. *STANDARD DESIGN TESTS & QUALIFICATION TESTS.
3. **QUALIFICATION TESTS.

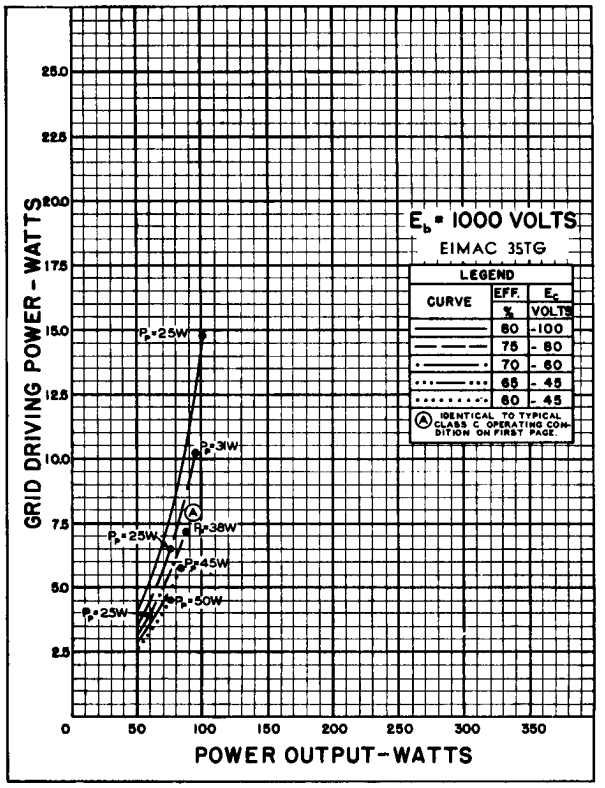
DRIVING POWER vs. POWER OUTPUT

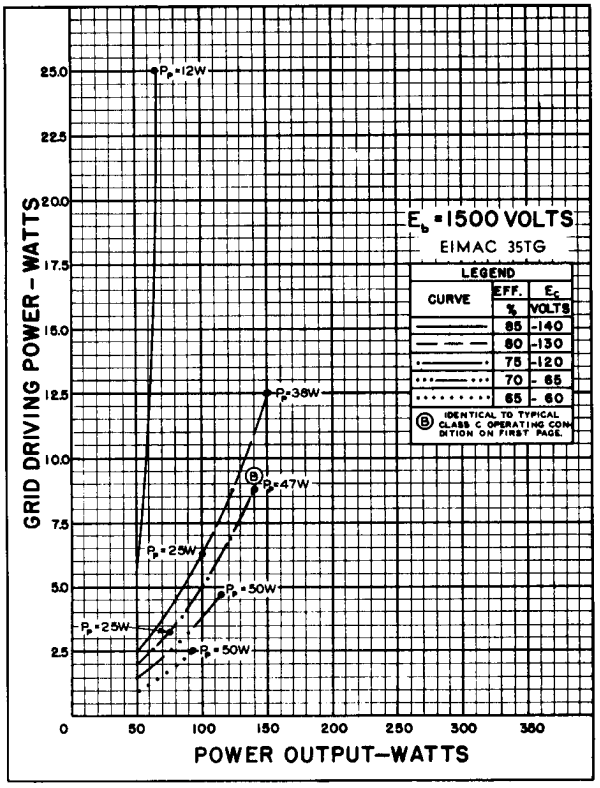
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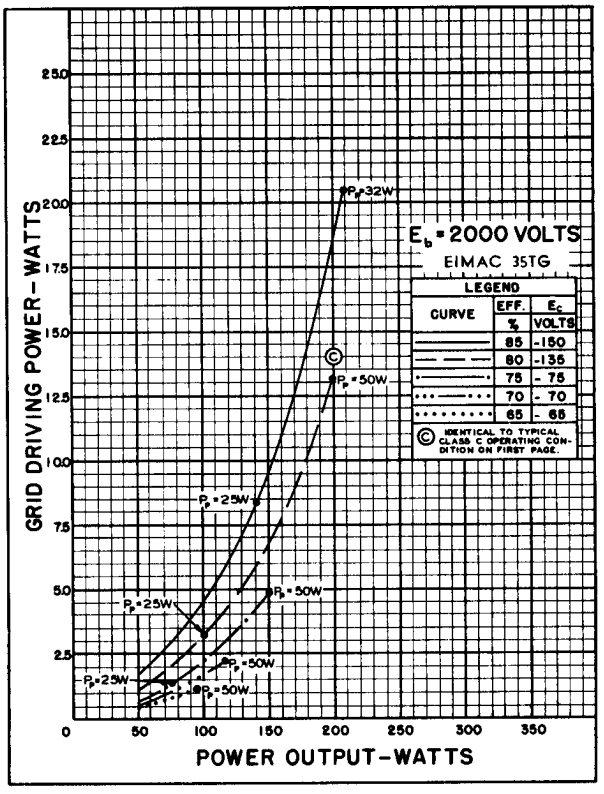
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

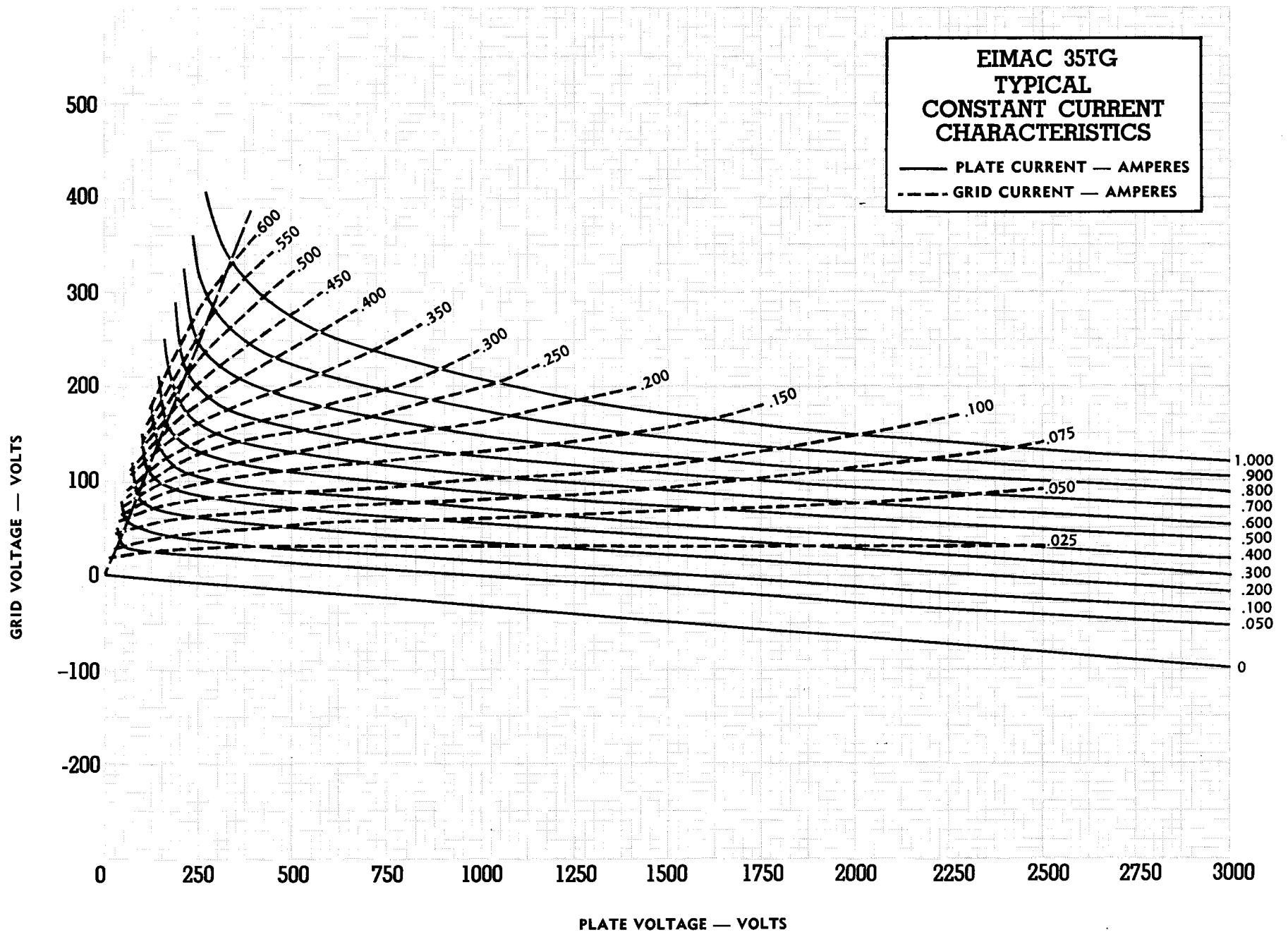
Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.

•





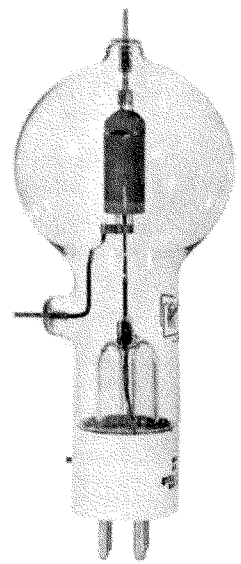



EIMAC 35TG
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT — AMPERES
GRID CURRENT — AMPERES
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS
500
400
300
200
100
0
-100
-200
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
.600
.550
.500
.450
.400
.350
.300
.250
.200
.150
.100
.075
.050
.025
1.000
.900
.800
.700
.600
.500
.400
.300
.200
.100
.050
0

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

75TH

MEDIUM-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER



The Eimac 75TH is a medium-mu power triode intended for use as an amplifier, oscillator, or modulator. It has a maximum plate dissipation rating of 75 watts and a maximum plate voltage rating of 3000 volts at frequencies up to 40 Mc. Forced-air cooling is not required in properly designed equipment operating at frequencies below 40 Mc.

The 75TH in Class-C R-F service will deliver up to 225 watts plate power output with 10 watts driving power. Two 75TH's in Class-B modulator service will deliver up to 300 watts maximum-signal plate power output with 3 watts driving power.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	5.0 volts
Current	6.25 amperes
Amplification Factor (Average)	20
Direct Interelectrode Capacitances (Average)	
Grid-Plate	2.3 $\mu\mu$f
Grid-Filament	2.7 $\mu\mu$f
Plate-Filament	0.3 $\mu\mu$f
Transconductance (I_b=225 ma., E_b=3000 v.)	4150 μmhos
Highest Frequency for Maximum Ratings	40 Mc

MECHANICAL

Base	Medium 4-pin bayonet
Basing	See outline drawing
Socket	Johnson type No. 122-224, National type No. XC-4 or CIR-4, or equivalent
Mounting Position	Vertical, base down or up
Cooling	Convection and radiation
Maximum Temperature of Plate and Grid Seals	225°C
Recommended Heat Dissipating Connectors:	
Plate	Eimac HR-3
Grid	Eimac HR-2
Maximum Overall Dimensions:	
Length	7.25 inches
Diameter	2.81 inches
Net Weight	3 ounces
Shipping Weight (Average)	1.5 pounds

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy (Key-down conditions, 1 tube)

MAXIMUM RATINGS (Frequencies up to 40 Mc.)

D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C PLATE CURRENT	225 MAX. MA.
PLATE DISSIPATION	75 MAX. WATTS
GRID DISSIPATION	16 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 40 Mc.)

D-C Plate Voltage	1000	1500	2000	volts
D-C Grid Voltage	—80	—125	—200	volts
D-C Plate Current	215	167	150	ma.
D-C Grid Current (approx.)	35	23	32	ma.
Peak R-F Grid Input Voltage (approx.)	270	280	350	volts
Driving Power (approx.)	9	6	10	watts
Plate Power Input	215	250	300	watts
Plate Dissipation	75	75	75	watts
Plate Power Output	140	175	225	watts

PLATE MODULATED RADIO FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS (Frequencies up to 40 Mc.)

D-C PLATE VOLTAGE	2400 MAX. VOLTS
D-C PLATE CURRENT	180 MAX. MA.
PLATE DISSIPATION	50 MAX. WATTS
GRID DISSIPATION	16 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 40 Mc.)

D-C Plate Voltage	1000	1500	2000	volts
D-C Grid Voltage	—150	—200	—300	volts
D-C Plate Current	135	115	110	ma.
D-C Grid Current (approx.)	20	14	15	ma.
Peak R-F Grid Input Voltage (approx.)	300	330	440	volts
Driving Power (approx.)	6	5	6	watts
Grid Dissipation	3	2	2	watts
Plate Power Input	135	175	220	watts
Plate Dissipation	50	50	50	watts
Plate Power Output	85	125	170	watts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-B

MAXIMUM RATINGS (Per tube)

D-C PLATE VOLTAGE	3000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT	225 MAX. MA.
PLATE DISSIPATION	75 MAX. WATTS
GRID DISSIPATION	16 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	1000	1500	2000	volts
D-C Grid Voltage (approx.)[1]	—30	—60	—90	volts
Zero-Signal D-C Plate Current	90	67	50	ma.
Max-Signal D-C Plate Current	350	267	225	ma.
Effective Load, Plate-to-Plate	5300	11,400	19,300	ohms
Peak A-F Grid Input Voltage (per tube)	175	165	175	volts
Max-Signal Driving Power (approx.)	7	4	3	watts
Max-Signal Plate Dissipation (per tube)	75	75	75	watts
Max-Signal Plate Power Output	200	250	300	watts
Total Harmonic Distortion	1.5	2.0	2.0	per cent

[1]Adjust to give stated zero-signal plate current.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING MAXIMUM RATINGS, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.

(Effective 1-2-52) Copyright 1952 by Eitel-McCullough, Inc.

▶ Indicates change from sheet dated 7-1-44.

APPLICATION

MECHANICAL

Mounting—The 75TH must be mounted vertically, base down or up. The plate and grid leads should be flexible. The tube must be protected from vibration and shock.

Cooling—Heat Dissipating Connectors (Eimac HR-3 and HR-2) should be used at the plate and grid terminals of the 75TH. If the free circulation of air around the tube is restricted, a small fan or centrifugal blower should be used to provide additional cooling for the plate and grid seals.

Cooling requirements will be met if the temperature of the plate and grid seals is not allowed to exceed 225°C. One method of measuring these temperatures is provided by the use of "Tempilaq", a temperature-sensitive lacquer available from the Tempil Corporation, New York 11, N.Y.

ELECTRICAL

Filament Voltage—For maximum tube life the filament voltage, as measured directly at the base pins, should be the rated value of 5.0 volts. Variations must be kept within the range of 4.75 to 5.25 volts.

Bias Voltage—Although there is no maximum limit on the bias voltage which may be used on the 75TH, there is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained by a grid leak, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Plate Voltage—The plate-supply voltage for the 75TH should not exceed 3000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

Grid Dissipation—The power dissipated by the grid of the 75TH must not exceed 16 watts. Grid dissipation may be calculated from the following expression:

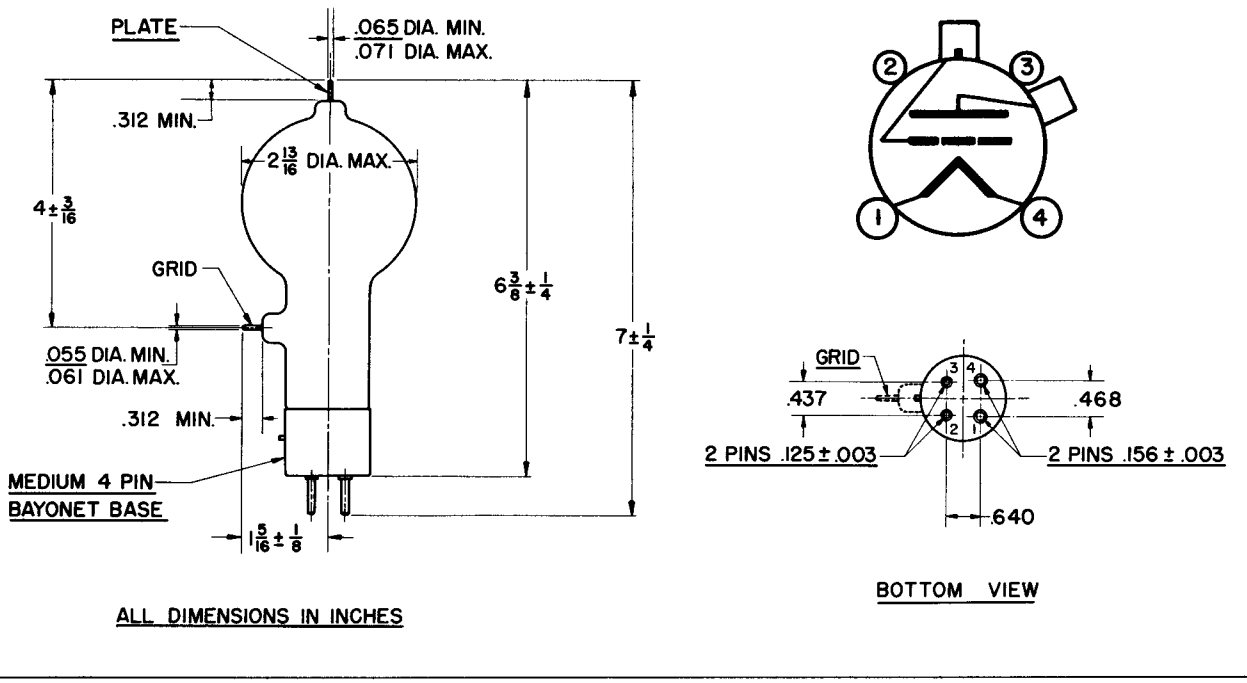
$$P_g = e_{cmp} I_c$$

where P_g = Grid dissipation,
e_{cmp} = Peak positive grid voltage, and
I_c = D-c grid current.

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid[1]. In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

Plate Dissipation—The plate of the 75TH operates at a visibly red temperature at its maximum rated dissipation of 75 watts. Plate dissipation in excess of the maximum rating is permissible only for short periods of time, such as during tuning procedures.

[1] For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings", **Eimac News**, January, 1945. This article is available in reprint form on request.



▶ Indicates change from sheet dated 7-1-44.

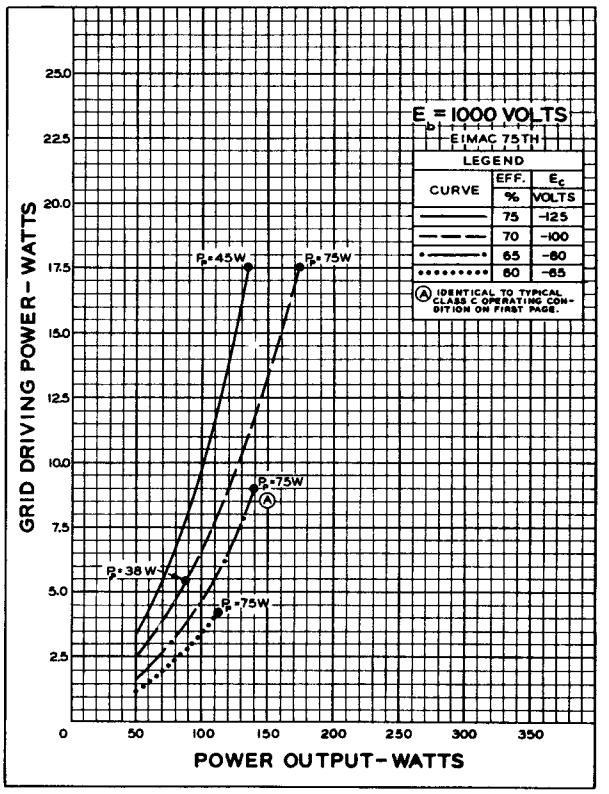
DRIVING POWER vs. POWER OUTPUT

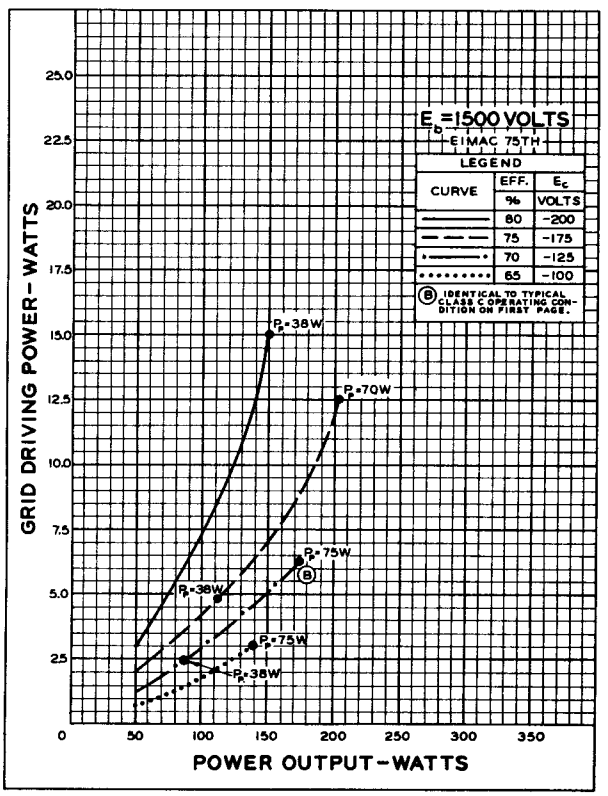
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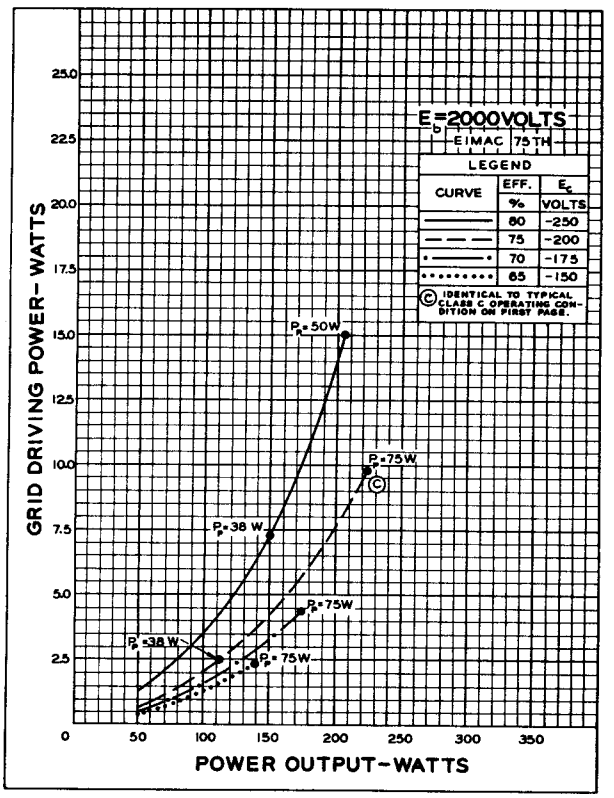
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

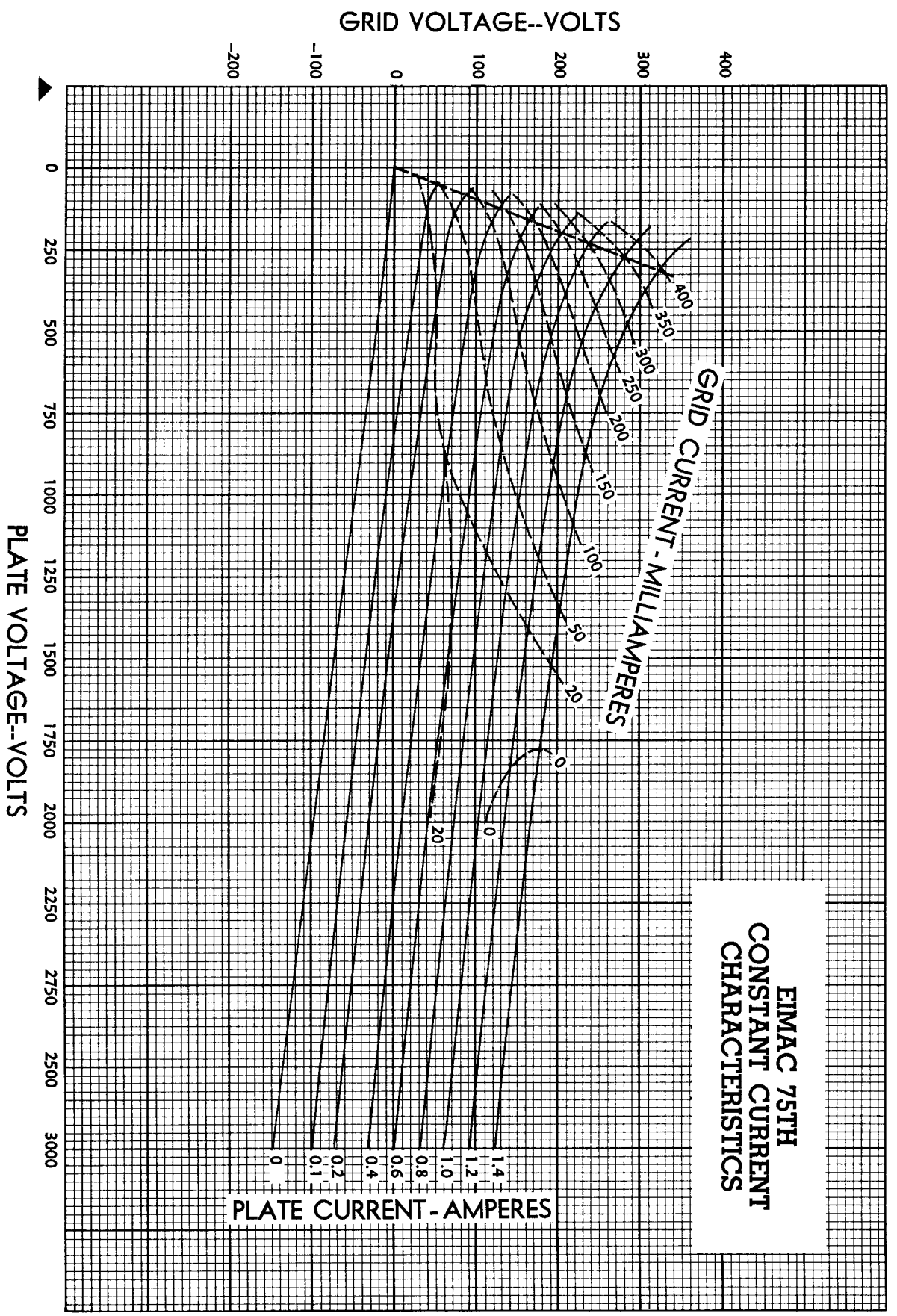
Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.

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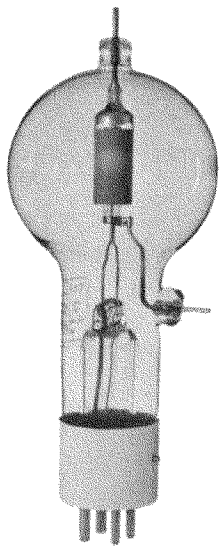
▶ Indicates change from sheet dated 7-1-44.

PRINTED IN U. S. A. 5-G1-76230

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

75TL

LOW-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER



The Eimac 75TL is a low-mu, high-vacuum transmitting triode intended for amplifier, oscillator and modulator service. It has a maximum plate dissipation rating of 75 watts. Cooling of the 75TL is accomplished by radiation from the plate, which operates at a visibly red temperature at maximum dissipation, and by air circulation around the envelope.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten
- Voltage - - - - - - - - - - - - - - - 5.0 volts
- Current - - - - - - - - - - - - - - - 6.25 amperes

Amplification Factor (Average) - - - - - - - - - - - - - - 12

Direct Interelectrode Capacitances (Average)
- Grid-Plate - - - - - - - - - - - - - - - 2.4 $\mu\mu$fd.
- Grid-Filament - - - - - - - - - - - - - - - 2.6 $\mu\mu$fd.
- Plate-Filament - - - - - - - - - - - - - - - 0.4 $\mu\mu$fd.

Transconductance (i_b = 225ma., E_b = 2500v., E_c = −182 v.) - 3350 μmhos

MECHANICAL

Base - - - - - - Medium 4-pin bayonet, ceramic, RMA type M8-078
Basing - - - - - - - - - - - - - - - - - - RMA type 2M
Cooling - - - - - - - - - - - - - Radiation and air circulation

Maximum Overall Dimensions:
- Length - 7.25 inches
- Diameter - 2.81 inches

Net weight - 3 ounces
Shipping weight (Average) - 1.5 pounds

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy (Key-down conditions, 1 tube)

MAXIMUM RATINGS (Frequencies below 40 Mc.)

D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C PLATE CURRENT	225 MAX. MA.
PLATE DISSIPATION	75 MAX. WATTS
GRID DISSIPATION	13 MAX. WATTS

TYPICAL OPERATION (Frequencies below 40 Mc.)

D-C Plate Voltage	1000	1500	2000	volts
D-C Plate Current	215	167	150	ma.
Plate Dissipation	75	75	75	watts
D-C Grid Voltage	−150	−250	−300	volts
D-C Grid Current	28	22	21	ma.
Peak R-F Grid Input Voltage (approx.)	320	355	425	volts
Driving Power, (approx.)	8	6	8	watts
Plate Power Input	215	250	300	watts
Plate Power Output	140	175	225	watts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-AB$_1$ (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	225 MAX. MA.
PLATE DISSIPATION, PER TUBE	75 MAX. WATTS

[1] The effective grid-circuit resistance for each tube must not exceed 250,000 ohms.

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AUDIO FREQUENCY AMPLIFIER (Continued)

TYPICAL OPERATION

D-C Plate Voltage	1500	2000	volts
D-C Grid Voltage [1]	−105	−160	volts
Peak A-F Grid Input Voltage (per tube)	105	160	volts
Zero-Signal D-C Plate Current	67	50	ma.
Max-Signal D-C Plate Current	143	130	ma.
Driving Power	0	0	watt
Effective Load, Plate-to-Plate	10,200	21,200	ohms
Max-Signal Plate Power Output	64	110	watts
Max-Signal Plate Dissipation (per tube)	75	75	watts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	225 MAX. MA.
PLATE DISSIPATION, PER TUBE	75 MAX. WATTS
GRID DISSIPATION, PER TUBE	13 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	1000	1500	2000	volts
D-C Grid Voltage	−65	−105	−160	volts
Peak A-F Grid Input Voltage (per tube)	205	225	267	volts
Zero-Signal D-C Plate Current	100	67	50	ma.
Max-Signal D-C Plate Current	350	285	250	ma.
Max-Signal Avg. Driving Power (approx.)	7	6	5	watts
Max-Signal Peak Driving Power	26	23	19	watts
Effective Load, Plate-to-Plate	5,300	11,000	18,000	ohms
Max-Signal Plate Power Output	200	280	350	watts
Max-Signal Plate Dissipation (per tube)	75	75	75	watts

APPLICATION

MECHANICAL

Mounting—The 75TL must be mounted vertically, base up or base down. Flexible connecting straps should be provided between the grid and plate terminals and the external grid and plate circuits. The tube must be protected from severe vibration and shock.

Cooling—Provision should be made for ample circulation of air around the 75TL. In the event that the design of the equipment restricts natural circulation, a small fan or centrifugal blower should be used to provide additional cooling for the envelope and plate and grid seals.

ELECTRICAL

Filament Voltage—The filament voltage, as measured directly at the filament pins, should be between 4.75 and 5.25 volts.

Bias Voltage—Although there is no maximum limit on the bias voltage which may be used on the 75TL, there is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained by a grid leak, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Plate Voltage—The plate-supply voltage for the 75TL should not exceed 3000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

Grid Dissipation—The power dissipated by the grid of the 75TL must not exceed 13 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp} I_c$$

where P_g = Grid dissipation,

e_{cmp} = Peak positive grid voltage, and

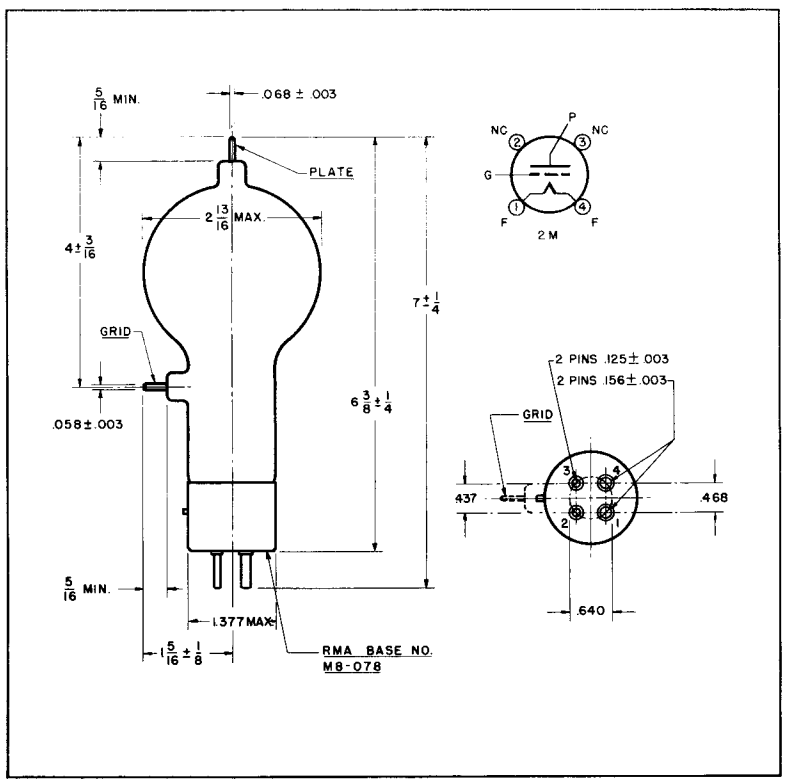
I_c = D-c grid current.

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid.[2] In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

Plate Dissipation—Under normal operating conditions, the power dissipated by the plate of the 75TL should not be allowed to exceed 75 watts. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

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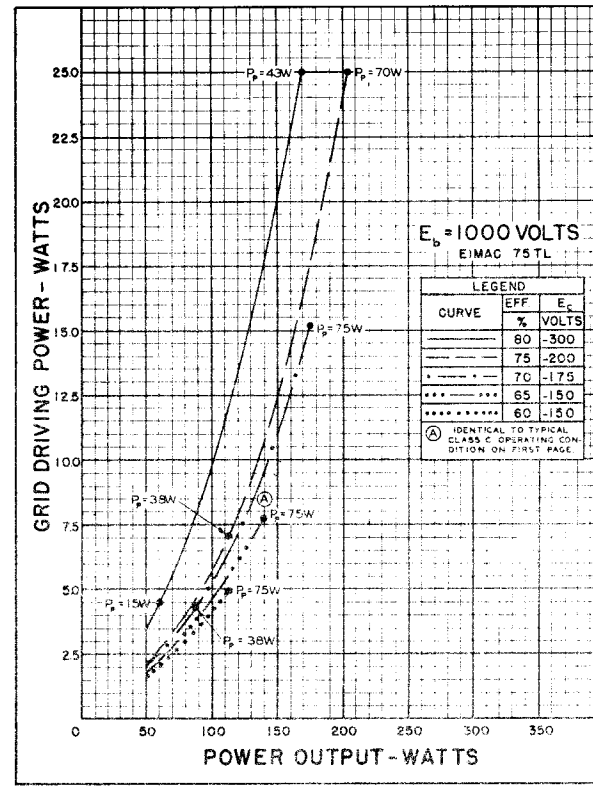
[2] For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings," Eimac News, January, 1945. This article is available in reprint form on request.

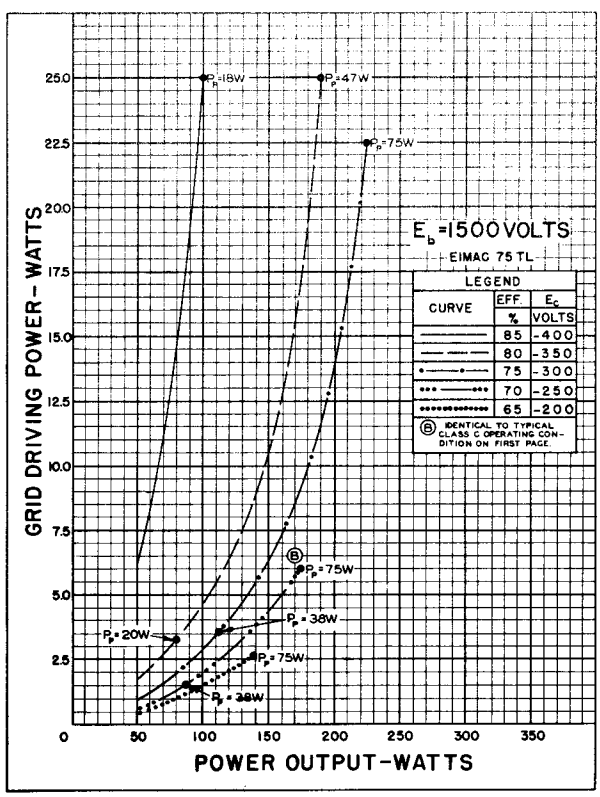


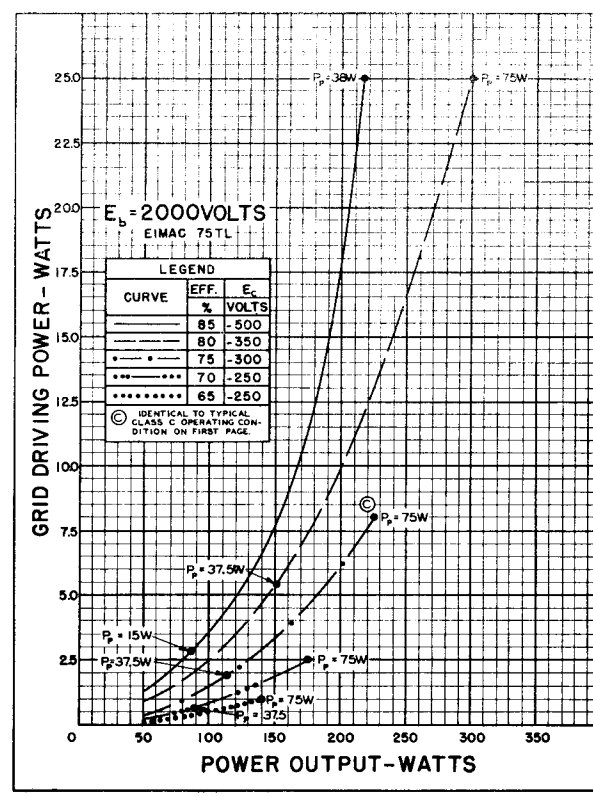
DRIVING POWER vs. POWER OUTPUT

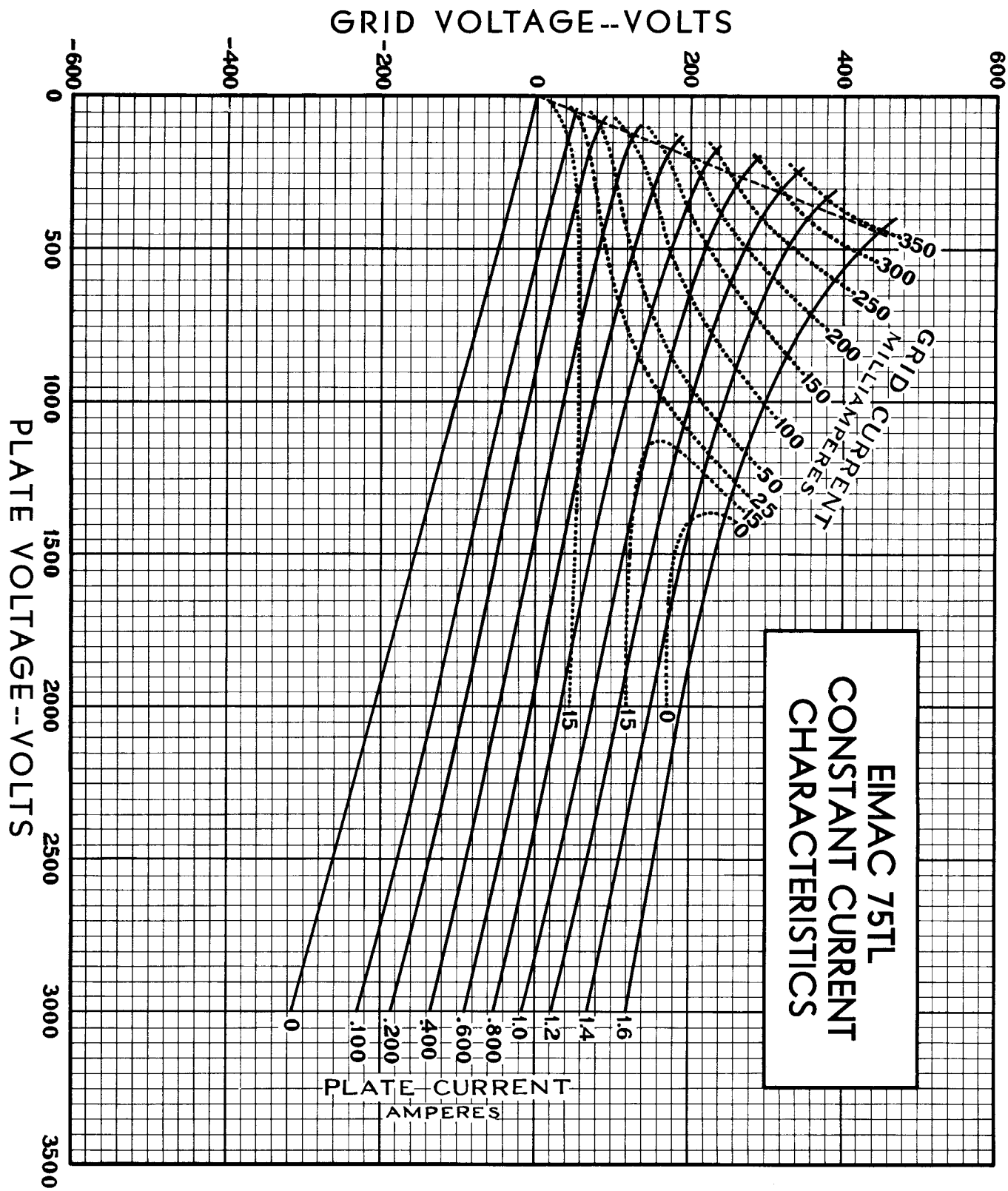
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1000, 1500 and 2000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1000, 1500, and 2000 volts respectively.









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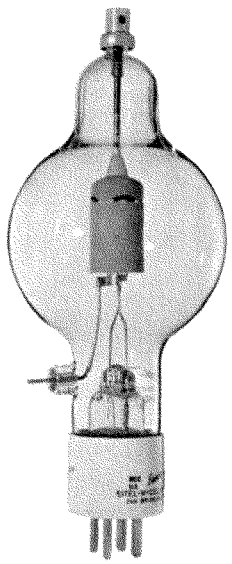
EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

100TH

HIGH-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER

The Eimac 100TH is a high-mu power triode having a maximum plate dissipation rating of 100 watts, and is intended for use as an amplifier, oscillator, or modulator. It can be used at its maximum ratings at frequencies as high as 40-Mc.

Cooling of the 100TH is accomplished by radiation from the plate, which operates at a visible red color at maximum dissipation, and by means of air circulation by convection around the envelope.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	5.0 volts
Current	6.3 amperes
▶ Amplification Factor (Average)	38
Direct Interelectrode Capacitances (Average)	
Grid-Plate	2.0 $\mu\mu$f
Grid-Filament	2.9 $\mu\mu$f
▶ Plate-Filament	0.3 $\mu\mu$f
▶ Transconductance (i_b=200 ma., E_b=3000v., e_c= –5v.)	4500 μmhos
Frequency for Maximum Ratings	40 Mc.

MECHANICAL

Base (Medium 4-pin bayonet, ceramic)	RMA type M8-078
Basing	RMA type 2M
▶ Mounting	Vertical, base down or up.
▶ Cooling	Convection and Radiation.
▶ Recommended Heat Dissipating Connectors:	
Plate	Eimac HR-6
Grid	Eimac HR-2
Maximum Overall Dimensions:	
Length	7.75 inches
Diameter	3.19 inches
Net weight	4 ounces
Shipping weight (Average)	1.5 pounds

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-AB$_2$ (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	225 MAX. MA.
PLATE DISSIPATION, PER TUBE	100 MAX. WATTS

▶ TYPICAL OPERATION

D-C Plate Voltage	1500	2000	2500 Volts
D-C Grid Voltage (approx.)*	—20	—35	—50 Volts
Zero-Signal D-C Plate Current	80	60	48 Ma.
Max-Signal D-C Plate Current	320	280	250 Ma.
Effective Load, Plate-to-Plate	8800	15,000	22,000 Ohms.
Peak A-F Grid Input Voltage (per tube)	145	150	155 Volts
Max-Signal Peak Driving Power	18	19	15 Watts
Max-Signal Nominal Driving Power (approx.)	9	9.5	7.5 Watts
Max-Signal Plate Power Output	280	360	425 Watts

*Adjust to give stated zero signal plate current.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C PLATE CURRENT	225 MAX. MA.
PLATE DISSIPATION	100 MAX. WATTS
▶ GRID DISSIPATION	20 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	1500	2000	3000 Volts
D-C Grid Voltage	—65	—80	—200 Volts
D-C Plate Current	190	165	165 Ma.
D-C Grid Current	48	39	51 Ma.
Peak R-F Grid Input Voltage	230	230	385 Volts
Driving Power (approx.)	10	8	18 Watts
Grid Dissipation	7	5	10 Watts
Plate Power Input	285	335	500 Watts
Plate Dissipation	100	100	100 Watts
Plate Power Output	185	235	400 Watts

▶ PLATE MODULATED RADIO FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

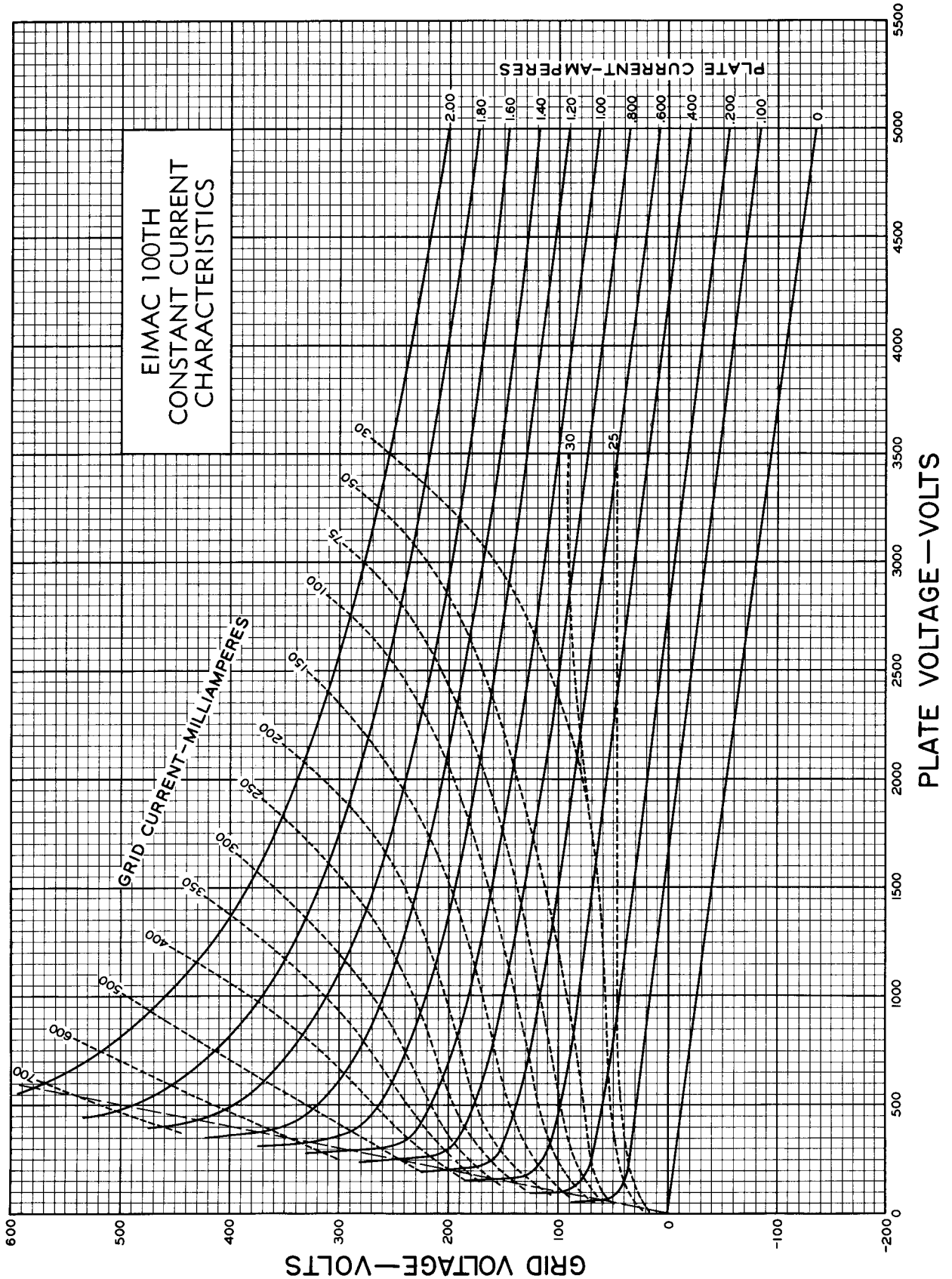
D-C PLATE VOLTAGE	2500 MAX. VOLTS
D-C PLATE CURRENT	180 MAX. MA.
PLATE DISSIPATION	65 MAX. WATTS
GRID DISSIPATION	20 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	1500	2000	2500 Volts
D-C Grid Voltage	—150	—200	—250 Volts
D-C Plate Current	160	150	140 Ma.
D-C Grid Current	46	41	40 Ma.
Peak R-F Grid Input Voltage	325	375	425 Volts
Driving Power (approx.)	15	15.5	17 Watts
Grid Dissipation	8	7.3	7 Watts
Plate Power Input	240	300	350 Watts
Plate Dissipation	65	65	65 Watts
Plate Power Output	175	235	285 Watts

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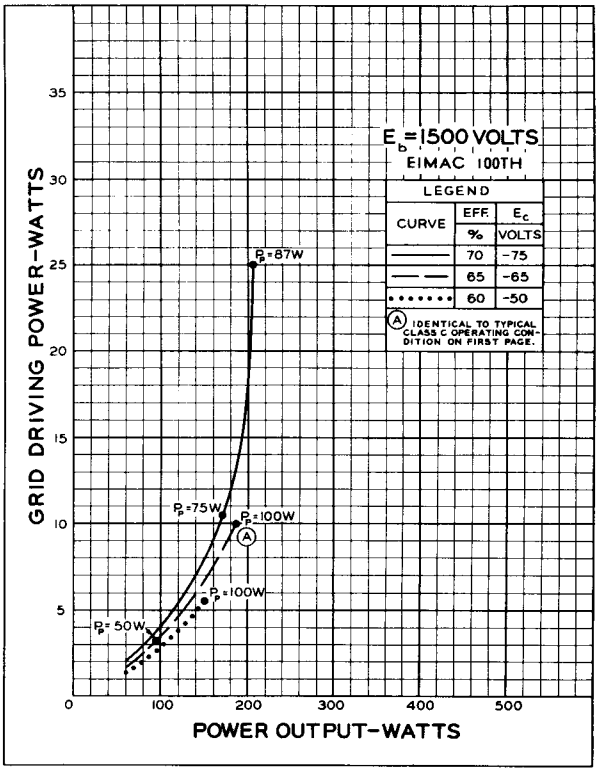
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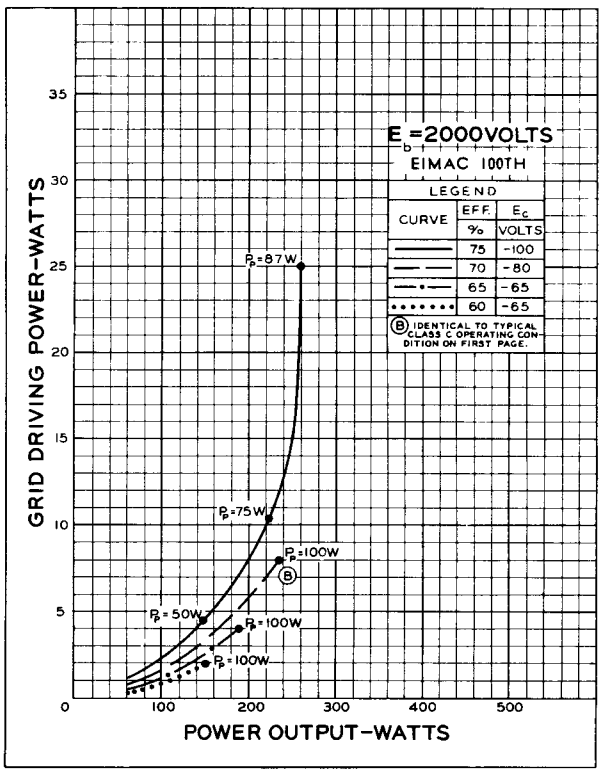

EIMAC 100TH
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT-AMPERES
2.00
1.80
1.60
1.40
1.20
1.00
.800
.600
.400
.200
.100
0
GRID CURRENT-MILLIAMPERES
30
50
75
100
150
200
250
300
350
400
500
600
700
30
25
PLATE VOLTAGE—VOLTS
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
GRID VOLTAGE—VOLTS
600
500
400
300
200
100
0
-100
-200

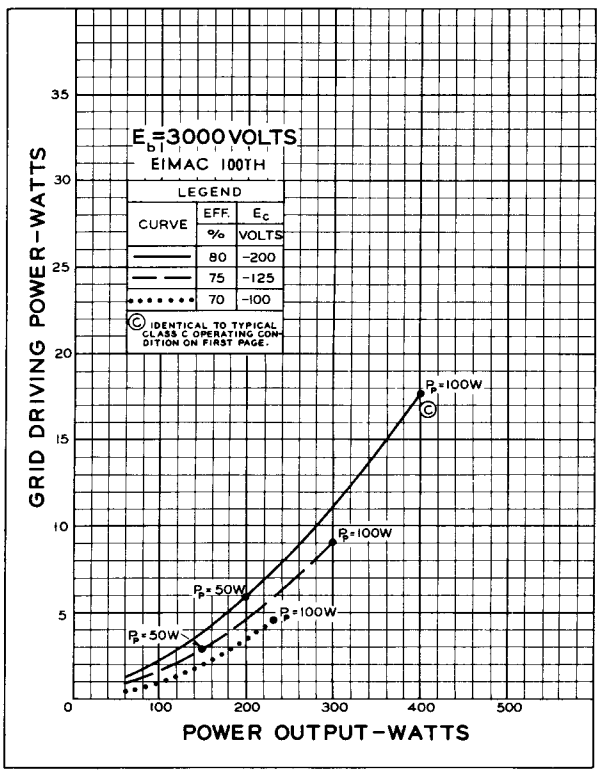
DRIVING POWER vs. POWER OUTPUT

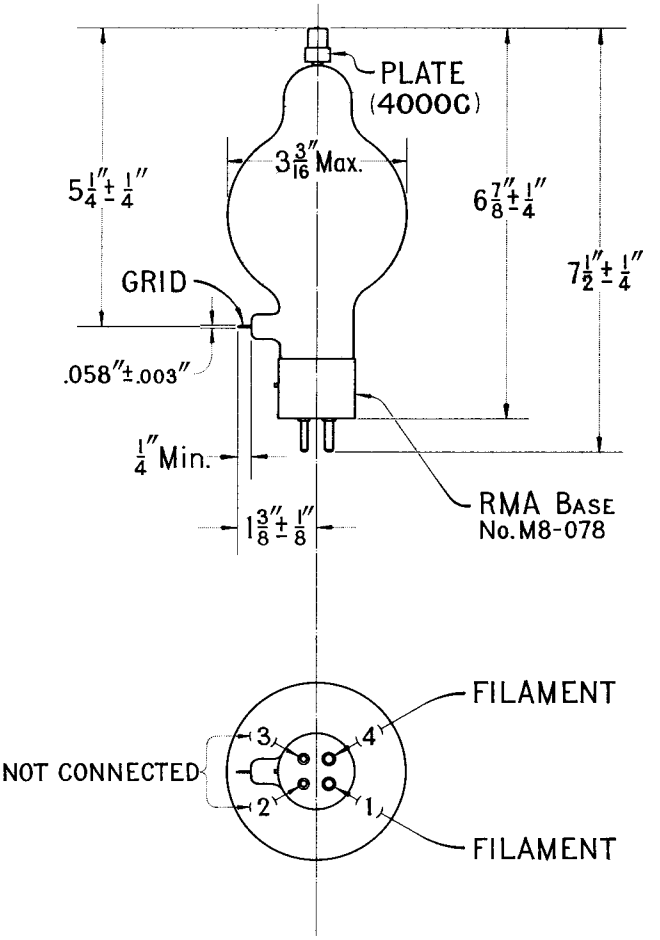
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

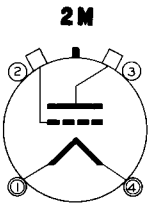
Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.

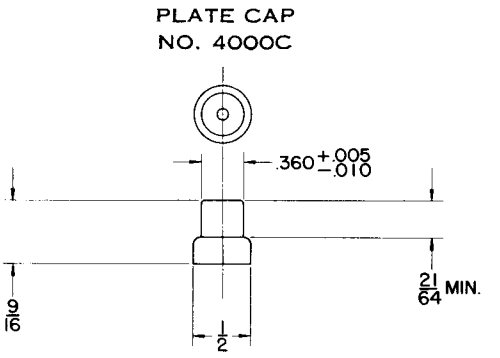







PLATE
(4000C)
3 3/16" Max.
5 1/4" ± 1/4"
6 7/8" ± 1/4"
7 1/2" ± 1/4"
GRID
.058" ± .003"
1/4" Min.
1 3/8" ± 1/8"
RMA BASE
No. M8-078
FILAMENT
NOT CONNECTED
3
4
2
1
FILAMENT


2M
2
3
1
4


PLATE CAP
NO. 4000C
.360 +.005 -.010
21/64 MIN.
9/16
1/2
GRID CAP
(SEE TUBE OUTLINE DRAWING)

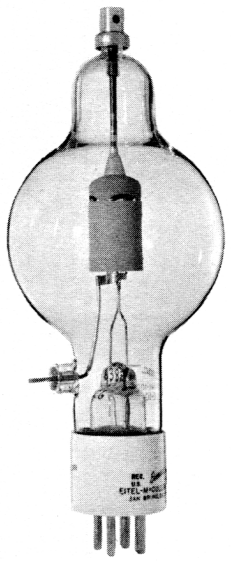
EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

100TL

LOW-MU TRIODE
●
MODULATOR
OSCILLATOR
AMPLIFIER

The Eimac 100TL is a low-mu power triode having a maximum plate dissipation rating of 100 watts, and is intended for use as an amplifier, oscillator or modulator. It can be used at its maximum ratings at frequencies as high as 40-Mc.

Cooling of the 100TL is accomplished by radiation from the plate, which operates at a visible red color at maximum dissipation, and by means of air circulation by convection around the envelope.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	5.0 volts
Current	6.3 amperes
Amplification Factor (Average)	14
Direct Interelectrode Capacitances (Average)	
Grid-Plate	2.0 $\mu\mu$f
Grid-Filament	2.3 $\mu\mu$f
Plate-Filament	0.4 $\mu\mu$f
Transconductance (i_b=225 ma., E_b=3000v., e_c= –90v.)	3000 μmhos
Frequency for Maximum Ratings	40 Mc.

MECHANICAL

Base (Medium 4-pin bayonet, ceramic)	RMA type M8-078
Basing	RMA type 2M
Mounting	Vertical, base down or up.
Cooling	Convection and Radiation.
Recommended Heat Dissipating Connectors:	
Plate	Eimac HR-6
Grid	Eimac HR-2
Maximum Overall Dimensions:	
Length	7.75 inches
Diameter	3.19 inches
Net weight	4 ounces
Shipping weight (Average)	1.5 pounds

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-AB$_2$ (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	225 MAX. MA.
PLATE DISSIPATION, PER TUBE	100 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	1500	2000	2500 Volts
D-C Grid Voltage (approx.)*	—65	—110	—145 Volts
Zero-Signal D-C Plate Current	80	60	48 Ma.
Max-Signal D-C Plate Current	320	280	250 Ma.
Effective Load, Plate-to-Plate	8800	15,000	22,000 Ohms
Peak A-F Grid Input Voltage (per tube)	235	270	290 Volts
Max-Signal Peak Driving Power	21	22	20 Watts
Max-Signal Nominal Driving Power (approx.)	10.5	11	10 Watts
Max-Signal Plate Power Output	280	360	425 Watts

*Adjust to give stated zero signal plate current.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C PLATE CURRENT	225 MAX. MA.
PLATE DISSIPATION	100 MAX. WATTS
GRID DISSIPATION	15 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	1500	2000	3000 Volts
D-C Grid Voltage	—175	—225	—400 Volts
D-C Plate Current	190	165	165 Ma.
D-C Grid Current	37	28	30 Ma.
Peak R-F Grid Input Voltage	425	450	650 Volts
Driving Power (approx.)	14	11	20 Watts
Grid Dissipation	7.5	5	8 Watts
Plate Power Input	285	335	500 Watts
Plate Dissipation	100	100	100 Watts
Plate Power Output	185	235	400 Watts

PLATE MODULATED RADIO FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

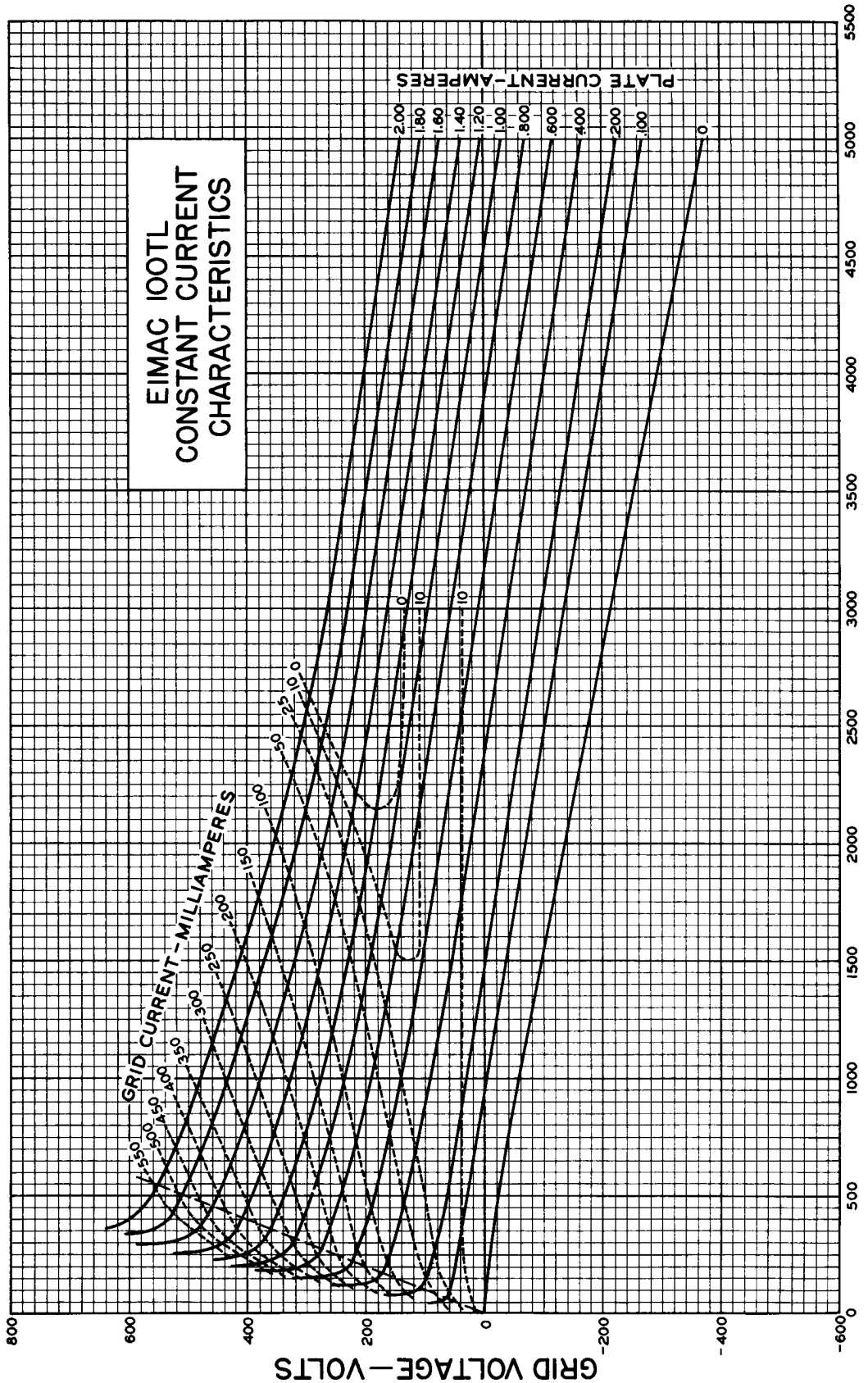
D-C PLATE VOLTAGE	2500 MAX. VOLTS
D-C PLATE CURRENT	180 MAX. MA.
PLATE DISSIPATION	65 MAX. WATTS
GRID DISSIPATION	15 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	1500	2000	2500 Volts
D-C Grid Voltage	—300	—400	—500 Volts
D-C Plate Current	160	150	140 Ma.
D-C Grid Current	32	31	31 Ma.
Peak R-F Grid Input Voltage	530	655	750 Volts
Driving Power (approx.)	17	20	23 Watts
Grid Dissipation	8	7.5	7.5 Watts
Plate Power Input	240	300	350 Watts
Plate Dissipation	65	65	65 Watts
Plate Power Output	175	235	285 Watts

(Effective 5-1-52) Copyright, 1949

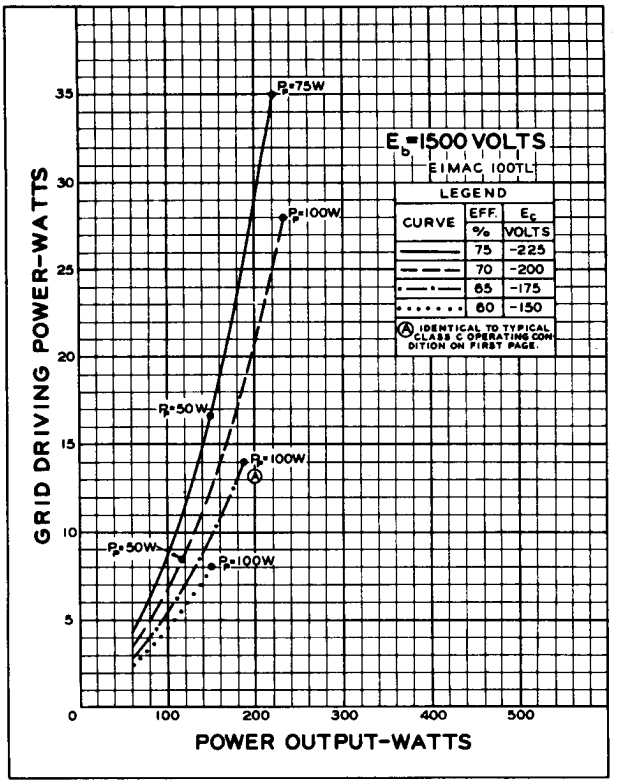
PRINTED IN U. S. A.

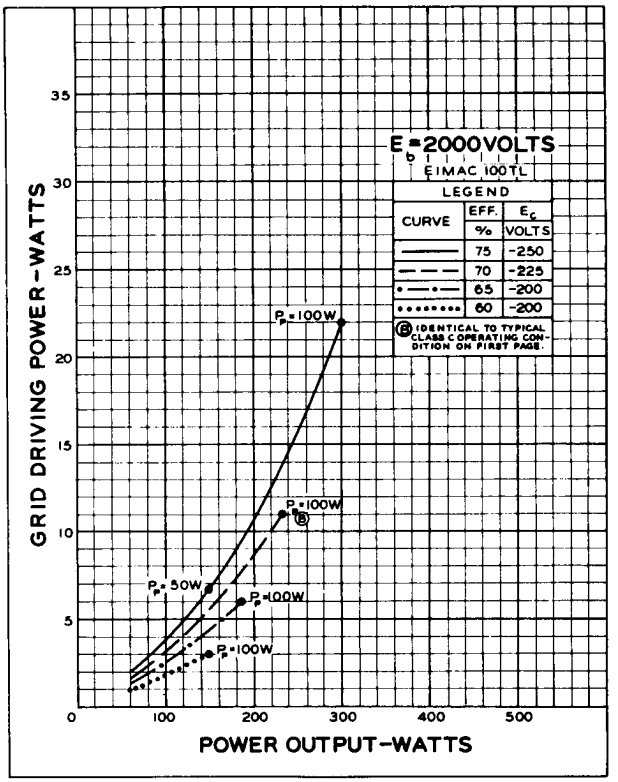

EIMAC 100TL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT-AMPERES
2.00
1.80
1.60
1.40
1.20
1.00
.800
.600
.400
.200
.100
0
GRID CURRENT-MILLIAMPERES
-550
-500
-450
-400
-350
-300
-250
-200
-150
-100
-50
-25
-10
0
10
10
0
GRID VOLTAGE—VOLTS
800
600
400
200
0
-200
-400
-600
PLATE VOLTAGE—VOLTS
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500

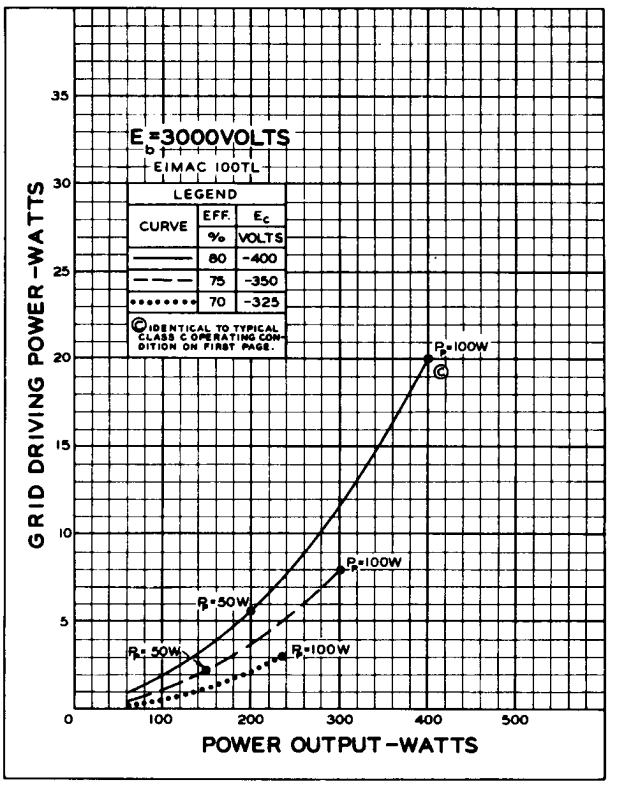
DRIVING POWER vs. POWER OUTPUT

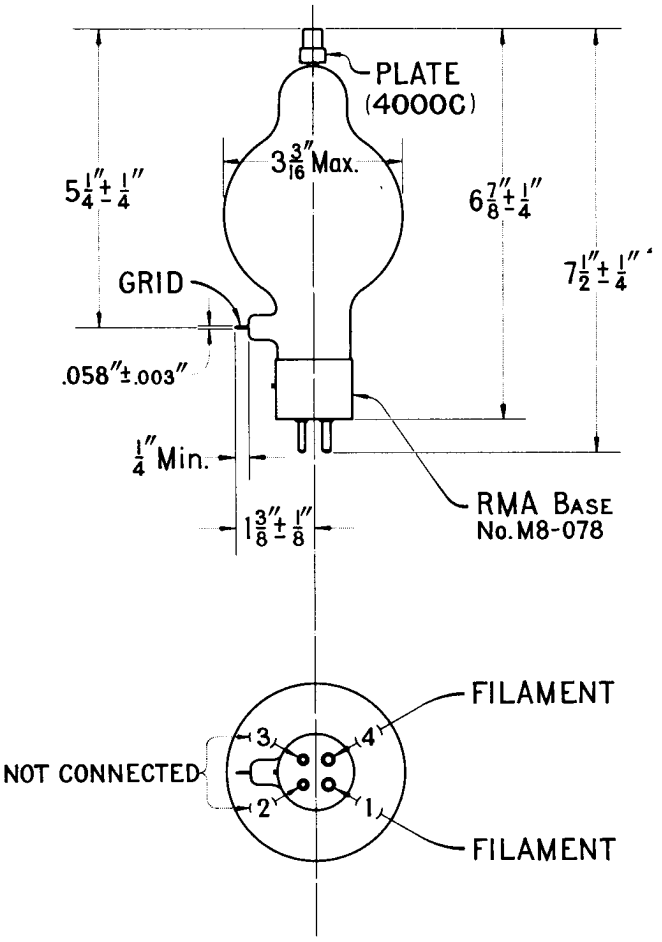
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.









2M

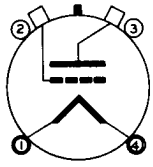
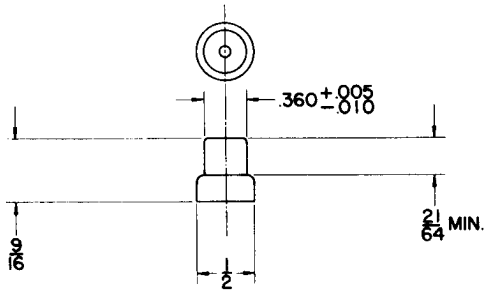


PLATE CAP
NO. 4000C

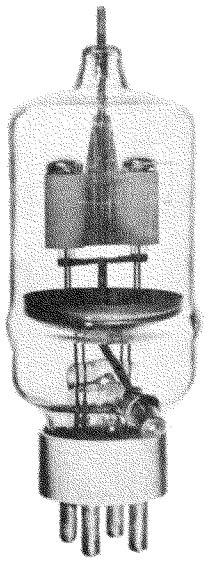


GRID CAP
(SEE TUBE OUTLINE DRAWING)

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

152TH

MEDIUM-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten		
Voltage	5.0 or 10.0	volts
Current	12.5 or 6.25	amperes
Amplification Factor (Average)	20	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	4.8	μμf
Grid-Filament	5.7	μμf
Plate-Filament	0.8	μμf
Transconductance (i_b = 500 ma., E_b = 3000 v., E_c = –40 v.)	8300	μmhos
Frequency for Maximum Ratings	40	mc

MECHANICAL

Base	Special 4 pin, No. 5000B	
Basing	RMA type 4BC	
Maximum Overall Dimensions:		
Length	7.625	inches
Diameter	2.563	inches
Net weight	7	ounces
Shipping weight (Average)	2.0	pounds

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage	1500	2000	3000	3000	volts
Max.-Signal D-C Plate Current, per tube*	•	•	•	450	ma.
Plate Dissipation, per tube*	•	•	•	150	watts
D-C Grid Voltage (approx.)	–65	–90	–150		volts
Peak A-F Grid Input Voltage	340	350	430		volts
Zero-Signal D-C Plate Current	133	100	67		ma.
Max.-Signal D-C Plate Current	535	450	335		ma.
Max.-Signal Driving Power (approx.)	9	6	3		watts
Effective Load, Plate-to-Plate	5700	9600	20300		ohms
Max.-Signal Plate Power Output	500	600	700		watts

*Averaged over any sinusoidal audio frequency cycle.

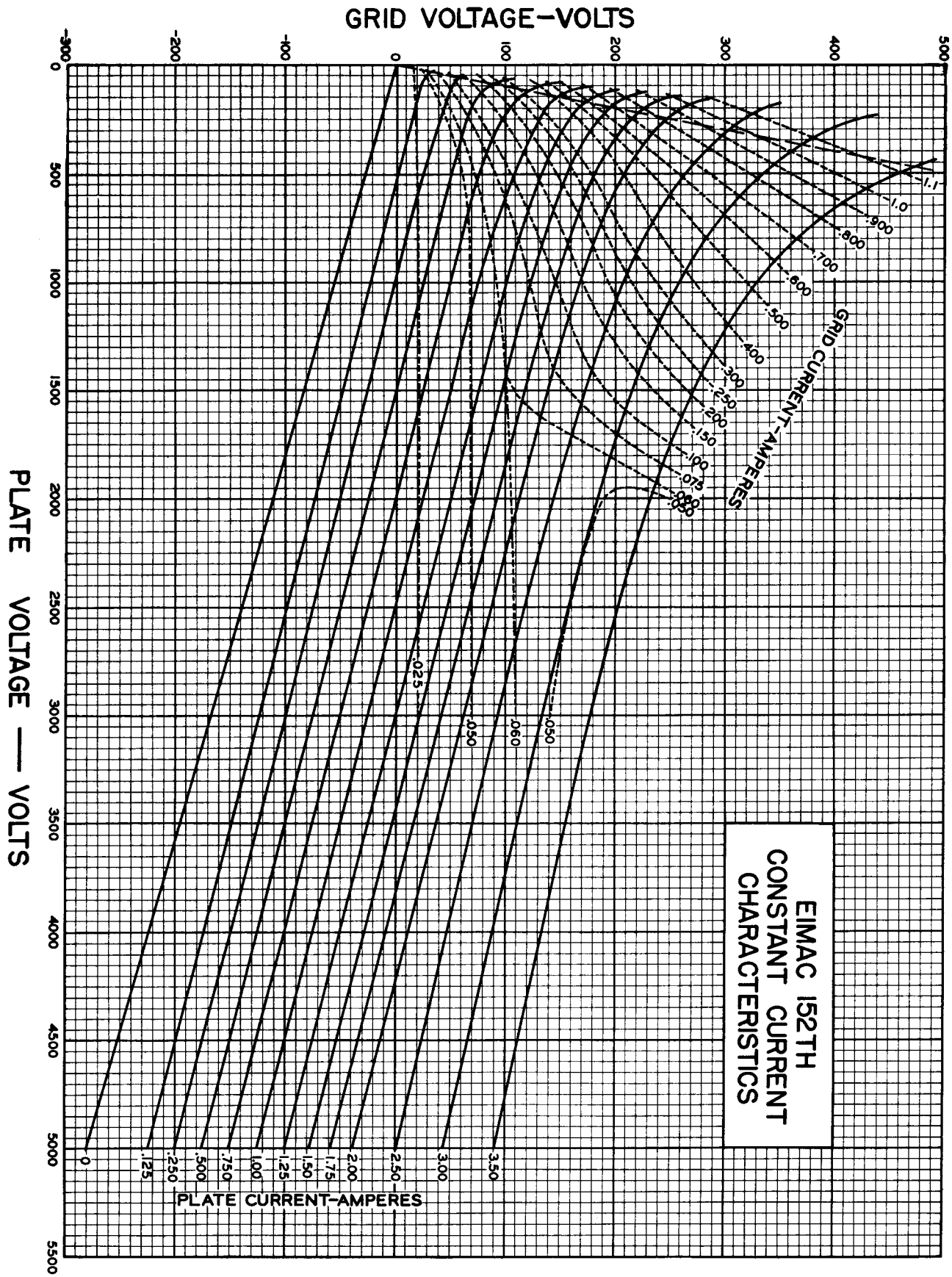
RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C *Telegraphy
(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage	1500	2000	3000	3000	volts
D-C Plate Current	333	300	250	450	ma.
D-C Grid Current	58	74	70	85	ma.
D-C Grid Voltage	–125	–200	–300		volts
Plate Power Output	350	450	600		watts
Plate Input	500	600	750		watts
Plate Dissipation	150	150	150	150	watts
Peak R. F. Grid Input Voltage, (approx.)	267	334	410		volts
Driving Power, (approx.)	13	20	27		watts

*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

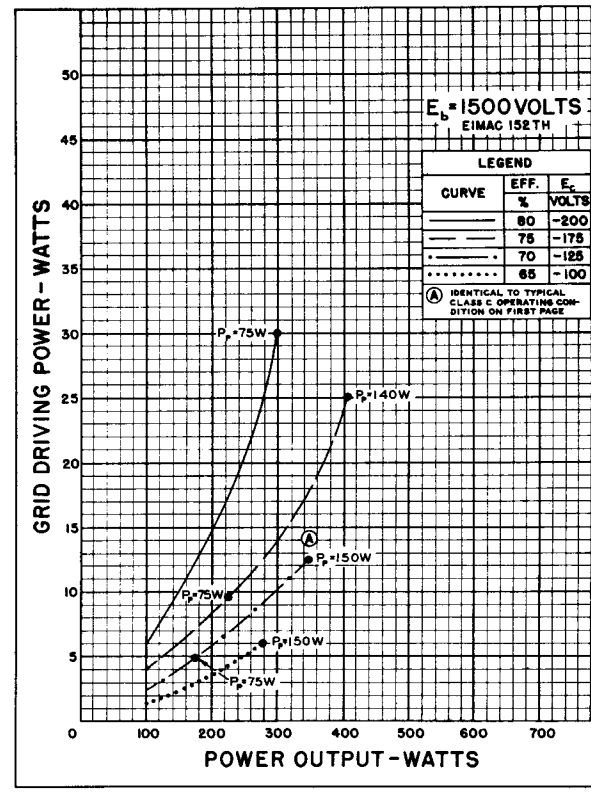
(Effective 6-1-44) Copyright, 1946 by Eitel-McCullough, Inc.

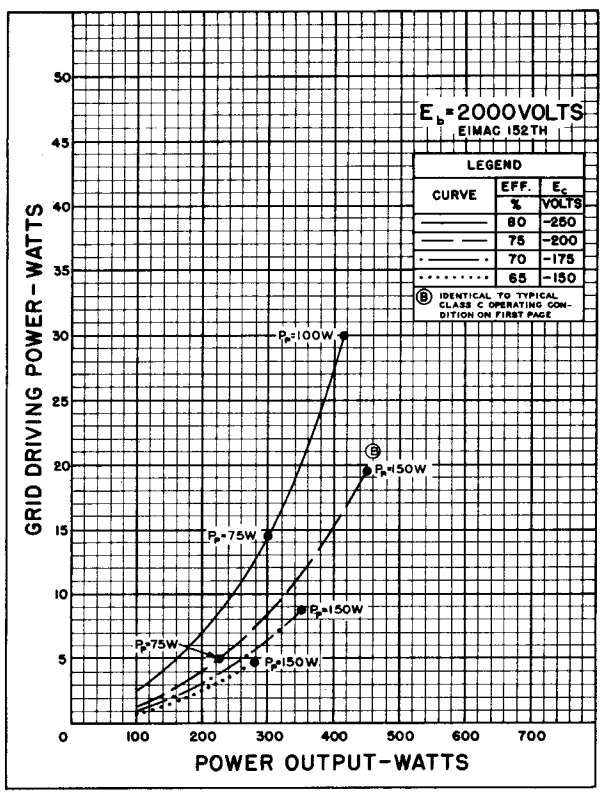

GRID VOLTAGE—VOLTS
-300
-200
-100
0
100
200
300
400
500
PLATE VOLTAGE — VOLTS
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
GRID CURRENT—AMPERES
1.1
1.0
.900
.800
.700
.600
.500
.400
.300
.250
.200
.150
.100
.075
.050
.025
.050
.060
.050
PLATE CURRENT—AMPERES
0
.125
.250
.500
.750
1.00
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1.75
2.00
2.50
3.00
3.50
EIMAC 152TH
CONSTANT CURRENT
CHARACTERISTICS

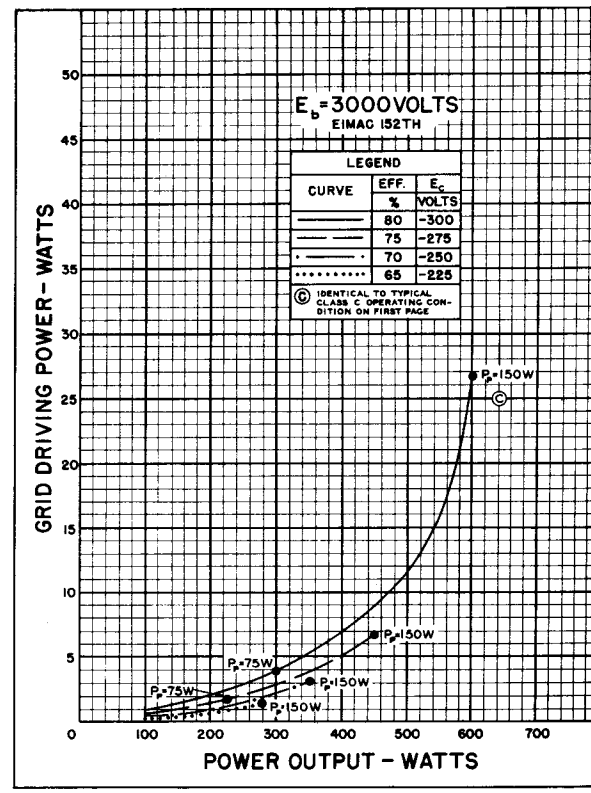
DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.







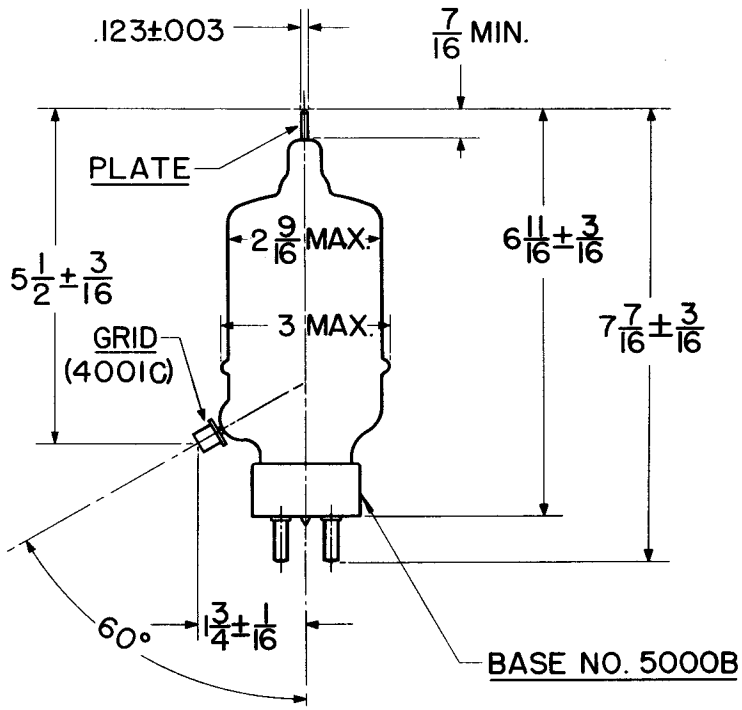
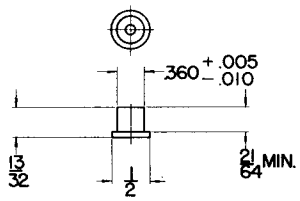
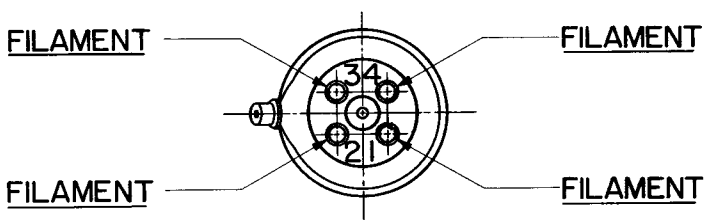


PLATE CAP

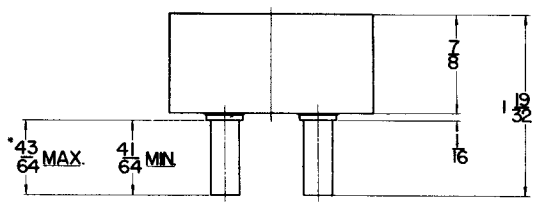
(SEE TUBE OUTLINE DRAWING)

GRID CAP
NO. 4001C

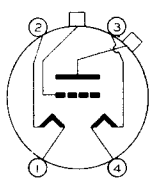


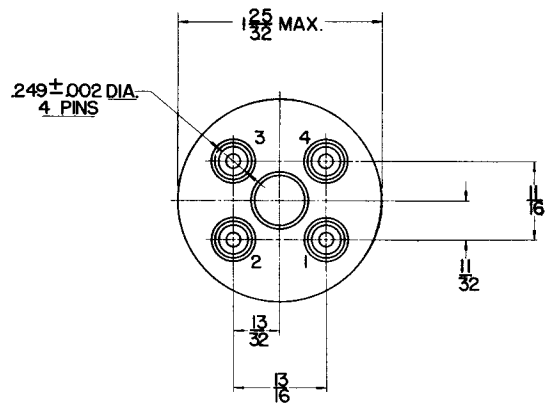


BASE NO. 5000B



4BC





*ON FINISHED TUBE ADD .060 FOR SOLDER

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

152TL

LOW-MU TRIODE

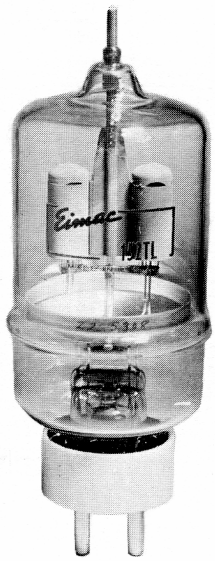
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MODULATOR
OSCILLATOR
AMPLIFIER

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten		
Voltage	5.0 or 10.0	volts
Current	12.5 or 6.25	amperes
Amplification Factor (Average)	12	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	4.4	pF
Grid-Filament	4.5	pF
Plate-Filament	0.7	pF
Transconductance (i_b = 500 ma., E_b = 3000V, E_c = −85V)	7150	umhos



MECHANICAL

Base	Special 4 pin, No. 5000B	
Basing	RMA type 4BC	
Maximum Overall Dimensions		
Length	7.625	inches
Diameter	2.563	inches
Net Weight	7	ounces
Shipping weight (Average)	2.0	pounds

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class B

	ZERO GRID CURRENT OPERATION — 2 TUBES			TYPICAL OPERATION 2 TUBES			MAX. RATING	
DC Plate Voltage	1500	2000	3000	1500	2000	3000	3000	volts
Max.-Signal DC Plate Current, per tube*	—	—	—	—	—	—	450	ma.
Plate Dissipation, per tube*	—	—	—	—	—	—	150	watts
DC Grid Voltage (approx.)	-105	-160	-260	-105	-160	-260		volts
Peak AF Grid Input Voltage	210	320	520	500	620	675		volts
Zero-Signal DC Plate Current	135	100	65	135	100	65		ma.
Max.-Signal DC Plate Current	286	260	220	570	500	335		ma.
Max.-Signal Driving Power (approx.)	—	—	—	15	13	3		watts
Effective Load, Plate-to-Plate	5100	10500	24000	5500	9000	20400		ohms
Max.-Signal Plate Power Output	130	220	370	560	700	700		watts

*Averaged over any sinusoidal audio frequency cycle.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class C *Telegraphy
(Key down conditions without modulation)

	TYPICAL OPERATION — 1 TUBE			MAX. RATING	
DC Plate Voltage	1500	2000	3000	3000	volts
DC Plate Current	333	300	250	450	ma.
DC Grid Current	45	42	40	75	ma.
DC Grid Voltage	-250	-300	-400		volts
Plate Power Output	350	450	600		watts
Plate Input	500	600	750		watts
Plate Dissipation	150	150	150	150	watts
Peak RF Grid Input Voltage (approx.)	400	455	550		volts
Driving Power (approx.)	16	18	20		watts

*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

(Revised 4-1-67) © 1944, 1967 by Varian

Printed in U.S.A.

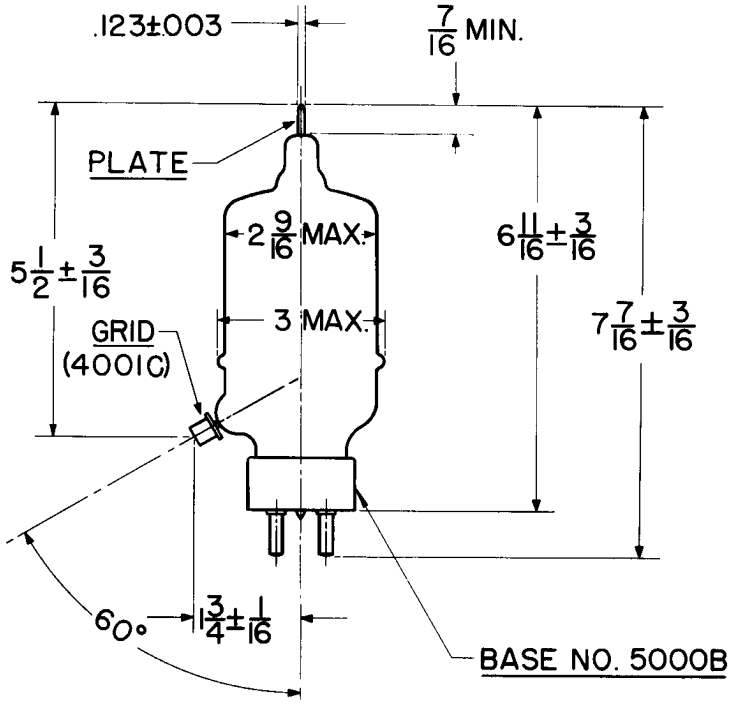
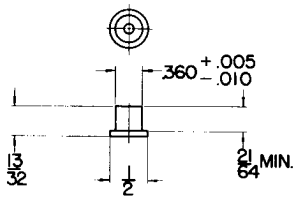
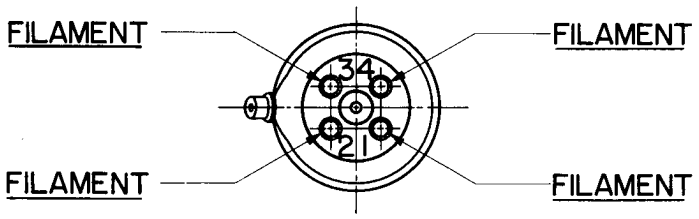


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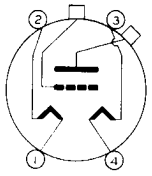
(SEE TUBE OUTLINE DRAWING)

GRID CAP
NO. 4001C

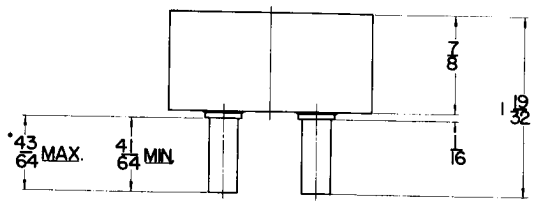


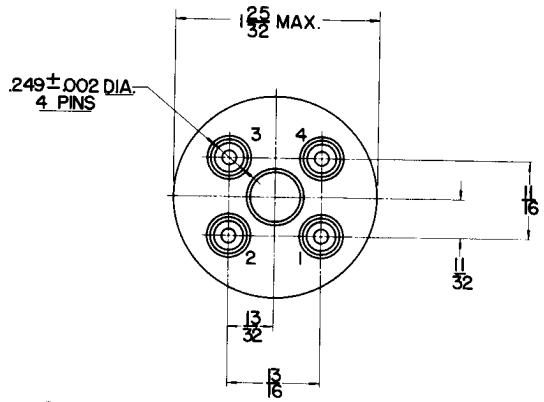


4BC



BASE NO. 5000B



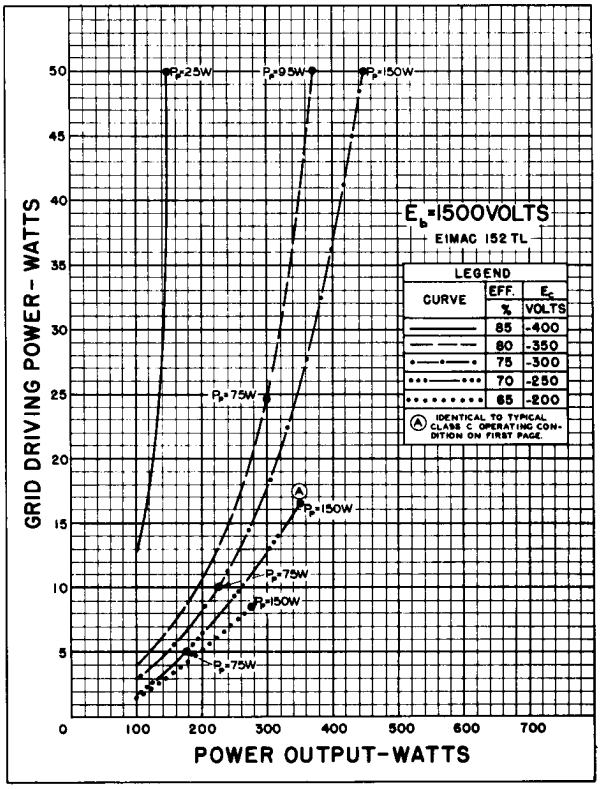


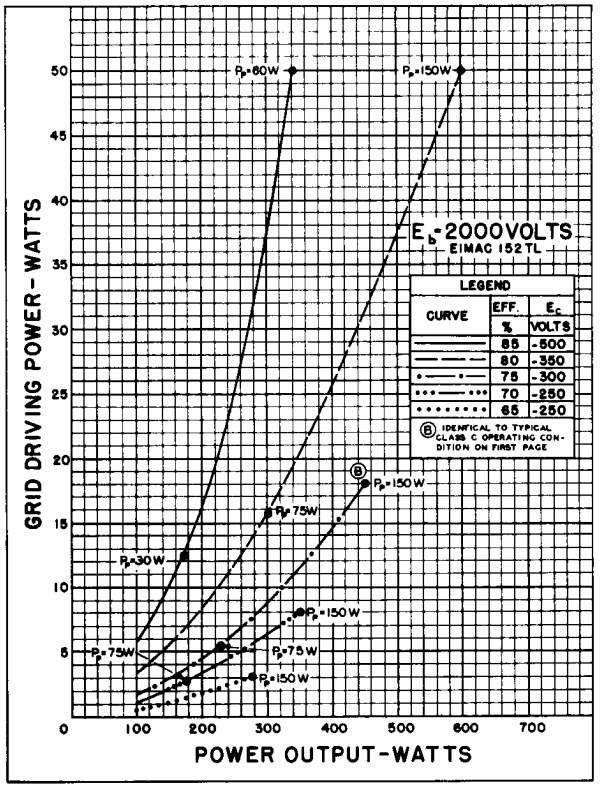
*ON FINISHED TUBE ADD .060 FOR SOLDER

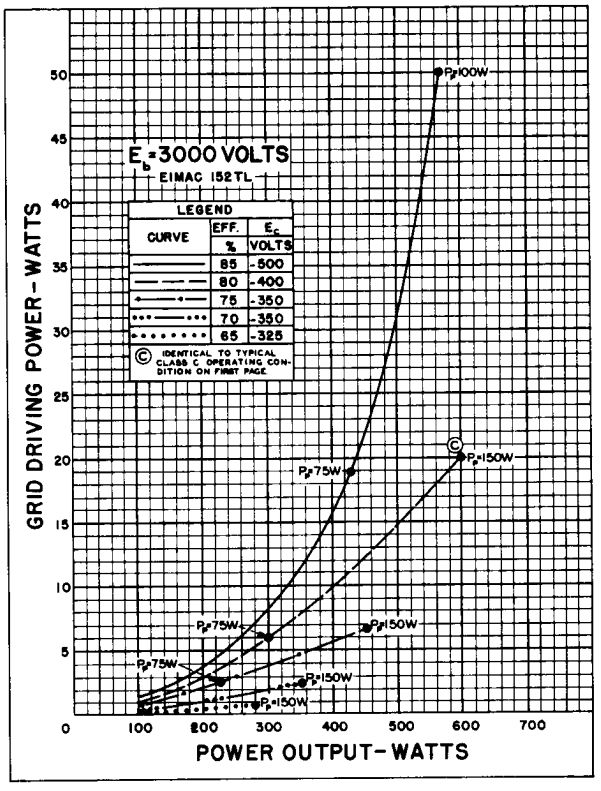
DRIVING POWER vs. POWER OUTPUT

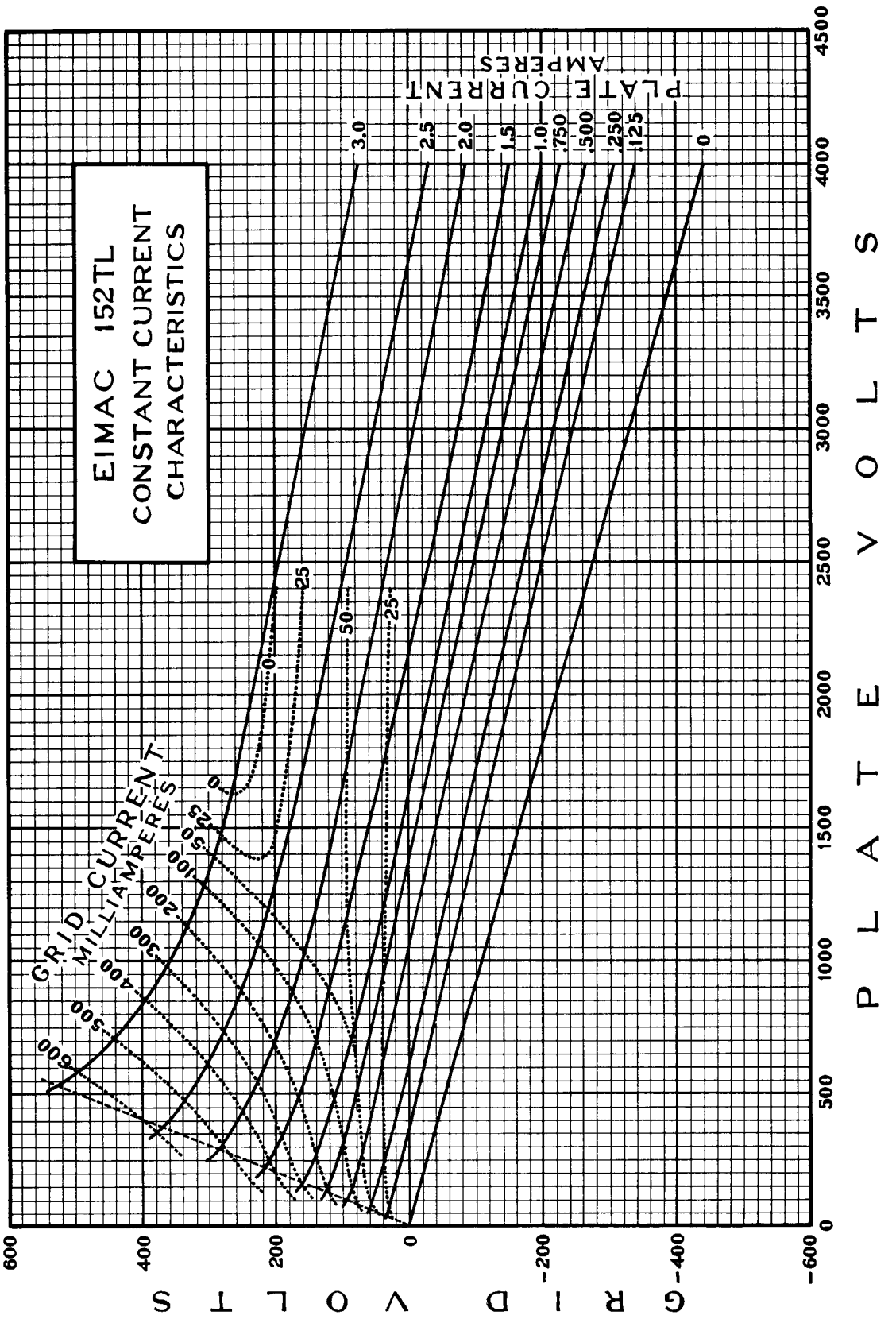
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.









Printed in U.S.A. 1012

TECHNICAL DATA

2-01C
INSTRUMENT DIODE

The Eimac 2-01C is a small, closely-spaced, low-capacitance, high-vacuum diode designed for use through ultra-high frequencies. In measurement work, it is well suited to mounting in a probe and will maintain accuracy in the order of ± 1 decibel up to 700 megacycles. It is useful as an indicator at frequencies as high as 3000 megacycles.

The 2-01C has a maximum d-c current rating of 1.0 milliampere and a maximum peak inverse voltage rating of 1000 volts. Cooling is by convection and radiation.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode—Oxide-Coated, Unipotential

	Min.	Nom.	Max.	
Heating Time	30	60		seconds
Heater Voltage		5.0		volts
Heater Current	0.31		0.39	amperes
Direct Interelectrode Capacitance			0.7	pF
Zero Signal Voltage (110 Megohm Load)	0.6		1.4	volts
Resonant Frequency		2800		MHz
Plate Resistance (E_b = 12 volts)		8000	24,000	ohms



Actual Size

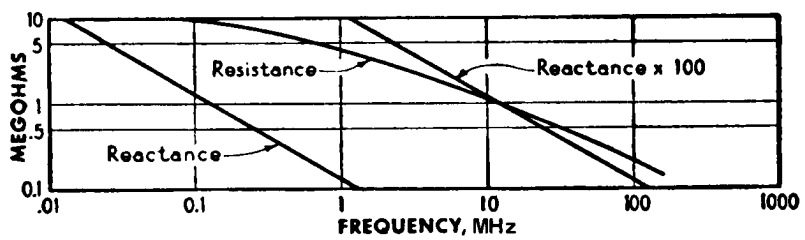
MAXIMUM RATINGS

PEAK INVERSE ANODE VOLTAGE	1000 MAX. VOLTS
D-C PLATE CURRENT	1.0 MAX. MA
PLATE DISSIPATION	0.1 MAX. WATT
SEAL TEMPERATURE	175°C MAX.

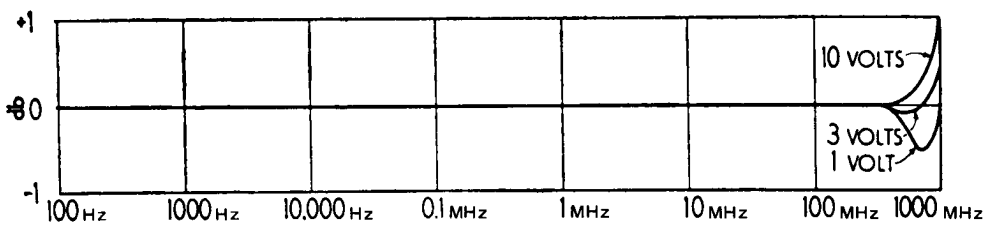
MECHANICAL

Length	1.813 inches	Net Weight	0.2 ounce
Diameter	0.563 inches	Shipping Weight (Approx.)	1.0 pound

INPUT CHARACTERISTICS



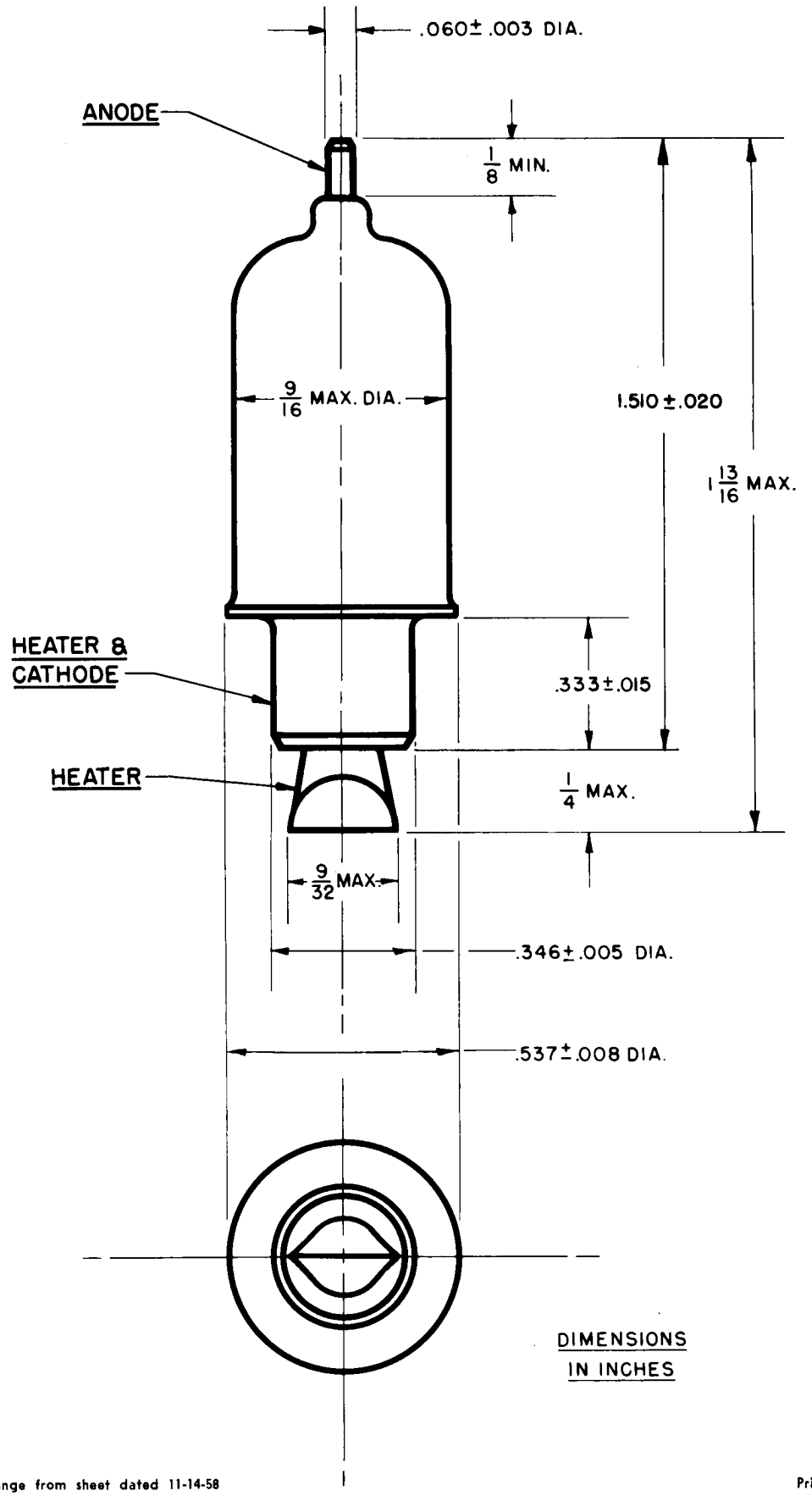
RESPONSE



Input Impedance and Frequency Response of an Eimac 2-01C operating in a Hewlett-Packard Model 410B Vacuum Tube Voltmeter. Reproduced from Hewlett-Packard Catalog No. 21-A, 1952.

(Effective 1-22-60) Copyright 1960 by Eitel-McCullough, Inc.

▶ Indicates change from sheet dated 11-14-58

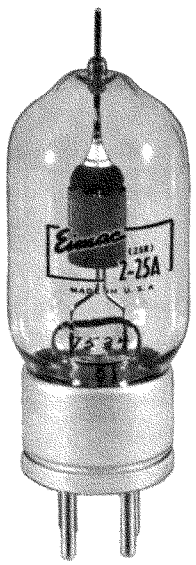


▶ Indicates change from sheet dated 11-14-58

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

2-25A

HIGH-VACUUM RECTIFIER



The Eimac 2-25A diode is a high-vacuum rectifier intended for use in rectifier units, voltage multipliers, or in special applications, whenever conditions of extreme ambient temperatures, high operating frequency, high peak inverse voltages, or the production of high-frequency transients would prevent the use of gas-filled rectifier tubes.

The 2-25A has a maximum d-c current rating of 50 milliamperes and a maximum peak inverse voltage rating of 25,000 volts. Cooling is by convection and radiation.

A single 2-25A will deliver 40 milliamperes at 10,000 volts to a capacitor-input filter with 8800 volts single-phase supply. Four 2-25A's in a bridge circuit will deliver 100 milliamperes at 15,600 volts to a choke-input filter with 17,600 volts single-phase supply.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	6.3 volts
Current	3.0 amperes

MECHANICAL

Base	Small 4-pin
Basing	Refer to outline drawing
Socket	Refer to discussion under "Application"
Mounting Position	Vertical, base down or up
Cooling	Convection and radiation
Maximum Temperature of Plate Seal	225°C
Recommended Heat Dissipating Plate Connector	Eimac HR-1
Maximum Overall Dimensions:	
Length	4.38 inches
Diameter	1.44 inches
Net Weight	1.2 ounces
Shipping Weight (approx.)	1.0 pound

MAXIMUM RATINGS (Per tube)

PEAK INVERSE PLATE VOLTAGE	25,000 MAX. VOLTS
PLATE DISSIPATION	15 MAX. WATTS
D-C PLATE CURRENT[1]	50 MAX. MA
PEAK PLATE CURRENT	1.0 MAX. AMPERE

[1]Averaged over one cycle for each tube. Applies only when the rectifier is coupled to the load by a choke-input filter incorporating the "critical" value (or larger) of input inductance. For maximum d-c current ratings under this and other load conditions see discussion under "Application".

APPLICATION

MECHANICAL

Mounting—The 2-25A must be mounted vertically with the base either down or up. The lead to the plate terminal of the tube should be flexible.

The small 4-pin base fits an E. F. Johnson Co. No 122-224, a National Co. No. XC-4 or CIR-4, or an equivalent socket. In some circuits, particularly those of the voltage multipliers illustrated in Fig. 2, it may be necessary to mount the socket on stand-off insulators, or on a sheet of insulating material, to provide adequate insulation to ground.

Cooling—The 2-25A is cooled by convection and radiation. Clearance should be provided around the glass envelope adequate for the free circulation of air. An Eimac HR-1 Heat Dissipating Connector or equivalent is required on the plate terminal.

The maximum temperature at the plate seal must not exceed 225°C. A convenient accessory for measuring this temperature is "Tempilaq", a temperature-sensitive lacquer available from the Tempil Corporation, 132 W. 22nd St., New York 11, N. Y.

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APPLICATION (Continued)

ELECTRICAL

Filament Operation—For maximum tube life, the filament voltage, as measured at the base pins, should be the rated value of 6.3 volts. Variations must be kept within the range from 6.0 to 6.6 volts. In applications which require the diode to deliver high peak currents, it is important to maintain the filament voltage at the rated value.

CAUTION SHOULD BE OBSERVED WHEN MEASURING RECTIFIER FILAMENT VOLTAGE. THE FILAMENT CIRCUIT MAY BE AT HIGH POTENTIAL.

The thoriated-tungsten filament of the 2-25A reaches operating temperature in a fraction of a second after application of voltage. Plate voltage may be applied simultaneously with filament voltage.

Plate Operation—With low room illumination, the plate of the 2-25A begins to show color as the maximum plate dissipation rating of 15 watts is approached. The maximum peak inverse voltage rating of 25,000 volts should not be exceeded at any time.

Performance—The accompanying table shows some maximum performance capabilities of the 2-25A when used as a power-supply rectifier.

2-25A MAXIMUM-PERFORMANCE CAPABILITIES

		Capacitor-Input Filter		Choke-Input Filter	
Circuit Type	A-C Input Voltage (volts rms)	D-C Output Voltage (volts)	D-C Output Current (ma)	D-C Output Voltage (volts)	D-C Output Current (ma)
Single-Phase, Half-Wave	8800	10,000	40	.....	.....
Single-Phase, Full-Wave	8800[1]	10,000	80	7900	100
Single-Phase, Bridge	17,600	20,000	80	15,800	100

[1]One-half the transformer secondary voltage.

Maximum D-C Current Ratings—Plate dissipation rather than peak current usually limits the d-c current which the 2-25A is capable of delivering to the load. Because the plate dissipation associated with a given d-c current depends upon the amount of ripple and its wave-shape, circuit conditions will determine the maximum d-c current rating of the tube.

Choke-Input Filter—The maximum d-c current rating of the 2-25A is 50 milliamperes when the load incorporates a choke-input filter with the "critical" value (or larger) of input inductance (L_l in Fig. 1):

$$L_o = \frac{R_{eff}}{18.8f} \quad \text{for full-wave single-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{75f} \quad \text{for half-wave three-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{660f} \quad \text{for full-wave three-phase rectifiers,}$$

where: L_o = "critical" value of input inductance (henries),
f = supply-line frequency (cycles per second),

$$R_{eff} = \frac{\text{Load voltage (volts)}}{\text{Load current (amps)}}.$$

Choke-input filters are not normally used with single-phase half-wave rectifiers.

Capacitor-Input Filter—The 2-25A is particularly suitable for power-supply applications demanding high voltage at low current. Under these conditions capacitor-input filter circuits become desirable. The maximum d-c current rating of the 2-25A when no input choke is incorporated in the filter depends upon the total series resistance of the capacitor-charging circuit relative to the effective load resistance seen by each tube. The circuit diagrams and tabulation in Fig. 2 are so arranged and labeled that this required series resistance may be found for a wide range of load conditions. This may be done by determining the value of the following quantities:

E_c is the filter-input d-c voltage. While this is usually the entire load voltage, in the case of voltage multipliers it is the load voltage divided by the multiplication factor.

I_p is the d-c current per tube. This is the entire load current only in the case of the simple half-wave rectifier or half- or full-wave multiplier. In the case of full-wave center-tapped or bridge rectifiers, I_p is half the load current.

R_c is the total charging-circuit resistance. A certain minimum value of charging-circuit resistance is necessary to limit the peak value of current to which the tubes will be subjected under given load conditions. This required minimum depends upon the d-c current per tube (I_p), and has been tabulated in Fig. 2 as a percentage of the effective load resistance per tube (E_c/I_p). The total charging-circuit resistance involves the internal resistance of the rectifier tube, R_p, the added series resistor, R_s, and the equivalent internal resistance of the a-c voltage supply, R_i.

R_p is the plate resistance of the 2-25A, which may be taken as 1200 ohms.

R_i is the equivalent internal resistance of the supply. This may be taken as the regulation of the high-voltage supply expressed as a decimal multiplied by the load resistance used in measuring this regulation.

R_s is the series resistor which must be inserted in the charging circuit to bring the total charging-circuit resistance (R_c) up to the required minimum. Its value may be found from the formula associated with each of the circuits of Fig. 2. This resistor must be inserted in such a position in the circuit that it protects all tubes.

Tubes may be operated in parallel to increase the output capability in a given circuit. When two tubes are placed in parallel at each place where one is shown in the circuits of Fig. 2, the plate resistance (R_p) will be half as great and the maximum allowable load current twice as great as indicated.

Peak Inverse Voltage—The peak inverse voltage rating of the 2-25A is 25,000 volts. In single-phase power-supply rectifier circuits the peak inverse voltage to be used in design is the peak a-c supply voltage (1.41 times E_{rms} in Fig. 2) in the case of bridge circuits, and twice this value in the case of half- and full-wave rectifiers and voltage multipliers. Peak inverse voltage in three-phase operation depends upon the circuit employed, and will be found listed in the handbooks.

Special Applications—The ratings given for capacitor-input filter circuits assume values of input capacitance large enough to hold the ripple to a low value. In special applications where a larger percent ripple is tolerable, and filter capacitance is low, the 2-25A is capable of larger d-c output currents.

As a unidirectional conductor in d-c circuits where the current is continuous and the percent ripple is moderate, the maximum current rating of the 2-25A is 90 milliamperes.

The plate characteristic curve for the 2-25A serves as a guide to special applications. The maximum plate dissipation rating of 15 watts, the maximum peak inverse voltage rating of 25,000 volts, and the maximum peak plate current of 1.0 ampere must not be exceeded.

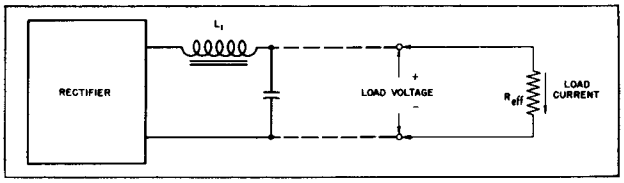
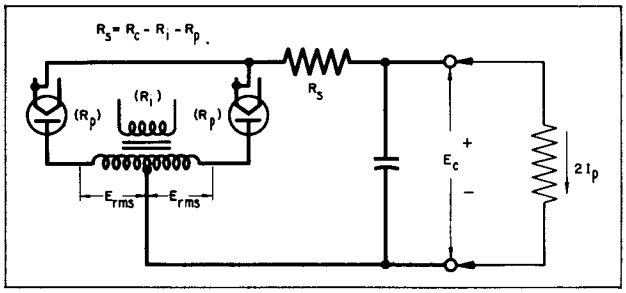
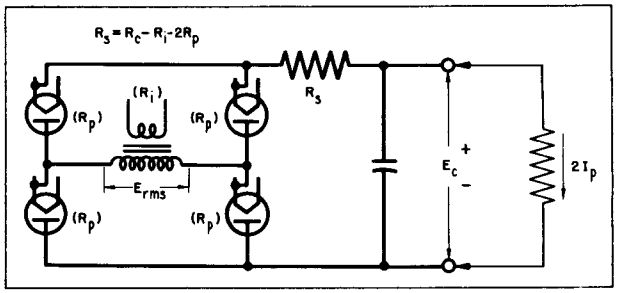


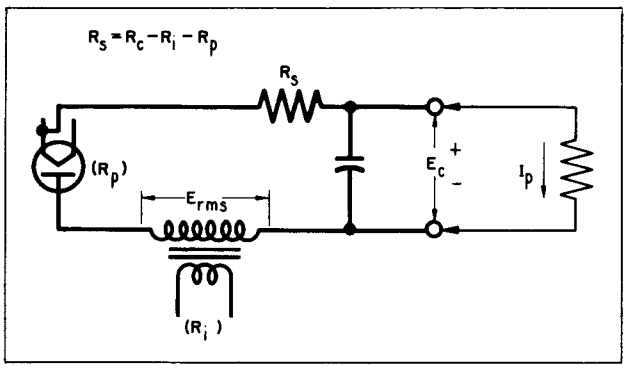
Fig. 1. Rectifier with Choke-Input Filter



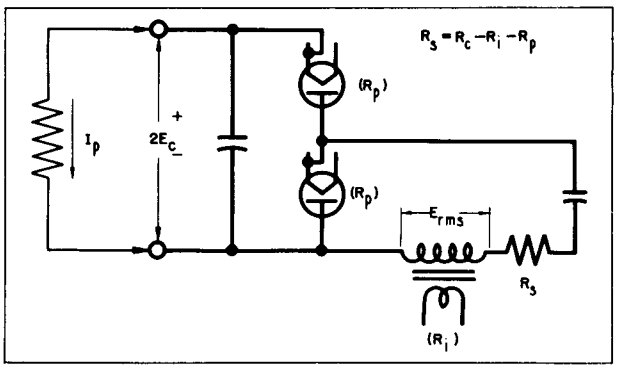
a. Full-Wave Center-Tapped Rectifier



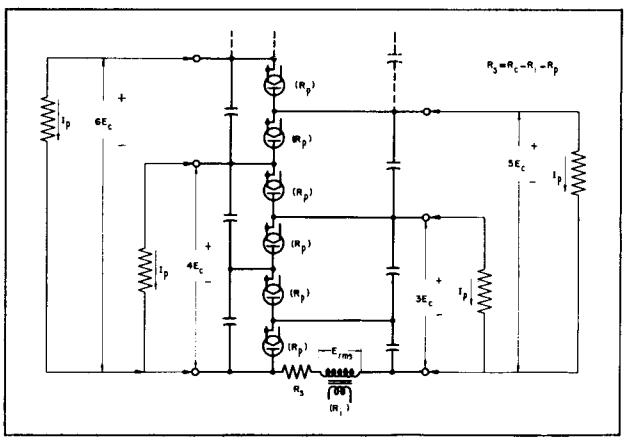
b. Full-Wave Bridge Rectifier



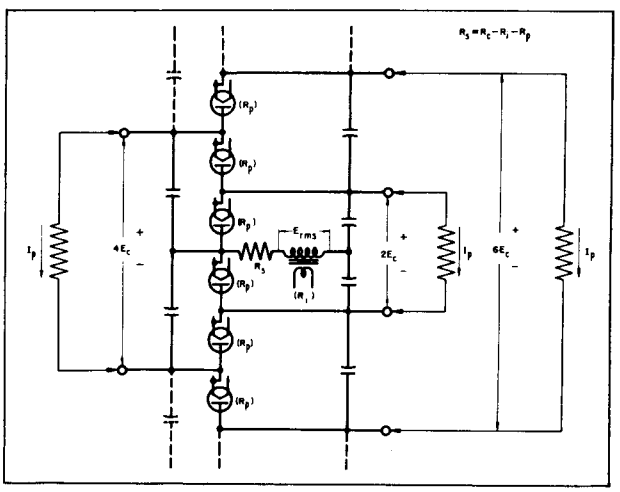
c. Half-Wave Rectifier



d. Half-Wave Voltage Doubler



e. Half-Wave Voltage Multiplier (with common ground when R_s is inserted on the "high" side of E_{rms})



f. Full-Wave Voltage Multiplier

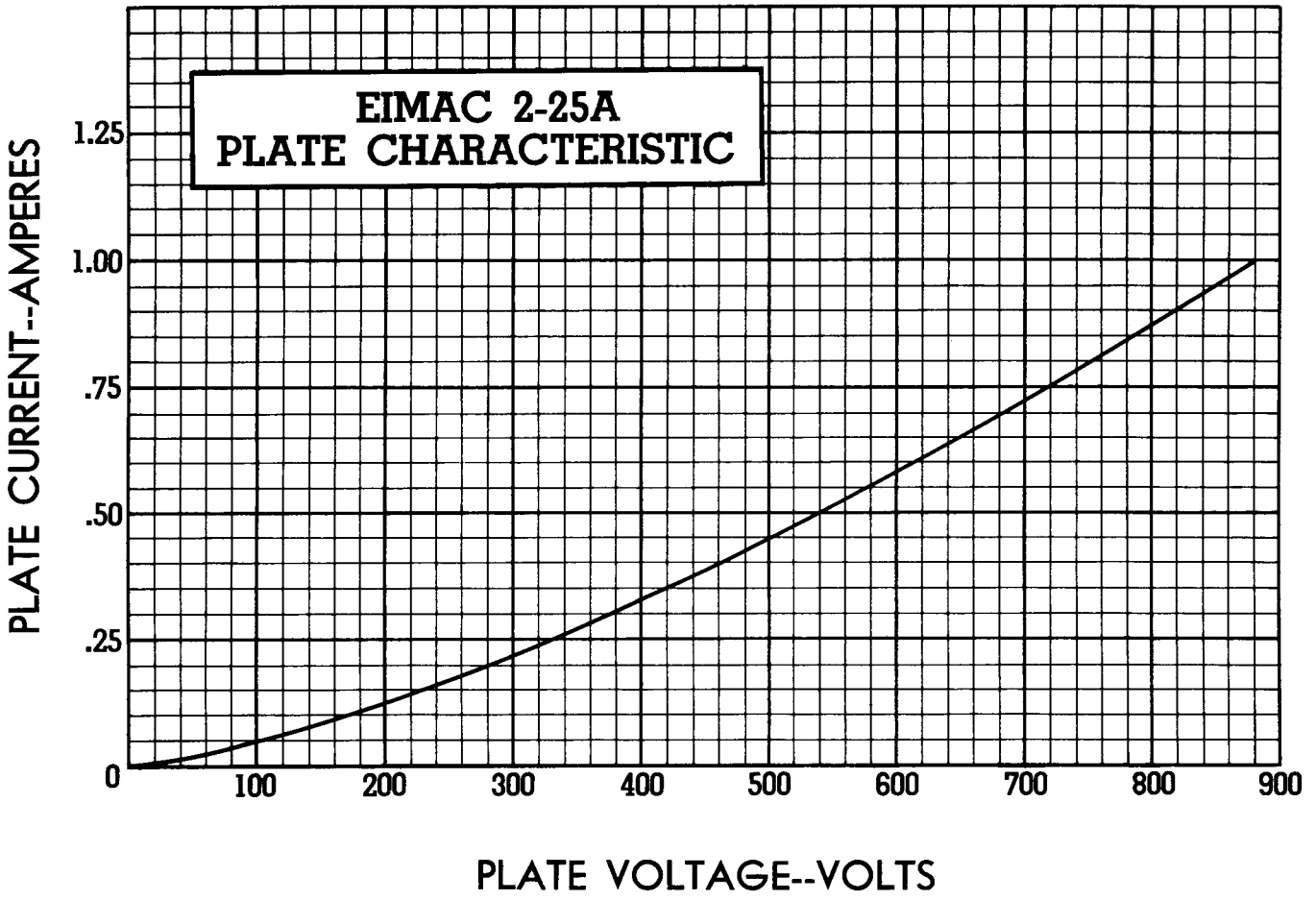
Eimac 2-25A Maximum D-C Current Ratings for R-C Filter Applications								
D-C Plate Current (I_p)	35.0	37.5	40.0	42.5	45.0	47.5	50.0	milliamperes per tube
Total Charging-Circuit Resistance (R_c)	1.3	2.0	3.4	5.5	9.0	16	27	percent of Effective Load Resistance per Tube (E_c / I_p)
A-C Supply Voltage (E_{rms})	0.80	0.83	0.88	0.94	1.05	1.23	1.50	times Filter-Input D-C Voltage (E_c)
Peak Inverse Voltage (½ these values for circuit b.)	2.3	2.4	2.5	2.7	3.0	3.5	4.3	times Filter-Input D-C Voltage (E_c)

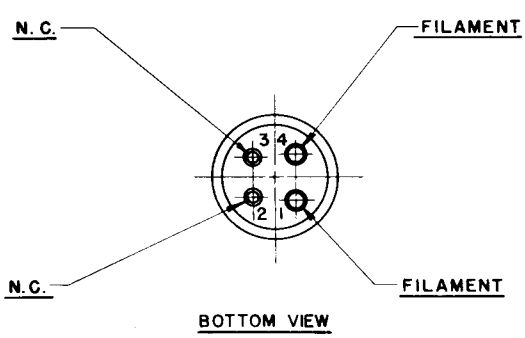
Fig. 2. Eimac 2-25A Basic R-C Circuits (for any one of the indicated loads)

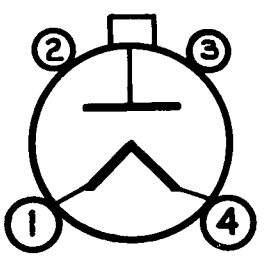
R_i = Equivalent resistance of voltage source.

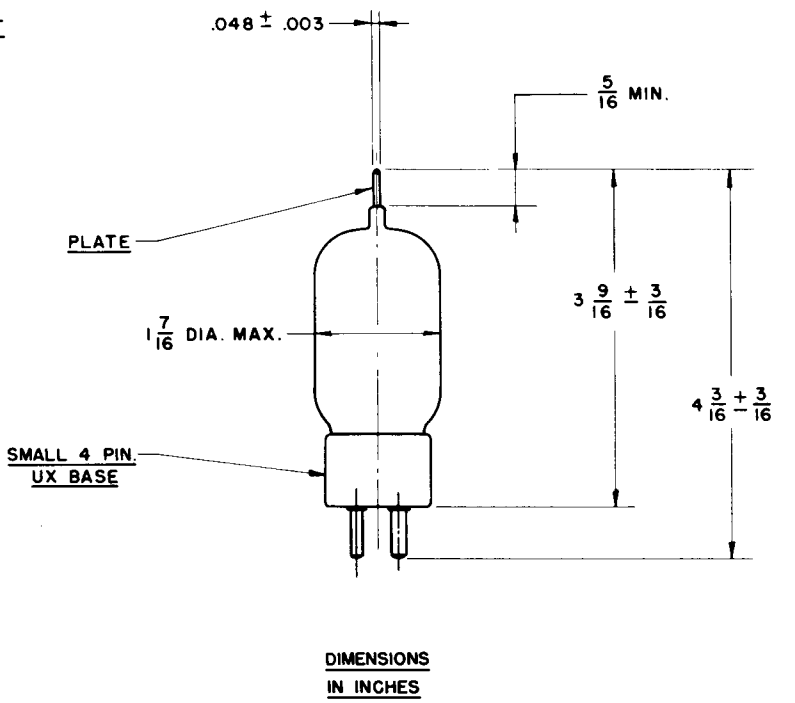
R_p = 1200 ohms (600 ohms for two tubes in parallel)

EIMAC 2-25A
PLATE CHARACTERISTIC







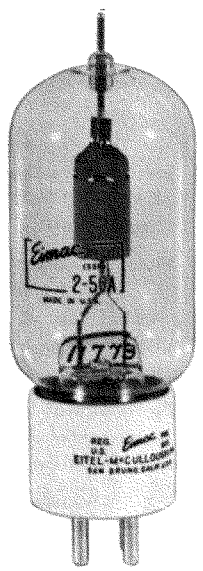


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EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

2-50A

HIGH-VACUUM RECTIFIER



The Eimac 2-50A diode is a high-vacuum rectifier intended for use in rectifier units, voltage multipliers, or in special applications, whenever conditions of extreme ambient temperatures, high operating frequency, high peak inverse voltages, or the production of high-frequency transients would prevent the use of gas-filled rectifier tubes.

The 2-50A has a maximum d-c current rating of 75 milliamperes and a maximum peak inverse voltage rating of 30,000 volts. Cooling is by convection and radiation.

A single 2-50A will deliver 60 milliamperes at 12,500 volts to a capacitor-input filter with 10,600 volts single-phase supply. Four 2-50A's in a bridge circuit will deliver 150 milliamperes at 19,000 volts to a choke-input filter with 21,200 volts single-phase supply.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	5.0 volts
Current	4.0 amperes

MECHANICAL

Base	Medium 4-pin bayonet
Basing	Refer to outline drawing
Socket	Refer to discussion under "Application"
Mounting Position	Vertical, base down or up
Cooling	Convection and radiation
Maximum Temperature of Plate Seal	225°C
Recommended Heat Dissipating Plate Connector	Eimac HR-3
Maximum Overall Dimensions:	
Length	5.50 inches
Diameter	1.82 inches
Net Weight	2.5 ounces
Shipping Weight (approx.)	1.0 pound

MAXIMUM RATINGS (Per tube)

PEAK INVERSE PLATE VOLTAGE	30,000 MAX. VOLTS
PLATE DISSIPATION	30 MAX. WATTS
D-C PLATE CURRENT[1]	75 MAX. MA
PEAK PLATE CURRENT	1.0 MAX. AMPERE

[1]Averaged over one cycle for each tube. Applies only when the rectifier is coupled to the load by a choke-input filter incorporating the "critical" value (or larger) of input inductance. For maximum d-c current ratings under this and other load conditions see discussion under "Application".

APPLICATION

MECHANICAL

Mounting—The 2-50A must be mounted vertically with the base either down or up. The lead to the plate terminal of the tube should be flexible.

The medium 4-pin base fits an E. F. Johnson Co. No. 122-224, a National Co. No. XC-4 or CIR-4, or an equivalent socket. In some circuits, particularly those of the voltage multipliers illustrated in Fig. 2, it may be necessary to mount the socket on stand-off insulators, or on a sheet of insulating material, to provide adequate insulation to ground.

Cooling—The 2-50A is cooled by convection and radiation. Clearance should be provided around the glass envelope adequate for the free circulation of air. An Eimac HR-3 Heat Dissipating Connector or equivalent is required on the plate terminal.

The maximum temperature at the plate seal must not exceed 225°C. A convenient accessory for measuring this temperature

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APPLICATION (Continued)

is "Tempilaq" a temperature-sensitive lacquer available from the Tempil Corporation, 132 W. 22nd St., New York 11, N. Y.

ELECTRICAL

Filament Operation—For maximum tube life, the filament voltage, as measured at the base pins, should be the rated value of 5.0 volts. Variations must be kept within the range from 4.75 to 5.25 volts. In applications which require the diode to deliver high peak currents, it is important to maintain the filament voltage at the rated value.

CAUTION SHOULD BE OBSERVED WHEN MEASURING RECTIFIER FILAMENT VOLTAGE. THE FILAMENT CIRCUIT MAY BE AT A HIGH POTENTIAL.

The thoriated-tungsten filament of the 2-50A reaches operating temperature in a fraction of a second after application of voltage. Plate voltage may be applied simultaneously with filament voltage.

Plate Operation—With low room illumination the plate of the 2-50A begins to show color as the maximum plate dissipation rating of 30 watts is approached. The maximum peak inverse voltage rating of 30,000 volts should not be exceeded at any time.

Performance—The accompanying table shows some maximum performance capabilities of the 2-50A when used as a power-supply rectifier.

2-50A MAXIMUM-PERFORMANCE CAPABILITIES

Circuit Type	A-C Input Voltage (volts rms)	Capacitor-Input Filter D-C Output Voltage (volts)	Capacitor-Input Filter D-C Output Current (ma)	Choke-Input Filter D-C Output Voltage (volts)	Choke-Input Filter D-C Output Current (ma)
Single-Phase, Half-Wave	10,600	12,500	60	.....	.....
Single-Phase, Full-Wave	10,600[1]	12,500	120	9500	150
Single-Phase, Bridge	21,200	25,000	120	19,000	150

[1]One-half the transformer secondary voltage.

Maximum D-C Current Ratings—Plate dissipation rather than peak current usually limits the d-c current which the 2-50A is capable of delivering to the load. Because the plate dissipation associated with a given d-c current depends upon the amount of ripple and its wave-shape, circuit conditions will determine the maximum d-c current rating of the tube.

Choke-Input Filter—The maximum d-c current rating of the 2-50A is 75 milliamperes when the load incorporates a choke-input filter with the "critical" value (or larger) of input inductance (L_i in Fig. 1):

$$L_o = \frac{R_{eff}}{18.8f} \quad \text{for full-wave single-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{75f} \quad \text{for half-wave three-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{660f} \quad \text{for full-wave three-phase rectifiers,}$$

where: L_o = "critical" value of input inductance (henries),
f = supply-line frequency (cycles per second),

$$R_{eff} = \frac{\text{Load voltage (volts)}}{\text{Load current (amps)}}.$$

Choke-input filters are not normally used with single-phase half-wave rectifiers.

Capacitor-Input Filter—The 2-50A is particularly suitable for power-supply applications demanding high voltage at low current. Under these conditions capacitor-input filter circuits become desirable. The maximum d-c current rating of the 2-50A when no input choke is incorporated in the filter depends upon the total series resistance of the capacitor-charging circuit relative to the effective load resistance seen by each tube. The circuit diagrams and tabulation in Fig. 2 are so arranged and labeled that this required series resistance may be found for a wide range of load conditions. This may be done by determining the value of the following quantities:

E_c is the filter-input d-c voltage. While this is usually the entire load voltage, in the case of voltage multipliers it is the load voltage divided by the multiplication factor.

I_p is the d-c current per tube. This is the entire load current only in the case of the simple half-wave rectifier or half- or full-wave multiplier. In the case of full-wave center-tapped or bridge rectifiers, I_p is half the load current.

R_c is the total charging-circuit resistance. A certain minimum value of charging-circuit resistance is necessary to limit the peak value of current to which the tubes will be subjected under given load conditions. This required minimum depends upon the d-c current per tube (I_p), and has been tabulated in Fig. 2 as a percentage of the effective load resistance per tube (E_c/I_p). The total charging-circuit resistance involves the internal resistance of the rectifier tube, R_p, the added series resistor, R_s, and the equivalent internal resistance of the a-c voltage supply, R_i.

R_p is the plate resistance of the 2-50A, which may be taken as 1000 ohms.

R_i is the equivalent internal resistance of the supply. This may be taken as the regulation of the high-voltage supply expressed as a decimal multiplied by the load resistance used in measuring this regulation.

R_s is the series resistor which must be inserted in the charging circuit to bring the total charging-circuit resistance up to the required minimum. Its value may be found from the formula associated with each of the circuits of Fig. 2. This resistor must be inserted in such a position in the circuit that it protects all tubes.

Tubes may be operated in parallel to increase the output capability in a given circuit. When two tubes are placed in parallel at each place where one is shown in the circuits of Fig. 2, the plate resistance (R_p) will be half as great and the maximum allowable load current twice as great as indicated.

Peak Inverse Voltage—The peak inverse voltage rating of the 2-50A is 30,000 volts. In single-phase power-supply rectifier circuits the peak inverse voltage to be used in design is the peak a-c supply voltage (1.41 times E_{rms} in Fig. 2) in the case of bridge circuits, and twice this value in the case of half- and full-wave rectifiers and voltage multipliers. Peak inverse voltage in three-phase operation depends upon the circuit employed, and will be found listed in the handbooks.

Special Applications—The ratings given for capacitor-input filter circuits assume values of input capacitance large enough to hold the ripple to a low value. In special applications where a larger percent ripple is tolerable, and filter capacitance is low, the 2-50A is capable of larger d-c output currents.

As a unidirectional conductor in d-c circuits where the current is continuous and the percent ripple is moderate, the maximum current rating of the 2-50A is 145 milliamperes.

The plate characteristic curve for the 2-50A serves as a guide to special applications. The maximum plate dissipation rating of 30 watts, the maximum peak inverse voltage rating of 30,000 volts, and the maximum peak plate current of 1.0 ampere must not be exceeded.

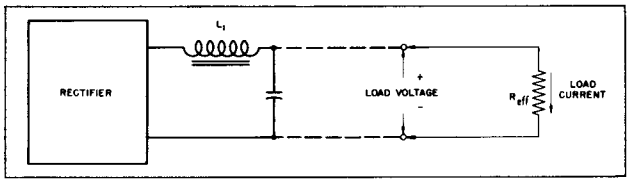
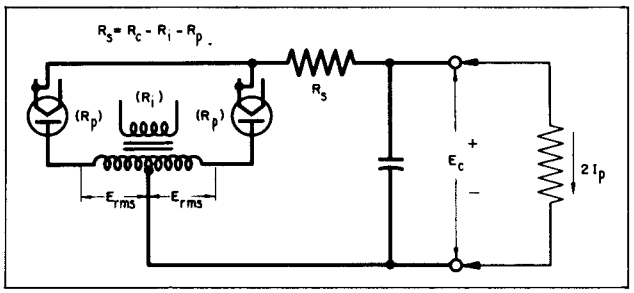
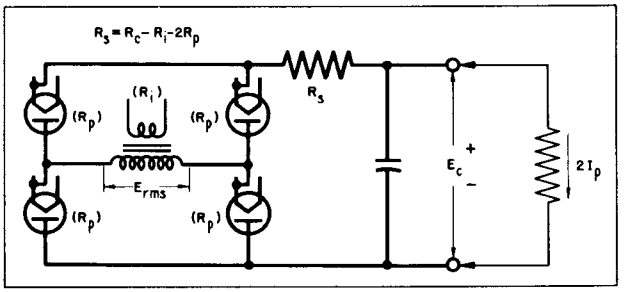


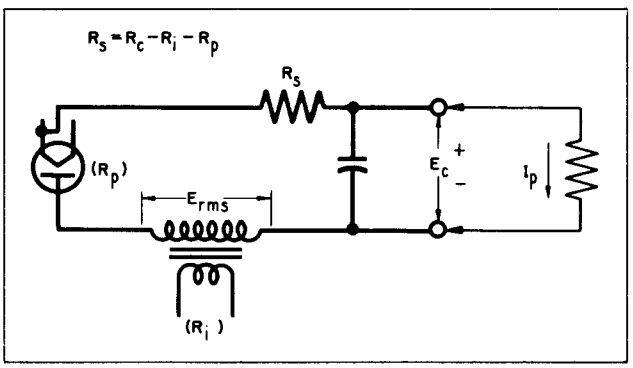
Fig. 1. Rectifier with Choke-Input Filter



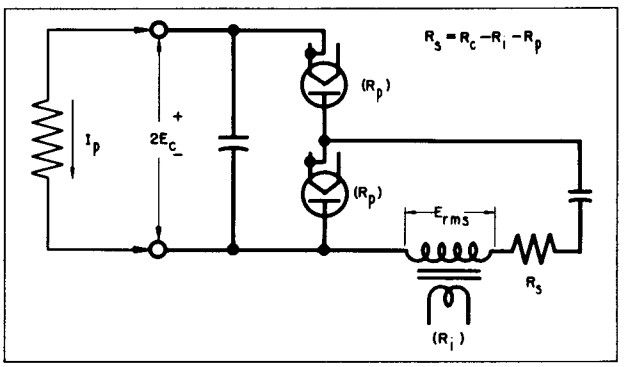
a. Full-Wave Center-Tapped Rectifier



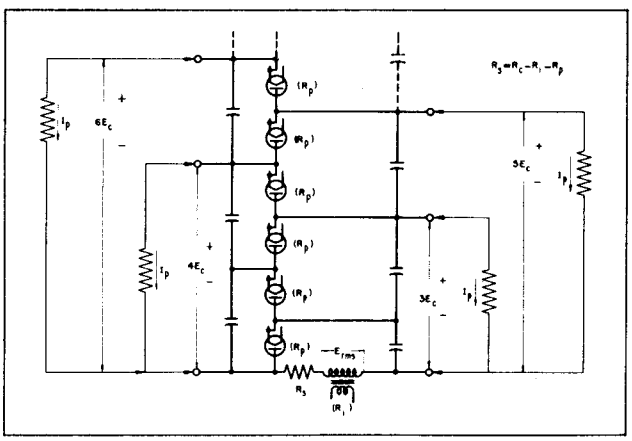
b. Full-Wave Bridge Rectifier



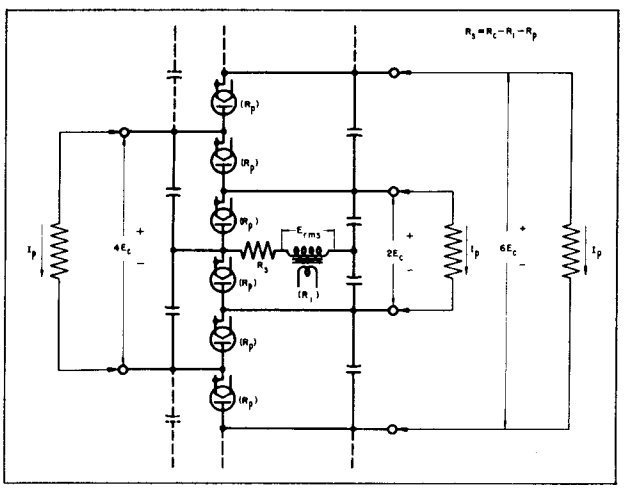
c. Half-Wave Rectifier



d. Half-Wave Voltage Doubler



e. Half-Wave Voltage Multiplier (with common ground when R_s is inserted on the "high" side of E_{rms})



f. Full-Wave Voltage Multiplier

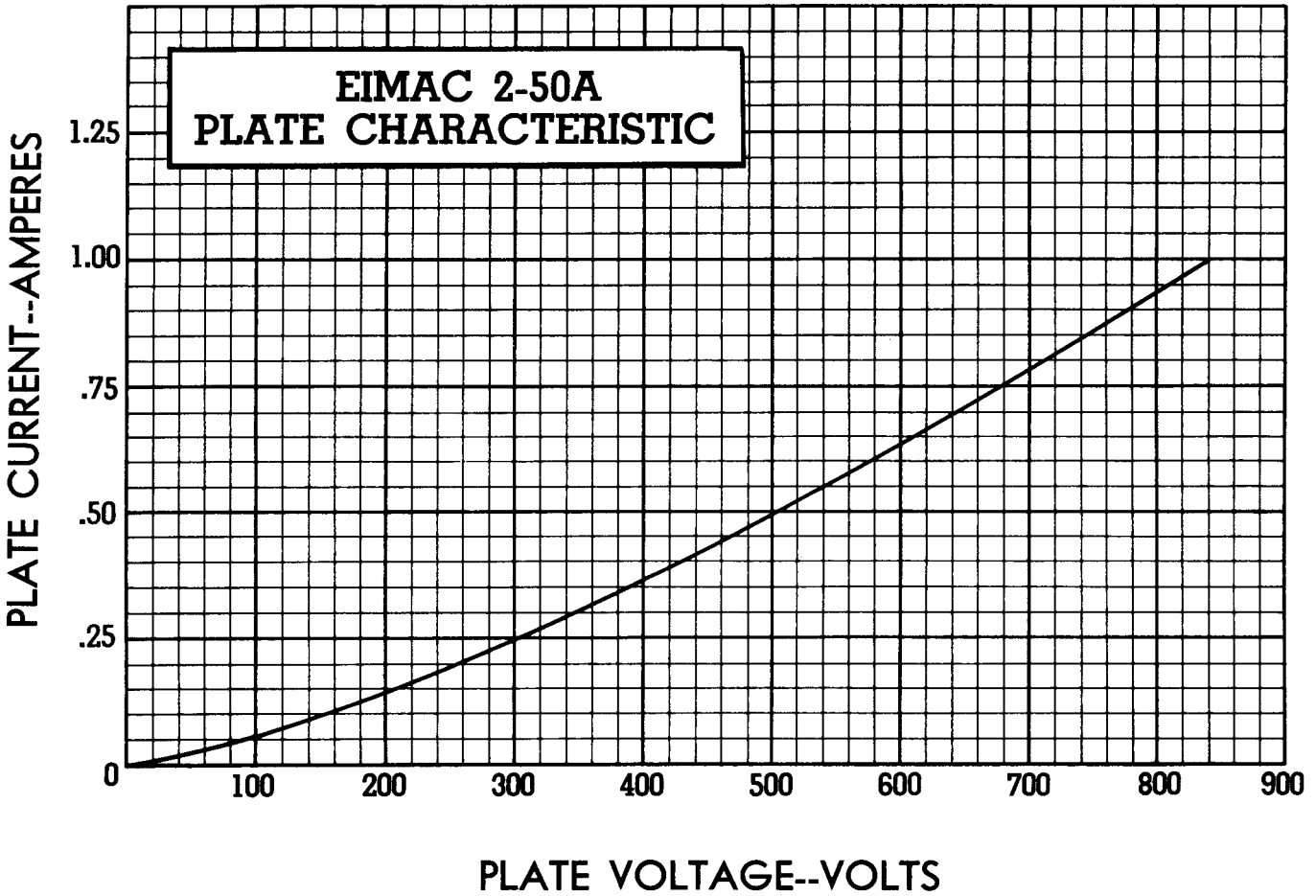
Eimac 2-50A Maxium D-C Current Ratings for R-C Filter Applications						
D-C Plate Current (I_p)	55	60	65	70	75	milliampere's per tube
Total Charging-Circuit Resistance (R_c)	1.3	2.4	4.7	8.5	17	percent of effective Load Resistance per Tube (E_c/I_p)
A-C Supply Voltage (E_{rms})	0.80	0.85	0.92	1.04	1.28	times Filter-Input D-C Voltage (E_c)
Peak Inverse Voltage (1/2 these values for circuit b.)	2.3	2.4	2.6	3.0	3.7	times Filter-Input D-C Voltage (E_c)

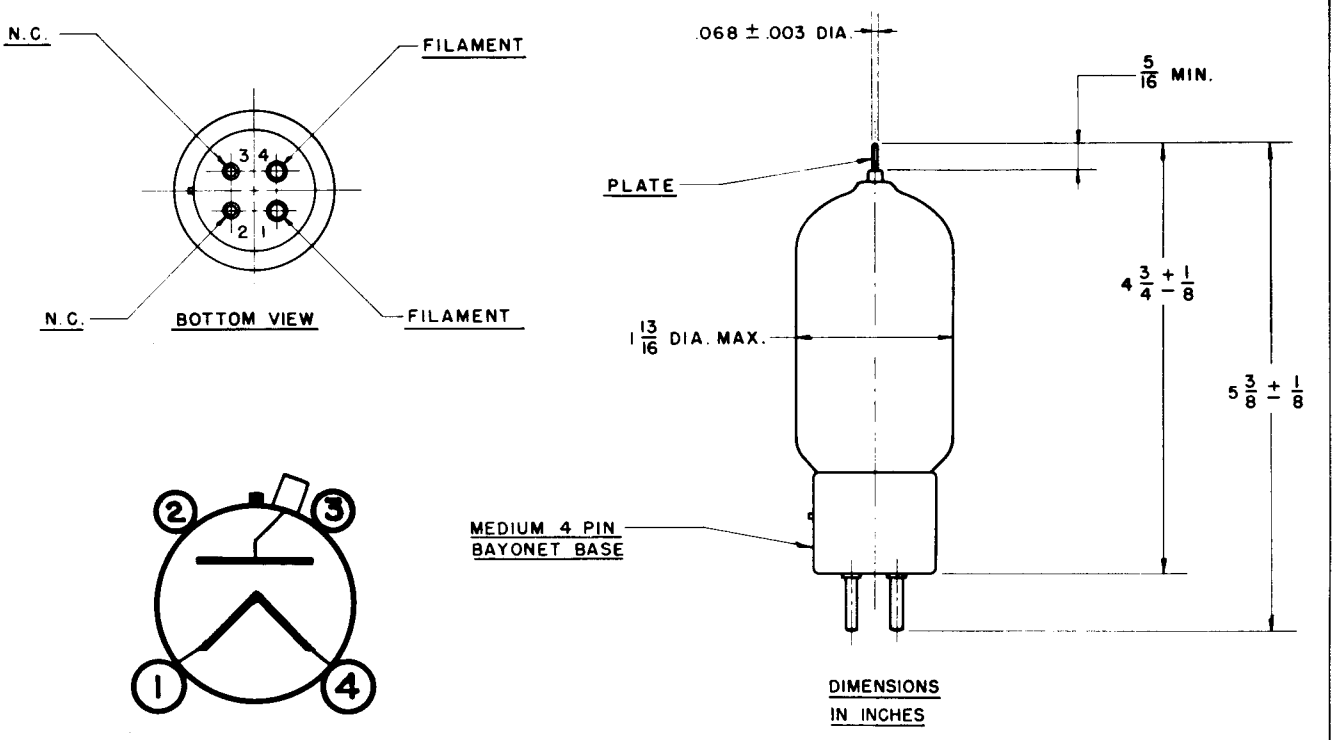
Fig. 2 Eimac 2-50A Basic R-C Circuits (for any one of the indicated loads)

R_i = Equivalent resistance of voltage source

R_p = 1000 ohms (500 ohms for two tubes in parallel)

EIMAC 2-50A
PLATE CHARACTERISTIC





Printed in U.S.A. I-FI-59695

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

250R
HIGH-VACUUM RECTIFIER



The Eimac 250R is a high-vacuum diode rectifier intended for use in rectifier units, voltage multipliers, or in special applications, whenever conditions of extreme ambient temperatures, high operating frequency, high peak inverse voltages, or the production of high-frequency transients would prevent the use of gas-filled rectifier tubes.

The 250R has a maximum d-c current rating of 250 milliamperes and a maximum peak inverse voltage rating of 60,000 volts. Cooling is by convection and radiation.

A single 250R will deliver 160 milliamperes at 24,000 volts to a capacitor-input filter with 21,000 volts single-phase supply. Four 250R's in a bridge circuit will deliver 500 milliamperes at 38,000 volts to a choke-input filter with 42,000 volts single-phase supply.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	5.0 volts
Current	10.5 amperes

MECHANICAL

Base	50-watt jumbo 4-pin bayonet
Basing	Refer to outline drawing
Socket	Refer to discussion under "Application"
Mounting Position	Vertical, base down or up
Cooling	Convection and Radiation
Maximum Temperature of Plate Seal	225°C
Recommended Heat Dissipating Plate Connector	Eimac HR-6
Maximum Over-all Dimensions:	
Length	10.13 inches
Diameter	3.82 inches
Net Weight	10 ounces
Shipping Weight (approx.)	3 pounds

MAXIMUM RATINGS (Per tube)

PEAK INVERSE PLATE VOLTAGE	60,000 MAX. VOLTS
PLATE DISSIPATION	150 MAX. WATTS
D-C PLATE CURRENT[1]	250 MAX. MA
PEAK PLATE CURRENT	2.5 MAX. AMPERES

[1]Averaged over one cycle for each tube. Applies only when the rectifier is coupled to the load by a choke-input filter incorporating the "critical" value (or larger) of input inductance. For maximum d-c current ratings under this and other load conditions see discussion under "Application"

APPLICATION

MECHANICAL

Mounting—The 250R must be mounted vertically with the base either down or up. The lead to the plate terminal of the tube should be flexible.

The 50-watt jumbo 4-pin bayonet base fits an E. F. Johnson Co. No. 123-211, a National Co. No. XM-50, or an equivalent socket. In some circuits, particularly those of the voltage multipliers illustrated in Fig. 2, it may be necessary to mount the socket on stand-off insulators, or on a sheet of insulating material, to provide adequate insulation to ground.

Cooling—The 250R is cooled by convection and radiation. Clearance should be provided around the glass envelope adequate for the free circulation of air. An Eimac HR-6 Heat Dissipating Connector or equivalent is required on the plate terminal.

The maximum temperature at the plate seal must not exceed

(Revised 12-15-65) Copyright 1952, 1965 by Varian Associates

APPLICATION (Continued)

225°C. A convenient accessory for measuring this temperature is "Tempilaq", a temperature-sensitive lacquer available from the Tempil Corporation, 132 W. 22nd St., New York 11, N. Y.

ELECTRICAL

Filament Operation—For maximum tube life, the filament voltage, as measured at the base pins, should be the rated value of 5.0 volts. Variations must be kept within the range from 4.75 to 5.25 volts. In applications which require the diode to deliver high peak currents, it is important to maintain the filament voltage at the rated value.

CAUTION SHOULD BE OBSERVED WHEN MEASURING RECTIFIER FILAMENT VOLTAGE. THE FILAMENT CIRCUIT MAY BE AT HIGH POTENTIAL.

The thoriated-tungsten filament of the 250R reaches operating temperature in a fraction of a second after application of voltage. Plate voltage may be applied simultaneously with filament voltage.

Plate Operation—With low room illumination, the plate of the 250R begins to show color as the maximum plate dissipation rating of 150 watts is approached. The maximum peak inverse voltage rating of 60,000 volts should not be exceeded at any time.

Performance—The accompanying table shows some maximum performance capabilities of the 250R when used as a power-supply rectifier.

250R MAXIMUM-PERFORMANCE CAPABILITIES

		Capacitor-Input Filter		Choke-Input Filter	
Circuit Type	A-C Input Voltage (volts rms)	D-C Output Voltage (volts)	D-C Output Current (ma)	D-C Output Voltage (volts)	D-C Output Current (ma)
Single-Phase, Half-Wave	21,000	24,000	160	.....	.....
Single-Phase, Full-Wave	21,000[1]	24,000	320	19,000	500
Single-Phase, Bridge	42,000	48,000	320	38,000	500

[1]One-half the transformer secondary voltage.

Maximum D-C Current Ratings—Plate dissipation rather than peak current usually limits the d-c current which the 250R is capable of delivering to the load. Because the plate dissipation associated with a given d-c current depends upon the amount of ripple and its wave-shape, circuit conditions will determine the maximum d-c current rating of the tube.

Choke-Input Filter—The maximum d-c current rating of the 250R is 250 milliamperes when the load incorporates a choke-input filter with the "critical" value (or larger) of input inductance (L_f in Fig. 1):

$$L_o = \frac{R_{eff}}{18.8f} \quad \text{for full-wave single-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{75f} \quad \text{for half-wave three-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{660f} \quad \text{for full-wave three-phase rectifiers,}$$

where: L_o = "critical" value of input inductance (henries),
f = supply-line frequency (cycles per second),

$$R_{eff} = \frac{\text{Load voltage (volts)}}{\text{Load current (amps)}}.$$

Choke-input filters are not normally used with single-phase half-wave rectifiers.

Capacitor-Input Filter—The 250R is particularly suitable for power-supply applications demanding high voltage at low current. Under these conditions capacitor-input filter circuits become desirable. The maximum d-c current rating of the 250R when no input choke is incorporated in the filter depends upon the total series resistance of the capacitor-charging circuit relative to the effective load resistance seen by each tube. The circuit diagrams and tabulation in Fig. 2 are so arranged and labeled that this required series resistance may be found for a wide range of load conditions. This may be done by determining the value of the following quantities:

E_c is the filter-input d-c voltage. While this is usually the entire load voltage, in the case of voltage multipliers it is the load voltage divided by the multiplication factor.

I_p is the d-c current per tube. This is the entire load current only in the case of the simple half-wave rectifier or half- or full-wave multiplier. In the case of full-wave center-tapped or bridge rectifiers, I_p is half the load current.

R_c is the total charging-circuit resistance. A certain minimum value of charging-circuit resistance is necessary to limit the peak value of current to which the tubes will be subjected under given load conditions. This required minimum depends upon the d-c current per tube (I_p), and has been tabulated in Fig. 2 as a percentage of the effective load resistance per tube (E_c/I_p). The total charging-circuit resistance involves the internal resistance of the rectifier tube, R_p, the added series resistor, R_s, and the equivalent internal resistance of the a-c voltage supply, R_i.

R_p is the plate resistance of the 250R, which may be taken as 750 ohms.

R_i is the equivalent internal resistance of the supply. This may be taken as the regulation of the high-voltage supply expersed as a decimal multiplied by the load resistance used in measuring this regulation.

R_s is the series resistor which must be inserted in the charging circuit to bring the total charging-circuit resistance up to the required minimum. Its value may be found from the formula associated with each of the circuits of Fig. 2. This resistor must be inserted in such a position in the circuit that it protects all tubes.

Tubes may be operated in parallel to increase the output capability in a given circuit. When two tubes are placed in parallel at each place where one is shown in the circuits of Fig. 2, the plate resistance (R_p) will be half as great and the maximum allowable load current twice as great as indicated.

Peak Inverse Voltage—The peak inverse voltage rating of the 250R is 60,000 volts. In single-phase power-supply rectifier circuits the peak inverse voltage to be used in design is the peak a-c supply voltage (1.41 times E_{rms} in Fig. 2) in the case of bridge circuits, and twice this value in the case of half- and full-wave rectifiers and voltage multipliers. Peak inverse voltage in three-phase operation depends upon the circuit employed, and will be found listed in the handbooks.

Special Applications—The ratings given for capacitor-input filter circuits assume values of input capacitance large enough to hold the ripple to a low value. In special applications where a larger percent ripple is tolerable, and filter capacitance is low, the 250R is capable of larger d-c output currents.

As a unidirectional conductor in d-c circuits where the current is continuous and the percent ripple is moderate, the maximum current rating of the 250R is 400 milliamperes.

The plate characteristic curve for the 250R serves as a guide to special applications. The maximum plate dissipation rating of 150 watts, the maximum peak inverse voltage rating of 60,000 volts, and the maximum peak plate current of 2.5 amperes must not be exceeded.

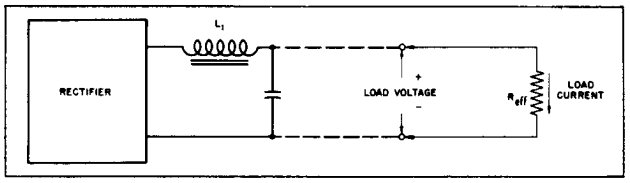
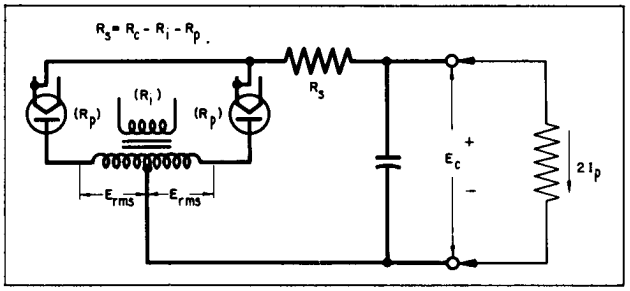
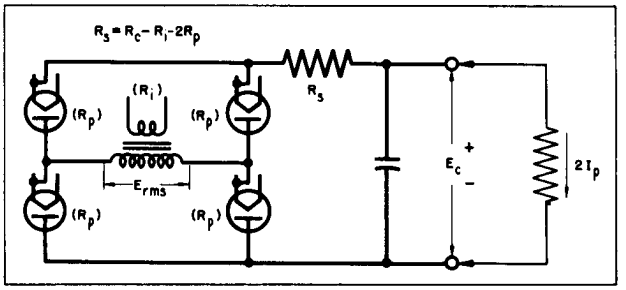


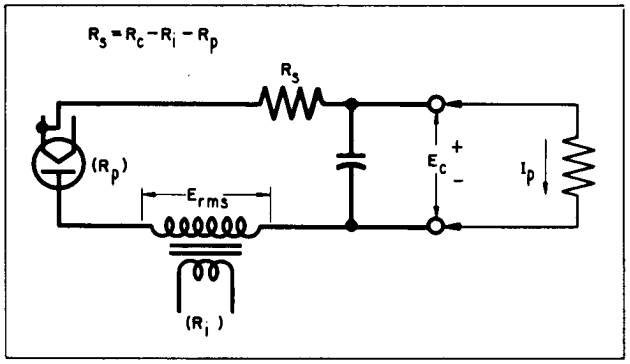
Fig. 1. Rectifier with Choke-Input Filter



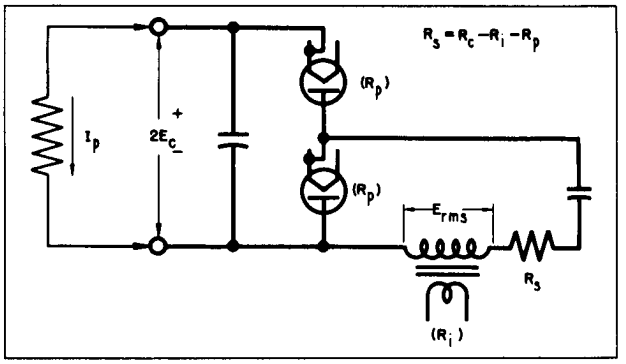
a. Full-Wave Center-Tapped Rectifier



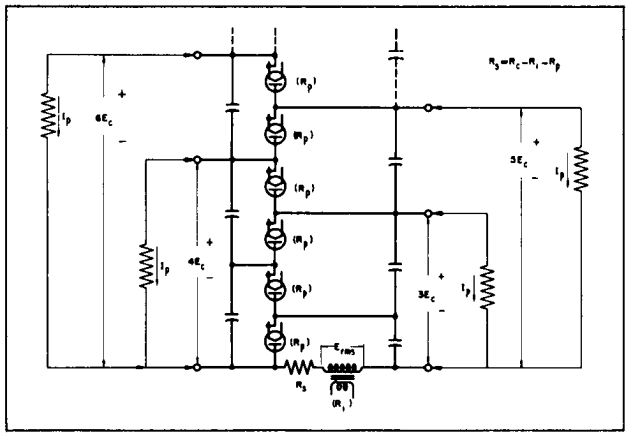
b. Full-Wave Bridge Rectifier



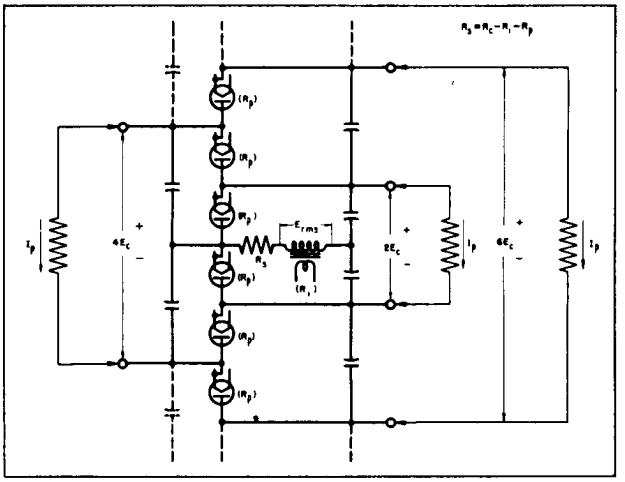
c. Half-Wave Rectifier



d. Half-Wave Voltage Doubler



e. Half-Wave Voltage Multiplier (with common ground when R_s is inserted on the "high" side of E_{rms})



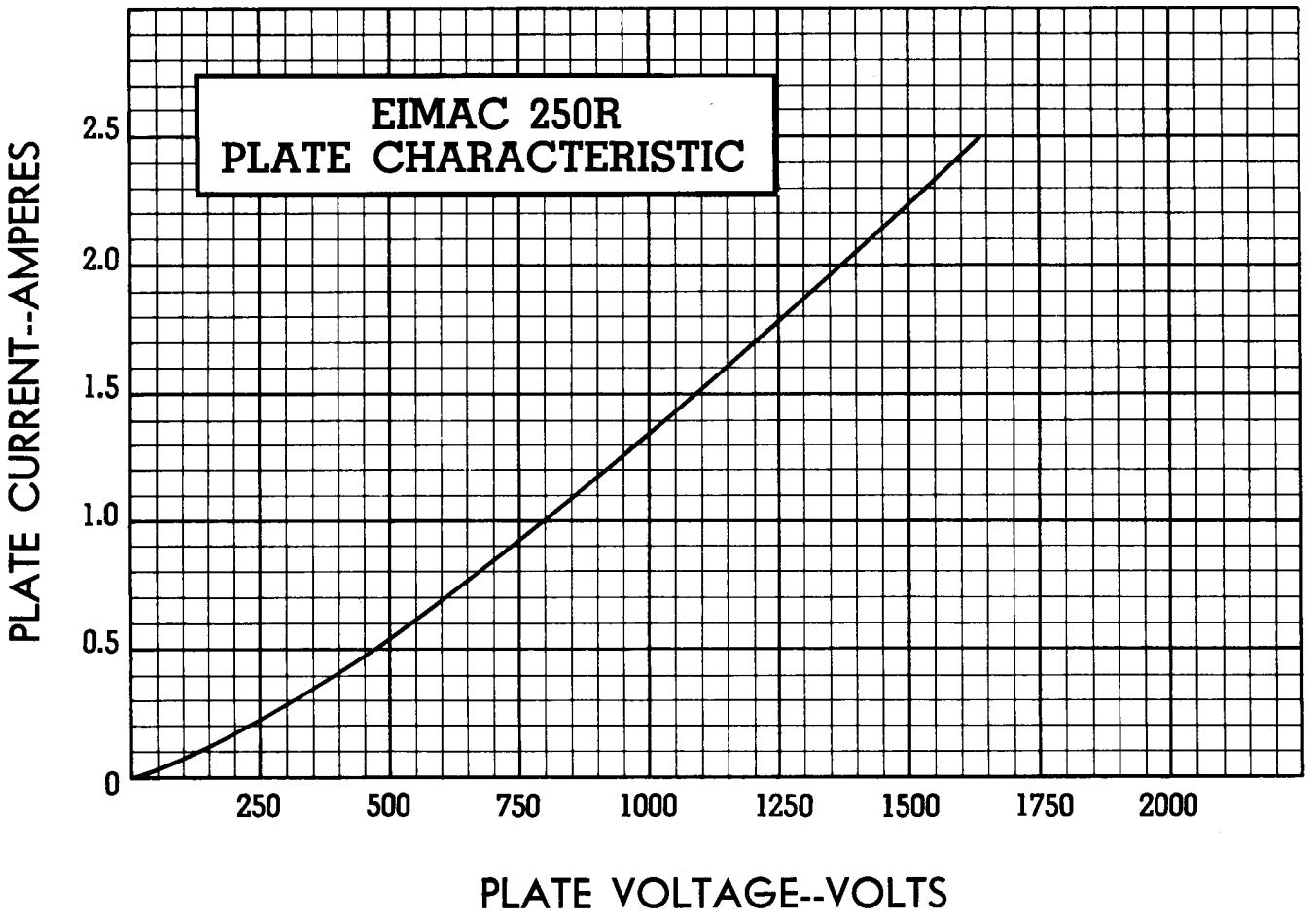
f. Full-Wave Voltage Multiplier

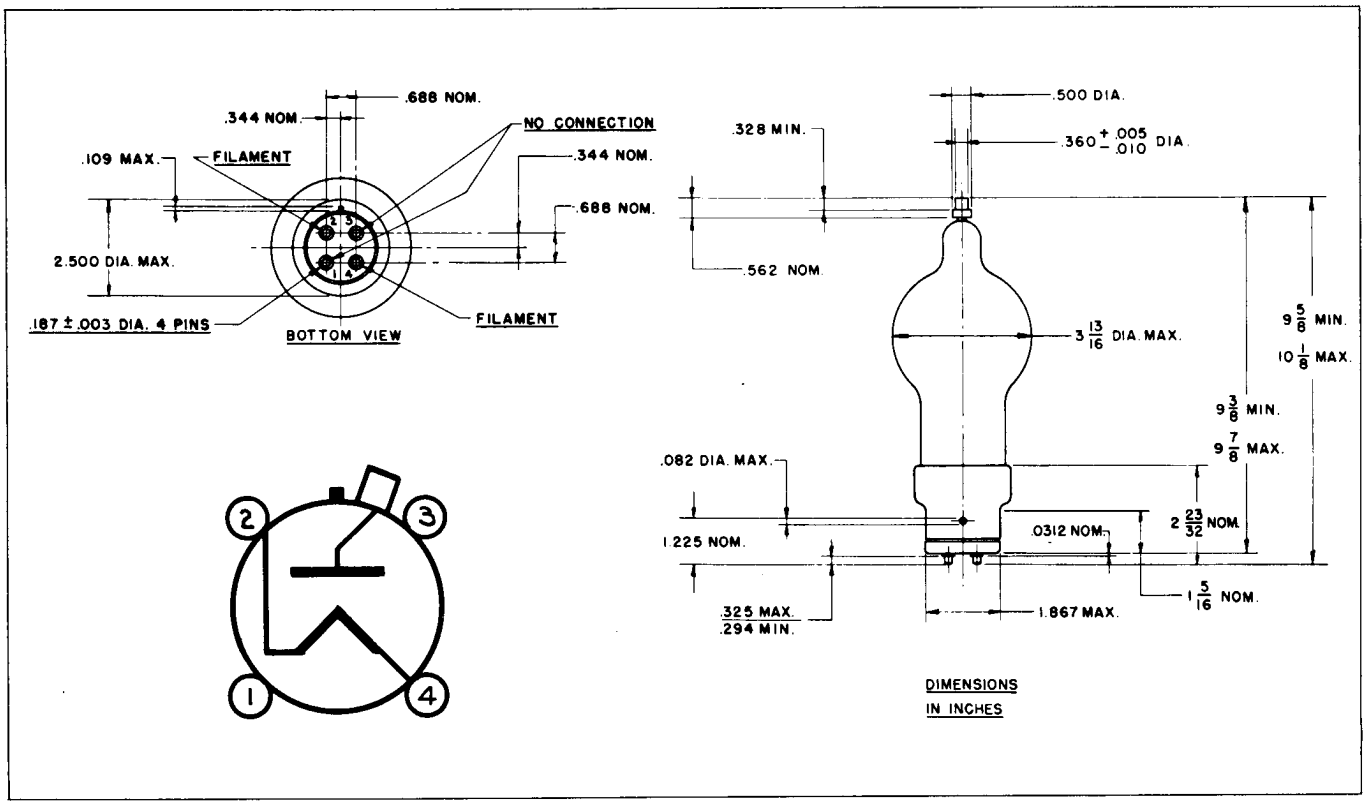
Eimac 250R Maximum D-C Current Ratings for R-C Filter Applications								
D-C Plate Current (I_p)	140	150	160	170	180	190	200	milliamperes per tube
Total Charging-Circuit Resistance (R_c)	1.2	1.9	3.0	4.8	7.6	12	19	percent of Effective Load Resistance per Tube (E_c/I_p)
A-C Supply Voltage (E_{rms})	0.80	0.83	0.87	0.93	1.01	1.14	1.33	times Filter-Input D-C Voltage (E_c)
Peak Inverse Voltage (½ these values for circuit b.)	2.3	2.4	2.5	2.7	2.9	3.2	3.7	times Filter-Input D-C Voltage (E_c)

Fig. 2 Eimac 250R Basic R-C Circuits (for any one of the indicated loads)

R_i = Equivalent resistance of voltage source

R_p = 750 ohms (375 ohms for two tubes in parallel)





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EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

250TH

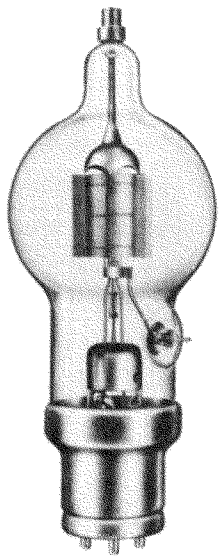
HIGH-MU TRIODE

•

MODULATOR

OSCILLATOR

AMPLIFIER



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten		
Voltage	5.0	volts
Current	10.5	amperes
Amplification Factor (Average)	37	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	2.9	uuf
Grid-Filament	5.0	uuf
Plate-Filament	0.7	uuf
Transconductance (I_b=300 ma., E_b=3000, e_c=–20)	6650	umhos
Frequency for Maximum Ratings	40	mc.

MECHANICAL

Base	4 pin, No. 5001B	
Basing	RMA type 2N	
Maximum Overall Dimensions:		
Length	10.125	inches
Diameter	3.813	inches
Net weight	12	ounces
Shipping weight (Average)	2.25	pounds

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage	1500	2000	3000	3000	volts
Max.-Signal D-C Plate Current, per tube*	•	•	•	350	ma.
Plate Dissipation, per tube*	•	•	•	250	watts
D-C Grid Voltage (approx.)	0	–30	–65		volts
Peak A-F Grid Input Voltage	410	460	460		volts
Zero-Signal D-C Plate Current	220	140	100		ma.
Max.-Signal D-C Plate Current	700	700	560		ma.
Max.-Signal Driving Power (approx.)	36	34	24		watts
Effective Load, Plate-to-Plate	4300	6000	12250		ohms
Max.-Signal Plate Power Output	650	900	1150		watts

*Averaged over any sinusoidal audio frequency cycle.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

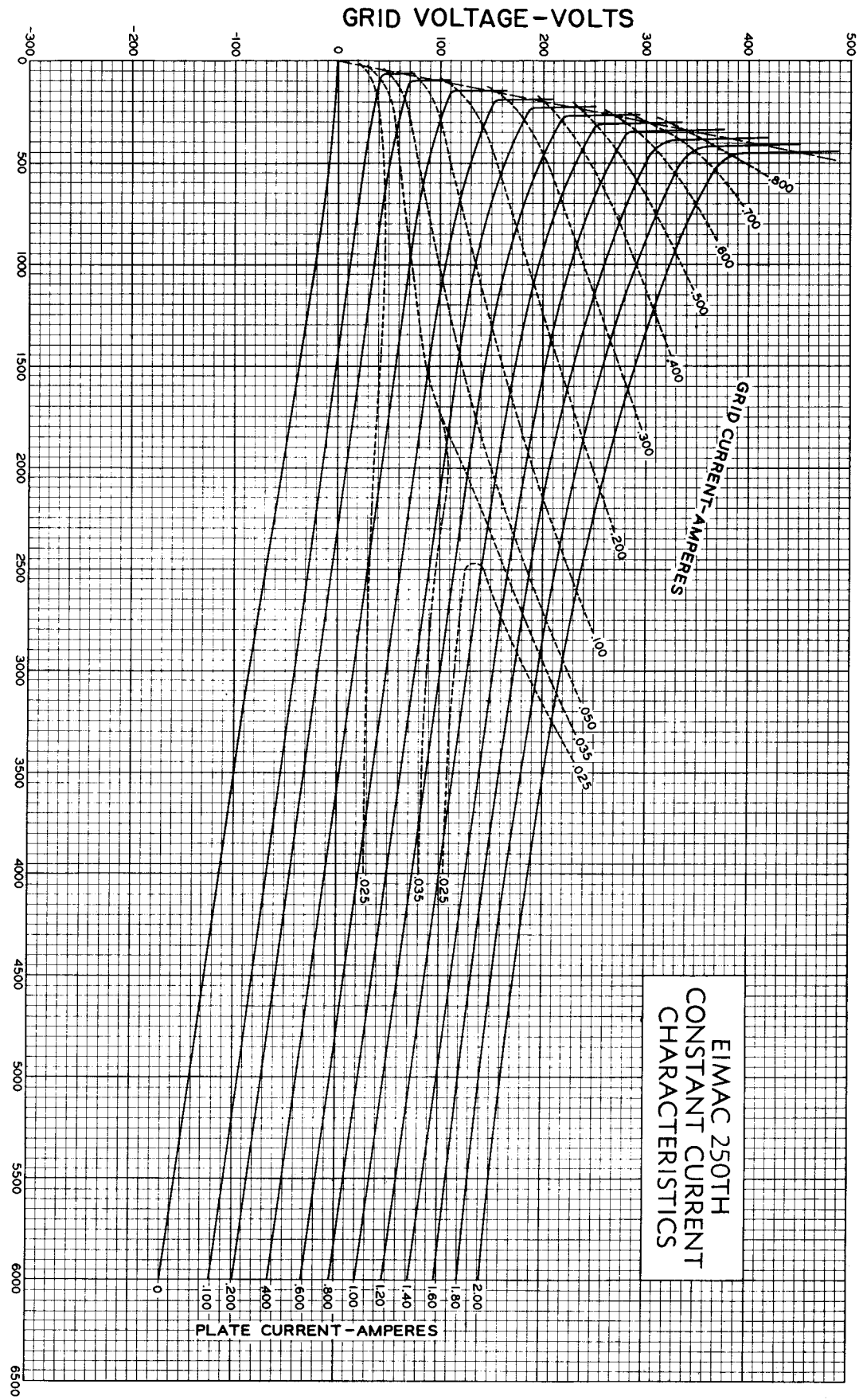
Class-C *Telegraphy

(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage	2000	3000	4000	4000	volts
D-C Plate Current	357	333	313	350	ma.
D-C Grid Current	94	90	93	100	ma.
D-C Grid Voltage	–100	–150	–220		volts
Plate Power Output	464	750	1000		watts
Plate Input	714	1000	1250		watts
Plate Dissipation	250	250	250	250	watts
Peak R. F. Grid Input Voltage, (approx.)	345	395	470		volts
Driving Power, (approx.)	29	32	39		watts

*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

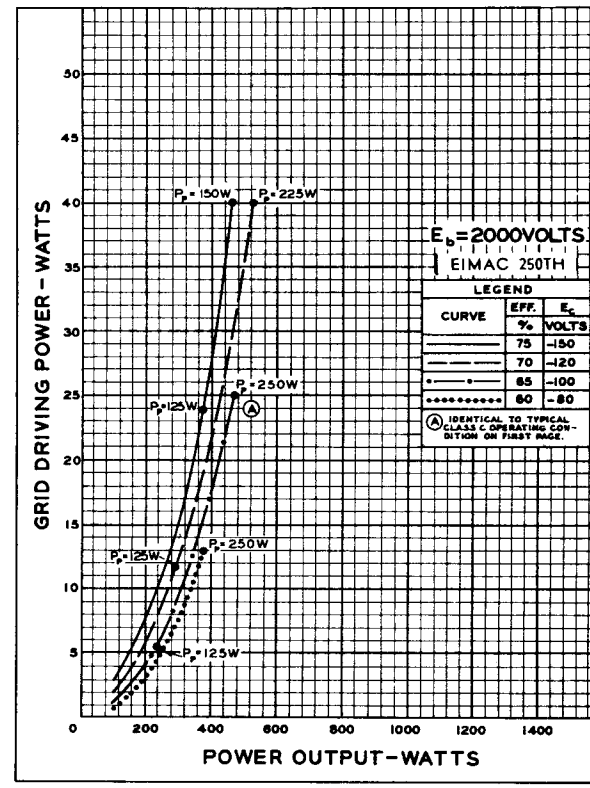
(Effective 10-17-44) Copyright, 1946 by Eitel-McCullough, Inc.

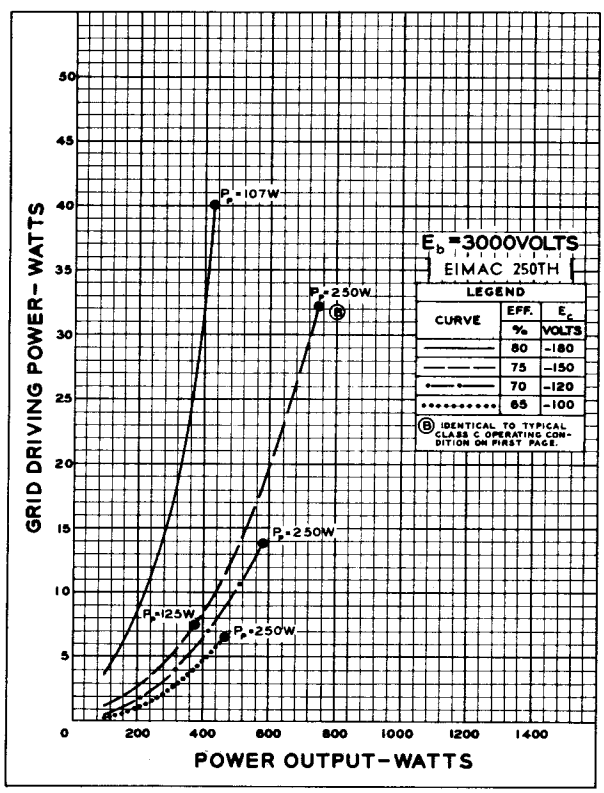

GRID VOLTAGE – VOLTS
-300
-200
-100
0
100
200
300
400
500
PLATE VOLTAGE – VOLTS
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
GRID CURRENT – AMPERES
.800
.700
.600
.500
.400
.300
.200
.100
.050
.035
.025
.025
.035
.025
PLATE CURRENT – AMPERES
0
.100
.200
.400
.600
.800
1.00
1.20
1.40
1.60
1.80
2.00
EIMAC 250TH
CONSTANT CURRENT
CHARACTERISTICS

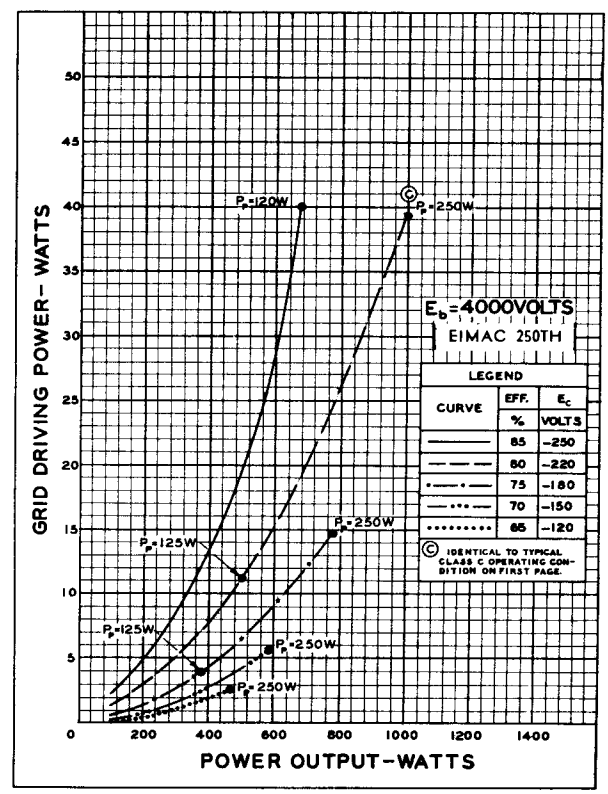
DRIVING POWER vs. POWER OUTPUT

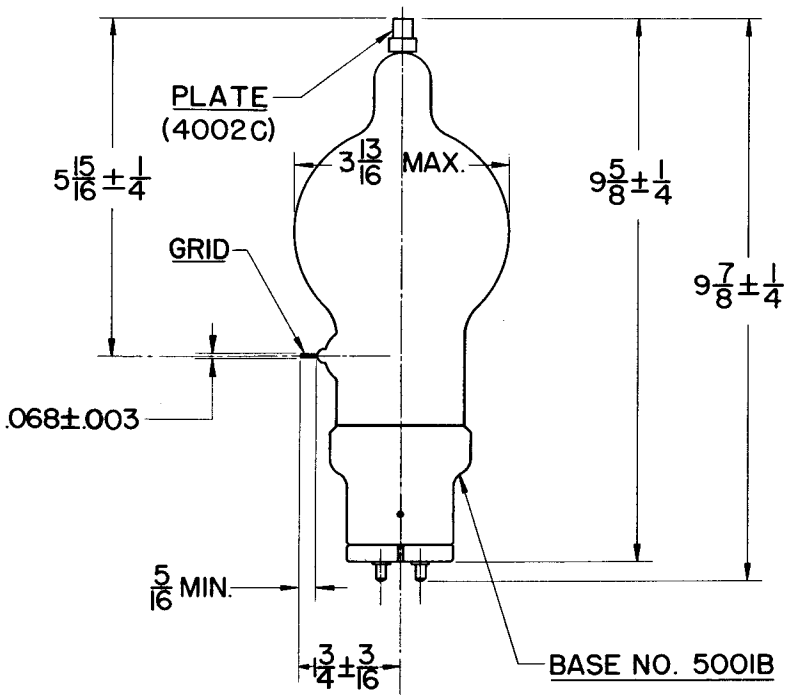
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 2000, 3000, and 4000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses.

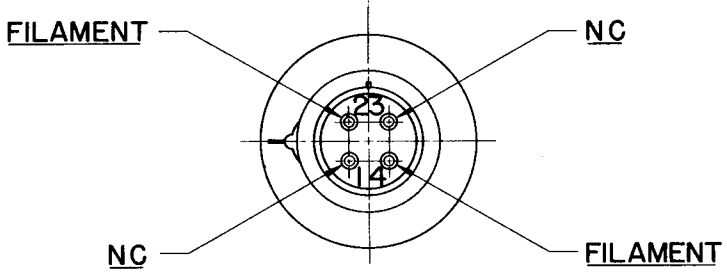
Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 2000, 3000, and 4000 volts respectively.

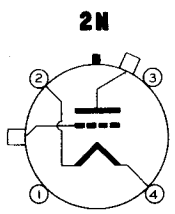






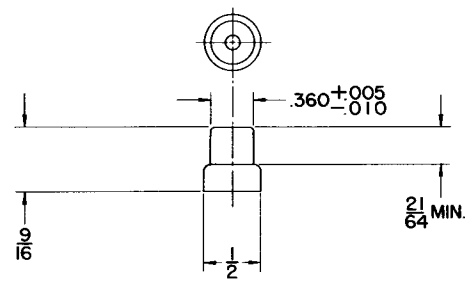






CAPS

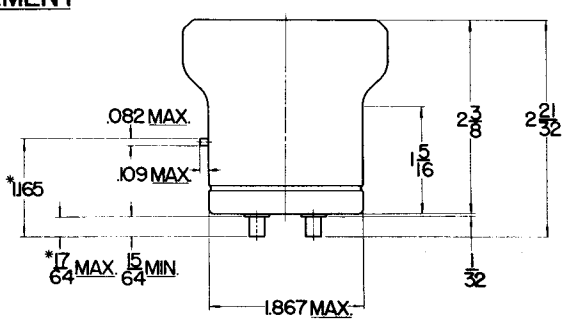
PLATE
CAP NO. 4002C

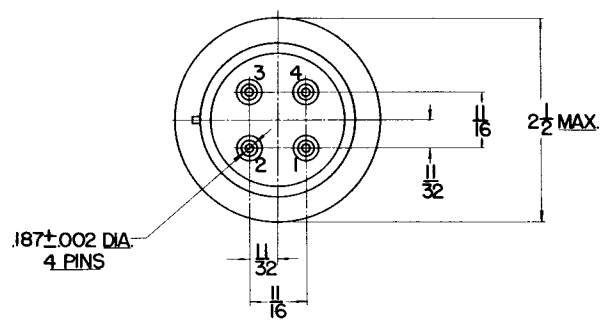


GRID

(SEE TUBE OUTLINE DRAWING)

BASE NO. 5001B





*ON FINISHED TUBE ADD .060 FOR SOLDER.

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

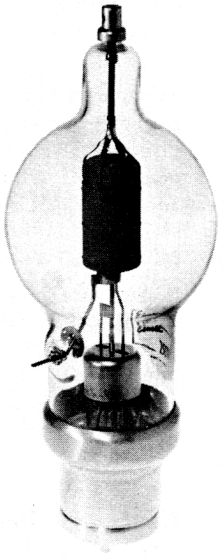
250TL

LOW-MU TRIODE

MODULATOR
OSCILLATOR
AMPLIFIER

The Eimac 250TL is a low-mu triode having a maximum plate dissipation of 250 watts. It is intended for use as an amplifier, oscillator or modulator, and can be used at its maximum ratings at frequencies up to 40 Mc.

Cooling of the 250TL is accomplished by radiation from the plate, which operates at a visible red color at maximum dissipation, and by means of air circulation around the envelope.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	5.0 volts
Current	10.5 amperes
Amplification Factor (Average)	14
Direct Interelectrode Capacitances (Average)	
Grid-Plate	3.0 $\mu\mu$f
Grid-Filament	3.7 $\mu\mu$f
Plate-Filament	0.7 $\mu\mu$f
Transconductance (I_b=350 ma., E_b=3000V.)	2650 μmhos
Frequency for Maximum Ratings	40 Mc

MECHANICAL

Base: Medium 4-pin bayonet type, fits E. F. Johnson No. 211 series sockets, National XM-50 socket, or the equivalent.
For pin connections, see outline drawing.

Mounting	Vertical, base down or up.
Cooling	Convection and radiation.
Recommended Heat Dissipating Connectors:	
Plate	Eimac HR-6
Grid	Eimac HR-3
Maximum Over-all Dimensions:	
Length	10.13 inches
Diameter	3.81 inches
Net Weight	10 ounces
Shipping Weight	3 pounds

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-AB_2 (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	4000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	350 MAX. MA.
MAX-SIGNAL PLATE DISSIPATION, PER TUBE	250 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	1500	2000	3000	Volts
D-C Grid Voltage (approx.)*	—40	—90	—170	Volts
Zero-Signal D-C Plate Current	200	150	100	Ma.
Max-Signal D-C Plate Current	700	650	500	Ma.
Effective Load, Plate-to-Plate	3800	6150	13,000	Ohms
Peak A-F Grid Input Voltage (per tube)	390	410	400	Volts
Max-Signal Peak Driving Power	76	74	32	Watts
Max-Signal Nominal Driving Power	38	37	16	Watts
Max-Signal Plate Power Output	580	800	1000	Watts

*Adjust for given zero-signal plate current.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C PLATE CURRENT	350 MAX. MA.
PLATE DISSIPATION	250 MAX. WATTS
GRID DISSIPATION	35 MAX. WATTS

TYPICAL OPERATION, per tube* (Frequencies up to 40 Mc.)

D-C Plate Voltage	2000	3000	4000	Volts
D-C Grid Voltage	—200	—350	—500	Volts
D-C Plate Current	350	335	310	Ma.
D-C Grid Current	45	45	40	Ma.
Peak R-F Grid Input Voltage (approx.)	575	720	900	Volts
Driving Power (approx.)	22	29	33	Watts
Grid Dissipation (approx.)	14	15	14	Watts
Power Input	700	1000	1250	Watts
Plate Dissipation	245	250	250	Watts
Plate Power Output	455	750	1000	Watts

*These figures show actual measured tube performance and do not allow for variations in circuit losses.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3200 MAX. VOLTS
D-C PLATE CURRENT	280 MAX. MA.
PLATE DISSIPATION	165 MAX. WATTS
GRID DISSIPATION	35 MAX. WATTS

TYPICAL OPERATION, per tube* (Frequencies up to 40 Mc.)

D-C Plate Voltage	2000	2500	3000	Volts
D-C Plate Current	250	225	200	Ma.
Total D-C Bias Voltage	—520	—520	—520	Volts
Grid Resistor	13,000	15,000	17,500	Ohms
Fixed D-C Bias Supply Voltage	—140	—220	—266	Volts
D-C Grid Current	29	20	14	Ma.
Peak R-F Grid Input Voltage	840	795	795	Volts
Driving Power (approx.)	24	16	11	Watts
Grid Dissipation (approx.)	9	6	5	Watts
Plate Power Input	500	565	600	Watts
Plate Dissipation	165	165	165	Watts
Plate Power Output	335	400	435	Watts

*These figures show actual measured tube performance and do not allow for variations in circuit losses.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EIMAC, FOR INFORMATION AND RECOMMENDATIONS.

APPLICATION

MECHANICAL

Mounting—The 250TL must be mounted vertically, base down or up. The plate and grid leads should be flexible, and the tube must be protected from vibration and shock.

Cooling—Heat Dissipating Connectors (Eimac HR-6 and HR-3 or equivalent) must be used at the plate and grid terminals of the 250TL. Forced-air cooling is not required in properly designed equipment operating at frequencies below 40 Mc. If the free circulation of air around the tube is restricted, a small fan or centrifugal blower should be used to provide additional cooling.

The temperature of the plate and grid seals must not be allowed to exceed 225° C. One method of measuring these temperatures is by the use of "Tempilaq," a temperature-sensitive lacquer manufactured by the Tempil Corporation, 11 W. 25th St., New York 10, N. Y.

ELECTRICAL

Filament Voltage—The filament voltage, as measured directly at the tube, should be 5.0 volts with maximum allowable variations due to line fluctuations from 5.25 to 4.75 volts.

Bias Voltage—When grid-leak bias is used, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation, and the grid-leak resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired value from tube to tube.

Grid Dissipation—The power dissipated by the grid of the 250TL must not exceed 40 watts. Grid dissipation may be calculated from the following expression.

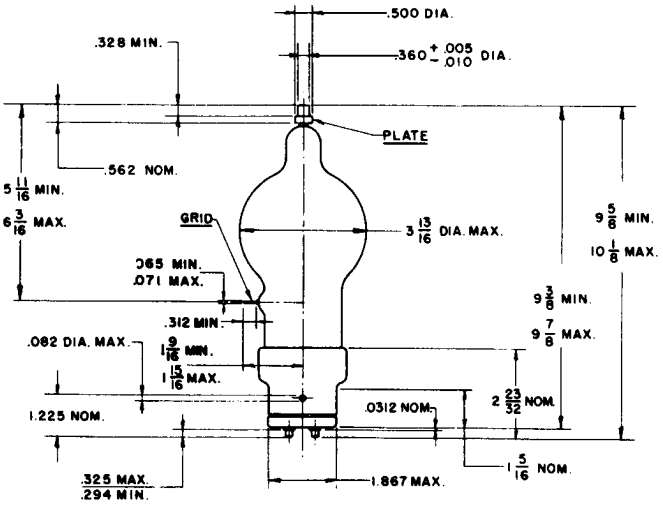
$$P_g = e_{cmp} I_c$$

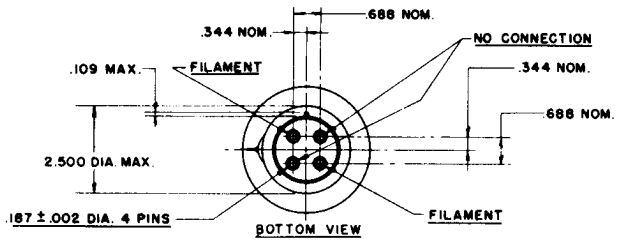
where P_g = grid dissipation,
e_{cmp} = peak positive grid voltage, and
I_c = d-c grid current

e_{cmp} may be measured by means of a suitable peak-reading voltmeter connected between filament and grid.[1] In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

Plate Dissipation—The plates of the 250TL operate at a visibly red color at the maximum rated dissipation of 250 watts. Plate dissipation in excess of the maximum rating is permissible only for short periods of time, such as during tuning procedures.

[1]For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings," **Eimac News**, January, 1945. This article is available in reprint form on request.



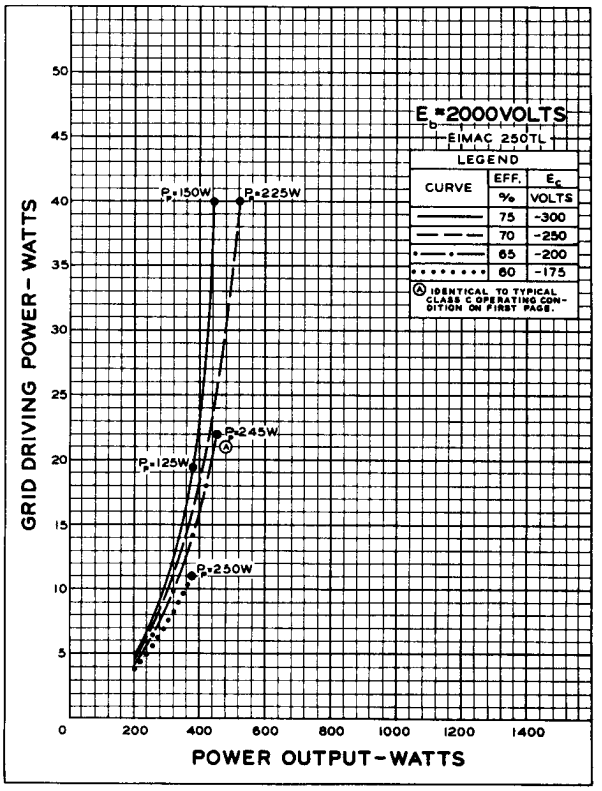


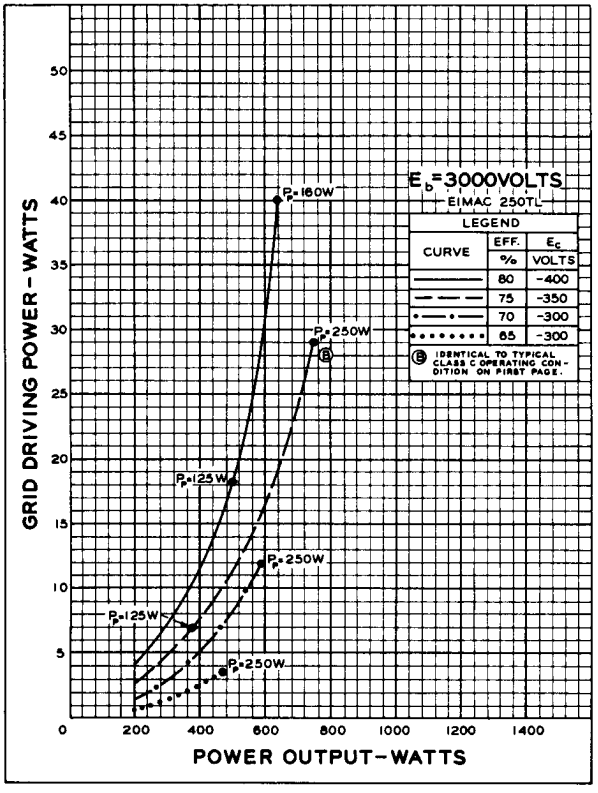
DIMENSIONS IN INCHES

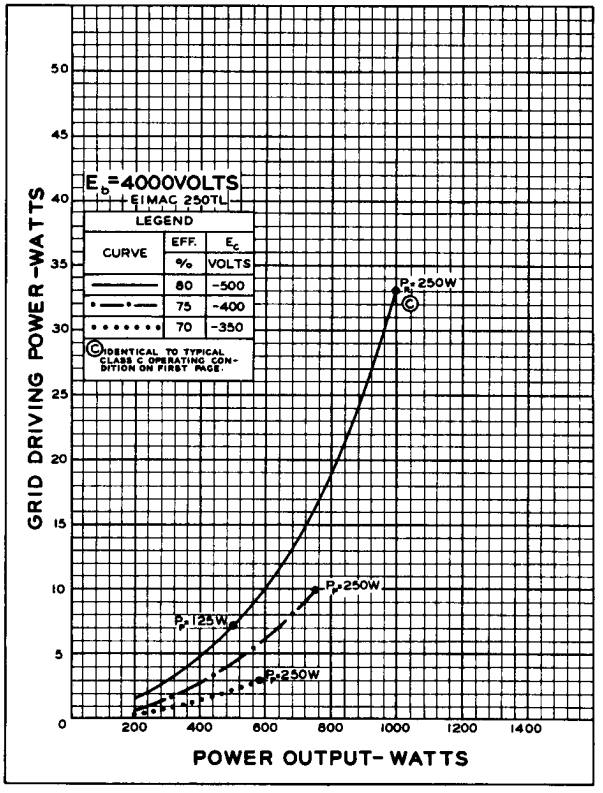
DRIVING POWER vs. POWER OUTPUT

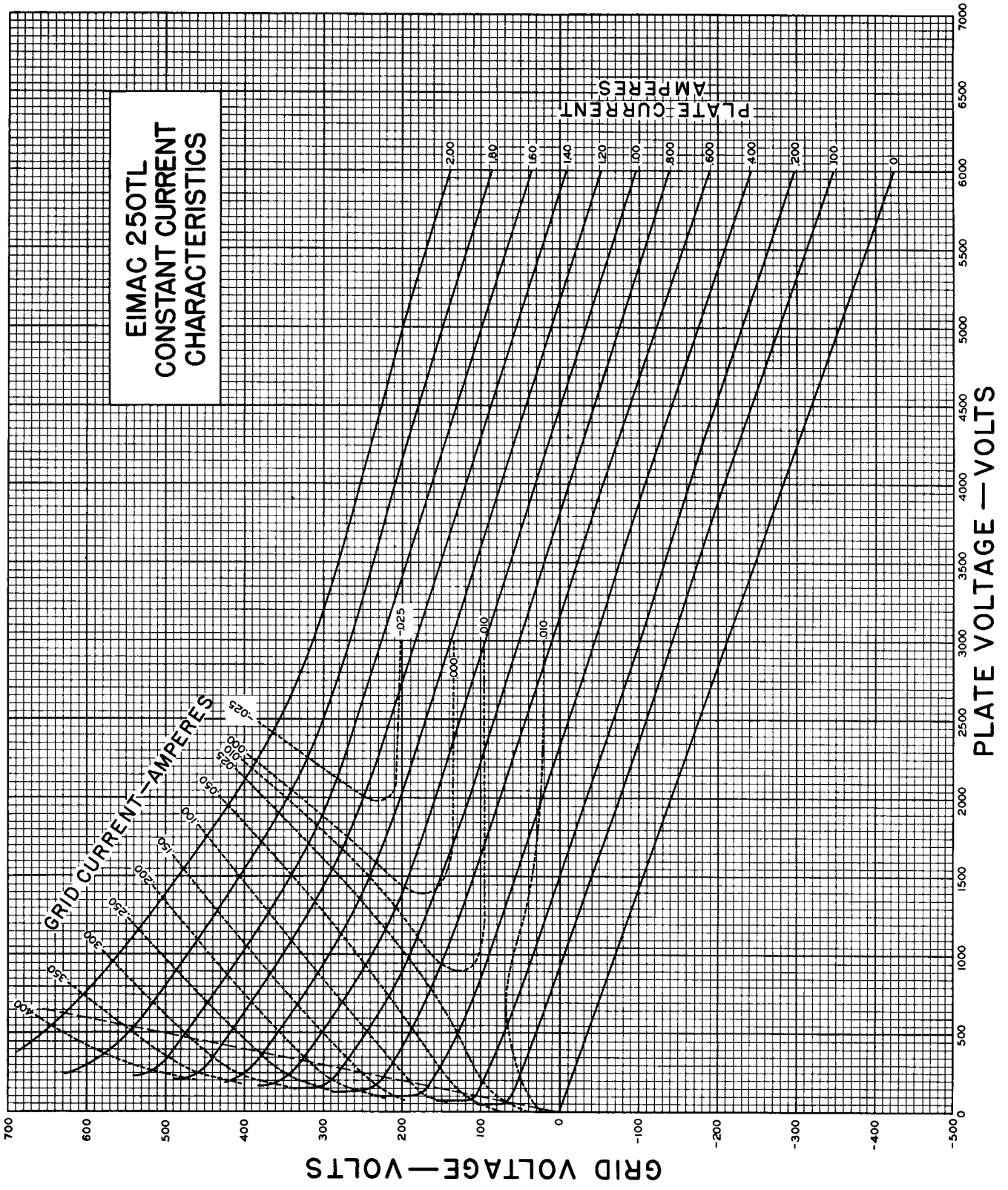
The three charts on this page show the relationship of plate efficiency, power output and approximate grid driving power at plate voltages of 2000, 3000 and 4000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by Pp.

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 2000, 3000, and 4000 volts respectively.









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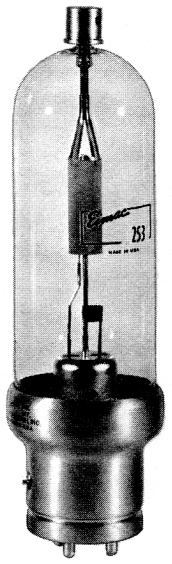
253

HIGH-VACUUM RECTIFIER

The Eimac 253 is a high-vacuum diode rectifier intended for use in rectifier units, voltage multipliers, or in special applications, whenever conditions of extreme ambient temperatures, high operating frequency, high peak inverse voltages, or the production of high-frequency transients would prevent the use of gas-filled rectifier tubes.

The 253 has a maximum d-c current rating of 350 milliamperes and a maximum peak inverse voltage rating of 15,000 volts. Cooling is by convection and radiation.

A single 253 will deliver 210 milliamperes at 5640 volts to a capacitor-input filter with 5300 volts single-phase supply. Four 253's in a bridge circuit will deliver 700 milliamperes at 9500 volts to a choke-input filter with 10,600 volts single-phase supply.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	5.0 volts
Current	10.0 amperes

MECHANICAL

Base	50-watt jumbo 4-pin bayonet
Basing	Refer to outline drawing
Socket	Refer to discussion under "Application"
Mounting Position	Vertical, base down or up
Cooling	Convection and Radiation
Maximum Temperature of Plate Seal	225°C
Recommended Heat Dissipating Plate Connector	Eimac HR-8
Maximum Over-all Dimensions:	
Length	8.75 inches
Diameter	2.50 inches
Net Weight	7 ounces
Shipping Weight (approx.)	1 pound

MAXIMUM RATINGS (Per Tube)

PEAK INVERSE PLATE VOLTAGE	15,000 MAX. VOLTS
PLATE DISSIPATION	100 MAX. WATTS
D-C PLATE CURRENT[1]	350 MAX. MA
PEAK PLATE CURRENT	2.5 MAX. AMPERES

[1]Averaged over one cycle for each tube. Applies only when the rectifier is coupled to the load by a choke-input filter incorporating the "critical" value (or larger) of input inductance. For maximum d-c current ratings under this and other load conditions see discussion under "Application".

APPLICATION

MECHANICAL

Mounting—The 253 must be mounted vertically with the base either down or up. The lead to the plate terminal of the tube should be flexible.

The 50-watt jumbo 4-pin bayonet base fits an E. F. Johnson Co. No. 123-211, a National Co. No. XM-50, or an equivalent socket. In some circuits, particularly those of the voltage multipliers illustrated in Fig. 2, it may be necessary to mount the socket on stand-off insulators, or on a sheet of insulating material, to provide adequate insulation to ground.

Cooling—The 253 is cooled by convection and radiation. Clearance should be provided around the glass envelope adequate for the free circulation of air. An Eimac HR-8 Heat Dissipating Connector or equivalent is required on the plate terminal.

The maximum temperature at the plate seal must not exceed 225°C. A convenient accessory for measuring this tem-

(Effective 7-1-52) © 1952, 1968 by Varian

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perature is "Tempilaq", a temperature-sensitive lacquer available from the Tempil Corporation, 132 W. 22nd Street, New York 11, N. Y.

ELECTRICAL

Filament Operation—For maximum tube life, the filament voltage, as measured at the base pins, should be the rated value of 5.0 volts. Variations must be kept within the range from 4.75 to 5.25 volts. In applications which require the diode to deliver high peak currents, it is important to maintain the filament voltage at the rated value.

CAUTION SHOULD BE OBSERVED WHEN MEASURING RECTIFIER FILAMENT VOLTAGE. THE FILAMENT CIRCUIT MAY BE AT HIGH POTENTIAL.

The thoriated-tungsten filament of the 253 reaches operating temperature in a fraction of a second after application of voltage. Plate voltage may be applied simultaneously with filament voltage.

Plate Operation—With low room illumination, the plate of the 253 begins to show color as the maximum plate dissipation rating of 100 watts is approached. The maximum peak inverse voltage rating of 15,000 volts should not be exceeded at any time.

Performance—The accompanying table shows some maximum performance capabilities of the 253 when used as a power-supply rectifier.

253 MAXIMUM-PERFORMANCE CAPABILITIES

		Capacitor-Input Filter		Choke-Input Filter	
Circuit Type	A-C Input Voltage (volts rms)	D-C Output Voltage (volts)	D-C Output Current (ma)	D-C Output Voltage (volts)	D-C Output Current (ma)
Single-Phase, Half-Wave	5300	5640	210	.....	.....
Single-Phase, Full-Wave	5300[1]	5640	420	4750	700
Single-Phase, Bridge	10,600	11,280	420	9500	700

[1]One-half the transformer secondary voltage.

Maximum D-C Current Ratings—Plate dissipation rather than peak current usually limits the d-c current which the 253 is capable of delivering to the load. Because the plate dissipation associated with a given d-c current depends upon the amount of ripple and its wave-shape, circuit conditions will determine the maximum d-c current rating of the tube.

Choke-Input Filter–The maximum d-c current rating of the 253 is 350 milliamperes when the load incorporates a choke-input filter with the "critical" value (or larger) of input inductance (L_I in Fig. 1):

$$L_o = \frac{R_{eff}}{18.8f} \quad \text{for full-wave single-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{75f} \quad \text{for half-wave three-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{660f} \quad \text{for full-wave three-phase rectifiers,}$$

where: L_o = "critical" value of input inductance (henries),
f = supply-line frequency (cycles per second),

$$R_{eff} = \frac{\text{Load voltage (volts)}}{\text{Load current (amps)}}.$$

Choke-input filters are not normally used with single-phase half-wave rectifiers.

Capacitor-Input Filter—The 253 is particularly suitable for power-supply applications demanding high voltage at low current. Under these conditions capacitor-input filter circuits become desirable. The maximum d-c current rating of the 253 when no input choke is incorporated in the filter depends upon the total series resistance of the capacitor-charging circuit relative to the effective load resistance seen by each tube. The circuit diagrams and tabulation in Fig. 2 are so arranged and labeled that this required series resistance may be found for a wide range of load conditions. This may be done by determining the value of the following quantities:

E_c is the filter-input d-c voltage. While this is usually the entire load voltage, in the case of voltage multipliers it is the load voltage divided by the multiplication factor.

I_p is the d-c current per tube. This is the entire load current only in the case of the simple half-wave rectifier or half- or full-wave multiplier. In the case of full-wave center-tapped or bridge rectifiers, I_p is half the load current.

R_c is the total charging-circuit resistance. A certain minimum value of charging-circuit resistance is necessary to limit the peak value of current to which the tubes will be subjected under given load conditions. This required minimum depends upon the d-c current per tube (I_p), and has been tabulated in Fig. 2 as a percentage of the effective load resistance per tube (E_c/I_p). The total charging-circuit resistance involves the internal resistance of the rectifier tube, R_p, the added series resistor, R_s, and the equivalent internal resistance of the a-c voltage supply, R_i.

R_p is the plate resistance of the 253, which may be taken as 300 ohms.

R_i is the equivalent internal resistance of the supply. This may be taken as the regulation of the high-voltage supply expressed as a decimal multiplied by the load resistance used in measuring this regulation.

R_s is the series resistor which must be inserted in the charging circuit to bring the total charging-circuit resistance up to the required minimum. Its value may be found from the formula associated with each of the circuits of Fig. 2. This resistor must be inserted in such a position in the circuit that it protects all tubes.

Tubes may be operated in parallel to increase the output capability in a given circuit. When two tubes are placed in parallel at each place where one is shown in the circuits of Fig. 2, the plate resistance (R_p) will be half as great and the maximum allowable load current twice as great as indicated.

Peak Inverse Voltage—The peak inverse voltage rating of the 253 is 15,000 volts. In single-phase power-supply rectifier circuits the peak inverse voltage to be used in design is the peak a-c supply voltage (1.41 times E_{rms} in Fig. 2) in the case of bridge circuits, and twice this value in the case of half- and full-wave rectifiers and voltage multipliers. Peak inverse voltage in three-phase operation depends upon the circuit employed, and will be found listed in the handbooks.

Special Applications–The ratings given for capacitor-input filter circuits assume values of input capacitance large enough to hold the ripple to a low value. In special applications where a larger percent ripple is tolerable, and filter capacitance is low, the 253 is capable of larger d-c output currents.

As a unidirectional conductor in d-c circuits where the current is continuous and the percent ripple is moderate, the maximum current rating of the 253 is 500 milliamperes.

The plate characteristic curve for the 253 serves as a guide to special applications. The maximum plate dissipation rating of 100 watts, the maximum peak inverse voltage rating of 15,000 volts, and the maximum peak plate current of 2.5 amperes must not be exceeded.

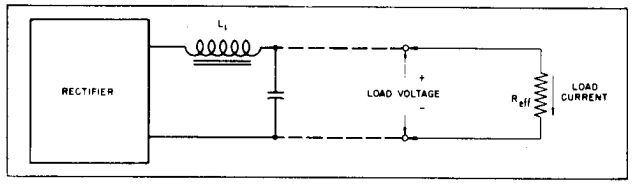
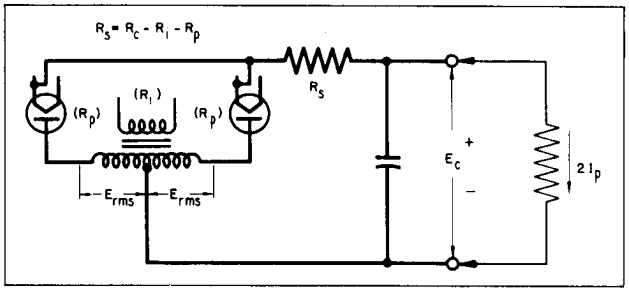
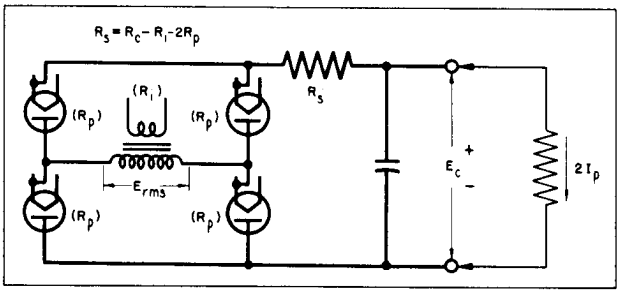


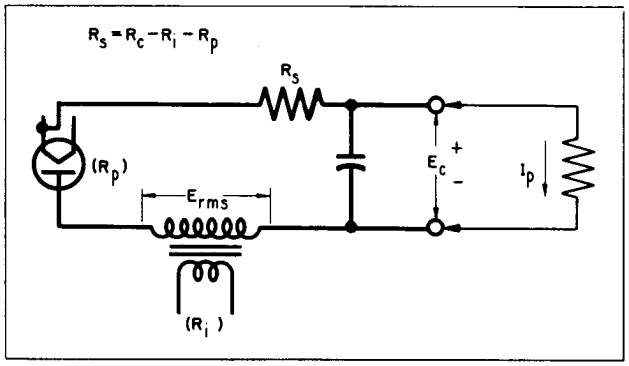
Fig. 1. Rectifier with Choke-Input Filter



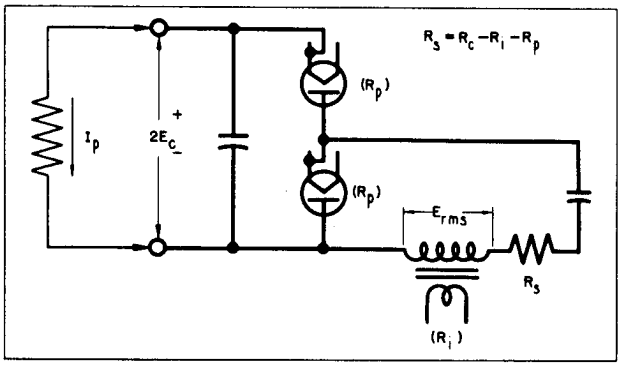
a. Full-Wave Center-Tapped Rectifier



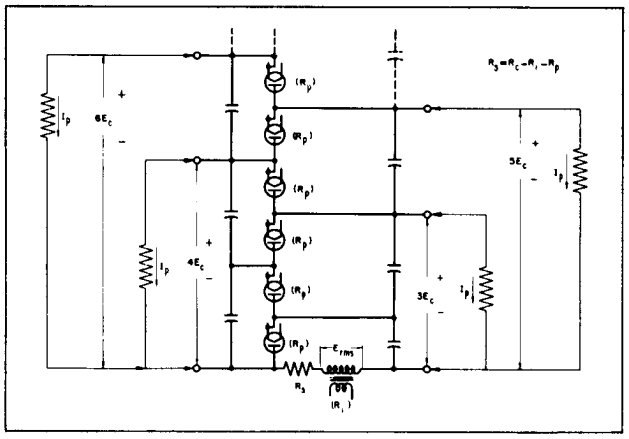
b. Full-Wave Bridge Rectifier



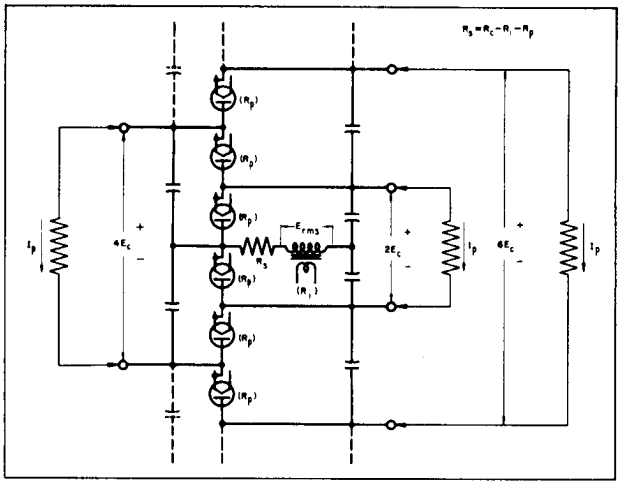
c. Half-Wave Rectifier



d. Half-Wave Voltage Doubler



e. Half-Wave Voltage Multiplier (with common ground when R_s is inserted on the "high" side of E_{rms})



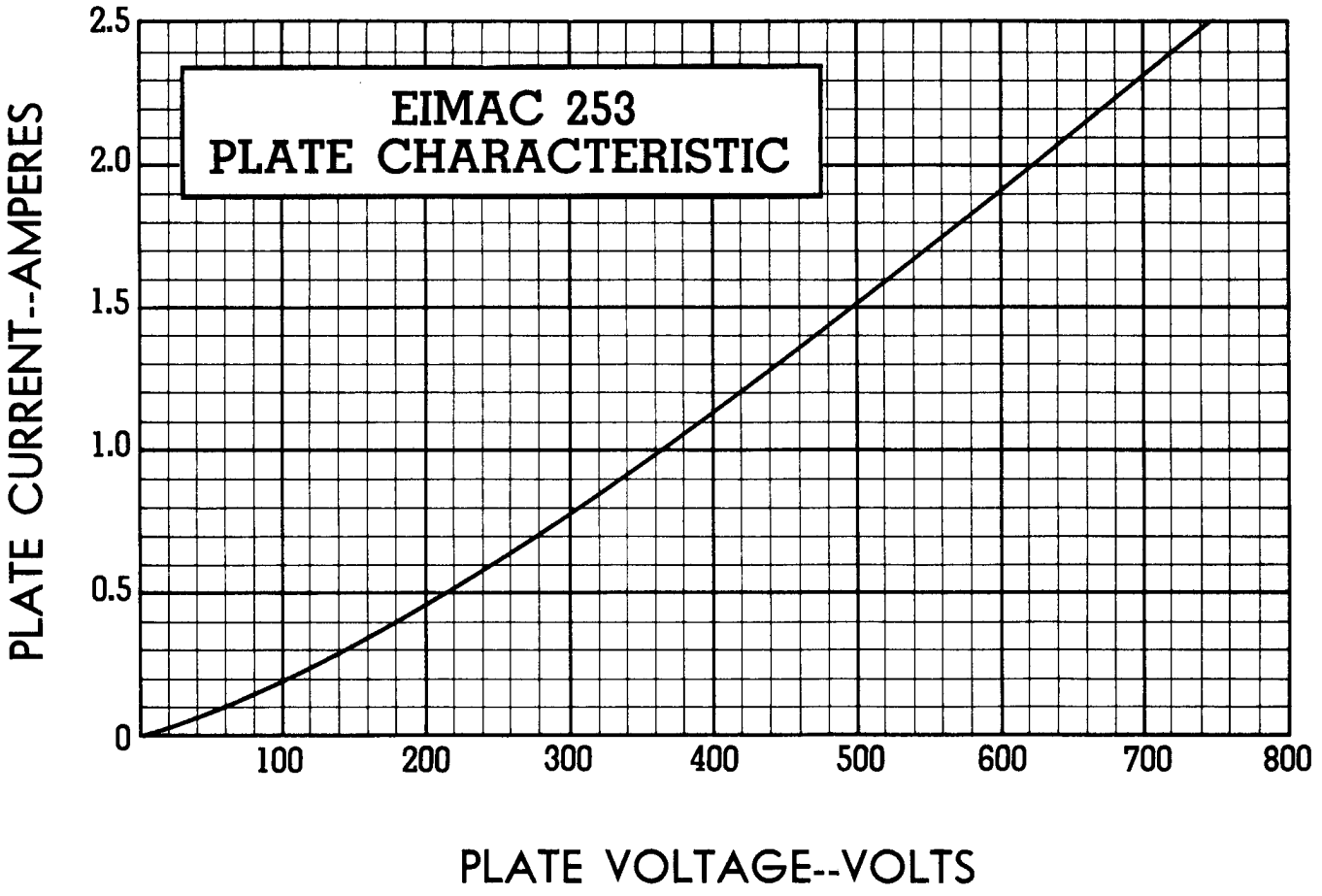
f. Full-Wave Voltage Multiplier

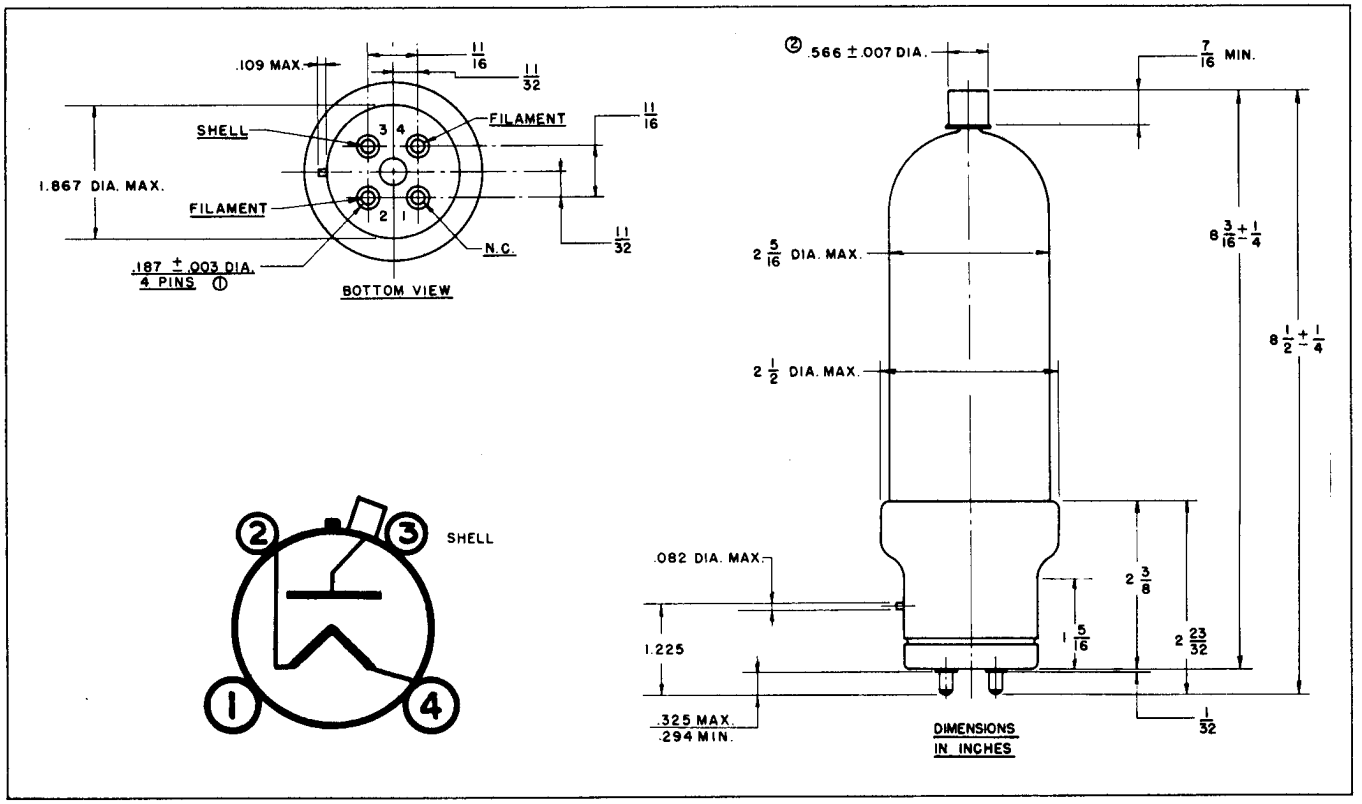
Eimac 253 Maximum D-C Current Ratings for R-C Filter Applications						
D-C Plate Current (I_p)	170	190	210	230	250	milliamperes per tube
Total Charging-Circuit Resistance (R_c)	1.1	2.3	5.0	10	27	percent of Effective Load Resistance per Tube (E_c/I_p)
A-C Supply Voltage (E_{rms})	0.80	0.85	0.94	1.08	1.50	times Filter-Input D-C Voltage (E_c)
Peak Inverse Voltage (1/2 these values for circuit b.)	2.3	2.4	2.7	3.1	4.3	times Filter-Input D-C Voltage (E_c)

Fig. 2 Eimac 253 Basic R-C Circuits (for any one of the indicated loads)

R_i = Equivalent resistance of voltage source

R_p = 300 ohms (150 ohms for two tubes in parallel)

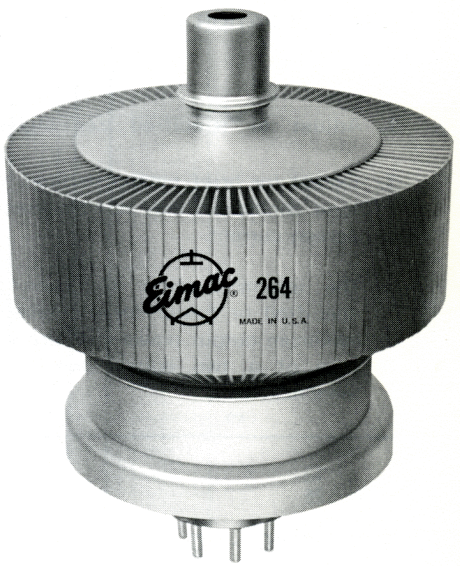

EIMAC 253
PLATE CHARACTERISTIC
PLATE CURRENT--AMPERES
2.5
2.0
1.5
1.0
0.5
0
100
200
300
400
500
600
700
800
PLATE VOLTAGE--VOLTS


.109 MAX.
11/16
11/32
SHELL
FILAMENT
11/16
1.867 DIA. MAX.
FILAMENT
11/32
N.C.
.187 ± .003 DIA.
4 PINS ①
BOTTOM VIEW
3
4
2
1
② .566 ± .007 DIA.
7/16 MIN.
2 5/16 DIA. MAX.
2 1/2 DIA. MAX.
8 3/16 ± 1/4
8 1/2 ± 1/4
.082 DIA. MAX.
2 3/8
1 5/16
2 23/32
1.225
.325 MAX.
.294 MIN.
1/32
DIMENSIONS
IN INCHES
2
3
SHELL
1
4

264/8576

RADIAL BEAM POWER PENTODE

The EIMAC 264/8576 is a ceramic/metal, forced-air cooled, radial beam pentode with a rated maximum plate dissipation of 3000 watts. The tube has very low input capacitance for its power-handling capability. It is well suited for use in broad-band linear amplifiers or in other high-performance Class AB_1 amplifier applications.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3	V
Current, at 6.0 volts	17	A
Transconductance (Average):		
I_b = 2.0 Adc, E_{c_2} = 750 Vdc	37,000	μmhos
Direct Interelectrode Capacitances (grounded cathode)[2]		
Input	55	pF
Output	18	pF
Feedback	0.13	pF
Frequency of Maximum Rating:		
CW	30	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length	6.188 in; 157.18 mm
Diameter	4.438 in; 112.73 mm
Net Weight	3.9 lb;1.77 kg
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250 °C
Anode Core	250 °C
Cooling	Forced Air
Base	7-Pin Special
Recommended Air-System Socket	EIMAC SK-265A
Recommended Air Chimney (included with SK-265A)	EIMAC C-265

Effective 6-5-70 © Varian Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN
Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000 VOLTS
DC SUPPRESSOR VOLTAGE	100 VOLTS
DC SCREEN VOLTAGE	1000 VOLTS
DC GRID VOLTAGE	-250 VOLTS
DC PLATE CURRENT	2.0 AMPERES
PLATE DISSIPATION	3000 WATTS
SCREEN DISSIPATION	50 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	4000	5000	5000	Vdc
Suppressor Voltage	0	0	0	Vdc
Screen Voltage	650	650	750	Vdc
Grid Voltage[1]	-92	-93	-109	Vdc
Zero-Signal Plate Current	400	400	400	mAdc
Single-Tone Plate Current	1.43	1.36	1.69	Adc
Two-Tone Plate Current	0.95	0.91	1.09	Adc
Zero-Signal Screen Current[4]	7	6	7	mAdc
Single-Tone Screen Current[2,4]	58	55	80	mAdc
Two-Tone Screen Current[4]	26	23	32	mAdc
Peak rf Grid Voltage[4]	92	90	108	v
Useful Output Power[5]	3300	4400	5500	W
Resonant Load Impedance	1350	1950	1550	Ω
Intermodulation Distortion Products[3]				
3rd Order	-28	-29	-26	db
5th Order	-45	-45	-40	db

1. Adjust to specified zero-signal dc plate current.
2. Except for brief tuneup periods, operation under single tone conditions may not be possible due to excessive screen current.
3. The intermodulation distortion products will be as specified or better for all levels from zero-signal to maximum output power and are referenced against one tone of a two equal tone signal. No degenerative feedback.
4. Approximate values.
5. Actual power output delivered to the load from a typical amplifier.

APPLICATION

MOUNTING - The 264/8576 may be operated in any position, and should normally be mounted in the air-system socket EIMAC type SK-265A, with a C-265 chimney. The SK-265A has a built-in bypass capacitor for the screen grid, and the suppressor grid contacts are grounded.

AIR SYSTEM SOCKET AND CHIMNEY - The SK-265A socket makes all electrical contacts to the 264/8576 except to the anode. The suppressor grid contact is grounded to the socket shell. An integral screen grid bypass capacitor is included, with a capacitance of 2000 pF and rated for 1000 Vdc maximum.
The C-265 air chimney is designed to mate with the SK-265A socket and guide the cooling air through the anode cooling fins of the tube.

COOLING - Forced-air cooling is required in all applications, and the use of an air-system socket, such as the EIMAC SK-265A, with a C-265 chimney, is recommended. Cooling is simplified if air is directed in a base-to-anode direction; when so directed, with full rated anode dissipation and with air at 50°C at sea level, an air flow of 110 cubic feet per minute, with a resultant pressure drop of approximately 0.95 inch of water for the tube/socket/chimney combination, is sufficient to limit the maximum tube temperature to 225°C. If air is not directed in the base-to-anode direction, additional cooling may be required for the base section of the tube. Cooling air should be supplied before or simultaneously with the application of electrode voltages, including heater, and should normally be maintained for a brief period after electrode voltages are removed to allow for tube cooldown.

HEATER - The rated heater voltage for the 264/8576 is 6.0 volts, as measured at the socket or tube base pins. Variations should be restricted to plus or minus 0.3 volts for long tube life and consistent performance.

GRID OPERATION - Grid-bias voltage must be obtained from a fixed bias supply in Class AB applications. The internal resistance of the bias source should not exceed 2500 ohms.

SCREEN OPERATION - In linear amplifier service, the screen voltage must be obtained from a well regulated source, to prevent excessive screen voltage variations due to changes in screen current which occur between zero-signal and full-signal conditions. The circuit should be arranged so that it is impossible to apply screen voltage without plate voltage. The use of a screen grid over-current relay is recommended, to remove screen voltage immediately in case of excessive screen current due to circuit problems, grid bias failure, or accidental removal of plate circuit loading. The relay should not break the screen-cathode d-c ground return path.

PLATE OPERATION - The maximum rated plate dissipation power for the 264/8576 is 3000 watts. Except for brief periods during circuit adjustment, this maximum value should not be exceeded. Contact to the plate may be made either at the top cap or by means of a circular clamp or spring-finger collet around the outer surface of the anode cooler itself. Points of electrical contact with the anode should be kept clean and free of oxide to minimize rf loss. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

NEUTRALIZATION FOR RF OPERATION - For minimum-distortion Class AB1 linear amplifier service, where reaction on the driver circuit should be eliminated completely, it will usually be found advisable to neutralize the small feedback capacitance of the tube.

GENERAL OPERATION NOTES - A metal chassis or equivalent means should be provided to separate the input and output circuits of an rf amplifier employing the 264/8576. Reasonable precautions should be observed in regard to bypassing and shielding of supply leads to prevent coupling between input and output through external circuits. The use of the EIMAC SK-265A air-system socket, with its integral screen grid bypass capacitance built in, is helpful in these respects.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

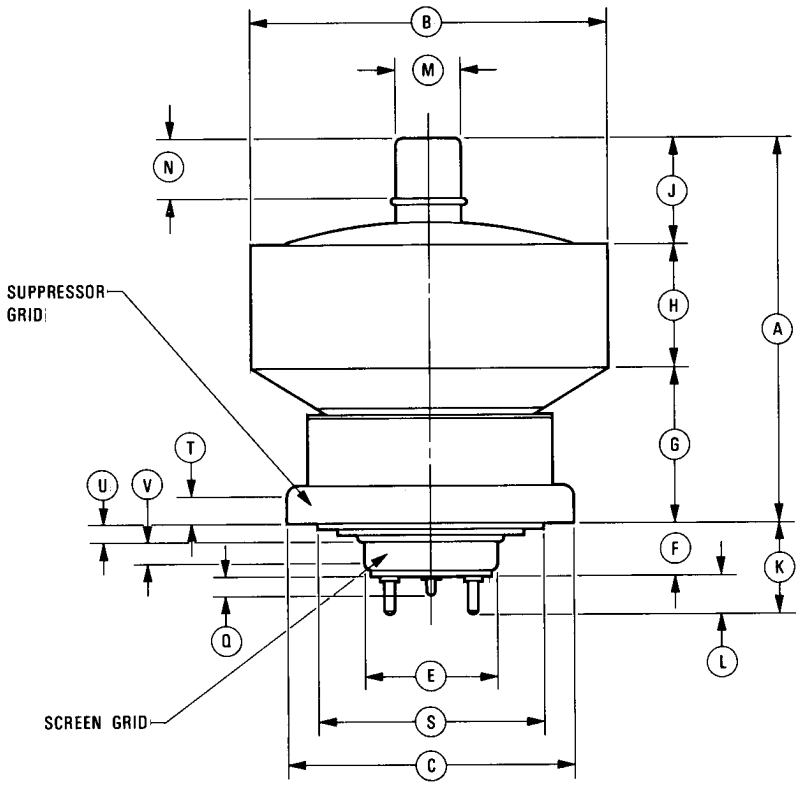
NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current.

RANGE VALUES FOR EQUIPMENT DESIGN

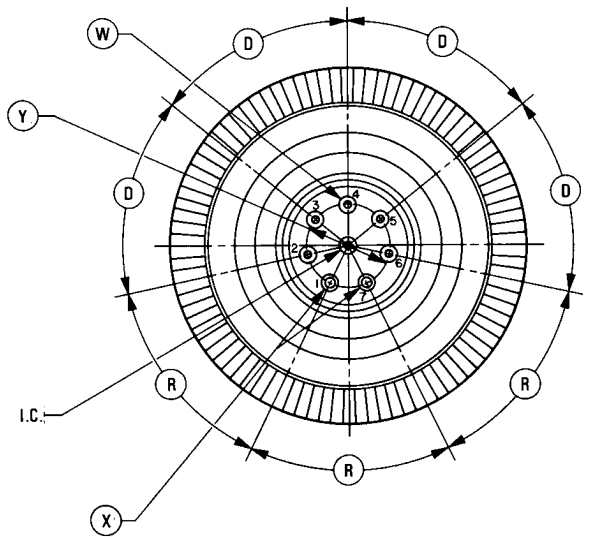
	Min.	Max.	
Heater: Current at 6.0 volts	15.5	18.5	A
Cathode Warmup Time[1]	5	---	minutes
Interelectrode Capacitances[2] (grounded cathode connection)			
Input	51.0	61.0	pF
Output	14.0	22.0	pF
Feedback	---	0.16	pF

1. Heater voltage should normally be applied for the stated time before voltages are applied to the other tube elements.

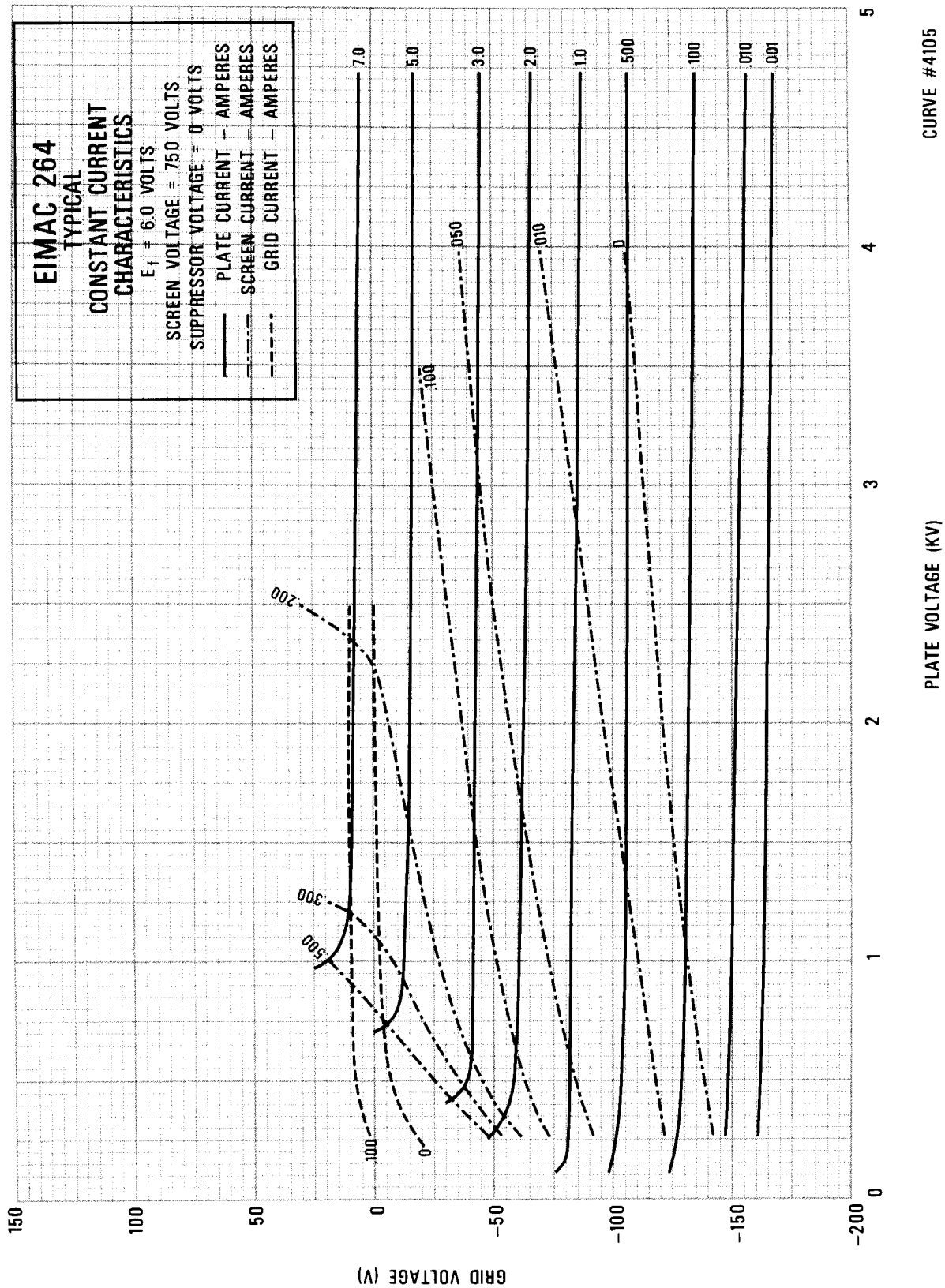
2. Capacitance values are for a cold tube as measured in a special shielded fixture.

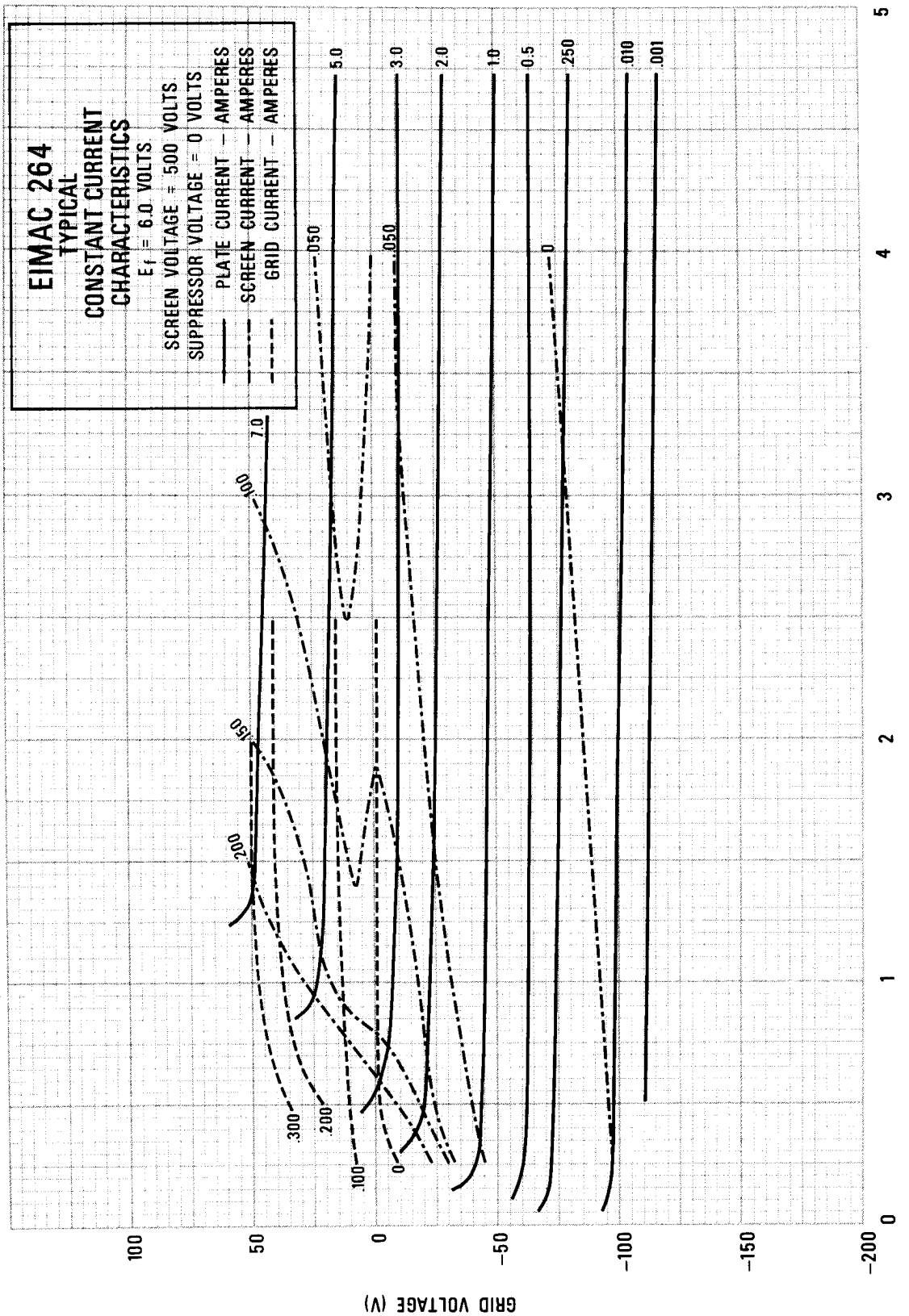


DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	— —	4.828	— —	122.63
B	4.374	4.438	111.09	112.72
C	3.484	3.516	88.49	89.31
E	1.615	1.630	41.02	41.40
F	0.625	0.750	15.87	19.05
G	1.813	1.937	46.05	49.20
H	1.530	1.560	38.86	39.62
J	1.219	1.343	30.96	34.11
K	1.160	1.360	29.46	34.54
L	0.540	0.600	13.72	15.24
M	0.805	0.819	20.45	20.80
N	0.688	— —	17.47	— —
S	— —	2.812	— —	71.42
T	0.350	— —	8.89	— —
V	0.220	— —	5.60	— —
W	0.122	0.128	3.10	3.25
X	0.149	0.159	3.78	4.04
REFERENCE DIMENSIONS				
D	51°		51°	
Q	0.205		5.21	
R	52°		52°	
U	0.250		6.35	
Y	1.000 DIA. P.C.		25.40 DIA. P.C.	



PIN CONNECTIONS	
PIN NO.	ELEMENT
1	k
2	g1
3	h
4	k
5	h
6	g1
7	k
CENTER PIN	INT. CON.
LOWER RING	g2
UPPER RING	g3
CAP	p


EIMAC 264
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
E_f = 6.0 VOLTS
SCREEN VOLTAGE = 750 VOLTS
SUPPRESSOR VOLTAGE = 0 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
7.0
5.0
3.0
2.0
1.0
.500
.100
.010
.001
.050
.010
0
.100
.200
.300
.500
150
100
50
0
–50
–100
–150
–200
0
1
2
3
4
5
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE #4105


EIMAC 264
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
E_f = 6.0 VOLTS
SCREEN VOLTAGE = 500 VOLTS
SUPPRESSOR VOLTAGE = 0 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
5.0
3.0
2.0
1.0
.5
.250
.010
.001
.050
0
.050
7.0
.400
.150
.200
.300
.200
.100
0
100
50
0
−50
−100
−150
−200
0
1
2
3
4
5
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE #4106

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

290

RADIAL BEAM POWER PENTODE

The EIMAC 290 is a ceramic/metal, forced-air cooled, radial beam pentode with a rated maximum plate dissipation of 5000 watts. The tube has very low input capacitance for its power-handling capability. It is well suited for use in broad-band linear amplifiers or other high-performance Class AB_1 amplifier applications.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3	V
Current, at 6.0 volts	17	A
Transconductance (Average):		
I_b = 2.0 Adc, E_{c2} = 750 Vdc	37,000	μmhos
Direct Interelectrode Capacitances (grounded cathode)[2]		
Input	56	pF
Output	18	pF
Feedback	0.13	pF
Frequency of Maximum Rating:		
CW	30	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the results of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length	7.250 in; 184.15 mm
Diameter	5.532 in; 140.51 mm
Net Weight	9 lbs 2½ oz; 4.154 kg
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250 °C
Anode Core	250 °C
Cooling	Forced Air
Base	7-Pin Special
Recommended Air System Socket	EIMAC SK-291A
Recommended Air Chimney (included with SK-291A)	EIMAC C-290

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RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN
Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE	6000	VOLTS
DC SUPPRESSOR VOLTAGE	100	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	2.0	AMPERES
PLATE DISSIPATION	5000	WATTS
SCREEN DISSIPATION	50	WATTS
GRID DISSIPATION	2	WATTS

1. Adjust to specified zero-signal dc plate current.
2. The intermodulation distortion products will be as specified or better for all levels from zero-signal to maximum output power and are referenced against one tone of a two equal tone signal.
3. Approximate values.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	5000	5000	6000	Vdc
Suppressor Voltage	0	0	0	Vdc
Screen Voltage	650	750	750	Vdc
Grid Voltage [1]	-93	-109	-111	Vdc
Zero-Signal Plate Current	400	400	400	mAdc
Single Tone Plate Current	1.36	1.69	1.74	Adc
Two-Tone Plate Current	0.91	1.09	1.11	Adc
Zero-Signal Screen Current [3]	6	7	6	mAdc
Single-Tone Screen Current [3/5]	55	80	60	mAdc
Two-Tone Screen Current [3]	23	32	25	mAdc
Peak rf Grid Voltage [3]	90	108	111	v
Useful Output Power [4]	4400	5500	6275	W
Resonant Load Impedance	1950	1550	1600	Ω
Intermodulation Distortion Products [2]				
3rd Order	-29	-26	-25	db
5th Order	-45	-40	-40	db

4. Actual power output delivered to the load from a typical amplifier.
5. Except for brief tuneup periods, operation under single tone conditions may not be possible due to excessive screen dissipation.

NOTE: TYPICAL OPERATION data are obtained by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	15.5	18.5	A
Cathode Warmup Time	5	---	minutes
Interelectrode Capacitances [1] (grounded cathode connection)			
Input	51.0	61.0	pF
Output	14.0	22.0	pF
Feedback	---	0.16	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture.

APPLICATION

MOUNTING - The EIMAC Type 290 may be operated in any position, and should normally be mounted in the air-system socket EIMAC type SK-291A, with a C-290 chimney. The SK-291A has a built-in bypass capacitor for the screen grid, and the suppressor grid contact is grounded.

AIR SYSTEM SOCKET AND CHIMNEY - The SK-291A socket makes all electrical contacts to the Type 290 except to the anode. The suppressor grid contact is grounded to the socket shell. An integral screen grid bypass capacitor is included, with a capacitance of 2000 pF and rated for 1000 Vdc maximum.

The C-290 chimney is designed to mate with the SK-291A socket and guide the cooling air through the anode cooling fins of the tube. The chimney is included with the socket and only when required as a replacement unit would separate procurement be necessary.

COOLING - Forced-air cooling is required in all applications, and the use of an air-system socket, such as the EIMAC SK-291A, with a C-290 chimney, is recommended. Cooling is simplified if air is directed, in a base-to-anode direction; when so directed, with air at 50°C at sea level, minimum air

flow requirements are shown, with approximate pressure drop values for the tube/socket/chimney combination, to limit the maximum anode core temperature to 200°C. If air is not directed in a base-to-anode direction, additional cooling may be required for the base section of the tube. Cooling air should be applied before or simultaneously with the application of electrode voltages, including the heater, and should normally be maintained for a brief period after electrode voltages are removed to allow for tube cooldown.

Anode Diss.	Air Flow	Press. Drop
3000 W	78 cfm	0.32 In. H_2O
4000	124	0.50
5000	166	0.72

HEATER - The rated heater voltage for the Type 290 is 6.0 volts, as measured at the socket or tube base pins. Variations should be restricted to plus or minus 0.3 volt for long tube life and consistent performance.

GRID OPERATION - Grid-bias voltage must be obtained from a fixed bias supply in Class AB applications. The internal resistance of the source should not exceed 2500 ohms.

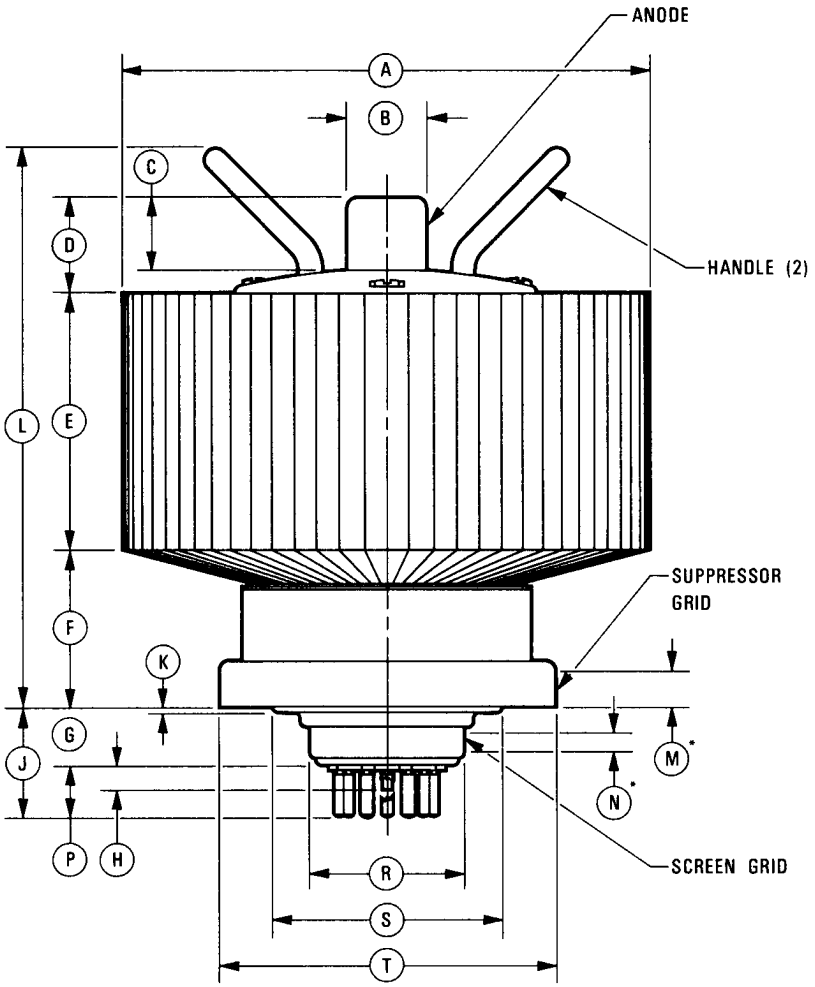
SCREEN OPERATION - In linear amplifier service, the screen voltage must be obtained from a well regulated source, to prevent excessive screen voltage variations due to changes in screen current which occur between zero-signal and full-signal conditions. The circuit should be arranged so that it is impossible to apply screen voltage without plate voltage. The use of a screen grid over-current relay is recommended, to remove screen voltage immediately in case of excessive screen current due to circuit problems, grid bias failure, or accidental removal of plate circuit loading.

PLATE OPERATION - The maximum rated plate dissipation power for the Type 290 is 5000 watts. Except for brief periods during circuit adjustment, this maximum value should not be exceeded. Contact to the plate may be made either at the top cap or by means of a circular clamp or spring-finger collet around the outer surface of the anode cooler itself. Points of electrical contact with the anode should be kept clean and free of oxide to minimize rf loss. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

NEUTRALIZATION FOR RF OPERATION - For minimum-distortion Class AB_1 linear amplifier service, where reaction on the driver circuit should be eliminated completely, it will usually be found advisable to neutralize the small feedback capacitance of the tube.

GENERAL OPERATION NOTES - A metal chassis or equivalent means should be provided to separate the input and output circuits of an rf amplifier employing the Type 290. Reasonable precautions should be observed in regard to bypassing and shielding of supply leads to prevent coupling between input and output through external circuits. The use of the EIMAC SK-291A air-system socket, with its integral screen grid bypass capacitance built in, is helpful in these respects.

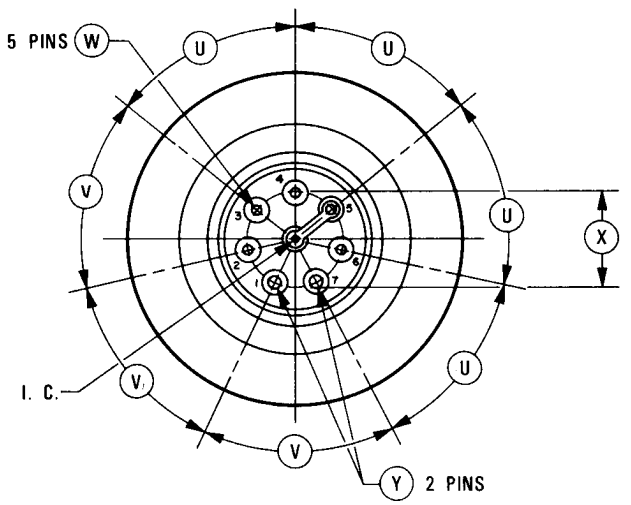
SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	5.468	5.532		138.89	140.51	
B	.805	.819		20.45	20.80	
C	.688	--		17.48	--	
D	.937	1.062		23.80	26.98	
E	2.624	2.688		66.65	68.28	
F	1.625	1.750		41.28	44.45	
G	.624	.688		15.85	17.48	
H	--	--	.187	--	--	4.75
J	1.062	1.250		26.97	31.75	
K	--	.125		--	3.18	
L	--	6.000		--	152.40	
M	.375	--		9.53	--	
N	.220	--		5.59	--	
P	.437	.562		11.10	14.27	
R	1.615	1.629		41.02	41.38	
S	--	2.812		--	46.02	
T	3.484	3.516		88.49	89.31	
U	--	--	51°	--	--	51°
V	--	--	52°	--	--	52°
W	.122	.128		3.10	3.25	
X	--	--	1.000	--	--	25.40
Y	.149	.159		3.78	4.04	

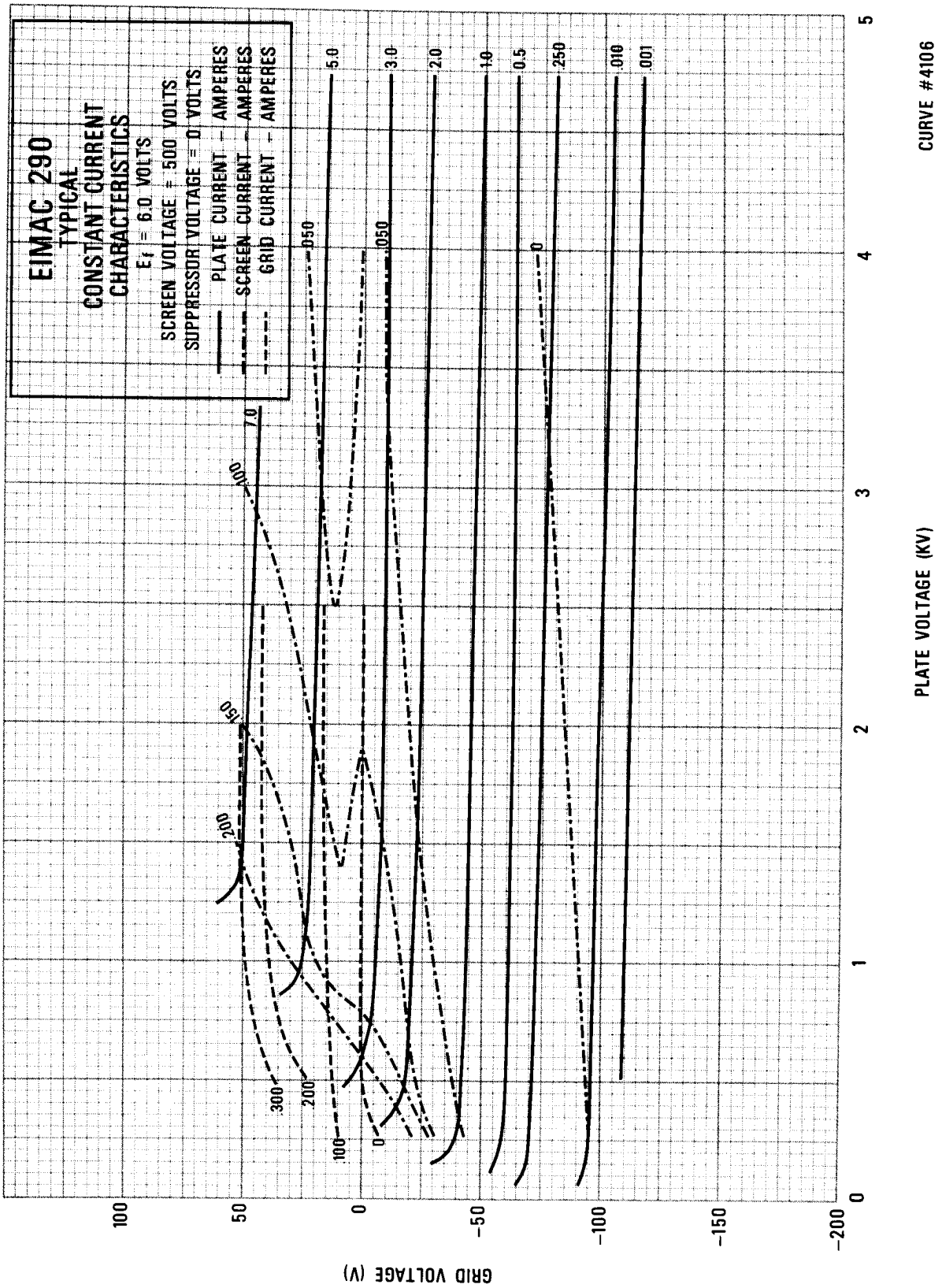
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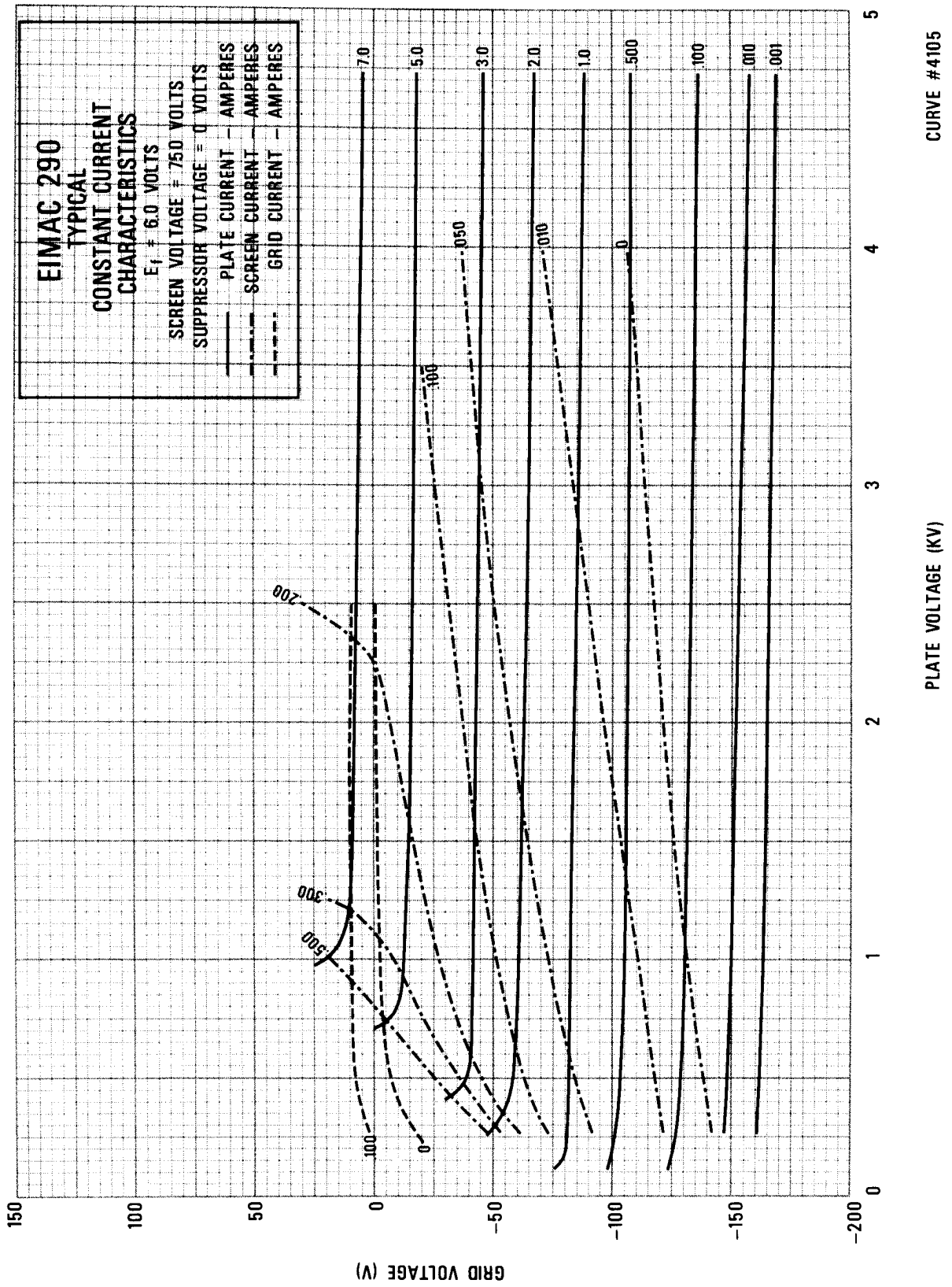
1. (*) CONTACT SURFACE
2. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



PIN CONNECTIONS

PIN NO.	ELEMENT
1	k
2	g1
3	h
4	k
5	h
6	g1
7	k
CENTER PIN	int. con.
LOWER RING	g2
UPPER RING	g3
CAP	p


EIMAC 290
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
E_f = 6.0 VOLTS
SCREEN VOLTAGE = 500 VOLTS
SUPPRESSOR VOLTAGE = 0 VOLTS
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
7.0
5.0
3.0
2.0
1.0
0.5
.250
.010
.001
.050
0
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE #4106


EIMAC 290
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
E_f = 6.0 VOLTS
SCREEN VOLTAGE = 750 VOLTS
SUPPRESSOR VOLTAGE = 0 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
7.0
5.0
3.0
2.0
1.0
.500
.100
.010
.001
.100
.050
.010
0
200
300
500
100
0
150
100
50
0
-50
-100
-150
-200
0
1
2
3
4
5
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE #4105

1000T

HIGH-MU TRIODE

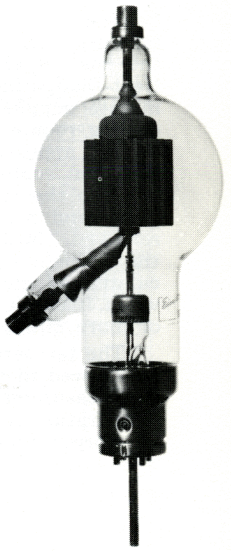
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MODULATOR
OSCILLATOR
AMPLIFIER

TECHNICAL DATA

The Eimac 1000T is a high-mu power triode intended for use as a modulator, oscillator, or amplifier. The tube has a maximum plate dissipation rating of 1000 watts, and a maximum plate voltage rating of 7500 volts at frequencies up to 50 Mc. Cooling is by forced air and radiation.

The 1000T in Class-C r-f service will deliver up to 3000 watts plate power output with 60 watts driving power. Two 1000T's in Class AB_2 modulator service will deliver up to 4600 watts maximum signal plate power output with 60 watts driving power.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	7.5 volts ± 5%
Current	15.5 amperes
Amplification Factor (Average)	35
Direct Interelectrode Capacitances (Average)	
Grid-Plate	5.1 μμf
Grid-Filament	9.3 μμf
Plate-Filament	0.5 μμf
Transconductance (I_b=750ma., E_b=6000v.)	9050 μmhos
Highest Frequency for Maximum Ratings	50 Mc

MECHANICAL

Base	50-watt jumbo 4-pin with air-conduction pipe
Connections	See outline drawing
Socket	Johnson type No. 123-211 or equivalent
Mounting Position	Vertical, base down or up
Cooling	Forced air and radiation
Maximum Temperature of Grid and Plate Seals	225°C
Recommended Grid and Plate Heat Dissipating Connectors	Eimac HR-9
Maximum Dimensions:	
Seated Height	12.3 inches
Diameter	5.13 inches
Net Weight	1.25 pounds
Shipping Weight (Average)	6.25 pounds

AUDIO-FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB_2

MAXIMUM RATINGS (Per tube)

D-C PLATE VOLTAGE	7500 MAX. VOLTS
D-C PLATE CURRENT	750 MAX. MA
PLATE DISSIPATION	1000 MAX. WATTS
GRID DISSIPATION	80 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	4000	5000	6000	volts
D-C Grid Voltage[1]	−85	−125	−160	volts
Zero-Signal D-C Plate Current	335	270	220	ma
Max-Signal D-C Plate Current	1.25	1.14	1.05	amps
Effective Load, Plate-to-Plate	6250	9200	13,300	ohms
Peak A-F Grid Voltage (per tube)	260	290	335	volts
Max-Signal Driving Power*	35	37	60	watts
Max-Signal Plate Power Input	5000	5700	6300	watts
Max-Signal Plate Power Output	3000	3700	4600	watts

[1]Adjust to stated Zero-Signal Plate Current.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions, per tube)

MAXIMUM RATINGS (Frequencies up to 50 Mc.)

D-C PLATE VOLTAGE	7500 MAX. VOLTS
D-C PLATE CURRENT	750 MAX. MA
PLATE DISSIPATION	1000 MAX. WATTS
GRID DISSIPATION	80 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 50 Mc.)

D-C Plate Voltage	3000	4000	5000	6000 volts
D-C Grid Voltage	−150	−150	−225	−350 volts
D-C Plate Current	750	713	667	667 ma
D-C Grid Current*	90	100	87	110 ma
Peak R-F Grid Voltage	350	365	420	610 volts
Driving Power*	30	33	33	60 watts
Grid Dissipation*	21	19	14	25 watts
Plate Power Input	2250	2850	3335	4000 watts
Plate Power Output	1350	1850	2335	3000 watts

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS (Frequencies up to 50 Mc.)

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	600 MAX. MA
PLATE DISSIPATION	665 MAX. WATTS
GRID DISSIPATION	80 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 50 Mc.)

D-C Plate Voltage	4000	5000	6000	volts
D-C Grid Voltage	−300	−400	−500	volts
D-C Plate Current	600	600	600	ma
D-C Grid Current*	80	90	95	ma
Peak R-F Grid Voltage	540	660	775	volts
Driving Power*	45	60	75	watts
Grid Dissipation*	20	24	25	watts
Plate Power Input	2400	3000	3600	watts
Plate Power Output	1735	2335	2935	watts

*Approximate values

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION," POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EIMAC DIVISION OF VARIAN ASSOCIATES, FOR INFORMATION AND RECOMMENDATIONS

(Revised 12-15-65) Copyright 1952, 1965 by Varian Associates

APPLICATION

MECHANICAL

Mounting—The 1000T must be mounted vertically. The base may be either down or up. The leads to the plate and grid terminals should be flexible, and the tube must be protected from vibration and shock.

Cooling—The envelope and seals of the 1000T require forced-air cooling. Air-conduction pipes are provided in the base of the tube and in the HR-9 plate and grid Heat-Dissipating Connectors. Two cubic feet of air per minute supplied to each of these pipes will satisfy the cooling requirements of the seals. An 8- or 10-inch fan located approximately a foot from the tube will provide sufficient cooling air for the envelope. Air must be supplied to the tube when plate and grid voltages are applied, and must be continued until these voltages are removed. In some cases, particularly in locations where the ambient temperature is high, or where the free circulation of air is impeded, cooling air must be supplied when filament voltage is applied, and continued for two or more minutes after all voltages are removed.

The temperature of the grid and plate seals must not be allowed to exceed 225°C. A convenient accessory for the measurements of these temperatures is "Tempilaq", a temperature-sensitive lacquer manufactured by the Tempil Corporation, 132 W. 22nd St., New York 11, N. Y.

ELECTRICAL

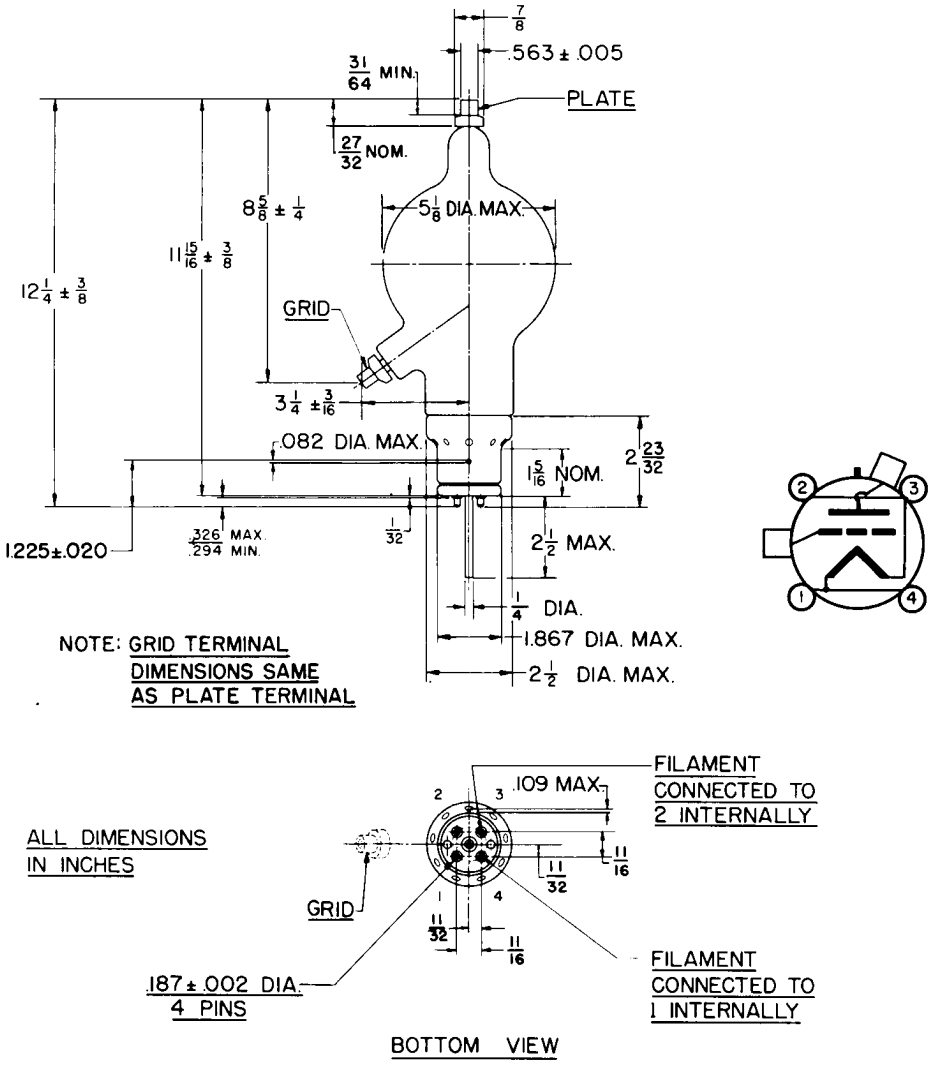
Filament—All four socket terminals should be used, putting two in parallel for each filament connection.

Bias Voltage—The maximum limit on bias voltages which may be used with the 1000T is considerably above those listed in "Typical Operation." Where bias is obtained by a grid leak, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Plate Voltage—The rated maximum d-c plate voltage of 7500 volts applies at frequencies up to 50 Mc. Above that frequency the tube must be operated at lower d-c voltages. In most cases there is little advantage in using plate supply voltages higher than those given under "Typical Operation" for the power output desired.

Grid Dissipation—Grid dissipation may be assumed to be the product of the d-c grid current and the peak positive cathode-to-grid voltage. This assumption is sufficiently accurate for the purpose of determining that the 1000T is operating within its maximum rated grid dissipation of 80 watts.

Plate Dissipation—Under normal operating conditions, the power dissipated by the plate of the 1000T should not be allowed to exceed 1000 watts. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.



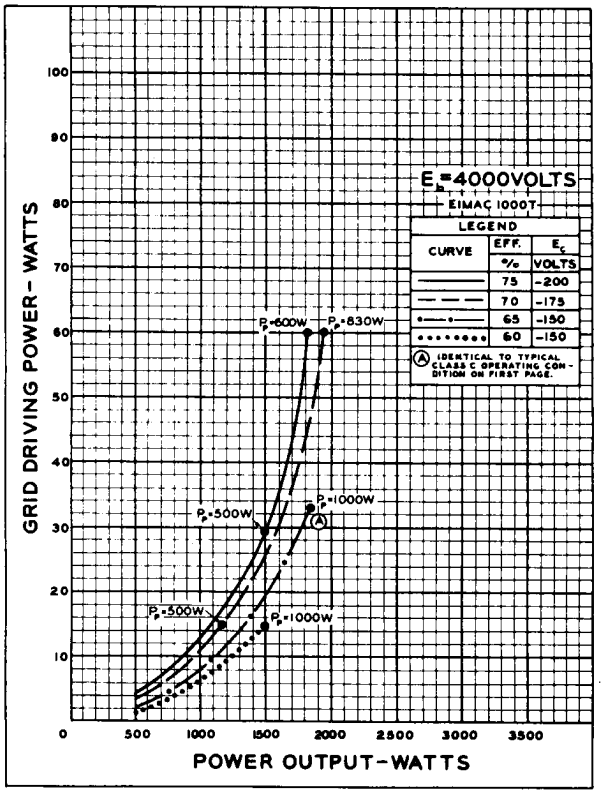
DRIVING POWER vs. POWER OUTPUT

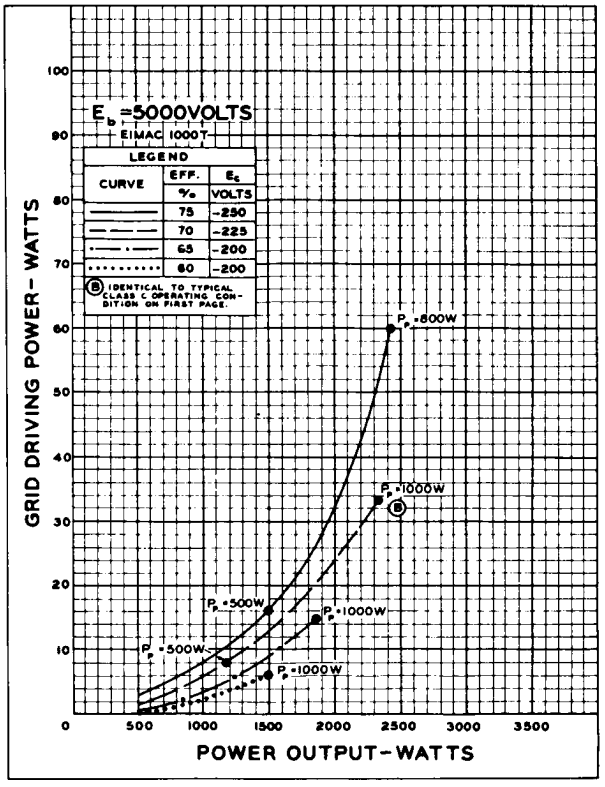
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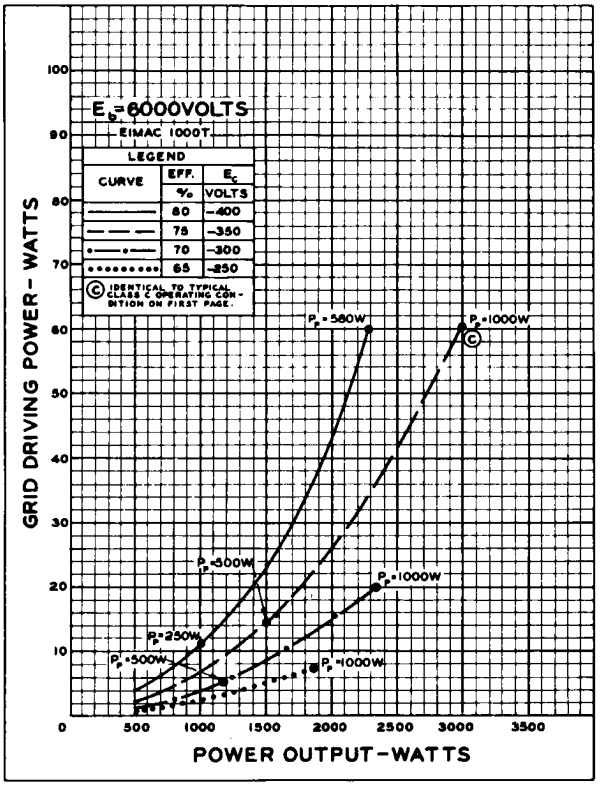
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 4000, 5000 and 6000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

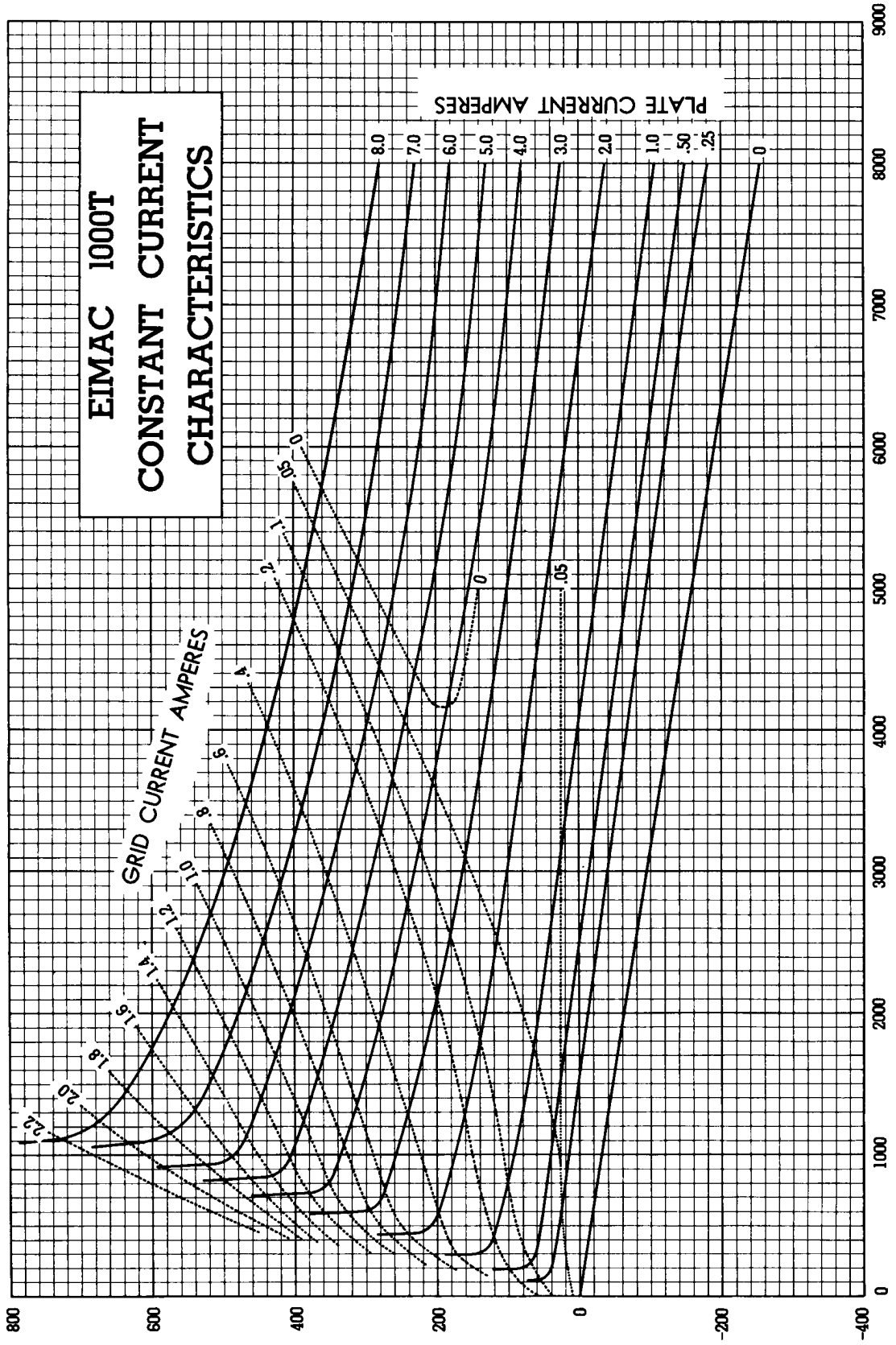
Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 4000, 5000, and 6000 volts respectively.

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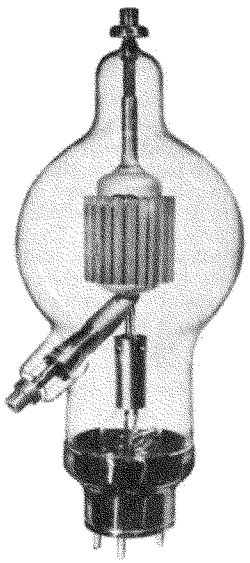


Printed in U.S.A. 924

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

1500T

MEDIUM-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER



The Eimac 1500T is a medium-mu, high-vacuum transmitting triode intended for amplifier, oscillator and modulator service. It has a maximum plate dissipation rating of 1500 watts. Cooling of the 1500T is accomplished by radiation from the plate, which operates at a visibly red temperature at maximum dissipation, and by means of forced air circulation around the envelope and at the seals.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	7.5 volts
Current	24.0 amperes
Amplification Factor (Average)	24
Direct Interelectrode Capacitances (Average)	
Grid-Plate	7.2 $\mu\mu$fd.
Grid-Filament	9.9 $\mu\mu$fd.
Plate-Filament	1.5 $\mu\mu$fd.
Transconductance (i_b = 1.25 amp., E_b = 6000 v., E_c = −155 v.)	10,000 μmhos

MECHANICAL

Base	Special 4-pin, No. 5005B
Basing	RMA type 4BD
Cooling	Radiation and forced air
Maximum Overall Dimensions:	
Length	17.0 inches
Diameter	7.125 inches
Net Weight	3.5 pounds
Shipping Weight (Average)	8.5 pounds

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy (Key-down conditions, 1 tube)

MAXIMUM RATINGS (Frequencies below 40 Mc.)

D-C PLATE VOLTAGE	▶8000 MAX. VOLTS
D-C PLATE CURRENT	1.25 MAX. AMPS.
PLATE DISSIPATION	1500 MAX. WATTS
GRID DISSIPATION	125 MAX. WATTS

TYPICAL OPERATION (Frequencies below 40 Mc.)

D-C Plate Voltage	5000	6000	7000	volts
D-C Grid Voltage	−375	−600	−500	volts
D-C Plate Current	1.00	1.00	.860	amps.
D-C Grid Current	150	165	110	ma.
Grid Dissipation	59	61	30	watts
Peak R-F Grid Input Voltage (approx.)	850	1100	885	volts
Driving Power (approx.)	115	160	85	watts
Plate Power Input	5000	6000	6000	watts
Plate Dissipation	1500	1500	1500	watts
Plate Power Output	3500	4500	4500	watts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	▶8000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	1.25 MAX. AMPS.
PLATE DISSIPATION, PER TUBE	1500 MAX. WATTS
GRID DISSIPATION, PER TUBE	125 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	4000	5000	6000	volts
D-C Grid Voltage (approx.)	−95	−145	−190	volts
Zero-Signal D-C Plate Current	500	400	330	ma.
Max-Signal D-C Plate Current	1.88	1.72	1.65	amps.
Effective Load, Plate-to-Plate	4150	6150	8200	ohms
Peak A-F Grid Input Voltage (per tube)	485	535	570	volts
Max-Signal Avg. Driving Power (approx.)	95	105	115	watts
Max-Signal Plate Dissipation	1500	1500	1450	watts
Max-Signal Plate Power Output	4500	5600	7000	watts

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▶ Indicates change from sheet dated 7-1-44.

APPLICATION

MECHANICAL

Mounting—The 1500T must be mounted vertically, base up or base down. Flexible connecting straps should be provided between the grid and plate terminals and the external grid and plate circuits. The tube must be protected from severe vibration and shock.

Cooling—The envelope and seals of the 1500T require artificial cooling. An ordinary 8- or 10-inch fan located one foot from the tube will provide sufficient air for cooling the envelope. The air should be directed at the tube in a manner which will allow the most uniform cooling of the envelope. The grid and plate seals each require a minimum flow of two cubic feet of air per minute. The air for the grid seal is fed through the grid connector. A special connector (Eimac HR-9) is available for this purpose. A special heat-dissipating connector (Eimac HR-8) is also available for use on the plate terminal. A minimum flow of two cubic feet of air per minute must likewise be supplied to the filament seals through the hole at the center of the base. Suitable electrical interlocks should be provided to remove the plate and filament voltages in the event that the supply of cooling air is interrupted.

ELECTRICAL

Filament Voltage—The filament voltage, as measured directly at the filament pins, should be between 7.125 and 7.875 volts.

Bias Voltage—Although there is no maximum limit on the bias voltage which may be used on the 1500T, there is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained by a grid leak, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Plate Voltage—The plate supply voltage for the 1500T should not exceed 8000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

Grid Dissipation—The power dissipated by the grid of the 1500T must not exceed 125 watts. Grid dissipation may be calculated from the following expression:

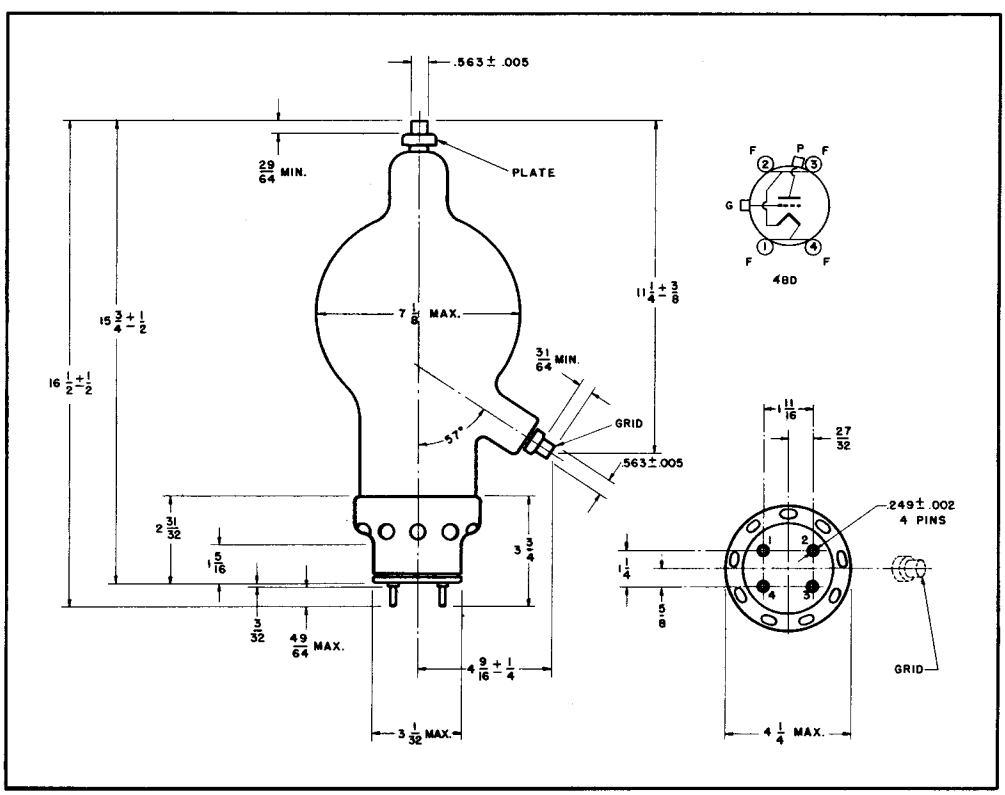
$$P_g = e_{cmp} I_c$$

where P_g = Grid dissipation,
e_{cmp} = Peak positive grid voltage, and
I_c = D-c grid current.

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid.[1] In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

Plate Dissipation—Under normal operating conditions, the power dissipated by the plate of the 1500T should not be allowed to exceed 1500 watts. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

[1] For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings," **Eimac News**, January, 1945. This article is available in reprint form on request.



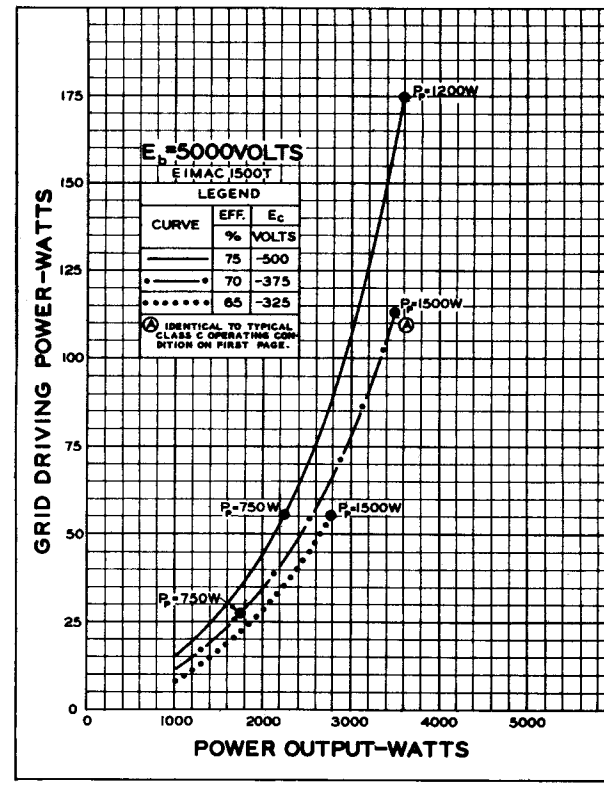
DRIVING POWER vs. POWER OUTPUT

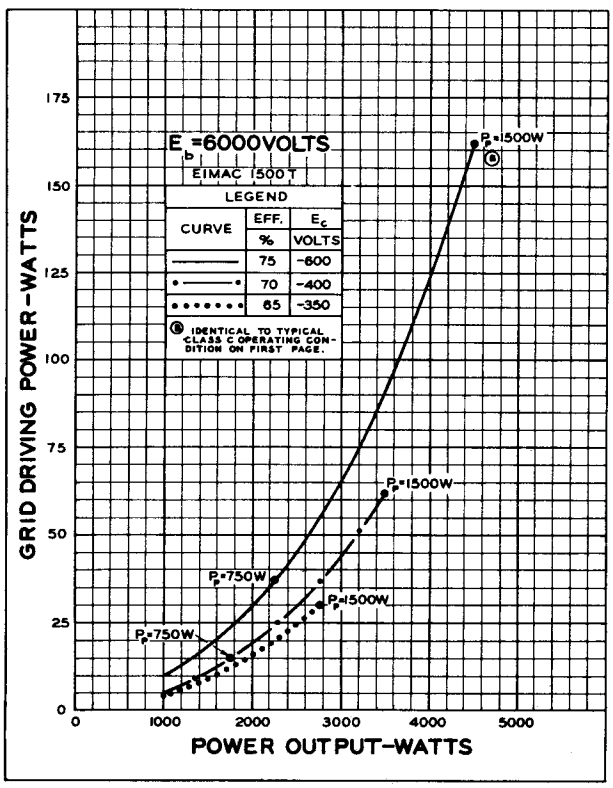
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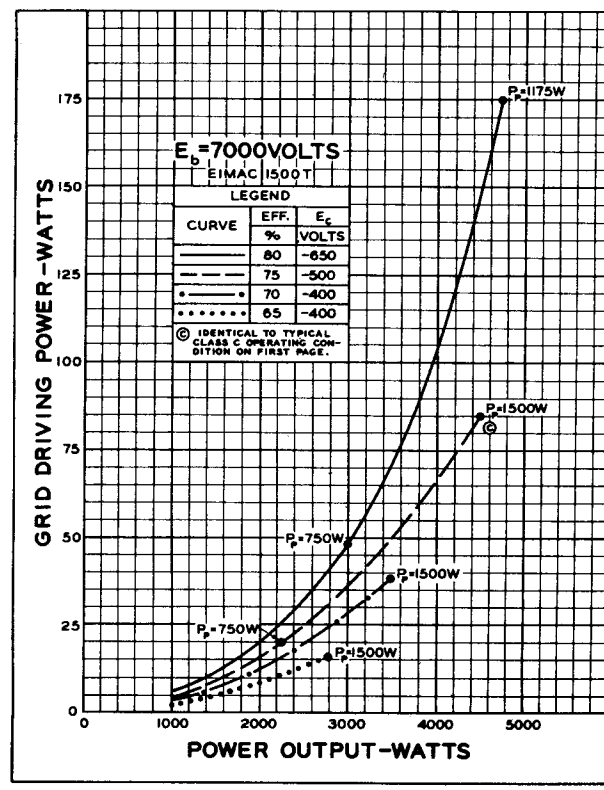
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 5000, 6000, and 7000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

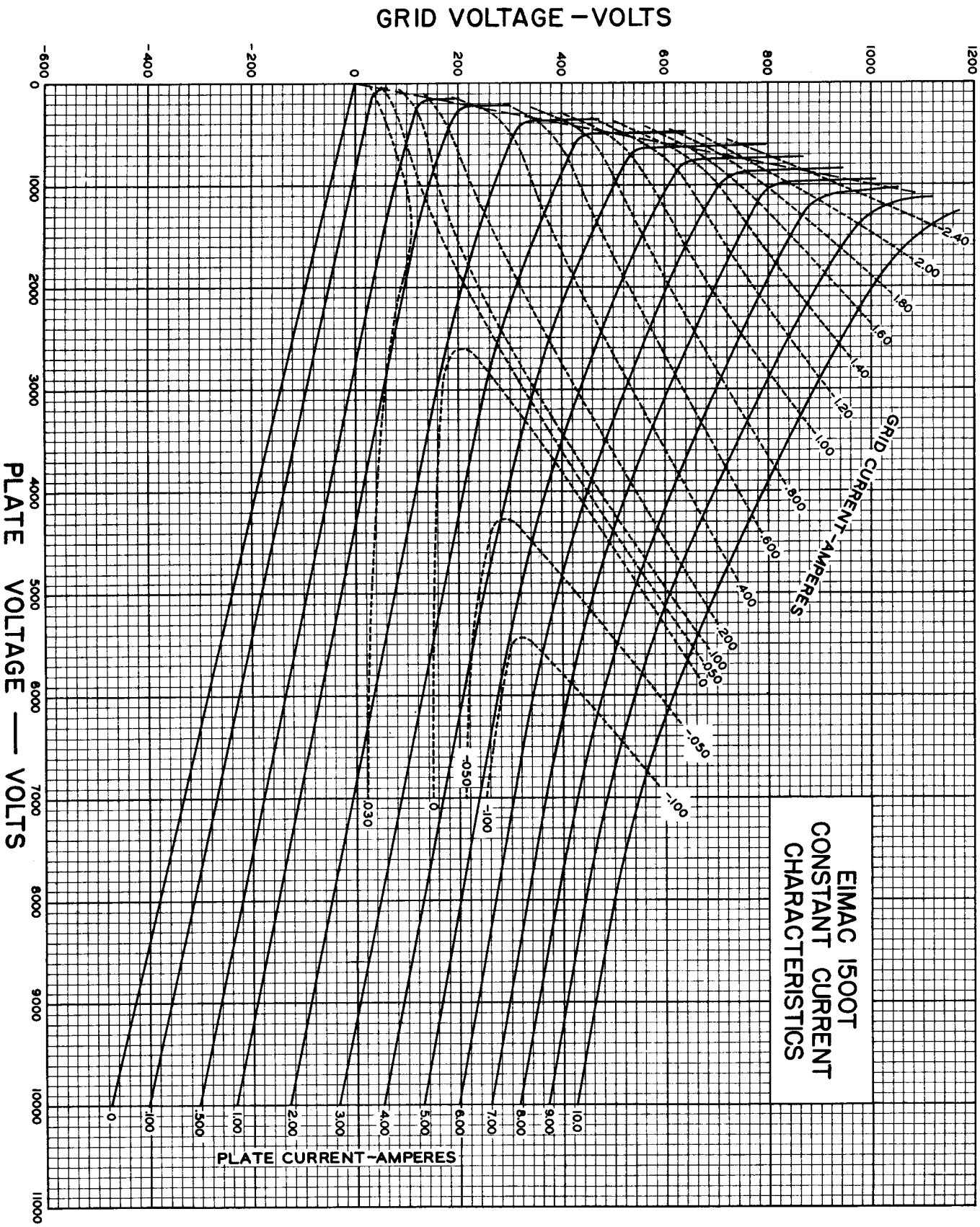
Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 5000, 6000, and 7000 volts respectively.

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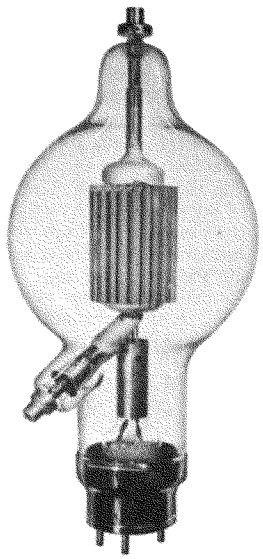
Printed in U. S. A. 3-E6-22648

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

2000T

MEDIUM-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER

The 2000T is a medium-mu, high-vacuum transmitting triode intended for amplifier, oscillator and modulator service. It has a maximum plate dissipation rating of 2000 watts. Cooling of the 2000T is accomplished by radiation from the plate, which operates at a visibly red temperature at maximum dissipation, and by means of forced air circulation around the envelope and at the seals.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	10.0 volts
Current	25.0 amperes
Amplification Factor (Average)	23
Direct Interelectrode Capacitances (Average)	
Grid-Plate	8.5 $\mu\mu$fd.
Grid-Filament	12.7 $\mu\mu$fd.
Plate-Filament	1.7 $\mu\mu$fd.
Transconductance ($i_b = 1.75$ amp., $E_b = 6000$ v., $E_c = -95$ v.)	11,000 μmhos

MECHANICAL

Base	Special 4-pin, No. 5006B
Basing	RMA type 4BD
Cooling	Radiation and forced air
Maximum Overall Dimensions:	
Length	17.75 inches
Diameter	8.125 inches
Net weight	3.5 pounds
Shipping weight (Average)	8.5 pounds

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy (Key-down conditions, 1 tube)

MAXIMUM RATINGS (Frequencies below 40 Mc.)

D-C PLATE VOLTAGE	▶8000 MAX. VOLTS
D-C PLATE CURRENT	1.75 MAX. AMPS.
PLATE DISSIPATION	2000 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION (Frequencies below 40 Mc.)

D-C Plate Voltage	5000	6000	7000	volts
D-C Grid Voltage	−350	−500	−600	volts
D-C Plate Current	1.35	1.35	1.15	amps
D-C Grid Current	175	165	120	ma.
Grid Dissipation	79	78	43	watts
Peak R-F Grid Input Voltage (approx.)	900	1050	1060	volts
Driving Power, (approx.)	140	160	115	watts
Plate Power Input	6670	8000	8000	watts
Plate Dissipation	2000	2000	2000	watts
Plate Power Output	4670	6000	6000	watts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	▶8000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	1.75 MAX. AMPS.
PLATE DISSIPATION, PER TUBE	2000 MAX. WATTS
GRID DISSIPATION, PER TUBE	150 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	5000	6000	7000	volts
D-C Grid Voltage	−180	−230	−290	volts
Zero-Signal D-C Plate Current	480	400	350	ma.
Max-Signal D-C Plate Current	2.00	1.88	1.86	amps.
Effective Load, Plate-to-Plate	4900	6650	8500	ohms
Peak A-F Grid Input Voltage (per tube)	470	525	590	volts
Max-Signal Avg. Driving Power (approx.)	50	60	75	watts
Max-Signal Peak Driving Power	178	184	212	watts
Max-Signal Plate Dissipation (per tube)	2000	1875	2000	watts
Max-Signal Plate Power Output	6000	7500	9000	watts

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▶Indicates change from sheet dated 6-15-44

APPLICATION

MECHANICAL

Mounting—The 2000T must be mounted vertically, base up or base down. Flexible connecting straps should be provided between the grid and plate terminals and the external grid and plate circuits. The tube must be protected from severe vibration and shock.

Cooling—The envelope and seals of the 2000T require artificial cooling. An ordinary 8- or 10-inch fan located one foot from the tube will provide sufficient air for cooling the envelope. The air should be directed at the tube in a manner which will allow the most uniform cooling of the envelope. The grid and plate seals each require a minimum flow of two cubic feet of air per minute. The air for the grid seal is fed through the grid connector. A special connector (Eimac HR-9) is available for this purpose. A special heat-dissipating connector (Eimac HR-8) is also available for use on the plate terminal. A minimum flow of two cubic feet of air per minute must likewise be supplied to the filament seals through the hole at the center of the base. Suitable electrical interlocks should be provided to remove the plate and filament voltages in the event that the supply of cooling air is interrupted.

ELECTRICAL

Filament Voltage—The filament voltage, as measured directly at the filament pins, should be between 9.5 and 10.5 volts.

Bias Voltage—Although there is no maximum limit on the bias voltage which may be used on the 2000T there is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained by a grid leak, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Plate Voltage—The plate supply voltage for the 2000T should not exceed 8000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

Grid Dissipation—The power dissipated by the grid of the 2000T must not exceed 150 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp} I_c$$

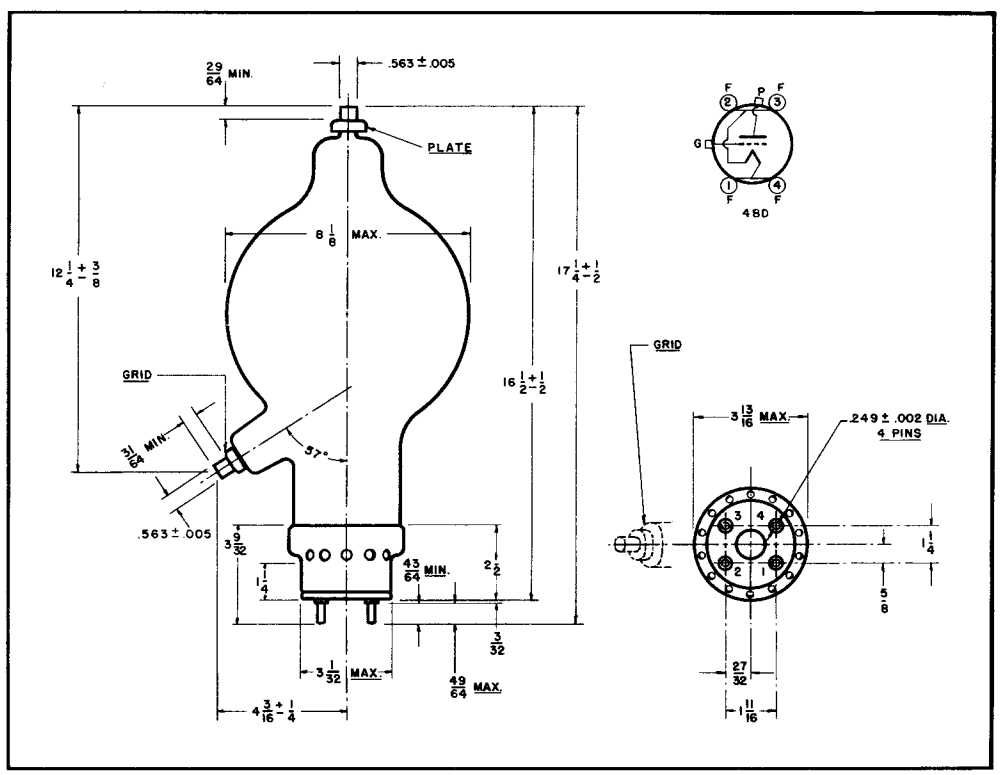
where P_g = Grid dissipation,
e_{cmp} = Peak positive grid voltage, and
I_c = D-c grid current.

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid.[1] In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

Plate Dissipation—Under normal operating conditions, the power dissipated by the plate of the 2000T should not be allowed to exceed 2000 watts. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

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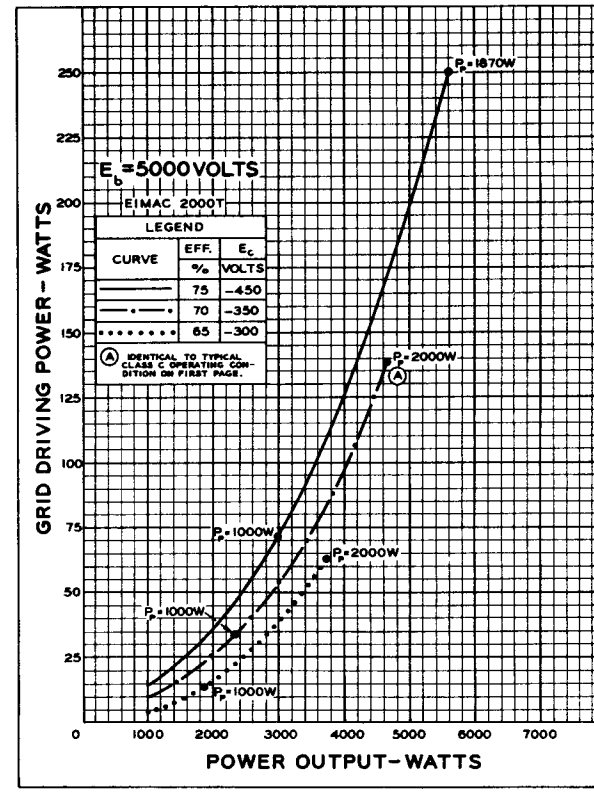
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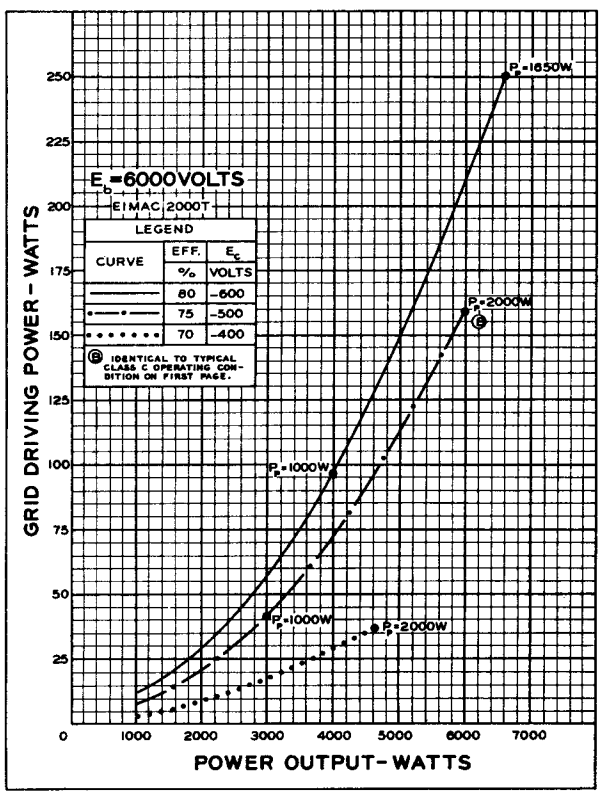


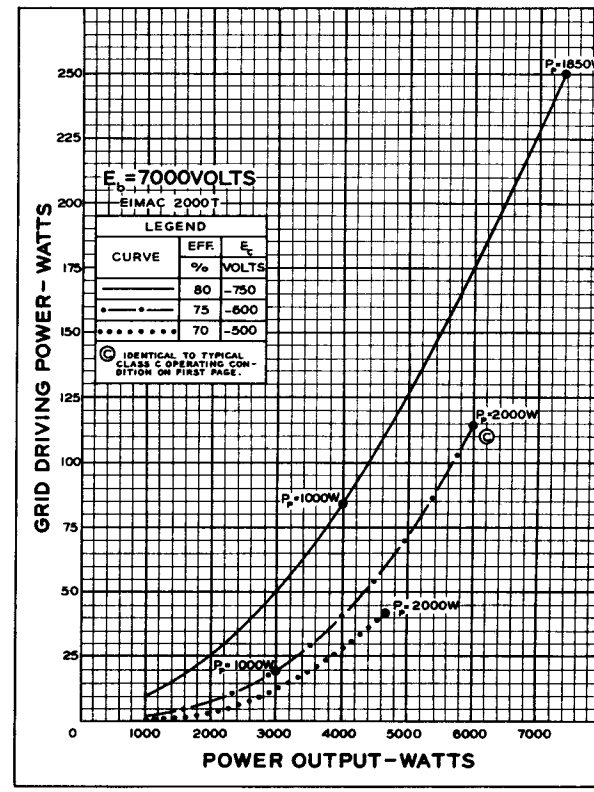
DRIVING POWER vs. POWER OUTPUT

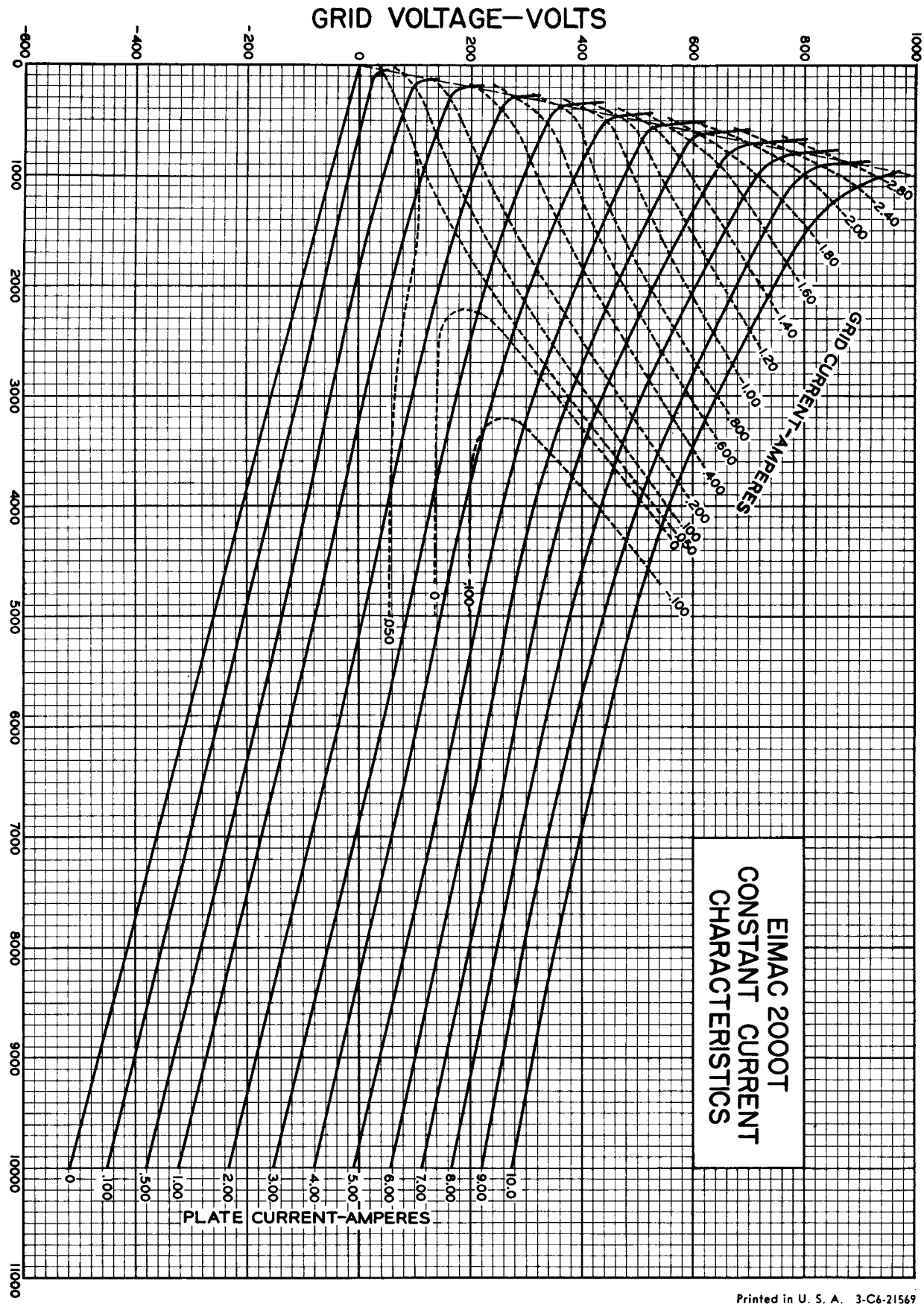
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 5000, 6000, and 7000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 5000, 6000, and 7000 volts respectively.







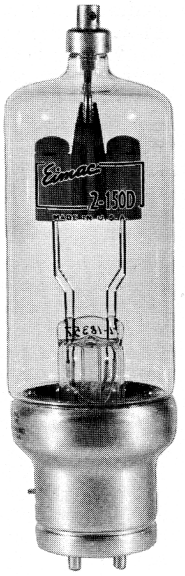


Printed in U. S. A. 3-C6-21569

EIMAC
A Division of Varian Associates
SAN CARLOS, CALIFORNIA

2-150D

HIGH-VACUUM RECTIFIER



The Eimac 2-150D is a high vacuum diode rectifier intended for use in rectifier units, voltage multipliers, or in special applications, whenever conditions of extreme ambient temperatures, high operating frequency, high peak inverse voltages, or the production of high-frequency transients would prevent the use of gas-filled rectifier tubes.

The 2-150D has a maximum d-c current rating of 250 milliamperes and a maximum peak inverse voltage rating of 30,000 volts. Cooling is by convection and radiation.

A single 2-150D will deliver 200 milliamperes at 11,800 volts to a capacitor-input filter with 10,600 volts single-phase supply. Four 2-150D's in a bridge circuit will deliver 500 milliamperes at 19,000 volts to a choke-input filter with 21,200 volts single-phase supply.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	5.0 volts
Current	13.0 amperes

MECHANICAL

Base	50-watt jumbo 4-pin bayonet
Basing	Refer to outline drawing
Socket	Refer to discussion under "Application"
Mounting Position	Vertical, base down or up
Cooling	Convection and Radiation
Maximum Temperature of Plate Seal	225°C
Recommended Heat Dissipating Plate Connector	Eimac HR-6
Maximum Over-all Dimensions:	
Length	8.88 inches
Diameter	2.50 inches
Net Weight	9 ounces
Shipping Weight (approx.)	1 pound

MAXIMUM RATINGS (Per tube)

PEAK INVERSE PLATE VOLTAGE	30,000 MAX. VOLTS
PLATE DISSIPATION	90 MAX. WATTS
D-C PLATE CURRENT[1]	250 MAX. MA
PEAK PLATE CURRENT	3.0 MAX. AMPERES

[1]Averaged over one cycle for each tube. Applies only when the rectifier is coupled to the load by a choke-input filter incorporating the "critical" value (or larger) of input inductance. For maximum d-c current ratings under this and other load conditions see discussion under "Application."

(Revised 12-15-65) Copyright 1952, 1965 by Varian Associates

APPLICATION

MECHANICAL

Mounting — The 2-150D must be mounted vertically with the base either down or up. The lead to the plate terminal of the tube should be flexible.

The 50-watt jumbo 4-pin bayonet base fits an E. F. Johnson Co. No. 123-211, a National Co. No. XM-50, or an equivalent socket. In some circuits, particularly those of the voltage multipliers illustrated in Fig. 2, it may be necessary to mount the socket on stand-off insulators, or on a sheet of insulating material, to provide adequate insulation to ground.

Cooling — The 2-150D is cooled by convection and radiation. Clearance should be provided around the glass envelope adequate for the free circulation of air. An Eimac HR-6 Heat Dissipating Connector or equivalent is required on the plate terminal.

The maximum temperature at the plate seal must not exceed 225°C. A convenient accessory for measuring this temperature is "Tempilaq," a temperature-sensitive lacquer available from the Tempil Corporation, 132 W. 22nd Street, New York 11, N.Y.

ELECTRICAL

Filament Operation — For maximum tube life, the filament voltage, as measured at the base pins, should be the rated value of 5.0 volts. Variations must be kept within the range from 4.75 to 5.25 volts. In applications which require the diode to deliver high peak currents, it is important to maintain the filament voltage at the rated value.

CAUTION SHOULD BE OBSERVED WHEN MEASURING RECTIFER FILAMENT VOLTAGE. THE FILAMENT CIRCUIT MAY BE AT HIGH POTENTIAL.

The thoriated-tungsten filament of the 2-150D reaches operating temperature in a fraction of a second after application of voltage. Plate voltage may be applied simultaneously with filament voltage.

Plate Operation—With low room illumination, the plate of the 2-150D begins to show color as the maximum plate dissipation rating of 90 watts is approached. The maximum peak inverse voltage rating of 30,000 volts should not be exceeded at any time.

Performance — The accompanying table shows some maximum performance capabilities of the 2-150D when used as a power-supply rectifier.

2-150D MAXIMUM-PERFORMANCE CAPABILITIES

Circuit Type	A-C Input Voltage (volts rms)	Capacitor-Input Filter D-C Output Voltage (volts)	Capacitor-Input Filter D-C Output Current (ma)	Choke-Input Filter D-C Output Voltage (volts)	Choke-Input Filter D-C Output Current (ma)
Single-Phase, Half-Wave	10,600	11,800	200	.....	.....
Single-Phase, Full-Wave	10,600[1]	11,800	400	9500	500
Single-Phase, Bridge	21,200	23,600	400	19,000	500

[1]One-half the transformer secondary voltage.

Maximum D-C Current Ratings — Plate dissipation rather than peak current usually limits the d-c current which the 2-150D is capable of delivering to the load. Because the plate dissipation associated with a given d-c current depends upon the amount of ripple and its wave-shape, circuit conditions will determine the maximum d-c current rating of the tube.

Choke-Input Filter — The maximum d-c current rating of the 2-150D is 250 milliamperes when the load incorporates a choke-input filter with the "critical" value (or larger) of input inductance (L_f in Fig. 1):

$$L_o = \frac{R_{eff}}{18.8f} \quad \text{for full-wave single-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{75f} \quad \text{for half-wave three-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{660f} \quad \text{for full-wave three-phase rectifiers,}$$

where: L_o = "critical" value of input inductance (henries),

f = supply-line frequency (cycles per second),

$$R_{eff} = \frac{\text{Load voltage (volts)}}{\text{Load current (amps)}}$$

Choke-input filters are not normally used with single-phase half-wave rectifiers.

Capacitor-Input Filter — The 2-150D is particularly suitable for power-supply applications demanding high voltage at low current. Under these conditions capacitor-input filter circuits become desirable. The maximum d-c current rating of the 2-150D when no input choke is incorporated in the filter depends upon the total series resistance of the capacitor-charging circuit relative to the effective load resistance seen by each tube. The circuit diagrams and tabulation in Fig. 2 are so arranged and labeled that this required series resistance may be found for a wide range of load conditions. This may be done by determining the value of the following quantities.

E_c is the filter-input d-c voltage. While this is usually the entire load voltage, in the case of voltage multipliers it is the load voltage divided by the multiplication factor.

I_p is the d-c current per tube. This is the entire load current only in the case of the simple half-wave rectifier or half- or full-wave multiplier. In the case of full-wave center-tapped or bridge rectifiers, I_p is half the load current.

R_c is the total charging-circuit resistance. A certain minimum value of charging-circuit resistance is necessary to limit the peak value of current to which the tubes will be subjected under given load conditions. This required minimum depends upon the d-c current per tube (I_p), and has been tabulated in Fig. 2 as a percentage of the effective load resistance per tube (E_c/I_p). The total charging-circuit resistance involves the internal resistance of the rectifier tube, R_p, the added series resistor, R_s, and the equivalent internal resistance of the a-c voltage supply, R_i.

R_p is the plate resistance of the 2-150D, which may be taken as 300 ohms.

R_i is the equivalent internal resistance of the supply. This may be taken as the regulation of the high-voltage supply expressed as a decimal multiplied by the load resistance used in measuring this regulation.

R_s is the series resistor which must be inserted in the charging circuit to bring the total charging-circuit resistance up to the required minimum. Its value may be found from the formula associated with each of the circuits of Fig. 2. This resistor must be inserted in such a position in the circuit that it protects all tubes.

Tubes may be operated in parallel to increase the output capability in a given circuit. When two tubes are placed in parallel at each place where one is shown in the circuits of Fig. 2, the plate resistance (R_p) will be half as great and the load maximum allowable load current twice as great as indicated.

Peak Inverse Voltage—The peak inverse voltage rating of the 2-150D is 30,000 volts. In single-phase power-supply rectifier circuits the peak inverse voltage to be used in design is the peak a-c supply voltage (1.41 times E_{rms} in Fig. 2) in the case of bridge circuits, and twice this value in the case of half- and full-wave rectifiers and voltage multipliers. Peak inverse voltage in three-phase operation depends upon the circuit employed, and will be found listed in the handbooks.

Special Applications—The ratings given for capacitor-input filter circuits assume values of input capacitance large enough to hold the ripple to a low value. In special applications where a larger percent ripple is tolerable, and filter capacitance is low, the 2-150D is capable of larger d-c output currents.

As a unidirectional conductor in d-c circuits where the current is continuous and the percent ripple is moderate, the maximum current rating of the 2-150D is 500 milliamperes.

The plate characteristic curve for the 2-150D serves as a guide to special applications. The maximum plate dissipation rating of 90 watts, the maximum peak inverse voltage rating of 30,000 volts, and the maximum peak plate current of 3.0 amperes must not be exceeded.

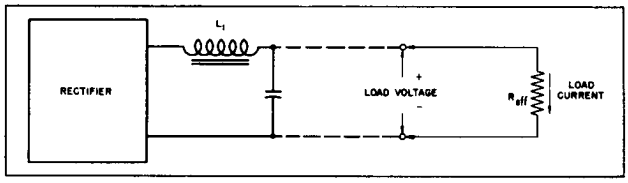
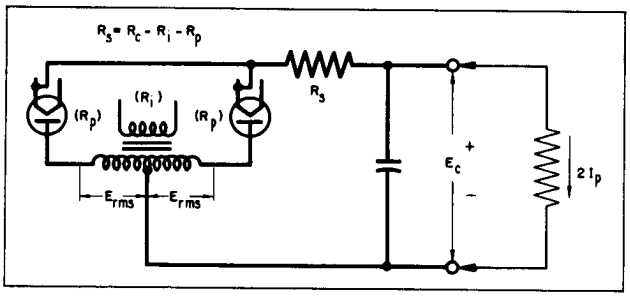
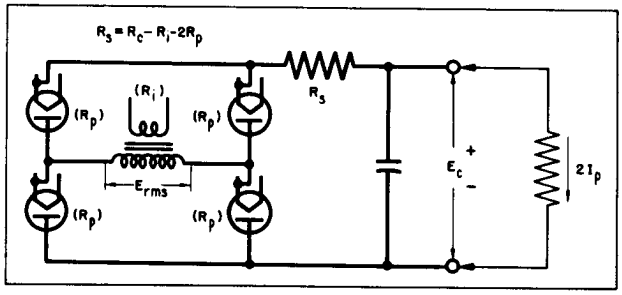


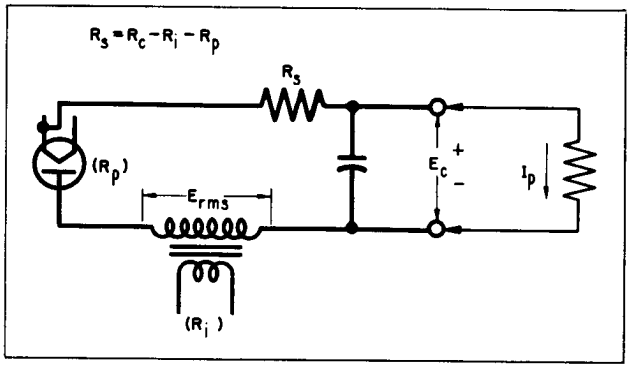
Fig. 1. Rectifier with Choke-Input Filter



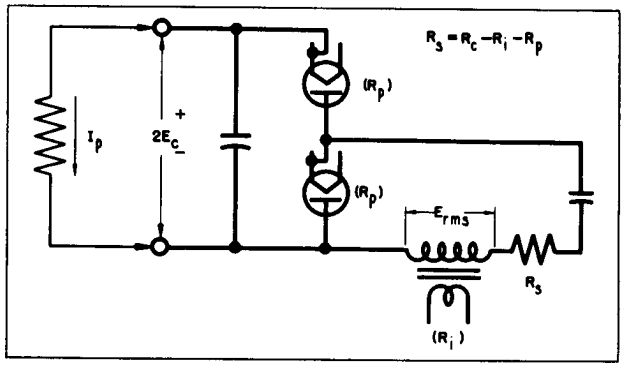
a. Full-Wave Center-Tapped Rectifier



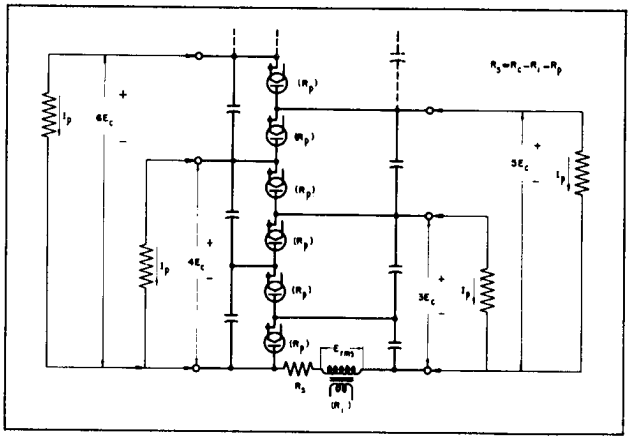
b. Full-Wave Bridge Rectifier



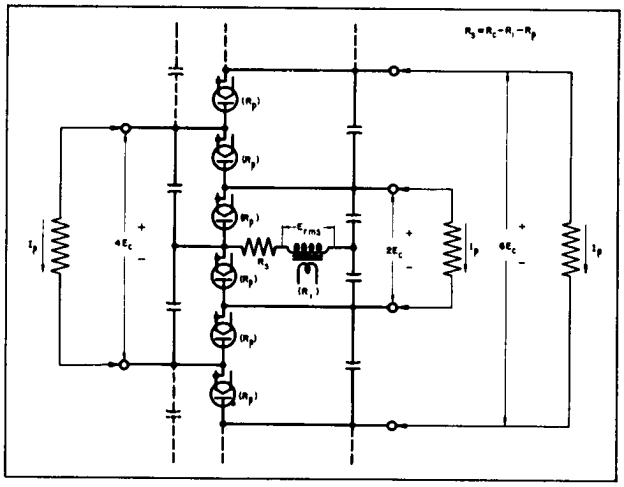
c. Half-Wave Rectifier



d. Half-Wave Voltage Doubler



e. Half-Wave Voltage Multiplier (with common ground when R_s is inserted on the "high" side of E_{rms})



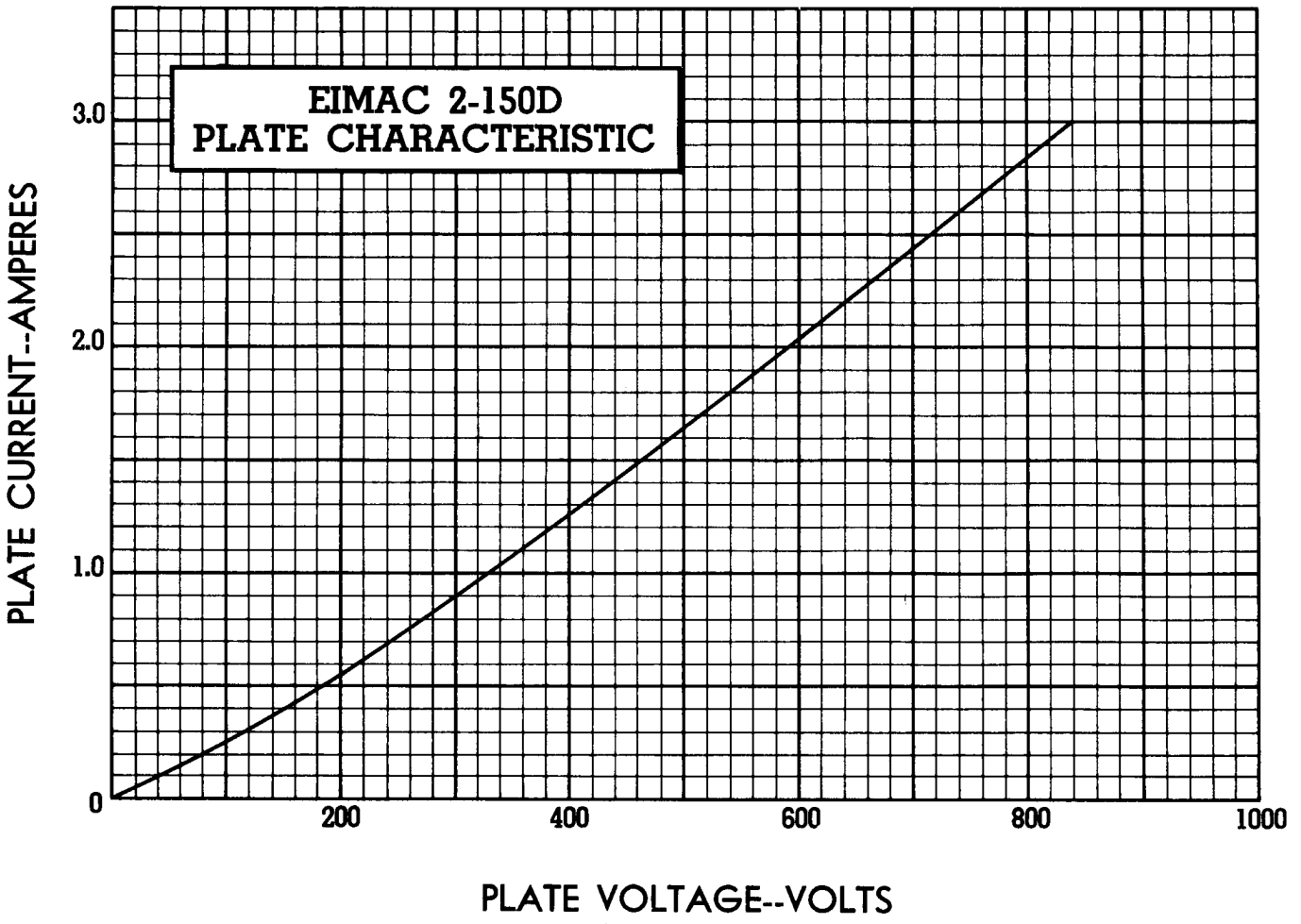
f. Full-Wave Voltage Multiplier

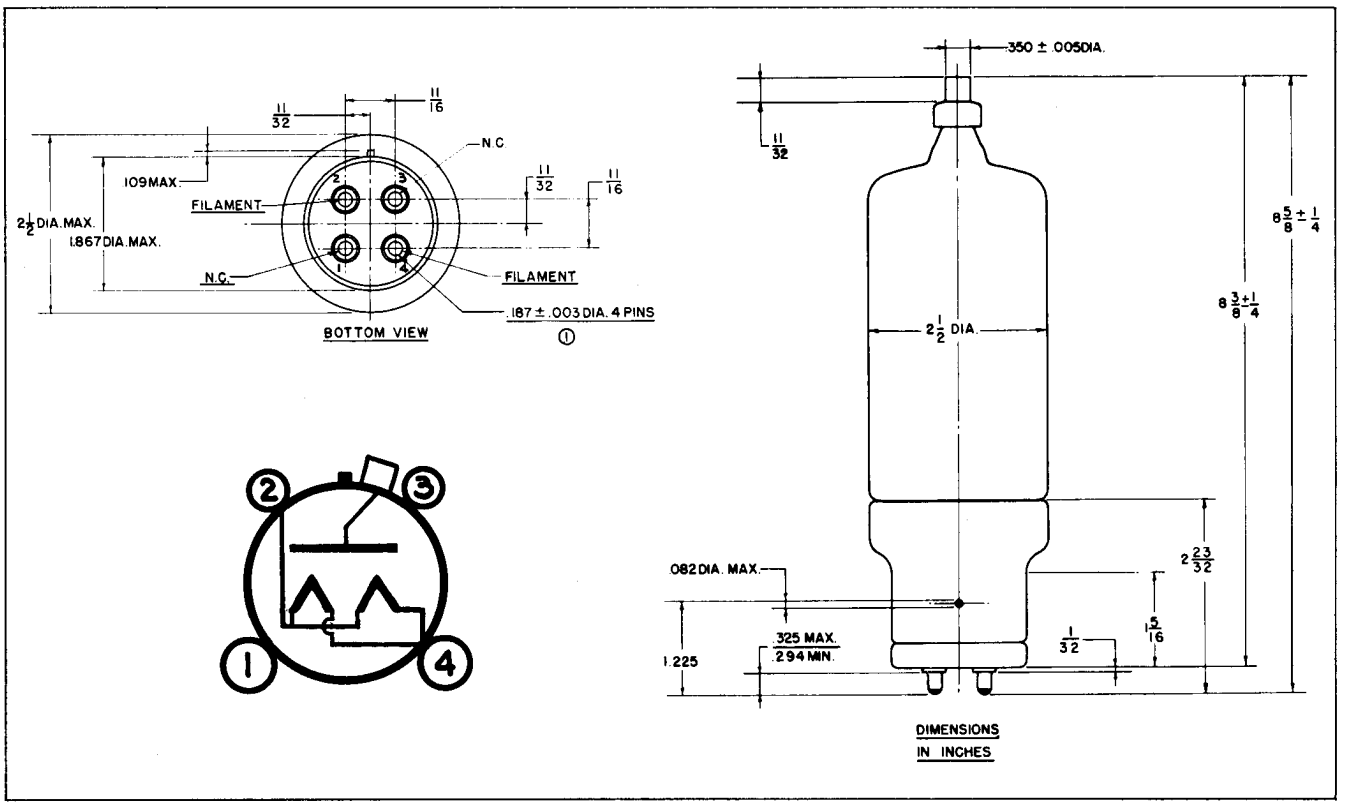
Eimac 2-150D Maximum D-C Current Ratings for R-C Filter Applications						
D-C Plate Current (I_p)	150	175	200	225	250	milliamperes per tube
Total Charging-Circuit Resistance (R_c)	0.7	1.6	3.9	9.6	27	percent of Effective Load Resistance per Tube (E_c/I_p)
A-C Supply Voltage (E_{rms})	0.78	0.82	0.90	1.07	1.50	times Filter-Input D-C Voltage (E_c)
Peak Inverse Voltage (1/2 these values for circuit b.)	2.2	2.4	2.6	3.0	4.3	times Filter-Input D-C Voltage (E_c)

Fig. 2 Eimac 2-150D Basic R-C Circuits (for any one of the indicated loads)

R_i = Equivalent resistance of voltage source

R_p = 300 ohms (150 ohms for two tubes in parallel)



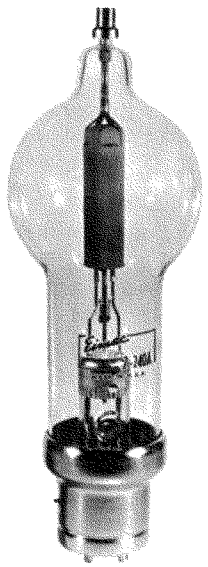


Printed in U.S.A. 882

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

2-240A

HIGH-VACUUM RECTIFIER



The Eimac 2-240A is a high vacuum diode rectifier intended for use in rectifier units, voltage multipliers, or in special applications, whenever conditions of extreme ambient temperatures, high operating frequency, high peak inverse voltages, or the production of high-frequency transients would prevent the use of gas-filled rectifier tubes.

The 2-240A has a maximum d-c current rating of 500 milliamperes and a maximum peak inverse voltage rating of 40,000 volts. Cooling is by convection and radiation.

A single 2-240A will deliver 320 milliamperes at 16,000 volts to a capacitor-input filter with 14,000 volts single-phase supply. Four 2-240A's in a bridge circuit will deliver 1.0 ampere at 25,000 volts to a choke-input filter with 28,000 volts single-phase supply.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	7.5 volts
Current	12.0 amperes

MECHANICAL

Base	50-watt jumbo 4-pin bayonet
Basing	Refer to outline drawing
Socket	Refer to discussion under "Application"
Mounting Position	Vertical, base down or up
Cooling	Convection and radiation
Maximum Temperature of Plate Seal	225°C
Recommended Heat Dissipating Plate Connector	Eimac HR-6
Maximum Over-all Dimensions:	
Length	11.2 inches
Diameter	3.82 inches
Net Weight	10 ounces
Shipping Weight (approx.)	3 pounds

MAXIMUM RATINGS (Per tube)

PEAK INVERSE PLATE VOLTAGE	40,000 MAX. VOLTS
PLATE DISSIPATION	150 MAX. WATTS
D-C PLATE CURRENT[1]	500 MAX. MA
PEAK PLATE CURRENT	4.0 MAX. AMPERES

[1]Averaged over one cycle for each tube. Applies only when the rectifier is coupled to the load by a choke-input filter incorporating the "critical" value (or larger) of input inductance. For maximum d-c current ratings under this and other load conditions see discussion under "Application".

APPLICATION

MECHANICAL

Mounting—The 2-240A must be mounted vertically with the base either down or up. The lead to the plate terminal of the tube should be flexible.

The 50-watt jumbo 4-pin bayonet base fits an E. F. Johnson Co. No.123-211, a National Co. No. XM-50, or an equivalent socket. In some circuits, particularly those of the voltage multipliers illustrated in Fig. 2, it may be necessary to mount the socket on stand-off insulators, or on a sheet of insulating material, to provide adequate insulation to ground.

Cooling—The 2-240A is cooled by convection and radiation. Clearance should be provided around the glass envelope adequate for the free circulation of air. An Eimac HR-6 Heat Dissipating Connector or equivalent is required on the plate terminal.

The maximum temperature at the plate seal must not exceed

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APPLICATION (Continued)

225°C. A convenient accessory for measuring this temperature is "Tempilaq", a temperature-sensitive lacquer available from the Tempil Corporation, 132 W. 22nd St., New York 11, N. Y.

ELECTRICAL

Filament Operation—For maximum tube life, the filament voltage, as measured at the base pins, should be the rated value of 7.5 volts. Variations must be kept within the range from 7.15 to 7.85 volts. In applications which require the diode to deliver high peak currents, it is important to maintain the filament voltage at the rated value. All four socket terminals should be used, placing two in parallel for each filament connection.

CAUTION SHOULD BE OBSERVED WHEN MEASURING RECTIFIER FILAMENT VOLTAGE. THE FILAMENT CIRCUIT MAY BE AT HIGH POTENTIAL.

The thoriated-tungsten filament of the 2-240A reaches operating temperature in a fraction of a second after application of voltage. Plate voltage may be applied simultaneously with filament voltage. All four socket terminals should be used, putting two in parallel for each filament connection.

Plate Operation—With low room illumination, the plate of the 2-240A begins to show color as the maximum plate dissipation rating of 150 watts is approached. The maximum peak inverse voltage rating of 40,000 volts should not be exceeded at any time.

Performance—The accompanying table shows some maximum performance capabilities of the 2-240A when used as a power-supply rectifier.

2-240A MAXIMUM-PERFORMANCE CAPABILITIES

Circuit Type	A-C Input Voltage (volts rms)	Capacitor-Input Filter D-C Output Voltage (volts)	Capacitor-Input Filter D-C Output Current (amperes)	Choke-Input Filter D-C Output Voltage (volts)	Choke-Input Filter D-C Output Current (amperes)
Single-Phase, Half-Wave	14,000	16,000	0.320	.....	.....
Single-Phase, Full-Wave	14,000[1]	16,000	0.640	12,500	1.00
Single-Phase, Bridge	28,000	32,000	0.640	25,000	1.00

[1]One-half the transformer secondary voltage.

Maximum D-C Current Ratings—Plate dissipation rather than peak current usually limits the d-c current which the 2-240A is capable of delivering to the load. Because the plate dissipation associated with a given d-c current depends upon the amount of ripple and its wave-shape, circuit conditions will determine the maximum d-c current rating of the tube.

Choke-Input Filter—The maximum d-c current rating of the 2-240A is 500 milliamperes when the load incorporates a choke-input filter with the "critical" value (or larger) of input inductance (L_1 in Fig. 1):

$$L_o = \frac{R_{eff}}{18.8f} \quad \text{for full-wave single-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{75f} \quad \text{for half-wave three-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{660f} \quad \text{for full-wave three-phase rectifiers,}$$

where: L_o = "critical" value of input inductance (henries),
f = supply-line frequency (cycles per second),

$$R_{eff} = \frac{\text{Load voltage (volts)}}{\text{Load current (amps)}}.$$

Choke-input filters are not normally used with single-phase half-wave rectifiers.

Capacitor-Input Filter—The 2-240A is particularly suitable for power-supply applications demanding high voltage at low current. Under these conditions capacitor-input filter circuits become desirable. The maximum d-c current rating of the 2-240A when no input choke is incorporated in the filter depends upon the total series resistance of the capacitor-charging circuit relative to the effective load resistance seen by each tube. The circuit diagrams and tabulation in Fig. 2 are so arranged and labeled that this required series resistance may be found for a wide range of load conditions. This may be done by determining the value of the following quantities:

E_c is the filter-input d-c voltage. While this is usually the entire load voltage, in the case of voltage multipliers it is the load voltage divided by the multiplication factor.

I_p is the d-c current per tube. This is the entire load current only in the case of the simple half-wave rectifier or half- or full-wave multiplier. In the case of full-wave center-tapped or bridge rectifiers, I_p is half the load current.

R_c is the total charging-circuit resistance. A certain minimum value of charging-circuit resistance is necessary to limit the peak value of current to which the tubes will be subjected under given load conditions. This required minimum depends upon the d-c current per tube (I_p), and has been tabulated in Fig. 2 as a percentage of the effective load resistance per tube (E_c/I_p). The total charging-circuit resistance involves the internal resistance of the rectifer tube, R_p, the added series resistor, R_s, and the equivalent internal resistance of the a-c voltage supply, R_i.

R_p is the plate resistance of the 2-240A, which may be taken as 200 ohms.

R_i is the equivalent internal resistance of the supply. This may be taken as the regulation of the high-voltage supply expressed as a decimal multiplied by the load resistance used in measuring this regulation.

R_s is the series resistor which must be inserted in the charging circuit to bring the total charging-circuit resistance up to the required minimum. Its value may be found from the formula associated with each of the circuits of Fig. 2. This resistor must be inserted in such a position in the circuit that it protects all tubes.

Tubes may be operated in parallel to increase the output capability in a given circuit. When two tubes are placed in parallel at each place where one is shown in the circuits of Fig. 2, the plate resistance (R_p) will be half as great and the maximum allowable load current twice as great as indicated.

Peak Inverse Voltage—The peak inverse voltage rating of the 2-240A is 40,000 volts. In single-phase power-supply rectifier circuits the peak inverse voltage to be used in design is the peak a-c supply voltage (1.41 times E_{rms} in Fig. 2) in the case of bridge circuits, and twice this value in the case of half- and full-wave rectifiers and voltage multipliers. Peak inverse voltage in three-phase operation depends upon the circuit employed and will be found listed in the handbooks.

Special Applications—The ratings given for capacitor-input filter circuits assume values of input capacitance large enough to hold the ripple to a low value. In special applications where a larger percent ripple is tolerable, and filter capacitance is low, the 2-240A is capable of larger d-c output currents.

As a unidirectional conductor in d-c circuits where the current is continuous and the percent ripple is moderate, the maximum current rating of the 2-240A is 800 milliamperes.

The plate characteristic curve for the 2-240A serves as a guide to special applications. The maximum plate dissipation rating of 150 watts, the maximum peak inverse voltage rating of 40,000 volts, and the maximum peak plate current of 4.0 amperes must not be exceeded.

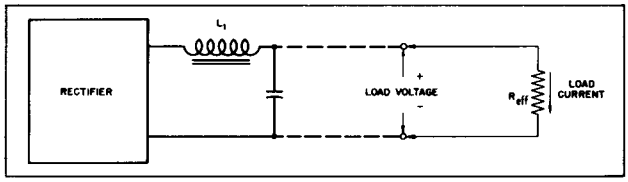
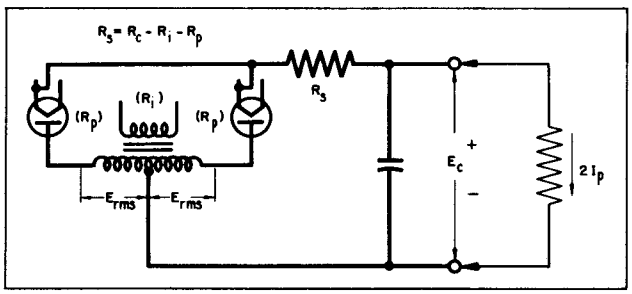
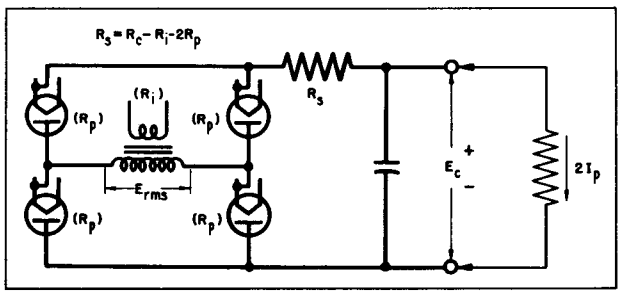


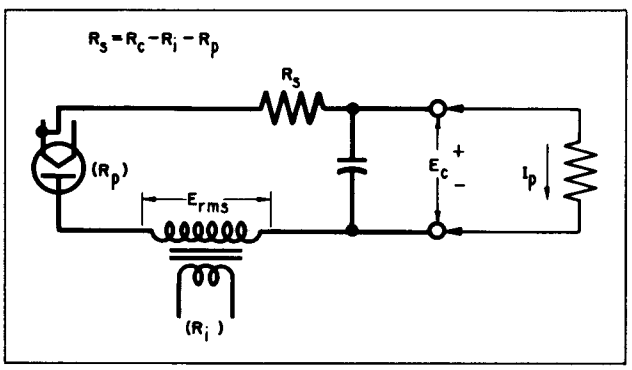
Fig. 1. Rectifier with Choke-Input Filter



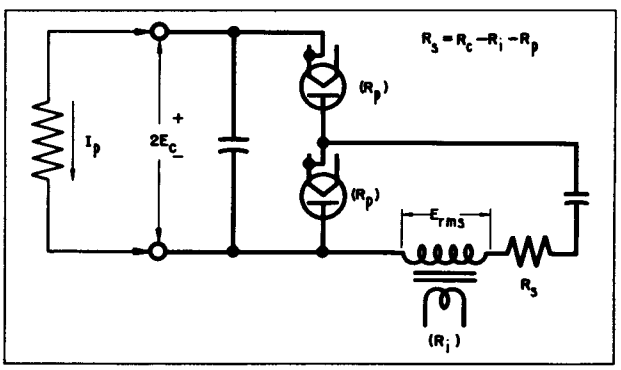
a. Full-Wave Center-Tapped Rectifier



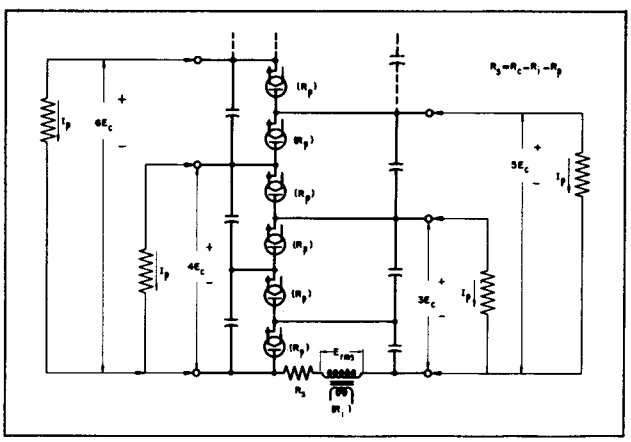
b. Full-Wave Bridge Rectifier



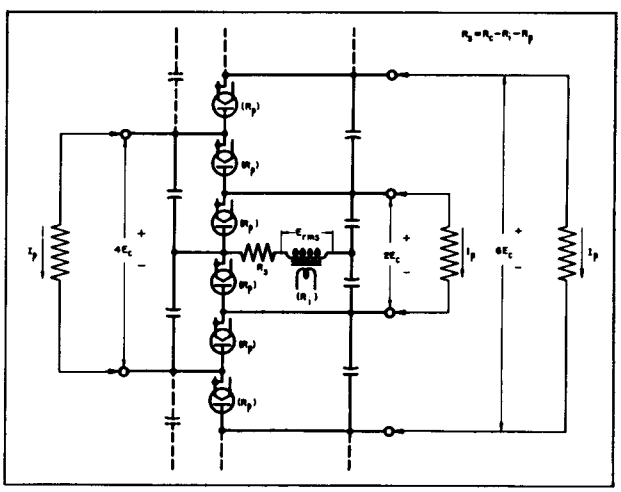
c. Half-Wave Rectifier



d. Half-Wave Voltage Doubler



e. Half-Wave Voltage Multiplier (with common ground when R_s is inserted on the "high" side of E_{rms})



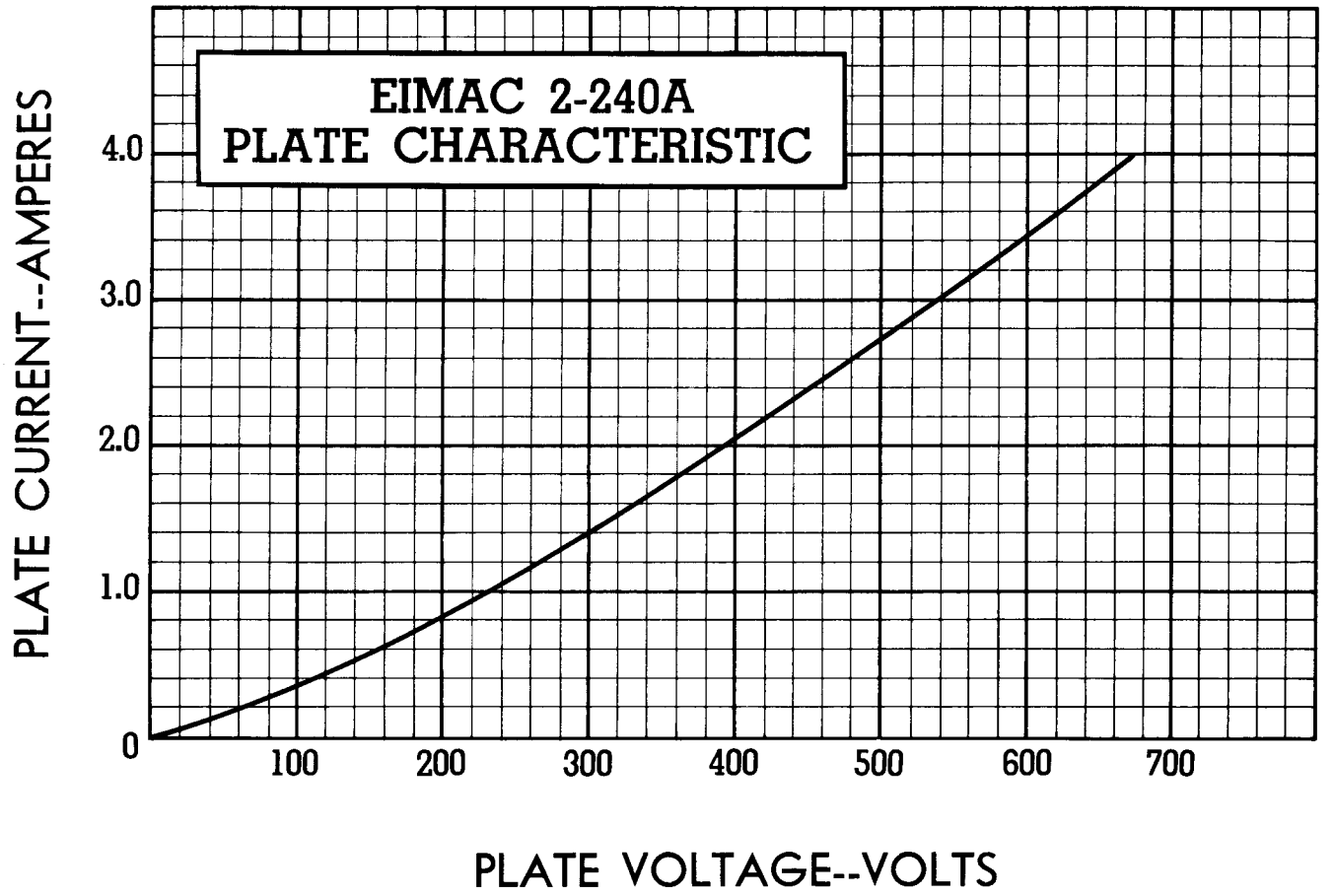
f. Full-Wave Voltage Multiplier

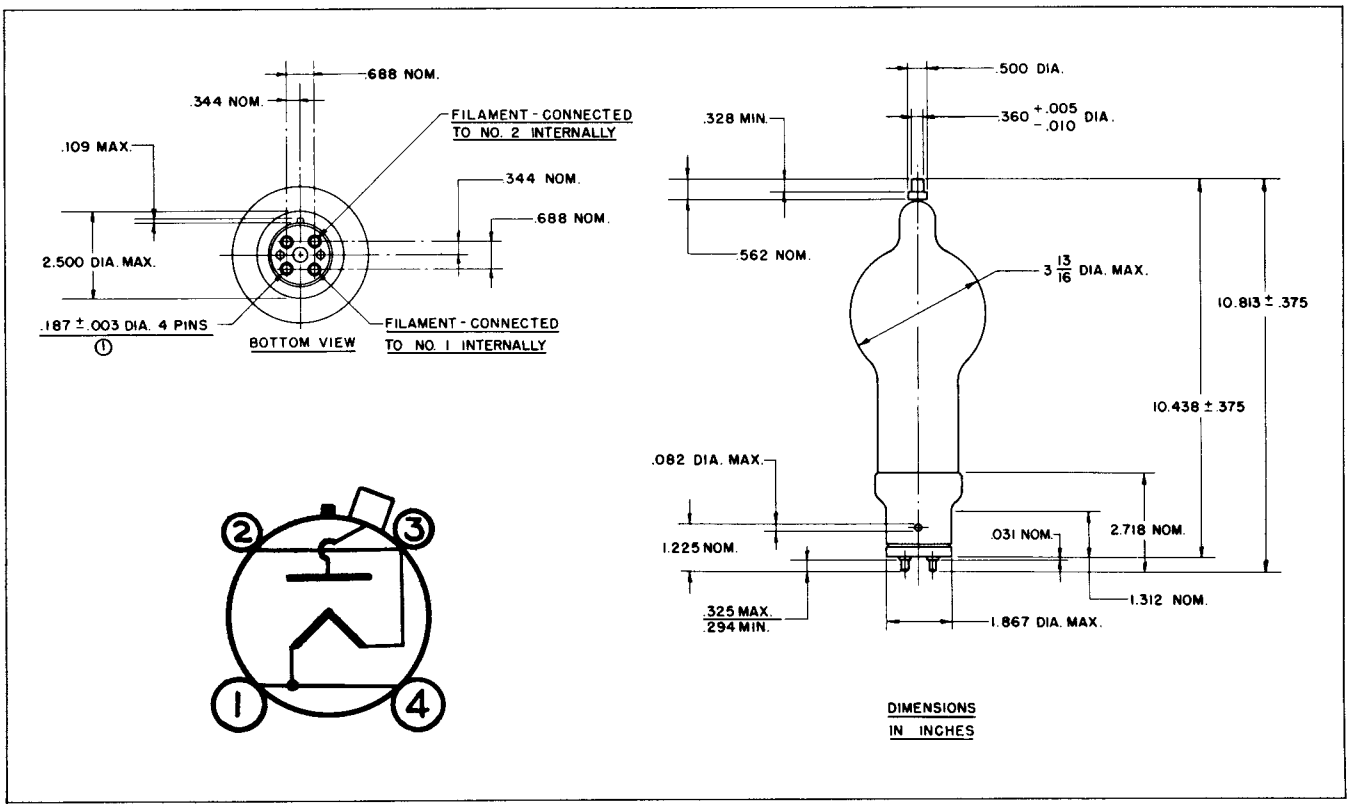
Eimac 2-240A Maximum D-C Current Ratings for R-C Filter Applications								
D-C Plate Current (I_p)	280	300	320	340	360	380	400	milliamperes per tube
Total Charging-Circuit Resistance (R_c)	1.0	1.8	3.0	5.0	7.5	12	20	percent of Effective Load Resistance per Tube (E_c/I_p)
A-C Supply Voltage (E_{rms})	0.80	0.83	0.87	0.94	1.01	1.14	1.33	times Filter-Input D-C Voltage (E_c)
Peak-Inverse Voltage (½ these values for circuit b.)	2.3	2.4	2.5	2.7	2.9	3.2	3.8	times Filter-Input D-C Voltage (E_c)

Fig. 2 Eimac 2-240A Basic R-C Circuits (for any one of the indicated loads)

R_i = Equivalent resistance of voltage source

R_p = 200 ohms (100 ohms for two tubes in parallel)





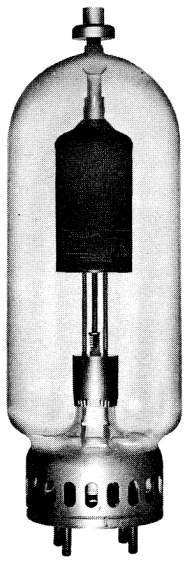
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EIMAC
A Division of Varian Associates
SAN CARLOS, CALIFORNIA

2-450A

HIGH-VACUUM RECTIFIER

The Eimac 2-450A is a high-vacuum diode rectifier intended for use in rectifier units, voltage multipliers, or in special applications where high peak-inverse voltages, extreme temperatures, high operating frequency, or the production of high-frequency transients would prevent the use of mercury-vapor or gas-filled rectifier tubes.



ELECTRICAL CHARACTERISTICS

	Min.	*Nom.*	*Max.*	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	25.0		28.0	amperes

MECHANICAL

Base	4-pin, metal shell
Socket	E. F. Johnson Co. 124-214 or equivalent
Operating Position	vertical, base down or up
Recommended Plate Connector	Eimac HR-8
Maximum Operating Temperatures:	
Plate Seal	225°C
Envelope	250°C
Net Weight	2.4 pounds
Shipping Weight (approximate)	9 pounds

COOLING

The temperature of the plate seal and envelope must not be allowed to exceed 225°C and 250°C respectively. When several tubes are being operated in the same compartment and at or near maximum rated plate dissipation, forced-air cooling is required. In any event, it should be remembered that the listed temperatures are maximums and that lower operating temperatures will result in longer life and improved reliability. The use of a temperature-sensitive paint, sparingly applied in the referenced areas, is recommended to determine the effectiveness of the cooling employed in any given installation.

MAXIMUM RATINGS

Peak Inverse Plate Voltage	30,000 MAX. VOLTS
Plate Dissipation	450 MAX. WATTS
D-C Plate Current	1 MAX. AMPERE
Peak Plate Current	8 MAX. AMPERES

MAXIMUM POWER-SUPPLY CAPABILITIES*

Circuit	Maximum A-C Input Voltage (volts rms)	Approx. D-C Output Voltage (volts)	Maximum D-C Output Current (amps)
Single-Phase, Full-Wave (2 tubes)	21,200 total	9,300	2.0
Single-Phase, Bridge (4 tubes)	21,200 total	18,600	2.0
Three-Phase, Full-Wave (6 tubes)	12,250 per leg	28,000	3.0

*Choke-input filter with L equal to or greater than twice "critical"; zero circuit loss assumed; tube drop considered.

CHOKE-INPUT FILTER

The maximum d-c current rating of the 2-450A is 1.0 amperes when the load incorporates a choke-input filter with the "critical" value (or larger) of input inductance. This value may be calculated from the appropiate formula below:

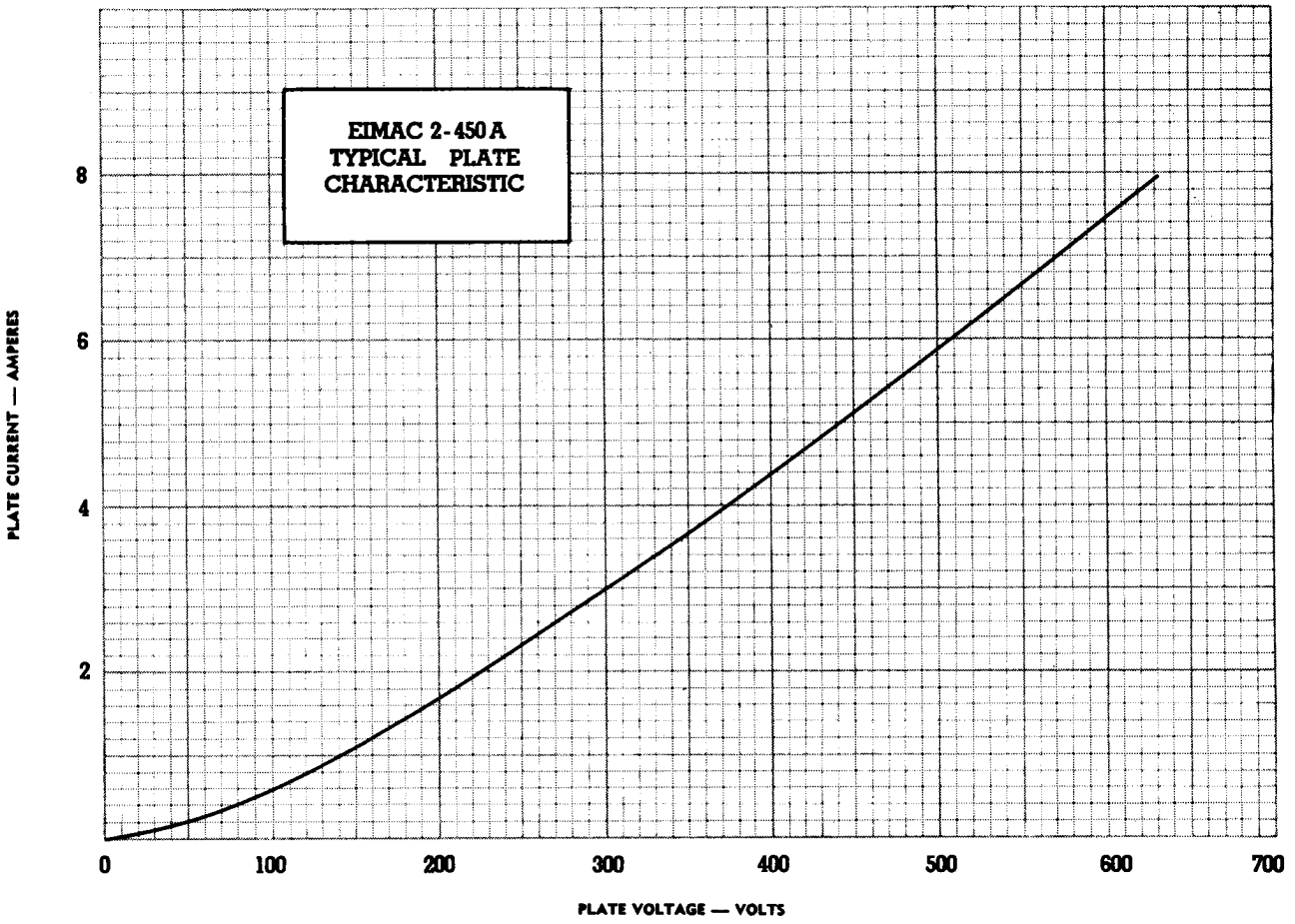
$$L_o = \frac{R_{eff}}{18.8f} \left\{ \begin{array}{l} \text{for full-wave} \\ \text{single wave} \\ \text{power supplies} \end{array} \right. \qquad L_o = \frac{R_{eff}}{75f} \left\{ \begin{array}{l} \text{for half-wave} \\ \text{three-phase} \\ \text{power supplies} \end{array} \right. \qquad L_o = \frac{R_{eff}}{660f} \left\{ \begin{array}{l} \text{for full-wave} \\ \text{three-phase} \\ \text{power supplies} \end{array} \right.$$

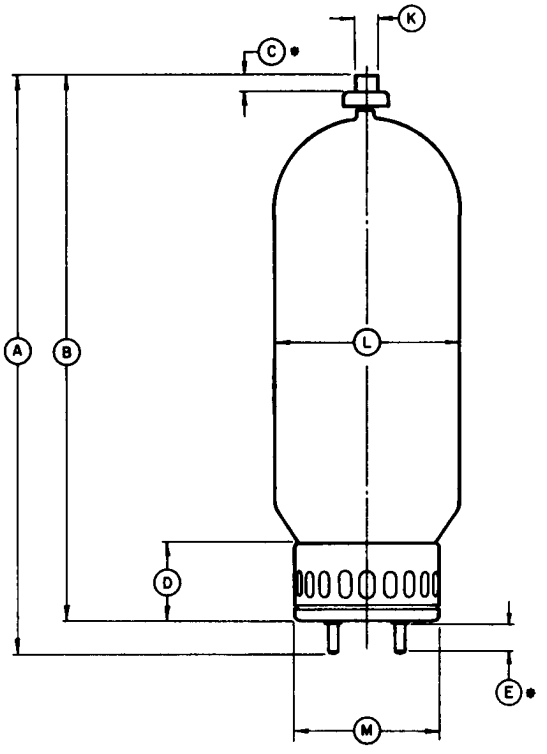
where: L_o = "critical" value of input inductance (henries) f = supply-line frequency (cycles per second)

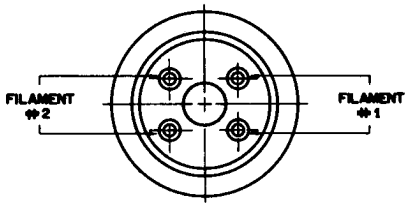
$$R_{eff} = \frac{\text{Load voltage (volts)}}{\text{Load current (amps)}}$$

THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

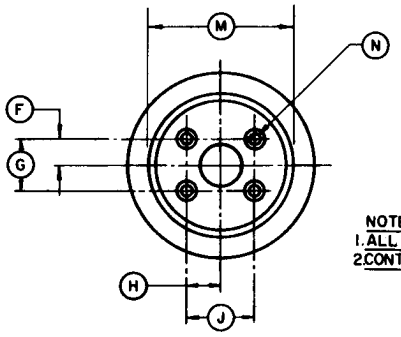
(Revised 3-1-66) Copyright 1959, 1966 by Varian Associates







DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		13 1/8	14 1/8
B		12 1/4	13 1/4
C		.445	.465
D	1 3/4		
E		.662	.712
F		.610	.640
G		1.235	1.265
H		.829	.859
J		1.672	1.702
K		.558 DIA.	.568 DIA.
L			4 5/8 DIA.
M			3 5/8 DIA.
N		.247 DIA.	.251 DIA.



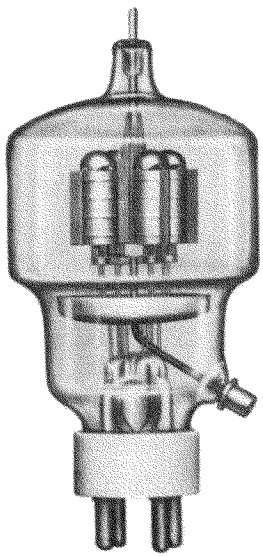
NOTES:
1. ALL DIMENSIONS IN INCHES.
2. CONTACT SURFACE (*).

Printed in U.S.A. 82587

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

304TH

MEDIUM-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten		
Voltage	5.0 or 10.0	volts
Current	25.0 or 12.5	amperes
Amplification Factor (Average)	20	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	10.2	μμf
Grid-Filament	13.5	μμf
Plate-Filament	0.7	μμf
Transconductance (I_b=1.0 amp., E_b=3000, e_c=–40)	16,700	μmhos
Frequency for Maximum Ratings	40	mc

MECHANICAL

Base	Special 4 pin, No. 5000B	
Basing	RMA type 4BC	
Maximum Overall Dimensions:		
Length	7.625	inches
Diameter	3.563	inches
Net weight	12	ounces
Shipping weight (Average)	3.0	pounds

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING	
D-C Plate Voltage	1500	2000	3000	3000	volts
Max.-Signal D-C Plate Current, per tube*	•	•	•	900	ma.
Plate Dissipation, per tube*	•	•	•	300	watts
D-C Grid Voltage (approx.)	–65	–90	–150		volts
Peak A-F Grid Input Voltage	330	350	420		volts
Zero-Signal D-C Plate Current	267	200	134		ma.
Max.-Signal D-C Plate Current	1066	900	667		ma.
Max.-Signal Driving Power (approx.)	17	12	6		watts
Effective Load, Plate-to-Plate	2840	4820	10200		ohms
Max.-Signal Plate Power Output	1000	1200	1400		watts

*Averaged over any sinusoidal audio frequency cycle.

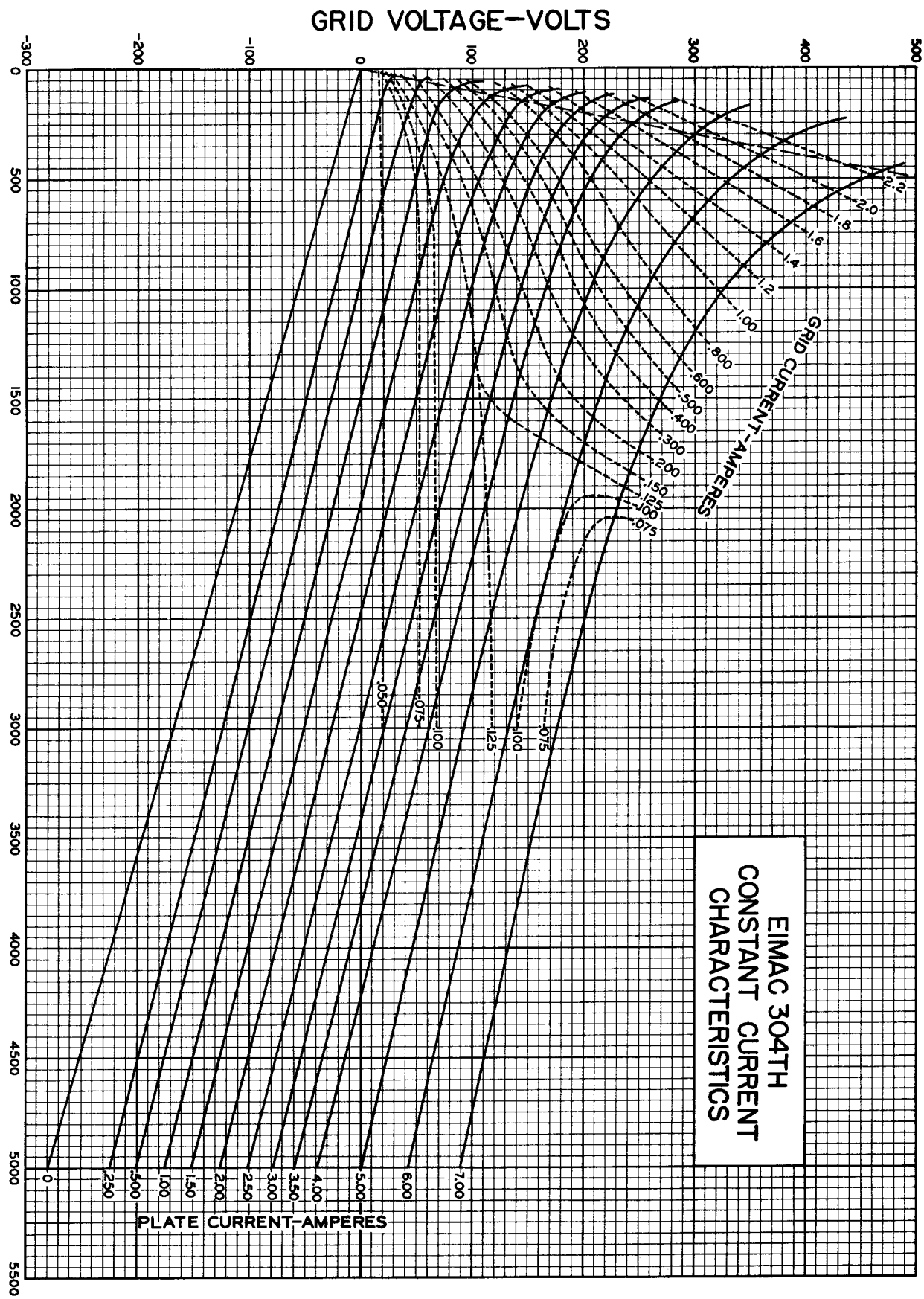
RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C *Telegraphy
(Key down conditions without modulation)

	TYPICAL OPERATION—1 TUBE			MAX. RATING	
D-C Plate Voltage	1500	2000	3000	3000	volts
D-C Plate Current	667	600	500	900	ma.
D-C Grid Current	115	125	135	170	ma.
D-C Grid Voltage	–125	–200	–300		volts
Plate Power Output	700	900	1200		watts
Plate Input	1000	1200	1500		watts
Plate Dissipation	300	300	300	300	watts
Peak R. F. Grid Input Voltage, (approx.)	250	325	395		volts
Driving Power, (approx.)	25	39	53		watts

*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

(Effective 6-1-44) Copyright, 1946 by Eitel-McCullough, Inc.


GRID VOLTAGE—VOLTS
-300
-200
-100
0
100
200
300
400
500
PLATE VOLTAGE — VOLTS
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
GRID CURRENT—AMPERES
2.2
2.0
1.8
1.6
1.4
1.2
1.00
.800
.600
.500
.400
.300
.200
.150
.125
.100
.075
.050
.075
.100
.125
.075
.100
PLATE CURRENT—AMPERES
0
.250
.500
1.00
1.50
2.00
2.50
3.00
3.50
4.00
5.00
6.00
7.00
EIMAC 304TH
CONSTANT CURRENT
CHARACTERISTICS

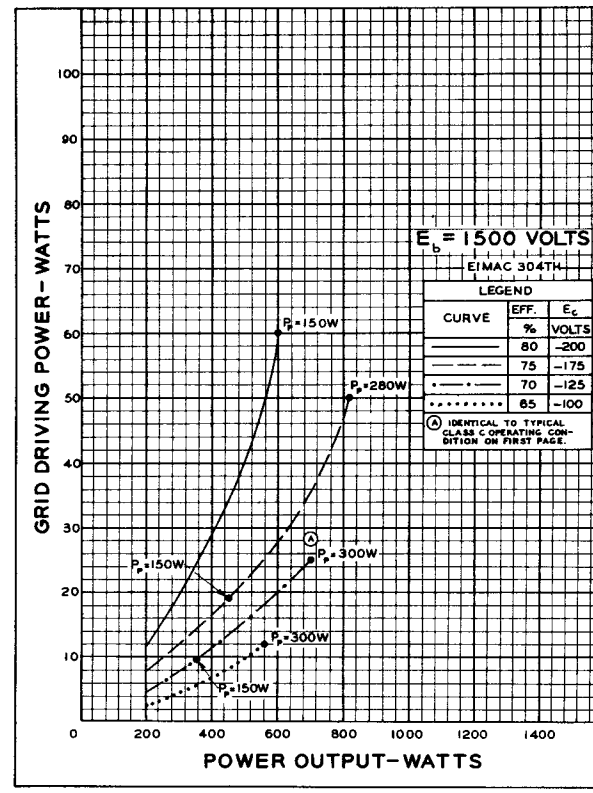
DRIVING POWER vs. POWER OUTPUT

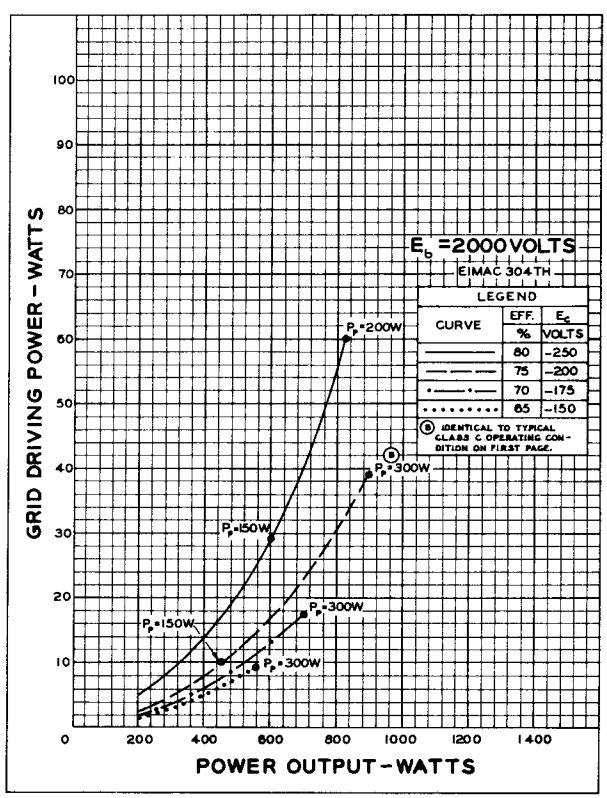
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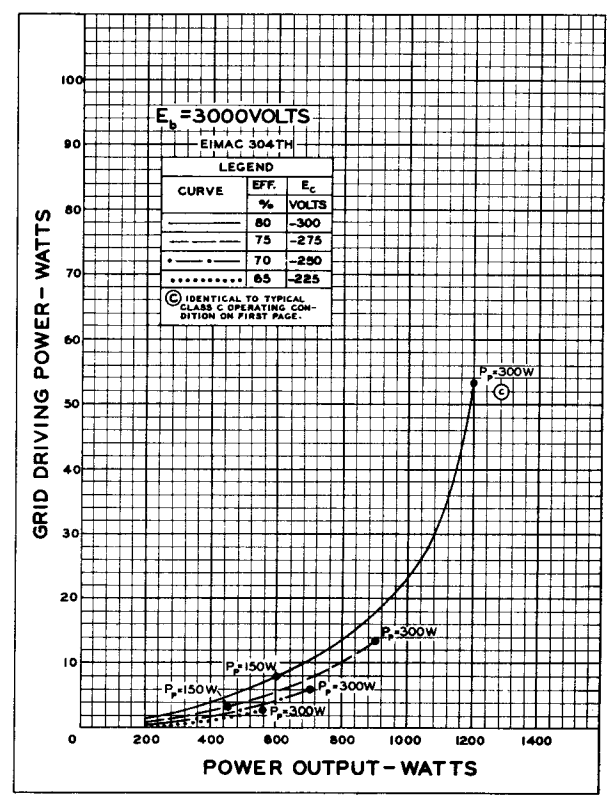
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.

•







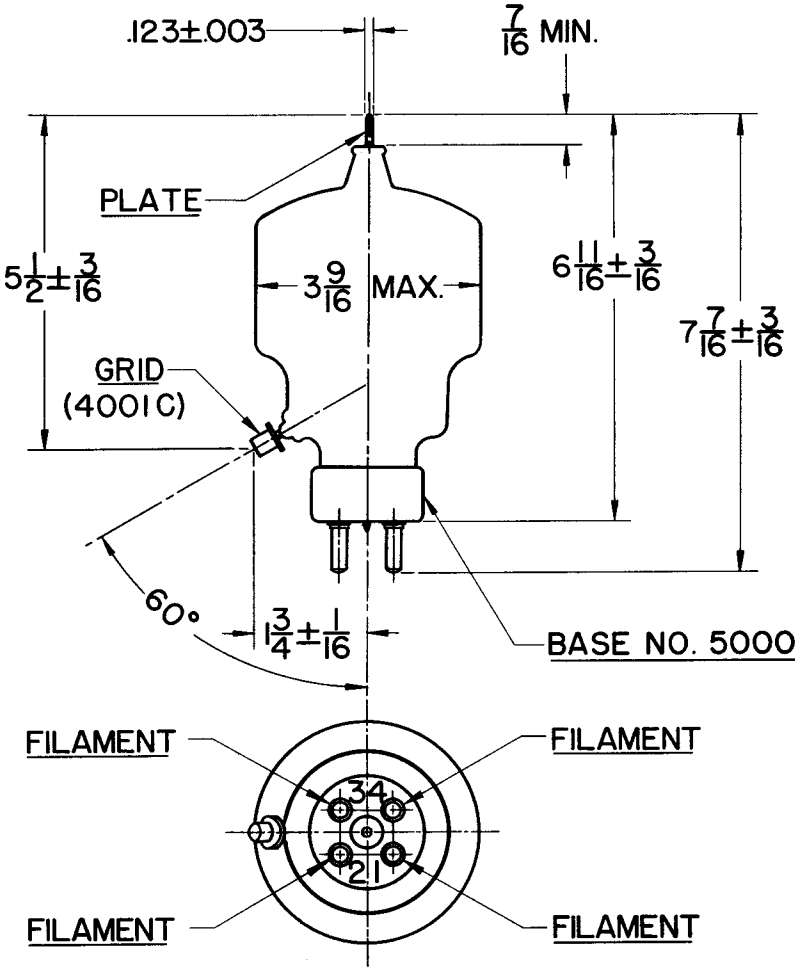
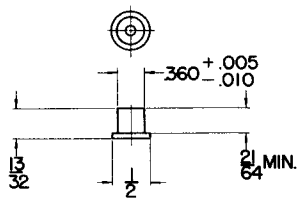


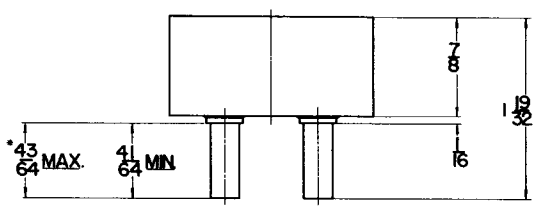
PLATE CAP

(SEE TUBE OUTLINE DRAWING)

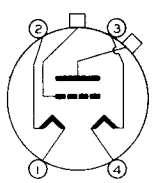
GRID CAP
NO. 4001C

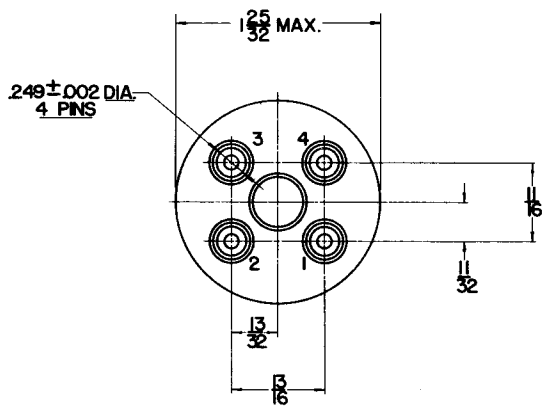


BASE NO. 5000B



4BC



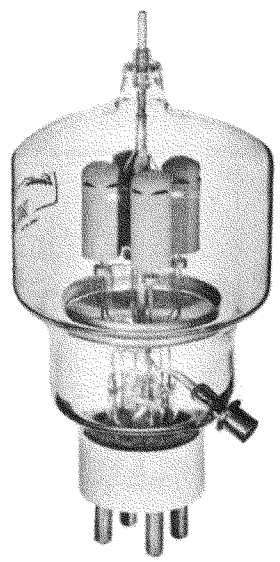


*ON FINISHED TUBE ADD .060 FOR SOLDER

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

304TL

LOW-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER



The Eimac 304TL is a low-mu, power triode having a maximum plate dissipation rating of 300 watts, and is intended for use as an amplifier, oscillator or modulator, where maximum performance can be obtained at low plate voltage. It can be used at its maximum ratings at frequencies as high as 40-Mc.

Cooling of the 304TL is accomplished by radiation from the plate, which operates at a visible red color at maximum dissipation, and by means of air convection around the envelope.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	5.0 or 10.0 volts
Current	25.0 or 12.5 amperes
Amplification Factor (Average)	12
▶Direct Interelectrode Capacitances (Average)	
Grid-Plate	8.6 $\mu\mu$f
Grid-Filament	12.1 $\mu\mu$f
Plate-Filament	.8 $\mu\mu$f
▶Transconductance (i_b = 1.0 amp., E_b = 3000 v, e_c = —175v.)	16,700 μmhos
Frequency for Maximum Ratings	40 Mc.

MECHANICAL

Base	Special 4 pin, No. 5000B
Basing	RMA type 4BC
▶Mounting	Vertical, base down or up
▶Cooling	Convection and Radiation
▶Recommended Heat Dissipating Connectors:	
Plate	HR-7
Grid	HR-6
Maximum Overall Dimensions:	
Length	7.625 inches
Diameter	3.563 inches
▶Net weight	9 ounces
▶Shipping weight (Average)	2 pounds

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	900 MAX. MA.
PLATE DISSIPATION, PER TUBE	300 MAX. WATTS

▶TYPICAL OPERATION, CLASS AB_1

D-C Plate Voltage	1500	2000	2500	3000	Volts
D-C Grid Voltage (approx.)*	—118	—170	—230	—290	Volts
Zero-Signal D-C Plate Current	270	200	160	130	Ma.
Max-Signal D-C Plate Current	572	546	483	444	Ma.
Effective Load, Plate-to-Plate	2540	5300	8500	12,000	Ohms
Peak A-F Grid Input Voltage (per tube)	118	170	230	290	Volts
Max-Signal Peak Driving Power	0	0	0	0	Watts
Max-Signal Plate Power Output	256	490	610	730	Watts

*Adjust to give stated zero-signal plate current. The effective grid circuit resistance for each tube must not exceed 250,000 ohms.

▶TYPICAL OPERATION, CLASS AB_2

D-C Plate Voltage	1500	2000	2500	3000	Volts
D-C Grid Voltage (approx.)*	—118	—170	—230	—290	Volts
Zero-Signal D-C Plate Current	270	200	160	130	Ma.
Max-Signal D-C Plate Current	1140	1000	900	800	Ma.
Effective Load, Plate-to-Plate	2750	4500	6600	9100	Ohms
Peak A-F Grid Input Voltage (per tube)	245	290	340	390	Volts
Max-Signal Peak Driving Power	78	87	95	110	Watts
Max-Signal Nominal Driving Power (approx.)	39	44	48	55	Watts
Max-Signal Plate Power Output	1100	1400	1650	1800	Watts

*Adjust to give stated zero-signal plate current.

▶PLATE MODULATED RADIO FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	2500 MAX. VOLTS
D-C PLATE CURRENT	700 MAX. MA.
PLATE DISSIPATION	200 MAX. WATTS
GRID DISSIPATION	50 MAX. WATTS

TYPICAL OPERATION (Power input limited to 500 and 1000 watts)*

D-C Plate Voltage	2000	2000	2500	2500	Volts
D-C Plate Current	250	500	200	400	Ma.
Total Bias Voltage	—500	—500	—525	—550	Volts
Fixed Bias Voltage	—410	—275	—300	—300	Volts
Grid Resistor	3000	3000	12,500	5000	Ohms
D-C Grid Current	30	75	18	50	Ma.
Peak R-F Grid Input Voltage	615	690	620	715	Volts
Driving Power	18	52	11	36	Watts
Grid Dissipation	3	15	2	9	Watts
Plate Power Input	500	1000	500	1000	Watts
Plate Dissipation	90	190	75	170	Watts
Plate Power Output	410	810	425	830	Watts

*The figures are for convenience in obtaining a 500 or 1000 Watt carrier input per tube to the modulated amplifier. The output figures do not allow for circuit losses.

TYPICAL OPERATION*

D-C Plate Voltage	1500	2000	2500	Volts
D-C Plate Current	520	525	450	Ma.
Total Bias Voltage	—370	—500	—550	Volts
Fixed Bias Voltage	—160	—260	—440	Volts
Grid Resistor	2800	3000	2000	Ohms
D-C Grid Current	75	80	55	Ma.
Peak R-F Grid Input Voltage	545	695	720	Volts
Driving Power	41	55	40	Watts
Grid Dissipation	13	15	10	Watts
Plate Power Input	780	1050	1125	Watts
Plate Dissipation	200	200	200	Watts
Power Output	580	850	925	Watts

*The figures are for one tube operating at maximum plate dissipation as a plate modulated Class C amplifier. The output figures do not allow for circuit losses.

(Effective 5-1-49) Copyright, 1949 by Eitel-McCullough, Inc.

(Continued on Next Page)

Eimac 304TL

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions, per tube)

MAXIMUM RATINGS

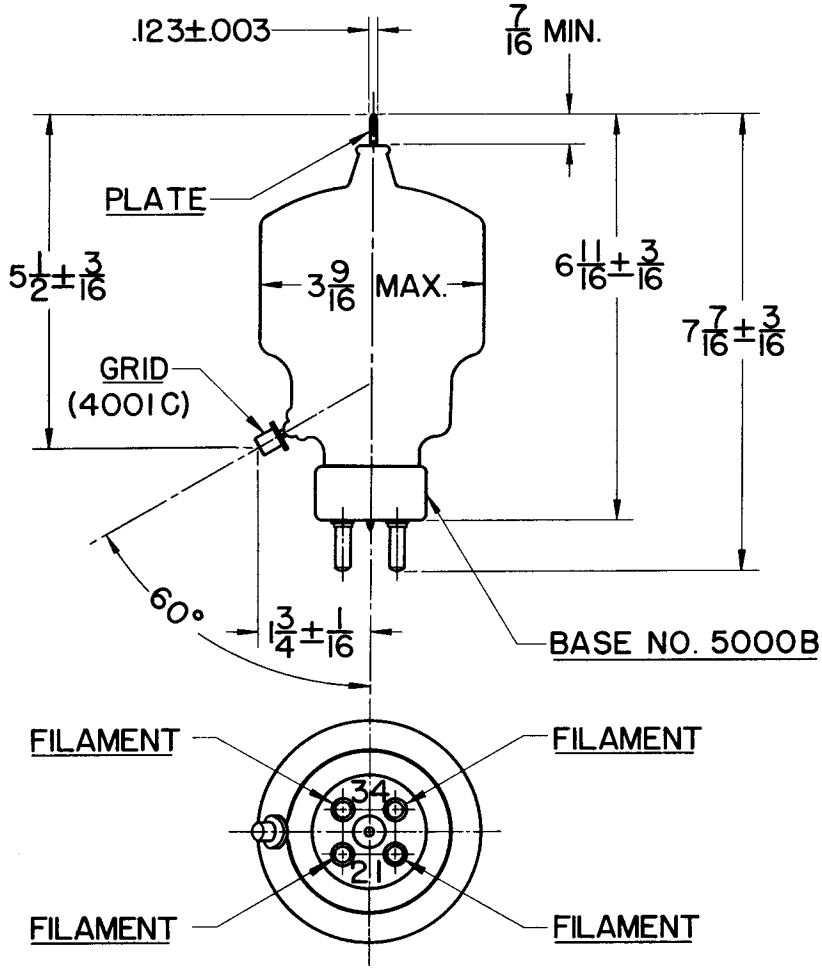
D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C PLATE CURRENT	900 MAX. MA.
PLATE DISSIPATION	300 MAX. WATTS
▶GRID DISSIPATION	50 MAX. WATTS

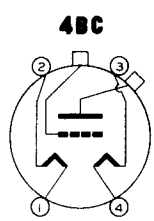
▶ Indicates change from sheet dated 1-1-44

TYPICAL OPERATION*

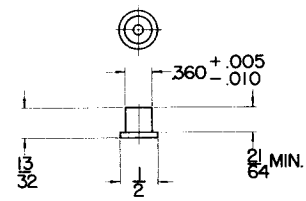
D-C Plate Voltage	1500	2000	3000 Volts
D-C Grid Voltage	—250	—300	—400 Volts
D-C Plate Current	665	600	500 Ma.
D-C Grid Current	90	85	80 Ma.
Peak R-F Grid Input Voltage	430	480	575 Volts
Driving Power (approx.)	33	36	40 Watts
Grid Dissipation	11	11	8 Watts
Plate Power Input	1000	1200	1500 Watts
Plate Dissipation	300	300	300 Watts
Plate Power Output	700	900	1200 Watts

*The figures show actual measured tube performance, and do not allow for circuit losses.

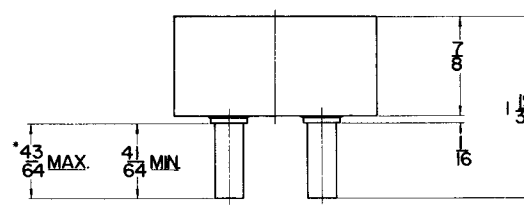


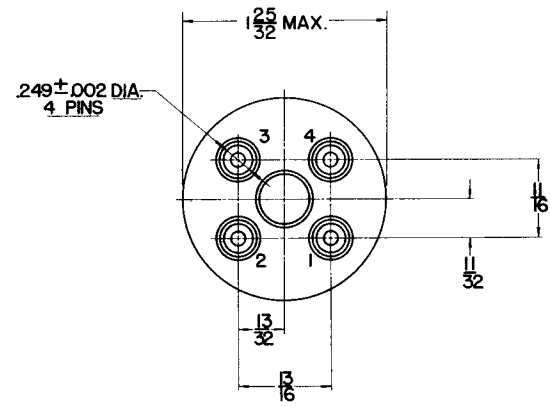


GRID CAP
NO. 4001C



BASE NO. 5000B



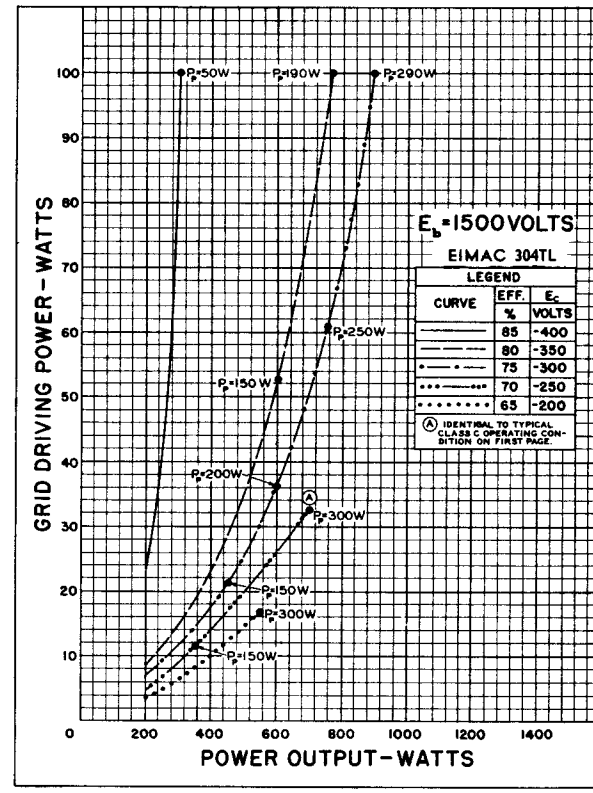


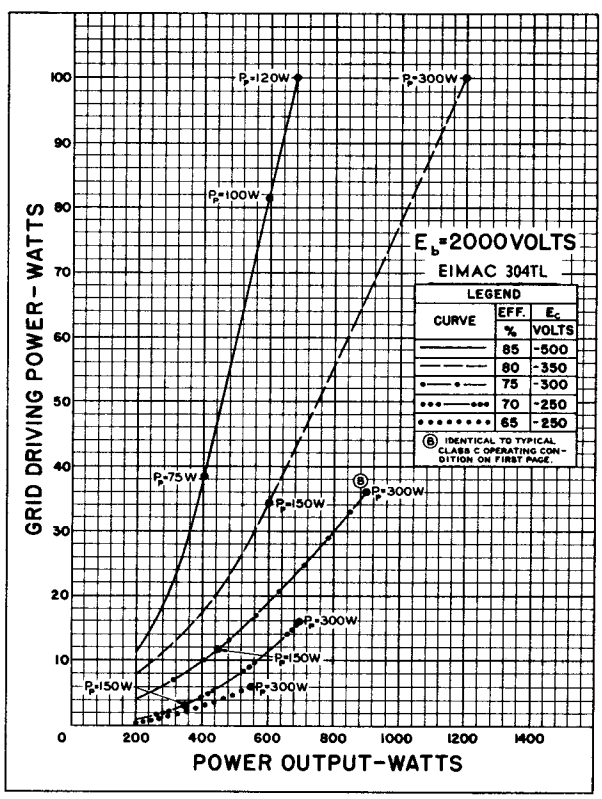
*ON FINISHED TUBE ADD .060 FOR SOLDER

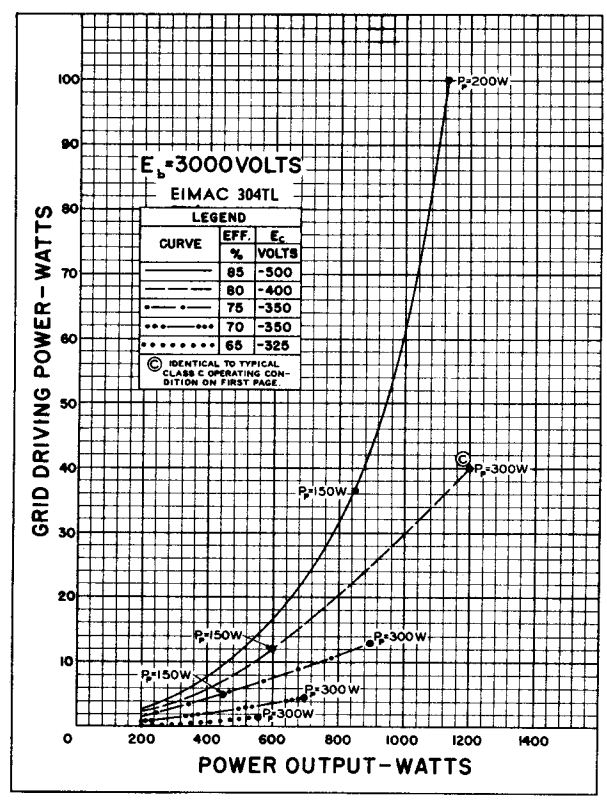
DRIVING POWER vs. POWER OUTPUT

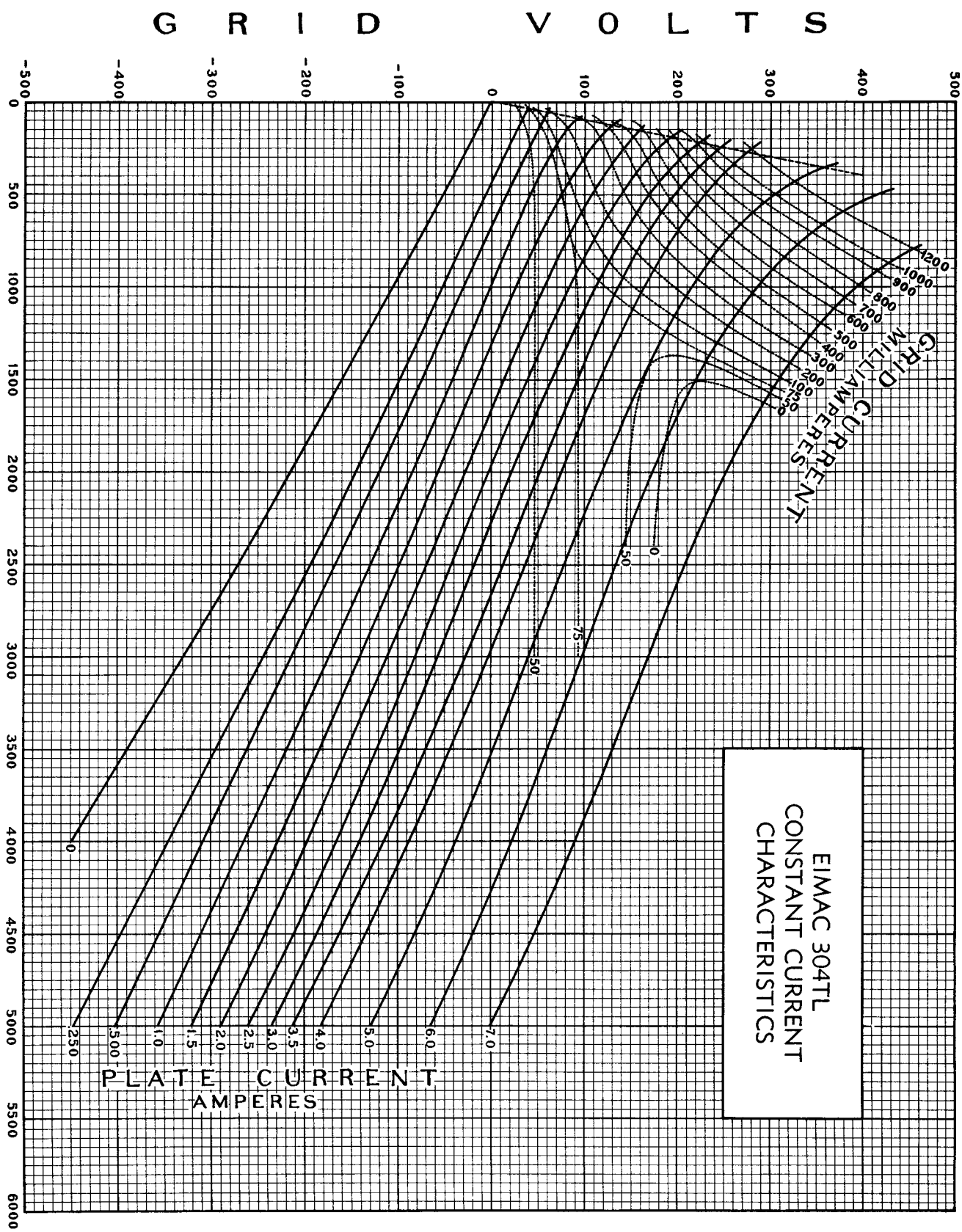
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 1500, 2000 and 3000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by Pp.

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 1500, 2000, and 3000 volts respectively.








GRID VOLTS
-500
-400
-300
-200
-100
0
100
200
300
400
500
PLATE VOLTS
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
GRID CURRENT
AMPERES
1200
1000
900
800
700
600
500
400
300
200
100
75
50
0
250
500
1.0
1.5
2.0
2.5
3.0
3.5
4.0
5.0
6.0
7.0
EIMAC 304TL
CONSTANT CURRENT
CHARACTERISTICS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

3-500Z

HIGH-MU POWER TRIODE

The EIMAC 3-500Z is a compact power triode intended to be used as a zero-bias Class-B amplifier in audio or radio-frequency applications. Operation with zero grid bias simplifies associated circuitry by eliminating the bias supply. In addition, grounded-grid operation is attractive since a power gain as high as twenty times can be obtained with the 3-500Z in a cathode-driven circuit.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	5.0	V
Current	14.5	A
Amplification Factor (Average)	160	
Interelectrode Capacitances (Average):*		
Grid-Filament	7.4	pF
Grid-Plate	4.1	pF
Plate-Filament	0.07	pF
Frequency for Maximum Ratings	110	MHz

MECHANICAL

Base	5 Pin Special
Basing	See Drawing
Mounting Position	Vertical, base down or up
Cooling	Radiation and Forced Air
Heat-Dissipating Plate Connector	HR-6
Recommended Socket	EIMAC SK-410
Recommended Chimney	EIMAC SK-406
Maximum Operating Temperatures:	
Plate Seal	225°C
Base Seals	200°C
Maximum Over-all Dimensions:	
Height	5.875 in
Diameter	3.438 in
Net Weight	7 oz

*In Shielded Fixture

(Effective 3-15-68) © 1968 by Varian

Printed in U.S.A.

R-F LINEAR AMPLIFIER GROUNDED-GRID, CLASS-B

MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC PLATE CURRENT	0.400	AMP
PLATE DISSIPATION	500	WATTS
GRID DISSIPATION	20	WATTS

TYPICAL OPERATION (Single-Tone Conditions)

DC Plate Voltage	3000	V
Zero-Sig DC Plate Current*	160	mA
Max-Sig DC Plate Current	370	mA
Max-Sig DC Grid Current	115	mA
Driving Impedance	115	ohms
Resonant Load Impedance	5000	ohms
Max-Sig Driving Power	30	W
Peak Envelope Plate Output Power	750	W

TYPICAL OPERATION (Minimum Distortion Products)*

DC Plate Voltage	2000	V
Zero-Sig DC Plate Current*	95	mA
Single-Tone DC Plate Current	400	mA
Single-Tone DC Grid Current	130	mA
Two-Tone DC Plate Current	270	mA
Two-Tone DC Grid Current	80	mA
Peak Envelope Useful Output Power	500	W
Resonant Load Impedance	2750	ohms
Intermodulation Distortion Products	-38	dB

TYPICAL OPERATION (Minimum Distortion Products at 1 KW PEP Input)**

DC Plate Voltage	2500	V
Zero-Sig DC Plate Current*	130	mA
Single-Tone DC Plate Current	400	mA
Single-Tone DC Grid Current	120	mA
Two-Tone DC Plate Current	280	mA
Two-Tone DC Grid Current	70	mA
Peak Envelope Useful Output Power	600	W
Resonant Load Impedance	3450	ohms
Intermodulation Distortion Products	-33	dB

TYPICAL OPERATION (Minimum Distortion Products at 1500 volts Plate Voltage)**

DC Plate Voltage	1500	V
Zero-Sig DC Plate Current*	65	mA
Single-Tone DC Plate Current	400	mA
Single-Tone DC Grid Current	130	mA
Two-Tone DC Plate Current	260	mA
Two-Tone DC Grid Current	80	mA
Peak Envelope Useful Output Power	330	W
Resonant Load Impedance	1600	ohms
Intermodulation Distortion Products	-46	dB

A-F AMPLIFIER OR MODULATOR, CLASS-B

MAXIMUM RATINGS (PER TUBE)

DC PLATE VOLTAGE	4000	VOLTS
DC PLATE CURRENT	0.400	AMP
PLATE DISSIPATION	500	WATTS
GRID DISSIPATION	20	WATTS

TYPICAL OPERATION (Sinusoidal Wave, Two Tubes, Grid Driven)

DC Plate Voltage	3000	V
DC Grid Voltage	0	V
Zero-Sig DC Plate Current*	300	mA
Max-Sig DC Plate Current	770	mA
Max-Sig DC Grid Current	244	mA
Driving Power	25	W
Peak A-F Driving Voltage (per tube)	100	V
Load Resistance, Plate-to-Plate	8600	ohms
Max-Sig Plate Output Power	1420	W

R-F POWER AMPLIFIER OR OSCILLATOR, CLASS-C

MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC PLATE CURRENT	0.350	AMP
PLATE DISSIPATION	500	WATTS
GRID DISSIPATION	20	WATTS

TYPICAL OPERATION

DC Plate Voltage	3500	V
DC Plate Current	300	mA
DC Grid Voltage	-75	V
DC Grid Current	115	mA
Peak R-F Grid Voltage	187	V
Grid Driving Power	22	W
Plate Output Power	850	W

R-F POWER AMPLIFIER PLATE-MODULATED

MAXIMUM RATINGS

DC PLATE VOLTAGE	3000	VOLTS
DC PLATE CURRENT	0.275	AMP
PLATE DISSIPATION	320	WATTS
GRID DISSIPATION	20	WATTS

TYPICAL OPERATION (Carrier Condition)

DC Plate Voltage	3000	V
DC Plate Current	275	mA
DC Grid Voltage	-100	V
DC Grid Current	120	mA
Peak R-F Grid Voltage	200	V
Grid Driving Power	25	W
Plate Output Power	640	W

NOTE: In most cases, "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made. Exceptions are distinguished by a listing of "Useful" output power as opposed to "Plate" output power. Values appearing in these groups have been obtained from existing equipment(s) and the output power is that measured at the load.

*Approximate Value
**Measured data from a single tube.

APPLICATION

Mounting: The 3-500Z must be operated vertically, base up or down. A flexible connecting strap should be provided between the heat dissipating plate connector and the external plate circuit. The tube must be protected from severe vibration and shock.

Socket: The EIMAC SK-410 air system socket and SK-406 chimney are recommended for use with the 3-500Z. When a socket other than the SK-410 is used, provisions must be made for equivalent cooling of the base, the envelope, and the plate lead.

Cooling: Forced-air cooling is required to maintain the base seals at a temperature below 200°C, and the plate seal at a temperature below 225°C. Air-flow requirements to maintain the above maximum temperatures are tabulated below. (For operation below 30 MHz.)

Base-to-Anode Air Flow		
Anode Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (inches-WC)
300	6.6	.023
400	10.3	.052
500	13.0	.082

In all cases, air flow rates in excess of the minimum requirements will prolong tube life. NOTE: Two 3-500Z tubes in a single amplifier, chassis mounted, may be adequately cooled by use of a fan so mounted as to pressurize the space below the sockets. Fans suitable for use at or near sea level are Pamotor Model 2000, or Model 6500.

Class-C Operation: Although specifically designed for class-B service, the 3-500Z may be operated as a class-C power amplifier or oscillator or as a plate-modulated radio-frequency power amplifier. The zero-bias characteristic of the 3-500Z can be used to advantage in class-C amplifiers operating at plate voltages of 3000 volts or below by employing only grid-leak bias. If driving power fails, plate dissipation is then kept to a low value because the tube will be operating at the normal static zero-bias conditions.

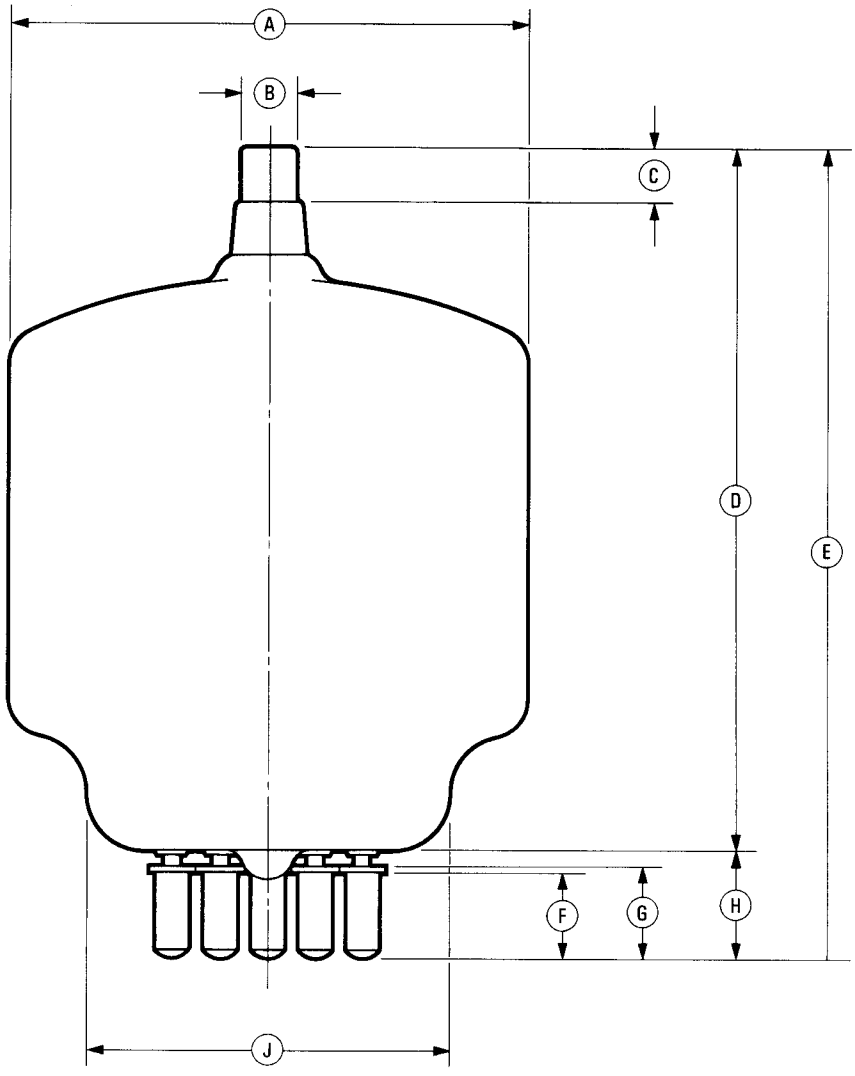
Filament Operation: The rated filament voltage for the 3-500Z is 5.0 volts. Filament voltage, as measured at the socket, must be maintained within the range of 4.75 to 5.25 volts to obtain maximum tube life.

Intermodulation Distortion: Typical operating conditions with distortion values included are the result of data taken during actual operation at 2 megahertz. Intermodulation values listed are those measured at the full peak envelope power noted.

Input Circuit: When the 3-500Z is operated as a grounded-grid r-f amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a "Q" of five or more.

Special Applications: If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, for information and recommendations.

3-500Z OUTLINE DRAWING AND PIN CONNECTIONS

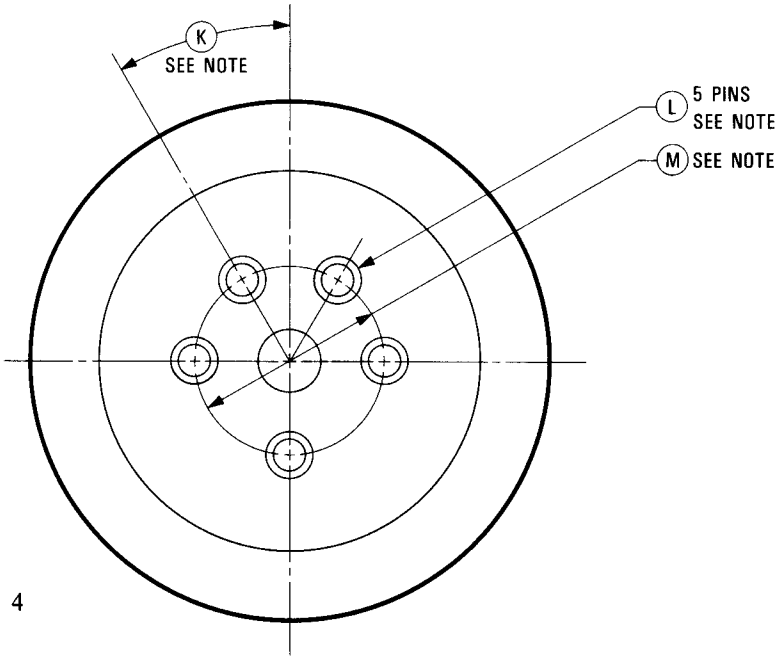


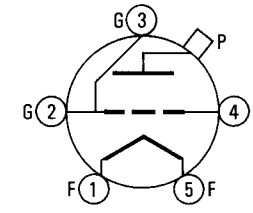
DIMENSIONS IN INCHES

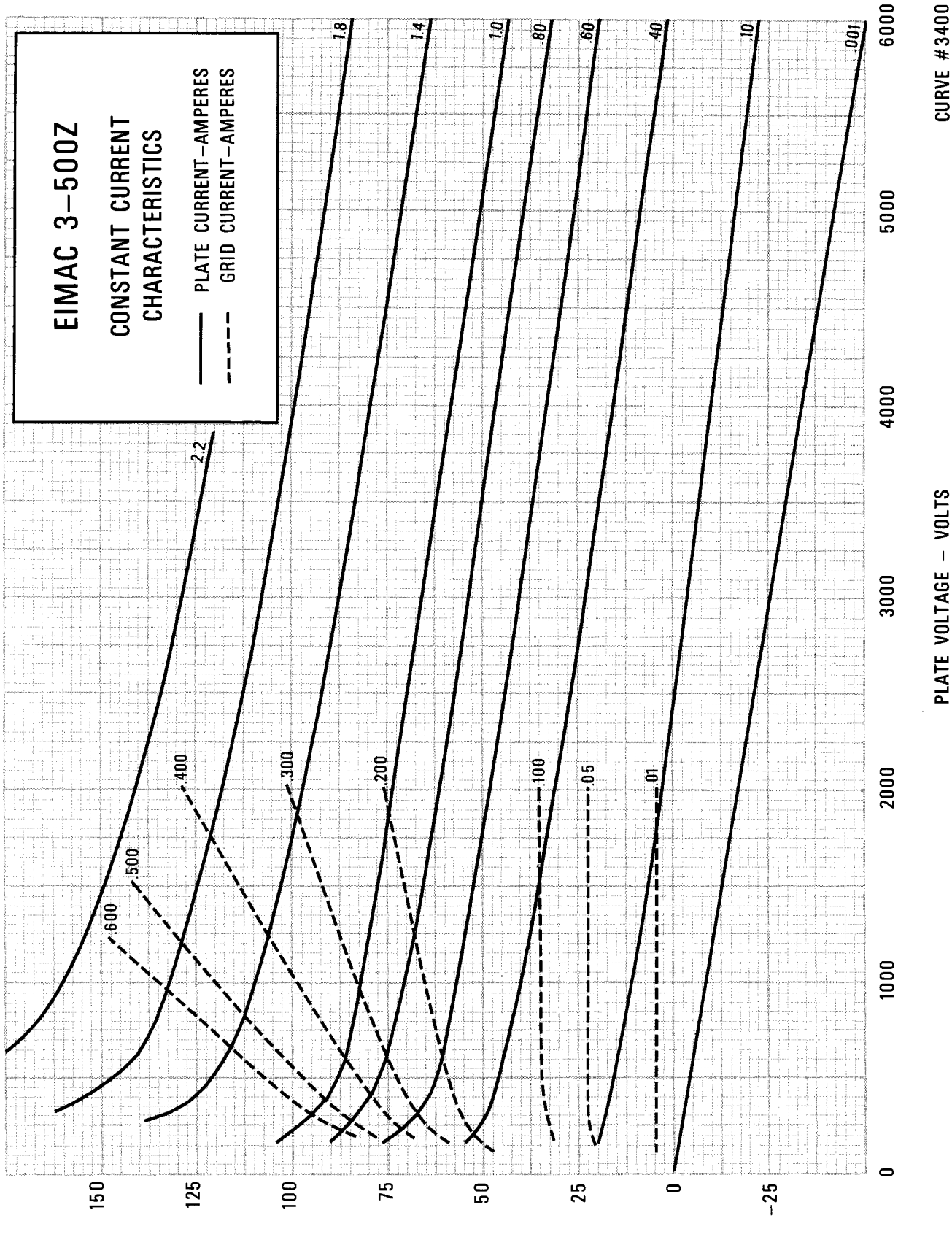
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		3 7/16 D	
B			.355 D
C			.355
D			4 27/32
E	5 3/8	5 7/8	
F	1/2	5/8	
G	9/16	11/16	
H			25/32
J		2-1/2 D	
K			30° TYP.
L	.185 D	.191 D	
M			11/4 D.P.C.

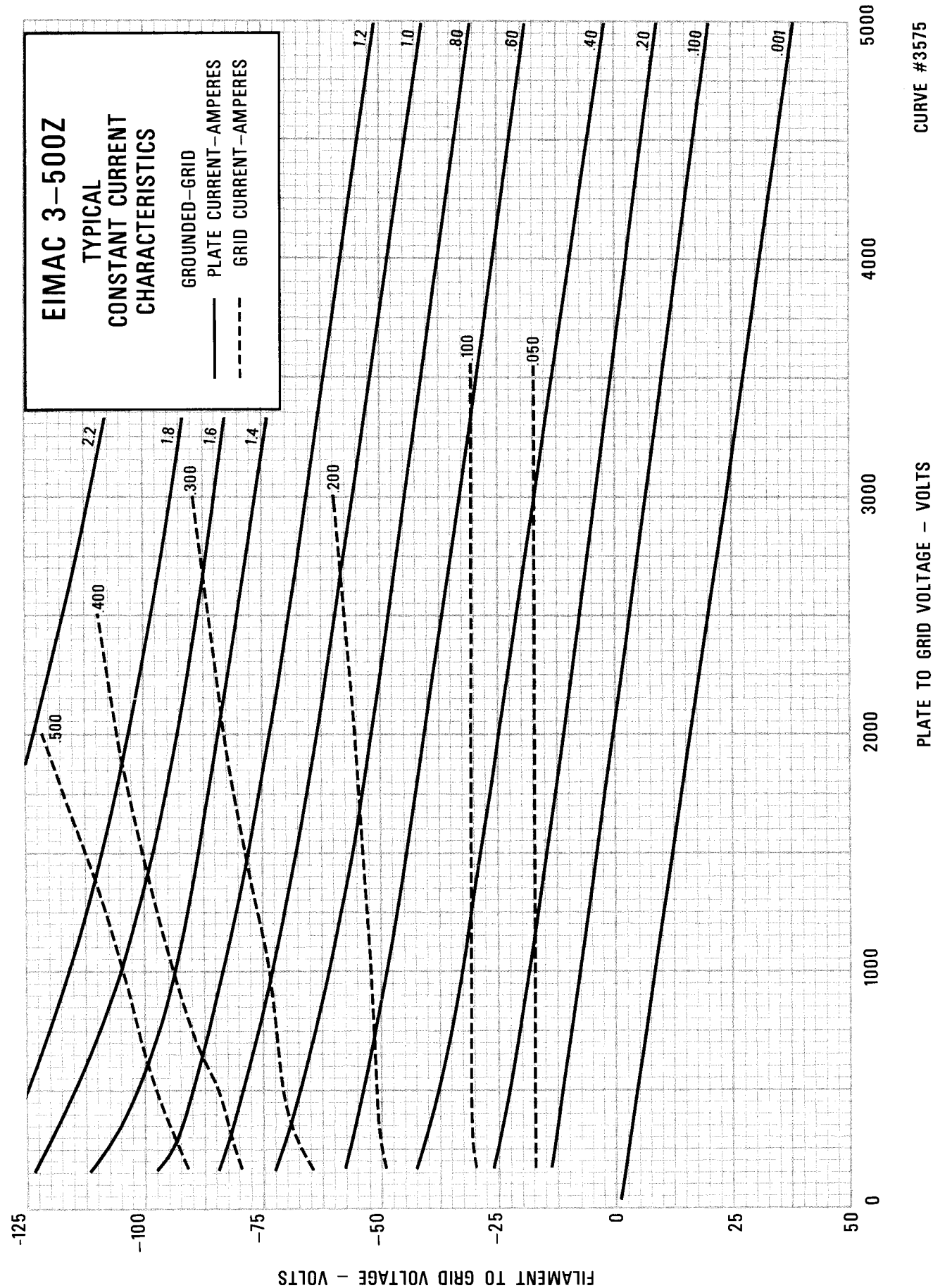
NOTE:

BASE PINS (L) ARE SO ALIGNED THAT THEY CAN BE FREELY INSERTED INTO A GAUGE ¼" THICK WITH HOLE DIA'S OF .204 LOCATED ON TRUE CENTERS BY THE GIVEN DIMENSIONS (K) & (M).






EIMAC 3–500Z
CONSTANT CURRENT CHARACTERISTICS
PLATE CURRENT–AMPERES
GRID CURRENT–AMPERES
1.8
1.4
1.0
.80
.60
.40
.10
.001
2.2
.600
.500
.400
.300
.200
.100
.05
.01
150
125
100
75
50
25
0
–25
0
1000
2000
3000
4000
5000
6000
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – VOLTS
CURVE #3400


EIMAC 3–500Z
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED–GRID
PLATE CURRENT–AMPERES
GRID CURRENT–AMPERES
2.2
1.8
1.6
1.4
1.2
1.0
.80
.60
.40
.20
.100
.001
.500
.400
.300
.200
.100
.050
-125
-100
-75
-50
-25
0
25
50
0
1000
2000
3000
4000
5000
FILAMENT TO GRID VOLTAGE – VOLTS
PLATE TO GRID VOLTAGE – VOLTS
CURVE #3575

4-125A

(4D21)
RADIAL-BEAM POWER TETRODE

●

MODULATOR
OSCILLATOR
AMPLIFIER

TECHNICAL DATA

The EIMAC 4-125A is a radial-beam power tetrode intended for use as an amplifier, oscillator, or modulator. It has a maximum plate-dissipation rating of 125 watts and a maximum plate-voltage rating of 3000 volts at frequencies up to 120 MHz.

The low grid-plate capacitance of this tetrode together with its low driving-power requirement allows considerable simplification of the associated circuit and driver stage.

Cooling is by radiation from the plate and by air circulation through the base and around the envelope.

The 4-125A in class-C rf service will deliver up to 375 watts plate power output with 1.2 watts nominal driving power.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	5.0	volts
Current	6.5	amperes
Grid-Screen Amplification Factor (Average)	5.9	
Direct Interelectrode Capacitances (Average)		
Grid-Plate	0.05	pF
Input	10.8	pF
Output	3.1	pF
Transconductance (I_b=50 mA, E_b=2500 V, E_{c2}=400 V)	2450	μmhos
Highest Frequency for Maximum Ratings	120	MHz

MECHANICAL

Base	5-pin metal shell
Basing	See outline drawing
Socket	E. F. Johnson Co. socket No. 122-275, National Co. No.HX-100, or equivalent
Mounting Position	Vertical, base down or up
Cooling	Radiation and forced air
Recommended Heat-Dissipating Plate Connector	EIMAC HR-6
Maximum Over-all Dimensions:	
Length	5.69 inches
Diameter	2.1 inches
Net Weight	6.5 ounces
Shipping Weight	1.5 pounds

(Revised 6-1-67) © 1958, 1967 by Varian

Printed in U.S.A.

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down condition, 1 tube)

MAXIMUM RATINGS

DC Plate Voltage[1]	3000 volts
DC Screen Voltage	400 volts
DC Grid Voltage	−500 watts
DC Plate Current	225 mA
Plate Dissipation	125 watts
Screen Dissipation	20 watts
Grid Dissipation	5 watts

TYPICAL OPERATION

(Frequencies below 120 MHz)

DC Plate Voltage	2000	2500	3000	volts
DC Screen Voltage	350	350	350	volts
DC Grid Voltage	−100	−150	−150	volts
DC Plate Current	200	200	167	mA
DC Screen Current	50	40	30	mA
DC Grid Current	12	12	9	mA
Screen Dissipation	18	14	10.5	watts
Grid Dissipation	1.6	2	1.2	watts
Peak RF Grid Input Voltage (approx.)	230	320	280	volts
Driving Power (approx.)[3]	2.8	3.8	2.5	watts
Plate Power Input	400	500	500	watts
Plate Dissipation	125	125	125	watts
Plate Power Output	275	375	375	watts

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-AB_1

MAXIMUM RATINGS

DC Plate Voltage	3000 volts
DC Screen Voltage	600 volts
Max-Signal DC Plate Current, per Tube	225 mA
Plate Dissipation, per Tube	125 watts
Screen Dissipation, per Tube	20 watts

TYPICAL OPERATION

(Sinusoidal wave, two tubes unless otherwise specified)

DC Plate Voltage	1500	2000	2500	volts
DC Screen Voltage	600	600	600	volts
DC Grid Voltage[2]	−90	−94	−96	volts
Zero-Signal DC Plate Current	60	50	50	mA
Max-Signal DC Plate Current	222	240	232	mA
Zero-Signal DC Screen Current	−1.0	−0.5	−0.3	mA
Max-Signal DC Screen Current	17	6.4	8.5	mA
Effective Load, Plate-to-Plate	10,200	13,400	20,300	ohms
Peak, AF Grid Input Voltage (per tube)	90	94	96	volts
Driving Power	0	0	0	watts
Max-Signal Plate Dissipation (per tube)	87.5	125	125	watts
Max-Signal Plate Power Output	158	230	330	watts
Total Harmonic Distortion	5	2	2.6	per ct.

HIGH-LEVEL MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony
(Carrier conditions unless otherwise specified, 1 tube)

MAXIMUM RATINGS

DC Plate Voltage[1]	2500 volts
DC Screen Voltage	400 volts
DC Grid Voltage	−500 watts
DC Plate Current	200 mA
Plate Dissipation	85 watts
Screen Dissipation	20 watts
Grid Dissipation	5 watts

TYPICAL OPERATION

(Frequencies below 120 MHz)

DC Plate Voltage	2000	2500	volts
DC Screen Voltage	350	350	volts
DC Grid Voltage	−220	−210	volts
DC Plate Current	150	152	mA
DC Screen Current	33	30	mA
DC Grid Current	10	9	mA
Screen Dissipation	11.5	10.5	watts
Grid Dissipation	1.6	1.4	watts
Peak AF Screen Voltage, 100% Modulation	210	210	volts
Peak RF Grid Input Voltage (approx.)	375	360	volts
Driving Power (approx.)[3]	3.8	3.3	watts
Plate Power Input	300	380	watts
Plate Dissipation	75	80	watts
Plate Power Output	225	300	watts

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-AB_2

MAXIMUM RATINGS

DC Plate Voltage	300 volts
DC Screen Voltage	400 volts
Max-Signal DC Plate Current, per Tube	225 mA
Plate Dissipation, per Tube	125 watts
Screen Dissipation, per Tube	20 watts

TYPICAL OPERATION

(Sinusoidal wave, two tubes unless otherwise specified)

DC Plate Voltage	1500	2000	2500	volts
DC Screen Voltage	350	350	350	volts
DC Grid Voltage	−41	−45	−43	volts
Zero-Signal DC Plate Current	87	72	93	mA
Max-Signal DC Plate Current	400	300	260	mA
Zero-Signal DC Screen Current	0	0	0	mA
Max-Signal DC Screen Current	34	5	6	mA
Effective Load, Plate-to-Plate	7200	13,600	22,200	ohms
Peak AF Grid Input Voltage (per tube)	141	105	89	volts
Max-Signal Avg. Driving Power (approx.)	2.5	1.4	1	watts
Max-Signal Peak Driving Power	5.2	3.1	2.4	watts
Max-Signal Plate Dissipation (per tube)	125	125	122	watts
Max-Signal Plate Power Output	350	350	400	watts
Total Harmonic Distortion	2.5	1	2.2	per ct.

(1) Above 120 MHz the maximum plate voltage rating depends upon frequency. See page 4.
(2) The effective grid circuit resistance for each tube must not exceed 250,000 ohms.
(3) Driving power increases above 70 MHz. See page 4.

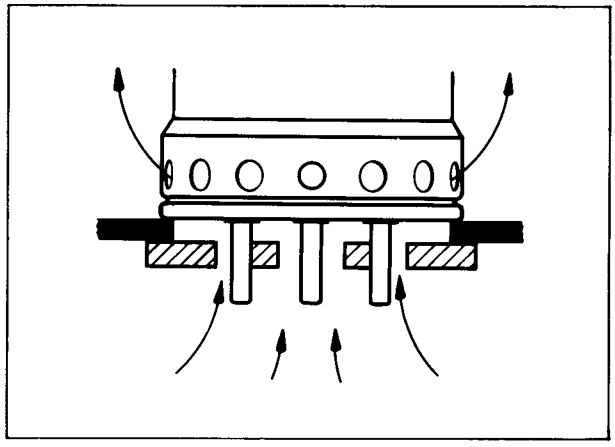
IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION" POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EIMAC DIVISION OF VARIAN ASSOCIATES, FOR INFORMATION AND RECOMMENDATIONS

APPLICATION

MECHANICAL

Mounting—The 4-125A must be mounted vertically, base down or base up. The socket must be constructed so as to allow an unimpeded flow of air through the holes in the base of the tube and must also provide clearance for the glass tip-off which extends from the center of the base. The tube should be mounted above the chassis deck to allow free circulation of air in the manner shown in the mounting diagram below. The above requirements are met by the E. F. Johnson Co. socket No. 122-275, the National Co. socket No. HX-100, or a similar socket.

A flexible connecting strap should be provided between the HR-6 Heat Dissipating Plate Connector on the plate terminal and the external circuit. The tube must be protected from severe vibration and shock.



4-125A mounting providing base cooling, shielding and isolation of output and input compartments.

Cooling—Adequate cooling must be provided for the seals and envelope of the 4-125A. In continuous-service applications, the temperature of the plate seal, as measured on the top of the plate cap, should not exceed 170° C. A relatively slow movement of air past the tube is sufficient to prevent seal temperatures in excess of maximum at frequencies below 30 MHz. At frequencies above 30 MHz, radio frequency losses in the leads and envelope contribute to seal and envelope heating, and special attention should be given to cooling. A small fan or centrifugal blower directed toward the upper portion of the envelope will usually provide sufficient circulation for cooling at frequencies above 30 MHz, however.

In intermittent-service applications where the "on" time does not exceed a total of five minutes in any ten-minute period, plate seal temperatures as high as 220° C. are permissible. When the ambient temperature does not exceed 30° C. it will not ordinarily be necessary to provide forced cooling to hold the temperatures below this maximum at frequencies below 30 MHz, provided that a heat-dissipating plate connector is used, and the tube is so located that normal circulation of air past the envelope is not impeded.

Provision must be made for circulation of air through the base of the tube. Where shielding or socket design makes it impossible to allow free circulation of air through the base, it will be necessary to apply forced-air cooling to the stem structure. An air flow of two cubic feet per minute through the base will be sufficient for stem cooling.

ELECTRICAL

Filament Voltage— For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated value of 5.0 volts. Unavoidable variations in filament voltage must be kept within the range from 4.75 to 5.25 volts.

Bias Voltage— Dc bias voltage for the 4-125A should not exceed 500 volts. If grid-leak bias is used, suitable protective means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation.

Screen Voltage— The dc screen voltage for the 4-125A should not exceed 400 volts, except for class-AB audio operation.

Plate Voltage—The plate-supply voltage for the 4-125A should not exceed 3000 volts for frequencies below 120 MHz. The maximum permissible plate voltage is less than 3000 volts above 120 MHz, as shown by the graph on page 5.

Grid Dissipation—Grid dissipation for the 4-125A should not be allowed to exceed five watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp} I_c$$

where P_g = Grid dissipation,
e_{cmp} = Peak positive grid voltage, and
I_c = D-c grid current.

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid.

Screen Dissipation—The power dissipated by the screen of the 4-125A must not exceed 20 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 20 watts in the event of circuit failure.

Plate Dissipation—Under normal operating conditions, the plate dissipation of the 4-125A should not be allowed to exceed 125 watts in unmodulated applications.

In high-level-modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 85 watts. The plate dissipation will rise to 125 watts under 100% sinusoidal modulation.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

OPERATION

Class-C Telegraphy or FM Telephony—The 4-125A may be operated as a class-C telegraph or FM telephone amplifier without neutralization up to about 30 MHz if reasonable precautions are taken to prevent coupling between input and output circuits external to the tube. A grounded metallic plate on which the socket may be mounted as shown in the mounting diagram on page three provides an effective isolating shield between grid and plate circuits. In single-ended circuits, plate, grid, filament and screen by-pass capacitors should be returned through the shortest possible leads to a common chassis point. In push-pull applications the filament and screen terminals of each tube should be by-passed to a common chassis point by the shortest possible leads, and short, heavy leads should be used to interconnect the screens and filaments of the two tubes. Care should be taken to prevent leakage of radio-frequency energy to leads entering the amplifier, to prevent grid-plate coupling between these leads external to the amplifier.

Where shielding is adequate, the feed-back at frequencies above 100 MHz is due principally to screen-lead-inductance effects, and it becomes necessary to introduce in-phase voltage from the plate circuit into the grid circuit. This can be done by adding capacitance between plate and grid external to the tube. Ordinarily, a small metal tab approximately ¾-inch square connected to the grid terminal and located adjacent to the envelope opposite the plate will suffice for neutralization. Means should be provided for adjusting the spacing between the neutralizing capacitor plate and the envelope, but care must be taken to prevent the neutralizing plate from touching the envelope. An alternative neutralization scheme is illustrated in the diagram below. In this circuit feed-back is eliminated by series-tuning the screen to ground with a small capacitor. The socket screen terminals should be strapped together, as shown on the diagram, by the shortest possible lead, and the leads from the screen terminal to the capacitor, C, and from the capacitor to ground should be made as short as possible. All connections to the screen terminals should be made to the center of the strap between the terminals, in order to equalize the current in the two screen leads and prevent overheating one of them. The value for C given under the diagram presupposes the use of the shortest possible leads.

At frequencies below 100 MHz ordinary neutralization systems may be used. With reasonably effective shielding, however, neutralization should not be required below about 30 MHz.

The driving power and power output under typical operating conditions, with maximum output and plate voltage, are shown on page 5. The power output shown is the actual plate power delivered by the tube; the power delivered to the load will depend upon the efficiency of the plate tank and output coupling system. The driving power is likewise the driving power required by the tube (includes bias loss). The driver output power should exceed the driving power requirement by a sufficient margin to allow for coupling-circuit losses. These losses will not ordinarily amount to more than 30 or 40 per cent of the driving power, except at frequencies above 150 MHz. The use of silver-plated linear tank-circuit elements is recommended at frequencies above 100 MHz.

Conventional capacitance-shortened quarter-wave linear grid tank circuits having a calculated Z_0 of 160 ohms or less may be used with the 4-125A up to 175 MHz. Above 175 MHz linear grid tank circuits employing a "capacitor"-type shortening bar, as illustrated in the diagram below, may be used. The capacitor, C_1, may consist of two silver-plated brass plates one inch square with a piece of .010 inch mica or polystyrene as insulation.

Class-C AM Telephony—The rf circuit considerations discussed above under Class-C Telegraphy or FM Telephony also apply to amplitude-modulated operation of the 4-125A. When the 4-125A is used as a class-C high-level-modulated amplifier, modulation should be applied to both plate and screen. Modulation voltage for the screen may be obtained from a separate winding on the modulation transformer, by supplying the screen voltage via a series dropping resistor from the unmodulated plate supply, or by the use of an audio-frequency reactor in the positive screen-supply lead. When screen modulation is obtained by either the series-resistor or the audio-reactor method, the audio-frequency variations in screen current which result from variations in plate voltage as the plate is modulated automatically give the required screen modulation. Where a reactor is used, it should have a rated inductance of not less than 10 henries divided by the number of tubes in the modulated amplifier and a maximum current rating of two or three times the operating dc screen current. To prevent phase shift between the screen and plate modulation voltages at high audio frequencies, the screen by-pass capacitor should be no larger than necessary for adequate rf by-passing. Where screen voltage is obtained from a separate winding on the modulation transformer, the screen winding should be designed to deliver the peak screen modulation voltage given in the typical operating data on page 2.

For high-level modulated service, the use of partial grid-leak bias is recommended. Any by-pass capacitors placed across the grid-leak resistance should have a reactance at the highest modulation frequency equal to at least twice the grid-leak resistance.

Class-AB_1 and Class-AB_2 Audio—Two 4-125A's may be used in a push-pull circuit to give relatively high audio output power at low distortion. Maximum ratings and typical operating conditions for class-AB_1 and class-AB_2 audio operation are given in the tabulated data.

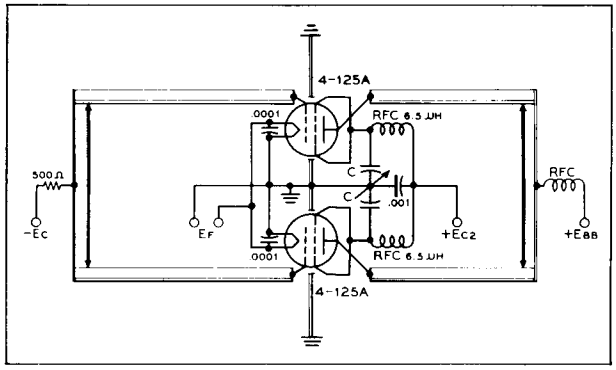
When type 4-125A tubes are used as class-AB_1, or class-AB_2 audio amplifiers at 1500 plate volts, under the conditions given under "Typical Operation," the screen voltage must be obtained from a source having reasonably good regulation, to prevent variations in screen voltage from zero-signal to maximum-signal conditions. The use of voltage regulator tubes in a standard circuit will provide adequate regulation. The variation in screen current at plate voltages of 2000 and above is low enough so that any screen power supply having a normal order

of regulation will serve. The driver plate supply makes a convenient source of screen voltage under these conditions.

Grid bias voltage for class-AB_2 service may be obtained from batteries or from a small fixed-bias supply. When a bias supply is used, the dc resistance of the bias source should not exceed 250 ohms. Under class-AB_1 conditions the effective grid-circuit resistance for each tube should not exceed 250,000 ohms.

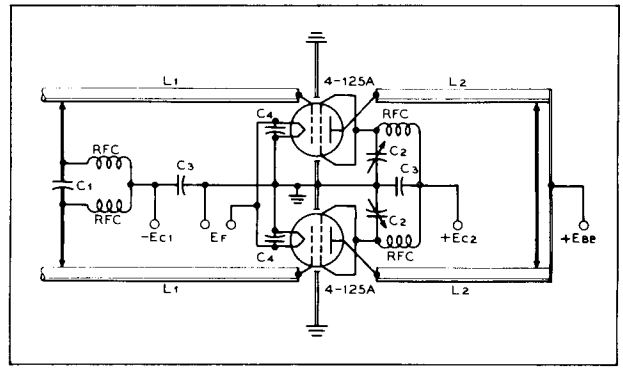
The peak driving power figures given in the class-AB_2 tabulated data are included to make possible an accurate determination of the required driver output power. The driving amplifier must be capable of supplying the peak driving power without distortion. The driver stage should, therefore, be capable of providing an undistorted average output equal to half the peak driving power requirement. A small amount of additional driver output should be provided to allow for losses in the coupling transformer.

The power output figures given in the tabulated data refer to the total power output from the amplifier tubes. The useful power output will be from 5 to 15 per cent less than the figures shown, due to losses in the output transformer.



Screen-tuning neutralization circuit for use above 100 Mc. C is a small split-stator capacitor.

$$C(\mu\mu fd) = \frac{640{,}000}{f^2\ (Mc.)}\ ,\ approx.$$



Typical circuit arrangement useful for frequencies above 175 Mc.

C_1—See above.

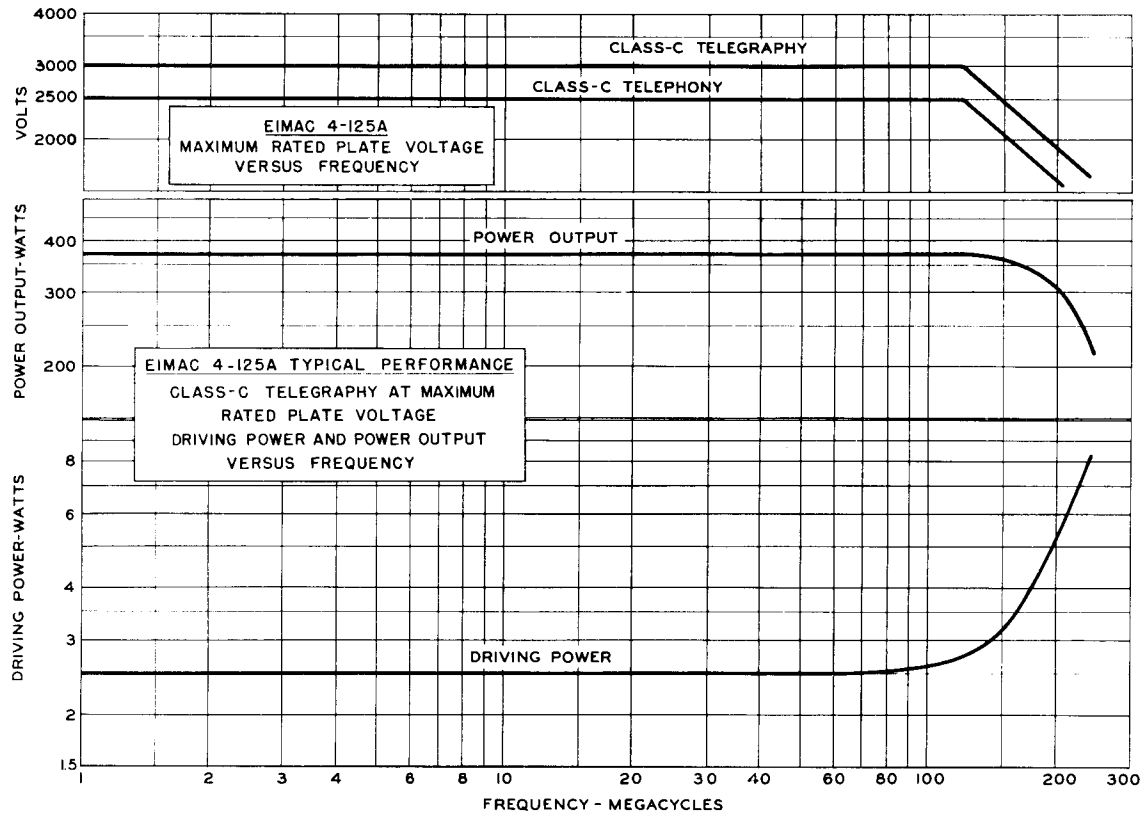
C_2—Neutralizing capacitor.

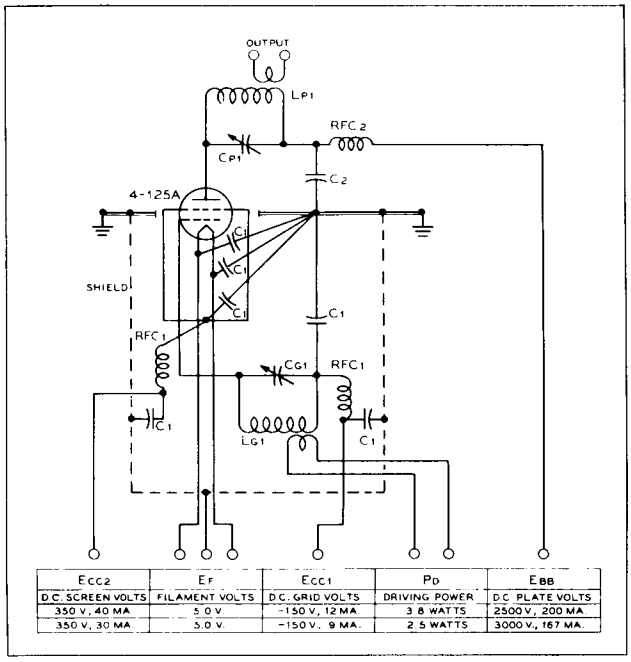
C_3—.001 μfd.

C_4—100 $\mu\mu$fd.

L_1—3/8" dia. copper spaced 1" center-to-center, 6" long.

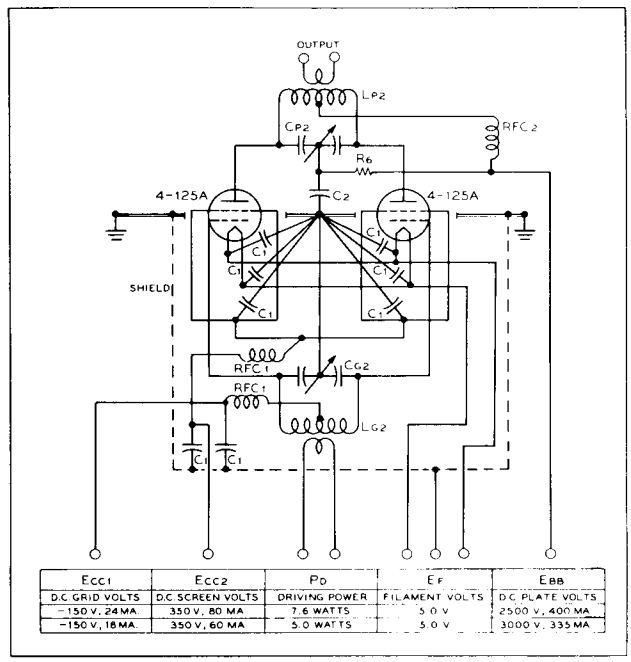
L_2—7/8" dia. brass, silver plated, spaced 1 1/2" center-to-center, 14" long.





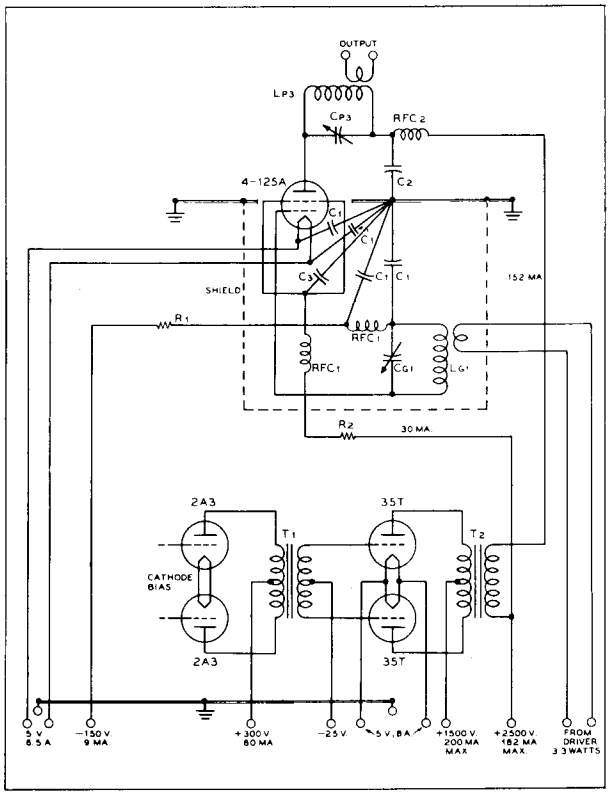
Ecc2	Ef	Ecc1	Po	Ebb
D.C. SCREEN VOLTS	FILAMENT VOLTS	D.C. GRID VOLTS	DRIVING POWER	D.C. PLATE VOLTS
350 V., 40 MA.	5.0 V.	-150 V., 12 MA.	3.8 WATTS	2500 V., 200 MA.
350 V., 30 MA.	5.0 V.	-150 V., 9 MA.	2.5 WATTS	3000 V., 167 MA.

Typical radio-frequency power amplifier circuit, Class-C telegraphy, 500 watts input.

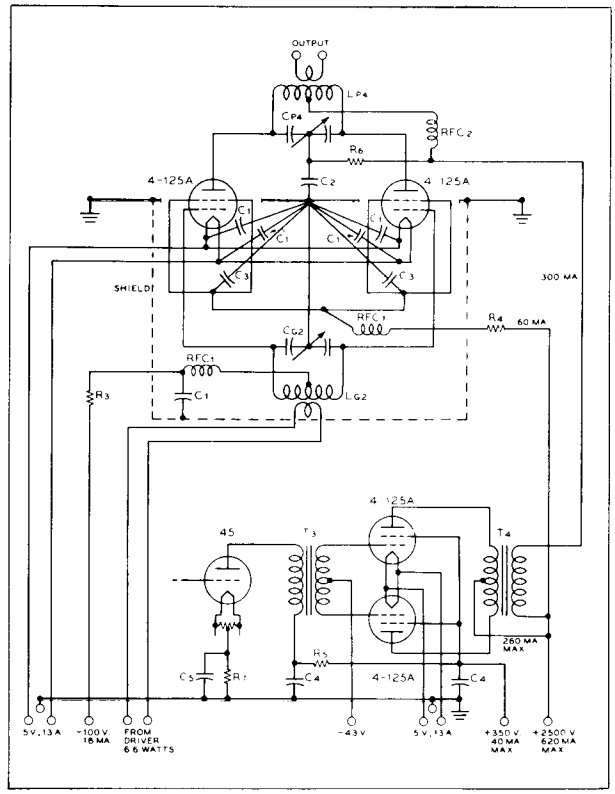


Ecc1	Ecc2	Po	Ef	Ebb
D.C. GRID VOLTS	D.C. SCREEN VOLTS	DRIVING POWER	FILAMENT VOLTS	D.C. PLATE VOLTS
-150 V., 24 MA.	350 V., 80 MA.	7.6 WATTS	5.0 V.	2500 V., 400 MA.
-150 V., 18 MA.	350 V., 60 MA.	5.0 WATTS	5.0 V.	3000 V., 335 MA.

Typical radio-frequency power amplifier circuit, Class-C telegraphy, 1000 watts input.



Typical high-level-modulated r-f amplifier circuit, with modulator and driver stages, 380 watts plate input.



Typical high-level-modulated r-f amplifier circuit, with modulator and driver stages, 750 watts plate input.

See opposite page for list of components.

COMPONENTS FOR TYPICAL CIRCUITS

(Diagrams, Page 6)

L_{p1} - C_{p1} —Tank circuit appropriate for operating frequency; Q = 12. Capacitor plate spacing = .200".

L_{p2} - C_{p2} —Tank circuit appropriate for operating frequency; Q = 12. Capacitor plate spacing = .200".

L_{p3} - C_{p3} —Tank circuit appropriate for operating frequency; Q = 12. Capacitor plate spacing = .375".

L_{p4} - C_{p4} —Tank circuit appropriate for operating frequency; Q = 12. Capacitor plate spacing = .375".

L_{g1} - C_{g1} — Tuned circuit appropriate for operating frequency.

L_{g2} - C_{g2} — Tuned circuit appropriate for operating freqency.

C_1 — .002-ufd., 500-v. mica

C_2 — .002-ufd., 5000-v. mica

C_3 — .001-ufd., 2500-v. mica

C_4 — 16-ufd., 450-v. electrolytic

C_5 — 10-ufd., 25-v. electrolytic

R_1 — 7000 ohms, 5 watts

R_2 — 70,000 ohms, 100 watts

R_3 — 3500 ohms, 5 watts

R_4 — 35,000 ohms, 200 watts

R_5 — 560 ohms, 1 watt

R_6 — 25,000 ohms, 2 watts

R_7 — 1500 ohms, 5 watts

RFC_1 — 2.5-mhy., 125-ma. r-f choke

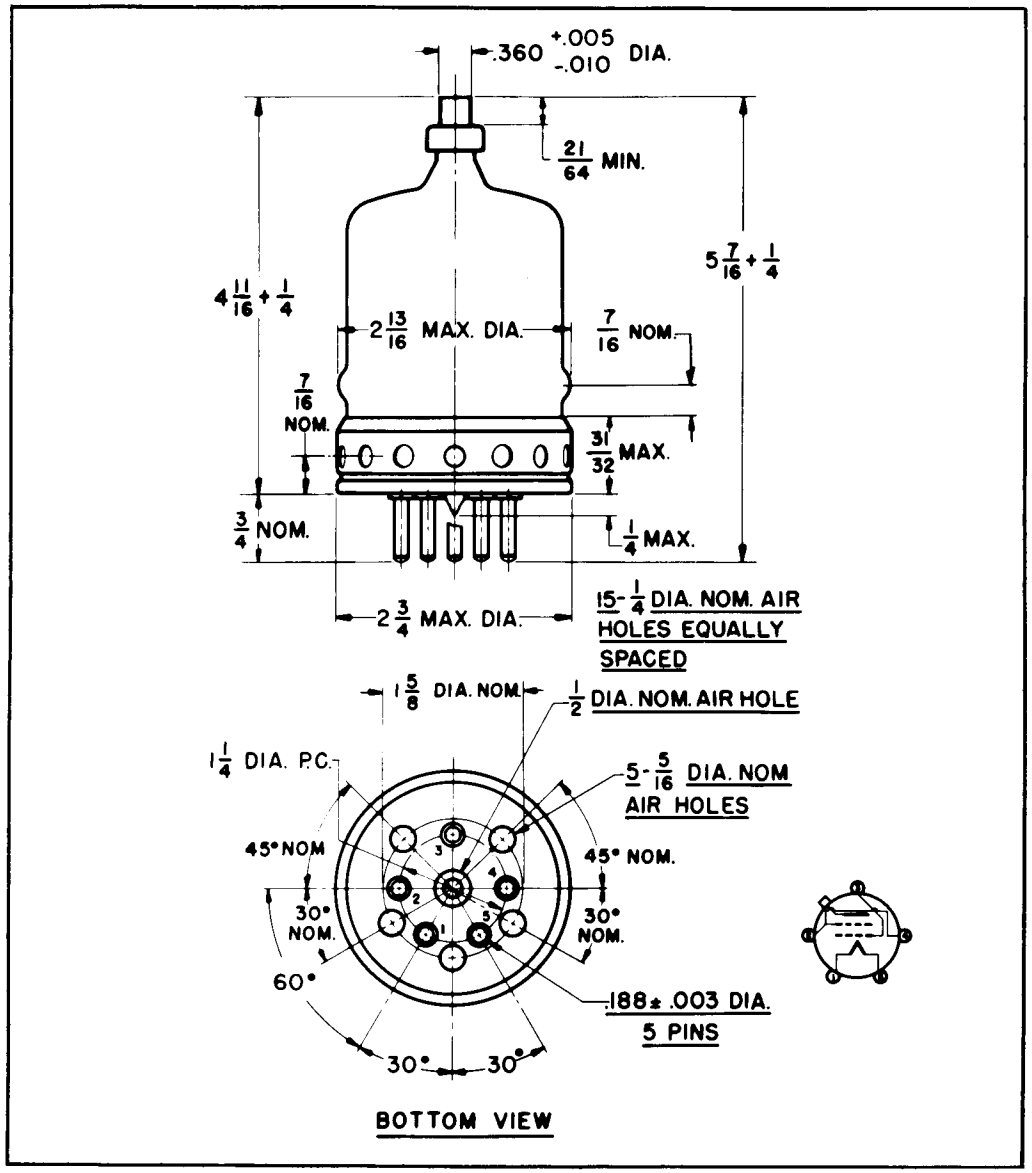
RFC_2 — 1-mhy., 500-ma. r-f choke

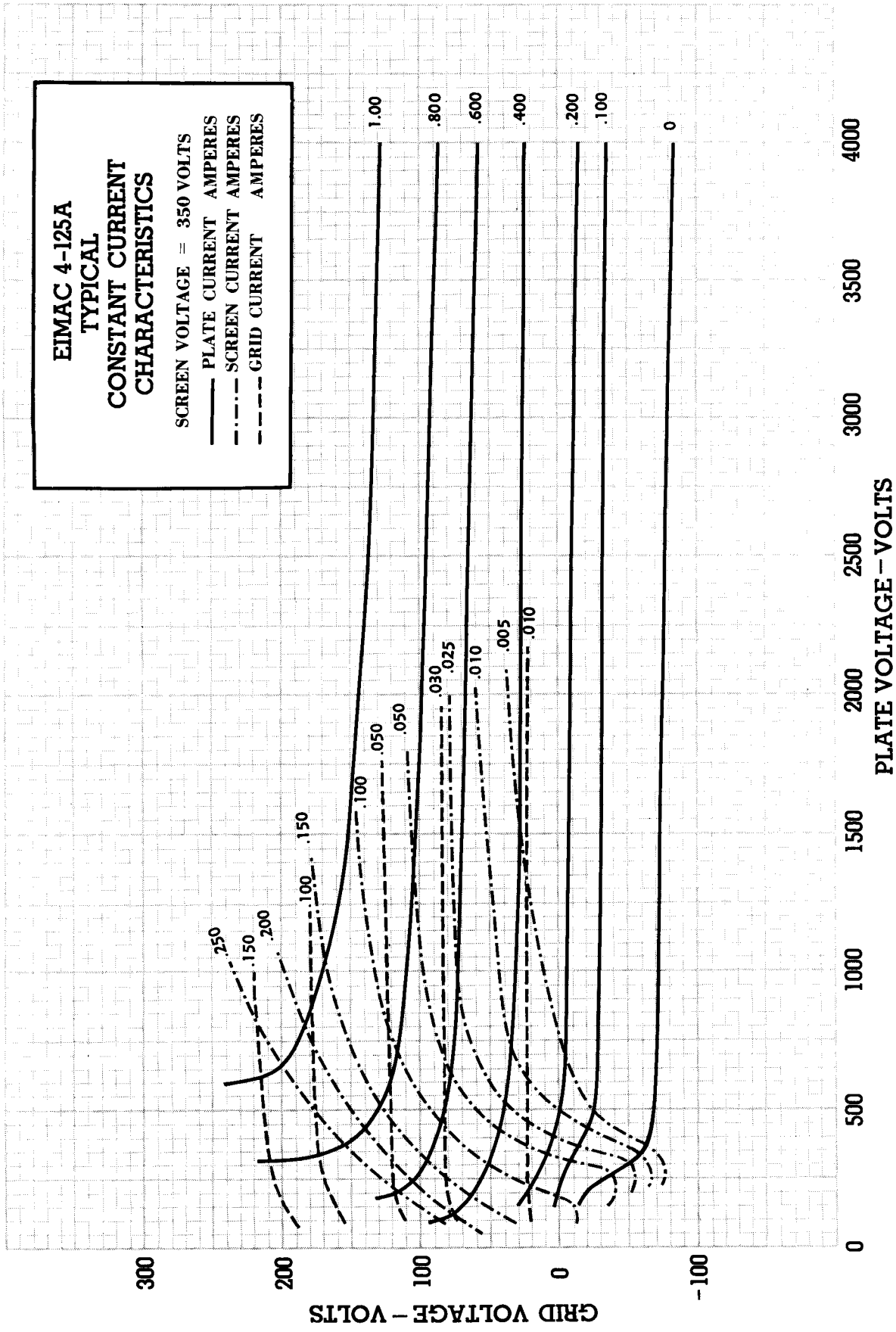
T_1 — 10-watt driver transformer; ratio pri. to ½ sec. approx. 2:1.

T_2 — 200-watt modulation transformer; ratio pri. to sec. approx. 1:1; pri. impedance = 16,200 ohms, sec. impedance = 16,500 ohms.

T_3 — 5-watt driver transformer; ratio pri. to ½ sec. approx. 1.1:1.

T_4 — 400-watt modulation transformer; ratio pri. to sec. approx. 2.7:1; pri. impedance = 22,200 ohms, sec. impedance = 8300 ohms.




EIMAC 4-125A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 350 VOLTS
PLATE CURRENT AMPERES
SCREEN CURRENT AMPERES
GRID CURRENT AMPERES
1.00
.800
.600
.400
.200
.100
0
.250
.150
.200
.100
.150
.100
.050
.050
.030
.025
.010
.005
.010
GRID VOLTAGE – VOLTS
300
200
100
0
-100
0
500
1000
1500
2000
2500
3000
3500
4000
PLATE VOLTAGE – VOLTS

4-250A

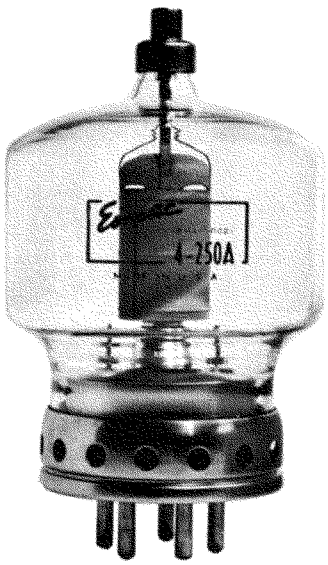
(5D22)

RADIAL-BEAM POWER TETRODE

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MODULATOR OSCILLATOR AMPLIFIER

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA



The Eimac 4-250A is a compact, ruggedly constructed power tetrode having a maximum plate dissipation rating of 250 watts. It is intended for use as an amplifier, oscillator or modulator. The low grid-plate capacitance of this tetrode coupled with its low driving-power requirement allows considerable simplification of the associated circuit and driver stage.

The 4-250A is cooled by radiation from the plate and by circulation of forced-air through the base and around the envelope.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	5.0 volts
Current	14.5 amperes
Grid-Screen Amplification Factor (Average)	5.1
Direct Interelectrode Capacitances (Average)	
Grid-Plate	0.12 $\mu\mu$f
Input	12.7 $\mu\mu$f
Output	4.5 $\mu\mu$f
Transconductance (I_b = 100 ma., E_b = 2500V., E_{c2} = 500V.)	4000 μmhos
Frequency for Maximum Ratings	110 Mc.

MECHANICAL

Base	5-pin metal shell
Recommended Socket	E. F Johnson Co. socket No. 122-275, National Co. No. HX-100, or equivalent.
Basing	See drawing
Mounting Position	Vertical, base down or up
Cooling	Radiation and forced air
Recommended Heat Dissipating Plate Connector	Eimac HR-6
Maximum Temperature of Base and Plate Seals — Base Seals	200° C.
Maximum Temperature of Base and Plate Seals — Plate Seal	170° C.
Maximum Over-all Dimensions — Length	6.38 inches
Maximum Over-all Dimensions — Diameter	3.56 inches
Net Weight	8.0 ounces
Shipping Weight	2.0 pounds

Note: Typical operation data are based on conditions of adjusting the r-f grid drive to a specified plate current, maintaining fixed conditions of grid bias and screen voltage. It will be found that if this procedure is followed, there will be little variation in power output between tubes even though there may be some variation in grid and screen currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C FM or Telegraphy (Key-down conditions, 1 tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE[1]	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	600 MAX. VOLTS
D-C GRID VOLTAGE	—500 MAX. VOLTS
D-C PLATE CURRENT	350 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	35 MAX. WATTS
GRID DISSIPATION	10 MAX. WATTS

TYPICAL OPERATION (Frequencies below 110 Mc.)

D-C Plate Voltage	2500	3000	4000 volts
D-C Screen Voltage	500	500	500 volts
D-C Grid Voltage	—150	—180	—225 volts
D-C Plate Current	300	345	312 ma
D-C Screen Current	60	60	45 ma
D-C Grid Current	9	10	9 ma
Screen Dissipation	30	30	22.5 watts
Grid Dissipation	0.35	0.8	0.46 watts
Peak R-F Grid Input Voltage (approx.)	220	265	303 volts
Driving Power (approx.)[2]	1.70	2.6	2.46 watts
Plate Power Input	750	1035	1250 watts
Plate Dissipation	175	235	250 watts
Plate Power Output	575	800	1000 watts

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony
(Carrier conditions unless otherwise specified, 1 tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE[1]	3200 MAX. VOLTS
D-C SCREEN VOLTAGE	600 MAX. VOLTS
D-C GRID VOLTAGE	—500 MAX. VOLTS
D-C PLATE CURRENT	275 MAX. MA
PLATE DISSIPATION	165 MAX. WATTS
SCREEN DISSIPATION	35 MAX. WATTS
GRID DISSIPATION	10 MAX. WATTS

TYPICAL OPERATION (Frequencies below 110 Mc.)

D-C Plate Voltage	2500	3000	volts
D-C Screen Voltage	400	400	volts
D-C Grid Voltage	—200	—310	volts
D-C Plate Current	200	225	ma
D-C Screen Current	30	30	ma
D-C Grid Current	9	9	ma
Peak A-F Screen Voltage (100% modulation)	350	350	volts
Screen Dissipation	12	12	watts
Grid Dissipation	1.8	2.7	watts
Peak R-F Grid Input Voltage (approx.)	255	365	volts
Driving Power (approx.)	2.2	3.2	watts
Plate Power Input	500	675	watts
Plate Dissipation	125	165	watts
Plate Power Output	375	510	watts

(Effective 7-15-55) Copyright 1952 by Eitel-McCullough, Inc.

[1]Above 110 Mc. the maximum plate voltage rating depends upon frequency. See page four.

[2]Driving power increases above 40 Mc. See page four.

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS AB

MAXIMUM RATINGS (PER TUBE)

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	600 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT	350 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	35 MAX. WATTS
GRID DISSIPATION	10 MAX. WATTS

TYPICAL OPERATION CLASS AB_1

(Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	1500	2000	2500	3000	volts
D-C Screen Voltage	600	600	600	600	volts
D-C Grid Voltage [1,2]	—95	—104	—110	—116	volts
Zero-Signal D-C Plate Current	120	110	120	120	ma
Max-Signal D-C Plate Current	400	405	430	417	ma
Zero-Signal D-C Screen Current	—0.4	—0.3	—0.3	—0.2	ma
Max-Signal D-C Screen Current	23	22	13	10.5	ma
Effective Load, Plate-to-Plate	6250	9170	11,400	15,000	ohms
Peak A-F Grid Input Voltage (per tube)	64	88	90	93	volts
Driving Power	0	0	0	0	watts
Max-Signal Plate Dissipation (per tube)	145	175	225	250	watts
Max-Signal Plate Power Output	310	460	625	750	watts
Total Harmonic Distortion	4	2.5	2	2.5	per cent

[1]Adjust for stated zero-signal plate current.
[2]The effective grid-circuit resistance must not exceed 250,000 ohms.

TYPICAL OPERATION CLASS AB_2

(Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	1500	2000	2500	3000	volts
D-C Screen Voltage	300	300	300	300	volts
D-C Grid Voltage[1]	—48	—48	—51	—53	volts
Zero-Signal D-C Plate Current	100	120	120	125	ma
Max-Signal D-C Plate Current	485	510	500	473	ma
Zero-Signal D-C Screen Current	0	0	0	0	ma
Max-Signal D-C Screen Current	34	26	23	33	ma
Effective Load, Plate-to-Plate	5400	8000	10,900	16,000	ohms
Peak A-F Grid Input Voltage (per tube)	96	99	100	99	volts
Max-Signal Avg. Driving Power (approx.)	2.1	2.3	2.2	1.9	watts
Max-Signal Peak Driving Power	4.7	5.5	4.8	4.6	watts
Max-Signal Plate Dissipation (per tube)	150	185	205	190	watts
Max-Signal Plate Power Output	428	650	840	1040	watts
Total Harmonic Distortion	3	4	4	4.5	per cent

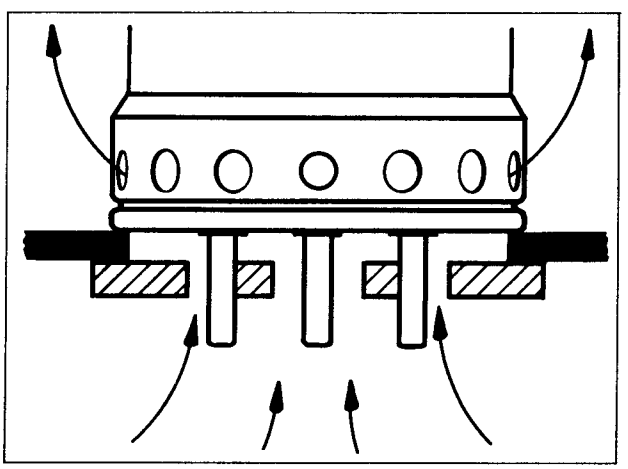
IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.

APPLICATION

Mechanical

Mounting—The 4-250A must be mounted vertically, base down or base up. The socket must be constructed so as to allow an unimpeded flow of air through the holes in the base of the tube and must also provide clearance for the glass tip-off which extends from the center of the base. The tube should be mounted above the chassis deck to allow free circulation of air in the manner shown in the mounting diagram below. The above requirements are met by the E. F. Johnson Co. socket No. 122-275, the National Co. socket No. HX-100, or a similar socket.

A flexible connecting strap should be provided between the HR-6 Heat Dissipating Plate Connector on the plate terminal and the external circuit. The tube must be protected from severe vibration and shock.



4-250A mounting providing base cooling, shielding and isolation of output and input compartments.

▶ **Cooling**—Adequate cooling must be provided for the seals and envelope of the 4-250A. At frequencies above 30Mc, cooling air in the amount of five cubic feet per minute through the base of the tube is required. This quantity is obtained when the pressure drop across the base of the tube is equal to 0.20 inch of water column. At frequencies below 30Mc the volume may be reduced to two cubic feet per minute. At this reduced air flow, the pressure drop is equal to 0.10 inch of water column. Base-cooling air should be applied simultaneously with filament power. The temperature of the plate seal, as measured on the top of the plate cap, should not exceed 170°C in continuous-service applications.

A relatively slow movement of air past the tube is sufficient to prevent a plate seal temperature in excess of the maximum rating at frequencies below 30 Mc. At frequencies above 30 Mc., radio-frequency losses in the leads and envelope contribute to seal and envelope heating and special attention should be given to bulb and plate seal cooling. A small fan or centrifugal blower directed toward the upper portion of the envelope will usually provide sufficient circulation for cooling at frequencies above 30 Mc. (The Eimac 4-400A Air-System Socket provides a convenient method of mounting and cooling the 4-250A at VHF, should the user desire to use it. Full information is available on the 4-400A Air-System Socket data sheet, or it will be sent from the factory on request.)

In intermittent-service applications where the "on" time does not exceed a total of five minutes in any ten-minute period, plate-seal temperatures as high as 220° C. are permissible. When the ambient temperature does not exceed 30° C. it will not ordinarily be necessary to provide forced cooling of the bulb and plate seal to hold the temperature below this maximum at frequencies below 30 Mc., provided that a heat-radiating plate connector is used, and the tube is so located that normal circulation of air past the envelope is not impeded. The five cubic feet per minute base-cooling requirement must be observed in intermittent service.

Electrical

Filament Voltage—For maximum tube life the filament voltage, as measured directly at the base pins, should be the rated value of 5.0 volts. Variations should be held within the range of 4.75 to 5.25 volts.

▶ Indicates change from sheet dated 8-24-53.

Bias Voltage—D-c bias voltage for the 4-250A should not exceed 500 volts. If grid-leak bias is used, suitable protective means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation.

Grid Dissipation—Grid dissipation for the 4-250A should not be allowed to exceed ten watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp} I_c$$

where P_g = Grid dissipation

e_{cmp} = Peak positive grid voltage, and

I_c = D-C grid current.

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid[3].

Screen Voltage—The d-c screen voltage for the 4-250A should not exceed 600 volts.

Screen Dissipation—The power dissipated by the screen of the 4-250A must not exceed 35 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load is removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 35 watts in the event of circuit failure.

Plate Voltage—The plate-supply voltage for the 4-250A should not exceed 4000 volts for frequencies below 110 Mc. Above 110 Mc., the maximum permissible plate voltage is less than 4000 volt, as shown by the graph on page four.

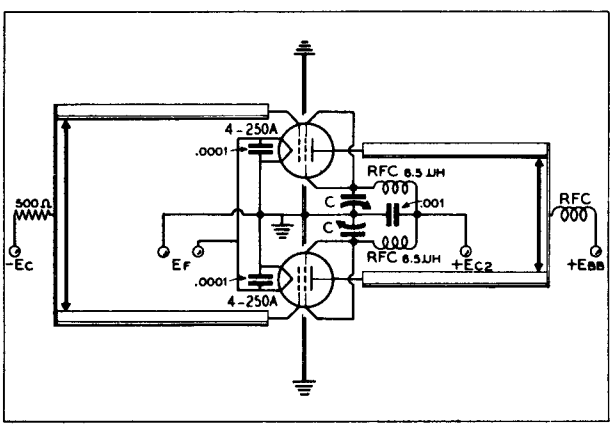
Plate Dissipation—Under normal operating conditions, the plate dissipation of the 4-250A should not be allowed to exceed 250 watts in unmodulated applications.

In plate-modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 165 watts.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

Operation

Class-C FM or Telegraphy—The 4-250A may be operated as a class-C amplifier, FM or telegraphy, without neutralization up to 30 Mc. if reasonable precautions are taken to prevent coupling between input and output circuits external to the tube. A grounded metallic plate on which the socket may be mounted and to which suitable connectors may be attached to ground the tube base shell, provides an effective isolating shield between grid and plate circuits. In single-ended circuits, plate, grid, filament and screen by-pass capacitors should be returned through the shortest possible leads to a common chassis point. In push-pull applications the filament and screen terminals of each tube should be by-passed to a common chassis point by the shortest possible leads, and short, heavy leads should be used to interconnect the screens and filaments of the two tubes. Care should be taken to prevent leakage of radio-frequency energy to leads entering the amplifier in order to minimize grid-plate coupling between these leads external to the amplifier.



Screen-tuning neutralization circuit for use above 45 Mc.
C — Approximately 100$\mu\mu$fd. per section, maximum.

At frequencies from 30 Mc. to 45 Mc. ordinary neutralization systems may be used.

Where shielding is adequate, the feed-back at frequencies above 45 Mc. is due principally to screen-lead-inductance effects, and it becomes necessary to introduce in-phase voltage from the plate circuit into the grid circuit. This can be done by adding capacitance between plate and grid external to the tube. Ordinarily, a small metal tab approximately ¾-inch square connected to the grid terminal and located adjacent to the envelope opposite the plate will suffice for neutralization. Means should be provided for adjusting the spacing between the neutralizing capacitor plate and the envelope. An alternative neutralization scheme is illustrated in the diagram below. In this circuit, feed-back is eliminated by series-tuning the screen to ground with a small capacitor. The socket screen terminals should be strapped together, as shown on the diagram, by the shortest possible lead, and the leads from the screen terminal to the capacitor, C, and from the capacitor to ground should be made as short as possible.

Driving power and power output under maximum output and plate voltage conditions are shown on page 4. The power output shown is the actual plate power delivered by the tube; the power delivered to the load will depend upon the efficiency of the plate tank and output coupling system. The driving power is likewise the driving power required by the tube (includes bias loss). The driver output power should exceed the driving power requirement by a sufficient margin to allow for coupling-circuit losses. The use of silver-plated linear tank-circuit elements is recommended for all frequencies above 110 Mc.

Class-C AM Telephony—The r-f circuit considerations discussed above under Class-C FM or Telegraphy also apply to amplitude-modulated operation of the 4-250A. When the 4-250A is used as a class-C plate-modulated amplifier, modulation should be applied to both plate and screen. Modulation voltage for the screen may be obtained from a separate winding on the modulation transformer, by supplying the screen voltage via a series dropping resistor from the unmodulated plate supply, or by the use of an audio-frequency reactor in the positive screen-supply lead. When screen modulation is obtained by either the series-resistor or the audio-reactor method, the audio-frequency variations in screen current which result from the variations in plate voltage as the plate is modulated automatically give the required screen modulation. Where a reactor is used, it should have a rated inductance of not less than 10 henries divided by the number of tubes in the modulated amplifier and a maximum current rating of two or three times the operating d-c screen current. To prevent phase shift between the screen and plate modulation voltages at high audio frequencies, the screen by-pass capacitor should be no larger than necessary for adequate r-f by-passing.

For plate-modulated service, the use of partial grid-leak bias is recommended. Any by-pass capacitors placed across the grid-leak resistance should have a reactance at the highest modulation frequency equal to at least twice the grid-leak resistance.

Class-AB$_1$ and Class-AB$_2$ Audio—Two 4-250A's may be used in a push-pull circuit to give relatively high audio output power at low distortion. Maximum ratings and typical operating conditions for class-AB$_1$ and class-AB$_2$ audio operation are given in the tabulated data.

Screen voltage should be obtained from a source having reasonably good regulation to prevent variations in screen voltage from zero-signal to maximum-signal conditions. The use of voltage regulator tubes in a standard circuit should provide adequate regulation.

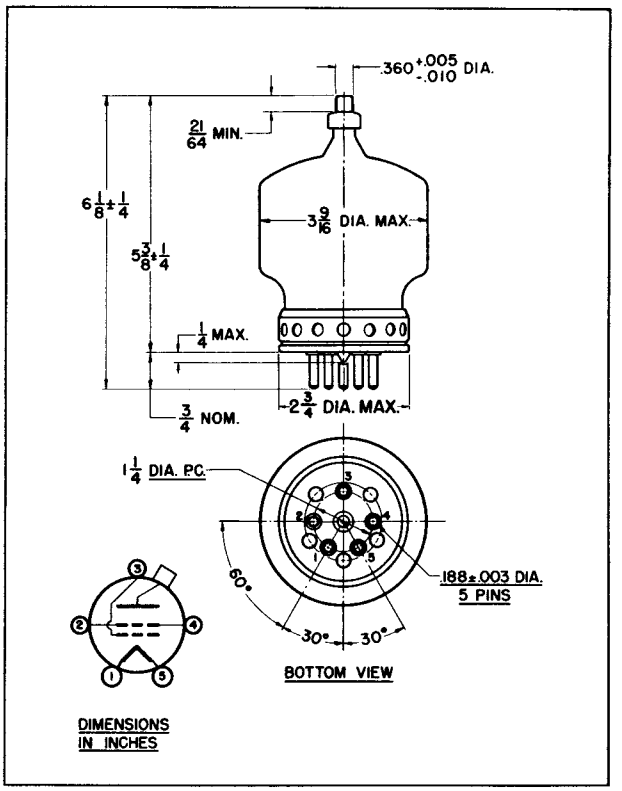
Grid bias voltage for class-AB$_2$ service may be obtained from batteries or from a small fixed-bias supply. When a bias supply is used the d-c resistance of the bias source should not exceed 250 ohms. Under class-AB$_1$ conditions the effective grid-circuit resistance should not exceed 250,000 ohms.

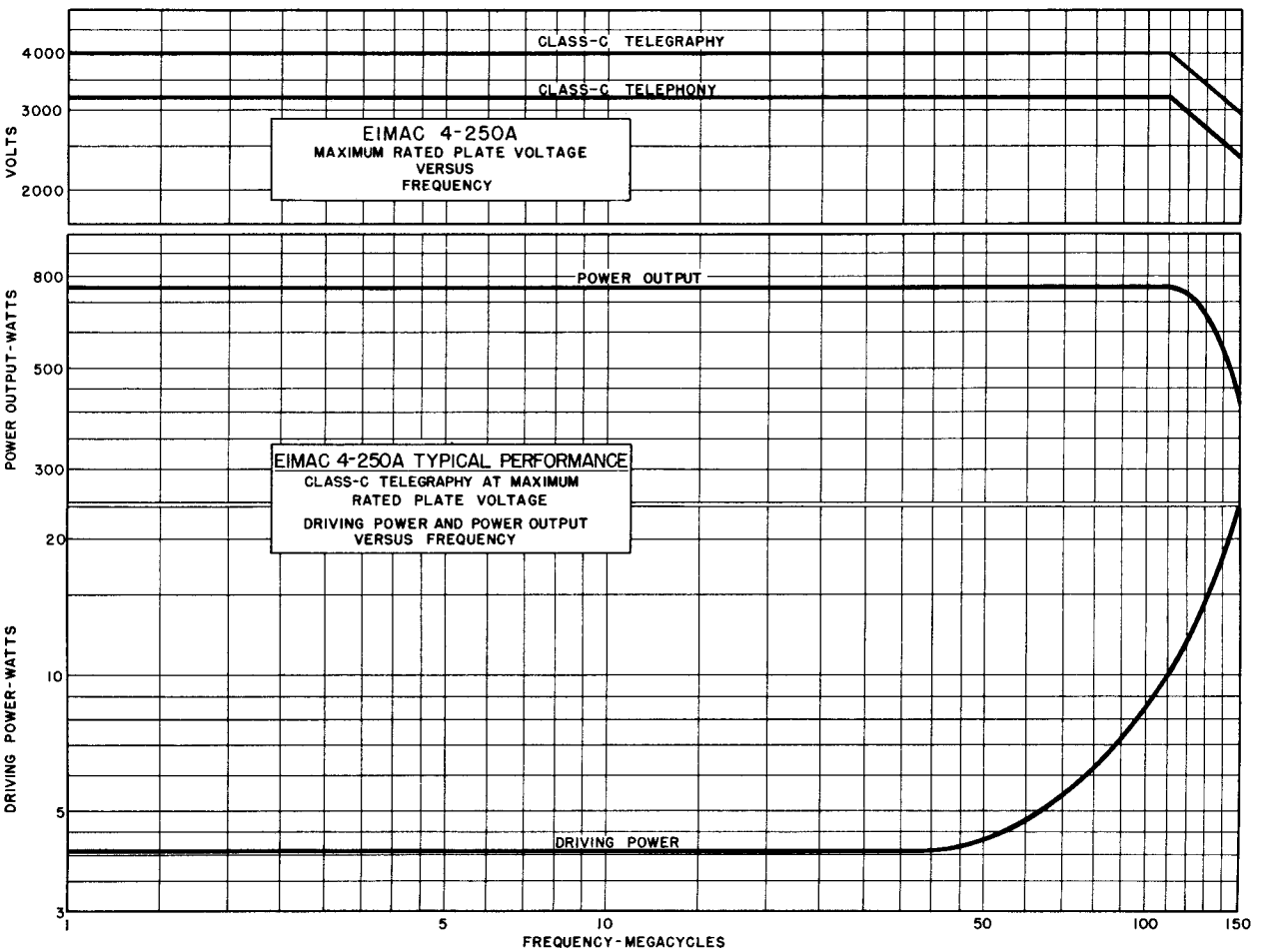
[3] For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings," **Eimac News**, January, 1945. This article is available in reprint form on request.

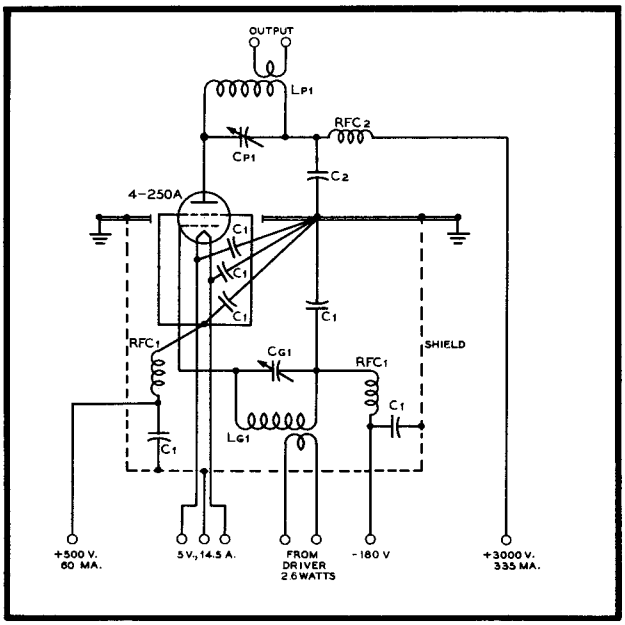
The peak driving power figures given in the class-AB_2 tabulated data are included to make possible an accurate determination of the required driver output power. The driver amplifier must be capable of supplying the peak driving power without distortion. The driver stage should, therefore, be capable of providing an undistorted average output equal to half the peak driving power requirement. A small amount of additional driver output should be provided to allow for losses in the coupling transformer.

In some cases the maximum-signal plate dissipation shown under "Typical Operation" is less than the maximum rated plate dissipation of the 4-250A. In these cases, the plate dissipation reaches a maximum value, equal to the maximum rating, at a point somewhat below maximum-signal conditions.

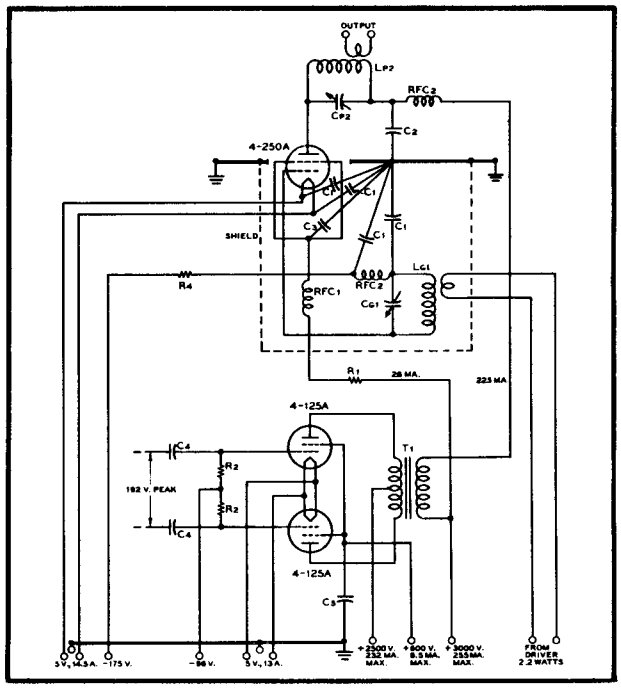
The power output figures given in the tabulated data refer to the total power output from the amplifier tubes. The useful power output will be from 5 to 15 per cent less than the figures shown, due to losses in the output transformer.



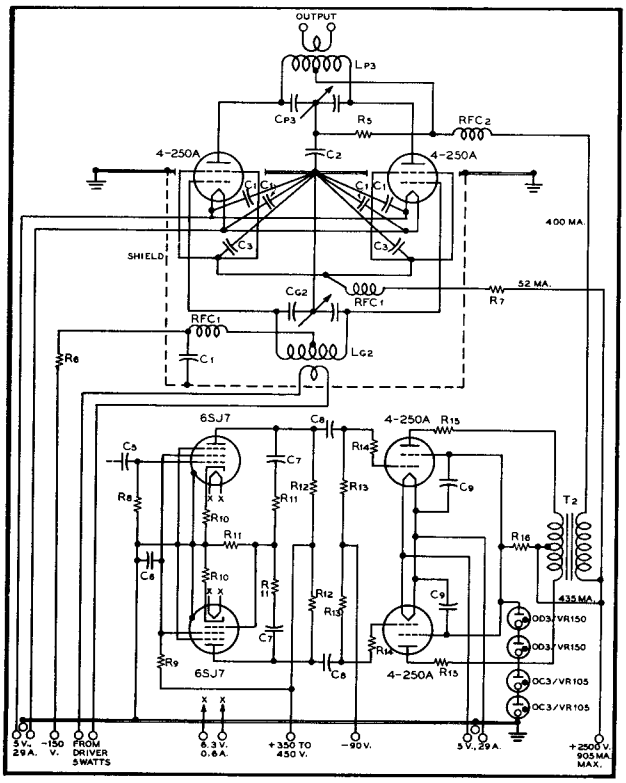




Typical radio frequency power amplifier circuit, Class-C telegraphy, 1000 watts input.



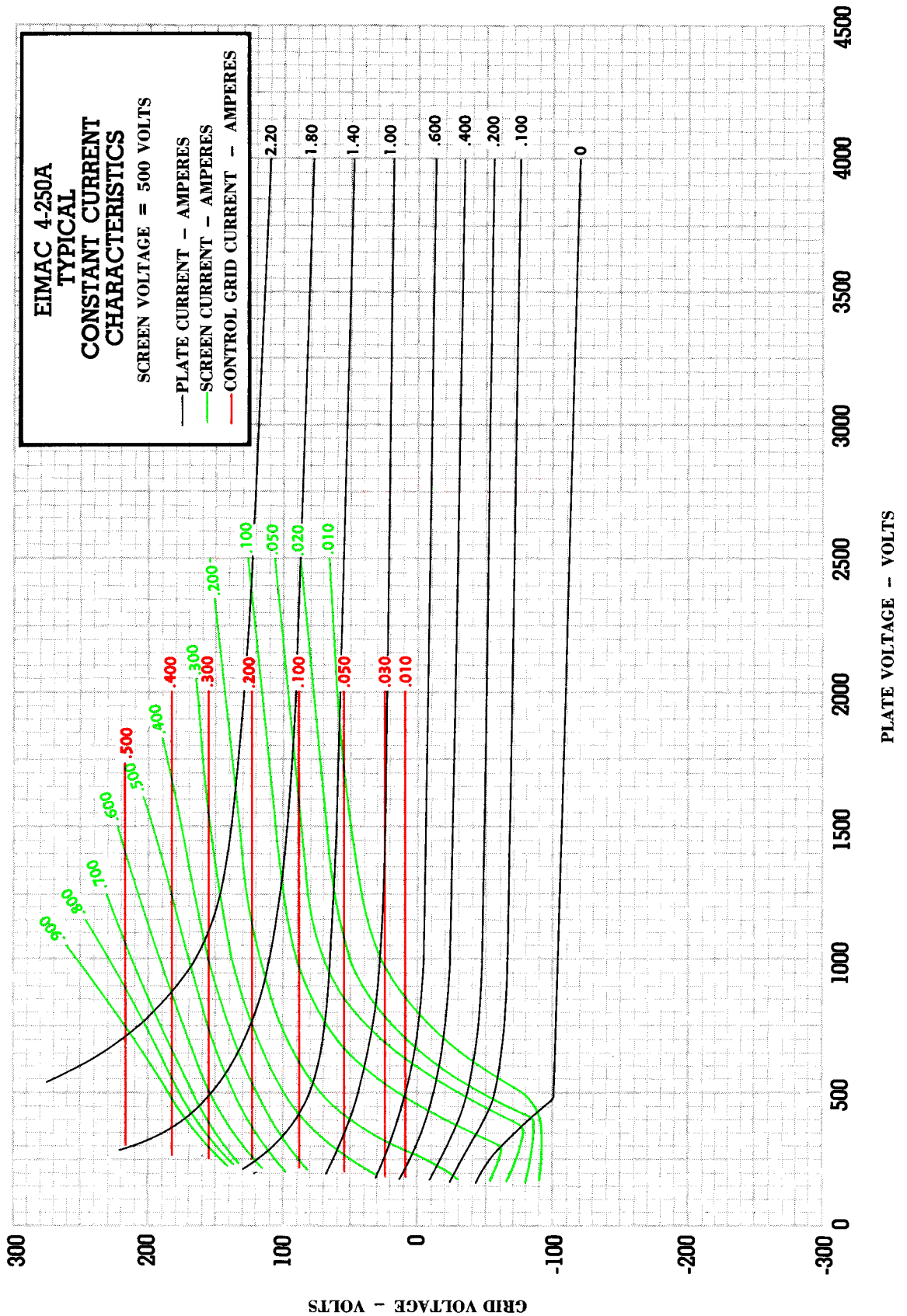
Typical high-level-modulated r-f amplifier circuit, with modulator stage, 675 watts input.



Typical high-level-modulated r-f amplifier circuit, with modulator and driver stages, 1000 watts input.

COMPONENTS FOR TYPICAL CIRCUITS

L_{p1} - C_{p1} — Tank circuit appropriate for operating frequency; Q = 12. Capacitor plate spacing = .200".
L_{p2} - C_{p2} — Tank circuit appropriate for operating frequency; Q = 12. Capacitor plate spacing = .200".
L_{p3} - C_{p3} — Tank circuit appropriate for operating frequency; Q = 12. Capacitor plate spacing = .375".
L_{g1} -C_{g1} — Tuned circuit appropriate for operating frequency.
L_{g2} -C_{g2} — Tuned circuit appropriate for operating frequency.
C_1 — .002-ufd. 500-v. mica
C_2 — .002-ufd. 5000-v mica
C_3 — .001-ufd., 2500-v. mica
C_4 — .1-ufd., 1000-v. paper
C_5 — .1-ufd. 600-v. paper
C_6 — .5-ufd. 600-v paper
C_7 — .03-ufd., 600-v. paper
C_8 — .1-ufd., 1000-v. paper
C_9 — .25-ufd., 1000-v. paper
R_1 — 86,700 ohms, adjustable 100,000 ohms, 100 watts
R_2 — 250,000 ohms, 1/2 watt
R_4 — 15,000 ohms, 5 watts
R_5 — 25,000 ohms, 2 watts
R_6 — 2,500 ohms, 5 watts
R_7 — 35,000 ohms, 160 watts
R_8 — 250,000 ohms, 1/2 watt
R_9 — 200,000 ohms, 2 watts
R_{10} — 500 ohms, 1/2 watt
R_{11} — 1 megohm, 1/2 watt
R_{12} — 100,000 ohms, 1 watt
R_{13} — 200,000 ohms, 1/2 watt
R_{14} — 10,000 ohms, 1/2 watt
R_{15} — 50 ohms, 10 watts
R_{16} — 100,000 ohms, 100 watts
RFC_1 — 2.5-mhy., 125-ma. r-f choke
RFC_2 — 1-mhy., 500-ma. r-f choke
T_1 — 350-watt modulation transformer; ratio pri. to sec. approx. 1.5 : 1; pri. impedance 20,300 ohms, sec. impedance 13,300 ohms.
T_2 — 600-watt modulation transformer; ratio pri. to sec. approx. 1.8 : 1; pri. impedance 11,400 ohms, sec. impedance 6,250 ohms.



Printed in U.S.A. 11-88561

4-400A

RADIAL-BEAM POWER TETRODE

●

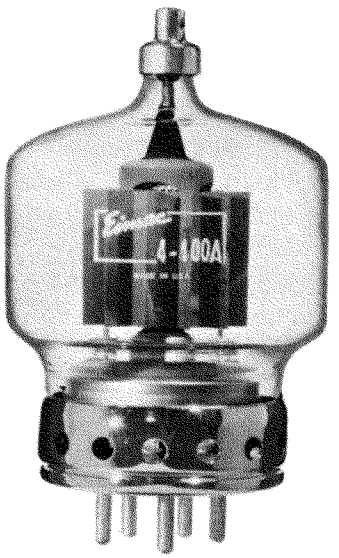
MODULATOR OSCILLATOR AMPLIFIER

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

The Eimac 4-400A is a compact, ruggedly constructed power tetrode having a maximum plate dissipation rating of 400 watts. It is intended for use as an amplifier, oscillator or modulator. The low grid-plate capacitance of this tetrode coupled with its low driving-power requirement allows considerable simplification of the associated circuit and driver stage.

The 4-400A is cooled by radiation from the plate and by circulation of forced-air through the base, around the envelope, and over the plate seal. Cooling can be greatly simplified by using an Eimac 4-400A/4000 Air-System Socket and its accompanying glass chimney. This socket is designed to maintain the correct balance of cooling air between the component parts of the tube.†



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	5.0 volts
Current	14.5 amperes
Grid-Screen Amplification Factor (Average)	5.1
Direct Interelectrode Capacitances (Average)	
Grid-Plate	0.12 $\mu\mu$fd
Input	12.5 $\mu\mu$fd
Output	4.7 $\mu\mu$fd
Transconductance (I_b=100ma., E_b=2500V., E_{c2}=500V.)	4,000 μmhos
Frequency for Maximum Ratings	110 Mc.

MECHANICAL

Base	See drawing
Basing	See drawing
Mounting Position	Vertical, base down or up
Cooling	Radiation and forced air
Recommended Heat Dissipating Plate Connector	Eimac HR-6
Recommended Socket	Eimac 4-400A/4000 Air-System Socket
Maximum Over-all Dimensions	
Length	6.38 inches
Diameter	3.56 inches
Net Weight	9 ounces
Shipping Weight	2.5 pounds

If an Air-System Socket is used, mounted on a 1/4 inch deck, the over-all dimensions of the system including chimney and HR-6 Heat Dissipating Plate Connector are:

Length	8.0 inches
Diameter	5.5 inches

▶ **Note:** Typical operation data are based on conditions of adjusting the r-f grid drive to a specified plate current, maintaining fixed conditions of grid bias and screen voltage. It will be found that if this procedure is followed, there will be little variation in power output between tubes even though there may be some variation in grid and screen currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony

MAXIMUM RATINGS (Key-down conditions, per tube to 110 Mc.)

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	600 MAX. VOLTS
D-C PLATE CURRENT	350 MAX. MA
PLATE DISSIPATION	400 MAX. WATTS
SCREEN DISSIPATION	35 MAX. WATTS
GRID DISSIPATION	10 MAX. WATTS

TYPICAL OPERATION (Frequencies below 75 Mc., one tube)

D-C Plate Voltage	2500	3000	4000	volts
D-C Screen Voltage	500	500	500	volts
D-C Grid Voltage	—200	—220	—220	volts
D-C Plate Current	350	350	350	ma
D-C Screen Current	46	46	40	ma
D-C Grid Current	18	19	18	ma
Screen Dissipation	23	23	20	watts
Grid Dissipation	1.8	1.9	1.8	watts
Peak R-F Grid Input Voltage	300	320	320	volts
Driving Power*	5.4	6.1	5.8	watts
Plate Power Input	875	1050	1400	watts
Plate Dissipation	235	250	300	watts
Plate Power Output	640	800	1100	watts

*Driving Power increases as frequency is increased. At 75 Mc. the driving power required is approximately 12 watts.

TYPICAL OPERATION (110 Mc., two tubes)

D-C Plate Voltage	3500	4000	volts
D-C Screen Voltage	500	500	volts
D-C Grid Voltage	—170	—170	volts
D-C Plate Current	500	540	ma
D-C Screen Current	34	31	ma
D-C Grid Current	20	20	ma
Driving Power (approx.)	20	20	watts
Plate Power Output (approx.)	1300	1600	watts
Useful Power Output	1160	1440	watts

†Guarantee applies only when the 4-400A is used as specified with adequate air in the 4-400A/4000 Air-System Socket or equivalent.

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▶ Indicates change from sheet dated 1-30-53.

PLATE MODULATED RADIO FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions unless otherwise specified. One tube)

MAXIMUM RATINGS (Frequencies below 75 Mc. Continuous Service)

D-C PLATE VOLTAGE	3200 MAX. VOLTS
D-C SCREEN VOLTAGE	600 MAX. VOLTS
D-C GRID VOLTAGE	—500 MAX. VOLTS
D-C PLATE CURRENT	275 MAX. MA
PLATE DISSIPATION	270 MAX. WATTS
SCREEN DISSIPATION	35 MAX. WATTS
GRID DISSIPATION	10 MAX. WATTS

TYPICAL OPERATION (Frequencies below 75 Mc. Continuous Service)

D-C Plate Voltage	2000	2500	3000	volts
D-C Screen Voltage	500	500	500	volts
D-C Grid Voltage	—220	—220	—220	volts
D-C Plate Current	275	275	275	ma
D-C Screen Current	30	28	26	ma
D-C Grid Current	12	12	12	ma
Screen Dissipation	15	14	13	watts
Grid Dissipation	1.1	1.1	1.1	watts
Peak A-F Screen Voltage (100% modulation)	350	350	350	volts
Peak R-F Grid Input Voltage	290	290	290	volts
Driving Power	3.5	3.5	3.5	watts
Plate Power Input	550	688	825	watts
Plate Dissipation	170	178	195	watts
Plate Power Output	380	510	630	watts

▶ MAXIMUM RATINGS (Frequencies below 30 Mc., Intermittent Service)

D-C Plate Voltage	4000 MAX. VOLTS
D-C Screen Voltage	600 MAX. VOLTS
D-C Grid Voltage	—500 MAX. VOLTS
D-C Plate Current	275 MAX. MA
Plate Dissipation	270 MAX. WATTS
Screen Dissipation	35 MAX. WATTS
Grid Dissipation	10 MAX. WATTS

TYPICAL OPERATION (Frequencies below 30 Mc., Intermittent Service)

D-C Plate Voltage	2000	2500	3000	3650	volts
D-C Screen Voltage	500	500	500	500	volts
D-C Grid Voltage	—220	—220	—220	—225	volts
D-C Plate Current	275	275	275	275	ma
D-C Screen Current	30	28	26	23	ma
D-C Grid Current	12	12	12	13	ma
Screen Dissipation	15	14	13	12	watts
Grid Dissipation	1.1	1.1	1.1	1.2	watts
Peak A-F Screen Voltage (100% modulation)	350	350	350	350	volts
Peak R-F Grid Input Voltage	290	290	290	315	volts
Driving Power	3.5	3.5	3.5	4.0	watts
Plate Power Input	550	688	825	1000	watts
Plate Dissipation	170	178	195	235	watts
Plate Power Output	380	510	630	765	watts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS AB

MAXIMUM RATINGS (PER TUBE)

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C SCREEN VOLTAGE	800 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT	350 MAX. MA.
PLATE DISSIPATION	400 MAX. WATTS
SCREEN DISSIPATION	35 MAX. WATTS
GRID DISSIPATION	10 MAX. WATTS

TYPICAL OPERATION CLASS AB_1

(Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	2500	3000	3500	4000	volts
D-C Screen Voltage	750	750	750	750	volts
D-C Grid Voltage (approx.)*	—130	—137	—145	—150	volts
Zero-Signal D-C Plate Current	190	160	140	120	ma
Max-Signal D-C Plate Current	635	635	610	585	ma
Zero-Signal D-C Screen Current	0	0	0	0	ma
Max-Signal D-C Screen Current	28	26	32	40	ma
Effective Load, Plate-to-Plate	6800	8900	11,500	14,500	ohms
Peak A-F Grid Input Voltage (per tube)	130	137	145	150	volts
Driving Power	0	0	0	0	watts
Max-Signal Plate Dissipation (per tube)	370	400	400	400	watts
Max-Signal Plate Power Output	850	1110	1330	1540	watts

*Adjust to give stated zero-signal plate current. The D-C resistance in series with the control grid of each tube should not exceed 250,000 ohms.

TYPICAL OPERATION CLASS AB_2

(Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	2500	3000	3500	4000	volts
D-C Screen Voltage	500	500	500	500	volts
D-C Grid Voltage (approx.)*	—75	—80	—85	—90	volts
Zero-Signal D-C Plate Current	190	160	140	120	ma
Max-Signal D-C Plate Current	700	700	700	638	ma
Zero-Signal D-C Screen Current	0	0	0	0	ma
Max-Signal D-C Screen Current	50	40	38	32	ma
Effective Load, Plate-to-Plate	7200	9100	10,800	14,000	ohms
Peak A-F Grid Input Voltage (per tube)	133	140	145	140	volts
Max-Signal Peak Driving Power	8.6	9.0	10.2	7.0	watts
Max-Signal Nominal Driving Power	4.3	4.5	5.1	3.5	watts
Max-Signal Plate Dissipation (per tube)	320	363	400	400	watts
Max-Signal Plate Power Output	1110	1375	1650	1750	watts

*Adjust for stated zero-signal plate current.

Pulse Service—For information on Pulse Service Ratings, "Application Bulletin No. 3, Pulse Service Notes", will be furnished free on request.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.

APPLICATION

MECHANICAL

Mounting—The 4-400A must be mounted vertically, base up or base down. The socket must be constructed so as to allow an unimpeded flow of air through the holes in the base of the tube and must also provide clearance for the glass tip-off which extends from the center of the base. The metal tube-base shell should be grounded by means of suitable spring fingers. The above requirements are met by the Eimac 4-400A/4000 Air-System Socket. A flexible connecting strap should be provided between the Eimac HR-6 cooler on the plate terminal and the external plate circuit. The tube must be protected from severe vibration and shock.

Cooling—Adequate forced-air cooling must be provided to maintain the base seals at a temperature below 200°C., and the plate seal at a temperature below 225°C.

When the Eimac 4-400A/4000 Air-System Socket is used, a minimum air flow of 14 cubic feet per minute at a static pressure of 0.25 inches of water, as measured in the socket at sea level, is required to provide adequate cooling under all conditions of operation. Seal temperature limitations may require that cooling air be supplied to the tube even when the filament alone is on during standby periods.

In the event an Air-System Socket is not used, pro-

▶ Indicates change from sheet dated 1-30-53.

vision must be made to supply equivalent cooling of the base, the envelope, and the plate lead.

▶ Tube temperatures may be measured with the aid of "Tempilaq", a temperature-sensitive lacquer manufactured by the Tempil Corporation, 11 West 25th Street, New York 10, N. Y.

ELECTRICAL

Filament Voltage—For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated voltage of 5.0 volts. Variations in filament voltage must be kept within the range from 4.75 to 5.25 volts.

Bias Voltage—The d-c bias voltage for the 4-400A should not exceed 500 volts. If grid leak bias is used, suitable means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation, and the grid-leak resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In operation above 50 Mc., it is advisable to keep the bias voltage as low as is practicable.

Screen Voltage—The d-c screen voltage for the 4-400A should not exceed 600 volts in r-f applications. In audio applications a maximum d-c screen voltage of 800 volts may be used. The screen voltages shown under "Typical Operation" are representative voltages for the type of operation involved.

Plate Voltage—The plate-supply voltage for the 4-400A should not exceed 4000 volts in CW and audio applications. In plate-modulated telephony service the d-c plate-supply voltage should not exceed 3200 volts, except below 30 Mc., intermittent service, where 4000 volts may be used.

Grid Dissipation—Grid dissipation for the 4-400A should not be allowed to exceed 10 watts. Grid dissipation may be calculated from the following expression,

$$P_g = e_{cmp} I_c$$

where P_g = Grid Dissipation
e_{cmp} = Peak positive grid to cathode voltage, and
I_c = D-c grid current

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid. (For suitable peak v.t.v.m. circuits see Eimac Application Bulletin Number 6, "Vacuum Tube Ratings." This bulletin is available on request.)

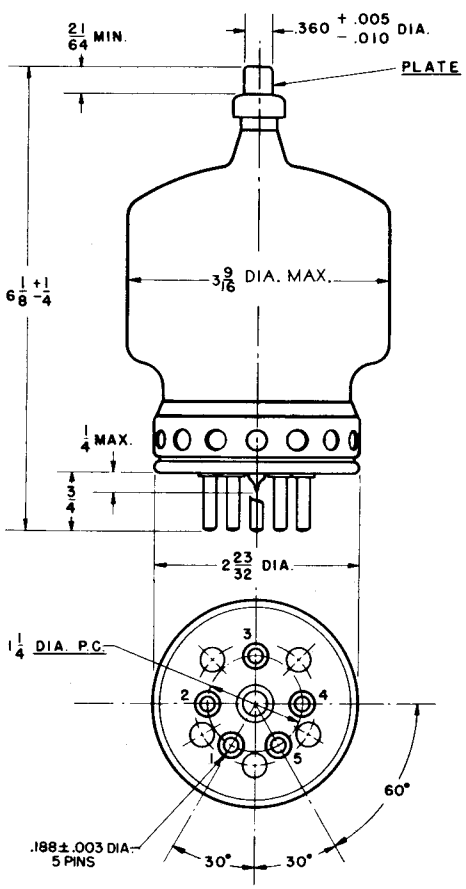
Screen Dissipation—The power dissipated by the screen of the 4-400A must not exceed 35 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 35 watts in event of circuit failure.

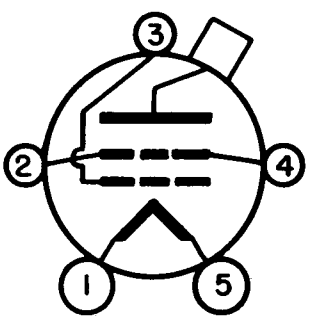
Plate Dissipation—Under normal operating conditions, the plate dissipation of the 4-400A should not be allowed to exceed 400 watts.

In plate modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 270 watts. The plate dissipation will rise to 400 watts under 100% sinusoidal modulation.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

GENERAL INFORMATION PERTAINING TO THE OPERATION OF THE 4-400A MAY BE FOUND IN APPLICATION BULLETIN NO. 8, "THE CARE AND FEEDING OF POWER TETRODES." THIS BULLETIN IS AVAILABLE UPON REQUEST.



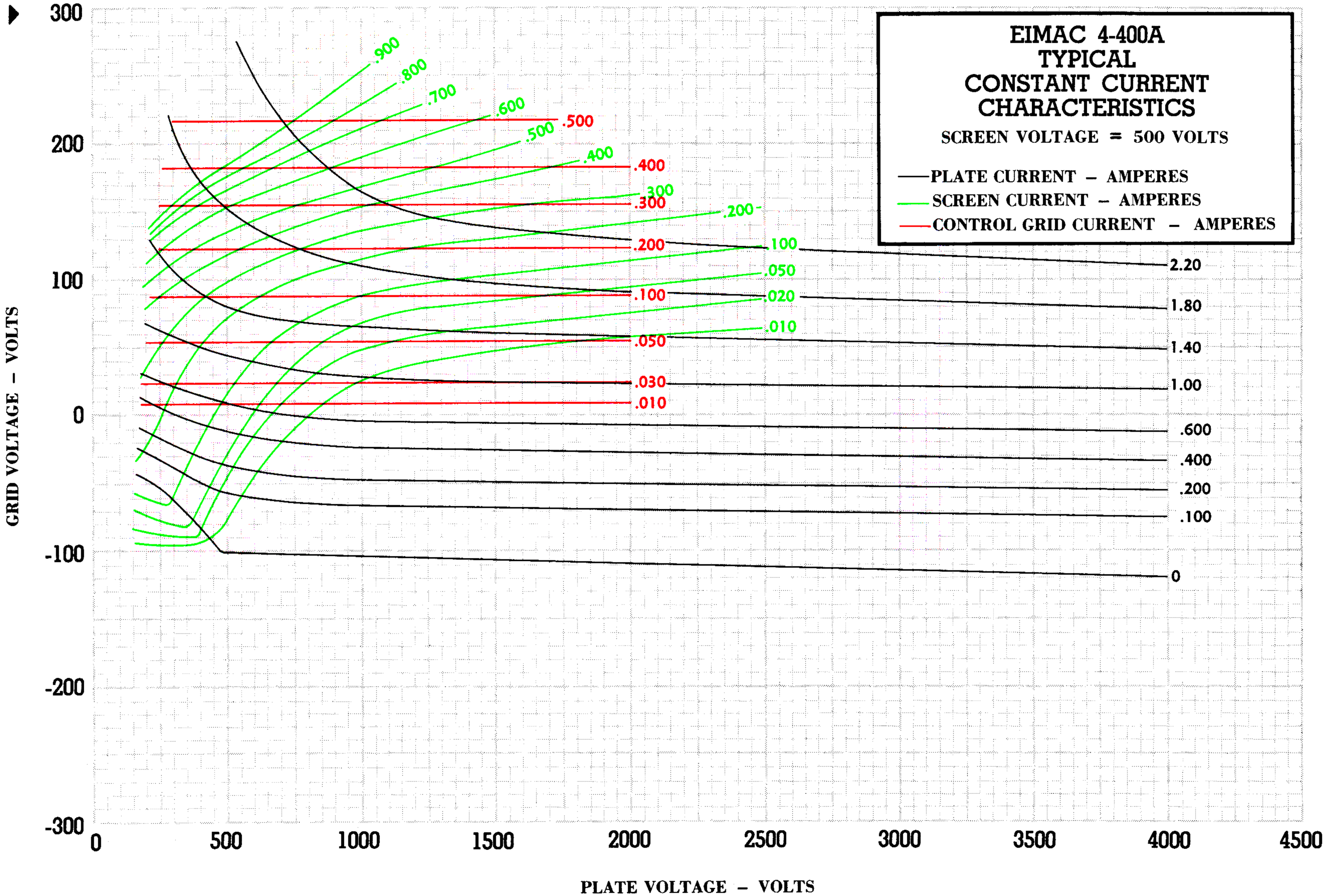


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EIMAC 4-400A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS

SCREEN VOLTAGE = 500 VOLTS

—— PLATE CURRENT – AMPERES
—— SCREEN CURRENT – AMPERES
—— CONTROL GRID CURRENT – AMPERES



Eimac 4-400A

Printed in U. S. A. 5-C6-85008

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4–500A

TECHNICAL DATA

RADIAL BEAM
POWER TETRODE

The EIMAC 4-500A is a compact, ruggedly constructed, broadcast-quality tetrode having a maximum plate dissipation rating of 500 watts. It is intended for use as an amplifier, oscillator, or modulator. The low grid-plate capacitance of this tetrode coupled with its low driving-power requirement allows considerable simplification of the associated circuit and driver stage.

The 4-500A is cooled by radiation from the plate and by circulation of forced-air through the base, around the envelope, and over the plate seal. Cooling can be greatly simplified by using an EIMAC SK-400 Series Air-System Socket, and its accompanying glass chimney. This socket is designed to maintain the correct balance of cooling air between the component parts of the tube.

The 4-500A is especially recommended for applications where long life and consistent performance are of prime consideration.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	10.0 ± 0.5 V
Current, at 10.0 volts	10.2 A
Amplification Factor (Average):	
Grid to Screen	5.5
Direct Interelectrode Capacitances (grounded filament)[2]	
Cin	15.0 pF
Cout	5.0 pF
Cgp	0.15 pF
Frequency of Maximum Rating:	
CW	110 MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	7.000 in; 177.80 mm
Diameter	3.562 in; 90.47 mm
Net Weight	8.7 oz; 245 gm

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Operating Position	Vertical, base up or down
Maximum Operating Temperature:	
Plate Seal	225°C
Base Seals	200°C
Cooling	Radiation and forced air
Base	Special 5-pin
Recommended Socket	EIMAC SK-410
Recommended Chimney	EIMAC SK-426
Recommended Heat-Dissipation Connectors:	
Plate	HR-6

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN Class AB_1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC PLATE CURRENT	0.450	AMPERE
PLATE DISSIPATION	500	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	12	WATTS

1. Adjust for specified zero-signal plate current.
2. Approximate values.
3. The intermodulation distortion products are referenced against one tone of a two-equal-tone signal.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	2500	3000	4000	Vdc
Screen Voltage	750	750	750	Vdc
Grid Voltage [1]	-117	-130	-140	Vdc
Zero-Signal Plate Current	150	100	80	mAdc
One-Tone Plate Current	338	320	322	mAdc
Two-Tone Plate Current	254	225	215	mAdc
Zero-Sig. Screen Current [2]	0	0	0	mAdc
One-Tone Screen Current [2]	38	36	32	mAdc
Two-Tone Screen Current [2]	12	10	8	mAdc
Peak rf Grid Voltage [2]	103	116	126	v
Plate Dissipation	418	427	500	W
One-Tone Plate Output Power	427	533	773	W
Resonant Load Impedance	3700	4800	6500	Ω
IMD Products [3]				
3rd Order	-33	-33	-29	dB
5th Order	-38	-35	-34	dB

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR (Class C Telegraphy or FM Telephony - Key Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC PLATE CURRENT	0.450	AMPERE
PLATE DISSIPATION	500	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	12	WATTS

1. Approximate value.
2. Driving power increases with frequency. Values shown are calculated or measured at Low Frequency.

TYPICAL OPERATION (Frequencies to 75 MHz)

Plate Voltage	2500	3000	3800	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-265	-270	-280	Vdc
Plate Current	402	428	445	mAdc
Screen Current [1]	34	48	49	mAdc
Peak rf Grid Voltage [1]	365	380	390	v
Driving Power [2]	6.6	8.4	9.0	W
Plate Input Power	1005	1285	1685	W
Plate Dissipation	360	395	420	W
Plate Output Power	645	890	1265	W
Resonant Load Impedance	2520	2970	4030	Ω

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER - GRID DRIVEN

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3200	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	0.35	AMPERE
PLATE DISSIPATION [1]	335	WATTS
SCREEN DISSIPATION [2]	35	WATTS
GRID DISSIPATION [2]	12	WATTS

1. Corresponds to 500 watts at 100% sine-wave modulation.
2. Average, with or without modulation.
3. Approximate value.
4. Driving power increases with frequency. Values shown are calculated for low frequency.

TYPICAL OPERATION (Frequencies to 30 MHz) (Continuous Service)

Plate Voltage	2700	3200	Vdc
Screen Voltage	500	500	Vdc
Grid Voltage	-280	-300	Vdc
Plate Current	338	337	mAdc
Screen Current [3]	30	40	mAdc
Grid Current [3]	12	15	mAdc
Peak af Screen Voltage [3] (100% modulation)	500	500	v
Peak rf Grid Voltage [3]	360	380	v
Calculated Driving Power [4]	4.3	5.8	W
Plate Input Power	915	1075	W
Plate Dissipation	245	245	W
Plate Output Power	670	830	W
Resonant Load Impedance	3610	4390	Ω

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB, Grid Driven, Sinusoidal Wave

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC PLATE CURRENT	0.450	AMPERE
PLATE DISSIPATION	500	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	12	WATTS

1. Approximate value.
2. Per tube.
3. Adjust to give stated zero-signal plate current.

TYPICAL OPERATION (Two Tubes - Class AB_1)

Plate Voltage	3000	3800	Vdc
Screen Voltage	750	750	Vdc
Grid Voltage[1/3]	-138	-150	Vdc
Zero-Signal Plate Current	200	150	mAdc
Max. Signal Plate Current	735	715	mAdc
Zero-Signal Screen Current	0	0	mAdc
Max. Signal Screen Current[1]	16	16	mAdc
Max. Signal Grid Current	0	0	mAdc
Peak af Grid Voltage[2]	123	135	v
Peak Driving Power	0	0	w
Max. Signal Plate Dissipation	480	500	W
Plate Output Power	1240	1720	W
Load Resistance (tube-to-tube)	7800	10500	Ω

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 10.0 volts	9.7	11.2	A
Interelectrode Capacitances[1] (grounded filament connection):			
Cin	13.0	17.0	pF
Cout	4.0	6.0	pF
Cgp	---	0.20	pF

1. In Shielded Fixture, per EIA Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4-500A must be mounted vertically. The socket must be constructed so as to allow an unimpeded flow of air through the holes in the base of the tube and must also provide clearance for the glass tip-off which extends from the center of the base. The metal tube-base shell should be grounded by means of suitable spring fingers. The above requirements are met by the EIMAC SK-410 Air-System Socket. A flexible connecting strap should be provided between the EIMAC HR-6 cooler on the plate terminal and the external plate circuit. The tube must be protected from severe vibration and shock.

COOLING - Adequate forced-air cooling must be provided to maintain the base seals at a temperature below 200°C, and the plate seal at a temperature below 225°C.

When the EIMAC SK-410 Socket and SK-426 Chimney are used, a minimum air flow of 14 cubic feet per minute at a static pressure of 0.25 inches of water or less, as measured in the socket or plenum chamber at sea level, is required to provide adequate cooling under all conditions of operation. Seal temperature limitations may require that cooling air be supplied to the tube even when the filament alone is on during standby periods.

Tube temperatures may be measured with a temperature sensitive paint, spray or crayon, such as manufactured by Tempil Division, Big Three Industrial Gas & Equipment Co., Hamilton Blvd., So. Plainfield, N.J. 07080.

ELECTRICAL

FILAMENT VOLTAGE - Filament voltage should be measured at the tube base with an accurate meter. When operating at the nominal

voltage, variations of ±5% are tolerable and should have little effect on electrical performance of the tube. However, when very long life and consistent performance are factors, voltage can often be reduced to a value lower than the nominal voltage, but should be regulated and held to ±1% when this is done. To achieve a regulated voltage and still have it adjustable, a typical procedure would involve a one-to-one regulating transformer, feeding a variable ratio transformer (such as a POWERSTAT or a VARIAC), which in turn feeds the filament transformer. The equipment is first operated with nominal filament voltage applied, and when stable operation is achieved, the voltage is then reduced in small steps (about 0.2 volt at a time) until the point is reached where performance of the tube is clearly affected. The voltage is then raised to a few tenths of a volt above this level for operation. Periodically (every 500 to 1000 hours) this procedure should be repeated and the operating value of the filament voltage readjusted if necessary.

BIAS VOLTAGE - The dc bias voltage for the 4-500A should not exceed 500 volts. If grid resistor bias is used, suitable means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation, and the grid resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In operation above 50 MHz, it is advisable to keep the bias voltage as low as is practicable.

SCREEN VOLTAGE - The dc screen voltage for the 4-500A should not exceed 1000 volts. The screen voltages shown under Typical Operation are representative voltages for the type of operation involved.

PLATE VOLTAGE - The plate-supply voltage for the 4-500A should not exceed 4000 volts in CW and audio applications. In plate-modulated telephony service the dc plate-supply voltage should not exceed 3200 volts, except below 30 MHz, intermittent service, where 4000 volts may be used.

GRID DISSIPATION - Grid dissipation for the 4-500A should not be allowed to exceed 12 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{gk} \times I_c$$

where P_g = Grid dissipation
e_{gk} = Peak positive grid to cathode voltage, and
I_c = dc grid current

SCREEN DISSIPATION - The power dissipated by the screen of the 4-500A must not exceed 35 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 35 watts in event of circuit failure.

PLATE DISSIPATION - Under normal operating conditions, the plate dissipation of the 4-500A should not be allowed to exceed 500 watts. The anode operates at a visibly red color at its maximum rated dissipation of 500 watts.

In plate modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 335 watts. The plate dissipation will rise to 500 watts under 100% sinusoidal modulation.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

MULTIPLE OPERATION - To obtain maximum power output with minimum distortion from tubes operated in multiple, it is desirable to adjust individual screen or grid bias voltages so that the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual dc plate currents will be approximately equal for full input signal for class AB 1 operation.

CAUTION-GLASS IMPLOSION - The EIMAC 4-500A is pumped to a very high vacuum, which is contained by a glass envelope. When handling a glass tube, remember that glass is a relatively fragile material, and accidental breakage can result at any time. Breakage will result in flying glass fragments, so safety glasses, heavy clothing, and leather gloves are recommended for protection.

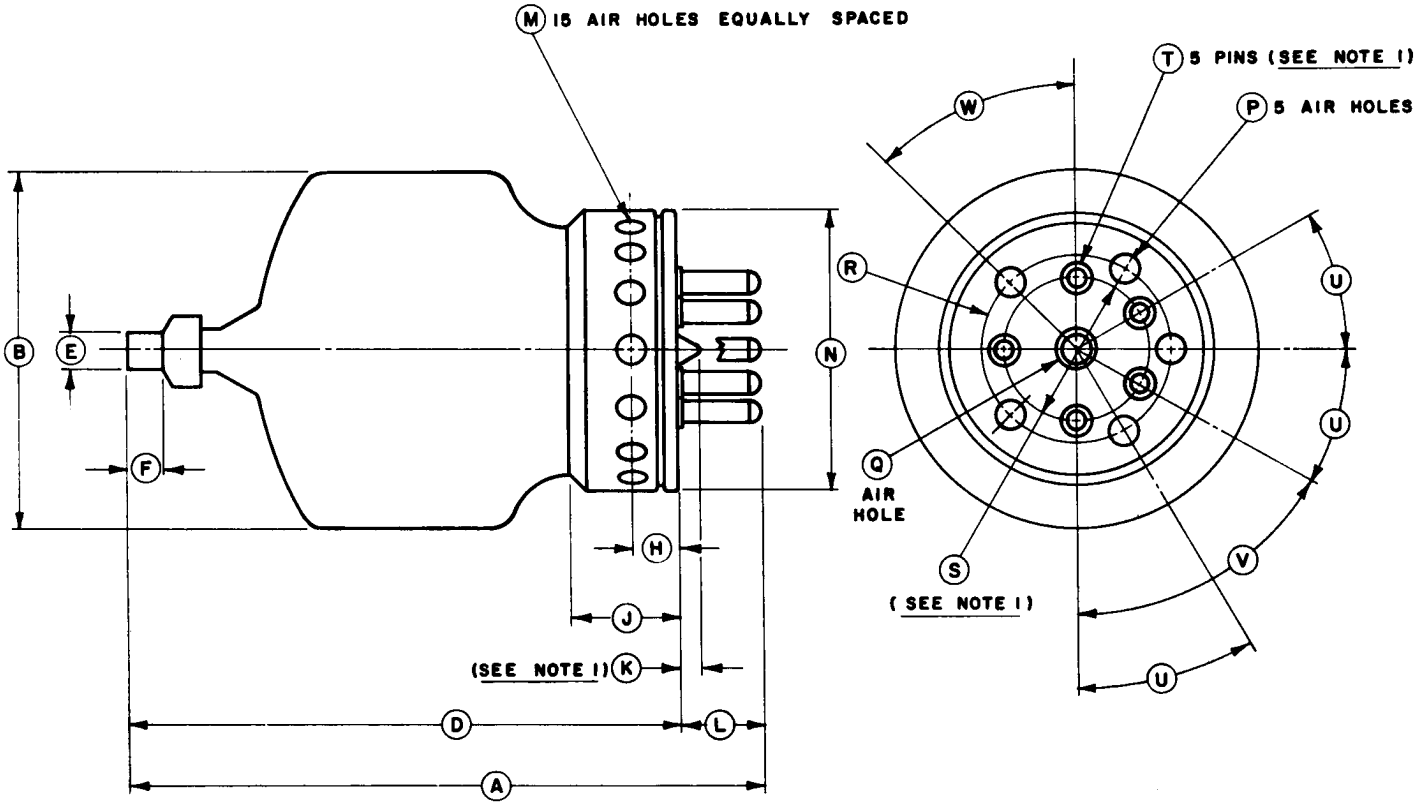
CAUTION-HIGH VOLTAGE - Operating voltage for the 4-500A can be deadly, so the equipment must be designed properly and operating precautions must be followed. Design equipment so that

no one can come in contact with high voltages. All equipment must include safety enclosures for high voltage circuits and terminals, with interlock switches to open the primary circuits of the power supply and to discharge high voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

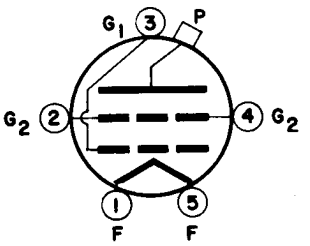
INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

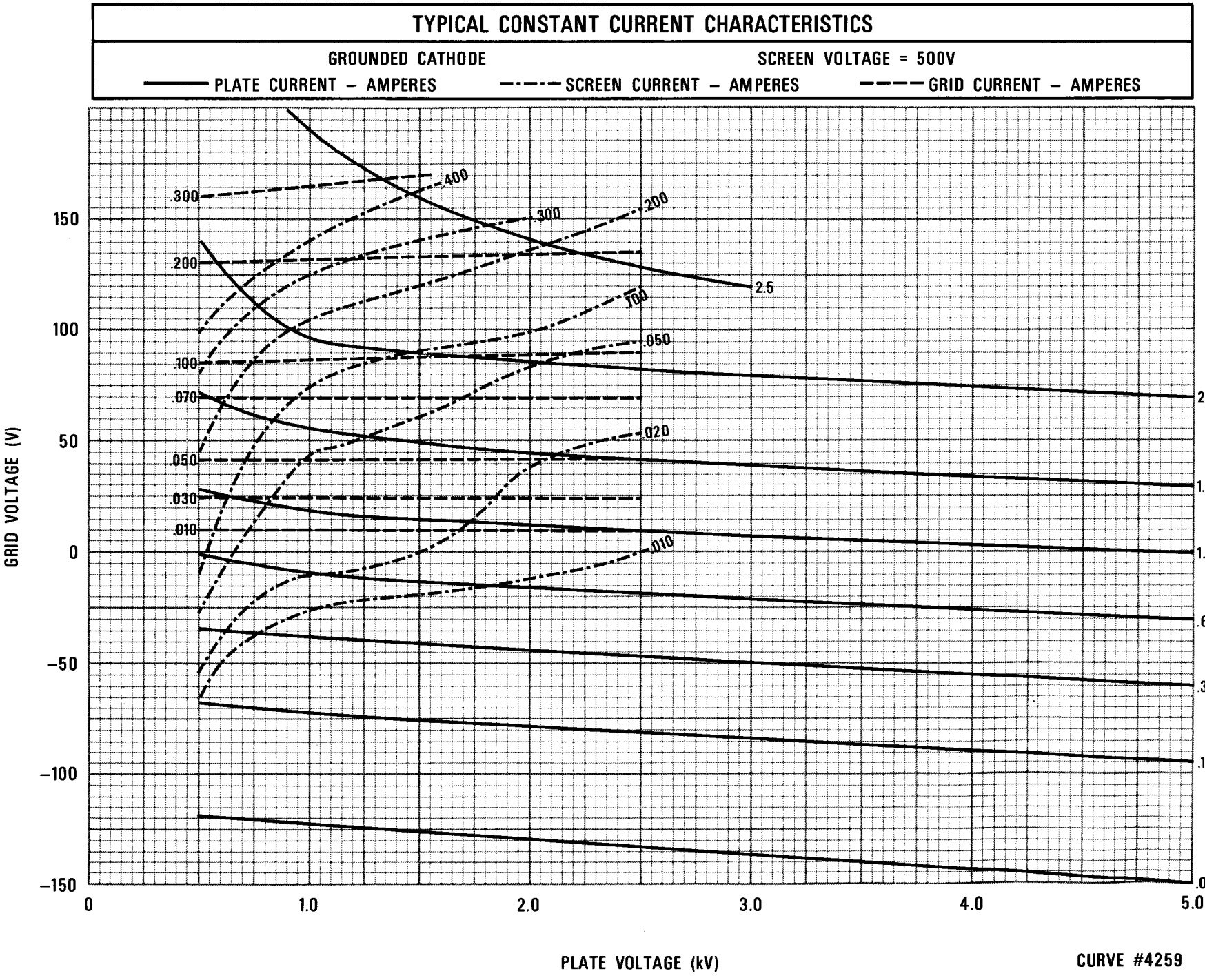


DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	6.500	7.000	- -	165.10	177.80	- -
B	- -	3.562	- -	- -	90.47	- -
D	5.750	6.250	- -	146.05	158.75	- -
E	0.350	0.365	- -	8.89	9.27	- -
F	0.328	- -	- -	8.33	- -	- -
H	- -	- -	0.468	- -	- -	11.89
J	- -	- -	1.125	- -	- -	28.57
K	- -	0.250	- -	- -	6.35	- -
L	- -	- -	0.750	- -	- -	19.05
M	- -	- -	0.250	- -	- -	6.35
N	- -	2.750	- -	- -	69.85	- -
P	- -	- -	0.312	- -	- -	7.92
Q	- -	- -	0.500	- -	- -	12.70
R	- -	- -	1.625	- -	- -	41.27
S	- -	- -	1.250	- -	- -	31.75
T	0.185	0.191	- -	4.70	4.85	- -
U	- -	- -	30°	- -	- -	30°
V	- -	- -	60°	- -	- -	60°
W	- -	- -	45°	- -	- -	45°

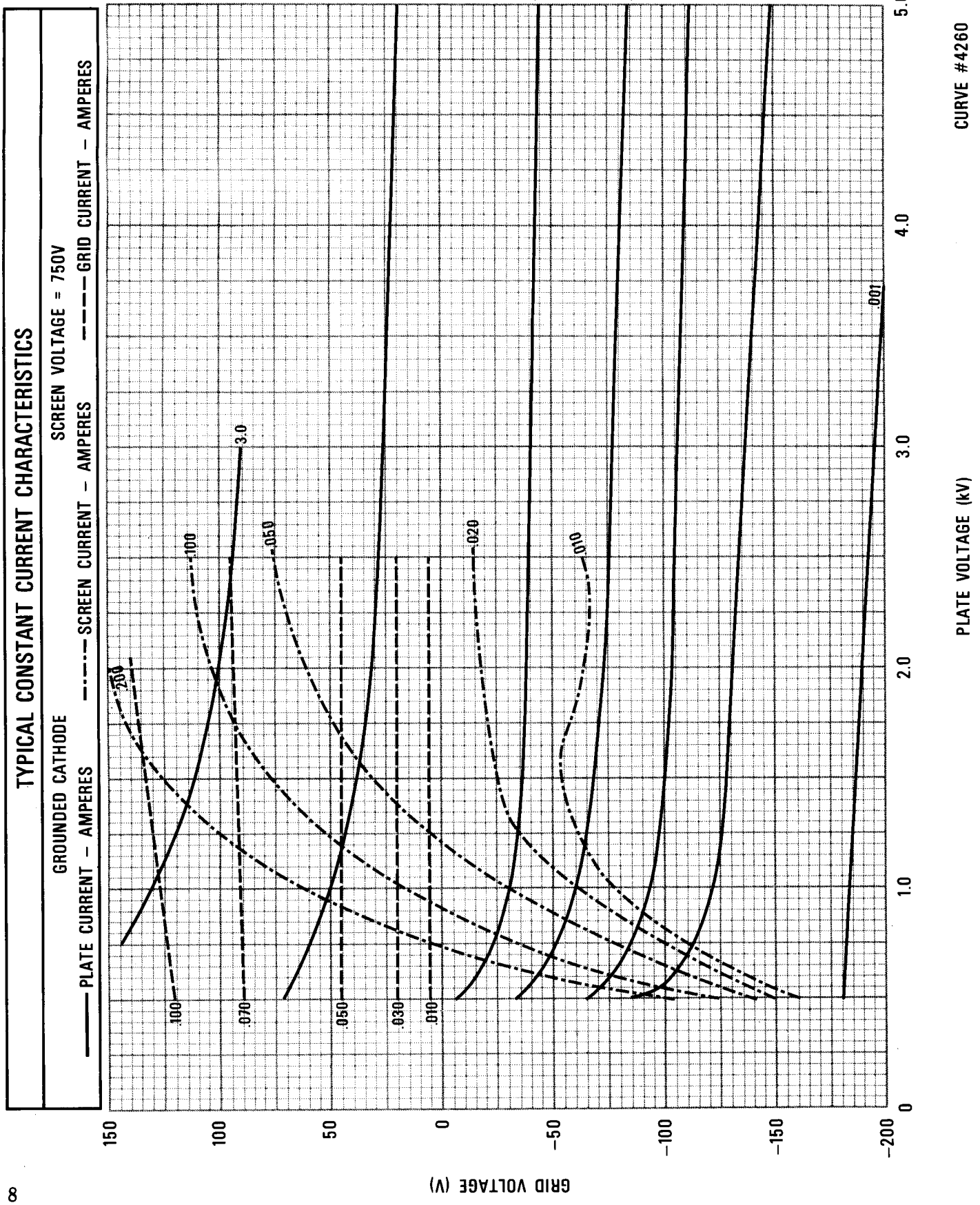


NOTES:

1. BASE PINS (T) & TUBULATION (K) ARE SO ALIGNED THAT THEY CAN BE FREELY INSERTED INTO A GAUGE 1/4 THICK WITH HOLE DIA'S OF .204 & .500 RESPECTIVELY LOCATED ON THE TRUE CENTERS BY THE GIVEN DIMENSIONS (V), (U) & (S).
2. REF. DIM'S ARE FOR INFO. ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 500V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
150
100
50
0
−50
−100
−150
0
1.0
2.0
3.0
4.0
5.0
PLATE VOLTAGE (kV)
.300
.200
.100
.070
.050
.030
.010
400
300
200
100
050
020
010
2.5
2.0
1.5
1.0
.600
.300
.100
.001

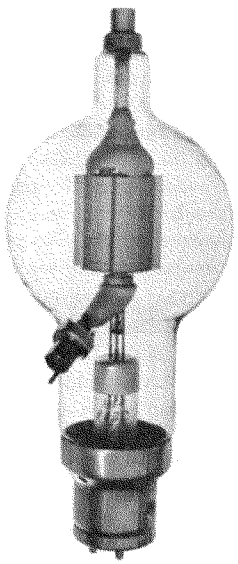
CURVE #4259


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 750V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #4260
150
100
50
0
–50
–100
–150
–200
0
1.0
2.0
3.0
4.0
5.0
2.0
1.0
.600
.300
.100
.001
3.0
.250
.100
.100
.070
.050
.050
.030
.010
.020
.010

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

450TH

HIGH-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER



The Eimac 450TH is a high-mu power triode having a maximum plate dissipation rating of 450 watts, and is intended for use as an amplifier, oscillator and modulator. It can be used at its maximum ratings at frequencies as high as 40 Mc.

Cooling of the 450TH is accomplished by radiation from the plate, which exhibits a red-orange color at maximum dissipation, and by means of air circulation around the envelope.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten		
Voltage	7.5	volts
Current	12.0	amperes
Amplification Factor (Average)	38	
Direct Interelectrode Capacitances (Average		
Grid-plate	5.0	μμfd.
Grid-Filament	8.8	μμfd.
Plate-Filament	0.8	μμfd.
Tranconductance (I_b=500 ma., E_b=4000 v.)	6650	μmhos

MECHANICAL

Base	Special 4-pin, No. 5002B
Basing	RMA type 4AQ
Cooling	Radiation and air circulation
Maximum Overall Dimentions:	
Length	12.625 inches
Diameter	5.125 inches
Net Weight	1 pound
Shipping Weight (Average)	4 pounds

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy (Key-down conditions, 1 tube)

MAXIMUM RATINGS (Frequencies below 40 Mc.)

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	600 MAX. MA.
PLATE DISSIPATION	450 MAX. WATTS
GRID DISSIPATION	65 MAX. WATTS

TYPICAL OPERATION (Frequencies below 40 Mc.)

D-C Plate Voltage	3000	4000	5000	volts
D-C Grid Voltage	−175	−200	−300	volts
D-C Plate Current	500	450	450	ma.
D-C Grid Current	95	85	90	ma.
Grid Dissipation	18.4	18	19	watts
Peak R-F Grid Input Voltage (approx.)	400	410	570	volts
Driving Power (approx.)	35	35	46	watts
Plate Power Input	1500	1800	2250	watts
Plate Dissipation	450	450	450	watts
Plate Power Output	1050	1350	1800	watts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	600 MAX. MA.
PLATE DISSIPATION, PER TUBE	450 MAX. WATTS
GRID DISSIPATION, PER TUBE	65 MAX. WATTS

TYPICAL OPERATION

D-C Grid Voltage (approx.)	−50	−85	−115	volts
D-C Plate Voltage	3000	4000	5000	volts
Zero-Signal D-C Plate Current	200	150	120	ma.
Max-Signal D-C Plate Current	770	675	620	ma.
Effective Load, Plate-to-Plate	7800	12,800	18,600	ohms
Peak A-F Grid Input Voltage (per tube)	225	235	267	volts
Max-Signal Avg. Driving Power (approx.)	17	14	10	watts
Max-Signal Peak Driving Power (approx.)	40	34	40	watts
Max-Signal Plate Dissipation (per tube)	450	450	450	watts
Max-Signal Plate Power Output	1400	1800	2200	watts

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT THAN THOSE GIVEN UNDER "TYPICAL OPERATION," AND WHICH POSSIBLY EXCEED MAXIMUM RATINGS, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.

(Effective 11-1-46) Copyright, 1946 by Eitel-McCullough, Inc.

APPLICATION

MECHANICAL

Mounting—The 450TH must be mounted vertically, base up or base down. Flexible connecting straps should be provided from the grid and plate terminals to the external grid and plate circuits. The tube must be protected from severe vibration and shock.

Cooling—Provision should be made for ample circulation of air around the 450TH. In the event that the design of the equipment restricts natural circulation, the use of a small fan or centrifugal blower to provide additional cooling for the tube will aid in obtaining maximum tube life. Special heat-dissipating connectors (Eimac HR-8) are available for use on the plate and grid terminals. These connectors help to prolong tube life by reducing the temperature of the seals.

The grid terminal of the 450TH is now .560" in diameter. To accomodate existing equipment designed for the older style 450TH having .098" diameter grid terminals, an adapter pin is provided with the newer tubes. This adapter pin is threaded so that it may be removed from the grid terminal of the tube. The small grid terminal requires an HR-4 heat-dissipating connector.

ELECTRICAL

Filament Voltage—For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated value of 7.5 volts. Unavoidable variations in filament voltage must be kept within the range from 7.03 to 7.88 volts.

Bias Voltage—Although there is no maximum limit on the bias voltage which may be used on the 450TH, there is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained by a grid leak, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Grid Dissipation—The power dissipated by the grid of the 450TH must not exceed 80 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp} I_c$$

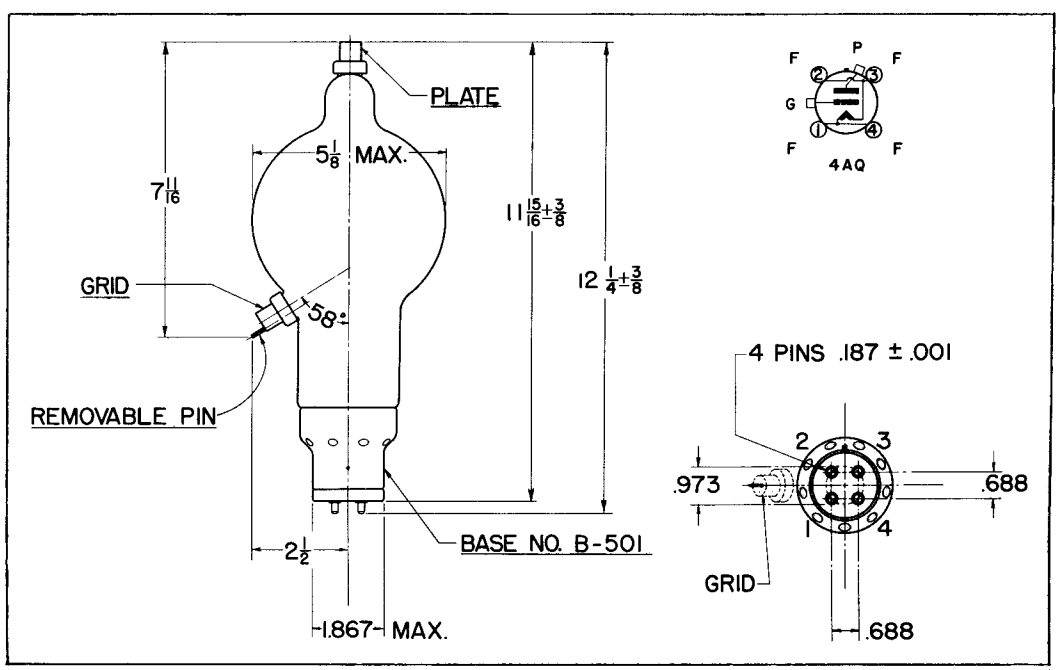
where P_g = Grid dissipation,
e_{cmp} = Peak positive grid voltage, and
I_c = D-c grid current.

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid.[1] In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any conditions of loading.

Plate Voltage—Except in very special applications, the plate supply voltage for the 450TH should not exceed 6000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

Plate Dissipation—Under normal operating conditions, the power dissipated by the plate of the 450TH should not be allowed to exceed 450 watts. At this dissipation the brightness temperature of the plate will appear a red-orange in color. The value of this color is somewhat affected by light from the filament as well as from external sources. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

[1] For suitable peak v.f.v.m. circuits see, for instance, "Vacuum Tube Ratings," **Eimac News**, January, 1945. This article is available in reprint form on request.



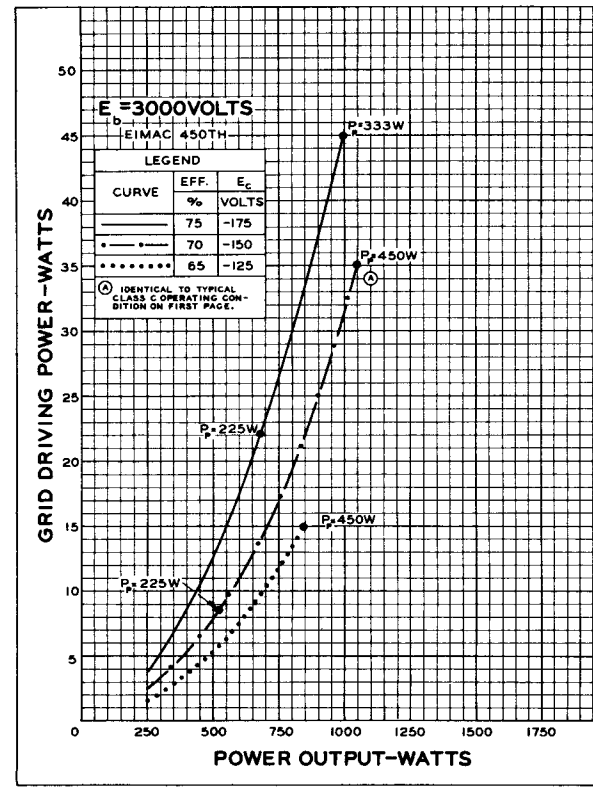
DRIVING POWER vs. POWER OUTPUT

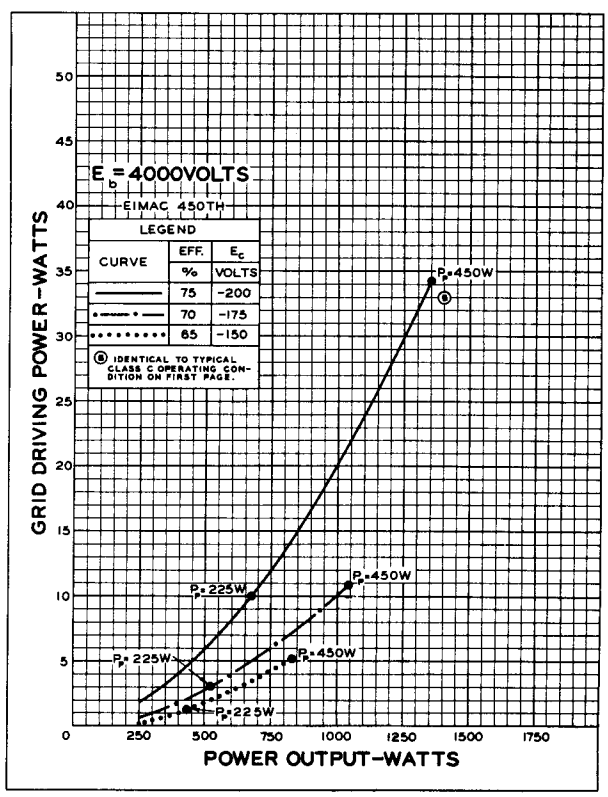
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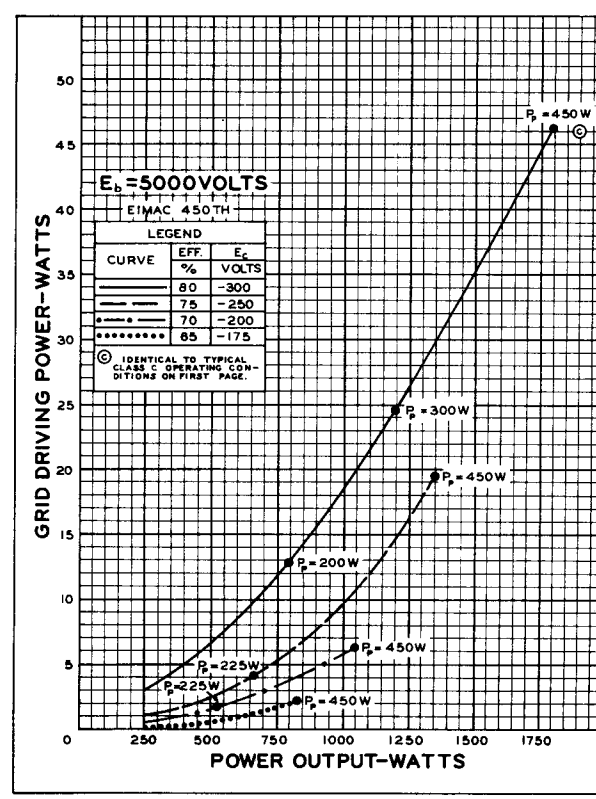
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 3000, 4000, and 5000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

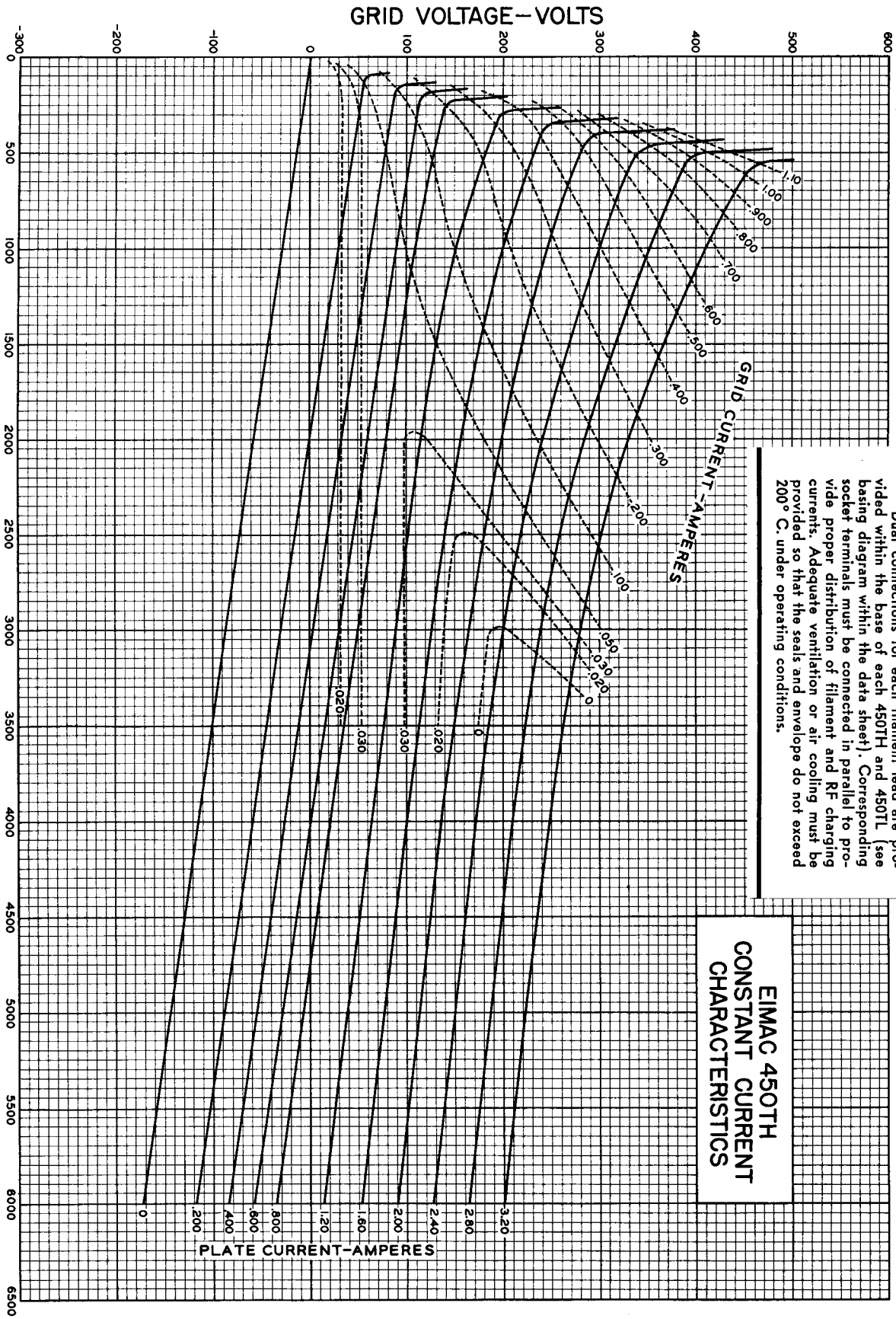
Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 3000, 4000, and 5000 volts respectively.

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Note:
Dual connections for each filament lead are provided within the base of each 450TH and 450TL (see basing diagram within the data sheet). Corresponding socket terminals must be connected in parallel to provide proper distribution of filament and RF charging currents. Adequate ventilation or air cooling must be provided so that the seals and envelope do not exceed 200° C. under operating conditions.

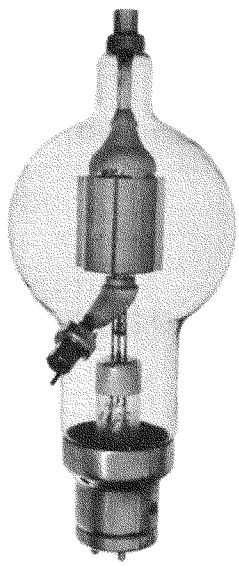
EIMAC 450TH CONSTANT CURRENT CHARACTERISTICS

PRINTED IN U. S. A. 2-G4-22648

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

450TL

MEDIUM-MU TRIODE
•
MODULATOR
OSCILLATOR
AMPLIFIER



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	7.5 volts
Current	12.0 amperes
Amplification Factor (Average)	18
Direct Interelectrode Capacitances (Average)	
Grid-Plate	5.2 μμf
Grid-Filament	7.3 μμf
Plate-Filament	0.9 μμf
Transconductance (I_b=500 ma., E_b=4000, e_c=–75)	6060 μmhos

MECHANICAL

Base	4 pin, No. 5002B
Basing	RMA type 4AQ
Maximum Overall Dimensions:	
Length	12.625 inches
Diameter	5.125 inches
Net weight	1 pound
Shipping weight (Average)	4 pounds

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR
Class B

	TYPICAL OPERATION—2 TUBES			MAX. RATING
D-C Plate Voltage	3000	4000	5000	6000 volts
Max.-Signal D-C Plate Current, per tube*	•	•	•	600 ma.
Plate Dissipation, per tube*	•	•	•	450 watts
D-C Grid Voltage (approx.)	–110	–175	–240	volts
Peak A-F Grid Input Voltage	650	740	860	volts
Zero-Signal D-C Plate Current	200	150	120	ma.
Max.-Signal D-C Plate Current	770	675	620	ma.
Max.-Signal Driving Power (approx.)	15	13	15	watts
Effective Load, Plate-to-Plate	7800	12800	18600	ohms
Max.-Signal Plate Power Output	1400	1800	2200	watts

*Averaged over any sinusoidal audio frequency cycle.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR
Class-C *Telegraphy
(Key down conditions without modulation)

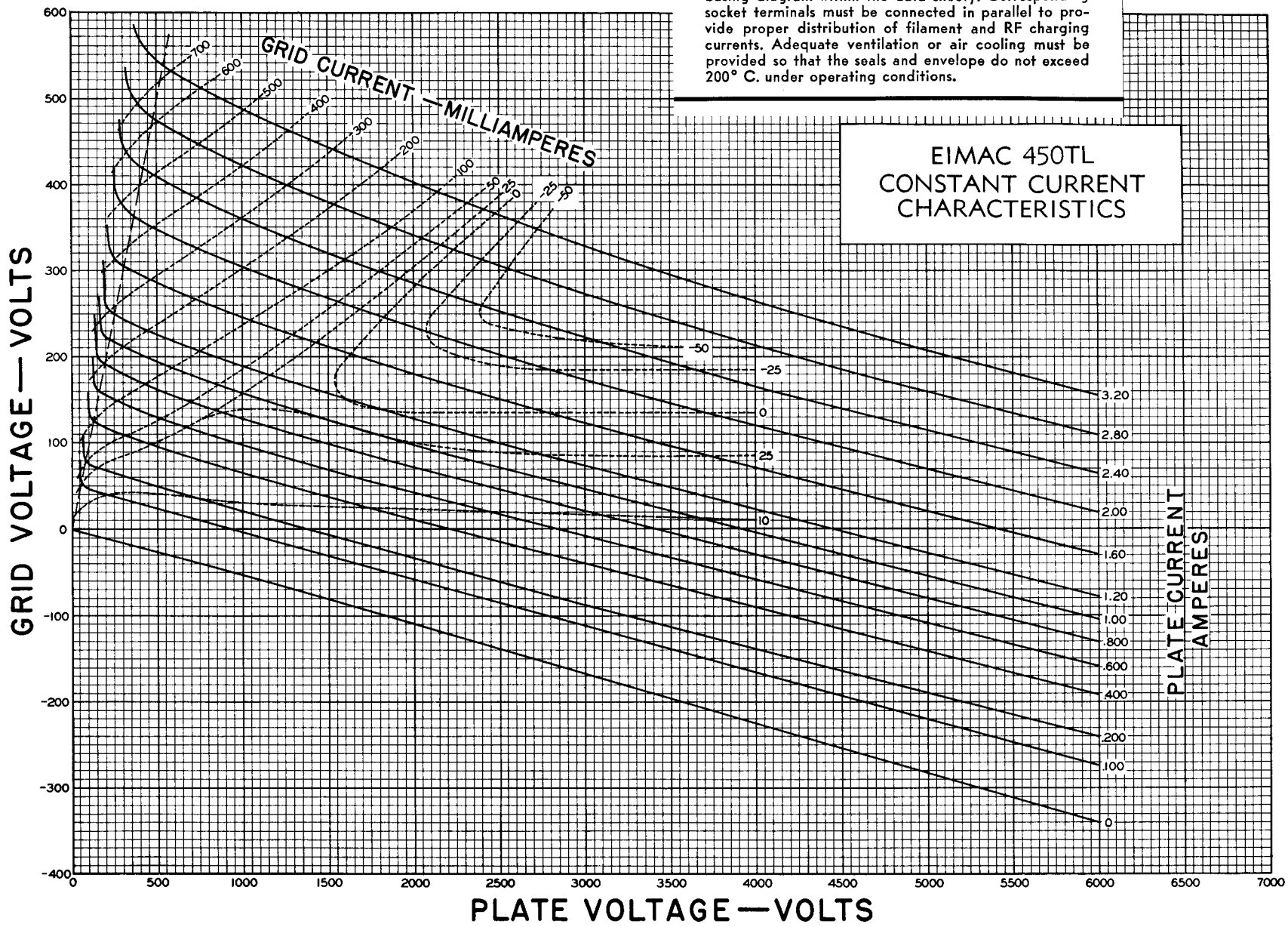
	TYPICAL OPERATION—1 TUBE			MAX. RATING
D-C Plate Voltage	3000	4000	5000	6000 volts
D-C Plate Current	500	450	450	600 ma.
D-C Grid Current	65	53	54	75 ma.
D-C Grid Voltage	–275	–400	–500	volts
Plate Power Output	1050	1350	1800	watts
Plate Input	1500	1800	2250	watts
Plate Dissipation	450	450	450	450 watts
Peak R. F. Grid Input Voltage, (approx.)	640	740	870	volts
Driving Power, (approx.)	38	35	42	watts

*The above figures show actual measured tube performance, and do not allow for variations in circuit losses.

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Note:

Dual connections for each filament lead are provided within the base of each 450TH and 450TL (see basing diagram within the data sheet). Corresponding socket terminals must be connected in parallel to provide proper distribution of filament and RF charging currents. Adequate ventilation or air cooling must be provided so that the seals and envelope do not exceed 200° C. under operating conditions.



Eimac 450TL

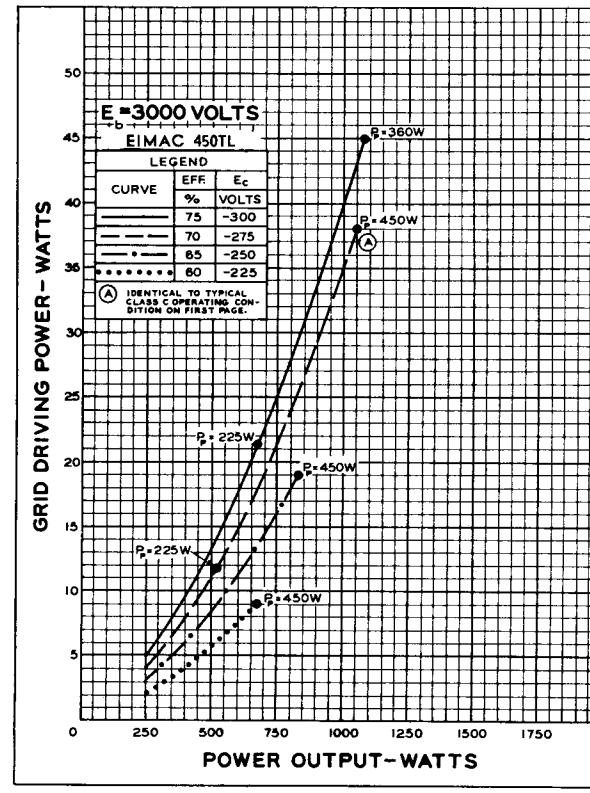
DRIVING POWER vs. POWER OUTPUT

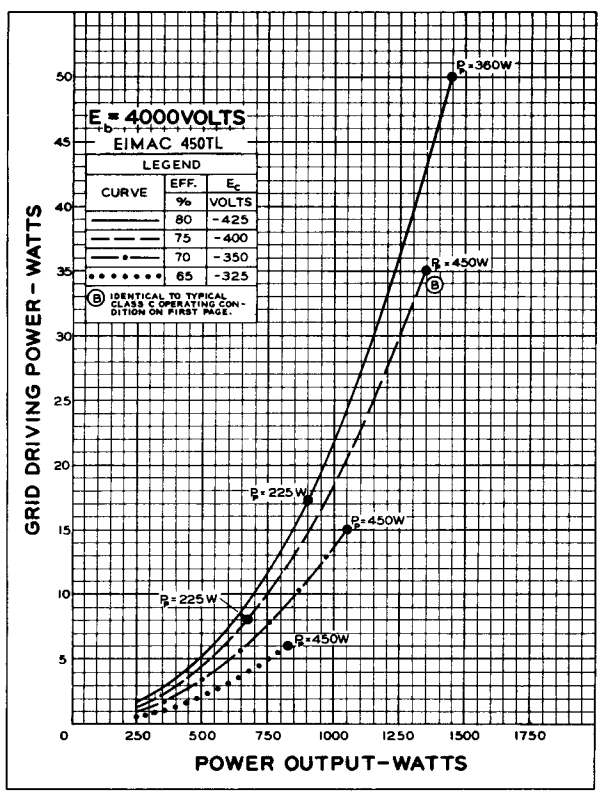
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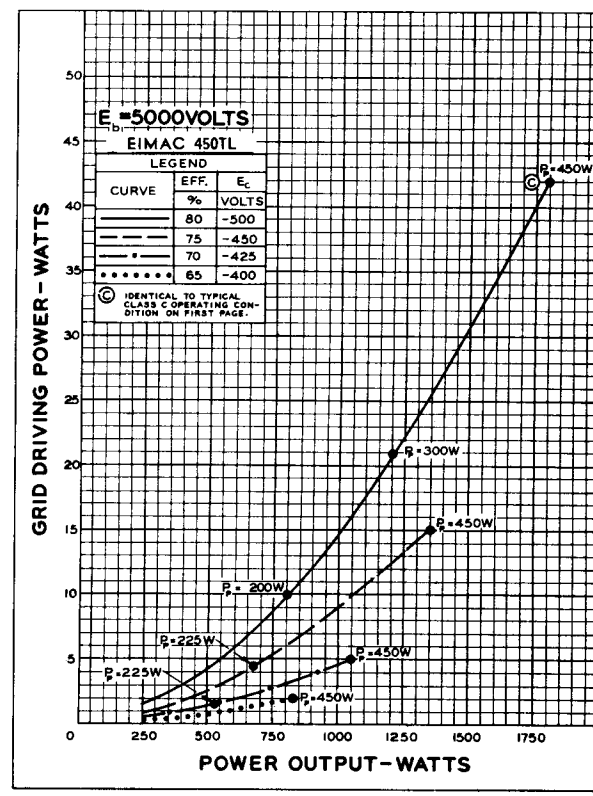
The three charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 3000, 4000, and 5000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 3000, 4000, and 5000 volts respectively.

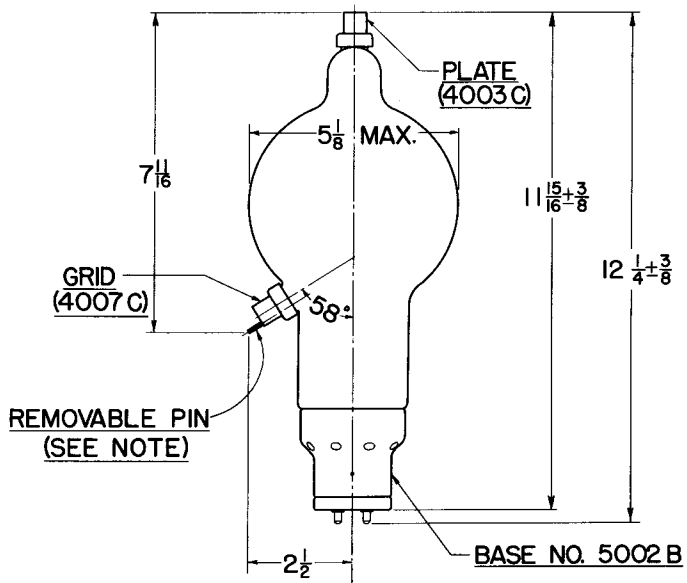
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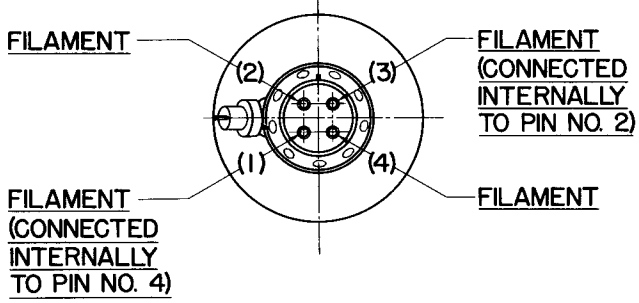






Eimac 450TL





4A0

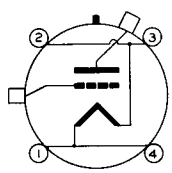
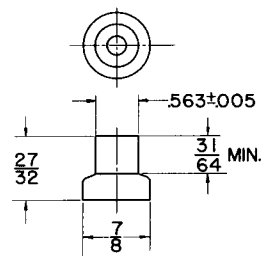
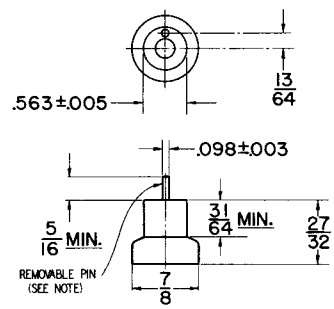


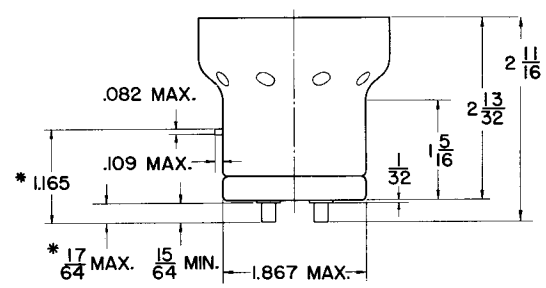
PLATE CAP
NO. 4003C

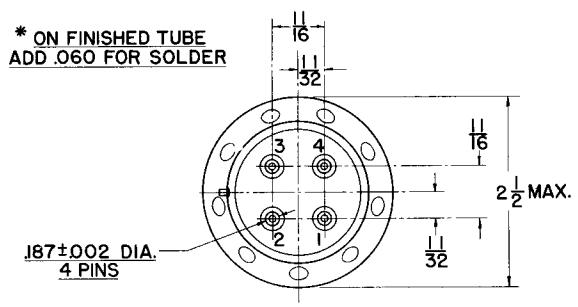


GRID CAP
NO. 4007C



BASE NO. 5002 B





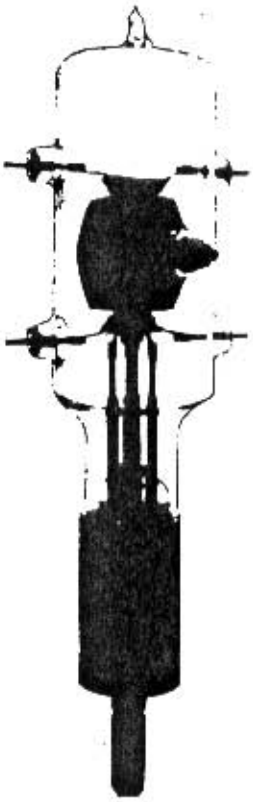
NOTE:—The grid terminal on the new 450TH and TL type tube is now .563" in diameter. To accommodate existing equipment which uses the 450TH or TL tubes with the old style .098" grid terminal, an adaptor pin is provided. This adaptor pin, if not needed, may be removed by unscrewing.

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

Eimac

527

HIGH-MU TRIODE



GENERAL CHARACTERISTICS
(TENTATIVE)

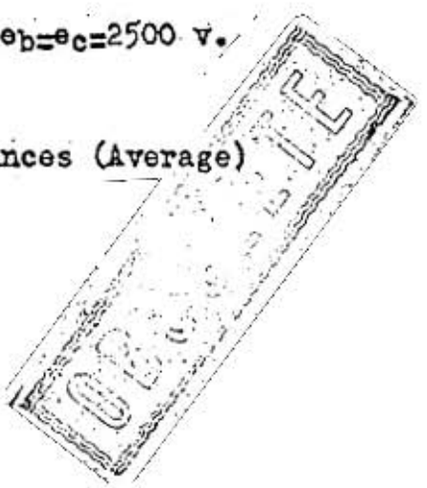
Filament	Thoriated Tungsten
Voltage	5.5 volts
Current	135 amperes
Amplification Factor (Average)	38
Plate Dissipation (Max.)	300 watts
Peak Filament Emission (Min.) $e_b=e_c=2500$ v.	100 amperes
Maximum Plate Voltage	20.0 kilovolts
Direct Interelectrode Capacitances (Avg.)	
Grid-Plate	12 mmfd.
Grid-Filament	19 mmfd.
Plate-Filament	1.4 mmfd.
Maximum Overall Dimensions	
Length	13 inches
Diameter	2-5/8 inches

EITEL-McCULLOUGH, INC.
SAN BRUNO CALIFORNIA

527 High-Mu Triode

GENERAL CHARACTERISTICS

Filament	Thoriated Tungsten
Voltage	5.5 Volts
Current	135 Amperes
Amplification Factor (Average)	38
Plate Dissipation (Max.)	300 Watts
Grid Dissipation (Max.)	60 Watts
Peak Filament Emission (Min.) $e_b=e_c=2500$ v.	100 Amperes
Maximum Plate Voltage	20.0 Kilovolts
Direct Interelectrode Capacitances (Average)	
Grid-Plate	12 Mmfd.
Grid-Filament	19 Mmfd.
Plate-Filament	1.4 Mmfd.
Maximum Overall Dimensions	
Length	13 Inches
Diameter	2-5/8 Inches
Forced Air Cooling	
Through Base Pin	2 CFM
Across Bulb (Min.)	



TYPICAL OPERATION - RF PULSED OSCILLATOR - 4 Tubes

Filament Voltage	5.5 Volts
Filament Current	135 Amperes
Plate Voltage	18,000 Volts
Duty Cycle	0.09 Per Cent
Average DC Plate Current	160 Milliampere
Average DC Grid Current	40 Milliampere
Grid Impedance	50 Ohms
Average Power Output	900 Watts
Peak RF Power Output	1000 Kilowatts

June 18, 1948

(TENTATIVE)

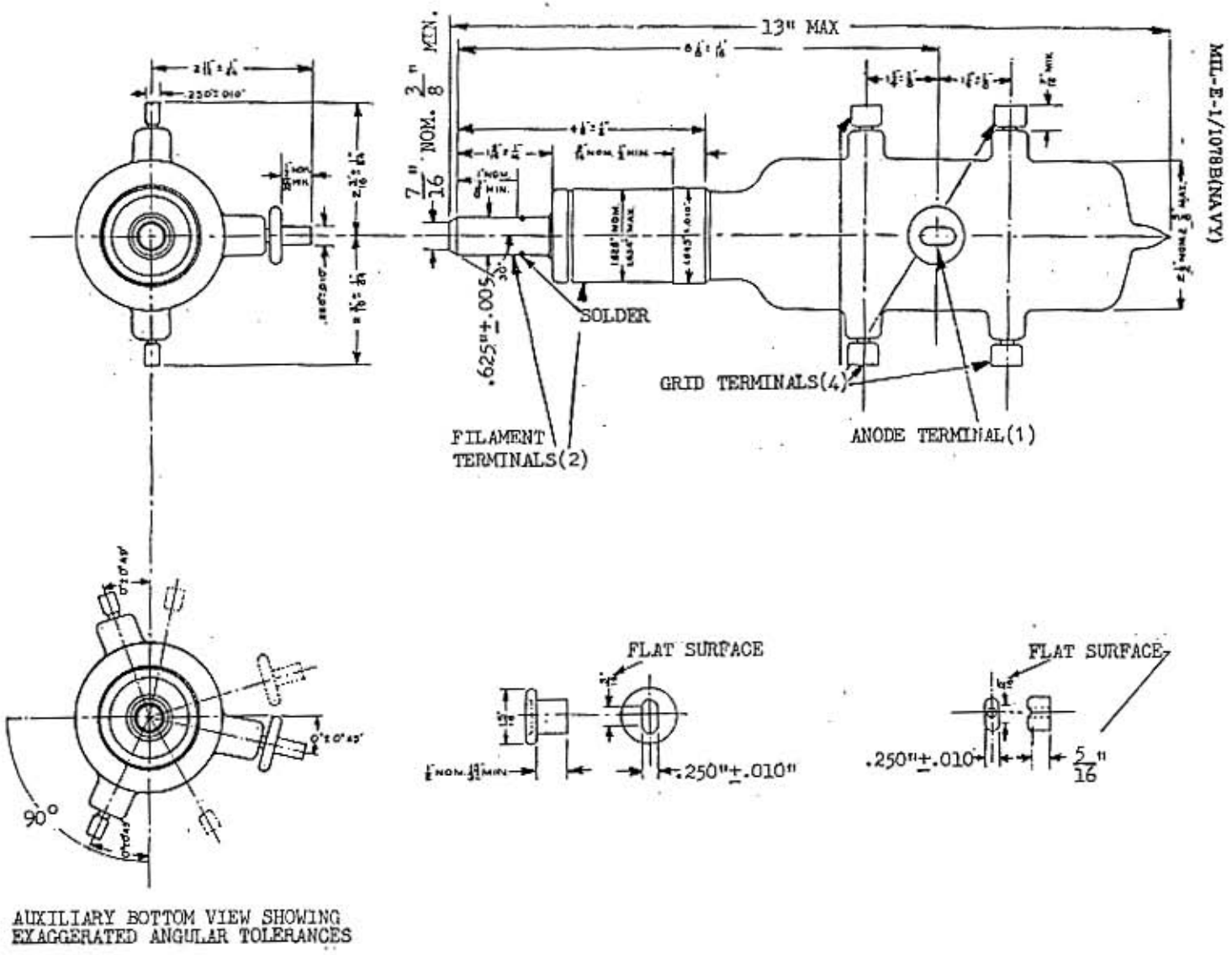
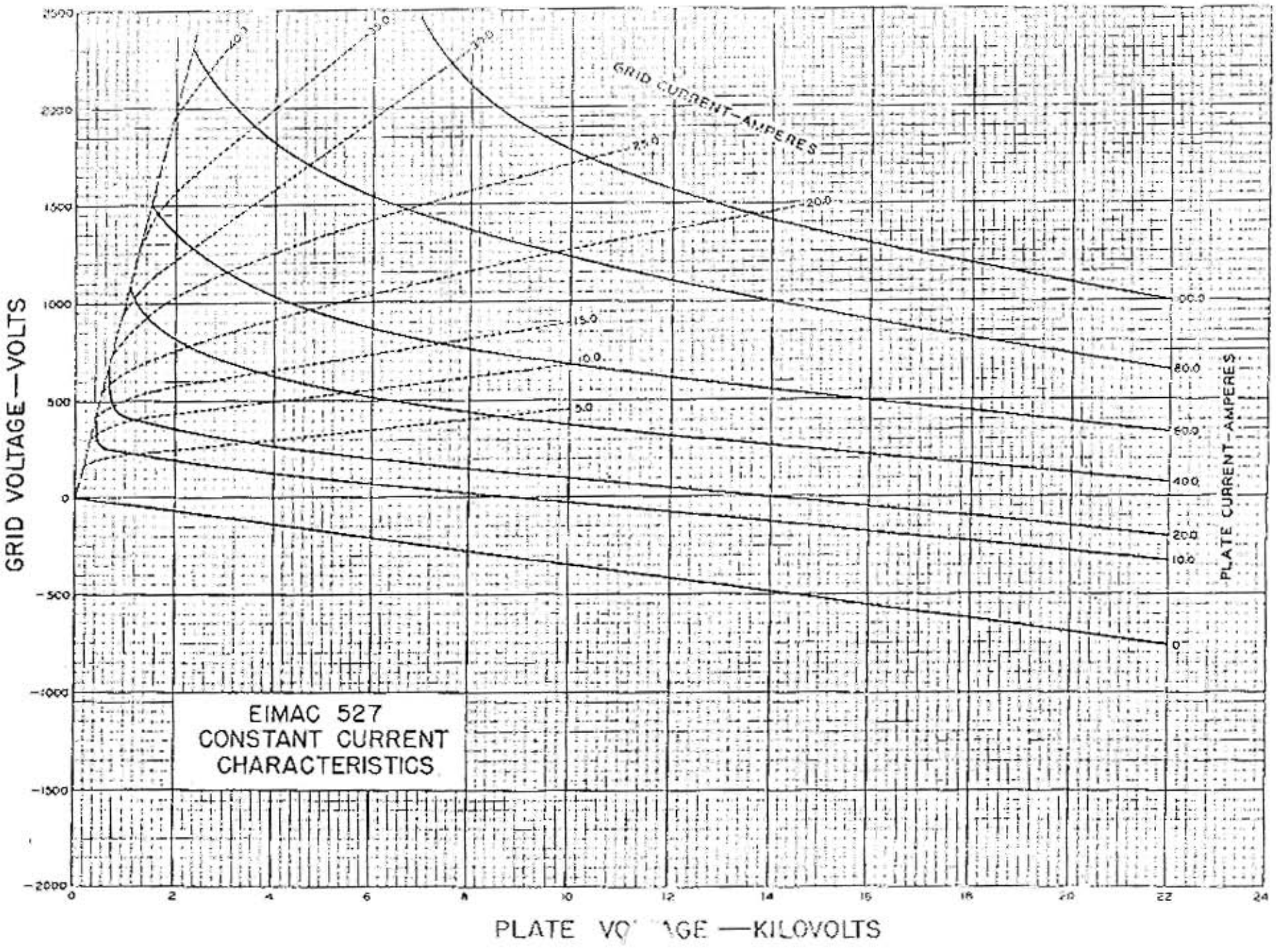


Figure 1 - Dimensions of tube type 527A.


GRID VOLTAGE—VOLTS
PLATE VOLTAGE—KILOVOLTS
PLATE CURRENT-AMPERES
GRID CURRENT-AMPERES
EIMAC 527
CONSTANT CURRENT
CHARACTERISTICS
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
0
2
4
6
8
10
12
14
16
18
20
22
24
35.0
25.0
20.0
15.0
10.0
5.0
80.0
60.0
40.0
20.0
10.0
0

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

5-500A

RADIAL-BEAM POWER PENTODE

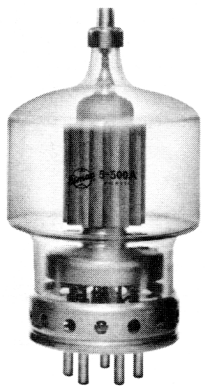
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MODULATOR
OSCILLATOR
AMPLIFIER

The Eimac 5-500A is a compact, ruggedly constructed radial-beam power pentode having a maximum plate dissipation rating of 500 watts. It is intended for use as an amplifier, oscillator or modulator. The high plate current rating, low grid-plate capacitance and low driving power requirements permit maximum power capability to be combined with circuit simplicity and economic driver requirements.

The Eimac 5-500A is cooled by radiation from the plate and by circulation of forced-air through the base, around the envelope and over the plate seal. Cooling may be greatly simplified by the use of the Eimac SK-400 or SK-410 Air System Socket and the accompanying Eimac SK-426 glass chimney. These sockets are designed to maintain the correct balance of cooling air between the component parts of the tube.

The suppressor element of the 5-500A terminates at the tube base shell, and is designed to be operated at ground (zero) potential. The base shell must be grounded by means of suitable spring clips.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten, balanced			
Voltage		10.0	volts
Current		10.2	amperes
Grid-Screen Amplification Factor (Average)		5.5	
Direct Interelectrode Capacitances, Grounded Cathode	*Min.*	*Max.*	
Grid-Plate	—	.10	pf
Input	15.0	19.0	pf
Output	9.5	12.0	pf

MECHANICAL

Base	see drawing
Basing	see drawing
Mounting Position	Vertical, base up or down
Cooling	Radiation and forced air
Recommended Heat Dissipating Connector	Eimac HR-6
Recommended Socket	Eimac SK-400 or SK-410 Air System Socket
Recommended Chimney	Eimac SK-426
Maximum Overall Dimensions	
Length	7.00 inches
Diameter	3.56 inches
Net Weight	11 ounces
Shipping Weight	2.5 pounds

NOTE: Typical operation data are based on conditions of adjusting the r-f grid drive to a specified plate current, maintaining fixed conditions of grid bias and screen voltage. It will be found that if this procedure is followed there will be little variation in power output between tubes even though there may be some variation in grid and screen currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

(Effective 5-1-68) © 1965, 1968 by Varian

Printed in U.S.A.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony

MAXIMUM RATINGS

D-C PLATE VOLTAGE	4000 Max. Volts
D-C SCREEN VOLTAGE	600 Max. Volts
D-C SUPPRESSOR VOLTAGE	100 Max. Volts
D-C PLATE CURRENT	450 Max. ma
PLATE DISSIPATION	500 Max. Watts
SCREEN DISSIPATION	35 Max. Watts
GRID DISSIPATION	12 Max. Watts

TYPICAL OPERATION

D-C Plate Voltage	2500	3000	4000 Volts
D-C Screen Voltage	500	500	500 Volts
D-C Grid Voltage	—210	—220	—240 Volts
D-C Suppressor Voltage	0	0	0 Volts
D-C Plate Current	405	432	450 ma
D-C Screen Current	55	65	65 ma
D-C Grid Current	28	35	38 ma
Screen Dissipation	27.5	32.5	33 Watts
Grid Dissipation	2.8	3.8	5.0 Watts
Peak R-F Grid Input Voltage	310	330	365 Volts
MF Driving Power*	8.7	12	14 Watts
Plate Power Input	1015	1300	1800 Watts
Plate Dissipation	265	495	500 Watts
Plate Power Output	750	805	1300 Watts

*Driving Power increases as frequency is increased.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class AB_1, Grounded Cathode, one tube

MAXIMUM RATINGS

DC PLATE VOLTAGE	4000 Max. Volts
DC SCREEN VOLTAGE	1000 Max. Volts
DC SUPPRESSOR VOLTAGE	100 Max. Volts
DC PLATE CURRENT	450 Max. ma
PLATE DISSIPATION	500 Max. Watts
SCREEN DISSIPATION	35 Max. Watts

TYPICAL OPERATION (Frequencies below 30 Mc.)
Peak-Envelope or Modulation-Crest Conditions.
Adjusted for minimum distortion.

DC Plate Voltage	2000	3000	4000 Volts
DC Screen Voltage	750	750	750 Volts
DC Suppressor Voltage	0	0	0 Volts
DC Control Grid Voltage*	—100	—112	—121 Volts
Zero-Signal DC Plate Current	150	100	80 mA
Single-Tone DC Plate Current	338	320	322 mA
Two-Tone DC Plate Current	252	221	212 mA
Single-Tone DC Screen Current	31	26	24 mA
Two-Tone DC Screen Current	15	12	10 mA
Peak RF Grid Voltage	100	112	121 Volts
Useful Output Power	395	612	832 Watts
Resonant Load Impedance	3600	5800	7700 Ohms
Third Order Intermodulation Products**	—52	—33	—28 db
Fifth Order Intermodulation Products**	—49	—41	—37 db

*1. Adjust to the specified zero-signal plate current.

**2. Equal or better than stated for all signal levels up to indicated useful output power. Reference to one tone of a two-tone test signal.

PLATE MODULATED RADIO FREQUENCY AMPLIFIER

Class-C Telephony
(Carrier conditions unless otherwise specified.)

MAXIMUM RATINGS

DC PLATE VOLTAGE	4000 Volts
DC SCREEN VOLTAGE	600 Volts
DC SUPPRESSOR VOLTAGE	100 Volts
DC GRID VOLTAGE	—500 Volts
DC PLATE CURRENT	340 ma
PLATE DISSIPATION	330 Watts
SCREEN DISSIPATION	35 Watts
GRID DISSIPATION	12 Watts

TYPICAL OPERATION

DC Plate Voltage	2700	3100	3500 Volts
DC Screen Voltage	450	470	500 Volts
DC Grid Voltage	—270	—310	—300 Volts
DC Suppressor Voltage	0	0	0 Volts
DC Plate Current	285	260	305 ma
DC Screen Current	68	50	55 ma
DC Grid Current	20	15	18 ma
Screen Dissipation	31	23	27 Watts
Peak A-F Screen Voltage Approx. (100% Modulation)	350	330	350 Volts
Peak R-F Grid Voltage	355	385	375 Volts
MF Grid Driving Power	7	6	7 Watts
Plate Dissipation	160	220	280 Watts
Plate Power Output	580	580	780 Watts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class AB

MAXIMUM RATINGS (Per Tube)

D-C PLATE VOLTAGE	4000 Max. Volts
D-C SCREEN VOLTAGE	1000 Max. Volts
D-C SUPPRESSOR VOLTAGE	100 Max. Volts
MAX-SIGNAL D-C PLATE CURRENT	450 ma
PLATE DISSIPATION	500 Max. Watts
SCREEN DISSIPATION	35 Max. Watts
GRID DISSIPATION	12 Max. Watts

TYPICAL OPERATION CLASS AB_1
(Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	3000	4000 Volts
D-C Screen Voltage	750	750 Volts
D-C Suppressor Voltage	0	0 Volts
D-C Grid Voltage (approx.)*	—112	—121 Volts
Zero-Signal D-C Plate Current	200	160 ma
Max-Signal D-C Plate Current	640	645 ma
Zero-Signal D-C Screen Current	0	0 ma
Max-Signal D-C Screen Current	52	48 ma
Effective Load, Plate-to-plate	11,600	15,400 Ohms
Peak A-F Grid Input Voltage (per tube)	112	121 Volts
Driving Power	0	0 Watts
Max-Signal Plate Power Output	1224	1664 Watts

*Adjust to give stated zero-signal plate current. The D-C resistance in series with the control grid of each tube should not exceed 250,000 ohms.

If it is desired to operate this tube under conditions widely different from those given under "Typical Operation," possibly exceeding the maximum ratings given for CW service, write Eimac, A Division of Varian Associates, for information and recommendations.

APPLICATION

MECHANICAL

MOUNTING—The 5-500A must be mounted vertically, base up or base down. The socket must be constructed so as to allow an unimpeded flow of air through the holes in the base of the tube and must also provide clearance for the glass tip-off which extends from the center of the base. The metal tube-base shell should be grounded by means of suitable spring fingers. The above requirements are met by the Eimac SK-400 and SK-410 Air-System Sockets. A flexible connecting strap should be provided between the Eimac HR-6 cooler on the plate terminal and the external plate circuit. The tube must be protected from severe vibration and shock.

COOLING—Adequate forced-air cooling must be provided to maintain the base seals at a temperature below 200°C., and the plate seal at a temperature below 225°C.

When the Eimac SK-400 or SK-410 Air-System Sockets and SK-426 chimney are used, a minimum air flow of 14 cubic feet per minute at a static pressure of 0.25 inches of water, as measured in the socket at sea level, is required to provide adequate cooling under all conditions of operation. Seal temperature limitations require that cooling air be supplied to the tube even when the filament alone is on during standby periods.

In the event an Air-System socket is not used, provision must be made to supply equivalent cooling of the base, the envelope, and the plate lead.

Tube temperatures may be measured with the aid of "Tempilaq," a temperature-sensitive laquer manufactured by the Tempil Corporation, 132 West 22nd Street, New York 11, N.Y.

ELECTRICAL

FILAMENT VOLTAGE—For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated voltage of 10.0 volts. Variations in filament voltage must be kept within the range of 9.5 to 10.5 volts.

The 5-500A features a balanced filament structure to help the designer meet FCC hum and noise specifications in AM service.

BIAS VOLTAGE — The d-c bias voltage for the 5-500A should not exceed 500 volts. If grid leak bias is used, suitable means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation, and the grid-leak resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In operation above 50 Mc., it is advisable to keep the bias voltage as low as is practicable.

SCREEN VOLTAGE—The d-c screen voltage for the 5-500A should not exceed 800 volts in r-f applications. In audio applications a maximum d-c screen voltage of 1,000 volts may be used. The screen voltages shown under "Typical Operation" are representative voltages for the type of operation involved.

PLATE VOLTAGE—The plate-supply voltage for the 5-500A should not exceed 4000 volts in CW and audio applications. In plate-modulated telephony service the d-c plate-supply voltage should not exceed 3200 volts, except below 30 Mc., intermittent service, where 4000 volts may be used.

GRID DISSIPATION — Grid dissipation for the 5-500A should not be allowed to exceed 12 watts. Grid dissipation may be calculated from the following expression,

$$Pg = \varepsilon cmp Ic$$

where Pg = Grid Dissipation

εcmp = Peak positive grid to cathode voltage, and

Ic = D-C grid current

εcmp may be measured by means of a suitable peak voltmeter connected between filament and grid.

SCREEN DISSIPATION — The power dissipated by the screen of the 5-500A must not exceed 35 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 35 watts in event of circuit failure.

PLATE DISSIPATION—Under normal operating conditions, the plate dissipation of the 5-500A should not be allowed to exceed 500 watts.

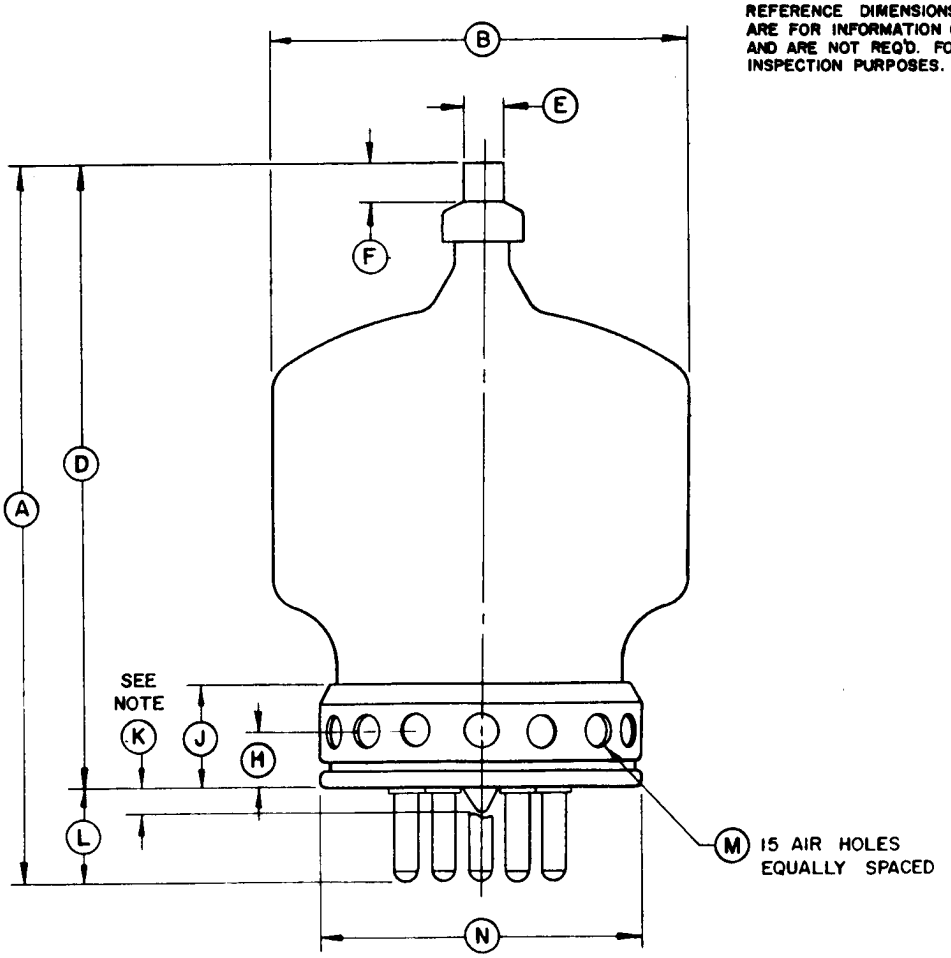
In plate modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 330 watts. The plate dissipation may rise to 500 watts under 100% sinusoidal modulation.

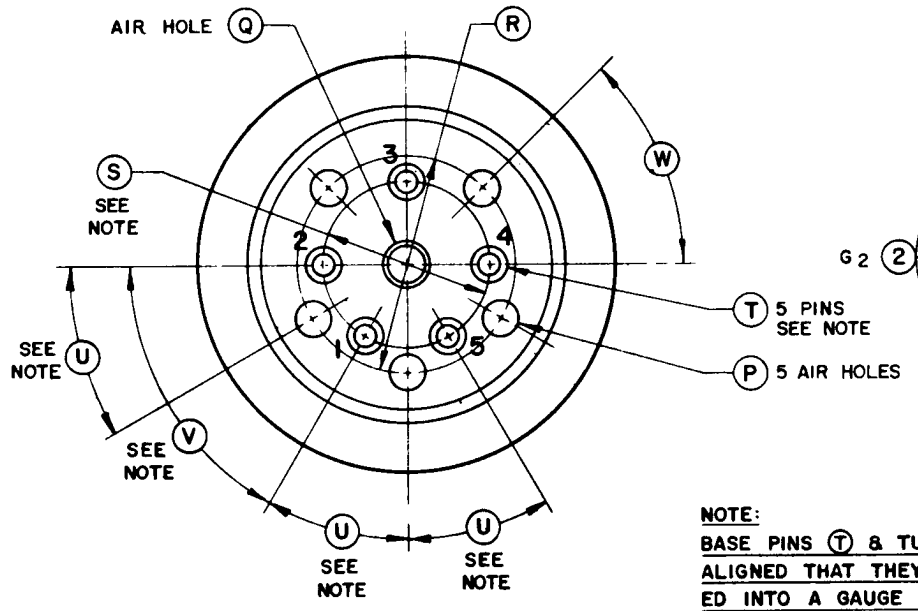
Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

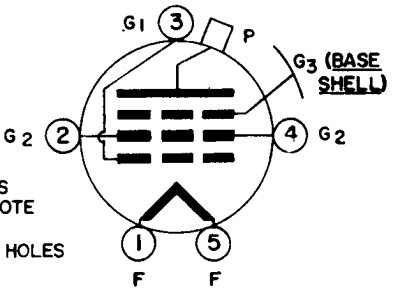
General information pertaining to the operation of the 5-500A may be found in Application Bulletin No. 8, "The Care and Feeding of Power Tetrodes." This Bulletin is available upon request.

REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQ'D. FOR INSPECTION PURPOSES.

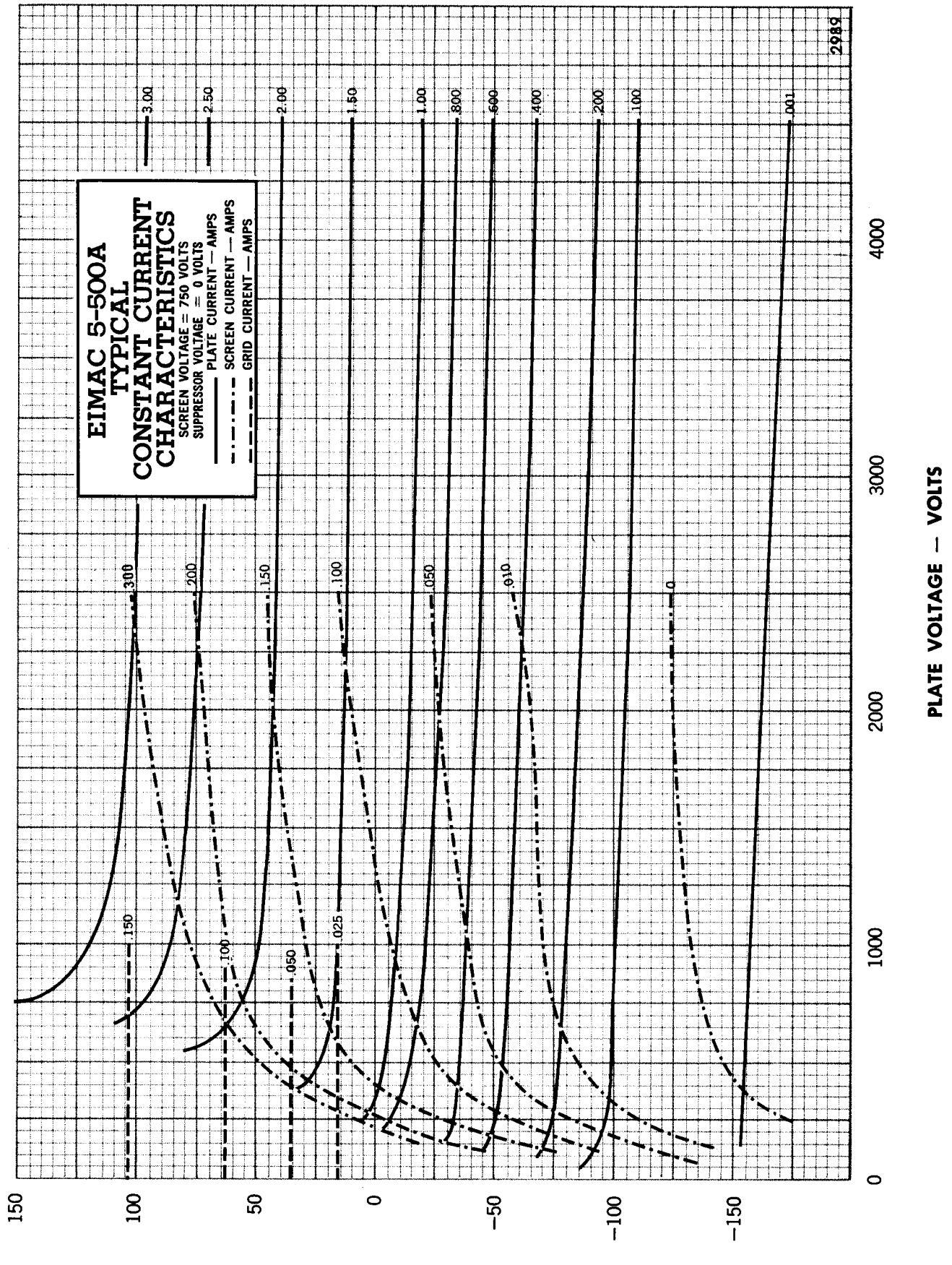
DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
DIM.	MIN	MAX.	REF.
A	6.500	7.000	
B		3-9/16 D.	
D	5.750	6.250	
E	.350 D.	.365 D.	
F	21/64		
H			7/16
J			31/32
K		1.1/4	
L			3/4
M			1/4 D.
N		2-3/4 D.	
P			5/16 D.
Q			1/2 D.
R			1-5/8 D.
S			1-1/4 D.P.C.
T	.185 D.	.191 D.	
U			30°
V			60°
W			45°

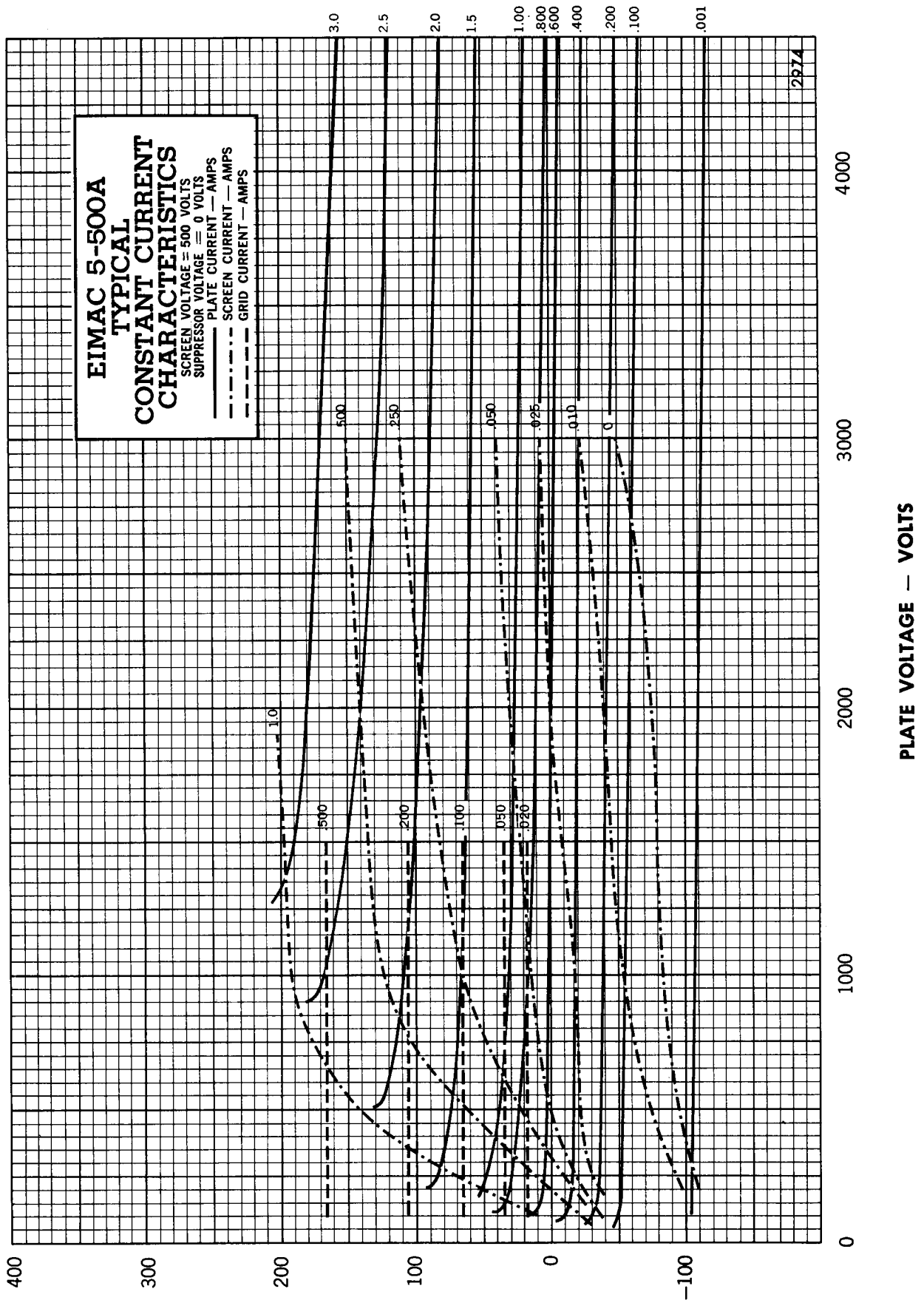






NOTE:
BASE PINS (T) & TUBULATION (K) ARE SO ALIGNED THAT THEY CAN BE FREELY INSERTED INTO A GAUGE 1/4" THICK WITH HOLE DIAMETERS OF .204 & .500 RESPECTIVELY LOCATED ON THE TRUE CENTERS BY THE GIVEN DIMENSIONS (V), (U), (S).

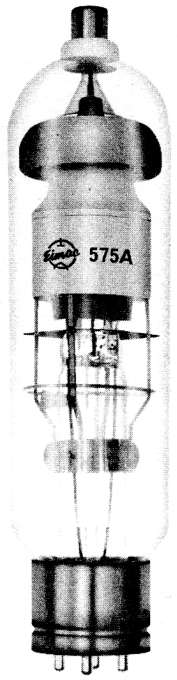

EIMAC 5-500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
SUPPRESSOR VOLTAGE = 0 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
3.00
2.50
2.00
1.50
1.00
.800
.600
.400
.200
.100
.001
.300
.200
.150
.100
.050
.025
.010
0
.150
.100
.050
2989
150
100
50
0
−50
−100
−150
0
1000
2000
3000
4000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS


EIMAC 5-500A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
SUPPRESSOR VOLTAGE = 0 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
2974
3.0
2.5
2.0
1.5
1.00
.800
.600
.400
.200
.100
.001
500
250
050
025
010
0
1.0
500
200
100
050
020
400
300
200
100
0
−100
0
1000
2000
3000
4000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

575A
673
MERCURY-VAPOR RECTIFIERS

The EIMAC 575A and 673 are half-wave mercury vapor-rectifiers incorporating features which enable them to withstand high peak inverse voltages and to conduct at relatively low applied voltages. The tubes differ only in basing.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Oxide-coated		
Voltage	5.0	volts
Current	9.0 to 11.5	amperes
Filament Heating Time	30	seconds
Anode Starting Voltage (approx.)	20	volts

MECHANICAL

Base	575A	50 watt, A4-29
	673	Industrial, A4-18
Recommended Socket	575A	E. F. Johnson #123-211
	673	E. F. Johnson #123-206
Maximum Overall Dimensions:		
Length	575A	11-1/8 inches
	673	11-7/16 inches
Diameter		2-9/16 inches
Net Weight		12 ounces

MAXIMUM RATINGS (per tube)

CONDENSED MERCURY TEMPERATURE LIMITS*	20-50	20-60	°C
PEAK INVERSE ANODE VOLTAGE	15	10	kV
PEAK ANODE CURRENT:			
Quadrature Filament Excitation**	10	10	Amps
In-Phase Filament Excitation	6	7	Amps
AVERAGE ANODE CURRENT: (Maximum averaging time - 20 seconds)			
Quadrature Filament Excitation**	2.5	2.5	Amps
In-Phase Filament Excitation	1.5	1.75	Amps
MAXIMUM AC SHORT CIRCUIT CURRENT***	100	100	Amps

*Condensed Mercury temperature rises approximately 18°C above ambient.
**Quadrature excitation refers to filament voltage 90°±30° out of phase with anode voltage.
***Max. duration 100 milliseconds.

APPLICATION

MECHANICAL

Mounting: The 575A and 673 must be mounted vertically base down.

Cooling: Provisions should be made for adequate air circulation around the tube. The temperature of the condensed mercury should be kept within the ranges given under "MAXIMUM RATINGS." This temperature should be maintained at 40°±5°C for most satisfactory operation of the tube. To measure the condensed-mercury temperature a thermocouple or small thermometer may be attached to the glass near the tube base using a small amount of putty. A condensed-mercury temperature lower than the

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Printed in U.S.A.

recommended value raises the voltage at which the tube becomes conducting and tends to reduce the life of the filament. A temperature higher than recommended lowers the voltage at which the tube becomes conducting and reduces the peak inverse voltage rating of the tube. The approximate condensed-mercury temperature rise above ambient is 18°C.

ELECTRICAL

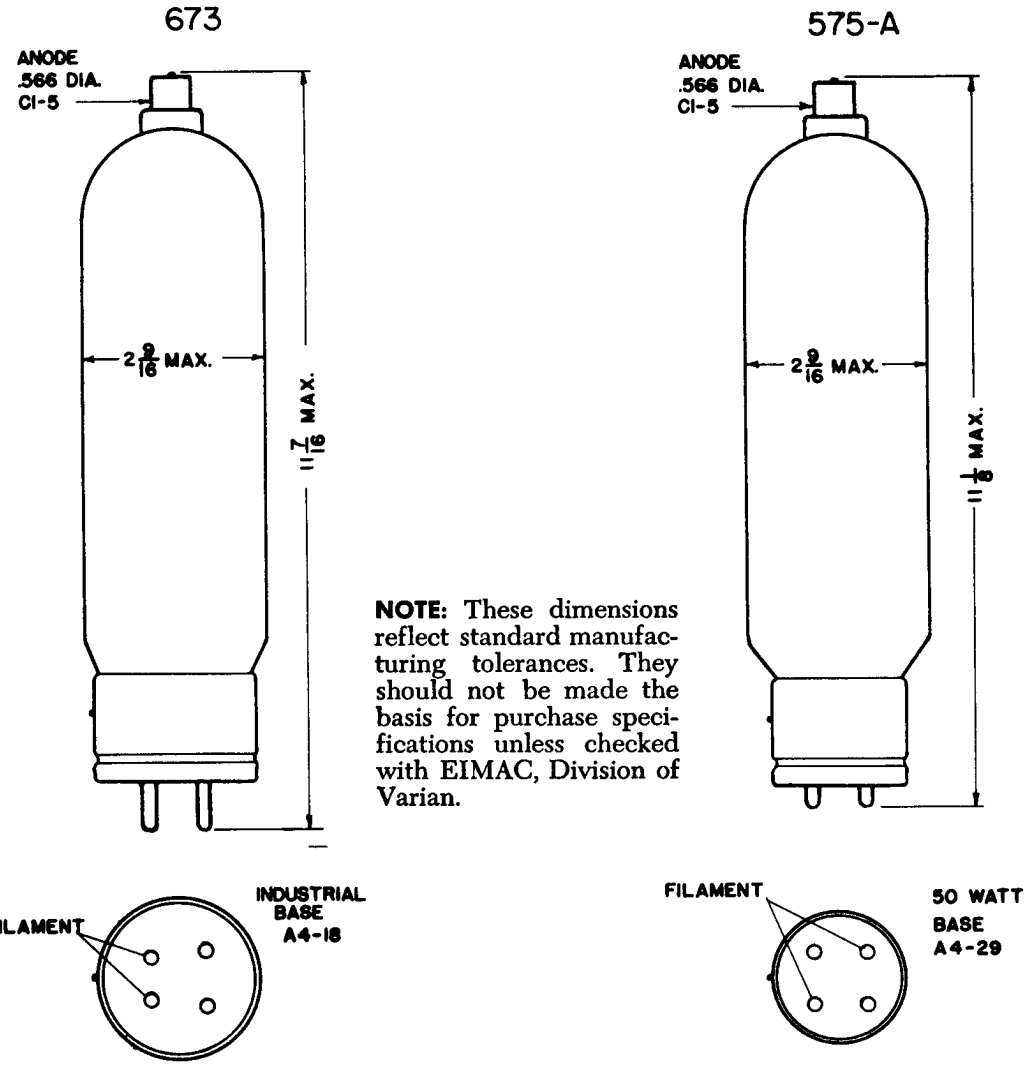
Filament Voltage: For maximum tube life, the filament voltage as measured directly at the filament pins, should be held at the rated value of 5.0 volts. Unavoidable variations in filament voltage must be kept within the range of 4.8 to 5.2 volts. A filament voltage less than the minimum recommended value may cause a high tube voltage drop, with consequent bombardment of the filament and eventual loss of emission. A filament voltage higher than the recommended maximum value will also decrease the life of the filament.

Caution should be observed in measuring the filament voltage as the filament circuit may be at a high dc potential.

The filament should be allowed to reach operating temperature before the plate voltage is applied. Under normal conditions, a delay of approximately 30 seconds will be required. The delay time should be increased if there is any evidence of arc-back within the tube.

When it is necessary to use a shield around the tube care must be taken to insure adequate ventilation and maintenance of normal condensed-mercury temperature. When a mercury-vapor rectifier is first installed, the filament should be operated at normal voltage for approximately ten minutes with no plate voltage applied, in order that the mercury may be properly distributed.

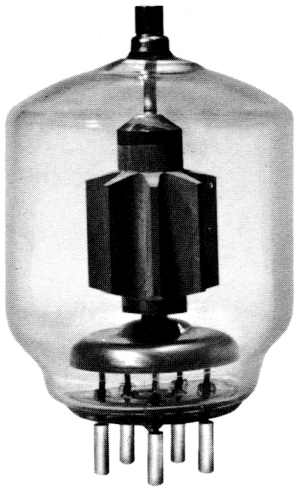
Shielding: Electromagnetic and electrostatic fields tend to cause the mercury vapor to break down, are detrimental to tube life and make proper operation difficult. Consequently, the tube should be isolated from such fields as exist around a transmitter or other similar equipment.



NOTE: These dimensions reflect standard manufacturing tolerances. They should not be made the basis for purchase specifications unless checked with EIMAC, Division of Varian.

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

5867A
AIR-COOLED MEDIUM MU POWER TRIODE



The Eimac 5867A is a power triode designed primarily for use in Industrial Heating applications. The large heat storage capacity of the graphite anode aids in compensating for the wide variations in loading generally associated with this type of sevrice. The 5867A is also suitable for use as an RF or AF Power Amplifier or Modulator.

The 5867A is cooled by radiation from the plate and by circulation of forced-air through the base, around the envelope, and over the plate seal. Cooling is greatly simplified by using the Eimac SK-410 Air-System Socket and SK-406 Air Chimney.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated Tungsten				
Voltage		5.0		volts
Current	13.5		14.7	amperes
Amplification Factor (E_b=2500 V, I_b=100 ma)		25		
Direct Interelectrode Capacitances				
Grid-Plate	5.0		6.2	uuf
Grid-Filament	6.5		8.0	uuf
Plate-Filament			0.5	uuf
Transconductance (I_b=100 ma)		5,000		umhos
Highest Frequency for Maximum Ratings			50	mc

MECHANICAL

Base	see drawing
Mounting	Vertical, base up or down
Cooling	Radiation and forced-air
Maximum Operating Temperatures:	
Plate Seals	220°C
Base Seals	180°C
Maximum Overal Dimensions:	
Height	5.875 inches
Diameter	3.438 inches
Socket	SK-410
Chimney	SK-406
Heat Radiator Connector	HR-6
Net Weight	6 ounces

(Effective 11-15-64) 1968 by VARIAN

Printed in U.S.A.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

CLASS-C FM or Telegraphy

MAXIMUM RATINGS

DC PLATE VOLTAGE	4,000 MAX. VOLTS
DC GRID VOLTAGE	—500 MAX. VOLTS
DC PLATE CURRENT	400 MAX. Ma.
PLATE DISSIPATION	350 MAX. WATTS
GRID DISSIPATION	30 MAX. WATTS

*Approximate Value.

TYPICAL OPERATION
(Frequencies below 50 mc., per tube)

DC Plate Voltage	2,000	3,000	4,000 volts
DC Grid Voltage	—150	—250	—350 volts
DC Plate Current	400	365	380 ma
DC Grid Current	80	70	80 ma
Peak Grid Driving Voltage	320	430	535 volts
Driving Power*	25	27	40 watts
Plate Input Power	800	1,090	1,520 watts
Plate Output Power	585	840	1,200 watts

CLASS-C OSCILLATOR, INDUSTRIAL APPLICATION SINGLE PHASE, FULL WAVE RECTIFIER, UNFILTERED

MAXIMUM RATINGS

DC PLATE VOLTAGE	3,800 MAX. VOLTS
DC GRID VOLTAGE	—500 MAX. VOLTS
DC PLATE CURRENT	360 MAX. Ma.
PLATE DISSIPATION	350 MAX. WATTS
GRID DISSIPATION	30 MAX. WATTS
PLATE INPUT POWER	1,500 MAX. WATTS

TYPICAL OPERATION
(Frequencies below 50 mc., per tube)

DC Plate Voltage	2,750	3,500 volts
DC Plate Current	340	325 ma
DC Grid Current	60	65 ma
Grid Resistor	3,330	4,500 ohms
Plate Input Power	935	1,400 watts
Plate Output Power	685	1,100 watts

CLASS-C OSCILLATOR, INDUSTRIAL APPLICATION SELF-RECTIFIED

MAXIMUM RATINGS

PLATE VOLTAGE (r.m.s.)	4,500 MAX. VOLTS
DC GRID VOLTAGE	—500 MAX. VOLTS
DC PLATE CURRENT	210 MAX. Ma.
PLATE DISSIPATION	350 MAX. WATTS
GRID DISSIPATION	30 MAX. WATTS
GRID RESISTOR	100,000 MAX. OHMS
PLATE INPUT POWER	900 MAX. WATTS

TYPICAL OPERATION
(Frequencies below 50 mc., per tube)

Plate Voltage (r.m.s.)	3,000	4,000 volts
DC Grid Voltage	—110	—280 volts
DC Plate Current	180	190 ma.
DC Grid Current	32	35 ma.
Plate Input Power	600	840 watts
Plate Output Power	415	630 watts
Grid Resistor	3,000	5,500 ohms

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

APPLICATION

MECHANICAL

Mounting

The 5867A must be operated vertically, base up or down. A flexible strap must be provided between the heat dissipating plate connector and the external plate circuit. The tube must be protected from severe vibration and shock.

Cooling

Forced-air cooling is required to maintain base and plate seal temperatures below 180°C and 220°C, respectively. When using the Eimac SK-410 Air system socket and SK-410 Air Chimney, complete with the HR-6 Heat Radiator, a minimum air-flow in the base to anode direction of 12 cfm at sea level is required to provide adequate cooling at an inlet air temperature of 50°C. This flow rate corresponds to a static pressure drop of 0.1 inches of water. At higher inlet air temperatures, higher altitudes, or at frequencies above 50 mc, the air flow rate must be increased to give adequate cooling. Cooling air must be supplied to the tube even when the filament alone is on during standby periods.

When a socket other than the SK-410 is used, provisions must be made for equivalent cooling of the base, envelope and plate seals. In all cases, air flow rates in excess of the minimum requirements will prolong tube life.

ELECTRICAL

Filament Voltage

For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated 5.0 volts. Variations in the filament voltage must be kept within the range of 4.75 and 5.25 volts.

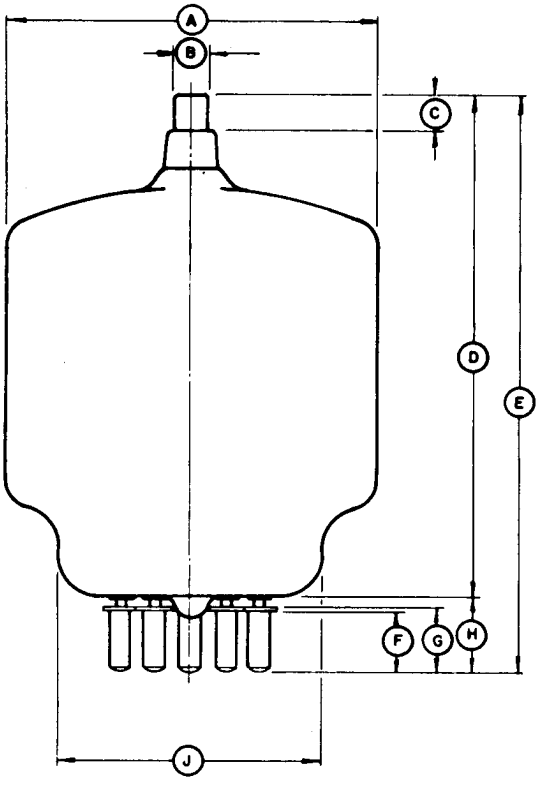
Grid Dissipation

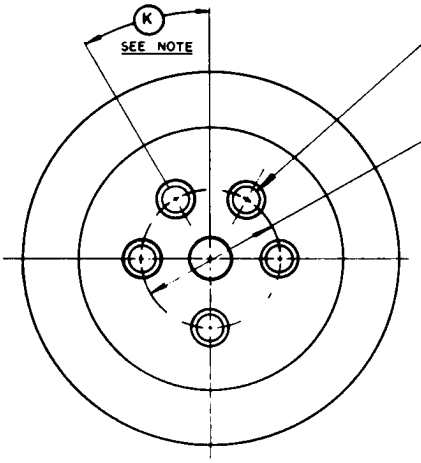
The rated grid dissipation of the Eimac 5867A is 30 watts. Grid dissipation is the approximate product of the dc grid current and the peak positive grid voltage. In equipment where the plate loading varies widely, such as radiofrequency heating oscillators, care should be taken to insure that the grid dissipation does not exceed the 30 watt maximum.

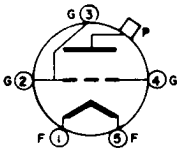
To prevent overheating of a grid pin by RF currents, it is advisable to connect all three grid pins into the circuit.

Special Applications

If it is desired to operate this tube under conditions widely different than those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.





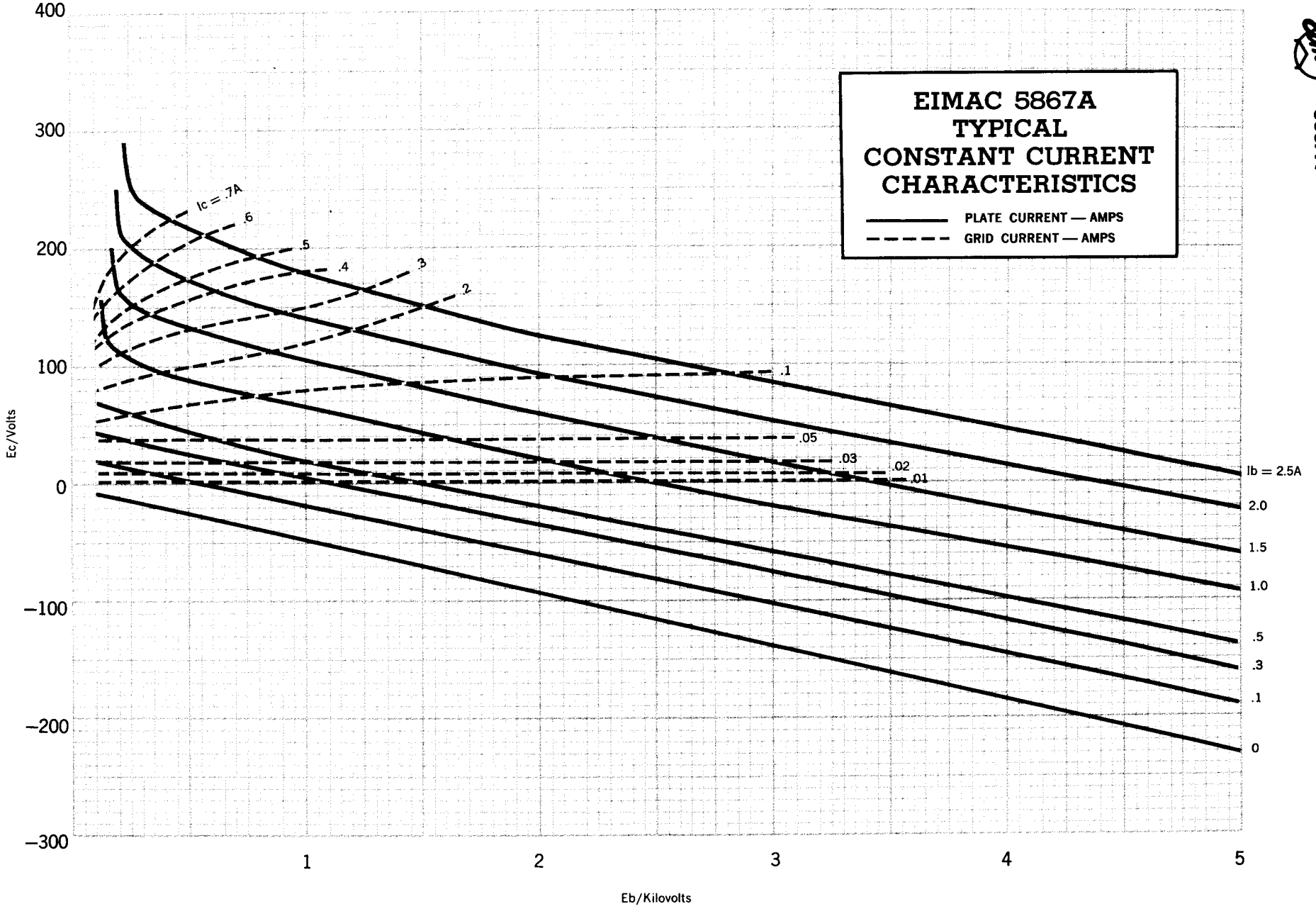


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		3 7/16 D.	
B			.355 D.
C			.356 D.
D			4 27/32
E	5 3/8	5 7/8	
F	1/2	5/8	
G	9/16	11/16	
H			25/32
J		2 7/16 D.	
K			30° TYP
L	.185 D.	.191 D.	
M			1-1/4 D.P.C.

NOTE

BASE PINS (L) ARE SO ALIGNED THAT THEY CAN BE FREELY INSERTED INTO A GAUGE 1/4" THICK WITH HOLE DIA'S OF .204 LOCATED ON TRUE CENTERS BY THE GIVEN DIMENSIONS (K) & (M)


EIMAC 5867A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT — AMPS
GRID CURRENT — AMPS
Ic = .7A
.6
.5
.4
.3
.2
.1
.05
.03
.02
.01
Ib = 2.5A
2.0
1.5
1.0
.5
.3
.1
0
400
300
200
100
0
−100
−200
−300
Ec/Volts
1
2
3
4
5
Eb/Kilovolts

Eimac®

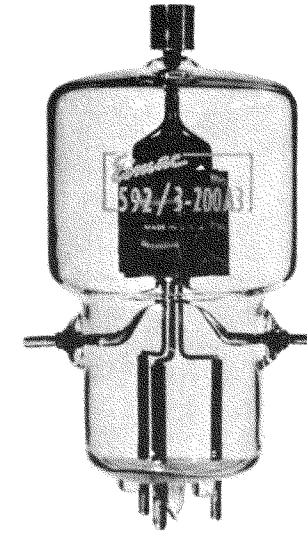
EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

592/3-200A3
MEDIUM-MU TRIODE

MODULATOR
OSCILLATOR
AMPLIFIER

The EIMAC 592/3-200A3 is a medium-mu power triode having a maximum plate dissipation rating of 200 watts, and it is intended for use as a power amplifier, oscillator, or modulator. It can be used at its maximum ratings at frequencies as high as 150 MHz.

Cooling of the 592/3-200A3 is accomplished by radiation from the plate, which operates at a visible red color at maximum plate dissipation, and by means of forced-air circulation around the envelope.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	10.0 volts
Current	5.0 amperes
Amplification Factor (Average)	25
Direct Interelectrode Capacitances (Average)	
Grid-Plate	3.3 $\mu\mu$f
Grid-Filament	3.6 $\mu\mu$f
Plate-Filament	0.29 $\mu\mu$f
Transconductance (I_b=200 ma., E_b=3000 v.)	3600 μmhos
Frequency for Maximum Ratings	150 MHz

MECHANICAL

Mounting	Vertical
Maximum Over-all Dimensions:	
Length	6.0 inches
Diameter	$3\frac{13}{32}$ inches
Net Weight (approx.)	6 ounces
Shipping Weight (approx.)	1½ pounds
Cooling	Radiation and Forced-Air
Recommended Heat Dissipating Connectors:	
Plate	EIMAC HR-10
Grid	EIMAC HR-5
Maximum Bulb Temperature	225°C
Maximum Seal Temperature	175°C

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class B

MAXIMUM RATINGS

DC PLATE VOLTAGE	3500 VOLTS
MAX-SIGNAL DC PLATE CURRENT	250 MA.
DC PLATE CURRENT	200 WATTS
GRID DISSIPATION	25 WATTS

TYPICAL OPERATION
Sinusoidal wave, two tubes unless otherwise specified.

DC Plate Voltage	2000	2500	3000 Volts
DC Grid Voltage (approx.)*	—50	—70	—90 Volts
Zero-Signal DC Plate Current	120	100	80 Ma.
Max-Signal DC Plate Current	500	450	400 Ma.
Effective Load, Plate-to-Plate	8500	12,600	18,000 Ohms
Peak AF Grid Input Voltage (per tube)	260	270	270 Volts
Max-Signal Peak Driving Power	50	52	40 Watts
Max-Signal Nominal Driving Power (approx.)	25	26	20 Watts
Max-Signal Plate Power Output	600	725	820 Watts

*Adjust to give stated zero-signal plate current.

PLATE MODULATED RADIO FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2600 VOLTS
PLATE DISSIPATION	200 MA.
PLATE DISSIPATION	130 WATTS
GRID DISSIPATION	25 WATTS

TYPICAL OPERATION

DC Plate Voltage	2000	2500 Volts
DC Plate Current	200	200 Ma.
DC Grid Voltage	—250	—300 Volts
DC Grid Current	35	35 Ma.
Peak RF Grid Input Voltage	480	535 Volts
Driving Power	17	19 Watts
Grid Dissipation	8	9 Watts
Plate Power Input	400	500 Watts
Plate Dissipation	115	125 Watts
Plate Power Output	285	375 Watts

The output figures do not allow for circuit losses.

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Printed in U.S.A.

Printed in U.S.A.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions, per tube)

MAXIMUM RATINGS

DC PLATE VOLTAGE	3500 VOLTS
DC PLATE CURRENT	250 MA.
PLATE DISSIPATION	200 WATTS
GRID DISSIPATION	25 WATTS

TYPICAL OPERATION

DC Plate Voltage	2000	2500	3000	3500 Volts
DC Plate Current	250	228	222	228 Ma.
DC Grid Voltage	—150	—180	—220	—270 Volts
DC Grid Current	32	28	25	30 Ma.
Peak RF Grid Input Voltage	380	400	440	505 Volts
Driving Power	12	11	11	15 Watts
Grid Dissipation	7	6	5.5	7 Watts
Plate Power Input	500	570	666	800 Watts
Plate Dissipation	200	200	200	200 Watts
Plate Power Output	300	370	466	600 Watts

The output figures do not allow for circuit losses.

APPLICATION

MECHANICAL

Mounting — The 592/3-200A3 must be mounted vertically, base down or base up. Flexible connecting straps should be provided from the grid and plate terminals to the external grid and plate circuits. The tube must be protected from severe vibration and shock.

Cooling — An air-flow of approximately 15 cubic feet per minute should be directed at the bulb from a 2 inch diameter nozzle located about three inches from the center line of the tube. The center line of the nozzle should be located about two inches down from the top of the plate terminal. The incoming air temperature should not exceed 50°C. Other methods of cooling may be used provided the maximum bulb and seal temperatures are not exceeded. An 8 inch, household-type fan located about 10 inches from the tube is one alternate method. Special heat-dissipating connectors EIMAC HR-5 and HR-10, or equivalent, for grid and plate terminals respectively) should be used with this tube. These connectors help to prolong tube life by reducing the temperature of the metal-glass seals.

ELECTRICAL

Filament Voltage — For maximum tube life, the filament voltage, as measured directly at the filament pins, should be the rated value of 10.0 volts. Unavoidable variations in filament voltage must be kept within the range of 9.5 to 10.5 volts.

Bias Voltage — There is little advantage in using bias voltages in excess of those given under "Typical Operation" except in certain very specialized applications. Where bias is obtained by a grid leak, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Grid Dissipation — The power dissipated by the grid of the 592/3-200A3 must not exceed 25 watts. Grid dissipation may be calculated from the following expression:

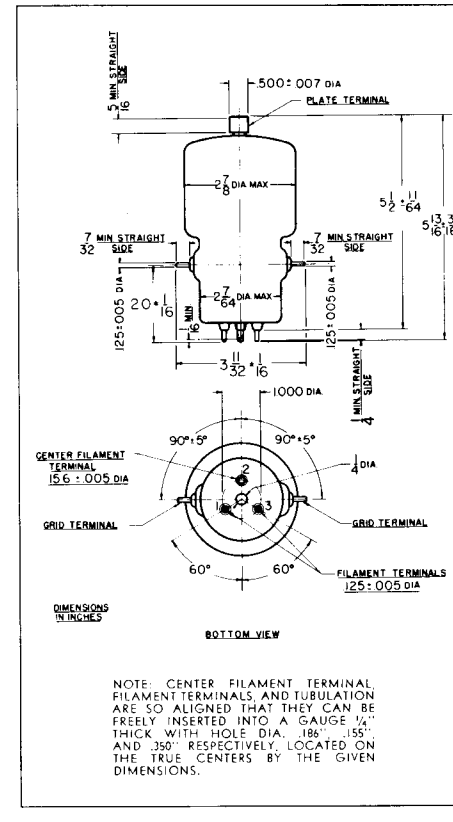
$$P_g = e_{cmp} I_c$$

where P_g = grid dissipation,
e_{cmp} = peak positive grid voltage, and
I_c = dc grid current.

e_{cmp} may be measured by means of a suitable peak-reading voltmeter connected between filament and grid.

Plate Voltage—Except for special applications, the plate supply voltage for the 592/3-200A3 should not exceed 3500 volts. In most cases there is little advantage in using plate-supply voltages in excess of those given under "Typical Operation" for the power output desired.

Plate Dissipation — Under normal operating conditions, the power dissipated by the plate of the 592/3-200A3 should not exceed 200 watts. At this dissipation the brightness temperature of the plate will appear a red-orange in color. The value of this color is somewhat affected by light from the filament, as well as from external sources. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

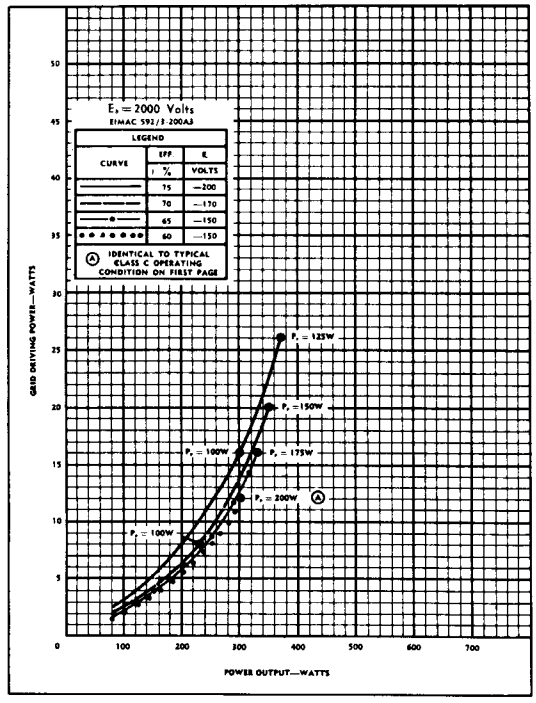


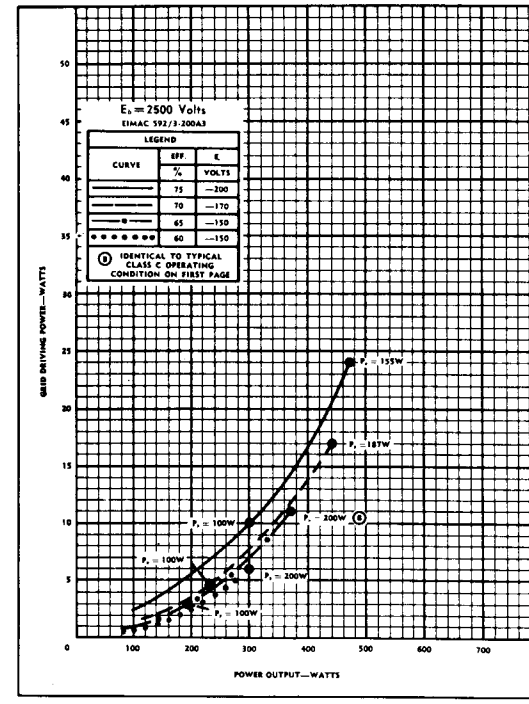
NOTE: CENTER FILAMENT TERMINAL, FILAMENT TERMINALS, AND TUBULATION ARE SO ALIGNED THAT THEY CAN BE FREELY INSERTED INTO A GAUGE ¼" THICK WITH HOLE DIA. .186", .155", AND .350" RESPECTIVELY, LOCATED ON THE TRUE CENTERS BY THE GIVEN DIMENSIONS.

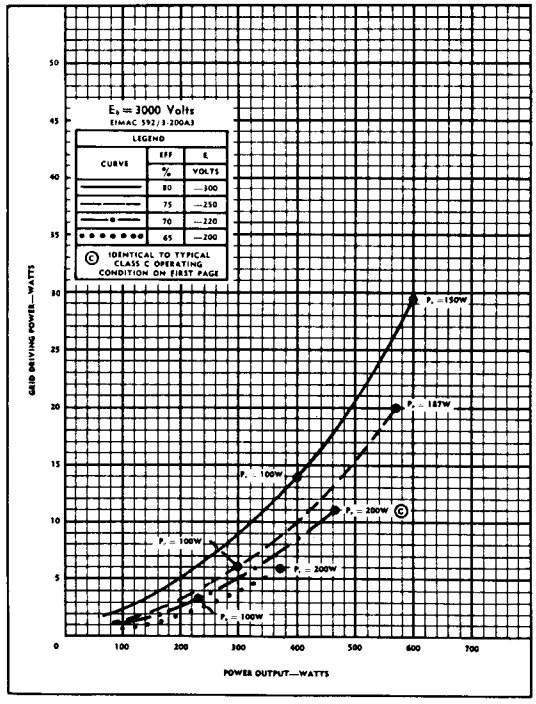
DRIVING POWER vs. POWER OUTPUT

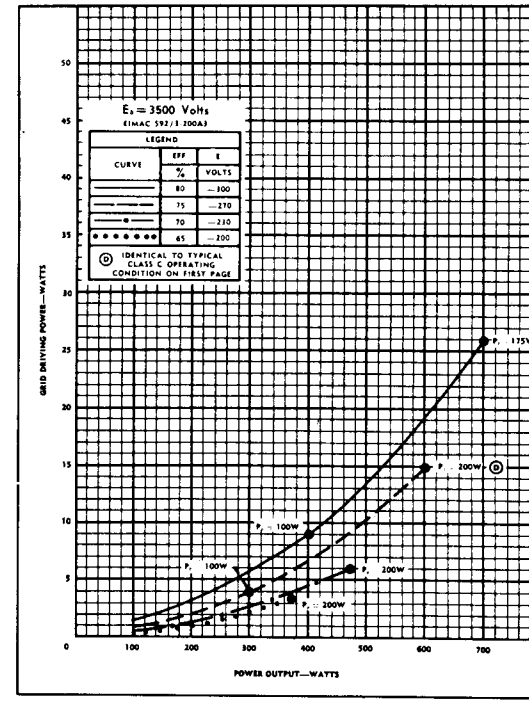
The four charts on this page show the relationship of plate efficiency, power output and grid driving power at plate voltages of 2000, 2500, 3000 and 3500 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by P_p.

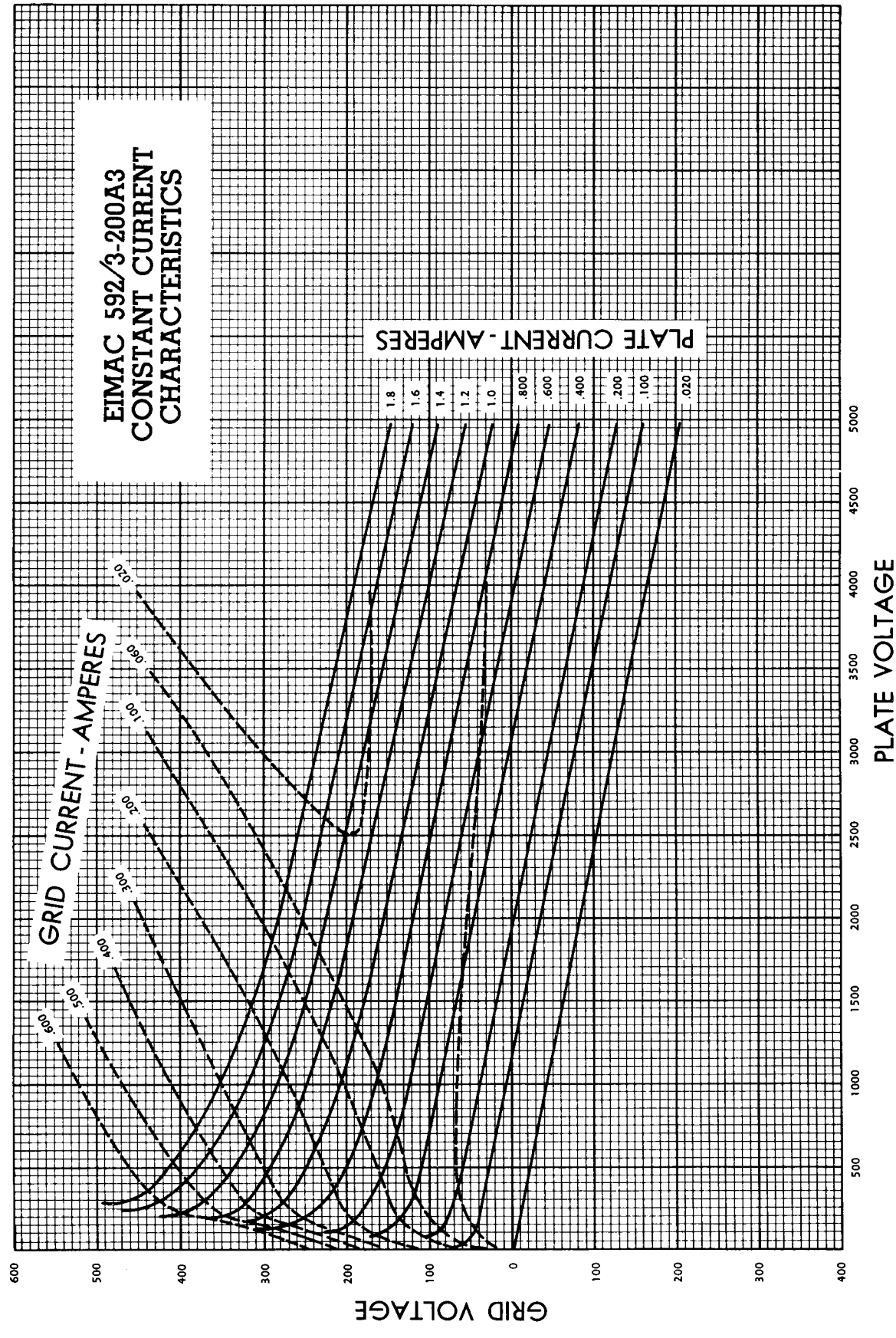
Points A, B, C, and D are identical to the typical Class C operating conditions shown on the first page under 2000, 2500, 3000, and 3500 volts respectively.









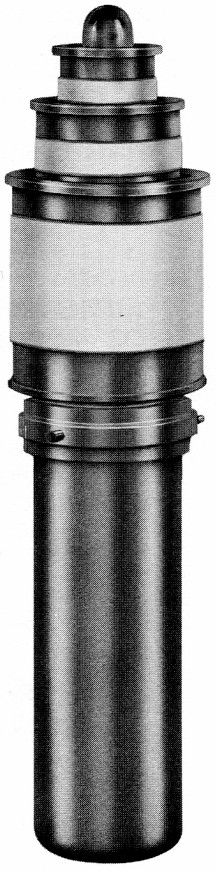


Printed in U.S.A.

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

6696A

WATER COOLED MEDIUM-MU POWER TRIODE



The Eimac 6696A is a water cooled ceramic-metal triode designed for industrial heating service. It is recommended also for use in broadcast and communications amplifiers.

Low-loss ceramic and metal construction permits operation at full ratings at frequencies up to 40 Mc. Useful power output can be obtained at frequencies up to 80 Mc at reduced plate voltage.

The 6696A anode is capable of dissipating 60 kilowatts at a moderate rate of water flow. A forced-air cooled version of this tube, type 6697A, and a vapor cooled version, type 7480, are also available.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated-Tungsten				
Voltage		13		volts
Current	190		220	amperes
Starting Current			800	amperes
Amplification Factor		20		
Direct Interelectrode Capacitances				
Grid-Plate	47		57	pf
Grid-Filament	65		85	pf
Plate-Filament	2.0		3.2	pf
Frequency for Maximum Ratings			40	Mc

MECHANICAL

Base	Coaxial
Operating Position	Vertical, base up
Cooling	Water and forced air
Maximum Seal Temperature	200°C
Maximum Outlet Water Temperature	70°C
Maximum Height	19.4 inches
Maximum Diameter	4.72 inches
Net Weight	17 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	16.0 KV
DC GRID VOLTAGE	−3200 VOLTS
DC PLATE CURRENT	11 AMPS
DC GRID CURRENT	2.0 AMPS
GRID DISSIPATION	1000 WATTS
PLATE DISSIPATION	60 KW

TYPICAL OPERATION

DC Plate Voltage	10	15 kV
DC Grid Voltage	−1200	−1600 volts
Peak RF Grid Voltage	1900	2100 volts
DC Plate Current	10.0	7.0 amps
DC Grid Current	810	300 mA
Resonant Load Impedance	440	970 ohms
Driving Power, approx.	1500	600 watts
Plate Output Power, approx.	72	80 kW

(Effective 10-15-64) © 1968 by Varian

Printed in U.S.A.

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	10.0 KV
DC GRID VOLTAGE	—3200 VOLTS
DC PLATE CURRENT	8.5 AMPS
DC GRID CURRENT	2.0 AMPS
GRID DISSIPATION	1000 WATTS
PLATE DISSIPATION	40 KW

TYPICAL OPERATION

DC Plate Voltage	9.5 kV
DC Grid Voltage	—1600 volts
Peak RF Grid Voltage	2300 volts
DC Plate Current	8.4 amps
DC Grid Current	900 mA
Resonant Load Impedance	510 ohms
Driving Power, approx.	2.0 kW
Plate Output Power, approx.	60 kW

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	16.0 KV
DC PLATE CURRENT	11.0 AMPS
PLATE DISSIPATION	60 KW

TYPICAL OPERATION (Two Tubes).

DC Plate Voltage	10	12 kV
DC Grid Voltage	—450	—600 volts
Peak AF Driving Voltage (per tube)	875	1060 volts
Zero-Sig DC Plate Current	3.0	2.0 amps
Max-Sig DC Plate Current	17.4	20.0 amps
Load Resistance, Plate-to-Plate	1170	1230 ohms
Max-Sig Driving Power, approx.	550	600 watts
Max-Sig Plate Output Power, approx.	110	152 kW

RADIO-FREQUENCY AM LINEAR AMPLIFIER

Class-AB (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	16.0 KV
DC PLATE CURRENT	9.0 AMPS
PLATE DISSIPATION	60 KW

TYPICAL OPERATION (AM Carrier conditions except where noted).

DC Plate Voltage	12	12 kV
DC Grid Voltage	—350	—550 volts
Peak RF Grid Voltage	510	640 volts
DC Plate Current	4.3	6.8 amps
DC Grid Current	0	0 amps
Resonant Load Impedance	780	500 ohms
Driving Power, approx.*	450	1500 watts
Plate Output Power, approx.	18	28 kW

*At modulation crest.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB, Single-Sideband Suppressed-Carrier Service

MAXIMUM RATINGS

DC PLATE VOLTAGE	16.0 KV
DC PLATE CURRENT	11.0 AMPS
PLATE DISSIPATION	60 KW

TYPICAL OPERATION (Peak-envelope or modulation-crest conditions in cathode-drive circuit).

DC Plate Voltage	12	12 kV
DC Cathode Voltage	600	600 volts
Peak RF Driving Voltage	830	1020 volts
DC Plate Current	5.2	9.8 amps
DC Grid Current, approx.	60	200 mA
Resonant Load Impedance	880	700 ohms
Driving Power, approx.	3.5	8.2 kW
Plate Power Output, approx.	43	83 kW

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses has been made.

APPLICATION

MECHANICAL

Mounting—

The 6696A should be mounted vertically anode down in the waterjacket (Machlett type F-17393 or equivalent). Filament and grid connections are made through clamp rings or spring-finger contacts to the O.D. of the sturdy copper terminals of the tube. Satisfactory anode contact can be made to the water jacket.

Anode Cooling—

Minimum cooling requirements are given in the accompanying table, where the pressure drop is measured at the jacket fittings. The water supply line must be connected to the inlet fitting of the water jacket.

MINIMUM ANODE COOLING REQUIREMENTS

Plate Dissipation kW	Water Flow Rate gpm	Pressure Drop psi
20	5.7	1.3
30	8.0	2.1
40	11.2	3.3
50	14.5	5.0
60	18.0	7.2

Base Cooling—

Forced-air cooling of the ceramic base and seals may be required, depending on ambient conditions and operating frequency. Air flow rate and direction should be determined to limit envelope temperatures to 200°C maximum and to maintain uniform temperature distribution around the seals. Spot temperatures are conveniently measured with Tempilaq (spray type) or equivalent. Often a flow of about 100 cfm, directed axially downward towards the tube, is sufficient.

ELECTRICAL

Filament Operation—

The rated filament voltage, as measured at the tube terminals, should be maintained within ±5% to assure long life and good performance within the rated power capability of the tube. To accommodate special requirements, the filament voltage may be centered near either of these extremes, e.g. at plus 5 percent for exceptionally high emission at a sacrifice of life, or at minus 5 percent for exceptionally long life where perhaps only half the full emission capability is required.

Grid Dissipation—

Grid dissipation should be limited to 1,000 watts maximum. Grid dissipation may be calculated approximately as the product of peak positive grid voltage and dc grid current.

In many r-f amplifier applications where it is impractical to measure the positive grid voltage, the dc grid current rating serves as a satisfactory guide. The maximum dc grid current rating under normal full load conditions is 2 amperes. In most cases, however, high power output and good efficiency can be realized with grid current less than one ampere. By limiting the grid current in this manner there is obviously more latitude for grid current excursions resulting from changes in loading.

High Frequency Operation—

The maximum ratings listed apply at frequencies up to 40 Mc. Useful output can be obtained at higher frequencies if the plate voltage and plate input power are reduced accordingly. For operation up to 60 Mc these parameters should be reduced to 75% of the listed dc plate voltage rating; for operation up to 80 Mc they should be reduced to 50%.

Aging—

The manner of operating most high power tubes differs in at least some respects from conditions under which the tubes are tested, therefore, some aging is almost always required to condition a new tube to its new environment. In basic terms, the different operating conditions are manifest as different distributions of heat and voltage gradients. Satisfactory aging is most easily achieved by gradual application of voltages, e.g. first filament voltage, then partial plate voltage, and drive, working up to the final values. If continuous or stepped plate voltage control is not used, sufficient load should be connected before snapping on full voltage to limit transients to about 120% of the dc voltage.

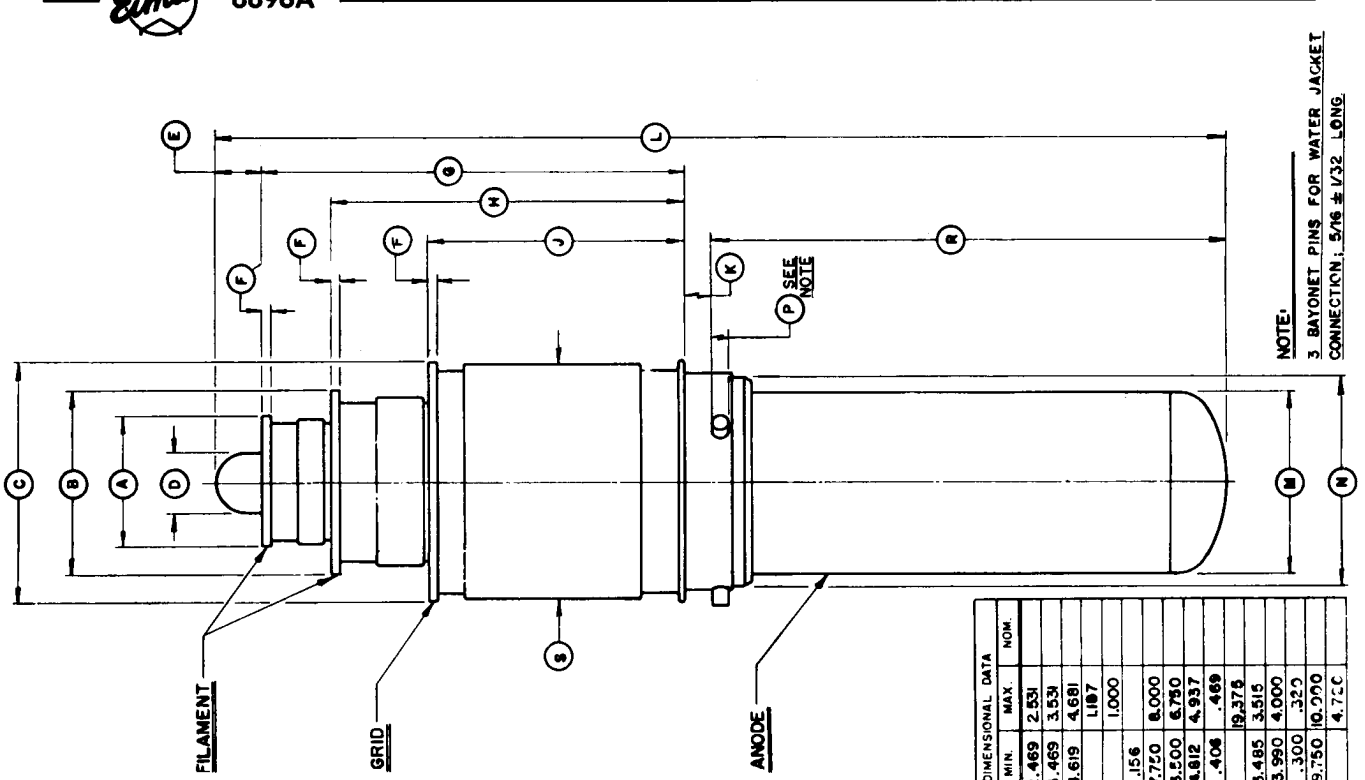
Tube Protection—

Since the possibility of fault overloads due to occasional tube or circuit instabilities is ever present, good engineering practice holds that suitable protective circuitry and devices be included in the equipment. In addition to the standard overcurrent relays, some series resistance should be placed in the output of the power supply to limit surge currents. In cases where no filter is used, the resistors may be placed in each rectifier lead to reduce the power loss during normal operation. In certain applications, furthermore, it is helpful to attach sphere gaps or rings to the tube terminals to divert any excessive transient voltages from the envelope and seals.

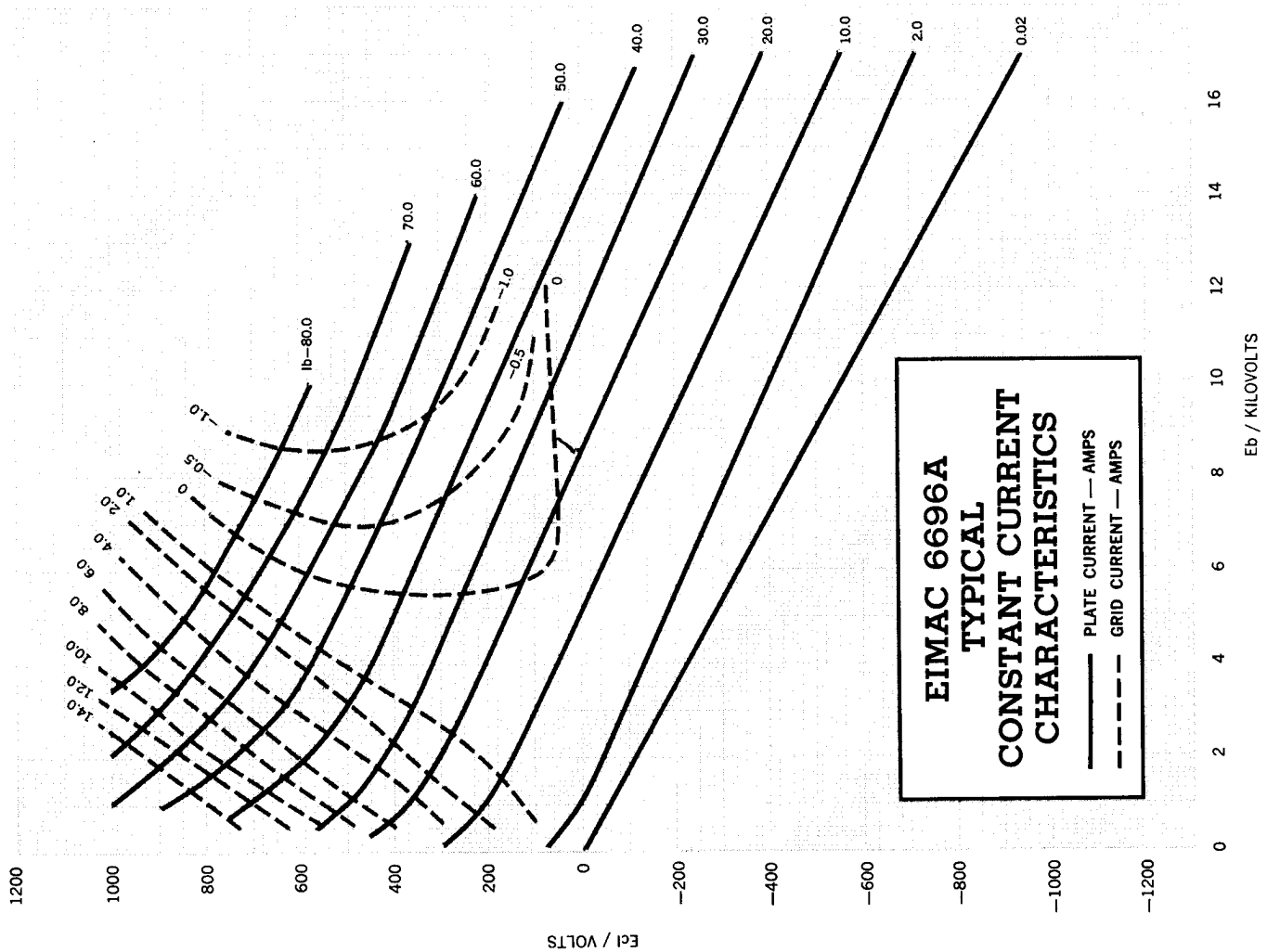
The use of an electronic fault diverter, or "crowbar" is probably the best way to insure high performance reliability and freedom from gassing or catastrophic failures. The crowbar system consists of circuitry to sense incipient fault currents and trigger the crowbar device, which is connected to short the power supply energy to ground, preferably within about 10 microseconds. The crowbar device, which is usually an ignitron, hydrogen thyratron, or spark gap, diverts most of the fault energy from the protected tube until the relay and circuit breakers open.

Special Applications—

If it is desired to operate this tube under conditions widely different from those given herein, write to Power Grid Tube Marketing, Eimac, Division of Varian, 301 Industrial Way, San Carlos, California.



DIMENSIONAL DATA			
REF	MIN.	MAX.	NOM.
A	2.469	2.531	
B	3.469	3.531	
C	4.619	4.681	
D		1.187	
E		1.000	
F	.156		
G	7.720	8.000	
H	6.500	6.780	
J	4.812	4.937	
K	.406	.469	
L		19.378	
M	3.485	3.515	
N	3.990	4.000	
P	.300	.325	
R	9.750	10.000	
S		4.720	



EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

6697A

FORCED-AIR COOLED MEDIUM-MU POWER TRIODE



The Eimac 6697A is a forced-air cooled ceramic-metal triode designed for AM broadcast and communications amplifiers and for industrial heating service.

Low-loss ceramic and metal construction permits operation at full ratings at frequencies up to 40 Mc. Useful power output can be obtained at frequencies up to 80 Mc at reduced plate voltage.

The 6697A anode is capable of dissipating 35 kilowatts. A water cooled version of this tube, type 6696A, and a vapor cooled version, type 7480, are also available.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.
Filament: Thoriated-Tungsten			
Voltage		13	volts
Current	190		220 amperes
Starting Current			800 amperes
Amplification Factor		20	
Direct Interelectrode Capacitances			
Grid-Plate	47		57 pf
Grid-Filament	65		85 pf
Plate-Filament	2.0		3.2 pf
Frequency for Maximum Ratings			40 Mc

MECHANICAL

Base	Coaxial
Operating Position	Vertical, base up
Cooling	Forced Air
Maximum Seal Temperature	200°C
Maximum Incoming Air Temperature	50°C
Maximum Height	19.9 inches
Maximum Diameter	5.28 inches
Net Weight	43 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	16.0 KV
DC GRID VOLTAGE	−3200 VOLTS
DC PLATE CURRENT	11 AMPS
DC GRID CURRENT	2.0 AMPS
GRID DISSIPATION	1000 WATTS
PLATE DISSIPATION	35 KW

TYPICAL OPERATION

DC Plate Voltage	10	15 kV
DC Grid Voltage	−1200	−1600 volts
Peak RF Grid Voltage	1900	2100 volts
DC Plate Current	10.0	7.0 amps
DC Grid Current	810	300 mA
Resonant Load Impedance	440	970 ohms
Driving Power, approx.	1500	600 watts
Plate Output Power, approx.	72	80 kW

(Effective 10-15-64) c 1968 by Varian

Printed in U.S.A.

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	10.0 KV
DC GRID VOLTAGE	—3200 VOLTS
DC PLATE CURRENT	8.5 AMPS
DC GRID CURRENT	2.0 AMPS
GRID DISSIPATION	1000 WATTS
PLATE DISSIPATION	23 KW

TYPICAL OPERATION

DC Plate Voltage	9.5 kV
DC Grid Voltage	—1600 volts
Peak RF Grid Voltage	2300 volts
DC Plate Current	8.4 amps
DC Grid Current	900 mA
Resonant Load Impedance	510 ohms
Driving Power, approx.	2.0 kW
Plate Output Power, approx.	60 kW

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	16.0 KV
DC PLATE CURRENT	11.0 AMPS
PLATE DISSIPATION	35 KW

TYPICAL OPERATION (Two Tubes).

DC Plate Voltage	10 kV
DC Grid Voltage	—450 volts
Peak AF Driving Voltage (per tube)	875 volts
Zero-Sig DC Plate Current	3.0 amps
Max-Sig DC Plate Current	17.4 amps
Load Resistance, Plate-to-Plate	1170 ohms
Max-Sig Driving Power, app	550 watts
Max-Sig Plate Output Power approx.	110 kW

RADIO-FREQUENCY AM LINEAR AMPLIFIER

Class-AB (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	16.0 KV
DC PLATE CURRENT	9.0 AMPS
PLATE DISSIPATION	35 KW

TYPICAL OPERATION (AM Carrier conditions except where noted).

DC Plate Voltage	12 kV
DC Grid Voltage	—550 volts
Peak RF Grid Voltage	510 volts
DC Plate Current	4.3 amps
DC Grid Current	0 amps
Resonant Load Impedance	780 ohms
Driving Power, approx.*	450 watts
Plate Output Power, approx.	18 kW

*At modulation crest.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB, Single-Sideband Suppressed-Carrier Service

MAXIMUM RATINGS

DC PLATE VOLTAGE	16.0 KV
DC PLATE CURRENT	11.0 AMPS
PLATE DISSIPATION	35 KW

TYPICAL OPERATION (Peak-envelope or modulation-crest conditions in cathode-drive circuit).

DC Plate Voltage	12 kV
DC Cathode Voltage	600 volts
Peak RF Driving Voltage	830 volts
DC Plate Current	5.2 amps
DC Grid Current, approx.	60 mA
Resonant Load Impedance	880 ohms
Driving Power, approx.	3.5 kW
Plate Power Output, approx.	43 kW

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses has been made.

APPLICATION

MECHANICAL

Mounting—

The 6697A should be mounted vertically anode down in the air distributor (Machlett type F-17759 or equivalent). Filament and grid connections are made through clamp rings or spring-finger contacts to the O.D. of the sturdy copper terminals of the tube. Anode contact can be made to the top ring of the air distributor.

Anode Cooling—

Minimum cooling requirements are given in the accompanying table, based on a maximum incoming air temperature of 50°C at sea level.

MINIMUM ANODE COOLING REQUIREMENTS

Plate Dissipation kW	Air Flow Rate cfm	Pressure Drop inches water
10	240	0.2
20	700	1.5
30	1350	5.0
35	1700	8.0

Base Cooling—

Forced-air cooling of the ceramic base and seals may be required, depending on ambient conditions and operating frequency. Air flow rate and direction should be determined to limit envelope temperatures to 200°C maximum and to maintain uniform temperature distribution around the seals. Spot temperatures are conveniently measured with Tempilaq (spray type) or equivalent. Often the anode air supply can be deflected to cool the envelope and seals.

ELECTRICAL

Filament Operation—

The rated filament voltage, as measured at the tube terminals, should be maintained within ±5% to assure long life and good performance within the rated power capability of the tube. To accommodate special requirements, the filament voltage may be centered near either of these extremes, e.g. at plus 5 percent for exceptionally high emission at a sacrifice of life, or at minus 5 percent for exceptionally long life where perhaps only half the full emission capability is required.

Grid Dissipation—

Grid dissipation should be limited to 1,000 watts maximum. Grid dissipation may be calculated approximately as the product of peak positive grid voltage and dc grid current.

In many r-f amplifier applications where it is impractical to measure the positive grid voltage, the dc grid current rating serves as a satisfactory guide. The maximum dc grid current rating under normal full load conditions is 2 amperes. In most cases, however, high power output and good efficiency can be realized with grid current less than one ampere. By limiting the grid current in this manner there is obviously more latitude for grid current excursions resulting from changes in loading.

High Frequency Operation—

The maximum ratings listed apply at frequencies up to 40 Mc. Useful output can be obtained at higher frequencies if the plate voltage and plate input power are reduced accordingly. For operation up to 60 Mc these parameters should be reduced to 75% of the listed dc plate voltage rating; for operation up to 80 Mc they should be reduced to 50%.

Aging—

The manner of operating most high power tubes differs in at least some respects from conditions under which the tubes are tested, therefore, some aging is almost always required to condition a new tube to its new environment. In basic terms, the different operating conditions are manifest as different distributions of heat and voltage gradients. Satisfactory aging is most easily achieved by gradual application of voltages, e.g. first filament voltage, then partial plate voltage, and drive, working up to the final values. If continuous or stepped plate voltage control is not used, sufficient load should be connected before snapping on full voltage to limit transients to about 120% of the dc voltage.

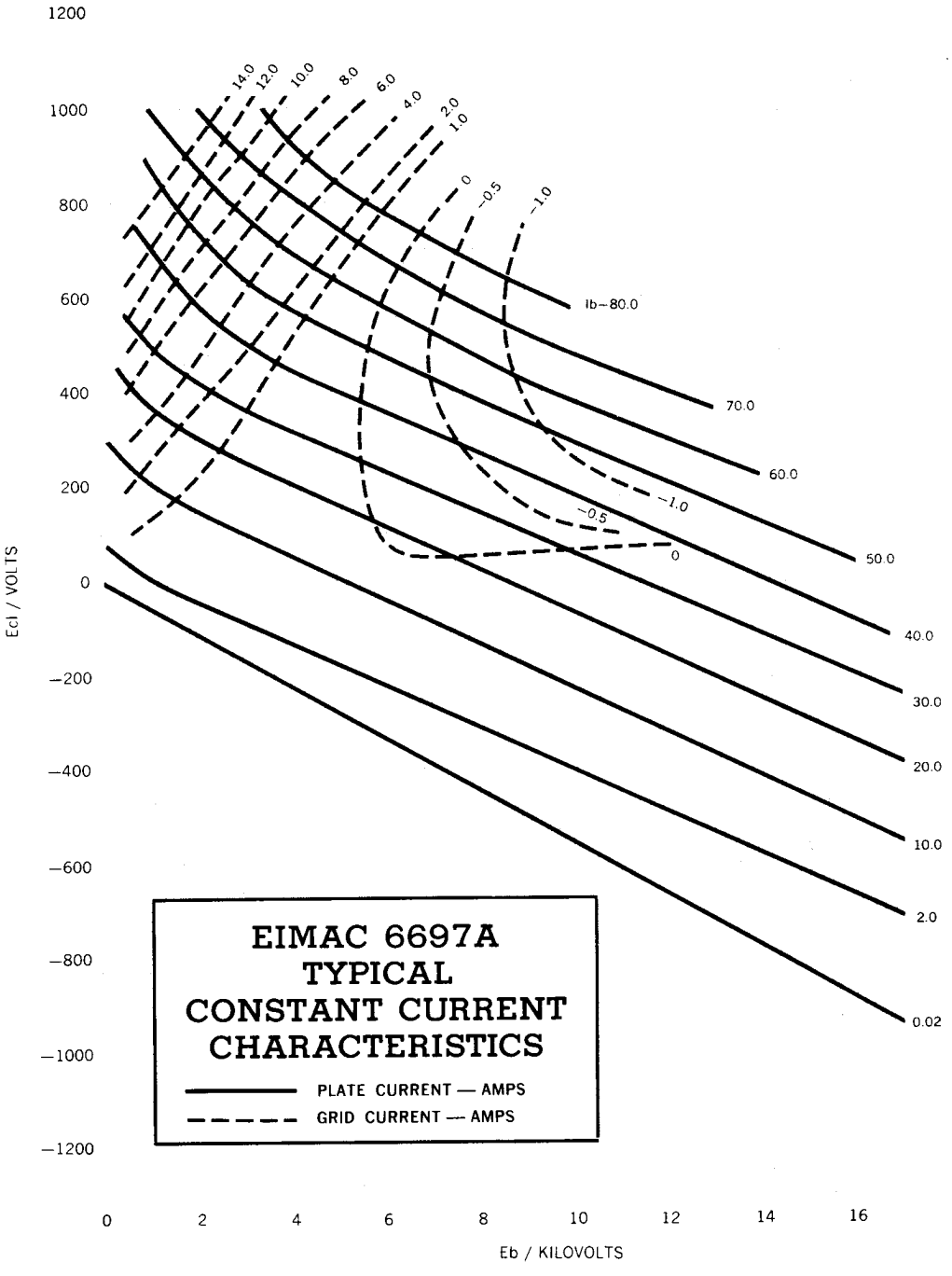
Tube Protection—

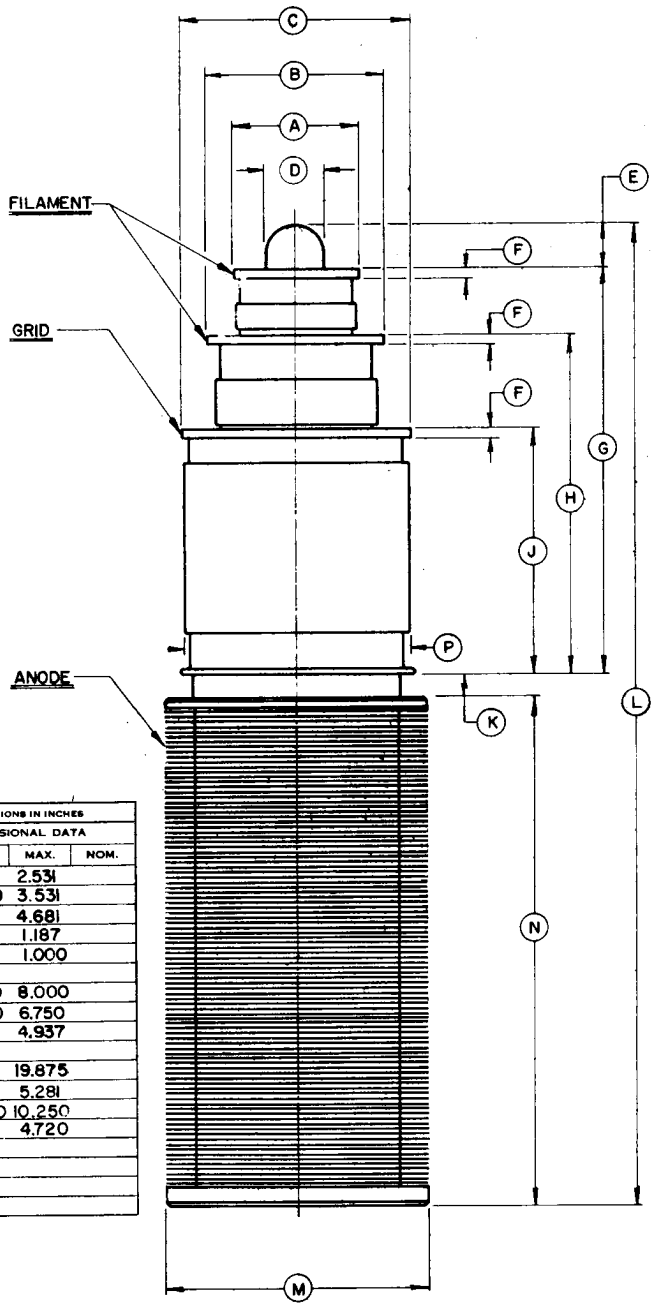
Since the possibility of fault overloads due to occasional tube or circuit instabilities is ever present, good engineering practice holds that suitable protective circuitry and devices be included in the equipment. In addition to the standard overcurrent relays, some series resistance should be placed in the output of the power supply to limit surge currents. In cases where no filter is used, the resistors may be placed in each rectifier lead to reduce the power loss during normal operation. In certain applications, furthermore, it is helpful to attach sphere gaps or rings to the tube terminals to divert any excessive transient voltages from the envelope and seals.

The use of an electronic fault diverter, or "crowbar" is probably the best way to insure high performance reliability and freedom from gassing or catastrophic failures. The crowbar system consists of circuitry to sense incipient fault currents and trigger the crowbar device, which is connected to short the power supply energy to ground, preferably within about 10 microseconds. The crowbar device, which is usually an ignitron, hydrogen thyratron, or spark gap, diverts most of the fault energy from the protected tube until the relay and circuit breakers open.

Special Applications—

If it is desired to operate this tube under conditions widely different from those given herein, write to Power Grid Tube Marketing, Eimac, Division of Varian, 301 Industrial Way, San Carlos, California.





DIMENSIONS IN INCHES

DIMENSIONAL DATA

REF.	MIN.	MAX.	NOM.
A	2.469	2.531	
B	3.469	3.531	
C	4.619	4.681	
D		1.187	
E		1.000	
F	.156		
G	7.750	8.000	
H	6.500	6.750	
J	4.812	4.937	
K	.312		
L		19.875	
M	5.219	5.281	
N	10.000	10.250	
P		4.720	

Eimac 6697A

TECHNICAL DATA

6775
4-400C

RADIAL BEAM
POWER TETRODE

The EIMAC 6775/4-400C is a compact, ruggedly constructed, broadcast-quality tetrode having a maximum plate dissipation rating of 400 watts. It is intended for use as an amplifier, oscillator, or modulator. The low grid-plate capacitance of this tetrode coupled with its low driving-power requirement allows considerable simplification of the associated circuit and driver stage.

The 6775/4-400C is cooled by radiation from the plate and by circulation of forced-air through the base, around the envelope, and over the plate seal. Cooling can be greatly simplified by using an EIMAC SK-400 Series Air-System Socket, and its accompanying glass chimney. This socket is designed to maintain the correct balance of cooling air between the component parts of the tube.[1]

The 6775/4-400C is especially recommended for applications where long life and consistent performance are of prime consideration.[2]



GENERAL CHARACTERISTICS[3]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	5.0 ± 0.25	V
Current, at 5.0 volts	14.7	A
Transconductance (Average):		
I_b = 100 mA, E_{c2} = 500 volts	4000	μmhos
Amplification Factor (Average):		
Grid to Screen	5.1	
Direct Interelectrode Capacitances (grounded filament)[4]		
Cin	12.5	pF
Cout	4.7	pF
Cgp	0.12	pF
Frequency of Maximum Rating:		
CW	110	MHz

1. Guarantee applies only when the 4-400C is used as specified with adequate cooling air in the SK-400 or SK-410 Air-System Socket and associated chimney, or equivalents.
2. See FILAMENT VOLTAGE section for recommended operating conditions when long life and consistent performance are of prime concern.
3. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
4. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

(Effective 4-1-71) © by Varian

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MECHANICAL

Maximum Overall Dimensions:	
Length	6.375 in; 161.93 mm
Diameter	3.563 in; 90.50 mm
Net Weight	9.0 oz; 255 gm
Operating Position	Any
Maximum Operating Temperature:	
Plate Seal	225°C
Base Seals	200°C
Cooling	Radiation and forced air
Base	Special 5-pin
Recommended Socket	EIMAC SK-400 Series
Recommended Chimney	EIMAC SK-406
Recommended Heat-Dissipating Connectors:	
Plate	HR-6

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_1

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	800	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Frequencies to 75 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	3000	Vdc
Screen Voltage	750	Vdc
Grid Voltage 1	-130	Vdc
Zero-Signal Plate Current	80	mAdc
Single-Tone Plate Current	290	mAdc
Single-Tone Screen Current 2	13	mAdc
Useful Output Power	470	w
Resonant Load Impedance	5000	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR (Class C Telegraphy or FM Telephony (Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Frequencies to 75 MHz)

Plate Voltage	2500	3000	4000	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-200	-220	-220	Vdc
Plate Current	350	350	350	mAdc
Screen Current[1]	46	46	40	mAdc
Screen Dissipation	23	23	20	W
Grid Current[1]	18	19	18	mAdc
Peak rf Grid Voltage[1]	300	320	320	v
Grid Dissipation	1.8	1.9	1.8	W
Calculated Driving Power[2]	5.4	6.1	5.8	W
Plate Input Power	875	1050	1400	W
Plate Dissipation	235	250	300	W
Plate Output Power	640	800	1100	W

1. Approximate value.
2. Driving Power increases with frequency. At 75 MHz driving power is approximately 12 watts.

TYPICAL OPERATION (110 MHz, two tubes)

Plate Voltage	3000	4000	Vdc
Screen Voltage	500	500	Vdc
Grid Voltage	-170	-170	Vdc
Plate Current	500	540	mAdc
Screen Current	34	31	mAdc
Grid Current	20	20	mAdc
Driving Power[1]	20	20	W
Plate Output Power[1]	1300	1600	W
Useful Output Power	1160	1440	W

1. Approximate value

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	3200	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	0.275	AMPERE
PLATE DISSIPATION[1]	270	WATTS
SCREEN DISSIPATION[2]	35	WATTS
GRID DISSIPATION[2]	10	WATTS

1. Corresponds to 400 watts at 100% sine-wave modulation.

TYPICAL OPERATION (Frequencies to 75 MHz, Continuous Service)

Plate Voltage	2000	2500	3000	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-220	-220	-220	Vdc
Plate Current	275	275	275	mAdc
Screen Current[1]	30	28	26	mAdc
Screen Dissipation	15	14	13	W
Grid Current[1]	12	12	12	mAdc
Grid Dissipation	1.1	1.1	1.1	W
Peak af Screen Voltage[1] (100% modulation)	350	350	350	v
Peak rf Grid Voltage[1]	290	290	290	v
Calculated Driving Power[1]	3.5	3.5	3.5	W
Plate Input Power	550	688	825	W
Plate Dissipation	170	178	195	W
Plate Output Power	380	510	630	W

1. Approximate value.

MAXIMUM RATINGS (Frequencies to 30 MHz, Intermittent Service)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	0.275	AMPERE
PLATE DISSIPATION[1]	270	WATTS
SCREEN DISSIPATION[2]	35	WATTS
GRID DISSIPATION[2]	10	WATTS

2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz, Intermittent Service)

Plate Voltage	2000	2500	3000	3650	Vdc
Screen Voltage	500	500	500	500	Vdc
Grid Voltage	-220	-220	-220	-225	Vdc
Plate Current	275	275	275	275	mAdc
Screen Current[1]	30	28	26	23	mAdc
Screen Dissipation	15	14	13	12	W
Grid Current[1]	12	12	12	13	mAdc
Grid Dissipation	1.1	1.1	1.1	1.2	W
Peak Screen Voltage (100% modulation)	350	350	350	350	v
Peak rf Grid Voltage[1]	290	290	290	315	v
Calculated Driving Power[1]	3.5	3.5	3.5	4.0	W
Plate Input Power	550	688	825	1000	W
Plate Dissipation	170	178	195	235	W
Plate Output Power	380	510	630	765	W

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB, Grid Driven
(Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	800	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Two Tubes) Class AB_1

Plate Voltage	2500	3000	3500	4000	Vdc
Screen Voltage	750	750	750	750	Vdc
Grid Voltage[1/4]	-130	-137	-145	-150	Vdc
Zero-Signal Plate Current	190	160	140	120	mAdc
Max.Signal Plate Current	635	635	610	585	mAdc
Zero-Signal Screen Current	0	0	0	0	mAdc
Max.Signal Screen Current[1]	28	26	32	40	mAdc
Peak af Grid Voltage[2]	130	137	145	150	v
Peak Driving Power[3]	0	0	0	0	w
Max Signal Plate Dissipation[2]	370	400	400	400	W
Plate Output Power	850	1100	1330	1540	W
Load Resistance (plate to plate)	6800	8900	11,500	14,000	Ω

TYPICAL OPERATION (Two Tubes) Class AB_2

Plate Voltage	2500	3000	3500	4000	Vdc
Screen Voltage	500	500	500	500	Vdc
Grid Voltage[1/4]	-75	-80	-85	-90	Vdc
Zero-Signal Plate Current	190	160	140	120	mAdc
Max.Signal Plate Current	700	700	700	638	mAdc
Zero-Signal Screen Current	0	0	0	0	mAdc
Max.Signal Screen Current	50	40	38	32	mAdc
Peak af Grid Voltage[2]	133	140	145	140	v
Peak Driving Power[3]	8.6	9.0	10.2	7.0	w
Max.Signal Plate Dissipation[2]	320	363	400	400	W
Plate Output Power	1110	1375	1650	1750	W
Load Resistance (plate to plate)	7200	9100	10,800	14,000	Ω

1. Approximate value.
2. Per Tube.
3. Nominal drive power is one-half peak power.
4. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 5.0 volts	14.0	15.3	A
Interelectrode Capacitances [1] (grounded filament connection):			
Cin	10.7	14.5	pF
Cout	4.2	5.6	pF
Cgp	----	0.17	pF

1. In Shielded Fixture, per EIA Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4-400C may be operated in any position. The socket must be constructed so as to allow an unimpeded flow of air through the holes in the base of the tube and must also provide clearance for the glass tip-off which extends from the center of the base. The metal tube-base shell should be grounded by means of suitable spring fingers. The above requirements are met by the EIMAC SK-400 and SK-410 Air-System Sockets. A flexible connecting strap should be provided between the EIMAC HR-6 cooler on the plate terminal and the external plate circuit. The tube must be protected from severe vibration and shock.

COOLING - Adequate forced-air cooling must be provided to maintain the base seals at a temperature below 200°C, and the plate seal at a temperature below 225°C.

When the EIMAC SK-400 or SK-410 Air-System Socket is used, a minimum air flow of 14 cubic feet per minute at a static pressure of 0.25 inches of water or less, as measured in the socket or plenum chamber at sea level, is required to provide adequate cooling under all conditions of operation. Seal temperature limitations may require that cooling air be supplied to the tube even when the filament alone is on during standby periods.

Tube temperatures may be measured with a temperature sensitive paint, spray or crayon, such as manufactured by Tempil Division, Big Three Industrial Gas & Equipment Co., Hamilton Blvd., So. Plainfield, N.J. 07080.

ELECTRICAL

FILAMENT VOLTAGE - Filament voltage should be measured at the tube base with an accurate meter. When operating at the nominal voltage, variations of ±5% are tolerable and should have little effect on electrical performance of the tube. However, when very long life and consistent performance are factors, voltage can often be reduced to a value lower than the nominal voltage, but should be regulated and held to ±1% when this is done. To achieve a regulated voltage and still have it adjustable, a typical procedure would involve a one-to-one regulating transformer, feeding a variable ratio transformer (such as a POWERSTAT or a VARIAC), which in turn feeds the filament transformer. The equipment is first operated with nominal filament voltage applied, and when stable operation is achieved, the voltage is then reduced in small steps (about 0.2 volt at a time) until the point is reached where performance of the tube is clearly affected. The voltage is then

raised to a few tenths of a volt above this level for operation. Periodically (every 500 to 1000 hours) this procedure should be repeated and the operating value of the filament voltage readjusted if necessary.

BIAS VOLTAGE - The dc bias voltage for the 4-400C should not exceed 500 volts. If grid resistor bias is used, suitable means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation, and the grid resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In operation above 50 MHz, it is advisable to keep the bias voltage as low as is practicable.

SCREEN VOLTAGE - The dc screen voltage for the 4-400C should not exceed 800 volts. The screen voltages shown under Typical Operation are representative voltages for the type of operation involved.

PLATE VOLTAGE - The plate-supply voltage for the 4-400C should not exceed 4000 volts in CW and audio applications. In plate-modulated telephony service the dc plate-supply voltage should not exceed 3200 volts, except below 30 MHz, intermittent service, where 4000 volts may be used.

GRID DISSIPATION - Grid dissipation for the 4-400C should not be allowed to exceed 10 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{gk} \times I_c$$

where P_g = Grid dissipation
e_{gk} = Peak positive grid to cathode voltage, and
I_c = dc grid current

SCREEN DISSIPATION - The power dissipated by the screen of the 4-400C must not exceed 35 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 35 watts in event of circuit failure.

PLATE DISSIPATION - Under normal operating conditions, the plate dissipation of the 4-400C should not be allowed to exceed 400 watts. The anode operates at a visibly red color at its maximum rated dissipation of 400 watts.

In plate modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 270 watts. The plate dissipation will rise to 400 watts under 100% sinusoidal modulation.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

MULTIPLE OPERATION - To obtain maximum power output with minimum distortion from tubes operated in multiple, it is desirable to adjust individual screen or grid bias voltages so that the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual dc plate currents will be approximately equal for full input signal for class AB1 operation.

CAUTION - GLASS IMPLOSION - The EIMAC 4-400C is pumped to a very high vacuum, which is contained by a glass envelope. When handling a glass tube, remember that glass is a relatively fragile material, and accidental breakage can result at any time. Breakage will result in flying glass fragments, so safety glasses, heavy clothing, and leather gloves are recommended for protection.

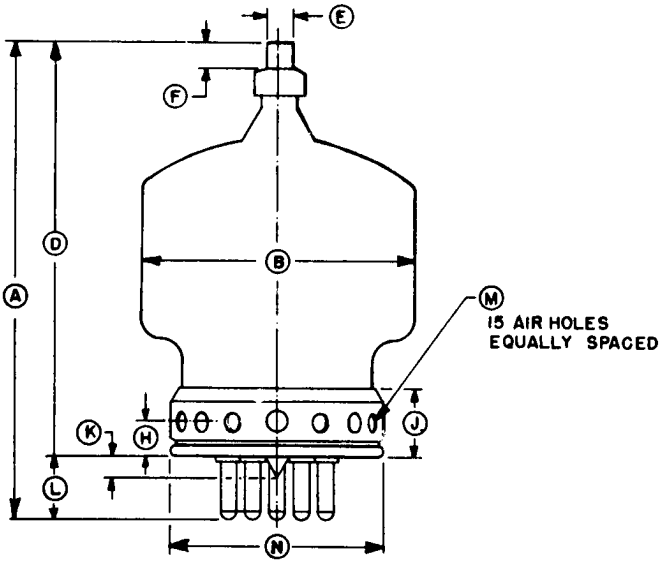
CAUTION-HIGH VOLTAGE - Operating voltage for the 4-400C can be deadly, so the equipment must be designed properly and operating precautions must be followed. Design equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high voltage circuits and terminals, with interlock switches to open the primary circuits of the power supply and to discharge high voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

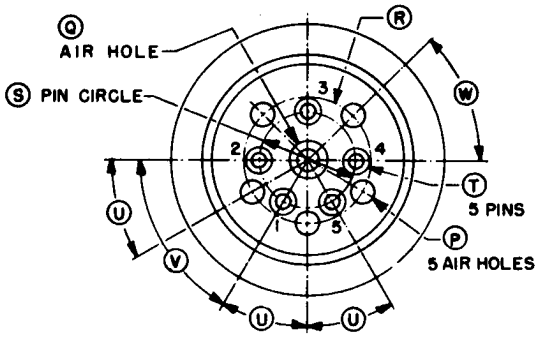
SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

DIMENSIONAL DATA

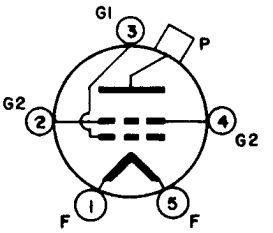
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	5.875	6.375	--	149.23	161.93	--
B	--	3.563	--	--	90.50	--
D	5.125	5.625	--	130.18	142.88	--
E	0.350	0.365	--	8.89	9.27	--
F	0.328	--	--	8.33	--	--
H	--	--	0.438	--	--	11.13
J	--	0.969	--	--	24.61	--
K	--	0.250	--	--	6.35	--
L	--	--	0.750	--	--	19.05
M	--	--	0.250	--	--	6.35
N	--	2.750	--	--	69.85	--
P	--	--	0.312	--	--	7.92
Q	--	--	0.500	--	--	12.70
R	--	--	1.625	--	--	41.28
S	--	--	1.250	--	--	31.75
T	0.185	0.191	--	4.70	4.85	--
U	--	--	30°	--	--	30°
V	--	--	60°	--	--	60°
W	--	--	45°	--	--	45°

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



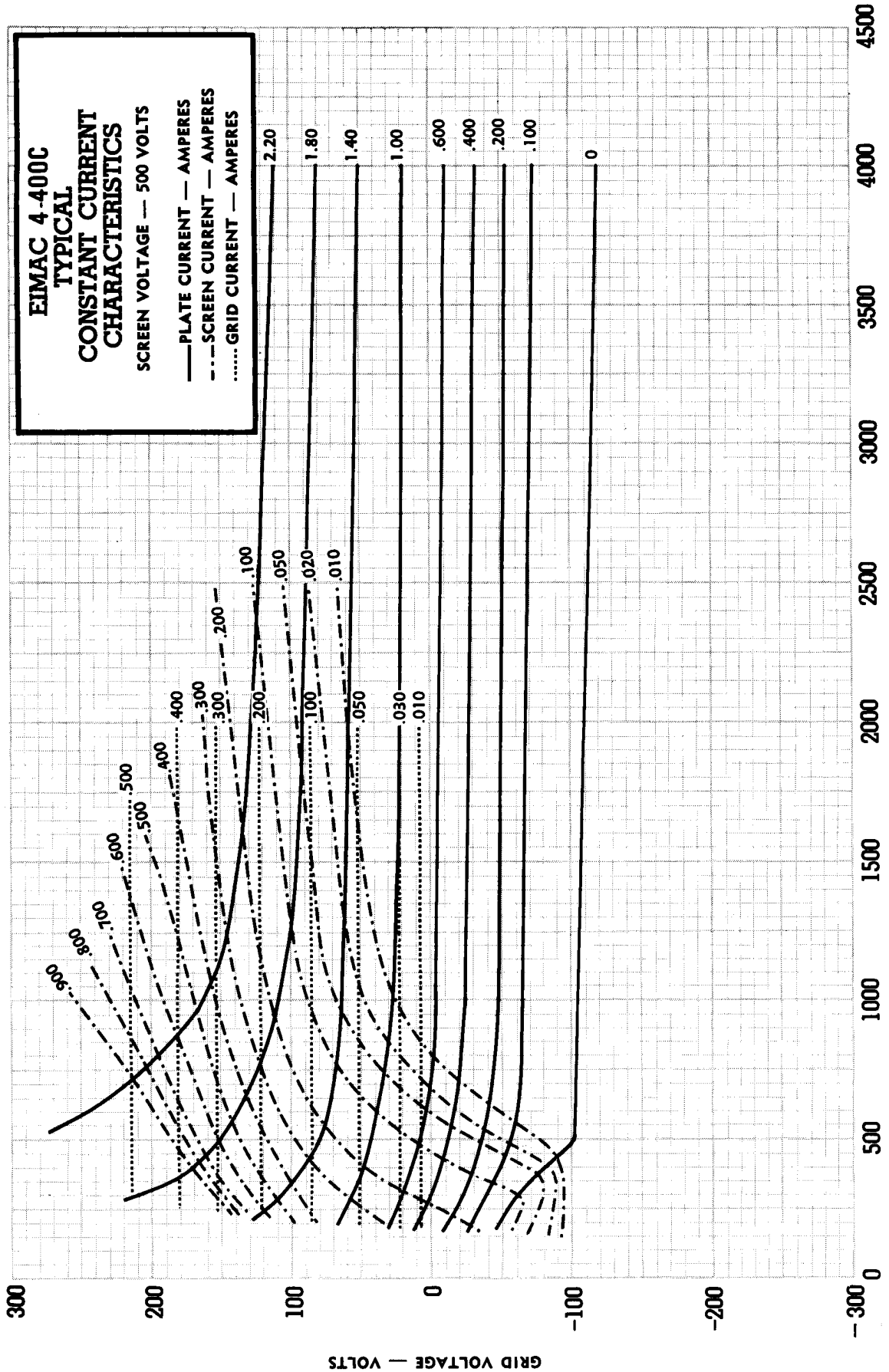


BOTTOM VIEW



NOTE:

Base pins T and tubulation K are so alined that they can be freely inserted in a gage ¼ inch (6.35 mm) thick with hole diameters of .204 (5.18 mm) and .500 (12.70 mm), respectively, located on the true centers by the given dimensions S, U, V.


EIMAC 4-400C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
——PLATE CURRENT — AMPERES
– – –SCREEN CURRENT — AMPERES
.....GRID CURRENT — AMPERES
2.20
1.80
1.40
1.00
.600
.400
.200
.100
0
.100
.050
.020
.010
.030
.010
.050
.200
.300
.400
.500
.600
.700
.800
.900
300
200
100
0
-100
-200
-300
0
500
1000
1500
2000
2500
3000
3500
4000
4500
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

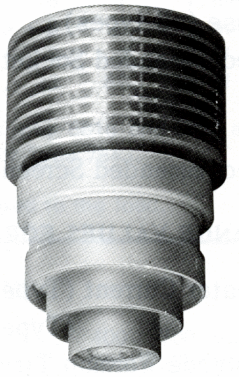
TECHNICAL DATA

6816
6884
7843

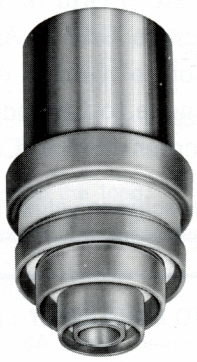
RADIAL-BEAM
POWER TETRODES

The EIMAC 6816, 6884, and 7843 are compact external anode ceramic/metal radial-beam tetrodes for use in rf power amplifier or oscillator service, linear rf power amplifier applications, and as audio amplifiers or modulators. The 6816 has a 6.3 volt heater, while the 6884 has a 26.5 volt heater, and both are designed for transverse-flow forced-air cooling of the anode. The 7843 has a 26.5 volt heater and its anode is designed for conduction cooling.

All three types have an F1 rating of 1215 MHz for full-rated power input, and are tested to give a useful power output of 80 watts at 400 MHz and 40 watts at 1200 MHz.



6816/6884



7843

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated Unipotential

Heater Voltage (6816)	6.3 ± 10%	V
Heater Current (at 6.3 V)	2.0	A
Heater Voltage (6884, 7843)	26.5 ± 10%	V
Heater Current (at 26.5 V)	0.53	A
Amplification Factor (Average):		
Grid to screen	18	
Direct Interelectrode Capacitances[2]		
Control Grid to Cathode	13.0	pF
Control Grid to Screen Grid	17.5	pF
Screen Grid to Anode	4.7	pF
Control Grid to Anode	0.05	pF
Anode to Cathode	0.01	pF
Screen Grid to Cathode	0.33	pF

1. Characteristics and operating values are based on performance tests. These figures may change without notice as a result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture, in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	6816 & 6884	7843
Length	1.930 In; 49.02 mm	1.955 In; 49.66 mm
Diameter	1.265 In; 32.13 mm	1.120 In; 28.45 mm
Net Weight	2.0 oz; 56.7 gm	1.7 oz; 48.2 gm
Operating Position	Any	Any

(Effective 11-15-71) © by Varian Printed in U.S.A.

Cooling:
- Type 6816, 6884 ..... Forced Air
- Type 7843 ..... Conduction Cooled

Operating Temperature, Maximum, all three types:
- Ceramic/Metal Seals and Anode Core ..... 250°C

Base (all types) ..... Special Coaxial

Recommended Sockets (Screen Grid bypass capacitor included): Erie 2948-000
E.F. Johnson 124-152-1
Jettron 89-001

Recommended Screen Grid bypass capacitor (separate unit): ..... Erie 2929-001

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater Current (Type 6816, at 6.3 volts)	1.84	2.26	V
(Type 6884, 7843, at 26.5 volts)	0.48	0.60	A
Cathode Warmup Time (all types)	60	---	Sec
Interelectrode Capacitances [1]			
Control Grid to Cathode	11.0	15.0	pF
Control Grid to Screen Grid	15.0	20.0	pF
Screen Grid to Anode	4.2	5.2	pF
Control Grid to Anode	---	0.065	pF
Anode to Cathode	---	0.013	pF
Screen Grid to Cathode	0.20	0.45	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture, in accordance with Electronic Industries Association Standard RS-191.

RADIO FREQUENCY LINEAR AMPLIFIER

Grid-driven, Class AB 1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	1000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-100	VOLTS
DC PLATE CURRENT [1]	.180	AMPERE
PLATE DISSIPATION [2]	115	WATTS
SCREEN DISSIPATION	4.5	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz) Class AB1 Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	650	850	Vdc
Screen Voltage	300	300	Vdc
Grid Voltage [3]	-18	-18	Vdc
Zero Signal Plate Current	40	40	mAdc
Single-Tone Plate Current	100	100	mAdc
Two-Tone Plate Current	75	75	mAdc
Single-Tone Screen Current [4]	8	4	mAdc
Two-Tone Screen Current [4]	3.5	2	mAdc
Resonant Load Impedance	2200	3500	Ω
Useful Power Output [5] PEP	25	40	W
Distortion Products [6] 3rd:	-35	-30	dB
5th:	-40	-35	dB

1. The maximum rating for a signal having a minimum peak-to-average power ratio less than 2.0, such as single-tone operation, is 180 mAdc. During short periods of circuit adjustment under single-tone conditions, the average anode current may reach the level of 250 mAdc.
2. With proper cooling for Types 6816 and 6884 and with adequate heat sink for Type 7843.
3. Adjust for the specified zero-signal plate current.
4. Approximate value.
5. Approximate value delivered to the load.
6. Referenced against one tone of a two equal-tone signal.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy or FM Telephony

(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	1000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-100	VOLTS
DC PLATE CURRENT	0.180	AMPERE
PLATE DISSIPATION [1]	115	WATTS
SCREEN DISSIPATION	4.5	WATTS
GRID DISSIPATION	1.0	WATT

TYPICAL OPERATION

	400 MHz		1200 MHz	
Plate Voltage	400	900	900	Vdc
Screen Voltage	200	300	300	Vdc
Grid Voltage	-35	-30	-22	Vdc
Plate Current	150	170	170	mAdc
Screen Current [2]	5	1	1	mAdc
Grid Current [2]	3	10	4	mAdc
Driving Power [2]	3	3	5	W
Useful Power Output [3]	23	80	40	W

1. With proper cooling for Types 6816 and 6884 and with adequate heat sink for Type 7843.
2. Approximate value.
3. Approximate power delivered to the load.

PLATE MODULATED POWER AMPLIFIER

Class C Telephony

(Key-Down Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	800	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-100	VOLTS
DC PLATE CURRENT	0.150	AMPERE
PLATE DISSIPATION [1]	75	WATTS
SCREEN DISSIPATION	4.5	WATTS
GRID DISSIPATION	1.0	WATT

TYPICAL OPERATION AT 400 MHz

Plate Voltage	400	700	Vdc
Screen Voltage	200	250	Vdc
Grid Voltage	-20	-50	Vdc
Plate Current	100	130	mAdc
Screen Current [2]	5	10	mAdc
Grid Current [2]	5	10	mAdc
Peak Screen Voltage [2] (100% modulation)	150	150	v
Driving Power [2]	2	3	W
Useful Power Output [3]	16	45	W

1. With proper cooling for Types 6816 and 6884 and with adequate heat sink for Type 7843.
2. Approximate value.
3. Approximate power delivered to the load.

AUDIO FREQUENCY POWER AMPLIFIER & MODULATOR Grid-driven, Class AB 1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	1000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC PLATE CURRENT	0.180	AMPERE
PLATE DISSIPATION [1]	115	WATTS
SCREEN DISSIPATION	4.5	WATTS

1. With proper cooling for Types 6816 and 6884 and with adequate heat sink for Type 7843.
2. Adjust for specified zero signal plate current.
3. Approximate value.

TYPICAL OPERATION, Class AB 1

Values are for 2 tubes

Plate Voltage	650	850	Vdc
Screen Voltage	300	300	Vdc
Grid Voltage [2]	-15	-15	Vdc
Peak Drive Voltage, grid-to-grid	30	30	v
Zero Signal Plate Current	80	80	mAdc
Maximum Signal Plate Current	200	200	mAdc
Zero Signal Screen Current [3]	0	0	mAdc
Maximum Signal Screen Current [3]	20	20	mAdc
Effective Load Resistance (plate to plate)	4330	7000	Ω
Maximum Signal Power Output [3]	50	80	W

AUDIO FREQUENCY POWER AMPLIFIER & MODULATOR Grid-driven, Class AB 2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	1000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC PLATE CURRENT	0.180	AMPERE
DC GRID CURRENT	0.030	AMPERE
PLATE DISSIPATION [1]	115	WATTS
SCREEN DISSIPATION	4.5	WATTS
GRID DISSIPATION	1.0	WATT

1. With proper cooling for Types 6816 and 6884 and with adequate heat sink for type 7843.
2. Adjust for specified zero signal plate current.
3. Approximate value.

TYPICAL OPERATION, Class AB 2

Values are for 2 tubes

Plate Voltage	650	850	Vdc
Screen Voltage	300	300	Vdc
Grid Voltage [2]	-15	-15	Vdc
Peak Drive Voltage, grid-to-grid	46	46	v
Zero Signal Plate Current	80	80	mAdc
Maximum Signal Plate Current	355	355	mAdc
Zero Signal Screen Current [3]	0	0	mAdc
Maximum Signal Screen Current [3]	25	25	mAdc
Maximum Signal Grid Current [3]	15	15	mAdc
Effective Load Resistance (plate to plate)	2450	3960	Ω
Driving Power [3]	0.3	0.3	W
Maximum Signal Power Output [3]	85	140	W

APPLICATION

ELECTRICAL

HEATER/CATHODE OPERATION - The rated heater voltage for the 6884 and the 7843 is 26.5 volts, and for the 6816, 6.3 volts, as measured at the base of the tube. Variations must be restricted to plus or minus ten percent, and where long life and consistent performance are factors, variation from the nominal value should be held to plus or minus five percent.

Because the cathode is subjected to considerable back bombardment (transit-time heating) as the frequency is increased, with resultant increase in cathode temperature, the heater voltage should be reduced in some applications, depending on operating conditions and frequency, to prevent overheating of the cathode and resultant short tube life.

ANODE CURRENT - The 6816, 6884, and 7843 are rated for 180 mAdc of continuous anode current. During short periods of circuit adjustment under CW or single-tone conditions, the average anode current may be as high as 250 mAdc, but care must be taken to keep the time period when the current is above the rating as brief as possible in order to prevent tube overheating.

HIGH VOLTAGE - The 6816, 6884, and 7843 operate at voltages which can be deadly and the equipment must be designed properly and operating precautions must be followed. Equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

MECHANICAL

MOUNTING & SOCKETING - The 6816, 6884, and 7843 may be mounted in any position. Sockets such as the E.F. Johnson 124-152-1, Erie 2948-000, Jettron 89-001, or equivalent may be used as long as there are no unusual circumstances which would allow the ceramic/metal base seal temperatures to exceed the rated maximum of 250°C. Mounting should be such that free movement of air past the base by convection is possible, or when forced-air cooling is being provided for the anode, some of this air may be bled off to provide for come circulation past the tube base.

The 7843 mounting is normally controlled by its heat-sink configuration and location. If air movement is restricted in the base area, the socket may also require coupling to a heat sink in order to limit base seal temperatures.

VIBRATION - These tubes are capable of satisfactorily withstanding ordinary shock and vibration, such as encountered in shipment and normal handling. The tubes will function well in automobile and truck mobile installations and similar environments. However, when shock and vibration more severe than this are expected, it is suggested the EIMAC 7457 be employed.

COOLING (6816 & 6884) - Forced-air cooling must be provided to maintain the anode core and seal temperatures within the maximum rating. For best cooling efficiency a close-fitting insulated cowl assembly should be used to direct air past the anode cooling fins, and with such a cowl 12 cfm of air at 50°C maximum at sea level is sufficient to limit the anode core temperature to 225°C. With a short section of cowl, the required pressure drop to produce this air flow is approximately 0.1 inch of water. At higher altitudes, additional air is required. For 10,000 feet, for example, flow rate and pressure drop values will both increase by a factor of 1.46. The equipment designer is cautioned to allow for some air circulation around the base of the tube to maintain temperatures well within ratings, and if necessary some of the air available for anode cooling should be bled into the vicinity of the base to provide a small amount of forced circulation.

COOLING (7843) - This tube is designed for use in a conduction-cooled system, where tube anode heat is transferred to a heat sink, which in turn may be cooled by natural (free) convection, forced-air convection, liquid cooling, or a combination of these methods. Anode dissipation is normally limited only by the allowable temperature rise for the seals and the anode core. The nominal dissipation rating of 115 watts may be realized with relatively simple heat sink configurations, with higher dissipation levels possible with more

thorough designs. In all cases, however, the cooling system must maintain the anode and ceramic/metal seal temperatures below 250°C, and in cases where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial.

Intimacy of contact and pressure are two factors which will effect transfer of heat from the tube anode to the heat sink. A good thermally conductive compound should be used in the interface between the anode and the sink to reduce thermal resistance of the joint. Examples of commercially available thermal joint compound are:

WAKEFIELD 120-Wakefield Engineering Co., Wakefield, MA 01880.
DOW CORNING 340-Dow Corning Corp., Midland, MI 48640.
ASTRODYNE THERMAL BOND 312-Astrodyne Inc., Burlington, MA 01803.
G.E. INSULGREASE G641-General Electric Co., Cleveland, OH 44117.

The designer is cautioned to allow for some movement in the socket mount to assure that the anode makes good contact to its heat sink without interference. If the tube anode and the sink are not making intimate contact, heat transfer will be seriously affected. The designer is encouraged to use temperature-sensitive paint or other temperature-sensing devices in connection with any equipment design before the layout is finalized.

GRID OPERATION - The maximum rated dc grid bias voltage is -100 volts and the maximum grid dissipation rating is 1.0 watts. In normal applications the grid dissipation will not approach the maximum rating.

At operating frequencies above the 100 MHz region, driving-power requirements for amplifiers increase noticeably. However, most of the driving power is absorbed in circuit losses other than grid dissipation, so that grid dissipation is increased only slightly. Satisfactory VHF/UHF operation of the tube in a stable amplifier is indicated by grid current values below approximately 15 mAdc.

The grid voltage required by different tubes may vary between limits approximately 20% above and below the center value, and means should be provided in the equipment to accommodate such variation. It is especially important that variations between individual tubes be compensated when tubes are operated in parallel or push-pull circuits, to assure equal load sharing.

The maximum permissible grid-circuit resistance per tube is 25,000 ohms.

SCREEN OPERATION - The maximum rated power dissipation for the screen grid is 4.5 watts, and the screen input power should be kept below this level. The product of peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

The screen current may reverse under certain conditions and produce negative current indications on the screen milliammeter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor or shunt regulator connected between screen and cathode. A series regulator circuit can be used only when an adequate bleeder resistor is provided.

Protection for the screen should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be on before screen voltage can be applied.

MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is a good engineering practice to provide individual metering and individual adjustment of bias or screen voltage to equalize the inputs.

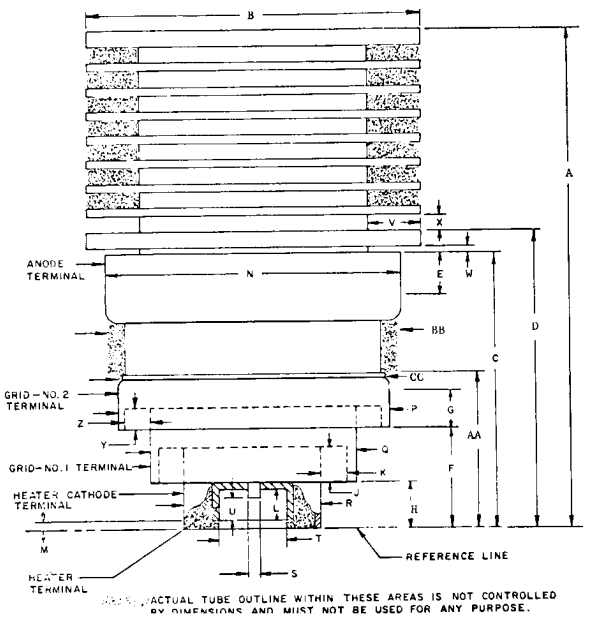
Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event one tube fails.

VHF OPERATION - The 6816, 6884, and 7843 are suitable for use in the VHF/UHF region. Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

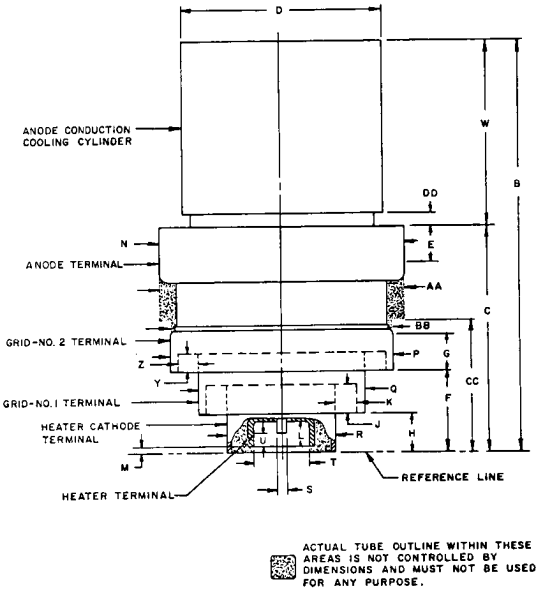
INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is increased by many variables in most applications, such as stray capacitance to the chassis,

capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191. The equipment designer is therefore cautioned to make allowance for the additional capacitance values which will exist in any normal application. Actual measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate any of these tubes under conditions widely different from those given here, write to Power Grid Division, Attention: Applications, EIMAC Division of Varian, 301 Industrial Way, San Carlos, CA 94070, for information and recommendations.



6816/6884



7843

DIM.	INCHES MIN.	INCHES MAX.	INCHES REF	MILLIMETERS MIN.	MILLIMETERS MAX.	MILLIMETERS REF
A	1.830	1.930	- -	46.48	49.02	- -
B	1.235	1.265	- -	31.37	32.13	- -
C	1.000	1.060	- -	25.40	26.92	- -
D	1.090	1.180	- -	27.26	29.97	- -
E	0.165	- -	- -	4.19	- -	- -
F	0.350	0.390	- -	8.89	9.91	- -
G	0.140	- -	- -	3.56	- -	- -
H	0.160	0.190	- -	4.06	4.83	- -
J	0.120	- -	- -	3.05	- -	- -
K	0.095	- -	- -	2.41	- -	- -
L	0.100	- -	- -	3.05	- -	- -
M	- -	0.050	- -	- -	1.27	- -
N	1.085	- -	- -	27.56	- -	- -
P	0.985	- -	- -	25.02	- -	- -
Q	0.735	- -	- -	18.67	- -	- -
R	0.480	- -	- -	12.19	- -	- -
S	- -	0.072	- -	- -	1.83	- -
T	0.240	0.260	- -	6.10	6.60	- -
U	0.054	- -	- -	1.37	- -	- -
V	0.200	- -	- -	5.08	- -	- -
W	0.035	- -	- -	0.89	- -	- -
X	0.050	- -	- -	1.27	- -	- -
Y	0.060	- -	- -	1.52	- -	- -
Z	0.090	- -	- -	2.29	- -	- -
AA	0.600	- -	- -	15.24	- -	- -
BB	- -	1.120	- -	- -	28.45	- -
CC	- -	1.020	- -	- -	25.91	- -

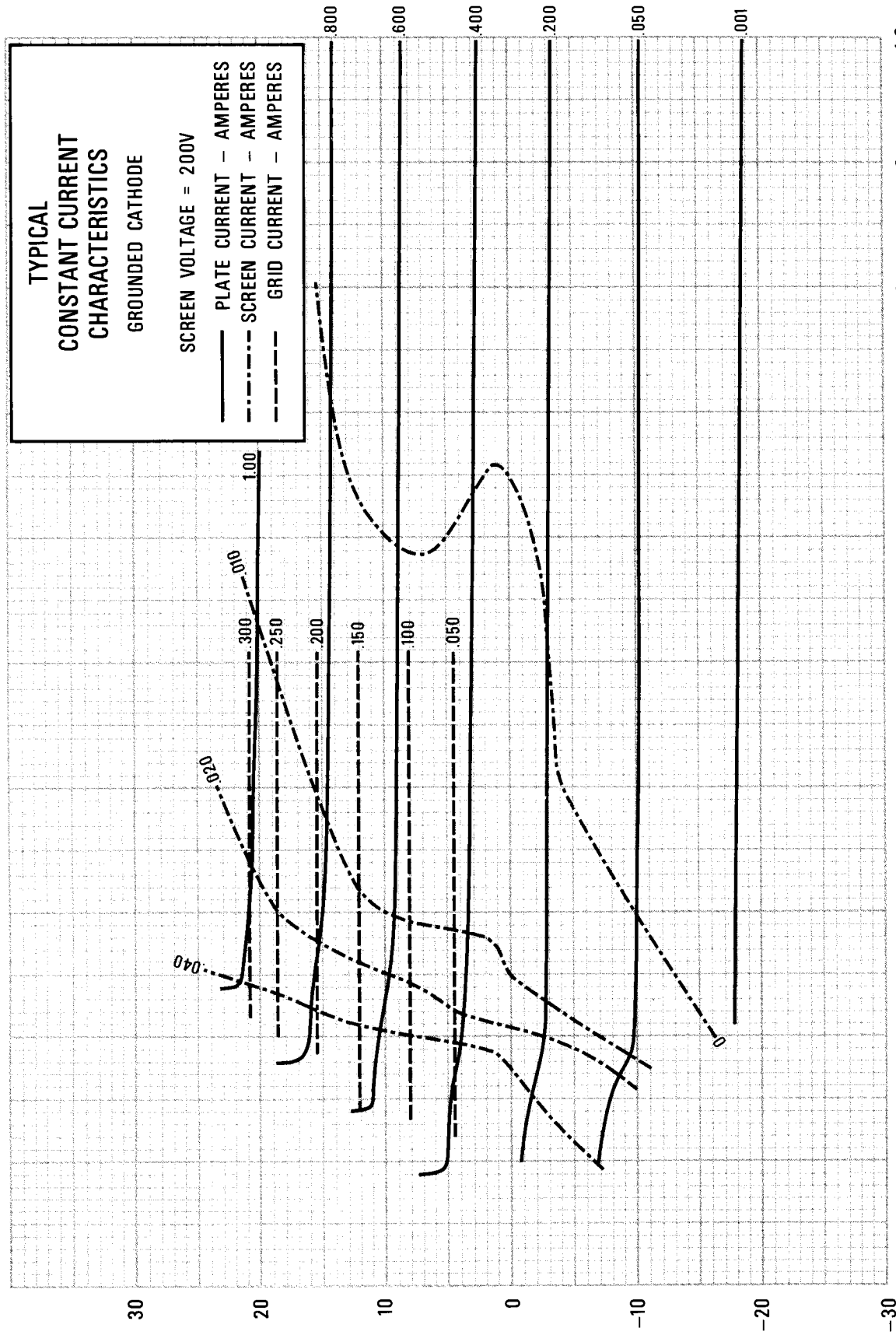
NOTE: With the cylindrical surfaces of anode terminal, screen grid terminal, control grid terminal, heater-cathode terminal, and heater terminal clean, smooth, and free from burrs, the tube shall enter a gage which defines diameters which are concentric within 0.001 inch (0.03 mm), with diameters as follows:

Radiator band	1.316 In.	33.43 mm
Anode terminal	1.120	28.45
Grid No. 2 (screen) terminal	1.020	25.91
Grid No. 1 (control) terminal	0.765	19.43
Heater-cathode terminal	0.520	13.21
Heater terminal	0.240	6.10
Axial Pin	0.072	1.83

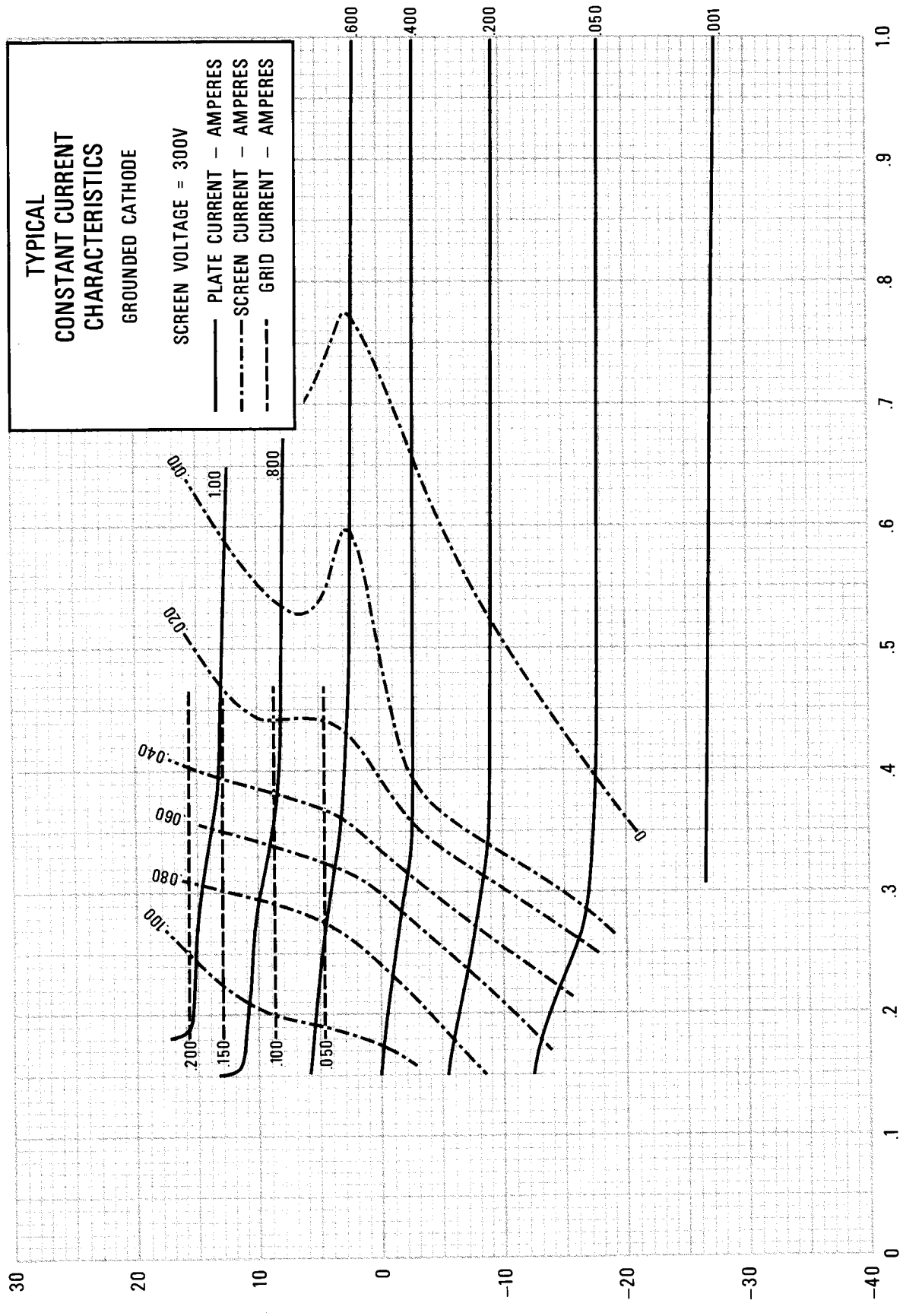
DIM.	INCHES MIN.	INCHES MAX.	INCHES REF	MILLIMETERS MIN.	MILLIMETERS MAX.	MILLIMETERS REF
B	1.805	1.955	- -	45.85	49.66	- -
C	0.990	1.080	- -	25.15	27.43	- -
D	0.895	0.905	- -	22.73	22.99	- -
E	0.165	- -	- -	4.19	- -	- -
F	0.340	0.410	- -	8.64	10.41	- -
G	0.140	- -	- -	3.56	- -	- -
H	0.150	0.200	- -	3.81	5.08	- -
J	0.120	- -	- -	3.05	- -	- -
K	0.095	- -	- -	2.41	- -	- -
L	0.100	- -	- -	2.54	- -	- -
M	0	0.050	- -	0	1.27	- -
N	1.085	- -	- -	27.56	- -	- -
P	0.985	- -	- -	25.02	- -	- -
Q	0.735	- -	- -	18.67	- -	- -
R	0.480	- -	- -	12.12	- -	- -
S	- -	0.072	- -	- -	1.83	- -
T	- -	0.260	- -	- -	6.60	- -
U	0.054	- -	- -	1.37	- -	- -
W	0.780	- -	- -	19.81	- -	- -
Y	0.060	- -	- -	1.52	- -	- -
Z	0.090	- -	- -	2.29	- -	- -
AA	- -	1.120	- -	- -	28.45	- -
BB	- -	1.020	- -	- -	25.91	- -
CC	0.600	- -	- -	15.24	- -	- -
DD	0	- -	- -	0	- -	- -

NOTE: With the cylindrical surfaces of anode terminal, screen grid terminal, control grid terminal, heater-cathode terminal, and heater terminal clean, smooth, and free from burrs, the tube shall enter a gage which defines diameters which are concentric within 0.001 inch (0.03 mm), with diameters as follows:

Anode proper	0.952 In.	24.19 mm
Anode terminal	1.120	28.45
Grid No. 2 (screen) terminal	1.020	25.91
Grid No. 1 (control) terminal	0.765	19.43
Heater-cathode terminal	0.520	13.21
Heater terminal	0.240	6.10
Axial pin	0.072	1.83


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 200V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
1.00
.010
.300
.250
.200
.150
.100
.050
.020
.040
0
800
600
400
200
050
001
30
20
10
0
−10
−20
−30
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)

CURVE #4354


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 300V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
.600
.400
.200
.050
.001
.000
1.00
.800
.020
.040
.060
.080
.100
.200
.150
.100
.050
0
GRID VOLTAGE (V)
30
20
10
0
-10
-20
-30
-40
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
PLATE VOLTAGE (kV)

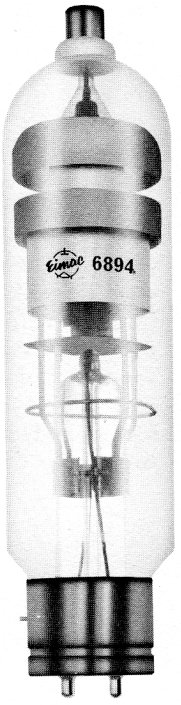
CURVE #4355

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

6894
6895

MERCURY-VAPOR RECTIFIERS

The EIMAC 6894 and 6895 are half-wave mercury-vapor rectifiers especially designed for high voltage power rectifier applications. They are mercury filled for high efficiency, long life and the ability to operate at high peak inverse voltage.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Oxide-coated		
Voltage	5.0	V
Current	9.0 to 11.0	A
Filament Heating Time	30	Sec
Anode Starting Voltage (approx.)	20	V

MECHANICAL

Base	6894	50 watt, A4-29
	6895	Industrial A4-18
Recommended Socket	6894	E.F. Johnson #123-211
	6895	E.F. Johnson #123-206
Maximum Overall Dimensions:		
Length	6894	10-17/32 in.
	6895	10-13/32 in.
Diameter		2-9/16 in.
Net Weight		4 oz.

MAXIMUM RATINGS (per tube)

PEAK INVERSE ANODE VOLTAGE	
20° -50°C Condensed Mercury Temperature Range*	20 MAX KV
20° -55°C Condensed Mercury Temperature Range	15 MAX KV
20° -60°C Condensed Mercury Temperature Range	10 MAX KV
PEAK ANODE CURRENT:	
Quadrature Filament Excitation**	11.5 MAX AMPS
In-Phase Filament Excitation	8.3 MAX AMPS
AVERAGE ANODE CURRENT	
Quadrature Filament Excitation	2.5 MAX AMPS
In-Phase Filament Excitation	1.8 MAX AMPS
MAXIMUM AC SHORT CIRCUIT CURRENT***	100 MAX AMPS

*Condensed Mercury Temperature rises approximately 20°C above ambient.
**Quadrature Excitation refers to filament voltage $90° \pm 30°$ out of phase with anode voltage.
***Max. duration 100 milliseconds.
All data based on load return to center tap of filament transformer.

APPLICATION

MECHANICAL

Mounting: The 6894 and 6895 must be mounted vertically, base down. These two tubes differ only in their basing and socketry.

Cooling: Provisions should be made for adequate air circulation around the tube. The temperature of the condensed mercury should be kept within

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the ranges given under "MAXIMUM RATINGS."

This temperature should be maintained at 40° ± 5°C for most satisfactory operation of the tube. To measure the condensed-mercury temperature a thermocouple or small thermometer may be attached to the glass near the tube base using a small amount of putty. A condensed-mercury temperature lower than the recommended value raises the voltage at which the tube becomes conducting and tends to reduce the life of the filament. A temperature higher than recommended lowers the voltage at which the tube becomes conducting and reduces the peak inverse voltage rating of the tube.

ELECTRICAL

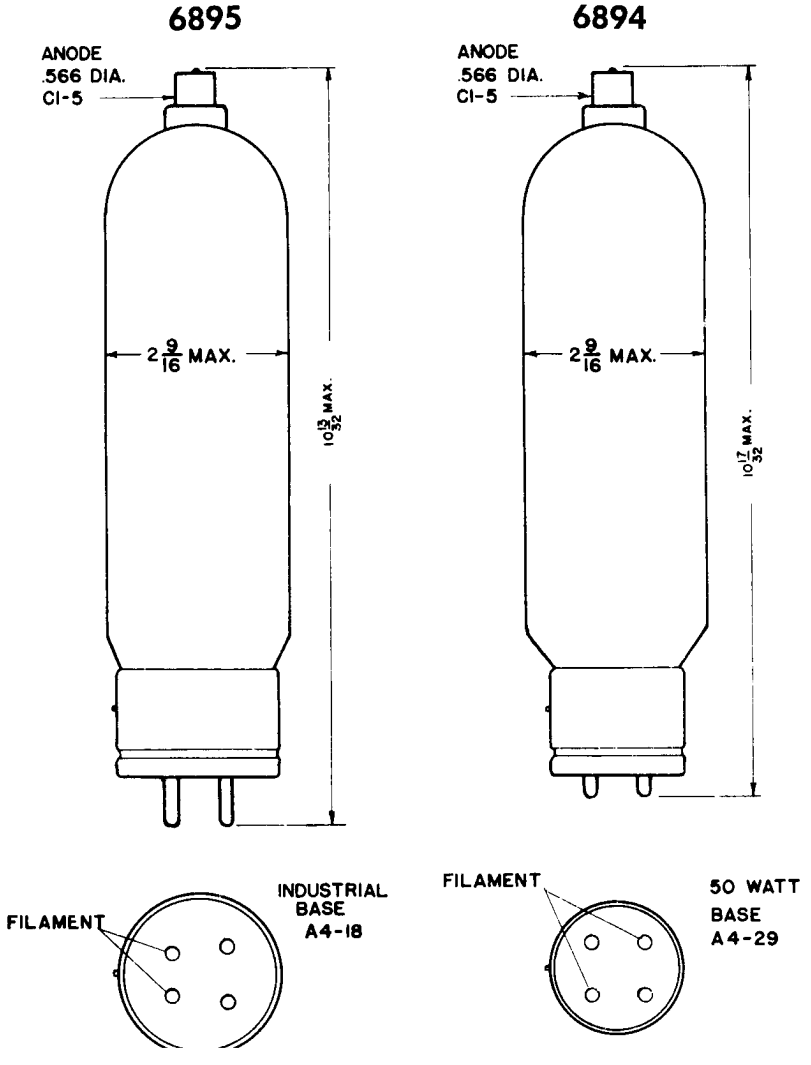
Filament Voltage: For maximum tube life, the filament voltage as measured directly at the filament pins, should be held at the rated value of 5.0 volts. Unavoidable variations in filament voltage must be kept within the range 4.8 to 5.2 volts. A filament voltage less than the minimum recommended value may cause a high tube voltage drop, with consequent bombardment of the filament and eventual loss of emission. A filament voltage higher than the recommended maximum value will also decrease the life of the filament.

Caution should be observed in measuring the filament voltage as the filament circuit may be at a high dc potential.

The filament should be allowed to reach operating temperature before the plate voltage is applied. Under normal conditions, a delay of approximately 30 seconds will be required. The delay time should be increased if there is any evidence of arc-back within the tube.

When it is necessary to use a shield around the tube care must be taken to insure adequate ventilation and maintenance of normal condensed-mercury temperature. When a mercury-vapor rectifier is first installed, the filament should be operated at normal voltage for approximately ten minutes with no plate voltage applied, in order that the mercury may be properly distributed.

Shielding: Electromagnetic and electrostatic fields tend to cause the mercury vapor to break down, are detrimental to tube life and make proper operation difficult. Consequently, the tube should be isolated from such fields as exist around transmitter or other similar equipment.



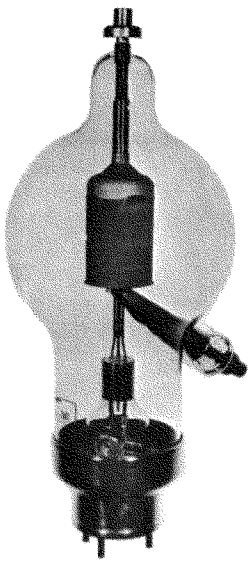
NOTE: These dimensions reflect standard manufacturing tolerances. They should not be made the basis for purchase specifications unless checked with EIMAC Division of Varian, 301 Industrial Way, San Carlos, Calif. 94070.

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

750TL

MEDIUM-MU TRIODE

MODULATOR
OSCILLATOR
AMPLIFIER



The Eimac 750TL is a medium-mu power triode intended for use as an amplifier, oscillator, or modulator. It has a maximum plate dissipation rating of 750 watts and a maximum plate voltage rating of 10,000 volts at frequencies up to 40 Mc. The 750TL is cooled by air-circulation and radiation.

The 750TL in class-C r-f service will deliver up to 3000 watts plate power output with 125 watts driving power. Two 750TL's in class-AB_2 modulator service will deliver up to 3500 watts maximum-signal plate power output with 46 watts driving power.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	7.5 volts
Current	21.0 amperes
Amplification Factor (Average)	15
Direct Interelectrode Capacitances (Average)	
Grid-Plate	5.8 $\mu\mu$f
Grid-Filament	8.5 $\mu\mu$f
Plate-Filament	1.2 $\mu\mu$f
Transconductance (I_b=250ma., E_b=5000v.)	3500 μmhos
Highest Frequency for Maximum Ratings	40 Mc

MECHANICAL

Base	Special 4-pin
Connections	See outline drawing
Socket	Johnson type No. 124-214 or equivalent
Mounting Position	Vertical, base down or up
Cooling	Air-circulation and radiation
Recommended Plate and Grid Heat Dissipating Connectors	Eimac HR-8
Maximum Overall Dimensions:	
Length	17.0 inches
Diameter	7.13 inches
Net Weight (Average)	2.9 pounds
Shipping Weight (Average)	13 pounds

AUDIO-FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB_2 (Sinusoidal wave)

MAXIMUM RATINGS (Per tube)

D-C PLATE VOLTAGE	10,000 MAX. VOLTS
D-C PLATE CURRENT	1000 MAX. MA
PLATE DISSIPATION	750 MAX. WATTS
GRID DISSIPATION	100 MAX. WATTS

TYPICAL OPERATION (Two tubes unless otherwise specified)

D-C Plate Voltage	4000	5000	6000	volts
D-C Grid Voltage[1]	—230	—320	—390	volts
Zero-Signal D-C Plate Current	250	200	166	ma.
Max-Signal D-C Plate Current	950	860	834	ma
Effective Load, Plate-to-Plate	8270	12,300	16,300	ohms
Peak A-F Grid Voltage (per tube)	490	560	650	volts
Max-Signal Driving Power*	38	28	46	watts
Max-Signal Plate Power Input	3800	4300	5000	watts
Max-Signal Plate Power Output	2300	2800	3500	watts

[1]Adjust to stated zero-signal plate current.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions, per tube)

MAXIMUM RATINGS (Frequencies up to 40 Mc.)

D-C PLATE VOLTAGE	10,000 MAX. VOLTS
D-C PLATE CURRENT	1000 MAX. MA
PLATE DISSIPATION	750 MAX. WATTS
GRID DISSIPATION	100 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 40 Mc.)

D-C Plate Voltage	3000	4000	5000	6000	volts
D-C Grid Voltage	—350	—450	—550	—700	volts
D-C Plate Current	713	625	600	625	ma
D-C Grid Current*	120	90	90	105	ma
Peak R-F Grid Voltage	805	885	985	1040	volts
Driving Power*	97	83	86	125	watts
Grid Dissipation*	55	40	38	50	watts
Plate Power Input	2140	2500	3000	3750	watts
Plate Power Output	1390	1750	2250	3000	watts

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

CLASS-C TELEPHONY (Carrier conditions, per tube)

MAXIMUM RATINGS (Frequencies up to 40 Mc.)

D-C PLATE VOLTAGE	8000 MAX. VOLTS
D-C PLATE CURRENT	800 MAX. MA
PLATE DISSIPATION	500 MAX. WATTS
GRID DISSIPATION	100 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 40 Mc.)

D-C Plate Voltage	3000	4000	5000	6000	volts
D-C Grid Voltage	—500	—650	—800	—950	volts
D-C Plate Current	415	400	400	415	ma
D-C Grid Current*	55	60	55	60	ma
Peak R-F Grid Voltage	830	985	1150	1330	volts
Driving Power*	45	50	60	75	watts
Grid Dissipation*	15	15	16	20	watts
Plate Power Input	1250	1600	2000	2500	watts
Plate Power Output	750	1100	1500	2000	watts

*Approximate values

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.

(Effective 6-2-52) Copyright 1952 by Eitel-McCullough, Inc.

▶ Indicates change from sheet dated 5- 5-44

APPLICATION

MECHANICAL

Mounting—The 750TL must be mounted vertically, base down or up. The plate and grid leads should be flexible. The tube must be protected from vibration and shock.

Cooling—Heat Dissipating Connectors (Eimac HR-8 or equivalent) must be used at the plate and grid terminals of the 750TL. Unobstructed circulation of air around the tube is required in sufficient quantity to prevent the seal temperatures from exceeding 225°C. Forced ventilation of compartments or equipment in which the tube is located is usually desirable. Forced movement of air across the tube seals and envelope is always beneficial, though not necessarily required.

Tube temperatures may be measured with the aid of "Tempilaq", a temperature-sensitive lacquer manufactured by the Tempil Corporation, 132 West 22nd Street, New York 11, N. Y.

ELECTRICAL

Filament Voltage—For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated value of 7.5 volts. Variations should be kept within the range of 7.5 to 7.85 volts. All four socket terminals should be used, placing two in parallel for each filament connection.

Bias Voltage—Although there is no maximum limit placed on the bias voltage which may be used with the 750TL, there is little advantage in using bias voltages in excess of those given under "Typical Operation", except in certain very specialized applications.

When grid-leak bias is used, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation, and the grid-leak resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired value from tube to tube.

Grid Dissipation—Grid dissipation may be calculated from the following expression:

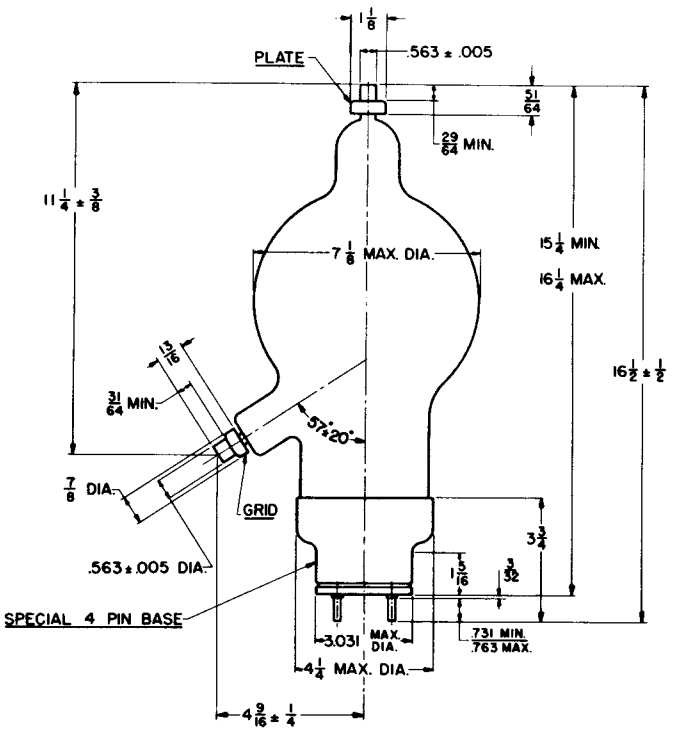
$$P_g = e_{cmp} I_c$$

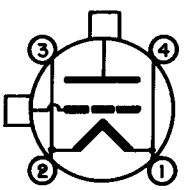
where: P_g = Grid dissipation,
e_{cmp} = Peak positive grid voltage, and
I_c = D-C grid current.

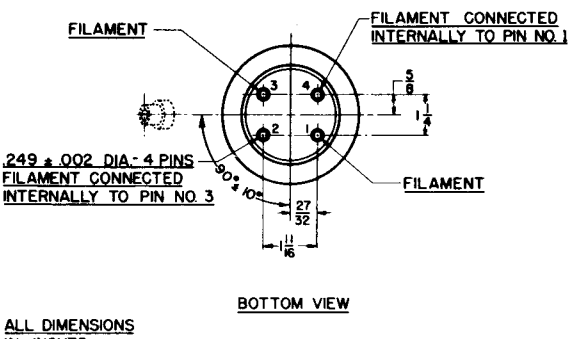
e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid.[1] In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating of 100 watts under any conditions of loading.

Plate Dissipation—Under normal operating conditions, the plate dissipation of the 750TL should not be allowed to exceed the maximum rating. Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

[1]For suitable peak v.t.v.m. circuits see, for instance, "Vacuum Tube Ratings", Eimac News, January, 1945. This article is available in reprint form on request.





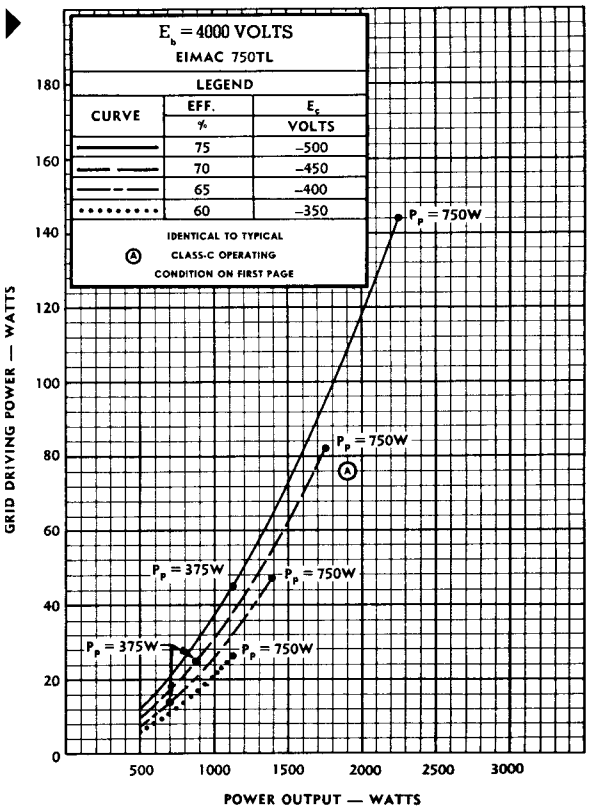


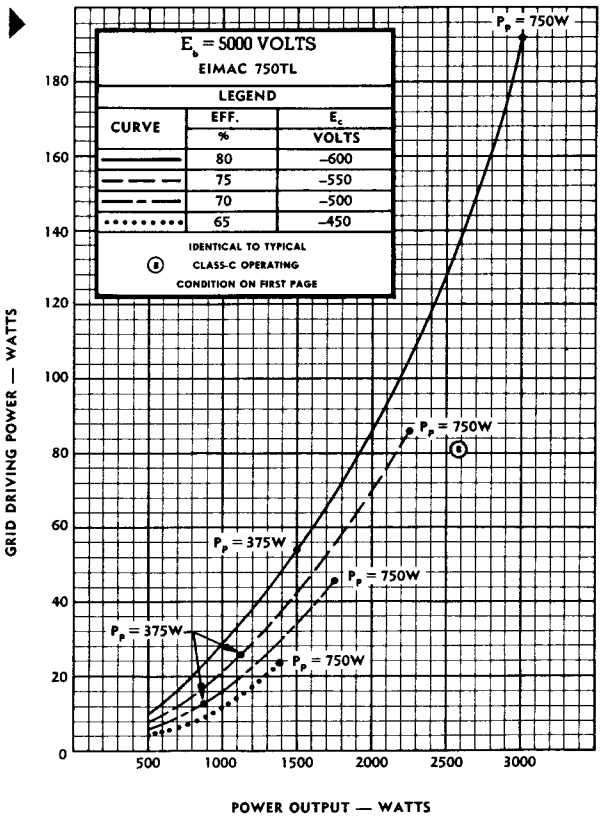
ALL DIMENSIONS IN INCHES

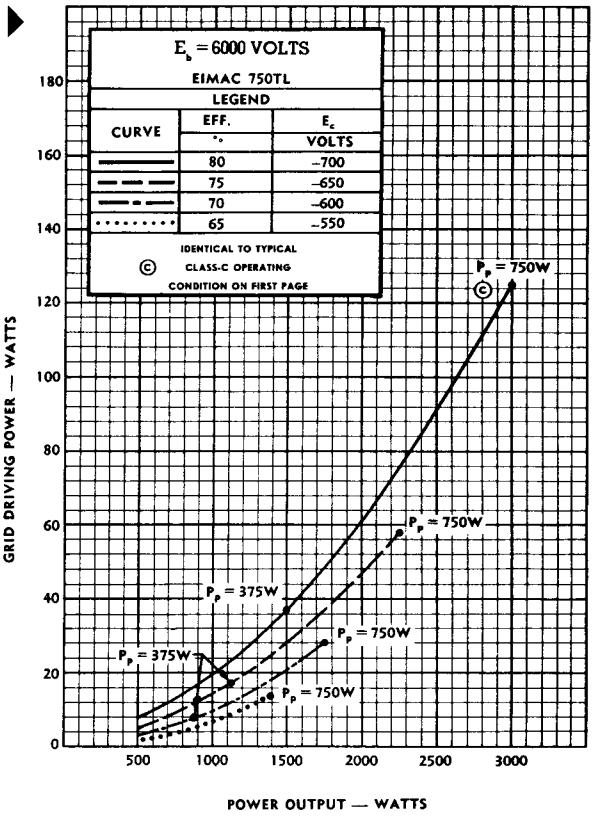
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DRIVING POWER vs. POWER OUTPUT

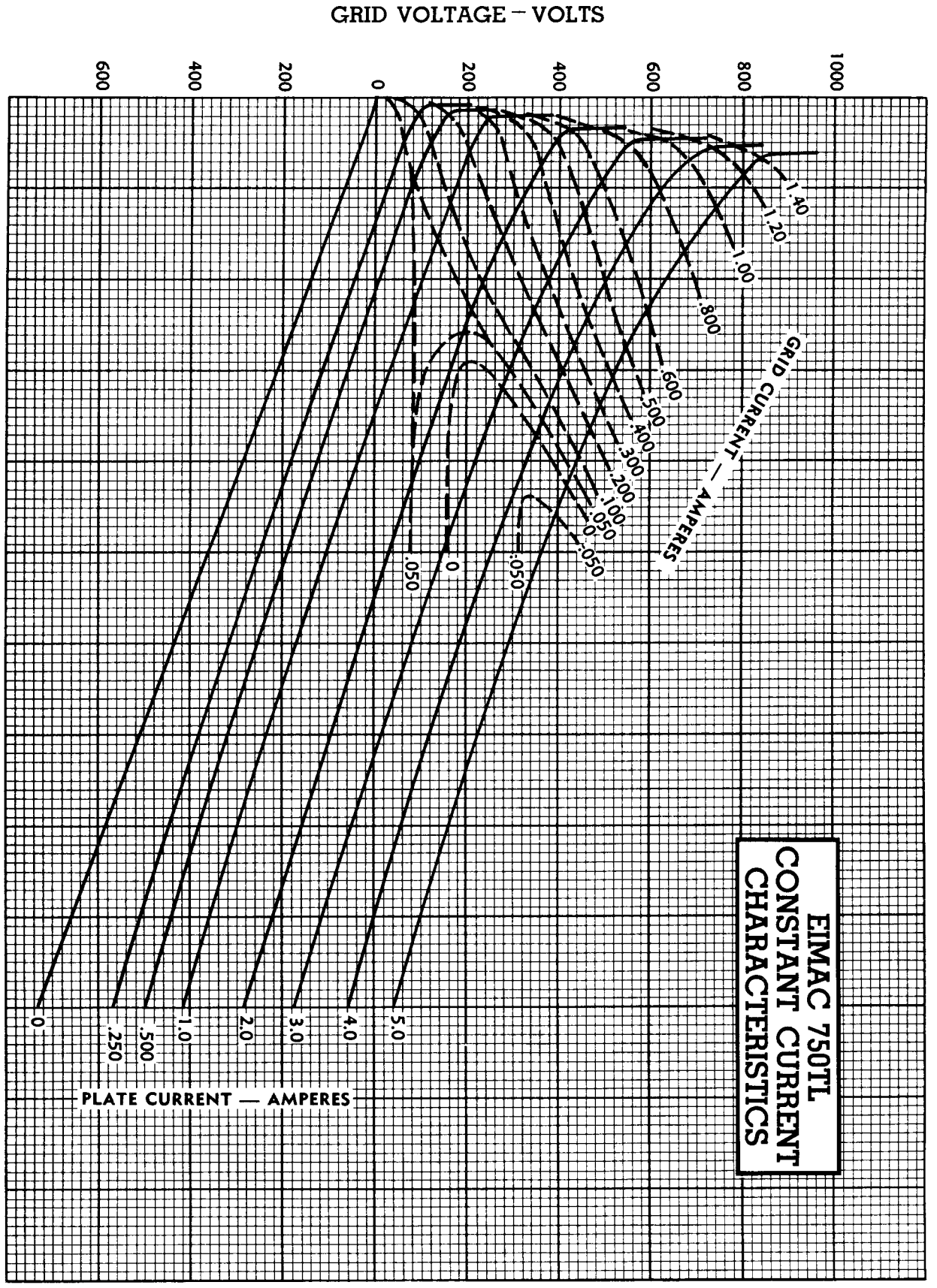
The three charts on this page show the relationship of plate efficiency, power output and approximate grid driving power at plate voltages of 4000, 5000 and 6000 volts. These charts show combined grid and bias losses only. The driving power and power output figures do not include circuit losses. The plate dissipation in watts is indicated by Pp. Points A, B and C are identical to the typical Class-C operating conditions shown on the first page under 4000, 5000 and 6000 volts, respectively.







▶ Indicates change from sheet dated 5-15-44



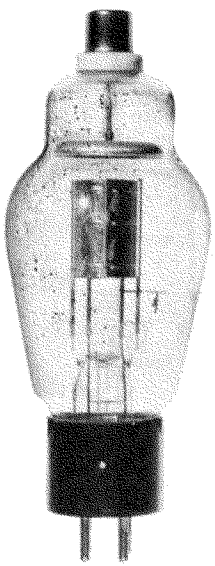
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EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

866A 866 MERCURY VAPOR RECTIFIER

The Eimac 866-A/866 is a half-wave mercury-vapor rectifier incorporating features which enable it to withstand high peak-inverse voltages and to conduct at relatively low applied-voltages. The shielded ribbon filament, edgewise-wound, provides a large emission reserve and long life.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Coated	
Voltage	2.5 volts
Current	5.0 amperes
Tube Voltage Drop (approx.)	15 volts

MECHANICAL

Base	Medium 4-pin bayonet, RMA A4-10
Basing	See base connection diagram
Maximum Overall Dimensions:	
Length	6.5 inches
Diameter	2.5 inches
Net Weight (Approx.)	2 ounces
Shipping Weight (Average)	0.5 pounds

MAXIMUM RATINGS (single tube)

PEAK INVERSE ANODE VOLTAGE	2,000	5,000	10,000	MAX. VOLTS
PEAK ANODE CURRENT	2.0	1.0	1.0	MAX. AMPERES
AVERAGE ANODE CURRENT	0.5	0.25	0.25	MAX. AMPERES
SUPPLY FREQUENCY	150	1,000	150	MAX. C. P. S.
CONDENSED-MERCURY TEMPERATURE RANGE[1]	25-70	25-70	25-60	°C

[1]Operation at 40 degrees plus or minus 5 degrees C is recommended.

APPLICATION

MECHANICAL

MOUNTING—The 866-A/866 must be mounted vertically, base down.

COOLING—Provision should be made for adequate air circulation around the tube, because cooling is accomplished by convection. The temperature of the condensed-mercury in the 866-A/866 should be kept within the ranges given under "MAXIMUM RATINGS". This temperature should be maintained at 40 degrees plus or minus 5 degrees C for most satisfactory operation of the tube. To measure the condensed-mercury temperature a thermocouple or small thermometer may be attached to the bulb in the area designated on the outline drawing, using a very small amount of putty. A condensed-mercury temperature lower than the recommended value raises the voltage at which the tube becomes conducting and tends to reduce the life of the filament. A temperature higher than recommended lowers the voltage at which the tube becomes conducting and tends to increase the life of the filament, but reduces the peak inverse voltage rating of the tube. When it is necessary to use a shield around the 866-A/866 care must be taken to insure adequate ventilation and maintenance of normal condensed-mercury temperature.

ELECTRICAL

FILAMENT VOLTAGE—For maximum tube life, the filament voltage as measured directly at the filament pins, should be held at the rated value of 2.5 volts. Unavoidable variations in filament voltage must be kept within the range of 2.38 to 2.63 volts. A filament voltage less than the minimum recommended value may cause a high tube voltage drop, with consequent bombardment of the filament and eventual loss of emission. A filament voltage higher than the recommended maximum value will also decrease the life of the filament.

CAUTION SHOULD BE OBSERVED IN MEASURING THE FILAMENT VOLTAGE, AS THE FILAMENT CIRCUIT MAY BE AT A HIGH D-C POTENTIAL.

The plate-circuit return of each tube should preferably be connected to the center tap of the transformer winding supplying the filament voltage; if this cannot be done, the return should be connected to that side of the filament to which the cathode shields are connected (pin No. 4). When the filaments of two or more tubes are connected in parallel, the filament terminals to which the cathode shields are connected should be joined. These precautions are recommended to insure uniform starting voltage for each tube when several are used in a given circuit.

The filament of the 866-A/866 should be allowed to reach operating temperature before the plate voltage is applied. Under normal conditions, a delay of approximately 30 seconds will be required. The delay time should be increased if there is any evidence of arc-back within the tube. In radio transmitter applications the filament should be kept at its rated voltage during "standby" periods to avoid delay due to warm-up. It is desirable to use a protective relay in the plate circuit to prevent the application of plate voltage before the filament has reached operating temperature. This relay should have a time delay adjustable up to a maximum of one minute.

When an 866-A/866 is first installed, the filament should be operated at normal voltage for approximately ten minutes with no plate voltage applied, in order that the mercury may be properly distributed. It will not be necessary to repeat this procedure unless the mercury is spattered on the filament and plate during subsequent handling.

SHIELDING—Electromagnetic and electrostatic fields tend to cause the mercury vapor to break down, are detrimental to tube life and make proper filtering difficult. Consequently, the 866-A/866 should be isolated from such fields as exist around a transmitter or other similar equipment. When the tubes are located in the region of such fields, shielding with adequate ventilation should be used around the tubes. R-f filtering should also be employed when the tubes are affected by r-f voltages.

FILTERING—The nomograph for circuits 1 and 3, and tables for circuits 2, 4 and 5 give empirical values of inductance and capacitance for a single-section choke-input filter which will keep the peak plate current below the maximum rated value, provided the average d-c load current does not exceed the maximum load current indicated. The values of L and C are based on a power-supply frequency of 60 cycles.

The value of the capacitor is made small enough to prevent excessive surges when power is first applied to the circuit. If the available inductance is larger than the minimum allowable value, the capacitance may be increased proportionately over its nomograph or table maximum. In a two-section filter with two unequal inductances, the input inductances should be the larger. The maximum value of each capacitor in such a filter is based upon the value of the preceding inductance.

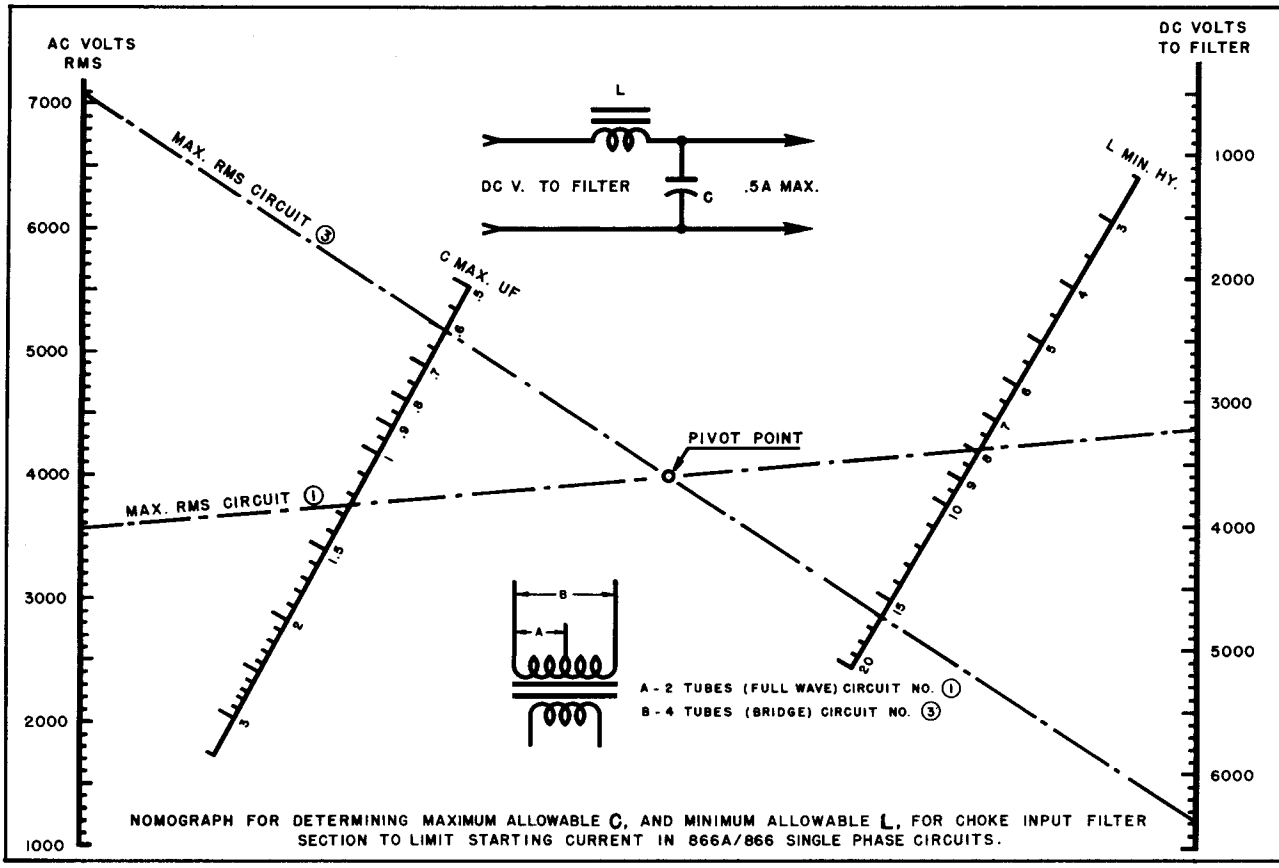
In the single phase circuits (1 and 3), if the current drawn by the load is reduced or varies under operating conditions to values less than approximately 70% of the indicated maximum d-c load current, a swinging (input) choke will supply the necessary additional inductance to prevent the voltage from rising, and will afford proper filtering over a much greater current range.

Arrangements such as those shown in Circuits 1, 2 and 3 produce less than 5% ripple voltage when a two-section filter with minimum inductance and corresponding maximum capacitance is employed. Circuits such as those shown in circuits 4 and 5 will produce less than 1% ripple voltage. Better filtering may be obtained with any of these circuits by using larger values of inductance than the minimum indicated. Still greater improvement may be had by then proportionately increasing the corresponding capacitor values.

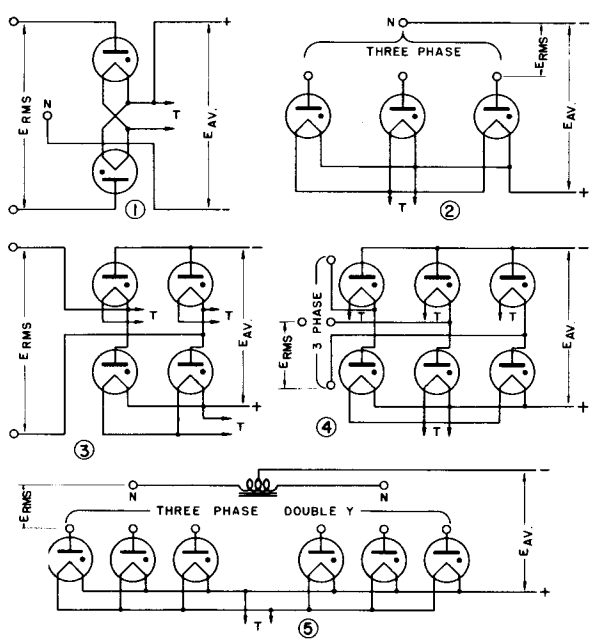
When "condenser input" filter is used, the peak current will be relatively high in respect to the usable load current, and the voltage across the capacitor may be as high as 1.4 times the nominal RMS voltage of the transformer.

For parallel operation of 866-A/866 rectifiers, suitable resistors or small inductors may be used in series with each plate lead to permit equal loading and starting characteristics. The inductors aid in reducing the peak current, and are more desirable due to their low d-c resistance. An approximate value for suitable resistors is 50 ohms, and for inductors, approximately one-third henry each.

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NOMOGRAPH FOR DETERMINING MAXIMUM ALLOWABLE C, AND MINIMUM ALLOWABLE L, FOR CHOKE INPUT FILTER SECTION TO LIMIT STARTING CURRENT IN 866A/866 SINGLE PHASE CIRCUITS.



NUMBER	CIRCUIT	E AVERAGE	E INVERSE	I AVERAGE
①	SINGLE - PHASE FULL - WAVE 2 TUBES	0.318 E MAXIMUM 0.450 E RMS	3.14 E AVERAGE	0.636 I MAXIMUM
②	THREE - PHASE HALF - WAVE	0.827 E MAXIMUM 1.170 E RMS	2.09 E AVERAGE	0.827 I MAXIMUM
③	SINGLE - PHASE FULL - WAVE 4 TUBES	0.636 E MAXIMUM 0.900 E RMS	1.57 E AVERAGE	0.636 I MAXIMUM
④	THREE - PHASE FULL - WAVE	1.65 E MAXIMUM 2.34 E RMS	1.045 E AVERAGE	0.955 I MAXIMUM
⑤	THREE - PHASE DOUBLE - Y PARALLEL	0.827 E MAXIMUM 1.170 E RMS	2.09 E AVERAGE	1.91 I MAXIMUM

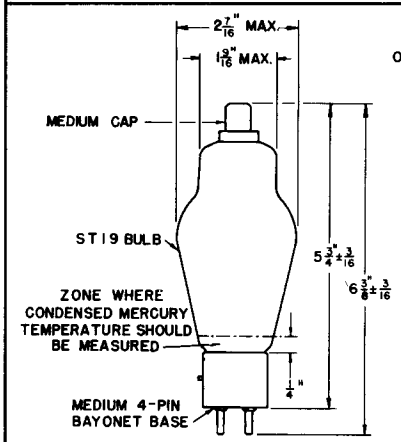
CONDITIONS ASSUMED

(1) SINE WAVE SUPPLY (2) BALANCED PHASE VOLTAGES (3) ZERO TUBE DROP (4) PURE RESISTANCE LOAD (5) NO FILTER USED

CIRCUIT	A-C INPUT VOLTS** (RMS)	MAX. D-C OUTPUT VOLTS TO FILTER	CHOKE INPUT ONE-SECTION FILTER MIN. CHOKE (L) henrys	CHOKE INPUT ONE-SECTION FILTER MAX. CONDENSER (C) uf	MAX. D-C LOAD CURRENT amperes
	per leg				
THREE-PHASE HALF-WAVE CIRCUIT 2	4080	4780	3.2	1.4	0.75
	3000	3510	2.2	2.0	0.75
	2000	2340	1.4	3.0	0.75
	1500	1750	1.1	4.0	0.75
	per leg				
THREE-PHASE FULL-WAVE CIRCUIT 4	4080	9570	1.8	0.5	0.75
	3000	7020	1.4	0.7	0.75
	2000	4680	0.9	1.2	0.75
	1500	3510	0.7	1.5	0.75
	per leg				
THREE-PHASE DOUBLE-Y PARALLEL CIRCUIT 5	4080	4780	2.0	0.5	1.5
	3000	3510	1.5	0.7	1.5
	2000	2340	1.0	1.1	1.5
	1500	1750	0.7	1.5	1.5
	per tube				
SINGLE PHASE FULL-WAVE (2 tubes) CIRCUIT 1*	3535	3950	—	—	0.25
	3000	3390	—	—	0.25
	2000	2260	—	—	0.25
	1500	1700	—	—	0.25

* With condenser input to filter.

**For use under the conditions of the 10000-volt peak inverse rating. If the 866-A/866 is to be used under frequency and/or temperature conditions such that the peak inverse voltage is limited to 5000 volts, the a-c input voltage and d-c output voltage values in the table should be multiplied by a factor of 0.5 to give new values for the 5000-volt conditions.



PIN 1 - FILAMENT
PIN 2 - NO CONNECTION
PIN 3 - NO CONNECTION
PIN 4 - FILAMENT
CAP - PLATE

● = GAS-TYPE TUBE

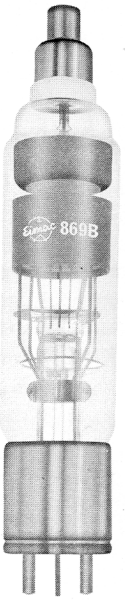
TUBE MOUNTING POSITION

VERTICAL - BASE DOWN ONLY

TECHNICAL DATA

869B
869BL
MERCURY-VAPOR RECTIFIERS

The EIMAC 869B and 869BL are half-wave mercury-vapor rectifiers incorporating features which enable them to withstand high peak inverse voltages and to conduct at relatively low applied voltages. The 869B and 869BL carry maximum ratings of 20 kV peak inverse voltage, 5 amperes dc and 20 amperes peak cathode current.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Oxide-coated	
Voltage	5.0 V
Current	17 to 21 A
Filament Heating Time	60 Sec
Anode Starting Voltage (approx.)	30 V

MECHANICAL

Base	See Drawing
Maximum Overall Dimensions:	
Length	14-7/16 in.
Diameter	3 in.
Net Weight	20 oz.

MAXIMUM RATINGS (Single Tube)

CONDENSED MERCURY TEMPERATURE RANGE*	30-60	30-50	30-40° C
PEAK INVERSE ANODE VOLTAGE	10	15	20 MAX KV
PEAK ANODE CURRENT:			
Quadrature Excitation**	20	20	20 MAX AMPS
In-Phase Excitation	10	10	10 MAX AMPS
AVERAGE ANODE CURRENT: (30 second maximum averaging time)			
Quadrature Excitation	5.0	5.0	5.0 MAX AMPS
In-Phase Excitation	2.5	2.5	2.5 MAX AMPS
MAXIMUM AC SHORT-CIRCUIT CURRENT***	100	100	100 MAX AMPS

*Condensed Mercury rises approximately 20°C above ambient.
**Quadrature excitation refers to anode current and filament current $90° \pm 30°$ out of phase.
***Maximum duration 100 milliseconds.
Data based on load return to center tap on filament transformer.

APPLICATION

MECHANICAL

Mounting: The 869B and 869BL must be mounted vertically, base down. The 869BL includes 3 inch insulated flexible leads with lugs.

Cooling: Provisions should be made for adequate air circulation around the tube. The temperature of the condensed mercury in the 869B and 869BL should be kept within the ranges given under "MAXIMUM RATINGS."

This temperature should be maintained at 40° ±5° C for most satisfactory operation of the tube. To measure the condensed-mercury temperature a thermocouple or small thermometer may be attached to the glass near the tube base using a small amount of putty. A condensed-mercury temperature lower than the recommended value raises the voltage at which the tube becomes conducting and tends to reduce the life of the filament. A temperature higher

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than recommended lowers the voltage at which the tube becomes conducting and reduces the peak inverse voltage rating of the tube.

In some installations a blast of air must be directed at the base of the tube to insure adequate cooling.

ELECTRICAL

Filament Voltage: For maximum tube life, the filament voltage as measured directly at the filament pins, should be held at the rated value of 5.0 volts. Unavoidable variations in filament voltage must be kept within the range of 4.8 to 5.2 volts. A filament voltage less than the minimum recommended value may cause a high tube voltage drop, with consequent bombardment of the filament and eventual loss of emission. A filament voltage higher than the recommended maximum value will also decrease the life of the filament.

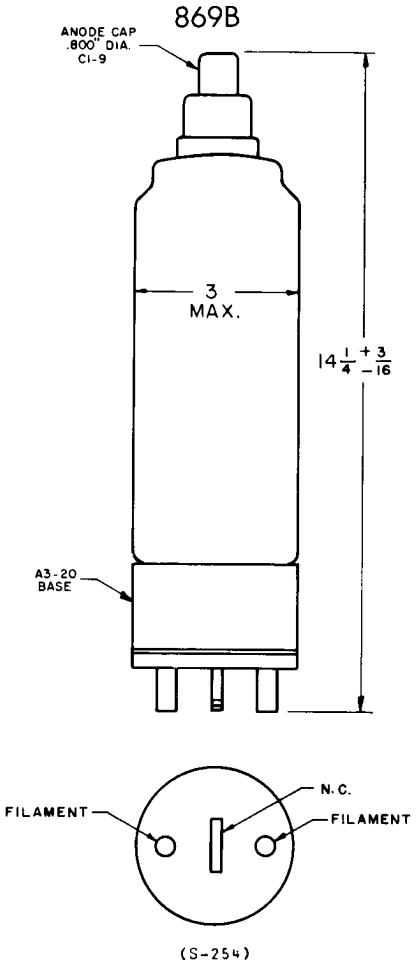
Caution should be observed in measuring the filament voltage as the filament circuit may be at a high dc potential.

The filament should be allowed to reach operating temperature before the plate voltage is applied Under normal conditions, a delay of approximately 60 seconds will be required. The delay time should be increased if there is any evidence of arc-back within the tube.

When it is necessary to use a shield around the tube care must be taken to insure adequate ventilation and maintenance of normal condensed-mercury temperature. When a mercury-vapor rectifier is first installed, the filament should be operated at normal voltage for approximately ten minutes with no plate voltage applied, in order that the mercury may be properly distributed.

X-Ray Radiation: Above approximately 16,000 peak inverse voltage, a rectifier will produce X-Rays. In most equipment, there is adequate shielding so that this does not constitute a health hazard, however, this should be checked in any new equipment. A standard reference on this subject is "X-Ray Protection, Handbook No. 93," National Bureau of Standards.

Shielding: Electromagnetic and electrostatic fields tend to cause the mercury vapor to break down, are detrimental to tube life and make proper operation difficult. Consequently, the 869B and 869BL should be isolated from such fields as exist around a transmitter or other similar equipment.



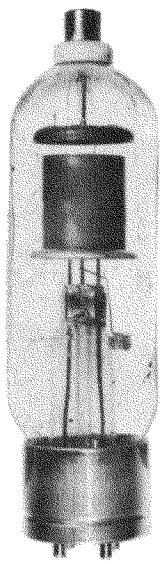
NOTE: These dimensions reflect standard manufacturing tolerances. They should not be made the basis for purchase specifications unless checked with EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, 94070.

869BL has 3 inch insulated flexible filament leads with spade terminals for #10 screw instead of pins shown on the 869B outline.

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

872A 872 MERCURY VAPOR RECTIFIER

The Eimac 872-A/872 is a half-wave mercury-vapor rectifier incorporating features which enable it to withstand high peak-inverse voltages and to conduct at relatively low applied-voltages. The shielded ribbon filament, edgewise-wound, provides a large emission reserve and long life.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Coated	
Voltage	5.0 volts
Current	7.5 amperes
Tube Voltage Drop (approx.)	10 volts

MECHANICAL

Base	Jumbo 4-pin, RMA type A4-29
Basing	See base connection diagram
Maximum Overall Dimensions:	
Length	8.5 inches
Diameter	2.31 inches
Net Weight (Approx.)	8 ounces
Shipping Weight (Average)	1.5 pounds

MAXIMUM RATINGS (single tube)

PEAK INVERSE ANODE VOLTAGE[1]	10,000	MAX. VOLTS
PEAK ANODE CURRENT	5	MAX. AMPERES
AVERAGE ANODE CURRENT	1.25	MAX. AMPERES
SUPPLY FREQUENCY	150	MAX. C. P. S.
CONDENSED-MERCURY TEMPERATURE RANGE[2]	20-60	°C

[1] Temperatures in excess of 60° C limit the peak-inverse rating to 5,000 volts with a corresponding reduction in permissible RMS supply voltages to one-half those listed in the table.
[2] Operation at 40° plus or minus 5° C is recommended.

APPLICATION

MECHANICAL

MOUNTING—The 872-A/872 must be mounted vertically, base down.

COOLING—Provision should be made for adequate air circulation around the tube, because cooling is accomplished by convection. The temperature of the condensed-mercury in the 872-A/872 should be kept within the ranges given under "MAXIMUM RATINGS". This temperature should be maintained at 40 degrees plus or minus 5 degrees C for most satisfactory operation of the tube. To measure the condensed-mercury temperature a thermocouple or small thermometer may be attached to the bulb in the area designated on the outline drawing, using a very small amount of putty. A condensed-mercury temperature lower than the recommended value raises the voltage at which the tube becomes conducting and tends to reduce the life of the filament. A temperature higher than recommended lowers the voltage at which the tube becomes conducting and tends to increase the life of the filament, but reduces the peak inverse voltage rating of the tube. When it is necessary to use a shield around the 872-A/872, care must be taken to insure adequate ventilation and maintenance of normal condensed-mercury temperature.

ELECTRICAL

FILAMENT VOLTAGE—For maximum tube life, the filament voltage as measured directly at the filament pins, should be held at the rated value of 5.0 volts. Unavoidable variations in filament voltage must be kept within the range of 4.75 to 5.25 volts. A filament voltage less than the minimum recommended value may cause a high tube voltage drop, with consequent bombardment of the filament and eventual loss of emission. A filament voltage higher than the recommended maximum value will also decrease the life of the filament.

CAUTION SHOULD BE OBSERVED IN MEASURING THE FILAMENT VOLTAGE, AS THE FILAMENT CIRCUIT MAY BE AT A HIGH D-C POTENTIAL.

The plate-circuit return of each tube should preferably be connected to the center tap of the transformer winding supplying the filament voltage; if this cannot be done, the return should be connected to that side of the filament to which the cathode shields are connected (pin No. 2). When the filaments of two or more tubes are connected in parallel, the filament terminals to which the cathode shields are connected should be joined. These precautions are recommended to insure uniform starting voltage for each tube when several are used in a given circuit.

The filament of the 872-A/872 should be allowed to reach operating temperature before the plate voltage is applied. Under normal conditions, a delay of approximately 30 seconds will be required. The delay time should be increased if there is any evidence of arc-back within the tube. In radio transmitter applications the filament should be kept at its rated voltage during "standby" periods to avoid delay due to warm-up. It is desirable to use a protective relay in the plate circuit to prevent the application of plate voltage before the filament has reached operating temperature. This relay should have a time delay adjustable up to a maximum of one minute.

When an 872-A/872 is first installed, the filament should be operated at normal voltage for approximately ten minutes with no plate voltage applied, in order that the mercury may be properly distributed. It will not be necessary to repeat this procedure unless the mercury is spattered on the filament and plate during subsequent handling.

SHIELDING—Electromagnetic and electrostatic fields tend to cause the mercury vapor to break down, are detrimental to tube life and make proper filtering difficult. Consequently, the 872-A/872 should be isolated from such fields as exist around a transmitter or other similar equipment. When the tubes are located in the region of such fields, shielding with adequate ventilation should be used around the tubes. R-f filtering should also be employed when the tubes are affected by r-f voltages.

FILTERING—A "choke input" filter will allow the greatest usable d-c output current to the load. When using a section of filter between rectifier and load, to prevent exceeding the maximum peak current of 5 amperes, a suitable maximum value for the first capacitor should be determined. Determination of this capacitance should be made under conditions simulating those to be used in service.

The relationship of voltage input, inductance, and capacitance is one in which a higher operating voltage requires greater input inductance, and less following capacitance to keep the peak STARTING current from exceeding 5 amperes. This is for the usual case where the supply is controlled by an on-off switch.

Where the rectifier plate voltage is started by a control which gradually raises the voltage from zero or a small amount to the desired operating value, starting current need not ordinarily be considered, and the characteristics of the filter may be based on preventing excessive peak current under normal operating conditions.

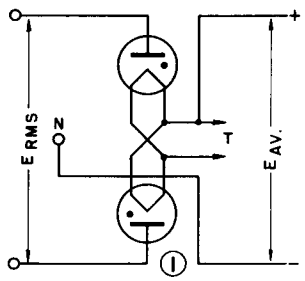
In the single phase circuits (1 and 3), if the current drawn by the load is reduced or varies under operating conditions to values less than approximately 70% of the indicated maximum d-c load current, a swinging (input) choke will supply the necessary additional inductance to prevent the voltage from rising, and will afford proper filtering over a much greater current range.

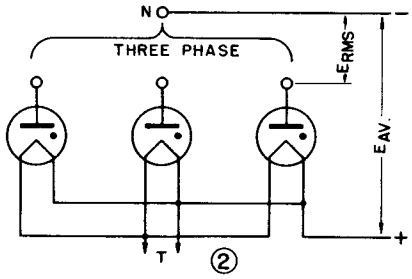
Where a larger value of inductance is desirable to obtain additional filtering, the subsequent capacitance may be proportionately increased to aid in still further filtering without excessive peak starting and operating current. Still lower ripple may of course be obtained by added sections of filter.

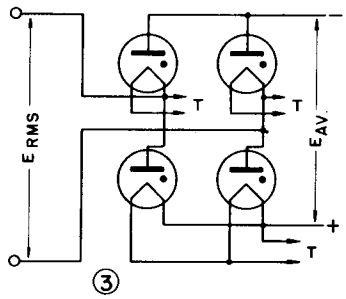
When "condenser input" filter is used, the peak current will be relatively high in respect to the usable load current, and the voltage across the capacitor may be as high as 1.4 times the nominal RMS voltage of the transformer.

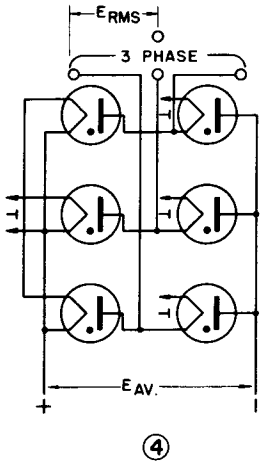
For parallel operation of 872-A/872 rectifiers, suitable resistors or small inductors may be used in series with each plate lead to permit equal loading and starting characteristics. The inductors aid in reducing the peak current, and are more desirable due to their low d-c resistance. An approximate value for suitable resistors is 50 ohms, and for inductors, approximately one-third henry each.

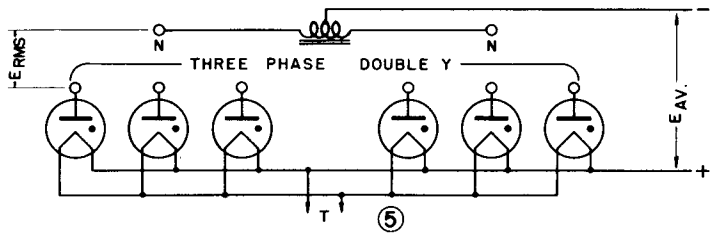
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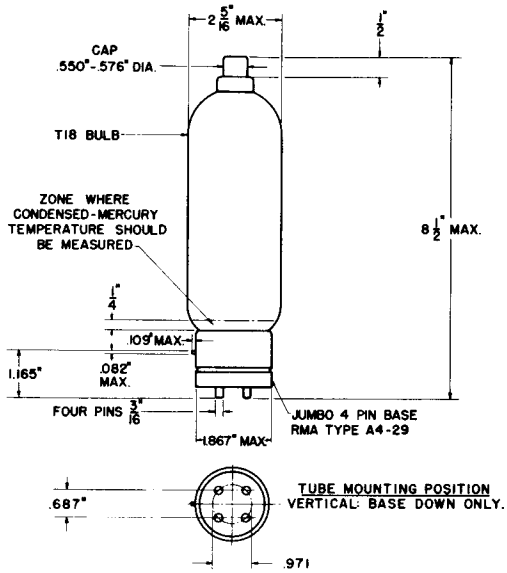




NUMBER	CIRCUIT	E AVERAGE	E INVERSE	I AVERAGE
①	SINGLE - PHASE FULL - WAVE 2 TUBES	0.318 E MAXIMUM 0.450 E RMS	3.14 E AVERAGE	0.636 I MAXIMUM
②	THREE - PHASE HALF - WAVE	0.827 E MAXIMUM 1.170 E RMS	2.09 E AVERAGE	0.827 I MAXIMUM
③	SINGLE - PHASE FULL - WAVE 4 TUBES	0.636 E MAXIMUM 0.900 E RMS	1.57 E AVERAGE	0.636 I MAXIMUM
④	THREE - PHASE FULL - WAVE	1.65 E MAXIMUM 2.34 E RMS	1.045 E AVERAGE	0.955 I MAXIMUM
⑤	THREE - PHASE DOUBLE - Y PARALLEL	0.827 E MAXIMUM 1.170 E RMS	2.09 E AVERAGE	1.91 I MAXIMUM

CONDITIONS ASSUMED

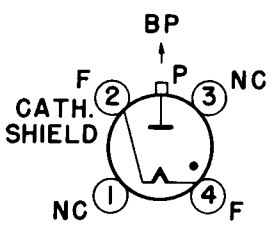
(1) SINE WAVE SUPPLY (2) BALANCED PHASE VOLTAGES (3) ZERO TUBE DROP
(4) PURE RESISTANCE LOAD (5) NO FILTER USED



CIRCUIT	INPUT VOLTS[1] MAXIMUM A-C (RMS)	APPROX. D-C OUTPUT VOLTS TO FILTER	MAXIMUM D-C OUTPUT CURRENT AMPERES
1	3535 per tube	3180	2.5
2	4080 per leg	4780	3.75
3	7070 total	6360	2.5
4	4080 per leg	9570	3.75
5	4080 per leg	4780	7.5

[1] Max. peak inverse voltage of 10,000 volts.

BOTTOM VIEW OF SOCKET CONNECTIONS



PIN 1 - NO CONNECTION
PIN 2 - FILAMENT, CATHODE SHIELD
PIN 3 - NO CONNECTION
PIN 4 - FILAMENT
CAP - PLATE
• - GAS TYPE TUBE

TECHNICAL DATA

7034
4X150A
7609

RADIAL-BEAM POWER TETRODE

The 7034/4X150A and 7609 are forced-air cooled, external-anode radial-beam tetrodes with a maximum plate dissipation rating of 250 watts and a maximum input-power rating of 500 watts up to 150 MHz, with reduced ratings applicable to 500 MHz. The 7034/4X150A is designed to operate with a heater voltage of 6.0 volts, while the 7609 is designed for operation at a heater voltage of 26.5 volts. Otherwise, the two tube types have identical characteristics.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage (7034)	6.0 ± 0.6	V
Current, at 6.0 volts	2.6	A
Cathode-Heater Potential	±150	V
Heater: Voltage (7609)	26.5 ± 2.6	V
Current at 26.5 volts	0.51	A
Cathode Heater Potential	±150	V
Amplification Factor (Average):		
Grid to Screen	5	
Direct Interelectrode Capacitances (Grounded Cathode)[2]		
Input	15.7	pF
Output (7034)	4.5	pF
Output (7609)	4.2	pF
Feedback	0.03	pF
Frequency of Maximum Rating:	150	MHz
Highest Useful Frequency:	500	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the results of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. In Shielded Fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length	2.414 in; 61.32 mm
Diameter	1.640 in; 41.66 mm
Net Weight	4 oz; 113 gm
Operating Position	Any

(Revised 8-1-74) 1962, 1970, 1974 Varian Printed in U.S.A.

Maximum Operating Temperature: Glass Seals	200 °C
Ceramic Seals	250 °C
Anode Core	250 °C
Cooling	Forced Air
Base	Special 9-pin JEDEC-B8-236
Recommended Socket	EIMAC SK-600 Series
Recommended Chimney	EIMAC SK-600 Series

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN (SSB)

Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE [1]	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Dc plate voltage rating is 1250 volts above 150 MHz.

TYPICAL OPERATION (Frequencies to 150 MHz)
Class AB1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage [2]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Single Tone Plate Current	250	250	250	mAdc
Two-Tone Plate Current	190	190	190	mAdc
Single-Tone Screen Current [3]	10	8	5	mAdc
Two-Tone Screen Current [3]	2	-1	-2	mAdc
Single-Tone Grid Current [3]	0	0	0	mAdc
Peak rf Grid Voltage [3]	50	50	50	v
Plate Output Power	120	215	300	W
Resonant Load Impedance	1750	3100	4750	Ω

2. Adjust to specified zero-signal dc plate current.
3. Approximate value.

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN, CARRIER CONDITIONS

Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE [1]	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Dc plate voltage rating is 1250 volts above 150 MHz.

TYPICAL OPERATION (Frequencies to 150 MHz)
Class AB_1, Grid Driven

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage [2]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Carrier Plate Current	150	150	150	mAdc
Carrier Screen Current	-3	-4	-4	mAdc
Peak rf Grid Voltage [3]	25	25	25	v
Plate Output Power	30	50	65	W

2. Adjust to specified zero-signal dc plate current.
3. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE [1]	2000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Dc plate voltage rating is 1250 volts above 150 MHz.

TYPICAL OPERATION (Frequencies to 150 MHz)					500 MHz [3]	
Plate Voltage	500	1000	1500	2000	1250	Vdc
Screen Voltage	250	250	250	250	250	Vdc
Grid Voltage	-90	-90	-90	-90	-80	Vdc
Plate Current	250	250	250	250	200	mAdc
Screen Current [2]	45	38	21	19	7	mAdc
Grid Current [2]	35	31	28	26	10	mAdc
Peak rf Grid Voltage [2]	114	114	112	112	---	v
Measured Driving Power [2]	4.0	3.5	3.2	2.9	10	W
Plate Input Power	125	250	375	500	250	W
Plate Output Power	70	190	280	390	140	W [2]
Heater Voltage	6.0	6.0	6.0	6.0	(4)	

2. Approximate value.
3. Measured values for a typical cavity amplifier circuit.
4. Heater voltage reduced to 5.5 volts and 24.3 volts for the 7034 and 7609 respectively.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE[1]	1600	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.20	AMPERE
PLATE DISSIPATION[2]	165	WATTS
SCREEN DISSIPATION[3]	12	WATTS
GRID DISSIPATION[3]	2	WATTS

1. Dc plate voltage rating is 1250 volts above 150 MHz.
2. Corresponds to 250 watts at 100% sine-wave modulation.
3. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 150 MHz)

Plate Voltage	500	1000	1600	Vdc
Screen Voltage	250	250	250	Vdc
Grid Voltage	-100	-100	-100	Vdc
Plate Current	200	200	200	mAdc
Screen Current[4]	25	20	18	mAdc
Grid Current[4]	23	21	21	mAdc
Peak rf Grid Voltage[4]	173	172	172	v
Calculated Driving Power[4]	4.0	3.6	3.6	W
Plate Input Power	100	200	320	W
Plate Output Power	47	140	250	W

4. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_1, Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube):

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Approximate value.
2. Per Tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage[1][3]	-55	-55	-55	Vdc
Zero-Signal Plate Current	200	200	200	mAdc
Max Signal Plate Current	500	500	500	mAdc
Max Signal Screen Current[1]	20	16	10	mAdc
Max Signal Grid Current[1]	0	0	0	mAdc
Peak af Grid Voltage[2]	50	50	50	v
Peak Driving Power	0	0	0	W
Plate Input Power	500	750	1000	W
Plate Output Power	240	430	600	W
Load Resistance (Plate to Plate)	3500	6200	9500	Ω

3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Nom.	Max.	
Heater: 7034-Current at 6.0 volts	2.3	---	2.9	A
Heater: 7609-Current at 26.5 volts	0.40	---	0.62	A
Cathode Warmup Time	30	60	---	sec
Interelectrode Capacitances[1] (grounded cathode connection)				
Input	14.5	---	17.0	pF
Output (7034)	4.0	---	4.8	pF
Output (7609)	3.7	---	4.45	pF
Feedback	---	---	0.05	pF

1. In Shielded Fixture.

APPLICATION

MECHANICAL

MOUNTING - The 7034 and 7609 may be operated in any position. An EIMAC Air-System Socket, SK-600 series, or a socket having equivalent characteristics, is required. Sockets are available with or without built-in screen capacitors and may be obtained with either grounded or ungrounded cathode terminals.

COOLING - Sufficient forced-air cooling must be provided for the anode, base seals, and body seals to maintain operating temperatures below the rated maximum values. Air requirements to maintain anode core temperatures at 200°C with an inlet air temperature of 50°C are tabulated below. These requirements apply when a socket of the EIMAC SK-600 series and an EIMAC SK-606 chimney are used with air flow in the base to anode direction.

SEA LEVEL			10,000 FEET	
Plate Dissipation(watts)	Air Flow (CFM)	Pressure Drop(In. of water)	Air Flow (CFM)	Pressure Drop(In. of water)
200	5.2	0.58	7.8	0.85
250	6.1	0.79	9.0	1.10

The blower selected in a given application must be capable of supplying the desired airflow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters. The blower must be designed to deliver the air at the desired altitude.

At 500 MHz or below, base cooling air requirements are satisfied automatically when the tube is operated in an EIMAC Air-System Socket and the recommended air flow rates are used. Experience has shown that if reliable long life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

VIBRATION - These tubes are capable of satisfactorily withstanding ordinary shock and vibration, such as encountered in shipment and normal handling. The tubes will function well in automobile and truck mobile installations and similar environments. However, when shock and vibration more severe than this is expected, it is suggested that the EIMAC 4CX300A or 4CX250R be employed.

ELECTRICAL

HEATER - The rated heater voltage for the 7034 and 7609 is 6.0 volts and 26.5 volts, respectively, and the voltage should be maintained as closely as practicable. Short-time changes of ± 10% will not damage the tube, but variations in performance must be expected. The heater voltage must be maintained within ± 5% to minimize these variations and to obtain maximum tube life.

At frequencies above approximately 300 MHz transit-time effects begin to influence the cathode temperature. The amount of driving power diverted to heating the cathode by back-bombardment will depend upon frequency, plate current, and driving power. When the tube is driven to maximum input as a class-C amplifier, the heater voltage should be reduced according to the table below:

Frequency MHz	7034	7609
300 and lower	6.00 volts	26.5 volts
301 to 400	5.75 volts	25.3 volts
401 to 500	5.50 volts	24.3 volts

CATHODE OPERATION - The oxide coated unipotential cathode must be protected against excessively high emission currents. The maximum rated dc input current is 200 mA for plate-modulated operation and 250 mA for all other types of operation except pulse.

The cathode is internally connected to the four even-numbered base pins and all four of the corresponding socket terminals should be used to make connection to the external circuits. At radio frequencies it is important to keep the cathode leads short and direct and to use conductors with large areas to minimize the inductive reactances in series with the cathode leads.

It is recommended that rated heater voltage be applied for a minimum of 30 seconds before other operating voltages are applied. Where the circuit design requires the cathode and heater to be operated at different potentials, the rated maximum heater-to-cathode voltage is 150 volts regardless of polarity.

GRID OPERATION - The maximum rated dc grid bias voltage is -250 volts and the maximum grid dissipation rating is 2.0 watts. In ordinary audio and radio-frequency amplifiers the grid dissipation usually will not approach the maximum rating. At operating frequencies above the 100 MHz region, driving-power requirements for

amplifiers increase noticeably. At 500 MHz as much as 20 watts of driving power may have to be supplied. However, most of the driving power is absorbed in circuit losses other than grid dissipation, so that grid dissipation is increased only slightly. Satisfactory 500 MHz operation of the tube in a stable amplifier is indicated by grid-current values below approximately 15 mA.

The grid voltage required by different tubes may vary between limits approximately 20% above and below the center value, and means should be provided in the equipment to accommodate such variation. It is especially important that variations between individual tubes be compensated when tubes are operated in parallel or push-pull circuits, to assure equal load sharing.

The maximum permissible grid-circuit resistance per tube is 100,000 ohms.

SCREEN OPERATION - The maximum rated power dissipation for the screen is 12 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

When signal voltages appear between screen and cathode, as in the case of screen-modulated amplifiers or cathode-driven tetrode amplifiers, the peak screen-to-cathode voltage is the sum of the dc screen voltage and the peak ac or rf signal voltage applied to screen or cathode.

Protection for the screen should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be applied before screen voltage can be applied.

The screen current may reverse under certain conditions and produce negative current indications on the screen milliammeter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor, gaseous voltage regulator tubes, or an electron tube *shunt* regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per connected screen. An electron tube *series* regulator can be used only when an adequate bleeder resistor is provided.

Self-modulation of the screen in plate-modulated tetrode amplifiers using these tubes may not be satisfactory because of the screen-voltage screen-current characteristics. Screen modulation from a tertiary winding on the modulation transformer or by means of a small separate modulator tube will usually be more satisfactory. Screen-voltage modulation factors between 0.75 and 1.0 will result in 100% modulation for plate-modulated rf amplifiers using the 7034 or 7609.

PLATE OPERATION - The maximum rated plate dissipation power is 250 watts. In plate-modulated applications the carrier plate dissipation power must be limited to 165 watts to avoid exceeding the plate dissipation rating with 100% sine wave modulation. The maximum dissipation rating may be exceeded for brief periods during circuit adjustment without damage to the tube.

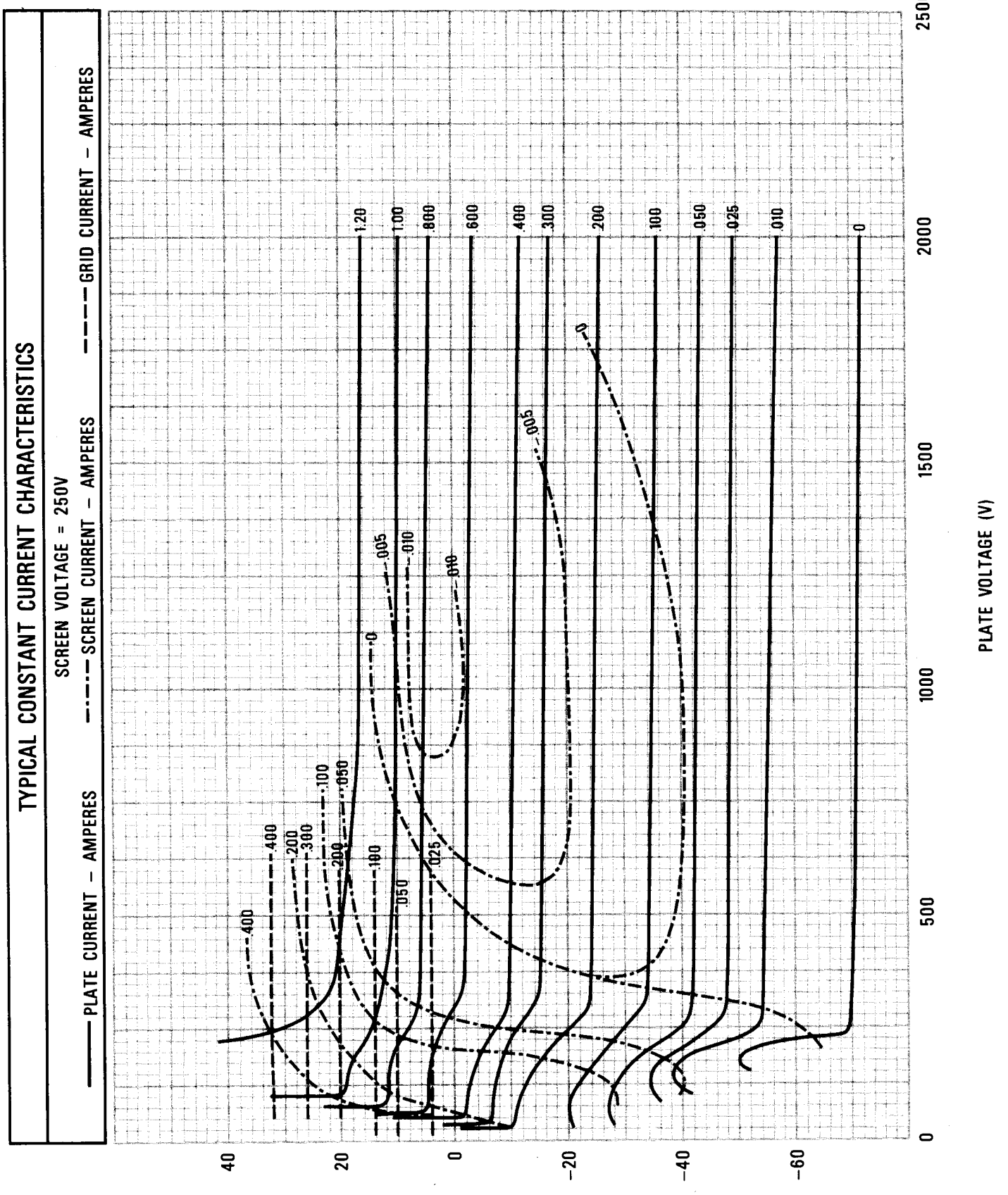
MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide individual metering and individual adjustment of bias or screen voltage to equalize the inputs.

Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event that one tube fails.

VHF OPERATION - The 7034 and 7609 are suitable for use in the VHF region. Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

HIGH VOLTAGE - The 7034 and 7609 operate at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

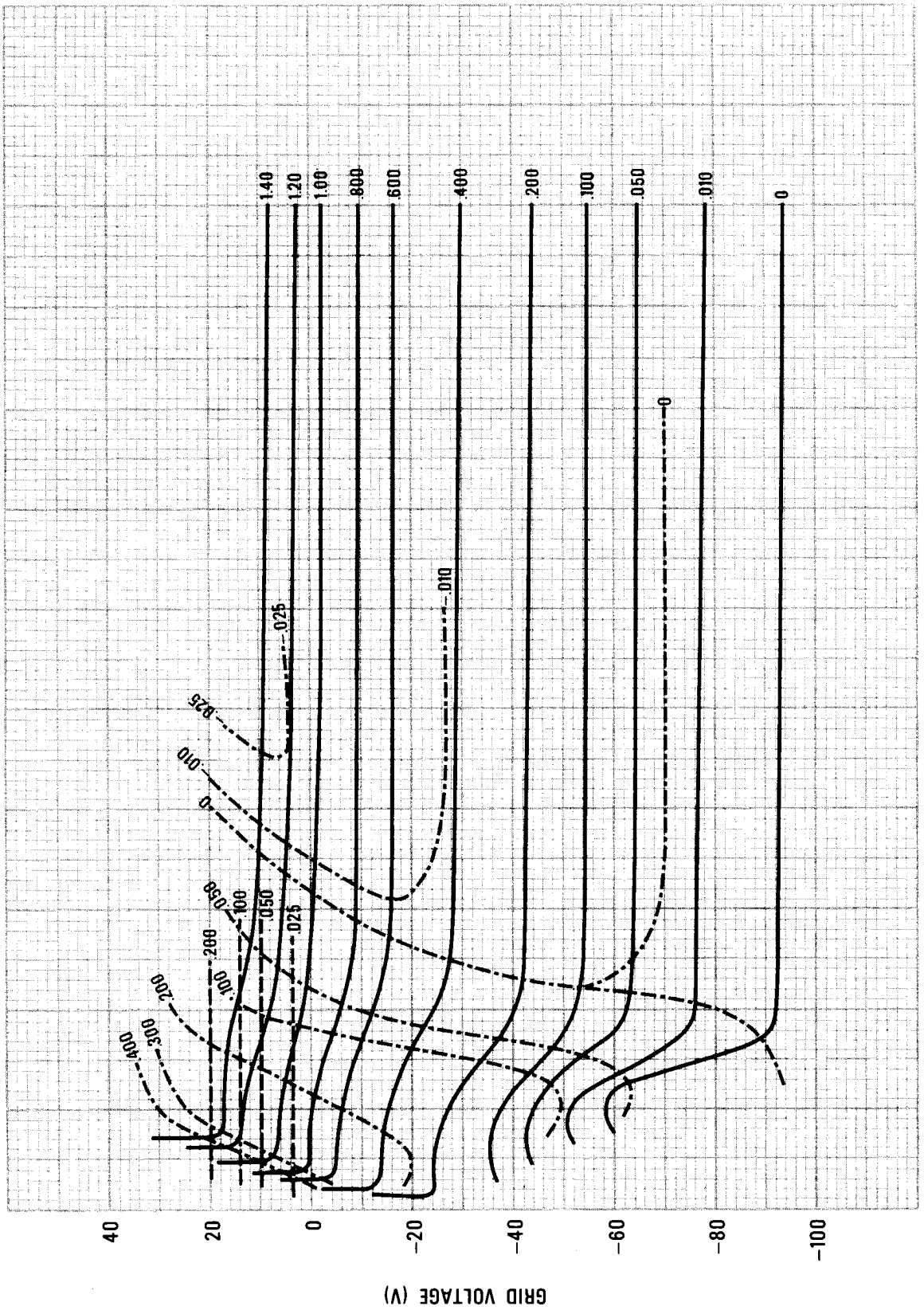
SPECIAL APPLICATIONS-If it is desired to operate these tubes under conditions widely different from those given here, write to Application Engineering Dept., EIMAC Division of Varian, San Carlos, Calif. 94070 for information and recommendations.

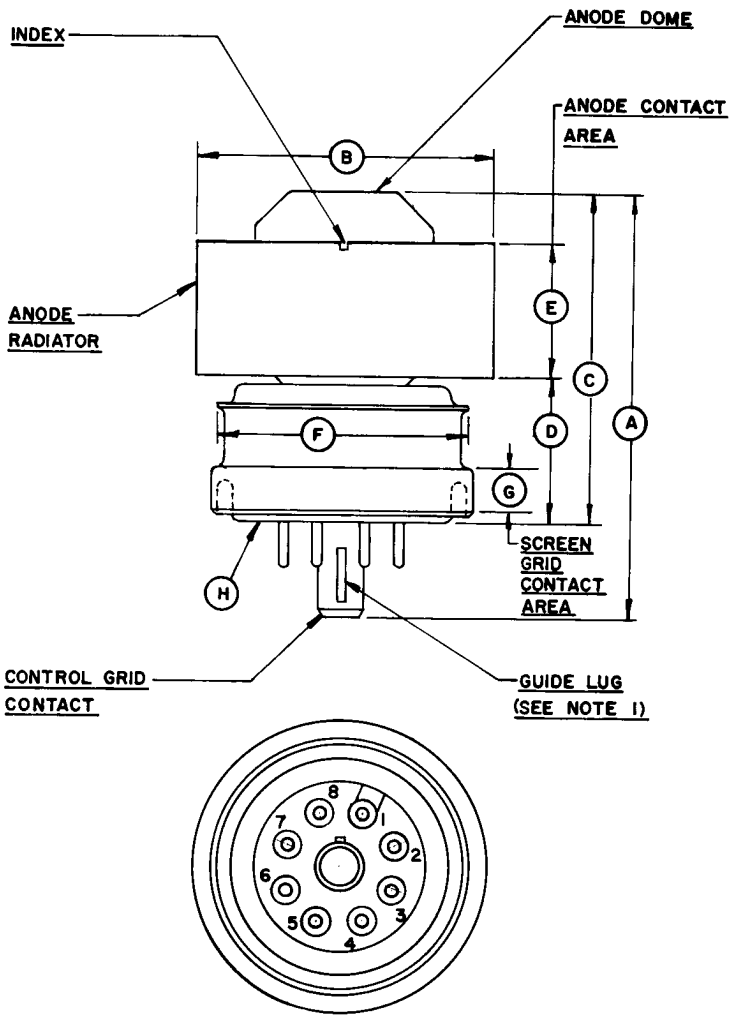

TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 250V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (V)
40
20
0
-20
-40
-60
0
500
1000
1500
2000
2500
1.20
1.00
.800
.600
.400
.300
.200
.100
.050
.025
.010
0
.400
.200
.100
.050
.025
.010
.005
0
.005
.010
.010
0

TYPICAL CONSTANT CURRENT CHARACTERISTICS

SCREEN VOLTAGE = 350V

—— PLATE CURRENT – AMPERES –·–·– SCREEN CURRENT – AMPERES – – – – GRID CURRENT – AMPERES





DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	NOM.	MIN.	MAX.	NOM.
A	2.224	2.414		59.03	62.59	
B	1.610	1.640		40.89	41.65	
C	1.710	1.860		43.43	47.24	
D	.750	.810		19.05	20.57	
E	.710	.790		18.03	20.07	
F		1.406			35.71	
G	.187			4.75		
H	BASE: B8-236 (JEDEC DESIGNATION)					

NOTES:

1. LOCATION OF GUIDE LUG OF CONTROL GRID CONTACT MAY BE REFERENCED BY AN ARROW OR NOTCH ON THE ANODE RADIATOR IN THE POSITION SHOWN.

PIN DATA

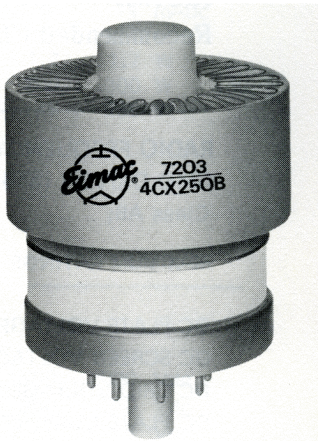
PIN NO. 1 SCREEN GRID
PIN NO. 2 CATHODE
PIN NO. 3 HEATER
PIN NO. 4 CATHODE
PIN NO. 5 I.C.-DO NOT USE FOR EXTERNAL CONNECTION
PIN NO. 6 CATHODE
PIN NO. 7 HEATER
PIN NO. 8 CATHODE
CENTER PIN-CONTROL GRID

TECHNICAL DATA

7203
4CX250B
8621
4CX250FG

RADIAL-BEAM
POWER TETRODE

The 7203/4CX250B and 8621/4CX250FG are ceramic/metal forced-air cooled, external-anode radial-beam tetrodes with a maximum plate dissipation rating of 250 watts and a maximum input-power rating of 500 watts. The 7203/4CX250B is designed to operate with a heater voltage of 6.0 volts, while the 8621/4CX250FG is designed for operation at a heater voltage of 26.5 volts. Otherwise, the two tube types have identical characteristics.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage (4CX250B)	6.0 ± 0.3	V
Current, at 6.0 volts	2.6	A
Cathode-Heater Potential, maximum	±150	V
Heater: Voltage (4CX250FG)	26.5 ± 1.3	V
Current, at 26.5 volts	0.54	A
Cathode-Heater Potential, maximum	±150	V
Amplification Factor (Average):		
Grid to Screen	5	
Direct Interelectrode Capacitances (Grounded cathode)[2]		
Input	15.7	pF
Output	4.5	pF
Feedback	0.04	pF
Direct Interelectrode Capacitances (grounded grid and screen)[2]		
Input	13	pF
Output	4.5	pF
Feedback	0.01	pF
Frequency of Maximum Rating:		
CW	500	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. In Shielded Fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length	2.46 in; 62.5 mm
Diameter	1.64 in; 41.7 mm
Net Weight	4 oz; 113 gm
Operating Position	Any

(Revised 8-1-74) © 1962, 1970, 1973, 1974 Varian Printed in U.S.A.

Maximum Operating Temperature:
- Ceramic/Metal Seals . . . . . 250°C
- Anode Core . . . . . 250°C

Cooling . . . . . Forced Air
Base . . . . . Special 9-pin JEDEC-B8-236
Recommended Socket . . . . . EIMAC SK-600 Series
Recommended Chimney . . . . . EIMAC SK-600 Series

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN (SSB)

Class AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage [1]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Single Tone Plate Current	250	250	250	mAdc
Two-Tone Plate Current	190	190	190	mAdc
Single-Tone Screen Current [2]	10	8	5	mAdc
Two-Tone Screen Current [2]	2	-1	-2	mAdc
Single-Tone Grid Current [2]	0	0	0	mAdc
Peak rf Grid Voltage [2]	50	50	50	v
Plate Output Power	120	215	300	W
Resonant Load Impedance	2000	3000	4000	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN, CARRIER CONDITIONS

Class AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)
Class AB_1, Grid Driven

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage [1]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Carrier Plate Current	150	150	150	mAdc
Carrier Screen Current	-3	-4	-4	mAdc
Peak rf Grid Voltage [2]	25	25	25	v
Plate Output Power	30	50	65	W

1. Adjust to specified zero-signal dc plate current

2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)					500 MHz [2]	
Plate Voltage	500	1000	1500	2000	2000	Vdc
Screen Voltage	250	250	250	250	300	Vdc
Grid Voltage	-90	-90	-90	-90	-90	Vdc
Plate Current	250	250	250	250	250	mAdc
Screen Current [1]	45	38	21	19	10	mAdc [2]
Grid Current [1]	35	31	28	26	10	mAdc [2]
Peak rf Grid Voltage [1]	114	114	112	112	---	v
Measured Driving Power [1]	4.0	3.5	3.2	2.9	---	W
Plate Input Power	125	250	375	500	500	W
Plate Output Power	70	190	280	390	290	W [2]
Heater Voltage (4CX250B)	6.0	6.0	6.0	6.0	5.5	V
Heater Voltage (4CX250FG)	26.5	26.5	26.5	26.5	24.3	V

1. Approximate value.
2. Measured values for a typical cavity amplifier circuit.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	1500	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.20	AMPERE
PLATE DISSIPATION[1]	165	WATTS
SCREEN DISSIPATION[2]	12	WATTS
GRID DISSIPATION[2]	2	WATTS

1. Corresponds to 250 watts at 100% sine-wave modulation.

2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 175 MHz)

Plate Voltage	500	1000	1500	Vdc
Screen Voltage	250	250	250	Vdc
Grid Voltage	-100	-100	-100	Vdc
Plate Current	200	200	200	mAdc
Screen Current	31	22	20	mAdc
Grid Current	15	14	14	mAdc
Peak rf Grid Voltage	118	117	117	v
Calculated Driving Power	1.8	1.7	1.7	W
Plate Input Power	100	200	300	W
Plate Output Power	60	145	235	W

3. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB , Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Approximate value.

2. Per Tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage 1/3	-55	-55	-55	Vdc
Zero-Signal Plate Current	200	200	200	mAdc
Max Signal Plate Current	500	500	500	mAdc
Max Signal Screen Current[1]	20	16	10	mAdc
Max Signal Grid Current[1]	0	0	0	mAdc
Peak af Grid Voltage[2]	50	50	50	v
Peak Driving Power	0	0	0	W
Plate Input Power	500	750	1000	W
Plate Output Power	240	430	600	W
Load Resistance (plate to plate)	3500	6200	9500	Ω

3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Nom.	Max.	
Heater: 4CX250B Current at 6.0 volts	2.3	---	2.9	A
Heater: 4CX250FG Current at 26.5 volts	0.45	---	0.62	A
Cathode Warmup Time	30	60	---	sec.
Interelectrode Capacitances[1] (grounded cathode connection)				
Input	14.2	---	17.2	pF
Output	4.0	---	5.0	pF †
Feedback	---	---	0.06	pF
Interelectrode Capacitances[1] (grounded grid and screen)				
Input	---	13.0	---	pF
Output	4.0	---	5.0	pF †
Feedback	---	0.01	---	pF

† Cout values shown are for 4CX250B; for 4CX250FG, values are ..... 4.0 --- 5.3 pF

APPLICATION

MECHANICAL

MOUNTING - The 4CX250B and 4CX250FG may be operated in any position. An EIMAC Air-System Socket, SK-600 series, or a socket having equivalent characteristics, is required. Sockets are available with or without built-in screen capacitors and may be obtained with either grounded or ungrounded cathode terminals.

COOLING - Sufficient forced-air cooling must be provided for the anode, base seals, and body seals to maintain operating temperatures below the rated maximum values. Air requirements to maintain anode core temperatures at 200°C with an inlet air temperature of 50°C are tabulated below. These requirements apply when a socket of the EIMAC SK-600 series and an EIMAC SK-606 chimney are used with air flow in the base to anode direction.

SEA LEVEL			10,000 FEET	
Plate Dissipation(watts)	Air Flow (CFM)	Pressure Drop(In.of water)	Air Flow (CFM)	Pressure Drop(In.of water)
200	5.0	0.52	7.3	0.76
250	6.4	0.82	9.3	1 20

The blower selected in a given application must be capable of supplying the desired airflow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters. The blower must be designed to deliver the air at the desired altitude.

At 500 MHz or below, base cooling air requirements are satisfied automatically when the tube is operated in an EIMAC Air-System Socket and the recommended air flow rates are used. Experience has shown that if reliable long life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

VIBRATION - These tubes are capable of satisfactorily withstanding ordinary shock and vibration, such as encountered in shipment and normal handling. The tubes will function well in automobile and truck mobile installations and similar environments. However, when shock and vibration more severe than this are expected, it is suggested that the EIMAC 4CX300A or 4CX250R be employed.

ELECTRICAL

HEATER - The rated heater voltage for the 4CX250B and 4CX250FG is 6.0 volts and 26.5 volts, respectively, and the voltage should be maintained as closely as practicable. Short-time changes of ± 10% will not damage the tube, but variations in performance must be expected. The heater voltage must be maintained within ± 5% to minimize these variations and to obtain maximum tube life.

At frequencies above approximately 300 MHz transit-time effects begin to influence the cathode temperature. The amount of driving power diverted to heating the cathode by back-bombardment will depend upon frequency, plate current, and driving power. When the tube is driven to maximum input as a class-C amplifier, the heater voltage should be reduced according to the table below;

Frequency MHz	4CX250B	4CX250FG
300 and lower	6.00 volts	26.5 volts
301 to 400	5.75 volts	25.3 volts
401 to 500	5.50 volts	24.3 volts

CATHODE OPERATION - The oxide coated unipotential cathode must be protected against excessively high emission currents. The maximum rated dc input current is 200 mA for plate-modulated operation and 250 mA for all other types of operation except pulse.

The cathode is internally connected to the four even-numbered base pins and all four of the corresponding socket terminals should be used to make connection to the external circuits. At radio frequencies it is important to keep the cathode leads short and direct and to use conductors with large areas to minimize the inductive reactances in series with the cathode leads.

It is recommended that rated heater voltage be applied for a minimum of 30 seconds before other operating voltages are applied. Where the circuit design requires the cathode and heater to be operated at different potentials, the rated maximum heater-to-cathode voltage is 150 volts regardless of polarity.

GRID OPERATION - The maximum rated dc grid bias voltage is -250 volts and the maximum grid dissipation rating is 2.0 watts. In ordinary audio and radio-frequency amplifiers the grid dissipation usually will not approach the maximum rating. At operating frequencies above the 100 MHz region, driving-power requirements for

amplifiers increase noticeably. At 500 MHz as much as 20 watts of driving power may have to be supplied. However, most of the driving power is absorbed in circuit losses other than grid dissipation, so that grid dissipation is increased only slightly. Satisfactory 500 MHz operation of the tube in a stable amplifier is indicated by grid-current values below approximately 15 mA.

The grid voltage required by different tubes may vary between limits approximately 20% above and below the center value, and means should be provided in the equipment to accommodate such variation. It is especially important that variations between individual tubes be compensated when tubes are operated in parallel or push-pull circuits, to assure equal load sharing.

The maximum permissible grid-circuit resistance per tube is 100,000 ohms.

SCREEN OPERATION - The maximum rated power dissipation for the screen is 12 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

When signal voltages appear between screen and cathode, as in the case of screen-modulated amplifiers or cathode-driven tetrode amplifiers, the peak screen-to-cathode voltage is the sum of the dc screen voltage and the peak ac or rf signal voltage applied to screen or cathode.

Protection for the screen should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be applied before screen voltage can be applied.

The screen current may reverse under certain conditions and produce negative current indications on the screen milliammeter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor, gaseous voltage regulator tubes, or an electron tube *shunt* regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per connected screen. An electron tube *series* regulator can be used only when an a equate bleeder resistor is provided.

Self-modulation of the screen in plate-modulated tetrode amplifiers using these tubes may not be satisfactory because of the screen-voltage screen-current characteristics. Screen modulation from a tertiary winding on the modulation transformer or by means of a small separate modulator tube will usually be more satisfactory. Screen-voltage modulation factors between 0.75 and 1.0 will result in 100% modulation for plate-modulated rf amplifiers using the 4CX250B or 4CX250FG.

PLATE OPERATION - The maximum rated plate dissipation power is 250 watts. In plate-modulated applications the carrier plate dissipation power must be limited to 165 watts to avoid exceeding the plate dissipation rating with 100% sine wave modulation. The maximum dissipation rating may be exceeded for brief periods during circuit adjustment without damage to the tube.

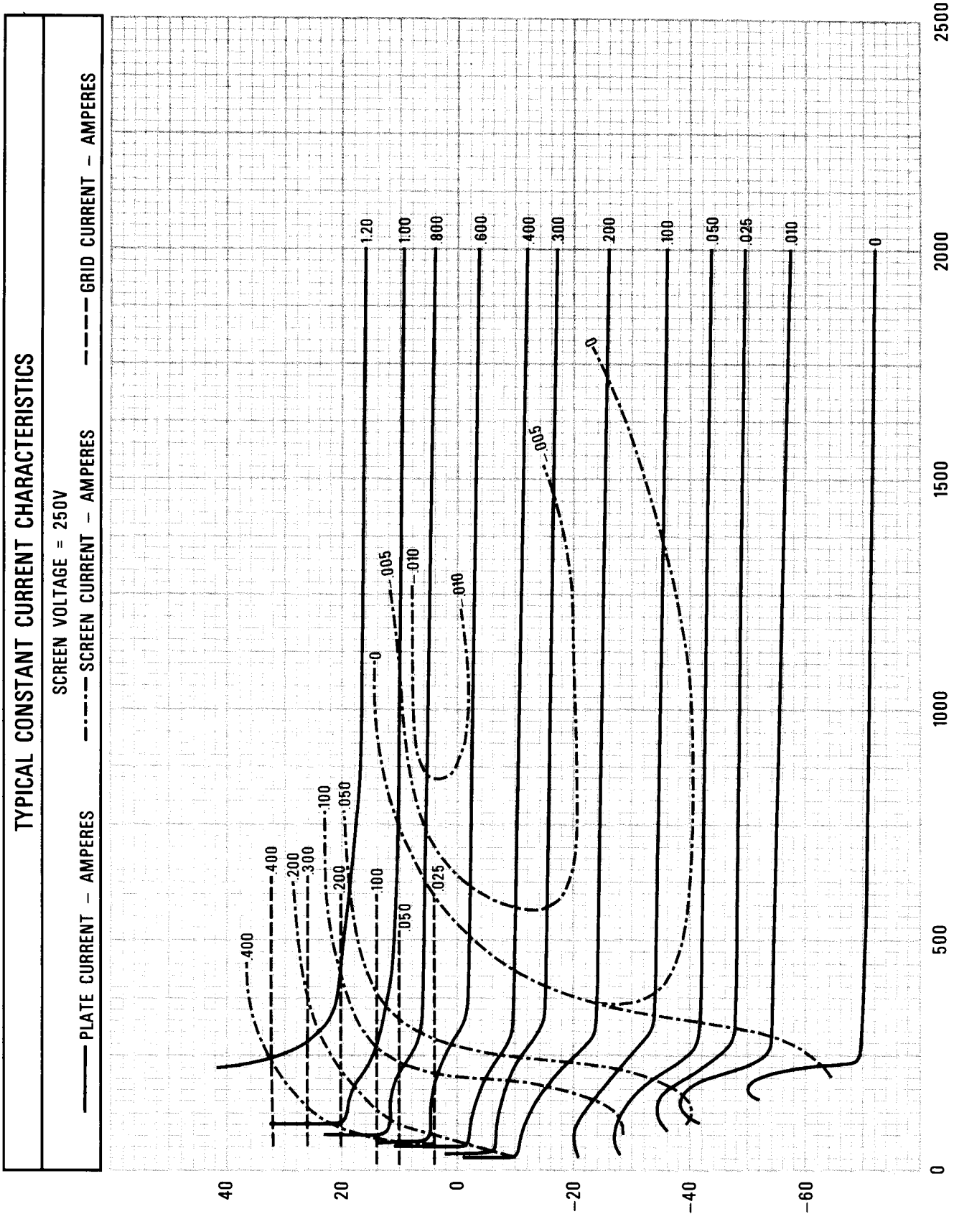
MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide individual metering and individual adjustment of bias or screen voltage to equalize the inputs.

Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event that one tube fails.

VHF OPERATION-The 4CX250B and 4CX250FG are suitable for use in the VHF region. Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

HIGH VOLTAGE - The 7203/4CX250B and 8621/4CX250FG operate at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

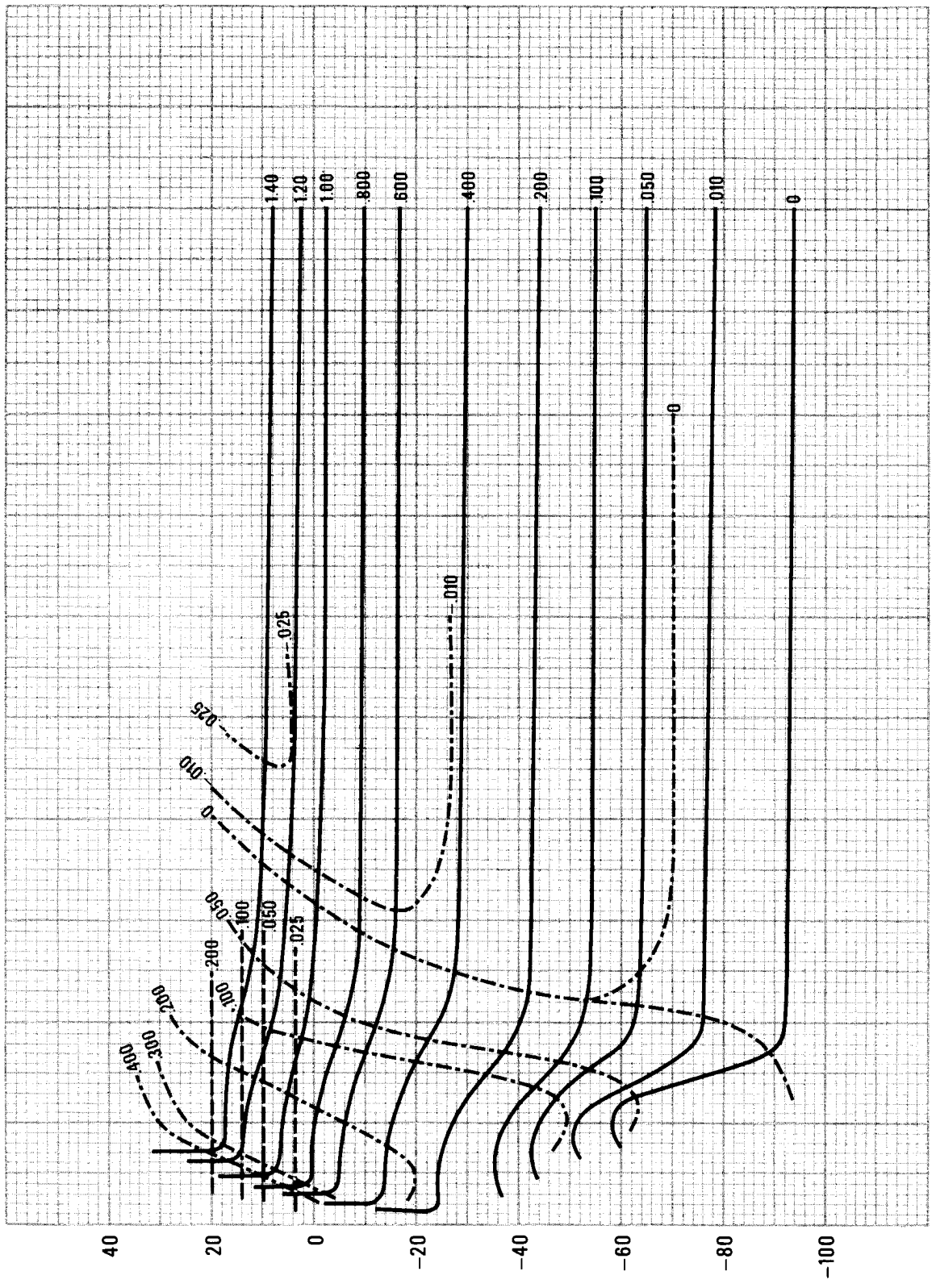
SPECIAL APPLICATIONS-If it is desired to operate these tubes under conditions widely different from those given here, write to Application Engineering Dept., EIMAC Division of Varian, San Carlos, Calif. 94070 for information and recommendations.


TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 250V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (V)
40
20
0
-20
-40
-60
0
500
1000
1500
2000
2500
1.20
1.00
.800
.600
.400
.300
.200
.100
.050
.025
.010
.005
0

TYPICAL CONSTANT CURRENT CHARACTERISTICS

SCREEN VOLTAGE = 350V

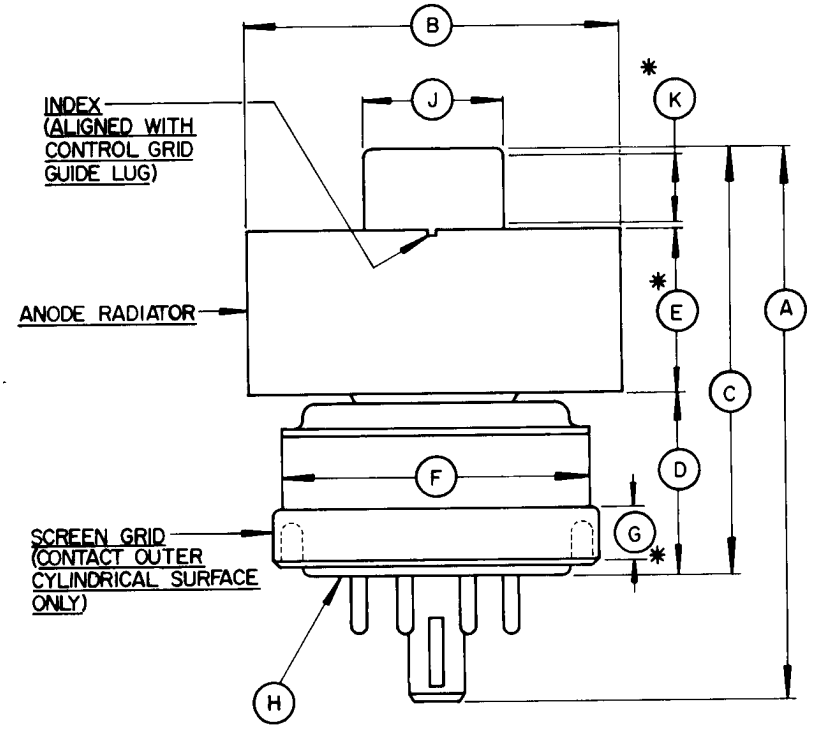
——— PLATE CURRENT – AMPERES –·–·– SCREEN CURRENT – AMPERES – – – – GRID CURRENT – AMPERES



PIN DESIGNATION

PIN NO. 1	SCREEN GRID
PIN NO. 2	CATHODE
PIN NO. 3	HEATER
PIN NO. 4	CATHODE
PIN NO. 5	I.C. DO NOT USE FOR EXTERNAL CONNECTION.
PIN NO. 6	CATHODE
PIN NO. 7	HEATER
PIN NO. 8	CATHODE
CENTER PIN	CONTROL GRID

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	2.342	2.464	59.03	62.59
B	1.610	1.640	40.89	41.66
C	1.810	1.910	45.97	48.51
D	0.750	0.810	19.05	20.57
E	0.710	0.790	18.03	20.07
F	--	1.406	--	35.71
G	0.187	--	4.75	--
H	BASE: B8-236 (JEDEC DESIGNATION)			
J	0.559	0.573	14.20	14.55
K	0.240	--	6.10	--

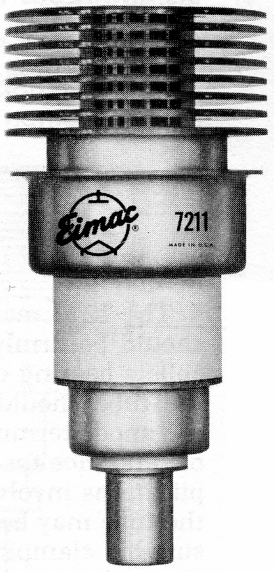


NOTES:
1. REF DIMS. ARE FOR INFO. ONLY AND ARE NOT REQD. FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACES.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

7211

HIGH-MU UHF TRIODE



The Eimac 7211 is a ceramic-and-metal planar triode designed for use as a power amplifier, oscillator, or frequency multiplier in applications requiring greater power output than can be realized from the 7289/3CX100A5. Although similar in appearance, the Eimac 7211 incorporates a significantly improved and enlarged cathode which increases the power input capability to a maximum of 190 watts at frequencies to 2500 mc.

Exacting dimensional tolerances inherent in the manufacturing processes provide the Eimac 7211 with the maximum mechanical uniformity. Critical electrical testing results in increased reliability and a minimum variation in electrical characteristics.

GENERAL CHARACTERISTICS

Electrical

	Min.	Nom.	Max.
Cathode: Oxide-coated, Unipotential			
Heating time	60		seconds
Heater:			
Voltage		6.3	volts
Current	1.2		1.4 amperes
Amplification Factor		80	

Direct Interelectrode Capacitances	Min.	Max.
Grid-Cathode	7.0	9.0 uuf
Grid-Plate	2.1	2.4 uuf
Plate-Cathode		0.06 uuf
Frequency for Maximum Ratings		2500 mc

Mechanical

Terminals	Graduated Cylindrical Surfaces
Maximum Operating Temperatures:	
Ceramic-to-metal Seals	250°C
Anode Core	250°C
Operating Position	Any
Cooling	Conduction and Forced Air
Maximum Overall Dimensions:	
Length	2.701 inches
Diameter	1.264 inches
Net Weight	2.5 ounces
Shipping Weight	7.0 ounces

Radio Frequency Power Amplifier or Oscillator

MAXIMUM RATING (Per Tube)

DC PLATE VOLTAGE	1000 VOLTS MAX.
DC CATHODE CURRENT	0.190 AMP. MAX.
DC GRID VOLTAGE	—150 VOLTS MAX.
DC GRID CURRENT	0.045 AMP. MAX.
INSTANTANEOUS PEAK POSITIVE GRID VOLTAGE	30 VOLTS MAX.
INSTANTANEOUS PEAK NEGATIVE GRID VOLTAGE	—400 VOLTS MAX.
PLATE DISSIPATION	100 WATTS MAX.
GRID DISSIPATION	2 WATTS MAX.

TYPICAL OPERATION (Per Tube)

	Power Amplifier Grounded-Grid (key-down conditions)	
	500 Mc	2500 Mc
DC PLATE VOLTAGE	900	900 Volts
DC GRID VOLTAGE (approx.)	—30	—20 Volts
DC PLATE CURRENT	140	140 Ma.
DC GRID CURRENT (approx.)	40	15 Ma.
DRIVING POWER (approx.)	9	-- Watts
USEFUL OUTPUT POWER	65	25 Watts

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PLATE MODULATED RADIO FREQUENCY AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	600 VOLTS MAX.
DC CATHODE CURRENT	0.140 AMP. MAX.
DC GRID VOLTAGE	—150 VOLTS MAX.
DC GRID CURRENT	0.050 AMP. MAX.
INSTANTANEOUS PEAK POSITIVE GRID VOLTAGE	30 VOLTS MAX.
INSTANTANEOUS PEAK NEGATIVE GRID VOLTAGE	—400 VOLTS MAX.
PLATE DISSIPATION	70 WATTS MAX.
GRID DISSIPATION	2 WATTS MAX.

TYPICAL OPERATION (Per Tube)
500 Mc, Grounded-Grid, Carrier Conditions.

DC PLATE VOLTAGE	600 Volts
DC GRID VOLTAGE (approx.)	—20 Volts
DC PLATE CURRENT	100 Milliamp.
DC GRID CURRENT (approx.)	35 Milliamp.
DRIVING POWER (approx.)	8 Watts
USEFUL CARRIER POWER OUTPUT	25 Watts

APPLICATION

MECHANICAL

Mounting —

The 7211 may be operated in any position. It should be firmly held in place by spring-finger collets bearing on the terminal surfaces. In use the tube should seat against the underside of the anode-terminal flange which is on the plane of reference for longitudinal dimensions. In applications involving severe shock and vibration, the tube may be clamped in place by applying a suitable clamping device to the anode-terminal flange. It is recommended that no other portion of the tube be subjected to clamping forces.

Connections —

The terminals are in the form of concentric cylinders of graduated diameters conveniently used with coaxial tuning devices. Spring-fingered collets should be used to make contact with the anode, grid, cathode and heater terminals. Adequate contact area and spring pressure should be provided to minimize heating and to prevent erratic circuit performance at the higher frequencies. Non-contacting or intermittently-contacting collet fingers will cause troublesome circuit behavior, especially at very-high and ultra-high frequencies. Electrode contact surfaces should be kept clean and free of oxide coatings.

Cooling —

Sufficient cooling air must be provided for the anode and body seals to maintain operating temperatures below the rated maximum value of 250° C.

At sea level, with an inlet air temperature of 20°C (68°F), 12.5 cubic feet per minute of air flow is required to cool the anode at 100 watts plate dissipation when the air cowling as illustrated is used. Operation at higher altitudes or with higher inlet temperatures requires increased volumes of flow to obtain equivalent cooling. When using the anode cowling as illustrated here, it is necessary to provide additional facilities for seal cooling.

It should be borne in mind that operating temperature is the sole criterion of cooling effectiveness, regardless of the coolant type, flow rate or coolant temperature. One method of measuring the surface temperatures is the use of temperature sensitive lacquer, such as "Tempilaq."

ELECTRICAL

Heater Operation —

The rated heater voltage for the 7211 is 6.3 volts. The heater voltage for the 7211 should be maintained within plus or minus 5% of its intended value to minimize variations in circuit performance and to obtain maximum tube life.

At frequencies above approximately 1000 megacycles, transit time effects begin to influence cathode temperature. The amount of driving power diverted to heating the cathode by back-bombardment will depend upon the frequency, the plate current, driving power, and duty factor. If the conditions of operation result in appreciable cathode back-heating, it may be necessary to start dynamic tube operation at normal heater voltage followed by a reduction of heater voltage to a lower value.

Cathode Operation —

The oxide-coated unipotential cathode in this tube must be protected against excessively high emission currents. For all types of operation the maximum rated dc current is 190 milliamperes.

It is recommended that the rated heater voltage be applied for a minimum of 60 seconds before other operating voltages are applied.

Control Grid Operation —

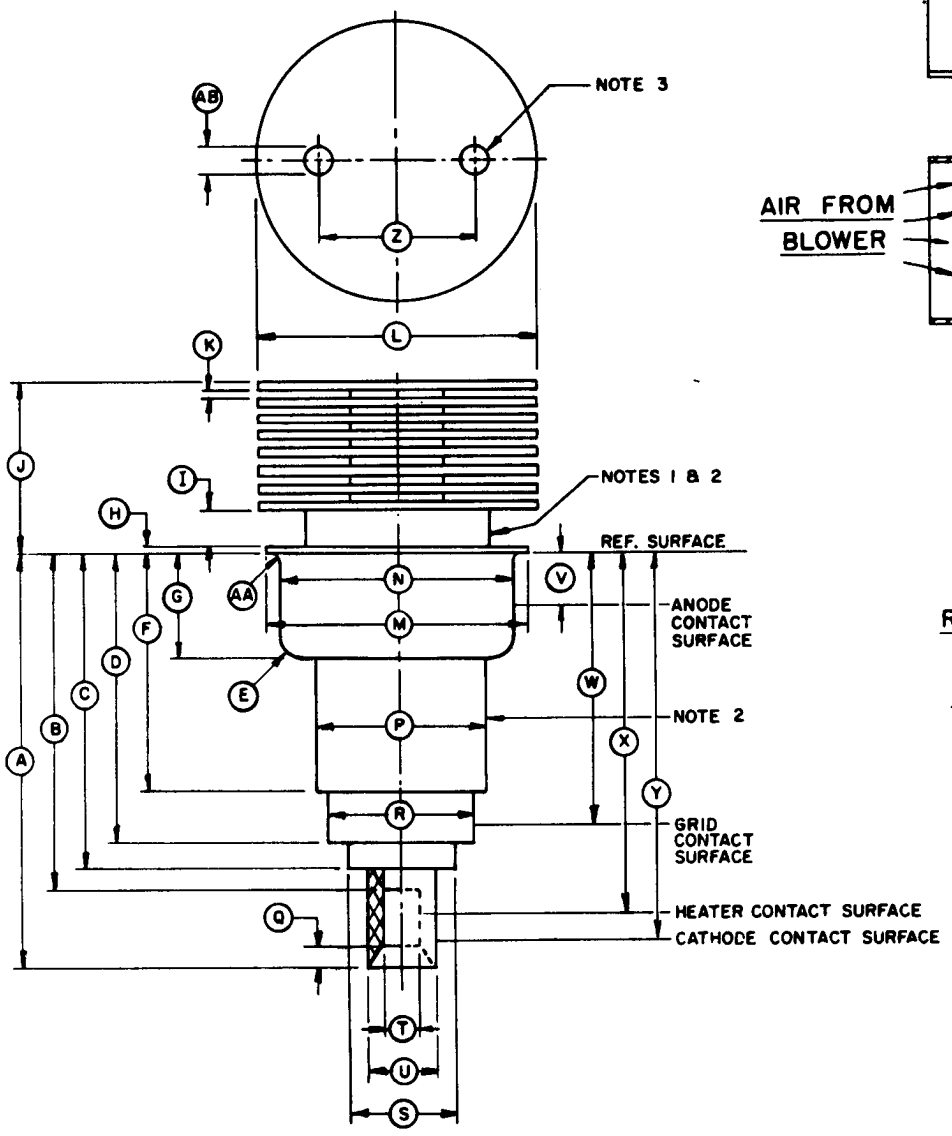
Grid dissipation must not exceed the rated maximum 2.0 watts grid dissipation power. In pulse applications the instantaneous peak grid-to-cathode voltage must be limited to —250 to —750 volts.

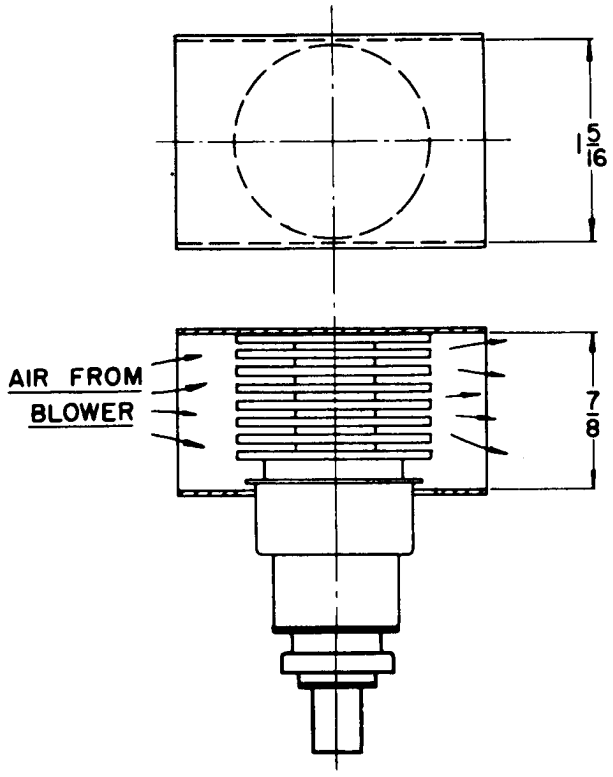
Special Applications —

If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.

NOTES:

1. MEASURE ANODE SHANK TEMPERATURE ON THIS SURFACE.
2. DO NOT CLAMP OR LOCATE ON THIS SURFACE.
3. HOLE PROVIDED FOR TUBE EXTRACTOR THROUGH TOP FIN ONLY.





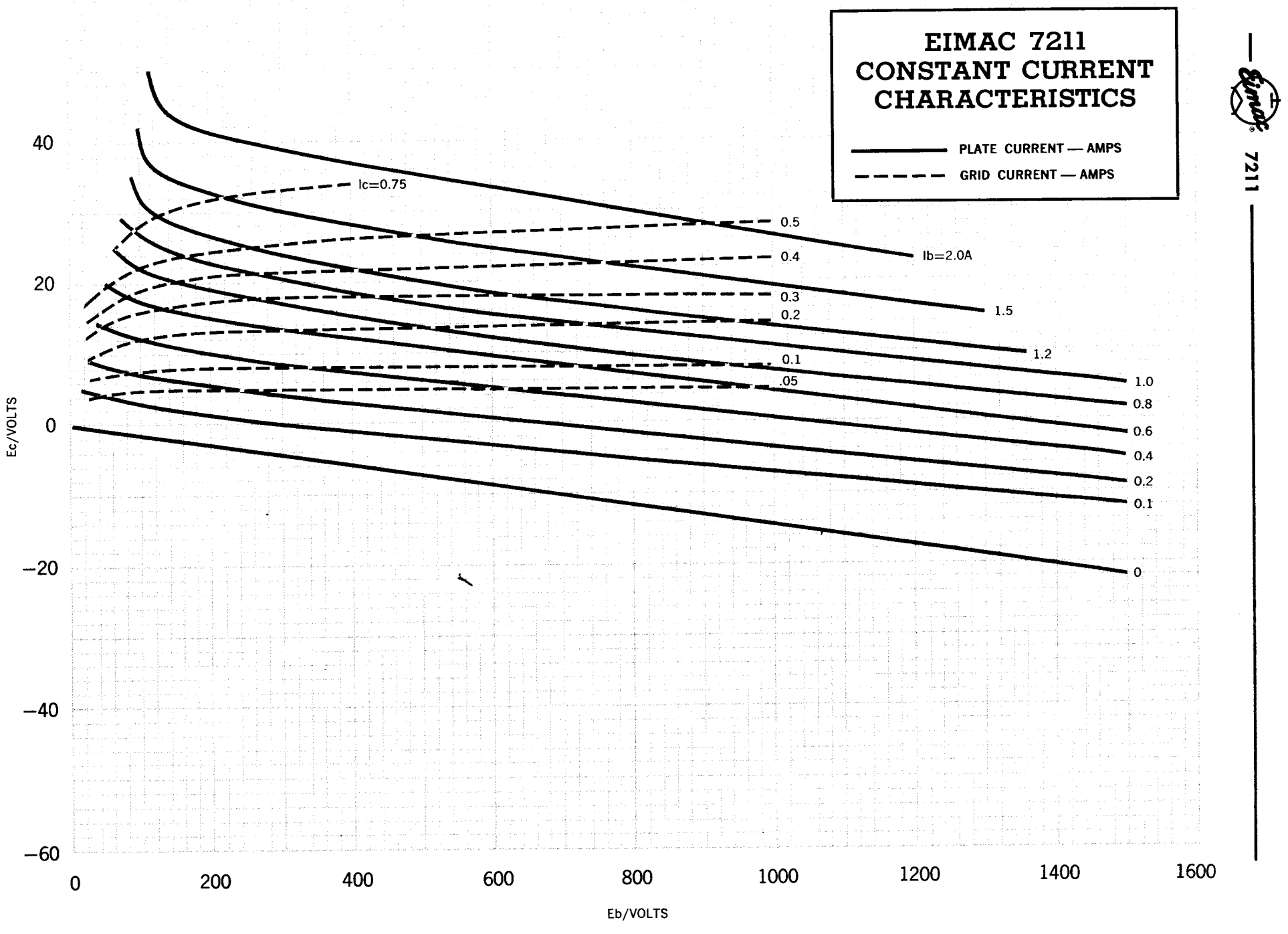
RECOMMENDED COWLING FOR FORCED-AIR COOLING OF ANODE

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	1.815	1.875	
B		1.534	
C		1.475	
D	1.289	1.329	
E		.100	
F	.970	1.010	
G	.462	.477	
H		.040	
I	.125	.185	
J	.766	.826	
K	.025	.046	
L	1.234	1.264	
M	1.180	1.195	
N	1.025	1.035	
P	.772	792	
Q		086	
R	.655	.665	
S		.545	
T	213	.223	
U	.315	.325	
Z	.650	.850	
AA		.035	
AB	.105	.145	

NOTES:

1. The total indicated runout of the anode contact surface and the grid contact surface with respect to the cathode contact surface shall not exceed .020.

2. The total indicated runout of the heater contact surface with respect to the cathode contact surface shall not exceed .012.


EIMAC 7211
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT — AMPS
GRID CURRENT — AMPS
Ic=0.75
0.5
0.4
0.3
0.2
0.1
.05
Ib=2.0A
1.5
1.2
1.0
0.8
0.6
0.4
0.2
0.1
0
40
20
0
−20
−40
−60
Ec/VOLTS
0
200
400
600
800
1000
1200
1400
1600
Eb/VOLTS

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

7289 / 3CX100A5
8250 / 3CX100F5

HIGH-MU UHF TRIODES



The Eimac 7289/3CX100A5 and 8250/3CX100F5 are ceramic-and-metal planar UHF triodes intended to supersede 2C39 types. The 7289/3CX100A5 has a 6.0-volt heater, while the 8250/3CX100F5 has a 26.5-volt heater. They are manufactured to exacting dimensional tolerances to provide the greatest mechanical uniformity. Extended and critical electrical testing results in increased reliability and a minimum variation in electrical characteristics. Full ratings apply at altitudes up to 60,000 feet and they are capable of sustained, reliable operation at elevated temperatures.

The mechanical and electrical characteristics of these tubes make them desirable for grid isolation circuits in cavity devices. They will deliver 27 watts of useful power at 500 megacycles and at 2900 megacycles, 9.5 watts of useful power can be realized.

GENERAL CHARACTERISTICS

ELECTRICAL

		MIN.	NOM.	MAX.	
Cathode: Oxide-coated, Unipotential					
Heating time				60	Seconds
Heater					
3CX100A5 Voltage (see applications)			6.0		Volts
Current (E_f = 6.0 volts)		0.90		1.05	Amperes
3CX100F5 Voltage (see applications)			26.5		Volts
Current (E_f = 26.5 volts)		0.20		0.24	Amperes
Amplification Factor			100		
Transconductance (I_b = 70 milliamperes)			25,000		Micromhos
Direct Interelectrode Capacitance					
C_{gk}		5.6		7.0	$\mu\mu f$
C_{gp}		1.95		2.15	$\mu\mu f$
C_{pk}				0.035	$\mu\mu f$
Frequency for Maximum Ratings				2500	Megacycles

MECHANICAL

Terminals: Graduated Cylindrical Surfaces

Maximum Operating Temperatures

Ceramic to Metal Seals	250°C (300°C short term overload value)
Anode Core	250°C (300°C short term overload value)
Operating Position	Any
Cooling	Forced Air
Maximum Overall Dimensions	
Length	2.701 Inches Max.
Diameter	1.264 Inches Max.
Net Weight	2.5 Ounces
Shipping Weight (approx.)	7.0 Ounces

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

MAXIMUM RATING (Per Tube)

DC PLATE VOLTAGE	1000 VOLTS MAX.
DC CATHODE CURRENT	0.125 AMP. MAX.
DC GRID VOLTAGE	—150 VOLTS MAX.
DC GRID CURRENT	0.050 AMP. MAX.
INSTANTANEOUS PEAK POSITIVE GRID VOLTAGE	30 VOLTS MAX.
INSTANTANEOUS PEAK NEGATIVE GRID VOLTAGE	—400 VOLTS MAX.
PLATE DISSIPATION	100 WATTS MAX.
GRID DISSIPATION	2 WATTS MAX.

TYPICAL OPERATION (Per Tube)

Power Amplifier Grounded-Grid (Key-down conditions)

	500 Mc	2500 Mc	2900 Mc	
DC PLATE VOLTAGE	800	900	1000	Volts
DC GRID VOLTAGE (approx.)	—20	—22	—9.5	Volts
DC PLATE CURRENT	80	90	100	Milliamp.
DC GRID CURRENT (approx.)	30	25	15	Milliamp.
DRIVING POWER (approx.)	6			Watts
USEFUL OUTPUT POWER	27	15	9.5	Watts

PLATE MODULATED RADIO FREQUENCY AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	600 VOLTS MAX.
DC CATHODE CURRENT	0.100 AMP. MAX.
DC GRID VOLTAGE	—150 VOLTS MAX.
DC GRID CURRENT	0.050 AMP. MAX.
INSTANTANEOUS PEAK POSITIVE GRID VOLTAGE	30 VOLTS MAX.
INSTANTANEOUS PEAK NEGATIVE GRID VOLTAGE	—400 VOLTS MAX.
PLATE DISSIPATION	70 WATTS MAX.
GRID DISSIPATION	2 WATTS MAX.

TYPICAL OPERATION (Per Tube)
500 Mc, Grounded-Grid, Carrier Conditions.

DC PLATE VOLTAGE	600 Volts
DC GRID VOLTAGE (approx.)	—15 Volts
DC PLATE CURRENT	65 Milliamp.
DC GRID CURRENT (approx.)	35 Milliamp.
DRIVING POWER (approx.)	5 Watts
USEFUL CARRIER POWER OUTPUT	16 Watts

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APPLICATION

MECHANICAL

Mounting — The 3CX100A5 and 3CX100F5 may be operated in any position. They should be firmly held in place by spring-finger collets bearing on the terminal surfaces. In use the tubes should seat against the under side of the anode-terminal flange which is on the plane of reference for longitudinal dimensions. In applications involving severe shock and vibration, the tubes may be clamped in place by applying a suitable clamping device to the anode-terminal flange. It is recommended that no other portion of the tube be subjected to clamping forces.

Connections — The terminals of each tube are in the form of concentric cylinders of graduated diameters so that they may be conveniently used with coaxial tuning devices. Spring-fingered collets should be used to make contact with the anode, grid, cathode and heater terminals. Adequate contact area and spring pressure should be provided to minimize heating and to prevent erratic circuit performance at the higher frequencies. Non-contacting or intermittently-contacting collet fingers will cause troublesome circuit behavior, especially at very-high and ultra-high frequencies. Electrode contact surfaces should be kept clean and free of oxide coatings.

Cooling — Sufficient cooling must be provided for the anode and body seals to maintain operating temperatures below the rated maximum values:

Ceramic to Metal Seals	250°C	(300°C short term overload value)
Anode Core	250°C	(300°C short term overload value)

At sea level, with an inlet air temperature of 20°C (68°F), 12.5 cubic feet per minute of air flow is required to cool the anode at 100 watts plate dissipation when the air cowling as illustrated is used. Operation at higher altitudes or with higher inlet temperatures requires increased volumes of flow to obtain equivalent cooling. When using the anode cowling as illustrated here, it is necesary to provide additional facilities for seal cooling.

It should be borne in mind that operating temperature is the sole criterion of cooling effectiveness, regardless of the coolant type, flow rate or coolant temperature. One method of measuring the surface temperatures is the use of temperature sensitive lacquer, such as "Tempilaq." This product can be obtained from the Tempil Corp., 132-34 West 22nd Street, New York 11, New York. When temperature sensitive materials are used, extremely thin applications must be used to avoid interference with the transfer of heat from the tube to the air stream, which would cause inaccurate indications.

ELECTRICAL

Heater Operation — The rated heater voltage for the 3CX100A5 is 6.0 volts, and for the 3CX100F5 26.5 volts. The working voltage should be selected from the table below. The heater voltage for each type should be maintained within plus or minus of 5% of its intended value to minimize variations in circuit performance and to obtain maximum tube life.

At frequencies above approximately 1000 megacycles, transit time effects begin to influence the cathode temperature. The amount of driving power diverted to heating the cathode by back-bombardment will depend upon the frequency, the plate current and driving power being supplied to the tube. If the conditions of operation result in appeciable cathode back-heating, it may be necessary to start dynamic tube operation at normal heater voltage followed by a reduction of heater voltage to the proper value. The following table is intended as a general guide in this respect.

Mc	3CX100A5 Ef	3CX100F5 Ef
Up to 1000	6.0	26.5
1000 to 2000	5.5	24.3
2000 and above	5.0	22.1

The heater of the 3CX100A5 must not be operated at less than 4.5 volts in any case, nor should the heater of the 3CX100F5 be operated at less than 20.0 volts in any case.

Cathode Operation — The oxide-coated unipotential cathode in these tubes must be protected against excessively high emission currents. For all types of operation the maximum rated dc current is 125 milliamperes. The cathode and one side of the heater are connected together internally.

It is recommended that the rated heater voltage be applied for a minimum of 30 seconds before other operating voltages are applied. Tube perfomance will become stabilized 60 seconds after the heater voltage is applied.

Control Grid Operation — Grid dissipation must not exceed the rated maximum 2.0 watts grid dissipation power.

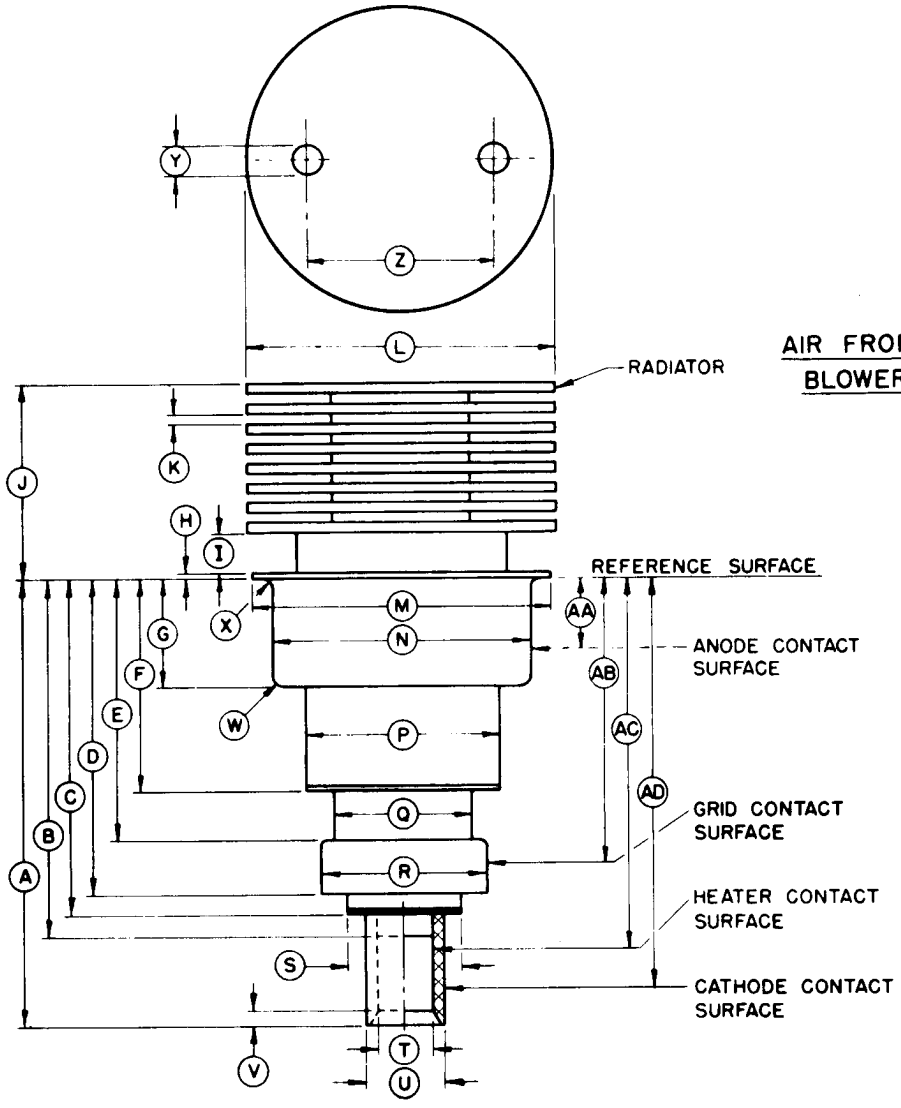
At operating frequencies near 500 megacycles, the driving power necessary for maximum output is in the order of 6 watts and as the operating frequency is increased the driving power requirements increase. Most of this increased driving power is absorbed in circuit losses other than grid dissipation, however, so that the grid dissipation will increase very little.

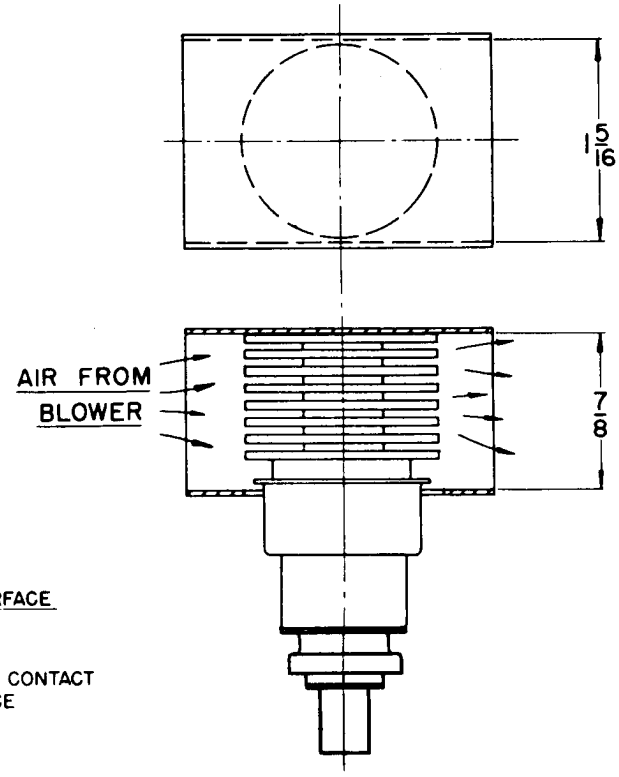
The maximum rated dc grid voltage is —150 volts and the grid may be driven to a maximum of 30 peak volts positive or to —400 peak volts negative.

The grid bias required by various individual tubes may vary between limits approximately 50% above and below the center value, and means should be provided in the equipment to accommodate such variation.

Plate Operation — The maximum rated plate dissipation power is 100 watts. In plate modulated applications, the carirer plate dissipation power must be limited to 70 watts to avoid exceeding the plate dissipation rating with 100% sine wave modulation.

Special Applications — If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California for information and recommendations.





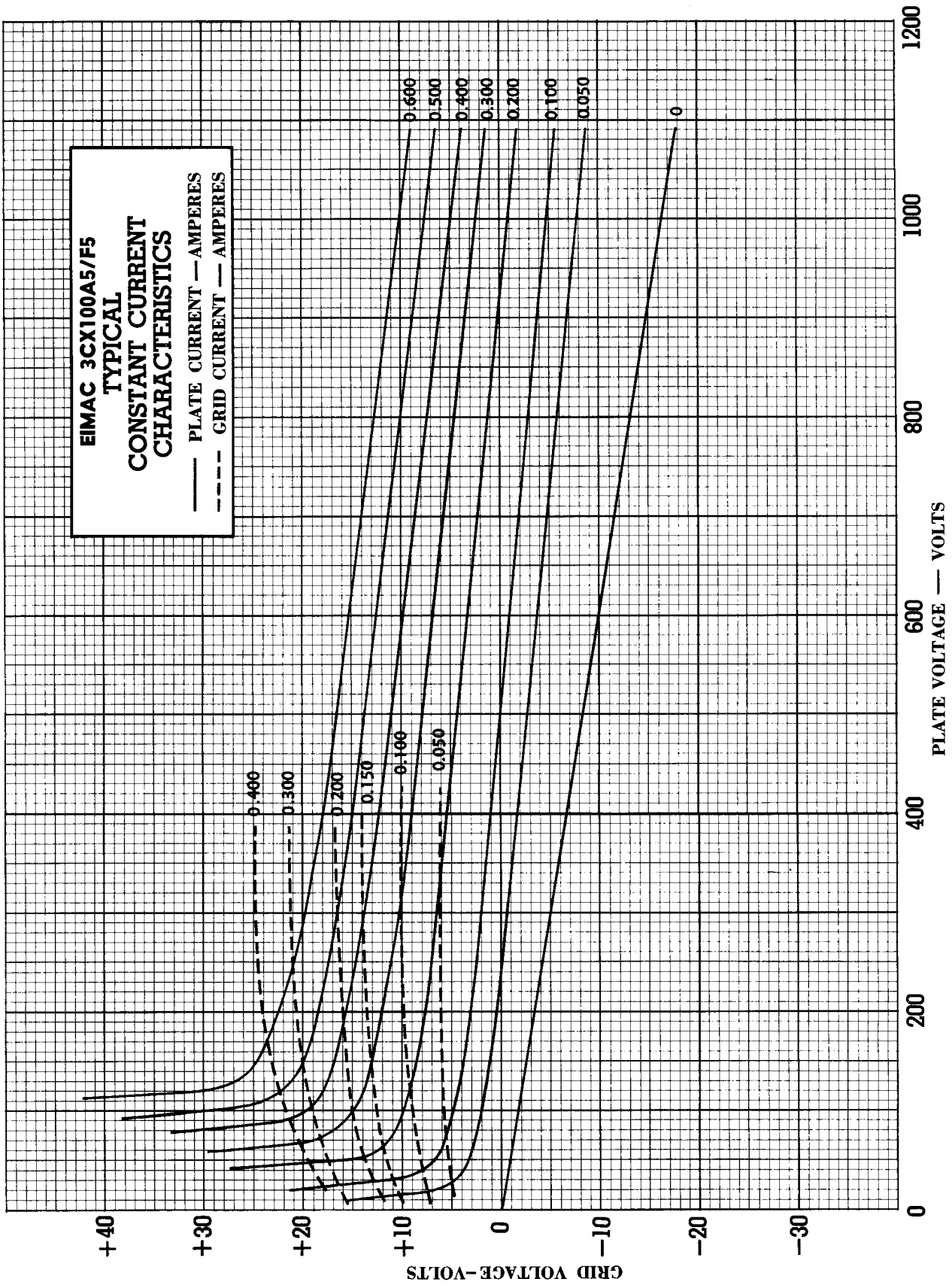
RECOMMENDED COWLING FOR FORCED-AIR COOLING OF ANODE

REF.	NOM.	MIN.	MAX.
A		1.815	1.875
B			1.534
C			1.475
D		1.289	1.329
E		1.085	1.135
F		.880	.920
G		.462	.477
H			.040
I		.125	.185
J		.766	.826
K		.025	.046
L		1.234	1.264
M		1.180	1.195
N		1.025	1.035
P		.772	.792
Q		.541	.561
R		.655	.665
S			.545
T		.213	.223
U		.315	.325
V			.086
W			.100
X			.035
Y		.105	.145
Z		.650	.850
AA		.035	.361
AB		1.185	1.265
AC		1.534	1.728
AD		1.475	1.815

NOTES:

1. The total indicated runout of the anode contact surface and the grid contact surface with respect to the cathode contact surface shall not exceed .020.

2. The total indicated runout of the heater contact surface with respect to the cathode contact surface shall not exceed .012.


EIMAC 3CX100A5/F5
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
—— PLATE CURRENT — AMPERES
- - - - GRID CURRENT — AMPERES
0.600
0.500
0.400
0.300
0.200
0.100
0.050
0
0.400
0.300
0.200
0.150
0.100
0.050
+40
+30
+20
+10
0
−10
−20
−30
0
200
400
600
800
1000
1200
GRID VOLTAGE—VOLTS
PLATE VOLTAGE — VOLTS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

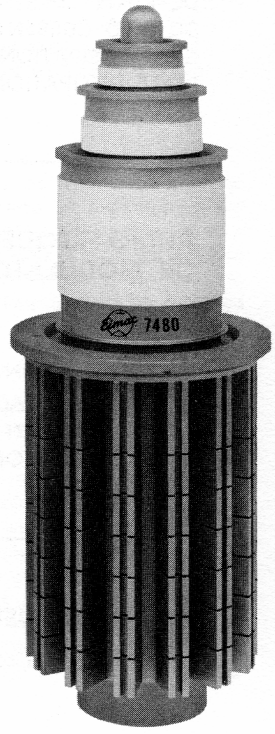
7480

VAPOR COOLED MEDIUM-MU POWER TRIODE

The Eimac 7480 is a vapor cooled ceramic-metal triode designed for AM broadcast and communications amplifiers and for industrial heating service.

Low-loss ceramic and metal construction permits operation at full ratings at frequencies up to 40 MHz. Useful power output can be obtained at frequencies up to 80 MHz at reduced plate voltage.

The 7480 anode is capable of dissipating 80 kilowatts continuously, and higher power during intermittent operation or momentary overloads. A water cooled version of this tube, type 6696A, and a forced-air cooled version, type 6697A, are also available.



CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated-Tungsten				
Voltage		13		V
Current	190		220	A
Amplification Factor		20		
Direct Interelectrode Capacitances				
Grid-Plate	50		60	pF
Grid-Filament	65		85	pF
Plate-Filament	2.0		3.2	pF
Frequency for Maximum Ratings			40	MHz

MECHANICAL

Recommended Terminal Connectors Small Filament	Eimac SK-1610
Large Filament	Eimac SK-1611
Grid	Eimac SK-1612
Operating Position	Vertical, base up
Cooling	Vaporization of water
Maximum Seal Temperature	200° C
Recommended Boiler	Eimac BR-400 Series or equivalent
Maximum Height	20.1 in
Maximum Diameter	7.12 in
Net Weight	50 lbs

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	16.0 KV
DC GRID VOLTAGE	—3200 VOLTS
DC PLATE CURRENT	11 AMPS
DC GRID CURRENT	2.0 AMPS
GRID DISSIPATION	1000 WATTS
PLATE DISSIPATION	80 KW

TYPICAL OPERATION

DC Plate Voltage	10	15 kV
DC Grid Voltage	—1200	—1600 volts
Peak RF Grid Voltage	1900	2100 volts
DC Plate Current	10.0	7.0 amps
DC Grid Current	810	300 mA
Resonant Load Impedance	440	970 ohms
Driving Power, approx.	1500	600 watts
Plate Output Power, approx.	72	80 kW

(Effective 11-1-68) © 1964, 1968 by Varian

Printed in U.S.A.

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	10.0 KV
DC GRID VOLTAGE	—3200 VOLTS
DC PLATE CURRENT	8.5 AMPS
DC GRID CURRENT	2.0 AMPS
GRID DISSIPATION	1000 WATTS
PLATE DISSIPATION	53 KW

TYPICAL OPERATION

DC Plate Voltage	9.5 kV
DC Grid Voltage	—1600 volts
Peak RF Grid Voltage	2300 volts
DC Plate Current	8.4 amps
DC Grid Current	900 mA
Resonant Load Impedance	510 ohms
Driving Power, approx.	2.0 kW
Plate Output Power, approx.	60 kW

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	16.0 KV
DC PLATE CURRENT	11.0 AMPS
PLATE DISSIPATION	80 KW

TYPICAL OPERATION (Two Tubes).

DC Plate Voltage	10	12 kV
DC Grid Voltage	—450	—600 volts
Peak AF Driving Voltage (per tube)	875	1060 volts
Zero-Sig DC Plate Current	3.0	2.0 amps
Max-Sig DC Plate Current	17.4	20.0 amps
Load Resistance, Plate-to-Plate	1170	1230 ohms
Max-Sig Driving Power, approx.	550	600 watts
Max-Sig Plate Output Power, approx.	110	152 kW

RADIO-FREQUENCY AM LINEAR AMPLIFIER

Class-AB (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	16.0 KV
DC PLATE CURRENT	9.0 AMPS
PLATE DISSIPATION	80 KW

TYPICAL OPERATION (AM Carrier conditions except where noted).

DC Plate Voltage	12	12 kV
DC Grid Voltage	—550	—550 volts
Peak RF Grid Voltage	510	640 volts
DC Plate Current	4.3	6.8 amps
DC Grid Current	0	0 amps
Resonant Load Impedance	780	500 ohms
Driving Power, approx.*	450	1500 watts
Plate Output Power, approx.	18	28 kW

*At modulation crest.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB, Single-Sideband Suppressed-Carrier Service

MAXIMUM RATINGS

DC PLATE VOLTAGE	16.0 KV
DC PLATE CURRENT	11.0 AMPS
PLATE DISSIPATION	80 KW

TYPICAL OPERATION (Peak-envelope or modulation-crest conditions in cathode-drive circuit).

DC Plate Voltage	12	12 kV
DC Cathode Voltage	600	600 volts
Peak RF Driving Voltage	830	1020 volts
DC Plate Current	5.2	9.8 amps
DC Grid Current, approx.	60	200 mA
Resonant Load Impedance	880	700 ohms
Driving Power, approx.	3.5	8.2 kW
Plate Power Output, approx.	43	83 kW

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses has been made.

APPLICATION

MECHANICAL

Mounting

The 7480 should be mounted vertically anode down in the boiler (Eimac type BR-400 or equivalent). Filament and grid connections are made through clamp rings or spring-finger contacts to the O.D. of the sturdy copper terminals of the tube. Satisfactory anode contact can be made to the boiler.

Anode Cooling

Efficient cooling is accomplished by vaporization of water in the boiler and transport of the vapor to a condenser at a temperature of about 100° C. The boiler, which is at anode potential, is isolated electrically from the rest of the system by sections of insulating pipe in the vapor and condensate return lines. The control box connected across the boiler on the ground side of the insulating tubes, displays the water level in the boiler, actuates warning or interlock circuits if the level is too low, and permits overflow if the level is too high. A reservoir is usually associated with the control box, either integral or remote, to replenish the system with distilled water as required.

Application information and typical system layout drawings are available from EIMAC. All accessory components and special hardware is available from Eimac except condensers, for which commercial sources exist.

Base Cooling

Forced-air cooling of the ceramic base and seals may be required, depending on ambient conditions and operating frequency. Air flow rate and direction should be determined to limit envelope temperatures to 200° C maximum and to maintain uniform temperature distribution around the seals. Spot temperatures are conveniently measured with Tempilaq (spray type) or equivalent. Often a flow of about 100 cfm, directed axially downward towards the tube, is sufficient.

ELECTRICAL

Filament Operation

The rated filament voltage, as measured at the tube terminals, should be maintained within ± 5% to assure long file and good performance within the rated power capability of the tube. To accommodate special requirements, the filament voltage may be centered near either of these extremes, e.g. at plus 5 percent for exceptionally high emission at a sacrifice of life, or at minus 5 percent for exceptionally long life where perhaps only half the full emission capability is required.

Grid Dissipation

Grid dissipation should be limited to 1,000 watts maximum. Grid dissipation may be calculated approximately as the product of peak positive grid voltage and dc grid current.

In many r-f amplifier applications where it is impractical to measure the positive grid voltage, the dc grid current rating serves as a satisfactory guide. The maximum dc grid current rating under normal full load conditions in 2 amperes. In most cases, however, high power output and good efficiency can be realized with grid current less than one ampere. By limiting the grid current in this manner there is obviously more latitude for grid current excursions resulting from changes in loading.

High Frequency Operation

The maximum ratings listed apply at frequencies up to 40 MHz. Useful output can be obtained at higher frequencies of the plate voltage and plate input power are reduced accordingly. For operation up to 60 MHz these parameters should be reduced to 75% of the listed dc plate voltage rating; for operation up to 80 MHz they should be reduced to 50%.

Aging

The manner of operating most high power tubes differs in at least some respects from conditions under which the tubes are tested, therefore, some aging is almost always required to condition a new tube to its new environment. In basic terms, the different operating conditions are manifest as different distributions of heat and voltage gradients. Satisfactory aging is most easily achieved by gradual application of voltages, e.g. first filament voltage, then partial plate voltage, and drive, working up to the final values. If continuous or stepped plate voltage control is not used, sufficient load should be connected before snapping on full voltage to limit transients to about 120% of the dc voltage.

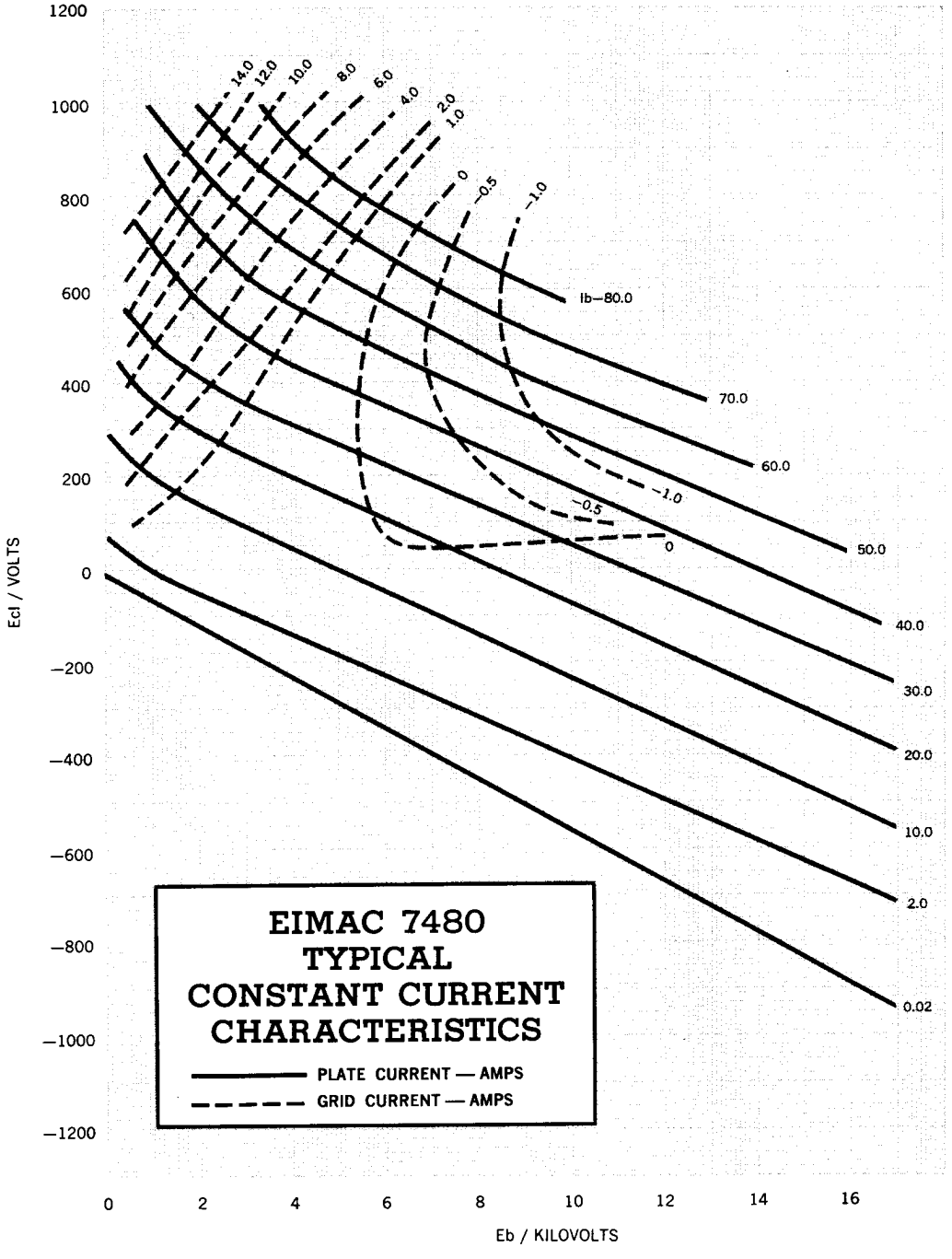
Tube Protection

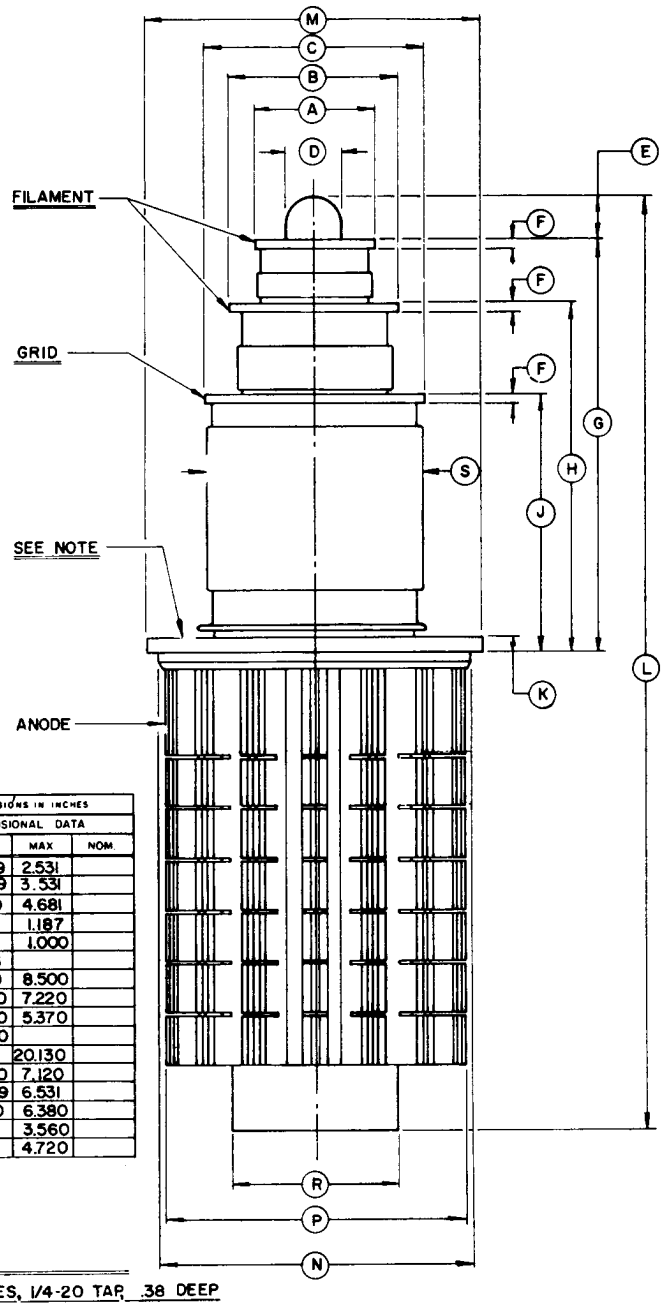
Since the possibility of fault overloads due to occasional tube or circuit instabilities is ever present, good engineering practice holds that suitable protective circuitry and devices be included in the equipment. In addition to the standard overcurrent relays, some series resistance should be placed in the output of the power supply to limit surge currents. In cases where no filter is used, the resistors may be placed in each rectifier lead to reduce the power loss during normal operation. In certain applications, furthermore, it is helpful to attach sphere gaps or rings to the tube terminals to divert any excessive transient voltages from the envelope and seals.

The use of an electronic fault diverter, or "crowbar" is probably the best way to insure high performance reliability and freedom from gassing or catastrophic failures. The crowbar system consists of circuitry to sense incipient fault currents and trigger the crowbar device, which is connected to short the power supply energy to ground, preferably within about 10 microseconds. The crowbar device, which is usually an ignitron, hydrogen thyratron, or spark gap, diverts most of the fault energy from the protected tube until the relay and circuit breakers open.

Special Applications

If it is desired to operate this tube under conditions widely different from those given herin, write to EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California 94070.





DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF	MIN	MAX	NOM.
A	2.469	2.531	
B	3.469	3.531	
C	4.619	4.681	
D		1.187	
E		1.000	
F	.156		
G	8.120	8.500	
H	6.900	7.220	
J	5.250	5.370	
K	.250		
L		20.130	
M	7.000	7.120	
N	6.469	6.531	
P	6.120	6.380	
R		3.560	
S		4.720	

NOTE:

3 HOLES, 1/4-20 TAP, .38 DEEP EQUALLY SPACED ON 5.740-5.760 POINT CIRCLE; FOR LIFTING.

7580

RADIAL-BEAM POWER TETRODE

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA



The 7580 is a compact, high-perveance, radial-beam tetrode designed specially for maximum power output as a class-AB_1 linear amplifier. It is capable of 470 watts peak envelope power output under two-tone conditions. A pair of 7580 tubes will provide audio or ultrasonic power of 595 watts operating in amplifier or modulator service, class-AB_1, with a transformer efficiency of 95%.

The upper frequency for use of the 7580 at maximum ratings is 500 megacycles.

GENERAL CHARACTERISTICS

ELECTRICAL

		Min.	Nom.	Max.	
Cathode:	Oxide-Coated, Unipotential				
	Heating Time	30	60		seconds
	Cathode-to-Heater Potential	—		±150	volts
Heater:	Voltage	-	6.0		volts
	Current	2.3		2.9	amperes
Direct Interelectrode Capacitances, Grounded Cathode:					
	Input	16.0		18.5	uuf
	Output	4.0		5.0	uuf
	Grid-to-Plate	-	-	0.06	uuf

MECHANICAL

Base	Special 9-pin
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250°C
Anode Core	250°C
Recommended Socket	Eimac SK-600 Series
Operating Position	Any
Maximum Dimensions:	
Height	2.464 inches
Seated Height	1.910 inches
Diameter	1.640 inches
Cooling	Forced Air
Net Weight	4 ounces
Shipping Weight (Approximate)	1.6 pounds

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1 - Single Sideband

MAXIMUM RATINGS

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	500 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	.250 MAX. AMP
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS

TYPICAL OPERATION

Two-Tone where peak envelope power is at least twice the average power output—Actual measurements—Tank circuit efficiency estimated at 95%.

D-C Plate Voltage	1500	2000	volts
Zero-Signal D-C Plate Current	.133	.070	amp
Two-Tone D-C Plate Current	.250	.245	amp
D-C Screen Voltage	350	400	volts
Two-Tone D-C Screen Current	—10	+1	ma
D-C Grid-Bias Voltage	—62	—80	volts
Peak Signal Voltage	56	80	volts
3rd Order Intermodulation products referred to signal level	—30	—23	db
5th Order Intermodulation products referred to signal level	—35	—27	db
Worst 3rd Order Intermodulation as drive signal is reduced	—29	—21	db
Load Resistance	2160	2840	ohms
Peak Envelope Power	262	470	watts

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RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1 (Carrier with Double Sidebands)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	500 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	.250 MAX. AMP
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS

TYPICAL OPERATION—Single Tube

(Quantities shown for carrier conditions, no modulation)

D-C Plate Voltage	1500	2000	volts
D-C Plate Current	.172	.172	amp
D-C Screen Voltage	350	400	volts
D-C Screen Current (Approx)	—3	—5	ma
D-C Grid-Bias Voltage	—58	—76	volts
Peak Grid-Signal Voltage	30	39	volts
Plate-Load Resistance	2320	3150	ohms
Power Output for Tank Circuit Efficiency of 95%	55	100	watts

AUDIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1

MAXIMUM RATINGS (Per Tube)

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	500 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	.250 MAX. AMP
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS

TYPICAL OPERATION (Two Tubes Push-Pull)

D-C Plate Voltage	1500	2000	volts
D-C Plate Current No Signal	.200	.140	amp
D-C Plate Current at Full Signal	.490	.500	amp
D-C Screen Voltage	300	350	volts
D-C Screen Current No Signal	—2	—4	ma
D-C Screen Current at Full Signal	0	+4	ma
D-C Grid-Bias Voltage (Approx)	—48	—66	volts
Plate-to-Plate Load Resistance	5920	8016	ohms
Power Output for Transformer Efficiency of 95%	390	595	watts

MAXIMUM RATINGS FOR OTHER TYPES OF OPERATION

Class-C Telegraphy or FM

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	.250 MAX. AMP
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

Class-C Plate Modulated

D-C PLATE VOLTAGE	1500 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	.200 MAX. AMP
PLATE DISSIPATION	165 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

APPLICATION

MECHANICAL

Mounting—The 7580 may be mounted in any position. An Eimac Air-System Socket of the SK-600 series or equivalent is recommended. These sockets may be obtained with or without the r-f screen by-pass capacitor, and with or without the four cathode terminals grounded to the socket shell. A simple Lock-in socket restricts the flow of cooling air and is not recommended.

Cooling—The 7580 has an efficient louvered anode cooler. The maximum allowable temperature for any external surface is 250°C.

For long service life at sea level, at an ambient temperature of 25°C and maximum rated anode dissipation of 250 watts, a *minimum* of 4.6 cfm air should flow from tube base through the anode cooler. The corresponding pressure drop with the recommended socket and chimney will be approximately .32 inch water column. See table for other dissipation levels and conditions.

4.6 cfm of air at 25°C is the same as a mass air flow of 18 pounds per hour. Higher ambient temperature requires greater air mass and volume. Higher altitude requires equivalent mass air flow for a given ambient temperature and therefore requires greater volume at increased back pressure.

The use of temperature-sensitive laquer is recommended to determine the effectiveness of a cooling system under operating conditions.

Plate Dissipation (Watts)	55°C AMBIENT			
	SEA LEVEL		10,000 FEET ALTITUDE	
	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
75	1.15	.025	1.8	.036
125	2.3	.09	3.35	.13
250	6.4	.59	9.3	.86

Vibration and Shock—The 7580 is designed to withstand low-frequency vibration of 25 cps, 0.80 inch total excursion as outlined in MIL-E-1D, no voltage. It will withstand a bump test as described in MIL-E-1D for a hammer angle of 20°.

ELECTRICAL

Heater—For maximum life and uniform performance, the heater voltage should be maintained within plus or minus 5% of the rated 6.0 volts at operating frequencies up to 300 Mc. For CW use between 300 and 400 Mc, 5.75 volts is recommended. For CW use, 400 to 500 Mc, 5.5 volts is recommended.

Cathode—The cathode is connected to the four even-numbered base pins to provide a low-inductance path, or permit separation of input and output circuits if required.

Rated heater voltage should be applied for 30 seconds before other operating voltages are applied.

Heater-to-cathode maximum voltage is ±150 volts.

Control Grid—Maximum rated d-c bias voltage is −250 volts. D-C resistance, grid to cathode, should be no more than 100,000 ohms.

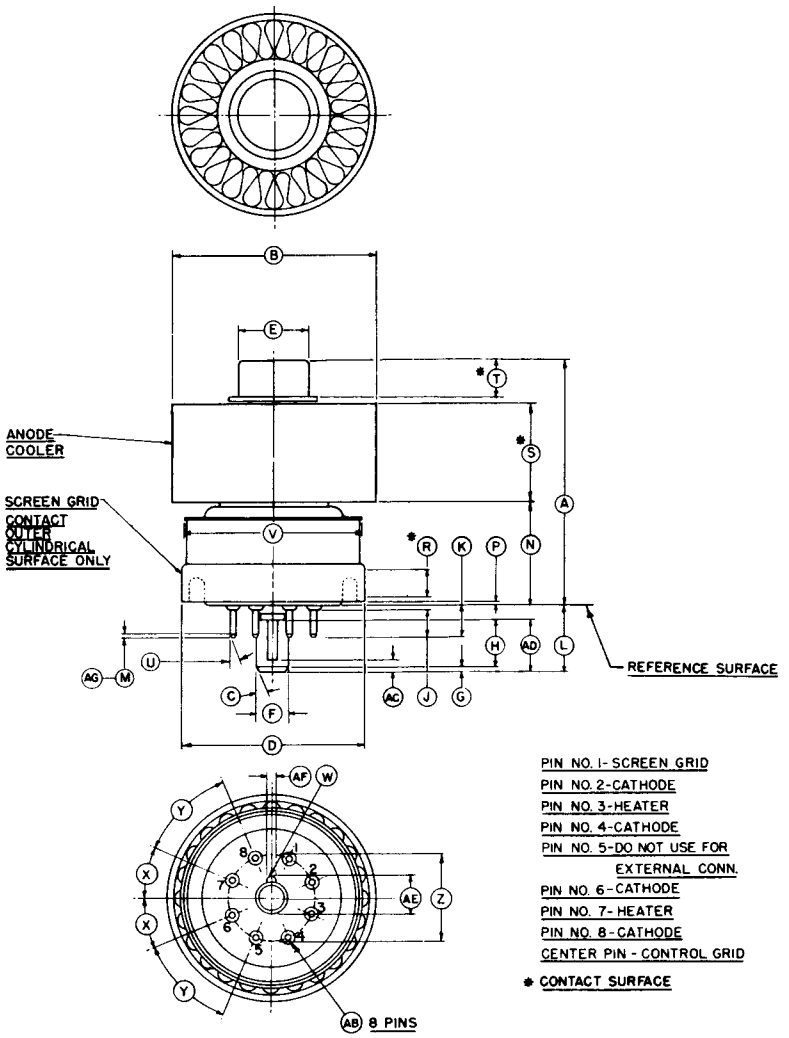
Screen Grid—Screen dissipation maximum is 12 watts, normally computed by multiplying d-c screen voltage by the average screen current. This computation is essentially correct except in the case of heavy plate loading when secondary-emission current may mask the normal screen current.

All tetrodes, under some conditions of loading and drive, will have secondary emission from the screen which changes the net current to the screen and may even cause the screen meter to reverse. Normally, secondary emission is harmless provided the screen voltage is stable. To insure stable screen voltage, it is recommended that a bleeder resistor to pass 15 ma from screen to ground be used.

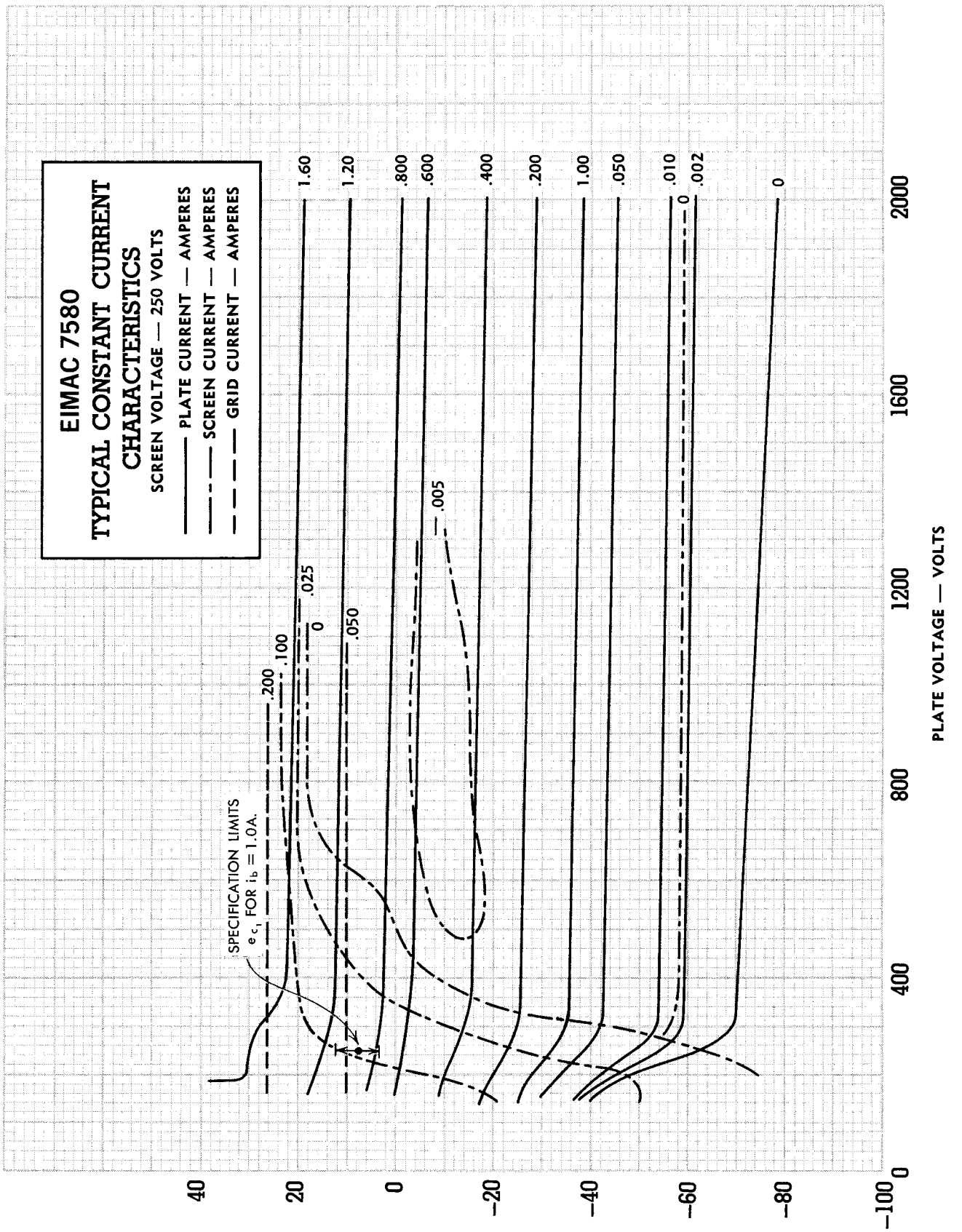
Plate Dissipation—The maximum plate dissipation is 250 watts. The usual single-sideband voice signal is complex and full peak envelope power shown in Typical Operating Conditions, may be developed without exceeding this plate dissipation. Single-tone testing for short periods with greater than 250 watts plate dissipation is permissible.

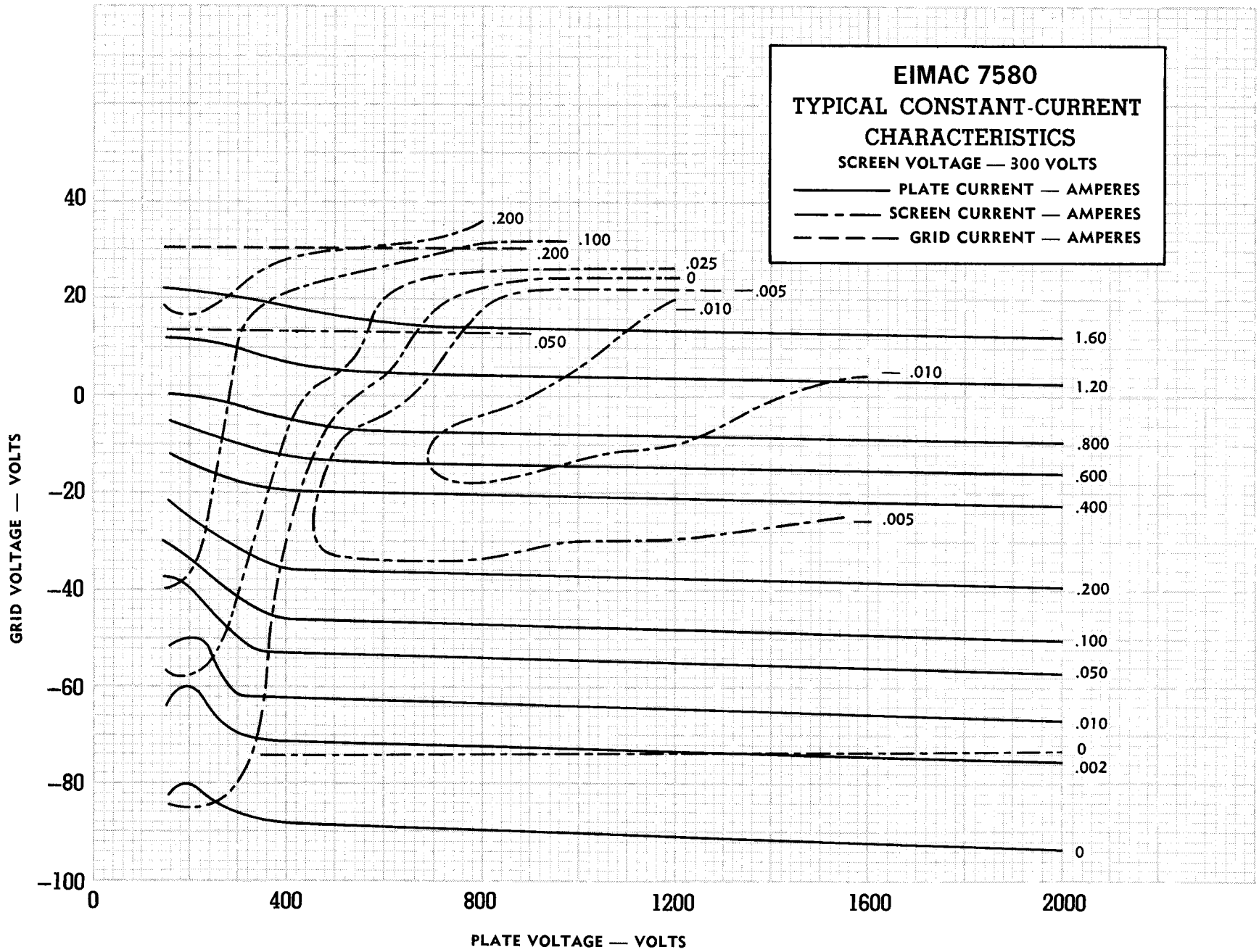
Multiple Operation — To obtain maximum power with minimum distortion from tubes operated in multiple it is desirable to adjust individual screen or grid-bias voltages so the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual d-c plate currents will be approximately equal for full input signal for class-AB_1 operation.

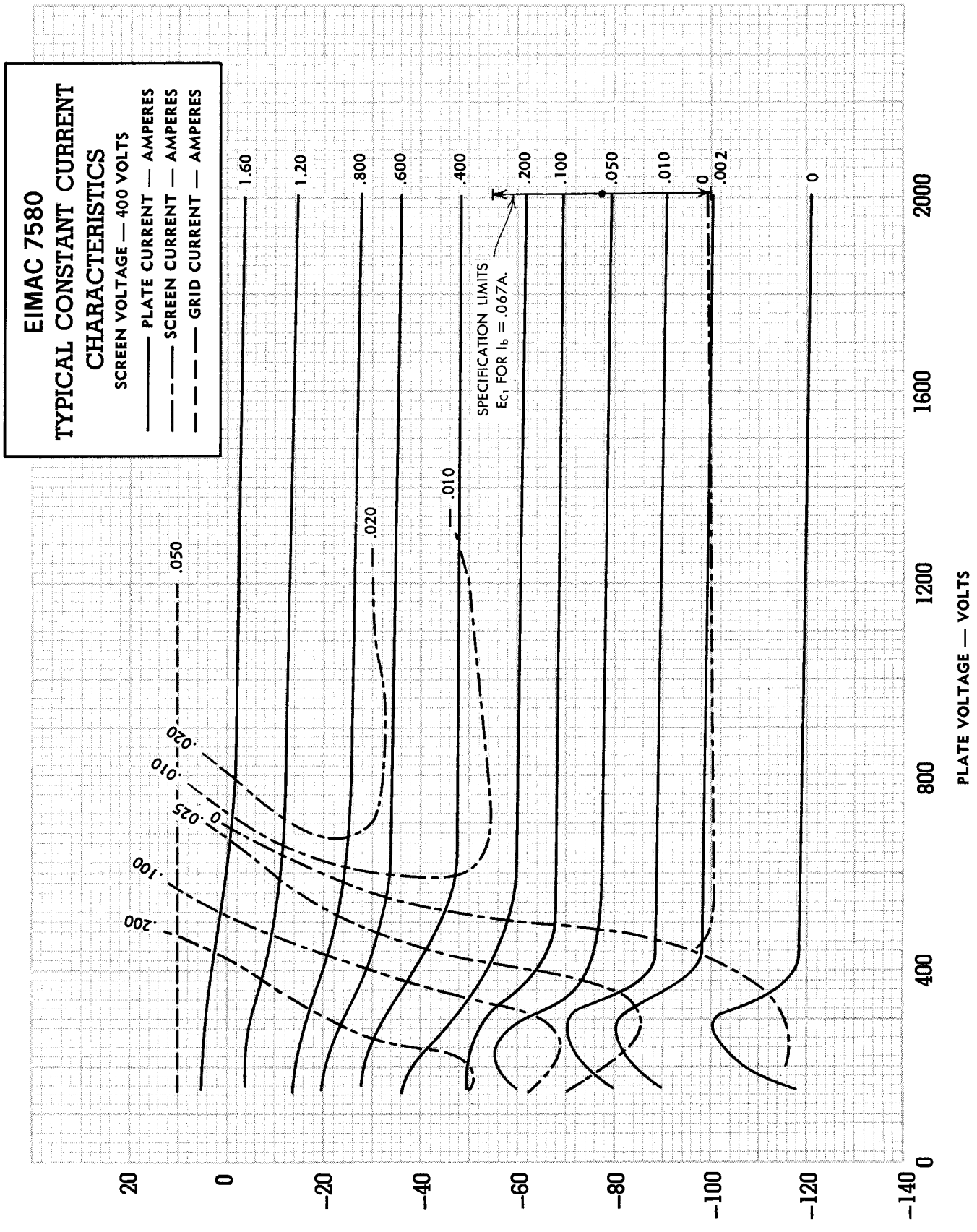
Special Application—If it is desired to use the 7580 under conditions widely different from those given here, consult the Power Grid Tube Marketing Department, Eitel-McCullough, Inc., San Carlos, California, or any of our regional offices or representatives.



DIMENSIONS IN INCHES		
REF.	MIN.	MAX.
A	1.810	1.910
B	1.610 DIA.	1.640 DIA.
C	30°	
D	1.417 DIA.	1.433 DIA.
E	.559 DIA.	.573 DIA.
F	.255 DIA.	.265 DIA.
G	.031	
H	.360	
J	.187	
K		.250
L	.514	.554
M	.035	
N	.750	.810
P	.020	
R	.187	
S	.710	.790
T	.240	.280
U	22 1/2°	
V		1.406 DIA.
W		.043 R.
X	22 1/2°	
Y	45°	
Z	.680 DIA. P.C.	.694 DIA. P.C.
AB	.045 DIA.	.053 DIA.
AC	.068	.108
AD		.456
AE	.298	.308
AF	.078	.086
AG	.005 R. MIN. (ALTERNATE TO M&U)	


EIMAC 7580
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE — 250 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
SPECIFICATION LIMITS
e_{c_1} FOR i_b = 1.0A.
1.60
1.20
.800
.600
.400
.200
1.00
.050
.010
0
.002
0
.200
.100
.050
0
.025
.005
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS
40
20
0
−20
−40
−60
−80
−100
0
400
800
1200
1600
2000


EIMAC 7580
TYPICAL CONSTANT-CURRENT CHARACTERISTICS
SCREEN VOLTAGE — 300 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS
40
20
0
−20
−40
−60
−80
−100
0
400
800
1200
1600
2000
.200
.100
.200
.025
0
.005
.010
.050
1.60
.010
1.20
.800
.600
.400
.005
.200
.100
.050
.010
0
.002
0



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EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

7580W
4CX250R
RADIAL-BEAM POWER TETRODE

The 4CX250R is a compact, high-perveance radial-beam tetrode designed specifically for use in class-AB$_1$ linear amplifiers where shock and/or vibration preclude the use of non-ruggedized tube types. The 4CX250R will replace the 7580 in almost all applications since it is electrically identical except for a minute (0.2 uuf) increase in output-capacitance limits. Further, it will replace the 4X250B or 4CX250B in equipments where the range of bias adjustment will tolerate this higher perveance tube and where tuning range can compensate for the small differences in input and output capacitances.

The 4CX250R will deliver more output power in most linear amplifiers which presently employ the 4X250B or 4CX250B and it will operate with maximum rated plate and screen voltages applied in equipments where shock and/or vibration is experienced. See **Shock and Vibration** section on page two for details.



GENERAL CHARACTERISTICS

ELECTRICAL

		Min.	Nom.	Max.	
Cathode:	Oxide-Coated, Unipotential				
	Heating Time	30	60		seconds
	Cathode-to-Heater Potential	—		±150	volts
Heater:	Voltage		6.0		volts
	Current	2.3		2.9	amperes
Direct Interelectrode Capacitances, Grounded Cathode:					
	Input	16.0		18.5	uuf
	Output	4.2		5.2	uuf
	Grid-to-Plate			0.06	uuf
Frequency for Maximum Ratings				500	Mc

MECHANICAL

Base	Special 9-pin
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250°C
Anode Core	250°C
Recommended Socket	Eimac SK-600 Series
Operating Position	Any
Maximum Dimensions:	
Height	2.464 inches
Seated Height	1.910 inches
Diameter	1.640 inches
Cooling	Forced Air
Net Weight	4 ounces
Shipping Weight (Approximate)	1.6 pounds

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB$_1$ - Single Sideband

MAXIMUM RATINGS

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	500 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS

TYPICAL OPERATION

Two-Tone where peak envelope power is at least twice the average power output—Actual measurements—Tank-circuit efficiency estimated at 95%.

D-C Plate Voltage	1500	2000	volts
Zero-Signal D-C Plate Current	133	070	ma
Two-Tone D-C Plate Current	250	245	ma
D-C Screen Voltage	350	400	volts
Two-Tone D-C Screen Current	—10	+1	ma
D-C Grid-Bias Voltage	—62	—80	volts
Peak Signal Voltage	56	80	volts
3rd Order Intermodulation products referred to signal level	—30	—23	db
5th Order Intermodulation products referred to signal level	—35	—27	db
Worst 3rd Order Intermodulation as drive signal is reduced	—29	—21	db
Load Resistance	2160	2840	ohms
Peak Envelope Power, Useful	262	470	watts

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RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1 (Carrier with Double Sidebands)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	500 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS

TYPICAL OPERATION—Single Tube

(Quantities shown for carrier conditions, no modulation)

D-C Plate Voltage	1500	2000	volts
D-C Plate Current	172	172	ma
D-C Screen Voltage	350	400	volts
D-C Screen Current (Approx)	—3	—5	ma
D-C Grid-Bias Voltage	—58	—76	volts
Peak Grid-Signal Voltage	30	39	volts
Plate-Load Resistance	2320	3150	ohms
Power Output for Tank Circuit Efficiency of 95%	55	100	watts

AUDIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1

MAXIMUM RATINGS (Per Tube)

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	500 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS

TYPICAL OPERATION (Two Tubes Push-Pull)

D-C Plate Voltage	1500	2000	volts
D-C Plate Current No Signal	200	140	ma
D-C Plate Current at Full Signal	490	500	ma
D-C Screen Voltage	300	350	volts
D-C Screen Current No Signal	—2	—4	ma
D-C Screen Current at Full Signal	0	+4	ma
D-C Grid-Bias Voltage (Approx)	—48	—66	volts
Plate-to-Plate Load Resistance	5920	8016	ohms
Power Output for Transformer Efficiency of 95%	390	595	watts

MAXIMUM RATINGS FOR OTHER TYPES OF OPERATION

Class-C Telegraphy or FM

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

Class-C, Plate Modulated

D-C PLATE VOLTAGE	1500 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	165 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

APPLICATION

MECHANICAL

Mounting—The 4CX250R may be mounted in any position. An Eimac Air-System Socket of the SK-600 series or equivalent is recommended. These sockets may be obtained with or without the r-f screen by-pass capacitor, and with or without the four cathode terminals grounded to the socket shell. A simple Lock-in socket restricts the flow of cooling air and is not recommended.

Cooling—The 4CX250R has an efficient louvered anode cooler. The maximum allowable temperature for any external surface is 250°C.

For long service life at sea level, at an ambient temperature of 25°C and maximum rated anode dissipation of 250 watts, a *minimum* of 4.6 cfm air should flow from tube base through the anode cooler. The corresponding pressure drop with the recommended socket and chimney will be approximately 0.32 inch water column. See table for other dissipation levels and conditions.

4.6 cfm of air at 25°C is the same as a mass air flow of 18 pounds per hour. Higher ambient temperature requires greater air mass and volume. Higher altitude requires equivalent mass air flow for a given ambient temperature and therefore requires greater volume at increased back pressure.

The use of temperature-sensitive laquer is recommended to determine the effectiveness of a cooling system under operating conditions.

Plate Dissipation (Watts)	55°C AMBIENT			
	SEA LEVEL		10,000 FEET ALTITUDE	
	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
75	1.15	0.025	1.8	0.036
125	2.3	0.09	3.35	0.13
250	6.4	0.59	9.3	0.86

Shock and Vibration—The 4CX250R is one of the Eimac tube types which is unique in that shock and vibration testing is performed with *maximum rated plate and screen voltages* applied. Two samples of production tubes are randomly selected periodically and tested under the conditions outlined below.

With *maximum rated plate and screen voltages* applied, each of the tubes in this sample is subjected to six shocks of 90 G (minimum) half-sine-wave motion, with a duration of 11 ± 2 milliseconds, in each of the three major axes (X1, X2, and Y1).

With *maximum rated plate and screen voltages* applied and with control-grid voltage adjusted to allow the flow of 100 ma through a plate load resistor of 4900 ohms, each of the tubes in this sample is vibrated in the three major axes throughout the range of 5-750-5 cps in a minimum time of six minutes per axis. The vibration level is maintained at 10 G from 28 cps to 750 cps and at 0.25 inch D.A. from 5 cps to 28 cps. During this test, noise voltage developed across the plate load resistor cannot exceed 30 volts rms. Sufficient plate power-supply voltage (2500 volts) is em-

ployed to assure that a minimum of 2000 volts appears at the plate of the tube under test even though 490 volts drop across the plate load resistor results from d-c plate-current flow.

The equipment designer is cautioned to provide adequate tube support to prevent relative motion between tube and socket in equipments where shock and/or vibration are anticipated.

ELECTRICAL

Heater—For maximum life and uniform performance, the heater voltage should be maintained within plus or minus 5% of the rated 6.0 volts at operating frequencies up to 300 Mc. For CW use between 300 and 400 Mc, 5.75 volts is recommended. For CW use, 400 to 500 Mc, 5.5 volts is recommended.

Cathode—The cathode is connected to the four even-numbered base pins to provide a low-inductance path, or permit separation of input and output circuits if required.

Rated heater voltage should be applied for 30 seconds before other operating voltages are applied.

Heater-to-cathode maximum voltage is ±150 volts.

Control Grid—Maximum rated d-c bias voltage is −250 volts. D-C resistance, grid to cathode, should be no more than 100,000 ohms.

Screen Grid—Maximum screen dissipation is 12 watts, normally computed by multiplying d-c screen voltage by the average screen current. This computation is essentially correct except in the case of heavy plate loading when secondary-emission current may mask the normal screen current.

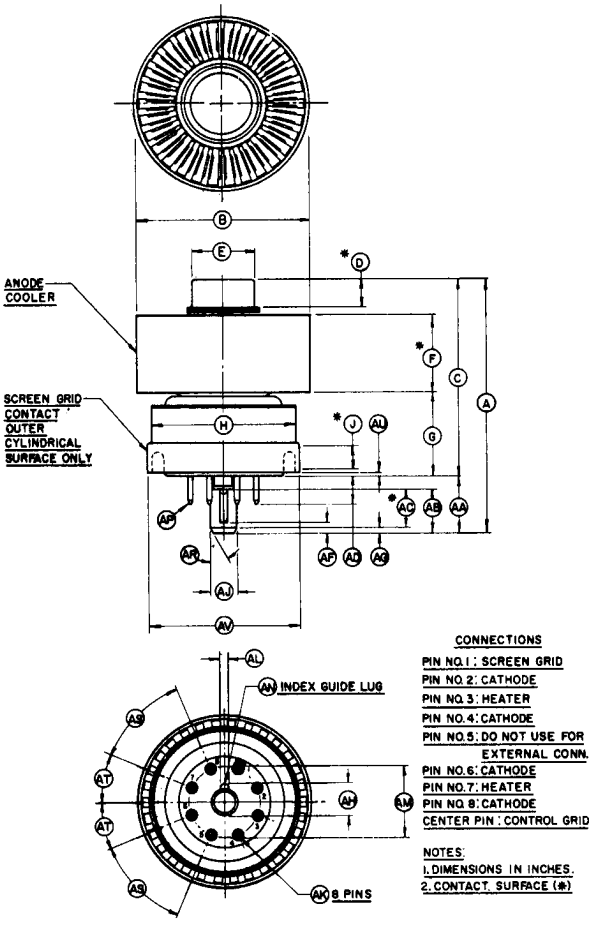
All tetrodes, under some conditions of loading and drive, will exhibit secondary emission from the screen which changes the net current to the screen and may even cause the screen meter to reverse. Normally, secondary emission is harmless provided the screen voltage is stable. To insure stable screen voltage, it is recommended that a bleeder resistor calculated to pass 15 ma from screen to ground be used.

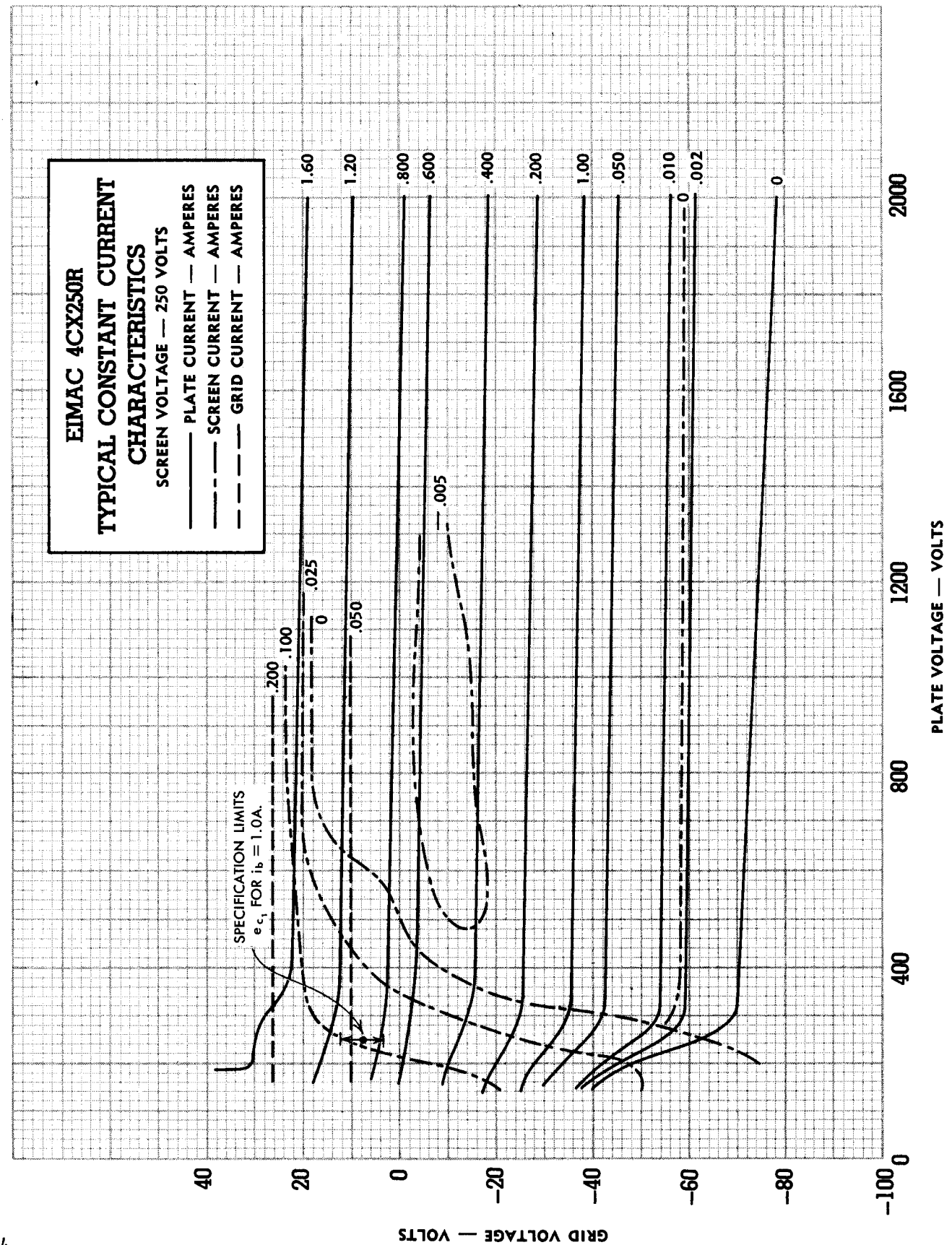
Plate Dissipation—The maximum plate dissipation is 250 watts. The usual single-sideband voice signal is complex and full peak envelope power shown in Typical Operating Conditions, may be developed without exceeding this plate dissipation. Single-tone testing for short periods with greater than 250 watts plate dissipation is permissible.

Multiple Operation — To obtain maximum power with minimum distortion from tubes operated in multiple it is desirable to adjust individual screen or grid-bias voltages so the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual d-c plate currents will be approximately equal for full input signal for class-AB_1 operation.

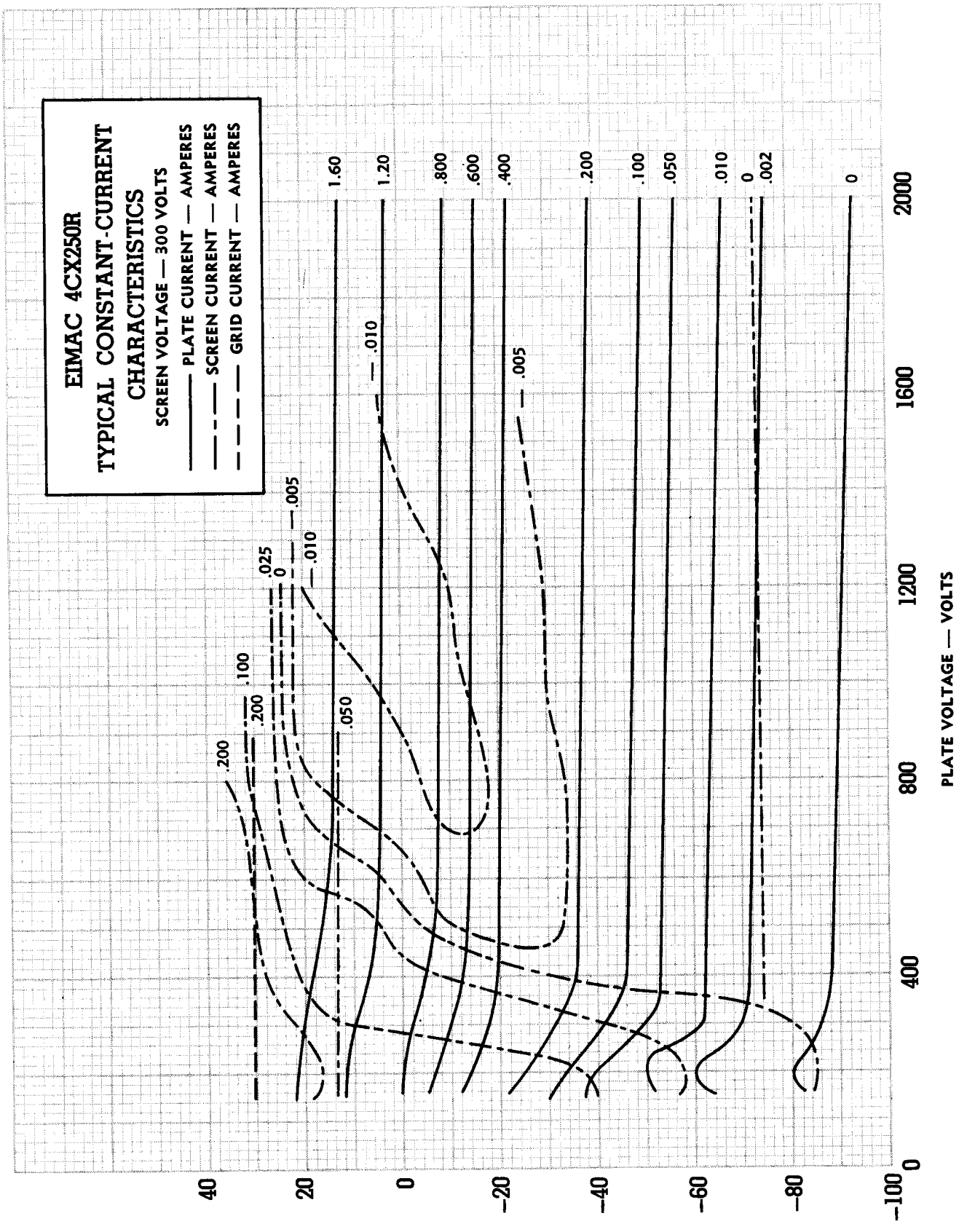
Special Application—If it is desired to use the 4CX250R under conditions widely different from those given here, consult the Power Grid Tube Marketing Department, EIMAC Division of Varian, San Carlos, California.

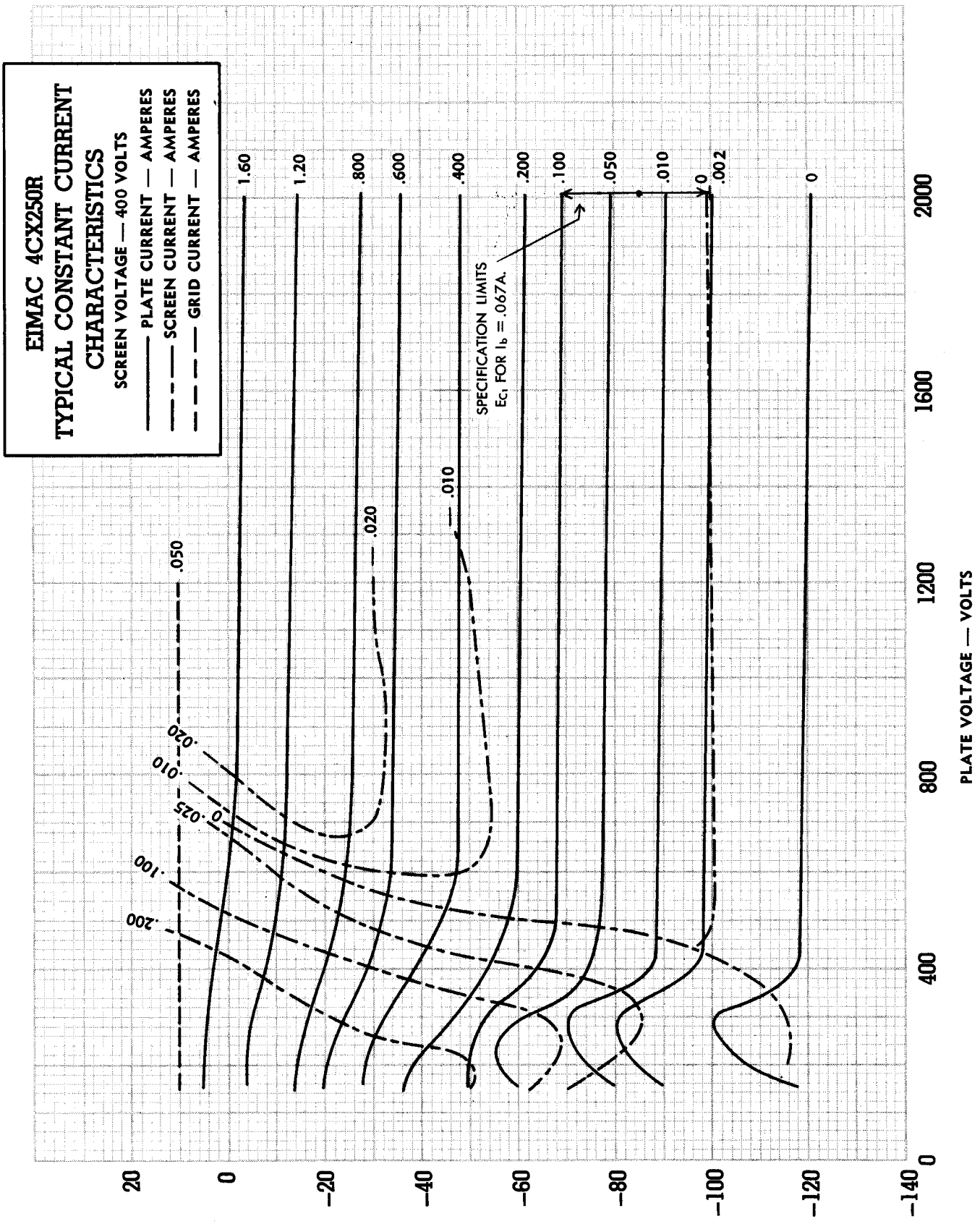
DIMENSION DATA		
REF.	MIN.	MAX.
A	2.324	2.464
B	1.610 DIA.	1.640 DIA.
C	1.810	1.910
D	.240	.280
E	.559 DIA.	.573 DIA.
F	.710	.790
G	.750	.810
H		1.406 DIA.
J	.187	
AA	.514	.554
AB		.456
AC	.360	
AD		.250
AF	.068	.108
AG	.031 NOM.	
AH	.298	.308
AJ	.255 DIA.	.265 DIA.
AK	.045 DIA.	.053 DIA.
AL	.078	.086
AM	.680 DIA.	.694 DIA.
AN		.043 R.
AP	.005 R. MIN. OR	
	.035 X 22.5°	
AR	30° NOM.	
AS	45° NOM.	
AT	22.5° NOM.	
AU	.080 NOM.	
AV	1.417 DIA.	1.433 DIA.




EIMAC 4CX250R
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE — 250 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
1.60
1.20
.800
.600
.400
.200
1.00
.050
.010
0
.002
0
.005
.025
0
.050
.100
.200
SPECIFICATION LIMITS
e_{c_1} FOR i_b = 1.0A.
40
20
0
-20
-40
-60
-80
-100
0
400
800
1200
1600
2000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

EIMAC 7580


EIMAC 4CX250R
TYPICAL CONSTANT-CURRENT CHARACTERISTICS
SCREEN VOLTAGE — 300 VOLTS
——— PLATE CURRENT — AMPERES
— - — - — SCREEN CURRENT — AMPERES
— — — — GRID CURRENT — AMPERES
1.60
1.20
.800
.600
.400
.200
.100
.050
.010
0
.002
0
.005
.010
.025
0
.005
.050
.100
.200
.200
40
20
0
-20
-40
-60
-80
-100
0
400
800
1200
1600
2000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS


EIMAC 4CX250R
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE — 400 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
1.60
1.20
.800
.600
.400
.200
.100
.050
.010
0
.002
0
.050
.020
.010
0
.025
.100
.200
.020
SPECIFICATION LIMITS
E_{C_1} FOR I_b = .067A.
20
0
-20
-40
-60
-80
-100
-120
-140
0
400
800
1200
1600
2000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

7815
3CPN10A5
UHF PULSE TRIODE



The Eimac 7815/3CPN10A5 is a low duty pulse rated version of the 3CX100A5 with the anode cooler removed. A longer grid-anode ceramic insulator is incorporated, making the tube useful at high altitude. The nominal plate dissipation rating is 10 watts but may be increased if sufficient cooling is provided. Cooling is accomplished by conduction through a suitable heat sink or convection. Where greater plate dissipation is required, the 7815R/3CPX100A5 should be used.

The tube is usable in pulse applications to 3000 Megacycles. Electrical characteristics except for plate dissipation are similar to the 3CX100A5.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide-coated, Unipotential				
Heating time	60			seconds
Heater:				
Voltage		6.0		volts
Current	0.90		1.05	amperes
Amplification Factor		100		
Transconductance (1 b = 70 milliamperes)		25,000		Micromhos

Direct Interelectrode Capacitances	Min.	Max.
Grid-Cathode	5.6	7.0 uuf
Grid-Plate	1.86	2.10 uuf
Plate-Cathode	-	0.035 uuf
Frequency for Maximum Ratings		3000 Megacycles

MECHANICAL

Terminals	Graduated Cylindrical Surfaces
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250°C
Anode Core	250°C
Operating Position	Any
Cooling	Conduction and Convection
Maximum Overall Dimensions:	
Length	2.701 inches
Diameter	1.195 inches
Net Weight	2.0 ounces
Shipping Weight (approx.)	7.0 ounces

PLATE PULSED OSCILLATOR OR AMPLIFIER CLASS-C

MAXIMUM RATINGS

PEAK PULSE PLATE VOLTAGE	3500 MAX. VOLTS
DC GRID VOLTAGE	-150 MAX. VOLTS
PULSE PLATE CURRENT	3.0 MAX. VOLTS
DC CATHODE CURRENT	125 MAX. MA
PULSE GRID CURRENT	1.8 MAX. AMPS
PLATE DISSIPATION (AVG)	10 MAX. WATTS
GRID DISSIPATION (AVG)	2 MAX. WATTS

TYPICAL OPERATION

Pulse Plate Voltage	3500	3500 volts
Pulse Plate Current	3.0	3.0 amps
DC Plate Current (avg)	7.5	9 mA
DC Grid Current (avg)	4.5	3 mA
Pulse Power Output	1600	2000 watts
Frequency	3000	2500 Mc
Pulse Length	3	5 usec
Duty Factor	0.0025	0.003

(Effective 1-1-63) © Copyright. 1963 by Eitel-McCullough, Inc.

GRID PULSED OSCILLATOR OR AMPLIFIER CLASS-C

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 MAX. VOLTS
DC GRID VOLTAGE	-150 MAX. VOLTS
PULSE PLATE CURRENT	3.0 MAX. AMPS
DC CATHODE CURRENT	125 MAX. MA.
PLATE DISSIPATION (AVG)	10 MAX. WATTS
GRID DISSIPATION (AVG)	2 MAX. WATTS

TYPICAL OPERATION

DC Plate Voltage	1600	1700 volts
DC Grid Voltage	-45	-45 volts
Pulse Plate Current	3.0	1.9 amps
Pulse Grid Current	1.8	1.1 amps
Pulse Power Output	1000	1500 watts
Frequency	3000	1100 Mc
Pulse Length	3	3.5 usec
Duty Factor	0.0025	0.001

APPLICATION

MECHANICAL

Mounting—The 3CPN10A5 may be operated in any position. It should be firmly held in place by spring-finger collets bearing on the terminal surfaces. In use the tube should seat against the underside of the anode-terminal flange which is on the plane of reference for longitudinal dimensions. In appplications involving severe shock and vibration, the tube may be clamped in place by applying a suitable clamping device to the anode-terminal flange. It is recommended that no other portion of the tube be subjected to clamping forces.

Connections—The terminals are in the form of concentric cylinders of graduated diameters conveniently used with coaxial tuning devices. Spring-fingered collets should be used to make contact with the anode, grid, cathode and heater terminals. Adequate contact area and spring pressure should be provided to minimize heating and to prevent erratic circuit performance at the higher frequencies. Non-contacting or intermittently-contacting collet fingers will cause troublesome circuit behavior, especially at very-high and ultra-high frequencies. Electrode contact surfaces should be kept clean and free of oxide coatings.

Cooling—Sufficient cooling air must be provided for the anode and body seals to maintain operating temperatures below the rated maximum value of 250°C.

The nominal plate dissipation rating is 10 watts and is dependent on convection cooling to a heat sink. Where adequate cooling is provided this value may be extended. Where greater plate dissipation is required use of the 3CPX100A5 is recommended.

It should be borne in mind that operating temperature is the sole criterion of cooling effectiveness, regardless of the coolant type, flow rate or coolant temperature. One method of measuring the surface temperatures is the use of temperature sensitive lacquer, such as "Tempilaq."

ELECTRICAL

Heater Operation—The rated heater voltage for the 3CPN10A5 is 6.0 volts. The heater voltage for the 3CPN10A5 should be maintained within plus or minus 5% of its intended value to minimize variations in circuit performance and to obtain maximum tube life.

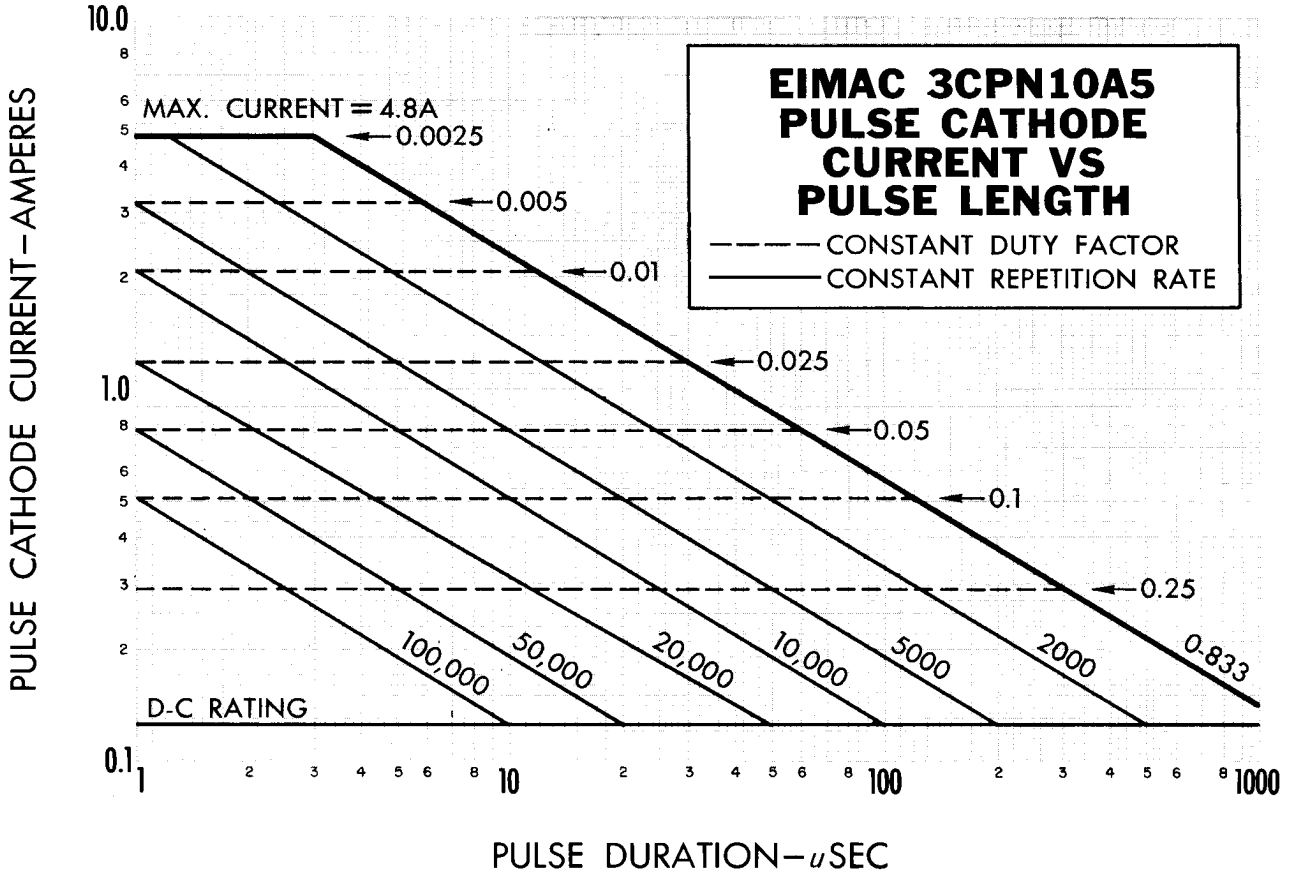
At frequencies above approximately 1000 megacycles, transit time effects begin to influence cathode temperature. The amount of driving power diverted to heating the cathode by back-bombardment will depend upon the frequency, the plate current, driving power, and duty factor. If the conditions of operation result in appreciable cathode back-heating, it may be necessary to start dynamic tube operation at normal heater voltage followed by a reduction of heater voltage to a lower value. The heater of the 3CPX10A5 must not be operated at less than 4.5 volts in any case.

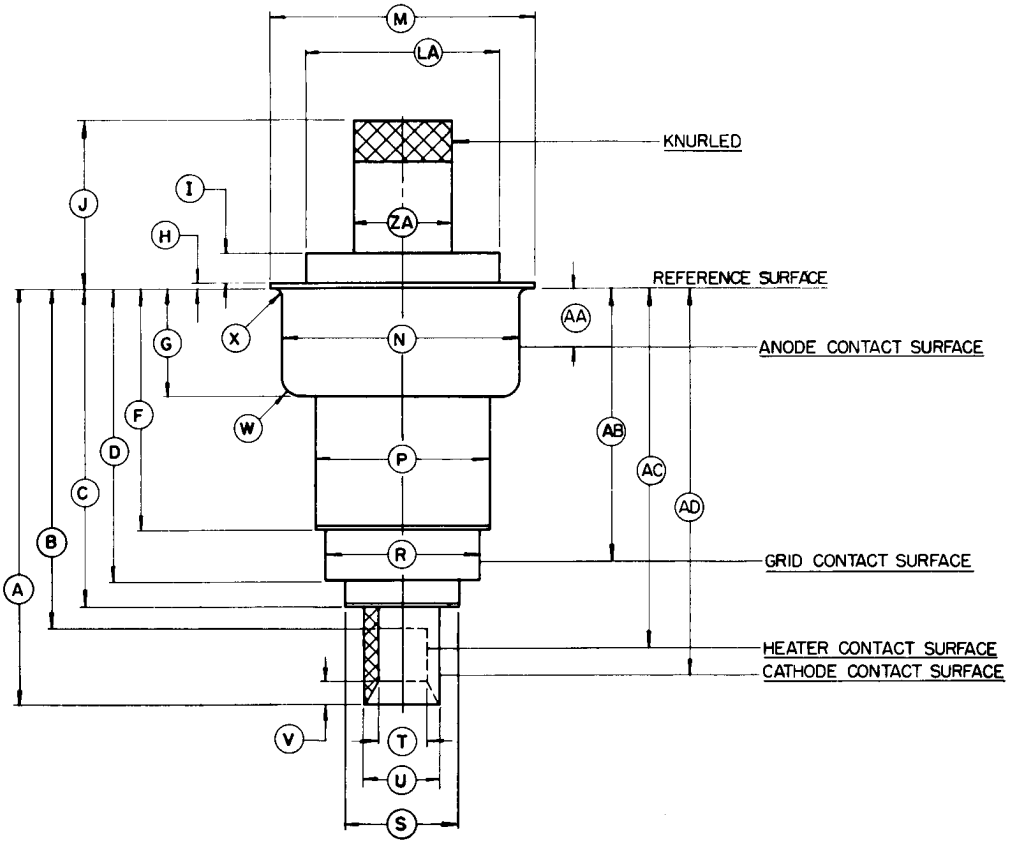
Cathode Operation—The oxide-coated unipotential cathode in this tube must be protected against excessively high emission currents. For all types of operation the maximum rated dc current is 125 milliamperes. In pulse service, current must be limited according to the curve on page 3.

It is recommended that the rated heater voltage be applied for a minimum of 60 seconds before other operating voltages are applied.

Control Grid Operation—Grid dissipation must not exceed the rated maximum 2.0 watts grid dissipation power. In pulse applications the instantaneous peak grid-to-cathode voltage must be limited to +250 to −750 volts.

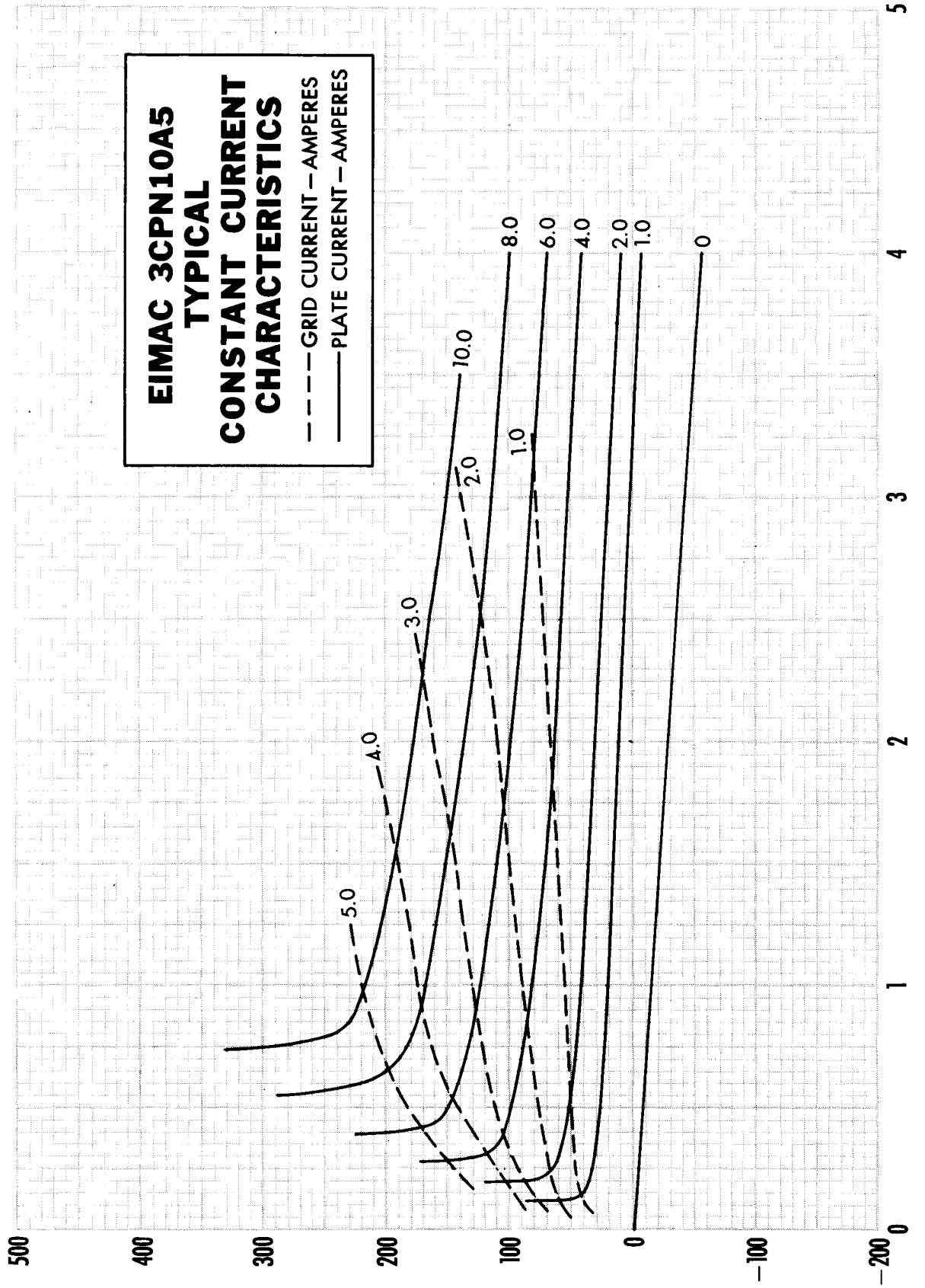
Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California for information and recommendations.





DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	1.815	1.875	
B		1.534	
C		1.475	
D	1.289	1.329	
F	.970	1.010	
G	.462	.477	
H		.040	
I		.185	
J	.766	.826	
M	1.180	1.195	
N	1.025	1.035	
P	.772	.792	
R	.655	.665	
S		.545	
T	.213	.223	
U	.315	.325	
V		.086	
W		.100	
X		.035	
LA			.850
ZA	.427	.447	

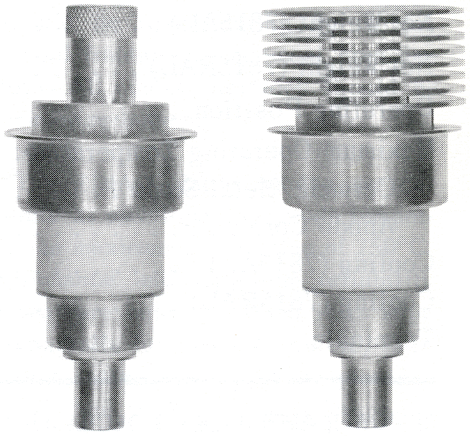
ELECTRODE CONTACT AREA		
REF		
AA	.198±.163	ANODE
AB	1.225±.040	GRID
AC	1.631±.097	HEATER
AD	1.645±.170	CATHODE


EIMAC 3CPN10A5
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
– – – – GRID CURRENT – AMPERES
——— PLATE CURRENT – AMPERES
10.0
8.0
6.0
5.0
4.0
3.0
2.0
1.0
4.0
2.0
1.0
0
500
400
300
200
100
0
–100
–200
0
1
2
3
4
5
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS

7815AL
7815RAL

PLANAR TRIODES

The EIMAC 7815AL and 7815RAL are ceramic/metal planar triodes specially processed and tested to assure high reliability in airborne service. Evaluation of these tubes is based upon operating conditions in grid- or plate-pulsed oscillator service (transponder) and in grid- or plate-pulsed amplifier service in distance measuring equipment (DME). The testing emphasizes cathode emission capability at reduced heater voltage and high voltage hold-off, both features which are demanded in airline service.



7815AL 7815RAL

The 7815AL is derived from the 7815/3CPN10A5 and the 7815RAL from the 7815R/3CPX100A5. These new improved tubes also contain the features of the original types, including rugged ceramic/metal construction, low interelectrode capacitance, high transconductance and high mu. The longer grid-anode ceramic insulator of the earlier type is used, making the 7815AL and 7815RAL tubes especially suited for high altitude airborne operation.

In addition to these features, these tubes also incorporate the arc-resistant cathode which assures stable operation under adverse conditions and which minimizes catastrophic failure due to arc-over during circuit malfunction. Both tubes are useable from dc to 3 GHz.

GENERAL CHARACTERISTICS [1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	5.7 (±2%)	V
Current, at 5.7 volts	0.95	A
Transconductance (Average):		
I_b = 70 mAdc, E_b = 600 Vdc	25	mmhos
Amplification Factor (Average)	100	
Direct Interelectrode Capacitance (grounded cathode)[2], without heater voltage:		
Grid-Cathode	6.30	pF
Grid-Plate	1.98	pF
Plate-Cathode(maximum)	0.035	pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture.

(Effective 7-1-70) © 1970 by Varian Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:	
Length	2.701 in; 68.60 mm
Diameter (7815AL)	1.195 in; 30.35 mm
Diameter (7815RAL)	1.264 in; 32.11 mm
Net Weight (7815AL)	1.8 oz; 48 gm
Net Weight (7815RAL)	2.2 oz; 63 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling (7815AL)	Conduction and Convection
Cooling (7815RAL)	Forced Air
Terminals	Special

RF POWER AMPLIFIER OR OSCILLATOR

Grid- or Plate-Pulsed

MAXIMUM RATINGS, ABSOLUTE VALUES

DC PLATE VOLTAGE	3500	VOLTS
PEAK PULSE PLATE VOLTAGE		
PLATE PULSED	4500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-700	VOLTS
Grid positive to cathode	250	VOLTS
PULSE PLATE CURRENT	3.0	AMPERE
PULSE GRID CURRENT	1.8	AMPERE
DC CATHODE CURRENT	125	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Conduction and Convection (7815AL)	10	WATTS
Forced Air Cooling(7815RAL)	45	WATTS
GRID DISSIPATION (Average)	2	WATTS
DUTY FACTOR[1]	.0033	
PULSE DURATION[1]	6	μs
FREQUENCY	3	GHz

1. For longer pulse duration or higher duty cycle, consult the nearest Varian Electron Tube and Device Group Sales Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah, or San Carlos, California.

OPERATING CONDITIONS FOR THE 7815AL and 7815RAL in REPRESENTATIVE APPLICATION.

Grid-Pulsed Oscillator

Frequency	1.090	GHz
Heater Voltage	5.7	V
DC Plate Voltage	2000	Vdc
DC Grid Voltage	-75	Vdc
Peak Plate Current	1.1	a
Peak Grid Current	0.8	a
Pulse Duration	0.5	μs
Duty	0.001	
Useful Power Output (Approx.)	750	w

Plate-Pulsed Amplifier

Frequency	1.1	GHz
Heater Voltage	5.7	V
Peak Plate Pulse Voltage	2000	Vdc
DC Grid Voltage	-45	Vdc
Peak Plate Current	1.8	a
Peak Grid Current	1.0	a
Pulse Duration	3.5	μs
Duty	0.001	
Driving Power	300	w
Useful Power Output (Approx.)	1800	w
Gain	8	db
Plate Efficiency	50%	

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater Current at 5.7 volts	0.87	1.02	A
Cut-off Bias [1]	---	-25	V
Grid-Plate Capacitance[2]	1.85	2.10	pF
Grid-Cathode Capacitance[2]	5.60	7.00	pF
Plate-Cathode Capacitance	---	0.035	pF

1. Measured with 1 mA plate current and a plate voltage of 1000 Vdc.
2. Capacitance values as measured with a cold tube and in a shielded socket. When the cathode is heated to the proper temperature the grid-cathode capacitance will increase by approximately 1 pF due to thermal expansion of the cathode support.

APPLICATION

MECHANICAL

MOUNTING - The important dimensions of the tube are carefully controlled with respect to the reference surface as shown on the outline drawing. The reference surface is intended to serve as a tube stop and the location of the tube in the circuit should therefore be determined by this surface coming in positive contact with a precisely positioned member of the socket or cavity. Adherence to this practice will assure both mechanical and electrical interchangeability of all tubes of a given type. If a non-designated surface is used as a tube stop, faulty positioning of the tube in the cavity and possible incomplete electrical contact can result in improper tuning, reduced power output and damage to the cavity, tube or both. Contact surfaces, with reference to the designated tube stop are shown in the outline drawing. Electrical contact to the cathode, grid, anode and also the heater should be restricted to these designated contact areas.

Dimensions should never be taken from sample tubes. Dimensional changes due to normal variations in undimensioned surfaces may occur within the limits specified on the outline drawing. Use of nondesignated electrical contact surfaces might therefore result in incomplete contact or mechanical interference, causing changes in cavity tuning.

Electrical contact should be made by spring finger collets bearing against the previously described contact areas. If connections are employed which do not provide multiple contacts to the designated contact areas, concentration of RF current will result in loss of output power, especially at higher frequencies. The spring contacts used should exert a firm pressure without gouging the plated contact surface. This latter phenomena can result in loose particles of material which can cause arcing or unstable operation of the cavity.

If the tubes are used in applications which call for severe shock or vibration the tube may be clamped in place by the knob or radiator, exerting pressure only on this part of the tube and against the tube stop. No other portion of the tube should be subject to any clamping force. In particular, electrical contacts which utilize setscrews or rigid clamps should be avoided. Such contact schemes can distort the contact surfaces causing undue stress in the metal-to-ceramic seal area which may result in a vacuum leak. Soldered electrical connections can be made, however great care should be taken during the solder operation to avoid fracture of the seal area due to thermal shock. All contact surfaces should be kept clean to minimize losses.

COOLING - The EIMAC planar triodes are designed to operate at envelope and anode temperatures of up to the maximum rated value of 250°C. However, performance and long-term reliability of any component are improved when it is kept as cool as technically feasible. Therefore, it is recommended that sufficient cooling be provided to keep the anode and seal areas well below the specified maximum temperature, where long tube life and high reliability are of great importance.

The maximum plate dissipation of the 7815AL is 10 watts average power. This can be accomplished by conduction, natural convection or forced air convection cooling. The maximum plate dissipation of the 7815RAL in pulse service is 45 watts average and forced air cooling must be employed at that level. When forced air cooling is used, it is recommended that additional airflow, apart from that flowing through the radiator be used to cool the tube envelope and other tube terminals. A certain amount of conduction cooling is usually inherent in the contact finger configuration. It should be noted, however, that spring fingers provide poor heat conduction and measurements have shown a temperature difference as much as 50°C between the contact finger and contact area.

It is suggested that in all new applications the envelope temperature be measured, especially if the tube is used close to the upper temperature limit. The temperature can easily be determined by the use of Tempilaq paint (Tempil Division, Big Three Industrial Gas & Equipment Co., Hamilton Blvd., So. Plainfield N.J. 07080) or Temp-Plate stickers (Pydrodyne, Inc., 1001 Colorado, Santa Monica, Calif. 90404)

ELECTRICAL

HEATER VOLTAGE - The rated heater voltage for either tube type is 5.7 volts and should be controlled within ±2% to obtain maximum tube life and to minimize variations in circuit performance.

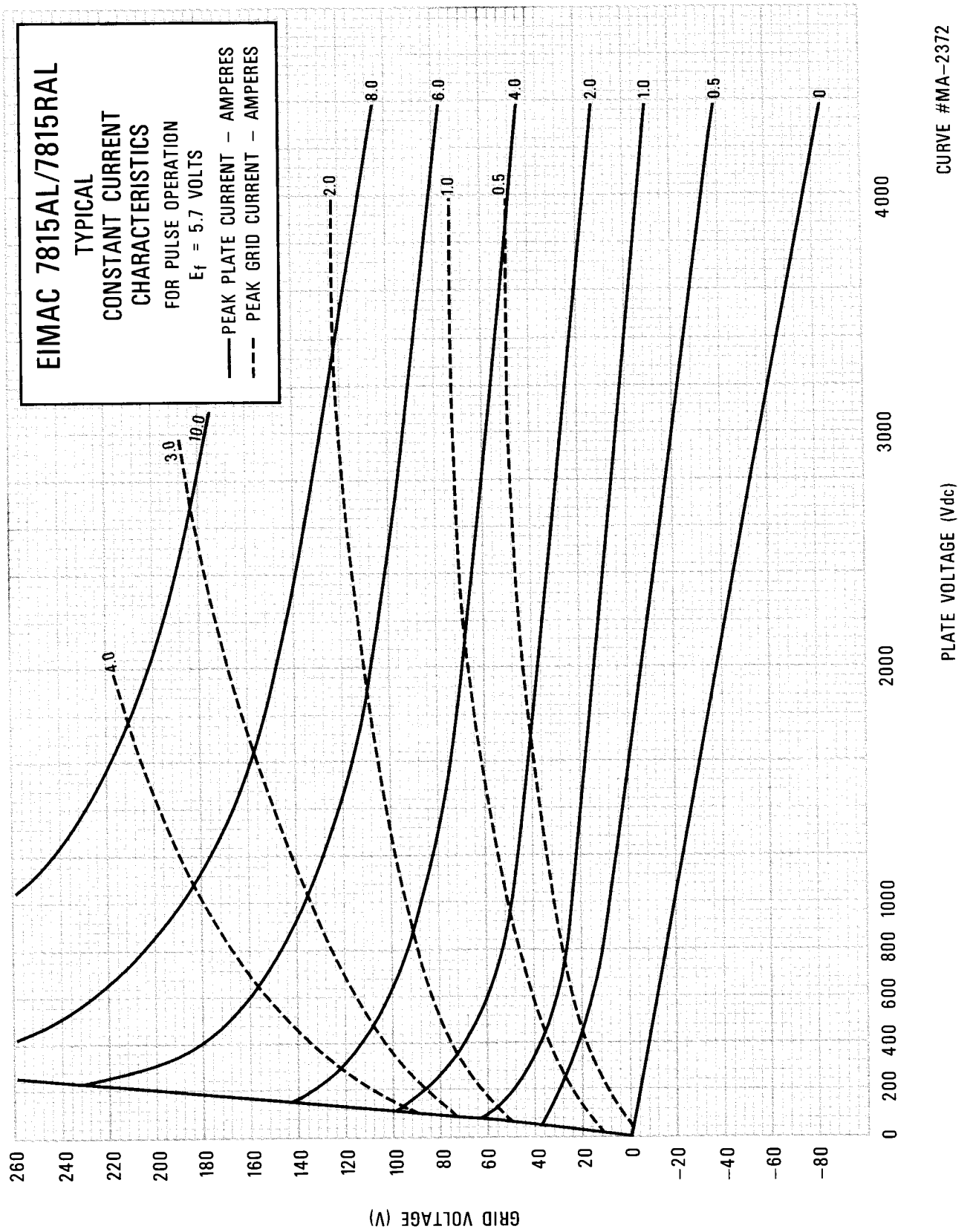
The rated heater voltage is optimum for most existing airborne applications such as DME and transponder systems. However, there are other applications where a different heater voltage than the nominal should be used to obtain the longest possible tube life. Depending on pulse width, power output and frequency of oscillation used a different heater voltage may be better for long reliable life. Electron transit time is not necessarily small with respect to the period of oscillation and the amount of driving power diverted will contribute to the cathode heating by electron bombardment.

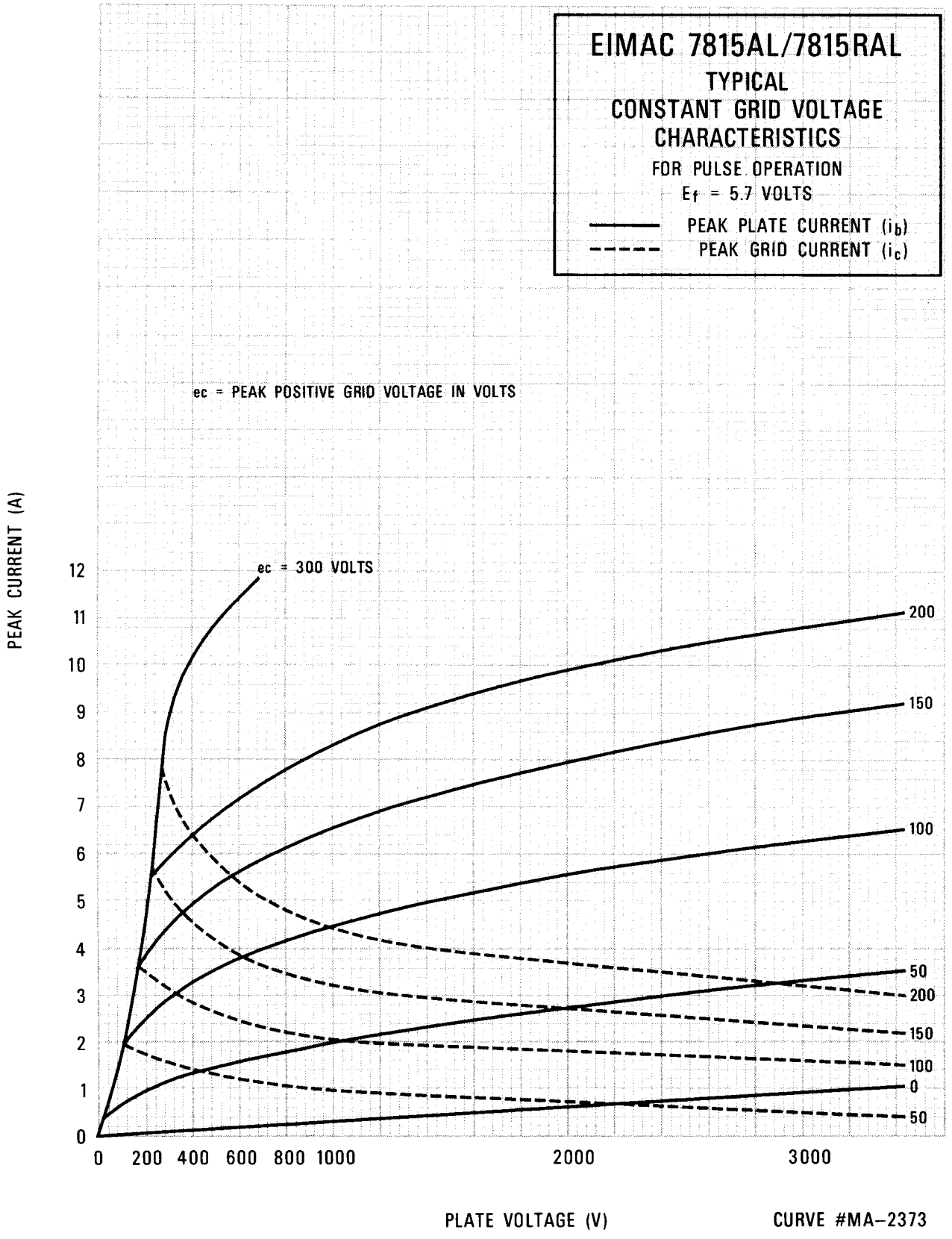
The proper adjustment of the heater voltage must be made to compensate for this additional heating, which depends on operating frequency and duty cycle employed.

INTERELECTRODE CAPACITANCES - As indicated, the capacitance values are shown for measurements made with no heater voltage. The cathode to grid and cathode to plate capacitance will increase with the application of the heater voltage, due to the thermal expansion of the cathode support. Typically, the increase in the grid to cathode capacitance will be 15%, or more, depending on the heater voltage. Since the heater voltage can vary depending on use, data taken without heater voltage is more useful for control of tube-to-tube uniformity. The grid to anode capacitance is not effected by the application of the heater voltage.

CIRCUIT TUNING - Especially under grid pulse conditions, it is important that the tube does not lose bias or momentarily go into a CW mode. Either of these events may result in tube failure. It is suggested that provision be made for initial circuit tune-up at reduced anode voltage and for extra tube protection when the circuit adjustment is critical. The average grid dissipation capability of these tubes is 2.0 watts. For many applications the limiting factor is often not anode dissipation or cathode emission capability, but grid dissipation. If pulse width control is lost in pulse applications the grid can exceed safe operating temperatures in 50 ms or less. Appropriate circuit protection during tune up is therefore recommended.

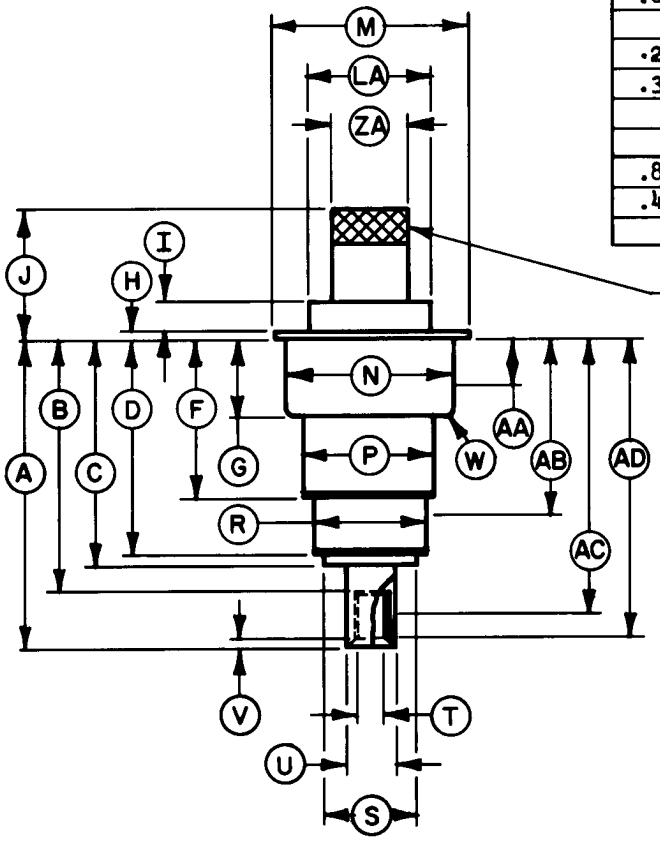
CATHODE OPERATION - The 7815AL and 7815RAL contain an arc-resistant cathode. Performance in the field and laboratory indicates these tubes are capable of withstanding some abuse due to high voltage arcs, however, poor circuit adjustment in the field may result in shortened tube life. It is, therefore, suggested that wherever feasible, the plate supply be designed such that its impedance limits the short circuit current to within five to ten times the maximum forward current. For pulse service the peak current should be limited to the values listed. Higher pulse width and duty cycles than given can be obtained with proper derating of the current. For this and special applications it is recommended that the user request additional information pertaining to his special application from the nearest Varian Electron Tube and Devices Field Office, or the Product Manager, Eimac Division of Varian, Salt Lake City, Utah or San Carlos, California.


EIMAC 7815AL/7815RAL
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 5.7 VOLTS
PEAK PLATE CURRENT – AMPERES
PEAK GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (Vdc)
CURVE #MA–2372
260
240
220
200
180
160
140
120
100
80
60
40
20
0
–20
–40
–60
–80
0
200
400
600
800
1000
2000
3000
4000
10.0
8.0
6.0
4.0
3.0
2.0
1.0
0.5
0


EIMAC 7815AL/7815RAL
TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
Ef = 5.7 VOLTS
PEAK PLATE CURRENT (ib)
PEAK GRID CURRENT (ic)
ec = PEAK POSITIVE GRID VOLTAGE IN VOLTS
PEAK CURRENT (A)
ec = 300 VOLTS
200
150
100
50
200
150
100
0
50
0 200 400 600 800 1000 2000 3000
PLATE VOLTAGE (V)
CURVE #MA-2373

ELECTRODE CONTACT AREA				
DIM	MIN.	MAX.	MIN.	MAX.
AA	.035	.361	.89	9.17
AB	1.185	1.265	30.10	32.14
AC	1.534	1.728	38.96	43.89
AD	1.475	1.815	37.47	46.10
	DIM. IN INCHES		DIM. IN MILLIMETERS	

DIMENSION DATA					
DIM. IN INCHES			DIM. IN MILLIMETERS		
MIN.	MAX.	DIM	MIN.	MAX.	NOTES
1.185	1.875	A	46.10	47.62	
	1.534	B		38.96	
	1.475	C		37.46	
1.289	1.329	D	32.74	33.76	
.970	1.010	F	24.64	25.65	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
	.185	I		4.70	
.766	.826	J	19.46	20.98	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	c
.752	.792	P	19.10	20.12	d
.655	.665	R	16.64	16.89	c
	.545	S		13.84	
.213	.223	T	5.41	5.66	c
.315	.325	U	8.00	8.26	c
	.086	V		2.18	
	.100	W		2.54	
.840	.860	LA	21.34	21.84	
.427	.447	ZA	10.75	11.35	



7815 AL –

NOTES:

a. METRIC EQUIVALENTS, TO THE NEAREST .01 mm, ARE FOR GENERAL INFORMATION ONLY & ARE BASED UPON 1 inch = 25.4 mm.

b. ECCENTRICITY OF CONTACT SURFACES SHALL BE GAGED FROM CENTER LINE OR REFERENCE & SHALL BE AS FOLLOWS:

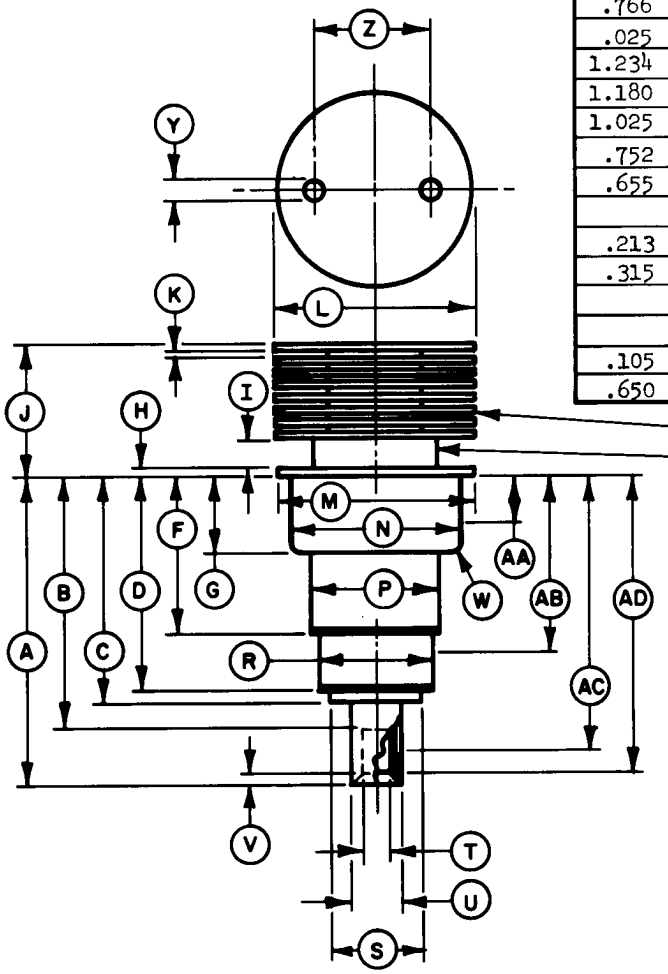
CONTACT SURFACE	TIR(MAX)	REFERENCE
ANODE	.020	CATHODE
GRID	.020	CATHODE
HEATER	.012	CATHODE

c. DIA'S N, R, T, & U SHALL APPLY THROUGHOUT ENTIRE LENGTH AS DEFINED BY DIM'S AA, AB, AC & AD RESPECTIVELY.

d. THIS SURFACE SHALL NOT BE USED FOR CLAMPING OR LOCATING.

ELECTRODE CONTACT DIMENSION				
DIM	MIN.	MAX.	MIN.	MAX.
AA	.035	.361	.89	9.17
AB	1.185	1.265	30.10	32.14
AC	1.534	1.728	38.96	43.89
AD	1.475	1.815	37.47	46.10
	DIM. IN INCHES		DIM. IN MILLIMETERS	

DIMENSION DATA					
DIM. IN INCHES			DIM. IN MILLIMETERS		
MIN.	MAX.	DIM	MIN.	MAX.	NOTES
1.185	1.875	A	46.10	47.62	
	1.534	B		38.96	
	1.475	C		37.46	
1.289	1.329	D	32.74	33.76	
.970	1.010	F	24.64	25.65	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
.125	.185	I	3.18	4.70	
.766	.826	J	19.46	20.98	
.025	.046	K	.64	1.17	
1.234	1.264	L	31.34	32.11	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	e
.752	.792	P	19.10	20.12	
.655	.665	R	16.64	16.89	
	.545	S		13.84	
.213	.223	T	5.41	5.66	e
.315	.325	U	8.00	8.26	e
	.086	V		2.18	
	.100	W		2.54	
.105	.145	Y	2.67	3.68	c
.650	.850	Z	16.51	21.59	



7815 RAL

NOTES:

a. METRIC EQUIVALENTS, TO THE NEAREST .01 mm, ARE GIVEN FOR GENERAL INFORMATION ONLY & ARE BASED ON 1 inch = 25.4 mm.

b. THIS SURFACE SHALL BE USED TO MEASURE ANODE SHANK TEMPERATURE.

c. HOLES FOR EXTRACTOR THROUGH TOP FIN ONLY.

d. ECCENTRICITY OF CONTACT SURFACES SHALL BE GAGED FROM CENTER LINE OF REFERENCE & SHALL BE AS FOLLOWS:

CONTACT SURFACE	TIR(MAX)	REFERENCE
ANODE	.020	CATHODE
GRID	.020	CATHODE
HEATER	.012	CATHODE

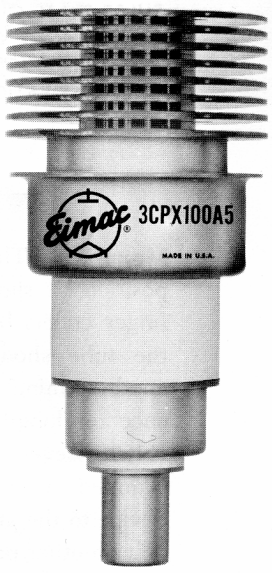
e. DIA'S N, R, T & U SHALL APPLY THROUGHOUT ENTIRE LENGTH AS DEFINED BY DIM'S AA, AB, AC & AD RESPECTIVELY.

f. THIS SURFACE SHALL NOT BE USED FOR CLAMPING OR LOCATING.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

7815R
3CPX100A5

UHF PULSE TRIODE



The Eimac 7815R/3CPX100A5 is a pulse rated version of the 3CX100A5. A longer grid-anode ceramic insulator is incorporated, making the tube useful at high altitude. The nominal plate dissipation rating is 100 watts.

The tube is usable in pulse applications to 3000 Megacycles. Electrical characteristics are similar to the 3CX100A5.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide-coated, Unipotential				
Heating time	60			seconds
Heater:				
Voltage		6.0		volts
Current	0.90		1.05	amperes
Amplification Factor		100		
Transconductance (1 b = 70 milliamperes)		25,000		Micromhos

Direct Interelectrode Capacitances	Min.	Max.
Grid-Cathode	5.7	7.0 uuf
Grid-Plate	1.85	2.10 uuf
Plate-Cathode		0.035 uuf
Frequency for Maximum Ratings		3000 Megacycles

MECHANICAL

Terminals	Graduated Cylindrical Surfaces
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250°C
Anode Core	250°C
Operating Position	Any
Cooling	Forced Air
Maximum Overall Dimensions:	
Length	2.701 inches
Diameter	1.264 inches
Net Weight	2.5 ounces
Shipping Weight (approx.)	7.0 ounces

PLATE PULSED OSCILLATOR OR AMPLIFIER
CLASS-C

MAXIMUM RATINGS

PEAK PULSE PLATE VOLTAGE	3500	MAX. VOLTS
DC GRID VOLTAGE	-150	MAX. VOLTS
PULSE PLATE CURRENT	3.0	MAX. VOLTS
DC CATHODE CURRENT	125	MAX. MA
PULSE GRID CURRENT	1.8	MAX. AMPS
PLATE DISSIPATION (AVG)	100	MAX. WATTS
GRID DISSIPATION (AVG)	2	MAX. WATTS

TYPICAL OPERATION

Pulse Plate Voltage	3500	3500	volts
Pulse Plate Current	3.0	3.0	amps
DC Plate Current (avg)	7.5	9	mA
DC Grid Current (avg)	4.5	3	mA
Pulse Power Output	1600	2000	watts
Frequency	3000	2500	Mc
Pulse Length	3	5	usec
Duty Factor	0.0025	0.003	

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GRID PULSED OSCILLATOR OR AMPLIFIER
CLASS-C

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 MAX. VOLTS
DC GRID VOLTAGE	-150 MAX. VOLTS
PULSE PLATE CURRENT	3.0 MAX. AMPS
DC CATHODE CURRENT	125 MAX. MA.
PLATE DISSIPATION (AVG)	100 MAX. WATTS
GRID DISSIPATION (AVG)	2 MAX. WATTS

TYPICAL OPERATION

DC Plate Voltage	1600	1700 volts
DC Grid Voltage	-45	-45 volts
Pulse Plate Current	3.0	1.9 amps
Pulse Grid Current	1.8	1.1 amps
Pulse Power Output	1000	1500 watts
Frequency	3000	1100 Mc
Pulse Length	3	3.5 usec
Duty Factor	0.0025	0.001

APPLICATION

MECHANICAL

Mounting—The 3CPX100A5 may be operated in any position. It should be firmly held in place by spring-finger collets bearing on the terminal surfaces. In use the tube should seat against the underside of the anode-terminal flange which is on the plane of reference for longitudinal dimensions. In appplications involving severe shock and vibration, the tube may be clamped in place by applying a suitable clamping device to the anode-terminal flange. It is recommended that no other portion of the tube be subjected to clamping forces.

Connections—The terminals are in the form of concentric cylinders of graduated diameters conveniently used with coaxial tuning devices. Spring-fingered collets should be used to make contact with the anode, grid, cathode and heater terminals. Adequate contact area and spring pressure should be provided to minimize heating and to prevent erratic circuit performance at the higher frequencies. Non-contacting or intermittently-contacting collet fingers will cause troublesome circuit behavior, especially at very-high and ultra-high frequencies. Electrode contact surfaces should be kept clean and free of oxide coatings.

Cooling—Sufficient cooling air must be provided for the anode and body seals to maintain operating temperatures below the rated maximum value of 250°C. At sea level, with 20°C air, approximately 12.5 CFM of cooling air directed across the anode through a suitale cowling will maintain safe anode temperature. In pulse applications requiring low plate dissipation and/or small size, the coolerless 3CPN10A5 should be considered.

The nominal plate dissipation rating is 10 watts and is dependent on convection cooling to a heat sink. Where adequate cooling is provided this value may be extended. Where greater plate dissipation is required use of the 3CPX100A5 is recommended.

It should be borne in mind that operating temperature is the sole criterion of cooling effectiveness, regardless of the coolant type, flow rate or coolant temperature. One method of measuring the surface temperatures is the use of temperature sensitive lacquer, such as "Tempilaq."

ELECTRICAL

Heater Operation—The rated heater voltage for the 3CPX100A5 is 6.0 volts. The heater voltage for the 3CPX100A5 should be maintained within plus or minus 5% of its intended value to minimize variations in circuit performance and to obtain maximum tube life.

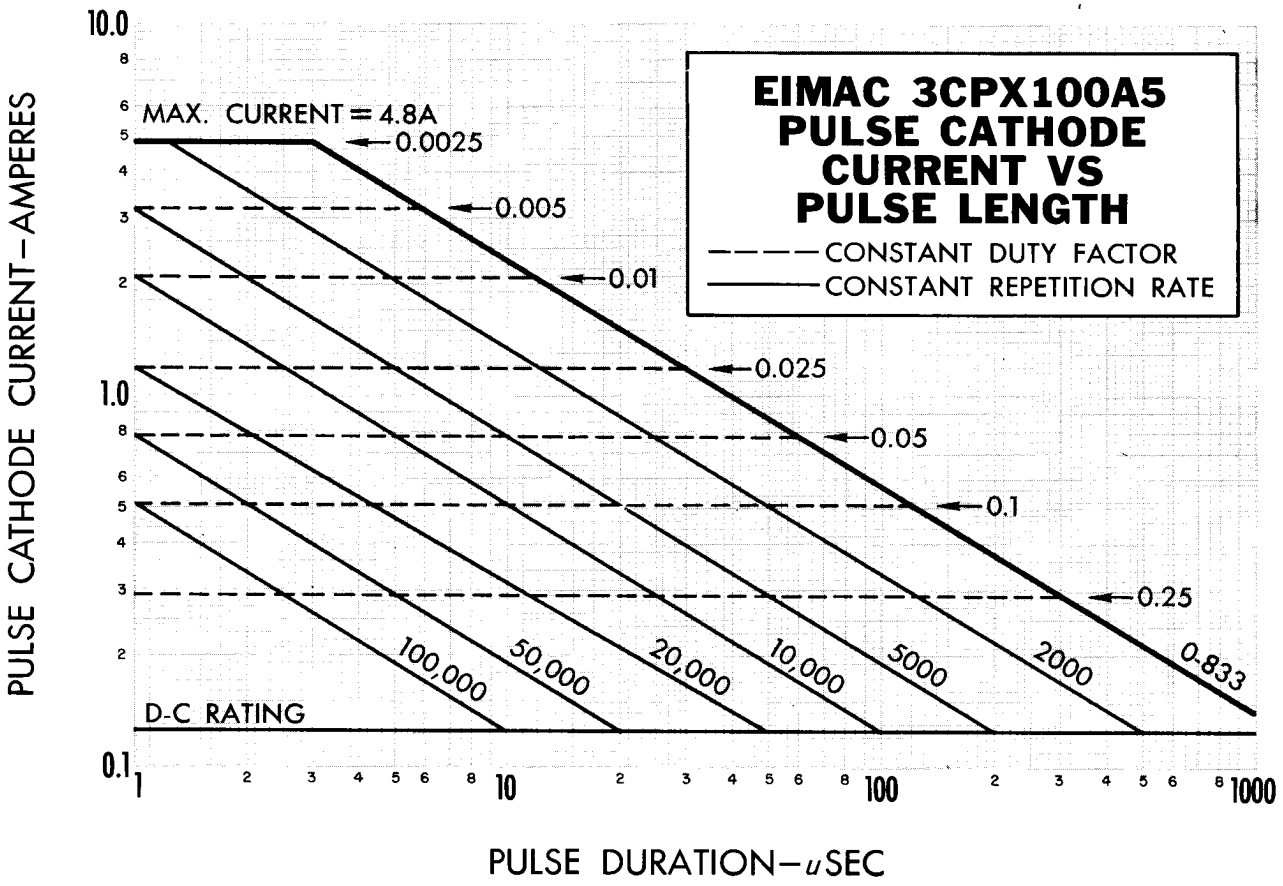
At frequencies above approximately 1000 megacycles, transit time effects begin to influence cathode temperature. The amount of driving power diverted to heating the cathode by back-bombardment will depend upon the frequency, the plate current, driving power, and duty factor. If the conditions of operation result in appreciable cathode back-heating, it may be necessary to start dynamic tube operation at normal heater voltage followed by a reduction of heater voltage to a lower value. The heater of the 3CPX100A5 must not be operated at less than 4.5 volts in any case.

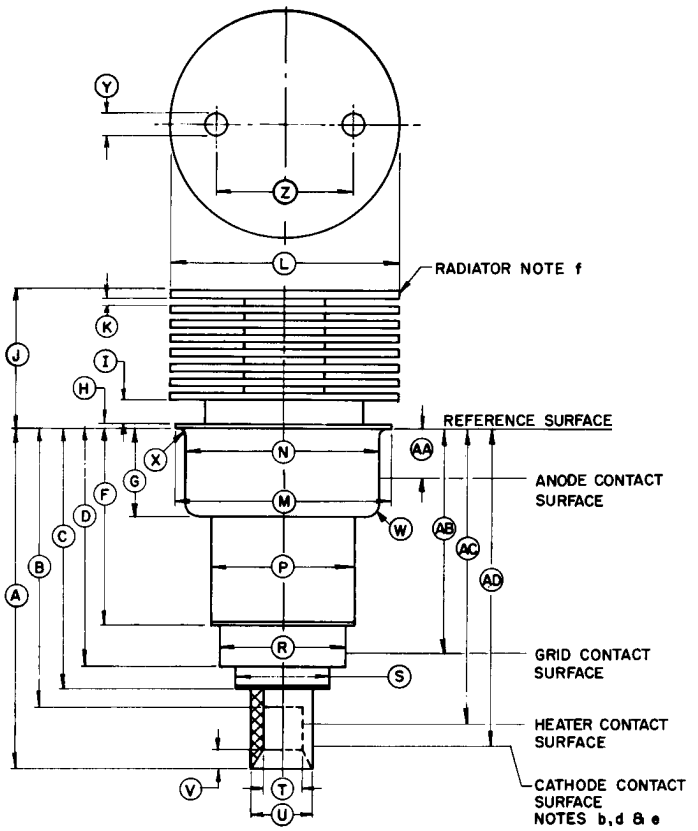
Cathode Operation—The oxide-coated unipotential cathode in this tube must be protected against excessively high emission currents. For all types of operation the maximum rated dc current is 125 milliamperes. In pulse service, current must be limited according to the curve on page 3.

It is recommended that the rated heater voltage be applied for a minimum of 60 seconds before other operating voltages are applied.

Control Grid Operation—Grid dissipation must not exceed the rated maximum 2.0 watts grid dissipation power. In pulse applications the instantaneous peak grid-to-cathode voltage must be limited to +250 to −750 volts.

Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California for information and recommendations.

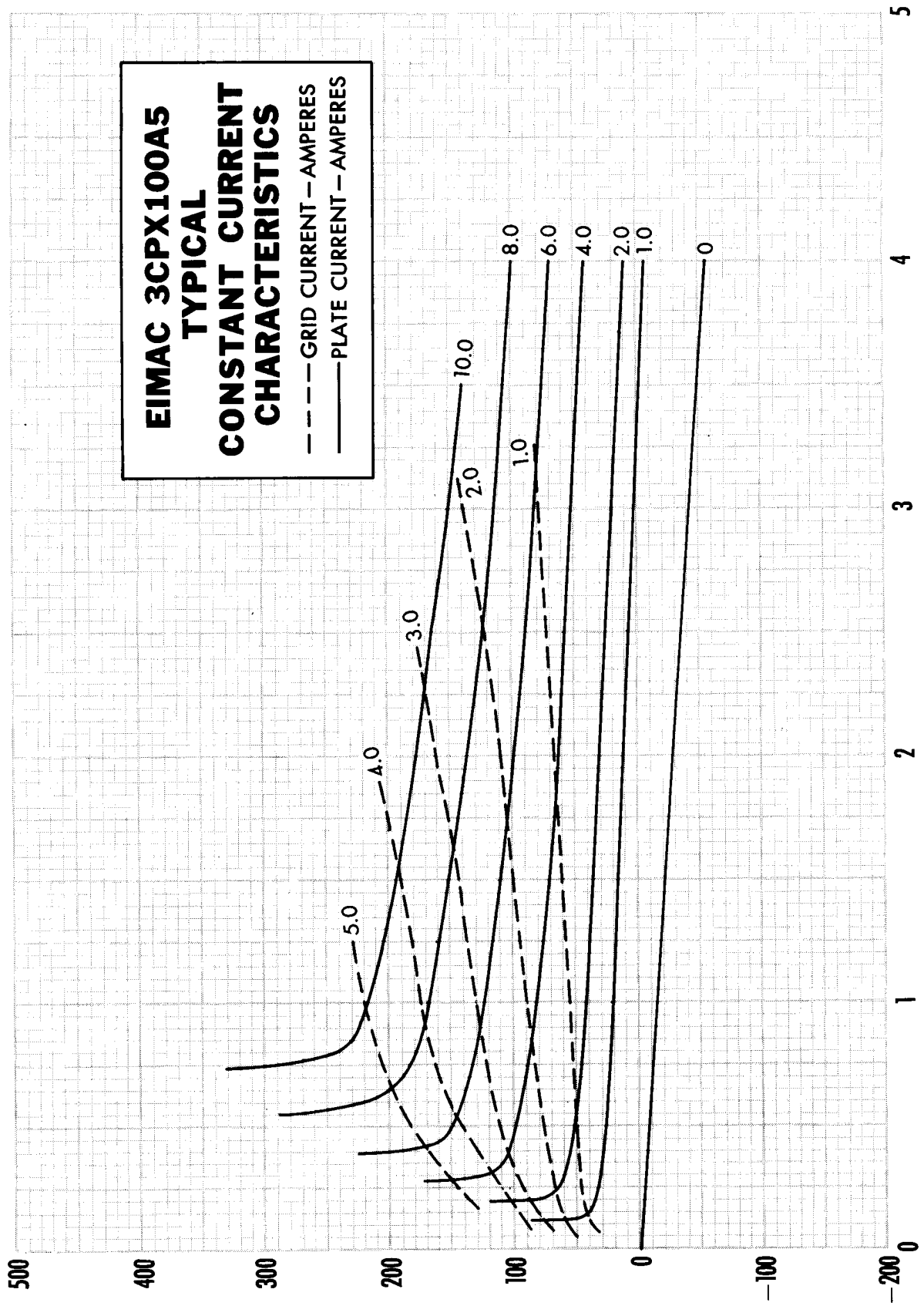




DIMENSIONS IN INCHES

DIMENSIONAL DATA

REF.	MIN.	MAX.	NOM.
A	1.815	1.875	
B		1.534	
C		1.475	
D	1.289	1.329	
F	.970	1.010	
G	.462	.477	
H		.040	
I	.125	.185	
J	.766	.826	
K	.025	.046	
L	1.234	1.264	
M	1.180	1.195	
N	1.025	1.035	
P	.772	.792	
R	.855	.865	
S		.545	
T	.213	.225	
U	.315	.325	
V		.086	
W		.100	
X		.035	
Y	.105	.145	
Z	.850	.850	
AA	.035	.361	
AB	1.185	1.265	
AC	1.534	1.726	
AD	1.475	1.815	

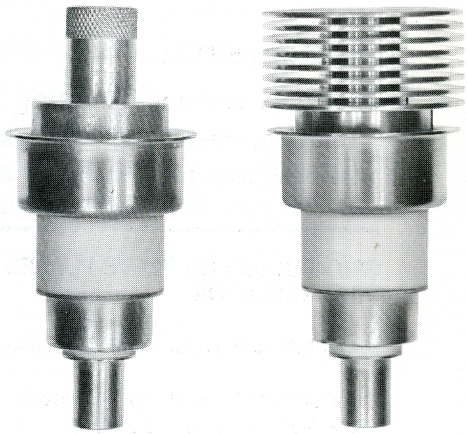

EIMAC 3CPX100A5
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
– – – – GRID CURRENT – AMPERES
——— PLATE CURRENT – AMPERES
10.0
8.0
6.0
5.0
4.0
3.0
2.0
1.0
0
500
400
300
200
100
0
–100
–200
0
1
2
3
4
5
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS

7855
7855K

TECHNICAL DATA

HIGH-MU
PLANAR TRIODE

The EIMAC 7855 and 7855K are ruggedized high-mu planar triodes of ceramic/metal construction, designed for grid pulsed, plate pulsed and CW operation in amplifiers, oscillators and frequency multipliers from low frequency to 3 GHz. The 7855 is supplied with a radiator for forced air cooling and the 7855K without radiator for conduction and convection cooling. Except for plate dissipation ratings, the characteristics of the two tubes are the same. In addition to the low interelectrode capacitances and high transconductance these tubes exhibit special design features such as a frequency stable anode and an arc resistant cathode to assure stable operation under adverse conditions and to minimize catastrophic failure due to arc over during a circuit malfunction.



GENERAL CHARACTERISTICS[1]

	7855K	7855
ELECTRICAL		
Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3 V	
Current, at 6.0 volts	1.00 A	
Transconductance (Average):		
I_b = 70 mA	25 mmhos	
Amplification Factor (Average):	80	
Direct Interelectrode Capacitances (Grounded Cathode)[2]		
Cin	6.8 pF	
Cout	0.04 pF	
Cgp	2.50 pF	
Cut-off Bias[3]	-30 V max.	

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.
3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

MECHANICAL		
Maximum Overall Dimensions:		
Length	2.39 in; 60.60 mm	
Diameter	1.27 in; 32.20 mm	
Net Weight (7855)	57 gm	
(7855K)	40 gm	
Operating Position	Any	

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Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling (7855)	Forced air
(7855K)	Conduction, convection
Terminals	Coaxial, special

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axes 55 to 500 Hz	10 G
Altitude, max (in a suitably designed circuit)	50,000 ft.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE (grid pulsed)	2500	VOLTS
PEAK PULSE PLATE VOLTAGE (plate pulsed)	3500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID CATHODE VOLTAGE		
Grid negative to cathode	-700	VOLTS
Grid positive to cathode	250	VOLTS
PULSE PLATE CURRENT	3.0	AMPERES
PULSE GRID CURRENT	1.8	AMPERES
PLATE DISSIPATION(7855)	100	WATTS
(7855K)	10	WATTS
GRID DISSIPATION	2.0	WATTS
FREQUENCY	3.0	GIGAHERTZ
PULSE DURATION[1]	6	μsec
DUTY FACTOR[1]	.0033	

TYPICAL OPERATION Grid Pulsed Oscillator, Representative Application

Plate Voltage	2000	Vdc
Grid Voltage	-75	Vdc
Heater Voltage	5.7	V
Peak Video Plate Current	1.3	a
Peak Video Grid Current	0.8	a
Useful Power Output (approx.)	750	w
Frequency	1.090	GHz
Pulse Duration	0.5	μs
Duty Factor	.001	

PULSE MODULATOR OR PULSE AMPLIFIER SERVICE

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE	2500	VOLTS
PEAK PLATE VOLTAGE	3500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	150	VOLTS
PULSE CATHODE CURRENT	4.8	AMPERES
DC PLATE CURRENT	100	MILLIAMPERES
PLATE DISSIPATION(7855)	100	WATTS
(7855K)	10	WATTS
GRID DISSIPATION	1.5	WATTS
PULSE DURATION[1]	6	μs
DUTY FACTOR[1]	.0033	
CUT-OFF MU	60	

1. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube and Device Field Office, or the Product Manager Eimac-Division of Varian, Salt Lake City, Utah.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	0.90	1.05	A
Cathode Heating Time	60	---	sec.
Interelectrode Capacitances [1](grounded cathode connection)			
Cin	6.00	7.50	pF
Cout	---	0.04	pF
Cgp	2.35	2.65	pF

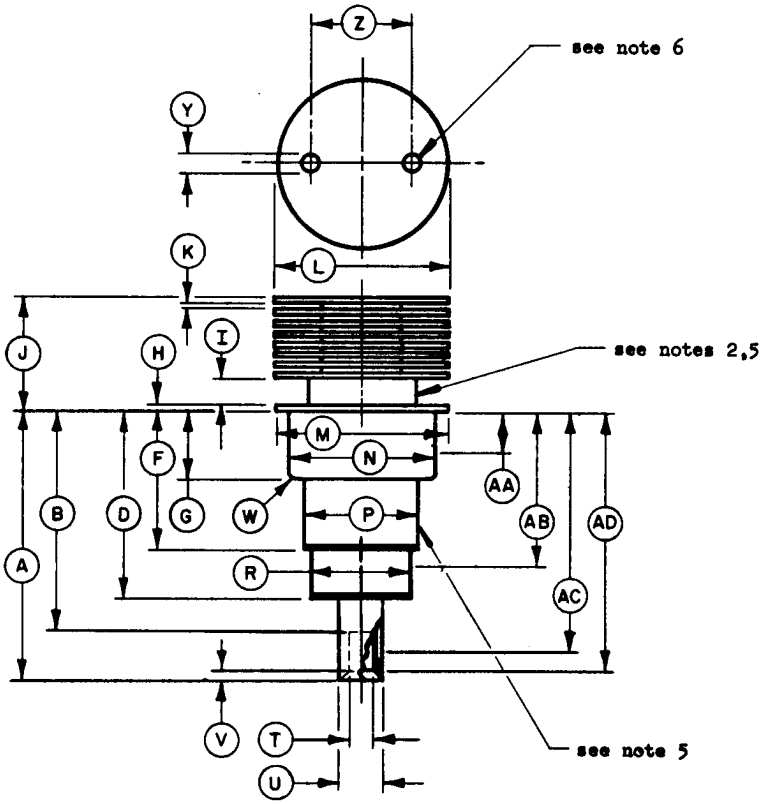
1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

APPLICATION

For operating information refer to EIMAC bulletin #15, "Operating Instruction for Planar Triodes."

ELECTRODE CONTACT DIMS. (see note 7)				
Dim. in Inches		Dim.	Dim. in Millim.	
Min.	Max.		Min.	Max.
.035	.361	AA	.89	9.17
1.021	1.101	AB	25.93	27.97
1.219	1.413	AC	30.96	35.89
1.160	1.500	AD	29.46	38.10

DIMENSIONAL DATA					
Dim. in Inches			Dim. in Millimeters		
Min.	Max.	Dim.	MIN.	MAX.	
1.500	1.560	A	38.10	39.62	
	1.214	B		30.84	
1.125	1.165	D	28.58	29.59	
.800	.840	F	20.32	21.34	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
.125	.185	I	3.18	4.70	
.766	.826	J	19.46	20.98	
.025	.046	K	.64	1.17	
1.234	1.264	L	31.34	32.11	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	
.752	.792	P	19.10	20.12	
.655	.665	R	16.64	16.89	
.213	.223	T	5.41	5.66	
.315	.325	U	8.00	8.26	
	.086	V		2.18	
	.100	W		2.54	
.105	.145	Y	2.67	3.68	
.650	.850	Z	16.51	21.59	



7855

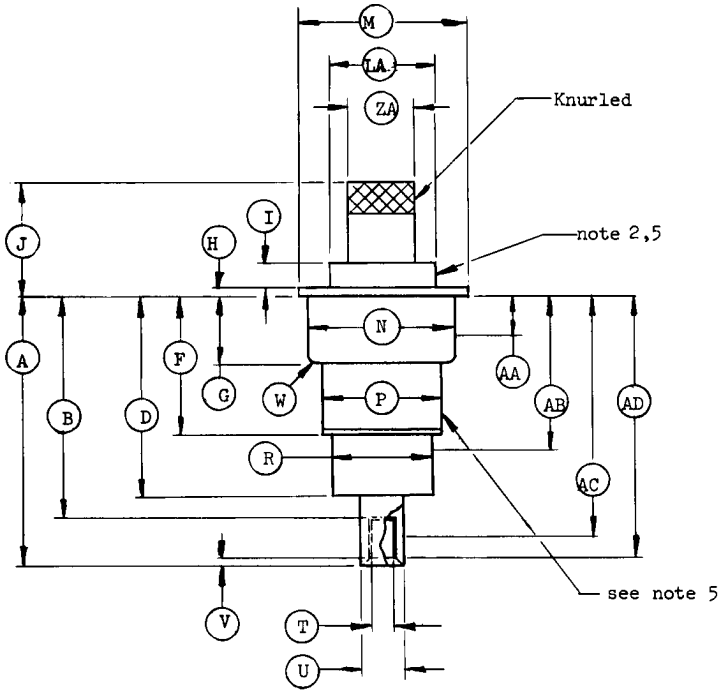
NOTES:
1. Metric equivalents, to the nearest .01 mm, are given for general information only & are based on 1 inch = 25.4 mm.
2. This surface to be used to measure anode shank temperature.
3. Eccentricity of contact surfaces shall be gaged from center line of reference & shall be as follows:

Contact Surface	TIR Max.	Reference
Anode	.020	Cathode
Grid	.020	Cathode
Heater	.012	Cathode

4. Dias. N,R,T & U shall apply throughout entire lenght as defined by dims. AA,AB,AC,AD respectively.
5. This surface shall not be used for clamping or locating.
6. Holes for extractor thru top fin only.
7. Electrode Contact dims. are for socket design purposes & are not intended for inspection purposes.

ELECTRODE CONTACT AREA (see note 6)				
Dim. in Millimeters		Dim.	Dim. in Inches	
Min.	Max.		Min.	Max.
.89	9.17	AA	.035	.361
25.93	27.97	AB	1.021	1.101
30.96	35.89	AC	1.219	1.413
29.46	38.10	AD	1.160	1.500

DIMENSIONAL DATA				
Dim. in Inches		Dim.	Dim. in Millimetres	
Min.	Max.		MIN.	MAX.
1.500	1.560	A	38.10	39.62
	1.215	B		30.84
1.125	1.165	D	28.58	29.59
.800	.840	F	20.32	21.34
.462	.477	G	11.73	12.12
	.040	H		1.02
	.185	I		4.70
.766	.826	J	19.46	20.98
.025	.046	K	.64	1.17
1.234	1.264	L	31.34	32.11
1.180	1.195	M	29.97	30.35
1.025	1.035	N	26.04	26.29
.752	.792	P	19.10	20.12
.655	.665	R	16.64	16.89
.213	.223	T	5.41	5.66
.315	.325	U	8.00	8.26
	.086	V		2.18
	.100	W		2.54
.840	.860	LA	21.34	21.84
.427	.447	ZA	10.85	11.35



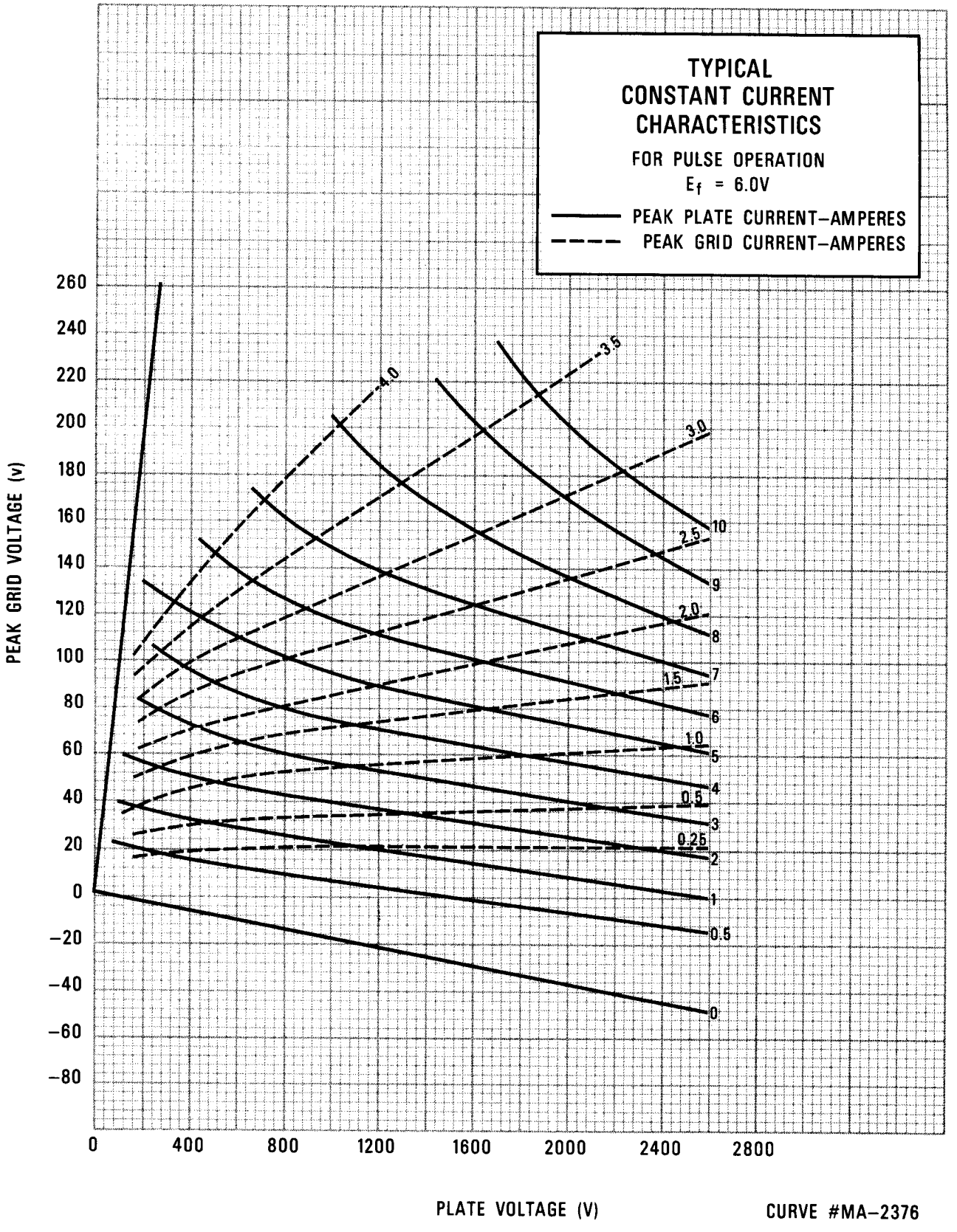
7855K

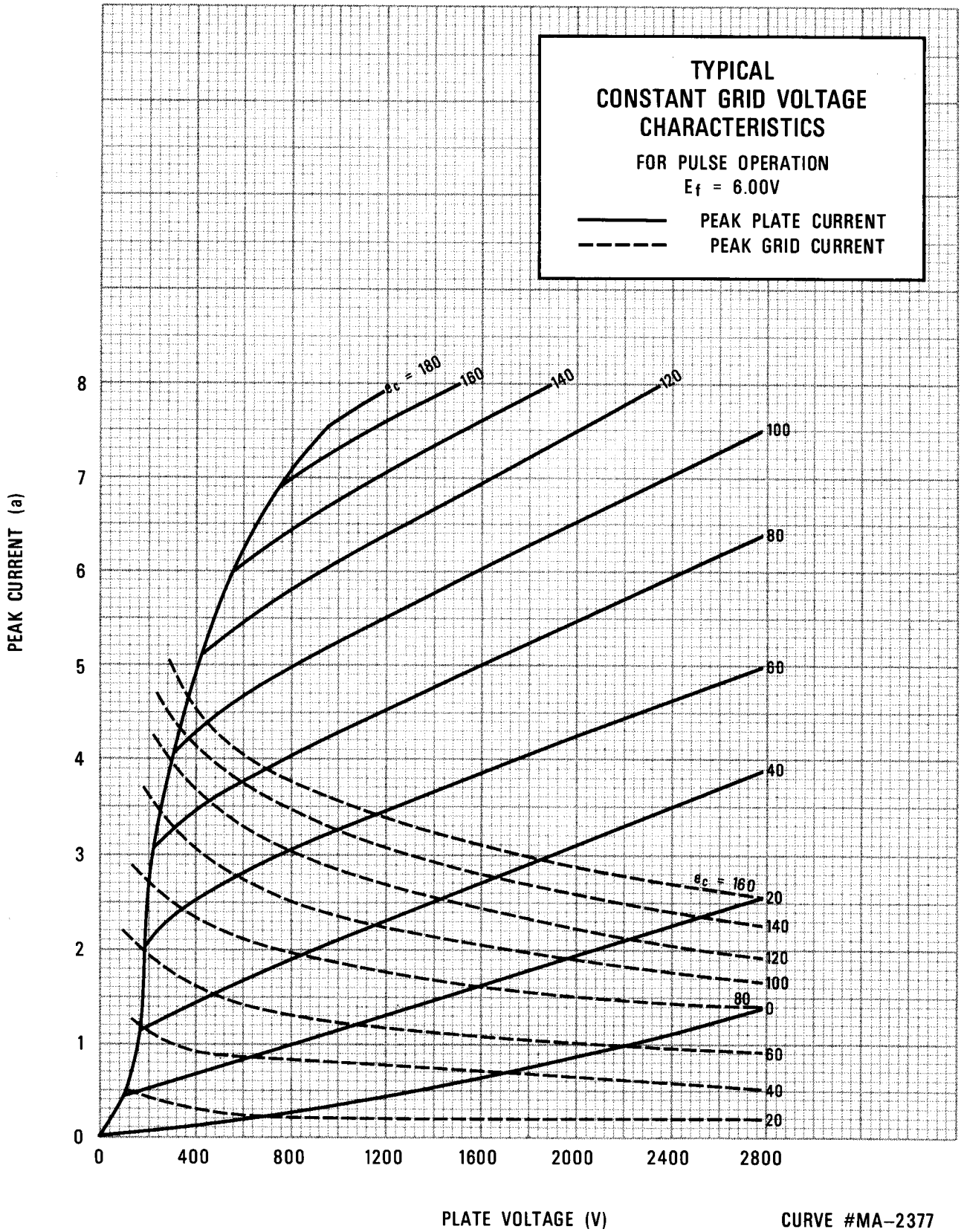
NOTES:

1. Metric equivalemts to the nwarest .01mm, are given for general information only & are based on 1 inch= 25.4 mm.
2. This surface shall be used to measure Anode shank temperature.
3. Eccentricity of contact surfaces shall be gaged from center line of reference & shall be as follows:

Contact Surface	TIR Max.	Reference
Anode	.020	Cathode
Grid	.020	Cathode
Heater	.012	Cathode

4. Dias. N,R,T,U shall apply throughout entire lenght as defined by dims. AA,AB,AC,AD respectively.
5. This surface shall not be used for clamping or locating.
6. Electrode Contact Dims. are intended for socket design only & are not intended for inspection purposes.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.0V
PEAK PLATE CURRENT–AMPERES
PEAK GRID CURRENT–AMPERES
PEAK GRID VOLTAGE (v)
260
240
220
200
180
160
140
120
100
80
60
40
20
0
−20
−40
−60
−80
0
400
800
1200
1600
2000
2400
2800
PLATE VOLTAGE (V)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.25
10
9
8
7
6
5
4
3
2
1
0.5
0
CURVE #MA–2376



CURVE #MA-2377

TECHNICAL DATA

7855AL
7855KAL

PLANAR TRIODE

The EIMAC 7855AL and 7855KAL are ceramic/metal planar triodes specially processed and tested to assure high reliability in airborne service. Evaluation of these tubes is based upon operating conditions found in commercial airborne applications such as transponders. The testing emphasizes cathode emission capability at reduced heater voltage and high voltage hold-off, both features which are demanded in airline service.

The 7855AL is derived from the 7855, the 7855KAL from the 7855K. These new improved tubes also contain features of the original types such as a frequency stable anode, rugged ceramic/metal construction, low interelectrode capacitance, high transconductance and high mu.



7855AL 7855KAL

In addition to these features, these tubes also incorporate the arc-resistant cathode which assures stable operation under adverse conditions and which minimizes catastrophic failures due to arc-over during circuit malfunction. These tubes are useable from dc to 3 GHz.

The 7855KAL utilizes conduction-convection cooling. The 7855AL is supplied with a radiator for forced-air cooling. Except for the plate dissipation ratings, the two tubes have identical electrical characteristics.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	5.7 ± 2%	V
Current, at 5.7 volts	0.95	A
Transconductance (Average):		
Ib = 70 mAdc, Eb = 600 Vdc	25	mmhos
Amplification Factor (Average)	100	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	6.80	pF
Cout	0.04	pF max.
Cgp	2.50	pF
Cut-off Bias [3]	-30	V
Frequency of Maximum Rating:		
Plate or Grid-Pulsed	3000	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pf due to thermal expansion of the cathode.
3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

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MECHANICAL

Maximum Overall Dimensions:	
Length (7855AL)	2.386 in; 60.60 mm
(7855KAL)	2.386 in; 60.60 mm
Diameter (7855AL)	1.264 in; 32.11 mm
(7855KAL)	1.195 in; 30.35 mm
Net Weight (7855AL)	2.01 oz; 57 gm
(7855KAL)	1.41 oz; 40 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling - 7855AL (With Radiator)	Forced Air
- 7855KAL (Without Radiator)	Conduction and Convection
Terminals	Coaxial special

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.
Heater: Current at 5.7 volts	0.87	1.02 A
Cathode Warmup Time	60	--- sec.
Interelectrode Capacitance[1] (grounded cathode connection)		
Cin	6.00	7.50 pF
Cout	---	0.40 pF
Cgp	2.35	2.65 pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE (grid pulsed)	2500 VOLTS
PEAK PULSE PLATE VOLTAGE (plate pulsed)	3500 VOLTS
DC GRID VOLTAGE	-150 VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE	
Grid negative to cathode	-750 VOLTS
Grid positive to cathode	250 VOLTS
PULSE PLATE CURRENT	3.0 AMPERES
PULSE GRID CURRENT	1.8 AMPERES
AVERAGE PLATE DISSIPATION	
Conduction and convection(7855KAL)	10 WATTS
Forced Air(7855AL)[1]	35 WATTS
GRID DISSIPATION (Average)	2.0 WATTS
FREQUENCY	3.0 GHz
PULSE DURATION[2]	6.0 μs
DUTY FACTOR[2]	.0033

1. Using EIMAC radiator PN 158601.

2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City.

OPERATING CONDITIONS

GRID PULSED OSCILLATOR

Frequency	1.090 GHz
Heater Voltage	5.7 V
DC Plate Voltage	2000 Vdc
DC Grid Voltage	-75 Vdc
Peak Video Plate Current	1.3 a
Peak Video Grid Current	0.8 a
Useful Power Output (approx.)	750 w
Pulse Duration	0.5 μs
Duty Factor	0.001

PLATE PULSED AMPLIFIER

Frequency	1.1 GHz
Heater Voltage	5.7 V
Peak Plate Voltage	2000 v
Peak Video Plate Current	1.8 a
Peak Video Grid Current	1.0 a
Useful Power Output (approx.)	1800 w
Pulse Duration	3.5 μs
Duty Factor	0.001
Gain	8 db
Plate Efficiency	50 %

APPLICATION

MECHANICAL

MOUNTING - The important dimensions of the tube are carefully controlled with respect to the reference surface as shown on the outline drawing. The reference surface is intended to serve as a tube stop and the location of the tube in the circuit should therefore be determined by this surface coming in positive contact with a precisely positioned member of the socket or cavity. Adherence to this practice will assure both mechanical and electrical interchangeability of all tubes of a given type. If a non-designated surface is used as a tube stop, faulty positioning of the tube in the cavity and possible incomplete electrical contact can result in improper tuning, reduced power output and damage to the cavity, tube or both. Contact surfaces, with reference to the designated tube stop are shown in the outline drawing. Electrical contact to the cathode, grid, anode and also the heater should be restricted to these designated contact areas.

Dimensions should never be taken from sample tubes. Dimensional changes due to normal variations in undimensioned surfaces may occur within the limits specified on the outline drawing. Use of nondesignated electrical contact surfaces might therefore result in incomplete contact or mechanical interference, causing changes in cavity tuning.

Electrical contact should be made by spring finger collets bearing against the previously described contact areas. If connections are employed which do not provide multiple contacts to the designated contact areas, concentration of RF current will result in loss of output power, especially at higher frequencies. The spring contacts used should exert a firm pressure without gouging the plated contact surface. This latter phenomena can result in loose particles of material which can cause arcing or unstable operation of the cavity.

If the tubes are used in applications which call for severe shock or vibration the tube may be clamped in place by the knob or radiator, exerting pressure only on this part of the tube and against the tube stop. No other portion of the tube should be subject to any clamping force. In particular, electrical contacts which utilize setscrews or rigid clamps should be avoided. Such contact schemes can distort the contact surfaces causing undue stress in the metal-to-ceramic seal area which may result in a vacuum leak. Soldered electrical connections can be made, however great care should be taken during the solder operation to avoid fracture of the seal area due to thermal shock. All contact surfaces should be kept clean to minimize losses.

COOLING - The EIMAC planar triodes are designed to operate at envelope and anode temperatures of up to the maximum rated value of 250°C. However, performance and long-term reliability of any component are improved when it is kept as cool as technically feasible. Therefore, it is recommended that sufficient cooling be provided to keep the anode and seal areas well below the specified maximum temperature, where long tube life and high reliability are of great importance.

The maximum plate dissipation of the 7855KAL is 10 watts average power. This can be accomplished by conduction, natural convection or forced air convection cooling. The maximum plate dissipation of the 7855AL in pulse service is 35 watts average and forced air cooling must be employed at that level. When forced air cooling is used, it is recommended that additional airflow, apart from that flowing through the radiator be used to cool the tube envelope and other tube terminals. A certain amount of conduction cooling is usually inherent in the contact finger configuration. It should be noted, however, that spring fingers provide poor heat conduction and measurements have shown a temperature difference as much as 50°C between the contact finger and contact area.

It is suggested that in all new applications the envelope temperature be measured, especially if the tube is used close to the upper temperature limit. The temperature can easily be determined by the use of Tempilaq paint (Tempil Division, Big Three Industrial Gas & Equipment Co., Hamilton Blvd., So. Plainfield N.J. 07080) or Temp-Plate stickers (Pydrodyne, Inc., 1001 Colorado, Santa Monica, Calif. 90404).

ELECTRICAL

HEATER VOLTAGE - The rated heater voltage for either tube type is 5.7 volts and should be controlled within ±2% to obtain maximum tube life and to minimize variations in circuit performance. The rated heater voltage is optimum for most

existing airborne applications such as DME and transponder systems. However, there are other applications where a different heater voltage than the nominal should be used to obtain the longest possible tube life. Depending on pulse width, power output and frequency of oscillation used a different heater voltage may be better for long reliable life. Electron transit time is not necessarily small with respect to the period of oscillation and the amount of driving power diverted will contribute to the cathode heating by electron bombardment.

The proper adjustment of the heater voltage must be made to compensate for this additional heating, which depends on operating frequency and duty cycle employed.

INTERELECTRODE CAPACITANCES - As indicated, the capacitance values are shown for measurements made with no heater voltage. The cathode to grid and cathode to plate capacitance will increase with the application of the heater voltage, due to the thermal expansion of the cathode support. Typically, the increase in the grid to cathode capacitance will be 15%, or more, depending on the heater voltage. Since the heater voltage can vary depending on use, data taken without heater voltage is more useful for control of tube-to-tube uniformity. The grid to anode capacitance is not effected by the application of the heater voltage.

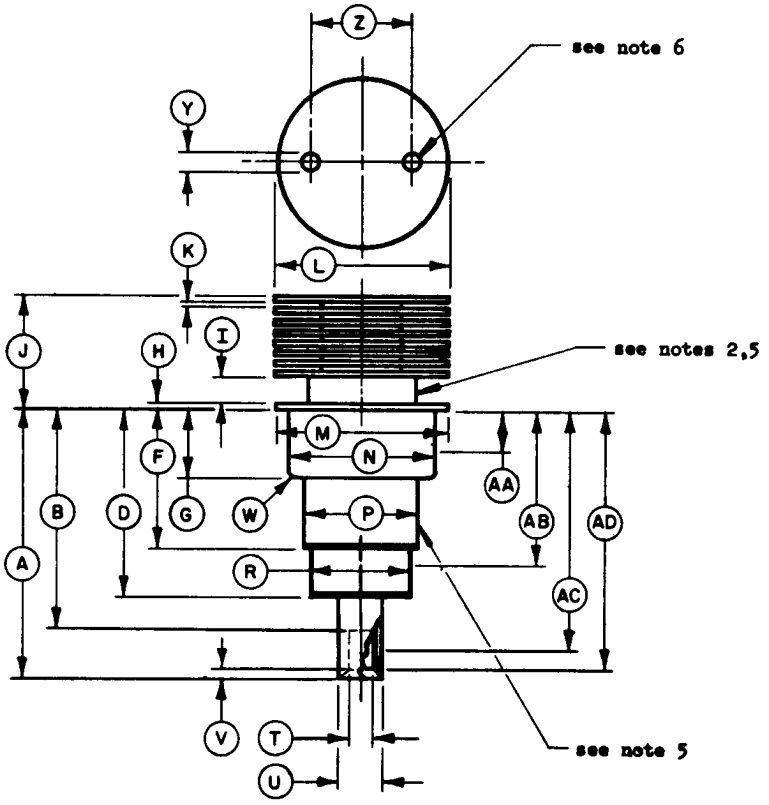
CIRCUIT TUNING - Especially under grid pulse conditions, it is important that the tube does not lose bias or momentarily go into a CW mode. Either of these events may result in tube failure. It is suggested that provision be made for initial circuit tune-up at reduced anode voltage and for extra tube protection when the circuit adjustment is critical. The average grid dissipation capability of these tubes is 2.0 watts. For many applications the limiting factor is often not anode dissipation or cathode emission capability, but grid dissipation. If pulse width control is lost in pulse applications the grid can exceed safe operating temperatures in 50 ms or less. Appropriate circuit protection during tune up is therefore recommended.

CATHODE OPERATION - The 7855AL and 7855KAL contain an arc-resistant cathode. Performance in the field and laboratory indicates these tubes are capable of withstanding some abuse due to high voltage arcs, however, poor circuit adjustment in the field may result in shortened tube life. It is, therefore, suggested that wherever feasible, the plate supply be designed such that its impedance limits the short circuit current to within five to ten times the maximum forward current. For pulse service the peak current should be limited to the values listed. Higher pulse width and duty cycles than given can be obtained with proper derating of the current. For this and special applications it is recommended that the user request additional information pertaining to his special application from the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

SPECIAL APPLICATION - For further operating information refer to EIMAC bulletin #15 "Operating Instructions for Planar Triodes".

ELECTRODE CONTACT DIMS. (see note 7)				
Dim. in Inches		Dim.	Dim. in Millim.	
Min.	Max.		Min.	Max.
.035	.361	AA	.89	9.17
1.021	1.101	AB	25.93	27.97
1.219	1.413	AC	30.96	35.89
1.160	1.500	AD	29.46	38.10

DIMENSIONAL DATA					
Dim. in Inches			Dim. in Millimeters		
Min.	Max.	Dim.	MIN.	MAX.	
1.500	1.560	A	38.10	39.62	
	1.214	B		30.84	
1.125	1.165	D	28.58	29.59	
.800	.840	F	20.32	21.34	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
.125	.185	I	3.18	4.70	
.766	.826	J	19.46	20.98	
.025	.046	K	.64	1.17	
1.234	1.264	L	31.34	32.11	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	
.752	.792	P	19.10	20.12	
.655	.665	R	16.64	16.89	
.213	.223	T	5.41	5.66	
.315	.325	U	8.00	8.26	
	.086	V		2.18	
	.100	W		2.54	
.105	.145	Y	2.67	3.68	
.650	.850	Z	16.51	21.59	



NOTES:

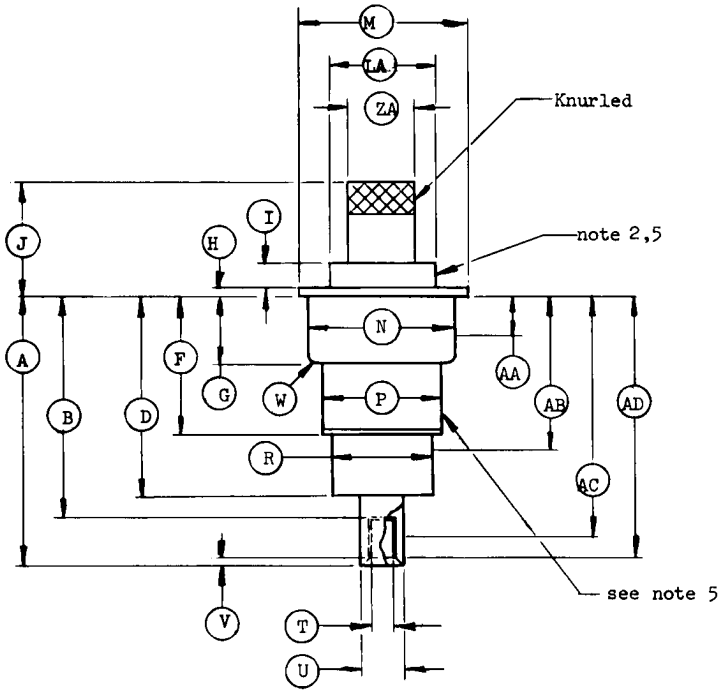
1. Metric equivalents, to the nearest .01 mm, are given for general information only & are based on 1 inch = 25.4 mm.
2. This surface to be used to measure anode shank temperature.
3. Eccentricity of contact surfaces shall be gaged from center line of reference & shall be as follows:

Contact Surface	TIR Max.	Reference
Anode	.020	Cathode
Grid	.020	Cathode
Heater	.012	Cathode

4. Dias. N,R,T & U shall apply throughout entire lenght as defined by dims. AA,AB,AC,AD respectively.
5. This surface shall not be used for clamping or locating.
6. Holes for extractor thru top fin only.
7. Electrode Contact dims. are for socket design purposes & are not intended for inspection purposes.

ELECTRODE CONTACT AREA (see note 6)				
Dim. in Millimeters		Dim.	Dim. in Inches	
Min.	Max.		Min.	Max.
.89	9.17	AA	.035	.361
25.93	27.97	AB	1.021	1.101
30.96	35.89	AC	1.219	1.413
29.46	38.10	AD	1.160	1.500

DIMENSIONAL DATA				
Dim. in Inches		Dim. in Millimetres		
Min.	Max.	Dim.	MIN.	MAX.
1.500	1.560	A	38.10	39.62
	1.215	B		30.84
1.125	1.165	D	28.58	29.59
.800	.840	F	20.32	21.34
.462	.477	G	11.73	12.12
	.040	H		1.02
	.185	I		4.70
.766	.826	J	19.46	20.98
.025	.046	K	.64	1.17
1.234	1.264	L	31.34	32.11
1.180	1.195	M	29.97	30.35
1.025	1.035	N	26.04	26.29
.752	.792	P	19.10	20.12
.655	.665	R	16.64	16.89
.213	.223	T	5.41	5.66
.315	.325	U	8.00	8.26
	.086	V		2.18
	.100	W		2.54
.840	.860	LA	21.34	21.84
.427	.447	ZA	10.85	11.35

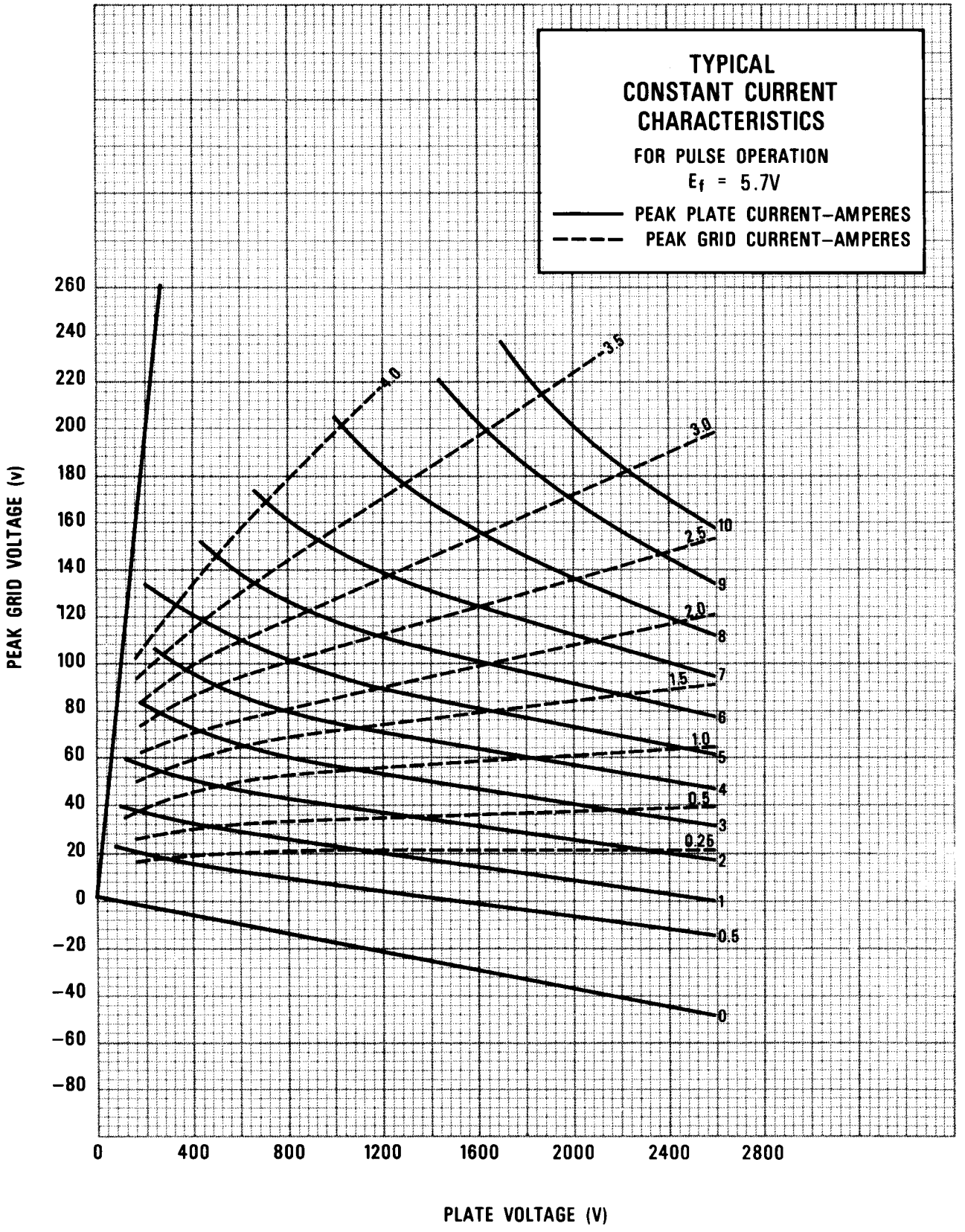


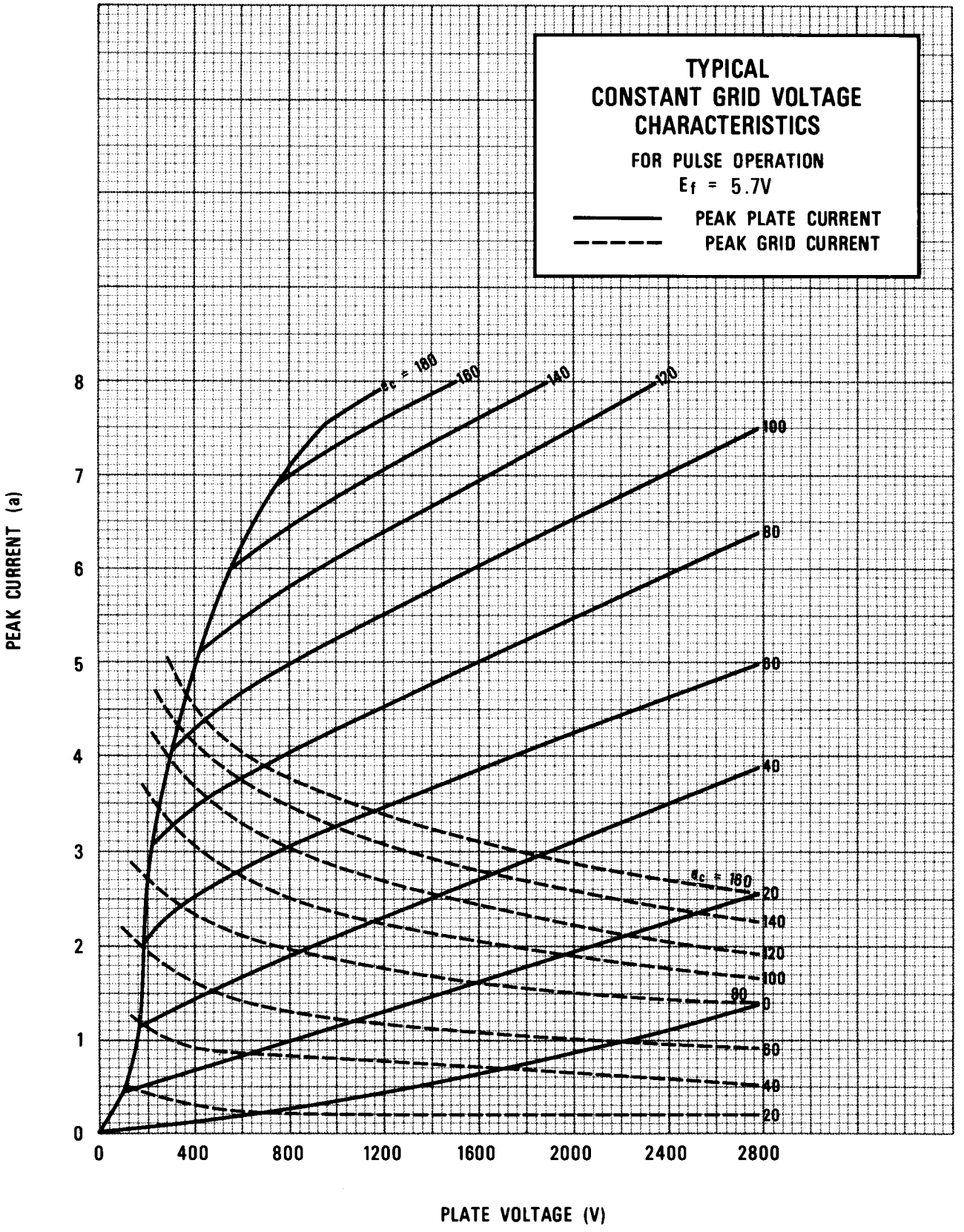
NOTES:

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Grid	.020	Cathode
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4. Dias. N,R,T,U shall apply throughout entire lenght as defined by dims. AA,AB,AC,AD respectively.
5. This surface shall not be used for clamping or locating.
6. Electrode Contact Dims. are intended for socket design only & are not intended for inspection purposes.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 5.7V
PEAK PLATE CURRENT–AMPERES
PEAK GRID CURRENT–AMPERES
PEAK GRID VOLTAGE (v)
260
240
220
200
180
160
140
120
100
80
60
40
20
0
−20
−40
−60
−80
0
400
800
1200
1600
2000
2400
2800
PLATE VOLTAGE (V)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.25
10
9
8
7
6
5
4
3
2
1
0.5
0


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
Ef = 5.7V
PEAK PLATE CURRENT
PEAK GRID CURRENT
PEAK CURRENT (a)
PLATE VOLTAGE (V)
0
1
2
3
4
5
6
7
8
0
400
800
1200
1600
2000
2400
2800
Ec = 180
160
140
120
100
80
60
40
20
Ec = 180
140
120
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20
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CALIFORNIA

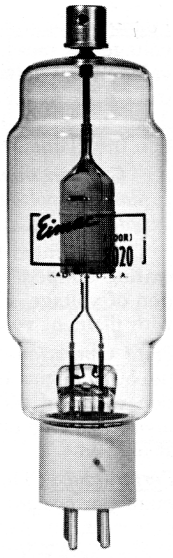
8020

HIGH-VACUUM RECTIFIER

The EIMAC 8020 diode is a high-vacuum rectifier intended for use in rectifier units, voltage multipliers, or in special applications, whenever conditions of extreme ambient temperatures, high operating frequency, high peak inverse voltages, or the production of high-frequency transients would prevent the use of gas-filled rectifier tubes.

The 8020 has a maximum dc current rating of 100 milliamperes and a maximum peak inverse voltage rating of 40,000 volts. Cooling is by convection and radiation.

A single 8020 will deliver 80 milliamperes at 17,000 volts to a capacitor-input filter with 14,000 volts single-phase supply. Four 8020's in a bridge circuit will deliver 200 milliamperes at 25,000 volts to a choke-input filter with 28,000 volts single-phase supply.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	5.0	volts
Current	6.5	amperes

MECHANICAL

Base	Medium 4-pin bayonet
Basing	Refer to outline drawing
Socket	Refer to discussion under "Application"
Mounting Position	Vertical, base down or up
Cooling	Convection and radiation
Maximum Temperature of Plate Seal	225°C
Recommended Heat Dissipating Plate Connector	EIMAC HR-8
Maximum Overall Dimensions:	
Length	8.00 inches
Diameter	2.32 inches
Net Weight	4 ounces
Shipping Weight (approx.)	1 pound

MAXIMUM RATINGS (Per Tube)

Peak Inverse Plate Voltage	40,000	volts
Plate Dissipation	60	watts
DC Plate Current[1]	100	ma
Peak Plate Current	1.5	ampere

[1] Averaged over one cycle for each tube. Applies only when the rectifier is coupled to the load by a choke-input filter incorporating the "critical" value (or larger) of input inductance. For maximum dc current ratings under this and other load conditions see discussion under "Application."

APPLICATION

MECHANICAL

Mounting—The 8020 must be mounted vertically with the base either down or up. The lead to the plate terminal of the tube should be flexible.

The medium 4-pin bayonet base fits an E. F. Johnson Co. No. 122-124, a National Co. No. XC-4 or CIR-4, or an equivalent socket. In some circuits, particularly those of the voltage multipliers illustrated in Fig. 2, it may be necessary to mount the socket on stand-off insulators, or on a sheet of insulating material, to provide adequate insulation to ground.

Cooling—The 8020 is cooled by convection and radiation. Clearance should be provided around the glass envelope adequate for free circulation of air. An EIMAC HR-8 Heat Dissipating Connector or equivalent is required on the plate terminal.

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APPLICATION (Continued)

The maximum temperature at the plate seal must not exceed 225°C. A convenient accessory for measuring this temperature is "Tempilaq," a temperature-sensitive lacquer available from the Tempil Corporation, 132 W. 22nd St., New York 11, N. Y.

ELECTRICAL

Filament Operation—For maximum tube life, the filament voltage, as measured at the base pins, should be the rated value of 5.0 volts. Variations must be kept within the range from 4.75 to 5.25 volts. In applications which require the diode to deliver high peak currents, it is important to maintain the filament voltage at the rated value.

Caution should be observed when measuring rectifier filament voltage. The filament circuit may be at high potential.

The thoriated-tungsten filament of the 8020 reaches operating temperature in a fraction of a second after application of voltage. Plate voltage may be applied simultaneously with filament voltage.

Plate Operation—With low room illumination, the plate of the 8020 begins to show color as the maximum plate dissipation rating of 60 watts is approached. The maximum peak inverse voltage rating of 40,000 volts should not be exceeded at any time.

Performance—The accompanying table shows some maximum performance capabilities of the 8020 when used as a power-supply rectifier.

8020 MAXIMUM PERFORMANCE CAPABILITIES

		Capacitor-Input Filter		Choke-Input Filter	
Circuit Type	AC Input Voltage (volts rms)	DC Output Voltage (volts)	DC Output Current (ma)	DC Output Voltage (volts)	DC Output Current (ma)
Single-Phase, Half-Wave	14,000	17,000	80	.....	...
Single-Phase, Full-Wave	14,000[1]	17,000	160	12,500	200
Single-Phase, Bridge	28,000	34,000	160	25,000	200

[1] One-half the transformer secondary voltage.

Maximum DC Current Ratings—Plate dissipation rather than peak current usually limits the dc current which the 8020 is capable of delivering to the load. Because the plate dissipation associated with a given dc current depends upon the amount of ripple and its wave-shape, circuit conditions will determine the maximum dc current rating of the tube.

Choke-Input Filter—The maximum dc current rating of the 8020 is 100 milliamperes when the load incorporates a choke-input filter with the "critical" value (or larger) of input inductance (L in Fig. 1):

$$L_o = \frac{R_{eff}}{18.8f}$$ for full-wave single-phase rectifiers,

$$L_o = \frac{R_{eff}}{75f}$$ for half-wave three-phase rectifiers,

$$L_o = \frac{R_{eff}}{660f}$$ for full-wave three-phase rectifiers,

where: L_o = "critical" value of input inductance (henries),
f = supply-line frequency (cycles per second),
$R_{eff} = \frac{\text{Load voltage (volts)}}{\text{Load current (amps)}}$

Choke-input filters are not normally used with single-phase half-wave rectifiers.

Capacitor-Input Filter—The 8020 is particularly suitable for power-supply applications demanding high voltage at low current. Under these conditions capacitor-input filter circuits become desirable. The maximum dc current rating of the 8020 when no input choke is incorporated in the filter depends upon the total series resistance of the capacitor-charging circuit relative to the effective load resistance seen by each tube. The circuit diagrams and tabulation in Fig. 2 are so arranged and labeled that this required series resistance may be found for a wide range of load conditions. This may be done by determining the value of the following quantities:

E_c is the filter-input dc voltage. While this is usually the entire load voltage, in the case of voltage multipliers it is the load voltage divided by the multiplication factor.

I_p is the dc current per tube. This is the entire load current only in the case of the simple half-wave rectifier or half- or full-wave multiplier. In the case of full-wave center-tapped or bridge rectifiers, I_p is half the load current.

R_c is the total charging-circuit resistance. A certain minimum value of charging-circuit resistance is necessary to limit the peak value of current to which the tubes will be subjected under given load conditions. This required minimum depends upon the dc current per tube (I_p), and has been tabulated in Fig. 2 as a percentage of the effective load resistance per tube $\left(\frac{E_c}{I_p}\right)$. The total charging circuit resistance involves the internal resistance of the rectifier tube, R_p, the added series resistor, R_s, and the equivalent internal resistance of the ac voltage supply, R_i.

R_p is the plate resistance of the 8020, which may be taken as 1000 ohms.

R_i is the equivalent internal resistance of the supply. This may be taken as the regulation of the high-voltage supply expressed as a decimal multiplied by the load resistance used in measuring this regulation.

R_s is the series resistor which must be inserted in the charging circuit to bring the total charging-circuit resistance up to the required minimum. Its value may be found from the formula associated with each of the circuits of Fig. 2. This resistor must be inserted in such a position in the circuit that it protects all tubes.

Tubes may be operated in parallel to increase the output capability in a given circuit. When two tubes are placed in parallel at each place where one is shown in the circuits of Fig. 2, the plate resistance (R_p) will be half as great and the maximum allowable load current twice as great as indicated.

Peak Inverse Voltage—The peak inverse voltage rating of the 8020 is 40,000 volts. In single-phase power-supply rectifier circuits the peak inverse voltage to be used in design is the peak ac supply voltage (1.41 times E_{rms} in Fig. 2) in the case of bridge circuits, and twice this value in the case of half- or full-wave rectifiers and voltage multipliers. Peak inverse voltage in three-phase operation depends upon the circuit employed, and will be found listed in the handbooks.

Special Applications—The ratings given for capacitor-input filter circuits assume values of input capacitance large enough to hold the ripple to a low value. In special applications where a large percent ripple is tolerable and filter capacitance is low, the 8020 is capable of larger dc output currents.

As a unidirectional conductor in dc circuits where the current is continuous and the percent ripple is moderate, the maximum current rating of the 8020 is 200 milliamperes.

The plate characteristic curve for the 8020 serves as a guide to special applications. The maximum plate dissipation rating of 60 watts, the maximum peak inverse voltage rating of 40,000 volts, and the maximum peak plate current of 1.5 amperes must not be exceeded.

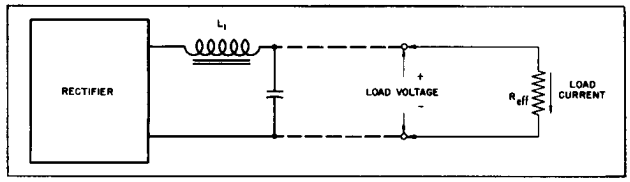
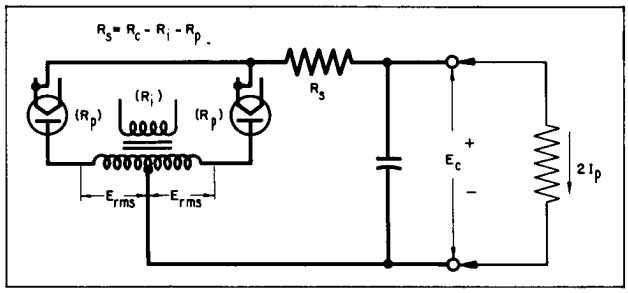
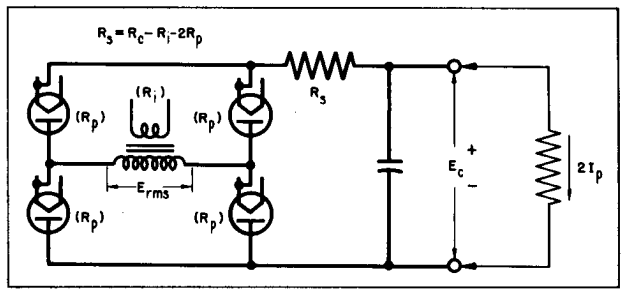


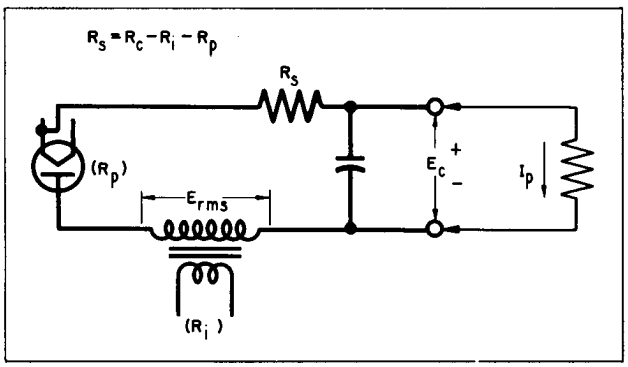
Fig. 1. Rectifier with Choke-Input Filter



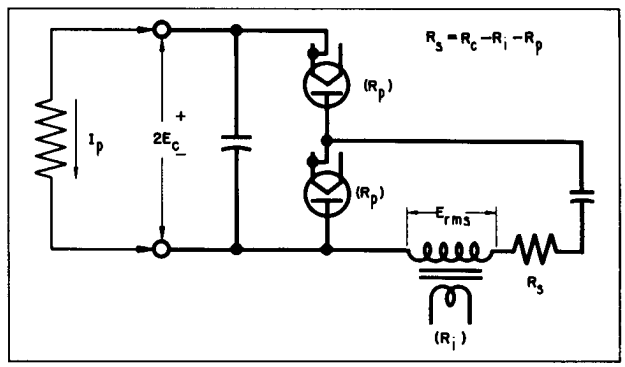
a. Full-Wave Center-Tapped Rectifier



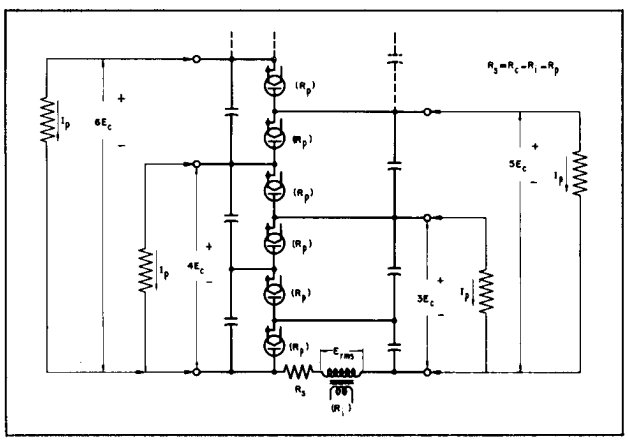
b. Full-Wave Bridge Rectifier



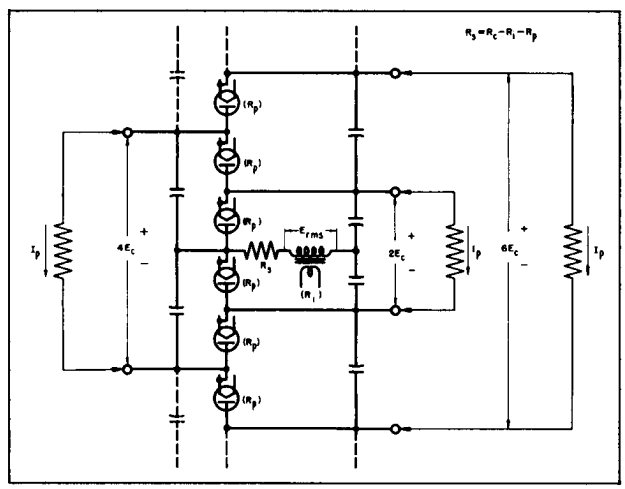
c. Half-Wave Rectifier



d. Half-Wave Voltage Doubler



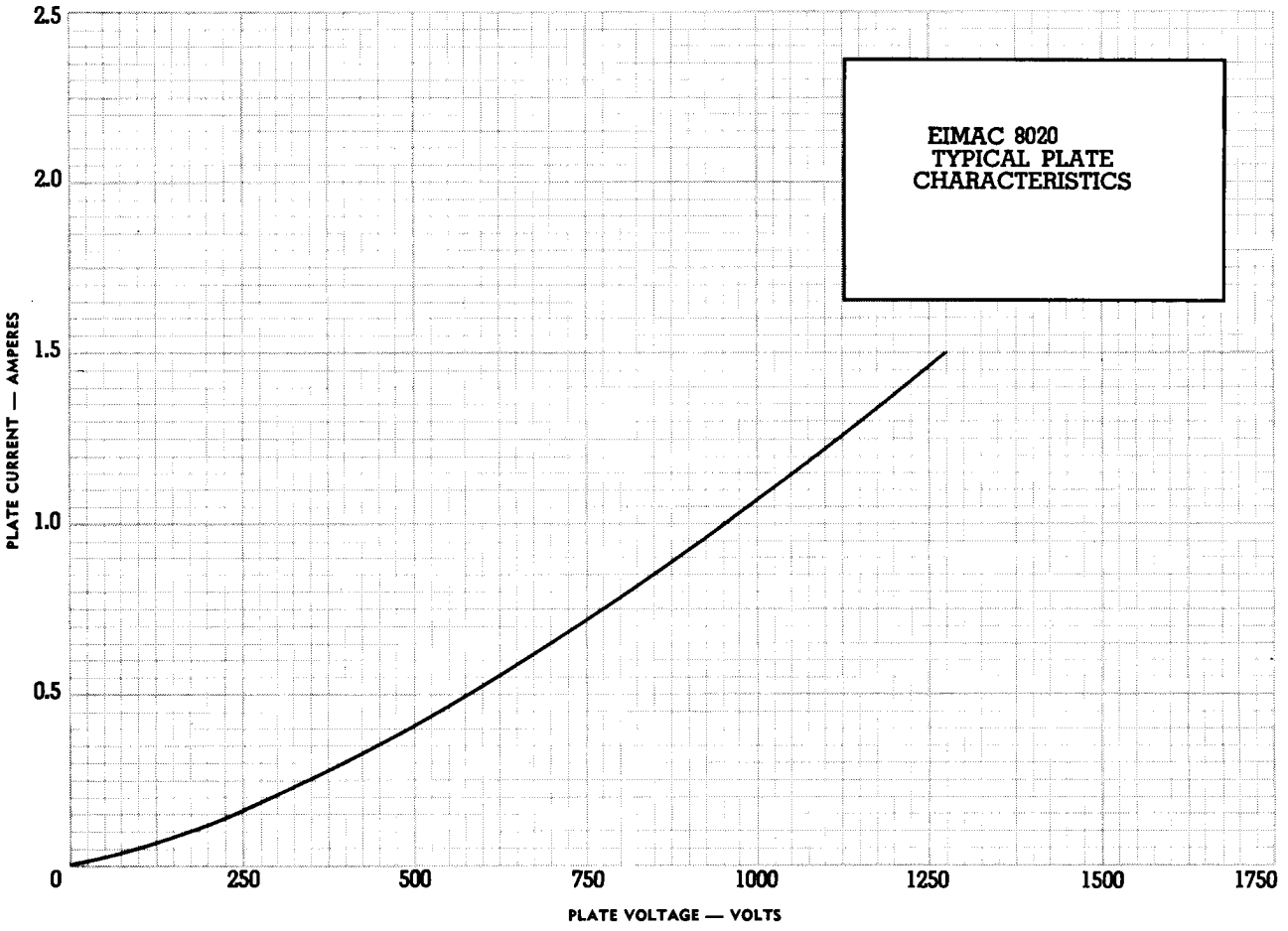
e. Half-Wave Voltage Multiplier (with common ground when R_s is inserted on the "high" side of E_{rms})

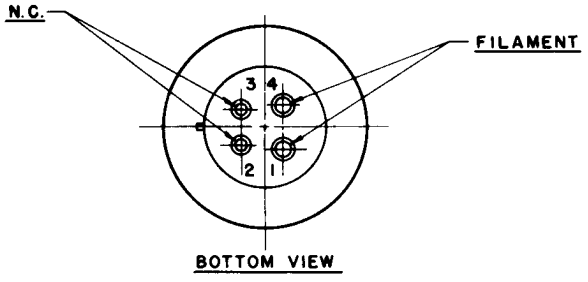


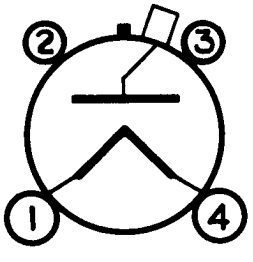
f. Full-Wave Voltage Multiplier

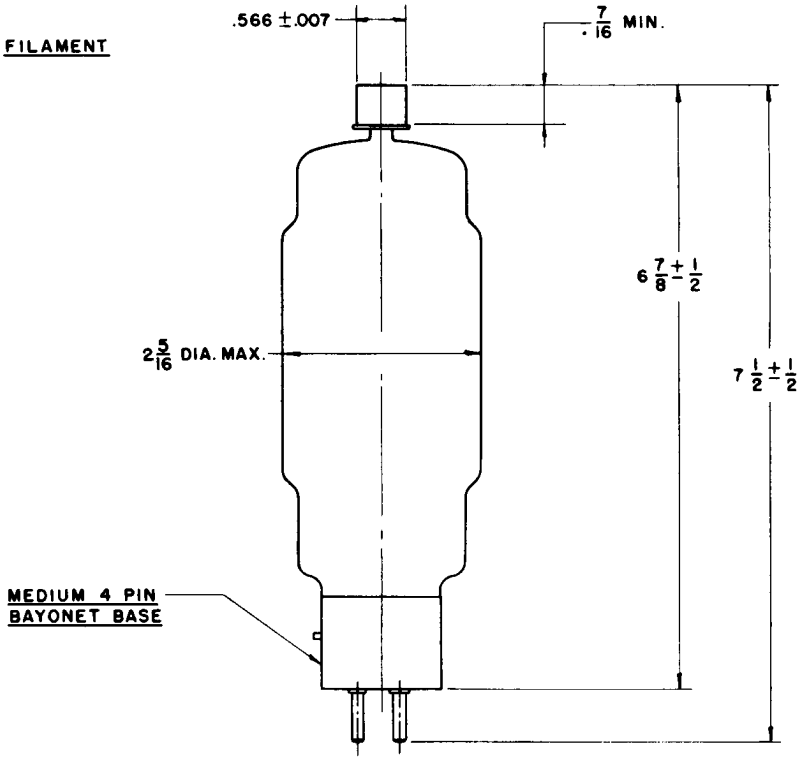
Eimac 8020 Maximum D-C Current Ratings for R-C Filter Applications								
D-C Plate Current (I_p)	70	75	80	85	90	95	100	milliamperes per tube
Total Charging-Circuit Resistance (R_c)	0.8	1.2	1.8	3.0	4.7	7.6	12	percent of Effective Load Resistance per Tube $\left(\frac{E_c}{I_p}\right)$
A-C Supply Voltage (E_{rms})	0.78	0.80	0.83	0.87	0.92	1.01	1.14	times Filter-Input D-C Voltage (E_c)
Peak Inverse Voltage (½ these values in circuit "b".)	2.2	2.3	2.4	2.5	2.6	2.9	3.2	times Filter-Input D-C Voltage (E_c)

Fig. 2. EIMAC 8020 Basic R-C Circuits (for any one of the indicated loads)
R_1 = Equivalent resistance of voltage source
R_p = 1000 ohms (500 ohms for two tubes in parallel)









DIMENSIONS
IN INCHES

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8158
3CX10,000A1

LOW-MU POWER TRIODE

The Eimac 8158/3CX10,000A1 is a ceramic and metal power triode intended primarily for use as an audio amplifier or modulator. This tube is also recommended for voltage-regulator applications where high current capability and low tube drop are important. Up to 12 kilowatts of plate power can be dissipated on its air-cooled anode. A water-cooled version, the 3CW20,000A1, is available with a 20 kw dissipation rating.



CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated-Tungsten				
Voltage		7.5		V
Current	94		104	A
Amplification Factor	5.5		7.0	
Interelectrode Capacitances:				
Grid-Filament	45		57	pF
Output	3.4		4.2	pF
Grid-Plate	25		32	
Transconductance (Ib = 2.0 amps, Eb = 3000 volts)	20,000			umhos

MECHANICAL

Base	Coaxial
Recommended Socket	Eimac SK-1300
Recommended Chimney	Eimac SK-1306
Operating Position	Vertical, base up or down
Cooling	Forced air
Maximum Operating Temperatures:	
Anode Core	250 °C
Ceramic-to-Metal Seals	250 °C
Maximum Dimensions:	
Height	8.75 in
Diameter	7.0 in
Net Weight	12 lbs

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR CLASS-AB1

MAXIMUM RATINGS (Per Tube)

DC Plate Voltage	7000	volts
DC Plate Current	5.0	amps
Plate Dissipation	12	kW
Grid Dissipation	100	watts

*Adjust for zero-signal plate current
**At max-signal without negative feedback

Effective grid circuit resistance must not exceed 200,000 ohms

TYPICAL OPERATION, Two Tubes, Sinusoidal Wave

DC Plate Voltage	7000	7000	volts
DC Grid Voltage*	−1300	−1300	volts
Zero-Sig DC Plate Current	1.5	1.5	amps
Max-Sig DC Plate Current	5.8	7.0	amps
Load Resistance, Plate-to-Plate	2460	1720	ohms
Peak AF Grid Driving Voltage (Per Tube)	1300	1300	volts
Max-Sig Driving Power	0	0	watts
Max-Sig Plate Output Power	24,400	29,100	watts
Total Harmonic Distortion**	2.9	3.6	percent

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AUDIO-FREQUENCY AMPLIFIER OR MODULATOR Class-A

MAXIMUM RATINGS

DC Plate Voltage	7000	volts
DC Plate Current	See Class-A derating table on Page 3	
Plate Dissipation	12,000	watts

*Adjust to give listed zero-signal DC plate current

TYPICAL OPERATION

DC Plate Voltage	2500	volts
DC Grid Voltage*	−290	volts
DC Plate Current	4.0	amps
Peak AF Grid Driving Voltage	290	volts
Load Resistance	2120	ohms
Plate Output Power	1800	watts

VOLTAGE REGULATOR SERVICE
Class-A

MAXIMUM RATINGS

DC Plate Voltage	10,000	volts
DC Plate Current	See Class-A derating table on Page 3	
Plate Dissipation	12,000	watts
Grid Dissipation	100	watts

TYPICAL OPERATION

DC Plate Voltage (tube drop)	0-5000	volts
DC Plate Current	0-5	amps

(These values are chosen according to Class-A derating table on Page 3)

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance for circuit losses, either input or output, has been made.

APPLICATION

Cooling — The maximum temperature rating for the external surfaces of the 3CX10, 000A1 is 250°C. Sufficient forced-air cooling must be provided to keep the temperature of the anode core and the temperature of the ceramic-metal seals below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below this maximum rating. Minimum air-flow requirements to maintain anode-core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated. The use of these air-flow rates through the recommended socket/chimney and tube combination in the base-to-anode direction provides effective cooling of the tube.

Plate** Dissipation (Watts)	SEA LEVEL		10,000 FEET	
	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
4000	85	0.18	125	0.25
6000	145	0.38	210	0.55
8000	215	0.68	315	0.99
10,000	295	1.08	430	1.60
12,000	390	1.62	565	2.35

**Since the power dissipated by the filament is about 750 watts and since grid dissipation can, under some circumstances, represent another 100 watts, allowance has been made in preparing this tabulation for an additional 850 watts dissipation.

APPLICATION

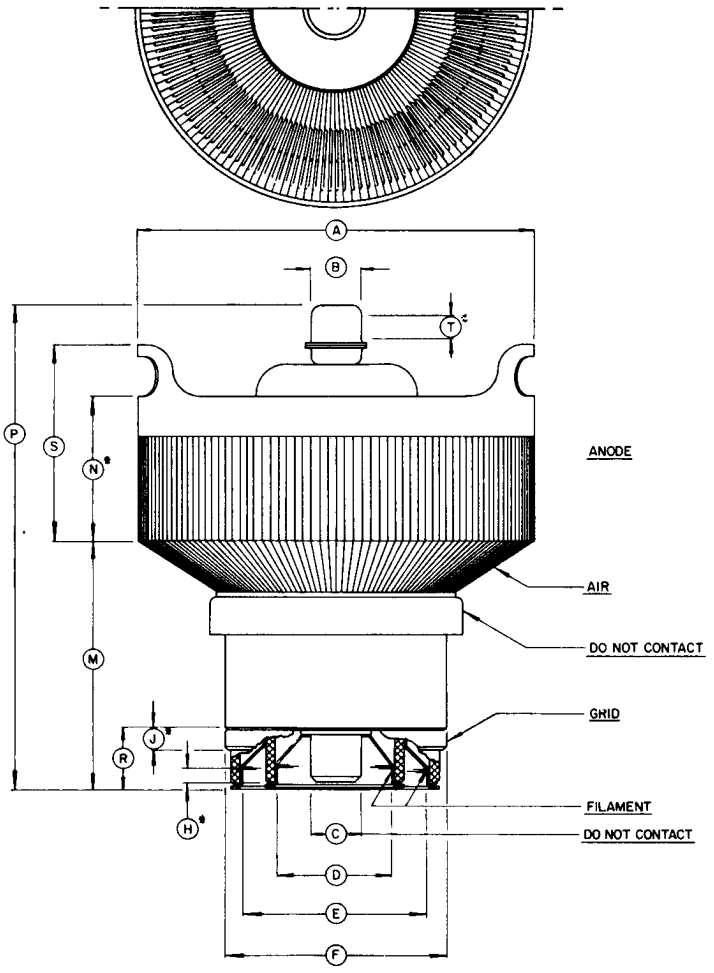
Voltage-Regulator Service — Maximum DC plate current and voltage are restricted according to the following table.

CLASS-A DERATING TABLE	
DC Plate Voltage (Volts)	Max. DC Plate Current (mA)
0 - 2400	5000
3000	4000
4000	3000
5000	2000
6000	1500
7000	1000
8000	700
9000	500
10,000	350

Filament Operation—The rated filament voltage for the 3CX10,000A1 is 7.5 volts. Filament voltage, as measured at the socket, should not be allowed to deviate from the rated value by more than plus or minus five percent.

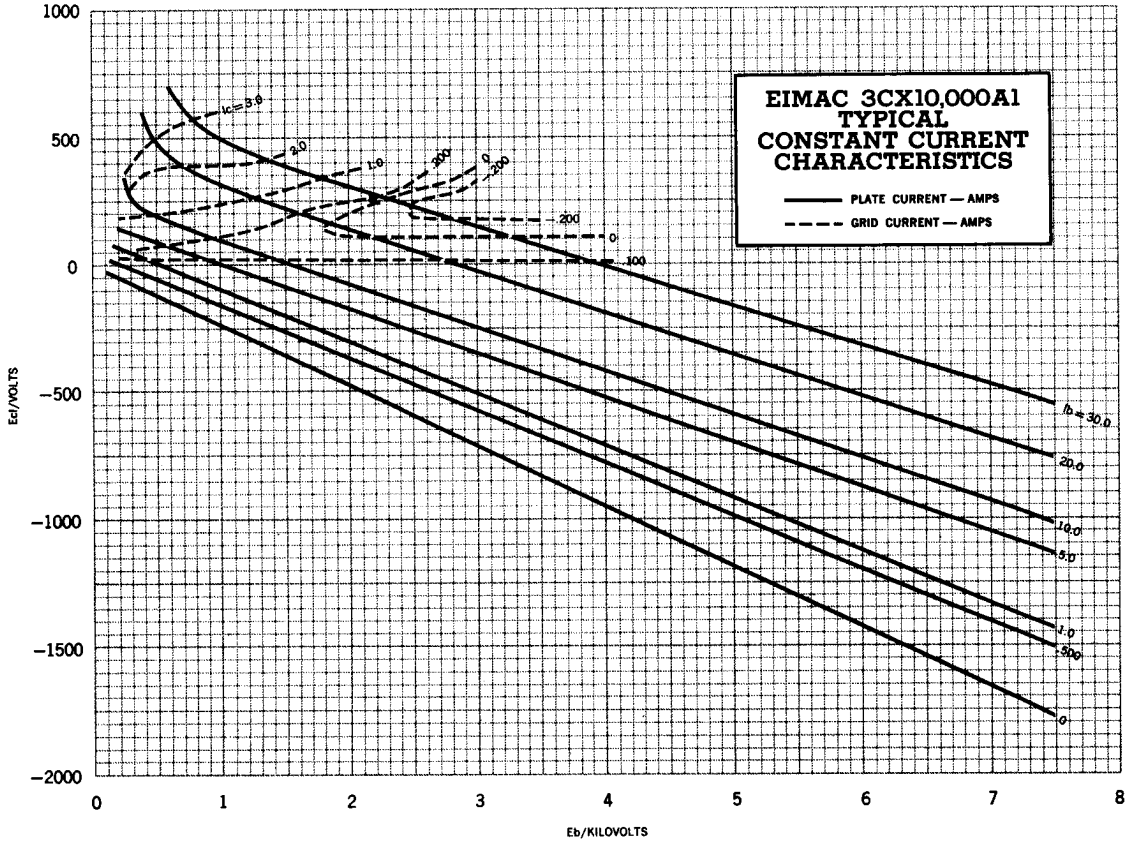
Cooling—The maximum temperature rating for the external surfaces of the 3CX10,000A1 is 250°C. Sufficient forced-air cooling must be provided to maintain the temperature of the ceramic-metal seals and anode core below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below this maximum rating. Minimum air-flow requirements to maintain anode-core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated. The use of these air-flow rates provides effective cooling of the tube. When air-flow is in the anode-to-base direction, special care must be taken to insure adequate cooling of the filament stem structure. A separate supply of air may have to be directed into the area between the filament contact areas to maintain safe seal temperatures.

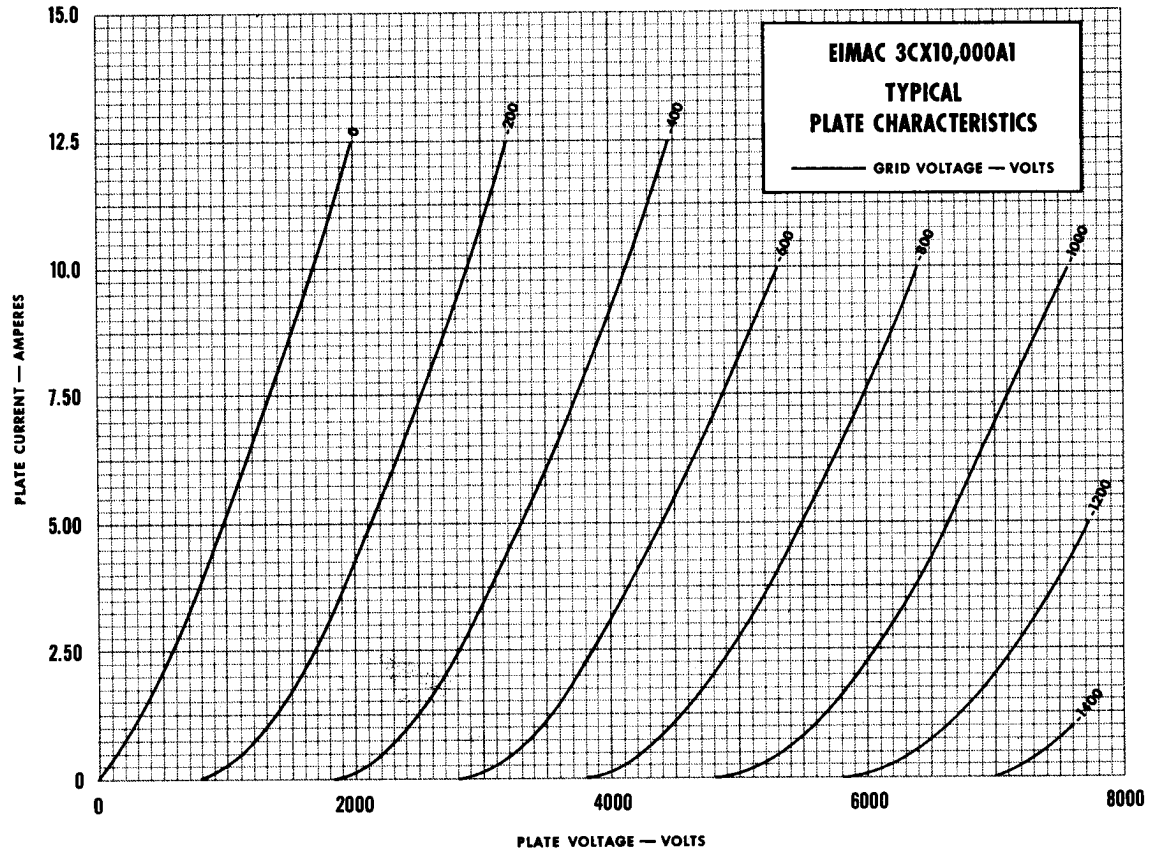
Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, Calif., for information and recommendations.



*CONTACT SURFACE
ALL DIMENSIONS IN INCHES

DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		6.928	7.050
B		.855	.895
C		.720	.760
D		1.896	1.936
E		3 133	3.173
F		3.792	3.832
H		.188	
J		.188	
M		3.950	4.300
N		2.412	2.788
P		8.250	8.750
R		.986	1.050
S		3.412	3.788
T		.375	


EIMAC 3CX10,000A1
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT — AMPS
GRID CURRENT — AMPS
Ec/VOLTS
Eb/KILOVOLTS
1000
500
0
−500
−1000
−1500
−2000
0
1
2
3
4
5
6
7
8
Ib = 30.0
20.0
10.0
5.0
1.0
.500
0
Ic = 3.0
2.0
1.0
.500
0
-200
-100
-200
0


EIMAC 3CX10,000A1
TYPICAL
PLATE CHARACTERISTICS
GRID VOLTAGE — VOLTS
PLATE CURRENT — AMPERES
PLATE VOLTAGE — VOLTS
15.0
12.5
10.0
7.50
5.00
2.50
0
0
2000
4000
6000
8000
0
-200
-400
-600
-800
-1000
-1200
-1400

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8159
3CX10,000A3
MEDIUM-MU POWER TRIODE

The EIMAC 3CX10,000A3 is a ceramic and metal power triode intended primarily for use as a power oscillator in industrial-heating applications. It is also recommended for use as a grounded-grid FM amplifier, as a conventional plate-modulated amplifier, or as a linear amplifier.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated-Tungsten				
Voltage		7.5		V
Current	94		104	A
Amplification Factor		20		
Interelectrode Capacitances, Grounded Cathode:				
Input	48		58	pF
Output	1.2		1.5	pF
Feedback	30		38	pF
Frequency for Maximum Ratings				140 MHz

MECHANICAL

Base	Coaxial
Recommended Socket	EIMAC SK-1300
Recommended Chimney	EIMAC SK-1306
Operating Position	Vertical, base up or down
Cooling	Forced air
Maximum Operating Temperatures:	
Anode Core	250°C
Ceramic-to-Metal Seals	250°C
Maximum Dimensions:	
Height	8.5 in
Diameter	7.0 in
Net Weight	12 lb

R-F INDUSTRIAL OSCILLATOR
CLASS-C

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7000	VOLTS
D-C PLATE CURRENT	4.0	AMPS
PLATE DISSIPATION	10	KW
GRID DISSIPATION	250	WATTS

TYPICAL OPERATION, Optimum Load

D-C Plate Voltage	6000	7000	volts
D-C Grid Voltage	-575	-670	volts
D-C Plate Current	4.0	4.0	amps
D-C Grid Current	610	670	mA
Plate Input Power	24	28	kW
Plate Output Power	18.9	22.4	kW

R-F POWER AMPLIFIER
GROUNDED-GRID, CLASS-C

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7000	VOLTS
D-C PLATE CURRENT	4.0	AMPS
PLATE DISSIPATION	10	KW
GRID DISSIPATION	250	WATTS

TYPICAL OPERATION

D-C Plate Voltage	6000	7000	volts
D-C Grid Voltage	-535	-625	volts
D-C Plate Current	4.0	4.0	amps
D-C Grid Current	545	530	mA
Driving Power	3700	4100	watts
Plate Output Power	20.5	24.5	kW

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R-F POWER AMPLIFIER
PLATE-MODULATED, CLASS-C

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5500	VOLTS
D-C PLATE CURRENT	3.0	AMPS
PLATE DISSIPATION	6.5	KW
GRID DISSIPATION	250	WATTS

TYPICAL OPERATION

D-C Plate Voltage	4000	5000	volts
D-C Grid Voltage	-480	-600	volts
D-C Plate Current	3.0	3.0	amps
D-C Grid Current	660	550	mA
Driving Power	530	515	watts
Plate Output Power	9.7	12.4	kW

R-F LINEAR AMPLIFIER
GROUNDED-GRID, CLASS-AB_2

MAXIMUM RATINGS

D-C PLATE VOLTAGE	7000	VOLTS
D-C PLATE CURRENT	5.0	AMPS
PLATE DISSIPATION	12	KW
GRID DISSIPATION	250	WATTS

TYPICAL OPERATION

D-C Plate Voltage	6000	7000	volts
Zero-Sig Grid Voltage*	-270	-325	volts
Max-Sig D-C Plate Current	4.0	4.0	amps
Max-Sig D-C Grid Current	300	250	mA
Driving Power	1900	2050	watts
Plate Output Power	18	20	kW

*Adjust to give 500 milliamperes zero-signal d-c plate current.

Note: "TYPICAL OPERATION" data are obtained by calculation from published characteristics curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

APPLICATION

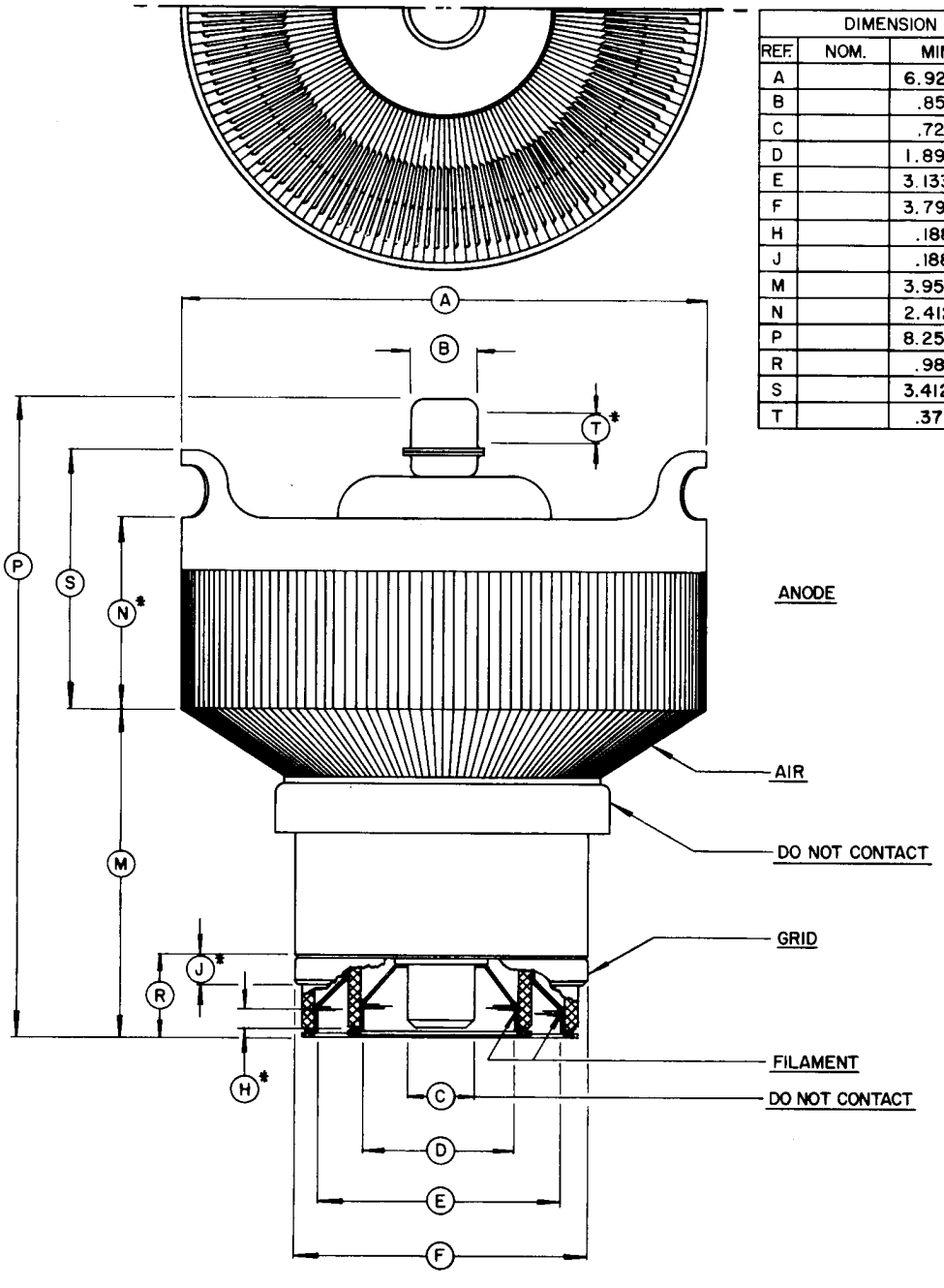
Cooling - The maximum temperature rating for the external surfaces of the 3CX10,000A3 is 250°C. Sufficient forced-air cooling must be provided to keep the temperature of the anode core and the temperature of the ceramic-metal seals below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below this maximum rating. Minimum air-flow requirements to maintain anode-core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated. The use of these air-flow rates through the recommended socket/chimney and tube combination in the base-to-anode direction provides effective cooling of the tube.

	Sea Level		10,000 Feet	
Plate** Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
4000	110	.25	160	.36
6000	180	.53	260	.78
8000	270	.95	390	1.4
10,000	373	1.55	545	2.25
12,000	448	2.00	650	2.9

**Since the power dissipated by the filament is about 750 watts and since grid dissipation can, under some circumstances, represent another 250 watts, allowance has been made in preparing this tabulation for an additional 1000 watts dissipation.

Filament Operation - The rated filament voltage for the 3CX10,000A3 is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate from the rated value by more than five percent.

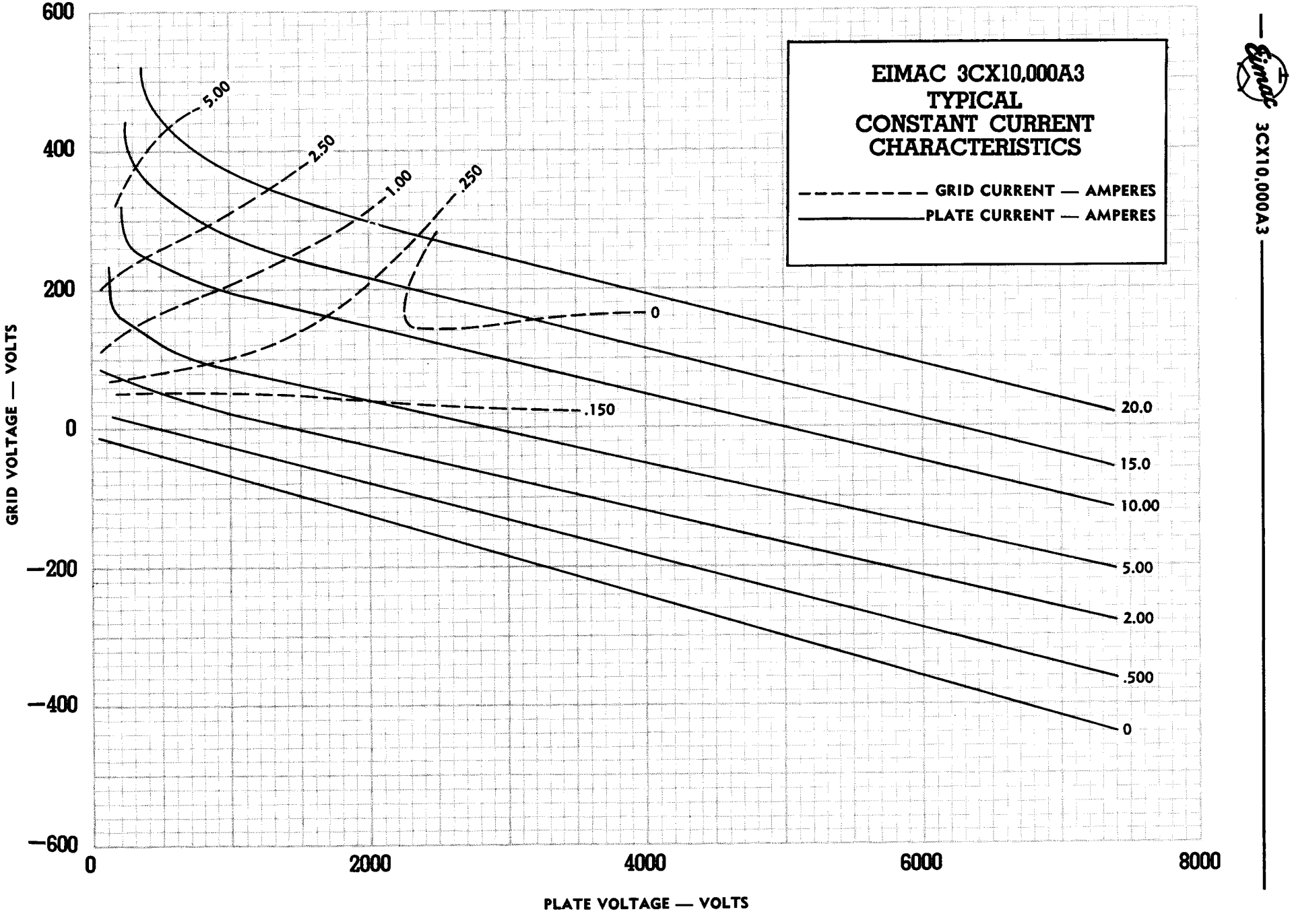
Special Applications - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		6.928	7.050
B		.855	.895
C		.720	.760
D		1.896	1.936
E		3.133	3.173
F		3.792	3.832
H		.188	
J		.188	
M		3.950	4.300
N		2.412	2.788
P		8.250	8.750
R		.986	1.050
S		3.412	3.788
T		.375	

*CONTACT SURFACE
ALL DIMENSIONS IN INCHES

▶ Indicates change from sheet dated 7-1-61


EIMAC 3CX10,000A3
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GRID CURRENT — AMPERES
PLATE CURRENT — AMPERES
5.00
2.50
1.00
.250
0
.150
20.0
15.0
10.00
5.00
2.00
.500
0
600
400
200
0
−200
−400
−600
0
2000
4000
6000
8000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

8160
3CX10,000A7

HIGH-MU
POWER TRIODE

TECHNICAL DATA



The EIMAC 8160/3CX10,000A7 is a ceramic and metal power triode intended to be used as a zero-bias Class-B amplifier in audio or radio-frequency applications. Operation with zero grid bias offers circuit simplicity by eliminating the bias supply. In addition, grounded-grid operation is attractive since a power gain as high as twenty times can be obtained with the 8160/3CX10,000A7.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-Tungsten	
Voltage	7.5 V
Current	100 A
Amplification Factor (Nominal)	200
Direct Interelectrode Capacitances:[2]	
Grid-Filament	59.0 pF
Grid-Plate	36.0 pF
Plate-Filament	0.2 pF
Frequency for Maximum Ratings	160 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Coaxial
Recommended Air-System Socket	EIMAC SK-1300
Recommended Air Chimney	EIMAC SK-1306
Operating Position	Vertical, base up or down
Cooling	Forced air
Maximum Operating Temperatures:	
Anode Core	250 °C
Ceramic/Metal Seals	250 °C
Maximum Dimensions:	
Height	8.75 in; 222.25 mm
Diameter	7.05 in; 179.07 mm
Net Weight	12 lbs; 5.45 kg

(Revised 2-1-73) © 1963, 1967, 1973 by Varian Printed in U.S.A.

RADIO-FREQUENCY LINEAR AMPLIFIER

Grounded Grid, Class-B

MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	12	KILOWATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.

TYPICAL OPERATION, Single-Tone Conditions

DC Plate Voltage	7000	7000	V
Zero-Signal DC Plate Current[1]	0.60	0.60	A
Max-Signal DC Plate Current	3.72	5.00	A
Max-Signal DC Grid Current	0.71	1.00	A
Driving Impedance	35	32	Ω
Resonant Load Impedance	1020	745	Ω
Max-Signal Driving Power	885	1540	w
Peak Envelope Plate Output Power.	17.7	24.2	kW
Power Gain	13	12	dB

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class B, Grid Driven

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	8000	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	12	KILOWATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.

TYPICAL OPERATION, Two Tubes, Sinusoidal Wave

DC Plate Voltage	7000	7000	V
DC Grid Voltage	0	0	V
Zero-Signal DC Plate Current[1]	1.20	1.20	A
Max-Signal DC Plate Current	7.50	10.0	A
Max-Signal DC Grid Current.	1.50	2.06	A
Driving Power	315	560	W
Peak AF Driving Voltage(Per Tube) .	250	310	v
Load Resistance, Plate-to-Plate	2000	1520	Ω
Max-Signal Plate Output Power	35.6	47.7	kW

RADIO-FREQUENCY LINEAR AMPLIFIER

Carrier Conditions, Grounded-Grid

MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	12	KILOWATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.
2. Modulation Crest Conditions

TYPICAL OPERATION

DC Plate Voltage	7000	V
DC Grid Voltage	0	V
Zero-Signal DC Plate Current[1]	0.60	A
DC Plate Current	2.40	A
DC Grid Current	0.25	A
Driving Impedance[2]	32	Ω
Peak Driving Voltage[2]	310	v
Driving Power	330	W
Plate Output Power	5650	W

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C, Grounded-Grid

MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	10	KILOWATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION

DC Plate Voltage	7600	V
DC Plate Current	3.68	A
DC Grid Voltage	-110	V
DC Grid Current	775	mA
Peak RF Cathode Voltage	400	v
Cathode Driving Power[1]	1510	W
Plate Output Power	22.5	kW

1. Approximate value.

PLATE-MODULATED RF POWER AMPLIFIER

MAXIMUM RATINGS

DC PLATE VOLTAGE	6500	VOLTS
DC PLATE CURRENT	3.0	AMPERES
PLATE DISSIPATION	6.5	KILOWATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION

DC Plate Voltage	5000	V
DC Plate Current	3.0	A
DC Grid Voltage	-200	V
DC Grid Current	775	mA
Peak RF Grid Voltage	490	v
Grid Driving Power[1]	380	W
Plate Output Power	11.9	kW

1. Approximate value.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

MOUNTING - The 3CX10,000A7 must be operated vertically base up or down. The tube must be protected from severe vibration and shock.

COOLING - The maximum temperature rating for the external surfaces of the 3CX10,000A7 is 250°C. Sufficient forced-air cooling must be provided to keep the temperature of the anode core and the temperature of the ceramic/metal seals below 250°C. Tube life is usually prolonged if these areas are maintained at temperatures below this maximum rating. Minimum air-flow requirements to maintain anode-core and seal temperatures below 225°C with an inlet-air temperature of 50°C are tabulated below. The use of these air-flow rates through the recommended socket/chimney and tube combination in the base-to-anode direction provides effective cooling of the tube.

Plate ** Dissipation (Watts)	SEA LEVEL		10,000 FEET	
	Air Flow (CFM)	Pressure Drop(Inches of Water)	Air Flow (CFM)	Pressure Drop(Inches of Water)
4000	105	.24	154	.35
6000	178	.50	275	.80
8000	253	.90	370	1.45
10,000	345	1.4	500	2.30
12,000	483	2.25	710	3.40

** Since the power dissipated by the filament is about 750 watts and since grid dissipation can, under some circumstances, represent another 500 watts, allowance has been made in preparing this tabulation for an additional 1250 watts dissipation.

INPUT CIRCUIT - When the 3CX10,000A7 is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a "Q" of two of more.

CLASS-C OPERATION - Although specifically designed for class-B service, the 3CX10,000A7 may be operated as a class-C power amplifier or oscillator or as a plate-modulated radio-frequency power amplifier.

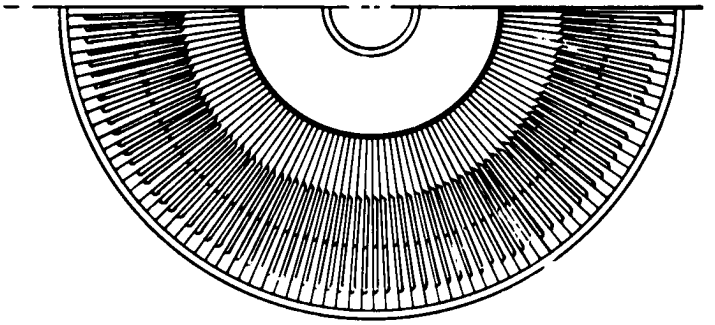
FILAMENT OPERATION - The rated filament voltage for the 3CX10,000A7 is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate from the rated value by more than plus or minus five percent.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

HIGH VOLTAGE - The 3CX10,000A7 operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

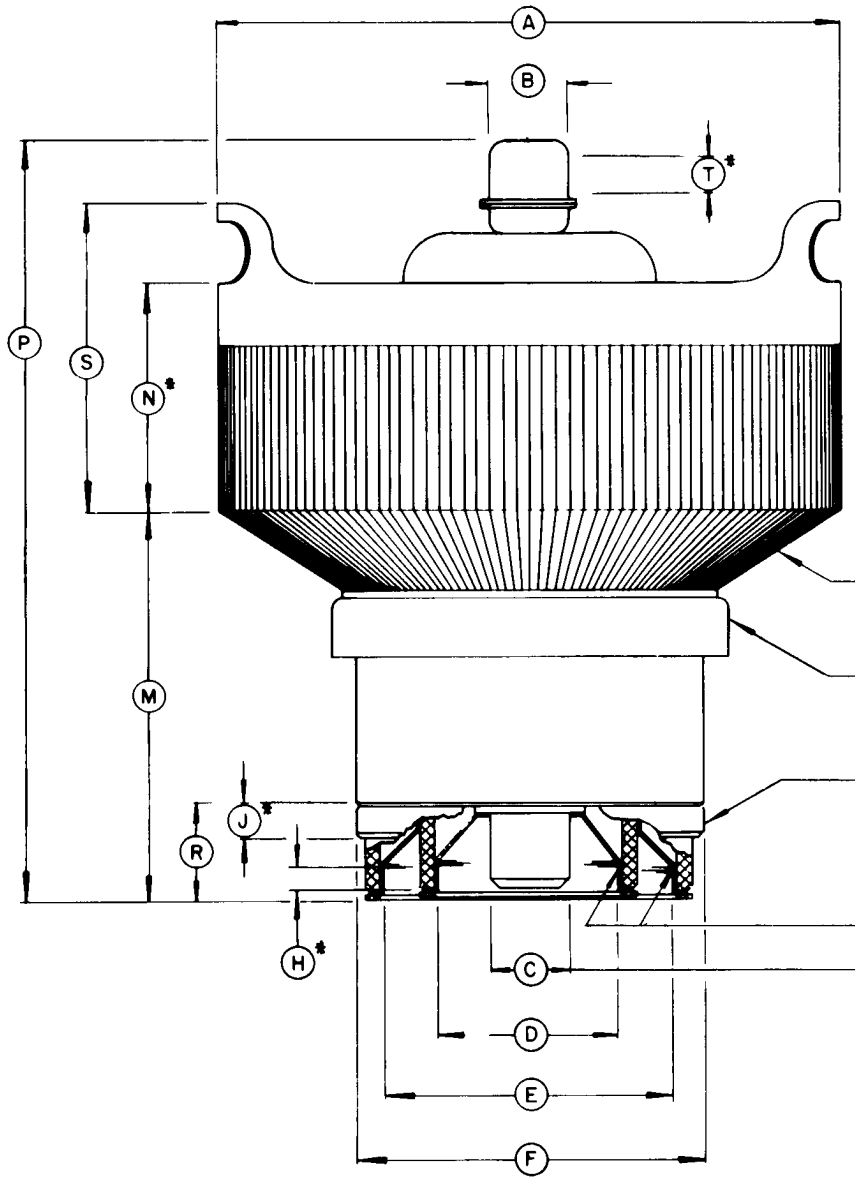
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid **Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, 94070, for information and recommendations.**



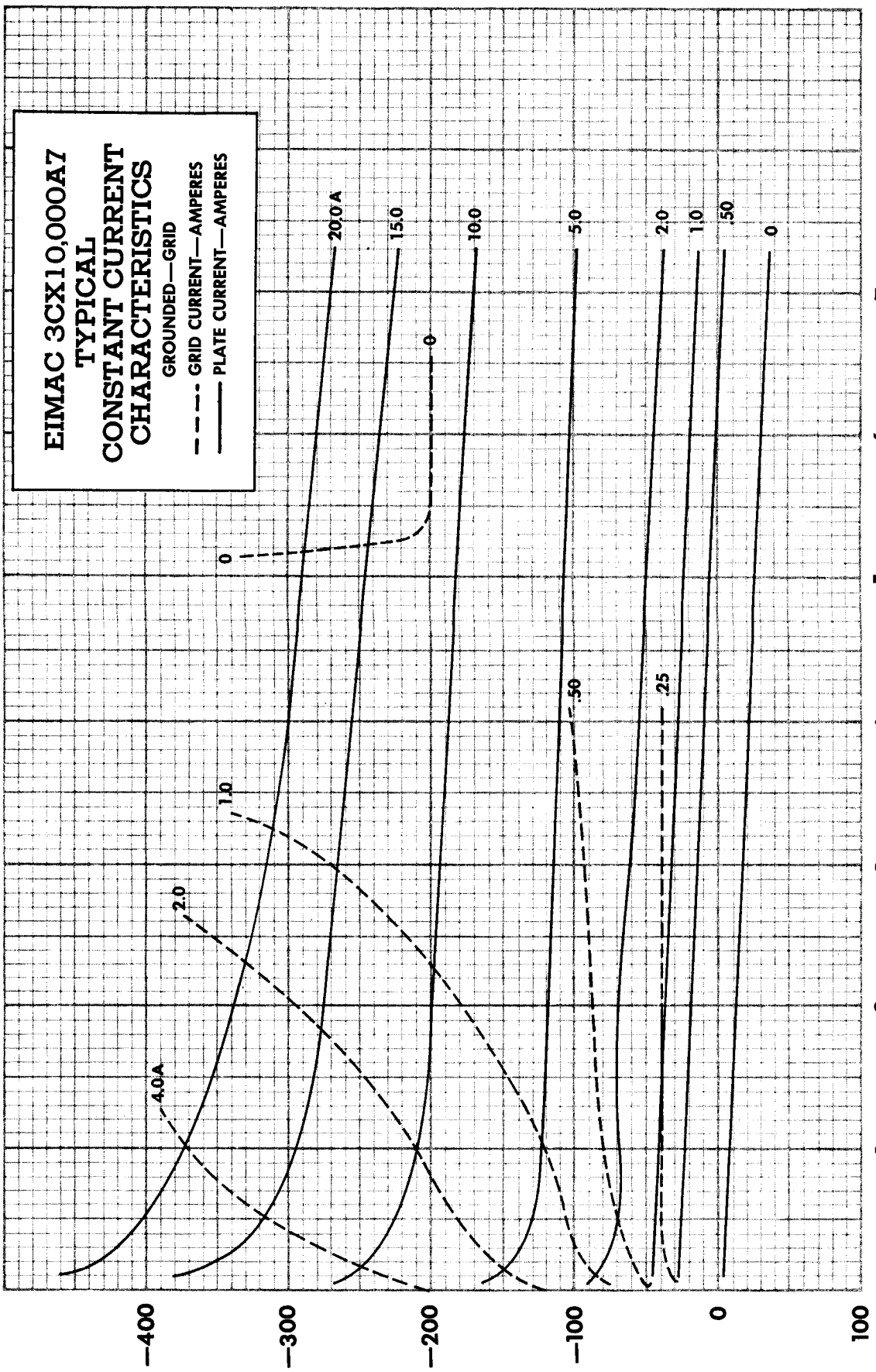
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	6.928	7.050	- -	175.97	179.07	- -
B	0.855	0.895	- -	21.72	25.49	- -
C	0.720	0.760	- -	18.29	19.30	- -
D	1.896	1.936	- -	48.16	49.17	- -
E	3.133	3.173	- -	79.58	80.59	- -
F	3.792	3.832	- -	96.32	97.33	- -
H	0.188	- -	- -	4.77	- -	- -
J	0.188	- -	- -	4.77	- -	- -
M	3.950	4.300	- -	100.33	109.22	- -
N	2.412	2.788	- -	61.26	70.81	- -
P	8.250	8.750	- -	209.55	222.25	- -
R	0.986	1.050	- -	25.04	26.67	- -
S	3.412	3.788	- -	86.66	96.21	- -
T	0.375	- -	- -	9.52	- -	- -

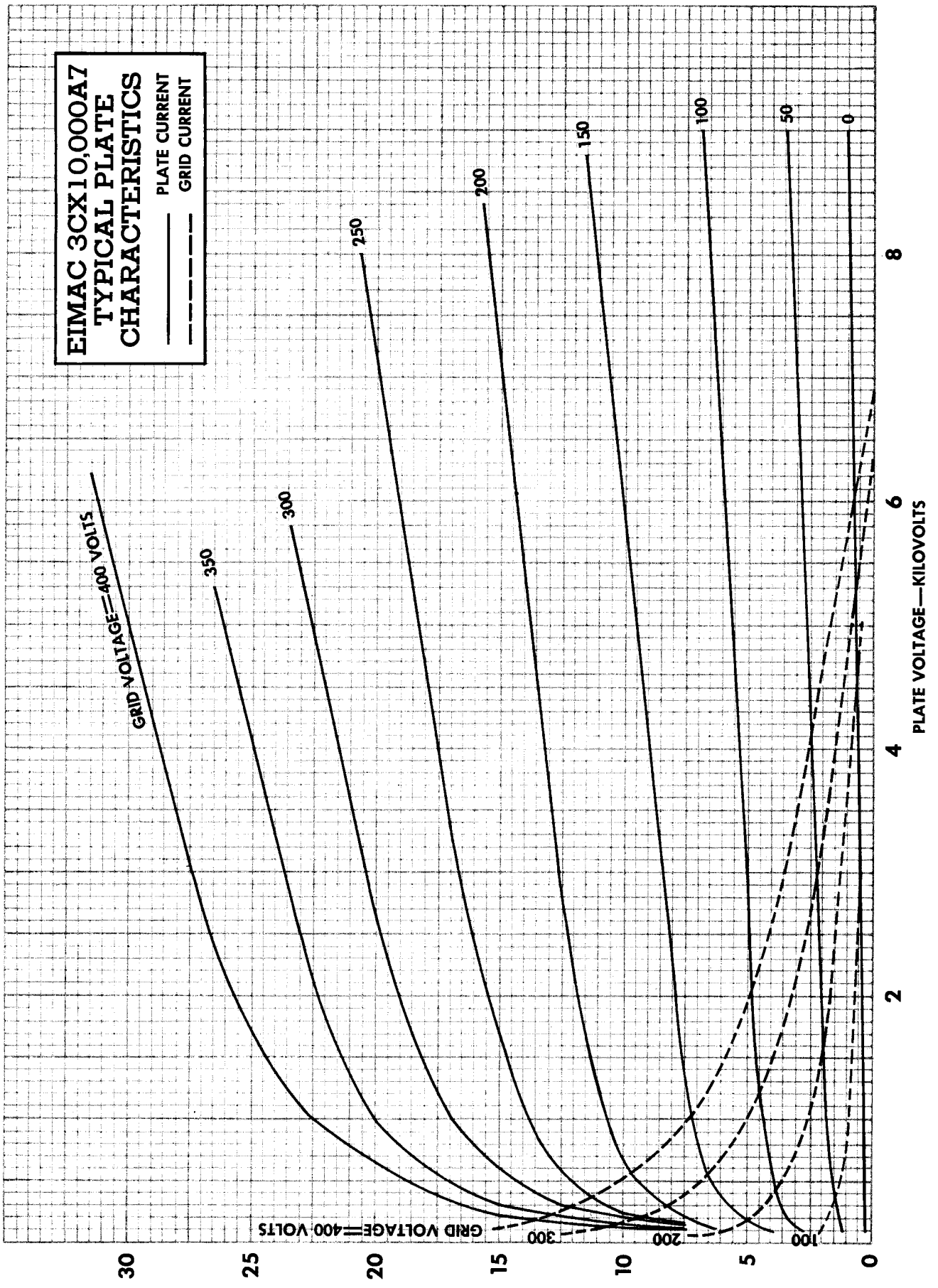
NOTES:

1. REF: DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



*CONTACT SURFACE
ALL DIMENSIONS IN INCHES


EIMAC 3CX10,000A7
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED—GRID
- - - - GRID CURRENT—AMPERES
——— PLATE CURRENT—AMPERES
20.0A
15.0
10.0
5.0
2.0
1.0
.50
0
4.0A
2.0
1.0
.50
.25
0
—400
—300
—200
—100
0
100
1
2
3
4
5
6
7
FILAMENT-TO-GRID VOLTAGE—VOLTS
PLATE -TO-GRID VOLTAGE—KILOVOLTS


EIMAC 3CX10,000A7
TYPICAL PLATE
CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
GRID VOLTAGE=400 VOLTS
350
300
250
200
150
100
50
0
GRID VOLTAGE=400 VOLTS
300
200
100
CURRENT—AMPERES
30
25
20
15
10
5
0
2
4
6
8
PLATE VOLTAGE—KILOVOLTS

TECHNICAL DATA

8161
3CX2500A3

MEDIUM MU TRIODE

The EIMAC 3CX2500A3 is an all ceramic and metal, medium-mu, forced-air cooled, external anode transmitting triode with a maximum plate dissipation rating of 2500 watts. Relatively high power output as an amplifier, oscillator, or modulator may be obtained from this tube at low plate voltages. The 3CX2500A3 is an exact replacement for the EIMAC 3X2500A3 and is suggested for use where higher ambient temperatures are to be expected or greater reliability is required. The all ceramic and metal construction allows a greater margin of safety with respect to tube operating temperatures while permitting higher processing temperatures to insure longer life.

The tube has a rugged, low-inductance cylindrical filament-stem structure, which readily becomes part of a linear filament tank circuit for VHF operation. The grid provides thorough shielding between the input and output circuits for grounded-grid applications and is conveniently terminated in a ring between the plate and filament terminals. The 3CX2500A3 may be installed or removed without the aid of tools.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	49		53	amperes
Amplification Factor	19		26	
Direct Interelectrode Capacitances				
Grid-Plate	16.8		23.2	pF
Grid-Filament	29.2		40.2	pF
Plate-Filament	0.6		1.2	pF
Tranconductance (Ib=830 ma., Eb=3000 v.)		20,000		umhos
Highest Frequency for Maximum Ratings			75	MHz

MECHANICAL

Base	See drawing
Mounting	Vertical, base down or up
Cooling	Forced Air
Maximum Anode Core and Seal Temperatures	250°C
Maximum Over-all Dimensions:	
Length	8.6 inches
Diameter	4.16 inches
Net Weight	6.25 pounds
Shipping Weight (Average)	17 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Conventional Neutralized Amplifier, (Frequencies below 75 MHz.)

Class-C FM or Telegraphy (Key-down conditions, per tube)

MAXIMUM RATINGS

DC PLATE VOLTAGE	6000	VOLTS
DC PLATE CURRENT	2.5	AMPS
PLATE DISSIPATION	2500	WATTS
GRID DISSIPATION	150	WATTS

TYPICAL OPERATION (Frequencies below 75 MHz per tube)

DC Plate Voltage	4000	5000	6000	volts
DC Plate Current	2.5	2.5	2.08	amps
DC Grid Voltage	—300	—450	—500	volts
DC Grid Current*	245	265	180	ma
Peak RF Grid Input Voltage*	580	750	765	volts
Driving Power*	142	197	136	watts
Grid Dissipation*	68	78	46	watts
Plate Power Input	10,000	12,500	12,500	watts
Plate Dissipation	2500	2500	2500	watts
Plate Power Output	7500	10,000	10,000	watts

*Approximate values.

(Revised 3-1-67) © 1967 Varian

Printed in U.S.A.

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Conventional Neutralized Amplifier, (Frequencies below 75 MHz.)

Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.0	AMPS
PLATE DISSIPATION	1670	VOLTS
GRID DISSIPATION	150	WATTS

TYPICAL OPERATION (Frequencies below 75 MHz per tube)

DC Plate Voltage	4000	4500	5000	volts
DC Plate Current	1.67	1.47	1.25	amps
DC Grid Voltage	—450	—500	—550	volts
DC Grid Current*	180	140	150	ma
Peak RF Grid Input Voltage*	685	715	760	volts
Driving Power*	125	100	115	watts
Grid Dissipation*	43	30	32	watts
Plate Power Input	6670	6615	6250	watts
Plate Dissipation	1670	1315	950	watts
Plate Power Output	5000	5300	5300	watts

*Approximate values.

AUDIO-FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB or B

MAXIMUM RATINGS

DC PLATE VOLTAGE	6000	VOLTS
DC PLATE CURRENT	2.5	AMPS
PLATE DISSIPATION	2500	WATTS
GRID DISSIPATION	150	WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

DC Plate Voltage	4000	5000	6000	volts
DC Grid Voltage[1]	—150	—190	—240	volts
Zero-Signal DC Plate Current	0.6	0.5	0.4	amps
Max-Signal DC Plate Current	4.0	3.2	3.0	amps
Effective Load, Plate to Plate	2200	3600	4650	ohms
Peak AF Grid Input Voltage (per tube)*	340	360	390	volts
Max-Signal Peak Driving Power*	340	230	225	watts
Max-Signal Nominal Driving Power*	170	115	113	watts
Max-Signal Plate Output Power	11,000	11,000	13,000	watts

*Approximate values.

[1]Adjust to give listed zero-signal plate current.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION," POSSIBLY EXCEEDNG THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EIMAC DIVISION OF VARIAN, FOR INFORMATION AND RECOMMENDATIONS.

APPLICATION

Cooling—Forced-air cooling must be provided to hold the ceramic-to-metal seals and anode core temperature below the maximum rating of 250°C. At ambient temperatures above 50°C, at higher altitudes and at operating temperatures above 30 MHz, additional air flow must be provided. Sea level and 10,000 foot altitude air-flow requirements to maintain seal temperatures below 200°C in 50°C ambient air are tabulated below (for operation below 30 MHz).

Anode-to-Base Air Flow[1]

	Sea Level		10,000 Feet	
Anode Dissipation Watts	Air Flow CFM	Pressure Drop Inches Water	Air Flow CFM	Pressure Drop Inches Water
1500	33	.6	48	.9
2500	66	1.25	96	1.82

Base-to-Anode Air Flow

	Sea Level		10,000 Feet	
Anode Dissipation Watts	Air Flow CFM	Pressure Drop Inches Water	Air Flow CFM	Pressure Drop Inches Water
1500	32	.6	47	.9
2500	57	1.0	83	1.5

*Since the power dissipated by the filament represents about 400 watts and since grid dissipation can, under some conditions represent another 150 watts, allowance has been made in preparing this tabulation for an additional 550 watts.

[1]When air is supplied in the anode-to-base direction, a minimum of 3 cfm must be directed into the filament-stem structure between the inner and outer filament terminals to maintain the base seals below 250°C. No separate air is required with base-to-anode airflow.

Simultaneous removal of all power and air (as in the case of a power failure) will not ordinarily injure the tube, but it is recommended that cooling airflow continue for at least three minutes after filament power has been removed.

Filament Voltage — The filament voltage, as measured directly at the tube, should be 7.5 volts with maximum allowable variations due to line fluctuation of from 7.12 to 7.87 volts.

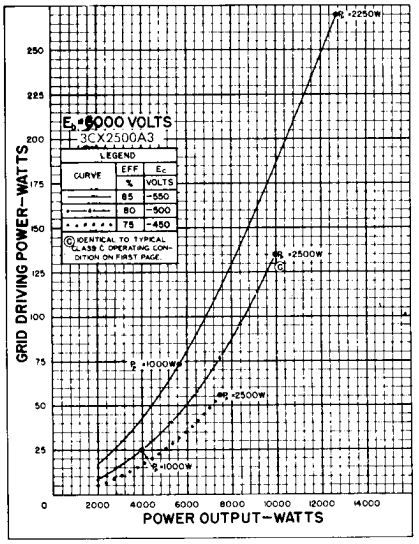
Bias Voltage — There is little advantage in using bias voltages in excess of those given under "TYPICAL OPERATION" except in certain very specialized applications. Where bias is obtained from a grid resistor, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

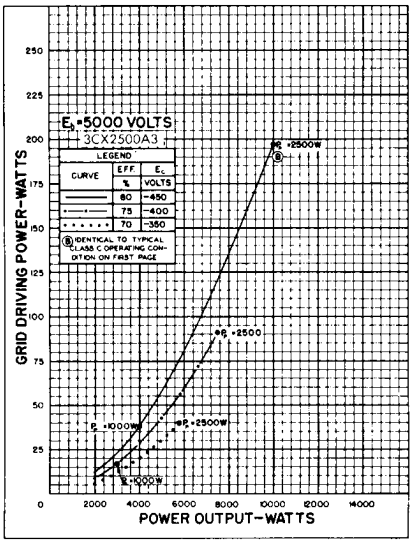
Plate Voltage — The plate-supply voltage for the 3CX2500A3 should not exceed 6000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "TYPICAL OPERATION" for the power output desired.

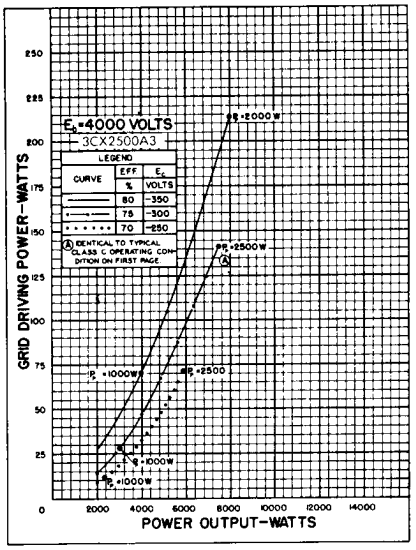
Grid Dissipation — The power dissipated by the grid of the 3CX2500A3 must never exceed 150 watts. Grid dissipation is the product of dc current and peak positive grid voltage.

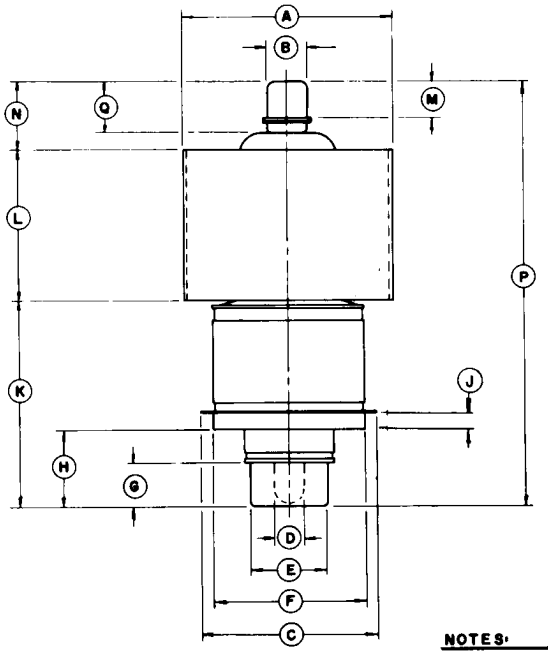
In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

InVHF operation, particularly above 75 MHz the dc grid current must not exceed 200 ma under any conditions of plate loading. With lightly loaded conditions the grid driving power should be reduced so that the grid current does not exceed one-tenth of the plate current.

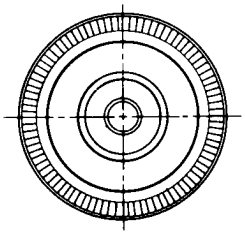








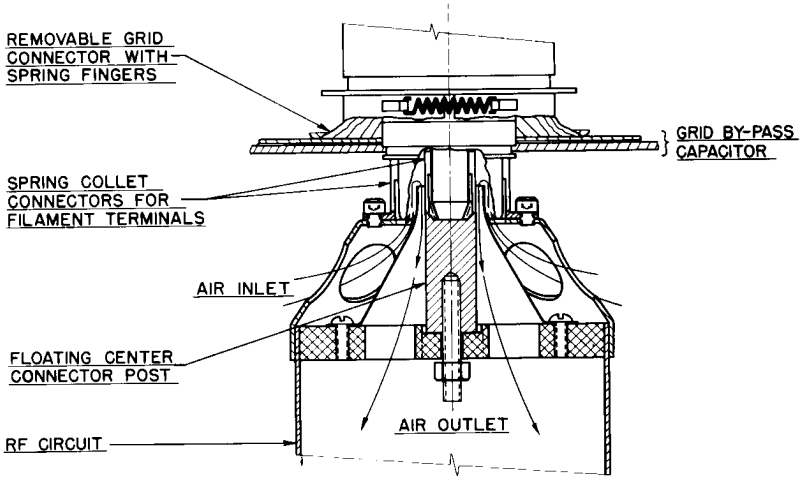
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	4 3/32	4 5/32	
B	25/32	27/32	
C		3 5/8	
D	.615	.635	
E	1.490	1.510	
F	2.990	3.010	
G	13/16	15/16	
H	1 3/8	1 5/8	
J	3/8	7/16	
K	3 7/8	4 1/4	
L	2 15/16	3 1/16	
M	11/16	13/16	
N	1 3/16	1 11/16	
P	8	9	
Q	1	1 1/8	



BOTTOM VIEW

NOTES:

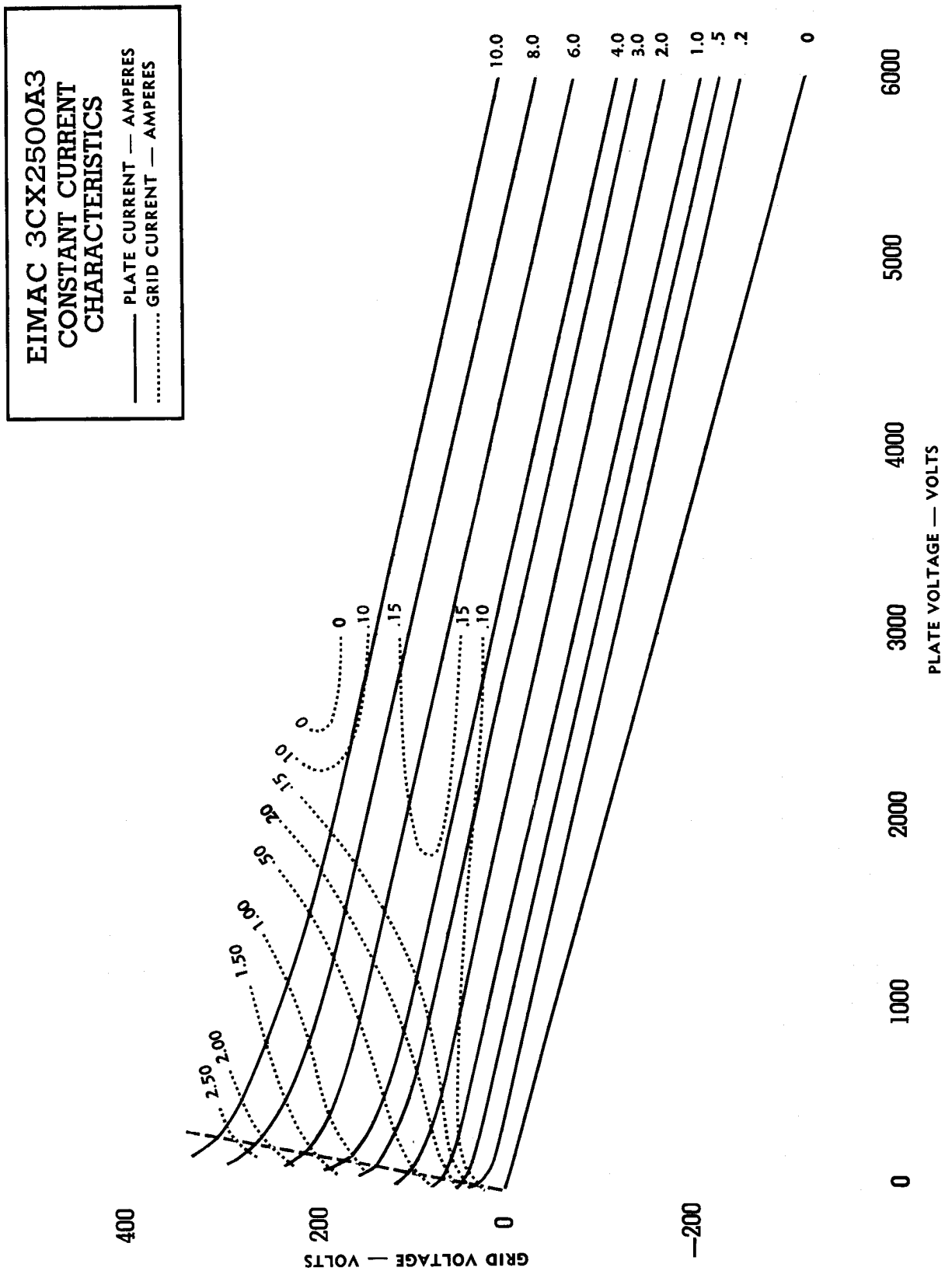
1. .040 MAXIUM RUNOUT OF GRID CONTACT SURFACE WITH RESPECT TO AXIS DETERMINED BY ANODE AND OUTER FILAMENT CONTACT SURFACE.
2. .025 MAXIUM RUNOUT OF INNER FILAMENT CONTACT SURFACE WITH RESPECT TO OUTER FILAMENT CONTACT SURFACE.
3. DIMENSIONS IN INCHES.



TYPICAL TUBE CONNECTORS AND STEM COOLING

DRIVING POWER vs. POWER OUTPUT

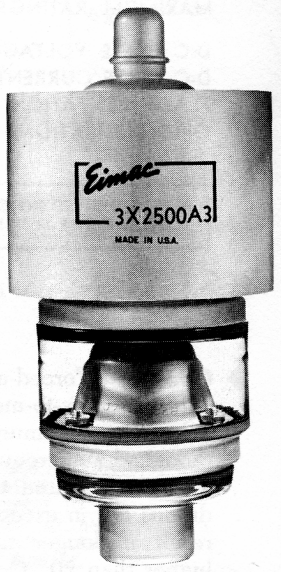
The three charts on this page show the relationship of plate efficiency, power output and approximate grid driving power at plate voltages of 4000, 5000 and 6000 volts. These charts show combined grid and bias losses only. The driving-power and power-output figures do not include circuit losses. The plate dissipation in watts is indicated by Pp. Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 4000, 5000 and 6000 volts respectively.


EIMAC 3CX2500A3
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT — AMPERES
GRID CURRENT — AMPERES
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.5
.2
0
2.50
2.00
1.50
1.00
.50
.20
.15
.10
0
.10
.15
.15
.10
0
400
200
0
—200
GRID VOLTAGE — VOLTS
0
1000
2000
3000
4000
5000
6000
PLATE VOLTAGE — VOLTS

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

8161
3X2500A3

MEDIUM MU TRIODE



The Eimac 8161/3X2500A3 is a medium-mu, forced-air-cooled, external-anode transmitting triode with a maximum plate-dissipation rating of 2500 watts. Relatively high power output as an amplifier, oscillator or modulator may be obtained from this tube at low plate voltages. A single tube will deliver a radio-frequency output of 7500 watts at 4000 plate volts at frequencies up to 110 Mc., as well as at lower frequencies.

The tube has a rugged, low-inductance cylindrical filament-stem structure, which readily becomes part of a linear filament tank circuit for V.H.F. operation. The grid provides thorough shielding between the input and output circuits for grounded-grid applications and is conveniently terminated in a ring between the plate and filament terminals. The 8161/3X2500A3 may be installed or removed without the aid of tools.

The approved Federal Communications Commission rating for the 8161/3X2500A3 is 5000 watts of carrier power when used as a plate-modulated amplifier and 1250 watts of carrier power when used as a grid-modulated or linear amplifier.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	49		54	amperes
Amplification Factor	19		26	
Direct Interelectrode Capacitances				
Grid-Plate	16.8		23.2	uuf
Grid-Filament	29.2		40.2	uuf
Plate-Filament	0.6		1.2	uuf
Transconductance (I_b = 830 ma., E_b = 3000 v.)		20,000		umhos
Highest Frequency for Maximum Ratings			75	mc

MECHANICAL

Base	See drawing
Mounting	Vertical, base down or up
Cooling	Forced air
▶ Maximum Anode Cooler Core and Seal Temperatures	175° C
Maximum Over-All Dimensions:	
Length	8.6 inches
Diameter	4.16 inches
Net Weight	6.25 pounds
Shipping Weight (Average)	17 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

(Conventional Neutralized Amplifier—Frequencies below 75Mc.)
Class-C FM or Telegraphy (Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPS
PLATE DISSIPATION	2500 MAX. WATTS
▶ PLATE COOLER CORE TEMPERATURE	175 MAX. ° C
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION (Frequencies below 75 Mc. per tube)

D-C Plate Voltage	4000	5000	6000 volts
D-C Plate Current	2.5	2.5	2.08 amps
D-C Grid Voltage	—300	—450	—500 volts
D-C Grid Current*	245	265	180 ma
Peak R-F Grid Input Voltage*	580	750	765 volts
Driving Power*	142	197	136 watts
Grid Dissipation*	68	78	46 watts
Plate Power Input	10,000	12,500	12,500 watts
Plate Dissipation	2500	2500	2500 watts
Plate Power Output	7500	10,000	10,000 watts

RADIO-FREQUENCY POWER AMPLIFIER

Grounded-Grid Circuit
Class-C FM Telephony

MAXIMUM RATINGS (Frequencies between 75 and 110 Mc.)

D-C PLATE VOLTAGE	4000 MAX. VOLTS
D-C PLATE CURRENT	2.0 MAX. AMPS
D-C GRID CURRENT	200 MAX. MA
PLATE DISSIPATION	2500 MAX. WATTS
▶ PLATE COOLER CORE TEMPERATURE	175 MAX. ° C
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION (110 Mc., per tube)

D-C Plate Voltage	3700	4000 volts
D-C Grid Voltage	—450	—500 volts
D-C Plate Current	1.8	1.85 amps
D-C Grid Current*	190	190 ma
Driving Power*	1600	1900 watts
Useful Power Output	6850	7500 watts

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

(Conventional Neutralized Amplifier—Frequencies below 75 Mc.)
Class-C Telephony (Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000 MAX. VOLTS
D-C PLATE CURRENT	2.0 MAX. AMPS
PLATE DISSIPATION	1670 MAX. WATTS
▶ PLATE COOLER CORE TEMPERATURE	175 MAX. ° C
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION (Frequencies below 75 Mc., per tube)

D-C Plate Voltage	4000	4500	5000 volts
D-C Plate Current	1.67	1.47	1.25 amps
D-C Grid Voltage	—450	—500	—550 volts
D-C Grid Current*	180	140	150 ma
Peak R-F Grid Input Voltage*	685	715	760 volts
Driving Power*	125	100	115 watts
Grid Dissipation*	43	30	32 watts
Plate Power Input	6670	6615	6250 watts
Plate Dissipation	1670	1315	950 watts
Plate Power Output	5000	5300	5300 watts

*Approximate values.

(Effective 11-20-62) Copyright, 1962 by Eitel-McCullough, Inc.

▶ Indicates change from sheet dated 1-1-61

AUDIO-FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB or B

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPS
PLATE DISSIPATION	2500 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

D-C Plate Voltage	4000	5000	6000 volts
D-C Grid Voltage[1]	—150	—190	—240 volts
Zero-Signal D-C Plate Current	0.6	0.5	0.4 amps
Max-Signal D-C Plate Current	4.0	3.2	3.0 amps
Effective Load, Plate to Plate	2200	3600	4650 ohms
Peak A-F Grid Input Voltage (per tube)*	340	360	390 volts
Max-Signal Peak Driving Power*	340	230	225 watts
Max-Signal Nominal Driving Power*	170	115	113 watts
Max-Signal Plate Output Power	11,000	11,000	13,000 watts

*Approximate values.

[1]Adjust to give listed zero-signal plate current.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS

APPLICATION

Cooling—Forced-air cooling must be provided to hold the glass-to-metal seals and the anode cooler core below the maximum rated temperature of 175° C. Although the air requirements stated below are sufficient to maintain rated tube temperatures under many conditions, air in excess of the amounts shown will usually result in longer tube life. At ambient temperatures higher than 20° C., at high altitudes, and at operating frequencies above 30 megacycles, additional air flow must be provided. In all cases, tube temperatures are the criteria which govern air requirements. Surface temperatures may be measured conveniently with the aid of temperature-sensitive paints.

Anode-to-Base Air-Flow				
	Sea Level		10,000 Feet	
Plate Dissipation (Watts)	Air-Flow (CFM)	Pressure Drop (Inches H_2O)	Air-Flow (CFM)	Pressure Drop (Inches H_2O)
2000	58.5	0.8	85.5	1.15
2500	85.5	1.6	125	2.3

Base-to-Anode Air-Flow				
	Sea Level		10,000 Feet	
Plate Dissipation (Watts)	Air-Flow (CFM)	Pressure Drop (Inches H_2O)	Air-Flow (CFM)	Pressure Drop (Inches H_2O)
2000	35.5	0.25	52	0.35
2500	42	0.5	61.5	0.75

Under the same conditions, a minimum air-flow rate of 6 CFM directed into the filament-stem structure between the inner and outer filament terminals is required to maintain the base seals below 175°C.

Simultaneous removal of all power and air (as in the case of a power failure) will not ordinarily injure the tube, but it is not recommended as a standard operating practice.

Filament Voltage—The filament voltage, as measured directly at the tube, should be 7.5 volts with maximum allowable variations due to line fluctuation of from 7.12 to 7.87 volts.

Bias Voltage—There is little advantage in using bias voltages in excess of those given under "Typical Operation" except in certain very specialized applications. Where bias is obtained from a grid resistor, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Plate Voltage — The plate-supply voltage for the 3X2500A3 should not exceed 6000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

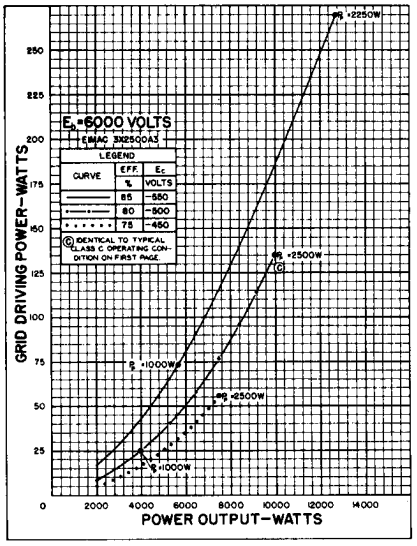
In Class-C FM or Telegraphy service a 0.1 —henry choke, shunted by a spark gap, should be series connected between the plates of the amplifier tubes and the high-voltage plate-supply capacitor to offer protection from transients and surges. In plate-modulated services where a plate-modulation transformer is used the protective choke is not normally required.

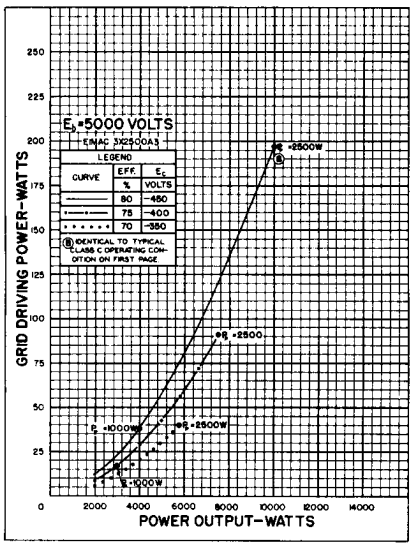
Grid Dissipation—The power dissipated by the grid of the 3X2500A3 must never exceed 150 watts. Grid dissipation is the product of d-c grid current and peak positive grid voltage.

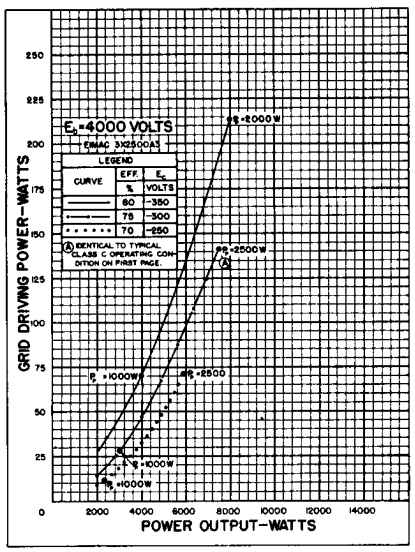
In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

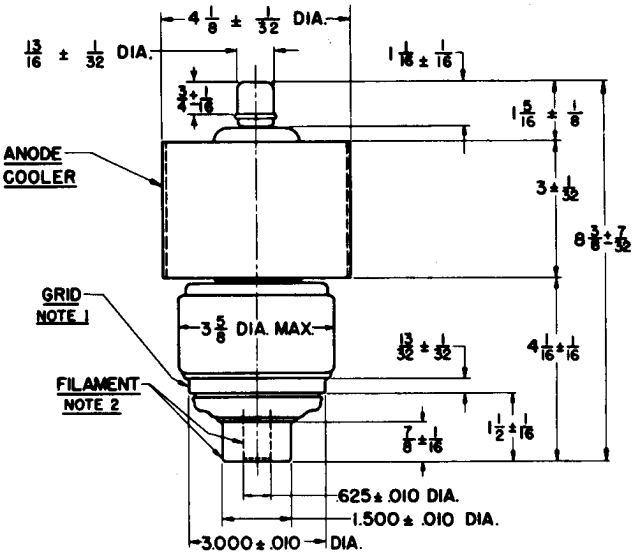
In VHF operation, particularly above 75 Mc., the d-c grid current must not exceed 200 ma. under any conditions of plate loading. With lightly loaded conditions the grid driving power should be reduced so that the grid current does not exceed one-tenth of the plate current.

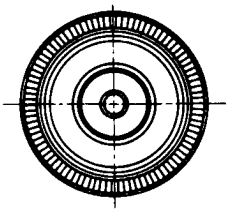
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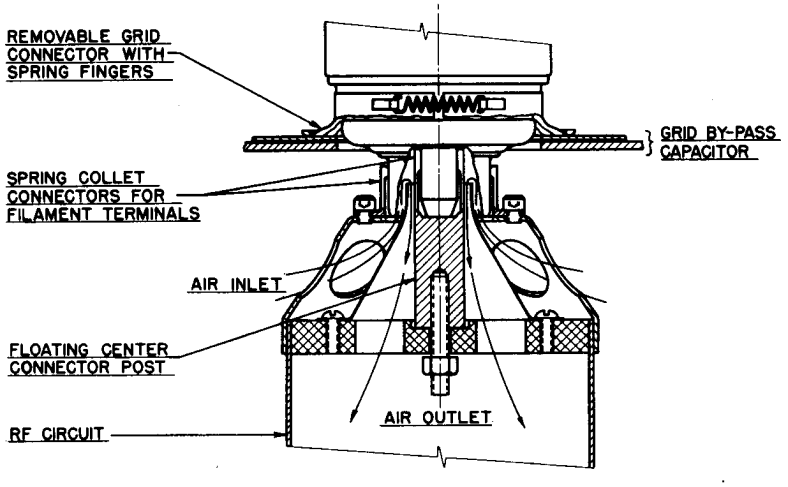


BOTTOM VIEW

NOTE 1
.040" MAXIMUM RUNOUT OF GRID CONTACT SURFACE WITH RESPECT TO AXIS DETERMINED BY ANODE AND OUTER FILAMENT CONTACT SURFACE.

NOTE 2
.025" MAXIMUM RUNOUT OF INNER FILAMENT CONTACT SURFACE WITH RESPECT TO TO OUTER FILAMENT CONTACT SURFACE.

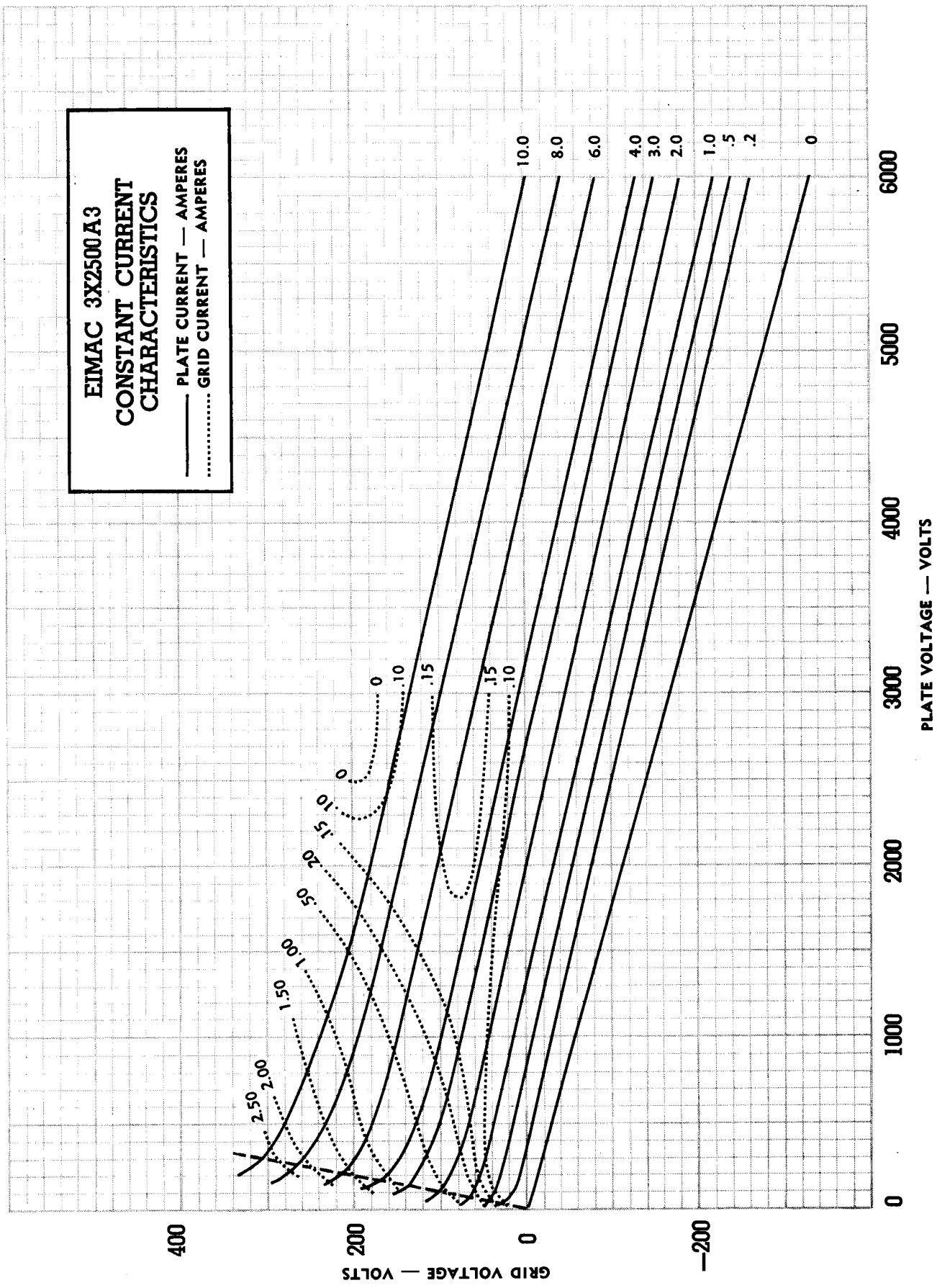
DIMENSIONS IN INCHES



TYPICAL TUBE CONNECTORS AND STEM COOLING

DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and approximate grid driving power at plate voltages of 4000, 5000 and 6000 volts. These charts show combined grid and bias losses only. The driving-power and power-output figures do not include circuit losses. The plate dissipation in watts is indicated by Pp. Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 4000, 5000 and 6000 volts respectively.



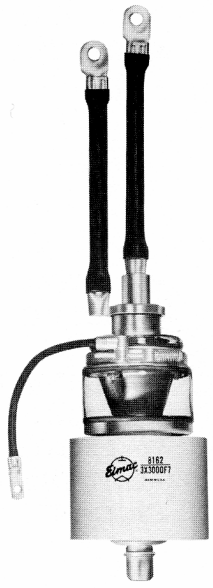
Printed in U.S.A. 839

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

TENTATIVE DATA

8162
3X3000F7

HIGH-MU POWER TRIODE



The Eimac 8162/3X3000F7 is an external-anode power triode intended to be used as a zero-bias Class-B amplifier in audio or radio-frequency applications. Operation with zero grid bias offers circuit simplicity by eliminating the bias supply. In addition, grounded-grid operation is attractive since a power gain of over twenty times can be obtained with the 8162/3X3000F7.

GENERAL CHARACTERISTICS

ELECTRICAL		
Filament: Thoriated-Tungsten		
Voltage	7.5	volts
Current	51	amperes
Amplification Factor	200	
Interelectrode Capacitances:		
Grid-Filament	38	uuf
Grid-Plate	24	uuf
Plate-Filament	0.6	uuf
Frequency for Maximum Ratings	30	Mc
MECHANICAL		
Base	See outline drawing	
Operating Position	Vertical, base up or down	
Cooling	Forced air	
Maximum Operating Temperatures:		
Anode Core and Seals	150°C	
Maximum Dimensions:		
Height (Does not include filament connectors)	8.6	inches
Diameter	4.16	inches
Net Weight	7.5	pounds

A-F AMPLIFIER OR MODULATOR CLASS-B, GRID-DRIVEN

MAXIMUM RATINGS (Per Tube)

D-C PLATE VOLTAGE	5000 VOLTS
D-C PLATE CURRENT	2.5 AMPS
PLATE DISSIPATION	3 KW
GRID DISSIPATION	225 WATTS

TYPICAL OPERATION, Two Tubes, Sinusoidal Wave

D-C Plate Voltage	4000	volts
D-C Grid Voltage	0	volts
Zero-Sig D-C Plate Current*	0.640	amps
Max-Sig D-C Plate Current	4.00	amps
Max-Sig D-C Grid Current	0.860	amps
Driving Power	120	watts
Peak A-F Driving Voltage (per tube)	185	volts
Load Resistance, Plate-to-Plate	2200	ohms
Max-Sig Plate Output Power	11,000	watts

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R-F LINEAR AMPLIFIER
CLASS-B, GROUNDED-GRID

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000 VOLTS
D-C PLATE CURRENT	2.5 AMPS
PLATE DISSIPATION	3 KW
GRID DISSIPATION	225 WATTS

TYPICAL OPERATION, Single-Tone Conditions

D-C Plate Voltage	4000	5000	volts
Zero-Sig D-C Plate Current*	0.32	0.44	amps
Max-Sig D-C Plate Current	2.00	1.56	amps
Max-Sig D-C Grid Current	0.42	0.33	amps
Driving Impedance	50	50	ohms
Resonant Load Impedance	1120	1850	ohms
Max-Sig Driving Power	360	215	watts
Peak Envelope Plate Output Power	5500	5500	watts
Power Gain	15.3	25.6	times

R-F LINEAR AMPLIFIER
CARRIER CONDITIONS, GRID-DRIVEN

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000 VOLTS
D-C PLATE CURRENT	2.5 AMPS
PLATE DISSIPATION	3 KW
GRID DISSIPATION	225 WATTS

TYPICAL OPERATION

D-C Plate Voltage	4000	volts
D-C Grid Voltage	0	volts
Zero-Sig D-C Plate Current*	0.32	amps
D-C Plate Current	0.815	amps
D-C Grid Current	0.205	amps
Driving Impedance †	220	ohms
Peak Driving Voltage †	160	volts
Driving Power	15	watts
Plate Output Power	1100	watts

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

APPLICATION

INPUT CIRCUIT - When the 3X3000F7 is operated as a grounded-grid r-f amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a "Q" of five or more.

COOLING - The maximum temperature rating for the anode core and seals of the 3X3000F7 is 150°C. Sufficient forced-air cooling must be provided to keep the temperature of the anode core and the temperatures of the glass-to-metal seals below 150°C. Tube life is usually prolonged if these areas are maintained at temperatures below the maximum rating. Minimum air flow requirements to maintain anode-core and seal temperatures below 150°C with inlet-air temperatures of 40°C and 55°C are tabulated. A maximum ambient temperature of 40°C will apply to most commercial installations, while the 55°C data is useful when designing equipment in conformance with MIL-E-5400 Curve A (Class I).

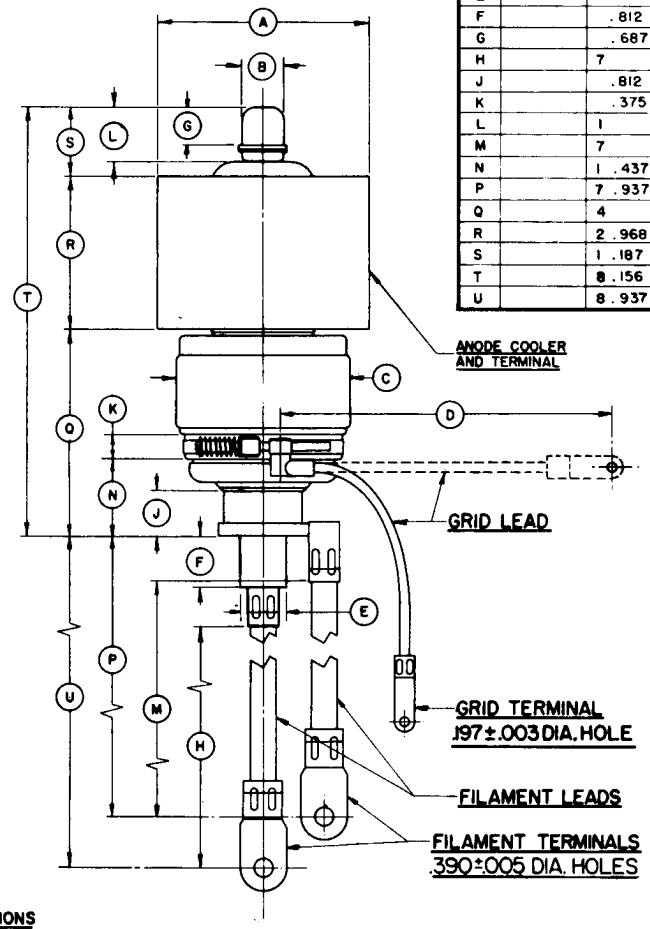
In addition, a minimum air flow of 7 CFM must be directed into the filament stem structure, between the inner and outer filament conductors. This rate of air flow provides sufficient stem cooling at ambient temperatures up to 55°C.

*Approximate Values

†Modulation Crest Conditions

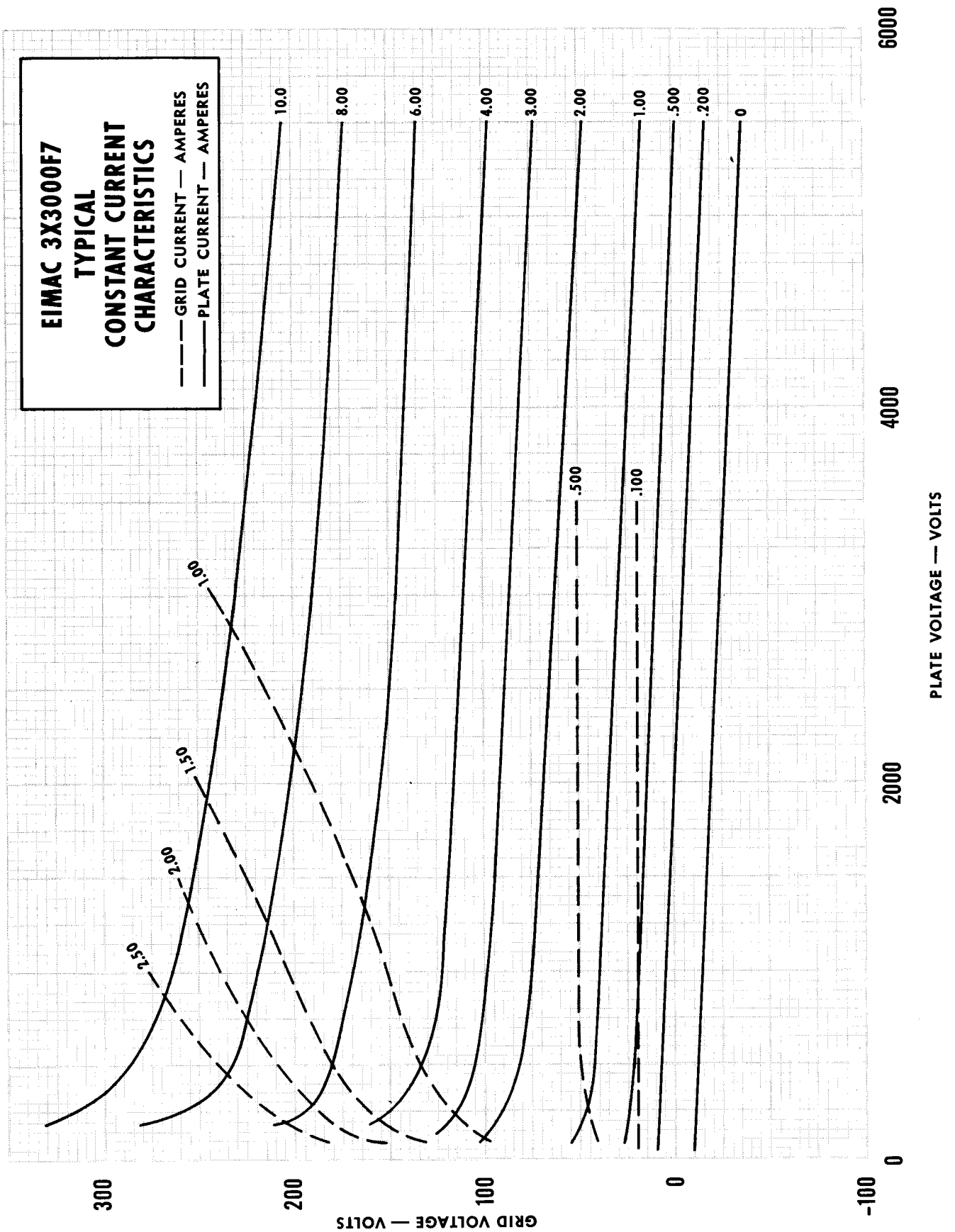
SEA LEVEL PRESSURE, ANODE-TO-BASE AIR FLOW				
	40°C Max Ambient Air Temp.		55°C Max Ambient Air Temp.	
Plate** Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
1000	45	0.43	65	0.65
2000	120	1.6	170	2.5
3000	235	4.0	330	6.0

**Since the power dissipated by the filament is about 375 watts and since grid dissipation can, under some circumstances, represent another 225 watts, allowance has been made in preparing this tabulation for an additional 600 watts dissipation.



DIMENSION DATA			
REF.	NOM	MIN	MAX
A		4.093	4.156
B		.781	.843
C			3.625
D		6.375	6.625
E		.859	.890
F		.812	.937
G		.687	.812
H		7	7.500
J		.812	.937
K		.375	.437
L		1	1.125
M		7	7.500
N		1.437	1.562
P		7.937	8.437
Q		4	4.125
R		2.968	3.031
S		1.187	1.437
T		8.156	8.593
U		8.937	9.437

ALL DIMENSIONS IN INCHES



Printed in U.S.A. 993

TECHNICAL DATA

8163
3-400Z

HIGH-MU
POWER TRIODE

The EIMAC 8163/3-400Z is a compact power triode intended to be used as a zero-bias Class-B amplifier in audio or radio-frequency applications. Operation with zero grid bias simplifies associated circuitry by eliminating the bias supply. In addition, grounded-grid operation is attractive since a power gain as high as twenty times can be obtained with the 8163/3-400Z in a cathode-driven circuit.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	5.0	V
Current	14.1	A
Amplification Factor (Average)	200	
Interelectrode Capacitances (Average),[2] Grounded-Grid Connection:		
Cin	7.1	pF
Cout	4.1	pF
Cpk	0.1	pF
Frequency for Maximum Ratings	110	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	5 Pin Special
Basing	See Drawing
Mounting Position	Vertical, base down or up
Cooling	Radiation and Forced Air
Heat-Dissipating Plate Connector	Supplied mounted on tube
Recommended Socket	EIMAC SK-410
Recommended Chimney	EIMAC SK-416
Maximum Operating Temperatures:	
Plate Seal	225°C
Base Seals	200°C
Maximum Over-All Dimensions:	
Height	5.375 In; 136.5 mm
Diameter	3.562 In; 90.47 mm
Net Weight (approximate)	7 Oz; 198 gm

(Effective 8-15-74) © 1961, 1967, 1968, 1974 by Varian

Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER GROUNDED-GRID, Class B

MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
DC PLATE CURRENT	0.40	AMPERE
PLATE DISSIPATION	400	WATTS
GRID DISSIPATION	20	WATTS

TYPICAL OPERATION (Single-Tone Conditions)

Plate Voltage	3000	Vdc
Zero Sig. Plate Current[1]	100	mAdc
Max. Sig. Plate Current	333	mAdc
Max. Sig. Grid Current[1]	120	mAdc
Driving Impedance	122	Ω
Resonant Load Impedance	4750	Ω
Max. Sig. Driving Power[1]	32	W
Peak Envelope Plate Output Power	655	W

TYPICAL OPERATION (Minimum Distortion Products)

Plate Voltage	2000	Vdc
Zero Sig. Plate Current[1]	62	mAdc
Single Tone Plate Current	400	mAdc
Single Tone Grid Current[1]	148	mAdc
Two Tone Plate Current	265	mAdc
Two Tone Grid Current[1]	87	mAdc
Driving Impedance	112	Ω
Resonant Load Impedance	2750	Ω
Max. Sig. Driving Power[1]	45	W
Peak Envelope Useful Output Power[1]	445	W
Intermodulation Distortion Products[2]	-40	dB

TYPICAL OPERATION (Minimum Distortion Products at 1 kW PEP Input)

Plate Voltage	2500	Vdc
Zero Sig. Plate Current[1]	73	mAdc
Single Tone Plate Current	400	mAdc
Single Tone Grid Current[1]	142	mAdc
Two Tone Plate Current	274	mAdc
Two Tone Grid Current[1]	82	mAdc
Driving Impedance	114	Ω
Resonant Load Impedance	3450	Ω
Peak Envelope Useful Output Power[1]	560	W
Max. Sig. Driving Power[1]	44	W
Intermodulation Distortion Products[2]	-35	dB

TYPICAL OPERATION (Minimum Distortion Products with E_b = 1500 Vdc)

Plate Voltage	1500	Vdc
Zero Sig. Plate Current[1]	46	mAdc
Single Tone Plate Current	400	mAdc
Single Tone Grid Current[1]	163	mAdc
Two Tone Plate Current	265	mAdc
Two Tone Grid Current[1]	92	mAdc
Driving Impedance	109	Ω
Resonant Load Impedance	1620	Ω
Peak Envelope Useful Output Power[1]	300	W
Max. Sig. Driving Power[1]	46	W
Intermodulation Distortion Products[2]	-37	dB

1. Approximate value.

2. Approximate value; referenced against one tone of a two equal-tone signal.

AUDIO FREQUENCY AMPLIFIER OR MODULATOR
Class B

MAXIMUM RATINGS (PER TUBE):

DC PLATE VOLTAGE	4000	VOLTS
DC PLATE CURRENT	0.40	AMPERE
PLATE DISSIPATION	400	WATTS
GRID DISSIPATION	20	WATTS

1. Approximate value.

TYPICAL OPERATION (Sinusoidal Wave, Two Tubes, Grid Driven)

Plate Voltage	3000	Vdc
Grid Voltage	0	Vdc
Zero Sig. Plate Current[1]	200	mAdc
Max. Sig. Plate Current	666	mAdc
Max. Sig. Grid Current[1]	240	mAdc
Driving Power[1]	26	W
Peak af Driving Voltage(per tube)[1]	88	v
Load Resistance, Plate/Plate	9500	Ω
Max. Sig. Plate Output Power[1]	1310	W

RADIO FREQUENCY AMPLIFIER OR OSCILLATOR
Class C

MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
DC PLATE CURRENT	0.35	AMPERE
PLATE DISSIPATION	400	WATTS
GRID DISSIPATION	20	WATTS

1. Approximate value.

TYPICAL OPERATION

Plate Voltage	3000	Vdc
Plate Current	333	mAdc
Grid Voltage	-75	Vdc
Grid Current[1]	130	mAdc
Peak rf Grid Voltage[1]	187	v
Grid Driving Power[1]	25	W
Plate Output Power[1]	730	W

RADIO FREQUENCY AMPLIFIER[1]
Plate Modulated, Class C

MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000	VOLTS
DC PLATE CURRENT	0.275	AMPERE
PLATE DISSIPATION	270	WATTS
GRID DISSIPATION	20	WATTS

1. Drive modulation is required with a high-mu triode.
2. Approximate value.

TYPICAL OPERATION

Plate Voltage	3000	Vdc
Plate Current	245	mAdc
Grid Voltage	-90	Vdc
Grid Current[2]	100	mAdc
Peak rf Grid Voltage[2]	185	v
Grid Driving Power[2]	18	W
Plate Output Power[2]	550	W

NOTE: In most cases, "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made. Exceptions are distinguished by a listing of "Useful" output power as opposed to "Plate" output power. Values appearing in these groups have been obtained from existing equipment(s) and the output power is that measured at the load.

RANGE VALUES FOR EQUIPMENT DESIGN:

	Min.	Max.	
Filament Current, at 5.0 volts	13.5	14.7	A
Zero Bias Plate Current (E_b = 3000 Vdc)	80	115	mAdc
Cut-Off Voltage (E_b = 3000 Vdc, I_b = 1.0 mAdc)	---	-25	Vdc
Interelectrode Capacitance (Grounded Cathode Connection)[1]			
Cin	6.0	9.0	pF
Cout	---	0.15	pF
Cgp	3.4	4.8	pF
Interelectrode Capacitance (Grounded Grid Connection)[1]			
Cin	6.0	9.0	pF
Cout	3.4	4.8	pF
Cpk	---	0.15	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MOUNTING - The 3-400Z must be operated vertically, base up or down. A flexible connecting strap should be provided between the heat dissipating plate connector and the external plate circuit, and the tube should be protected from severe vibration and shock.

The EIMAC SK-410 Air-System Socket is especially recommended for mounting, as the contacting clips are made with considerable flexibility in order to avoid applying undue lateral pressure on the tube pins, to avoid the possibility of damage to the base of the tube. The tube should always be inserted or removed from the socket with a straight-in or straight-out motion, and "rocking" the tube in or out of the socket should be avoided.

If a socket other than the EIMAC SK-410 is used, it should be ascertained that the contacts are flexible enough so they do not apply any significant lateral force against the tube base pins, as installed or during insertion or removal, to avoid the possibility of catastrophic damage to the glass tube base.

COOLING - Forced-air cooling is required to maintain the base seals at a temperature below 200°C. When using the EIMAC SK-410 Air-System Socket and SK-416 Chimney, a minimum air flow rate of 13 cubic feet per minute at a static pressure of approximately 0.13 inch of water at sea level is required to provide adequate cooling at an air temperature of 55°C. At higher inlet air

temperatures, higher altitudes, or at frequencies above 30 MHz,the air flow rate must be increased to give equivalent cooling. Cooling air must be supplied to the tube even when the filament alone is on during standby periods.

CLASS-C OPERATION - Although specifically designed for class-B service, the 3-400Z may be operated as a class-C power amplifier or oscillator or as a plate-modulated radio-frequency power amplifier. The zero-bias characteristic of the 3-400Z can be used to advantage in class-C amplifiers operating at plate voltages of 3000 volts or below by employing only grid-leak bias. If driving power fails, plate dissipation is then kept to a low value because the tube will be operating at the normal static zero-bias conditions.

FILAMENT OPERATION - The rated filament voltage for the 3-400Z is 5.0 volts. Filament voltage as measured at the socket, must be maintained within the range of 4.75 to 5.25 volts to obtain maximum tube life.

INTERMODULATION DISTORTION - Typical Operating conditions with distortion values included are the result of data taken during actual operation at 2 megahertz. Intermodulation values listed are those measured at the full peak envelope power noted. As the driving signal level is reduced, distortion products remain at the listed value, or better, below original peak envelope power level.

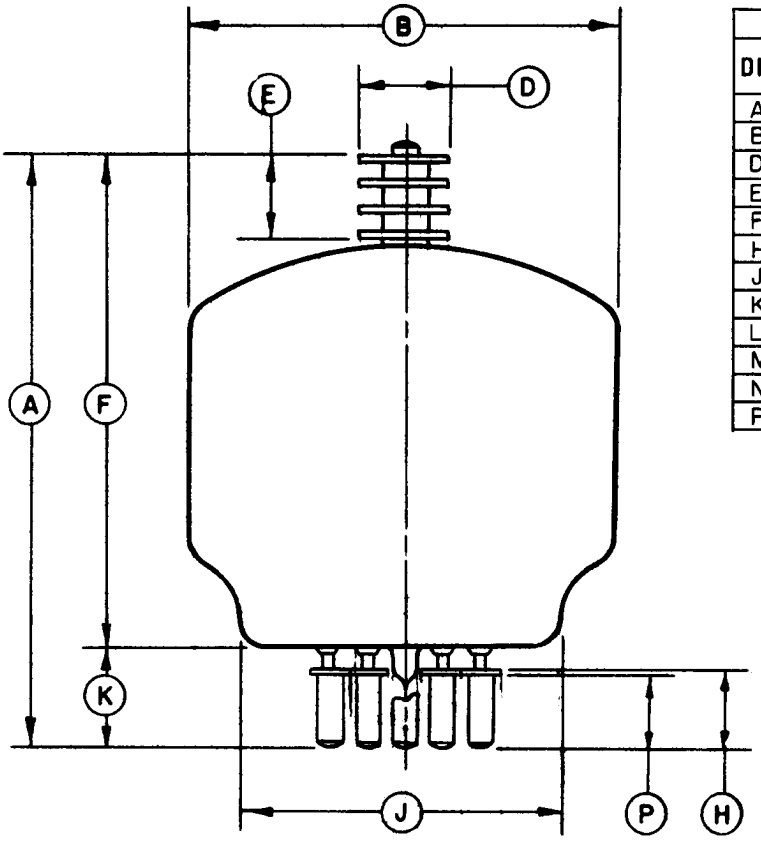
INPUT CIRCUIT - When the 3-400Z is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a "Q" of five or more.

HIGH VOLTAGE - Normal operating voltages used with the 8163/3-400Z are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate these tubes under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, San Carlos, Calif. 94070 for information and recommendations.

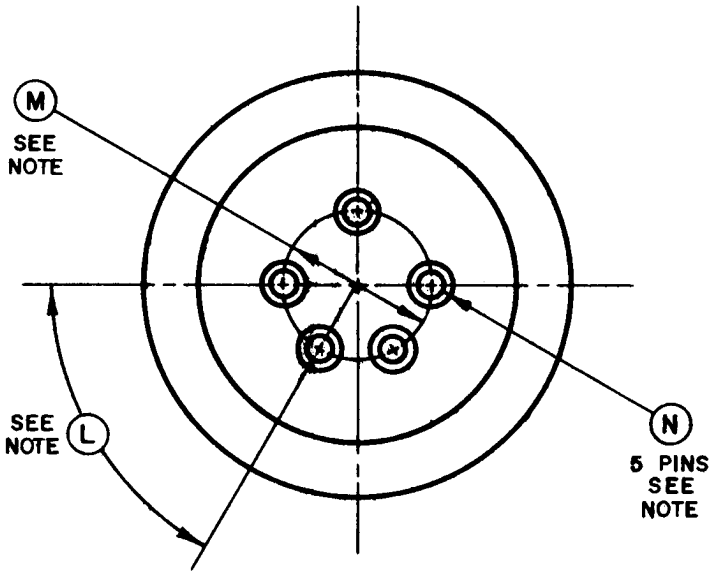


DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.875	5.375	- -	123.8	136.5	- -
B	- -	3.562	- -	- -	90.47	- -
D	0.740	0.760	- -	18.80	19.30	- -
E	0.635	0.665	- -	16.13	16.89	- -
F	3.937	4.437	- -	100.0	112.7	- -
H	0.688	0.813	- -	17.47	20.65	- -
J	- -	2.500	- -	- -	63.50	- -
K	- -	- -	0.937	- -	- -	23.80
L	- -	- -	60°	- -	- -	60°
M	- -	- -	1.250	- -	- -	31.75
N	0.185	0.191	- -	4.70	4.85	- -
P	0.625	0.750	- -	15.87	19.05	- -

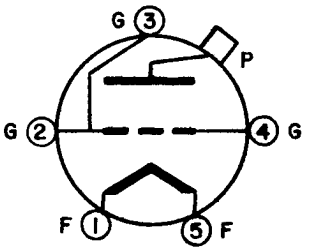
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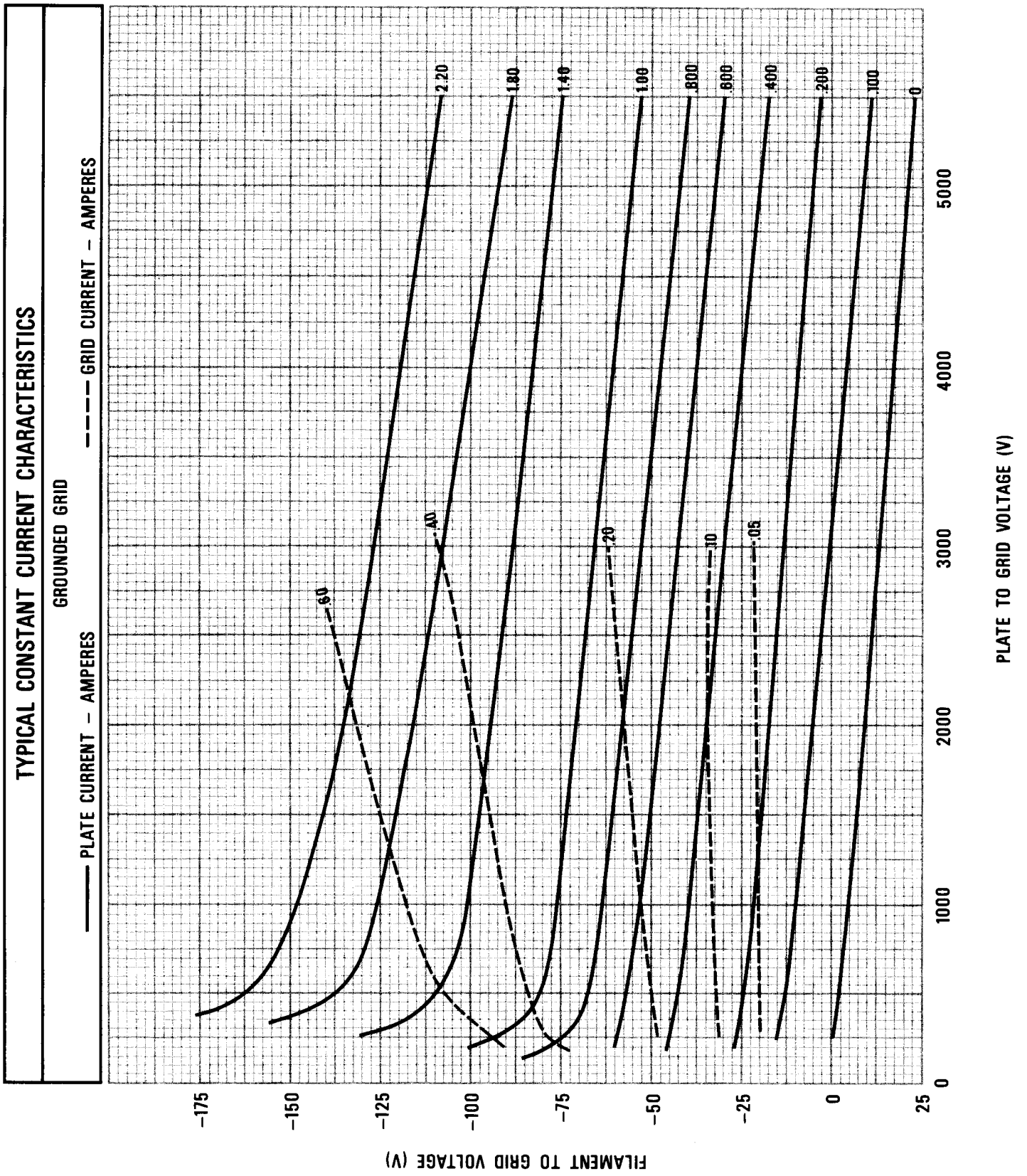
1. BASE PINS N ARE SO ALIGNED THAT THEY CAN BE FREELY INSERTED INTO A GAGE 1/4'' THICK WITH HOLE DIAMETERS OF 0.204 LOCATED ON THE TRUE CENTERS BY THE GIVEN DIMENSIONS L & M.

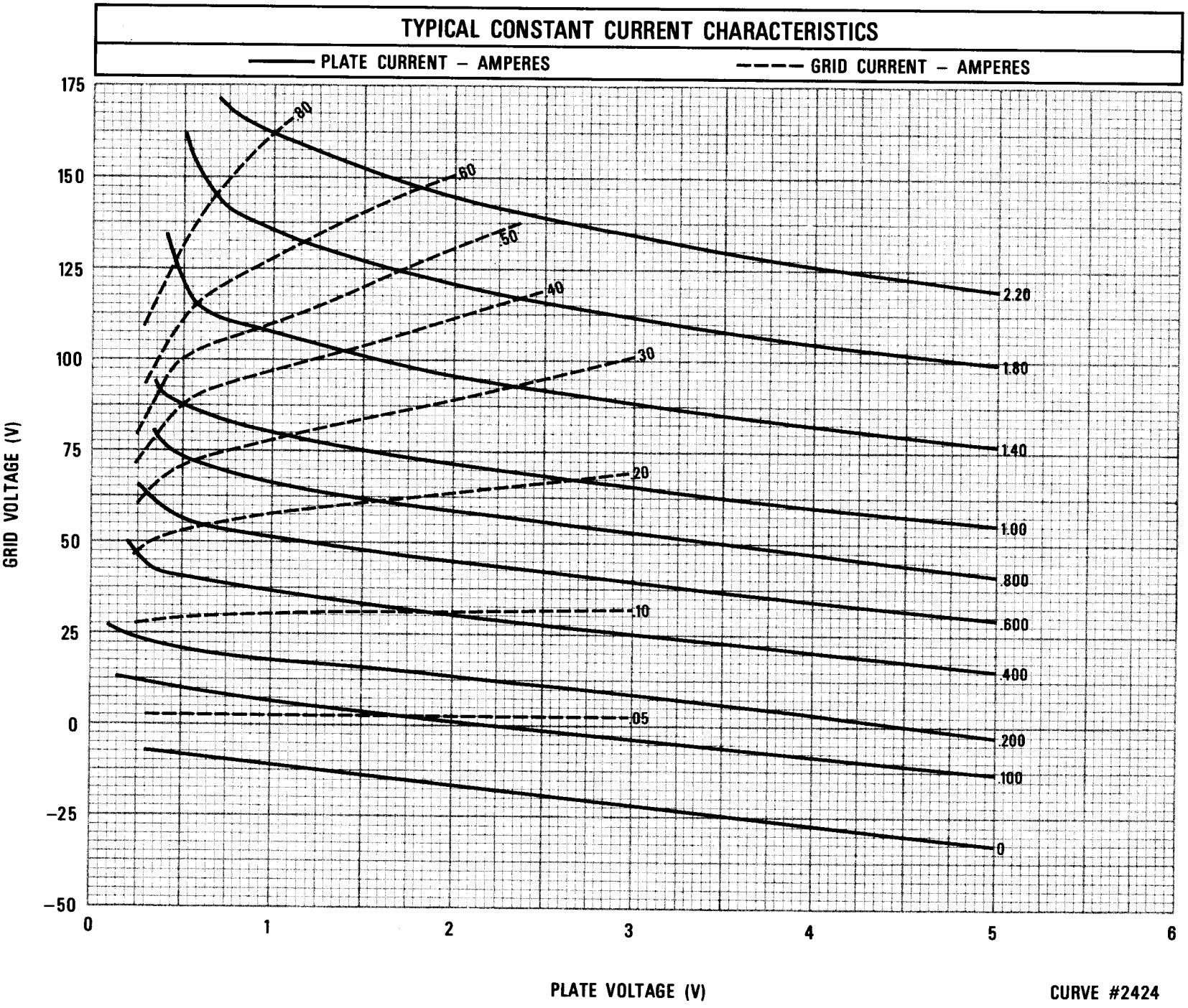
2. REFERENCE DIMENSIONS ARE FOR INFO ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.

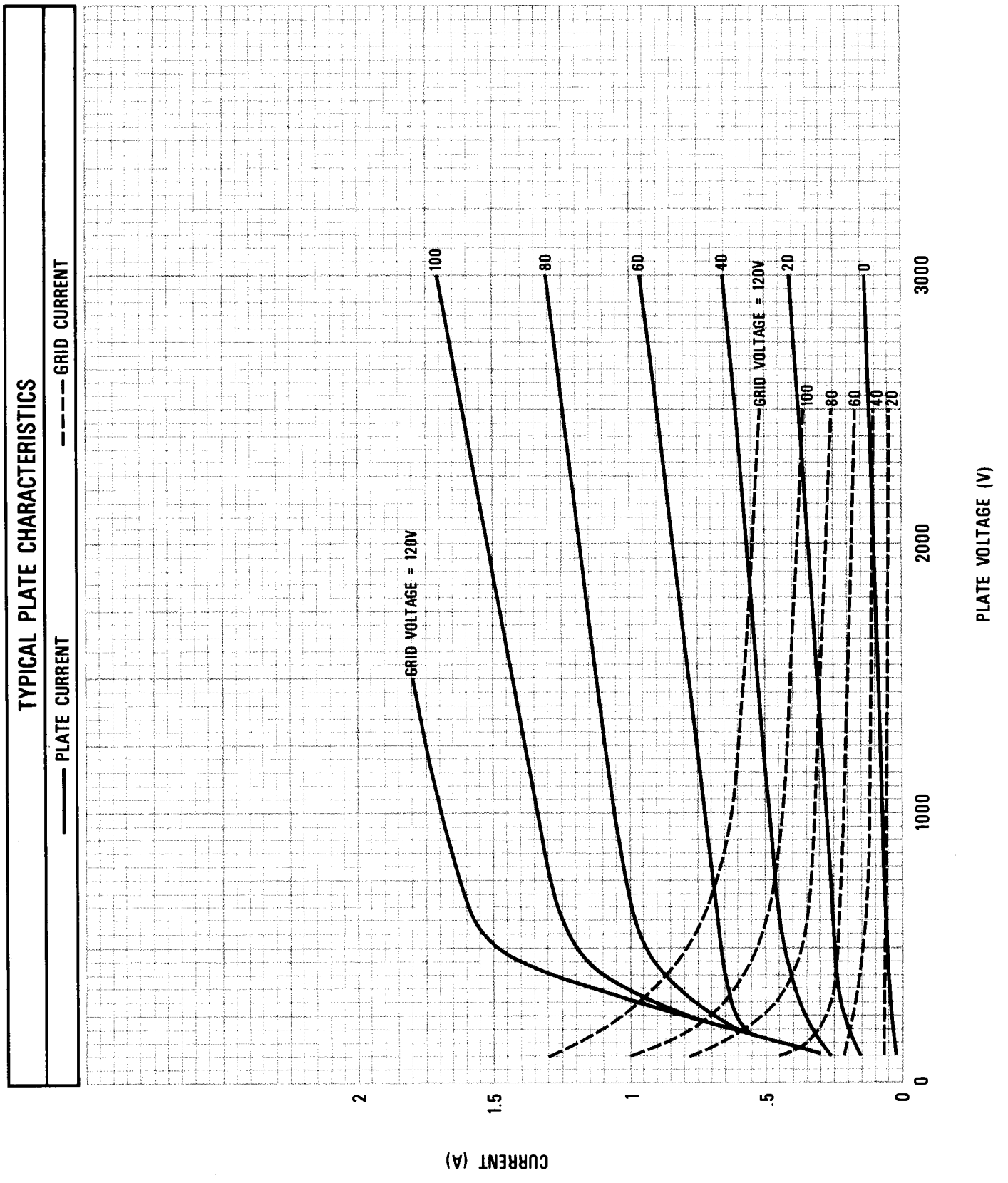


BOTTOM VIEW




TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED GRID
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
2.20
1.80
1.40
1.00
.800
.600
.400
.200
.100
0
.60
.40
.20
.10
.05
FILAMENT TO GRID VOLTAGE (V)
-175
-150
-125
-100
-75
-50
-25
0
25
0
1000
2000
3000
4000
5000
PLATE TO GRID VOLTAGE (V)


TYPICAL CONSTANT CURRENT CHARACTERISTICS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
175
150
125
100
75
50
25
0
–25
–50
0
1
2
3
4
5
6
PLATE VOLTAGE (V)
80
60
50
40
30
20
10
05
2.20
1.80
1.40
1.00
.800
.600
.400
.200
.100
0
CURVE #2424


TYPICAL PLATE CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
GRID VOLTAGE = 120V
100
80
60
40
20
0
GRID VOLTAGE = 120V
100
80
60
40
20
CURRENT (A)
0
.5
1
1.5
2
0
1000
2000
3000
PLATE VOLTAGE (V)

TECHNICAL DATA

8165
4-65A

RADIAL-BEAM
POWER TETRODE
MODULATOR
OSCILLATOR
AMPLIFIER

The Eimac 8165/4-65A is a small radial-beam tetrode with a maximum plate-dissipation rating of 65 watts. In most applications, no forced air is required, normal radiation and convection cooling being adequate. An instant-heating, thoriated tungsten filament is employed, allowing all electrode voltages to be applied simultaneously and permitting the conservation of power during standby periods. The 8165/4-65A is, therefore, a good choice for many mobile applications.

Short, heavy leads and low interelectrode capacities assure stable, efficient operation at high frequencies and permit its use at maximum ratings through 150 megacycles. The 8165/4-65A is equally useful in audio-amplifier or modulator service.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		6.0		volts
Current	3.2		3.8	amperes
Grid-Screen Amplification Factor	5		7	
Direct Interelectrode Capacitances:				
Grid-Plate			0.12	uuf
Input	6.0		8.3	uuf
Output	1.9		2.6	uuf
Frequency for Maximum Ratings			150	mc

MECHANICAL

Base	5-pin—National HX-29 or Johnson 122-101
Maximum Seal Temperature	200° C
Maximum Envelope Temperature	225° C
Recommended Socket Operating Position	Vertical, base down or up
Cooling	Convection and radiation
Recommended Heat Dissipating Connector	Eimac HR-6
Maximum Over-all Dimensions	
Length	4.19 inches
Diameter	2.38 inches
Net Weight	3 ounces
Shipping Weight (Approximate)	1.5 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony

MAXIMUM RATINGS (Key-down conditions)

D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C GRID VOLTAGE	—500 MAX. VOLTS
D-C PLATE CURRENT	150 MAX. MA
PLATE DISSIPATION	65 MAX. WATTS
SCREEN DISSIPATION	10 MAX. WATTS
GRID DISSIPATION	5 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 150 megacycles)

D-C Plate Voltage	1500	2000	2500	3000 volts
D-C Screen Voltage	250	250	250	250 volts
D-C Grid Voltage	—105	—105	—105	—105 volts
D-C Plate Current	150	137	124	112 ma
D-C Screen Current*	39	32	26	22 ma
D-C Grid Current*	19	15	13	9 ma
Peak R-F Grid Voltage*	205	195	185	175 volts
Driving Power*	3.9	2.9	2.4	1.6 watts
Plate Input Power	225	275	310	335 watts
Plate Output Power	160	210	245	270 watts

*Approximate values

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony

MAXIMUM RATINGS (Carrier conditions)

D-C PLATE VOLTAGE	2500 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C GRID VOLTAGE	—500 MAX. VOLTS
D-C PLATE CURRENT	120 MAX. MA
PLATE DISSIPATION	45 MAX. WATTS
SCREEN DISSIPATION	10 MAX. WATTS
GRID DISSIPATION	5 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 150 megacycles)

D-C Plate Voltage	1000	1500	2000	2500 volts
D-C Screen Voltage	250	250	250	250 volts
D-C Grid Voltage	—150	—150	—150	—150 volts
D-C Plate Current	120	120	113	102 ma
D-C Screen Current*	40	40	37	26 ma
D-C Grid Current*	20	20	18	13 ma
Peak R-F Voltage*	255	255	250	235 volts
Driving Power*	5.1	5.1	4.8	3.1 watts
Plate Input Power	120	180	226	255 watts
Plate Output Power	85	140	182	210 watts

*Approximate values

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AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB$_1$

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C SCREEN VOLTAGE	600 MAX. VOLTS
D-C PLATE CURRENT	150 MAX. MA
PLATE DISSIPATION	65 MAX. WATTS
SCREEN DISSIPATION	10 MAX. WATTS

RADIO-FREQUENCY SSB POWER AMPLIFIER

Class-AB$_1$

MAXIMUM RATINGS

D-C PLATE VOLTAGE	3000 MAX. VOLTS
D-C SCREEN VOLTAGE	600 MAX. VOLTS
D-C PLATE CURRENT	150 MAX. MA
PLATE DISSSIPATION	65 MAX. WATTS
SCREEN DISSIPATION	10 MAX. WATTS

TYPICAL OPERATION

Class-AB$_1$ (Sinusoidal wave, two tubes except where noted)

D-C Plate Voltage	1500	2000	2500	3000 volts
D-C Screen Voltage	500	500	400	400 volts
D-C Grid Voltage[1]	—90	—105	—85	—90 volts
Zero-Signal D-C Plate Current	60	40	30	30 ma
Max.-Signal D-C Plate Current	166	150	132	120 ma
Max.-Signal D-C Screen Current*	10	6	6	6 ma
Peak A-F Grid Voltage (per tube)*	70	80	77	77 volts
Effective Plate-to-Plate Load	13,300	24,000	37,500	50,000 ohms
Max.-Signal Plate Input Power	250	300	330	360 watts
Max.-Signal Plate Output Power	120	170	200	240 watts

[1]Adjust to obtain listed zero-signal d-c plate current.
*Approximate values.

TYPICAL OPERATION

Class-AB1 (Frequencies to 150 megacycles)

D-C Plate Voltage	1500	2000	2500	3000 volts
D-C Screen Voltage	500	500	400	400 volts
D-C Grid Voltage[1]	—90	—105	—85	—90 volts
Zero-Signal D-C Plate Current	30	20	15	15 ma
Max.-Signal D-C Plate Current	83	75	66	60 ma
Max.-Signal D-C Screen Current*	5	3	3	3 ma
Peak R-F Grid Voltage*	70	80	77	77 volts
Max.-Signal Plate Input Power	125	150	165	180 watts
Max.-Signal Plate Output Power	60	85	100	120 watts

[1]Adjust to obtain listed zero-signal d-c plate current.
*Approximate Values.

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

In class-C operation, adjustment of the r-f grid drive to obtain listed plate current at the listed grid bias, screen voltage, and plate voltage is assumed. Resultant screen and grid currents will vary from tube to tube, but little change in output power will be noted.

In class-AB$_1$ linear operation, screen current will also vary from tube to tube but is a useful indicator of relative linearity. In general, less screen current means better linearity, providing other conditions are held constant. The same degree of linearity will be obtained from different tubes if loading and drive are adjusted to give the same plate and screen current, although output power may vary from tube to tube.

APPLICATION

MECHANICAL

Mounting—The 4-65A must be operated vertically, base up or base down. The socket must provide clearance for the glass tip-off which extends from the center of the base. A flexible connecting strap should be provided between the plate terminal and the external plate circuit, and the Eimac HR-6 connector (or equivalent) used on the tube plate lead. The socket must not apply lateral pressure against the base pins. The tube must be protected from severe vibration and shock.

Adequate ventilation must be provided so that the seals and/or envelope under operating conditions do not exceed their rated maximum temperatures. For operation above 50 Mc. the plate voltage should be reduced, or special attention should be given to seal cooling.

When the ambient temperature does not exceed 30° C it will not ordinarily be necessary to provide forced-air cooling of the envelope or plate seal at frequencies below 50 Mc. provided that a heat-radiating plate connector is used and the tube is so located that normal circulation of air past the envelope is not impeded.

ELECTRICAL

Filament Voltage—The filament voltage, as measured at the filament pins, should be 6.0 volts. For long life, excursions from this value should not exceed ± 5 percent.

Bias Voltage—D-C bias voltage for the 4-65A should not exceed —500 volts. If grid-leak bias is used, suitable protective means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation.

Screen Voltage—The d-c screen voltage for the 4-65A should not exceed 400 volts except in the case of class-AB audio operation and Single-Side-Band r-f amplifier operation where it should not exceed 600 volts.

Screen Dissipation—The power dissipated by the screen of the 4-65A must not exceed 10 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load is removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 10 watts in the event of circuit failure.

Plate Voltage—The plate-supply voltage for the 4-65A should not exceed 3000 volts. Above 50 Mc. it is advisable to use a lower plate voltage than the maximum, since the seal heating due to r-f charging currents in the screen leads increases with plate voltage and frequency. See instructions on seal cooling under "Mechanical" and "Shielding."

Plate Dissipation—Under normal operating conditions, the plate dissipation of the 4-65A should not be allowed to exceed 65 watts in unmodulated applications.

In high-level-modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 45 watts.

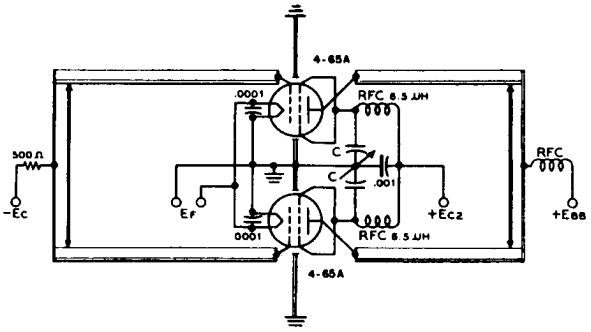
Plate dissipation in excess of the maximum rating is permissable for short periods of time, such as during tuning procedures.

OPERATION

Class-C FM or Telegraphy—The 4-65A may be operated as a class-C FM or telegraphy amplifier without

neutralization up to 110 Mc. if reasonable precautions are taken to prevent coupling between input and output circuits external to the tube. In single-ended circuits, plate, grid, filament, and screen by-pass capacitors should be returned through the shortest possible leads and short, heavy leads should be used to inter-connect the screens and filaments of the two tubes. Care should be taken to prevent leakage of radio-frequency energy to leads entering the amplifier in order to minimize grid-plate coupling between these leads external to the amplifier.

Where shielding is adequate, the feedback at frequencies above 110 Mc. is due principally to screen-lead-inductance effects and it becomes necessary to introduce in-phase voltage from the plate circuit into the grid cricuit. This can be done by adding capacitance between plate and grid external to the tube. Ordinarily, a small metal tab approximately ¾" square and located adjacent to the envelope opposite the plate will suffice for neutralization. Means should be provided for adjusting the spacing between the neutralizing capacitor plate and the envelope. An alternate neutralization scheme for use above 110 Mc. is illustrated in the diagram shown below. In this circuit, feedback is eliminated by series-tuning the screen to ground with a small capacitor. The socket screen terminals should be strapped together as shown on the diagram, by the shortest possible lead, and the lead from the mid point of this screen strap to the capacitor, C, and from the capacitor to ground should be made as short as possible.

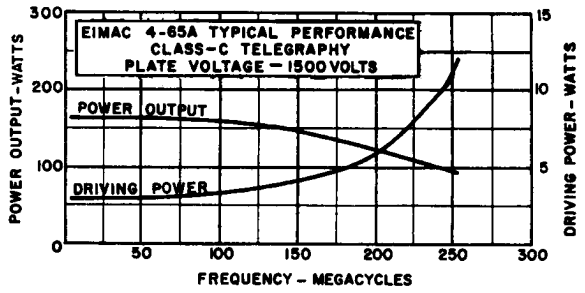


Screen-tuning neutralization circuit for use above 100 Mc. C is a small split-stator capacitor.

$$C(\mu\mu fd) = \frac{640{,}000}{f^2\ (Mc.)}\text{, approx.}$$

Typical driving power and output power versus frequency are shown below. The output power shown is the actual plate power delivered by the tube; the power delivered to the load will depend upon the efficiency of the plate tank and output coupling system. The driving power is likewise the driving power required by the tube (includes bias loss). The driver output should exceed the driving power requirements by a sufficient margin to allow for coupling-circuit losses. The use of silver-plated linear tank-circuit elements is recommended at frequencies above 75 Mc.

Class-C AM Telephony—The r-f circuit considerations discussed above under class-C FM or telegraphy also apply to amplitude-modulated operation of the 4-65A. When the 4-65A is used as a class-C high-level-modulated amplifier, both the plate and screen



should be modulated. Modulation voltage for the screen may be obtained by supplying the screen voltage through a series dropping resistor from the unmodulated plate supply, or by the use of an audio-frequency reactor in the positive screen-supply lead, or from a separate winding on the modulation transformer. When screen modulation is obtained by either the series-resistor or the audio-reactor methods, the audio-frequency variations in screen current, which result from the variations in plate voltage as the plate is modulated, automatically give the required screen modulation. Where a reactor is used, it should have a rated inductance of not less than 10 henries divided by the number of tubes in the modulated amplifier and a maximum current rating of two to three times the operating d-c screen current. To prevent phase-shift between the screen and plate modulation voltages at high audio frequencies, the screen by-pass capacitor should be no larger than necessary for adequate r-f by-passing.

For high-level modulated service, the use of partial grid-leak bias is recommended. Any by-pass capacitors placed across the grid-leak resistance should have a reactance at the highest modulation frequency equal to at least twice the grid-leak resistance.

Class-AB$_1$ and Class-AB$_2$ Audio—Two 4-65As may be used in a push-pull circuit to give relatively high audio output power at low distortion. Maximum ratings and typical operating conditions for class-AB$_1$ audio operation are given in the tabulated data.

Screen voltage should be obtained from a source having good regulation, to prevent variations in screen voltage from zero-signal to maximum-signal conditions. The use of voltage-regulator tubes in a standard circuit should provide adequate regulation.

Grid-bias voltage for class-AB$_2$ service may be obtained from batteries or from a small fixed-bias supply. When a bias supply is used, the d-c resistance of the bias source should not exceed 250 ohms. Under class-AB$_1$ conditions the effective grid-circuit resistance should not exceed 250,000 ohms.

In some cases the maximum-signal plate dissipation shown under "Typical Operation" is less than the maximum rated plate dissipation of 4-65A. In these cases, with sine-wave modulation, the plate dissipation reaches a maximum value, equal to the maximum rating, at a point somewhat below maximum-signal conditions.

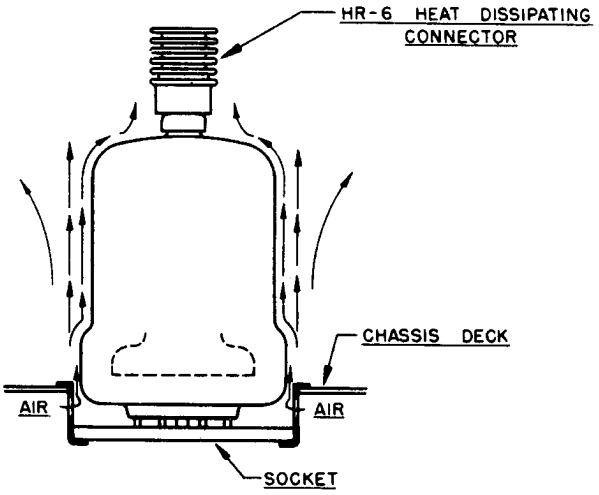
The output-power figures given in the tabulated data refer to the total output power from the amplifier tubes. The useful output power will be from 5 to 15 percent less than the figure shown, due to losses in the output transformer.

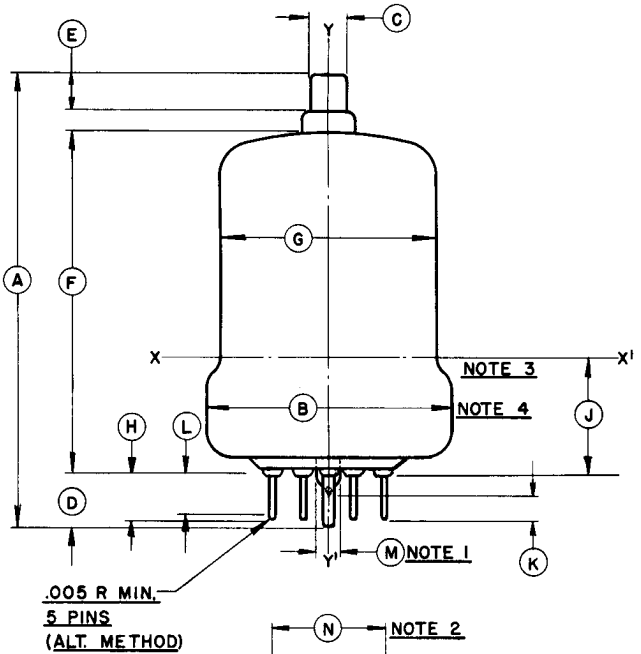
Shielding—The internal feedback of the tetrode has been substantially eliminated and in order to fully utilize this advantage, it is essential that the design of the equipment completely eliminate any feedback external to the tube. This means complete shielding of the output cricuit from the input circuit and earlier stages, proper reduction to low values of the inductance of the screen lead to the r-f ground, and elimination of r-f feedback in any common power-supply leads.

Complete shielding is easily achieved by mounting the socket of the tube flush with the deck of the chassis as shown in the sketch shown at the right.

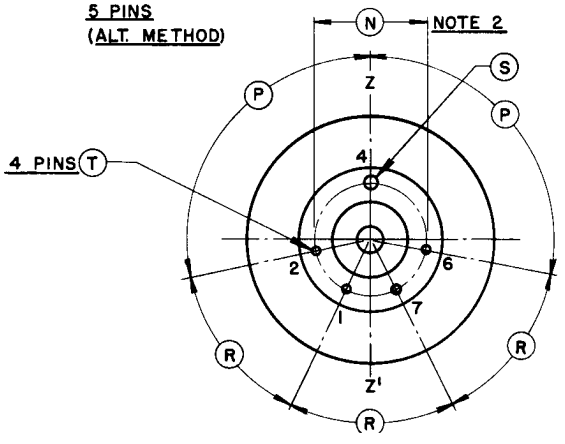
The holes in the socket permit the flow of convection air currents from below the chassis up past the seals in the base of the tube. This flow of air is essential to cool the tube and in cases where the complete under-part of the chassis is enclosed for electrical shielding, screened holes or louvers should be provided to permit air circulation. Note that shielding is completed by aligning the internal screen shield with the chassis deck and by proper r-f by-passing of the screen leads to r-f ground. The plate and output circuits should be kept above deck and the input circuit and circuits of earlier stages should be kept below deck or completely shielded.

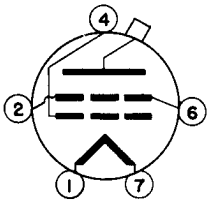
Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations. Copies of characteristic curves, either constant-grid-voltage or constant-current, for various screen potentials may be obtained from this department on request.



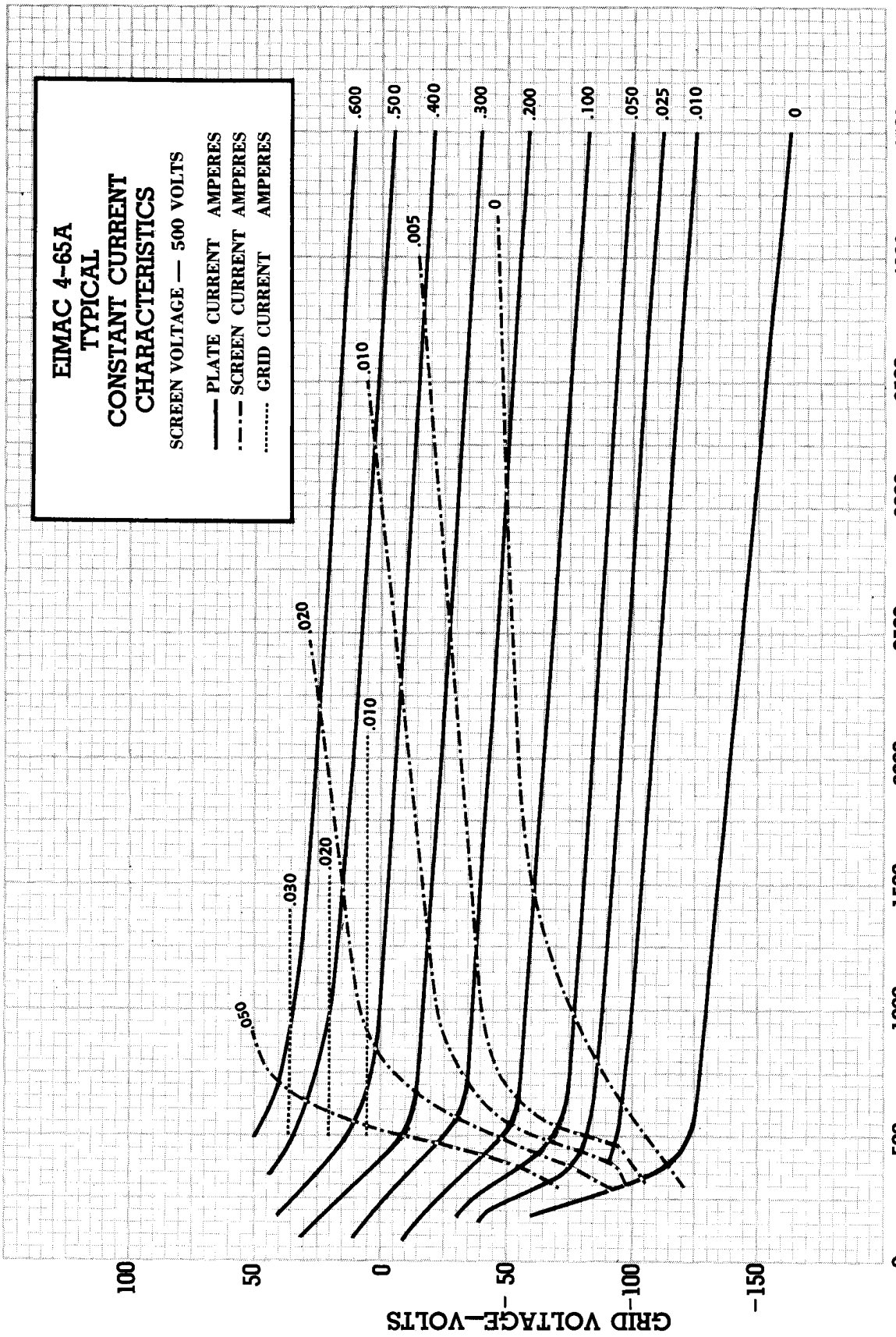


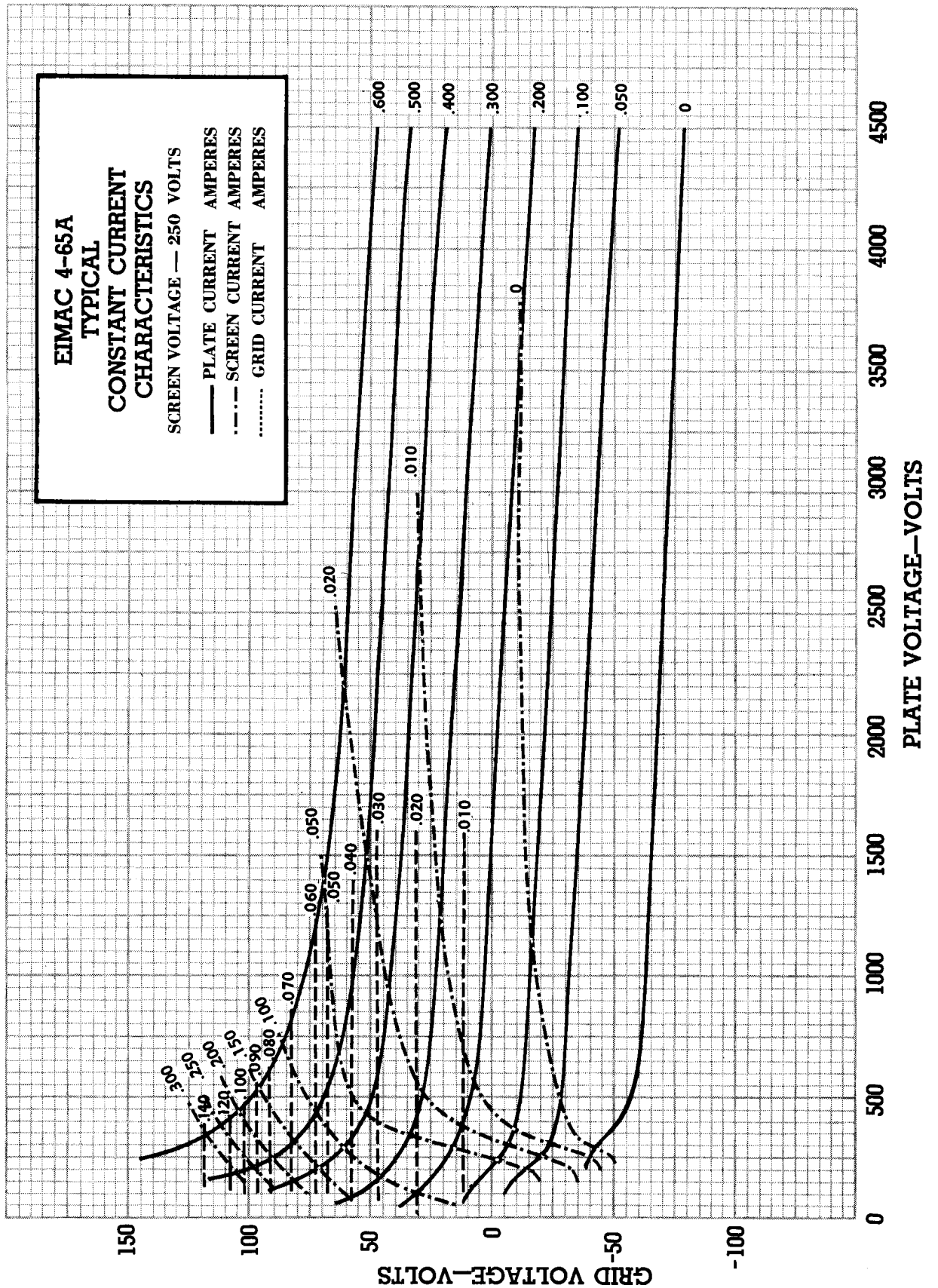
DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		4	4 3/16
B			2 3/8
C		.350	.365
D		7/16	9/16
E		21/64	
F		2 15/16	3 5/16
G			2 1/8
H		3/8	1/2
J		.844	1.219
K		.000	
L		5/16	
M			3/8
N	1.000		
P	102°		
R	52°		
S		.122 DIA.	.128 DIA.
T		.055 DIA.	.061 DIA.





ALL DIMENSIONS IN INCHES.


EIMAC 4-65A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT AMPERES
SCREEN CURRENT AMPERES
GRID CURRENT AMPERES
.600
.500
.400
.300
.200
.100
.050
.025
.010
0
.005
.010
.020
.030
.050
.020
.010
0
100
50
0
−50
−100
−150
GRID VOLTAGE—VOLTS
0
500
1000
1500
2000
2500
3000
3500
4000
4500
PLATE VOLTAGE—VOLTS

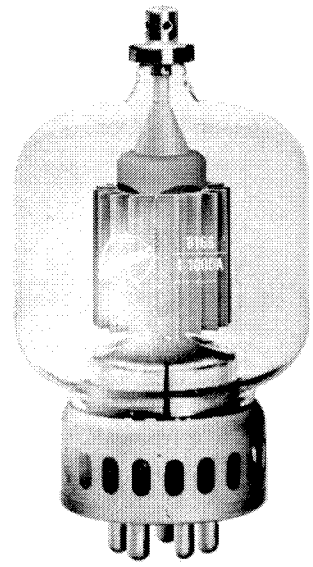


Printed in USA

8166
4-1000A

RADIAL-BEAM POWER TETRODE

TECHNICAL DATA



The EIMAC 8166/4-1000A is a radial-beam tetrode with a maximum plate dissipation rating of 1000 watts. Intended for use as an amplifier, oscillator, or modulator, the 8166/4-1000A is capable of efficient operation well into the VHF range.

In FM broadcast service on 110 Megahertz, two 8166/4-1000A tetrodes will deliver a useful output power of over 5000 watts.

Operating under class AB_2 modulator conditions with less than 10 watts of peak driving power, two of these tubes will deliver 3900 watts of output power.

In class AB_1, a pair of 8166/4-1000A tetrodes will deliver 3800 watts of output power.

Cooling of the tube is accomplished by radiation from the plate and by circulation of forced-air through the base and around the envelope. Cooling can be simplified through the use of the EIMAC SK-500 Air-System Socket.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated tungsten				
Voltage		7.5		volts
Current	20.0		22.7	amperes
Amplification Factor (Grid to Screen)	6.1		7.7	
Direct Interelectrode Capacitances:†				
Grid-Plate			0.35	μμf
Input	23.8		32.4	μμf
Output	6.8		9.4	μμf
Transconductance (I_b=300 ma)		10,000		μmhos
Highest Frequency for Maximum Ratings			110	MHz

MECHANICAL

Base	5-pin metal shell
Basing	See drawing
Recommended Socket	EIMAC SK-500 Air-System Socket
Recommended Chimney	SK-506
Operating Position	Vertical, base up or down
Cooling	Radiation and forced air
Recommended Heat-Dissipating Connector:	
Plate	EIMAC HR-8
Maximum Over-all Dimensions:	
Length	9.63 inches
Diameter	5.25 inches
Net Weight (tube only)	1.5 pounds
Shipping Weight	12 pounds

†In Shielded Fixture

(Revised 10-30-66) © 1963, 1966 Varian

Printed in U.S.A.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony

MAXIMUM RATINGS (Key-down conditions, per tube to 110 MHz)

DC PLATE VOLTAGE	6000 VOLTS
DC SCREEN VOLTAGE	1000 VOLTS
DC GRID VOLTAGE	—500 VOLTS
DC PLATE CURRENT	700 MA
PLATE DISSIPATION	1000 WATTS
SCREEN DISSIPATION	75 WATTS
GRID DISSIPATION	25 WATTS

TYPICAL OPERATION (Frequencies below 110 MHz, one tube)

DC Plate Voltage	3000	4000	5000	6000	volts
DC Screen Voltage	500	500	500	500	volts
DC Grid Voltage	—150	—150	—200	—200	volts
DC Plate Current	700	700	700	700	ma
DC Screen Current	146	137	147	140	ma
DC Grid Current	38	39	45	42	ma
Screen Dissipation	73	69	73	70	watts
Grid Dissipation	5	6	7	6	watts
Peak RF Grid Input Voltage (approx.)	290	290	355	350	volts
Driving Power (approx.)*	11	12	16	15	watts
Plate Input Power	2100	2800	3500	4200	watts
Plate Dissipation	670	700	690	800	watts
Plate Output Power	1430	2100	2810	3400	watts

*Apparent driving power requirements increase above 30 MHz. At 110 MHz the driver should be capable of supplying 200 watts per tube to take care of feed-through, circuit losses, and radiation.

TYPICAL OPERATION (110 MHz, two tubes, push-pull)

DC Plate Voltage	4000	5000	6000	volts
DC Screen Voltage	450	500	500	volts
DC Grid Voltage	—150	—160	—180	volts
DC Plate Current	1.15	1.25	1.25	amps
DC Screen Current	280	240	250	ma
DC Grid Current	80	80	100	ma
Screen Dissipation (per tube)	63	60	63	watts
Driving Power (approx.)	350	400	400	watts
Plate Input Power	4600	6250	7500	watts
Plate Dissipation (per tube)	650	850	900	watts
Useful Output Power	3000	4200	5200	watts

These 110 MHz typical performance figures were obtained by direct measurement in operating equipment. The output power is useful power measured in a load circuit. The driving power is that taken by the tube and a practical resonant circuit. In many cases with further refinement and improved techniques, better performance might be obtained.

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier Conditions)

MAXIMUM RATINGS (Per tube to 110 MHz)

DC PLATE VOLTAGE	5000 VOLTS†
DC SCREEN VOLTAGE	1000 VOLTS
DC GRID VOLTAGE	—500 VOLTS
DC PLATE CURRENT	600 MA
PLATE DISSIPATION	670 WATTS
SCREEN DISSIPATION	25 WATTS
GRID DISSIPATION	75 WATTS

†5500 Max. volts below 30 MHz.

TYPICAL OPERATION (Frequencies below 110MHz, one tube)

DC Plate Voltage	3000	4000	5000	5500*	volts
DC Screen Voltage	500	500	500	500	volts
DC Grid Voltage	—200	—200	—200	—200	volts
DC Plate Current	600	600	600	600	ma
DC Screen Current	145	132	130	105	ma
DC Grid Current	36	33	33	28	ma
Screen Dissipation	72	66	65	52	watts
Grid Dissipation	5	4	4	3	watts
Peak AF Screen Voltage (100% modulation)	250	250	250	250	volts
Peak RF Grid Input Voltage	340	335	335	325	volts
Driving Power**	12	11	11	9	watts
Plate Input Power	1800	2400	3000	3300	watts
Plate Dissipation	410	490	560	670	watts
Plate Output Power	1390	1910	2440	2630	watts

*5500 volt operation may be used below 30 MHz only.

**Apparent driving power requirements increase above 30 MHz. At 110 MHz the driver should be capable of supplying 200 watts per tube to take care of feed-through, circuit losses, and radiation.

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class-AB

MAXIMUM RATINGS (Per tube)

DC PLATE VOLTAGE	6000 VOLTS
DC SCREEN VOLTAGE	1000 VOLTS
MAX-SIGNAL DC PLATE CURRENT	700 MA
PLATE DISSIPATION	1000 WATTS
SCREEN DISSIPATION	75 WATTS

TYPICAL OPERATION Class-AB_1
(Sinusoidal wave, two tubes unless otherwise specified)

DC Plate Voltage	4000	5000	6000	volts
DC Screen Voltage	1000	1000	1000	volts
DC Grid Voltage (approx.)*	—115	—125	—135	volts
Zero-Signal DC Plate Current	300	240	200	ma
Max-Signal DC Plate Current	1.05	1.00	0.95	amps
Zero-Signal DC Screen Current	0	0	0	ma
Max-Signal DC Screen Current	60	60	64	ma
Effective Load, Plate-to-Plate	7000	10,000	14,000	ohms
Peak AF Grid Input Voltage (per tube)	115	125	135	volts
Driving Power	0	0	0	watts
Max-Signal Plate Dissipation (per tube)	930	950	930	watts
Max-Signal Plate Output Power	2340	3100	3840	watts

*Adjust to give stated zero-signal plate current. The DC resistance in series with the control grid of each tube should not exceed 250,000 ohms.

TYPICAL OPERATION Class-AB_2
(Sinusoidal wave, two tubes unless otherwise specified)

DC Plate Voltage	4000	5000	6000	volts
DC Screen Voltage	500	500	500	volts
DC Grid Voltage (approx.)*	—60	—70	—75	volts
Zero-Signal DC Plate Current	300	200	150	ma
Max-Signal DC Plate Current	1.20	1.10	.95	amps
Zero-Signal DC Screen Current	0	0	0	ma
Max-Signal DC Screen Current	95	90	65	ma
Effective Load, Plate-to-Plate	7000	11,000	15,000	ohms
Peak AF Grid Input Voltage (per tube)	140	145	130	volts
Max-Signal Peak Driving Power	11.0	11.0	9.4	watts
Max-Signal Nominal Driving Power (approx.)	5.5	5.5	4.7	watts
Max-Signal Plate Dissipation (per tube)	900	850	900	watts
Max-Signal Plate Output Power	3000	3800	3900	watts

*Adjust to give stated zero-signal plate current.

Note: Typical operation data are based on conditions of adjusting the rf grid drive to a specified plate current, maintaining fixed conditions of grid bias and screen voltage. It will be found that if this procedure is followed there will be little variation in output power between tubes even though there may be some variation in grid and screen currents. Where grid bias is obtained principally by means of a grid resistor, it is necessary to make the resistor adjustable to control plate current.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION," POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EIMAC DIVISION OF VARIAN ASSOCIATES, FOR INFORMATION AND RECOMMENDATIONS

APPLICATION

MECHANICAL

Mounting — The 4-1000A must be operated vertically. The base may be down or up. The recommended socket for this tube is the SK-500 Air-System Socket.

Cooling — Adequate forced-air cooling must be provided to maintain the base seal temperatures below 150°C and the plate seal temperature below 200°C. Cooling is simplified by the use of the EIMAC SK-500 Air-System Socket, and its SK-506 Air Chimney, which control the flow of air around the tube.

When the EIMAC SK-500 Air-System Socket is used, the following flow rates apply to sea level operation, with an ambient temperature of 25°C for the operating conditions described:

At 110 megahertz, with maximum rated plate dissipation, an air-flow rate of 35 cfm is required. The corresponding pressure drop as measured in the socket is 1.9 inches of water column.

At frequencies below 30 megahertz, an air-flow rate of 20 cfm provides adequate cooling. The corresponding pressure drop as measured in the socket is 0.6 inch of water column.

In the event that an Air-System Socket and Air Chimney are not used, air must be circulated through the base of the tube and over the envelope surface and the plate seal in sufficient quantities to maintain the temperatures below the maximum ratings. Seal-temperature ratings may require that cooling air be supplied to the tube if the filament is maintained at operating temperature during standby periods.

In any questionable situation, the only criterion for correct cooling practice is temperature. A convenient medium for measuring tube temperatures is a temperature-sensitive paint.

ELECTRICAL

Filament Voltage — For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated voltage of 7.5 volts. Variations in filament voltage must be kept within the range of 7.13 to 7.87 volts.

Bias Voltage — The dc bias voltage for the 4-1000A should not exceed 500 volts. With grid-leak bias, suitable means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation. The grid-resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In the case of operation above 50 megahertz, it is advisabe to keep the bias voltage as low as possible.

Screen Voltage — The dc screen voltage for the 4-1000A should not exceed 1000 volts. The screen voltages shown under "Typical Operation" are representative voltages for the type of operation involved.

Plate Voltage — The plate-supply voltage for the 4-1000A should not exceed 6000 volts in CW and audio applications. In plate-modulated telephony service above 30 megahertz, the dc plate-supply voltage should not exceed 5000 volts; however, below 30 megahertz, 5500-volts may be used.

Grid Dissipation — Grid dissipation for the 4-1000A should not be allowed to exceed 25 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp} I_c$$

where: P_g = Grid dissipation,
e_{cmp} = Peak positive grid to cathode voltage
I_c = DC grid current.

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid.

Screen Dissipation—The power dissipated by the screen of the 4-1000A must not exceed 75 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 75 watts in event of circuit failure.

Plate Dissipation — Under normal operating conditions, the plate dissipation of the 4-1000A should not be allowed to exceed 1000 watts.

In plate-modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 670 watts. The plate dissipation will rise to 1000 watts under 100 per-cent sinusoidal modulation.

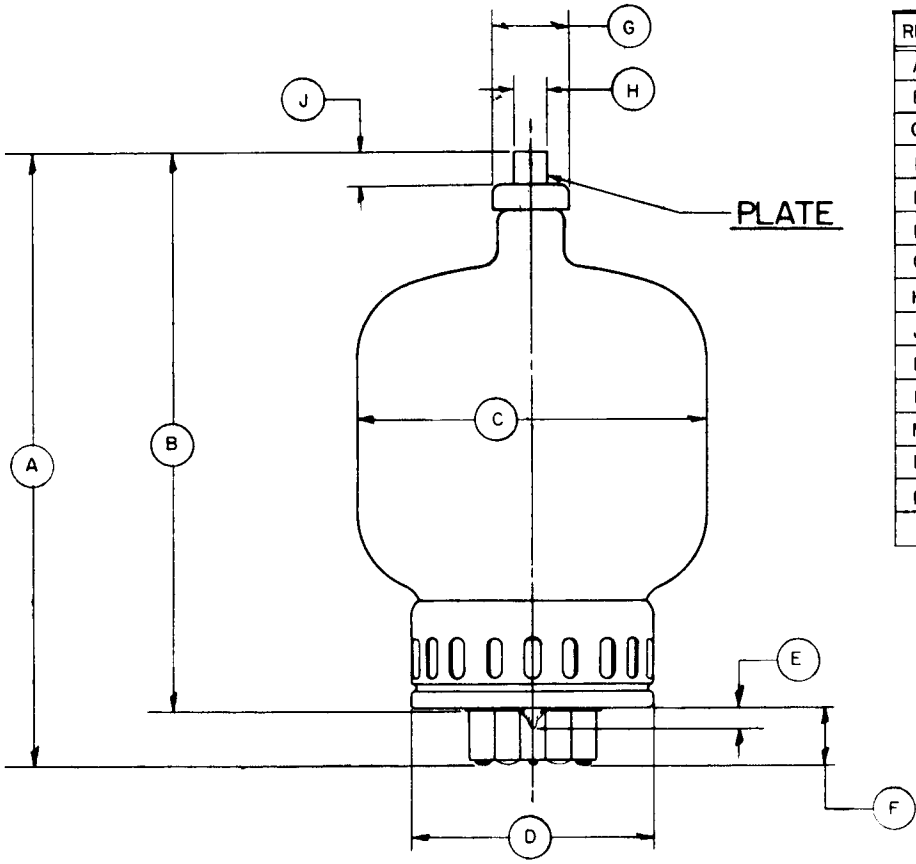
Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

Neutralization — If reasonable precautions are taken to prevent coupling between input and output circuits, the 4-1000A may be operated up to the 10-megahertz region without neutralization. In the region between 10 megahertz and 30 megahertz, the conventional type of cross-neutralizing may be used with push-pull circuits. In single-ended circuits ordinary neutralization systems may be used which provide 180° out of phase voltage to the grid.

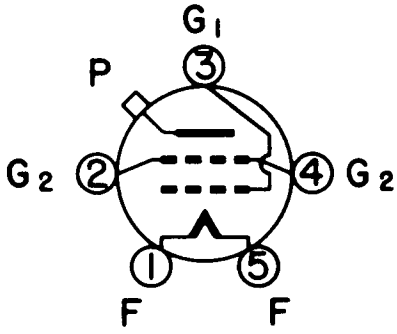
At frequencies above 30 megahertz the feedback is principally due to screen-lead-inductance effects. Feedback is eliminated by using series capacitance in the screen leads between the screen and ground. A variable capacitor of from 25 to 50 $\mu\mu$fds will provide sufficient capacitance to neutralize each tube in the region of 100 megahertz. When using this method, the two screen terminals on the socket should be strapped together by the shortest possible lead. The lead from the mid-point of this screen strap to the variable capacitor and from the variable capacitor to ground should have as little inductance as possible.

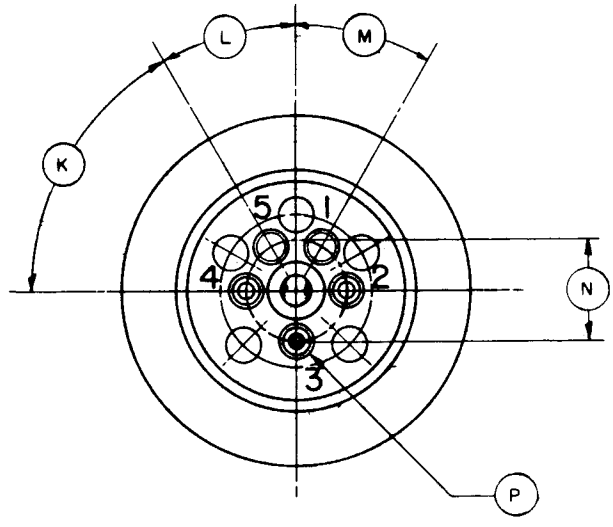
In general, plate, grid, filament, and screen-bypass or screen-neutralizing capacitors should be returned to rf ground through the shortest possible leads.

In order to take full advantage of the high power gain obtainable with the 4-1000A, care should be taken to prevent feedback from the output to input circuits. A conventional method of obtaining the necessary shielding between the grid and plate circuits is to use a suitable metal chassis with the grid circuit mounted below the deck and the plate circuit mounted above the deck. Power-supply leads entering the amplifier should be bypassed to the ground and properly shielded to avoid feedback coupling in these leads. The output circuit and antenna feeders should be arranged so as to preclude any possibility of feedback into other circuits.



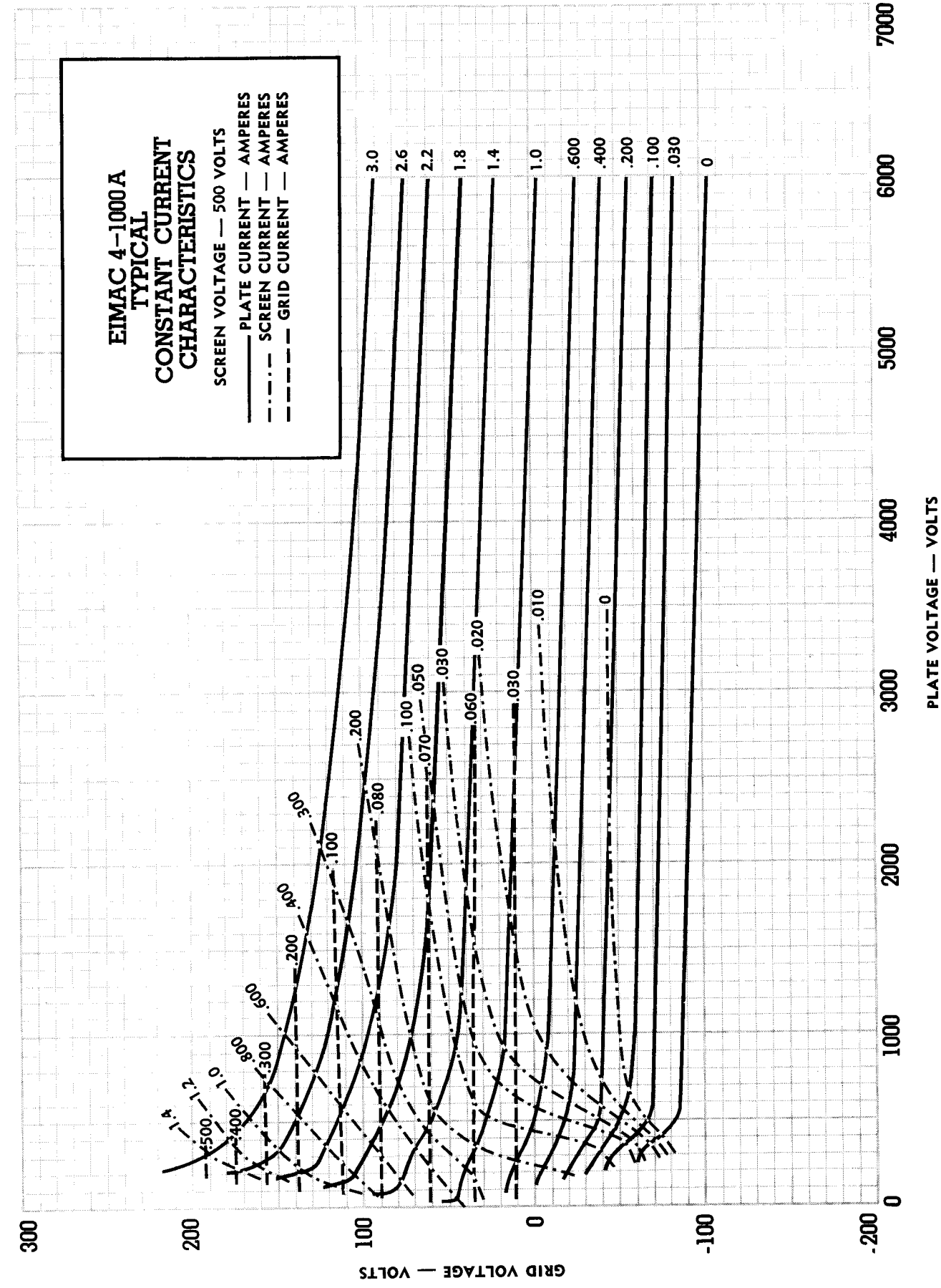
REF.	MIN.	NOM.	MAX.
A	8.875	9.250	9.625
B	8.000	8.375	8.750
C			5.250
D			3.625
E			.313
F	.825	.875	.925
G	1.110	1.125	1.140
H	.559	.566	.573
J	.484		
K		60°	
L		30°	
M		30°	
N	1.495	1.500	1.505
P	.371	.374	.377





BOTTOM VIEW

DIMENSIONS
IN INCHES


EIMAC 4-1000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
3.0
2.6
2.2
1.8
1.4
1.0
.600
.400
.200
.100
.030
0
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8167
4CX300A

CERAMIC POWER TETRODE

The EIMAC 4CX300A is a compact integral-finned external-anode power tetrode having a maximum plate-dissipation rating of 300 watts. The 4CX300A may be operated at frequencies up to 500 megahertz.

The all-ceramic-and-metal construction and the internally-unitized electrode structure combine to make the 4CX300A especially durable and free from mechanically-induced noise under conditions of severe acceleration caused by shock or vibration.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide-Coated, Unipotential				
Heating Time	30	60		S
Cathode-to-Heater Potential			±150	V
Heater: Voltage (See "Application")		6.0		V
Current (E_f=6.0 volts)	2.6		3.1	A
Amplification Factor (Grid to Screen)	4.0		5.6	
Transconductance (I_b=200 ma.)		12,000		μmhos
Direct Interelectrode Capacitances, Grounded Cathode:				
Input	25		33	pF
Output	3.5		4.5	pF
Feedback			0.06	pF

Direct Interelectrode Capacitances, Grounded Grid and Screen:	Min.	Nom.	Max.	
Input		16.2		pF
Output	3.5		4.5	pF
Feedback		0.01		pF
Frequency for Maximum Ratings			500	MHz

MECHANICAL

Base	Special, breechblock terminal surfaces
Recommended Socket	EIMAC SK-700 Series
Operating Position	Any
Maximum Operating Temperatures:	
Ceramic-to-metal Seals	250°C
Anode Core	250°C
Cooling	Forced Air
Maximum Over-all Dimensions:	
Height	2.5 in
Diameter	1.65 in
Net Weight	4 oz
Shipping Weight (Approximate)	1 lb

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RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 VOLTS
DC SCREEN VOLTAGE	300 VOLTS
DC GRID VOLTAGE	—250 VOLTS
DC PLATE CURRENT	250 MA
PLATE DISSIPATION	300 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION

DC Plate Voltage	500	1000	1500	2000	2500‡	2000	volts
DC Screen Voltage	250	250	250	250	250	250	volts
DC Grid Votage	—90	—90	—90	—90	—90	—90	volts
DC Plate Current	250	250	250	250	250	250	ma
DC Screen Current*	45	38	21	19	16	10†	ma
DC Grid Current*	35	31	28	26	25	25†	ma
Peak RF Grid Voltage*	114	114	112	112	111	—	volts
Driving Power*	4.0	3.5	3.2	2.9	2.8	—	watts
Plate Input Power	125	250	375	500	625	500	watts
Plate Output Power	70	190	280	390	500	225†	watts
Heater Voltage						5.0	volts

*Approximate values
†Measured values for a typical cavity amplifier circuit at 500 MHz.
‡For operation below 250Mc. only.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per tube)

DC PLATE VOLTAGE	2500 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC PLATE CURRENT	250 MA
PLATE DISSIPATION	300 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

DC Plate Voltage	1000	1500	2000	2500	volts
DC Screen Voltage	350	350	350	350	volts
DC Grid Voltage[1]	—55	—55	—55	—55	volts
Zero-Signal DC Plate Current	200	200	200	200	ma
Max-Signal DC Plate Current	500	500	500	500	ma
Max-Signal DC Screen Current	20	16	10	8	ma
Effective Load, Plate to Plate	3500	6200	9500	11,600	ohms
Peak AF Grid Input Voltage (per tube)*	50	50	50	50	volts
Driving Power	0	0	0	0	watts
Max-Signal Plate Output Power	240	430	600	800	watts

*Approximate values.
[1]Adjust grid bias to obtain listed zero-signal plate current.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1 (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2500 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC PLATE CURRENT	250 MA
PLATE DISSIPATION	300 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION

DC Plate Voltage	1000	1500	2000	2500 volts
DC Screen Voltage	350	350	350	350 volts
DC Grid Voltage[1]	—55	—55	—55	—55 volts
Zero-Signal DC Plate Current	100	100	100	100 ma
DC Plate Current	150	150	150	150 ma
DC Screen Current*	—3	—4	—4	—4 ma
Peak RF Grid Voltage*	25	25	25	25 volts
Plate Output Power	30	50	65	85 watts

*Approximate values.
[1]Adjust grid bias to obtain listed zero-signal plate current.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1 (Single-Sideband Suppressed-Carrier Operation)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2500 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC PLATE CURRENT	250 MA
PLATE DISSIPATION	300 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Peak-envelope conditions except where noted)

DC Plate Voltage	1000	1500	2000	2500 volts
DC Screen Voltage	350	350	350	350 volts
DC Grid Voltage[1]	—55	—55	—55	—55 volts
Zero-Signal DC Plate Current	100	100	100	100 ma
Peak RF Grid Voltage*	50	50	50	50 volts
DC Plate Current	250	250	250	250 ma
DC Screen Current*	10	8	5	4 ma
Plate Input Power	250	375	500	625 watts
Plate Output Power	120	215	300	400 watts
Two-Tone Average DC Plate Current	190	190	190	190 ma
Two-Tone Average DC Screen Current*	2	—1	—2	—2 ma

*Approximate values.
[1]Adjust grid bias to obtain listed zero-signal plate current.

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	1500 VOLTS
DC SCREEN VOLTAGE	300 VOLTS
DC GRID VOLTAGE	—250 VOLTS
DC PLATE CURRENT	200 MA
PLATE DISSIPATION	200 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION

DC Plate Voltage	500	1000	1500	volts
DC Screen Voltage	250	250	250	volts
DC Grid Voltage	—100	—100	—100	volts
DC Plate Current	200	200	200	ma
DC Screen Current*	31	22	20	ma
DC Grid Current*	15	14	14	ma
Peak RF Grid Input Voltage*	118	117	117	volts
Driving Power*	1.8	1.7	1.7	watts
Plate Input Power	100	200	300	watts
Plate Output Power	60	145	235	watts

*Approximate values.

NOTE: "TYPICAL OPERATION" data are obtainable by calculation from published characteristic curves and confirmed by direct tests. The driving power and output power shown are substantially correct at frequencies below 175 MHz. Allowance must be made for grid and plate circuit losses. At frequencies above 175 MHz. additional allowance must be made for high-frequency effects within the tube itself. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf driving voltage is applied.

APPLICATION

MECHANICAL

Mounting — The 4CX300A may be operated in any position. Recommended sockets for the 4CX300A are the EIMAC Air-System Sockets type SK-700 (ungrounded cathode) or type SK-710 (cathode and one heater contact grounded). Both sockets provide connections to all electrodes except the anode and each incorporates a screen by-pass capacitor of approximately 1100 $\mu\mu$f. The SK-606 chimney is recommended for use with the SK-700 and SK-710 sockets.

Other sockets suitable for use with the 4CX300A include the SK-740, SK-760, and SK-770. These sockets do not incorporate screen by-pass capacitors. The SK-760 and SK-770 incorporate integral air chimneys. Screen contacts are connected to the mounting flange in the SK-770 and are, therefore, grounded when the socket is installed in the usual manner.

Cooling — The maximum rated ceramic-to-metal seal temperature for the 4CX300A is 250°C. Adequate forced-air cooling must be provided to assure that this maximum temperature rating is not exceeded. Air flow requirements to maintain seal temperatures at 200°C in 50°C ambient air are tabulated below.

	Sea Level		10,000 Feet	
Plate Dissipation (watts)	Air Flow (CFM)	Pressure Drop (inches of water)	Air Flow (CFM)	Pressure Drop (inches of water)
100	2.2	0.065	3.2	0.095
150	3.4	0.14	4.9	0.21
200	4.6	0.26	6.7	0.37
250	5.9	0.40	8.6	0.58
300	7.2	0.58	10.5	0.85

A new, more efficient cooling fin design is incorporated in the 4CX300A which results in lower airflow requirements. This is reflected in the table above (which assumes the use of an EIMAC SK-700 or SK-710 socket and SK-606 chimney).

At high altitudes and high ambient temperatures the flow rate must be increased to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using the maximum rated temperature as the criterion for satisfactory cooling.

Cooling effectiveness should also be determined on an individual basis if the 4CX300A is operated immersed in an insulating fluid such as silicone oil, again using the maximum rated temperature as the criterion.

Impact and Vibration — The 4CX300A is designed to operate under impact or vibration capable of disabling a conventional tube of similar power capabilities. Impact forces up to 50g with 11-millisecond duration, or vibratory accelerations up to 20g at frequencies from 20 to 2000 cycles per second, will not destroy a normal 4CX300A unless unduly prolonged.

It is not suggested that the 4CX300A be subjected to abusive treatment unnecessarily, but in applications where operation under severe environmental conditions is unavoidable the 4CX300A will provide more reliable service than will conventional tubes.

ELECTRICAL

Heater Operation — The rated heater voltage for the 4CX300A is 6.0 volts. At frequencies higher than 300 megacycles the heater voltage should be reduced according to the following schedule:

Frequency (MHz)	Heater Voltage (Volts)
Up to 300	6.00
300 to 400	5.75
400 to 500	5.50

The heater voltage must be maintained within $\pm 5\%$ of the selected operating voltage if variations in circuit performance are to be minimized and best tube life obtained.

Cathode Operation — The 4CX300A employs a cylindrical indirectly-heated oxide-coated unipotential cathode. The minimum warm-up time is 30 seconds when rated heater voltage is applied.

Grid Operation — The 4CX300A control grid has a maximum dissipation rating of 2.0 watts, and precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the Typical Operation sections of the data sheet whenever possible.

At frequencies higher than 300 MHz., the driving power required by the circuits associated with the tube begins to increase, until at 500 MHz., as much as 30 watts of driving power may be required. The power dissipated by the control grid increases only slightly, however, in spite of the greatly increased driving power required by the circuit. Satisfactory 500-megahertz operation of the 4CX300A in a stable, "straight-through" amplifier is indicated by grid-current values below approximately 25 milliamperes.

In class-A and class-AB_1 amplifiers, where no grid current flows, the grid bias voltage may be applied through a resistor. The maximum permissible series resistance per tube is 100,000 ohms.

Screen Operation — The maximum rated screen dissipation for the 4CX300A is 12 watts. The maximum rated dc screen supply voltage is 300 volts when the tube is operated in class-C amplifier or oscillator service, and 400 volts when the tube is operated in class-AB or class-B amplifier service.

Under certain operating conditions the screen current of a tetrode may reverse. This makes it dangerous to rely on a screen-dropping resistor or a series regulator to supply the screen voltage unless a bleeder or regulator tube is connected from screen to cathode. This bleeder should draw at least 15 milliamperes for each tube connected to the screen supply.

The power input to the screen can be calculated from the voltage and current whenever

the screen-to-cathode potential does not vary. Screen modulation or cathode driving of tetrode amplifiers can lead to errors in measurement of screen input when the effective voltage and current exceed the indicated dc values. When there is reason to suspect that the screen input exceeds the indicated power, it is advisable to maintain the indicated screen power input below approximately 75% of the rated screen dissipation.

A screen by-pass capacitor of approximately 1100 $\mu\mu$f is incorporated in the body of the EIMAC SK-700 and SK-710 Air-System Sockets and is adequate for normal amplifier operation at high and ultra-high radio frequencies. Operation at low radio frequencies or audio frequencies may require that additional capacitance be connected externally. In the latter case, the screen by-pass capacitance within the socket helps to eliminate the high-frequency parasitic oscillations occasionally encountered in tetrode amplifiers.

The self-neutralizing frequency of the 4CX300A is above the useful high-frequency limit for the tube when either of the sockets with integral screen by-pass capacitors is used.

Plate Operation—The 4CX300A has a finned external anode for forced-air cooling. Connection to the anode may be made at the top cap or cylindrical cooler shell. The latter is usually used when the tube is installed in coaxial lines or cavities.

The absolute maximum plate-dissipation rating for the 4CX300A is 300 watts, which is also the rated maximum dissipation for class-C amplifier or oscillator applications and for class-B or class-AB amplifier applications. When the 4CX300A is used in plate-modulated amplifier applications, the plate-dissipation rating is 200 watts under carrier conditions, rising to 300 watts under 100% sine-wave modulation. Plate dissipation may be permitted to exceed the maximum rated value for brief periods, such as may occur while tuning.

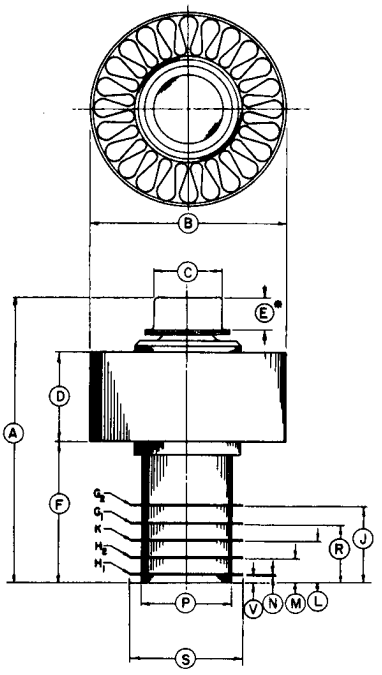
The maximum rated plate voltage for class-AB_1 operation at frequencies up to 500 megahertz is 2500 volts. In class-C telegraphy and plate-modulated service the maximum rated plate voltage for operation up to 500 megahertz is 2000 and 1500 volts respectively. However, at frequencies below 250 megahertz, a plate potential of 2500 volts may be used in class-C telegraphy and FM telephony service.

Modulation — The 4CX300A can be modulated by any of the methods commonly used with tetrode tubes. Its large reserve plate dissipation makes it especially suited for use in screen-modulated and linear amplifiers in which the plate efficiency is low.

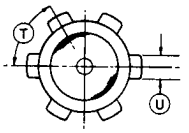
Plate modulation can be applied to the 4CX-300A when it is operated as a class-C amplifier. To obtain 100% modulation with minimum distortion the screen supply voltage should be modulated in phase with the modulation applied to the plate supply voltage. Screen voltage modulation factors between 0.75 and 1.00 may be used.

"Self-modulation" of the screen by means of a resistor in series with the screen supply line is not recommended because of the effects which require a bleeder from screen to cathode as described under "Screen Operation."

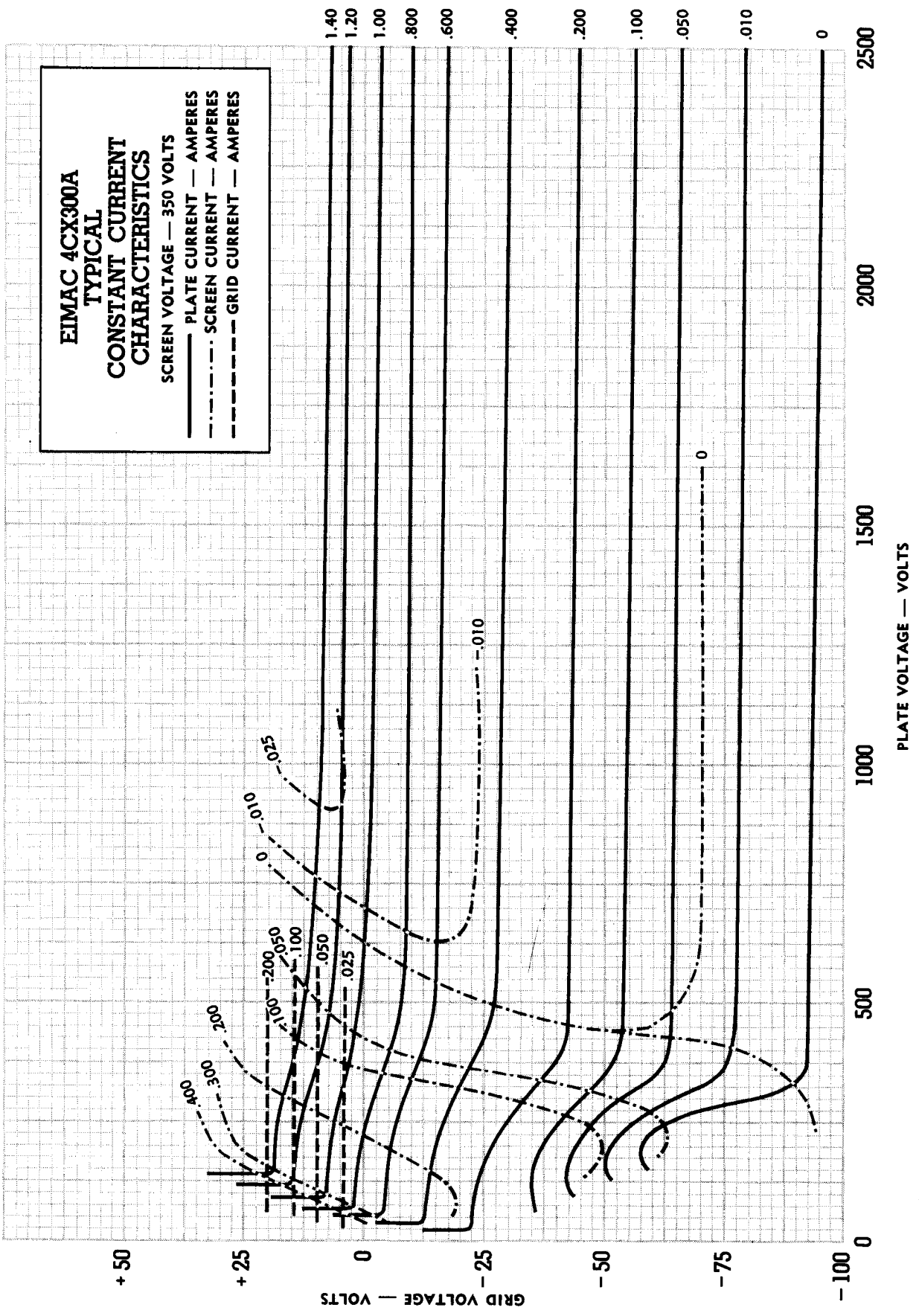
Special Applications — If it is desired to operate this tube under conditions widely different from those given here, write to EIMAC, Division of Varian, for information and recommendations.

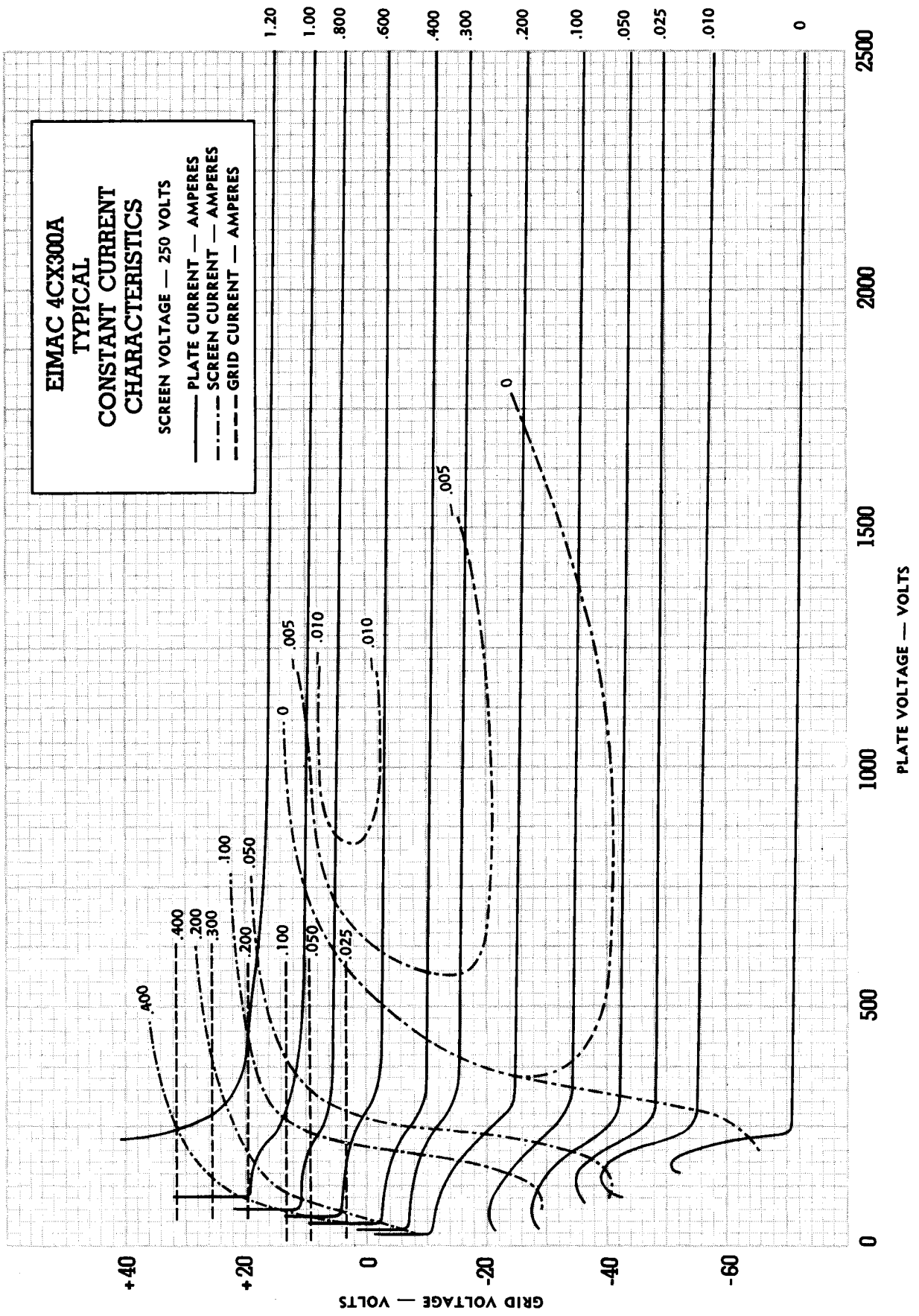


DIMENSION DATA			
REF	NOM.	MIN.	MAX.
A	2.400	2.300	2.500
B	1.625	1.610	1.640
C	.566	.559	.573
D	.750	.710	.790
E		.240	.280
F	1.164	1.133	1.195
J	.622	.602	.642
L	.344	.329	.359
M	.203	.193	.213
N	.015	.010	.020
P	.755	.740	.770
R	.485	.470	.500
S	.946	.936	.956
T	60°		
U	.175	.170	.185
V	.061	.050	.072



*CONTACT SURFACE


EIMAC 4CX300A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 350 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
1.40
1.20
1.00
.800
.600
.400
.200
.100
.050
.010
0
-.025
-.010
0
.025
.050
.100
.200
.300
.400
GRID VOLTAGE — VOLTS
+ 50
+ 25
0
- 25
- 50
- 75
- 100
0
500
1000
1500
2000
2500
PLATE VOLTAGE — VOLTS


EIMAC 4CX300A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 250 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
1.20
1.00
.800
.600
.400
.300
.200
.100
.050
.025
.010
0
.005
.010
.005
0
.400
.400
.200
.300
.200
.100
.100
.050
.050
.025
+40
+20
0
-20
-40
-60
GRID VOLTAGE — VOLTS
0
500
1000
1500
2000
2500
PLATE VOLTAGE — VOLTS

TECHNICAL DATA

8168
4CX1000A

CERAMIC POWER TETRODE

The EIMAC 8168/4CX1000A is a ceramic/metal, forced-air cooled, radial-beam tetrode with a rated maximum plate dissipation of 1000 watts. It is a low-voltage, high-current tube specifically designed for Class-AB_1 rf linear-amplifier or audio-amplifier applications where its high gain may be used to advantage. At its rated maximum plate voltage of 3000 volts, it is capable of producing 1630 watts of peak-envelope output power. Two 8168/4CX1000As operating in Class-AB_1 will produce 3260 watts of audio power.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3	V
Current, at 6.0 volts	9.0	A
Transconductance (Average):		
I_b = 1.0 Adc	37,000	μmhos
Direct Interelectrode Capacitances (grounded cathode)[2]		
Input	81	pF
Output	11.8	pF
Feedback	0.015	pF
Direct Interelectrode Capacitances (grounded grid and screen)[2]		
Input	35.5	pF
Output	12	pF
Feedback	0.004	pF
Frequency of Maximum Rating:		
CW	110	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. In Shielded Fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length	4.80 in; 122 mm
Diameter	3.37 in; 85.5 mm
Net Weight	27 oz; 768 gm
Operating Position	Any

(Revised 5-1-70) © 1963, 1966, 1967 Varian Printed in U.S.A.

Maximum Operating Temperature:
- Ceramic/Metal Seals . . . . . 250°C
- Anode Core . . . . . 250°C

Cooling . . . . . Forced Air
Base . . . . . Special, breechblock terminal surfaces
Recommended Socket . . . . . EIMAC SK-800 Series
Recommended Chimney . . . . . EIMAC SK-806 Series

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN

Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1000	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	0	WATT

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1 Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	2000	2500	3000	Vdc
Screen Voltage	325	325	325	Vdc
Grid Voltage[1]	-60	-60	-60	Vdc
Zero-Signal Plate Current	250	250	250	mAdc
Single Tone Plate Current	890	885	875	mAdc
Two-Tone Plate Current	645	650	635	mAdc
Zero-Signal Screen Current	8	6	5	mAdc
Single-Tone Screen Current[2]	35	35	35	mAdc
Two-Tone Screen Current[2]	10	8	8	mAdc
Plate Output Power	930	1300	1630	W

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_1, Grid Driven(Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	3000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1000	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	0	WATT

TYPICAL OPERATION (Two Tubes)

Plate Voltage	2000	2500	3000	Vdc
Screen Voltage	325	325	325	Vdc
Grid Voltage[1,2]	-60	-60	-60	Vdc
Zero-Signal Plate Current	500	500	500	mAdc
Max Signal Plate Current	1.78	1.77	1.75	Adc
Zero-Signal Screen Current[1]	16	12	10	mAdc
Max Signal Screen Current[1]	70	70	70	mAdc
Plate Output Power	1860	2600	3260	W
Load Resistance (plate to plate)	2040	2850	3860	Ω

1. Approximate value.
2. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. When grid drive is applied, the screen voltage required to obtain the specified value of plate current without drawing grid current may vary somewhat from the typical values shown.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	8.1	9.9	A
Cathode Warmup Time	3	---	min.
Interelectrode Capacitances[1] (grounded cathode connection)			
Input	75	88	pF
Output	10.8	12.8	pF
Feedback	---	0.022	pF

1. In shielded fixture

APPLICATION

MECHANICAL

COOLING - Sufficient cooling must be provided for the anode and ceramic/metal seals to maintain operating temperatures below the rated maximum values:

Ceramic/Metal Seals	250°C
Anode Core	250° C

A flow rate of 25 cubic feet per minute will be adequate for operation at maximum rated plate dissipation at sea level and with inlet air temperatures up to 40°C. Under these conditions, 25 cfm of air flow corresponds to a pressure difference across the tube and socket of 0.2 inch of water column. Experience has shown that if reliable long-life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube.

At higher altitudes and at VHF increased air flow will be required. For example, at an altitube of 10,000 feet, a flow rate of 37 cfm will be required and will be obtained with a pressure drop across tube and socket of 0.3 inch of water column. In selecting a blower for use at high altitudes, care must be taken to assure that the blower is designed to deliver the desired volume of air at the corresponding pressure drop and *at the particular altitude.*

In cases where there is any doubt regarding the adequacy of the supplied cooling, it should be borne in mind that operating temperature is the sole criterion of cooling effectiveness. Surface temperatures may be easily and effectively measured by using one of the several temperature-sensitive paints or sticks available from various chemical or scientific-equipment suppliers. When these materials are used, extremely thin applications must be made to avoid interference with the transfer of heat from the tube to the air stream, which would cause inaccurate indications.

The 4CX1000A is tested for vibration (noise) from 10 Hz to 500 Hz. Vibration level is 10 G units peak 28 Hz to 500 Hz. Below 28 Hz vibration double amplitude is .25 inch.

The 4CX1000A is tested for shock, 50 G, 11 ms, three axes, after which the tube must be within specification for grid bias voltage and gas current.

ELECTRICAL

HEATER - The rated heater voltage for the 4CX1000A is 6.0 volts. The voltage, as measured at the socket, should be maintained at this value to minimize variations in operation and to obtain maximum tube life. In no case should the voltage be allowed to exceed 5% above the rated value.

The cathode and one side of the heater are internally connected.

It is recommended that the heater voltage be applied for a period of not less than 3 minutes before other operating voltages are applied. From an initial cold condition, tube operation will stabilize after a period of approximately 5 minutes.

GRID OPERATION - The grid dissipation rating of the 4CX1000A is zero watts. The design features which make the tube capable

of maximum power operation without driving the grid into the positive region also make it necessary to avoid positive-grid operation.

Although the average grid-current rating is zero, peak grid currents of less than five-milliamperes as read on a five-milliampere meter may be permitted to flow for peak-signal monitoring purposes.

SCREEN OPERATION - Tetrode tubes may exhibit reversed screen current to a greater or lesser degree depending on individual tube design. This characteristic is prominent in the 4CX1000A and, under some operating conditions, indicated negative screen currents in the order of 25 milliamperes may be encountered.

The maximum rated power dissipation for the screen grid in the 4CX1000A is 12 watts and the screen power should be kept below this level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative. In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage. Experience has shown that the screen will operate within the limits established for this tube if the indicated screen current, plate voltage and drive voltage approximate the "Typical Operation" values.

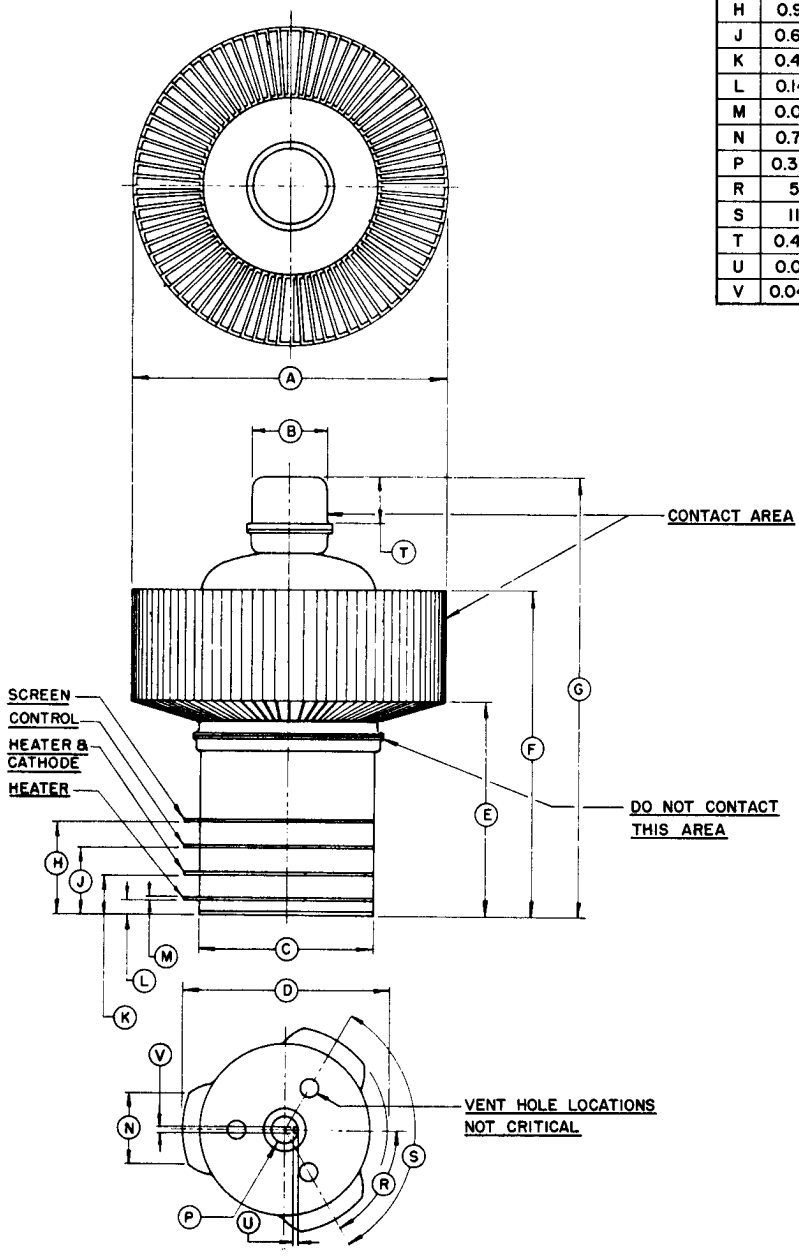
The screen supply voltage must be maintained constant for any values of negative and positive screen currents that may be encountered. Dangerously high plate currents may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished in several different ways. A bleeder resistor may be connected from screen to cathode; a combination of VR tubes may be connected from screen to cathode; or an electron-tube regulator circuit may be used in the screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed. The screen bleeder current should approximate 70 milliamperes to adequately stabilize the screen voltage. It should be observed that this bleeder power may be usefully employed to energize low-power stages of the transmitter.

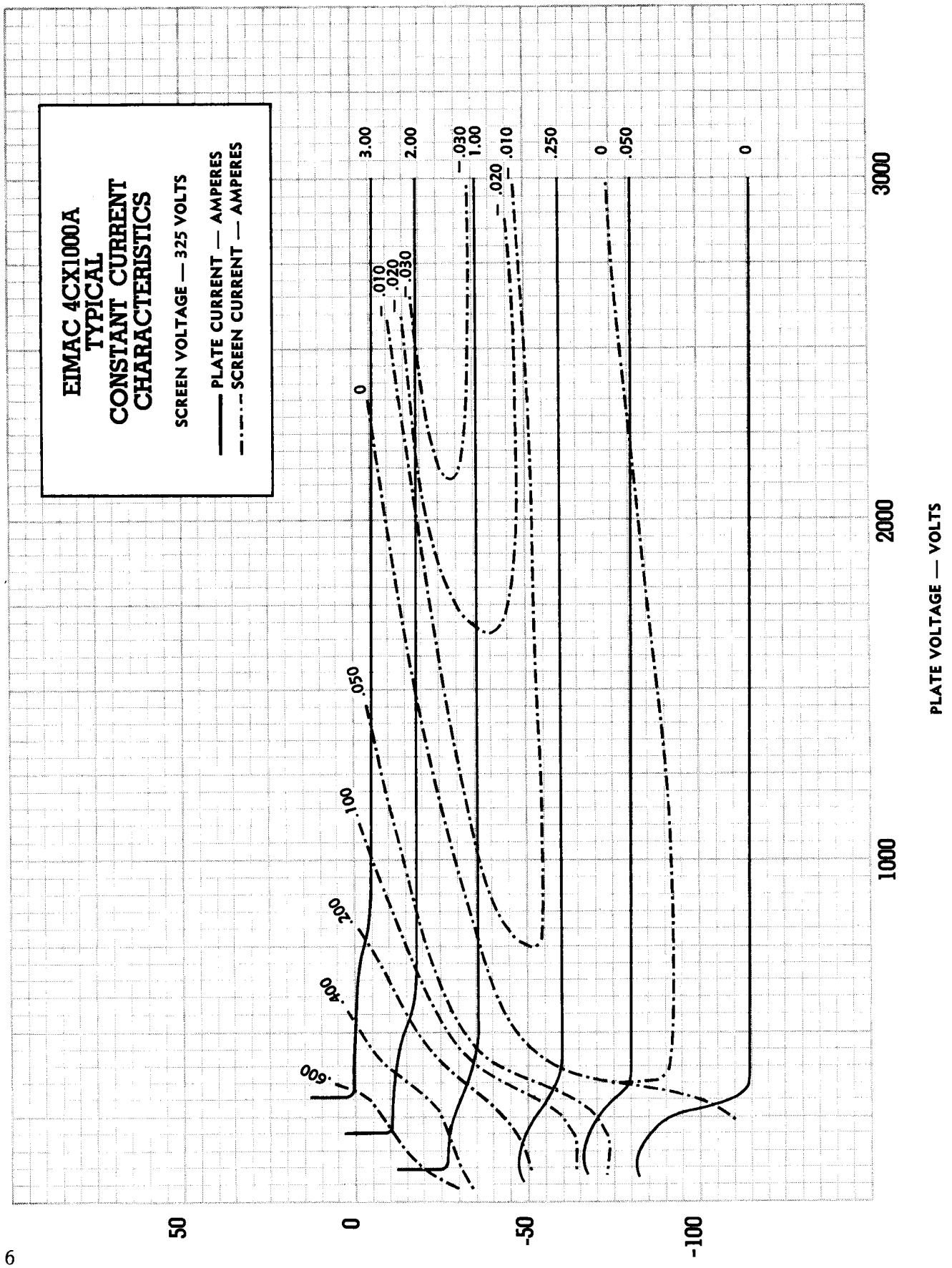
PLATE OPERATION - The maximum rated plate dissipation power is 1000 watts. Except for brief periods during circuit adjustments, this maximum value should not be exceeded.

The top cap on the anode cooler may be used as a plate terminal at low frequencies or a circular clamp or spring-finger collet encircling the cylindrical outer surface of the anode cooler may be used at high frequencies.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions different from those given here, write to the Power Grid Tube Marketing Department, EIMAC Division of Varian, San Carlos, California 94070, for information and recommendations.

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	3.335	3.365	84.71	85.47
B	0.807	0.817	20.50	20.75
C	1.870	1.900	47.50	48.26
D	2.250D	2.300D	57.15D	58.42D
E	2.195	2.380	55.75	60.45
F	3.410	3.550	86.61	90.17
G	4.600	4.800	116.84	121.92
H	0.965	0.988	24.51	25.10
J	0.690	0.710	17.53	18.03
K	0.415	0.435	10.54	11.05
L	0.140	0.165	3.56	4.19
M	0.020	0.030	0.51	0.76
N	0.700	0.800	17.78	20.32
P	0.314D	0.326D	7.98D	8.28D
R	55°	65°	55°	65°
S	115°	125°	115°	125°
T	0.470	0.530	11.94	13.46
U	0.025	0.048	0.63	1.22
V	0.045D	0.070D	1.14	1.78




EIMAC 4CX1000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 325 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
3.00
2.00
1.00
.250
0
.050
0
.030
.020
.010
0
.050
.100
.200
.400
.600
50
0
-50
-100
1000
2000
3000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8169
4CX3000A
RADIAL-BEAM POWER TETRODE

The EIMAC 8169/4CX3000A is a ceramic and metal power tetrode designed to be used as a Class-AB_1 linear amplifier in audio or radio-frequency applications. Its characteristics of low intermodulation distortion make it especially suitable for single sideband service.

This tube is unique in that a production test is included to insure minimum distortion products. The 8169/4CX3000A must produce a *minimum* of 5300 watts in Class AB_1 service with IM distortion at least 32 db down, 3rd order.

The tube is also recommended for use as a Class-C radio-frequency power amplifier and plate-modulated radio-frequency power amplifier.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated Tungsten				
Voltage		9.0		volts
Current	39.5		43.5	amps
Amplification Factor (Grid Screen)		5.5		
Frequency For Maximum Ratings			150	MHz
Direct Interelectrode Capacitances, Grounded Cathode:				
Input	120		140	pF
Output	10.5		14.5	pF
Feedback			1.4	pF

Direct Interelectrode Capacitances, Grounded Grid and Screen:	*Min.*	*Max.*	
Input	55	67	pF
Output	10.5	14.5	pF
Feedback		0.2	pF

MECHANICAL

Base	Special ring and breechblock terminal surfaces
Maximum Seal Temperature	250°C
Maximum Anode Core Temperature	250°C
Recommended Socket	EIMAC SK-1400 series
Recommended Air Chimney	EIMAC SK-1406
Operating Position	Axis vertical, base up or down
Maximum Dimensions:	
Height	7.9 inches
Diameter	4.6 inches
Cooling	Forced air
Net Weight	5.5 pounds
Shipping Weight (Approximate)	10 pounds

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Printed in U.S.A.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	7000 VOLTS
DC SCREEN VOLTAGE	1000 VOLTS
DC PLATE CURRENT	2.0 AMPS
PLATE DISSIPATION	3000 WATTS
SCREEN DISSIPATION	175 WATTS
GRID DISSIPATION	50 WATTS

TYPICAL OPERATION

DC Plate Voltage	5000	7000 volts
DC Screen Voltage	500	500 volts
DC Grid Voltage	—280	—300 volts
DC Plate Current	1.9	1.9 amps
DC Screen Current	250	230 mA
DC Grid Current	100	100 mA
Peak RF Grid Voltage	385	405 volts
Driving Power	39	41 watts
Plate Dissipation	1900	2300 watts
Plate Output Power	7600	11,000 watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier Conditions unless noted)

MAXIMUM RATINGS

DC PLATE VOLTAGE	5000 VOLTS
DC SCREEN VOLTAGE	600 VOLTS
DC PLATE CURRENT	1.4 AMPS
PLATE DISSIPATION*	2000 WATTS
SCREEN DISSIPATION	175 WATTS
GRID DISSIPATION	50 WATTS

*Corresponds to 3000 watts at 100 percent sine-wave modulation.

TYPICAL OPERATION

DC Plate Voltage	5000 volts
DC Screen Voltage	500 volts
Peak AF Screen Voltage (For 100% Modulation)	415 volts
DC Grid Voltage	—375 volts
DC Plate Current	1.4 amps
DC Screen Current	170 mA
DC Grid Current	68 mA
Peak RF Grid Voltage	455 volts
Grid Driving Power	31 watts
Plate Dissipation	1250 watts
Plate Output Power	5750 watts

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB

MAXMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	6000 VOLTS
DC SCREEN VOLTAGE	1000 VOLTS
DC PLATE CURRENT	2.0 AMPS
PLATE DISSIPATION	3500 WATTS
SCREEN DISSIPATION	175 WATTS
GRID DISSIPATION	50 WATTS

*Per tube
**Approximate values

TYPICAL OPERATION (Two Tubes), Class AB_1

DC Plate Voltage	5000	6000 volts
DC Screen Voltage	850	850 volts
DC Grid Voltage*	—180	—200 volts
Max-Signal Plate Current	3.6	3.1 amps
Zero-Signal Plate Current	1.0	0.7 amp
Max-Signal Screen Current**	170	120 mA
Zero-Signal Screen Current	0	0 mA
Peak AF Driving Voltage*	155	175 volts
Driving Power	0	0 watts
Load Resistance, Plate-to-Plate	3000	4160 ohms
Max-Signal Plate Dissipation*	3300	3100 watts
Max-Signal Plate Output Power	11,400	12,400 watts

NOTE: In Class AB operation, maximum plate voltage and plate current must not be applied simultaneously, as plate dissipation will be exceeded.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB

MAXIMUM RATINGS

DC PLATE VOLTAGE	6000 VOLTS
DC SCREEN VOLTAGE	1000 VOLTS
DC PLATE CURRENT	2.0 AMPS
PLATE DISSIPATION	3500 WATTS
SCREEN DISSIPATION	175 WATTS
GRID DISSIPATION	50 WATTS

*Approximate values

These values are obtained in existing equipment. A design test is performed on a sampling basis, insuring that the 4CX3000A will perform as indicated with respect to IM distortion products and power output.

TYPICAL OPERATION Class AB_1, Grid Driven

DC Plate Voltage	5000 volts
DC Screen Voltage	850 volts
DC Grid Voltage*	180 volts
Zero-Signal DC Plate Current	0.5 amp
Single-Tone DC Plate Current	1.65 amps
Single-Tone DC Screen Current	25 mA
Two-Tone DC Plate Current	1.10 amps
Two-Tone DC Screen Current	20 mA
Peak RF Grid Voltage	155 volts
Driving Power	0 watts
Peak Envelope Useful Output Power	5300 watts
Resonant Load Impedance	1700 ohms
Intermodulation Distortion Products (without negative feedback)	—32 db

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance is made for circuit losses. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed.

APPLICATION

MECHANICAL

Mounting — The 4CX3000A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

Socket — The EIMAC SK-1400A and SK-1470A sockets have been designed especially for the 4CX3000A. The use of recommended air-flow rates through these sockets provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals through an Air Chimney, the SK-1406, and through the anode cooling fins.

Cooling — The maximum temperature rating for the external surfaces of the 4CX3000A is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic-metal seals below 250°C. Air-flow requirements to maintain seal temperature at 200°C in 40°C ambient air are tabulated below (for operation below 30 megahertz).

Plate Dissipation* (Watts)	SEA LEVEL		10,000 FEET	
	Air Flow (CFM)	Pressure Drop (Inches of water)	Air Flow (CFM)	Pressure Drop (inches of water)
1500	36.5	0.3	53	0.4
2500	60	0.8	88	1.2
3500	86	1.6	125	2.3

***Since the power dissipated by the filament represents about 450 watts and since grid-plus-screen dissipation can, under some conditions, represent another 225 watts, allowance has been made in preparing this tabulation for an additional 675 watts dissipation.**

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

Filament Operation—The rated filament voltage for the 4CX3000A is 9.0 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than plus or minus five percent from the rated value.

Intermodulation Distortion — The operating conditions including distortion data are the results of actual operation in a neutralized, grid-driven amplifier. This test is performed on sample tubes from regular production runs. A plot of IM distortion versus power output under two-tone condition for a typical tube is shown on the next page.

Control Grid Operation — The rated dissipation of the grid is 50 watts. This is approximately the product of dc grid current and peak positive grid voltage. Operation at bias and drive levels near those listed will insure safe operation.

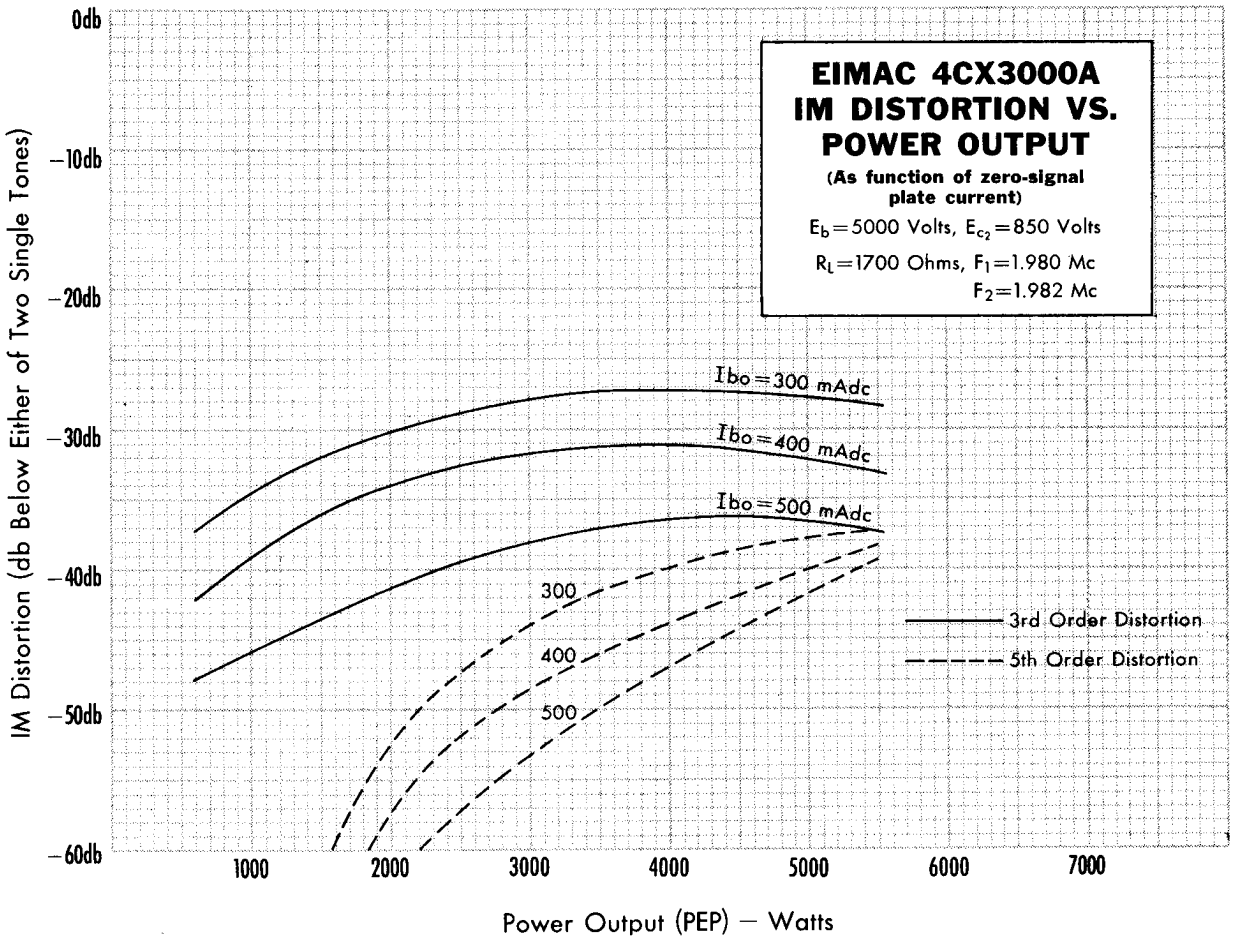
Screen-Grid Operation — The power dissipated by the screen of the 4CX3000A must not exceed 175 watts.

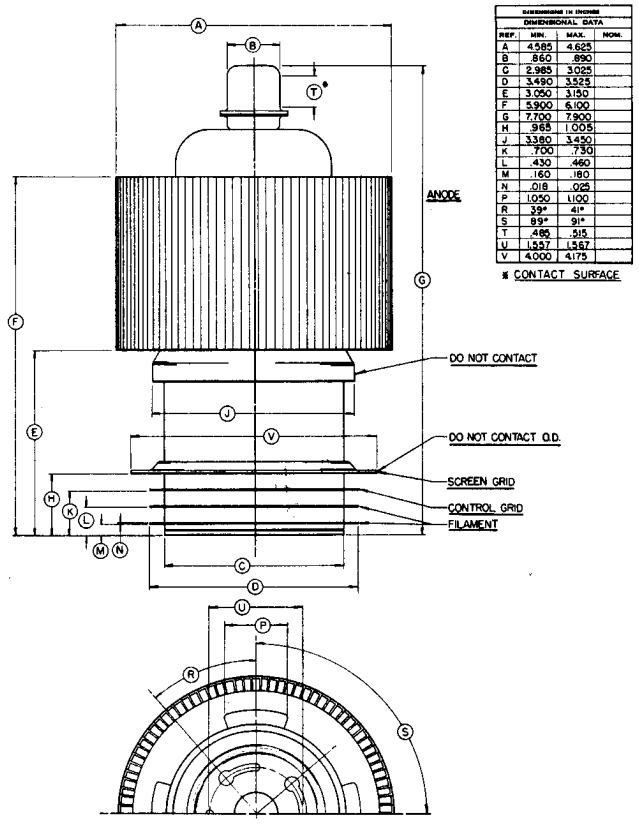
Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 175 watts in the event of circuit failure.

Plate Dissipation—The plate-dissipation ratings for the 4CX3000A are 2000 watts for Class-C plate-modulated service and 3000 watts for Class-C telegraphy. In Class-AB operation this rating has been increased to 3500 watts to allow more input. In any Class-AB application maximum plate current and maximum plate voltage should not be applied simultaneously as the plate-dissipation rating would be exceeded.

Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to the Power Grid Tube Division or Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, for information and recommendations.



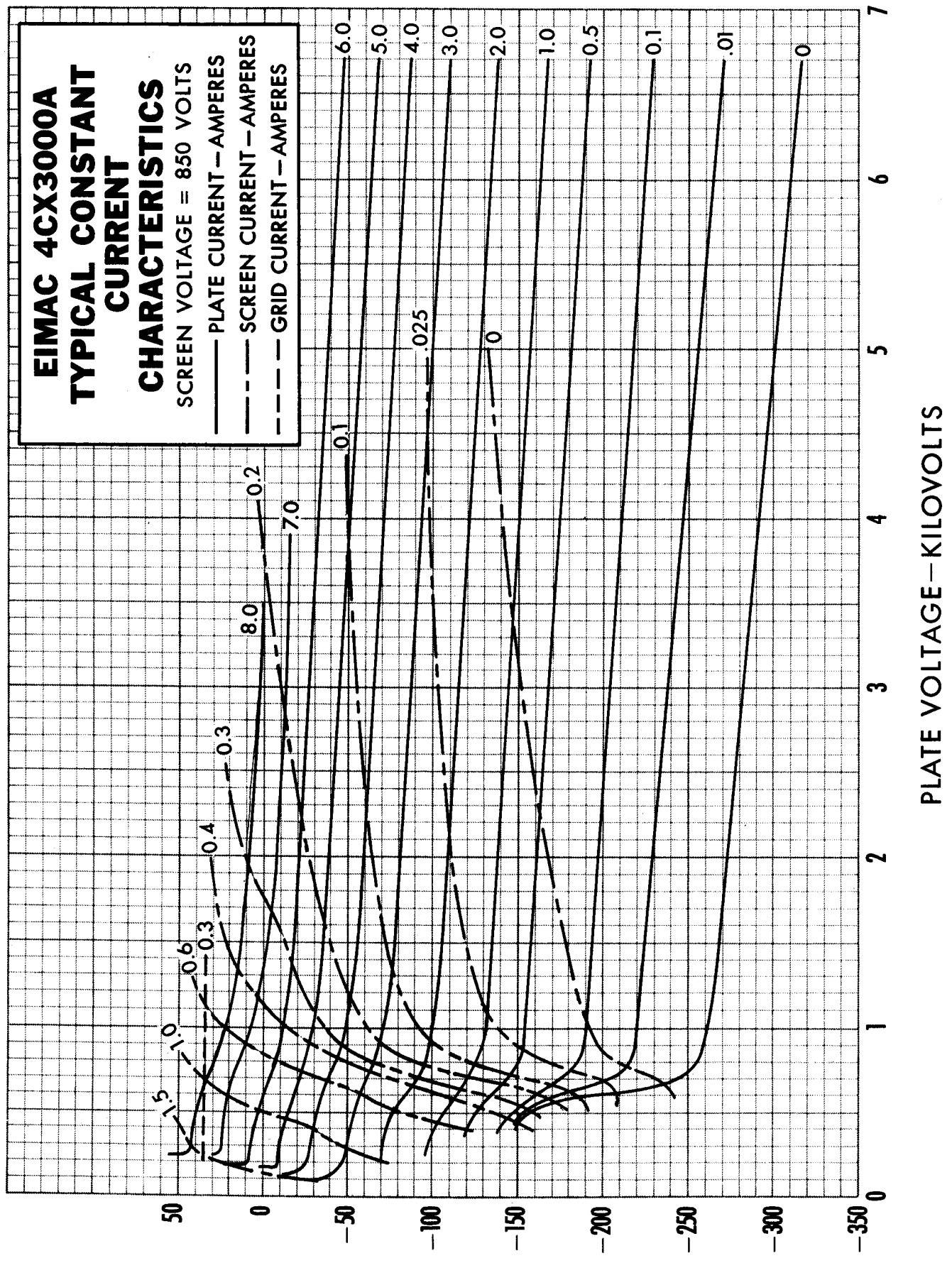


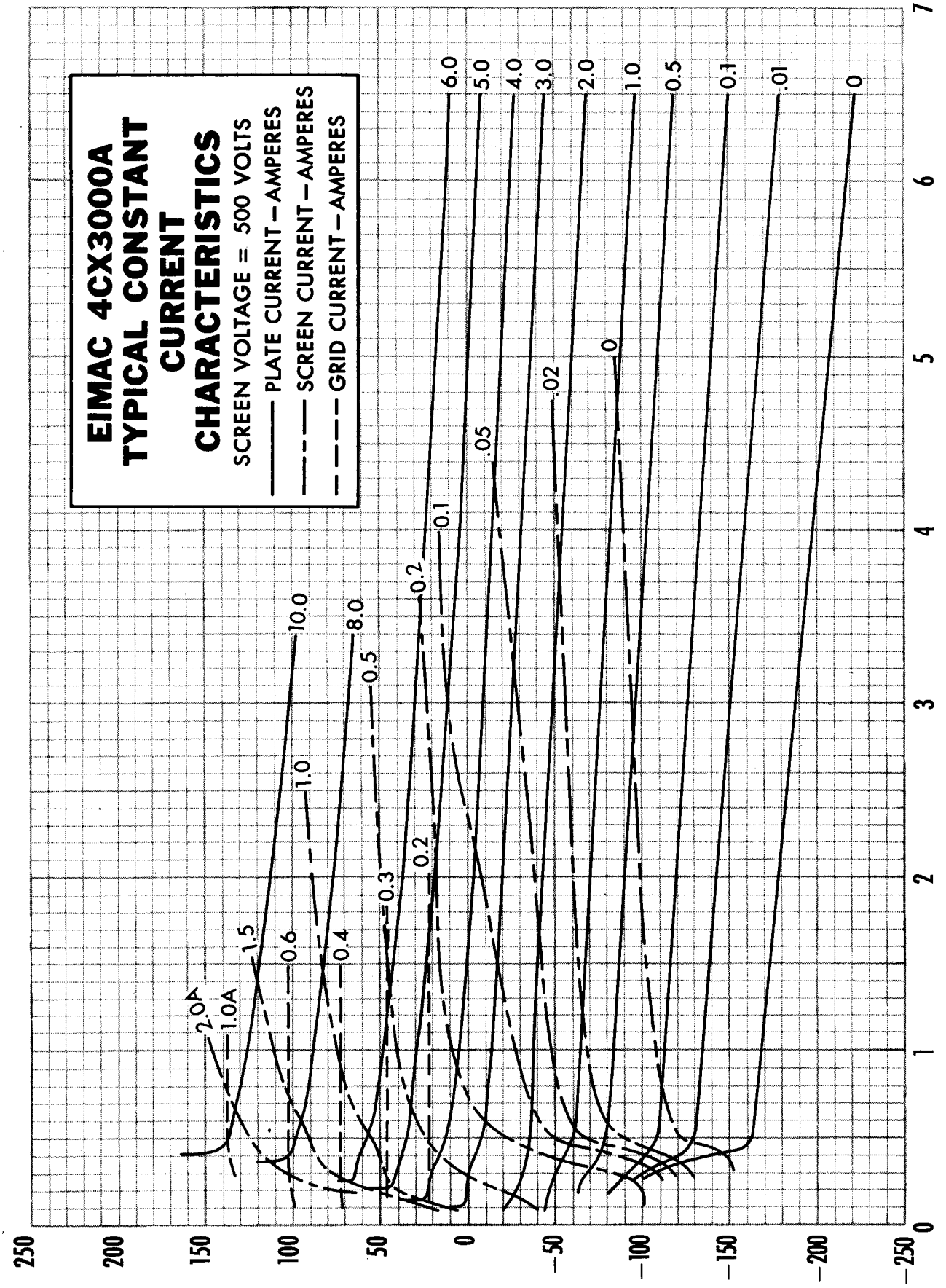
DIMENSIONS IN INCHES

DIMENSIONAL DATA

REF.	MIN.	MAX.	NOM.
A	4.585	4.625	
B	.860	.890	
C	2.985	3.025	
D	3.490	3.525	
E	3.050	3.150	
F	5.900	6.100	
G	7.700	7.900	
H	.965	1.005	
J	3.380	3.450	
K	.700	.730	
L	.430	.460	
M	.160	.180	
N	.018	.025	
P	1.050	1.100	
R	39°	41°	
S	89°	91°	
T	.485	.515	
U	1.557	1.567	
V	4.000	4.175	

* CONTACT SURFACE


EIMAC 4CX3000A
TYPICAL CONSTANT
CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 850 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
6.0
5.0
4.0
3.0
2.0
1.0
0.5
0.1
.01
0
.025
0.1
0.2
7.0
8.0
0.3
0.4
0.6
0.3
1.0
1.5
50
0
−50
−100
−150
−200
−250
−300
−350
0
1
2
3
4
5
6
7
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS


EIMAC 4CX3000A
TYPICAL CONSTANT
CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—KILOVOLTS
250
200
150
100
50
0
−50
−100
−150
−200
−250
0
1
2
3
4
5
6
7
2.0A
1.0A
1.5
0.6
1.0
10.0
0.4
8.0
0.5
0.3
0.2
0.2
0.1
6.0
5.0
4.0
3.0
2.0
1.0
0.5
0.1
.01
0
.05
.02
0

8170
4CX5000A

RADIAL-BEAM POWER TETRODE

TECHNICAL DATA

The EIMAC 8170/4CX5000A is a compact high-power ceramic and metal tetrode cooled by forced air. It is useful as an oscillator, amplifier, or modulator at frequencies up to 110 megahertz and is particularly suited for use as a linear single-sideband amplified, Class-AB_1 audio amplifier, or as a screen-modulated radio-frequency amplifier.

A pair of these tubes will deliver 17.5 kilowatts of audio-frequency or radio-frequency power with zero driving power. The rated plate dissipation is five kilowatts for most classes of services and six kilowatts for Class-AB operation.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	73		78	amperes
Amplification Factor (Grid Screen)		4.5		
Direct Interelectrode Capacitances, Grounded Cathode:				
Input	108		122	pF
Output	18		23	pF
Feedback			1.0	pF

Direct Interelectrode Capacitances, Grounded Grid and Screen:	Min.	Max.	
Input	48	58	pF
Output	18	23	pF
Feedback		0.16	pF

MECHANICAL

Base	Special concentric
Maximum Seal Temperature	250°C
Maximum Anode-Core Temperature	250°C
Recommended Socket	EIMAC SK-300A
Recommended Chimney	EIMAC SK-306
Operating Position	Axis vertical, base up or down
Maximum Dimensions:	
Height	9.13 inches
Diameter	4.94 inches
Cooling	Forced air
Net Weight	9.5 pounds
Shipping Weight (Approximate)	22 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR (Up to 30 megahertz)

Class-C Telegraphy (Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	7500 VOLTS
DC SCREEN VOLTAGE	1500 VOLTS
DC PLATE CURRENT	3 AMPS
PLATE DISSIPATION	5000 WATTS
SCREEN DISSIPATION	250 WATTS
GRID DISSIPATION	75 WATTS

TYPICAL OPERATION
(Frequencies below 30 megahertz)

DC Plate Voltage	7500 volts
DC Screen Voltage	500 volts
DC Grid Voltage	—350 volts
DC Plate Current	2.8 amps
DC Screen Current	0.5 amp
DC Grid Current	0.25 amp
Peak RF Grid Voltage	590 volts
Driving Power	150 watts
Plate Dissipation	5000 watts
Plate Output Power	16,000 watts

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RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR
(From 30 to 220 MHz)

Class-C Telegraphy or FM Telephony

MAXIMUM RATINGS

DC PLATE VOLTAGE:	
30 to 60 MHz	7000 VOLTS
60 to 110 MHz	6500 VOLTS
110 to 220 MHz	5800 VOLTS
DC SCREEN VOLTAGE	1500 VOLTS
DC PLATE CURRENT:	
30 to 60 MHz	2.8 AMPS
60 to 220 MHz	2.6 AMPS
PLATE DISSIPATION	5000 WATTS
SCREEN DISSIPATION	250 WATTS
GRID DISSIPATION	75 WATTS

TYPICAL OPERATION

	108MHz	220MHz	
DC PLATE VOLTAGE	6500	5500	volts
DC SCREEN VOLTAGE	750	680	volts
DC GRID VOLTAGE	-350	-140	volts
DC PLATE CURRENT	2.3	1.6	amperes
DC SCREEN CURRENT	.2	.034	amperes
DC GRID CURRENT	.05	.030	amperes
DRIVING POWER	100	---	watts
USEFUL OUTPUT POWER	10,000	5,500	watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony
(Carrier conditions except where noted)

MAXIMUM RATINGS

DC PLATE VOLTAGE	5500 VOLTS
DC SCREEN VOLTAGE	1000 VOLTS
DC PLATE CURRENT	2.5 AMPS
PLATE DISSIPATION*	3500 WATTS
SCREEN DISSIPATION	250 WATTS
GRID DISSIPATION	75 WATTS

*Corresponds to 5000 watts at 100-percent sine-wave modulation.

TYPICAL OPERATION (Frequencies below 30 megahertz)

DC Plate Voltage	5000 volts
DC Screen Voltage	500 volts
Peak AF Screen Voltage (For 100-percent modulation)	450 volts
DC Grid Voltage	—400 volts
DC Plate Current	1.4 amperes
DC Screen Current	0.26 ampere
DC Grid Current	0.05 ampere
Peak RF Grid Voltage	520 volts
Grid Driving Power	25 watts
Plate Dissipation	1100 watts
Plate Output Power	5.8 kilowatts

SCREEN-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony
(Carrier conditions except where noted)

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	7500 VOLTS
DC SCREEN VOLTAGE	750 VOLTS
DC PLATE CURRENT	3.0 AMPS
PLATE DISSIPATION	5000 WATTS
SCREEN DISSIPATION	250 WATTS
GRID DISSIPATION	75 WATTS

TYPICAL OPERATION (Frequencies below 30 megahertz per tube)

DC Plate Voltage	7500	7500 volts
DC Screen Voltage	350	350 volts
Peak AF Screen Voltage (For 100-percent modulation)	550	550 volts
DC Grid Voltage	—300	—300 volts
DC Plate Current	0.9	1.14 amperes
DC Screen Current*	—0.01	—0.01 ampere
DC Grid Current	0.015	0.03 ampere
Peak RF Grid Voltage	350	375 volts
Grid Driving Power	7	11 watts
RF Load Impedance	2000	1600 ohms
Plate Dissipation	4000	5000 watts
Useful Output Power	2750	3550 watts

*DC Screen Current is a function of loading; values of plus or minus 20 milliamperes may be considered typical at carrier level.

NOTE: Two tubes can be employed under conditions listed in the first column to obtain more than five kilowatts plate output power. Likewise, three tubes can be utilized at conditions listed in the second column to obtain better than ten kilowatts output power.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	7500 VOLTS
DC SCREEN VOLTAGE	1500 VOLTS
DC PLATE CURRENT	4.0 AMPS
PLATE DISSIPATION	6000 WATTS
SCREEN DISSIPATION	250 WATTS
GRID DISSIPATION	75 WATTS

TYPICAL OPERATION, two tubes

DC Plate Voltage	4000	5000	6000	7000 volts
DC Screen Voltage	1250	1250	1250	1250 volts
DC Grid Voltage	—270	—280	—310	—325 volts
Max-Signal Plate Current	5.10	4.40	4.25	3.65 amperes
Zero-Signal Plate Current	1.25	1.00	0.83	0.70 amperes
Max-Signal Screen Current	0.35	0.33	0.30	0.24 ampere
Zero-Signal Screen Current	0	0	0	0 amperes
Peak AF Driving Voltage	250	240	270	235 volts
Driving Power	0	0	0	0 watts
Load Resistance, Plate-to-Plate	1500	2370	2940	4100 ohms
Max-Signal Plate Dissipation*	4200	4200	4200	4200 watts
Max-Signal Plate Output Power	11,500	13,500	17,000	17,500 watts

*Per Tube

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	7500 VOLTS
DC SCREEN VOLTAGE	1500 VOLTS
DC PLATE CURRENT	4.0 AMPS
PLATE DISSIPATION	6000 WATTS
SCREEN DISSIPATION	250 WATTS
GRID DISSIPATION	75 WATTS

TYPICAL OPERATION, Peak-Envelope or modulation-Crest Conditions, (Frequencies below 30 megahertz)

DC Plate Voltage	7500 volts
DC Screen Voltage	1250 volts
DC Grid Voltage*	—300 volts
Max-Signal Plate Current	1.9 amperes
Zero-Signal Plate Current	0.50 ampere
Max-Signal Screen Current	0.20 ampere
Peak RF Grid Voltage	300 volts
Driving Power	0 watts
Plate Dissipation	4200 watts
Plate Output Power **	10,000 watts

*Adjust grid voltage to obtain specified Zero-Signal plate current.
**PEP output or rf output power at crest of modulation envelope.

NOTE: In most cases, "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made. Exceptions are distinguished by a listing of "Useful" output power as opposed to "Plate" output power. Values appearing in these groups have been obtained from existing equipment(s) and the output power is that measured at the load.

APPLICATION

MECHANICAL

Mounting — The 4CX5000A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

Socket—The EIMAC SK-300A Air-System Socket is designed especially for the concentric base terminals of the 4CX5000A. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through an Air Chimney, the SK-306, into the anode cooling fins. The SK-300 socket may be used instead of the SK-300A, but its use will result in a slightly less efficient cooling system at high dissipation levels.

Cooling — The maximum temperature rating for the external surfaces of the 4CX5000A is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic-metal seals below 250°C. Sea level air-flow requirements to maintain seal temperatures at 200°C in 50°C ambient air are tabulated below (for operation below 30 megahertz).

Plate Dissipation* (Watts)	SK-300A Socket		SK-300 Socket	
	Air Flow (CFM)	Pressure Drop (Inches of water)	Air Flow (CFM)	Pressure Drop (inches of water)
2000	75	0.4	75	0.4
3000	105	0.7	100	0.7
4000	145	1.1	135	1.2
5000	190	1.5	165	1.8
6000	230	2.0	200	2.5

***Since the power dissipated by the filament represents about 560 watts and since grid-plus-screen dissipation can, under some conditions, represent another 200 to 300 watts, allowance has been made in preparing this tabulation for an additional 1000 watts dissipation.**

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At higher altitudes, higher frequencies, or higher ambient temperatures the flow rate must be increased to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using maximum rated temperatures as the criteria for satisfactory cooling.

ELECTRICAL

Filament Operation—The rated filament voltage for the 4CX5000A is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than 5 percent from the rated value.

Electrode Dissipation Ratings—The maximum dissipation ratings for the 4CX5000A must be respected to avoid damage to the tube. An exception is the plate dissipation, which may be permitted to rise above the maximum rating during brief periods, such as may occur during tuning.

Control Grid Operation — The 4CX5000A control grid has a maximum dissipation rating of 75 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in "Typical Operation" sections of the data sheet whenever possible.

Screen-Grid Operation — The power dissipated by the screen of the 4CX5000A must not exceed 250 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

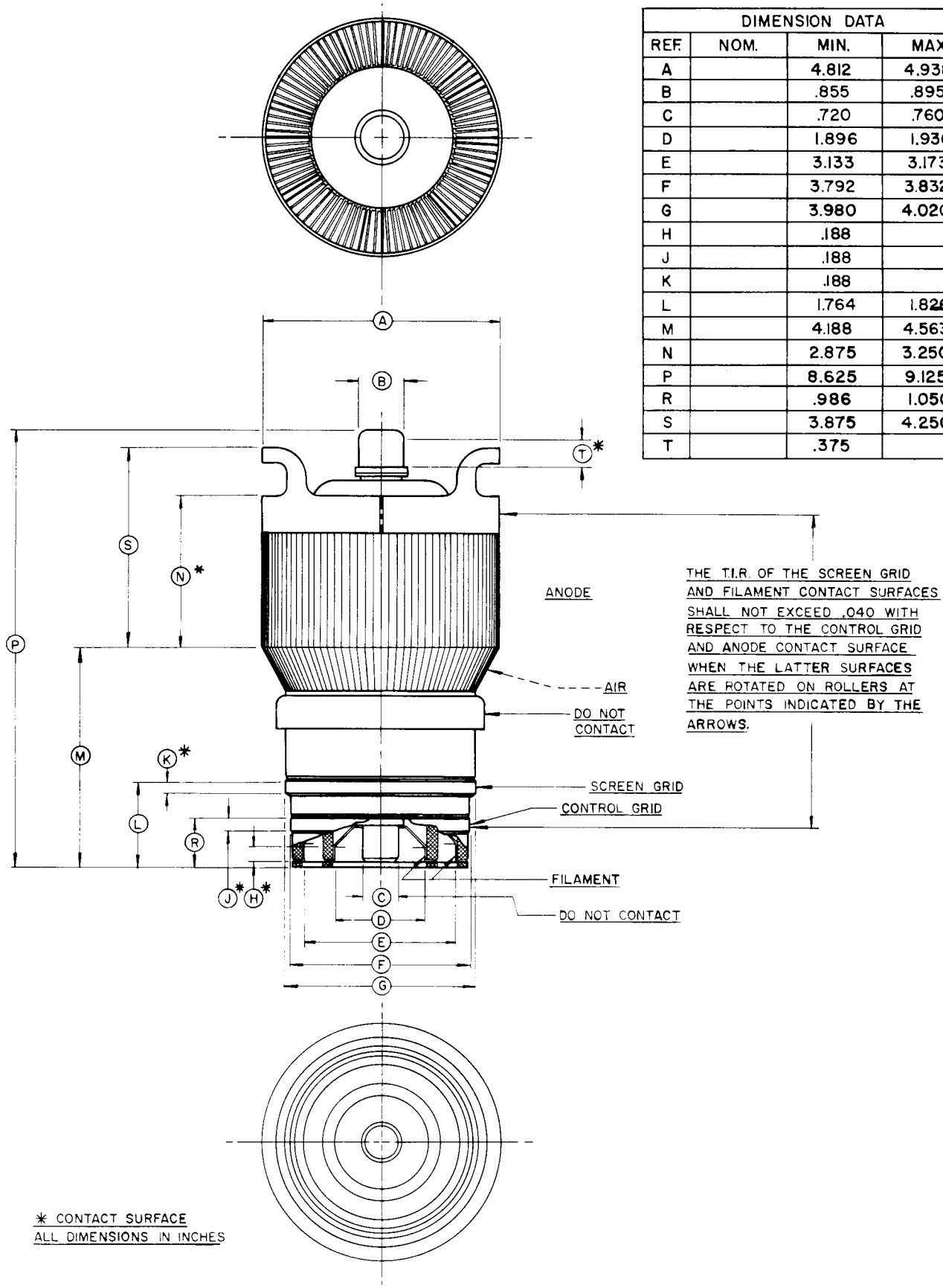
Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 250 watts in the event of circuit failure.

Plate Dissipation—The plate-dissipation rating for the 4CX5000A is 5000 watts for most applications but for audio and SSB amplifier applications, the maximum allowable dissipation is 6000 watts.

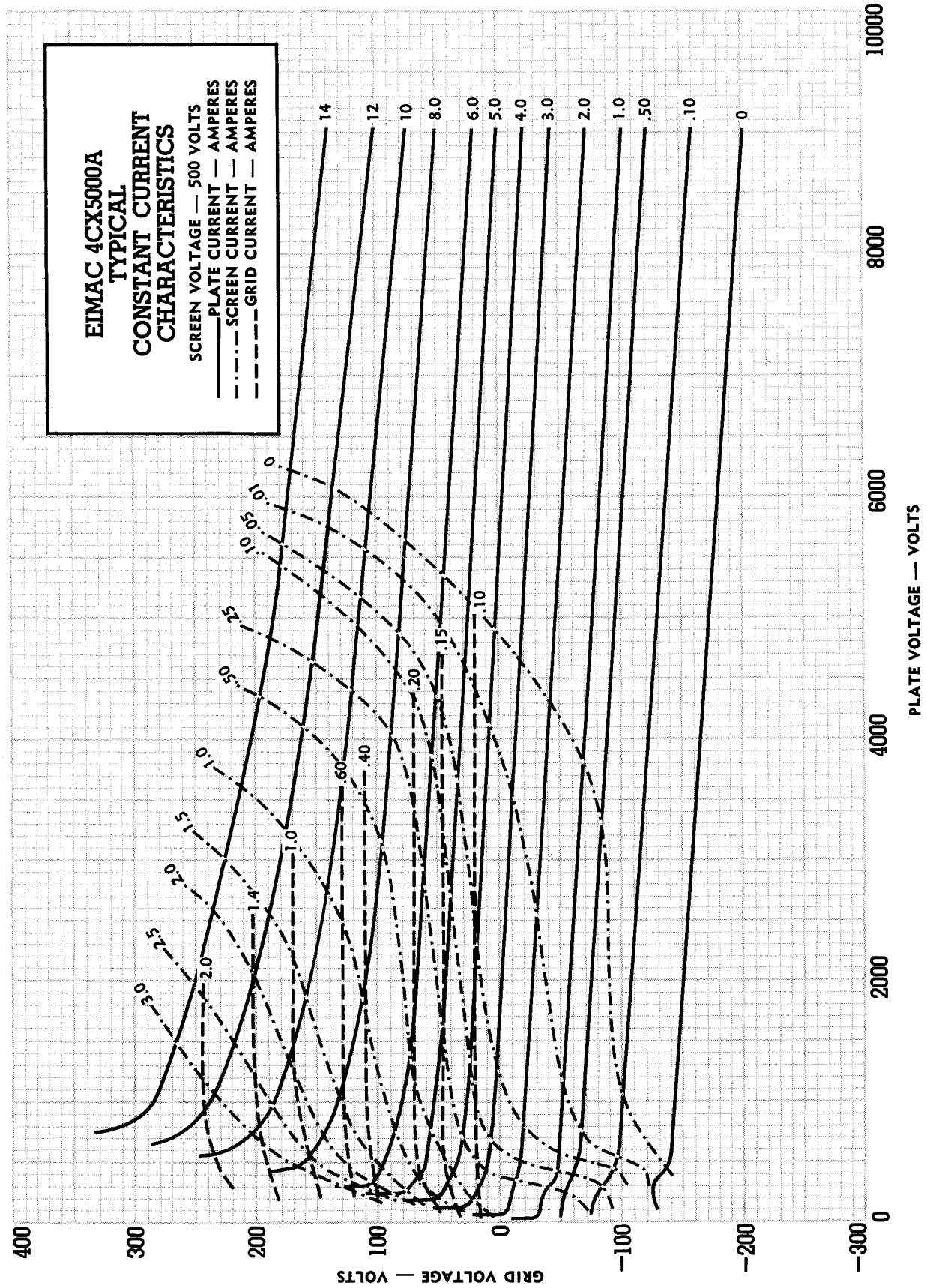
When the 4CX5000A is operated as a plate-modulated rf power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 3500-watt maximum plate dissipation rating will be exceeded.

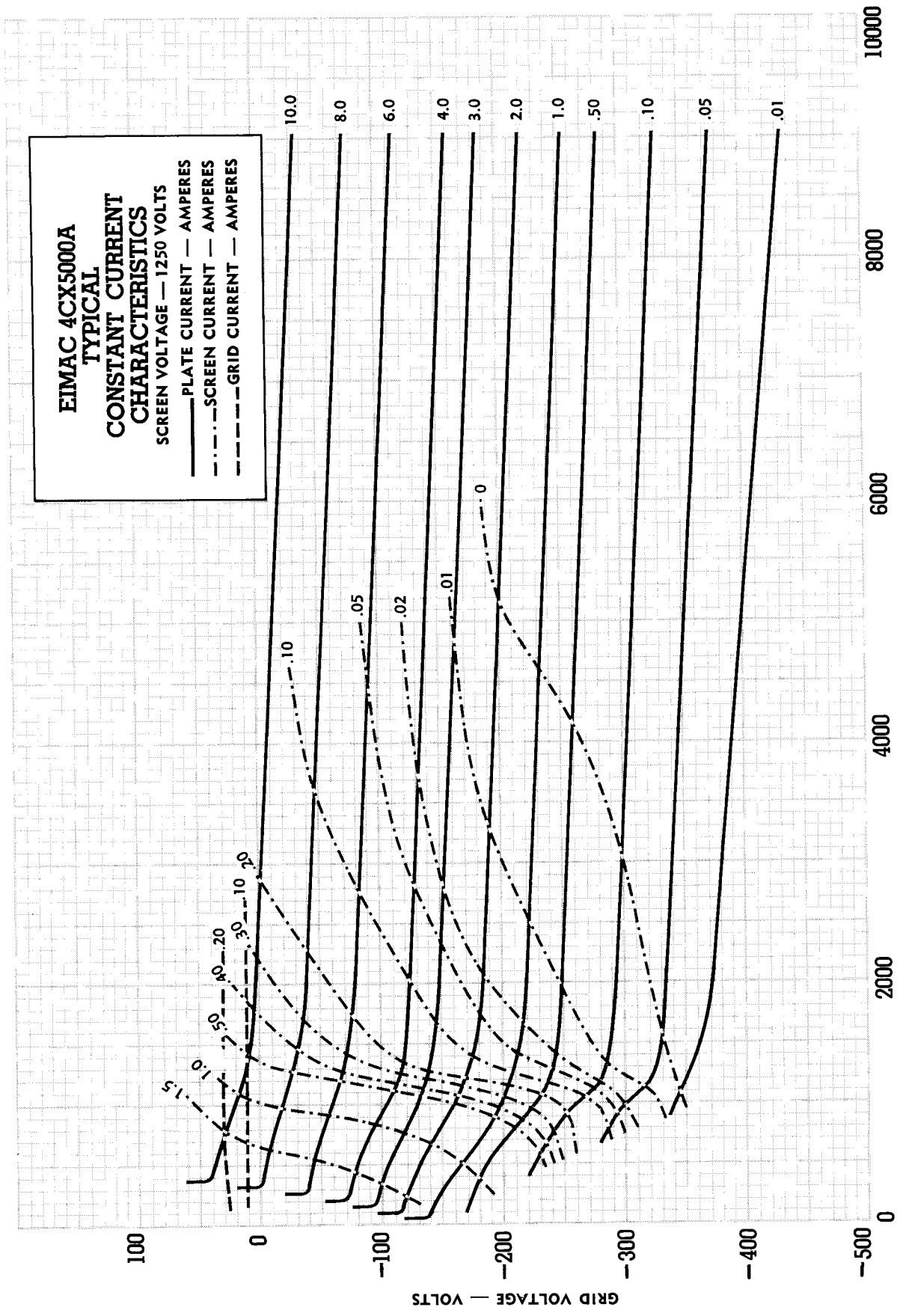
Special Applications—If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, for information and recommendations.

DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		4.812	4.938
B		.855	.895
C		.720	.760
D		1.896	1.936
E		3.133	3.173
F		3.792	3.832
G		3.980	4.020
H		.188	
J		.188	
K		.188	
L		1.764	1.826
M		4.188	4.563
N		2.875	3.250
P		8.625	9.125
R		.986	1.050
S		3.875	4.250
T		.375	



* CONTACT SURFACE
ALL DIMENSIONS IN INCHES


EIMAC 4CX5000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS
400
300
200
100
0
−100
−200
−300
0
2000
4000
6000
8000
10000
14
12
10
8.0
6.0
5.0
4.0
3.0
2.0
1.0
.50
.10
0
3.0
2.5
2.0
1.5
1.0
.5
0
2.5
2.0
1.4
1.0
.60
.40
.20
.15
.10


EIMAC 4CX5000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 1250 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.50
.10
.05
.01
0
.01
.02
.05
.10
1.5
1.0
.50
.40
.30
.20
.10
.20
100
0
−100
−200
−300
−400
−500
0
2000
4000
6000
8000
10000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

TECHNICAL DATA

8170W
4CX5000R

RADIAL-BEAM
POWER TETRODE

The EIMAC 8170W/4CX5000R is a compact, high-power, ceramic/metal tetrode. It is directly interchangeable with the 8170/4CX5000A but incorporates more rugged internal construction features, including a sturdy mesh cathode, which allows it to meet demanding vibration and shock specifications.

The 8170W/4CX5000R is useful up to 110 Mc and is recommended for use as a radio-frequency linear amplifier, a Class-AB audio amplifier, or a Class-C power amplifier or plate-modulated amplifier.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	7.5 ± 0.37	V
Current, at 7.5 volts	75	A
Amplification Factor (Average):		
Grid to Screen	4.5	
Direct Interelectrode Capacitance (grounded filament)[2]		
Cin	115	pF
Cout	20	pF
Cgp	0.7	pF
Direct Interelectrode Capacitance (grounded grid)[2]		
Cin	53	pF
Cout	22.5	pF
Cpk	0.10	pF
Frequency of Maximum Rating:		
CW	100	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	9.125 in;231.77 mm
Diameter	4.938 in;125.43 mm
Net Weight	9.5 lb; 4.31 kg
Operating Position	Axis vertical, base up or down

(Effective 5-1-76) © 1963, 1970, 1971, 1976 by Varian Printed in U.S.A.

Maximum Operating Temperature:
Ceramic/Metal Seals or Anode Core . . . . . 250°C
Cooling . . . . . Forced Air
Base . . . . . Special concentric
Recommended Air System Socket . . . . . SK-300 or SK-300A
Recommended (Air) Chimney SK-306

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_1

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	6000	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

TYPICAL OPERATION (Frequencies to 100 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	7500	Vdc
Screen Voltage	1250	Vdc
Grid Voltage [1]	-300	Vdc
Zero-Signal Plate Current	0.50	Adc
Single-Tone Plate Current	1.90	Adc
Single-Tone Screen Current [2]	0.20	Adc
Peak rf Grid Voltage [2]	300	v
Plate Dissipation	4200	W
Single-Tone Plate Output Power	10,000	W

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	3.0	AMPERES
PLATE DISSIPATION	5000	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

TYPICAL OPERATION (Frequencies to 100 MHz)

Plate Voltage	6500	Vdc
Screen Voltage	750	Vdc
Grid Voltage	-350	Vdc
Plate Current	2.30	Adc
Screen Current [1]	0.20	Adc
Grid Current [1]	0.05	Adc
Measured Driving Power [1]	100	W
Useful Output Power	10,000	W

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION [1]	3500	WATTS
SCREEN DISSIPATION [2]	250	WATTS
GRID DISSIPATION [2]	75	WATTS

1. Corresponds to 5000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 100 MHz)

Plate Voltage	5000	Vdc
Screen Voltage	500	Vdc
Grid Voltage	-400	Vdc
Plate Current	1.40	Adc
Screen Current [1]	0.26	Adc
Grid Current [1]	0.05	Adc
Peak af Screen Voltage [1] (100% modulation)	450	v
Peak rf Grid Voltage [1]	520	v
Calculated Driving Power	25	W
Plate Dissipation	1200	W
Plate Output Power	5800	W

1. Approximate value

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR
Class AB_1, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	6000	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

TYPICAL OPERATION (Two Tubes)

Plate Voltage	4000	5000	6000	7000	Vdc
Screen Voltage	1250	1250	1250	1250	Vdc
Grid Voltage 1/4	-270	-280	-310	-325	Vdc
Zero-Signal Plate Current	1.25	1.00	0.83	0.70	Adc
Max. Signal Plate Current	5.10	4.40	4.25	3.65	Adc
Max. Signal Screen Current[1]	0.35	0.33	0.30	0.24	Adc
Peak af Grid Voltage[2]	250	240	270	235	v
Max. Signal Plate Dissipation[1]	4200	4200	4200	4200	W
Plate Output Power	11,500	13,500	17,000	17,500	W
Load Resistance (plate to plate)	1500	2370	2940	4100	Ω

1. Approximate value.
2. Per Tube.
3. Nominal drive power is one-half peak power.
4. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 7.5 volts	73	78	A
Interelectrode Capacitances[1] (grounded filament connection)			
Cin	108	122	pF
Cout	18	23	pF
Cgp	---	1.0	pF
Interelectrode Capacitances[1] (grounded grid connection)			
Cin	48	58	pF
Cout	19	24	pF
Cpk	---	0.16	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX5000R must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC SK-300A Air-System Socket is designed especially for the concentric base terminals of the 4CX5000R. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through an Air Chimney, the SK-306, into the anode cooling fins. The SK-300 socket may be used instead of the SK-300A, but its use will result in a slightly less efficient cooling system at high dissipation levels.

COOLING - The maximum temperature rating for the external surfaces of the 4CX5000R is 250°C. Sufficient forced-air circulation must be

provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Sea level air-flow requirements to maintain seal temperatures at 200°C in 50°C ambient air are tabulated below (for operation below 30 megacycles).

	SK-300A Socket		SK-300 Socket	
Plate Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (Inches of water)	Air Flow (CFM)	Pressure Drop (Inches of water)
2000	75	0.4	75	0.4
3000	105	0.7	100	0.7
4000	145	1.1	135	1.2
5000	190	1.5	165	1.8
6000	230	2.0	200	2.5

Since the power dissipated by the filament represents about 560 watts and since grid-plus screen dissipation can, under some conditions, represent another 200 to 300 watts, allowance has been made in preparing this tabulation for an additional 1000 watts dissipation

At higher altitudes, higher frequencies, or higher ambient temperatures the flow rate must be increased to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using maximum rated temperatures as the criteria for satisfactory cooling.

IMPACT AND VIBRATION - The 4CX5000R is designed to operate under shock and vibration that might disable a less rugged tube. Up to 50 g of impact of 11 millisecond duration can be sustained and vibratory acceleration up to 5 g from 14 to 200 Hz and 2 g from 200 to 500 Hz will not ordinarily injure the tube unless prolonged. Production tubes are subjected to testing to insure this ruggedness.

ELECTRICAL

FILAMENT VOLTAGE - The rated filament voltage for the 4CX5000R is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than 5 percent from the rated value.

GRID DISSIPATION - The 4CX5000R control grid has a maximum dissipation rating of 75 watts. Precautions should be observed to avoid exceeding this rating. Grid Dissipation is approximately the product of dc grid current and peak positive grid voltage. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible.

SCREEN DISSIPATION - The power dissipated by the screen of the 4CX5000R must not exceed 250 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 250 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX5000R is 5000 watts for most applications but for audio and SSB amplifier applications, the maximum allowable dissipation is 6000 watts. Plate dissipation may be permitted to rise above the maximum rating during brief periods, such as may occur during tuning.

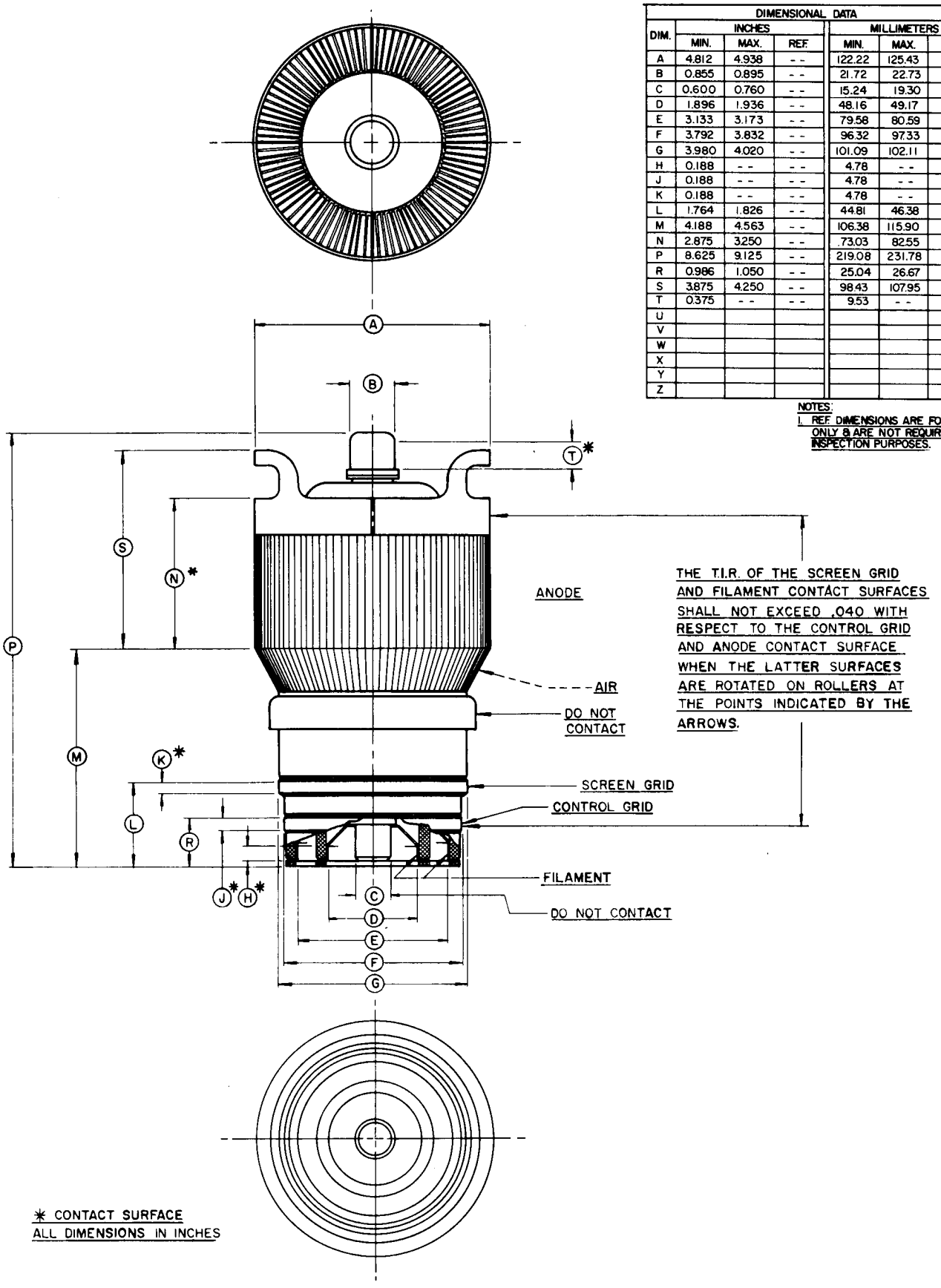
When the 4CX5000R is operated as a plate-modulated rf power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 3500-watt maximum plate dissipation rating will be exceeded.

HIGH VOLTAGE - The 4CX5000R operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

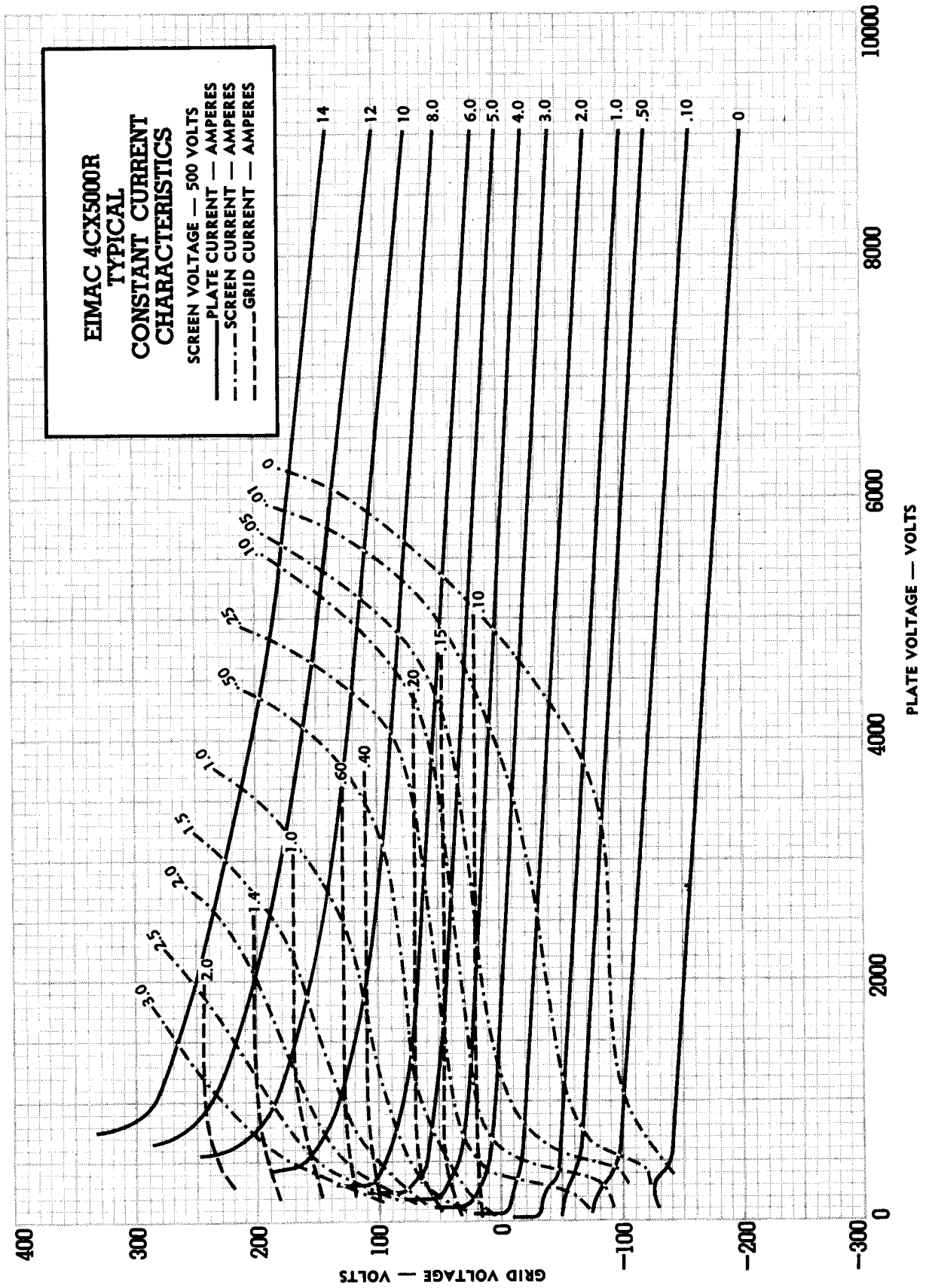
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

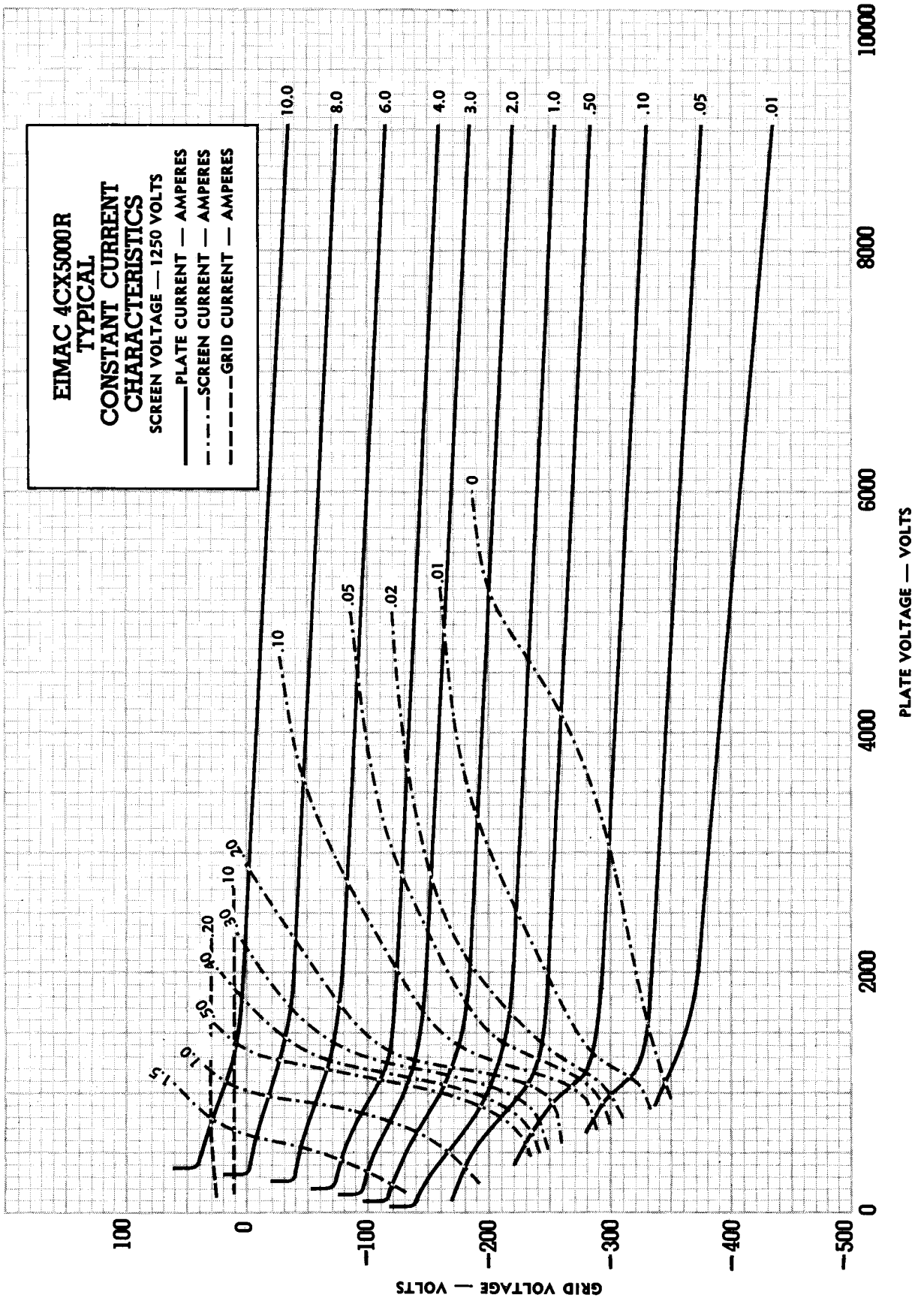
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.812	4.938	--	122.22	125.43	--
B	0.855	0.895	--	21.72	22.73	--
C	0.600	0.760	--	15.24	19.30	--
D	1.896	1.936	--	48.16	49.17	--
E	3.133	3.173	--	79.58	80.59	--
F	3.792	3.832	--	96.32	97.33	--
G	3.980	4.020	--	101.09	102.11	--
H	0.188	--	--	4.78	--	--
J	0.188	--	--	4.78	--	--
K	0.188	--	--	4.78	--	--
L	1.764	1.826	--	44.81	46.38	--
M	4.188	4.563	--	106.38	115.90	--
N	2.875	3.250	--	73.03	82.55	--
P	8.625	9.125	--	219.08	231.78	--
R	0.986	1.050	--	25.04	26.67	--
S	3.875	4.250	--	98.43	107.95	--
T	0.375	--	--	9.53	--	--
U						
V						
W						
X						
Y						
Z						

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



* CONTACT SURFACE
ALL DIMENSIONS IN INCHES

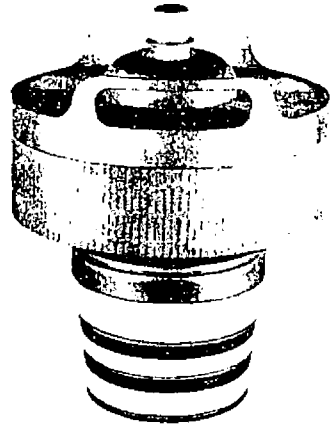

EIMAC 4CX5000R
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS
400
300
200
100
0
−100
−200
−300
0
2000
4000
6000
8000
10000
14
12
10
8.0
6.0
5.0
4.0
3.0
2.0
1.0
.50
.10
0
3.0
2.5
2.0
1.5
1.0
.50
.25
.10
0
2.0
1.4
1.0
.60
.40
.20
.15
.10


EIMAC 4CX5000R
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 1250 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.50
.10
.05
.01
0
.02
.05
.10
1.5
1.0
.50
.20
.10
.20
100
0
−100
−200
−300
−400
−500
0
2000
4000
6000
8000
10000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

8171
4CX10,000D

TECHNICAL DATA

RADIAL-BEAM
POWER TETRODE



The EIMAC 8171/4CX10,000D is a ceramic/metal tetrode which is identical electrically to the 8170/4CX5000A except for its rated plate dissipation. Its increased dissipation capability, resulting from a larger cooler, is most useful in linear applications where plate dissipation is generally the limiting factor.

The larger cooler also allows the 8171/4CX10,000D to be used in place of the 8170/4CX5000A with less cooling for any given plate dissipation, or results in cooler operation at any given air-flow rate.

The 8171/4CX10,000D is useful as an oscillator, amplifier, or modulator at frequencies up to 110 megahertz and is particularly suited for use as a linear rf amplifier or class-AB_1 audio amplifier.

A pair of these tubes, operating class-AB_1, will deliver more than 30 kilowatts of audio-frequency or radio-frequency plate output power.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	7.5 ± 0.37 V
Current, at 7.5 volts	75 A
Amplification Factor (Grid Screen), Average	4.5
Direct Interelectrode Capacitances, Grounded Cathode: [2]	
Cin	115 pF
Cout	20.5 pF
Cgp	0.7 pF
Direct Interelectrode Capacitances, Grounded Grid: [2]	
Cin	53 pF
Cout	20.5 pF
Cpk	0.10 pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special concentric
Maximum Seal Temperature	250 °C
Maximum Anode-Core Temperature	250 °C
Recommended Socket	EIMAC SK-300A

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varian, EIMAC division/301 industrial way/san carlos/california 94070

from JEDEC release #3578I, Oct. 30, 1979

Recommended Air Chimney	EIMAC SK-1306
Operating Position	Axis vertical, base up or down
Cooling	Forced Air

Maximum Dimensions:

Length	9.06 in; 230.17	mm
Diameter	7.05 in; 179.07	mm
Net Weight (Approximate)	12 lbs; 5.5	kg
Shipping Weight (Approximate)	23 lbs; 10.5	kg

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 7.5 volts	73	78	A
Interelectrode Capacitance (grounded cathode connection) [1]			
Cin	108	122	pF
Cout	18	23	pF
Cgp	---	1.0	pF
Interelectrode Capacitance (grounded grid connection) [1]			
Cin	48	58	pF
Cout	18	23	pF
Cpk	---	0.16	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR (Up to 110 megahertz)

Class-C Telegraphy or FM Telephony (Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE up to 30 MHz	7500	VOLTS
30 to 60 MHz	7000	VOLTS
60 to 110 MHz	6500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT up to 30 MHz	3.0	AMPERES
30 to 60 MHz	2.8	AMPERES
60 to 110 MHz	2.6	AMPERES
PLATE DISSIPATION	10,000	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

TYPICAL OPERATION
(Frequencies below 30 megahertz)

DC Plate Voltage	7500	Vdc
DC Screen Voltage	500	Vdc
DC Grid Voltage	-350	Vdc
DC Plate Current	2.8	Adc
DC Screen Current	0.5	Adc
DC Grid Current	0.25	Adc
Peak rf Grid Voltage	590	v
Driving Power	150	W
Plate Dissipation	5000	W
Plate Output Power	16,000	W

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class C Telephony (Carrier conditions except where noted)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC SCREEN VOLTAGE	1000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION [1]	6650	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

1. Corresponds to 10,000 watts at 100% sine-wave modulation.

TYPICAL OPERATION
(Frequencies below 30 megahertz)

DC Plate Voltage	5000	Vdc
DC Screen Voltage	500	Vdc
Peak af Screen Voltage (For 100% modulation)	450	v
DC Grid Voltage	-400	Vdc
DC Plate Current	1.4	Adc
DC Screen Current	0.26	Adc
DC Grid Current	0.05	Adc
Peak rf Grid Voltage	520	v
Grid Driving Power	25	W
Plate Dissipation	1100	W
Plate Output Power	5.8	kW

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class AB 1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	12,000	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

TYPICAL OPERATION, two tubes

DC Plate Voltage	4000	5000	6000	7500	Vdc
DC Screen Voltage	1500	1500	1500	1500	Vdc
DC Grid Voltage	-315	-320	-330	-340	Vdc
Max.Signal Plate Current	6.66	6.66	6.66	6.66	Adc
Zero-Signal Plate Current[1]	0.50	0.50	0.50	0.50	Adc
Max.Signal Screen Current	0.33	0.32	0.30	0.25	Adc
Zero-Signal Screen Current	0	0	0	0	Adc
Peak af Driving Voltage	305	310	320	330	v
Driving Power	0	0	0	0	W
Load Resistance plate to plate	940	1320	1700	2280	Ω
Max. Signal Plate Dissipation	6670	7950	8100	9050	W
Max.Signal Plate Output Power	13,300	17,500	23,800	31,900	W

1. Per Tube

RADIO-FREQUENCY LINEAR AMPLIFIER

Class AB 1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	12,000	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

TYPICAL OPERATION, Peak-Envelope or Modulation-Crest Conditions(Frequencies below 30 megahertz)

DC Plate Voltage	7500	Vdc
DC Screen Voltage	1500	Vdc
DC Grid Voltage[1]	-340	Vdc
Max.Signal Plate Current	3.33	Adc
Zero-Signal Plate Current	0.50	Adc
Max.Signal Screen Current	.125	Adc
Peak rf Grid Voltage	330	v
Driving Power	0	W
Plate Dissipation	9025	W
Plate Output Power[2]	15,950	W

1. Adjust grid voltage to obtain specified Zero-Signal plate current.
2. PEP output or rf output power at crest of modulation envelope.

NOTE: TYPICAL OPERATION data is obtained by direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias screen and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In Class C service, if grid bias is obtained principally by means of a grid resistor the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

APPLICATION

MECHANICAL

MOUNTING - The 4CX10000D must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC Air-System Socket Type SK-300A has been designed especially for the concentric base terminals of the 4CX10000D. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through an Air Chimney, the SK-1306, into the anode cooling fins.

COOLING - The maximum temperature rating for the external surfaces of the 4CX10000D is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air-flow requirements to maintain seal temperatures at 200°C in 50°C ambient air are tabulated below (for operation below 30 megahertz) for the socket/tube/chimney combination.

	SEA LEVEL		10,000 FEET	
Plate Dissipation* (Watts)	Air Flow (CFM)	Pressure Drop(Inches of water)	Air Flow (CFM)	Pressure Drop(Inches of water)
4000	114	0.36	166	0.53
6000	226	1.0	330	1.46
8000	363	2.0	530	2.90
10000	500	3.5	730	5.10
12000	720	6.0	1050	8.8

* Since the power dissipated by the filament represents about 560 watts and since grid-plus-screen dissipation can, under some conditions, represent another 200 to 300 watts, allowance has been made in preparing this tabulation for an additional 1000 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

FILAMENT OPERATION - The rated filament voltage for the 4CX10000D is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than plus or minus 5 percent from the rated value.

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings for the 4CX10000D must be respected to avoid damage to the tube. An exception is the plate dissipation, which may be permitted to rise above the rated maximum during brief periods, such as may occur during tuning.

CONTROL-GRID OPERATION - The 4CX10000D control grid has a maximum dissipation rating of 75 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible.

SCREEN-GRID OPERATION - The power dissipated by the screen of the 4CX10000D must not exceed 250 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 250 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX10000D is 10,000 watts for most applications, but for audio and SSB amplifier applications, the maximum allowable dissipation is 12,000 watts.

When the 4CX10000D is operated as a plate-modulated rf power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 6650-watt maximum plate dissipation rating will be exceeded.

HIGH VOLTAGE - Normal operating voltages used with the 4CX10000D are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most

applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of power tubes involves one or more of the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE - Normal operating voltages can be deadly.

b. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE AFFECTED.

c. X-RAY RADIATION - High voltage tubes can produce dangerous and possibly fatal x-rays.

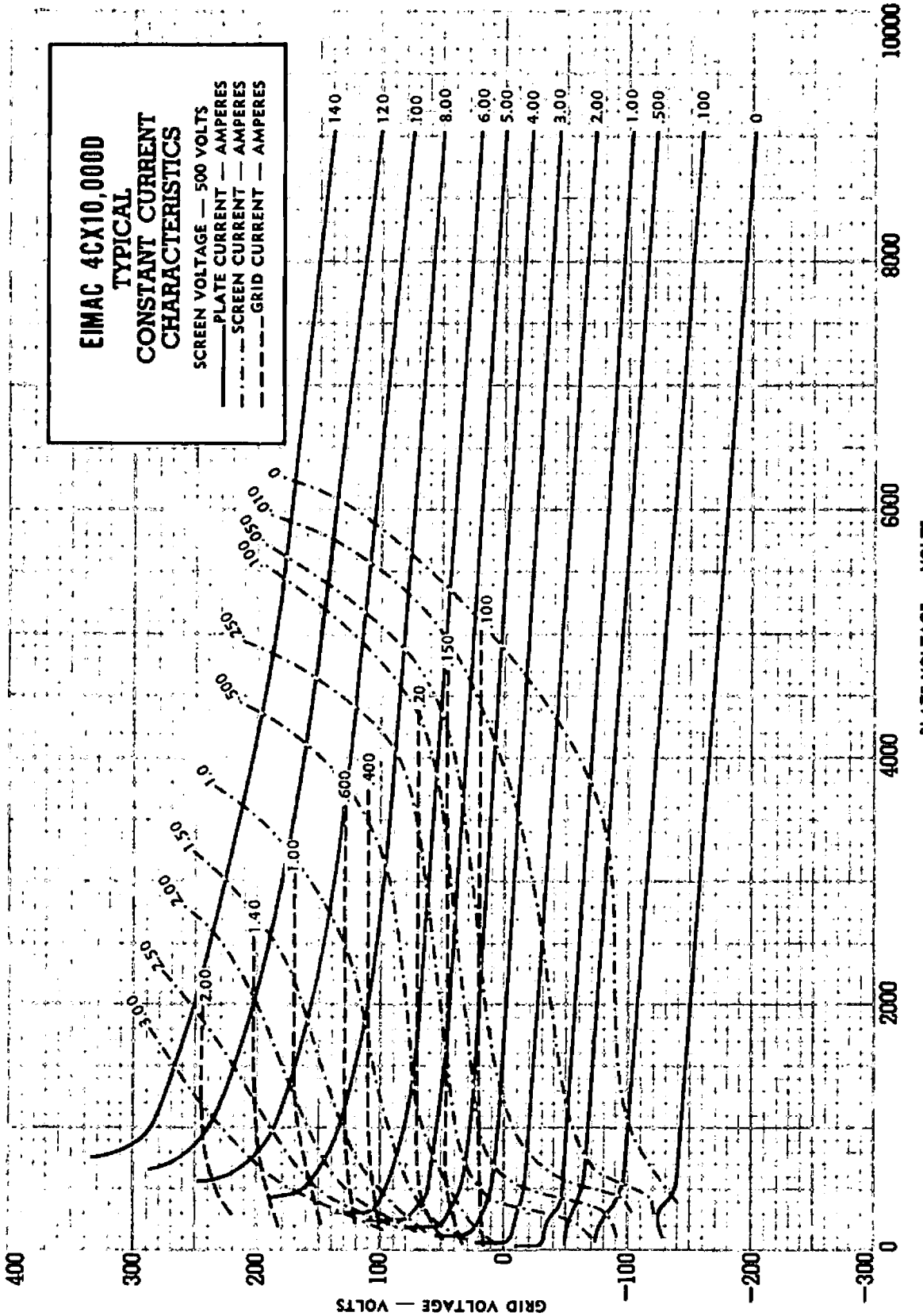
d. BERYLLIUM OXIDE POISONING - Dust or fumes from BeO ceramics used as thermal links with some conduction-cooled power tubes are highly toxic and can cause serious injury or death.

e. GLASS EXPLOSION - Many electron tubes have glass envelopes. Breaking the glass can cause an implosion, which will result in an explosive scattering of glass particles. Handle glass tubes carefully.

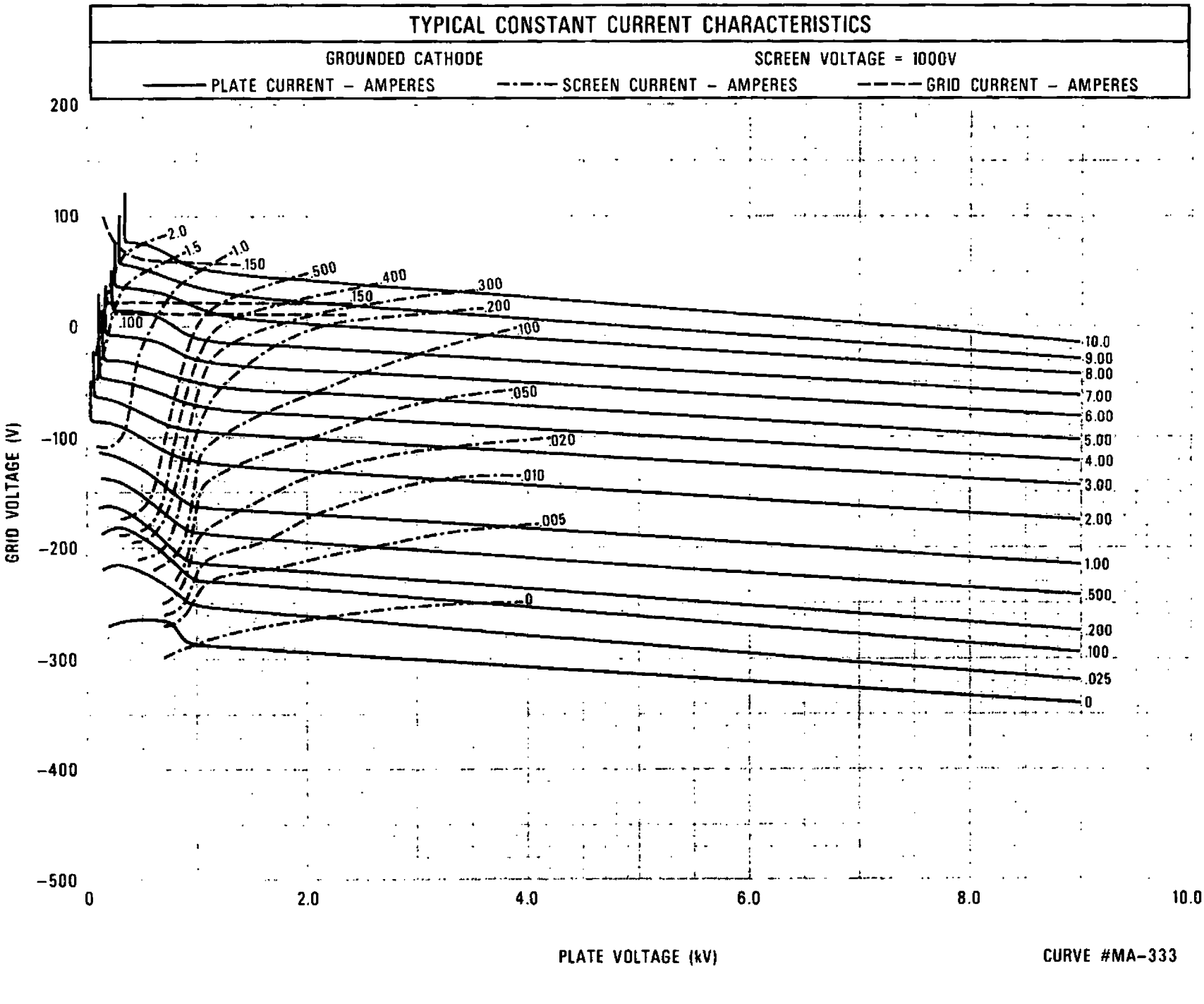
f. HOT WATER - Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

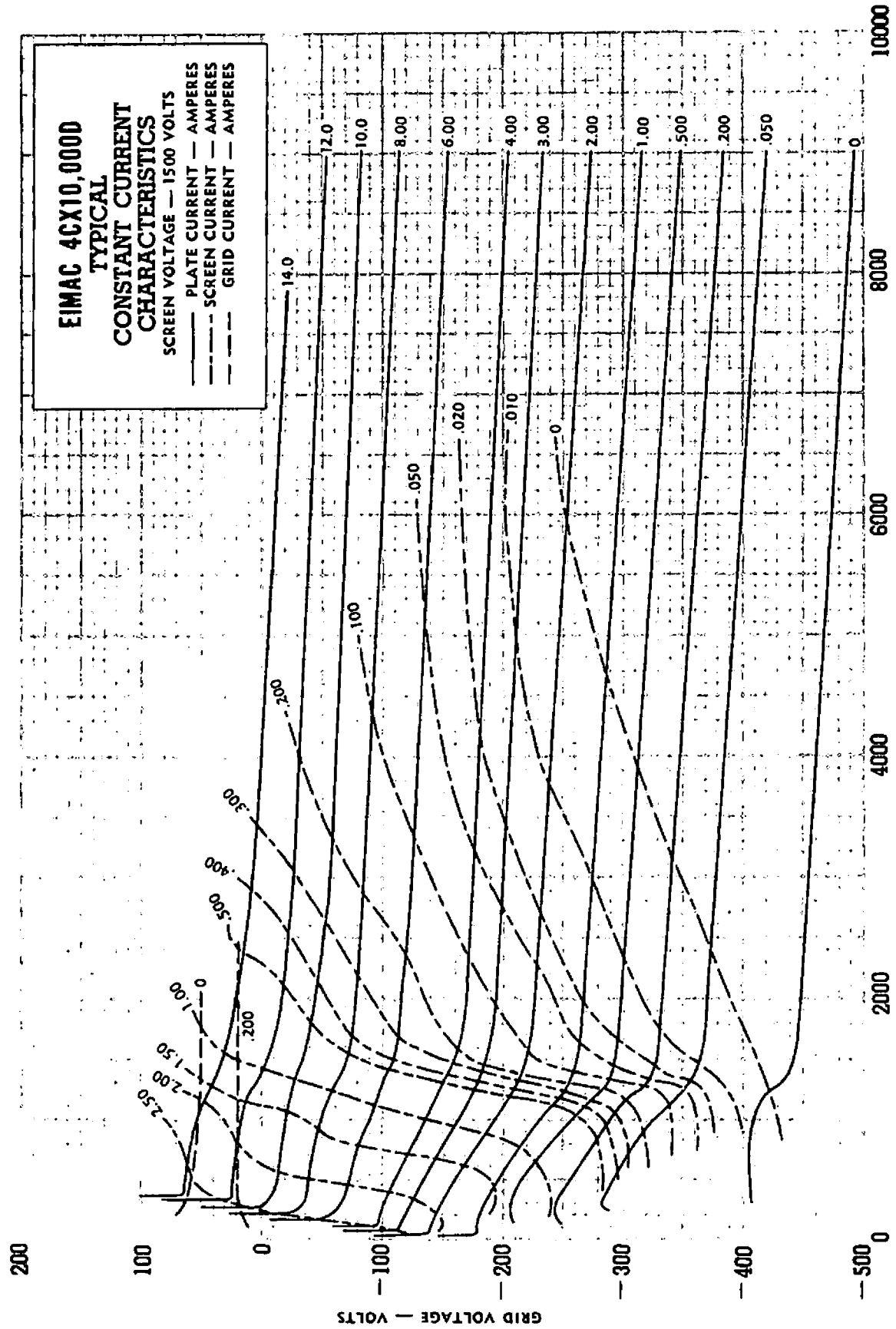
g. HOT SURFACES - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred degrees centigrade and cause serious burns if touched.

Please review the detailed operating hazards sheet enclosed with each tube or request a copy from the address shown below: Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070.


EIMAC 4CX10,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS
400
300
200
100
0
−100
−200
−300
0
2000
4000
6000
8000
10000

CURVE MA-335


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 1000V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
200
100
0
-100
-200
-300
-400
-500
0
2.0
4.0
6.0
8.0
10.0
PLATE VOLTAGE (kV)
2.0
1.5
1.0
.150
.500
.400
.300
.150
.200
.100
.100
.050
.020
.010
.005
0
10.0
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.500
.200
.100
.025
0
CURVE #MA-333
8171/4CX10,000D


EIMAC 4CX10,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 1500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
14.0
12.0
10.0
8.00
6.00
4.00
3.00
2.00
1.00
.500
.200
.050
0
.020
.010
0
.050
.100
.200
.300
.400
.500
0
1.00
.200
1.50
2.00
2.50
200
100
0
−100
−200
−300
−400
−500
0
2000
4000
6000
8000
10000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

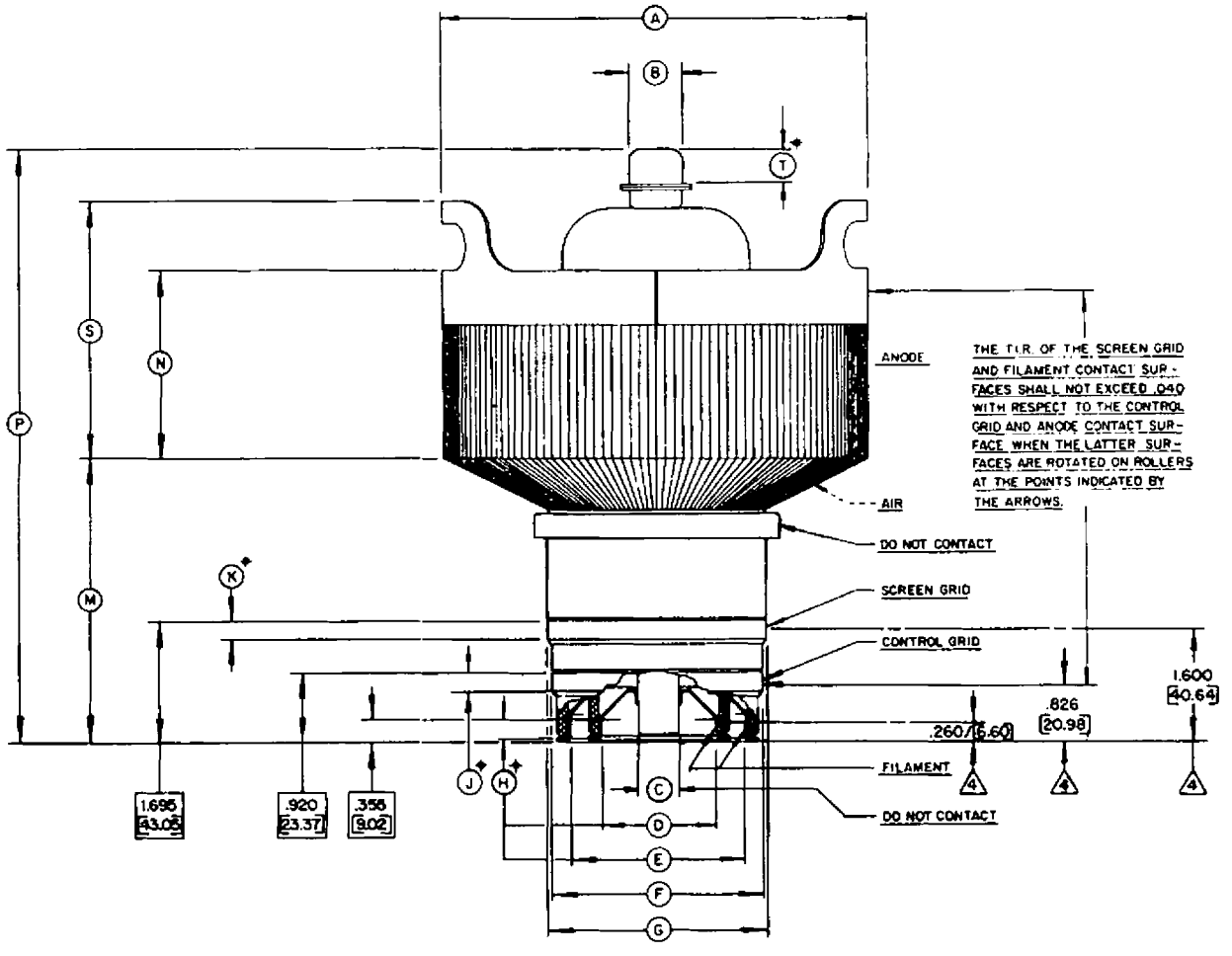
CURVE MA-317

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. DIMENSIONS IN [ ] ARE MILLIMETERS.
3. (*) CONTACT SURFACE.
4. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES.

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	6.928	7.050		175.97	179.07	
B	.855	.895		21.72	22.73	
C	.600	.760		15.24	19.30	
D	1.896	1.936		48.16	49.17	
E	3.133	3.173		79.58	80.59	
F	3.792	3.832		96.32	97.33	
G	3.980	4.020		101.09	102.11	
H	.188			4.78		
J	.188			4.78		
K	.188			4.78		
M	4.186	4.568		106.32	116.03	
N	2.412	2.788		61.26	70.82	
P	8.812	9.062		223.82	230.17	
S	3.412	3.788		86.66	96.22	
T	.375			9.53		

4CX10,000D



8172
4X150G

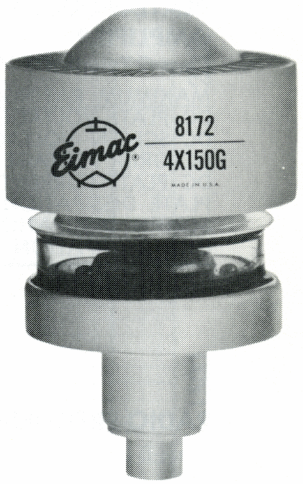
RADIAL-BEAM POWER TETRODE

TECHNICAL DATA

The EIMAC 8172/4X150G is an extremely compact external-anode tetrode intended for use as a radio-frequency amplifier, frequency multiplier, or oscillator at frequencies well into the UHF region or as an amplifier in any service requiring a high-gain tube capable of delivering high power-output at low plate-voltage. The combination of a high ratio of transconductance to capacitance and a plate dissipation capability of 250 watts makes the tube an excellent wide-band amplifier for video applications.

The cathode, grid and screen electrodes are mounted on conical and cylindrical supports giving a minimum of circuit discontinuities and lead inductance. The rugged cylindrical terminals, progressively larger in size, allow the tube to be inserted in coaxial line cavities. The screen support and terminal provide maximum isolation between the grid-cathode terminals and the plate circuit.

In amplifier service at 500 megahertz, output power of 140 watts per tube, with a stage power-gain of 14, can be obtained. At 1000 megahertz an output power of 50 watts per tube is obtained with a power-gain of five.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Cathode: Oxide-Coated, Unipotential				
Heating Time	30	60		seconds
Cathode-to-heater Potential			150	volts
Heater: Voltage		2.5		volts
Current	6.2		7.3	amperes
Amplification Factor (Grid-to-Screen)		5		

Direct Interelectrode Capacitances, Grounded Cathode:	*Min.*	*Max.*	
Input	25.0	29.0	pf
Output	4.0	4.9	pf
Feedback		0.05	pf
Direct Interelectrode Capacitances, Grounded Grid and Screen	***Min.***	***Max.***	
Input	14.5	19	pf
Output	4.0	4.9	pf
Feedback		0.01	pf

Frequency for Maximum Ratings (CW)	500 MHz
(pulsed)	1500 MHz

MECHANICAL

Base	Coaxial
Maximum Operating Temperatures:	
Glass-to-Metal Seals	175°C
Ceramic-to-Metal Seals	250°C
Anode Core	250°C
Operating Position	Any
Maximum Dimensions:	
Height	2.75 inches
Diameter	1.635 inches
Cooling	Forced Air
Net Weight	6 ounces
Shipping Weight (Approximate)	1.6 pounds

(Revised 10-15-73)© 1959, 1966, 1973 Varian

Printed in U.S.A.

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	1250 VOLTS
DC SCREEN VOLTAGE	300 VOLTS
DC GRID VOLTAGE	—250 VOLTS
DC PLATE CURRENT	250 MA
PLATE DISSIPATION	250 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Frequencies up to 165 MHz)

DC Plate Voltage	600	750	1000	1250	1250	volts
DC Screen Voltage	250	250	250	250	250	volts
DC Grid Voltage	—75	—80	—80	—90	—80	volts
DC Plate Current	200	200	200	200	200	mA
DC Screen Current*	37	37	30	20	7	mA†
DC Grid Current*	10	10	10	10	10	mA†
Peak RF Grid Voltage*	90	95	95	105	—	volts
Driving Power*	0.7	0.7	0.7	0.8	10	watts†
Plate Input Power	120	150	200	250	250	watts
Plate Output Power	85	110	150	195	140	watts†

*Approximate values.
†Measured values for a typical cavity amplifier circuit.

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	1000 VOLTS
DC SCREEN VOLTAGE	300 VOLTS
DC GRID VOLTAGE	—250 VOLTS
DC PLATE CURRENT	200 MA
PLATE DISSIPATION	165 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Frequencies up to 165 MHz)

DC Plate Voltage	600	800	1000	volts
DC Screen Voltage	250	250	250	volts
DC Grid Voltage	—95	—100	—105	volts
DC Plate Current	200	200	200	mA
DC Screen Current*	35	25	20	mA
DC Grid Current*	8	10	15	mA
Peak RF Grid Input Voltage*	120	120	125	volts
Driving Power*	1	1.5	2	watts
Plate Input Power	40	60	60	watts
Plate Output Power	120	160	200	watts

*Approximate values.

RADIO-FREQUENCY POWER AMPLIFIER

Class-B Linear, Television Visual Service (per tube)

MAXIMUM RATINGS

DC PLATE VOLTAGE	1250 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC GRID VOLTAGE	250 VOLTS
DC PLATE CURRENT (Average)	250 MA
PLATE DISSIPATION	250 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION
(Frequencies up to 216 MHz, 5-MHz bandwidth)

DC Plate Voltage	750	1000	1250 volts
DC Screen Voltage	300	300	300 volts
DC Grid Voltage	—60	—65	—70 volts
During Sync-Pulse Peak:			
DC Plate Current	335	330	305 mA
DC Screen Current	50	45	45 mA
DC Grid Current	15	20	25 mA
Peak RF Grid Voltage	85	95	100 volts
RF Driving Power (approx.)	7	8	9 watts
Useful Power Output	135	200	250 watts
Black Level:			
DC Plate Current	245	240	230 mA
DC Screen Current	20	15	10 mA
DC Grid Current	4	4	4 mA
Peak RF Grid Voltage (approx.)	65	70	75 volts
RF Driver Power (approx.)	4.25	4.7	5.5 watts
Plate Power Input	185	240	290 watts
Useful Power Output	75	110	140 watts

PLATE PULSED RADIO FREQUENCY AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS

PULSED PLATE VOLTAGE	7000 VOLTS
PULSED SCREEN VOLTAGE	1500 VOLTS
DC GRID VOLTAGE	—500 VOLTS
PULSE DURATION	5 USEC
PULSED CATHODE CURRENT	7 AMPS
AVERAGE POWER INPUT	250 WATTS
PLATE DISSIPATION	250 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL PULSE OPERATION
Single tube oscillator, 1200-MHz

Pulsed Plate Voltage	5	7	kV
Pulsed Plate Current	4.0	6.0	amps
Pulsed Screen Voltage	800	1200	volts
Pulsed Screen Current	0.3	0.4	amps
DC Grid Voltage	—200	—250	volts
Pulsed Grid Current	0.5	0.6	amps
Pulse Duration	4	5	μsec
Pulse Repetition Rate	2500	1000	pps
Peak Power Output	7	17	kW

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1 (Single-Sideband Suppressed-Carrier Operation)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC PLATE CURRENT	250 MA
PLATE DISSIPATION	250 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Frequencies up to 165 MHz
peak-envelope conditions except where noted)

DC Plate Voltage	1000	1250	volts
DC Screen Voltage	350	350	volts
DC Grid Voltage*	—55	—55	volts
Zero-Signal DC Plate Current	100	100	mA
Peak RF Grid Voltage**	50	50	volts
DC Plate Current	250	250	mA
DC Screen Current**	10	9	mA
Plate Input Power	250	310	watts
Plate Output Power	120	170	watts
Two-Tone Average DC Plate Current	190	190	mA
Two-Tone Average DC Screen Current**	2	—1	mA

*Approximate values.
**Adjust grid bias to obtain listed zero-signal plate current.

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf driving voltage is applied.

APPLICATION

MECHANICAL

Mounting—The 4X150G may be mounted in any position. The concentric arrangements of the electrode terminals permits the use of the tube in coaxial line or cavity type circuits to advantage.

Connections to the contact surfaces should be made by means of spring-finger collets which have sufficient pressure to maintain a good electrical contact at all fingers. Points of electrical contact should be kept clean and free of oxidation to minimize rf losses.

Cooling — The 4X150G requires sufficient forced air to keep the glass-to-metal seals below 175°C and the ceramic-metal seals and anode core below 250°C. The air flow must be started when power is applied to the heater and must continue without interruption until all electrode voltages have been removed from the tube.

Effective cooling of the anode is accomplished by directing six cubic feet per minute of air through the anode cooler. This flow is obtained at a pressure drop across the cooler of approximately 0.25 inch of water column. The grid, cathode and heater terminals are cooled by high velocity air directed at the terminals and the connecting collets which aid in the removal of heat from the terminals by conduction. The volume required will depend upon the socket arrangement and should be adequate to keep the metal-to-glass seals below 175°C and the center heater terminal below 250°C.

The air requirements stated above are based on operation at sea level an ambient temperature of 20°C. Operation at high altitudes or at high ambient temperatures requires a greater volume of air flow.

Temperature of the external parts of a tube may be measured with the aid of a temperature-sensitive lacquer.

ELECTRICAL

Heater — The rated heater voltage for the 4X150G is 2.5 volts, and should be maintained at this value plus or minus five percent. At frequencies above 300 megahertz, transit time effects begin to influence the cathode temperature. The amount of driving power diverted to cathode heating will depend on frequency, plate current and driving power. When the tube is driven to maximum input as a class-C CW amplifier, the heater voltage should be reduced according to the following table.

Frequency	Heater Voltage
301 to 400 MHz	2.4 volts
401 to 500 MHz	2.3 volts

At low duty, in pulse service, no reduction in heater voltage is normally required up to 1500 MHz.

Cathode — The oxide-coated unipotential cathode must be protected against excessively high emission currents. The maximum dc plate current must be limited to 250 mA under CW conditions. Pulse current must never exceed 6.0 amperes.

Where it is necessary to operate with some heater-to-cathode potential, the maximum heater-to-cathode voltage is 150 volts regardless of polarity.

Grid Dissipation—Maximum grid dissipation is 2.0 watts. In ordinary af and rf amplifiers the grid dissipation usually will not reach this level. Above 100 MHz drive power requirements increase, but most of this increase is absorbed in circuit losses rather than in grid dissipation. Satisfactory operation at 500 MHz in a "straight through" amplifier is indicated by grid currents below approximately 15 milliamperes. Grid circuit resistance should not exceed 100,000 ohms per tube.

Screen-Grid Operation — The maximum rated power dissipation for the screen grid is 12 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

When screen voltages appear between screen and cathode, as in the case of screen-modulated amplifiers or cathode-driven tetrode amplifiers, the peak screen-to-cathode voltage is the sum of the dc screen voltage and the peak ac or rf signal voltage applied to screen or cathode.

Protection for the screen should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be applied before screen voltage can be applied.

The screen current may reverse under certain conditions and produce negative current indications on the screen milliammeter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor, gaseous voltage regulator tubes or an electron tube shunt regulator connected

between screen and cathode and arranged to pass approximately 15 milliamperes per connected screen. An electron tube series regulator can be used only when an adequate bleeder resistor is provided.

Self-modulation of the screen in plate-modulated tetrode amplifiers using these tubes may not be satisfactory because of the screen-voltage screen-current characteristics. Screen modulation from a tertiary winding on the modulation transformer or by means of a small separate modulator tube will usually be more satisfactory. Screen-voltage modulation factors between 0.75 and 1.0 will result in 100% modulation for plate-modulated rf amplifiers using the 4X150G.

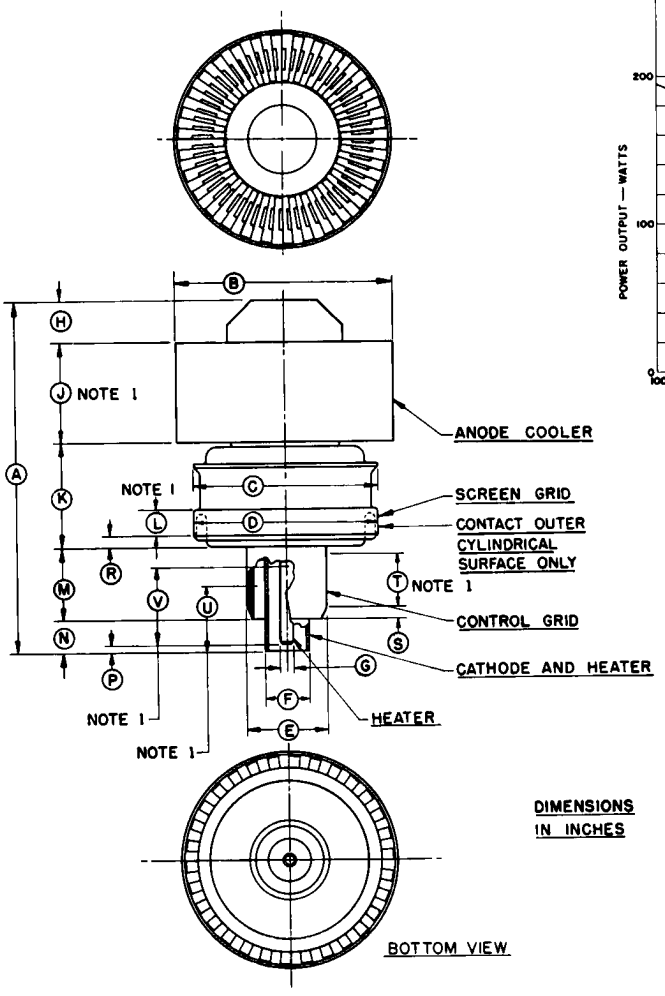
Plate Operation — The maximum rated plate-dissipation power is 250 watts. In plate-modulated applications the carrier plate-dissipation power must be limited to 165 watts to avoid exceeding the plate-dissipation rating with 100% sine wave modulation. The maximum dissipation rating may be exceeded for brief periods during circuit adjustment without damage to the tube.

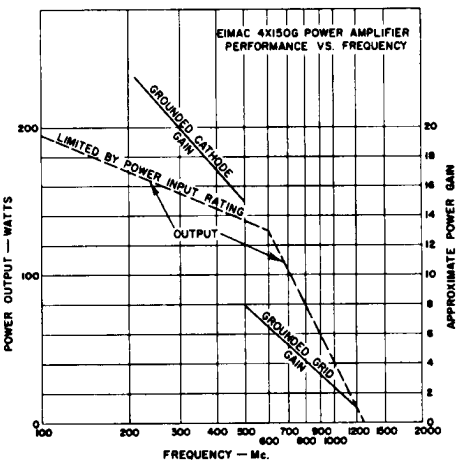
UHF Operation — The 4X150G is suitable use in the UHF region. Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

Multiple Operation—Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide individual metering and individual adjustments of bias or screen voltage to equalize the inputs.

Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event that one tube fails.

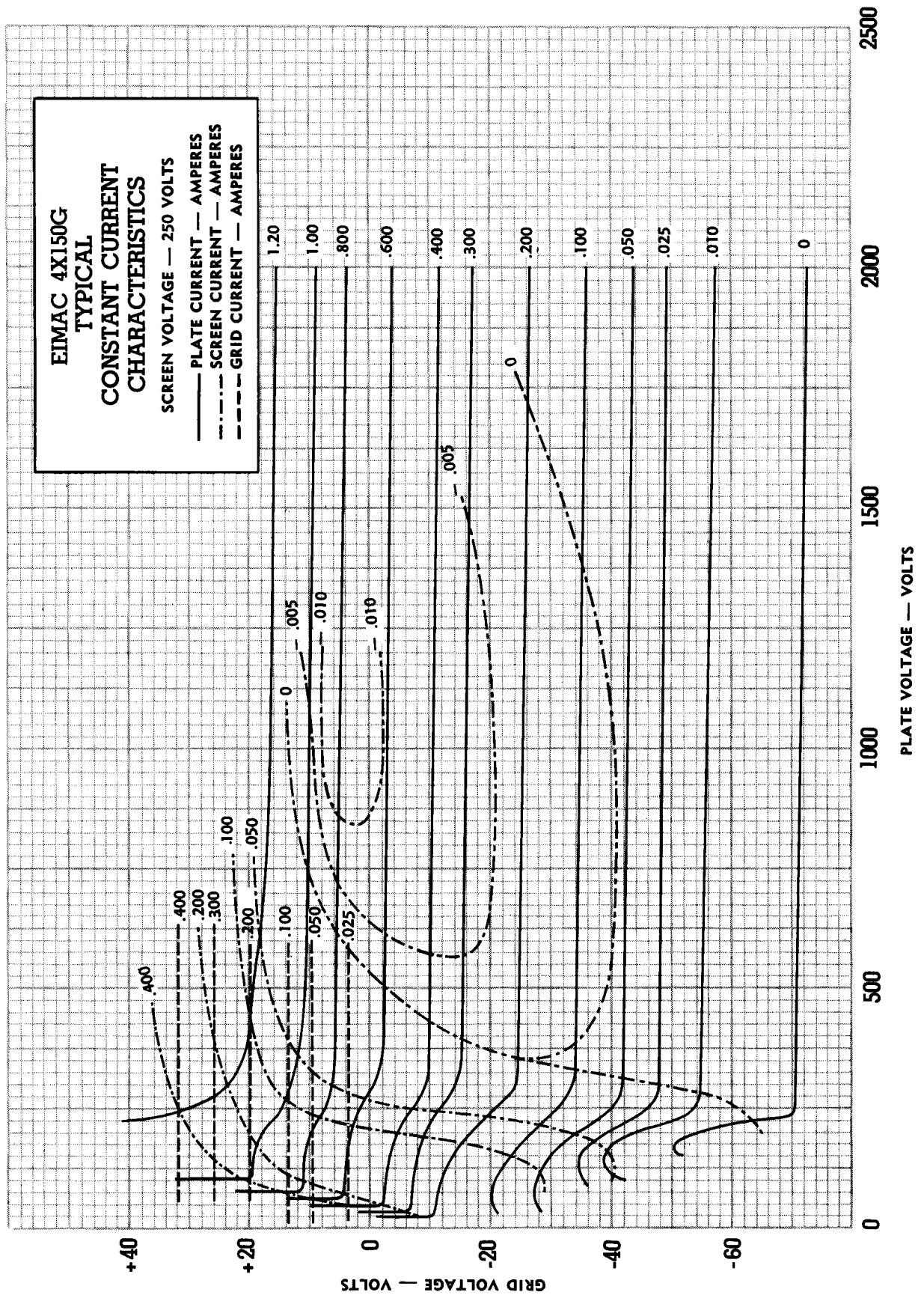
Special Applications—If it is desired to operate these tubes under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, CA 94070, for information and recommendations.

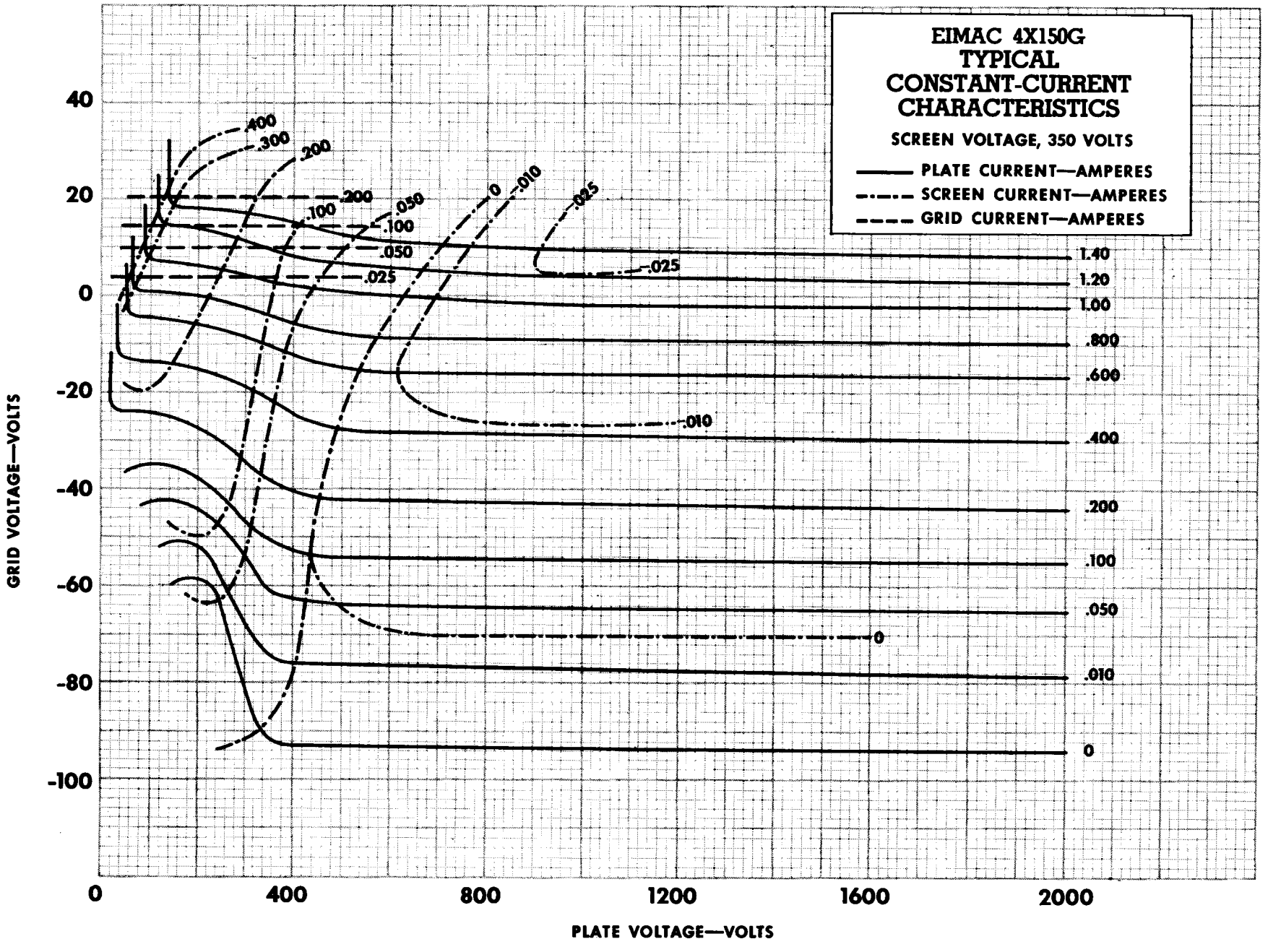




DIMENSION			
REF	NOMINAL	MINIMUM	MAXIMUM
A			2 3/4
B		1.615	1.635
C			1.406
D		1.417	1.433
E		.587	.597
F		.317	.327
G		.088	.098
H			5/16
J		23/32	25/32
K		3/4	13/16
L		3/16	
M		.500	.578
N		15/64	17/64
P		1/32	1/16
R	3/32		
S	1/8		
T		11/32	
U		13/32	
V		15/32	

NOTE 1. LENGTH AVAILABLE FOR CONTACT.


EIMAC 4X150G
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 250 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
1.20
1.00
.800
.600
.400
.300
.200
.100
.050
.025
.010
0
.005
GRID VOLTAGE — VOLTS
+40
+20
0
-20
-40
-60
PLATE VOLTAGE — VOLTS
0
500
1000
1500
2000
2500

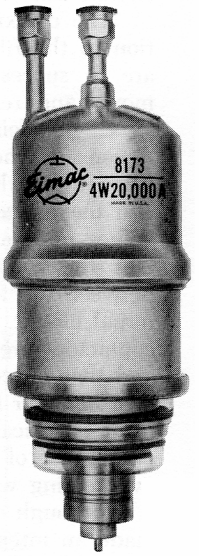

EIMAC 4X150G
TYPICAL
CONSTANT-CURRENT
CHARACTERISTICS
SCREEN VOLTAGE, 350 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—VOLTS
40
20
0
-20
-40
-60
-80
-100
0
400
800
1200
1600
2000
1.40
1.20
1.00
.800
.600
.400
.200
.100
.050
.010
0
.400
.300
.200
.200
.100
.050
.025
0
.010
.025
.025
.010
0

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

8173
4W20,000A
RADIAL-BEAM POWER TETRODE

The Eimac 8173/4W20,000A is a high-power, water-cooled transmitting tetrode having a maximum plate dissipation rating of 20 kilowatts. This tube will operate efficiently as a power-amplifier at frequencies up to 250 Mc. A single 8173/4W20,000A operating as a television visual r-f amplifier will deliver a synchronizing power output of 26 kilowatts at 216 Mc., with a 5-Mc. bandwidth.

The coaxial terminal arrangement of the tube is ideally suited for use in cavity circuits. The cathode is a unipotential thoriated tungsten cylinder of rugged construction, heated by electron bombardment.



GENERAL CHARACTERISTICS

▶ ELECTRICAL

Cathode: Unipotential, thoriated tungsten. Heated by electron bombardment.	
DC Voltage	1300 to 1500 volts
DC Current	1.7 to 1.9 amperes
Filament: Thoriated Tungsten, Helical	
Voltage (See Page 2)	10 volts
Current (without cathode bombardment)	30 amperes
Current (with cathode bombardment)	25 amperes
Maximum allowable starting current	50 amperes
Direct Interelectrode Capacitances (Grounded-Grid)	
Plate-Cathode	0.4 to 0.6 $\mu\mu$f
Input	75 to 87 $\mu\mu$f
Output	21 to 25.5 $\mu\mu$f
Screen-Grid Amplification Factor (Average)	5.5
Transconductance (I_b=6.6 A., E_b=3.0 kV., E_{c2}=1200 V.)	75,000 μmhos

▶ MECHANICAL

Base	Special, Concentric
Mounting Position	Vertical, base down or up
Cooling	Water and Forced Air
Maximum Over-all Dimensions	
Length (Including Tubing)	15 inches
Diameter (Anode)	5.03 inches
Net Weight	7.6 pounds

RADIO FREQUENCY POWER AMPLIFIER
MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	8 MAX. KV
DC PLATE CURRENT	15 MAX. AMP
PLATE DISSIPATION	20 MAX. KW
SCREEN DISSIPATION	200 MAX. WATTS
GRID DISSIPATION	60 MAX. WATTS

TYPICAL OPERATION

Class-C Telegraphy or FM Telephony (Per tube—220 Mc.)

DC Plate Voltage	5000	6000	7000	volts
DC Screen Voltage	1200	1200	1200	volts
DC Grid Voltage	—350	—370	—400	volts
DC Plate Current	3.6	3.6	3.4	amps
DC Screen Current (approx.)*	167	167	167	ma
DC Grid Current (approx.)	50	50	50	ma
Peak RF Input Voltage	455	475	505	volts
Driving Power (approx.)*	750	780	830	watts
Screen Dissipation	200	200	200	watts
Plate Power Input	18	21.6	23.8	kw
Plate Dissipation	7.0	8.6	8.0	kw
Useful Power Output	9.2	11.5	13.0	kw

*The performance figures listed above are obtained by calculation from the characteristic tube curves and confirmed by direct tests. The driving power and output power allow for losses associated with practical resonant circuits.

TYPICAL OPERATION

Class-B Linear Amplifier—Television Visual Service
(Per tube, 5-Mc. Bandwidth up to 216 Mc.)

Peak Synchronizing Level		
Load Impedance	650	ohms
Effective Length of Plate Line	¼	wave
DC Plate Voltage	7000	volts
DC Screen Voltage	1200	volts
DC Control Grid Voltage	—150	volts
DC Plate Current	6.0	amps
DC Screen Current (approx.)	230	ma
DC Control Grid Current (approx.)	90	ma
Peak RF Grid Input Voltage	280	volts
Driving Power (approx.)	500	watts
Plate Power Input	42	kw
Plate Dissipation	16	kw
Useful Plate Power Output	26	kw
Black Level		
DC Plate Current	4.5	amps
DC Screen Current	100	ma
DC Control Grid Current (approx.)	45	ma
Peak RF Grid Input Voltage	220	volts
Driving Power (approx.)	300	watts
Plate Power Input	32	kw
Plate Dissipation	16.5	kw
Useful Power Output	15.5	kw

These 216 Mc. typical performance figures were obtained by direct measurement in test equipment. The output power is useful power measured in a load circuit. The driving power is that taken by the tube and a practical resonant grid circuit. These figures are subject to variation and in many cases, with further refinement and improved techniques, better performance might be obtained.

▶ Indicates change from sheet dated 2-1-62.

(Effective 4-15-64) © Copyright 1962-1964 by Eitel-McCullough, Inc.

Note: Typical operation data are based on conditions of adjusting to a specificied plate current, maintaining fixed conditions of grid bias, screen voltage, suppressor voltage and r-f grid voltage. It will be found that if this procedure is followed, there will be little variation in power output between tubes even though there may be some variation in grid, screen and suppressor currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

APPLICATION

Mounting—The 4W20,000A must be mounted vertically. Base-down or base-up mounting is optional.

The co-axial contact surfaces provided for connection to the filament, cathode, grid, screen, and anode are of successively larger diameters to facilitate removal and replacement of tubes.

Cavity circuits may be designed around the dimensions shown in the outline drawing. At very high frequencies the points of contact between the tube and the external circuit will be required to carry high values of charging current. It is, therefore, essential that the contactors make firm and uniform contact between the terminal surfaces of the tube and the external circuit. Particular care should be taken that the contactors are not inadvertently forced out of shape, and that all contact surfaces are maintained free from dust or other foreign matter which would prevent uniform electrical connection. At VHF, poor contact by one finger of a multi-finger collet can result in local overheating which may damage the tube seals.

Although contact fingers or slotted collets are often made an integral part of cavity circuits, there is some advantage to reversing the plan by providing contact-finger assemblies which are designed to be clamped firmly to the terminal surfaces of the tube itself and to make sliding contact with the cavity as the tube is inserted. This arrangement facilitates replacement of worn or damaged contactors and tends to remove incidental local heating from the vicinity of the tube seals. Tubes held in reserve for emergency replacement may be fitted with contact finger assemblies and water-line extensions to minimize lost time in making changes.

Cathode Heating Power — The cathode of the 4W20,000A is a unipotential, thoriated tungsten cylinder, heated by electron bombardment of its inner surface. Bombardment is obtained by using the cylindrical cathode as the anode of a diode. A helical filament is mounted on the axis of the cathode cylinder to supply the bombarding electrons. A d-c potential of approximately 1400 volts is applied between the filament and the cathode cylinder, and the recommended cathode heating power of 2500 watts is obtained with approximately 1.8 amperes.

The inner filament is designed to operate under space-charge limited conditions so that the cathode temperature may be varied by changing the voltage applied between the inner filament and the cathode cylinder.

For maximum tube life the filament voltage, as measured directly at the filament terminals, must be reduced after the cathode has reached operating temperature. The proper filament voltage for a given cathode bombardment power may be found in the table below. The filament voltage should remain at the 10.0-volt value until the cathode has reached operating temperature, an interval of approximately thirty seconds. The filament voltage should be maintained to within 5% of the proper operating value and the cathode bombardment power should be held within plus or minus 100 watts of the recommended value.

Cathode Bombardment Power	2000	2250	2500	2750	3000
Filament Voltage	6.0	5.2	4.3	3.2	2.0

A cathode bombardment power of 2250 watts is normal for average CW conditions. In applications requiring peak values of cathode current in excess of 75 amperes the cathode bombardment power may be increased to a value between 2250 and 3000 watts as required.

Further increases in cathode efficiency will result in a decrease in the cathode bombardment power requirements. The cathode bombardment power supply should, therefore, be capable of providing a minimum of approximately 2000 watts.

Caution: It must be kept in mind that the filament is at a potential of 1400 volts d-c with respect to ground. The filament transformer and voltmeter must be adequately insulated for this voltage.

Grid Voltage Regulation—The practice of designing grid voltage supplies to maintain adequate regulation under conditions of varying grid current is particularly desirable with the 4W20,000A. Because the cathode of the 4W20,000A is a complete cylinder, grid temperatures run higher than usual. For this reason, even with no excitation, control grid current reversal might conceivably be several milliamperes and safe design should allow for possible peaks on the order of 100 milliamperes.

Anode Cooling—The water-cooled anode requires 8 gallons per minute of cooling water for the rated 20 kilowatts of plate dissipation. This corresponds to a pressure drop of 7 pounds per square inch across the water jacket. The inlet water pressure must not exceed a maximum of 50 pounds per square inch.

The outlet water temperature must not exceed a maximum of 70°C under any conditions.

Seal Cooling—The grid and screen tube contact surfaces and adjacent glass and ceramic must be cooled by high-velocity air which may be accomplished by means of ring manifolds. The quantity, velocity and direction of air must be adjusted to limit the maximum seal temperatures to 150°C.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.

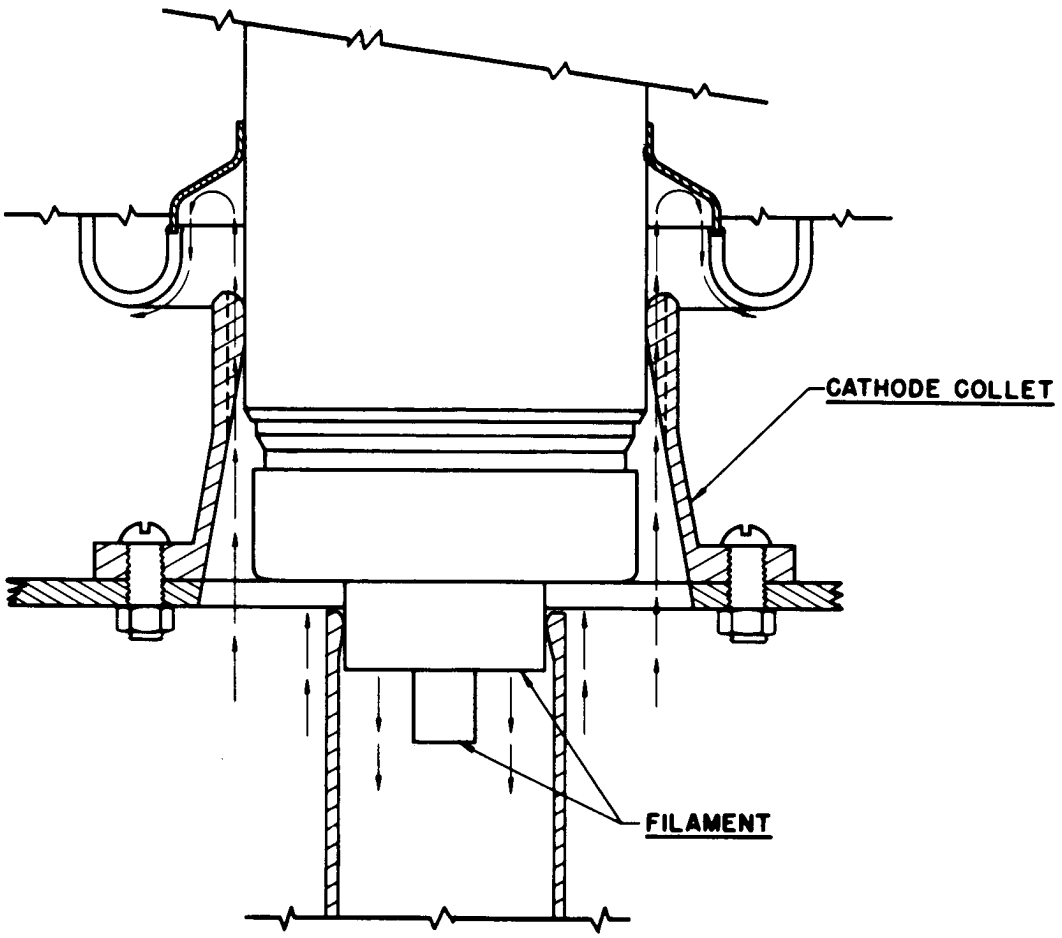
The cathode and filament stem also require forced-air cooling in sufficient quantity so that the region on the cathode terminal opposite the glass of the grid terminal seal does not exceed a maximum of 150°C. The major portion of this air must be guided along the surface of the terminal sleeve. The remaining air flows through the nine holes inside the terminal sleeve, cools the filament stem and vents through the three holes in the tube base enclosed by the outer filament spring collet connection.

By employing a cathode collet such as is shown in the accompanying drawings, the recommended cooling requirements will be fulfilled with an air flow of 60 cubic feet per minute at a static manifold pressure of 2 inches of water column.

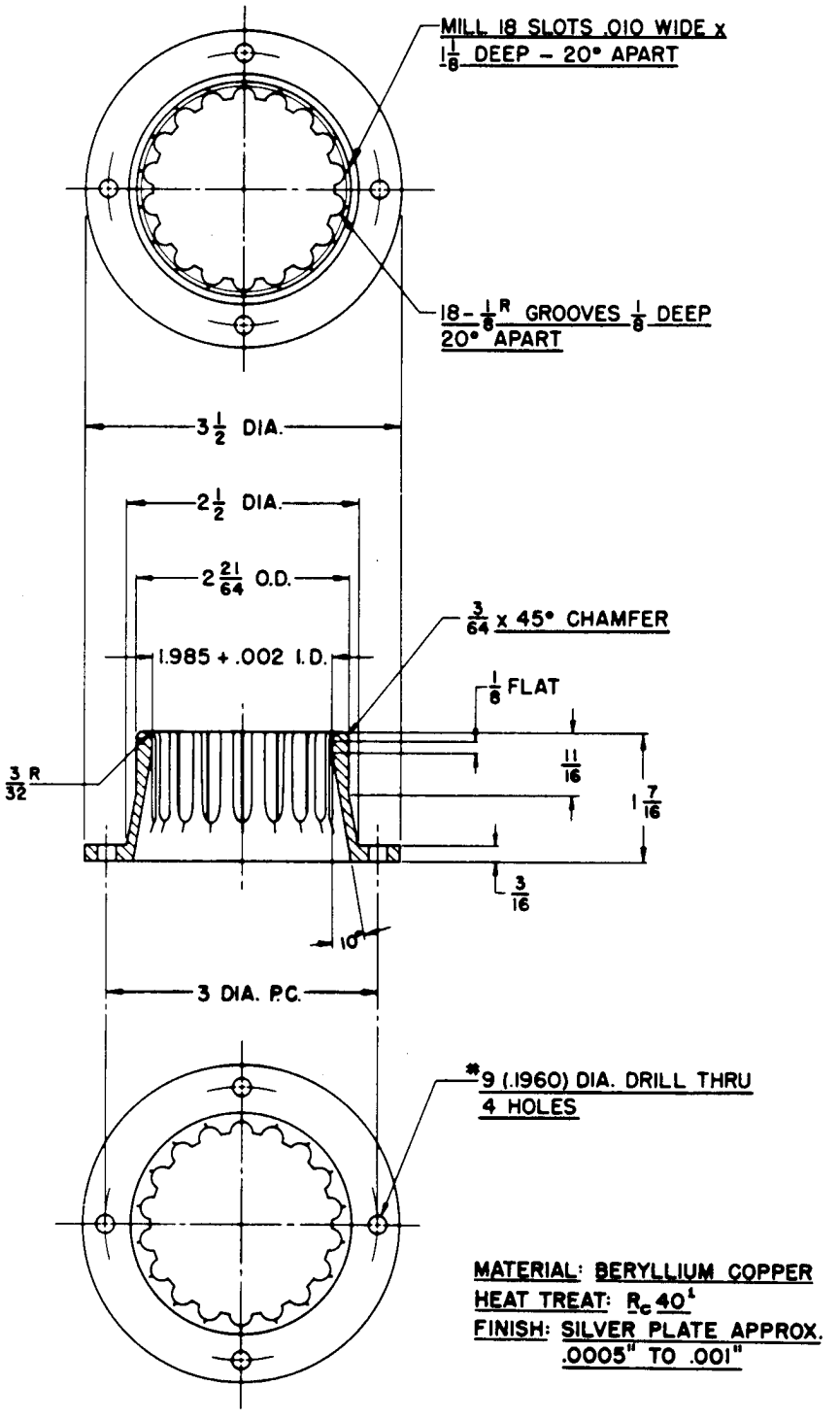
Air and water flow must be started before filament and cathode power are applied and maintained for at least two minutes after the filament and cathode power have been removed.

4W20,000A

SUGGESTED STEM AIR COOLING

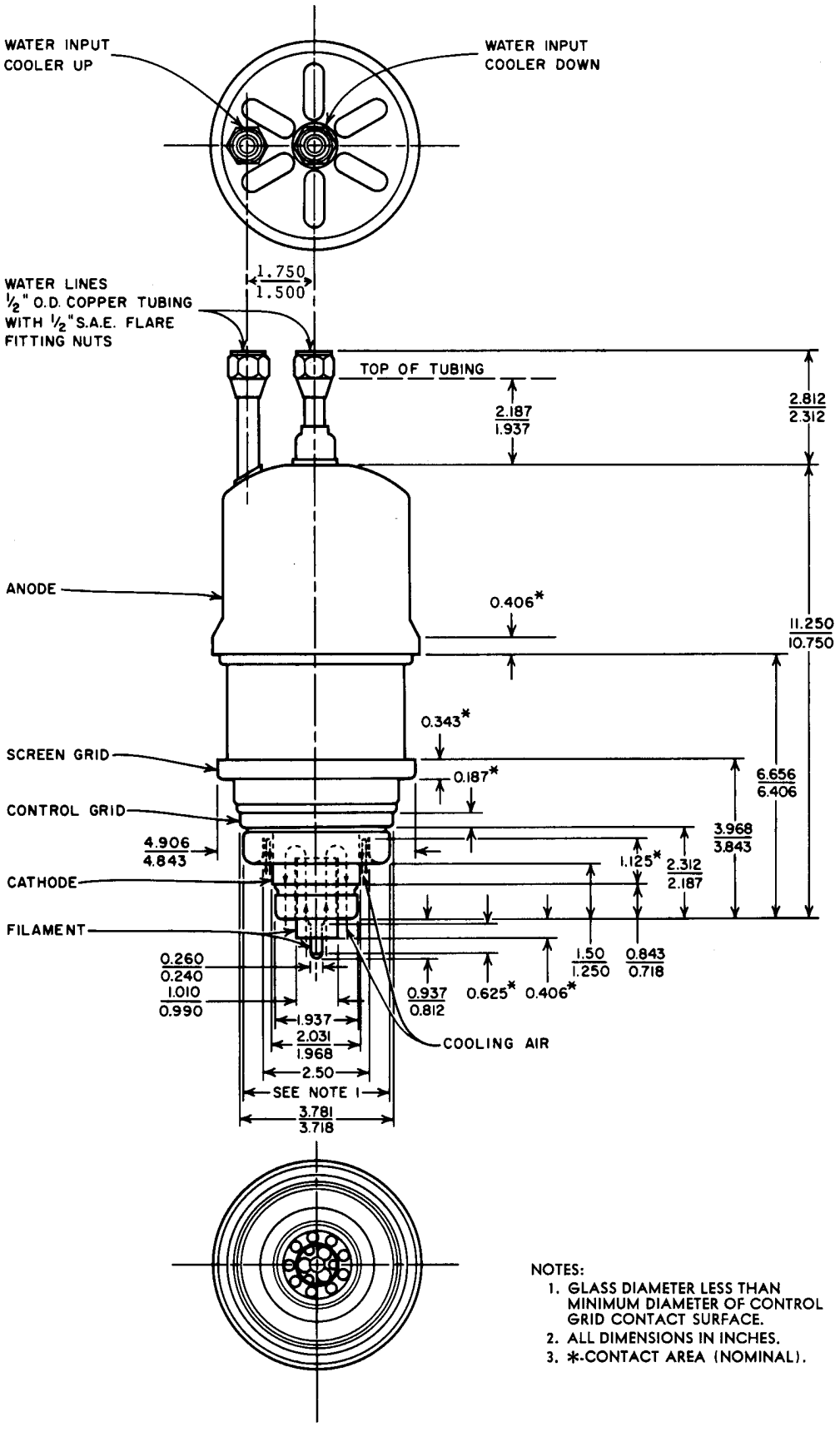


4W20,000A
CATHODE COLLET



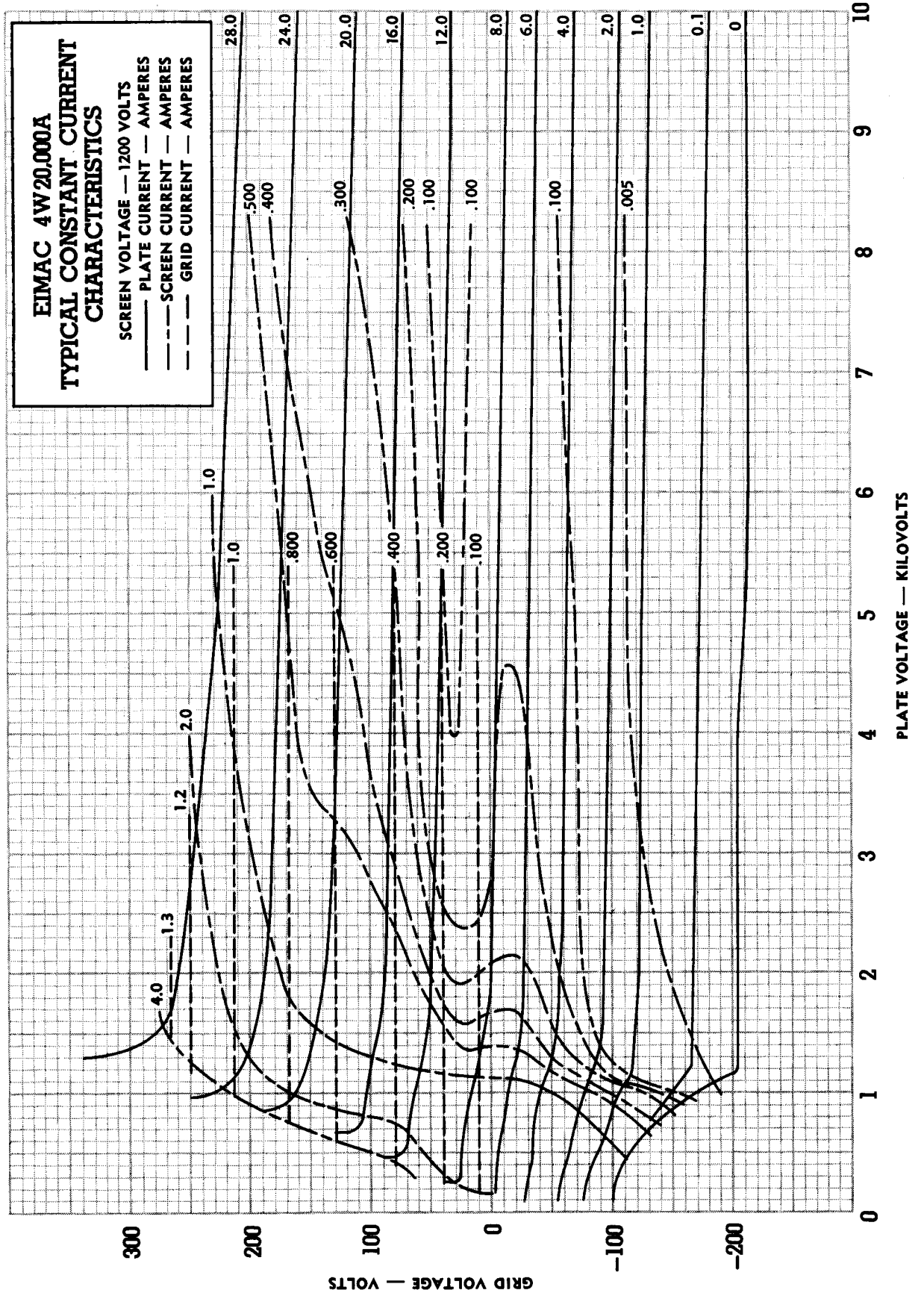
MATERIAL: BERYLLIUM COPPER
HEAT TREAT: R_C 40[1]
FINISH: SILVER PLATE APPROX. .0005" TO .001"

[1] 385°C FOR APPROX. 5–6 HRS. IN NON-REDUCING ATMOSPHERE



NOTES:

1. GLASS DIAMETER LESS THAN MINIMUM DIAMETER OF CONTROL GRID CONTACT SURFACE.
2. ALL DIMENSIONS IN INCHES.
3. *-CONTACT AREA (NOMINAL).



Printed in U.S.A. 194A

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8187
4PR65A

RADIAL-BEAM PULSE TETRODE

●

MODULATOR
OSCILLATOR
AMPLIFIER

The Eimac 8187/4PR65A is a pulse tetrode intended for use in pulse-modulator, pulsed-amplifier, and pulsed-oscillator service. This compact, high vacuum, radial-beam tetrode, incorporating a Pyrovac plate and non-emitting grids, is recommended for use in new equipments where high voltage, high current, or high duty factor is encountered.

Cooling of the tube is accomplished by radiation from the plate and by circulation of forced-air through the base and around the envelope.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated tungsten				
Voltage	-	6.0		volts
Current	3.2		3.8	amperes
Amplification Factor (Grid to Screen)	-	6.0		
Direct Interelectrode Capacitances, Grounded Cathode:†				
Grid-Plate	-	-	0.12	uuf
Input	6.0		8.3	uuf
Output	1.9		2.6	uuf
Highest Frequency for Maximum Ratings	-	-	150	mc

MECHANICAL

Base	5-pin
Basing	See drawing
Recommend Socket	National HX-29 or Johnson 122-101
Operating Position	Vertical, base down or up
Maximum Operating Temperatures:	
Base Seals	200°C
Plate Seal	225°C
Cooling	Radiation and forced-air
Recommended Heat-Dissipating Plate Connector	Eimac HR-6
Maximum Over-all Dimensions:	
Length	4.19 inches
Diameter	2.38 inches
Net Weight (tube only)	3 ounces
Shipping Weight	1.5 pounds

†In Shielded Fixture

PULSE MODULATOR SERVICE

MAXIMUM RATINGS

DC PLATE VOLTAGE	15 MAX. KILOVOLTS
DC SCREEN VOLTAGE	2.0 MAX. KILOVOLTS
DC GRID VOLTAGE	—1.0 MAX. KILOVOLT
PEAK PLATE CURRENT	1.0 MAX. AMPERES
PLATE DISSIPATION (AVG.)	65 MAX. WATTS
SCREEN DISSIPATION (AVG.)	10 MAX. WATTS
GRID DISSIPATION (AVG.)	5 MAX. WATTS

TYPICAL OPERATION

DC Plate Voltage	5	10	15 kilovolts
DC Screen Voltage	500	500	500 volts
DC Grid Voltage	—180	—225	—270 volts
Pulse Plate Voltage	4.35	9.35	14.35 kilovolts
Peak Plate Current	0.95	0.95	0.95 amperes
Pulse Screen Current	0.20	0.20	0.20 ampere
Pulse Grid Current	0.12	0.12	0.12 ampere
Pulse Pos. Grid Voltage	100	100	100 volts
Pulse Drive Power	33.6	39.0	44.5 watts
Pulse Plate Input Power	4.75	9.50	14.25 kilowatts
Pulse Plate Output Power	4.10	8.85	13.60 kilowatts
Duty	10	10	10 percent

(Effective 2-15-63) c 1968 by Varian

Printed in U.S.A.

RADIO-FREQUENCY PLATE AND SCREEN-PULSED AMPLIFIER AND OSCILLATOR*

MAXIMUM RATINGS

PEAK DC PLATE VOLTAGE	10 MAX. KILOVOLTS
DC SCREEN VOLTAGE	2.0 MAX. KILOVOLTS
D-C GRID VOLTAGE	—1.0 MAX. KOLOVOLT
PEAK CATHODE CURRENT (Note 1)	1.5 MAX. AMPERES
PLATE DISSIPATION (AVG.)	65 MAX. WATTS
SCREEN DISSIPATION (AVG.)	10 MAX. WATTS
GRID DISSIPATION (AVG.)	5 MAX. WATTS

*When used as a RF Plate-and Screen-Pulsed Amplifier, the grid drive must also be pulsed to avoid overheating this element during the inter-pulse periods.

TYPICAL OPERATION

Pulse Plate Voltage	5	7.5	10 kilovolts
Pulse Screen Voltage	500	500	500 volts
DC Grid Voltage	—265	—300	—335 volts
Pulse Plate Current (Note 1)	200	200	200 mA
Pulse Screen Current	20	20	20 mA
Pulse Grid Current	12	12	12 mA
Peak RF Grid Voltage	370	405	440 volts
Pulse Drive Power	4.5	4.85	5.3 watts
Pulse Plate Input Power	1000	1500	2000 watts
Pulse Plate Output Power	815	1270	1720 watts
Duty	35	28	23 percent

RADIO-FREQUENCY GRID-PULSED AMPLIFIER AND OSCILLATOR

MAXIMUM RATINGS

DC PLATE VOLTAGE	7.5 MAX. KILOVOLTS
DC SCREEN VOLTAGE	2.0 MAX. KILOVOLTS
DC GRID VOLTAGE	—1.0 MAX. KILOVOLT
PEAK CATHODE CURRENT (Note 1)	1.5 MAX. AMPERES
PLATE DISSIPATION (AVG.)	65 MAX. WATTS
SCREEN DISSIPATION (AVG.)	10 MAX. WATTS
GRID DISSIPATION (AVG.)	25 MAX. WATTS

TYPICAL OPERATION

DC Plate Voltage	4.5	6.0	7.5 kilovolts
DC Screen Voltage	500	500	500 volts
DC Grid Voltage	—260	—280	—300 volts
Pulse Plate Current (Note 1)	200	200	200 mA
Pulse Screen Current	20	20	20 mA
Pulse Grid Current	12	12	12 mA
Peak RF Grid Voltage	365	385	405 volts
Pulse Drive Power	4.4	4.6	4.9 watts
Pulse Plate Input Power	900	1200	1500 watts
Pulse Plate Output Power	725	1000	1265 watts
Duty	37	32	27 percent

Note 1: The maximum peak cathode current rating refers to the instantaneous peak cathode current available. This rating is based on available emission throughout life of 80 milliamperes per watt of filament power. The pulse plate current data shown under the Typical Operation section refers to the dc plate current component during the pulse.

APPLICATION

MECHANICAL

Mounting—The 8187/4PR65A must be operated vertically, base up or down. The socket must provide clearance for the glass tip-off which extends from the center of the base. A flexible connecting strap should be provided between the plate terminal and the external plate circuit, and the Eimac HR-6 connector (or equivalent) used on the tube plate lead. The socket must not apply lateral pressure against the base pins. The tube must be protected from severe vibration and shock.

Cooling—When the inlet air temperature does not exceed 30° C it will not ordinarily be necessary to provide forced-air cooling of the envelope or the plate seal at frequencies below 30 Mc. provided the HR-6 Heat-Radiating plate connector is used and the tube is so located that normal circulation of air past the envelope is not impeded.

In the event the inlet air temperature is expected to be greater than 30° C, adequate forced-air cooling must be provided to maintain base-seal and plate-seal temperatures below 200° C and 225° C, respectively. In all classes of operation it is recommended that a heat radiating connector, the Eimac HR-6 or equivalent, be installed on the anode terminal, and that a socket be employed which provides for proper seal cooling. When the Eimac 8187/4PR65A, utilizing an HR-6 heat radiator, is operated at dc or low frequencies in a Johnson 122-101 socket, the minimum airflow requirements to maintain seal temperatures at 200° C in 50° C inlet air are tabulated below:

	Sea Level		10,000 Feet	
Avg. Plate Dissipation (watts)	Air Flow (CFM)	Plenum Pressure Drop. (Inches of Water)	Air Flow (CFM)	Plenum Pressure Drop. (Inches of Water)
40	1.7	0.013	2.5	0.02
50	2.4	0.024	3.5	0.04
65	3.3	0.036	4.8	0.06

When the Eimac 8187/4PR65A is used as a pulsed-amplifier or oscillator at frequencies above 30 Mc, additional cooling may be required to compensate for the effects of plate and base-seal heating caused by rf charging currents and dielectric losses. Since the amount of seal heating varies with the particular application, it is suggested that the user monitor the seal temperatures to determine the adequacy of the cooling air.

Cooling air should be applied before or simultaneously with the application of filament voltage and may be removed simultaneously with filament voltage. In any questionable situation, the only criterion for adequate cooling is temperature. Tube temperature may be measured conveniently by using a temperature-sensitive paint.

ELECTRICAL

Filament Voltage—For maximum tube life the filament voltage, as measured directly at the filament pins, should be 6.0 volts. Variations in filament voltage must

be kept within the range of 5.7 to 6.3 volts.

When the 8187/4PR65A is utilized in pulse applications where high peak currents are demanded, filament voltage must be maintained at the rated value; the normally allowable five-percent variation in this voltage cannot be tolerated if the tube's peak-current capabilities are to be realized.

Element Dissipation—Under normal operating conditions, the average plate dissipation of the 8187/4PR65A should not be allowed to exceed 65 watts. Dissipation in excess of this maximum rating is permissable for short periods of time, such as during tuning procedures.

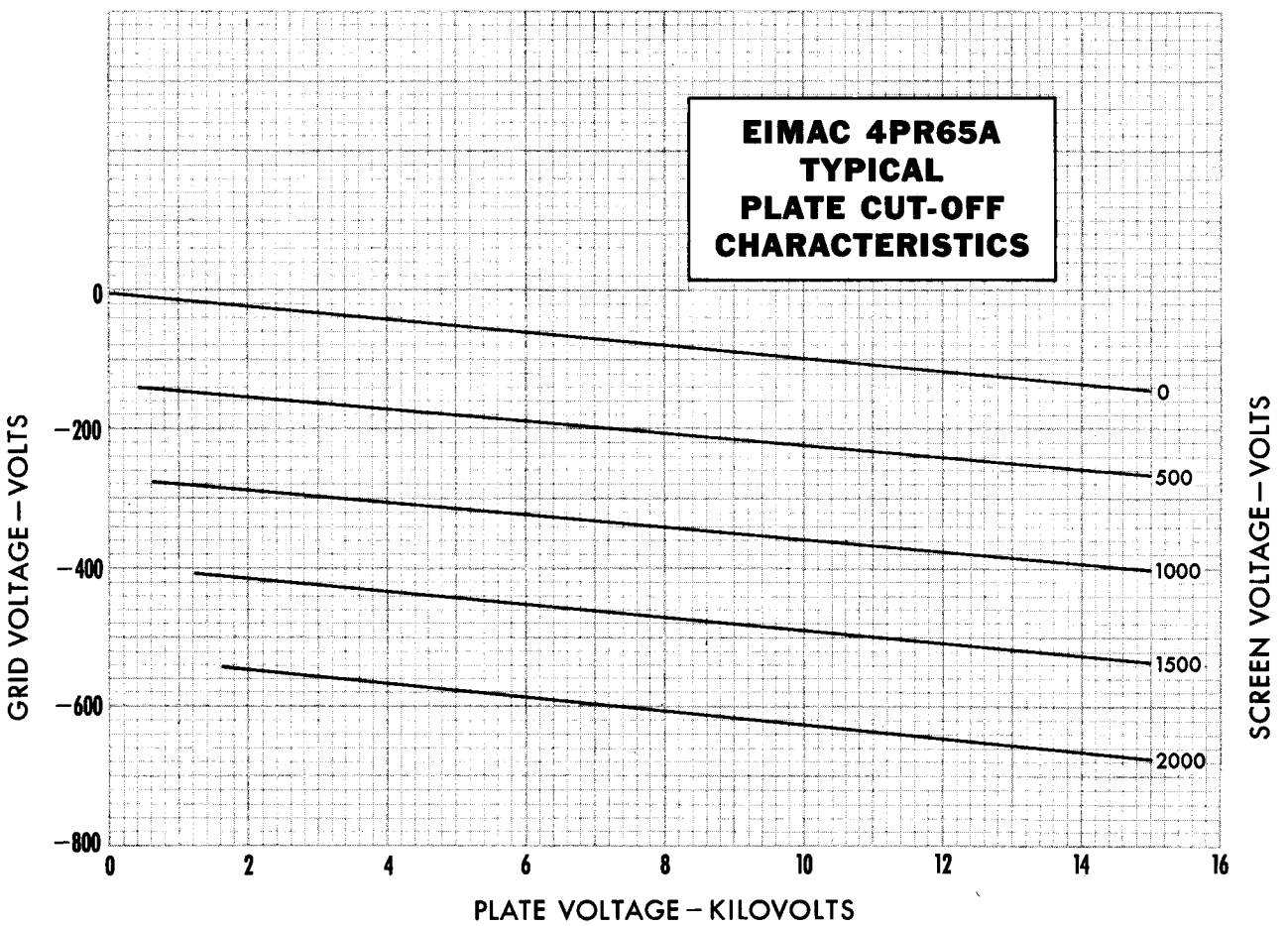
The average power dissipated by the screen-grid and the control-grid must not exceed 10 watts and 5 watts, respectively.

Cut-Off Characteristics—The Plate Current Cut-Off Characteristics of the 8187/4PR65A are shown in the graph below. These curves indicate the value of negative grid voltage required to maintain a plate-current flow of 50 microamperes or less at the various plate and screen voltages noted. These curves were plotted from a "typical" tube whose electrical characteristics closely approximate the mean value in the tube test specification.

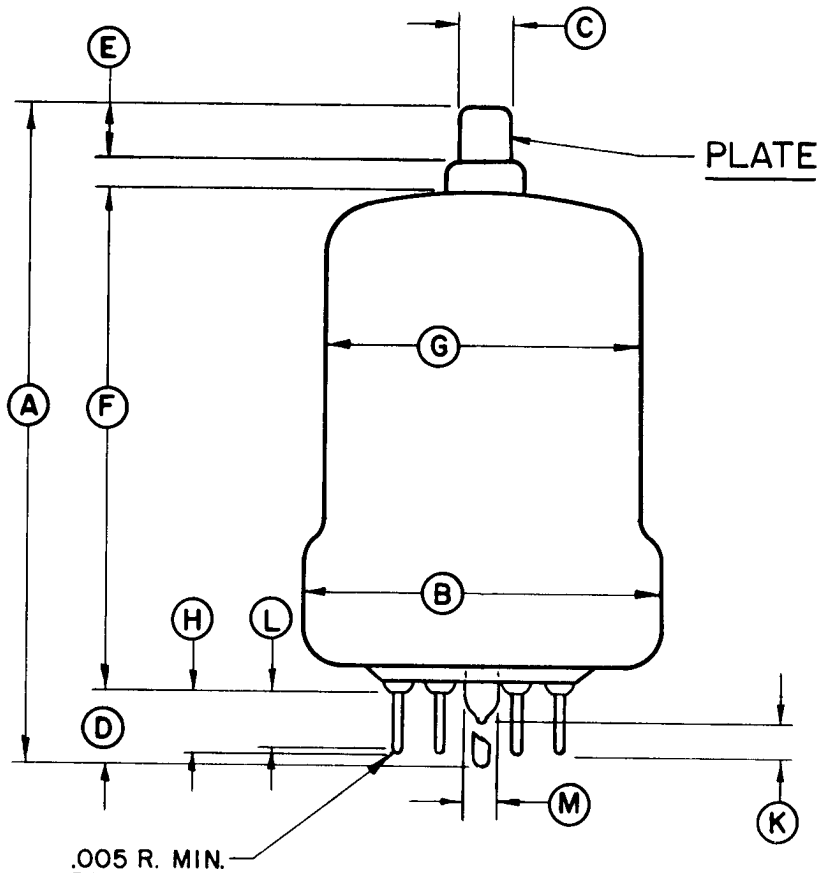
Each 8187/4PR65A is tested to insure proper cut-off characteristics at maximum ratings. This cut-off test is made with a plate voltage of 15 KV, a screen voltage of 1.5 KV with the grid voltage adjusted to maintain a plate current of 10 microamperes. Under these test conditions the negative grid bias must not exceed 575 volts. Due to tube-to-tube variations this cut-off point will vary and the typical range can be expected to be between 350 volts and 500 volts.

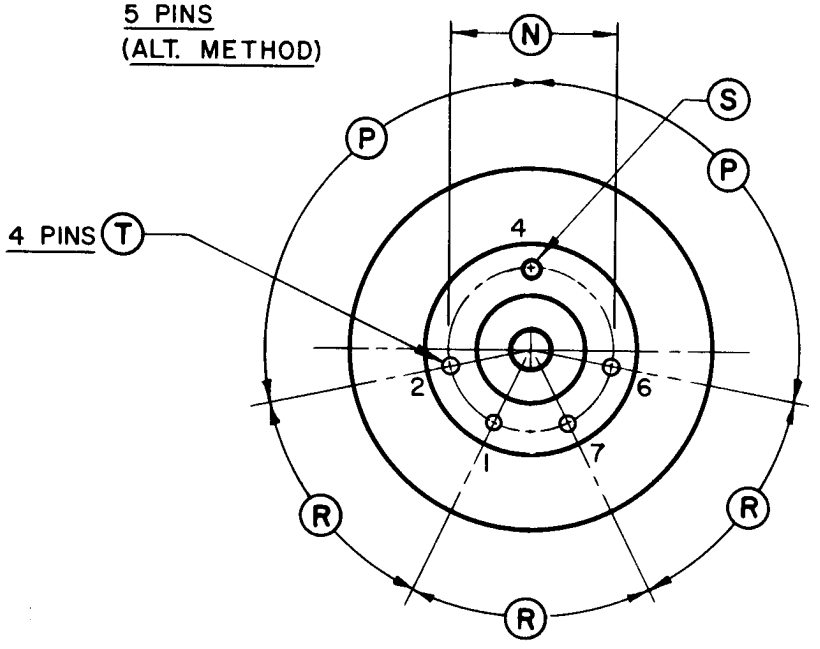
Pulse-Modulator Service—The data shown in the "Typical Operating" section of Pulse-Modulator Service was calculated assuming a rectangular plate voltage wave-form, ignoring the effects of shunt capacity. In reality, the total shunt capacitance (including the output capacity of the tube, stray capacitance, etc.) affects the output wave form and can have considerable effect on plate dissipation. Since the actual plate waveform is not rectangular, even though the grid pulse is, additional power will be dissipated during the rise time and can, under some circumstances, be much greater than that dissipated during the remainder of the pulse. The total power dissipated is then the sum of the power dissipated during the rise time and the power dissipated during the remainder of the pulse.

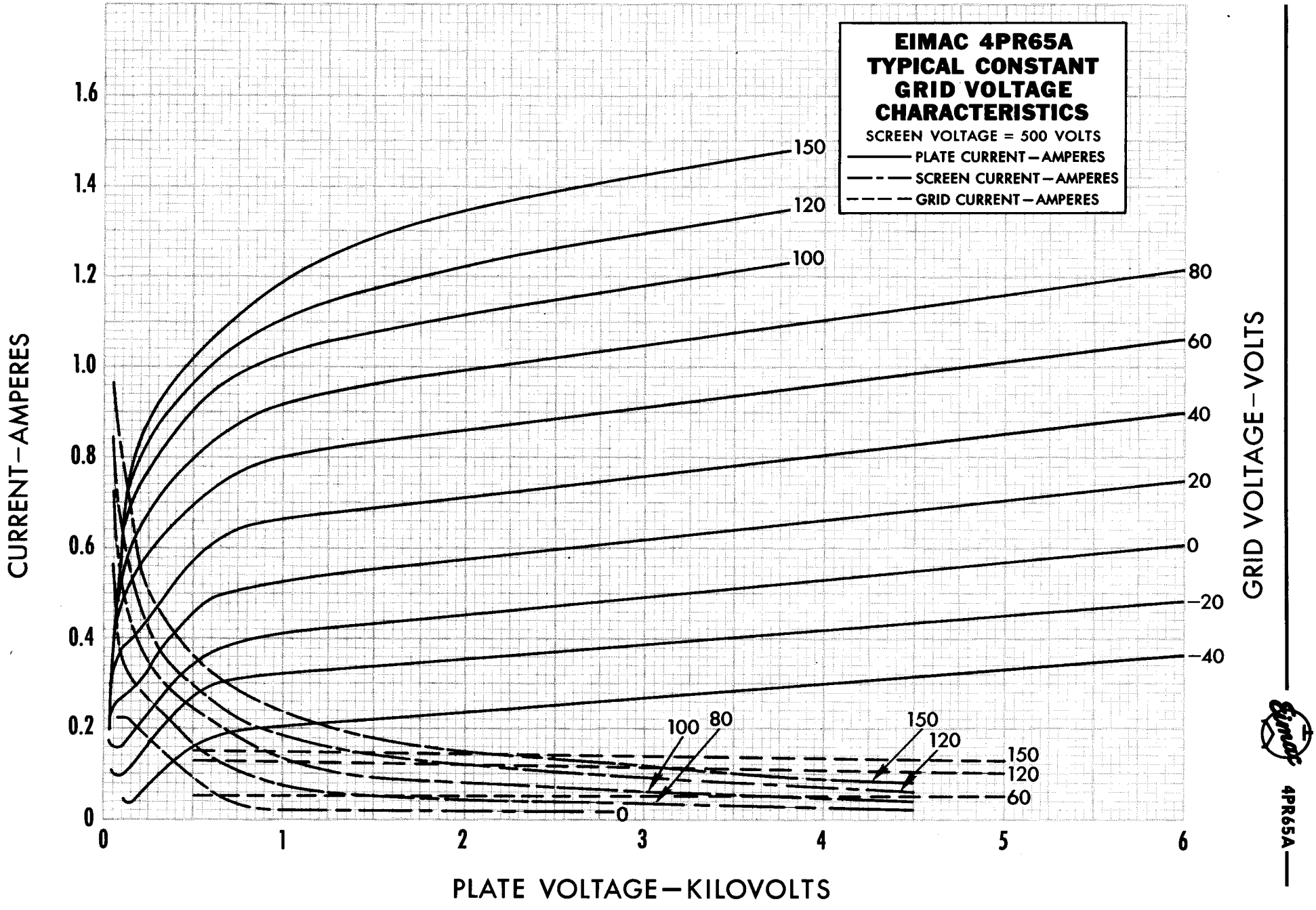
Special Applications—If it is desired to operate this tube under conditions widely different from those given here, please write to Power Grid Tube Marketing, Eimac, Division of Varian, 301 Industrial Way, San Carlos, California, for information and recommendations.

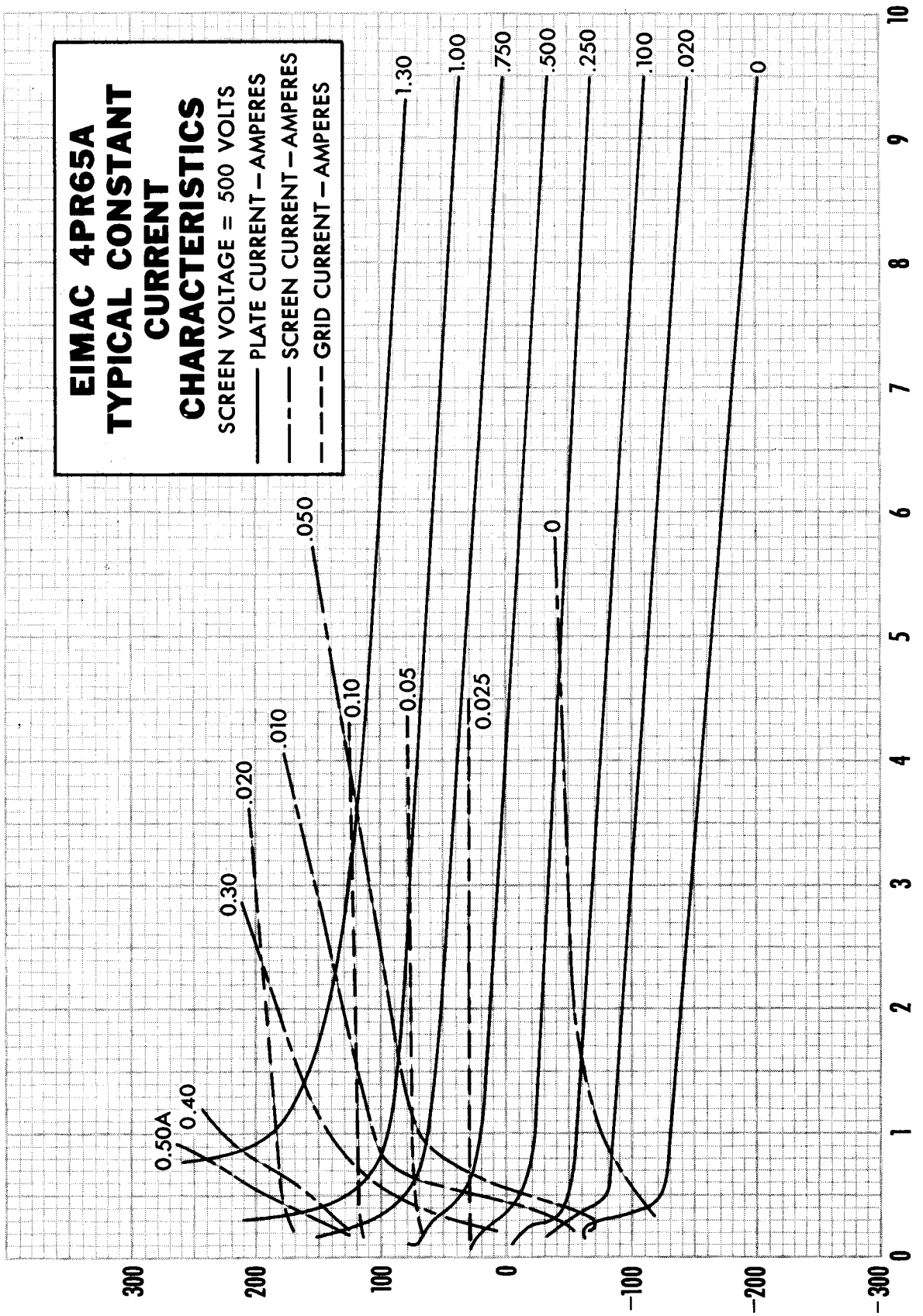


DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	4	4-3/16	
B		2-3/8	
C	.350	.365	
D	7/16	9/16	
E	21/64		
F	2-15/16	3-5/16	
G		2-1/8	
H	3/8	1/2	
K	.000		
L	5/16		
M		3/8	
N			1.000
P			102°
R			52°
S	.122 DIA.	.128 DIA.	
T	.055 DIA.	.061 DIA.	






EIMAC 4PR65A
TYPICAL CONSTANT
GRID VOLTAGE
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
CURRENT – AMPERES
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1
2
3
4
5
6
150
120
100
80
60
40
20
0
–20
–40


EIMAC 4PR65A
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
1.30
1.00
.750
.500
.250
.100
.020
0
.050
.010
.020
0.30
0.40
0.50A
0.10
0.05
0.025
0
300
200
100
0
−100
−200
−300
0
1
2
3
4
5
6
7
8
9
10
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS

8188
4PR400A

RADIAL-BEAM PULSE TETRODE MODULATOR OSCILLATOR AMPLIFIER

EIMAC

A Division of Varian Associates

SAN CARLOS, CALIFORNIA

The Eimac 8188/4PR400A is a pulse tetrode intended for use in pulse-modulator, pulsed-amplifier, and pulsed-oscillator service. This compact, high vacuum, radial-beam tetrode, incorporating a Pyrovac plate and non-emitting grids, is recommended for use in new equipments where high voltage, high current, or high duty factor is encountered.

Cooling of the tube is accomplished by radiation from the plate and by circulation of forced-air through the base and around the envelope. Cooling can be simplified by the use of the Eimac SK-410 Air-System Socket and the SK-406 Air Chimney.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage	-	5.0		volts
Current	13.5		14.7	amperes
Amplification Factor (Grid to Screen)	-	5.1		
Direct Interelectrode Capacitances, Grounded Cathode:*				
Grid-Plate	-	-	0.17	uuf
Input	10.7		14.5	uuf
Output	4.2		5.6	uuf
Transconductance (1_b = 100 ma)	-	4,000		umhos
Highest Frequency for Maximum Ratings	-	-	110	mc

MECHANICAL

Base	5-pin metal shell
Basing	See drawing
Recommend Socket	Eimac SK-410 Air-System Socket
Operating Position	Vertical, base down or up
Maximum Operating Temperatures:	
Base Seals	200° C
Plate Seal	225° C
Cooling	Radiation and forced-air
Recommended Heat-Dissipating Plate Connector	Eimac HR-6
Maximum Over-all Dimensions	
Length	6.38 inches
Diameter	3.56 inches
Net Weight (tube only)	9 ounces
Shipping Weight	2.5 pounds

*In Shielded Fixture

PULSE MODULATOR SERVICE

MAXIMUM RATINGS	
DC PLATE VOLTAGE	20 MAX. KILOVOLTS
DC SCREEN VOLTAGE	2.5 MAX. KILOVOLTS
DC GRID VOLTAGE	-1.0 MAX. KILOVOLT
PEAK PLATE CURRENT	4.0 MAX. AMPERES
PLATE DISSIPATION (AVG.)	400 MAX. WATTS
SCREEN DISSIPATION (AVG.)	35 MAX. WATTS
GRID DISSIPATION (AVG.)	10 MAX. WATTS

TYPICAL OPERATION			
DC Plate Voltage	10	15	20 kilovolts
DC Screen Voltage	1.5	1.5	1.5 kilovolts
DC Grid Voltage	-450	-490	-525 volts
Pulse Plate Voltage	8.25	13.25	18.25 kilovolts
Peak Pulse Current	3.5	3.5	3.5 amperes
Pulse Screen Current	0.40	0.40	0.40 ampere
Pulse Grid Current	0.06	0.06	0.06 ampere
Pulse Pos. Grid Voltage	60	60	60 volts
Pulse Drive Power	31.0	33.0	35.0 watts
Pulse Plate Input Power	35.0	52.5	70.0 kilowatts
Pulse Plate Output Power	29.0	46.5	64.0 kilowatts
Duty	5.5	5.5	5.5 percent

(Revised 9-15-65) © Copyright 1962, 1964 by Varian Associates

RADIO-FREQUENCY PLATE AND SCREEN-PULSED AMPLIFIER AND OSCILLATOR*

MAXIMUM RATINGS	
PEAK DC PLATE VOLTAGE	15 MAX. KILOVOLTS
DC SCREEN VOLTAGE	2.5 MAX. KILOVOLTS
DC GRID VOLTAGE	-1.0 MAX. KILOVOLT
PEAK CATHODE CURRENT**	5.4 MAX. AMPERES
PLATE DISSIPATION (AVG.)	400 MAX. WATTS
SCREEN DISSIPATION (AVG.)	35 MAX. WATTS
GRID DISSIPATION (AVG.)	10 MAX. WATTS

*When used as a rf Plate-and Screen-Pulsed Amplifier, the grid drive must also be pulsed to avoid over-heating this element during the inter-pulse periods.

TYPICAL OPERATION			
Pulse Plate Voltage	10	12.5	15 kilovolts
Pulse Screen Voltage	1.5	1.5	1.5 kilovolt
DC Grid Voltage	-725	-750	-785 volts
Pulse Plate Current**	0.87	0.87	0.87 ampere
Pulse Screen Current	70	70	70 ma
Pulse Grid Current	10	10	10 ma
Peak RF Grid Voltage	845	870	905 volts
Pulse Drive Power	8.5	8.7	9.0 watts
Pulse Plate Input Power	8.7	11.0	13.0 kilowatts
Pulse Plate Output Power	6.8	8.8	10.5 kilowatts
Duty	20	18	16 percent

RADIO-FREQUENCY GRID-PULSED AMPLIFIER AND OSCILLATOR

MAXIMUM RATINGS	
DC PLATE VOLTAGE	10 MAX. KILOVOLTS
DC SCREEN VOLTAGE	2.5 MAX. KILOVOLTS
DC GRID VOLTAGE	-1.0 MAX. KILOVOLT
PEAK CATHODE CURRENT**	5.4 MAX. AMPERES
PLATE DISSIPATION (AVG.)	400 MAX. WATTS
SCREEN DISSIPATION (AVG.)	35 MAX. WATTS
GRID DISSIPATION (AVG.)	10 MAX. WATTS

TYPICAL OPERATION			
DC Plate Voltage	5	7.5	10 kilovolts
DC Screen Voltage	1.5	1.5	1.5 kilovolts
DC Grid Voltage	-680	-700	-725 volts
Pulse Plate Current**	0.87	0.87	0.87 ampere
Pulse Screen Current	70	70	70 ma
Pulse Grid Current	10	10	10 ma
Peak RF Grid Voltage	800	820	845 volts
Pulse Drive Power	8.0	8.2	8.5 watts
Pulse Plate Input Power	4.3	6.5	8.7 kilowatts
Pulse Plate Output Power	2.7	4.7	6.6 kilowatts
Duty	25	22	19 percent

** The maximum peak cathode current rating refers to the instantaneous peak cathode current available. This rating is based on available emission throughout life of 80 milliamperes per watt of filament power. The pulse plate current data shown under the Typical Operation section refers to the dc plate current component during the pulse.

APPLICATION

MECHANICAL

Mounting— The 4PR400A must be operated vertically, base up or down. When the SK-410 Air-System Socket is used in conjunction with the SK-406 Air Chimney, the socket must be mounted to the under surface of the chassis to maintain proper air space between the plate seal and the chimney opening, otherwise plate seal cooling will be seriously impaired.

In the event the SK-410 Air-System Socket is not used, the socket must provide clearance for the glass tip-off which extends from the center of the tube. The metal tube-base shell should be grounded by means of suitable spring fingers.

Cooling— Adequate forced-air cooling must be provided to maintain base-seal and plate-seal temperatures below 200° C and 225° C, respectively. In all classes of operation it is recommended that a heat-radiating connector, the Eimac HR-6 or equivalent, be installed on the anode terminal, and that a socket and chimney be employed which provides for proper seal cooling. When the Eimac 4PR400A is operated at d-c or low frequencies in an Eimac SK-410 Air System Socket, complete with SK-406 Air Chimney and HR-6 Heat Radiator, the minimum airflow requirements to maintain seal temperatures at 200° C in 50° C inlet air are tabulated:

	Sea Level		10,000 Feet	
Ave. Plate Dissipation (watts)	Air Flow (CFM)	Plenum Pressure Drop. (Inches of Water)	Air Flow (CFM)	Plenum Pressure Drop. (Inches of Water)
200	6.5	0.045	9.5	0.063
300	8.5	0.076	12.5	0.110
400	10.5	0.125	15.5	0.180

When the Eimac 4PR400A is used as a pulsed-amplifier or oscillator at frequencies above 30 Mc, additional cooling may be required to compensate for the effects of plate and base-seal heating caused by r-f charging currents and dielectric losses. Since the amount of seal heating varies with the particular application, it is suggested that the user monitor the seal temperatures to determine the adequacy of the cooling air.

Cooling air should be applied before or simultaneously with the application of filament voltage and may be removed simultaneously with filament voltage. In any questionable situation, the only criterion for adequate cooling is temperature. Tube temperature may be measured conveniently by using a temperature-sensitive paint.

ELECTRICAL

Filament Voltage— For maximum tube life the filament voltage, as measured directly at the filament pins, should be 5.0 volts. Variations in filament voltage must be kept within the range of 4.75 to 5.25 volts.

When the 4PR400A is utilized in pulse applications where high peak currents are demanded, filament voltage must be maintained at the rated value; the normally allowable five-percent variation in this voltage cannot be tolerated if the tube's peak-current capabilities are to be realized.

Element Dissipation— Under normal operating conditions, the average plate dissipation of the 4PR400A should not be allowed to exceed 400 watts. Dissipation in excess of this maximum rating is permissable for short periods of time, such as during tuning procedures.

The average power dissipated by the screen-grid and the control-grid must not exceed 35 watts and 10 watts, respectively.

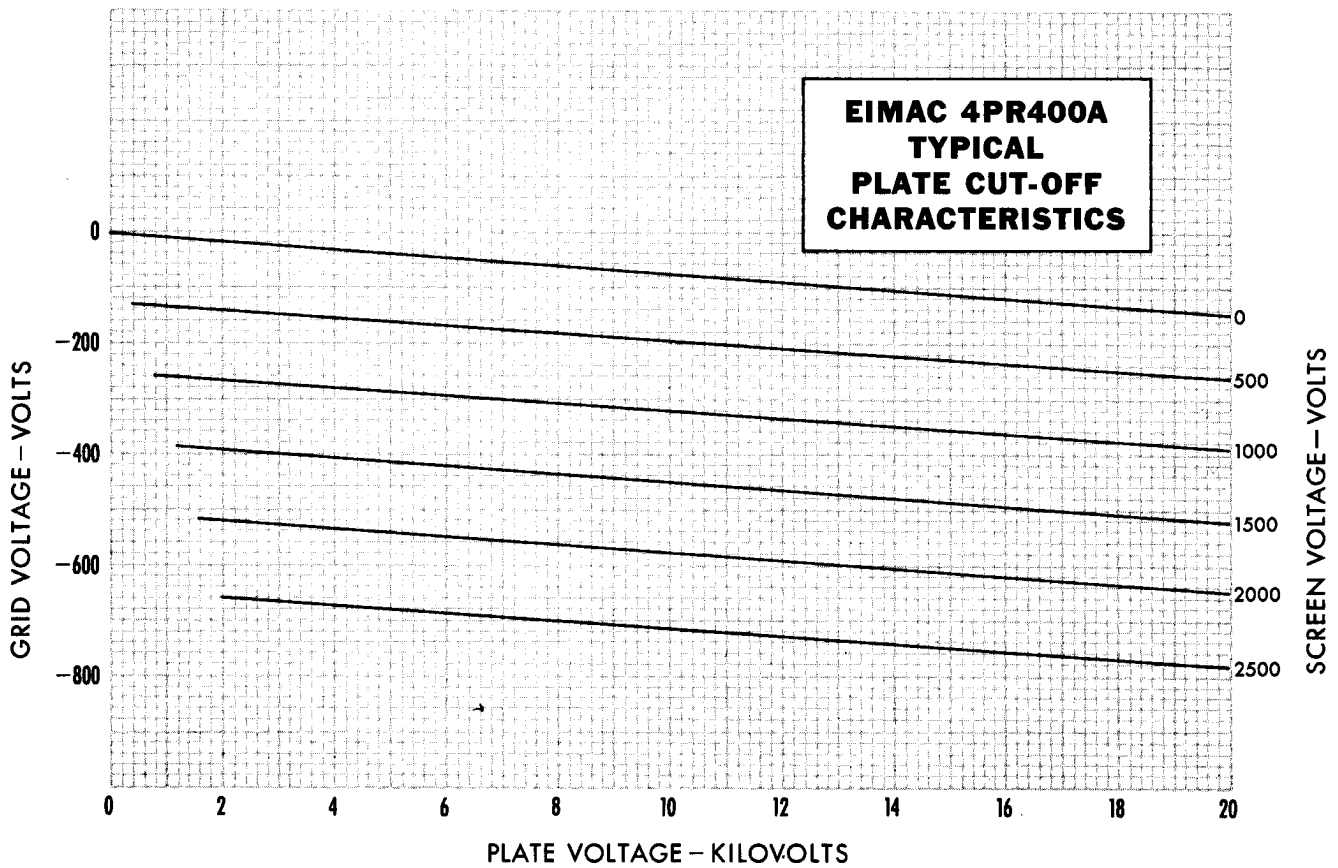
Cut-Off Characteristics— The Plate Current Cut-Off Characteristics of the 4PR400A are shown in the graph below. These curves indicate the value of negative grid voltage required to maintain a plate-current flow of 50 microamperes or less at the various plate and screen voltages noted. These curves were plotted from a "typical" tube whose electrical characteristics closely approximate the mean value in the tube test specification.

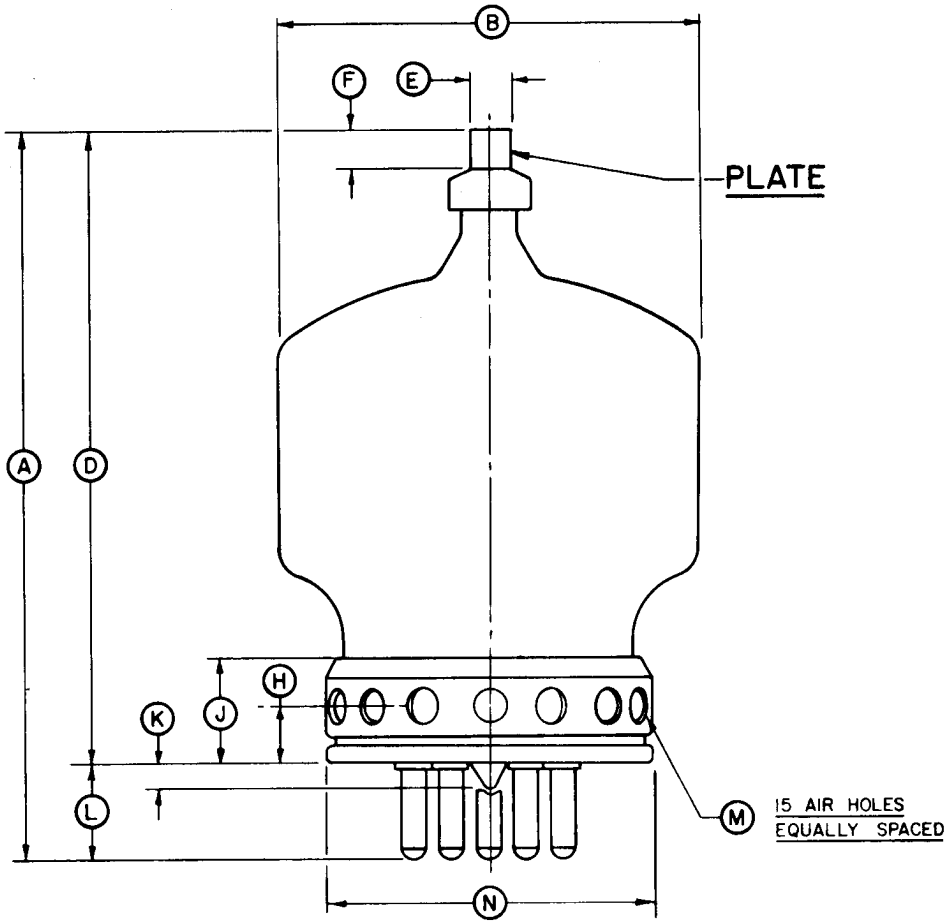
Each 4PR400A is tested to insure proper cut-off characteristics at maximum ratings. This cut-off test is made with a plate voltage of 20 KV, a screen voltage of 1.5 KV, with the grid voltage adjusted to maintain a plate current of 10 microamperes. Under these test conditions the negative grid bias must not exceed 675 volts. Due to tube-to-tube variation this cut-off point will vary and the typical range can be expected to be between -500 volts and -650 volts.

Pulse-Modulator Service— The data shown in the "Typical Operating" section of Pulse-Modulator Service was calculated assuming a rectangular plate voltage waveform, ignoring the effects of shunt capacity. In reality, the total shunt capacitance (including the output capacity of the tube, stray capacitance, etc.) affects the output wave form and can have considerable effect on plate dissipation. Since the actual plate wave form is not rectangular, even though the grid pulse is, additional power will be dissipated during the rise time and can, under some circumstances, be much greater than that dissipated during the remainder of the pulse. The total power dissipated is then the sum of the power dissipated during the rise time and the power dissipated during the remainder of the pulse.

Special Applications

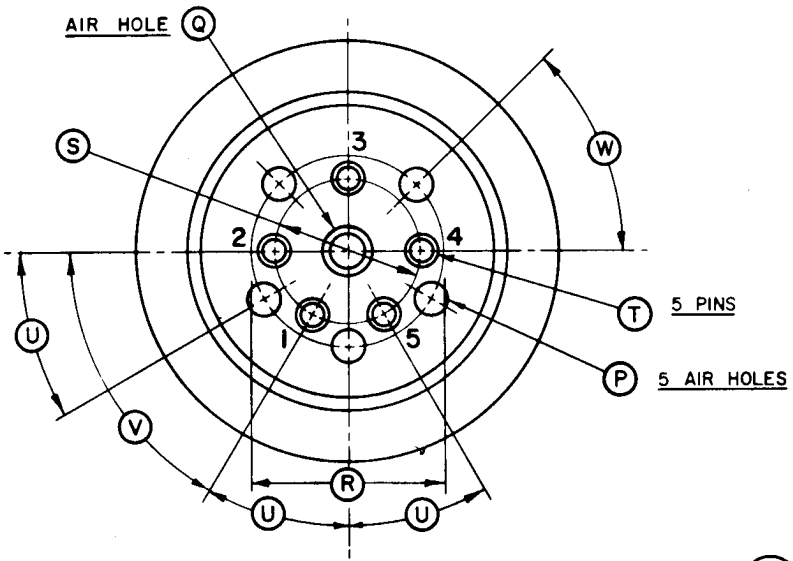
If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eimac Division of Varian Associates, 301 Industrial Way, San Carlos, California, for information and recommendations.



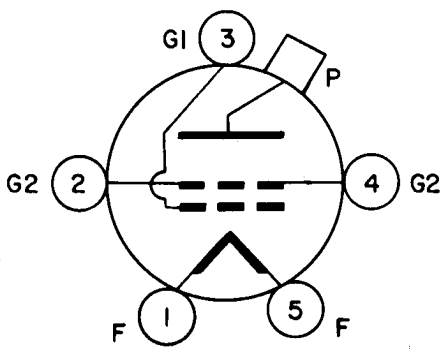


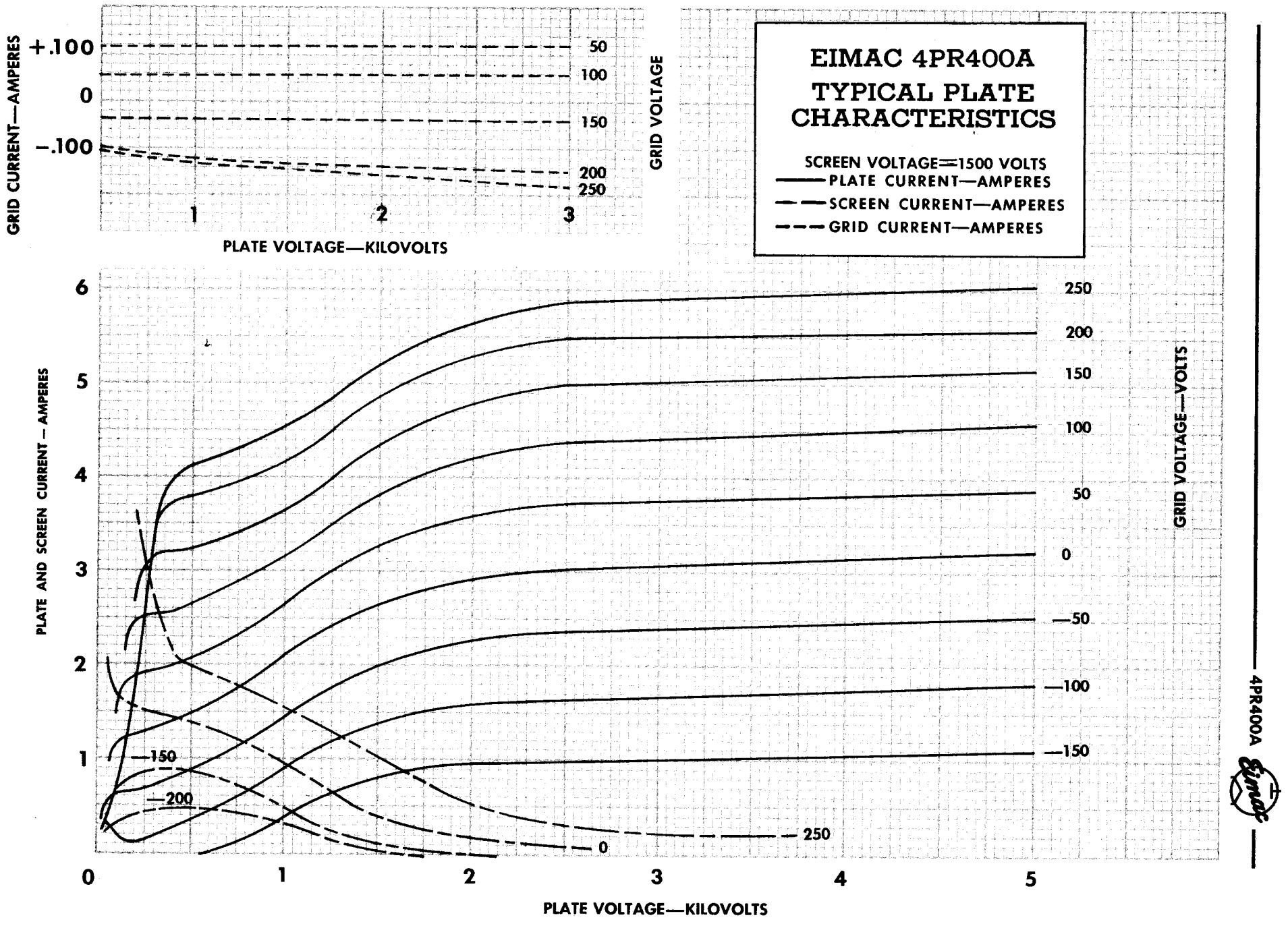
DIMENSIONS IN INCHES

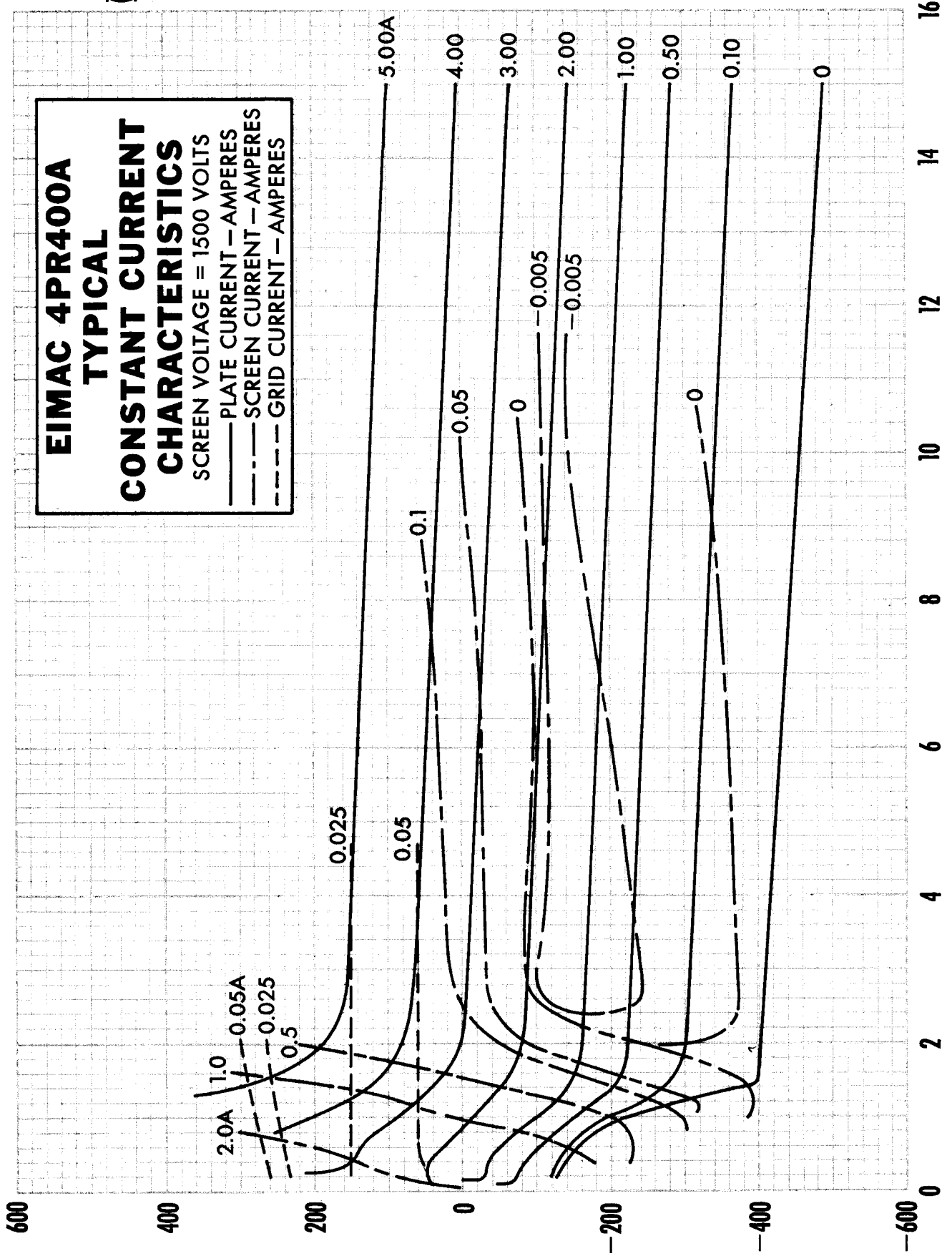
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	5-7/8	6-3/8	
B		3-9/16 D.	
D	5-1/8	5-5/8	
E	.350 DIA.	.365 DIA.	
F	21/64		
H			7/16
J		31/32	
K		1/4	
L			3/4
M			1/4 D.
N		2-3/4 D.	
P			5/16 D.
Q			1/2 D.
R			1-5/8 D.
S			1-1/4 D. P.C.
T	.185 DIA.	.191 DIA.	
U			30°
V			60°
W			45°



BOTTOM VIEW




EIMAC 4PR400A
TYPICAL PLATE
CHARACTERISTICS
SCREEN VOLTAGE=1500 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
GRID CURRENT—AMPERES
+.100
0
-.100
50
100
150
200
250
1
2
3
PLATE VOLTAGE—KILOVOLTS
GRID VOLTAGE
PLATE AND SCREEN CURRENT—AMPERES
6
5
4
3
2
1
0
250
200
150
100
50
0
—50
—100
—150
—150
—200
—250
0
1
2
3
4
5
PLATE VOLTAGE—KILOVOLTS
GRID VOLTAGE—VOLTS


EIMAC 4PR400A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
——PLATE CURRENT – AMPERES
—·—·—SCREEN CURRENT – AMPERES
– – – – GRID CURRENT – AMPERES
5.00A
4.00
3.00
2.00
1.00
0.50
0.10
0
0.1
0.05
0
−0.005
−0.005
0.025
0.05
2.0A
1.0
0.05A
0.025
0.5
600
400
200
0
−200
−400
−600
0
2
4
6
8
10
12
14
16
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8189
4PR1000A
RADIAL-BEAM PULSE TETRODE
•
MODULATOR OSCILLATOR AMPLIFIER

The Eimac 8189/4PR1000A is a pulse tetrode intended for use in pulse-modulator, pulsed-amplifier, and pulsed-oscillator service. This compact, high vacuum, radial-beam tetrode, incorporating a Pyrovac plate and non-emitting grids, is recommended for use in new equipments where high voltage, high current, or high duty factor is encountered.

Cooling of the tube is accomplished by radiation from the plate and by circulation of forced-air through the base and around the envelope. Cooling can be simplified by the use of the Eimac SK-510 Air-System Socket and the SK-506 Air Chimney.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated tungsten				
Voltage	-	7.5		volts
Current	20.0		22.7	amperes
Amplification Factor (Grid to Screen)	-	6.9		
Direct Interelectrode Capacitances, Grounded Cathode:†				
Grid-Plate	-	-	0.35	uuf
Input	23.8		32.4	uuf
Output	6.8		9.4	uuf
Transconductance (I_b=300 ma)	-	10,000		umhos
Highest Frequency for Maximum Ratings	-	-	110	mc

MECHANICAL

Base	5-pin metal shell
Basing	See drawing
Recommend Socket	Eimac SK-510 Air-System Socket
Operating Position	Vertcial, base down or up
Maximum Operating Temperatures:	
Base Seals	150°C
Plate Seal	200°C
Cooling	Radiation and forced-air
Recommended Heat-Dissipating Plate Connector	Eimac HR-8
Maximum Over-all Dimensions:	
Length	9.63 inches
Diameter	5.25 inches
Net Weight (tube only)	1.5 pounds
Shipping Weight	12 pounds

†In Shielded Fixture

PULSE MODULATOR SERVICE

MAXIMUM RATINGS

D-C PLATE VOLTAGE	30 MAX. KILOVOLTS
D-C SCREEN VOLTAGE	2.5 MAX. KILOVOLTS
D-C GRID VOLTAGE	—1.0 MAX. KILOVOLTS
PEAK PLATE CURRENT	8.0 MAX. AMPERES
PLATE DISSIPATION (AVE.)	1000 MAX. WATTS
SCREEN DISSIPATION (AVE.)	75 MAX. WATTS
GRID DISSIPATION (AVE.)	25 MAX. WATTS

TYPICAL OPERATION

D-C Plate Voltage	20	25	30 Kilovolts
D-C Screen Voltage	1.5	1.5	1.5 Kilovolts
D-C Grid Voltage	—335	—360	—380 Volts
Pulse Plate Voltage	17.7	22.7	27.7 Kilovolts
Peak Plate Current	8.0	8.0	8.0 Amperes
Pulse Screen Current	1.25	1.25	1.25 Amperes
Pulse Grid Current	0.2	0.2	0.2 Ampere
Pulse Pos. Grid Voltage	200	200	200 Volts
Pulse Drive Power	107	112	116 Watts
Pulse Plate Input Power	160	200	240 Kilowatts
Pulse Plate Output Power	140	180	220 Kilowatts
Duty	4.0	4.0	4.0 Percent

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RADIO-FREQUENCY PLATE AND SCREEN-PULSED AMPLIFIER AND OSCILLATOR*

MAXIMUM RATINGS	
PEAK D-C PLATE VOLTAGE	20 MAX. KILOVOLTS
D-C SCREEN VOLTAGE	2.5 MAX. KILOVOLTS
D-C GRID VOLTAGE	—1.0 MAX. KILOVOLTS
PEAK CATHODE CURRENT (Note 1)	12.0 MAX. AMPERES
PLATE DISSIPATION (AVE.)	1000 MAX. WATTS
SCREEN DISSIPATION (AVE.)	75 MAX. WATTS
GRID DISSIPATION (AVE.)	25 MAX. WATTS

*When used as a R-F Plate and Screen-Pulsed Amplifier, the grid drive must also be pulsed to avoid overheating this element during the inter-pulse periods.

TYPICAL OPERATION			
Pulse Plate Voltage	10	15	20 Kilovolts
Pulse Screen Voltage	1.5	1.5	1.5 Kilovolts
D-C Grid Voltage	—480	—510	—535 Volts
Pulse Plate Current (Note 1)	1.95	1.95	1.95 Amperes
Pulse Screen Current	0.32	0.32	0.32 Ampere
Pulse Grid Current	0.02	0.02	0.02 Ampere
Peak R-F Grid Voltage	735	760	785 Volts
Pulse Drive Power	14.7	15.2	15.7 Watts
Pulse Plate Input Power	19.5	29.3	39.0 Kilowatts
Pulse Plate Output Power	17.0	23.0	31.5 Kilowatts
Duty	15.0	15.0	12.0 Percent

RADIO-FREQUENCY GRID-PULSED AMPLIFIER AND OSCILLATOR

MAXIMUM RATINGS	
D-C PLATE VOLTAGE	15 MAX. KILOVOLTS
D-C SCREEN VOLTAGE	2.5 MAX. KILOVOLTS
D-C GRID VOLTAGE	—1.0 MAX. KILOVOLTS
PEAK CATHODE CURRENT (Note 1)	12.0 MAX. AMPERES
PLATE DISSIPATION (AVE.)	1000 MAX. WATTS
SCREEN DISSIPATION (AVE.)	75 MAX. WATTS
GRID DISSIPATION (AVE.)	25 MAX. WATTS

TYPICAL OPERATION			
D-C Plate Voltage	10	12.5	15 Kilovolts
D-C Screen Voltage	1.5	1.5	1.5 Kilovolts
D-C Grid Voltage	—480	—495	—510 Volts
Pulse Plate Current (Note 1)	1.95	1.95	1.95 Amperes
Pulse Screen Current	0.32	0.32	0.32 Ampere
Pulse Grid Current	0.02	0.02	0.02 Ampere
Peak R-F Grid Voltage	735	745	760 Volts
Pulse Drive Power	14.7	15.0	15.2 Watts
Pulse Plate Input Power	19.5	24.4	29.3 Kilowatts
Pulse Plate Output Power	17.0	18.6	23.0 Kilowatts
Duty	15.0	15.0	15.0 Percent

Note 1: The maximum peak cathode current rating refers to the instantaneous peak cathode current available. This rating is based on an available emission throughout life of 80 milliamperes per watt of filament power. The pulse plate current data shown under the Typical Operation sections refers to the d-c plate current component during the pulse.

APPLICATION

MECHANICAL

Mounting—The 4PR1000A must be operated vertically, base up or down. When the SK-510 Air-System Socket is used in conjunction with the SK-506 Air Chimney, the socket must be mounted to the under surface of the chassis to maintain proper air space between the plate seal and the chimney opening, otherwise plate seal cooling will be seriously impaired.

In the event the SK-510 Air-System Socket is not used, the socket must provide clearance for the glass tip-off which extends from the center of the tube. The metal tube-base shell should be grounded by means of suitable spring fingers.

COOLING—Adequate forced-air cooling must be provided to maintain base-seal and plate-seal temperatures below 150° C and 200° C, respectively. In all classes of operation it is recommended that a heat-radiating connector, the Eimac HR-8 or equivalent, be installed on the anode terminal, and that a socket and chimney be employed which provides for proper seal cooling. When the Eimac 4PR1000A is operated at d-c or low frequencies in an Eimac SK-510 Air System Socket, complete with SK-506 Air Chimney and HR-8 Heat Radiator, the minimum airflow requirements to maintain seal temperatures at 150° C in 50° C inlet air are tabulated below:

	Sea Level		10,000 Feet	
Ave. Plate Dissipation (watts)	Air Flow (CFM)	Plenum Pressure Drop. (Inches of Water)	Air Flow (CFM)	Plenum Pressure Drop. (Inches of Water)
600	17.0	0.30	24.0	0.45
800	20.0	0.40	28.0	0.56
1000	25.0	0.55	36.0	0.80

When the Eimac 4PR1000A is used as a pulsed-amplifier or oscillator at frequencies above 30 Mc, additional cooling may be required to compensate for the effects of plate and base-seal heating caused by r-f charging currents and dielectric losses. Since the amount of seal heating varies with the particular application, it is suggested that the user monitor the seal temperatures to determine the adequacy of the cooling air.

Cooling air should be applied before or simultaneously with the application of filament voltage and may be removed simultaneously with filament voltage. In any questionable situation, the only criterion for adequate cooling is temperature. Tube temperature may be measured conveniently by using a temperature-sensitive paint.

ELECTRICAL

Filament Voltage—For maximum tube life the filament voltage, as measured directly at the filament pins,

should be 7.5 volts. Variations in filament voltage must be kept within the range of 7.13 to 7.87 volts.

When the 4PR1000A is utilized in pulse applications where high peak currents are demanded, filament voltage must be maintained at the rated value; the normally allowable five-percent variation in this voltage cannot be tolerated if the tube's peak-current capabilities are to be realized.

Element Dissipation—Under normal operating conditions, the average plate dissipation of the 4PR1000A should not be allowed to exceed 1000 watts. Dissipation in excess of this maximum rating is permissable for short periods of time, such as during tuning procedures.

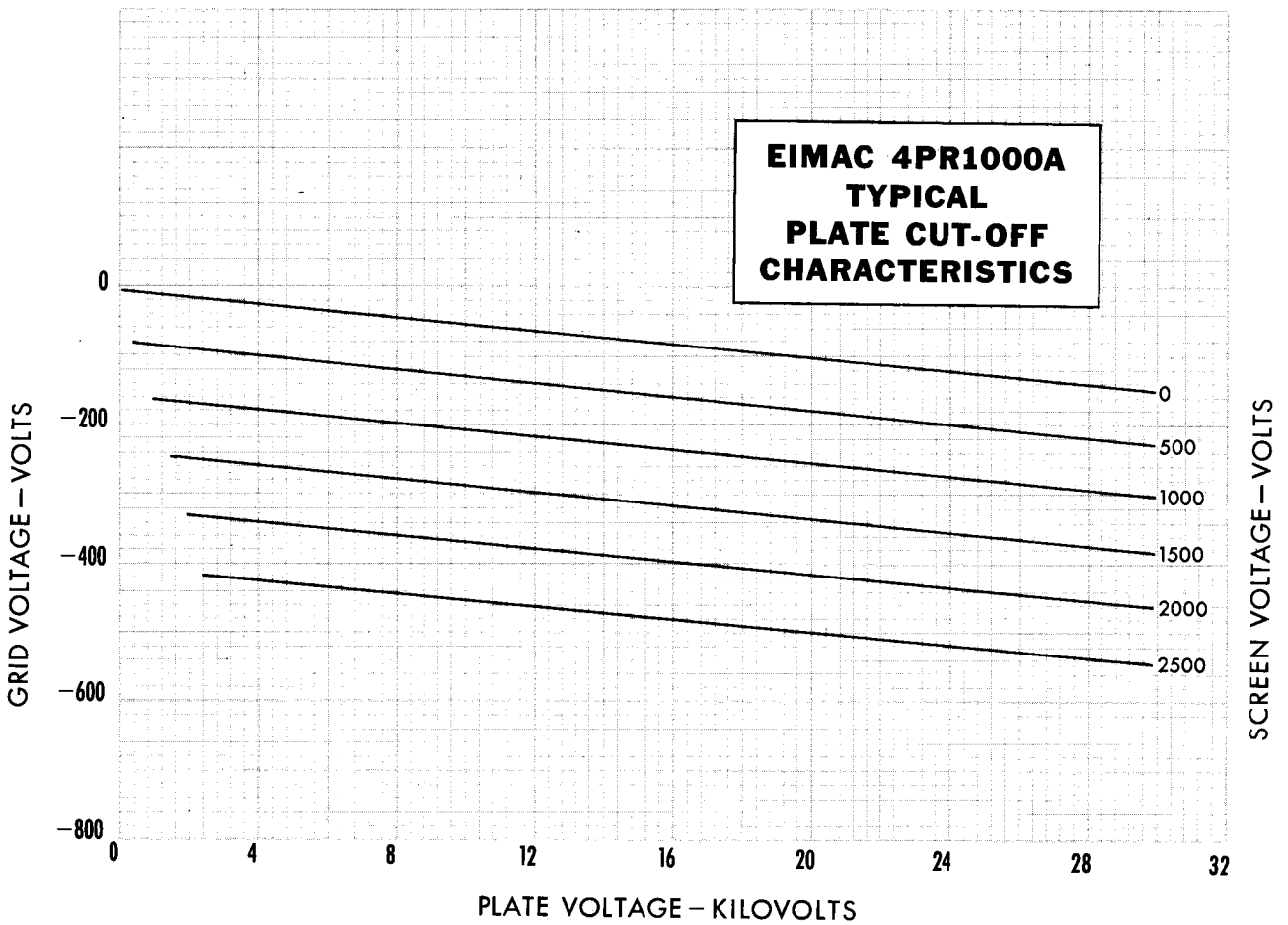
The average power dissipated by the screen-grid and the control-grid must not exceed 75 watts and 25 watts, respectively.

Cut-Off Characteristics—The Plate Current Cut-Off Characteristics of the 4PR1000A are shown in the graph below. These curves indicate the value of negative grid voltage required to maintain a plate-current flow of 50 microamperes or less at the various plate and screen voltages noted. These curves were plotted from a "typical" tube whose electrical characteristics closely approximate the mean value in the tube test specification.

Each 4PR1000A is tested to insure proper cut-off characteristics at maximum ratings. This cut-off test is made with a plate voltage of 30 KV, a screen voltage of 2.5 KV with the grid voltage adjusted to maintain a plate current of 10 microamperes. Under these test conditions the negative grid bias must not exceed 600 volts. Due to tube-to-tube variation this cut-off point will vary and the typical range can be expected to be between −470 volts and −585 volts.

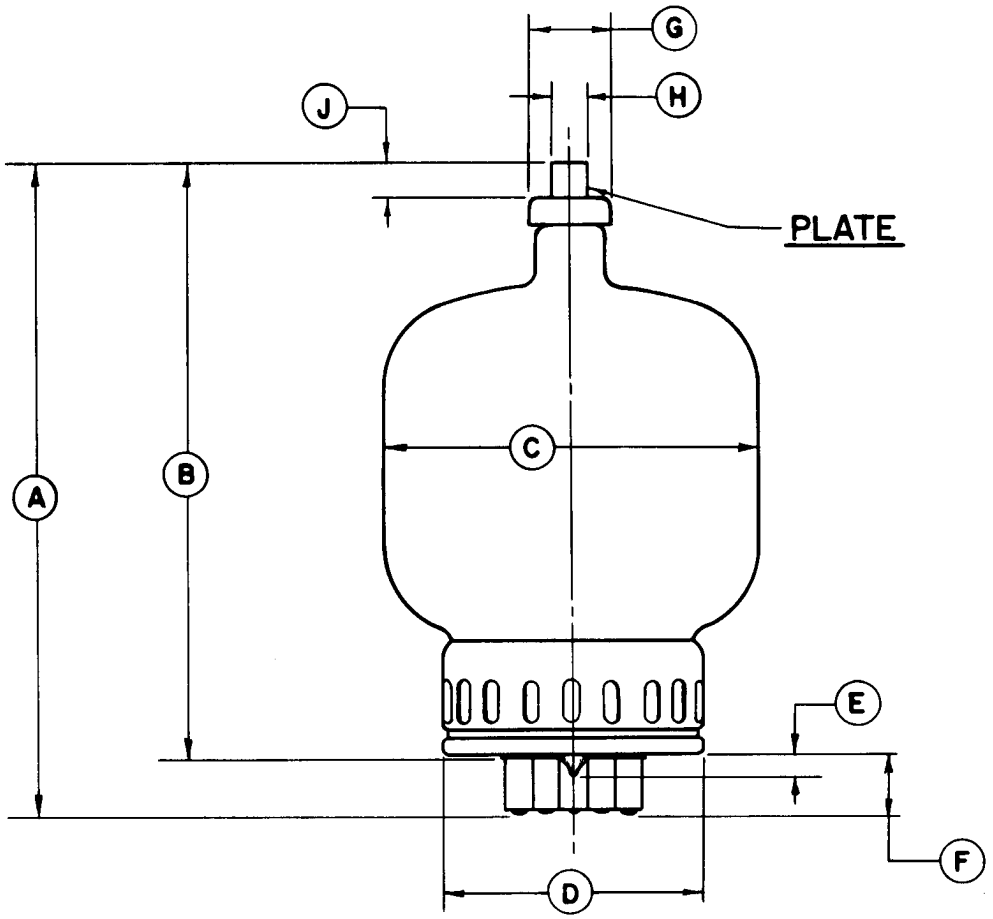
Pulse-Modulator Service—The data shown in the "Typical Operating" section of Pulse-Modulator Service was calculated assuming a rectangular plate voltage wave-form, ignoring the effects of shunt capacity. In reality, the total shunt capacitance (including the output capacity of the tube, stray capacitance, etc.) affects the output wave form and can have considerable effect on plate dissipation. Since the actual plate waveform is not rectangular, even though the grid pulse is, additional power will be dissipated during the rise time and can, under some circumstances, be much greater than that dissipated during the remainder of the pulse. The total power dissipated is then the sum of the power dissipated during the rise time and the power dissipated during the remainder of the pulse.

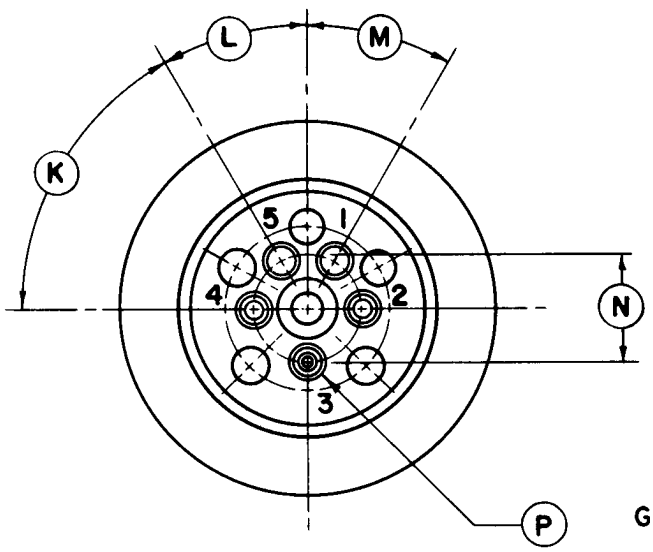
Special Applications — If it is desired to operate this tube under conditions widely different from those given here, please write to Power Grid Tube Marketing, Eimac, a division of Varian Associates, 301 Industrial way, San Carlos, California, for information and recommendations.



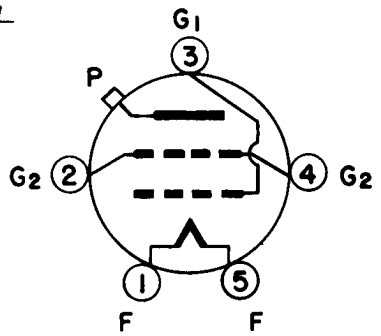
DIMENSIONS IN INCHES

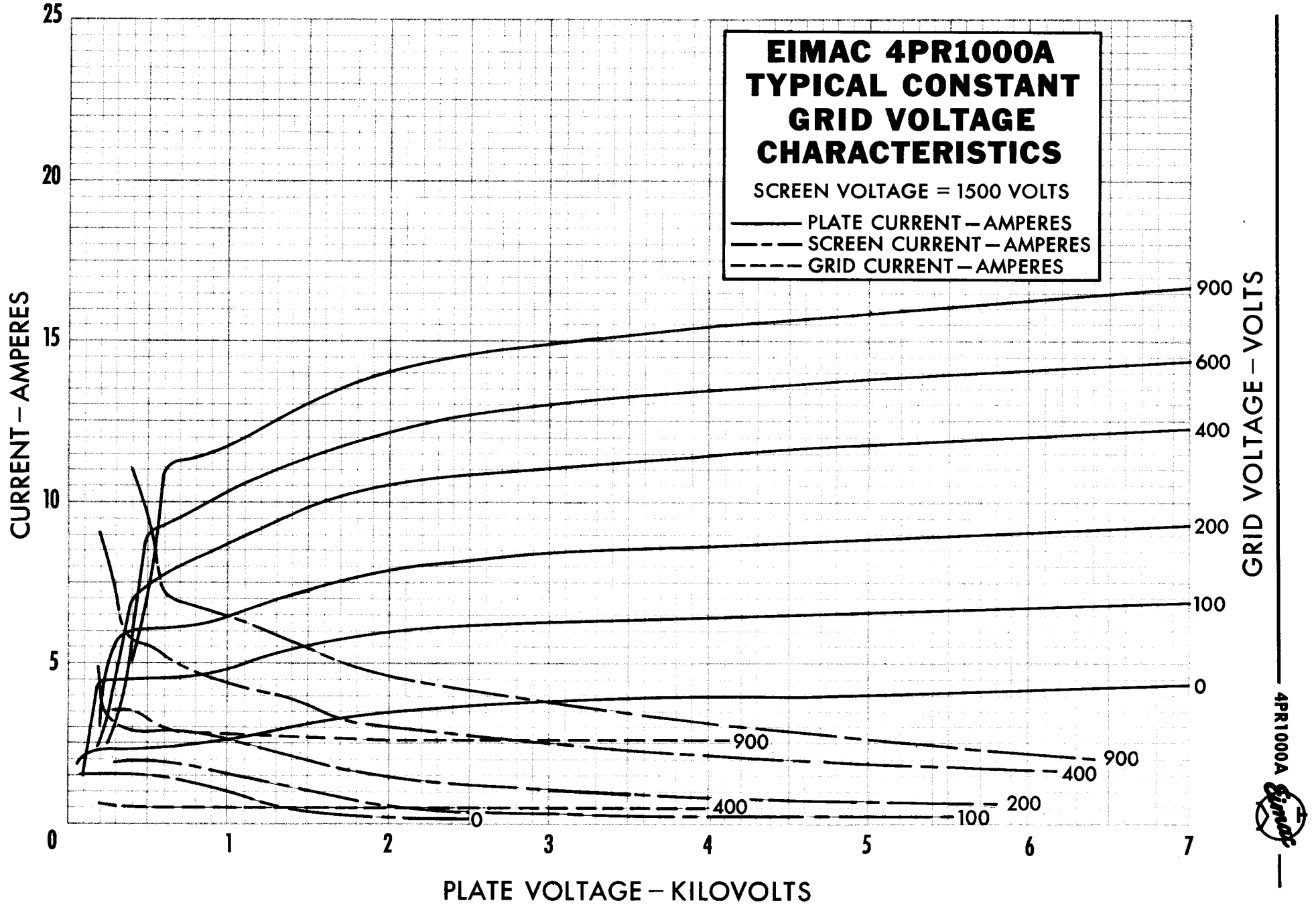
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	8.875	9.625	9.250
B	8.000	8.750	8.375
C		5.250	
D		3.625	
E		.313	
F	.825	.925	.875
G	1.110	1.140	1.250
H	.559	.573	.566
J	.484		
K			60°
L			30°
M			30°
N	1.495	1.505	1.500
P	.371	.377	.374

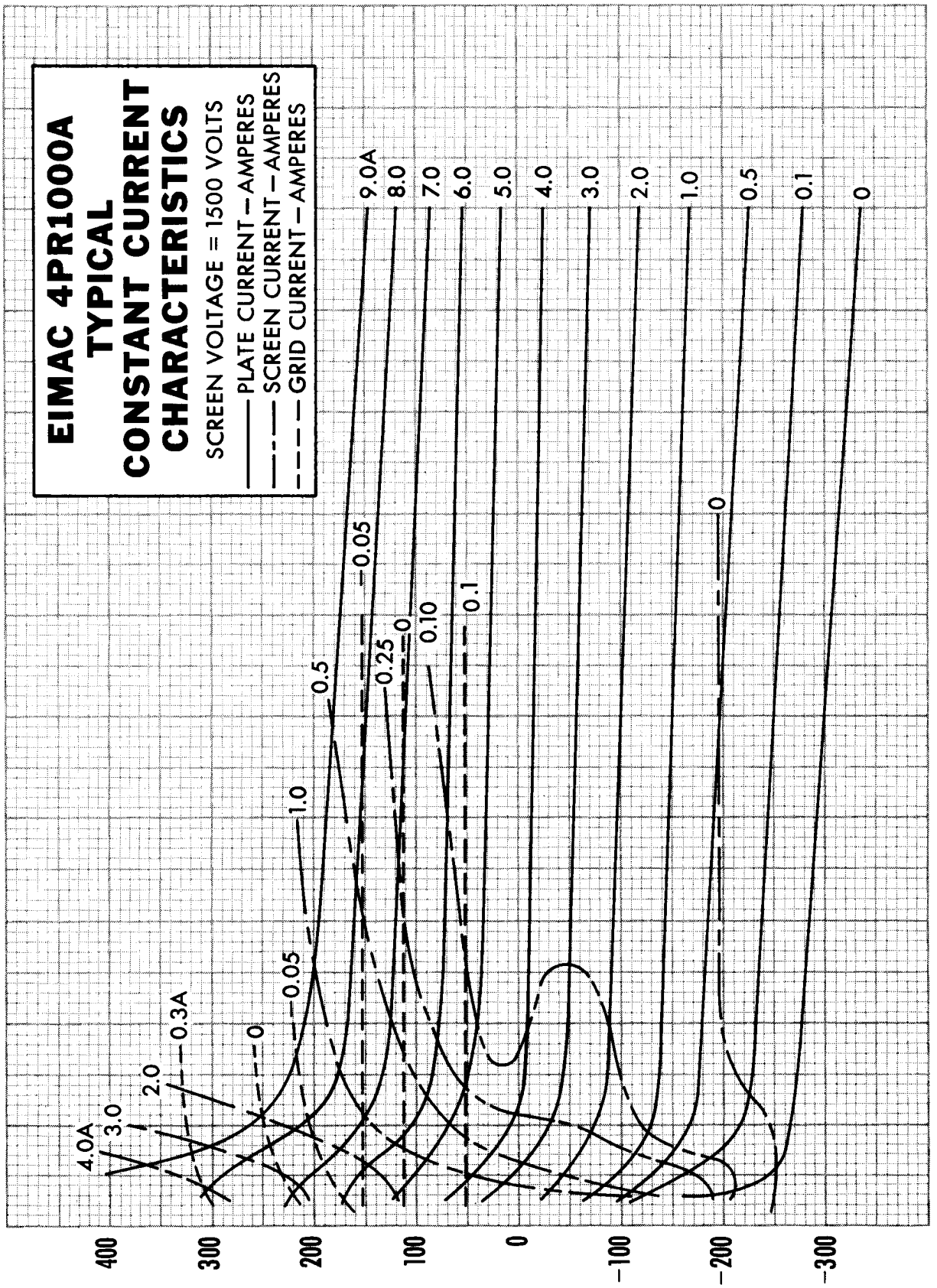




BOTTOM VIEW




EIMAC 4PR1000A
TYPICAL CONSTANT
GRID VOLTAGE
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
CURRENT – AMPERES
PLATE VOLTAGE – KILOVOLTS
GRID VOLTAGE – VOLTS
0
5
10
15
20
25
1
2
3
4
5
6
7
900
600
400
200
100
0
900
400
900
400
200
100
0
4PR1000A
Eimac


EIMAC 4PR1000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
9.0A
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.5
0.1
0
0.05
0.10
0.25
4.0A
3.0
2.0
0.3A
0
0.05
1.0
0.5
0.25
0
0.10
0.1
0
400
300
200
100
0
-100
-200
-300
0
2
4
6
8
10
12
14
16
18
20
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

8198
EM-778

TRAVELING WAVE TUBE
5.0 to 11.0 Gc.
1 Watt Min.
60 db Gain



TENTATIVE DATA FOR EIMAC EM-778 TRAVELING WAVE TUBE

The Eimac 8198/EM-778 is a ruggedized, ceramic and metal, periodic permanent magnet focused, power-amplifier traveling wave tube. It is capable of delivering a minimum CW output power of one watt throughout the frequency range of 5.0 to 11.0 gigacycles with a nominal small signal gain of 60 decibels. The 8198/EM-778 is designed to operate under severe environmental extremes of shock, vibration, temperature and altitude such as encountered in airborne applications.

The use of temperature compensated permanent magnets allows the 8198/EM-778 to be operated over a wide temperature range without degradation of performance. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	−50 dbm
Minimum Saturated Output Power	1 watt
Frequency Range	5.0 to 11.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3000 VOLTS
D-C FOCUS ELECTRODE VOLTAGE*:	
NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	25 MILLIAMPERES

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TYPICAL OPERATING CHARACTERISTICS

Frequency	5.0 to 11.0 gigacycles
Minimum Output Power	1.0 watt
Small Signal Gain	60 decibels
D-C Beam Voltage*	2900 volts
D-C Cathode Current	23 milliamperes
D-C Focus Electrode Voltage*	−30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-778 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-778 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

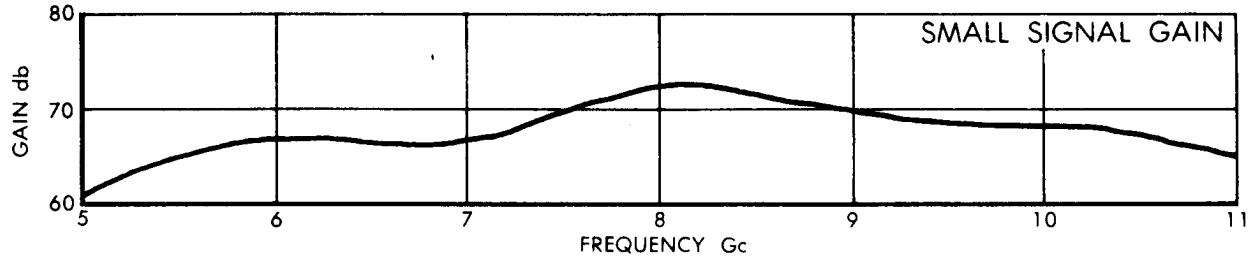
Temperature: −54°C to + 85°C

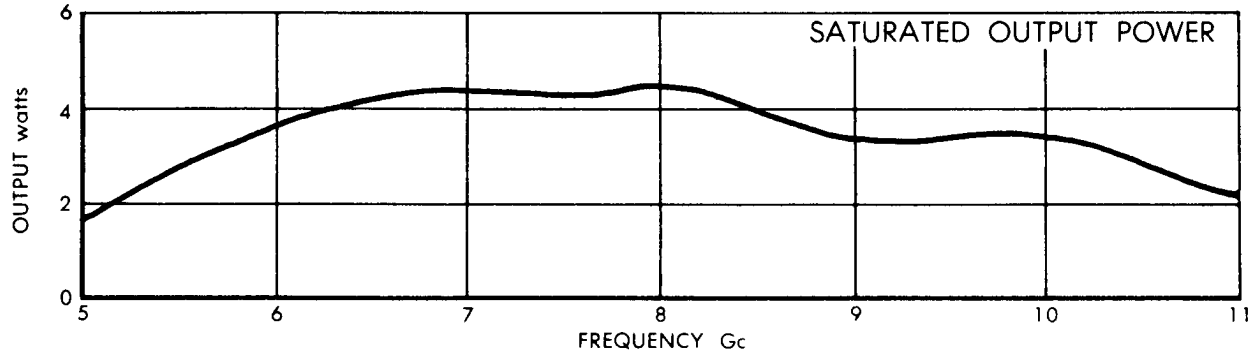
Altitude: 70,000 ft.

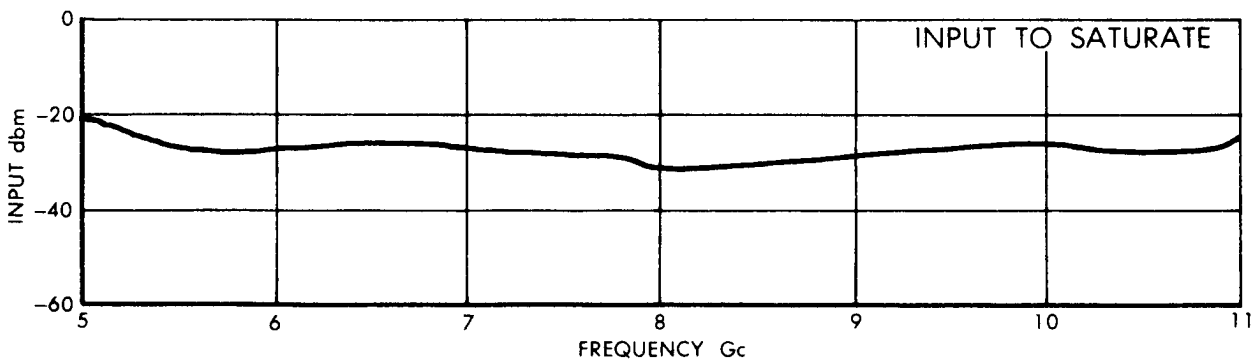
NOTE: This data should not be used for final equipment design.

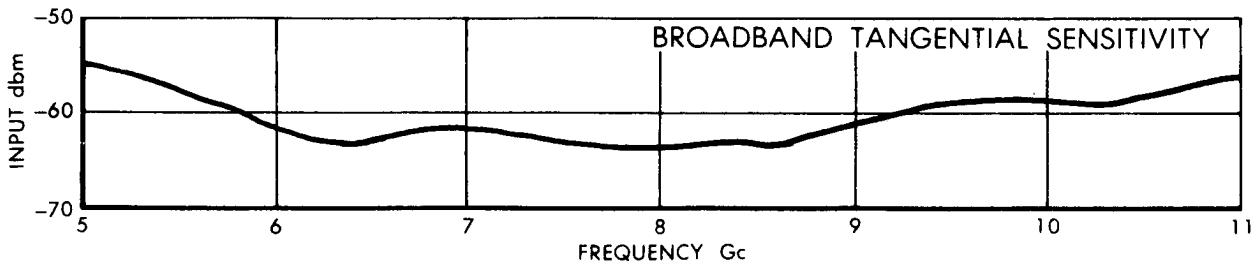
EM-778 TYPICAL OPERATING CHARACTERISTICS

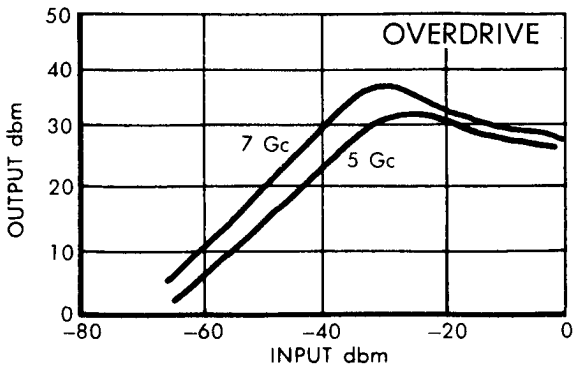
ANODE VOLTAGE	2900 Vdc	FOCUS VOLTAGE	−30 V dc
CATHODE CURRENT	23 mAdc	FILAMENT VOLTAGE	6.3 Vac

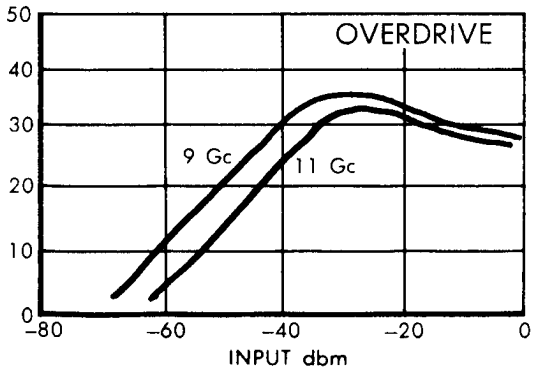








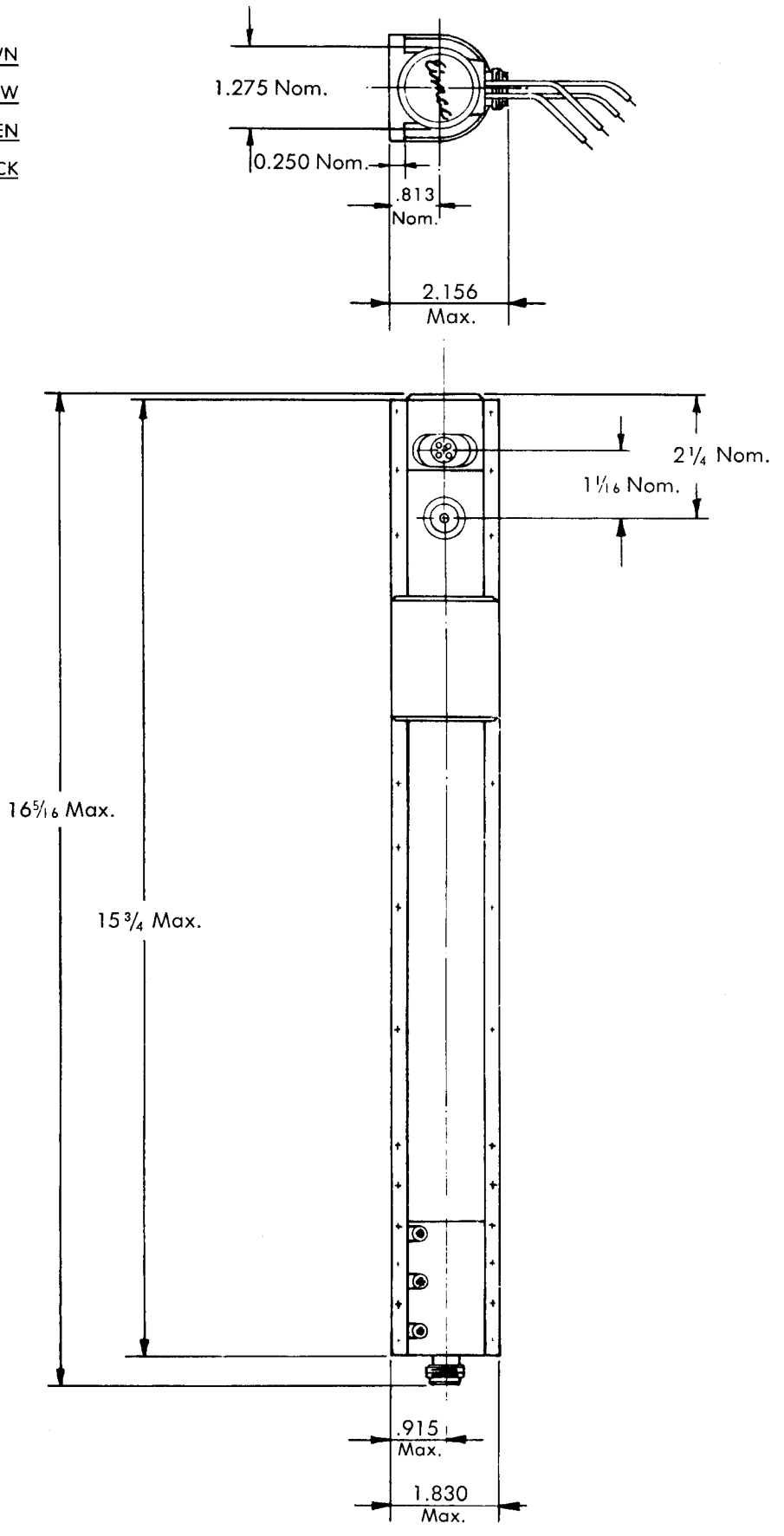




EM-778

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

8238
3X3000A1

LOW-MU TRIODE



The Eimac 8238/3X3000A1 is a low-mu forced-air cooled power triode intended for use as an audio amplifier or modulator. The maximum rated plate dissipation is 3000 watts.

Two 3X3000A1's in class-AB_1 audio service will deliver up to 10 kilowatts maximum-signal plate output power at 6000 plate volts without drawing grid current.

The 3X3000A1 is provided with a low inductance, coaxial filament structure. A water-cooled version, the 3W5000A1, rated at 5 kW plate dissipation, is also available.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	49		54	amperes
Amplification Factor	4.4		5.6	
Direct Interelectrode Capacitances (Average)				
Grid-Plate		17		uufd
Grid-Filament		29		uufd
Plate-Filament		2.5		uufd
Transconductance (I_b = 1.0 amp., E_b = 3000 V)		11,000		umhos
Maximum Frequency			75	Mc

MECHANICAL

Base	See outline drawing
Mounting Position	Vertical, base down or up
Cooling	Forced air
▶ Maximum Temperatures:	
Grid and Filament Seals	175°C
Anode Cooler Core	250°C
Maximum Diameter	4.16 inches
Maximum Height	8.59 inches
Net Weight	6.25 pounds
Shipping Weight	16 pounds

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per tube)

DC PLATE VOLTAGE	6000 MAX.	VOLTS
DC PLATE CURRENT	2.5 MAX.	AMPERES
PLATE DISSIPATION	3000 MAX.	WATTS
GRID DISSIPATION	50 MAX.	WATTS

*Adjust to stated Zero-Signal DC Plate Current. Can be expected to vary ±15%. Effective grid-circuit resistance must not exceed 200,000 ohms.

**At maximum signal without negative feedback.

TYPICAL OPERATION (Sinusoidal wave, two tubes)
Class AB_1

DC Plate Voltage	4000	5000	6000	volts
DC Grid Voltage (Approx)*	-860	-1080	-1300	volts
Zero-Signal DC Plate Current	500	400	335	mA
Max-Signal DC Plate Current	3.00	2.80	2.65	amps
Effective Load, Plate-to-Plate	2160	3320	4560	ohms
Peak AF Grid Input Voltage (per tube)	760	995	1250	volts
Max-Signal Driving Power	0	0	0	watts
Max-Signal Plate Input Power	12,000	14,000	16,000	watts
Max-Signal Plate Dissipation (per tube)	3000	3000	3000	watts
Max-Signal Plate Output Power	6000	8000	10,000	watts
Total Harmonic Distortion**	1.8	2.6	2.1	percent

(Effective 2-18-63) © Copyright 1952, 1953, 1963 by Eitel-McCullough, Inc. Printed in U.S.A.

▶ Change from data sheet dated 2-1-52

APPLICATION

MECHANICAL

Mounting: The 3X3000A1 must be mounted vertically with its base up or down at the convenience of the designer. The filament connections should be made through spring collets and care must be taken not to impart strain to the terminals or base assembly.

The tube must be protected from severe shock and vibration during shipment and operation.

Cooling: Sufficient forced air cooling must be provided to maintain seal and anode core temperature at 175° C or below. Air-flow must be started when filament power is applied and it is advisable to continue air-cooling for two minutes after all voltages are removed.

The table below lists minimum air-flow requirements to maintain tube temperatures below 175° C with air flowing in both the base-to-anode and anode-to-base directions. This tabulation presumes air at 25° C and sea level. A separate supply of approximately six cubic feet per minute, directed into the filament structure is also required to maintain rated filament seal temperatures. This is best accomplished using a small diameter insulating tubing directed into the stem between the filament seals.

	MINIMUM COOLING AIR-FLOW REQUIREMENTS			
	BASE-TO-ANODE FLOW		ANODE-TO-BASE FLOW	
Plate Dissipation (Watts)	AIR-FLOW (CFM)	PRESSURE DROP (inches of water)	AIR-FLOW (CFM)	PRESSURE DROP (inches of water)
1000	14	0.1	20	0.1
2000	37	0.3	61	0.8
3000	74	1.0	122	3.0

Note:
An extra 425 watts have been added to these plate dissipation figures in preparing this tabulation, to compensate for grid and filament dissipation.

For operation at high altitudes or higher ambient temperatures, these quantities should be increased. In all cases it is suggested that actual temperatures be measured to insure adequate cooling.

ELECTRICAL

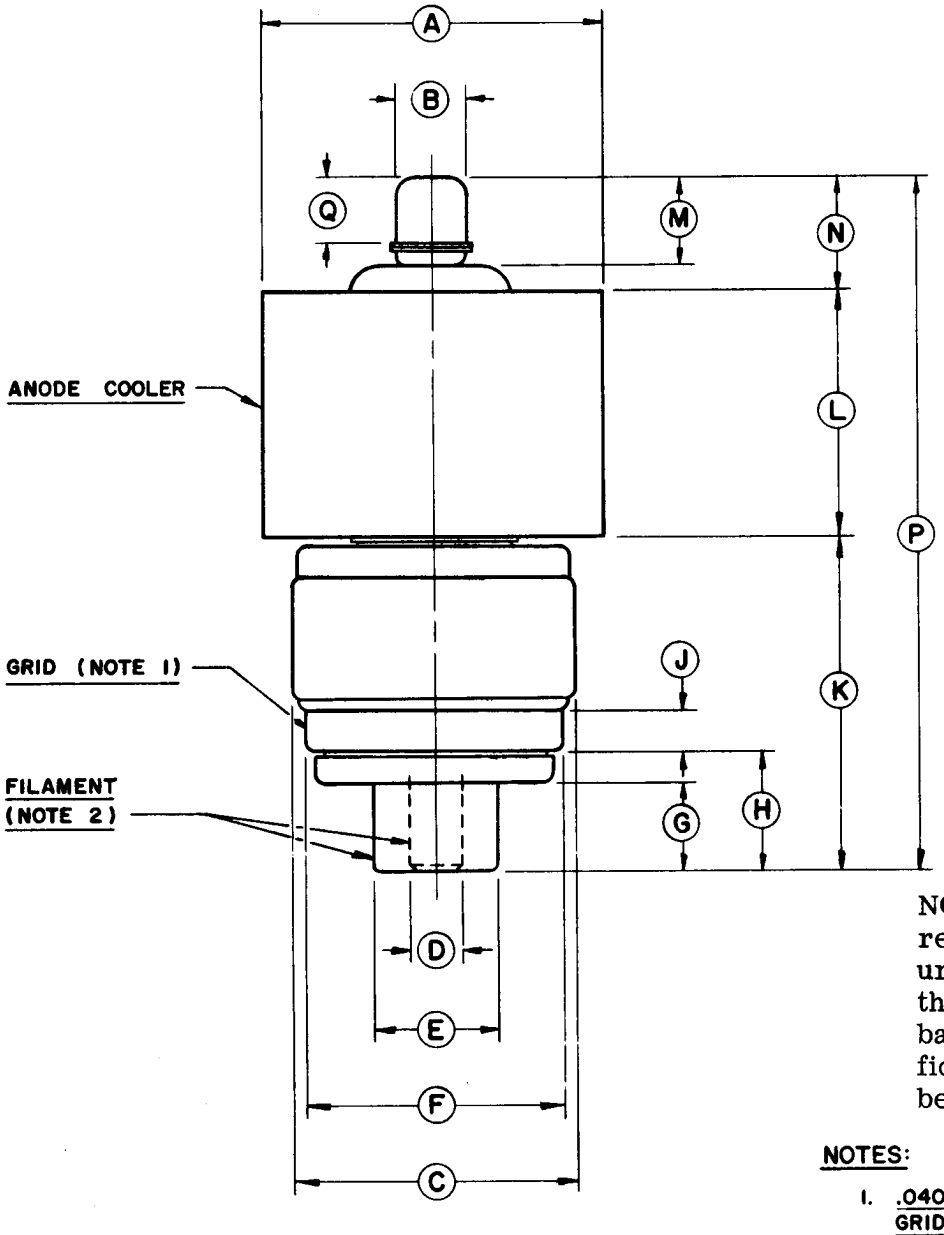
Filament: The rated filament voltage for the 3X3000A1 is 7.5 volts and should not exceed this value by more than five percent if maximum tube life is to be realized. Reduction of filament voltage to about 7.2 volts will actually enhance tube life and provision should be made for this adjustment where the lower emission can be tolerated.

Grid Operation: The grid dissipation rating of the 3X3000A1 is 50 watts. This is the product of the peak positive grid voltage and average dc grid current. When tubes are used in parallel in amplifier or modulator service, provision should be made for individual adjustment of bias voltage, in order to match the tubes. In practice, individual adjustment of drive voltage will not be necessary.

Special Applications: If it is desired to operate the tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.

DIMENSIONS IN INCHES

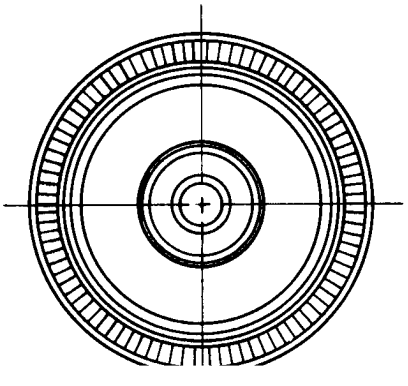
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	4.093	4.156	
B	.781	.843	
C		3.625	
D	.615	.635	
E	1.490	1.510	
F	2.990	3.010	
G	.812	.937	
H	1.437	1.562	
J	.375	.437	
K	4.	4.125	
L	2.968	3.031	
M	1.	1.125	
N	1.187	1.437	
P	8.156	8.593	
Q	.687	.812	

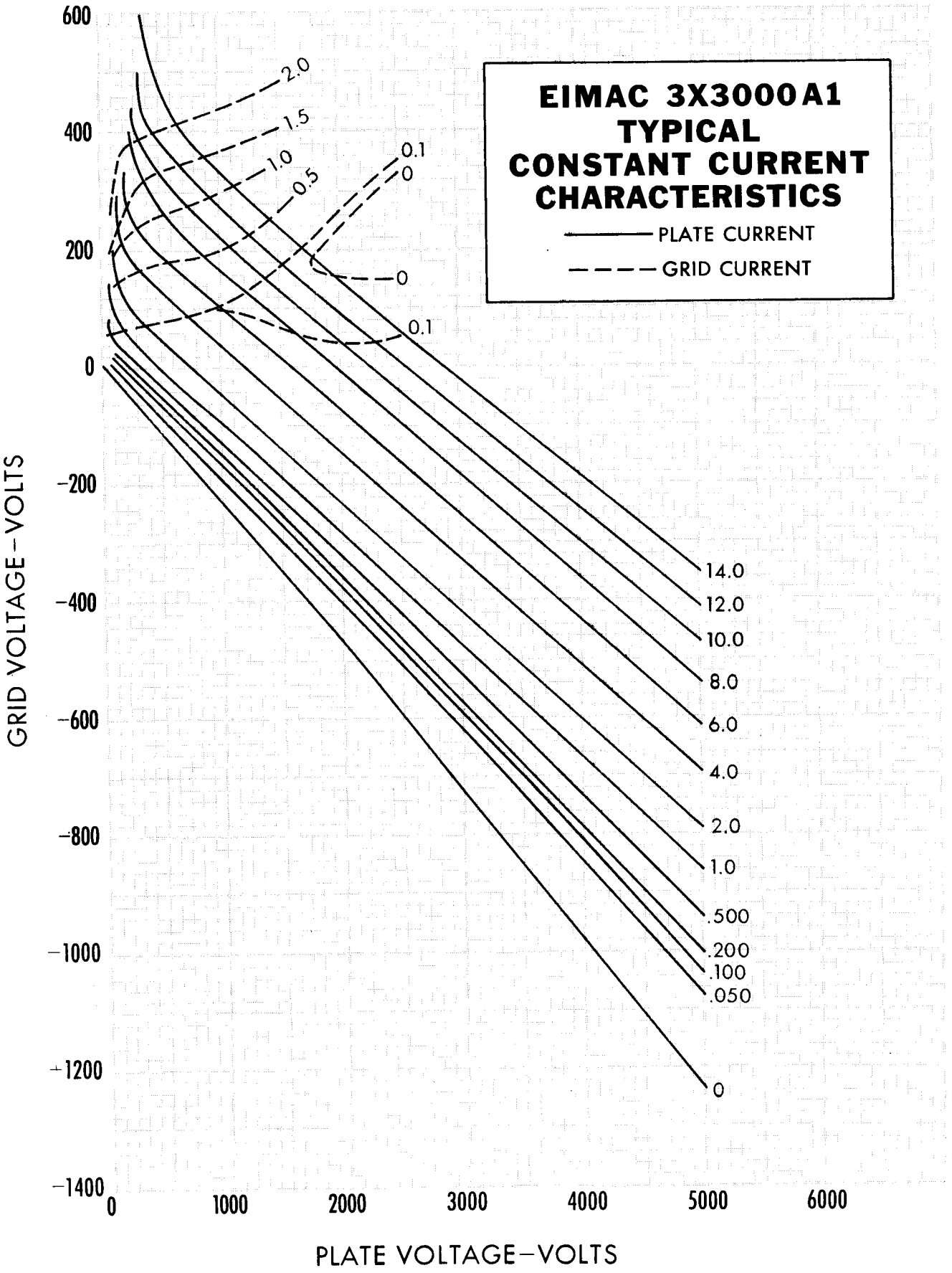


NOTE: These dimensions reflect standard manufacturing tolerances. Where they are to be made the basis of purchase specifications, they should first be checked with the factory.

NOTES:

1. .040 MAX. RUNOUT OF GRID CONTACT SURFACE WITH RESPECT TO AXIS DETERMINED BY ANODE AND OUTER FILAMENT CONTACT SURFACE.
2. .025 MAX. RUNOUT OF INNER FILAMENT CONTACT SURFACE WITH RESPECT TO OUTER FILAMENT CONTACT SURFACE.

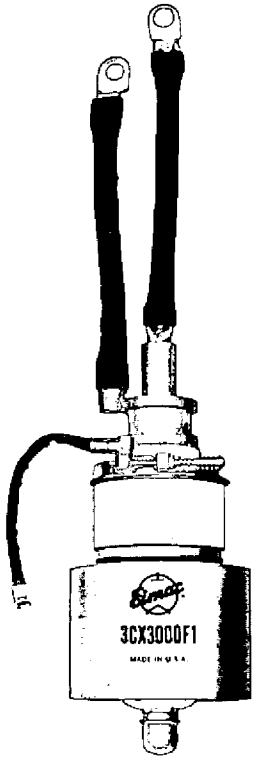



EIMAC 3X3000A1
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
600
400
200
0
-200
-400
-600
-800
-1000
-1200
-1400
GRID VOLTAGE-VOLTS
0
1000
2000
3000
4000
5000
6000
PLATE VOLTAGE-VOLTS
2.0
1.5
1.0
0.5
0.1
0
0
0.1
14.0
12.0
10.0
8.0
6.0
4.0
2.0
1.0
.500
.200
.100
.050
0

Eimac®

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8239
3CX3000F1
LOW-MU TRIODE



The Eimac 8239/3CX3000F1 is a low-mu forced-air cooled power triode intended for use as an audio amplifier or modulator. The maximum rated plate dissipation is 3000 watts.

Two 3CX3000F1s in class-AB$_1$ audio service will deliver up to 10 kilowatts maximum-signal plate output power at 6000 plate volts without drawing grid current.

The 3CX3000F1 is provided with "flying leads" for filament and grid connections.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated Tungsten				
Voltage		7.5		V
Current	48		53	A
Amplification Factor	4.3		5.6	
Direct Interelectrode Capacitances (Average)				
Grid-Plate		17		pF
Grid-Filament		29		pF
Plate-Filament		2.5		pF
Transconductance (I_b = 1.0A, E_b = 3000V)		11,000		umhos

MECHANICAL

Base	See outline drawing
Mounting Position	Vertical, base down or up
Cooling	Forced Air
Maximum Temperatures:	
Grid and Filament Seals	250°C
Anode Cooler Core	250°C
Maximum Diameter	4.16 in.
Net Weight	7.5 lbs.
Shipping Weight	17 lbs.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB$_1$

MAXIMUM RATINGS (Per tube)

DC PLATE VOLTAGE	6000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	3000	WATTS
GRID DISSIPATION	50	WATTS

*Adjust to stated Zero-Signal DC Plate Current. Can be expected to vary ±15%. Effective grid-current resistance must not exceed 200,000 ohms.

TYPICAL OPERATION (Sinusoidal wave, two tubes)

Class AB$_1$

DC Plate Voltage	4.0	5.5	kV
DC Grid Voltage (Approx)*	-750	-1070	Volts
Zero-Signal DC Plate Current	500	500	mA
Max-Signal DC Plate Current	2.75	2.2	Amps
Effective Load, Plate-to-Plate	2120	4000	Ohms
Peak AF Grid Input Voltage (per tube)	750	1070	Volts
Max-Signal Driving Power	0	0	Watts
Max-Signal Plate Input Power	11.0	13.1	kW
Max-Signal Plate Dissipation (per tube)	2.75	2.55	kW
Max-Signal Plate Output Power	5.5	8.25	kW

(Effective 11-1-67) © 1967 by Varian

Printed in U.S.A.

from JEDEC release #3784H, June 10, 1968

APPLICATION

MECHANICAL

Mounting: The 3CX3000F1 must be mounted vertically with its base up or down at the convenience of the designer. The base is fitted with heavy filament leads to facilitate connections. These leads should be arranged to prevent mechanical stress on the filament structure. The grid is also fitted with a flying lead.

The tube must be protected from severe shock and vibration during shipment and operation.

Cooling: Sufficient forced air cooling must be provided to maintain seal temperature at 250°C or below. Air-flow must be started when filament power is applied and it is advisable to continue air-cooling for two minutes after all voltages are removed.

The table below lists minimum air-flow requirements to maintain tube temperatures below 250°C with air flowing in both the base-to-anode and anode-to-base directions. This tabulation presumes air at 50°C and sea level. A separate supply of approximately 3 cubic feet per minute, directed into the filament structure is also required to maintain rated filament seal temperatures. This is best accomplished using a small diameter insulating tubing directed into the stem, between the filament seals.

	MINIMUM COOLING AIR-FLOW REQUIREMENTS			
	BASE-TO-ANODE FLOW		ANODE-TO-BASE FLOW	
Plate Dissipation (Watts)	AIR-FLOW (CFM)	PRESSURE DROP (inches of water)	AIR-FLOW (CFM)	PRESSURE DROP (inches of water)
1000	32	0.49	39	0.65
2000	67.5	1.52	85	2.16
3000	106	3.15	138	4.55

NOTE:
An extra 450 watts have been added to these plate dissipation figures in preparing this tabulation, to compensate for grid and filament dissipation.

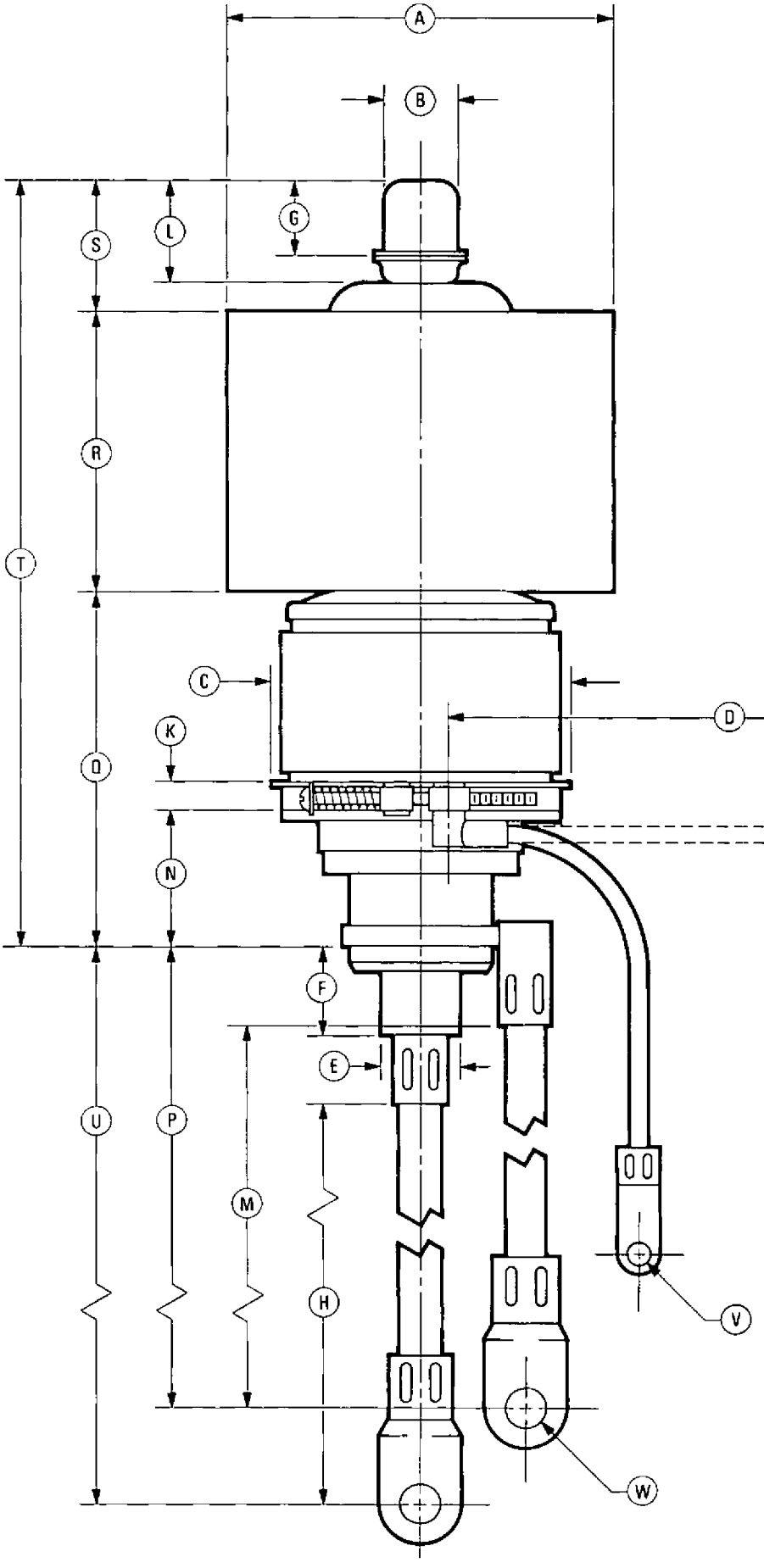
For operation at high altitudes or higher ambient temperatures, these quantities should be increased. In all cases it is suggested that actual temperatures be measured to insure adequate cooling.

ELECTRICAL

Filament: The rated filament voltage for the 3CX3000F1 is 7.5 volts and should not be exceeded by more than five percent if maximum tube life is to be realized. Reduction of filament voltage to about 7.2 volts will actually enhance tube life and provision should be made for this adjustment where the lower emission can be tolerated.

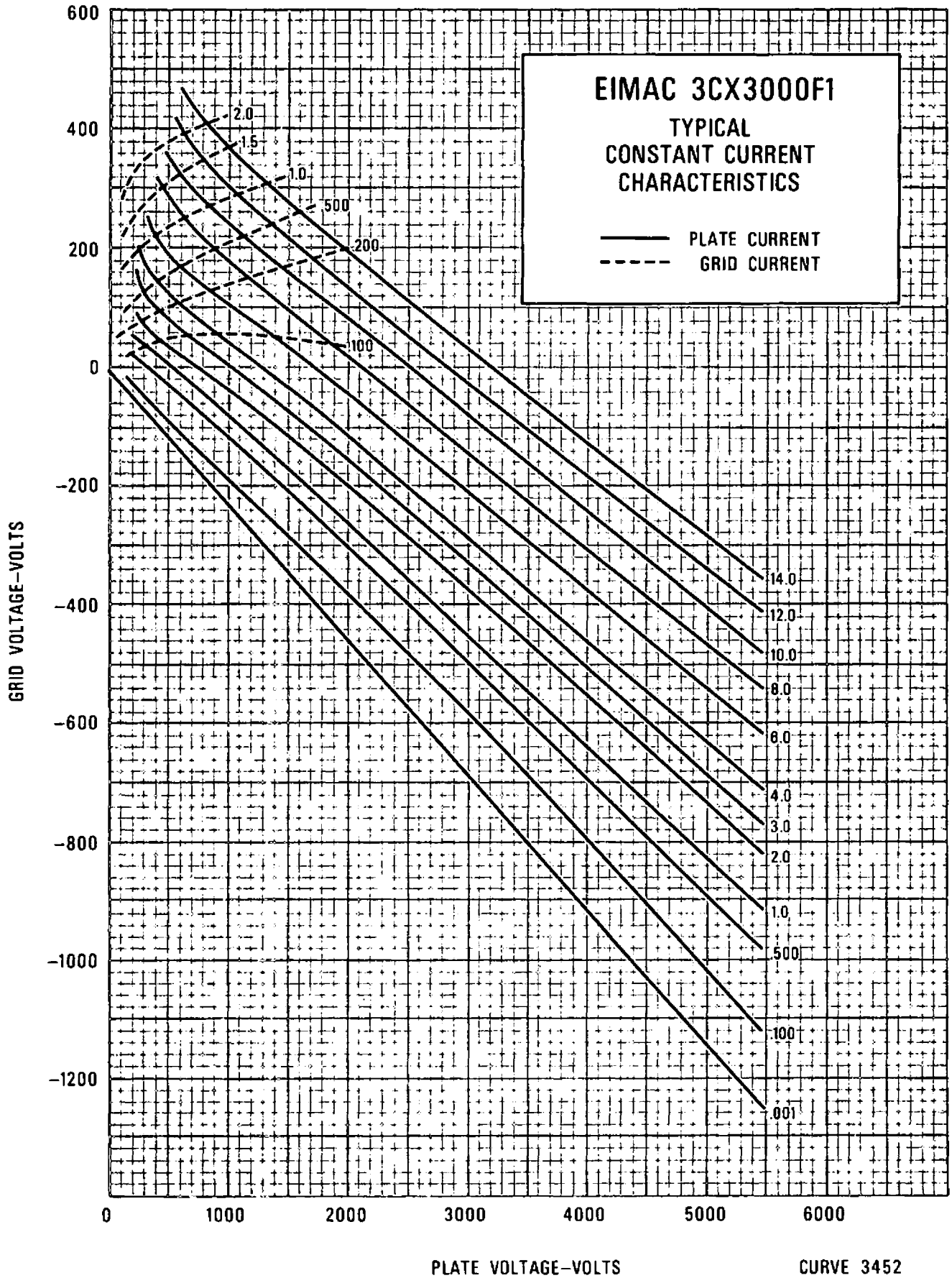
Grid Operation: The grid dissipation rating of the 3CX3000F1 is 50 watts. This is the product of the peak positive grid voltage and average dc grid current. When tubes are used in parallel in amplifier or modulator service, provision should be made for individual adjustment of bias voltage, in order to match the tubes.

Special Applications: If it is desired to operate the tube under conditions widely different from those given here, write to Eimac Division of Varian Assoc., 301 Industrial Way, San Carlos, California, for information and recommendations.



DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	4 3/32	4 5/32	
B	25/32	27/32	
C		3 5/8	
D	6.375	6.625	
E	.859	.890	
F	.812	.937	
G	11/16	13/16	
H	7.000	7.500	
K	3/8	7/16	
L	1	1 1/8	
M	7.000	7.500	
N	1 3/8	1 5/8	
P	7.937	8.437	
Q	3 7/8	4 1/4	
R	2 15/16	3 1/16	
S	1 3/16	1 11/16	
T	8	9	
U	8.937	9.437	
V	.194	.200	
W	.385	.395	


EIMAC 3CX3000F1
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
2.0
1.5
1.0
500
200
100
14.0
12.0
10.0
8.0
6.0
4.0
3.0
2.0
1.0
500
100
.001
600
400
200
0
-200
-400
-600
-800
-1000
-1200
0
1000
2000
3000
4000
5000
6000
GRID VOLTAGE-VOLTS
PLATE VOLTAGE-VOLTS

CURVE 3452

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

8240
3W5000A1

LOW-MU WATER-COOLED TRIODE



The Eimac 8240/3W5000A1 is a low-mu water-cooled power triode intended for use as an audio amplifier or modulator. The maximum rated plate dissipation is 5000 watts.

Two 3W5000A1's in class-AB_1 audio service will deliver more than 10 kilowatts maximum-signal plate output power at 6000 plate volts without drawing grid current.

The 3W5000A1 is electrically identical to the air-cooled 3X3000A1 except for its plate dissipating rating.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	49		54	amperes
Amplification Factor	4.4		5.6	
Direct Interelectrode Capacitances (Average)				
Grid-Plate		17		uufd
Grid-Filament		29		uufd
Plate-Filament		2.5		uufd
Transconductance (I_b = 1.0 amp., E_b = 3000V)		11,000		umhos
Maximum Frequency			75	Mc

MECHANICAL

Base	See outline drawing
Mounting Position	Vertical, base down or up
Cooling	Water and forced air
Maximum Temperatures:	
Grid and Filament Seals	175° C
Anode Cooler Core	250° C
Maximum Diameter	3.63 inches
Maximum Height	12.6 inches
Net Weight	3.5 pounds
Shipping Weight	15 pounds

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per tube)

DC PLATE VOLTAGE	6000 MAX.	VOLTS
DC PLATE CURRENT	2.5 MAX.	AMPERES
PLATE DISSIPATION	5000 MAX.	WATTS
GRID DISSIPATION	50 MAX.	WATTS

*Adjust to stated Zero-Signal DC Plate Current. Can be expected to vary ±15%. Effective grid-circuit resistance must not exceed 200,000 ohms.

**At maximum signal without negative feedback.

TYPICAL OPERATION (Sinusoidal wave, two tubes)
Class-AB_1

DC Plate Voltage	4000	5000	6000	volts
DC Grid Voltage (Approx)*	-860	-1080	-1300	volts
Zero-Signal DC Plate Current	500	400	335	mA
Max-Signal DC Plate Current	3.00	2.80	2.65	amps
Effective Load, Plate-to-Plate	2160	3320	4560	ohms
Peak AF Grid Input Voltage (per tube)	760	995	1250	volts
Max-Signal Driving Power	0	0	0	watts
Max-Signal Plate Input Power	12,000	14,000	16,000	watts
Max-Signal Plate Dissipation (per tube)	3000	3000	3000	watts
Max-Signal Plate Output Power	6000	8000	10,000	watts
Total Harmonic Distortion**	1.8	2.6	2.1	percent

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APPLICATION

MECHANICAL

Mounting: The 3W5000A1 must be mounted vertically with its base up or down at the convenience of the designer. The filament connections should be made through spring collets and care must be taken not to impart strain to the terminals or base.

The tube must be protected from severe shock and vibration during shipment and operation.

Cooling: Sufficient cooling must be provided to maintain seal and anode core temperature at 175°C or below. Cooling water and air-flow must be started when filament power is applied and it is advisable to continue for two minutes after all voltages are removed.

The table below lists minimum water-flow requirements to maintain tube temperatures below 175°C for various water-inlet temperatures. The water outlet temperature must not exceed 70° C and inlet water pressure must be less than 60 pounds per square inch. A separate air-flow supply of approximately six cubic feet per minute, directed into the filament structure is also required to maintain rated filament seal temperatures. This is best accomplished using a small diameter insulating tubing directed into the stem, between the filament seals.

MINIMUM WATER COOLING REQUIREMENTS

Water Inlet Temp. (°C)	Plate Dissipation							
	2 KW		3 KW		4 KW		5 KW	
	Flow Rate GPM	Pressure Drop PSI	Flow Rate GPM	Pressure Drop PSI	Flow Rate GPM	Pressure Drop PSI	Flow Rate GPM	Pressure Drop PSI
20	1.7	0.68	2.6	1.3	3.9	2.3	5.6	3.9
30	2.3	1.1	3.2	1.7	4.5	2.8	6.2	4.5
40	3.0	1.6	3.8	2.2	5.3	3.5	6.9	5.3
50	3.9	2.3	4.7	3.0	6.0	4.3	7.7	6.1

Note:
An extra 425 watts have been added to these plate dissipation figures in preparing this tabulation, to compensate for grid and filament dissipation.

For operation at high altitudes or higher ambient temperatures, these quantities should be increased. In all cases it is suggested that actual temperatures be measured to insure adequate cooling.

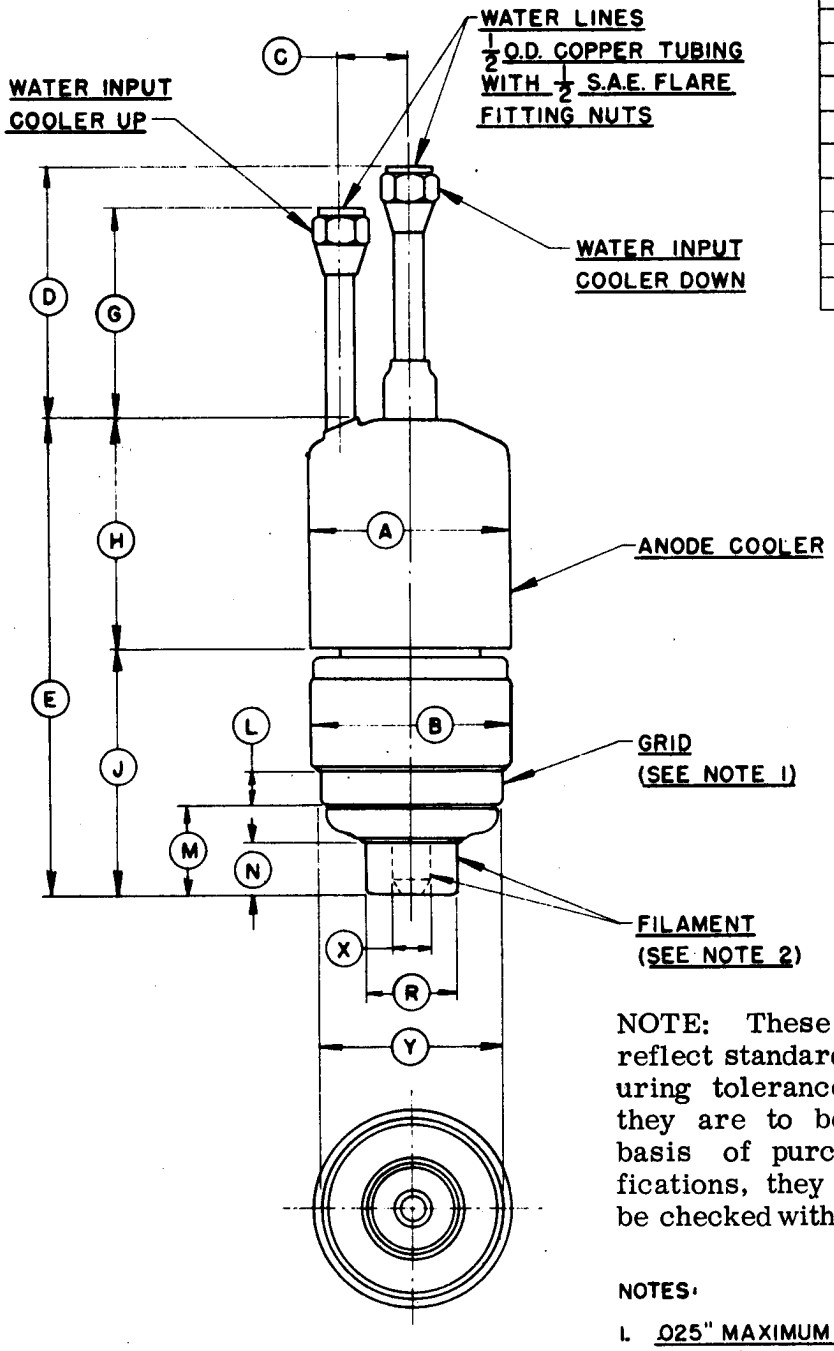
ELECTRICAL

Filament: The rated filament voltage for the 3W5000A1 is 7.5 volts and should not exceed this value by more than five percent if maximum tube life is to be realized. Reduction of filament voltage to about 7.2 volts will actually enhance tube life and provision should be made for this adjustment where the lower emission can be tolerated.

Grid Operation: The grid dissipation rating of the 3W5000A1 is 50 watts. This is the product of the peak positive grid voltage and average dc grid current. When tubes are used in parallel in amplifier or modulator service, provision should be made for individual adjustment of bias voltage, in order to match the tubes. In practice, individual adjustment of drive voltage will not be necessary.

Special Applications: If it is desired to operate the tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.

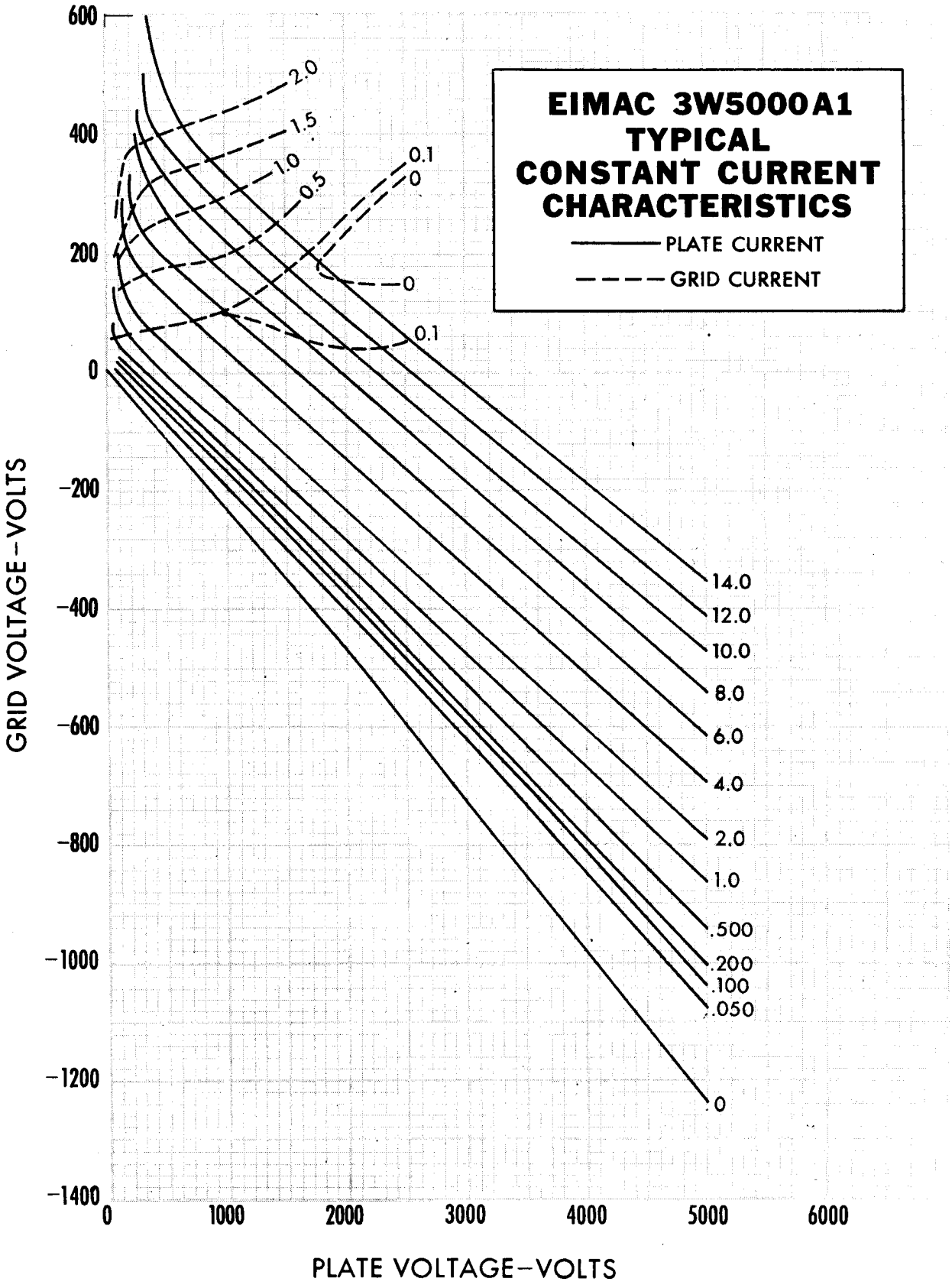
DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		3.234	3.266
B			3.625
C		1.062	1.187
D		4.000	4.500
E		7.562	8.062
G		3.250	3.750
H		3.625	3.875
J		3.937	4.187
L		.375	.437
M		1.437	1.562
N		.812	.937
R		1.490	1.510
X		.615	.635
Y		2.990	3.010



NOTE: These dimensions reflect standard manufacturing tolerances. Where they are to be made the basis of purchase specifications, they should first be checked with the factory.

NOTES:

1. .025" MAXIMUM RUNOUT OF INNER FILAMENT CONTACT SURFACE WITH RESPECT TO OUTER FILAMENT CONTACT SURFACE.
2. DIMENSIONS IN INCHES.


EIMAC 3W5000A1
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
600
400
200
0
-200
-400
-600
-800
-1000
-1200
-1400
GRID VOLTAGE-VOLTS
0
1000
2000
3000
4000
5000
6000
PLATE VOLTAGE-VOLTS
2.0
1.5
1.0
0.5
0.1
0
0
0.1
14.0
12.0
10.0
8.0
6.0
4.0
2.0
1.0
.500
.200
.100
.050
0

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

8241
3W5000F1

LOW-MU WATER-COOLED TRIODE



The Eimac 8241/3W5000F1 is a low-mu water-cooled power triode intended for use as an audio amplifier or modulator. The maximum rated plate dissipation is 5000 watts.

Two 3W5000F1's in class-AB_1 audio service will deliver more than 10 kilowatts maximum-signal plate output power at 6000 plate volts without drawing grid current.

The 3W5000F1 is provided with "flying leads" for simplifying filament and grid connections.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	49		54	amperes
Amplification Factor	4.4		5.6	
Direct Interelectrode Capacitances (Average)				
Grid-Plate		17		uufd
Grid-Filament		29		uufd
Plate-Filament		2.5		uufd
Transconductance (I_b = 1.0 amp., E_b = 3000 V)		11,000		umhos
Maximum Frequency			30	Mc

MECHANICAL

Base	See outline drawing
Mounting Position	Vertical, base down or up
Cooling	Forced air
Maximum Temperatures:	
Grid and Filament Seals	175° C
Anode Cooler Core	250° C
Maximum Diameter	3.63 inches
Net Weight	4.8 pounds
Shipping Weight	15 pounds

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per tube)

DC PLATE VOLTAGE	6000 MAX.	VOLTS
DC PLATE CURRENT	2.5 MAX.	AMPERES
PLATE DISSIPATION	3000 MAX.	WATTS
GRID DISSIPATION	50 MAX.	WATTS

*Adjust to stated Zero-Signal DC Plate Current. Can be expected to vary ±15%. Effective grid-circuit resistance must not exceed 200,000 ohms.

**At maximum signal without negative feedback.

TYPICAL OPERATION (Sinusoidal wave, two tubes) (Class AB_1)

DC Plate Voltage	4000	5000	6000	volts
DC Grid Voltage (Approx)*	-860	-1080	-1300	volts
Zero-Signal DC Plate Current	500	400	335	mA
Max-Signal DC Plate Current	3.00	2.80	2.65	amps
Effective Load, Plate-to-Plate	2160	3320	4560	ohms
Peak AF Grid Input Voltage (per tube)	760	995	1250	volts
Max-Signal Driving Power	0	0	0	watts
Max-Signal Plate Input Power	12,000	14,000	16,000	watts
Max-Signal Plate Dissipation (per tube)	3000	3000	3000	watts
Max-Signal Plate Output Power	6000	8000	10,000	watts
Total Harmonic Distortion**	1.8	2.6	2.1	percent

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APPLICATION

MECHANICAL

Mounting: The 3W5000F1 must be mounted vertically with its base up or down at the convenience of the designer. The base is fitted with heavy filament leads to facilitate connections. These leads should be arranged to prevent mechanical stress on the filament structure. The grid is also fitted with a flying lead.

The tube must be protected from severe shock and vibration during shipment and operation.

Cooling: Sufficient cooling must be provided to maintain seal and anode core temperature at 175° C or below. Cooling must be started when filament power is applied and it is advisable to continue for two minutes after all voltages are removed.

The table below lists minimum water-flow requirements to maintain tube temperatures below 175°C for various water-inlet temperatures. The water outlet temperature must not exceed 70° C and inlet water pressure must be less than 60 pounds per square inch. A separate air-flow supply of approximately six cubic feet per minute, directed into the filament structure is also required to maintain rated filament seal temperatures. This is best accomplished using a small diameter insulating tubing directed into the stem, between the filament seals.

MINIMUM WATER COOLING REQUIREMENTS

Water Inlet Temp. (°C)	Plate Dissipation							
	2 KW		3 KW		4 KW		5 KW	
	Flow Rate GPM	Pressure Drop PSI	Flow Rate GPM	Pressure Drop PSI	Flow Rate GPM	Pressure Drop PSI	Flow Rate GPM	Pressure Drop PSI
20	1.7	0.68	2.6	1.3	3.9	2.3	5.6	3.9
30	2.3	1.1	3.2	1.7	4.5	2.8	6.2	4.5
40	3.0	1.6	3.8	2.2	5.3	3.5	6.9	5.3
50	3.9	2.3	4.7	3.0	6.0	4.3	7.7	6.1

Note:
An extra 425 watts have been added to these plate dissipation figures in preparing this tabulation, to compensate for grid and filament dissipation.

For operation at high altitudes or higher ambient temperatures, these quantities should be increased. In all cases it is suggested that actual temperatures be measured to insure adequate cooling.

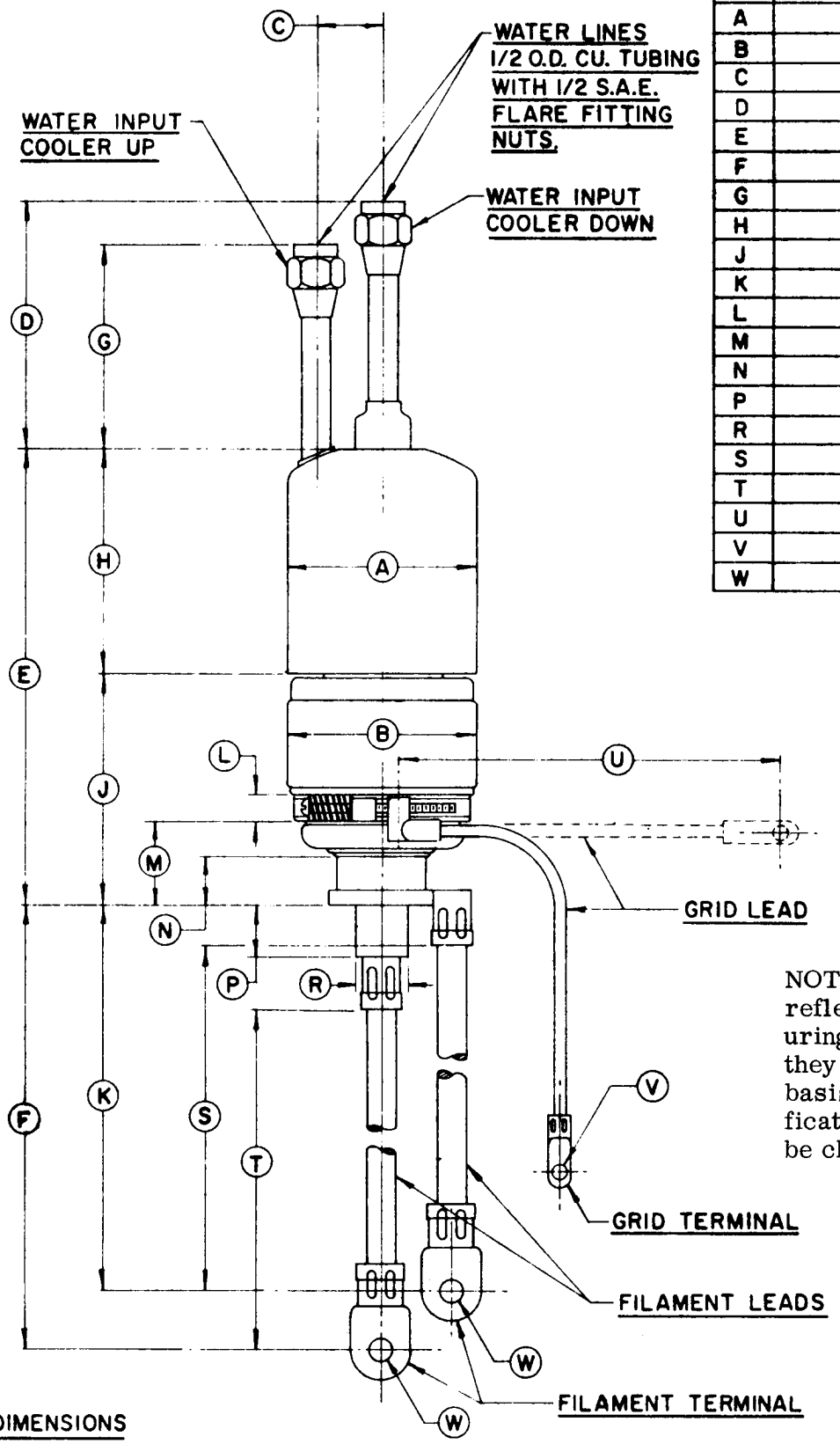
ELECTRICAL

Filament: The rated filament voltage for the 3W5000F1 is 7.5 volts and should not exceed this value by more than five percent if maximum tube life is to be realized. Reduction of filament voltage to about 7.2 volts will actually enhance tube life and provision should be made for this adjustment where the lower emission can be tolerated.

Grid Operation: The grid dissipation rating of the 3W5000F1 is 50 watts. This is the product of the peak positive grid voltage and average dc grid current. When tubes are used in parallel in amplifier or modulator service, provision should be made for individual adjustment of bias voltage, in order to match the tubes. In practice, individual adjustment of drive voltage will not be necessary.

Special Applications: If it is desired to operate the tube under conditions widely different from those given here, write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.

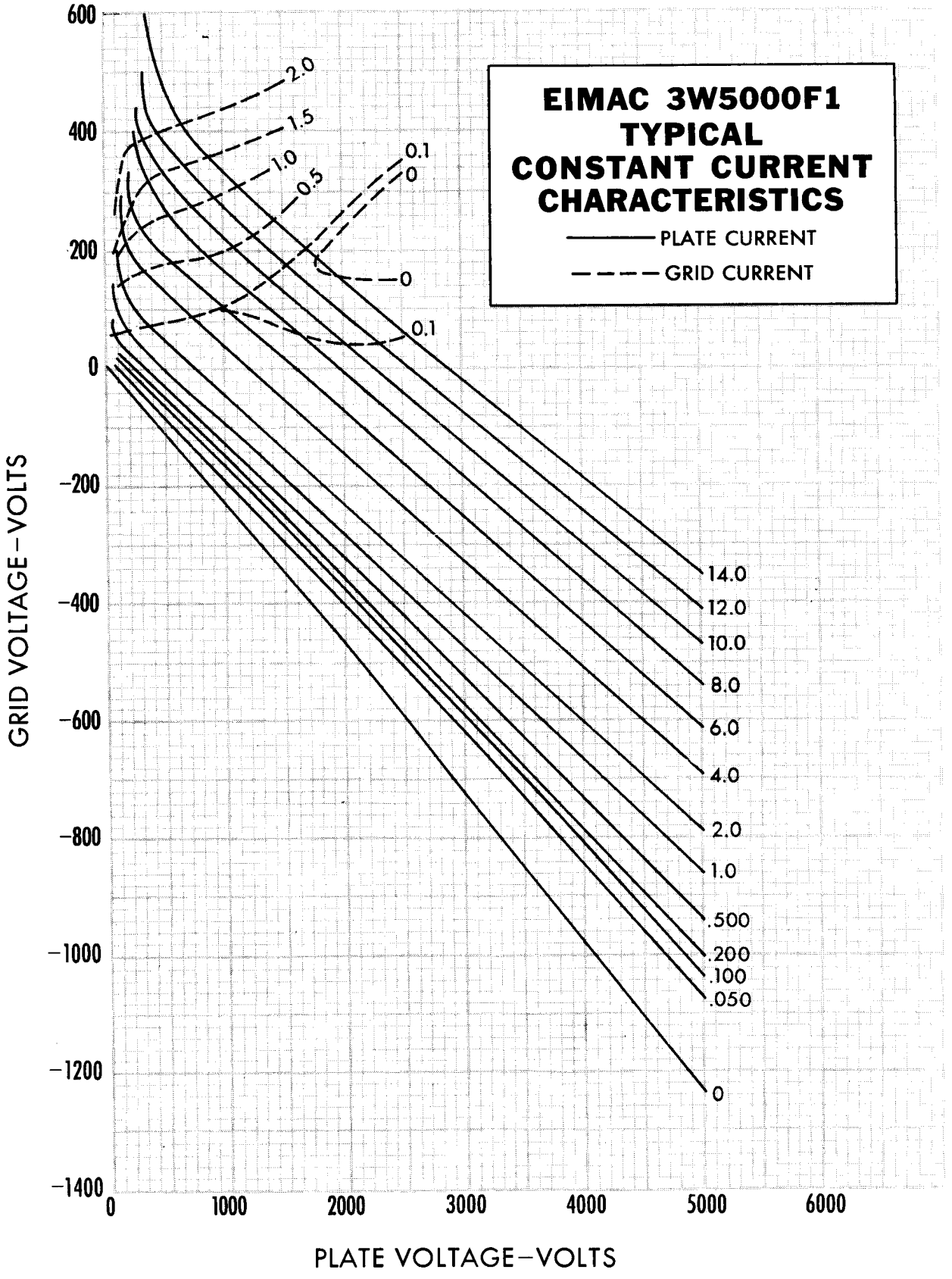
DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		3.234	3.266
B			3.625
C		1.062	1.187
D		4.000	4.500
E		7.562	8.062
F		8.937	9.437
G		3.250	3.750
H		3.625	3.875
J		3.937	4.187
K		7.937	8.437
L		.375	.437
M		1.437	1.562
N		.812	.937
P		.812	.937
R		.859	.890
S		7.000	7.500
T		7.000	7.500
U		6.375	6.625
V		.194	.200
W		.385	.395



NOTE: These dimensions reflect standard manufacturing tolerances. Where they are to be made the basis of purchase specifications, they should first be checked with the factory.

ALL DIMENSIONS
IN INCHES

(TENTATIVE)


EIMAC 3W5000F1
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
2.0
1.5
1.0
0.5
0.1
0
0
0.1
14.0
12.0
10.0
8.0
6.0
4.0
2.0
1.0
.500
.200
.100
.050
0
600
400
200
0
-200
-400
-600
-800
-1000
-1200
-1400
0
1000
2000
3000
4000
5000
6000
GRID VOLTAGE-VOLTS
PLATE VOLTAGE-VOLTS

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

8242
3W5000A3

MEDIUM-MU POWER TRIODE

The Eimac 8242/3W5000A3 is a water-cooled, medium-mu power triode intended for amplier, oscillator or modulator service. It has a maximum plate dissipation rating of 5000 watts and is capable of high output at relatively low plate voltages. A single 3W5000A3 will deliver a radio frequency plate power-output of 7500 watts at a plate voltage of 4000 volts.

NOTE: The 8242/3W5000A3 is a water-cooled version of the air-cooled 8161/3X25000A3.

The 8242/3W5000A3 should be used where water cooling is preferred and for industrial applications or installations where reserve anode dissipation is desired.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated tungsten				
Voltage		7.5		volts
Current	49		54	amperes
Amplification Factor (Average)		20		
Direct Interelectrode Capacitances (Average)				
Grid-Plate	17.8		24.2	μμf
Grid-Filament	29.2		40.2	μμf
Plate-Filament	0.60		1.20	μμf
Transconductance (I_b=830 ma, E_b=3000v)		20,000		μmhos
Frequency for Maximum Ratings			75	mc

MECHANICAL

Base	see drawing
Mounting	vertical, base down or up
Maximum Over-All Dimensions:	
Length	12.56 inches
Diameter	3.63 inches
Net Weight	4.8 pounds
Cooling	Water and forced air

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

(Frequencies below 75 Mc.)
Class-C FM or Telegraphy
(Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPS
PLATE DISSIPATION	5000 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION
(Frequencies below 75 Mc., per tube)

D C Plate Voltage	4000	5000	6000	volts
D-C Plate Current	2.5	2.5	2.08	amps
D-C Grid Voltage	—300	—450	—500	volts
D-C Grid Current	245	265	180	ma
Peak R-F Grid Input Voltage	580	750	765	volts
Driving Power (approx.)	142	197	136	watts
Grid Dissipation	68	78	46	watts
Plate Power Input	10,000	12,500	12,500	watts
Plate Dissipation	2500	2500	2500	watts
Plate Power Output	7500	10,000	10,000	watts

PLATE MODULATED RADIO FREQUENCY AMPLIFIER

(Frequencies below 75 Mc.)
Class-C Telephony
(Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000 MAX. VOLTS
D-C PLATE CURRENT	2.0 MAX. AMPS
PLATE DISSIPATION	3350 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION
(Frequencies below 75 Mc., per tube)

D C Plate Voltage	4000	4500	5000	volts
D-C Plate Current	1.67	1.55	1.45	amps
Total Bias Voltage	—450	—500	—550	volts
Fixed Bias Voltage	—230	—325	—410	volts
Grid Resistor	1500	1500	1400	ohms
D-C Grid Current	150	120	100	ma
Peak R-F Grid Input Voltage	680	720	760	volts
Driving Power (approx.)	102	86	76	watts
Grid Dissipation	35	26	21	watts
Plate Power Input	6670	6970	7250	watts
Plate Dissipation	1670	1670	1670	watts
Plate Power Output	5000	5300	5580	watts

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AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D C PLATE VOLTAGE	6000 MAX. VOLTS
MAX-SIGNAL D C PLATE CURRENT, PER TUBE	2.5 MAX. AMPS
PLATE DISSIPATION, PER TUBE	5000 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

D C Plate Voltage	4000	5000	6000	volts
D C Grid Voltage[1]	—150	—190	—240	volts
Zero-Signal D C Plate Current	0.6	0.5	0.4	amps
Max-Signal D C Plate Current	4.0	3.2	3.0	amps
Effective Load, Plate to Plate	2200	3600	4650	ohms
Peak A-F Grid Input Voltage (per tube)*	340	360	390	volts
Max-Signal Peak Driving Power*	340	230	225	watts
Max-Signal Nominal Driving Power*	170	115	113	watts
Max-Signal Plate Output Power	11,000	11,000	13,000	watts

*Approximate values.

[1]Adjust to give listed zero-signal plate current.

TYPICAL OPERATION CLASS AB_2 (Two Tubes)

Modulator service for 4000 and 5000 volt operation, to modulate one or two tubes, as shown under "Plate Modulated Radio Frequency Amplifier" (Page 1)

D C Plate Voltage	4000	5000	4000	5000	volts
D C Grid Voltage (approx.)*	—155	—200	—145	—190	volts
Zero-Signal D C Plate Current	0.4	0.4	0.6	0.5	amps
Max-Signal D C Plate Current	1.35	1.13	2.70	2.26	amps
Effective Load, Plate to Plate	6600	10,000	3300	5000	ohms
Peak A-F Grid Input Voltage (per tube)	240	275	285	310	volts
Max-Signal Peak Driving Power	42	40	134	118	watts
Max-Signal Nominal Driving Power (approx.)	21	20	67	59	watts
Max-Signal Plate Power Output	3700	4000	7400	8000	watts
Will Modulate one Tube R F Final Input of	6670	7250			watts
Will Modulate two tubes R F Final Input of			13,340	14,500	watts

*Adjust to give stated zero-signal plate current.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION," POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATON AND RECOMMENDATIONS

APPLICATION

Cooling— Minimum recommended water-flow rate and pressure drop values for different water-inlet temperatures and plate dissipations are tabulated on the opposite page. The outlet water temperature must not exceed a maximum of 70° C under any conditions. The inlet water pressure must not exceed a maximum of 60 pounds per square inch.

The grid-terminal contact surface and adjacent glass must be cooled by forced air. The quantity, velocity and direction must be adjusted to limit the maximum seal temperature to 175° C.

The filament stem structure also requires forced-air cooling. A minimum of 6 cubic feet per minute must be directed into the space between the inner and outer filament contacting surfaces.

Air and water flow must be started before filament power is applied and maintained for at least five minutes after the filament power has been removed.

Filament Voltage—The filament voltage, as measured directly at the tube, should be 7.5 volts with maximum allowable variations due to line fluctuation of from 7.12 to 7.87 volts.

Bias Voltage—There is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained from a grid resistor, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Plate Voltage — The plate supply voltage for the 3W5000A3 should not exceed 6000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

In Class-C FM or Telegraphy service, a 0.1 henry choke, shunted by a spark gap, should be series connected between the plates of the amplifier tubes and the high voltage plate supply capacitor to offer protection from transients and surges. In plate modulated service, where a plate modulation transformer is used, the protective choke is not normally required.

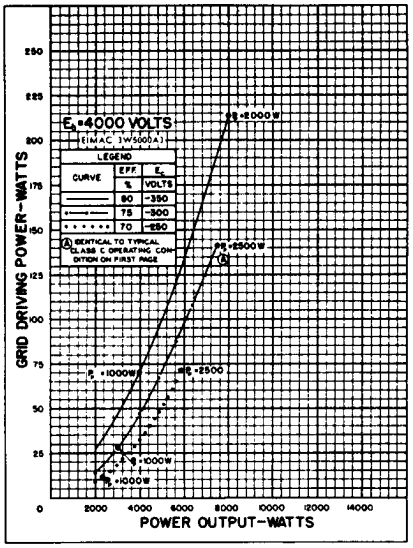
Grid Dissipation—The power dissipated by the grid of the 3W5000A3 must never exceed 150 watts. Grid dissipation may be calculated from the following expression

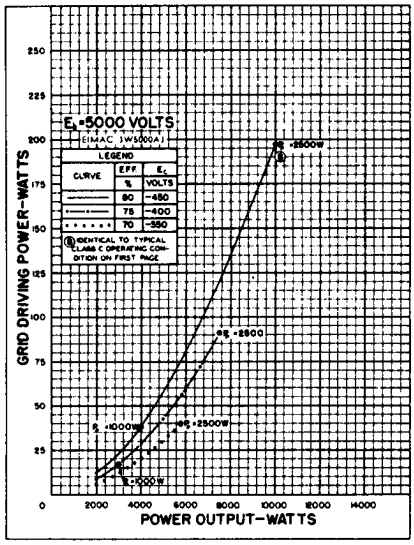
$$P_g = e_{cmp} I_c$$

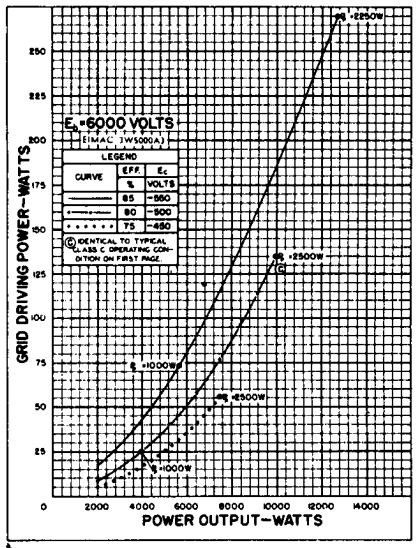
where P_g = Grid dissipation,
e_{cmp} = Peak positive grid voltage, and
I_c = D-C grid current

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid. Any suitable peak v.t.v.m. circuit may be used.

In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.



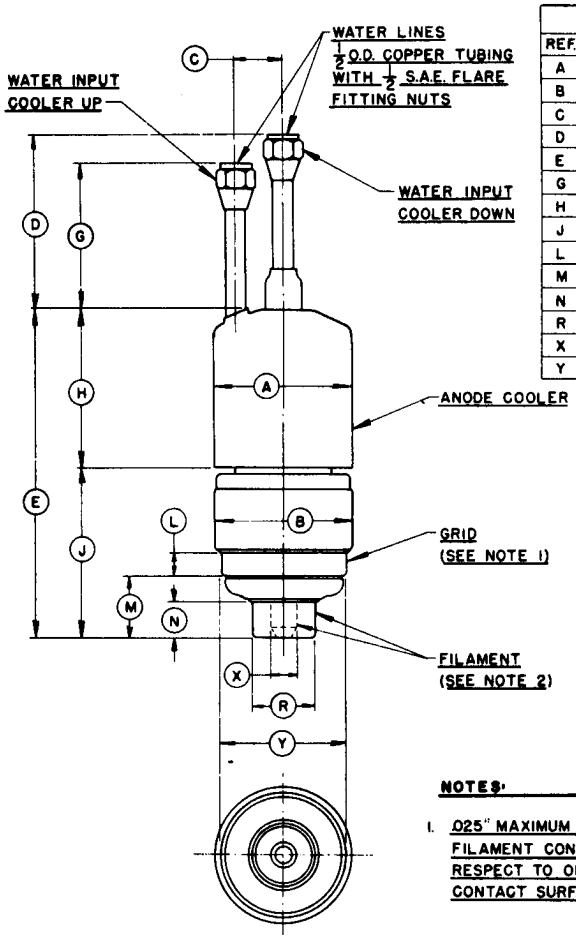




▶ Indicates change from sheet dated 10-21-59

▶ MINIMUM WATER COOLING REQUIREMENTS

Water Inlet Temp. (°C)	Plate Dissipation							
	2 KW		3 KW		4 KW		5 KW	
	Flow Rate GPM	Pressure Drop PSI	Flow Rate GPM	Pressure Drop PSI	Flow Rate GPM	Pressure Drop PSI	Flow Rate GPM	Pressure Drop PSI
20	1.7	0.68	2.6	1.3	3.9	2.3	5.6	3.9
30	2.3	1.1	3.2	1.7	4.5	2.8	6.2	4.5
40	3.0	1.6	3.8	2.2	5.3	3.5	6.9	5.3
50	3.9	2.3	4.7	3.0	6.0	4.3	7.7	6.1



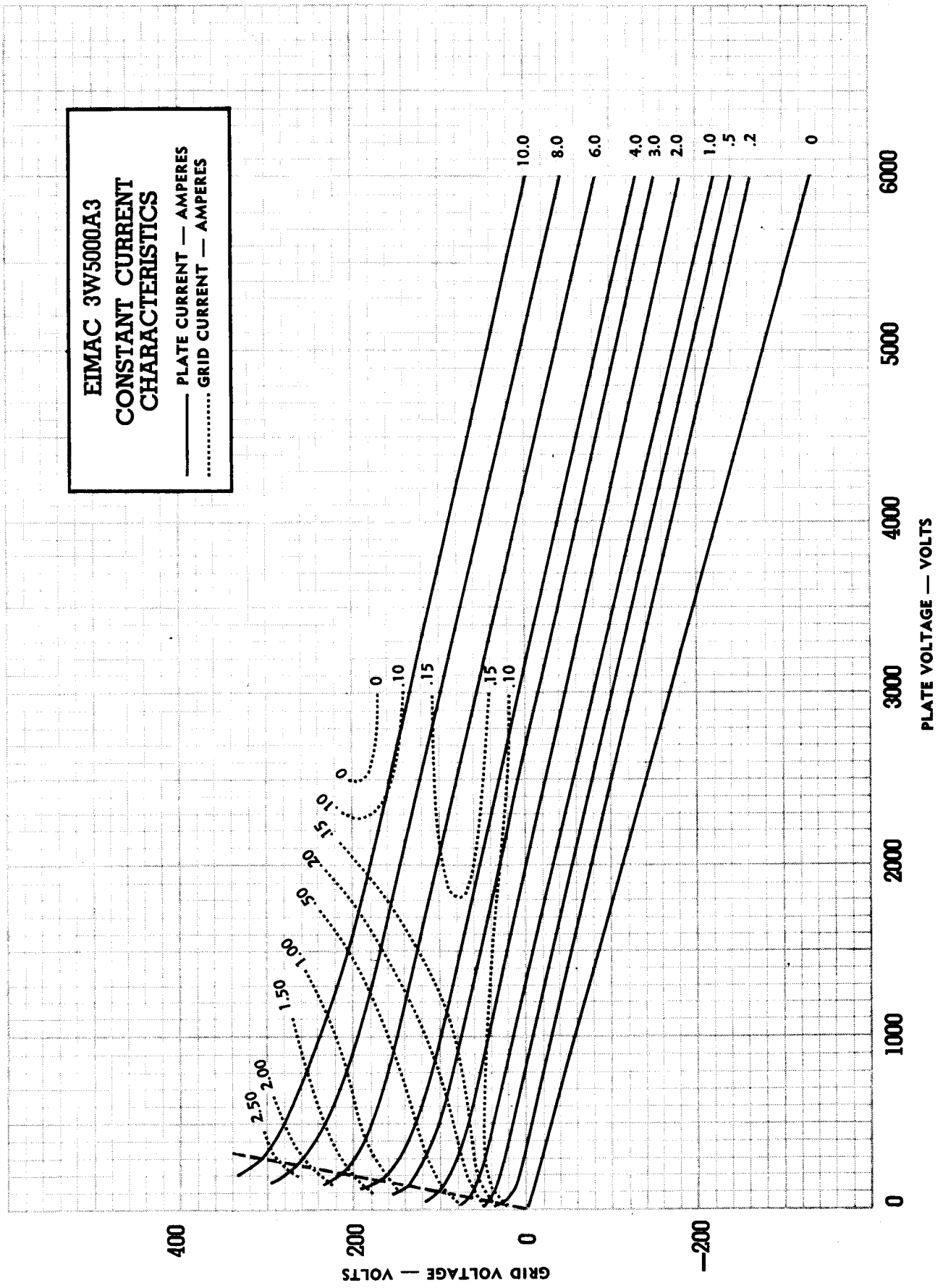
DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A		3.234	3.266
B			3.625
C		1.062	1.187
D		4.000	4.500
E		7.562	8.062
G		3.250	3.750
H		3.625	3.875
J		3.937	4.187
L		.375	.437
M		1.437	1.562
N		.812	.937
R		1.490	1.510
X		.615	.635
Y		2.990	3.010

NOTES:

1. .025" MAXIMUM RUNOUT OF INNER FILAMENT CONTACT SURFACE WITH RESPECT TO OUTER FILAMENT CONTACT SURFACE.

DRIVING POWER vs. POWER OUTPUT

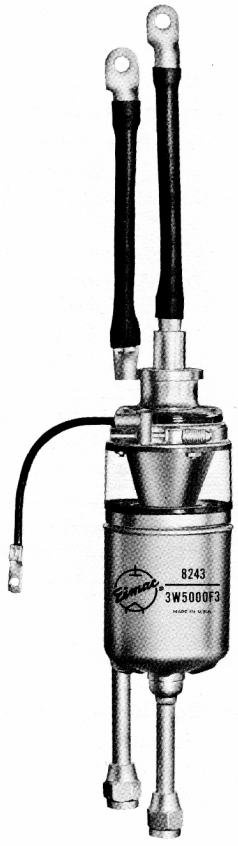
The three charts on this page show the relationship of plate efficiency, power output and approximate grid driving power at plate voltages of 4000, 5000 and 6000 volts. These charts show combined grid and bias losses only. The driving-power and power-output figures do not include circuit losses. The plate dissipation in watts is indicated by Pp. Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 4000, 5000 and 6000 volts respectively.


EIMAC 3W5000A3
CONSTANT CURRENT CHARACTERISTICS
PLATE CURRENT — AMPERES
GRID CURRENT — AMPERES
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.5
.2
0
2.50
2.00
1.50
1.00
.50
.20
.15
.10
0
.10
.15
.15
.10
0
400
200
0
—200
GRID VOLTAGE — VOLTS
0
1000
2000
3000
4000
5000
6000
PLATE VOLTAGE — VOLTS

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

8243
3W5000F3

MEDIUM-MU POWER TRIODE



The Eimac 8243/3W5000F3 is a water-cooled, medium-mu power triode intended for amplifier, oscillator or modulator service. It has a maximum plate dissipation rating of 5000 watts and is capable of high output at relatively low plate voltages. A single 3W5000F3 will deliver a radio frequency plate power-output of 7500 watts at a plate voltage of 4000 volts.

The tube is equipped with flexible filament and grid leads which simplifies socketing and equipment design for industrial and communication frequencies below 30 Mc.

NOTE: The 8243/3W5000F3 is a water-cooled version of the air-cooled 8251/3X2500F3.

The 8243/3W5000F3 should be used where water cooling is preferred and for industrial applications or installations where reserve anode dissipation is desired.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated tungsten				
Voltage		7.5		volts
Current	49		54	amperes
Maximum allowable starting current			100	amperes
Amplification Factor (Average)		20		
Direct Interelectrode Capacitances (Average)				
Grid-Plate	17.8		24.2	μμf
Grid-Filament	29.2		40.2	μμf
Plate-Filament	0.60		1.20	μμf
Transconductance (I_b=830 ma, E_b=3000v)		20,000		μmhos
Frequency for Maximum Ratings			30	mc

MECHANICAL

Base	see drawing
Mounting	vertical, base down or up
Maximum Over-All Dimensions:	
Length (Does not include filament connectors)	12.56 inches
Diameter	3.63 inches
Net Weight	4.8 pounds
Shipping Weight (Average)	15 pounds
Cooling	Water and forced air

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

(Frequencies below 30 Mc.)
Class-C FM or Telegraphy
(Key-down conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPS
PLATE DISSIPATION	5000 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION
(Frequencies below 30 Mc., per tube)

D C Plate Voltage	4000	5000	6000	volts
D-C Plate Current	2.5	2.5	2.08	amps
D-C Grid Voltage	—300	—450	—500	volts
D-C Grid Current	245	265	180	ma
Peak R-F Grid Input Voltage	580	750	765	volts
Driving Power (approx.)	142	197	136	watts
Grid Dissipation	68	78	46	watts
Plate Power Input	10,000	12,500	12,500	watts
Plate Dissipation	2500	2500	2500	watts
Plate Power Output	7500	10,000	10,000	watts

PLATE MODULATED RADIO FREQUENCY AMPLIFIER

(Frequencies below 30 Mc.)
Class-C Telephony
(Carrier conditions, per tube)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	5000 MAX. VOLTS
D-C PLATE CURRENT	2.0 MAX. AMPS
PLATE DISSIPATION	3350 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION
(Frequencies below 30 Mc., per tube)

D C Plate Voltage	4000	4500	5000	volts
D-C Plate Current	1.67	1.55	1.45	amps
Total Bias Voltage	—450	—500	—550	volts
Fixed Bias Voltage	—230	—325	—410	volts
Grid Resistor	1500	1500	1400	ohms
D-C Grid Current	150	120	100	ma
Peak R-F Grid Input Voltage	680	720	760	volts
Driving Power (approx.)	102	86	76	watts
Grid Dissipation	35	26	21	watts
Plate Power Input	6670	6970	7250	watts
Plate Dissipation	1670	1670	1670	watts
Plate Power Output	5000	5300	5580	watts

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AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class B (Sinusoidal wave, two tubes unless otherwise specified)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT, PER TUBE	2.5 MAX. AMPS
PLATE DISSIPATION, PER TUBE	5000 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

D-C Plate Voltage	4000	5000	6000	volts
D-C Grid Voltage[1]	—150	—190	—240	volts
Zero-Signal D-C Plate Current	0.6	0.5	0.4	amps
Max-Signal D-C Plate Current	4.0	3.2	3.0	amps
Effective Load, Plate to Plate	2200	3600	4650	ohms
Peak A-F Grid Input Voltage (per tube)*	340	360	390	volts
Max-Signal Peak Driving Power*	340	230	225	watts
Max-Signal Nominal Driving Power*	170	115	113	watts
Max-Signal Plate Output Power	11,000	11,000	13,000	watts

*Approximate values.

[1]Adjust to give listed zero-signal plate current.

TYPICAL OPERATION CLASS AB_2 (Two Tubes)

Modulator service for 4000 and 5000 volt operation, to modulate one or two tubes, as shown under "Plate Modulated Radio Frequency Amplifier" (Page 1)

D-C Plate Voltage	4000	5000	4000	5000	volts
D-C Grid Voltage (approx.)*	—155	—200	—145	—190	volts
Zero-Signal D-C Plate Current	0.4	0.4	0.6	0.5	amps
Max-Signal D-C Plate Current	1.35	1.13	2.70	2.26	amps
Effective Load, Plate to Plate	6600	10,000	3300	5000	ohms
Peak A-F Grid Input Voltage (per tube)	240	275	285	310	volts
Max-Signal Peak Driving Power	42	40	134	118	watts
Max-Signal Nominal Driving Power (approx.)	21	20	67	59	watts
Max-Signal Plate Power Output	3700	4000	7400	8000	watts
Will Modulate one Tube R-F Final Input of	6670	7250			watts
Will Modulate two tubes R-F Final Input of			13,340	14,500	watts

*Adjust to give stated zero-signal plate current.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION," POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATON AND RECOMMENDATIONS

APPLICATION

► **Cooling**— Minimum recommended water-flow rate and pressure drop values for different water-inlet temperatures and plate dissipations are tabulated on the opposite page. The outlet water temperature must not exceed a maximum of 70° C under any conditions. The inlet water pressure must not exceed a maximum of 60 pounds per square inch.

The grid-terminal contact surface and adjacent glass must be cooled by forced air. The quantity, velocity and direction must be adjusted to limit the maximum seal temperature to 150° C.

The filament stem structure also requires forced-air cooling. A minimum of 6 cubic feet per minute must be directed into the space between the inner and outer filament contacting surfaces.

Air and water flow must be started before filament power is applied and maintained for at least five minutes after the filament power has been removed.

Filament Voltage—The filament voltage, as measured directly at the tube, should be 7.5 volts with maximum allowable variations due to line fluctuation of from 7.12 to 7.87 volts.

Bias Voltage—There is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained from a grid resistor, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

Plate Voltage — The plate supply voltage for the 3W5000F3 should not exceed 6000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "Typical Operation" for the power output desired.

In Class-C FM or Telegraphy service, a 0.1 henry choke, shunted by a spark gap, should be series connected between the plates of the amplifier tubes and the high voltage plate supply capacitor to offer protection from transients and surges. In plate modulated service, where a plate modulation transformer is used, the protective choke is not normally required.

Grid Dissipation—The power dissipated by the grid of the 3W5000F3 must never exceed 150 watts. Grid dissipation may be calculated from the following expression

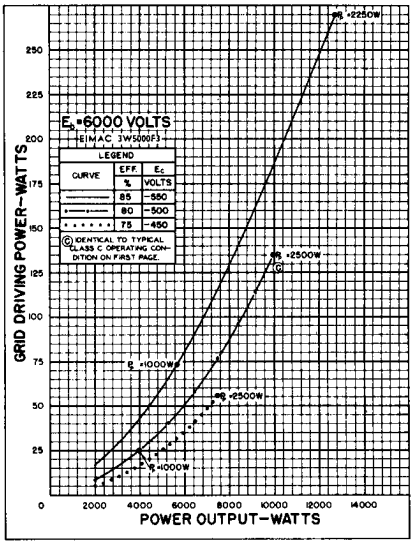
$$P_g = e_{cmp} I_c$$

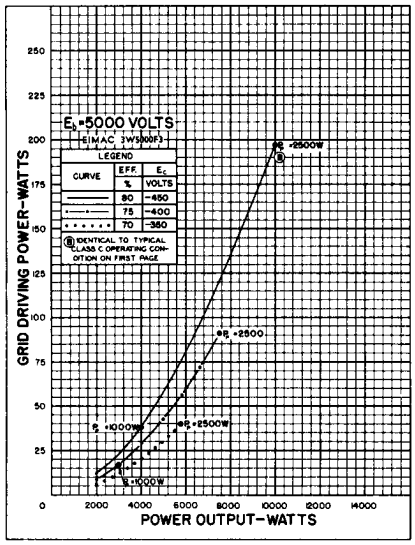
where P_g = Grid dissipation,
e_{cmp} = Peak positive grid voltage, and
I_c = D-C grid current

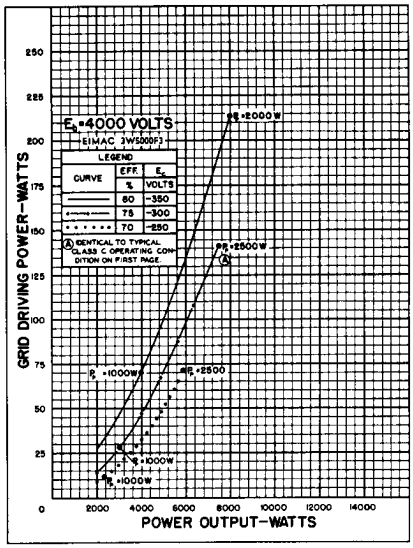
e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid. Any suitable peak v.t.v.m. circuit may be used.

In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading.

► Indicates change from sheet dated 8-26-58



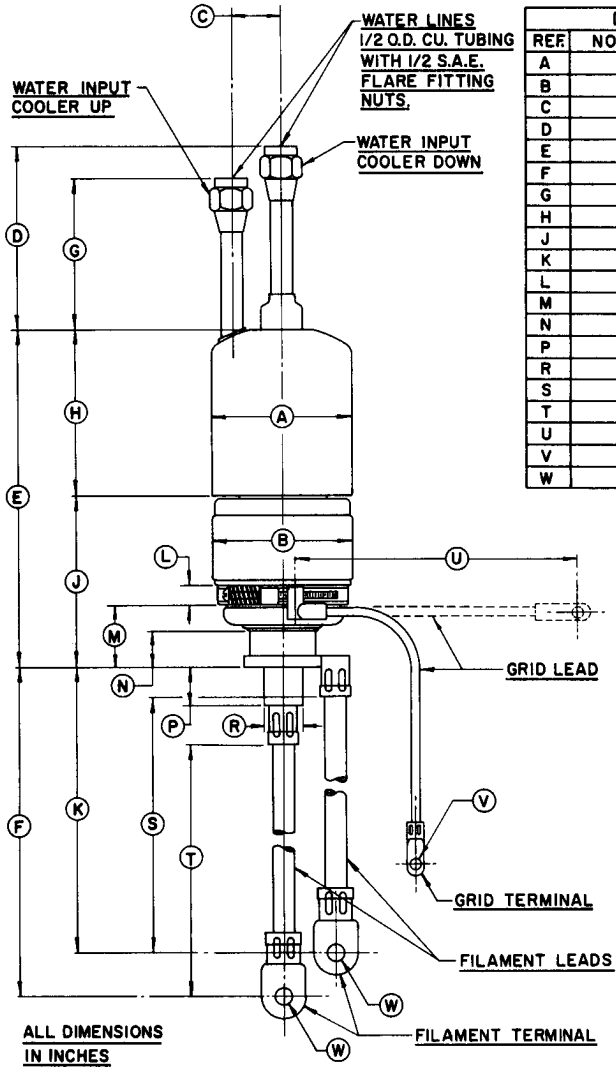




▶ Indicates change from sheet dated 8-26-58

▶

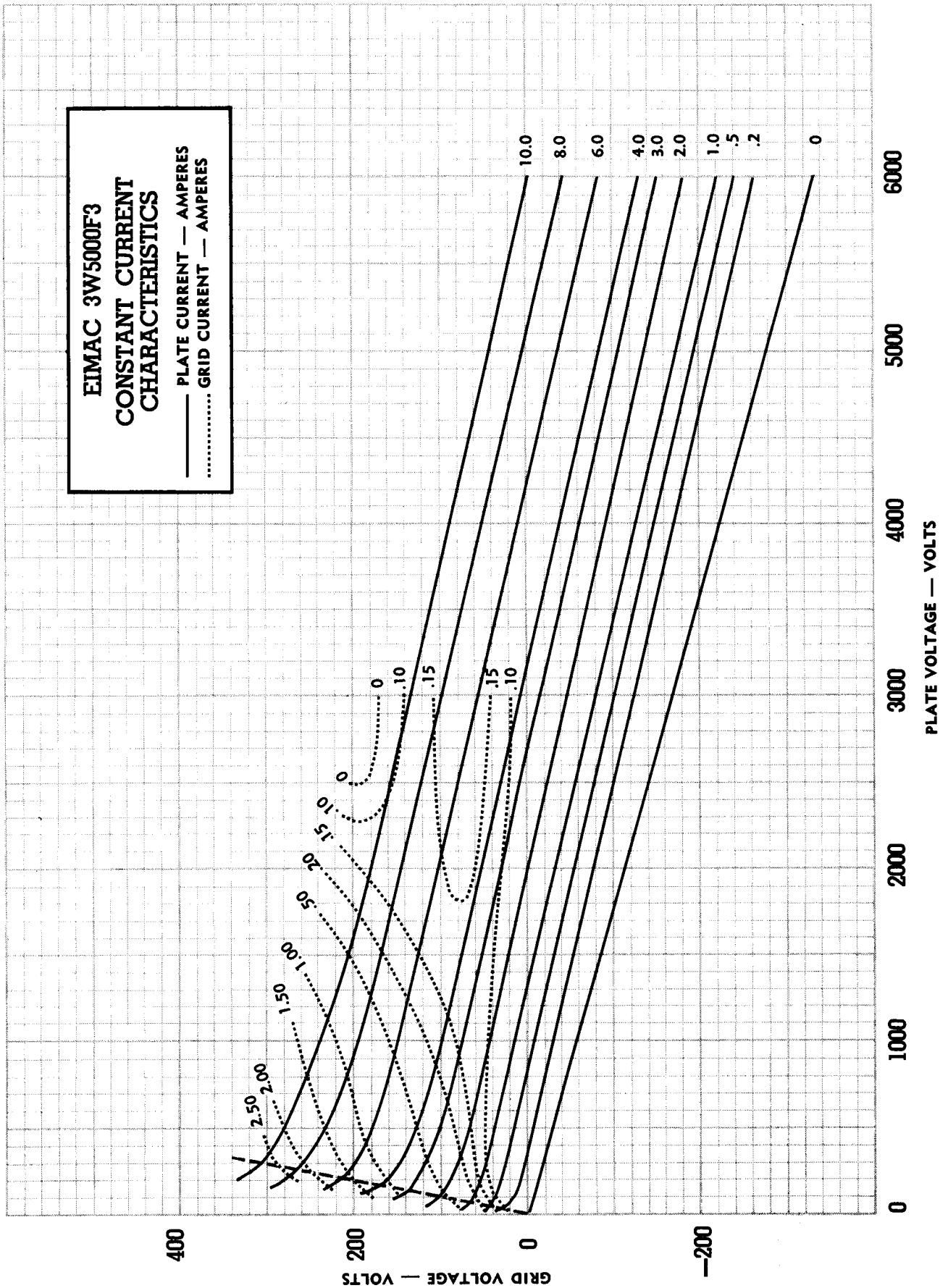
Water Inlet Temp. (°C)	MINIMUM WATER COOLING REQUIREMENTS: Plate Dissipation 2 KW Flow Rate GPM	2 KW Pressure Drop PSI	3 KW Flow Rate GPM	3 KW Pressure Drop PSI	4 KW Flow Rate GPM	4 KW Pressure Drop PSI	5 KW Flow Rate GPM	5 KW Pressure Drop PSI
20	1.7	0.68	2.6	1.3	3.9	2.3	5.6	3.9
30	2.3	1.1	3.2	1.7	4.5	2.8	6.2	4.5
40	3.0	1.6	3.8	2.2	5.3	3.5	6.9	5.3
50	3.9	2.3	4.7	3.0	6.0	4.3	7.7	6.1



DIMENSION DATA REF.	NOM.	MIN.	MAX.
A		3.234	3.266
B			3.625
C		1.062	1.187
D		4.000	4.500
E		7.562	8.062
F		8.937	9.437
G		3.250	3.750
H		3.625	3.875
J		3.937	4.187
K		7.937	8.437
L		.375	.437
M		1.437	1.562
N		.812	.937
P		.812	.937
R		.859	.890
S		7.000	7.500
T		7.000	7.500
U		6.375	6.625
V		.194	.200
W		.385	.395

DRIVING POWER vs. POWER OUTPUT

The three charts on this page show the relationship of plate efficiency, power output and approximate grid driving power at plate voltages of 4000, 5000 and 6000 volts. These charts show combined grid and bias losses only. The driving-power and power-output figures do not include circuit losses. The plate dissipation in watts is indicated by Pp. Points A, B, and C are identical to the typical Class C operating conditions shown on the first page under 4000, 5000 and 6000 volts respectively.


EIMAC 3W5000F3
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT — AMPERES
GRID CURRENT — AMPERES
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.5
.2
0
2.50
2.00
1.50
1.00
.50
.20
.15
.10
0
.10
.15
.20
.50
1.00
1.50
2.00
2.50
0
1000
2000
3000
4000
5000
6000
PLATE VOLTAGE — VOLTS
400
200
0
—200
GRID VOLTAGE — VOLTS

8244
4CW2000A

CERAMIC
POWER TETRODE

The EIMAC 8244/4CW2000A is a ceramic/metal water cooled radial-beam tetrode with a rated maximum plate dissipation of 2000 watts. It is a low-voltage high current tube designed for Class AB1 rf linear amplifier or audio amplifier applications where its high gain may be used to advantage. It is also recommended for voltage or current regulator service. As a regulator, the maximum dc plate voltage rating is 6000 volts. The 8244/4CW2000A is the water-cooled version of the 8168/4CX1000A.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide-coated Unipotential		
Heater Voltage	6.0 ± 0.3	V
Heater Current, at 6.0 volts	9.0	A
Transconductance (Average):		
I_b = 1.0 Adc, E_{c2} = 325 Vdc	37,000	μmhos
Amplification Factor (Average):		
Grid to Screen	3.8	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	81.5	pF
Cout	11.8	pF
Cgp	0.015	pF
Frequency of Maximum Rating:		
CW	110	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	5.69 in; 144.5 mm
Diameter	2.66 in; 67.6 mm
Net Weight	27 oz; 766 gm
Operating Position	Vertical
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Cooling	Water
Base	Special, breechlock terminal surfaces
Recommended Socket	EIMAC SK-800 Series

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RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_1 or B (Single Side-Band Suppressed-Carrier Operation)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	2000	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	0	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	2000	2500	3000	Vdc
Screen Voltage	325	325	325	Vdc
Grid Voltage[1]	-60	-60	-60	Vdc
Zero-Signal Plate Current	250	250	250	mAdc
Single-Tone Plate Current[2]	890	885	875	mAdc
Two-Tone Plate Current[2]	645	650	635	mAdc
Zero-Signal Screen Current[2]	8	6	5	mAdc
Single-Tone Screen Current[2]	35	35	35	mAdc
Two-Tone Screen Current[2]	10	8	8	mAdc
Plate Output Power	930	1300	1630	W

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB , Grid Driven, Sinusoidal Wave

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	3000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	2000	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	0	WATTS

TYPICAL OPERATION (Two Tubes)

Plate Voltage	2000	2500	3000	Vdc
Screen Voltage	325	325	325	Vdc
Grid Voltage[1]	-60	-60	-60	Vdc
Zero-Signal Plate Current	500	500	500	mAdc
Maximum-Signal Plate Current	1.78	1.77	1.75	Adc
Zero-Signal Screen Current[2]	16	12	10	mAdc
Maximum-Signal Screen Current[2]	70	70	70	mAdc
Plate Output Power	1860	2600	3260	W
Load Resistance (Plate to Plate)	2040	2850	3860	Ω

1. Adjust to give stated zero-signal plate current.
2. Approximate value.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	8.1	9.9	A
Cathode Warmup Time	3.0	---	Min.
Amplification Factor (g1 to g2)	3.2	4.5	---
Interelectrode Capacitance (grounded cathode connection)[1]			
Cin	75.0	88.0	pF
Cout	10.8	12.8	pF
Cgp	---	0.022	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

COOLING - Sufficient cooling must be provided for the anode and ceramic/metal seals to maintain operating temperatures below the rated maximum value of 250°C.

Anode cooling is accomplished by circulating water through the integral water jacket. The tabulation below lists the minimum water flow requirements for 50°C inlet water temperature.

Plate Dissipation (Watts)	Water Flow (gpm)	Pressure Drop (psi)
1000	1.0	1.0
2000	2.0	2.5

Water pressure should never exceed 50 psi and outgoing water temperature must be limited to 70°C.

At ambient temperatures of 25°C, or less, when mounted in an EIMAC SK-800B socket, the 4CW2000A does not require base cooling. At higher temperatures, however separate base cooling may be required.

In cases where there is any doubt regarding the adequacy of the supplied cooling, it should be borne in mind that operating temperature is the sole criterion of cooling effectiveness. Surface temperatures may be easily and effectively measured by using one of the several temperature-sensitive paints or sticks available from various chemical or scientific equipment suppliers. When these materials are used, extremely thin applications must be made to avoid interference with the transfer of heat from the tube to the air stream, which would cause inaccurate indications.

SHOCK AND VIBRATION - The 4CW2000A has the same internal construction as the EIMAC 4CX1000A, and both are capable of operation under vibration conditions at 10 g to 500 Hz, or long-duration shock (11 milliseconds) of 50 g, with full rated voltages applied.

When environmental stress is anticipated, care must be taken in mounting of the tube and socket so there is sufficient support for the tube to prevent relative motion between tube and socket under stress conditions. The socket is not designed to provide sole support for the tube during shock or vibrational stress.

ELECTRICAL

HEATER - The rated heater voltage for the 4CW2000A is 6.0 volts. The voltage, as measured at the socket, should be maintained at this value to minimize variations in operation and to obtain maximum tube life. In no case should the voltage be allowed to exceed 5% above or below the rated value.

The cathode and one side of the heater are internally connected.

It is recommended that the heater voltage be applied for a period of not less than 3 minutes before other operating voltages are applied. From an initial cold condition, tube operation will stabilize after a period of approximately 5 minutes.

GRID OPERATION - The grid dissipation rating of the 4CW2000A is zero watts. The design features which make the tube capable of maximum power operation without driving the grid into the positive region also make it neccessary to avoid positive grid operation.

Although the average grid current rating is zero, peak grid currents of less than five milliamperes as read on a five milliampere meter may be permitted to flow for peak signal monitoring purposes.

SCREEN OPERATION - Tetrode tubes may exhibit reversed screen current to a greater or lesser degree depending on individual tube design. This characteristic is prominent in the 4CW2000A and, under some operating conditions, indicated negative screen currents in the order of 25 milliamperes may be encountered.

The maximum rated power dissipation for the screen grid in the 4CW2000A is 12 watts and the screen power should be kept below this level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative. In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage. Experience has shown that the screen will operate within the limits established for this tube if the indicated screen current, plate voltage and drive voltage approximate the "Typical Operation" values.

The screen supply voltage must be main-

tained constant for any values of negative and positive screen currents that may be encountered. Dangerously high plate currents may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished in several different ways. A bleeder resistor may be connected from screen or cathode; a combination of VR tubes may be connected from screen to cathode; or an electron-tube regulator circuit may be used in the screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed. The screen bleeder current should approximate 70 milliamperes to adequately stabilize the screen voltage. It should be observed that this bleeder power may be usefully employed to energize low-power stages of the transmitter.

PLATE OPERATION - The maximum rated plate dissipation power is 2000 watts. Except for brief periods during circuit adjustments, this maximum value should not be exceeded.

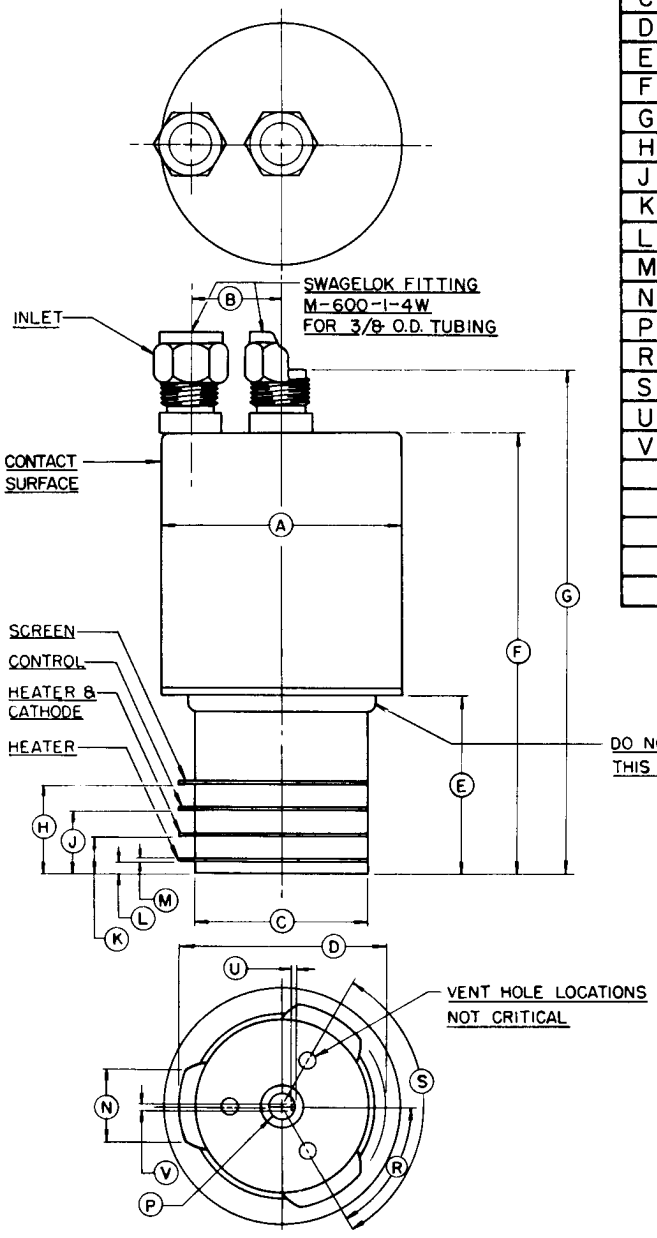
VOLTAGE OR CURRENT REGULATOR - The 4CW2000A is attractive for regulator service. As a voltage or current regulator the dc plate voltage rating is increased to 6000 volts. All other ratings remain the same.

HIGH VOLTAGE - The 4CW2000A operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

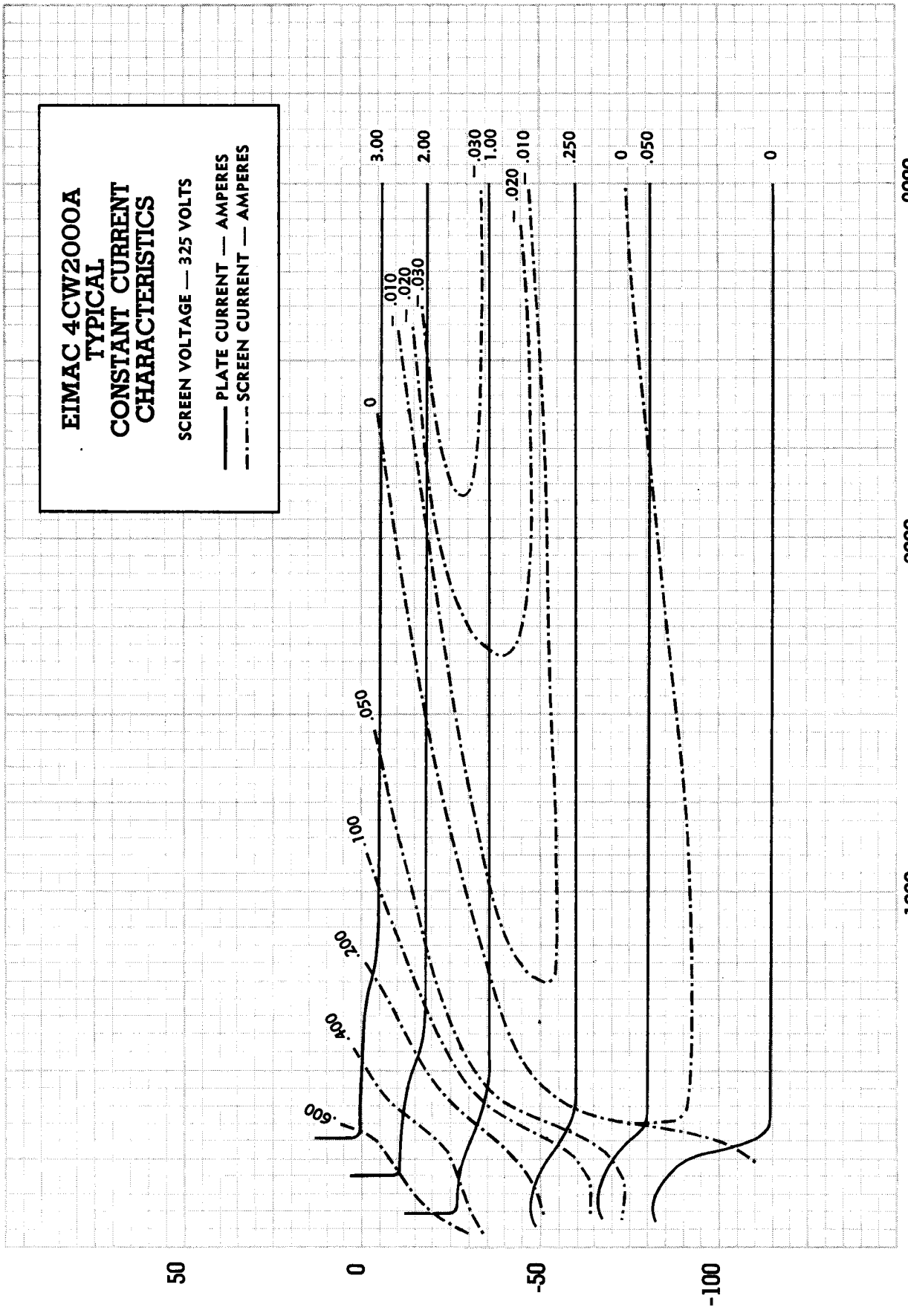
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions different from those given here, write to the Application Engineering Department, EIMAC Division of Varian, San Carlos, California, 94070, for information and recommendations.



DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	2.609	2.663	- -	66.27	66.88	- -
B	- -	- -	0.984	- -	- -	24.99
C	1.870	1.900	- -	47.50	48.26	- -
D	2.250	2.300	- -	57.15	58.42	- -
E	2.017	2.153	- -	51.23	54.69	- -
F	4.820	4.960	- -	122.43	125.98	- -
G	5.497	5.685	- -	139.62	144.40	- -
H	0.965	0.988	- -	24.51	25.10	- -
J	0.670	0.710	- -	17.02	18.03	- -
K	0.415	0.435	- -	10.54	11.05	- -
L	0.140	0.165	- -	3.56	4.19	- -
M	0.020	0.030	- -	0.51	0.76	- -
N	0.700	0.800	- -	17.78	20.32	- -
P	0.314	0.326	- -	7.98	8.28	- -
R	55°	65°	- -	55°	65°	- -
S	115°	125°	- -	115°	125°	- -
U	0.025	0.048	- -	0.64	1.22	- -
V	0.045	0.070	- -	1.14	1.78	- -

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.


EIMAC 4CW2000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 325 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
3.00
2.00
1.00
.250
0
.050
0
.030
.020
.010
0
.030
.020
.010
0
.050
100
200
400
600
50
0
-50
-100
1000
2000
3000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8245 4CX250K
8246 4CX250M
RADIAL-BEAM POWER TETRODE

The 8245/4CX250K and 8246/4CX250M are compact, forced-air cooled, external-anode radial-beam tetrodes with a maximum plate dissipation rating of 250 watts and a maximum input-power rating of 500 watts. The 8245/4CX250K is designed to operate with a heater voltage of 6.0 volts, while the 8246/4CX-250M is designed for operation at a heater voltage of 26.5 volts. Otherwise, the two tube types have identical characteristics.

These tubes are of coaxial construction and are especially designed for cavity operation.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide-Coated, Unipotential				
Heating Time	30	60		s
Cathode-to-heater Potential			±150	V
Heater: Voltage 4CX250K		6.0		V
Current 4CX250K	2.30		3.0	A
Voltage 4CX250M		26.5		V
Current 4CX250M	0.35		0.68	A
Amplification Factor (Grid-to-Screen)		5		
Direct Interelectrode Capacitances, Grounded Cathode:				
Input	25.0		29.0	pF
Output	4.2		5.2	pF
Feedback			0.05	pF

Direct Interelectrode Capacitances, Grounded Grid and Screen	Min.	Max.	
Input	14.5	19	pF
Output	4.2	5.2	pF
Feedback		0.01	pF
Frequency for Maximum Ratings (CW)		500	MHz
(Pulsed)		1500	MHz

MECHANICAL

Base	Coaxial
Maximum Operating Temperatures:	
Ceramic-to-Metal-Seals	250° C
Anode Core	250° C
Operating Position	Any
Maximum Dimensions:	
Height	2.813 in
Diameter	1.640 in
Cooling	Forced Air
Net Weight	4.6 oz
Shipping Weight (Approximate)	1.6 lbs

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions)
MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 VOLTS
DC SCREEN VOLTAGE	300 VOLTS
DC GRID VOLTAGE	-250 VOLTS
DC PLATE CURRENT	250 MA
PLATE DISSIPATION	250 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION

	Frequencies up to 175 MHz				500 MHz	
DC Plate Voltage	500	1000	1500	2000	2000	volts
DC Screen Voltage	250	250	250	250	300	volts
DC Grid Voltage	-90	-90	-90	-90	-90	volts
DC Plate Current	250	250	250	250	250	mA
DC Screen Current*	45	38	21	19	10**	mA
DC Grid Current*	35	31	28	26	25**	mA
Peak RF Grid Voltage*	114	114	112	112	—	volts
Driving Power*	4.0	3.5	3.2	2.9	—	watts
Plate Input Power	125	250	375	500	500	watts
Plate Output Power	70	190	280	390	225**	watts
Heater Voltage	6.0	6.0	6.0	6.0	5.5	volts

* Approximate values.

** Measured Values for a typical cavity amplifier circuit.

(Effective 5-1-68) © 1959, 1962, 1963, 1968 by Varian

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PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	1500 VOLTS
DC SCREEN VOLTAGE	300 VOLTS
DC GRID VOLTAGE	-250 VOLTS
DC PLATE CURRENT	200 MA
PLATE DISSIPATION	165 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Frequencies up to 175 MHz)

DC Plate Voltage	500	1000	1500	volts
DC Screen Voltage	250	250	250	volts
DC Grid Voltage	-100	-100	-100	volts
DC Plate Current	200	200	200	mA
DC Screen Current*	31	22	20	mA
DC Grid Current*	15	14	14	mA
Peak RF Grid Input Voltage*	118	117	117	volts
Driving Power*	1.8	1.7	1.7	watts
Plate Input Power	100	200	300	watts
Plate Output Power	60	145	235	watts

* Approximate values.

RADIO-FREQUENCY POWER AMPLIFIER

Class-B Linear, Television Visual Service (per tube)

DC PLATE VOLTAGE	1250 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC GRID VOLTAGE	-250 VOLTS
DC PLATE CURRENT (AVERAGE)	250 MA
PLATE DISSIPATION	250 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Frequencies up to 216 MHz, 5 MHz bandwidth)

DC Plate Voltage	750	1000	2000	volts
DC Screen Voltage	300	300	350	volts
DC Grid Voltage	-60	-65	-70	volts
During Sync-Pulse Peak:				
DC Plate Current	335	330	360	mA
DC Screen Current	50	45	29	mA
DC Grid Current	15	20	25	mA
Peak RF Grid Voltage	85	95	100	volts
RF Driver Power (approx.)	7	8	9	watts
Useful Power Output	135	200	440	watts
Black Level:				
DC Plate Current	245	240	250	mA
DC Screen Current	20	15	0	mA
DC Grid Current	4	4	4	mA
Peak RF Grid Voltage (approx.)	65	70	75	volts
RF Driver Power (approx.)	4.25	4.7	5.5	watts
Plate Power Input	185	240	500	watts
Useful Power Output	75	110	250	watts

PLATE PULSED RADIO FREQUENCY AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS

PULSED PLATE VOLTAGE	7000 VOLTS
PULSED SCREEN VOLTAGE	1500 VOLTS
DC GRID VOLTAGE	-500 VOLTS
MAXIMUM PULSE DURATION	5 μS
PULSED CATHODE CURRENT	7 AMPS
AVERAGE POWER INPUT	250 WATTS
PLATE DISSIPATION	250 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL PULSE OPERATION

Single tube oscillator, 1200 MHz

Pulsed Plate Voltage	5	7	kV
Pulsed Plate Current	4.0	6.0	amps
Pulsed Screen Voltage	800	1200	volts
Pulsed Screen Current	0.3	0.4	amps
DC Grid Voltage	-200	-250	volts
Pulsed Grid Current	0.5	0.6	amps
Pulse Duration	4	5	μsec
Pulse Repetition Rate	2500	1000	pps
Peak Power Output	7	17	kW

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1 (Single-Sideband Suppressed-Carrier Operation)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC PLATE CURRENT	250 MA
PLATE DISSIPATION	250 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Frequencies up to 175 MHz, peak-envelope conditions except where noted)

DC Plate Voltage	1000	1500	2000	volts
DC Screen Voltage	350	350	350	volts
DC Grid Voltage*	-55	-55	-55	volts
Zero-Signal DC Plate Current	100	100	100	mA
Peak RF Grid Voltage**	50	50	50	volts
DC Plate Current	250	250	250	mA
DC Screen Current**	10	8	5	mA
Plate Input Power	250	375	500	watts
Plate Output Power	120	215	300	watts
Two-Tone Average DC Plate Current	190	190	190	mA
Two-Tone Average DC Screen Current**	2	-1	-2	mA

* Approximate values.

** Adjust grid bias to obtain listed zero-signal plate current.

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direst tests. Adjustment of the r-f grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this proceedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct r-f driving voltage is applied.

APPLICATION

MECHANICAL

Mounting The 4CX250K and 4CX250M may be mounted in any position. The concentric arrangements of the electrode terminals permits the use of the tube in coaxial line or cavity type circuits to advantage.

Connections to the contact surfaces should be made by means of spring-finger collets which have sufficient pressure to maintain a good electrical contact at all fingers. Points of electrical contact should be kept clean and free of oxidation to minimize rf losses.

Cooling Sufficient forced-air cooling must be provided to maintain the anode core and seal temperatures below 250° C. Special care must be observed to insure that there is adequate cooling in the area of the coaxial filament and grid terminals.

The table below lists the minimum cooling requirements at sea level with 50° C ambient air to maintain 225° C on the anode. For operation at 10,000 feet, the air-flow values should be multiplied by 1.46.

	BASE-TO-ANODE FLOW		ANODE-TO-BASE FLOW	
Plate Dissipation (Watts)	Air Flow (CFM)	Static Pressure (inches of water)	Air Flow (CFM)	Static Pressure (inches of water)
150	3.5	0.3	3.1	0.2
200	4.3	0.4	4.6	0.4
250	5.5	0.7	6.1	0.7

ELECTRICAL

Heater The rated heater voltages for the 4CX-250K and 4CX250M are 6.0 and 26.5 volts, respectively and should be maintained at these values plus or minus five percent. At frequencies above 300 megahertz, transit time effects begin to influence the cathode temperature. The amount of driving power diverted to cathode heating will depend on frequency, plate current and driving power. When the tube is driven to maximum input as a class-C amplifier, the heater voltage should be reduced according to the following table. Further reduction in filament voltage may be needed in pulse service above 500 MHz.

Frequency, MHz	4CX250K	4CX250M
301 to 400	5.75 volts	25.5 volts
401 to 500	5.50 volts	24.3 volts

Cathode The oxide-coated unipotential cathode must be protected against excessively high emission currents. The maximum dc plate current must be limited to 250 mA under CW conditions. Pulse current must never exceed 6.0 amperes.

Where it is necessary to operate with some heater-to-cathode potential, the maximum heater-to-cathode voltage is 150 volts regardless of polarity.

Grid Dissipation Maximum grid dissipation is 2.0 watts. In ordinary af and rf amplifiers the grid dissipation usually will not reach this level. Above 100 MHz, drive power requirements increase, but most of this increase is absorbed in circuit losses rather than in grid dissipation. Satisfactory operation at 500 MHz in a "straight through" amplifier is indicated by grid currents below approximately 15 milliamperes. Grid circuit resistance should not exceed 100,000 ohms per tube.

Screen-Grid Operation The maximum rated power dissipation for the screen grid is 12 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

When screen voltages appear between screen and cathode, as in the case of screen-modulated amplifiers or cathode-driven tetrode amplifiers, the peak screen-to-cathode voltage is the sum of the dc screen voltage and the peak ac or rf signal voltage applied to screen or cathode.

Protection for the screen should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be applied before screen voltage can be applied.

The screen current may reverse under certain conditions and produce negative current indications on the screen milliammeter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor, gaseous voltage regulator tubes or an electron tube shunt regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per connected screen. An electron tube series regulator can be used only when an adequate bleeder resistor is provided.

Self-modulation of the screen in plate-modulated tetrode amplifiers using these tubes may not be satisfactory because of the screen-voltage screen-current characteristics. Screen modulation from a tertiary winding on the modulation transformer or by means of a small separate modulator tube will usually be more satisfactory. Screen-voltage modulation factors between 0.75 and 1.0 will result in 100% modulation for plate-modulated rf amplifiers using the 4CX250K or 4CX250M.

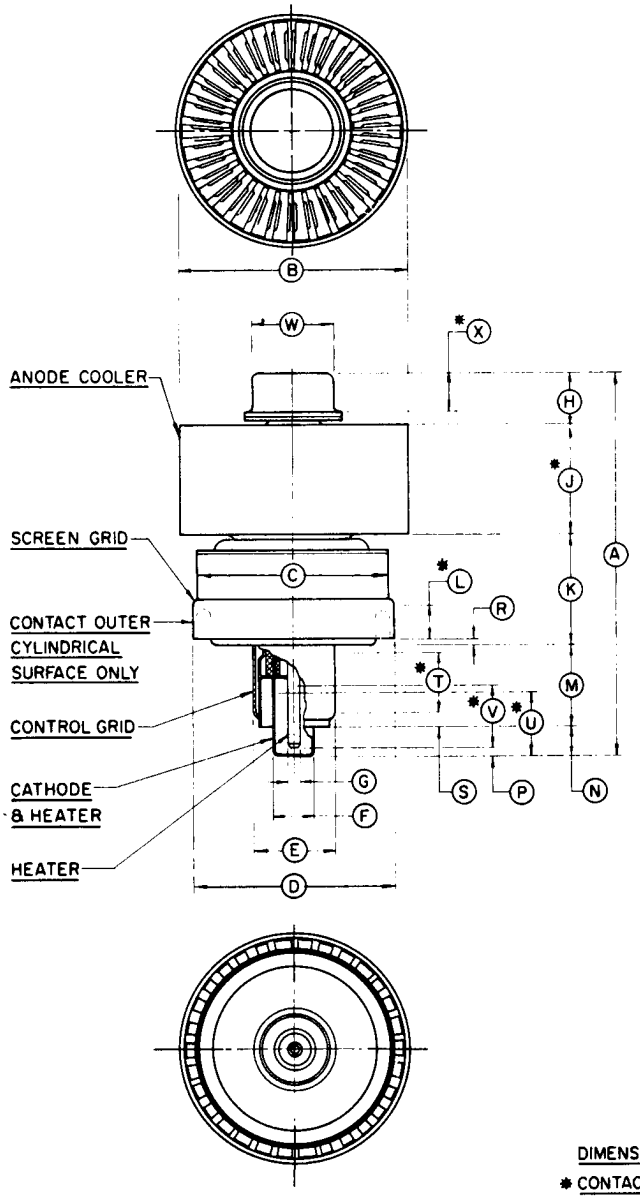
Plate Operation The maximum rated plate-dissipation power is 250 watts. In plate-modulated applications the carrier plate-dissipation power must be limited to 165 watts to avoid exceeding the plate dissipation rating with 100% sine wave modulation. The maximum dissipation rating may be exceeded for brief periods during circuit adjustment without damage to the tube.

UHF Operation The 4CX250K and 4CX250M are suitable for use in the UHF region. Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

Multiple Operation Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide individual metering and individual adjustments of bias or screen voltage to equalize the inputs.

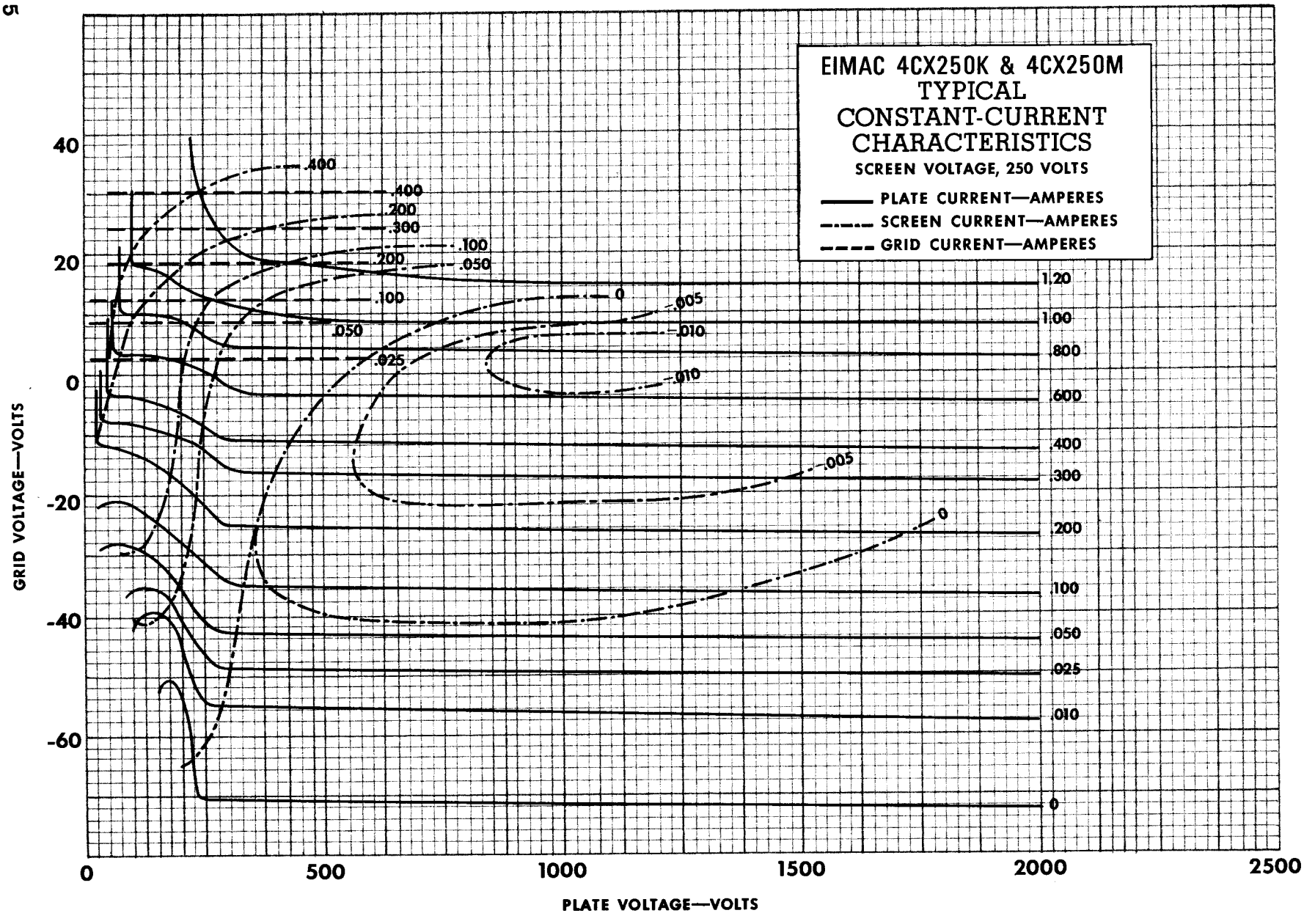
Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event that one tube fails.

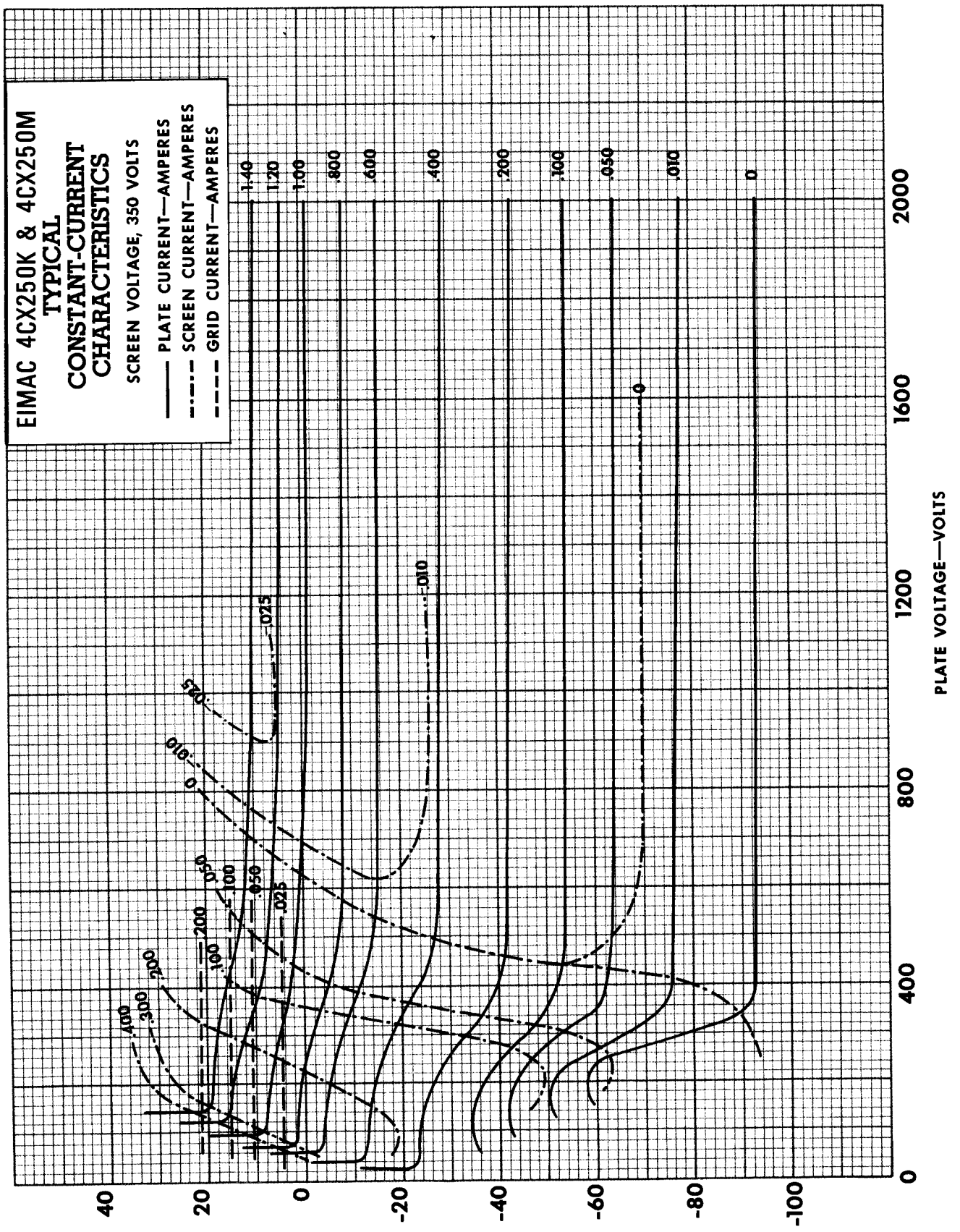
Special Applications If it is desired to operate these tubes under conditions widely different from those given here, write to Product Manager, Eimac Division of Varian, San Carlos, California, for information and recommendations.



DIMENSIONS		
REF.	MIN.	MAX.
A		2.813
B	1.610 DIA.	1.640 DIA.
C		1.406 DIA.
D	1.410 DIA.	1.440 DIA.
E	.587 DIA.	.597 DIA.
F	.317 DIA.	.327 DIA.
G	.088 DIA.	.098 DIA.
H		.358
J	.710	.790
K	.740	.820
L	.187	
M	.500	.580
N	.235	.265
P	.032	.062
R	.020 NOM.	
S	.125 NOM.	
T	11/32	
U	13/32	
V	15/32	
W	.559	.573
X	.240	.280

DIMENSIONS IN INCHES
* CONTACT SURFACE


EIMAC 4CX250K & 4CX250M
TYPICAL
CONSTANT-CURRENT
CHARACTERISTICS
SCREEN VOLTAGE, 250 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—VOLTS
40
20
0
-20
-40
-60
0
500
1000
1500
2000
2500
1.20
1.00
.800
.600
.400
.300
.200
.100
.050
.025
.010
0
.400
.200
.300
.100
.200
.050
.100
.050
.025
.010
0
.005
.010
.005
0


EIMAC 4CX250K & 4CX250M
TYPICAL
CONSTANT-CURRENT
CHARACTERISTICS
SCREEN VOLTAGE, 350 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
1.40
1.20
1.00
.800
.600
.400
.200
.100
.050
.010
0
.025
.010
0
.050
.025
.100
.050
.200
.100
.300
.200
.400
.300
.500
.400
40
20
0
-20
-40
-60
-80
-100
0
400
800
1200
1600
2000
PLATE VOLTAGE—VOLTS
GRID VOLTAGE—VOLTS

8247
4PR125A

RADIAL-BEAM PULSE TETRODE
MODULATOR
OSCILLATOR
AMPLIFIER

TECHNICAL DATA

The Eimac 8247/4PR125A is a pulse tetrode intended for use in pulse-modulator, pulsed-amplifier, and pulsed-oscillator service. This compact, high vacuum, radial-beam tetrode, incorporating a Pyrovac plate and non-emitting grids, is recommended for use in new equipments where high voltage, high current, or high duty factor is encountered.

Cooling of the tube is accomplished by radiation from the plate and by circulation of forced-air through the base and around the envelope. Cooling can be simplified by the use of the Eimac SK-410 Air-System Socket and the SK-406 Air Chimney.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated tungsten				
Voltage	-	5.0		volts
Current	6.0		7.0	amperes
Amplification Factor (Grid to Screen)	-	5.9		
Direct Interelectrode Capacitances, Grounded Cathode: †				
Grid-Plate	-	-	0.07	uuf
Input	9.2	-	12.4	uuf
Output	2.5	-	3.5	uuf
Transconductance (I_b = 50 ma)	-	2,450		umhos
Highest Frequency for Maximum Ratings	-	-	120	mc

MECHANICAL

Base	5-pin metal shell
Basing	See drawing
Recommend Socket	Eimac SK-410 Air-System Socket
Operating Position	Vertical, base down or up
Maximum Operating Temperatures:	
Base Seals	200°C
Plate Seal	170°C
Cooling	Radiation and forced-air
Recommended Heat-Dissipating Plate Connector	Eimac HR-6
Maximum Over-all Dimensions:	
Length	5.69 inches
Diameter	2.81 inches
Net Weight (tube only)	6.5 ounces
Shipping Weight	1.5 pounds

† in Shielded Fixture

PULSE MODULATOR SERVICE

MAXIMUM RATINGS	
DC PLATE VOLTAGE	18 MAX. KILOVOLTS
DC SCREEN VOLTAGE	2.0 MAX. KILOVOLTS
DC GRID VOLTAGE	-1.0 MAX. KILOVOLT
PEAK PLATE CURRENT	1.5 MAX. AMPERES
PLATE DISSIPATION (AVG.)	125 MAX. WATTS
SCREEN DISSIPATION (AVG.)	20 MAX. WATTS
GRID DISSIPATION (AVG.)	5 MAX. WATTS

TYPICAL OPERATION				
DC Plate Voltage	10	14	18	kilovolts
DC Screen Voltage	1.0	1.0	1.0	kilovolts
DC Grid Voltage	-245	-260	-275	volts
Pulse Plate Voltage	9.0	13.0	17.0	kilovolts
Peak Plate Current	1.0	1.0	1.0	ampere
Pulse Screen Current	0.2	0.2	0.2	ampere
Pulse Grid Current	25	25	25	ma
Pulse Pos. Grid Voltage	30	30	30	volts
Pulse Drive Power	6.9	7.3	7.7	watts
Pulse Plate Input Power	10	14	18	kilowatts
Pulse Plate Output Power	9	13	17	kilowatts
Duty	10	10	10	percent

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RADIO-FREQUENCY PLATE AND SCREEN-PULSED AMPLIFIER AND OSCILLATOR*

MAXIMUM RATINGS	
PEAK DC PLATE VOLTAGE	12 MAX. KILOVOLTS
DC SCREEN VOLTAGE	2.0 MAX. KILOVOLTS
DC GRID VOLTAGE	-1.0 MAX. KILOVOLT
PEAK CATHODE CURRENT**	2.5 MAX. AMPERES
PLATE DISSIPATION (AVG.)	125 MAX. WATTS
SCREEN DISSIPATION (AVG.)	20 MAX. WATTS
GRID DISSIPATION (AVG.)	5 MAX. WATTS

*When used as a rf Plate-and Screen-Pulsed Amplifier the grid drive must also be pulsed to avoid overheating this element during the inter-pulse periods.

TYPICAL OPERATION				
Pulse Plate Voltage	8	10	12	kilovolts
Pulse Screen Voltage	1.0	1.0	1.0	kilovolt
DC Grid Voltage	-380	-390	-400	volts
Pulse Plate Current **	416	416	416	ma
Pulse Screen Current	36	36	36	ma
Pulse Grid Current	6	6	6	ma
Peak RF Grid Voltage	520	530	540	volts
Pulse Drive Power	3.12	3.18	3.25	watts
Pulse Plate Input Power	3.33	4.16	5.0	kilowatts
Pulse Plate Output Power	2.52	3.24	4.0	kilowatts
Duty	15	13	12	percent

▶RADIO-FREQUENCY GRID-PULSED AMPLIFIER AND OSCILLATOR

MAXIMUM RATINGS	
DC PLATE VOLTAGE	9.0 MAX. KILOVOLTS
DC SCREEN VOLTAGE	2.0 MAX. KILOVOLTS
DC GRID VOLTAGE	-1.0 MAX. KILOVOLT-
PEAK CATHODE CURRENT**	2.5 MAX. AMPERES
PLATE DISSIPATION (AVG.)	125 MAX. WATTS
SCREEN DISSIPATION (AVG.)	20 MAX. WATTS
GRID DISSIPATION (AVG.)	5 MAX. WATTS

TYPICAL OPERATION				
DC Plate Voltage	5	7	9	kilovolts
DC Screen Voltage	1.0	1.0	1.0	kilovolts
DC Grid Voltage	-365	-375	-385	volts
Pulse Plate Current **	416	416	416	ma
Pulse Screen Current	36	36	36	ma
Pulse Grid Current	6	6	6	ma
Peak RF Grid Voltage	505	515	525	volts
Pulse Drive Power	3.0	3.1	3.2	watts
Pulse Plate Input Power	2.08	2.92	3.75	kilowatts
Pulse Plate Output Power	1.44	2.16	2.88	kilowatts
Duty	19	16	14	percent

**
The maximum peak cathode current rating refers to the instantaneous peak cathode current available. This rating is based on available emission throughout life of 80 milliamperes per watt of filament power. The pulse plate current data shown under the Typical Operation section refers to the dc plate current component during the pulse.

APPLICATION

MECHANICAL

Mounting— The 4PR125A must be operated vertically, base up or down. When the SK-410 Air-System Socket is used in conjunction with the SK-406 Air Chimney, the socket must be mounted to the under surface of the chassis to maintain proper air space between the plate seal and the chimney opening, otherwise plate seal cooling will be seriously impaired.

In the event the SK-410 Air-System Socket is not used, the socket must provide clearance for the glass tip-off which extends from the center of the tube. The metal tube-base shell should be grounded by means of suitable spring fingers.

Cooling— Adequate forced-air cooling must be provided to maintain base-seal and plate-seal temperatures below 200° C and 170° C, respectively. In all classes of operation it is recommended that a heat-radiating connector, the Eimac HR-6 or equivalent, be installed on the anode terminal, and that a socket and chimney be employed which provides for proper seal cooling. When the Eimac 4PR125A is operated at d-c or low frequencies in an Eimac SK-410 Air-System Socket, complete with SK-406 Air Chimney and HR-6 Heat Radiator, the minimum airflow requirements to maintain seal temperatures at 170° C in 50° C inlet air are tabulated:

	Sea Level		10,000 Feet	
Ave. Plate Dissipation (watts)	Air Flow (CFM)	Plenum Pressure Drop. (Inches of Water)	Air Flow (CFM)	Plenum Pressure Drop. (Inches of Water)
50	5.0	0.014	7.2	0.020
100	8.0	0.016	10.2	0.023
125	10.0	0.018	14.2	0.026

When the Eimac 4PR125A is used as a pulsed-amplifier or oscillator at frequencies above 30 Mc, additional cooling may be required to compensate for the effects of plate and base-seal heating caused by r-f charging currents and dielectric losses. Since the amount of seal heating varies with the particular application, it is suggested that the user monitor the seal temperatures to determine the adequacy of the cooling air.

Cooling air should be applied before or simultaneously with the application of filament voltage and may be removed simultaneously with filament voltage. In any questionable situation, the only criterion for adequate cooling is temperature. Tube temperature may be measured conveniently by using a temperature-sensitive paint.

▶ Indicates change from data sheet dated 7-15-62

ELECTRICAL

Filament Voltage— For maximum tube life the filament voltage, as measured directly at the filament pins, should be 5.0 volts. Variations in filament voltage must be kept within the range of 4.75 to 5.25 volts.

When the 4PR125A is utilized in pulse applications where high peak currents are demanded, filament voltage must be maintained at the rated value; the normally allowable five-percent variation in this voltage cannot be tolerated if the tube's peak-current capabilities are to be realized.

Element Dissipation—Under normal operating conditions, the average plate dissipation of the 4PR125A should not be allowed to exceed 125 watts. Dissipation in excess of this maximum rating is permissable for short periods of time, such as during tuning procedures.

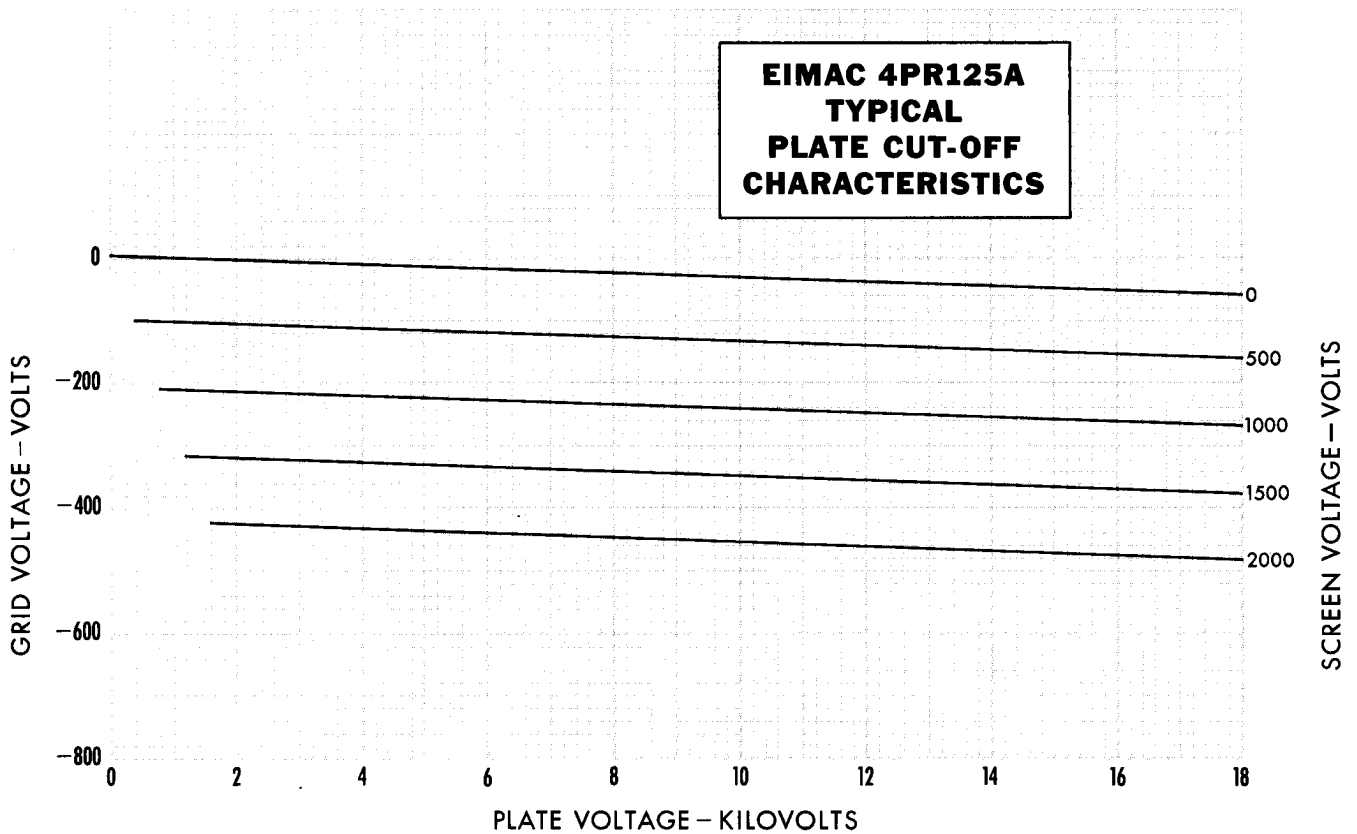
The average power dissipated by the screen-grid and the control-grid must not exceed 20 watts and 5 watts, respectively.

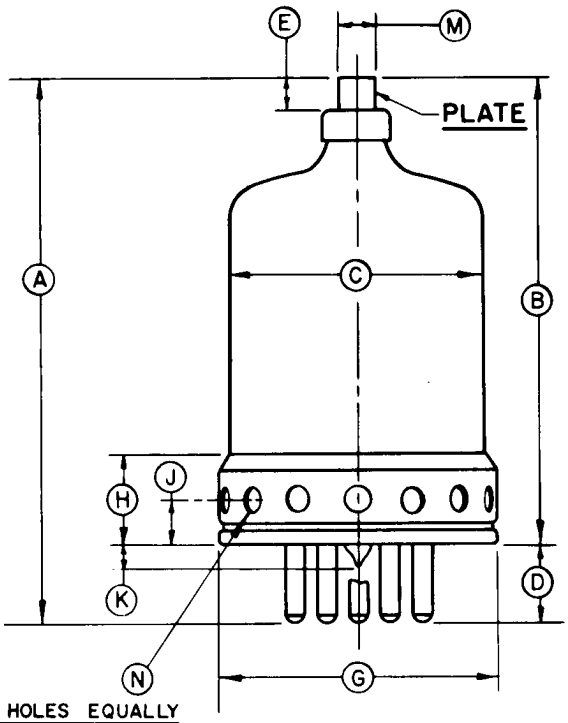
Cut-Off Characteristics— The Plate Current Cut-Off Characteristics of the 4PR125A are shown in the graph below. These curves indicate the value of negative grid voltage required to maintain a plate-current flow of 50 microamperes or less at the various plate and screen voltages noted. These curves were plotted from a "typical" tube whose electrical characteristics closely approximate the mean value in the tube test specification.

Each 4PR125A is tested to insure proper cut-off characteristics at maximum ratings. This cut-off test is made with a plate voltage of 18 KV, a screen voltage of 1.5 KV with the grid voltage adjusted to maintain a plate current of 10 microamperes. Under these test conditions the negative grid bias must not exceed 450 volts. Due to tube-to-tube variation this cut-off point will vary and the typical range can be expected to be between -370 volts and -445 volts.

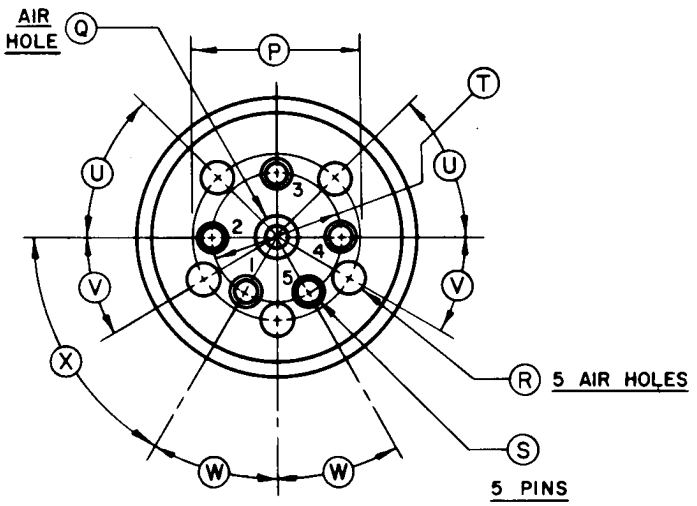
Pulse-Modulator Service— The data shown in the "Typical Operating" section of Pulse-Modulator Service was calculated assuming a rectangular plate voltage waveform, ignoring the effects of shunt capacity. In reality, the total shunt capacitance (including the output capacity of the tube, stray capacitance, etc.) affects the output wave form and can have considerable effect on plate dissipation. Since the actual plate waveform is not rectangular, even though the grid pulse is, additional power will be dissipated during the rise time and can, under some circumstances, be much greater than that dissipated during the remainder of the pulse. The total power dissipated is then the sum of the power dissipated during the rise time and the power dissipated during the remainder of the pulse.

Special Applications— If it is desired to operate this tube under conditions widely different from those given here write to Power Grid Tube Marketing, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California, for information and recommendations.

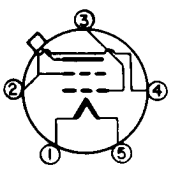


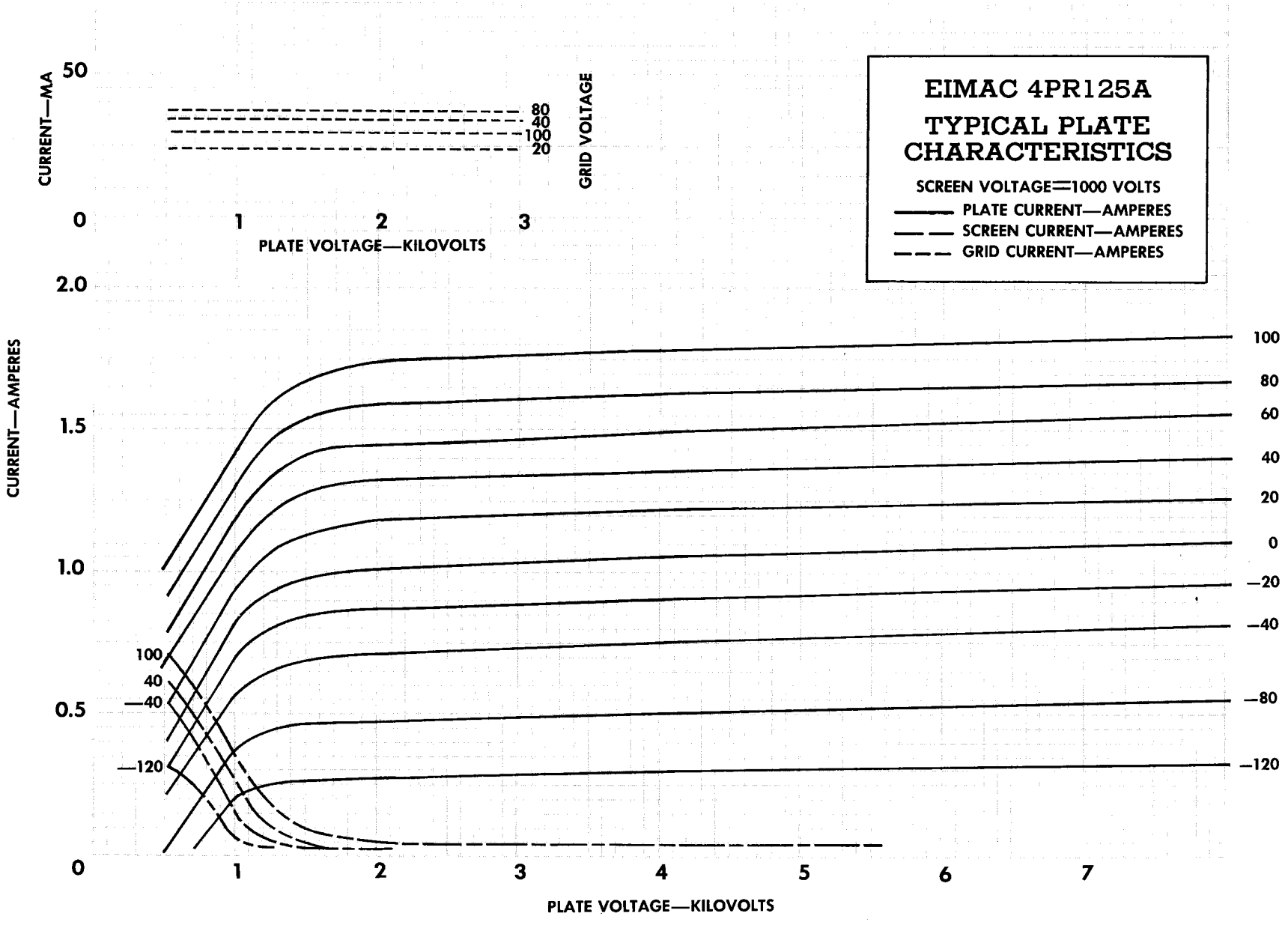


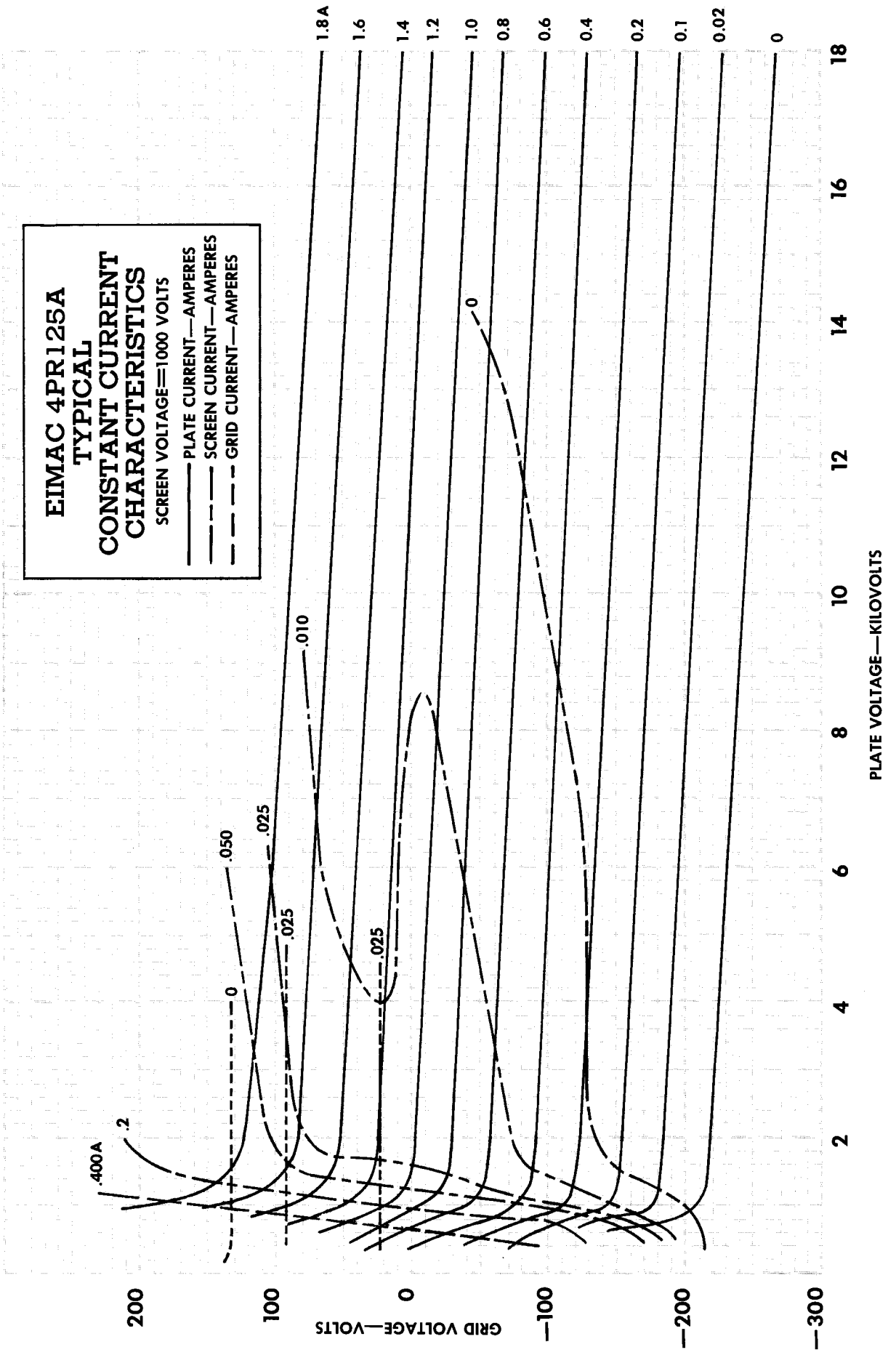
DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	5-3/16	5-11/16	5-7/16
B	4-7/16	4-15/16	4-11/16
C		2-5/8 D.	
D			3/4
E	21/64		
F		2-13/16 D.	
G		2-3/4 D.	
H		31/32	
J			7/16
K		1/4	
L			7/16
M	.350 D.	.365 D.	.360 D.
N			1/4 D.
P			1 5/8 D.
Q			1/2 D.
R			5/16 D.
S	.185 D.	.191 D.	.188 D.
T			1 1/4 D.
U			45°
V			30°
W			30°
X			60°



BOTTOM VIEW




EIMAC 4PR125A
TYPICAL PLATE CHARACTERISTICS
SCREEN VOLTAGE=1000 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
CURRENT—MA
GRID VOLTAGE
50
0
80
40
100
20
1
2
3
PLATE VOLTAGE—KILOVOLTS
CURRENT—AMPERES
2.0
1.5
1.0
0.5
0
100
40
—40
—120
100
80
60
40
20
0
—20
—40
—80
—120
GRID VOLTAGE—VOLTS
1
2
3
4
5
6
7
PLATE VOLTAGE—KILOVOLTS


EIMAC 4PR125A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE=1000 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
1.8A
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.1
0.02
0
.400A
.2
.050
.025
.010
.025
.025
0
200
100
0
—100
—200
—300
GRID VOLTAGE—VOLTS
2
4
6
8
10
12
14
16
18
PLATE VOLTAGE—KILOVOLTS

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8248
4PR250C

RADIAL-BEAM
PULSE TETRODE

The EIMAC 8248/4PR250C is a pulse tetrode intended for use in pulse-modulator, switch tube, pulsed-amplifier, and pulsed-oscillator service. This compact, high vacuum, radial-beam tetrode, incorporating a tantalum plate and non-emitting grids, is recommended for use in new equipments where voltages to 50 kilovolts are required.

Cooling of the tube is accomplished by radiation from the plate and by circulation of forced-air through the base and around the envelope. Cooling can be simplified by the use of the EIMAC SK-410 Air-System Socket.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten
- Voltage ..... 5.0 ± 0.25 V
- Current, at 5.0 volts ..... 14 A

Amplification Factor (Average):
- Grid to Screen 5.2

Direct Interelectrode Capacitances (grounded cathode)[2]
- Input ..... 13.0 pF
- Output ..... 3.3 pF
- Feedback ..... 0.10 pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. In Shielded Fixture.

MECHANICAL

Maximum Overall Dimensions:
- Length ..... 7.63 in; 191.8 mm
- Diameter ..... 3.60 in; 91.3 mm

Net Weight ..... 12.5 oz; 355 gm
Operating Position ..... Vertical, base down or up
Maximum Operating Temperature:
- Plate and Base Seals ..... 200 °C

Cooling ..... Radiation and forced-air
Base ..... 5-pin metal shell
Recommended Socket ..... EIMAC SK-410
Recommended Heat-Dissipating Connector :
- Plate ..... EIMAC HR-8

(Revised 9-1-70) © 1963, 1966 Varian

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PULSE MODULATOR SERVICE

MAXIMUM RATINGS:

DC PLATE VOLTAGE	50	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-1.0	KILOVOLT
PEAK PLATE CURRENT [1]	4.0	AMPERES
PLATE DISSIPATION [2]	250	WATTS
SCREEN DISSIPATION [2]	25	WATTS
GRID DISSIPATION [2]	5	WATTS

1. In switch tube applications with capacitive loads, plate current may be increased to 6.0 amperes.
2. Average value.

TYPICAL OPERATION

Plate Voltage	30	40	50	kVdc
Screen Voltage	1.5	1.5	1.5	kVdc
Grid Voltage	-600	-650	-700	Vdc
Pulse Plate Voltage	28	38	48	kv
Peak Pulse Current	4.0	4.0	4.0	a
Pulse Screen Current	0.5	0.5	0.5	a
Pulse Grid Current	0.03	0.03	0.03	a
Pulse Input Power	120	160	200	kw
Pulse Output Power	112	152	192	kw
Pulse Drive Power	25	25	25	w
Pulse Positive Grid Voltage	130	130	130	v
Duty	3	3	3	%

RF POWER AMPLIFIER AND OSCILLATOR

Plate and Screen Pulsed

MAXIMUM RATINGS:

PEAK DC PLATE VOLTAGE	35	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-1.0	KILOVOLT
PEAK CATHODE CURRENT [1]	5.5	AMPERES
PLATE DISSIPATION [2]	250	WATTS
SCREEN DISSIPATION [2]	25	WATTS
GRID DISSIPATION [2]	5	WATTS

1. The maximum peak cathode current rating refers to the instantaneous peak cathode current available. This rating is based on available emission throughout life of 80 milliamperes per watt of filament power. The pulse plate current data shown under the Typical Operation section refers to the dc plate current component during the pulse.

TYPICAL OPERATION
Class C, Grounded filament

Plate Voltage (Pulsed)	25	30	35	kv
Screen Voltage (Pulsed)	1.5	1.5	1.5	kv
Grid Voltage	-650	-675	-700	Vdc
Pulse Plate Current [1]	940	925	900	ma
Pulse Screen Current	30	30	30	ma
Pulse Grid Current	6	6	6	ma
Peak Grid Voltage [3]	780	805	830	v
Pulse Driving Power [3]	4.7	5.0	4.5	w
Pulse Input Power	23.5	27.7	31.5	kw
Pulse Output Power	19.0	23.0	26.5	kw
Duty	5.5	5	5	%

2. Average value.
3. When used as a rf plate and screen-pulsed amplifier, the grid drive must also be pulsed to avoid overheating this element during the interpulse period.

RF POWER AMPLIFIER AND OSCILLATOR

Grid Pulsed

MAXIMUM RATINGS:

DC PLATE VOLTAGE	25	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-1.0	KILOVOLTS
PEAK CATHODE CURRENT [1]	5.5	AMPERES
PLATE DISSIPATION [2]	250	WATTS
SCREEN DISSIPATION [2]	25	WATTS
GRID DISSIPATION [2]	10	WATTS

1. The maximum peak cathode current rating refers to the instantaneous peak cathode current available. This rating is based on available emission throughout life of 80 milliamperes per watt of filament power. The pulse plate current data shown under the Typical Operation section refers to the dc plate current component during the pulse.

TYPICAL OPERATION

Plate Voltage	20	25	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage	-600	-650	Vdc
Peak Grid Voltage (Pulsed)	730	780	v
Pulse Plate Current [1]	940	940	ma
Pulse Screen Current	30	30	ma
Pulse Grid Current	6	6	ma
Pulse Driving Power	4.4	4.7	w
Pulse Input Power	18.8	23.5	kw
Pulse Output Power	15.0	19.0	kw
Duty	6	5.5	%

2. Average Value.
3. When used as a rf plate and screen-pulsed amplifier, the grid drive must also be pulsed to avoid overheating this element during the interpulse period.

NOTE: TYPICAL OPERATION data are obtained by calculation from published characteristic curves. Adjustment of the grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Filament: Current at 5.0 volts	13.5	14.7	A
Interelectrode Capacitances [1] (grounded filament connection)			
Input	11.0	15.0	pF
Output	2.5	4.0	pF
Feedback		0.15	pF

1. In shielded fixture.

APPLICATION

MECHANICAL

MOUNTING - The 4PR250C must be operated vertically base up or down. The SK-410 Air-System Socket may be used to aid in directing air to the metal base shell.

In the event the SK-410 Air-System Socket is not used, the socket must provide clearance for the glass tip-off which extends from the center of the tube. The metal tube-base shell should be grounded by means of suitable spring fingers. The tube must be protected from severe shock and vibration.

COOLING - Adequate forced-air cooling must be provided to maintain base-seal and plate-seal temperatures below 200°C. In all classes of operation it is recommended that a heat-radiating connector, the EIMAC HR-8 or equivalent, be installed on the anode terminal, and that a socket be employed which provides for proper base seal cooling. When the EIMAC 4PR250C is operated at dc or low frequencies in an EIMAC SK-410 Air System Socket, the minimum airflow requirements to maintain seal temperatures at 200°C in 25°C inlet air are approximately 2 to 5 cfm.

When the EIMAC 4PR250C is used as a pulsed-amplifier or oscillator at frequencies above 30 MHz, additional cooling may be required to compensate for the effects of plate and base-seal heating caused by rf charging currents and dielectric losses. Since the amount of seal heating varies with the particular application, it is suggested that the user monitor the seal temperatures to determine the adequacy of the cooling air.

Cooling air should be applied before or simultaneously with the application of filament voltage and may be removed simultaneously with filament voltage. In any questionable situation, the only criterion for adequate cooling is temperature. Tube temperature may be measured by using a temperature-sensitive paint.

ELECTRICAL

FILAMENT VOLTAGE - For maximum tube life the filament voltage, as measured directly at the filament pins, should be 5.0 volts. Variations in filament voltage must be kept within the range of 4.75 to 5.25 volts.

When the 4PR250C is used in pulse applications where high peak currents are demanded, filament voltage must be maintained at the rated value; the normally allowable five-percent variation in this voltage cannot be tolerated if the tube's peak-current capabilities are to be realized.

ELEMENT DISSIPATION - Under normal operating conditions, the average plate dissipation of the 4PR250C should not be allowed to exceed 250 watts. Dissipation in excess of this maximum rating is permissible for short periods of time, such as during tuning procedures.

The average power dissipated by the screen-grid and the control-grid must not exceed 25 watts and 5 watts, respectively.

CUT-OFF CHARACTERISTICS - The plate current cut-off characteristics of the 4PR250C are shown in the following graph. These curves indicate the value of negative grid voltage required to maintain a plate-current flow of 50 microamperes or less at the various plate and screen voltages noted. These curves were plotted from a "typical" tube whose electrical characteristic closely approximate the mean value in the tube test specification.

Each 4PR250C is tested to insure proper cut-off characteristics at maximum ratings. This cut-off test is made with a plate voltage of 50 kV, a screen voltage of 1.5 kV, with the grid voltage adjusted to maintain a plate current of

10 microamperes. Under these test conditions the negative grid bias must not exceed 675 volts. Due to tube-to-tube variation this cut-off point will vary and the typical range can be expected to be between –500 volts and –650 volts.

PULSE-MODULATOR SERVICE-The data shown in the "Typical Operating" section of Pulse-Modulator Service was calculated assuming a rectangular plate voltage wave-form, ignoring the effects of shunt capacity. In reality, the total shunt capacitance (including the output capacity of the tube, stray capacitance, etc.) affects the output wave form and can have considerable effect on plate dissipation. Since the actual plate wave form is not rectangular, even though the grid pulse is, additional power will be dissipated during the rise time and can, under some circumstances, be much greater than that dissipated during the remainder of the pulse. The total power dissipated is then the sum of the power dissipated during the rise time and the power dissipated during the remainder of the pulse.

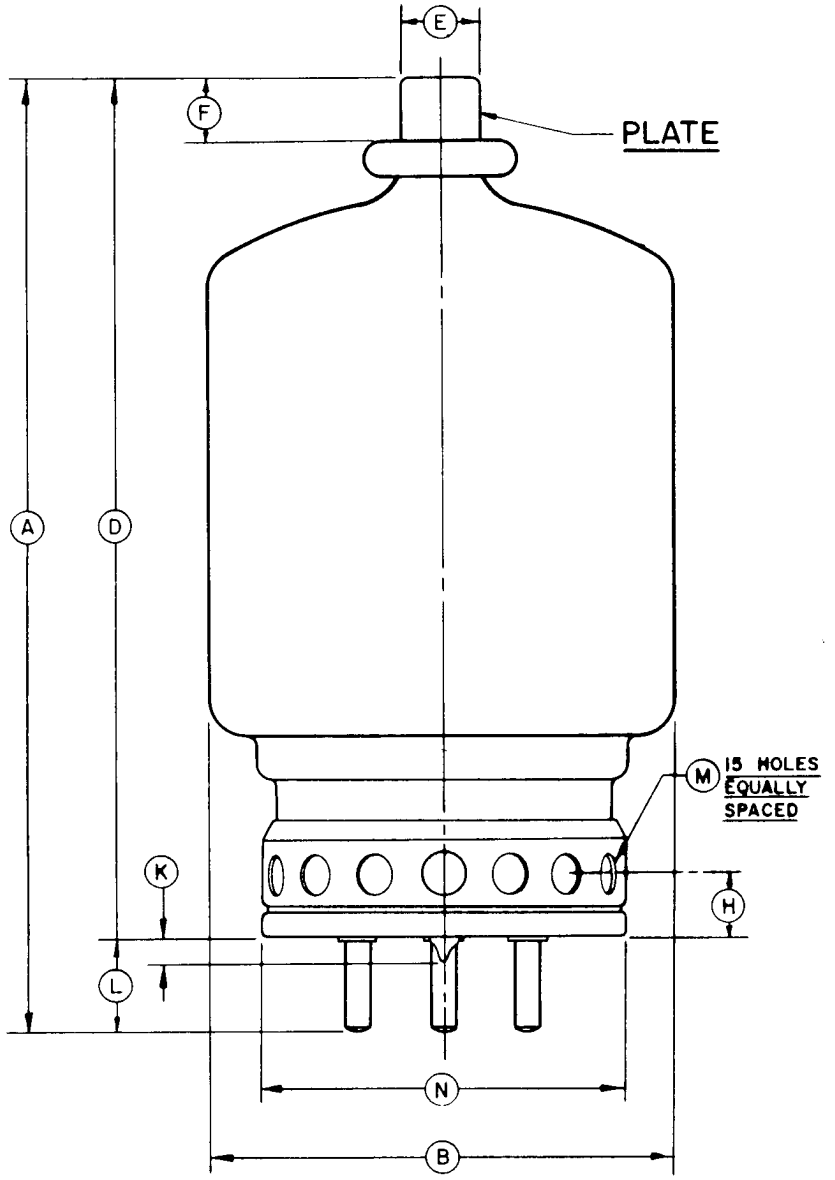
As a switch tube with capacitive loading, as in a floating deck modulator, the peak plate current during the pulse may reach 6.0 amperes. This can be tolerated since under capacitive load conditions the plate voltage at the beginning of the pulse is equal to applied dc voltage, with high plate current and low screen grid current. As the load is charged, plate current falls while screen current rises. Protection for the screen must be provided to limit dissipation at the end of the pulse.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased, and are therefore potential X-ray hazards. Very little shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly on older tubes with aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. When pulse transformers are involved, shielding may also be required for these. Periodic checks on the X-ray level should be made, and such tubes must never be operated without shielding in place. Lead glass which attenuates X-rays is available for viewing windows. If there is any doubt as to the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment. Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

Reference: MEDICAL X-RAY PROTECTION UP TO THREE MILLION VOLTS, National Bureau of Standards Handbook 76. Available from Superintendent of Documents, Washington, DC 20402. Price: 25 cents.
NCRP REPORT #33-MEDICAL X-RAY AND GAMMA RAY PROTECTION FOR ENERGIES UP TO 10 MEV. Available from N.C.R.P. Publications, P.O. Box 4867, Washington, DC 20008. Price: 75 cents.

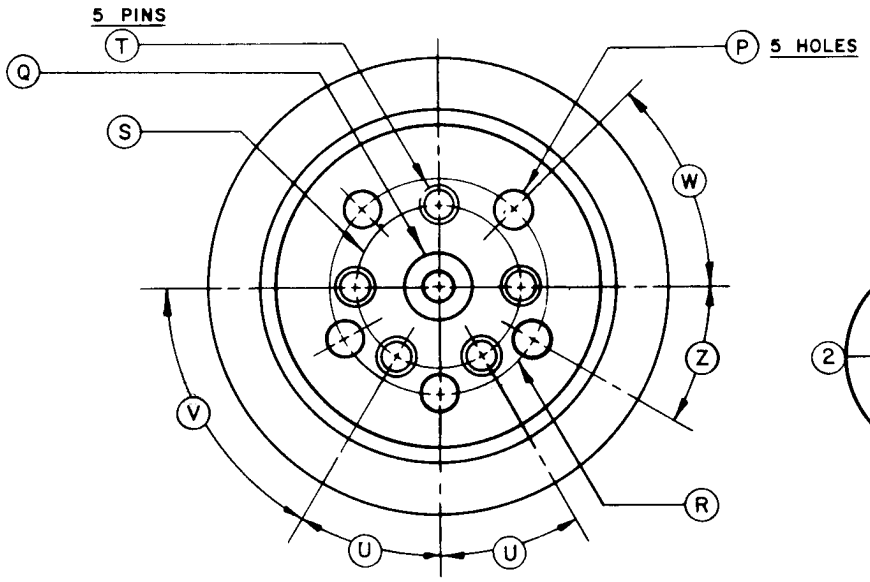
HIGH VOLTAGE - The 4PR250C operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

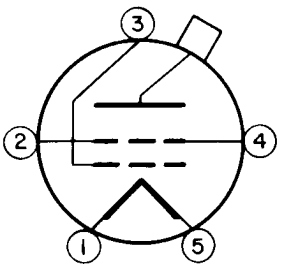
SPECIAL APPLICATIONS-If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Marketing, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.

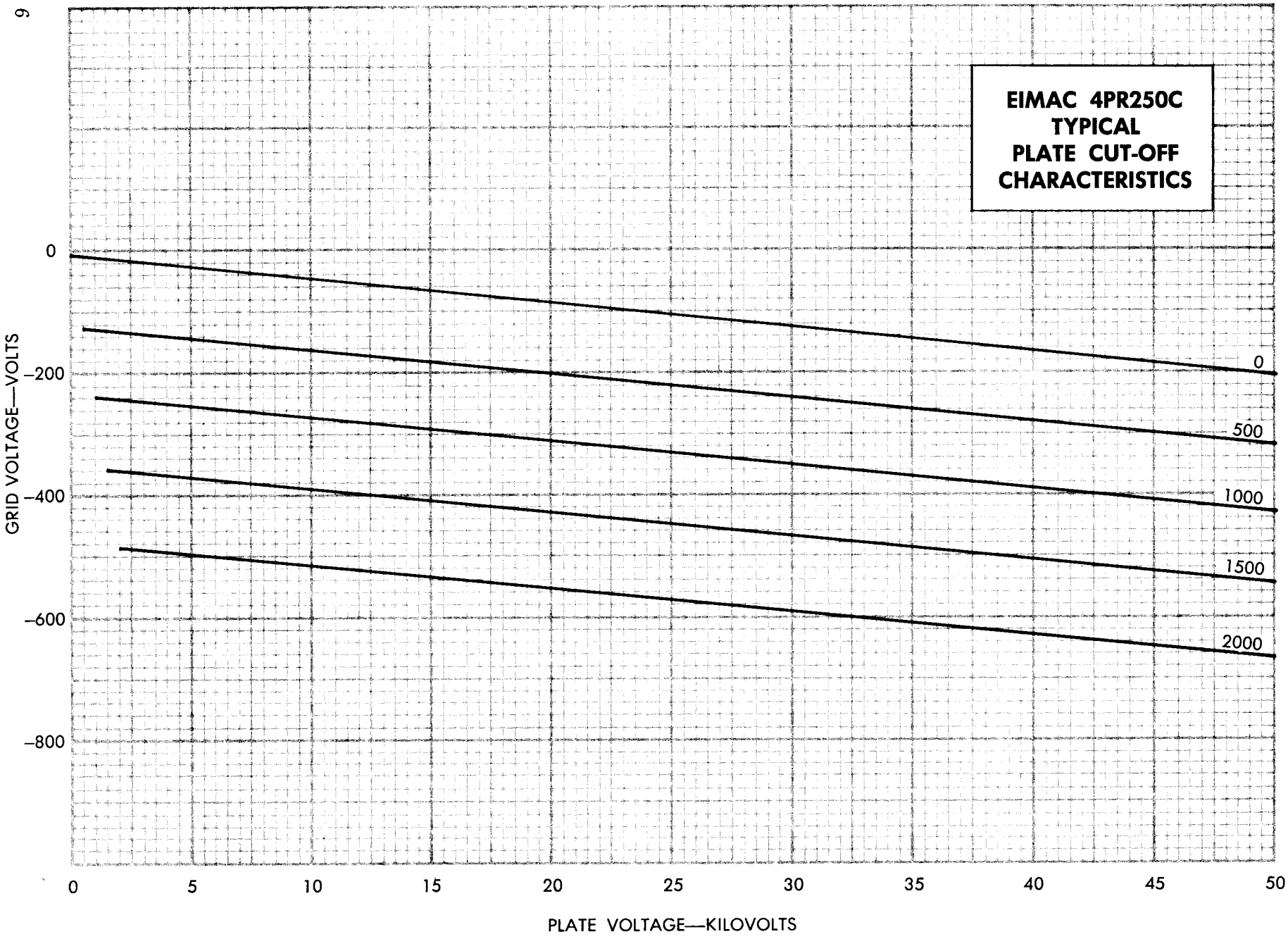


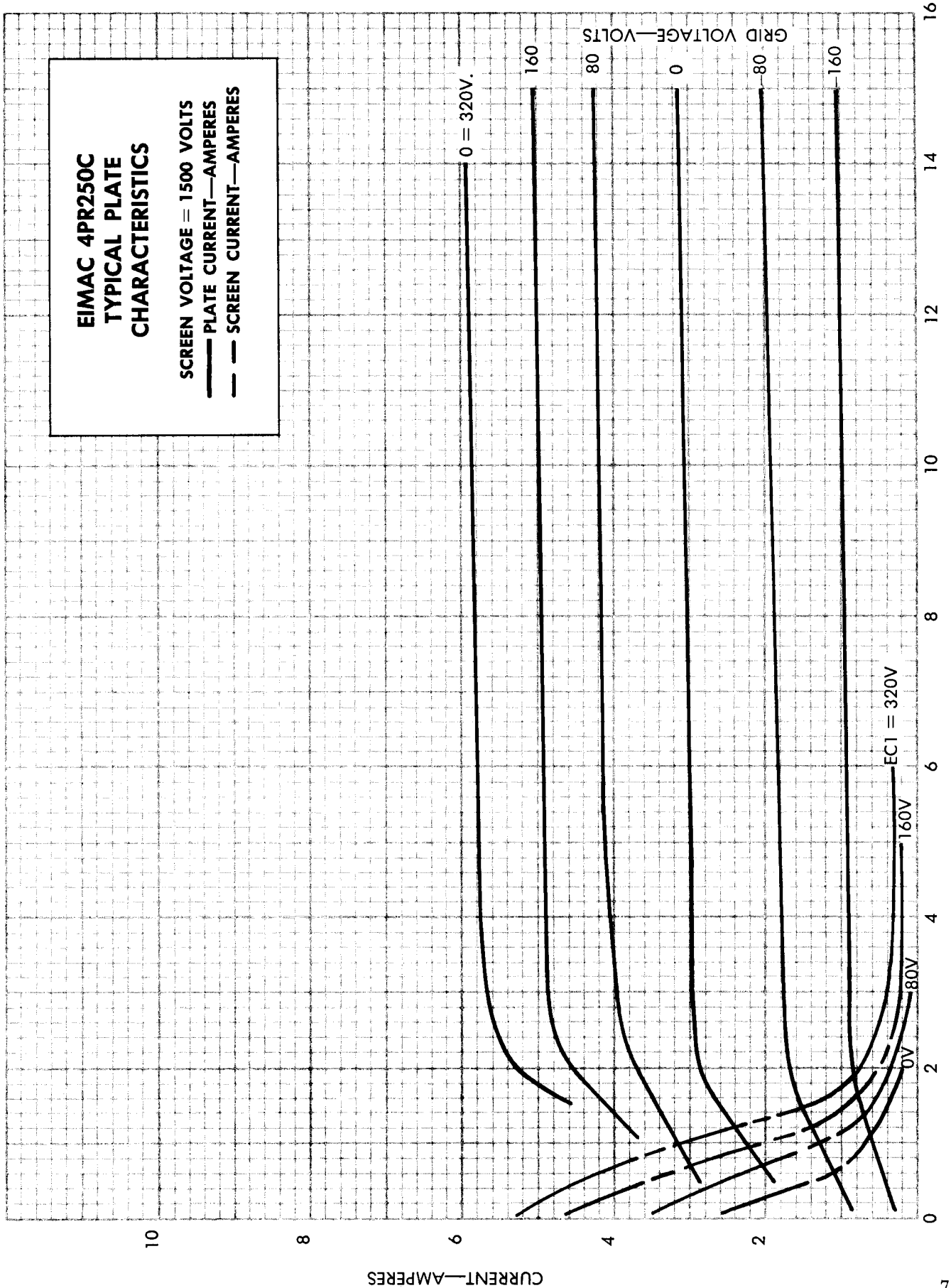
DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	7.062	7.625	179.37	193.68
B	3.406	3.594	86.51	91.29
D	6.313	6.813	160.35	173.05
E	0.557D	0.567D	14.15	14.40
F	0.469	0.531	11.91	13.49
H	0.375	0.500	9.53	12.70
K	0.250 (NOTE 1)		6.35 (NOTE 1)	
L	0.688	0.875	17.48	22.23
M	0.219D	0.281D	5.57	7.14
N	--	2.750	--	69.86
P	0.281	0.344	7.14	8.74
Q	0.469	0.531	12.60	13.49
R	1.594	1.656	40.49	42.06
S	0.250 (NOTE 1)		6.35 (NOTE 1)	
T	0.185D	0.191D(1)	4.70D	4.85(1)
U	30° (NOTE 1)		30° (NOTE 1)	
V	60° (NOTE 1)		60° (NOTE 1)	
W	45° (NOTE 1)		45° (NOTE 1)	
Z	30° (NOTE 1)		30° (NOTE 1)	

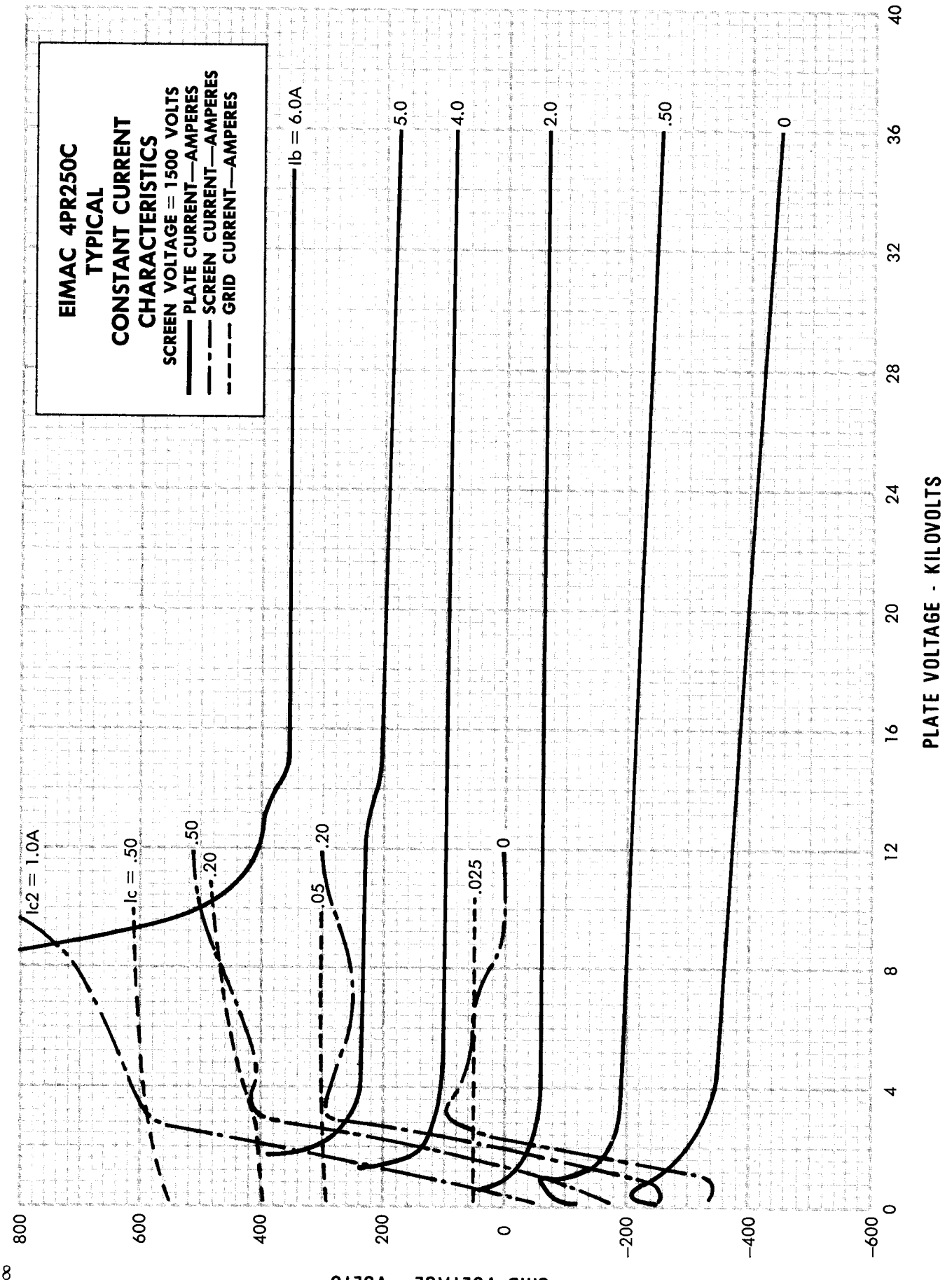
NOTES:
BASE PINS (T) AND TUBULATION (K) MUST BE ALIGNED SO THAT THEY CAN BE FREELY INSERTED IN A GAUGE 1/4" THICK WITH HOLE DIAMETERS OF .204 & .500 FOR PINS AND TUBULATION RESPECTIVELY LOCATED ON TRUE CENTERS DEFINED BY (S) (U) (V).






EIMAC 4PR250C
TYPICAL
PLATE CUT-OFF
CHARACTERISTICS
GRID VOLTAGE—VOLTS
0
-200
-400
-600
-800
0
500
1000
1500
2000
0
5
10
15
20
25
30
35
40
45
50
PLATE VOLTAGE—KILOVOLTS
SCREEN VOLTAGE—VOLTS


EIMAC 4PR250C
TYPICAL PLATE
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID VOLTAGE—VOLTS
0 = 320V.
160
80
0
80
160
EC1 = 320V
160V
80V
0V
CURRENT—AMPERES
PLATE VOLTAGE/KILOVOLTS
0
2
4
6
8
10
12
14
16


EIMAC 4PR250C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
Ib = 6.0A
5.0
4.0
2.0
.50
0
Ic2 = 1.0A
Ic = .50
.50
.20
.05
.20
.025
0
800
600
400
200
0
-200
-400
-600
0
4
8
12
16
20
24
28
32
36
40
GRID VOLTAGE - VOLTS
PLATE VOLTAGE - KILOVOLTS

TECHNICAL DATA

8249
4W300B

RADIAL BEAM
POWER TETRODE

The EIMAC 8249/4W300B is a ceramic/metal, water cooled, external-anode radial-beam tetrode with a maximum plate dissipation rating of 300 watts and a maximum power input rating of 500 watts. The 8249/4W300B is designed to operate with a heater voltage of 6.0 volts. Electrically identical to the 4CX250B, it is intended for use where water cooling is preferred or where reserve anode dissipation is desired.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3	V
Current, at 6.0 volts	2.6	A
Cathode - Heater Potential	±150	V
Transconductance (Average):		
I_b = 200 mAdc	12,000	μmhos
Amplification Factor (Average):		
Grid to Screen	5.0	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Input	15.7	pF
Output	4.5	pF
Feedback	0.04	pF
Direct Interelectrode Capacitance (grounded grid)[2]		
Input	13.0	pF
Output	4.5	pF
Feedback	0.01	pF
Frequency of Maximum Rating:		
CW	500	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length	3.407 in; 86.54 mm
Diameter	1.562 in; 39.67 mm
Net Weight	5.75 oz; 163.0 gm
Operating Position	Vertical, base up or down

(Revised 11-1-73) © 1970, 1973 by Varian

Printed in U.S.A.

Maximum Operating Temperature:
Ceramic/Metal Seals . . . . . 250°C
Cooling . . . . . Water and forced air
Base . . . . . Special 9-pin JEDEC-B8-236
Recommended Air System Socket . . . . . SK-600 series

MAXIMUM RATINGS:	Class C Plate Mod	Class C CW or FM	Class AB Audio or SSB	
DC PLATE VOLTAGE . . .	1500	2000	2000	VOLTS
DC SCREEN VOLTAGE . .	300	300	400	VOLTS
DC GRID VOLTAGE . . .	-250	-250	-250	VOLTS
DC PLATE CURRENT . . .	0.20	0.25	0.25	AMPERE
PLATE DISSIPATION . . .	200	300	300	WATTS
SCREEN DISSIPATION . .	12	12	12	WATTS
GRID DISSIPATION . . .	2	2	2	WATTS

TYPICAL OPERATION:	DC Plate Voltage (Volts)	Power Input (Watts)	Driving Power (Watts)	Power Output (Watts)
CLASS C AMPLIFIER				
CW or FM	2000	500	3	390
Plate Modulated	1500	300	2	235
CLASS AB_1 AMPLIFIER				
Audio (Two tubes)	2000	1000	0	600
SSB (One tube)	2000	500	0	300

For full listing of ratings, constant current curves and typical operating conditions, see EIMAC data sheet for 7203/4CX250B.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	2.3	2.9	A
Cathode Warmup Time	30	--	sec.
Interelectrode Capacitances[1] (grounded cathode connection)			
Input	14.2	17.2	pF
Output	4.0	5.0	pF
Feedback	---	0.06	pF

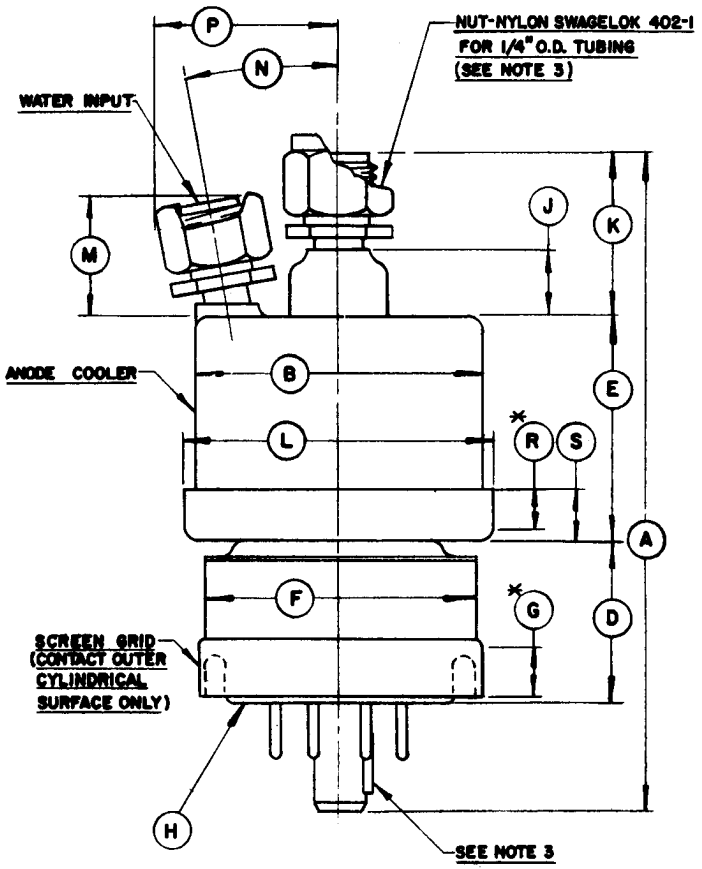
1. Capacitance values are for a cold tube as measured in a shielded fixture.

APPLICATION

COOLING - The water-cooled anode requires a minimum of 1/16 gallon of cooling water per minute for the rated plate dissipation of 300 watts. The outlet-water temperature should not exceed 70°C and the system pressure should not exceed 50 pounds per square inch.

The ceramic/metal seals must be cooled by forced air. At frequencies below 30 MHz and when one of the recommended sockets is used, a flow rate of 1.0 CFM is sufficient. As the operating frequency is increased, the air-flow rate must be increased. At 500 MHz a minimum of 3.8 CFM is required. In all cases, seal temperatures are the criteria which determine cooling effectiveness.

PIN NO. 1. SCREEN GRID
PIN NO. 2. CATHODE
PIN NO. 3. HEATER
PIN NO. 4. CATHODE
PIN NO. 5. IC-DO NOT USE FOR EXTERNAL CONNECTION
PIN NO. 6. CATHODE
PIN NO. 7. HEATER
PIN NO. 8. CATHODE
CENTER PIN-CONTROL GRID



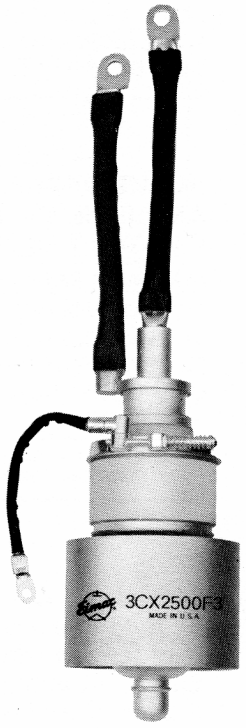
DIM	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	- -	3.407	- -	- -	86.54	- -
B	1.450	1.490	- -	36.83	37.85	- -
D	0.750	0.810	- -	19.05	20.57	- -
E	1.106	1.186	- -	28.09	30.12	- -
F	- -	1.406	- -	- -	35.71	- -
G	0.187	- -	- -	4.75	- -	- -
H	BASE: B8-236 (JEDEC DESIGNATION)					
J	- -	- -	0.244	- -	- -	6.20
K	0.797	0.857	- -	20.24	21.77	- -
L	- -	1.562	- -	- -	39.67	- -
M	- -	- -	0.670	- -	- -	17.02
N	- -	- -	10°	- -	- -	10°
R	0.156	- -	- -	3.96	- -	- -
S	- -	- -	0.250	- -	- -	6.35
P	- -	1.063	- -	- -	27.00	- -

NOTES:
1. REF. DIMENSIONS ARE FOR INFORMATION ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACE
3. AXIS OF FITTINGS IS ON AXIS OF INDEX OF CENTER PIN AS SHOWN.

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8251
3CX2500F3

MEDIUM MU TRIODE



The EIMAC 3CX2500F3 is an all ceramic and metal, medium-mu, forced-air cooled, external anode transmitting triode with a maximum plate dissipation rating of 2500 watts. Relatively high power output as an amplifier, oscillator, or modulator may be obtained from this tube at low plate voltages. The 3CX2500F3 is an exact replacement for the EIMAC 3X2500F3 and is suggested for use where higher ambient temperatures are to be expected or greater reliability is required. The all ceramic and metal construction allows a greater margin of safety with respect to tube operating temperatures while permitting higher processing temperatures to insure longer life.

The tube is equipped with flexible filament and grid leads which simplify socketing and equipment design for industrial and communication frequencies below 30 megahertz.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	48		53	amperes
Amplification Factor	19		26	
Direct Interelectrode Capacitances				
Grid-Plate	16.8		23.2	pF
Grid-Filament	29.2		40.2	pF
Plate-Filament	0.6		1.2	pF
Tranconductance (Ib=830 ma., Eb=3000 v.)		20,000		umhos
Highest Frequency for Maximum Ratings			30	MHz

MECHANICAL

Base	See outline drawing
Mounting	Vertical, base down or up
Maximum Anode Core and Seal Temperatures	250°C
Cooling	Forced Air
Maximum Over-all Dimensions:	
Length (Does not include filament connectors)	8.6 inches
Diameter	4.16 inches
Length of filament Connectors (Approximate)	9.5 inches
Net Weight	7.5 pounds
Shipping Weight (Approximate)	17 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Conventional Neutralized Amplifier, Class-C FM or Telegraphy (Key-down Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	6000 VOLTS
DC PLATE CURRENT	2.5 AMPS
PLATE DISSIPATION	2500 WATTS
GRID DISSIPATION	150 WATTS

TYPICAL OPERATION (Frequencies below 30 MHz)

DC Plate Voltage	4000	5000	6000 volts
DC Plate Current	2.5	2.5	2.08 amps
DC Grid Voltage	—300	—450	—500 volts
DC Grid Current	245	265	180 ma
Peak RF Grid Input Voltage*	580	750	765 volts
Driving Power*	142	197	136 watts
Grid Dissipation*	68	78	46 watts
Plate Input Power	10,000	12,500	12,500 watts
Plate Dissipation	2500	2500	2500 watts
Plate Output Power	7500	10,000	10,000 watts

*Approximate values.

(Revised 3-1-67) © 1967 Varian

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PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Conventional Neutralized Amplifier, Class-C Telephony (Carrier Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	5500	VOLTS
DC PLATE CURRENT	2.0	AMPS
PLATE DISSIPATION	1670	VOLTS
GRID DISSIPATION	150	WATTS

TYPICAL OPERATION (Frequencies below 30 MHz)

DC Plate Voltage	4000	4500	5000	volts
DC Plate Current	1.67	1.47	1.25	amps
DC Grid Voltage	—450	—500	—550	volts
DC Grid Current*	180	140	150	ma
Peak RF Grid Input Voltage*	685	715	760	volts
Driving Power*	125	100	115	watts
Grid Dissipation*	43	30	32	watts
Plate Input Power	6670	6615	6250	watts
Plate Dissipation	1670	1315	950	watts
Plate Output Power	5000	5300	5300	watts

*Approximate values.

AUDIO-FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB or B

MAXIMUM RATINGS

DC PLATE VOLTAGE	6000	VOLTS
DC PLATE CURRENT	2.5	AMPS
PLATE DISSIPATION	2500	WATTS
GRID DISSIPATION	150	WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

DC Plate Voltage	4000	5000	6000	volts
DC Grid Voltage[1]	—150	—190	—240	volts
Zero-Signal DC Plate Current	0.6	0.5	0.4	amps
Max-Signal DC Plate Current	4.0	3.2	3.0	amps
Effective Load, Plate to Plate	2200	3600	4650	ohms
Peak AF Grid Input Voltage (per tube)*	340	360	390	volts
Max-Signal Peak Driving Power*	340	230	225	watts
Max-Signal Nominal Driving Power*	170	115	113	watts
Max-Signal Plate Output Power	11,000	11,000	13,000	watts

*Approximate values.
[1]Adjust to give listed zero-signal plate current.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION," POSSIBLY EXCEEDNG THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EIMAC DIVISION OF VARIAN, FOR INFORMATION AND RECOMMENDATIONS.

APPLICATION

Cooling—Forced-air cooling must be provided to hold the ceramic-to-metal seals and anode core temperature below the maximum rating of 250°C. At ambient temperatures above 50°C, at higher altitudes and at operating temperatures above 30 MHz, additional air flow must be provided. Sea level and 10,000 foot altitude air-flow requirements to maintain seal temperatures below 200°C in 50°C ambient air are tabulated below (for operation below 30 MHz).

Anode-to-Base Air Flow[1]

	Sea Level		10,000 Feet	
Anode Dissipation Watts	Air Flow CFM	Pressure Drop Inches Water	Air Flow CFM	Pressure Drop Inches Water
1500	33	.6	48	.9
2500	66	1.25	96	1.82

Base-to-Anode Air Flow

	Sea Level		10,000 Feet	
Anode Dissipation Watts	Air Flow CFM	Pressure Drop Inches Water	Air Flow CFM	Pressure Drop Inches Water
1500	32	.6	47	.9
2500	57	1.0	83	1.5

*Since the power dissipated by the filament represents about 400 watts and since grid dissipation can, under some conditions represent another 150 watts, allowance has been made in preparing this tabulation for an additional 550 watts.

[1] When air is supplied in the anode-to-base direction, a minimum of 3 cfm must be directed into the filament-stem structure between the inner and outer filament terminals to maintain the base seals below 250°C. No separate air is required with base-to-anode airflow.

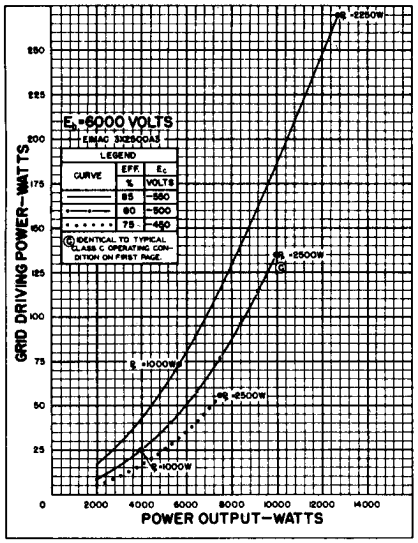
Filament Voltage — The filament voltage, as measured directly at the tube, should be 7.5 volts with maximum allowable variations due to line fluctuation of from 7.12 to 7.87 volts. Tube life may be extended by operation at the lower end of this range.

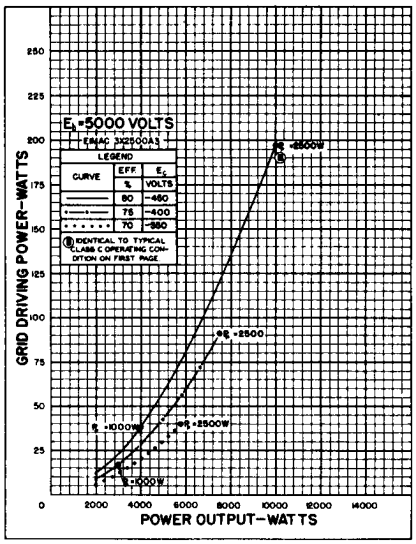
Bias Voltage — There is little advantage in using bias voltages in excess of those given under "TYPICAL OPERATION" except in certain very specialized applications. Where bias is obtained from a grid resistor, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

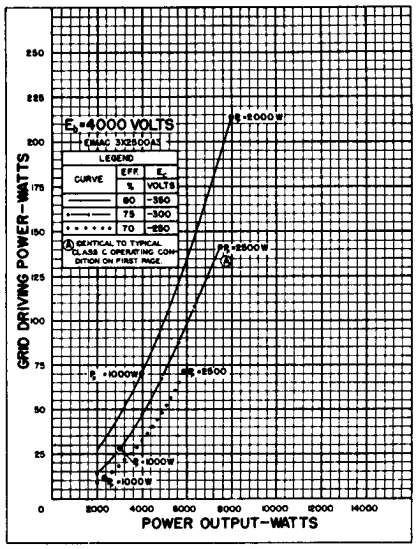
Plate Voltage — The plate-supply voltage for the 3CX2500F3 should not exceed 6000 volts. In most cases there is little advantage in using plate-supply voltages higher than those given under "TYPICAL OPERATION" for the power output desired.

Grid Dissipation — The power dissipated by the grid of the 3CX2500F3 must never exceed 150 watts. Grid dissipation is the product of dc current and peak positive grid voltage.

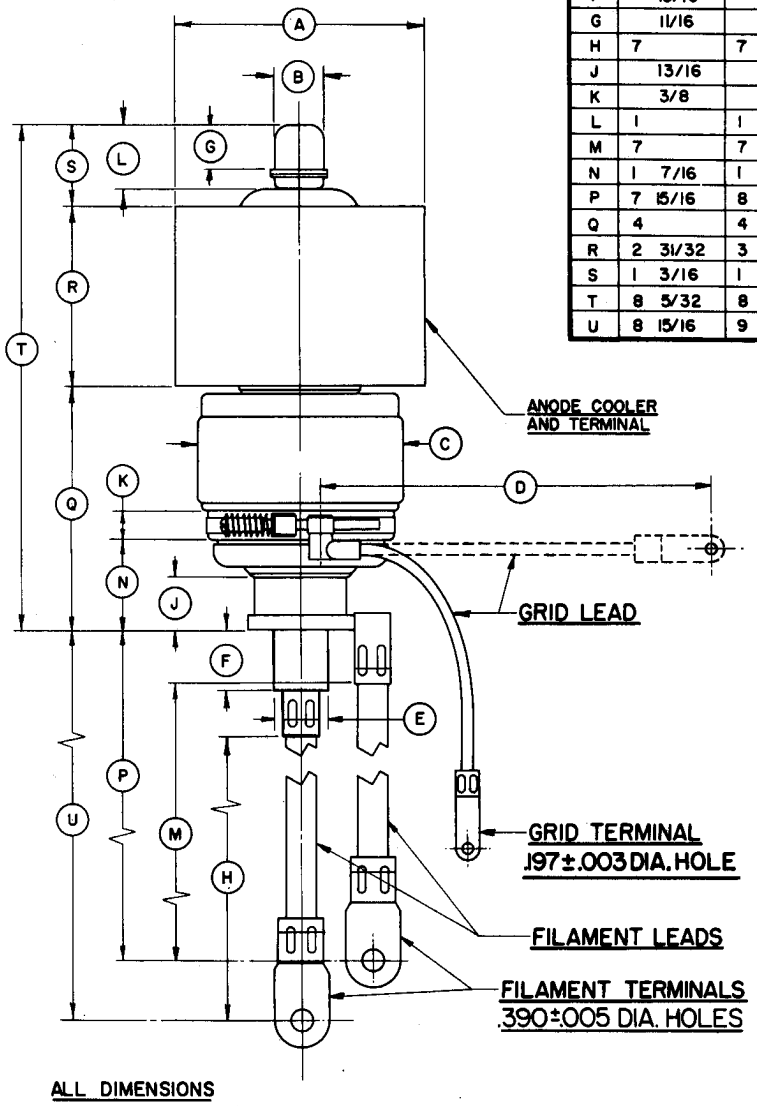
In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading. With lightly loaded conditions the grid driving power should be reduced so that the grid current does not exceed one-tenth of the plate current.





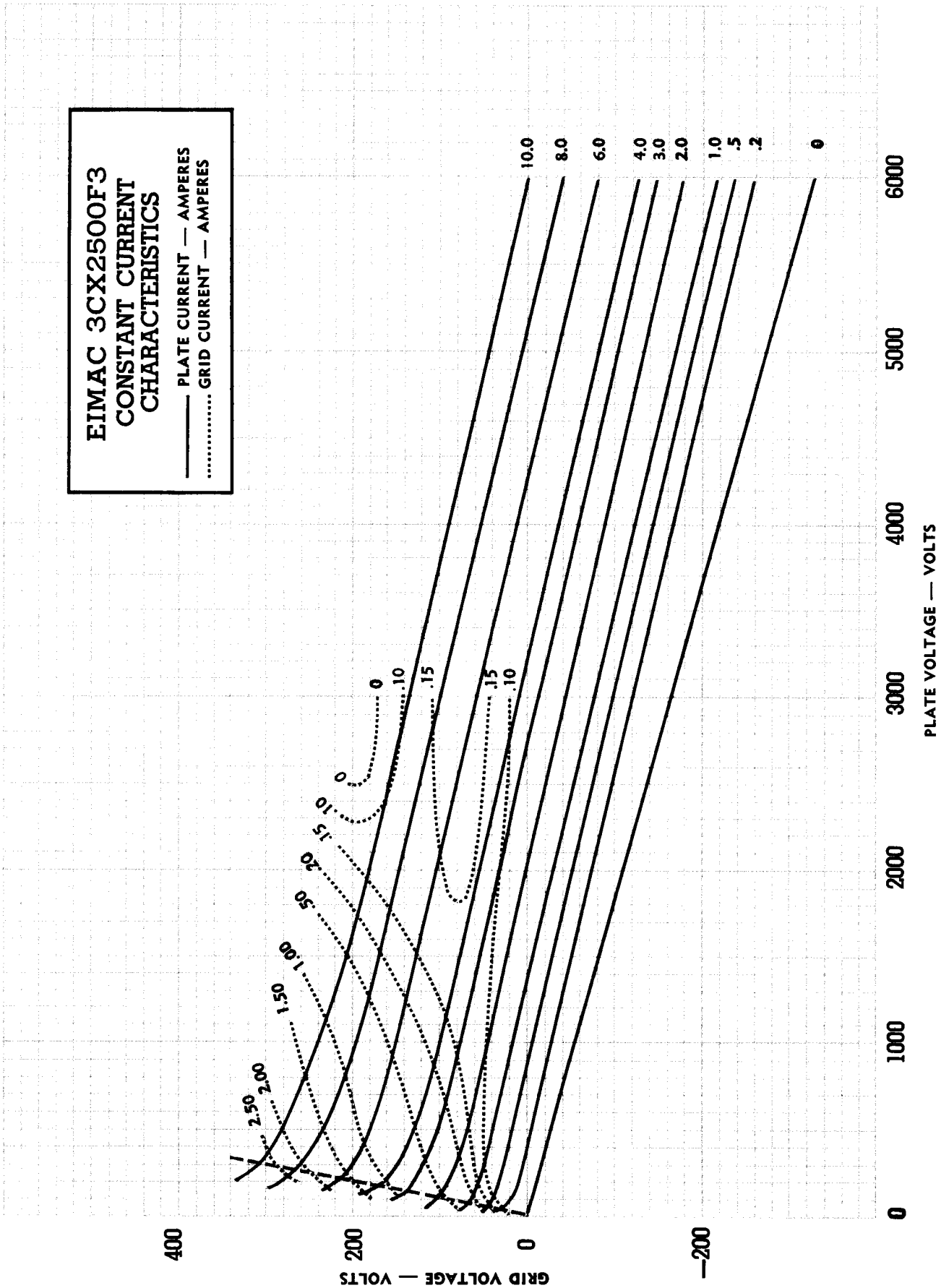


DIMENSION DATA		
REF.	MIN	MAX
A	4 3/32	4 5/32
B	25/32	27/32
C		3 5/8
D	6 3/8	6 5/8
E	55/64	57/64
F	13/16	15/16
G	11/16	13/16
H	7	7 1/2
J	13/16	15/16
K	3/8	7/16
L	1	1 1/8
M	7	7 1/2
N	1 7/16	1 9/16
P	7 15/16	8 7/16
Q	4	4 1/8
R	2 31/32	3 1/32
S	1 3/16	1 7/16
T	8 5/32	8 19/32
U	8 15/16	9 7/16



ALL DIMENSIONS IN INCHES

▶ Indicates change from sheet dated 1-27-58


EIMAC 3CX2500F3
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT — AMPERES
GRID CURRENT — AMPERES
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.5
.2
0
.10
.15
.10
.15
0
.10
.15
.20
.50
1.00
1.50
2.00
2.50
400
200
0
—200
GRID VOLTAGE — VOLTS
0
1000
2000
3000
4000
5000
6000
PLATE VOLTAGE — VOLTS

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

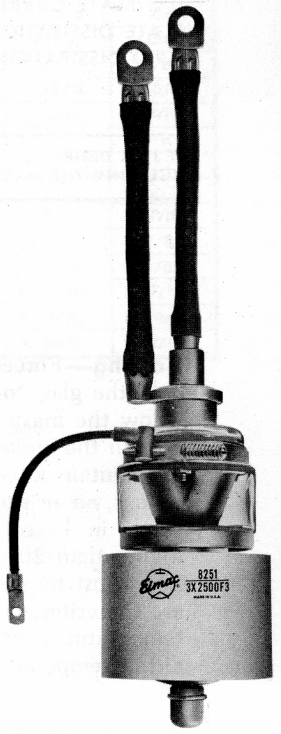
8251
3X2500F3

MEDIUM-MU TRIODE

The Eimac 8251/3X2500F3 is a medium-mu, forced-air cooled, external-anode power triode intended for amplifier, oscillator, or modulator service. It has a maximum plate-dissipation rating of 2500 watts and is capable of high output at relatively low plate voltages. A single 8251/3X2500F3 will deliver a radio-frequency plate power output of 7500 watts at a plate voltage of 4000 volts.

The tube is equipped with flexible filament and grid leads which simplify socketing and equipment design for industrial and communication frequencies below 30 megacycles.

The approved Federal Communications Commission rating for the 8251/3X2500F3 is 5000 watts of carrier power when used as a plate-modulated amplifier and 1250 watts of carrier power when used as a grid-modulated or linear amplifier.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Filament: Thoriated Tungsten				
Voltage		7.5		volts
Current	48		53	amperes ◀
Amplification Factor	19		26	
Direct Interelectrode Capacitances:				
Grid-Plate	16.8		23.2	uuf
Grid-Filament	29.2		40.2	uuf
Plate-Filament	0.6		1.2	uuf
Transconductance (I_b=830 ma., E_b=3000 v.)		20,000		umhos
Highest Frequency for Maximum Ratings			30	mc

MECHANICAL

Base	See outline drawing
Mounting	Vertical, base down or up
Maximum Anode Cooler Core and Seal Temperatures	175° C
Cooling	Forced air
Maximum Over-All Dimensions:	
Length (Does not include filament connectors)	8.6 inches
Diameter	4.16 inches
Length of Filament Connectors (Approximate)	9.5 inches
Net Weight	7.5 pounds
Shipping Weight (Approximate)	17 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Conventional Neutralized Amplifier,
Class-C FM or Telegraphy (Key-Down Conditions)

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPS
PLATE DISSIPATION	2500 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION (Frequencies below 30 Mc)

D-C Plate Voltage	4000	5000	6000 volts
D-C Plate Current	2.5	2.5	2.08 amps
D-C Grid Voltage	—300	—450	—500 volts
D-C Grid Current	245	265	180 ma
Peak R-F Grid Input Voltage*	580	750	765 volts
Driving Power*	142	197	136 watts
Grid Dissipation*	68	78	46 watts
Plate Input Power	10,000	12,500	12,500 watts
Plate Dissipation	2500	2500	2500 watts
Plate Output Power	7500	10,000	10,000 watts

*Approximate values.

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Conventional Neutralized Amplifier,
Class-C Telephony (Carrier Conditions)

MAXIMUM RATINGS

▶ D-C PLATE VOLTAGE	5500 MAX. VOLTS
D-C PLATE CURRENT	2.0 MAX. AMPS
PLATE DISSIPATION	1670 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION (Frequencies below 30 Mc)

D-C Plate Voltage	4000	4500	5000 volts
D-C Plate Current	1.67	1.47	1.25 amps
D-C Grid Voltage	—450	—500	—550 volts
D-C Grid Current*	180	140	150 ma
Peak R-F Grid Input Voltage*	685	715	760 volts
Driving Power*	125	100	115 watts
Grid Dissipation*	43	30	32 watts
Plate Input Power	6670	6615	6250 watts
Plate Dissipation	1670	1315	950 watts
Plate Output Power	5000	5300	5300 watts

*Approximate values.

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▶ Indicates change from sheet dated 12-5-62

AUDIO-FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB or B

MAXIMUM RATINGS

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C PLATE CURRENT	2.5 MAX. AMPS
PLATE DISSIPATION	2500 MAX. WATTS
GRID DISSIPATION	150 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

D-C Plate Voltage	4000	5000	6000 volts
D-C Grid Voltage[1]	—150	—190	—240 volts
Zero-Signal D-C Plate Current	0.6	0.5	0.4 amps
Max-Signal D-C Plate Current	4.0	3.2	3.0 amps
Effective Load, Plate to Plate	2200	3600	4650 ohms
Peak A-F Grid Input Voltage (per tube)*	340	360	390 volts
Max-Signal Peak Driving Power*	340	230	225 watts
Max-Signal Nominal Driving Power*	170	115	113 watts
Max-Signal Plate Output Power	11,000	11,000	13,000 watts

*Approximate values.

[1]Adjust to give listed zero-signal plate current.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS

APPLICATION

Cooling—Forced-air cooling must be provided to hold the glass-to-metal seals and the anode cooler core below the maximum rated temperature of 175° C. Although the air requirements stated below are sufficient to maintain rated tube temperatures under many conditions, air in excess of the amounts shown will usually result in longer tube life, At ambient temperatures higher than 20° C and at high altitudes additional air flow must be provided. In all cases, tube temperatures are the criteria which govern air requirements. Surface temperatures may be measured conveniently with the aid of temperature-sensitive paints.

Anode-to-Base Air-Flow				
	Sea Level		10,000 Feet	
Plate Dissipation (Watts)	Air-Flow (CFM)	Pressure Drop (Inches H_2O)	Air-Flow (CFM)	Pressure Drop (Inches H_2O)
2000	58.5	0.8	85.5	1.15
2500	85.5	1.6	125	2.3

Base-to-Anode Air-Flow				
	Sea Level		10,000 Feet	
Plate Dissipation (Watts)	Air-Flow (CFM)	Pressure Drop (Inches H_2O)	Air-Flow (CFM)	Pressure Drop (Inches H_2O)
2000	35.5	0.25	52	0.35
2500	42	0.5	61.5	0.75

Under the same conditions, a minimum air-flow rate of 6 CFM directed into the filament-stem structure betv een the inner and outer filament terminals is required to maintain the base seals below 175° C.

Simultaneous removal of all power and air (as in the case of a power failure) will not ordinarily injure the tube, but it is not recommended as a standard operating practice.

Filament Voltage—The filament voltage as measured directly at the tube, should be 7.5 volts with maximum allowable variations due to line fluctuation of from 7.12 to 7.87 volts. Tube life may be extended by operation at the lower end of this range.

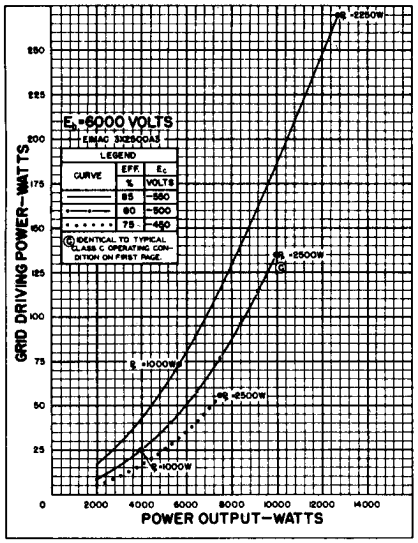
Bias Voltage—There is little advantage in using bias voltages in excess of those given under "Typical Operation," except in certain very specialized applications. Where bias is obtained from a grid resistor, suitable protective means must be provided to prevent excessive plate dissipation in the event of loss of excitation.

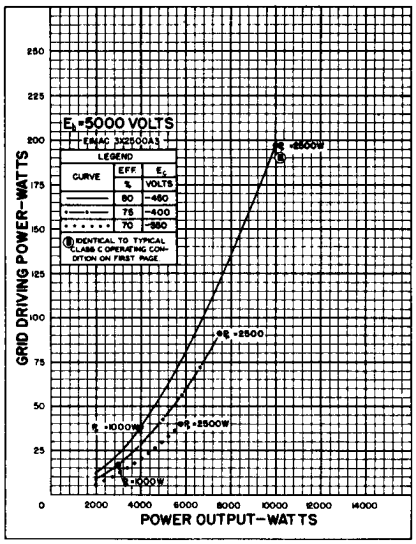
Plate Voltage — The plate-supply voltage for the 3X2500F3 should not exceed 6000 volts.

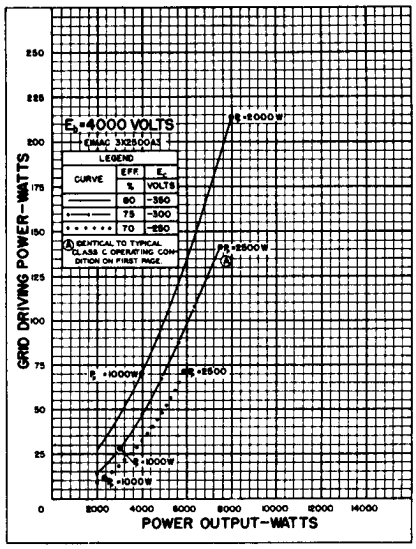
In Class-C FM or Telegraphy service, a 0.1-henry choke, shunted by a spark gap, should be series connected between the plates of the amplifier tubes and the high-voltage plate-supply capacitor to offer protection from transients and surges. In plate-modulated service, where a plate-modulation transformer is used, the protective choke is not normally required.

Grid Dissipation—The power dissipated by the grid of the 3X2500F3 must never exceed 150 watts. Grid dissipation is the product of dc grid current and peak positive grid voltage.

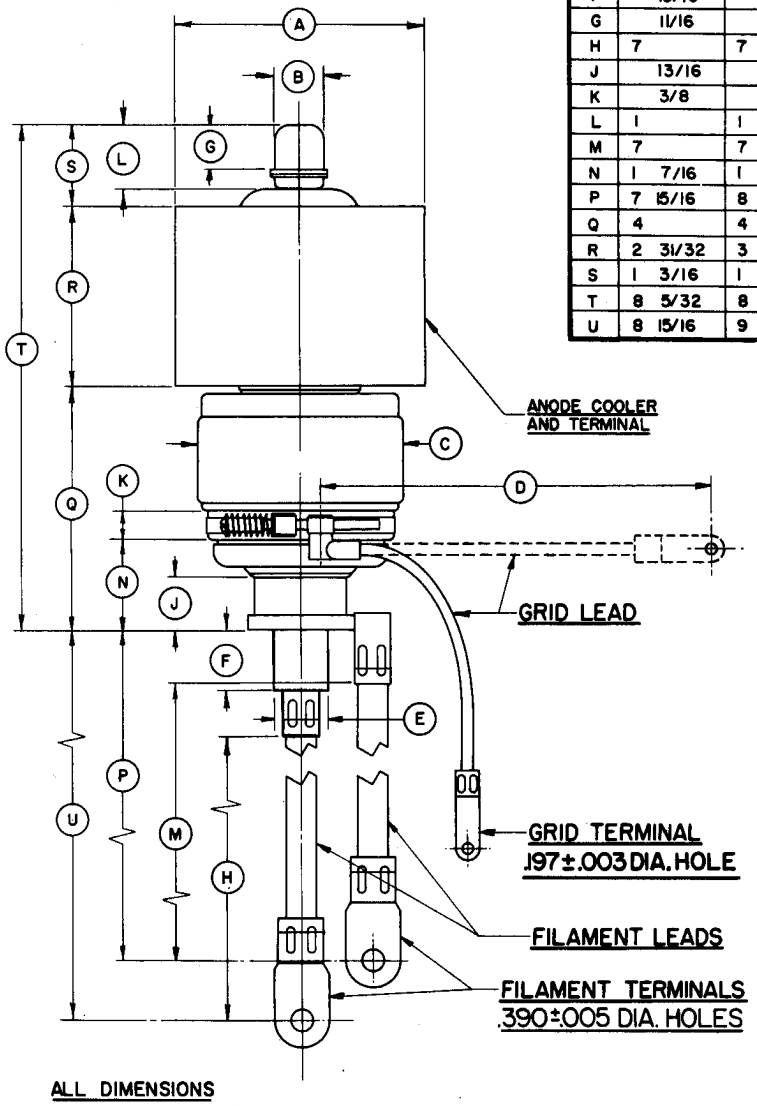
In equipment in which the plate loading varies widely, such as oscillators used for radio-frequency heating, care should be taken to make certain that the grid dissipation does not exceed the maximum rating under any condition of loading. With lightly loaded conditions the grid driving power should be reduced so that the grid current does not exceed one-tenth of the plate current.





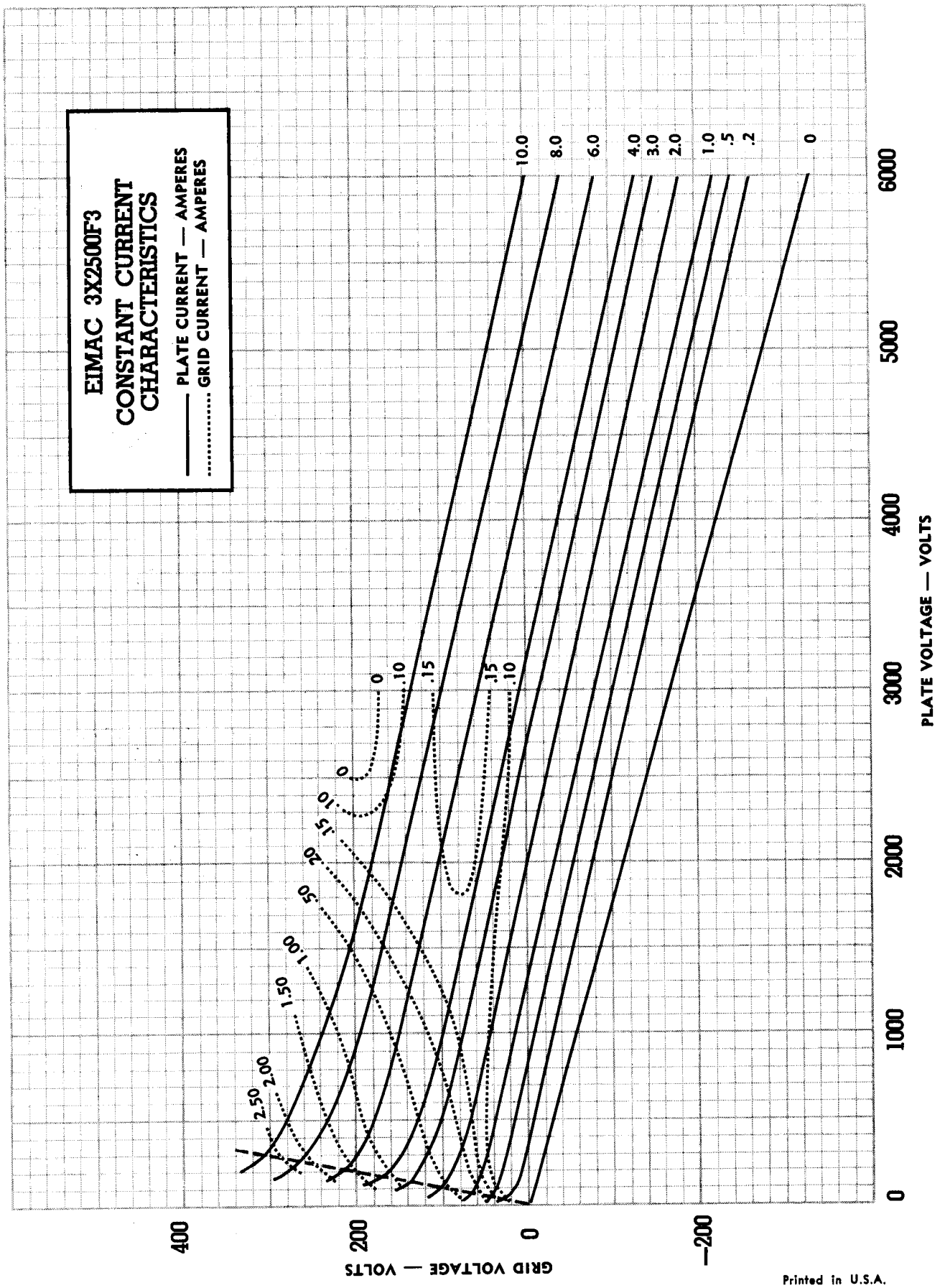


DIMENSION DATA		
REF.	MIN	MAX
A	4 3/32	4 5/32
B	25/32	27/32
C		3 5/8
D	6 3/8	6 5/8
E	55/64	57/64
F	13/16	15/16
G	11/16	13/16
H	7	7 1/2
J	13/16	15/16
K	3/8	7/16
L	1	1 1/8
M	7	7 1/2
N	1 7/16	1 9/16
P	7 15/16	8 7/16
Q	4	4 1/8
R	2 31/32	3 1/32
S	1 3/16	1 7/16
T	8 5/32	8 19/32
U	8 15/16	9 7/16



ALL DIMENSIONS IN INCHES

▶ Indicates change from sheet dated 1-27-58



Printed in U.S.A.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

8252
4PR60B

RADIAL-BEAM PULSE TETRODE

•

MODULATOR AMPLIFIER



The Eimac 8252/4PR60B is a high-vacuum tetrode intended for pulse-modulator service in circuits employing inductive or resistive loads. This tube unilaterally replaces the 715C and the 5D21 and supersedes the 4PR60A.

The 8252/4PR60B has a maximum plate dissipation rating of 60 watts, is cooled by radiation and convection, and delivers pulse output power in the region of 300 kilowatts with less than one kilowatt of pulse driving power.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide-coated, Unipotential				
Heater Voltage		26.0		volts
Heater Current		2.1		amperes
Cathode Heating Time	3	5		minutes
Direct Interelectrode Capacitances				
Grid-Plate			2.0	μμf
Input	35		50	μμf
Output	6.0		11	μμf

MECHANICAL

Minimum Shock Test	190g, 0.5ms half sine
Base	Fits E. F. Johnson Co. Socket Number 122-234 or equivalent
Mounting Position	Any
Cooling	Radiation and Convection
Recommended Heat Dissipating Plate Connector	Eimac HR-8
Maximum Seal and Envelope Temperatures	200° C
Maximum Over-All Dimensions	
Length	6.000 inches
Diameter	3.063 inches
Net Weight	12 ounces
Shipping Weight	2.5 pounds

RATINGS

MAXIMUM RATINGS—Pulse Modulator Service (Per Tube)

D-C PLATE VOLTAGE	20 MAX. KILOVOLTS
D-C SCREEN VOLTAGE	1.5 MAX. KILOVOLTS
D-C GRID VOLTAGE†	—1.0 MAX. KILOVOLT
PEAK POSITIVE GRID VOLTAGE	300 MAX. VOLTS
PEAK PLATE CURRENT	18 MAX. AMPERES
PEAK POSITIVE PLATE VOLTAGE	25 MAX. KILOVOLTS
PLATE DISSIPATION (AVERAGE)	60 MAX. WATTS
SCREEN DISSIPATION (AVERAGE)	8 MAX. WATTS
GRID DISSIPATION (AVERAGE)	1 MAX. WATT
DUTY	See chart page 4

†Effective grid-circuit resistance must not exceed 100,000 ohms.

TYPICAL OPERATION

Pulse Modulator (Per Tube)

D-C Plate Voltage	16.0	20.0	kilovolts
Pulse Plate Current	10.0	18.0	amperes
D-C Screen Voltage	1.25	1.25	kilovolts
Pulse Screen Current*	1.8	2.7	amperes
D-C Grid Voltage	—550	—600	volts
Pulse Grid Current*	0.20	0.75	ampere
Pulse Positive Grid Voltage	30	150	volts
Duty	0.0025	.001	
Pulse Duration	5	2	μsec
Peak Positive Plate Voltage	25	25	kilovolts
Pulse Input Power	160	360	kilowatts
Pulse Output Power	150	337	kilowatts
Pulse Output Voltage	15.0	18.75	kilovolts

*Approximate value.

(Effective 2-15-62) Copyright 1962 by Eitel-McCullough, Inc. Printed in U.S.A.

APPLICATION

MECHANICAL

MOUNTING—The 4PR60B may be mounted and operated in any position. A flexible connecting strap must be provided between the plate terminal and the external plate circuit.

The 4PR60B is designed to withstand 200g shocks of 0.5 millisecond duration transferred to the tube through clamps on the metal skirt. Such clamps must be shaped to fit the contour of the skirt and must be fastened to the tube before being tightened to the chassis in order that no distorting force will be applied. No lateral pressure or clamping action should be applied to the base pins or to any part of the tube other than the skirt. The skirt is internally connected to the cathode. The 4PR60B must be protected from severe vibration.

Cooling—Adequate ventilation must be provided so that seal and/or envelope temperatures do not exceed 200° C under any operating or standby condition. When the 4PR60B is operated where air circulation is restricted, these temperatures can easily reach 225° C or more which will accelerate seal deterioration and cause early tube failure.

Adequate control of the base temperature, in particular, is necessary. Envelope and plate-seal temperatures do not ordinarily require special attention provided that an HR-8 heat-dissipating plate connector is used. However, each individual application of the 4PR60B should be carefully evaluated to assure safe operating temperatures. A blower is usually required only when normal air circulation is restricted, when the ambient temperature exceeds 25° C, when the altitude is other than sea level, or when a combination of these factors exists.

ELECTRICAL

Heater Operation—The heater voltage, as measured directly at the heater pins, should be maintained at the rated value of 26.0 volts. Maximum variations in heater voltage must be kept within the range of 23.4 to 28.6 volts. Where consistent performance and long tube life are factors, the heater voltage must be kept within the range of 24.7 to 27.3 volts. The peak pulse-emission capability of the cathode may be impaired at low heater voltages, and high heater voltages contribute to short tube life.

A heater noise test is conducted periodically on 4PR60B samples. This test insures that the heater/cathode assembly will not generate excessive r-f noise during vibration over the frequency range of 10 to 50 cps.

A 500-hour heater cycling test is also conducted periodically on 4PR60B samples. This test consists of at least 1000 complete on-off cycles and insures that grid-to-cathode shorts will not occur as a result of cumulative hysteresis effects upon mechanical joints in the cathode assembly.

Cathode Operation—It is essential that the minimum cathode heating time of three minutes be observed prior to the flow of cathode current. Conservative design for reliable tube operation in pulse circuits dictates the use of five minutes minimum heating time.

The "Cathode Current Derating Chart" on page 4 depicts the current capabilities of the 4PR60B cathode at various pulse durations and duty factors. To use this chart, enter with pulse duration and note the intersection with desired pulse ***cathode*** current (the total of plate, screen, and grid currents during a particular pulse condition). At this intersection read off values of maximum duty and/or pulse repetition rate.

Under a given set of operating conditions, element dissipations may limit the maximum permissible duty to a value less than that which cathode considerations would dictate. When this occurs, it will usually be found that screen dissipation is the limiting factor under low tube-voltage-drop conditions and that plate dissipation limits the maximum duty under high tube-voltage-drop conditions.

Control-Grid Operation—The average power dissipated by the control grid of the 4PR60B must not exceed one watt. Control-grid dissipation is not usually a limiting factor with this tube, but can be computed as the product of pulse grid current, pulse positive grid voltage, and duty factor. Similarly, pulse driving power is pulse grid current times pulse grid voltage swing (bias voltage plus positive grid voltage).

Screen-Grid Operation—The average power dissipated by the screen of the 4PR60B must not exceed eight watts. Screen dissipation is the product of d-c screen voltage, pulse screen current, and duty factor. Excessive screen dissipation is likely to occur under conditions of low tube-voltage drop during conduction. This condition can be relieved by using a lower plate load resistance which will cause higher tube-voltage drop during conduction.

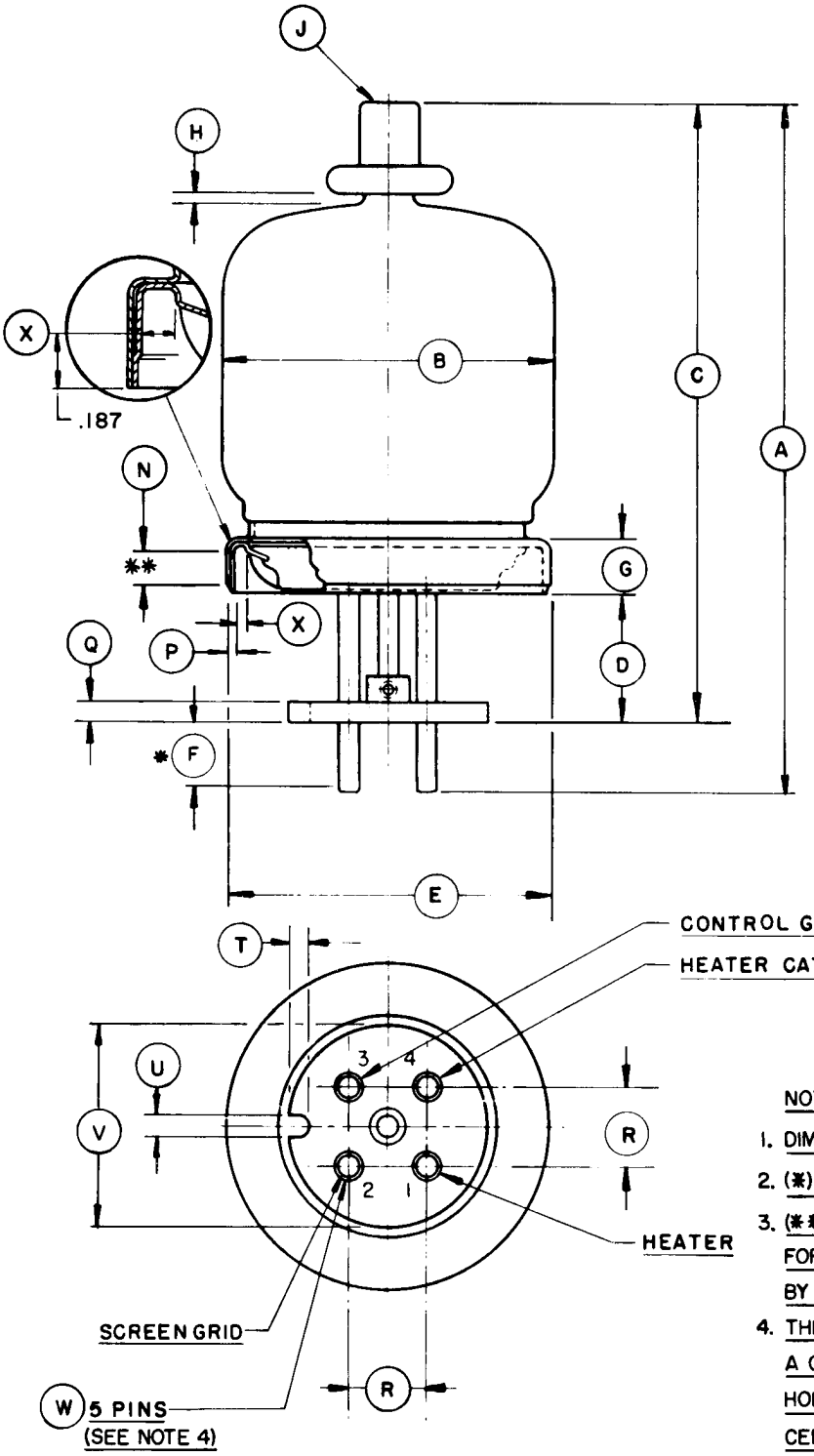
A bleeder resistance designed to draw at least 10 milliamperes of current should be connected directly from screen to cathode of the 4PR60B. This bleeder resistance will insure that only a positive current load is presented to the screen supply.

Plate Operation—The plate of the 4PR60B is radiation cooled and is rated at 60 watts maximum dissipation. Average plate dissipation must not exceed 60 watts. The 4PR60B should not be operated without a heat-dissipating plate connector such as the recommended Eimac HR-8.

Average plate dissipation may be calculated as the product of pulse plate current, pulse tube-voltage drop, and duty factor. Excessive average plate dissipation is likely to occur at high values of pulse tube-voltage drop. The calculated value of plate dissipation may be well below 60 watts in a given case, but excessive dissipation may result if pulse rise and fall times are appreciable compared to pulse duration. This excessive plate dissipation occurs because long rise and fall times slow down the plate voltage swing and allow plate current to flow for longer periods in the high voltage-drop region.

The plate-supply voltage for the 4PR60B should not exceed 20 kilovolts. In circuits employing inductive loading, the peak instantaneous plate voltage should not exceed 25 kilovolts.

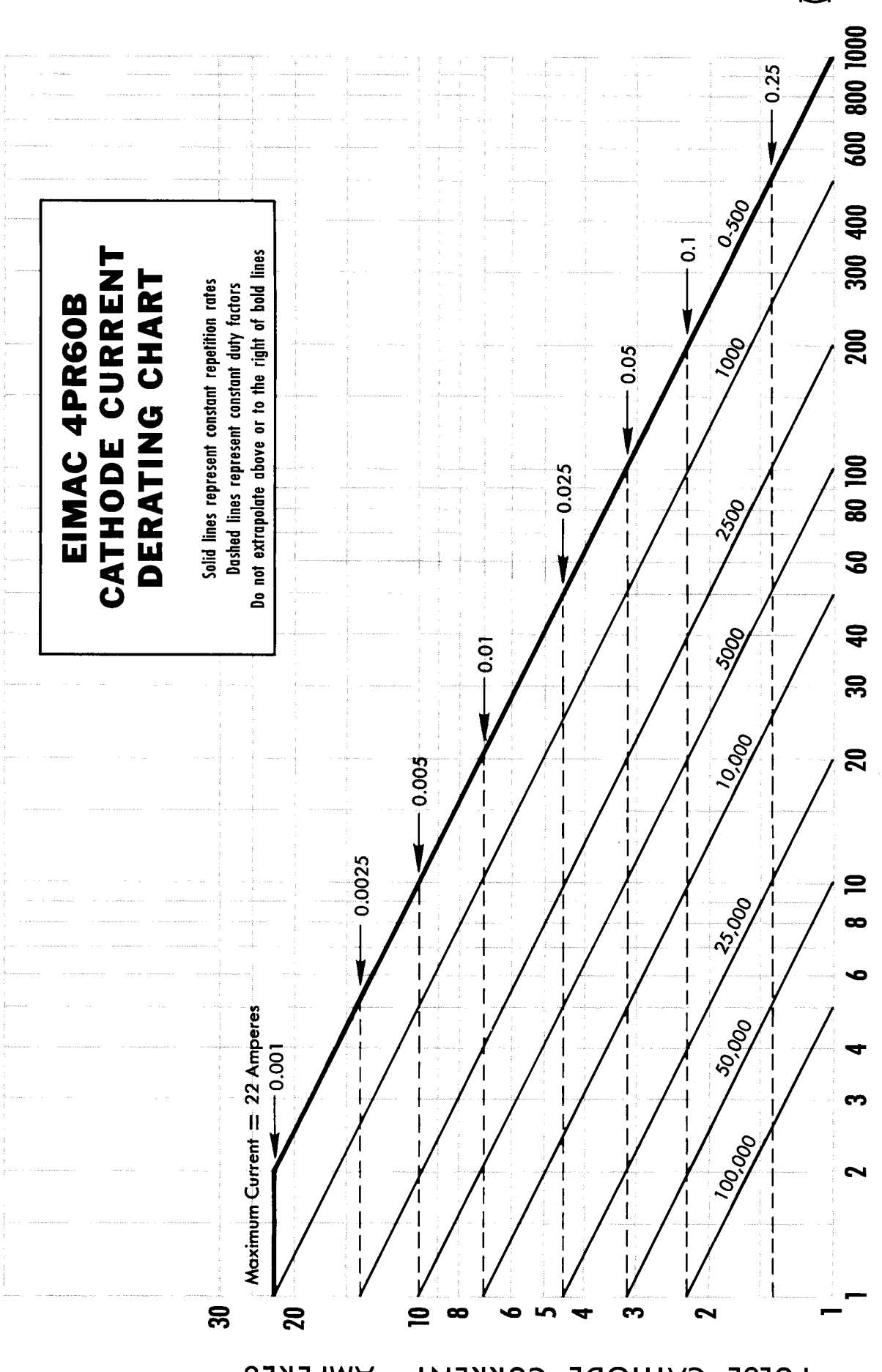
4PR60B OUTLINE DRAWING AND DIMENSIONS

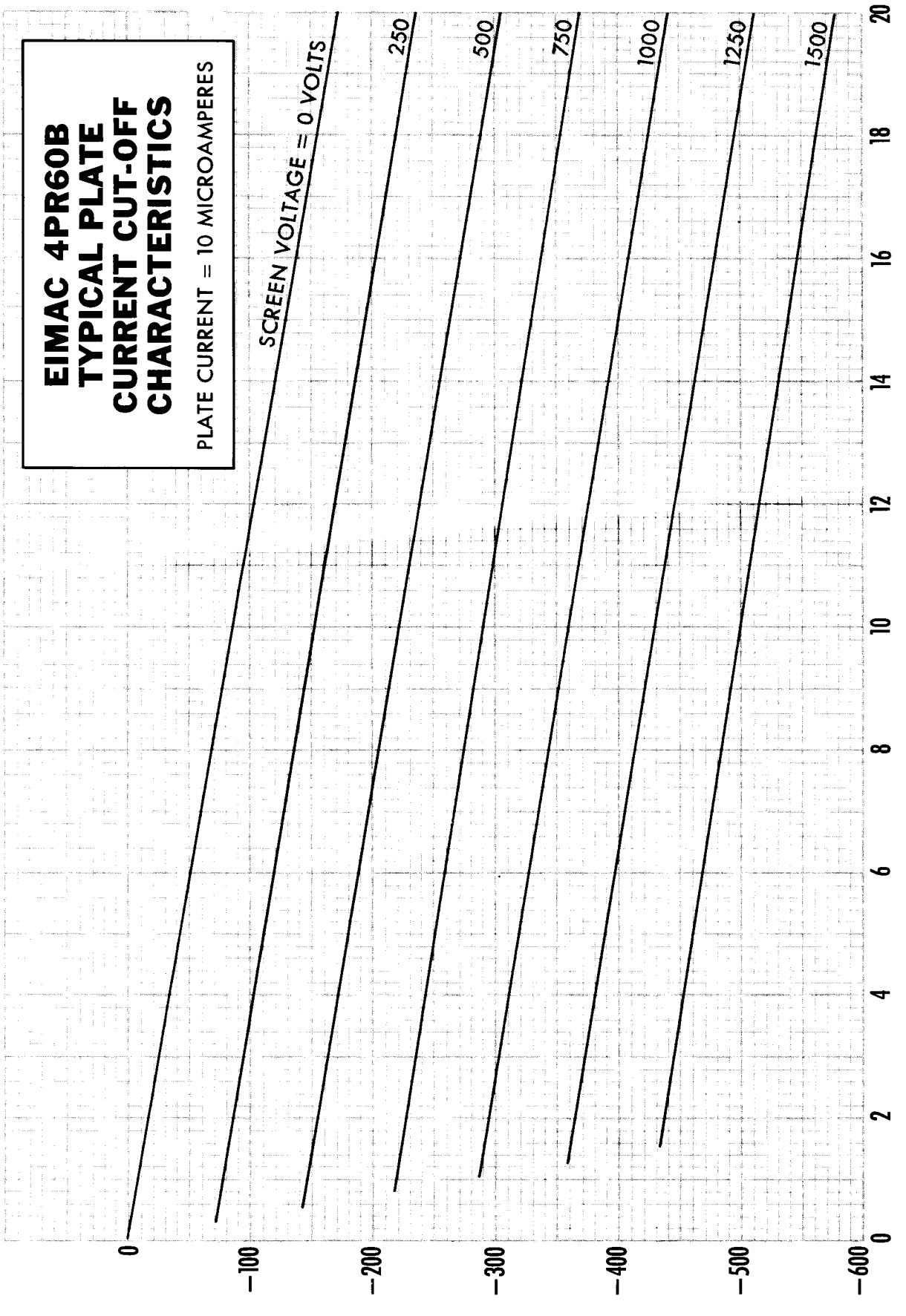


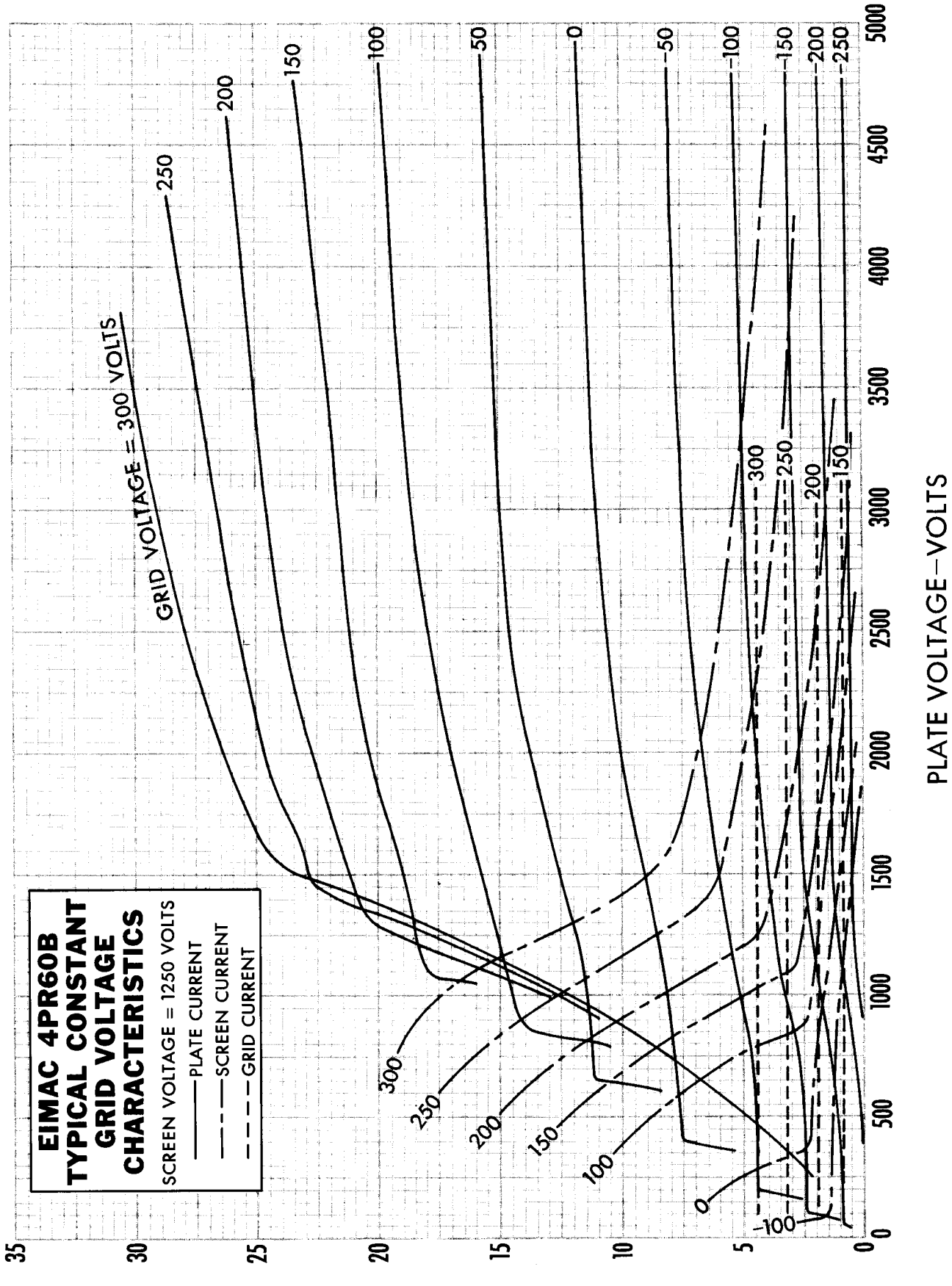
DIMENSION DATA		
REF.	MIN.	MAX.
A	5.750	6.000
B		3.063 DIA.
C	5.344	5.594
D	1.125	1.250
E	2.885 DIA.	2.905 DIA.
F	.328	
G	.438	.500
H	.016	
J	CAP: C1-41 (JEDEC DESIGNATION)	
N	.250	
P	.043	.057
Q	.188	
R	.687	
T	.171	.203
U	.171	.203
V	1.788 DIA.	1.813 DIA.
W	.183 DIA.	.191 DIA.
X	.157	

NOTES:

1. DIMENSIONS IN INCHES.
2. (*) CONTACT AREA.
3. (**) DEFINES CYLINDRICAL AREA AVAILABLE FOR CLAMPING WHICH MUST NOT BE DISTORTED BY CLAMPING ACTION.
4. THE BASE PINS SHALL BE CAPABLE OF ENTERING A GAUGE 1/4 INCH THICK HAVING FOUR .214" DIA. HOLES LOCATED ON 11/16 CENTERS AND A CENTER HOLE .250 DIA


EIMAC 4PR60B
CATHODE CURRENT
DERATING CHART
Solid lines represent constant repetition rates
Dashed lines represent constant duty factors
Do not extrapolate above or to the right of bold lines
Maximum Current = 22 Amperes
0.001
0.0025
0.005
0.01
0.025
0.05
0.1
0.25
0-500
1000
2500
5000
10,000
25,000
50,000
100,000
PULSE CATHODE CURRENT — AMPERES
30
20
10
8
6
5
4
3
2
1
1
2
3
4
6
8
10
20
30
40
60
80
100
200
300
400
600
800
1000
PULSE DURATION — MICROSECONDS


EIMAC 4PR60B
TYPICAL PLATE
CURRENT CUT-OFF
CHARACTERISTICS
PLATE CURRENT = 10 MICROAMPERES
SCREEN VOLTAGE = 0 VOLTS
250
500
750
1000
1250
1500
0
−100
−200
−300
−400
−500
−600
GRID VOLTAGE−VOLTS
0
2
4
6
8
10
12
14
16
18
20
PLATE VOLTAGE−KILOVOLTS


EIMAC 4PR60B
TYPICAL CONSTANT
GRID VOLTAGE
CHARACTERISTICS
SCREEN VOLTAGE = 1250 VOLTS
PLATE CURRENT
SCREEN CURRENT
GRID CURRENT
GRID VOLTAGE = 300 VOLTS
CURRENT–AMPERES
PLATE VOLTAGE–VOLTS

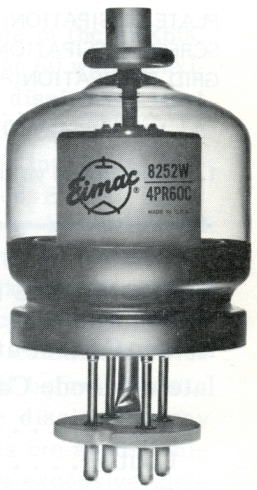
8252W/4PR60C

TECHNICAL DATA

PULSE MODULATOR TETRODE

The EIMAC 8252W/4PR60C is a high-vacuum tetrode intended for pulse-modulator service in circuits employing inductive or resistive loads. This tube unilaterally replaces the 715C and the 5D21 and supersedes the 8252/4PR60B. The internal structure of the tube has been strengthened to minimize the effects of shock and vibration.

The 8252W/4PR60C has a maximum plate dissipation rating of 60 watts, is cooled by radiation and convection, and delivers pulse output power in the region of 300 kilowatts with less than one kilowatt of pulse driving power.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide-coated, Unipotential		
Heater Voltage	26.0	V
Heater Current	2.1	A
Cathode Heating Time	3	Min.
Direct Interelectrode Capacitances[2]		
Cin	43	pF
Cout	8.5	pF
Cgp	1.5	pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191A.

MECHANICAL

Environmental Capability	See Application Note
Base	Fits E.F. Johnson Co. Socket Number 122-234 or equivalent
Mounting Position	Any
Cooling	Radiation and Convection
Recommended Heat Dissipating Plate Connector	EIMAC HR-8
Maximum Seal and Envelope Temperatures	200°C
Maximum Over-All Dimensions	
Length	6.000 in; 152.4 mm
Diameter	3.063 in; 77.9 mm
Net Weight	12 oz; 0.34 kg
Shipping Weight	2.5 lb; 1.14 kg

(Revised 6-30-71) © 1962, 1966, 1971 Varian

Printed in U.S.A.

PULSE MODULATOR OR SWITCH TUBE SERVICE

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	20 KILOVOLTS
DC SCREEN VOLTAGE	1.5 KILOVOLTS
DC GRID VOLTAGE[2]	-1.0 KILOVOLT
PEAK POSITIVE GRID VOLTAGE	300 VOLTS
PEAK PLATE CURRENT	18 AMPERES
PEAK POSITIVE PLATE VOLTAGE	25 KILOVOLTS
PLATE DISSIPATION(Average)	60 WATTS
SCREEN DISSIPATION (Average)	8 WATTS
GRID DISSIPATION(Average)	1 WATT
DUTY	See chart page 6

1. Approximate value.

TYPICAL OPERATION

Pulse Modulator (Per Tube)			
DC Plate Voltage	16.0	20.0	kVdc
Pulse Plate Current	10.0	18.0	a
DC Screen Voltage	1.25	1.25	kVdc
Pulse Screen Current[1]	1.8	2.7	a
DC Grid Voltage	-550	-600	Vdc
Pulse Grid Current[1]	0.20	0.75	a
Pulse Positive Grid Voltage	30	150	v
Duty	0.0025	.001	
Pulse Duration	5	2	μs
Peak Positive Plate Voltage	25	25	kv
Pulse Input Power	160	360	kw
Pulse Output Power	150	337	kw
Pulse Output Voltage	15.0	18.75	kv

2. The effective grid-circuit resistance must not exceed 100,000 ohms.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater Current at E_f = 27.0 volts	1.95	2.35	A
Interelectrode Capacitances[1] (grounded cathode connection)			
Cin	35	50	pF
Cout	6.0	11	pF
Cgp	---	2.0	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4PR60C may be mounted and operated in any position. A flexible connecting strap should be provided between the plate terminal and the external plate circuit.

If environmental stress, such as shock or vibration is expected, the tube must be clamped into position by means of clamps on the metal skirt. Such clamps must be shaped to fit the contour of the skirt and must be fastened to the tube before being tightened to the chassis in order that no distorting force will be applied. No lateral pressure or clamping action should be applied to the base pins or to any part of the tube other than the skirt. The skirt is internally connected to the cathode.

COOLING - Adequate ventilation must be provided so that seal and/or envelope temperatures do not exceed 200°C under any operating or standby condition. When the 4PR60C is operated where air circulation is restricted, these temperatures can easily reach 225°C or more which will accelerate seal deterioration and cause early tube failure.

Adequate control of the base temperature, in particular, is necessary. Envelope and plate-seal temperatures do not ordinarily require special attention provided that an HR-8 heat dissipating plate connector is used. However, each individual application of the 4PR60C should be carefully evaluated to assure safe operating temperatures. A blower is usually required only when normal air circulation is restricted, when the ambient temperature exceeds 25°C, when the altitude is other than sea level, or when a combination of these factors exists.

ELECTRICAL

HEATER OPERATION - The heater voltage, as measured directly at the heater pins, should be maintained at the rated value of 26.0 volts. Maximum variations in heater voltage must be kept within the range of 23.4 to 28.6 volts. Where consistent performance and long tube life are factors, the heater voltage must be kept within range of 24.7 to 27.3 volts. The peak pulse-emission capability of the cathode may be impaired at low

heater voltages, and high heater voltages contribute to short tube life.

A heater noise test is conducted periodically on 4PR60C samples. This test insures that the heater/cathode assembly will not generate excessive rf noise during vibration over the frequency range of 10 to 50 cps.

A 500-hour heater cycling test is also conducted periodically on 4PR60C samples. This test consists of at least 1000 complete on-off cycles and insures that grid-to-cathode shorts will not occur as a result of cumulative hysteresis effects upon mechanical joints in the cathode assembly.

CATHODE OPERATION - It is essential that the minimum cathode heating time of three minutes be observed prior to the flow of cathode current. Conservative design for reliable tube operation in pulse circuits dictates the use of five minutes minimum heating time.

The "Cathode Current Derating Chart" depicts the current capabilities of the 4PR60C cathode at various pulse durations and duty factors. To use this chart, enter with pulse duration and note the intersection with desired pulse *cathode* current (the total of plate, screen, and grid currents during particular pulse condition). At this intersection read off values of maximum duty and/or pulse repetition rate.

Under a given set of operating conditions, element dissipations may limit the maximum permissible duty to a value less than that which cathode considerations would dictate. When this occurs, it will usually be found that screen dissipation is the limiting factor under low tube-voltage-drop conditions and that plate dissipation limits the maximum duty under high tube-voltage-drop conditions.

CONTROL-GRID OPERATION - The average power dissipated by the control grid of the 4PR60C must not exceed one watt. Control-grid dissipation is not usually a limiting factor with this tube, but can be computed as the product of pulse grid current, pulse positive grid voltage, and duty factor. Similarly, pulse driving power is pulse grid current times pulse grid voltage swing (bias voltage plus positive grid voltage).

SCREEN-GRID OPERATION - The average power dissipated by the screen of the 4PR60C must not exceed eight watts. Screen dissipation is the product of dc screen voltage, pulse screen current, and duty factor. Excessive screen dissipation is likely to occur under conditions of low tube-voltage drop during conduction. This condition can be relieved by using a lower plate load resistance which will cause higher tube-voltage drop during conduction.

A bleeder resistance designed to draw at least 10 milliamperes of current should be connected directly from screen to cathode of the 4PR60C. This bleeder resistance will insure that only a positive current load is presented to the screen supply.

PLATE OPERATION - The plate of the 4PR60C is radiation cooled and is rated at 60 watts maximum dissipation. Average plate dissipation must not exceed 60 watts. The 4PR60C should not be operated without a heat-dissipating plate connector such as the recommended EIMAC HR-8.

Average plate dissipation may be calculated as the product of pulse plate current, pulse tube-voltage drop, and duty factor. Excessive average plate dissipation is likely to occur at high values of pulse tube-voltage drop. The calculated value of plate dissipation may be well below 60 watts in a given case, but excessive dissipation may result if pulse rise and fall times are appreciable compared to pulse duration. This excessive plate dissipation occurs because long rise and fall times slow down the plate voltage swing and allow plate current to flow for longer periods in the high voltage-drop region.

The plate-supply voltage for the 4PR60C should not exceed 20 kilovolts. In circuits employing inductive loading, the peak instantaneous plate voltage should not exceed 25 kilovolts.

CAUTION-HIGH VOLTAGE - Operating voltage for the 4PR60C can be deadly, so the equipment must be designed properly and operating precautions must be followed. Design equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high voltage circuits and terminals, with interlock switches to open the primary circuits of the power supply and to discharge high voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

SHOCK/VIBRATION - The internal structure of the 4PR60C has been reinforced to minimize the effects of shock and vibration in the grid-cathode section of the tube. When environmental stress is expected, proper mounting is extremely important (see MOUNTING).

Production samples are periodically tested for ability to survive 50 G, 11 millisecond shock im-

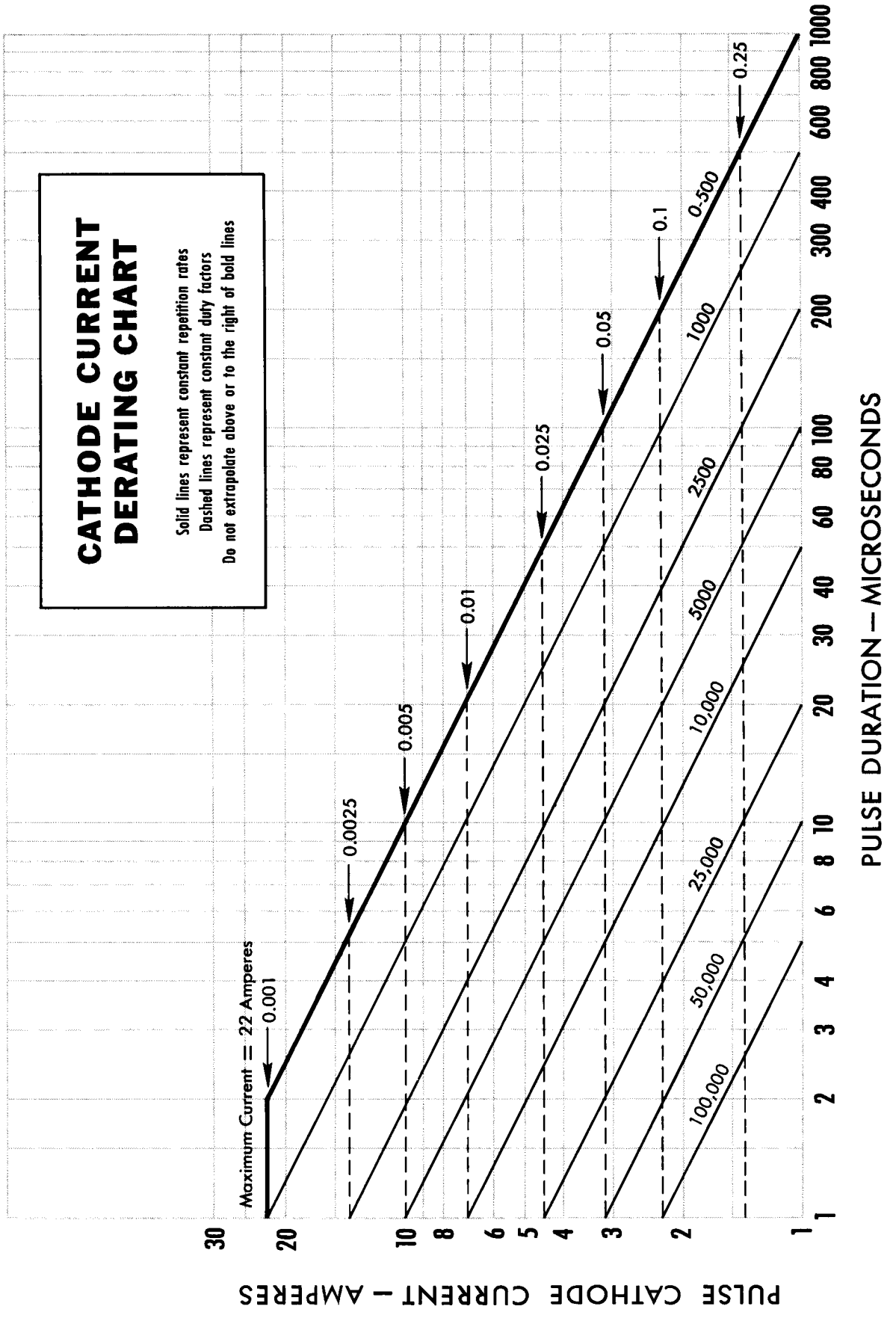
pact, and vibration at a fixed double-amplitude of 0.08 inch over the range of 10 to 50 Hz and 10 G of acceleration over the range of 50 to 200 Hz.

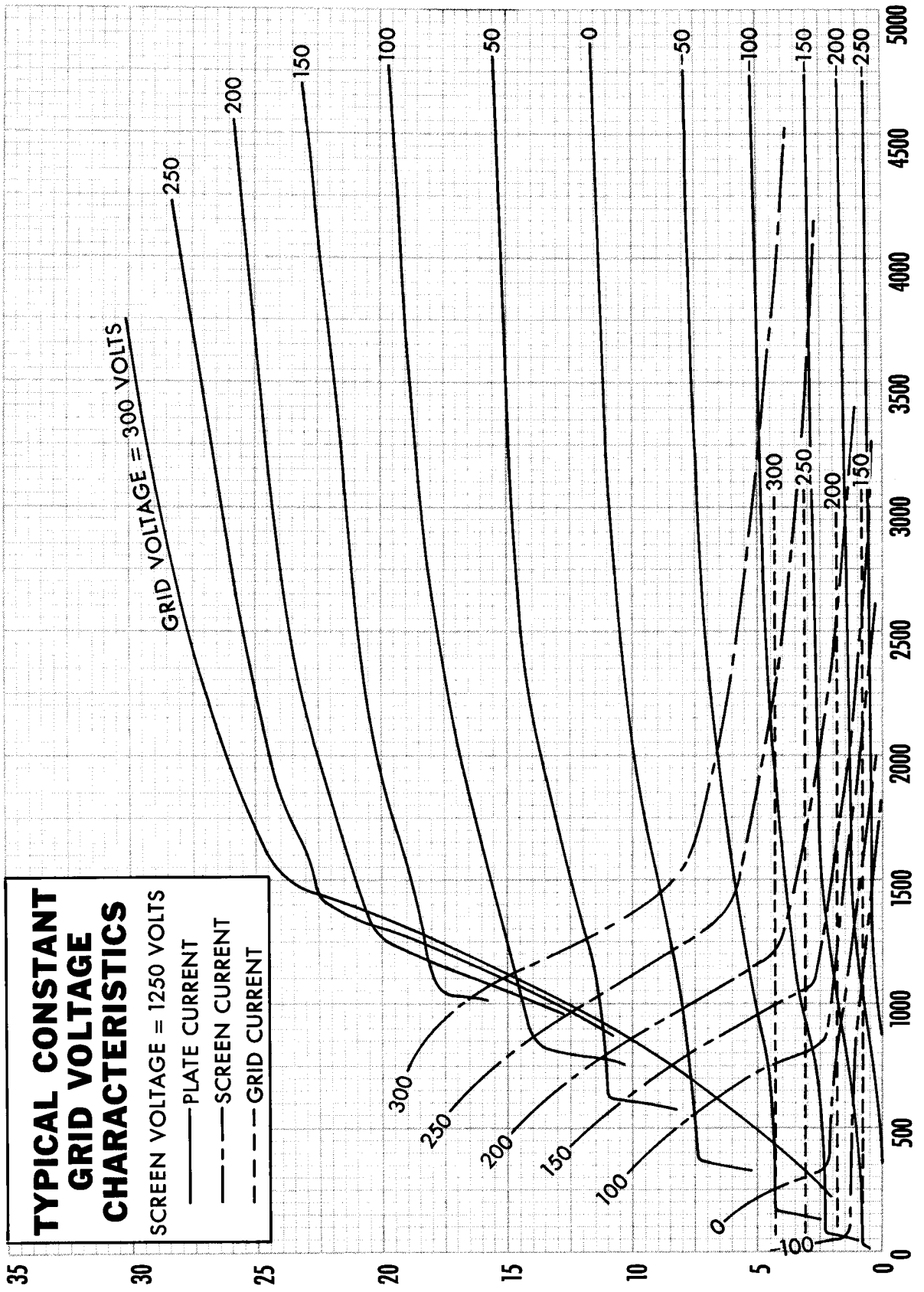
X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4PR60C, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

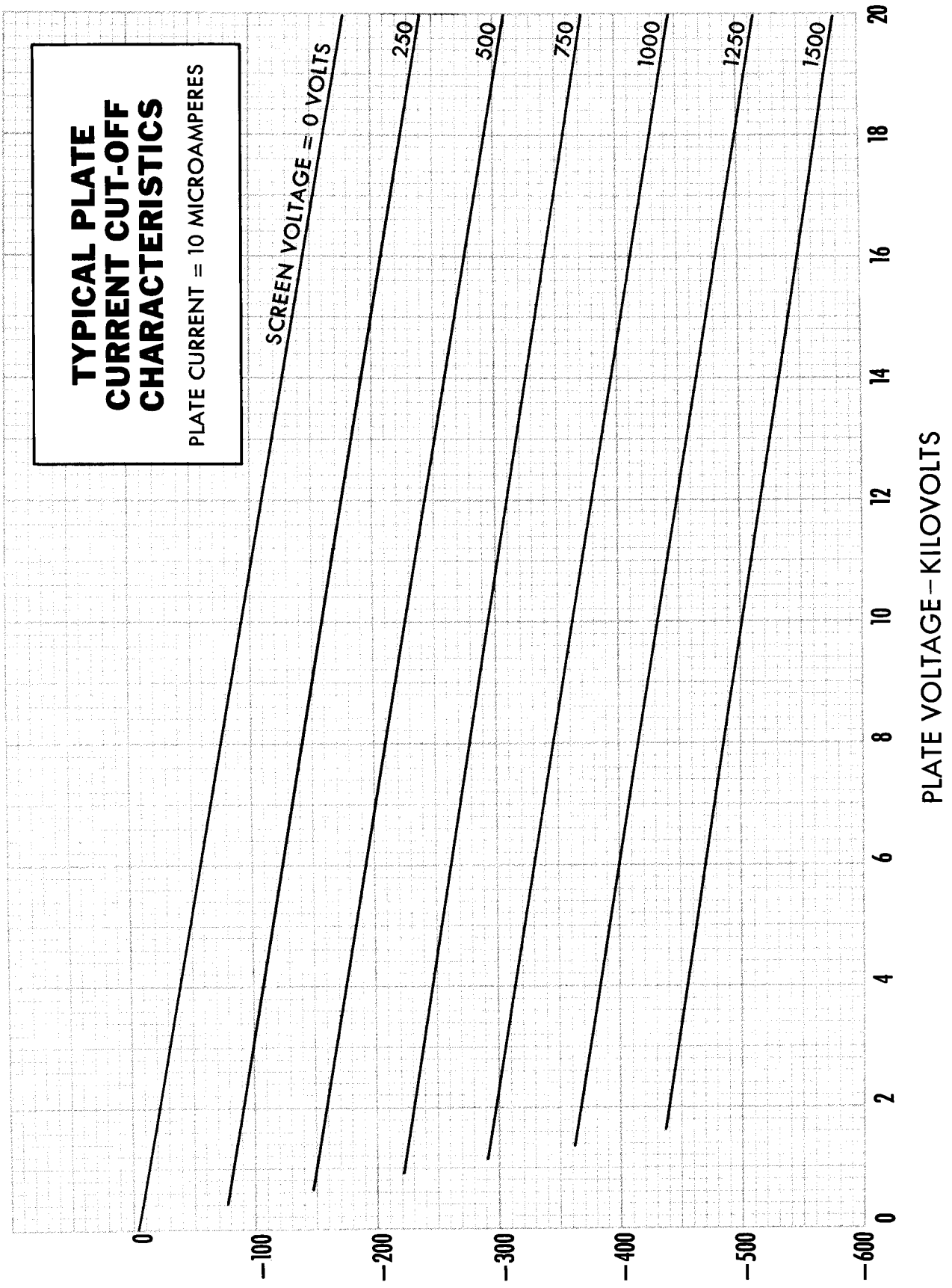
Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

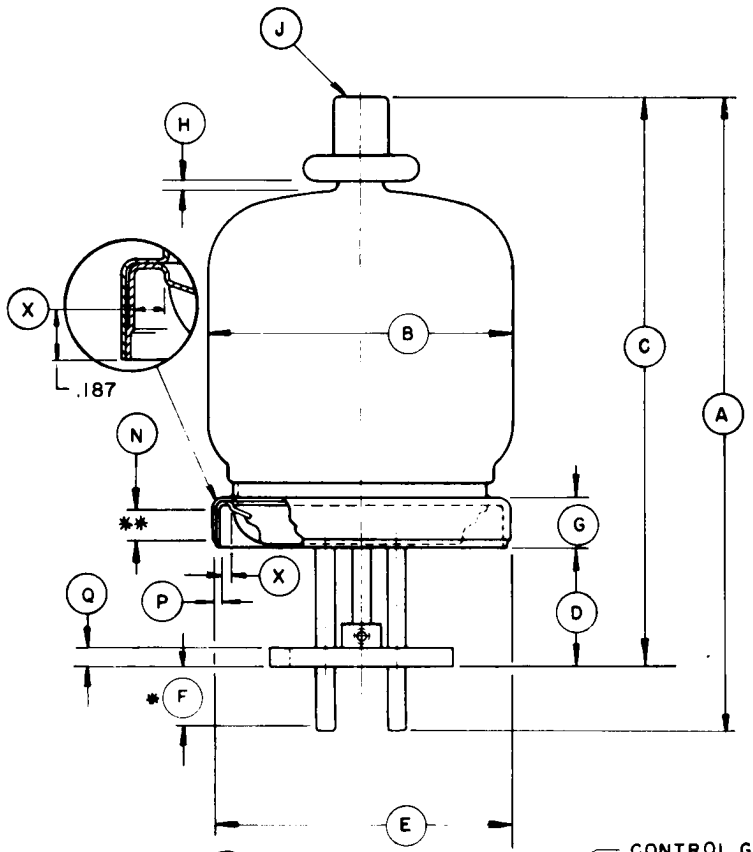
CAUTION-GLASS IMPLOSION - The EIMAC 4PR60C is pumped to a very high vacuum, which is contained by a glass envelope. When handling a glass tube, remember that glass is a relatively fragile material, and accidental breakage can result at any time. Breakage will result in flying glass fragments, so safety glasses, heavy clothing, and leather gloves are recommended for protection.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

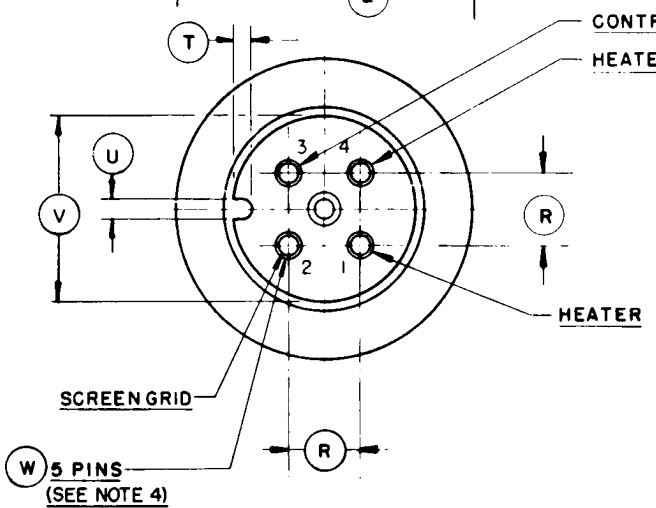

CATHODE CURRENT
DERATING CHART
Solid lines represent constant repetition rates
Dashed lines represent constant duty factors
Do not extrapolate above or to the right of bold lines
Maximum Current = 22 Amperes
0.001
0.0025
0.005
0.01
0.025
0.05
0.1
0.250
0.500
1000
2500
5000
10,000
25,000
50,000
100,000
PULSE CATHODE CURRENT – AMPERES
30
20
10
8
6
5
4
3
2
1
1
2
3
4
6
8
10
20
30
40
60
80
100
200
300
400
600
800
1000
PULSE DURATION – MICROSECONDS


TYPICAL CONSTANT GRID VOLTAGE CHARACTERISTICS
SCREEN VOLTAGE = 1250 VOLTS
PLATE CURRENT
SCREEN CURRENT
GRID CURRENT
GRID VOLTAGE = 300 VOLTS
CURRENT—AMPERES
PLATE VOLTAGE—VOLTS
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5
10
15
20
25
30
35
300
250
200
150
100
50
0
-50
-100
-150
-200
-250


TYPICAL PLATE CURRENT CUT-OFF CHARACTERISTICS
PLATE CURRENT = 10 MICROAMPERES
SCREEN VOLTAGE = 0 VOLTS
250
500
750
1000
1250
1500
0
−100
−200
−300
−400
−500
−600
0
2
4
6
8
10
12
14
16
18
20
GRID VOLTAGE–VOLTS
PLATE VOLTAGE–KILOVOLTS



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	5.750	6.000	--	146.10	152.40	--
B	--	3.063	--	--	77.80	--
C	5.344	5.594	--	135.7	142.1	--
D	1.125	1.250	--	28.57	31.75	--
E	2.885	2.905	--	73.28	73.79	--
F	0.328	--	--	8.33	--	--
G	0.438	0.500	--	11.13	12.70	--
H	0.016	--	--	0.41	--	--
J	CAP: C1-41 (JEDEC DESIGNATION)					
N	0.250	--	--	6.35	--	--
P	0.043	0.057	--	1.09	1.45	--
Q	--	--	0.188	--	4.77	--
R	--	--	0.687	--	17.45	--
T	0.171	0.203	--	4.34	5.16	--
U	0.171	0.203	--	4.34	5.16	--
V	1.788	1.813	--	45.42	46.05	--
W	0.183	0.191	--	4.65	4.85	--
X	0.157	--	--	3.99	--	--



NOTES:

1. DIMENSIONS IN INCHES.
2. (*) CONTACT AREA.
3. (**) DEFINES CYLINDRICAL AREA AVAILABLE FOR CLAMPING WHICH MUST NOT BE DISTORTED BY CLAMPING ACTION.
4. THE BASE PINS SHALL BE CAPABLE OF ENTERING A GAUGE 1/4 INCH THICK HAVING FOUR .214" DIA. HOLES LOCATED ON 11/16 CENTERS AND A CENTER HOLE .250 DIA

X NOV 87. Now Eimac have added wire GAGE 30 AWG (= 0.254 mm/m Ø Cu. wire).

8281
4CX15,000A

TECHNICAL DATA

RADIAL BEAM
POWER TETRODE

The EIMAC 8281/4CX15,000A is a ceramic/metal power tetrode intended for use in audio or radio frequency applications. It features a new type of internal mechanical structure which results in higher rf operating efficiency. Low rf losses in this mechanical structure permit operation of the 8281/4CX15,000A at full ratings up to 110 MHz, and at reduced ratings, to 225 MHz.

The 8281/4CX15,000A is also recommended for radio-frequency linear power amplifier service, and for VHF television linear amplifier service.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	6.3 ± 0.3 V
Current, at 6.3 volts	160 A
Amplification Factor, average	
Grid to Screen	4.5
Direct Interelectrode Capacitances (cathode grounded): [2]	
Cin	160.0 pF
Cout	24.5 pF
Cgp	1.5 pF
Direct Interelectrode Capacitances (grid and screen grounded): [2]	
Cin	67.0 pF
Cout	25.5 pF
Cpk	0.2 pF
Maximum Frequency Ratings	
CW	110 MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	9.375 in; 238.13 mm
Diameter	7.580 in; 192.53 mm
Net Weight	12.8 lb; 5.81 kg
Operating Position	Axis vertical, base up or down
Cooling	Forced air
Operating Temperature, maximum	
Ceramic/Metal Seals and Anode Core	250°C
Base	Special, concentric
Recommended Air System Socket	SK-300A
Recommended Air Chimney	SK-316

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RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN, Class AB_1

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	6.0	AMPERES
PLATE DISSIPATION	15,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

1. Adjust for specified zero-signal plate current.
2. Approximate value.

TYPICAL OPERATION
Peak Envelope or Modulation Crest Conditions

Plate Voltage	7,500	10,000	Vdc
Screen Voltage	1,500	1,500	Vdc
Grid Voltage [1]	-350	-370	Vdc
Zero-Signal Plate Current	1.0	1.0	Adc
Single-Tone Plate Current	4.0	4.25	Adc
Single-Tone Screen Current [2]	170	150	mAdc
Peak rf Grid Voltage [2]	330	340	v
Plate Dissipation	12.2	14.0	kW
Single-Tone Plate Output Power	20.8	28.5	kW
Resonant Load Impedance	865	1,260	Ω

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM Telephony
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	15,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION

Plate Voltage	7,500	10,000	Vdc
Screen Voltage	750	750	Vdc
Grid Voltage	-510	-550	Vdc
Plate Current	4.65	4.55	Adc
Screen Current [1]	0.59	0.54	Adc
Grid Current [1]	0.30	0.27	Adc
Peak rf Grid Voltage [1]	730	790	v
Calculated Driving Power	220	220	W
Plate Dissipation	8.1	9.0	kW
Plate Output Power	26.7	36.5	kW

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER
GRID DRIVEN Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8000	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	10,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION

Plate Voltage	6,000	8,000	Vdc
Screen Voltage	750	750	Vdc
Grid Voltage	-600	-640	Vdc
Plate Current	3.75	3.65	Adc
Screen Current [1]	0.45	0.43	Adc
Grid Current [1]	0.18	0.18	Adc
Peak af Screen Voltage [1] 100% modulation	740	710	v
Peak rf Grid Voltage [1]	800	840	v
Calculated Driving Power	150	150	W
Plate Dissipation	5.1	5.8	kW
Plate Output Power	17.4	23.5	kW

1. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR
GRID DRIVEN, Class AB_1 (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	6.0	AMPERES
PLATE DISSIPATION	15,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION (Two tubes)

Plate Voltage	7,500	10,000	Vdc
Screen Voltage	1,500	1,500	Vdc
Grid Voltage [1]	-350	-370	Vdc
Zero-Signal Plate Current [3]	1.00	1.00	Adc
Maximum Signal Plate Current	8.80	8.50	Adc
Maximum Signal Screen Current [2]	0.34	0.30	Adc
Peak af Grid Voltage [2]	330	340	v
Maximum Signal Plate Dissipation [3]	12.2	14.0	kW
Plate Output Power	41.6	57.0	kW
Load Resistance (plate to plate)	1,730	2,520	Ω

1. Adjust for specified zero-signal plate current.
2. Approximate value.
3. Per Tube.

TELEVISION LINEAR AMPLIFIER

Cathode Driven

ABSOLUTE MAXIMUM RATINGS

110 MHz to 225 MHz

DC PLATE VOLTAGE	6500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	15,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION, Composite Signal Black Level Unless Otherwise Stated

Plate Voltage	5000	6000	Vdc
Screen Voltage	500	700	Vdc
Grid Voltage [1]	-160	-180	Vdc
Plate Current (zero sig.)	.500	.650	Adc
Plate Current	2.800	3.335	Adc
Grid Current	.075	.035	Adc
Screen Current	.060	.040	Adc
Peak Cath. Volt. (pk synch.)	310	345	v
Cath. Driving Power (pk. synch.)	975	1350	w
Plate Output Power (pk. synch.)	11.0	16.5	kw
Plate Load Resistance	600	600	Ω

1. Approximate value.

TYPICAL OPERATION values are obtained by calculations from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to produce the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater Current, at 6.3 volts	152	168	A
Interelectrode Capacitances, cathode grounded [1]			
Cin	154.0	167.0	pF
Cout	22.0	27.0	pF
Cgp	----	2.0	pF
Interelectrode Capacitances, grid and screen grounded [1]			
Cin	62.0	72.0	pF
Cout	23.0	28.0	pF
Cpk	----	0.3	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

MOUNTING - The 4CX15,000A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC Air-System Socket Type SK-300A is designed especially for the concentric base terminals of the 4CX15,000A. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through the SK-316 Air Chimney, into the anode cooling fins.

COOLING - The maximum temperature rating for the external surfaces of the 4CX15,000A is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air-flow requirements to maintain seal temperatures at 225°C in 50°C ambient air are tabulated below (for operation below 30 megahertz). This data is for the tube mounted in an SK-300A socket with an SK-316 chimney.

APPLICATION

SEA LEVEL			10,000 FEET	
Plate Dissipation * (Watts)	Air Flow (CFM)	Pressure Drop(Inches of Water)	Air Flow (CFM)	Pressure Drop(Inches of Water)
7,500	230	.7	336	1.0
12,500	490	2.7	710	4.1
15,000	645	4.6	945	7.0

*Since the power dissipated by the filament represents about 1000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 600 watts, allowance has been made in preparing this tabulation for an additional 1600 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

FILAMENT OPERATION - The rated filament voltage for the 4CX15,000A is 6.3 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than plus or minus five percent from the rated value.

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings for the 4CX15,000A must be respected to avoid damage to the tube. An exception is the plate dissipation which may be permitted to rise above the rated maximum during brief periods, such as may occur during tuning.

GRID OPERATION - The 4CX15,000A control grid has a maximum dissipation rating of 200 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible. The maximum grid circuit resistance should not exceed 100,000 ohms per tube.

SCREEN OPERATION - The power dissipated by the screen of the 4CX15,000A must not exceed 450 watts.

Screen dissipation, in cases where there is no AC applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 450 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX15,000A is 15,000 watts.

When the 4CX15,000A is operated as a plate-modulated rf power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 10,000 watt maximum plate dissipation rating will be exceeded.

HIGH VOLTAGE - Normal operating voltages used with the 4CX15,000A are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CX15,000A, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as the 4CX 15,000A, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry --- the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

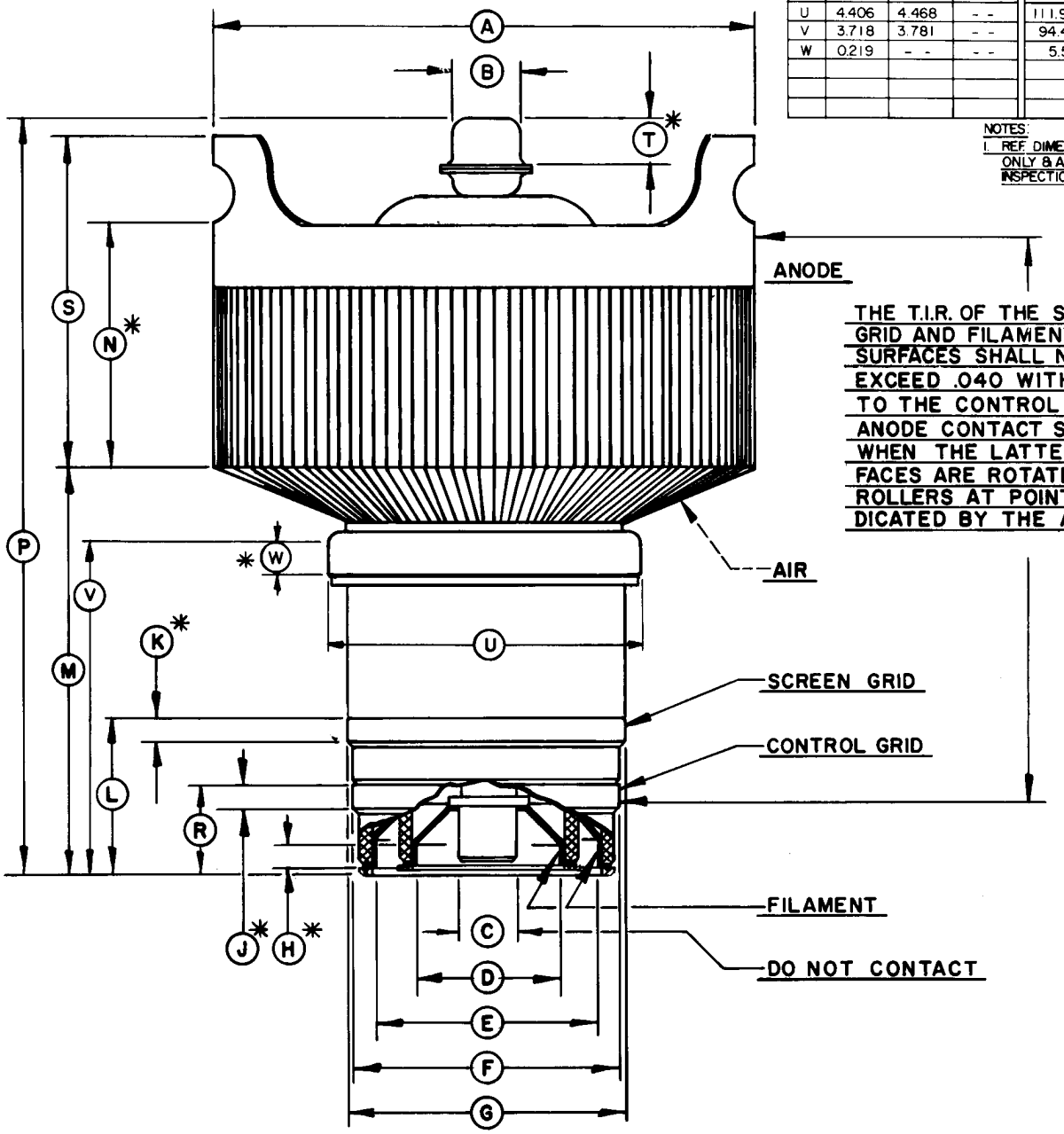
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to the Application Engineering Dept., Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, 94070 for information and recommendations.

DIMENSIONAL DATA

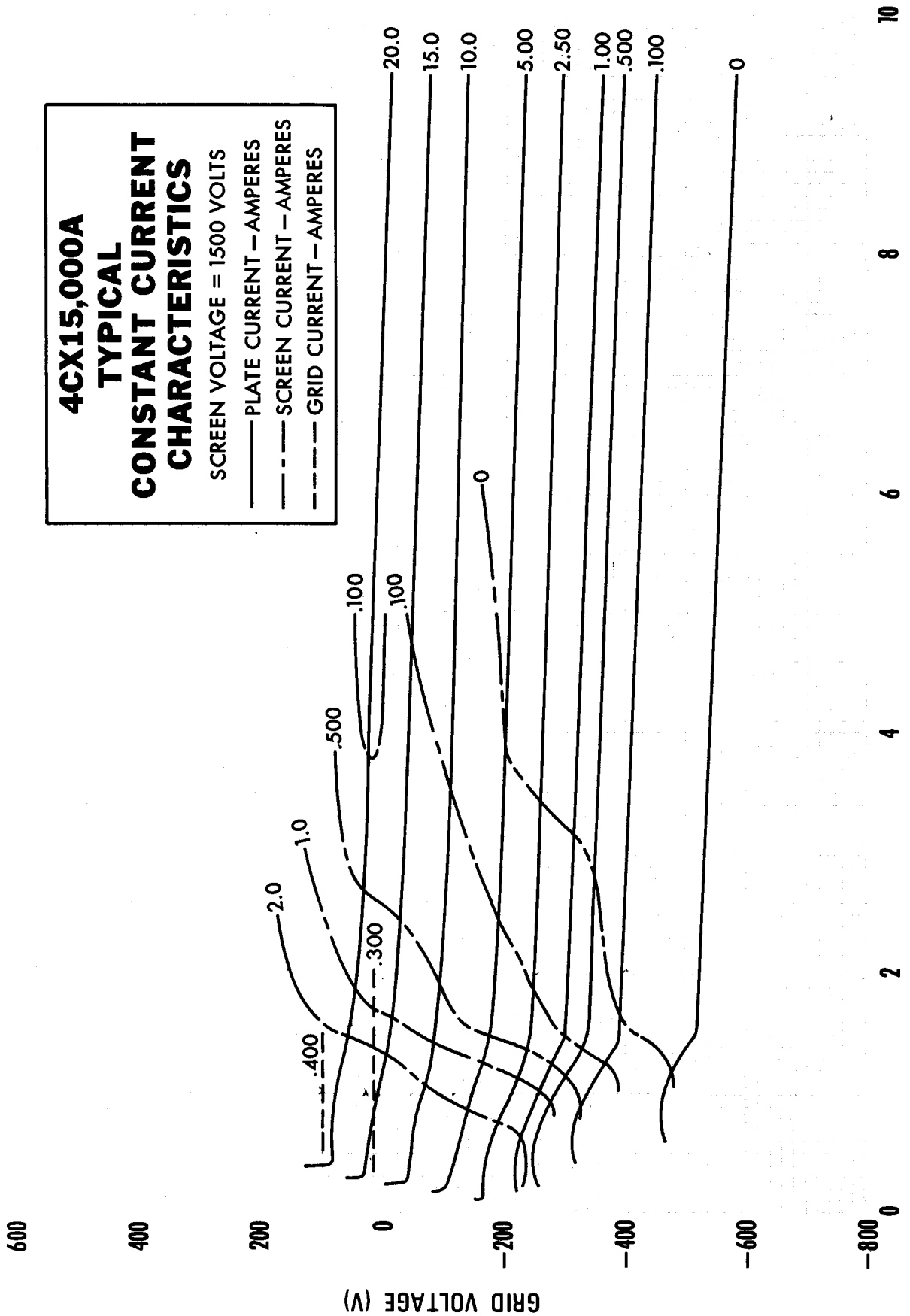
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	7.460	7.580	- -	189.48	192.53	- -
B	0.855	0.895	- -	21.72	22.73	- -
C	0.720	0.760	- -	18.29	19.30	- -
D	1.896	1.936	- -	46.63	49.17	- -
E	3.133	3.173	- -	79.58	80.59	- -
F	3.792	3.832	- -	96.32	97.33	- -
G	3.980	4.020	- -	101.09	102.11	- -
H	0.188	- -	- -	4.78	- -	- -
J	0.188	- -	- -	4.78	- -	- -
K	0.188	- -	- -	4.78	- -	- -
L	1.764	1.826	- -	44.81	46.38	- -
M	4.659	4.783	- -	118.34	121.49	- -
N	2.412	2.788	- -	61.26	70.82	- -
P	9.000	9.375	- -	228.60	238.13	- -
R	0.986	1.050	- -	25.04	26.67	- -
S	3.560	3.684	- -	90.42	93.57	- -
T	0.375	- -	- -	9.53	- -	- -
U	4.406	4.468	- -	111.91	113.49	- -
V	3.718	3.781	- -	94.44	96.04	- -
W	0.219	- -	- -	5.56	- -	- -

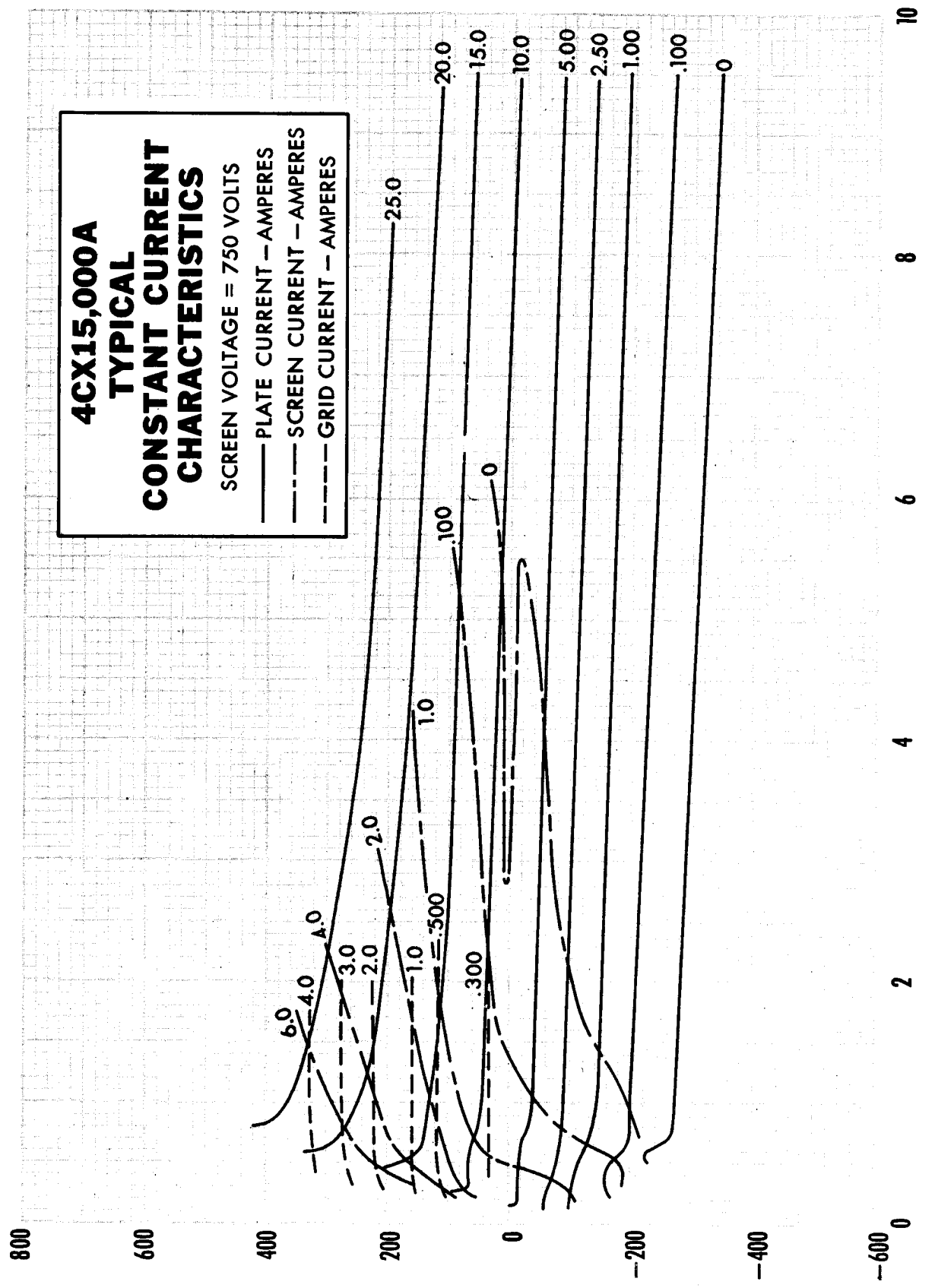
NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



THE T.I.R. OF THE SCREEN GRID AND FILAMENT CONTACT SURFACES SHALL NOT EXCEED .040 WITH RESPECT TO THE CONTROL GRID AND ANODE CONTACT SURFACE WHEN THE LATTER SURFACES ARE ROTATED ON ROLLERS AT POINTS INDICATED BY THE ARROWS

* CONTACT SURFACE


4CX15,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
20.0
15.0
10.0
5.00
2.50
1.00
.500
.100
0
.100
.500
1.0
2.0
.400
.300
600
400
200
0
−200
−400
−600
−800
0
2
4
6
8
10
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)


4CX15,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
25.0
20.0
15.0
10.0
5.00
2.50
1.00
.100
0
6.0
4.0
3.0
2.0
1.0
.500
.300
.100
0
2.0
1.0
4.0
800
600
400
200
0
−200
−400
−600
0
2
4
6
8
10
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)

MIL-E-1/1767B
2 May 1984
SUPERSEDING
MIL-E-1/1767A(EC)
31 July 1978

MILITARY SPECIFICATION SHEET

ELECTRON TUBE, POWER

TYPE 8281

Ⓑ This specification is approved for use by all Departments and Agencies of the Department of Defense.

The complete requirements for acquiring the electron tube described herein shall consist of this specification and the latest issue of MIL-E-1.

DESCRIPTION: Tetrode, ceramic-metal
See figure 1
Mounting position: Vertical, base down or up
Weight: 12.8 pounds (5.8 kg) nominal

ABSOLUTE RATINGS: F = 110 MHz

Parameter: Unit: Maximum:	Ef V ac	Eb kV dc	Ec2 kV dc	Ec1 kV dc	Ib A dc	Pg1 W	Pg2 W	Pp kW	Anode core & seal T °C	Cooling --- (Note 1)
C Teleg:	6.3 ±5%	10	2	-1.5	5	200	450	15	250	---
C Telep: (anode mod)	6.3 ±5%	8	1.5	-1.5	4	200	450	10	250	---
Class AB:	6.3 ±5%	10	2	---	6	200	450	15	250	---
TEST CONDITIONS:	6.3	2	0.75	Adj	1	---	---	---	---	Note 2

Ⓑ GENERAL:

Qualification - Required

RECEIVED
14 AUG 1984

Ⓑ denotes changes

Method	Requirement or test	Notes	Conditions	AQL (percent defective)	Inspection level or code	Symbol	Limits Min	Limits Max	Unit
	Quality conformance inspection, part 1								
1301	Filament current	-	t = 120 ±15	0.65	II	If	152	168	A ac
1261	Electrode voltage (grid)	-		0.65	II	Ec1	-110	-146	V dc
1266	Total grid current	-		0.65	II	Ic1	---	-25	µA dc
1256	Electrode current (screen)	-		0.65	II	Ic2	---	25	mA dc
1231	Peak emission	-	eb = ec2 = ec1 = 2.5 kv	0.65	II	is	90	---	a
1266	Primary grid emission (grid)	-	Pg1 = 200 W; t = 120 max or until stable; anode and g2 floating	0.65	II	Isg1	---	-500	µA dc
1266	Primary grid emission (screen)	-	Pg2 = 450 W; Ec1 = 0 V dc; t = 120 max or until stable; anode floating	0.65	II	Isg2	---	-500	µA dc
	Quality conformance inspection, part 2								
1331	Direct-interelectrode capacitance (ground cathode connection)	-		---	---	Cin	154	167	pF
						Cout	22	27	pF
						Cgp	---	2	pF
1331	Direct-interelectrode capacitance (ground grid connection)	-		---	---	Cin	62	72	pF
						Cout	23	28	pF
						Cpk	---	0.30	pF
1372	Current division (method B, short pulse)	-	Eb = Ec2 = 2,000 V dc; Ec1 = -800 V dc; egk/ib = 19 a	---	---	egk	---	0	v
				---	---	ic2	---	3.2	a
---	Power output	6	Class AB1 amp; F = 1 MHz (min); Eb = 9 kV dc; Ec2 = 2 kV dc; Ec1/Ibo = 0.1 A dc; Eg1/Ib = 3.7 A dc; Rℓ = 1,125 ±5%; anode tank Q = 10 to 15	---	---	Po	20	---	kW (useful)

Method	Requirement or test	Notes	Conditions	AQL (percent defective)	Inspection level or code	Symbol	Limits		Unit
							Min	Max	
	Quality conformance inspection, part 3								
---	Service-life guarantee	3		---	---	---	---	---	---
1042	Shock, specified pulse	4	No voltages applied; shock = 11 ms half-sine; accel = 15 G peak (min); impacts = 6 (3 each X and Z axes)	---	---	---	---	---	---
1032	Vibration, mechanical	4	No voltages applied; accel = 2 G peak (min); F = 10 to 50 Hz, ascending only; sweep t = 3 to 8 minutes; 1 sweep each X and Y axes	---	---	---	---	---	---
---	Shock and vibration, mechanical end points:								
1261	Electrode voltage (grid)	-		---	---	Ec1	-100	-146	V dc
1266	Total grid current	-		---	---	Ic1	---	-30	µA dc
1301	Filament current	5		---	---	ΔIf	---	3	A ac

NOTES:

1. Minimum airflow requirements for incoming air at 50°C maximum at sea level, for operation under 30 MHz, are shown. Additional cooling may be required for operation above 30 MHz. In all cases of operation a socket which provides for forced-air cooling of the base must be used, such as the EIMAC SK-300A, or equivalent, used with the EIMAC SK-316 Air Chimney, or equivalent, with air flowing in a base-to-anode direction. Where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial. Cooling air should be applied before or simultaneously with the application of electrode voltages, including the filament, and should normally be maintained for a short period after all voltages are removed to allow for tube cool-down. The cooling data shown is for the tube in a SK-300A socket with a SK-316 Air Chimney.

Anode dissipation	Sea level		10,000 feet	
	Airflow (cfm)	Approximate pressure drop ($In.H_2O$)	Airflow (cfm)	Approximate pressure drop ($In.H_2O$)
7,500 W	220	0.4	320	0.6
12,500 W	555	2.5	810	3.6
15,000 W	775	5.0	1,130	7.3

2. In all electrical tests involving application of filament voltage an air-system socket and chimney may be used and forced-air cooling is allowable.

3. The tube manufacturer warrants the tube for 1 year from date of shipment, or 1,000 hours of filament life, whichever first elapses. This warranty applies only when the tube is operated within the maximum ratings (see "Absolute Ratings" of MIL-E-1). A defective tube shall either be replaced, or at the option of the manufacturer, a credit shall be made in the amount of the original purchase price pro rated on the basis of 1,000 hours of "filament-on" time.

4. Testing shall be performed every 6 months, with sampling as follows:

$n_1 = 4$ $c_1 = 0$

$n_2 = 4$ $c_2 = 1$;

where c_2 represents the total allowable failures for the first and second samples combined.

Separate samples may be used at the option of the manufacturer. None of the listed tests shall be considered destructive except in case of failure. In th event of failure after double sampling, that specific test shall become qualit conformance inspection, part 2; after three consecutive successful submissions, the testing may revert to the quality conformance inspection, part 3 tests.

5. Any change in filament current resulting from the vibration or shock testing (considered individually) shall not exceed the specified limit for ΔIf.

6. During this test the tube shall be operated as a Class AB1 amplifier; the control grid shall not be driven positive, as indicated by grid current flow.

Custodians:
Army - ER
Navy - EC
Air Force - 85

Review activities:
Air Force - 99
DLA - ES

User activities:
Navy - AS, OS, MC, CG
Air Force - 11, 19

Agent:
DLA - ES

Preparing activity:
Navy - EC

(Project 5960-3331)

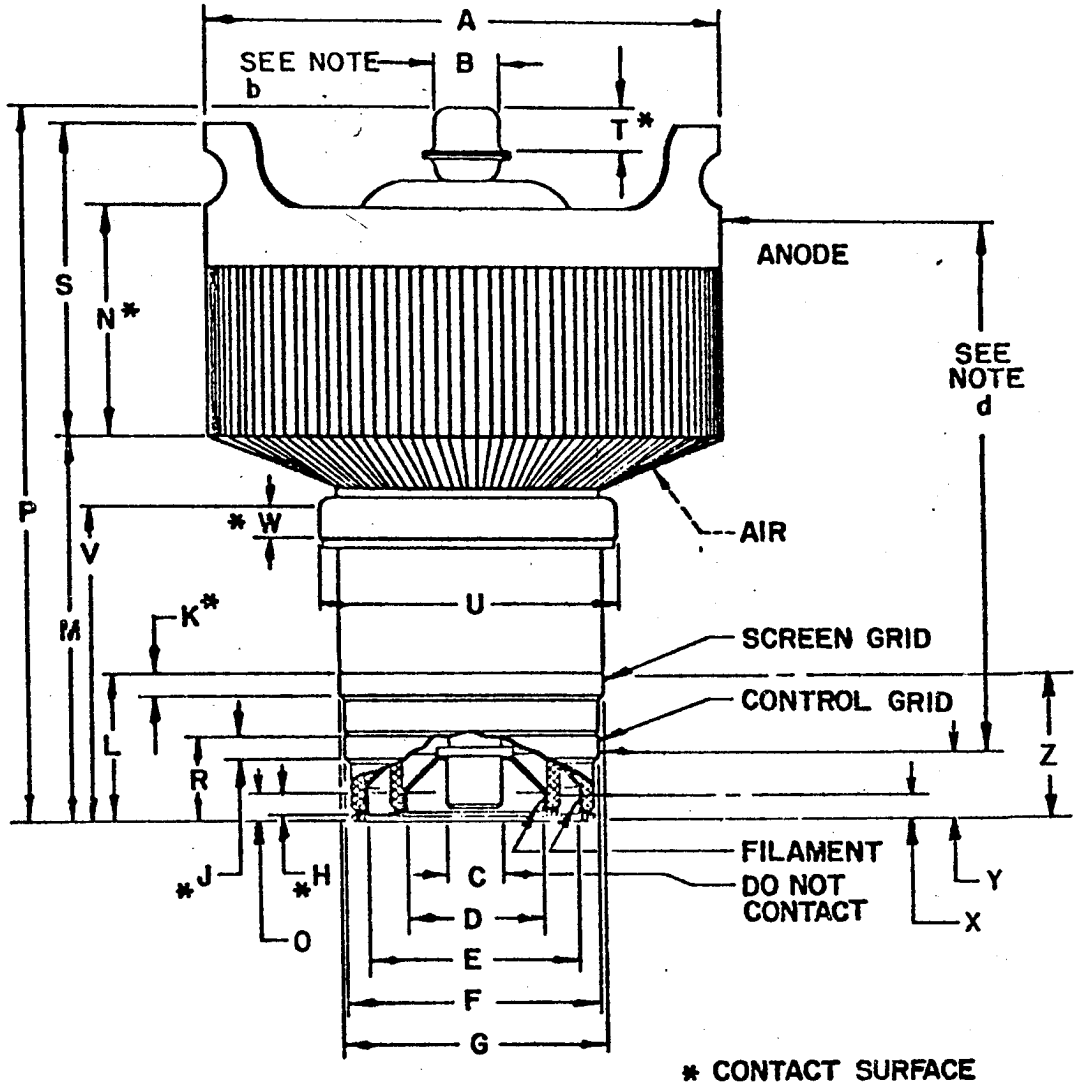


FIGURE 1. Outline drawing of electron tube type 8281.

Ltr	Dimensions in inches with metric equivalents (mm) in parentheses	
	Minimum	Maximum
Quality conformance inspection, part 2		
C	.600 (15.24)	.760 (19.30)
D	1.896 (48.16)	1.936 (49.17)
E	3.133 (79.58)	3.173 (80.59)
F	3.792 (96.32)	3.832 (97.33)
G	3.980 (101.09)	4.020 (102.11)
H	.188 (4.78)	--- ---
J	.188 (4.78)	--- ---
K	.188 (4.78)	--- ---
L	1.695 (43.05) BASIC (See note e)	
O	.355 (9.02) BASIC (See note e)	
P	9.000 (228.60)	9.375 (238.12)
R	.920 (23.37) BASIC (See note e)	
T	.375 (9.52)	--- ---
U	4.406 (111.91)	4.468 (113.49)
V	3.718 (94.44)	3.781 (96.04)
W	.219 (5.56)	--- ---
Quality conformance inspection, part 3 (See note c)		
A	7.460 (189.48)	7.580 (192.53)
B	.855 (21.72)	.895 (22.73)
M	4.550 (115.57)	4.783 (121.49)
N	2.412 (61.26)	2.788 (70.82)
S	3.560 (90.42)	3.684 (93.57)
Reference dimensions (See notes f & g)		
X	.260 (6.60)	
Y	.826 (20.98)	
Z	1.600 (40.64)	

FIGURE 1. Outline drawing of electron tubes type 8281 - Continued.

NOTES:

a. The total indicator reading (T.I.R.) (the sum of the positive and negative deflection shown by the indicator when measuring the eccentricity of the surface with respect to another, with the reference axis established) of the screen grid and filament contact surfaces shall not exceed .040 (1.02 mm) with respect to the control grid and anode contact surfaces when the latter surfaces are rotated on rollers at the points indicated by the arrows. Quality conformance inspection part 2, shall apply.

b. Top cap outline optional provided it meets requirements of dimensions B and T.

c. Dimensions shall be checked every 6 months, with sampling as follows:

$n_1 = 4$ $c_1 = 0$ where c_2 represents the total allowable
$n_2 = 4$ $c_2 = 1$; failures for the first and second samples combined.

Separate samples may be used at the option of the manufacturer. None of the listed tests shall be considered destructive except in case of failure. In the event of failure after double sampling, that specific test shall become quality conformance inspection, part 2; after three consecutive successful submissions, the testing may revert to the quality conformance inspection, part 3 tests.

d. The T.I.R. of the screen grid and filament contact surfaces shall not exceed .040 (1.02 mm) with respect to the control grid and anode contact surface when the latter surfaces are rotated on rollers at points indicated by the arrows.

e. Basic dimension is a numerical value used to describe the theoretically exact size, shape or location of a feature or datum target. It is the basis from which permissible variations are established by tolerances on other dimensions, in notes or by feature control symbols.

f. Optimum filament and grid connector heights for socket design purposes.

g. Reference or nominal dimensions are listed for information only, and are not required for inspection purposes.

FIGURE 1. Outline drawing of electron tube type 8281 - Continued.

* U.S. GOVERNMENT PRINTING OFFICE: 1994—705—040/A2833

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PREVIOUS EDITION IS OBSOLETE.

8283
3CX1000A7

HIGH-MU
POWER TRIODE

The EIMAC 8283/3CX1000A7 is a ceramic-metal zero-bias triode intended for Class-AB2 linear amplifier service in either grid-driven or cathode-driven configuration. It is recommended for use as a grid driven, push-pull audio amplifier or modulator and as a cathode driven linear amplifier through the VHF-TV bands.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-Tungsten Mesh		
Voltage	5.0 ± 0.25	V
Current, at 5.0 volts	30.5	A
Amplification Factor (Average)	200	
Direct Interelectrode Capacitance (Grounded Cathode)[2]		
Cin	32.0	pF
Cgp	14.0	pF
Cout	0.15	pF
Direct Interelectrode Capacitance (Grounded Grid)[2]		
Cin	32.0	pF
Cpk	0.15	pF
Cout	14.0	pF
Frequency of Maximum Ratings	220	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or produce refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	4.80 in; 121.9 mm
Diameter	3.38 in; 85.8 mm
Net Weight	2 lb; 0.91 kg
Operating Position	Vertical, base up or down
Cooling	Forced Air
Base	Special Breechlock
Recommended Air-System Socket	EIMAC SK-860 or SK-870
Recommended Air Chimney	EIMAC SK-816
Maximum Temperature, Anode Core & Ceramic/Metal Seals	250°C

(Effective 3-25-75) © 1963, 1968, 1975 by Varian Printed in U.S.A.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_2 Grid Driven

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3500	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1000	WATTS
GRID DISSIPATION	45	WATTS

TYPICAL OPERATION, (Two tubes)

Plate Voltage	2000	2500	Vdc
Grid Voltage	0	0	Vdc
Zero-Signal Plate Current	400	500	mAdc
Max-Signal Plate Current	2.0	2.0	Adc
Max-Signal Grid Current	590	480	mAdc
Peak AF driving Voltage (per tube)	95	90	v
Driving Power	25	44	W
Load Resistance (plate-to-plate)	1900	2580	Ω
Max-Signal Plate Output Power	2350	3100	W

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_2, Grounded-Grid

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3500	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
GRID DISSIPATION	45	WATTS

TYPICAL OPERATION

Plate Voltage	2000	2500	3500	Vdc
Grid Voltage[1]	0	0	-12	Vdc
Zero-Signal Plate Current	238	305	129	mAdc
Single-Tone Plate Current	875	800	857	mAdc
Two-Tone Plate Current	600	585	590	mAdc
Single-Tone Grid Current	230	205	225	mAdc
Two-Tone Grid Current	130	120	120	mAdc
Peak RF Driving Voltage	80	74	110	v
Driving Power	80	60	100	W
Peak Envelope Power Output	940	1170	2060	W
Resonant Load Impedance	1100	1670	2300	Ω
RF Driving Impedance	40	45	60	Ω
Third Order IM Distortion[2]	-29	-31	-31	dB
Fifth Order IM Distortion[2]	-37	-40	-39	dB

1. The bias voltage in this set of typical operating conditions was obtained by means of a -12 volt 50 watt Zener diode in the negative return to the center-tap of the filament transformer.

2. The intermodulation distortion products are referenced against one tone of a two equal tone signal.

RADIO-FREQUENCY AMPLIFIER OR OSCILLATOR - Class C.

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3500	VOLTS
DC GRID VOLTAGE	-100	VOLTS
DC PLATE CURRENT	0.7	AMPERE
PLATE DISSIPATION	1000	WATTS
GRID DISSIPATION	45	WATTS

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER - Class C.

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	2000	VOLTS
DC GRID VOLTAGE	-100	VOLTS
DC PLATE CURRENT	0.55	AMPERE
PLATE DISSIPATION	670	WATTS
GRID DISSIPATION	45	WATTS

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament Current, at 5.0 volts	28.0	33.0	A
Zero Bias Plate Current, with E_b = 2500 Vdc	250	350	mA
Cut-off Grid Voltage (E_b = 2500 Vdc; I_b = 1.0 mA)	---	-25	V
Interelectrode Capacitances (Grounded Cathode)[1]			
Cin	29.0	35.0	pF
Cout	---	0.2	pF
Cgp	12.0	16.0	pF
Interelectrode Capacitances (Grounded Grid)[1]			
Cin	29.0	35.0	pF
Cout	12.0	16.0	pF
Cpk	---	0.2	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MOUNTING & SOCKETING - The 3CX1000A7 must be operated with its axis vertical, base up or down. The EIMAC SK-860 and SK-870 air-system sockets are available for use with the tube. The SK-870 has its grid contacts grounded to the socket frame. No contacts are grounded with the SK-860. The EIMAC SK-816 air-chimney is also available to direct cooling air from the socket through the anode cooling fins.

COOLING - The maximum temperature rating for the external surfaces and the anode core of the 3CX1000A7 is 250°C. Tube life is prolonged if these areas are maintained at somewhat lower temperatures. The table lists air-flow requirements to maintain tube temperatures below 225°C with 50°C inlet air and base-to-anode air flow.

SEA LEVEL		
Plate Diss. (watts)	Air Flow (cfm)	Press. Drop (In. H_2O)
600	12	0.12
800	16	0.19
1000	20.5	0.30
1500	33	0.65
10,000 FEET		
600	18	0.18
800	24	0.28
1000	31	0.45
1500	50	0.97

FILAMENT - Rated filament voltage for the 3CX1000A7 is 5.0 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain optimum performance and maximum tube life. In no case should it be allowed to deviate from 5.0 volts by more than plus or minus five per cent.

INPUT CIRCUIT - When the 3CX1000A7 is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended to obtain greatest linearity and power output. For best results with a single-ended amplifier, it is suggested that the cathode tank circuit operate at a "Q" of five or more.

CLASS-C OPERATION - Although designed for Class-AB_2 service, the 3CX1000A7 may be operated as a Class-C power amplifier or oscillator, or as a plate-modulated rf amplifier. The zero-bias characteristic can be used to advantage in Class-C amplifiers by employing only grid leak bias, provided the anode voltage is not over 2500 Vdc. If driving power fails under these circumstances, plate dissipation will be kept within the maximum rating since the tube will operate at normal static zero-bias conditions.

For Class C operation with anode voltage in excess of 2500 Vdc additional protective bias voltage is required.

INTERLOCKS - An interlock device should be provided to insure that cooling air is established before application of electrical power, including the filament voltage. The circuit should be so arranged that rf drive cannot be applied in the absence of normal anode voltage.

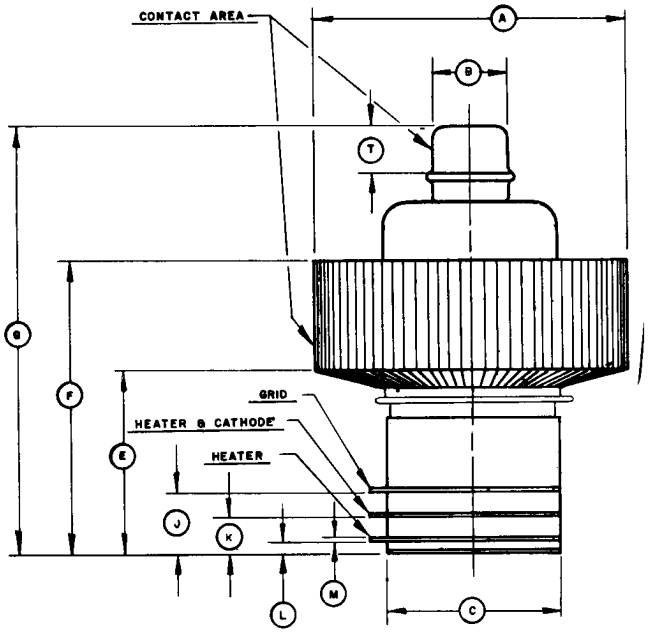
HIGH VOLTAGE - The 3CX1000A7 operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between the tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Indus-

tries Association Standard RS-191. This requires the use of specially constructed test fixtures with effectively shield all external tube terminals or leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

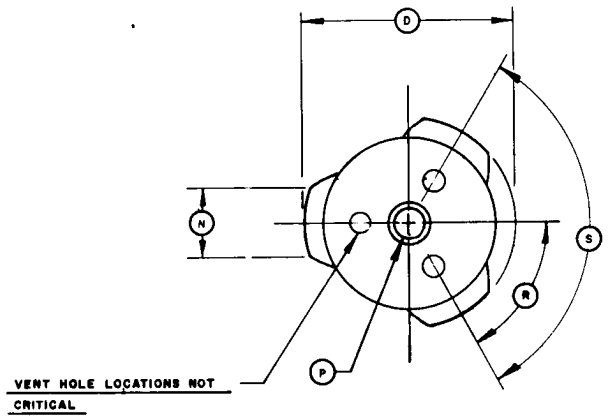
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

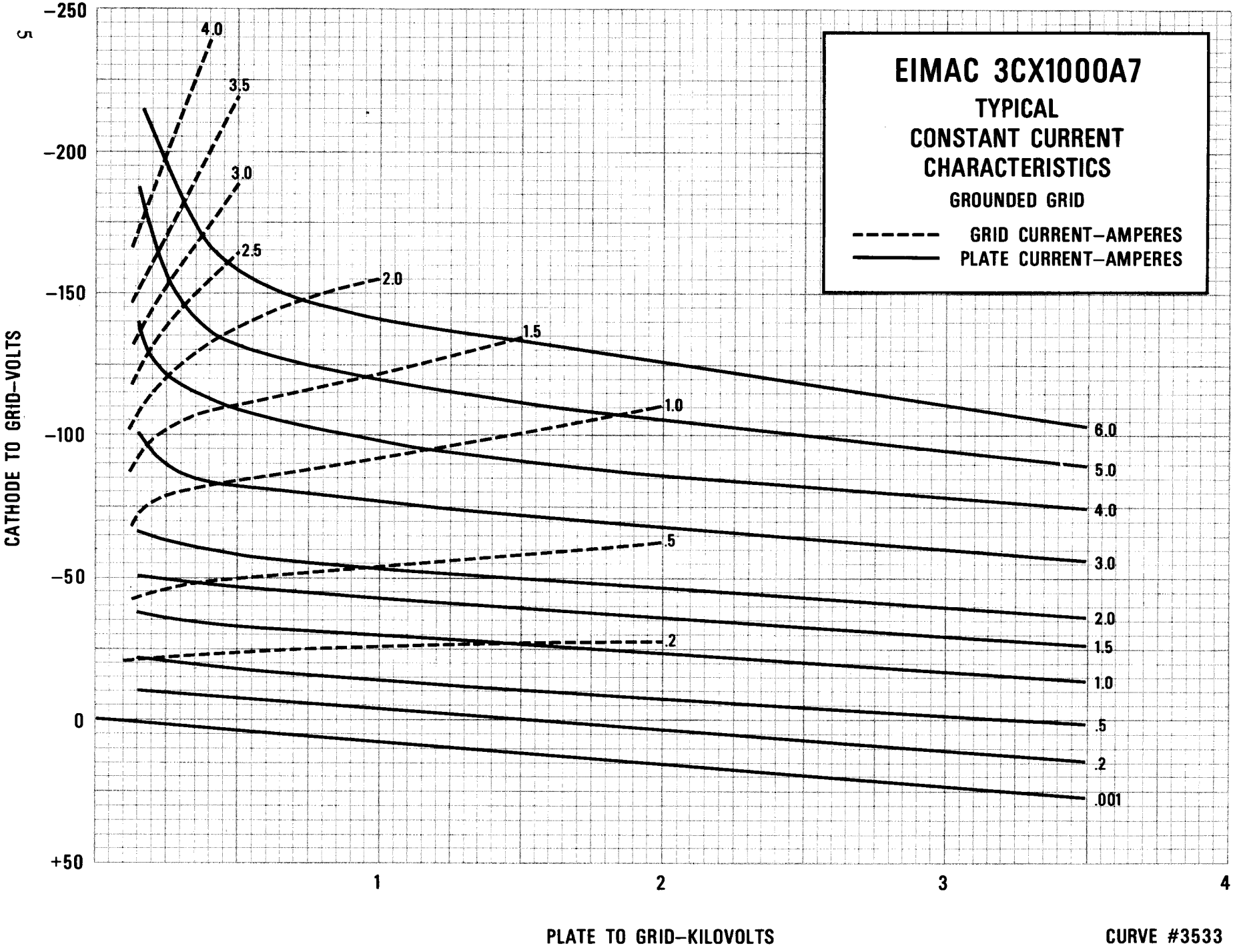
SPECIAL APPLICATIONS - If it is desired to operate these tubes under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.325	3.375	- -	84.45	85.72	- -
B	0.807	0.817	- -	20.50	20.75	- -
C	1.870	1.900	- -	47.50	48.26	- -
D	2.250	2.300	- -	57.15	58.42	- -
E	2.000	2.194	- -	50.80	55.73	- -
F	3.175	3.375	- -	80.64	85.72	- -
G	4.600	4.800	- -	116.8	121.9	- -
J	0.690	0.710	- -	17.53	18.03	- -
K	0.415	0.435	- -	10.54	11.04	- -
L	0.140	0.165	- -	3.56	4.19	- -
M	0.020	0.030	- -	0.508	0.762	- -
N	0.700	0.800	- -	17.78	20.32	- -
P	0.314	0.316	- -	7.97	8.03	- -
R	55°	65°	- -	55°	65°	- -
S	115°	125°	- -	115°	125°	- -
T	0.470	0.530	- -	11.94	13.46	- -

NOTE:
REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.




EIMAC 3CX1000A7
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
GRID CURRENT–AMPERES
PLATE CURRENT–AMPERES
CATHODE TO GRID–VOLTS
−250
−200
−150
−100
−50
0
+50
1
2
3
4
PLATE TO GRID–KILOVOLTS
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
.2
6.0
5.0
4.0
3.0
2.0
1.5
1.0
.5
.2
.001

CURVE #3533

8295A

TECHNICAL DATA

RADIAL BEAM
POWER PENTODE

The EIMAC 8295A is a ceramic/metal, forced-air cooled, radial beam pentode with a rated maximum plate dissipation of 1000 watts. It is capable of high power gain and excellent efficiency at relatively low plate voltage. The 8295A is a direct replacement for the 8295.

This external-anode tube is especially suited for Class AB_1 linear rf amplifier service, but will also provide excellent performance in Class AB_2, Class B, and Class C service.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3	V
Current, at 6.0 volts	8.2	A
Amplification Factor (Average):		
Grid to Screen	3.4	

Direct Interelectrode Capacitances (grounded cathode)[2]

Input	40	pF
Output	18.5	pF
Feedback	0.09	pF
Frequency of Maximum Rating:		
CW	30	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	5.05 in; 128 mm
Diameter	4.03 in; 102 mm
Net Weight	2.8 lb; 1.27 kg
Operating Position	Any

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Maximum Operating Temperature	
Ceramic/Metal Seals	250 °C
Anode Core	250 °C
Cooling	Forced Air
Base	7-Pin Special
Recommended Socket (includes integral chimney)	EIMAC SK-184 or EIMAC SK-184A

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN, Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000 VOLTS
DC SUPPRESSOR VOLTAGE	100 VOLTS
DC SCREEN VOLTAGE	600 VOLTS
DC PLATE CURRENT	0.8 AMPERE
PLATE DISSIPATION	1000 WATTS
SCREEN DISSIPATION	30 WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	2000	2500	3000	Vdc
Suppressor Voltage	35	0	35	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage [1]	-116	-119	-120	Vdc
Zero-Signal Plate Current	200	200	200	mAdc
Single Tone Plate Current [4]	800	800	800	mAdc
Zero-Signal Screen Current	5	5	4	mAdc
Single-Tone Screen Current [3/4]	75	43	54	mAdc
Peak rf Grid Voltage [3]	116	119	120	v
Single Tone Useful Output Power	1100	1250	1700	W
Resonant Load Impedance	1400	1500	2100	Ω
Intermodulation Distortion Products [2] - 3rd Order	-24	-22	-23	db
5th Order	-37	-50	-40	db

1. Adjust to specified zero-signal dc plate current.

2. The intermodulation distortion products are referenced against one tone of a two equal tone signal.

3. Approximate value

4. For peak conditions, or for single-tone modulation at full signal. Except for brief tuneup periods, operation under single-tone conditions may not be possible because of excessive screen dissipation.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM Telephony
(Key-Down Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000 VOLTS
DC SUPPRESSOR VOLTAGE	75 VOLTS
DC SCREEN VOLTAGE	500 VOLTS
DC GRID VOLTAGE	-200 VOLTS
DC PLATE CURRENT	1.0 AMPERE
PLATE DISSIPATION	1000 WATTS
SCREEN DISSIPATION	30 WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	2000	2500	3000	Vdc
Suppressor Voltage	35	35	35	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-175	-200	-200	Vdc
Plate Current	850	840	820	mAdc
Screen Current [1]	42	40	42	mAdc
Grid Current [1]	10	10	10	mAdc
Peak rf Grid Voltage [1]	188	210	210	v
Calculated Driving Power [1]	1.9	2.1	2.1	W
Plate Input Power	1700	2100	2460	W
Useful Output Power	1155	1440	1770	W

1. Approximate value.

NOTE: TYPICAL OPERATION data are obtained by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	7.7	8.7	A
Cathode Warmup Time	3	---	minutes
Interelectrode Capacitances [1] (grounded cathode connection)			
Input	36.0	44.0	pF
Output	16.5	20.5	pF
Feedback	---	0.12	pF
Amplification Factor			
Grid to Screen	3.0	3.8	

1. Capacitance values are for a cold tube as measured in a shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MOUNTING - The 8295A may be operated in any position, and should normally be mounted in the EIMAC air-system socket SK-184 or SK-184A, or equivalent. The SK-184 socket has built-in bypass capacitors for the screen grid and suppressor grid. The SK-184A socket has a built-in bypass capacitor for the screen grid and has grounded suppressor grid contacts.

HEATER - The rated heater voltage for the 8295A is 6.0 volts, as measured at the socket or tube base pins. Variations should be restricted to plus or minus 0.3 volts for long tube life and consistent performance.

COOLING - Forced-air cooling is required in all applications, and the use of an air-system socket, such as the EIMAC SK-184 or EIMAC SK-184A, is recommended. Each of these sockets includes an integral chimney to direct air through the anode cooling fins. Cooling is simplified if air is directed in a base-to-anode direction. At full rated dissipation, with air at 50°C at sea level, an air flow of 25 cubic feet per minute, with a resulting pressure drop of approximately 0.15 inches of water, is sufficient to limit maximum tube temperature to 225°C. If air is not directed in the base-to-anode direction, additional cooling may be required for the base section of the tube. Cooling air should be applied before or simultaneously with the application of electrode voltages, including heater, and may be removed simultaneously with them.

CATHODE WARMUP TIME - Heater voltage should be applied for a minimum of three minutes before the application of other electrode voltages to allow proper conditioning of the cathode surface.

GRID OPERATION - In Class AB applications, grid bias voltage must be obtained from a fixed bias supply. The internal resistance of the bias source should not exceed 5000 ohms in Class AB_1 applications or 2000 ohms in Class AB_2 applications. Either fixed bias or cathode bias, or a combination of the two, is recommended for Class C applications. Partial grid leak bias, in combination with fixed or cathode bias, or both, may be used in Class C application provided the total resistance of the grid leak plus the bias source does not exceed 5000 ohms.

SCREEN OPERATION - If the screen voltage is obtained from a power supply separate from the plate voltage supply, the circuit should be arranged so that it is impossible to apply screen voltage without plate voltage. The use of a screen over-current relay is recommended, to remove screen voltage immediately in case of excessive screen current due to circuit problems, grid bias failure, or accidental removal of plate circuit loading. In linear amplifier service, the screen voltage must be obtained from a well regulated source, to prevent excessive screen voltage variation due to changes in screen current which occur between zero-signal and full-signal conditions.

SUPPRESSOR OPERATION - The 8295A performs well with the suppressor operated at cathode potential. For maximum efficiency at high power input and low plate voltages, a positive voltage of about 35 volts should be applied to the suppressor. However, the actual value is not critical, and voltages between 25 and 45 volts may be used with only minor differences in performance. The internal resistance of the suppressor grid voltage supply should not exceed 3000 ohms.

PLATE OPERATION - The maximum rated plate dissipation power for the 8295A is 1000 watts. Except for brief periods during circuit adjustment, this maximum value should not be exceeded. Contact to the plate may be made either at the top cap or by means of a circular clamp or spring-finger collet around the outer surface of the anode cooler itself. Points of electrical contact with the anode should be kept clean and free of oxide to minimize rf loss. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

GENERAL OPERATION NOTES - A metal chassis or equivalent means should be provided to separate the input and output circuits of an amplifier employing the 8295A. Reasonable precautions should be observed in regard to bypassing and shielding of the supply leads to prevent coupling between input and output through external circuits. The use of the EIMAC SK-184 or SK-184A air-system sockets, with integral bypass capacitance built in, is helpful in these respects. When it is desired to apply voltage to the suppressor of the tube, it is recommended that any suppressor bypass capacitance be located on the anode side of a chassis. Total suppressor bypass capacitance should be sufficient to result in a reactance of 3 ohms or less at the operating frequency. The dc supply lead to the suppressor should either be located entirely on the anode side of the shielding (chassis), or fed through an effective rf choke located well out of the field of the plate tank circuit and again bypassed before passing through the shielding into any compartment exposed to the control grid circuit.

NEUTRALIZATION FOR RF OPERATION - In most Class C applications, the 8295A may be operated without neutralization provided the suppressor grid and screen grid are effectively grounded for radio frequencies. The use of the EIMAC air-system sockets is helpful in this respect. For minimum-distortion Class AB1 linear amplifier service, where reaction on the driver circuit should be eliminated completely, it will usually be found advisable to neutralize the small feedback capacitance of the tube.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

HIGH VOLTAGE - The 8295A operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

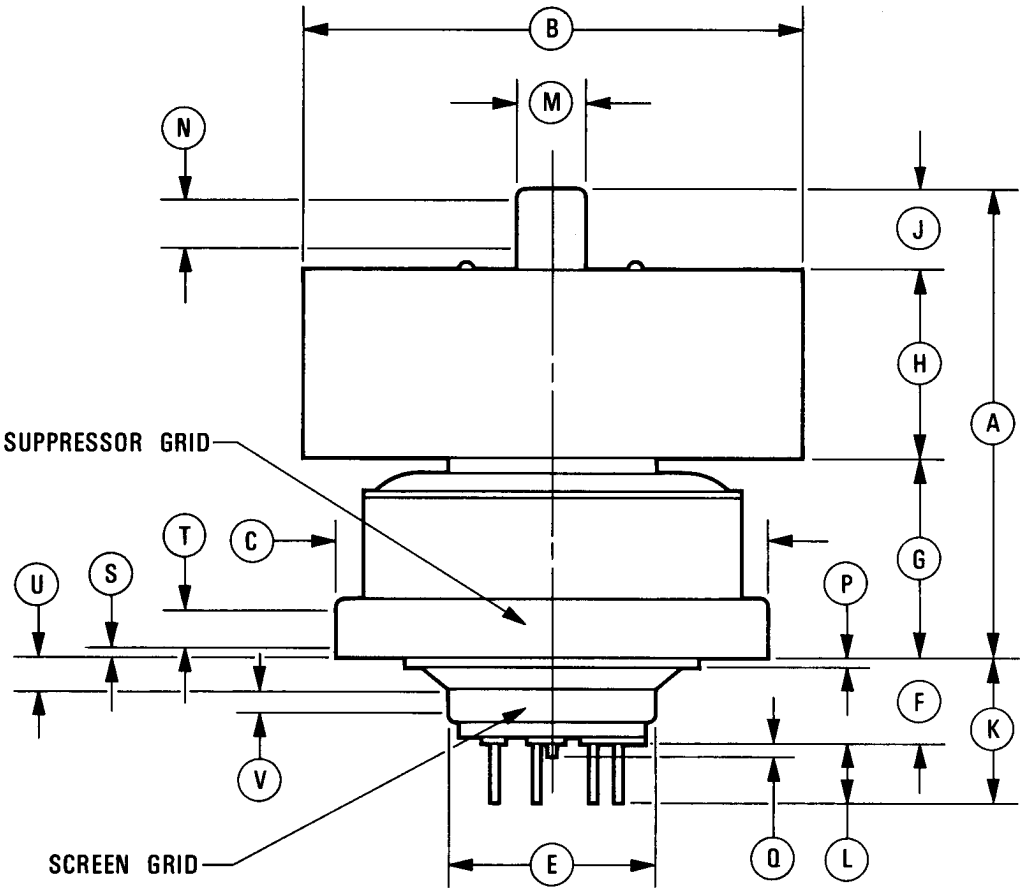
AIR-SYSTEM SOCKETS

Two air-system sockets are available for the 8295A, each of which makes all electrical contacts to the tube except to the anode. The characteristics of these sockets are as follows:

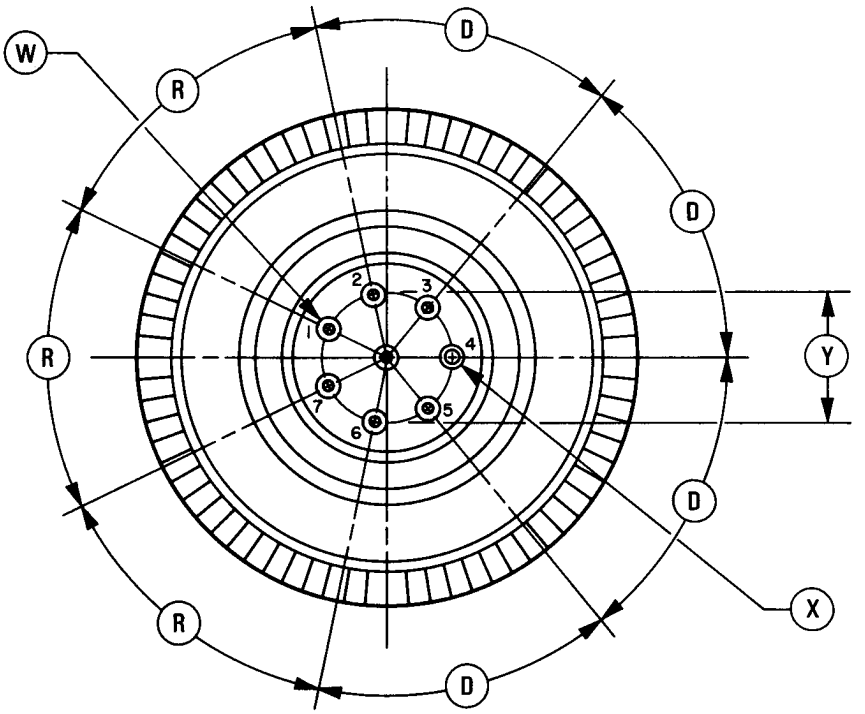
	EIMAC SK-184	EIMAC SK-184A
Screen Grid Bypass Capacitor	2000 pF,1000 Vdc	2000 pF, 1000 Vdc
Suppressor Grid Bypass Capacitor	2500 pF, 500 Vdc	none
Grounded Contacts (to socket frame)	none	Suppressor Grid
Anode Air Chimney	Integral	Integral

SPECIAL APPLICATION

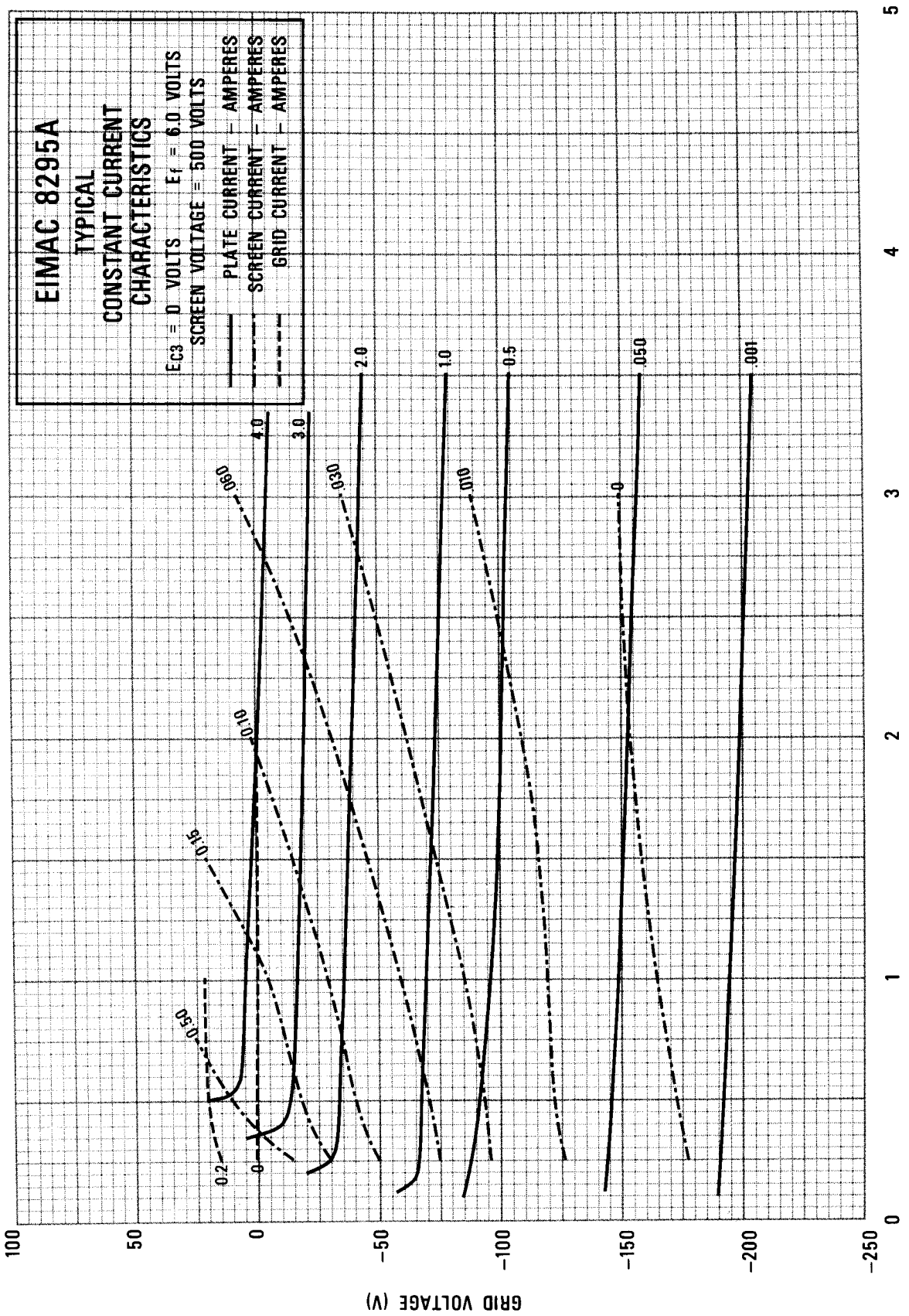
If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



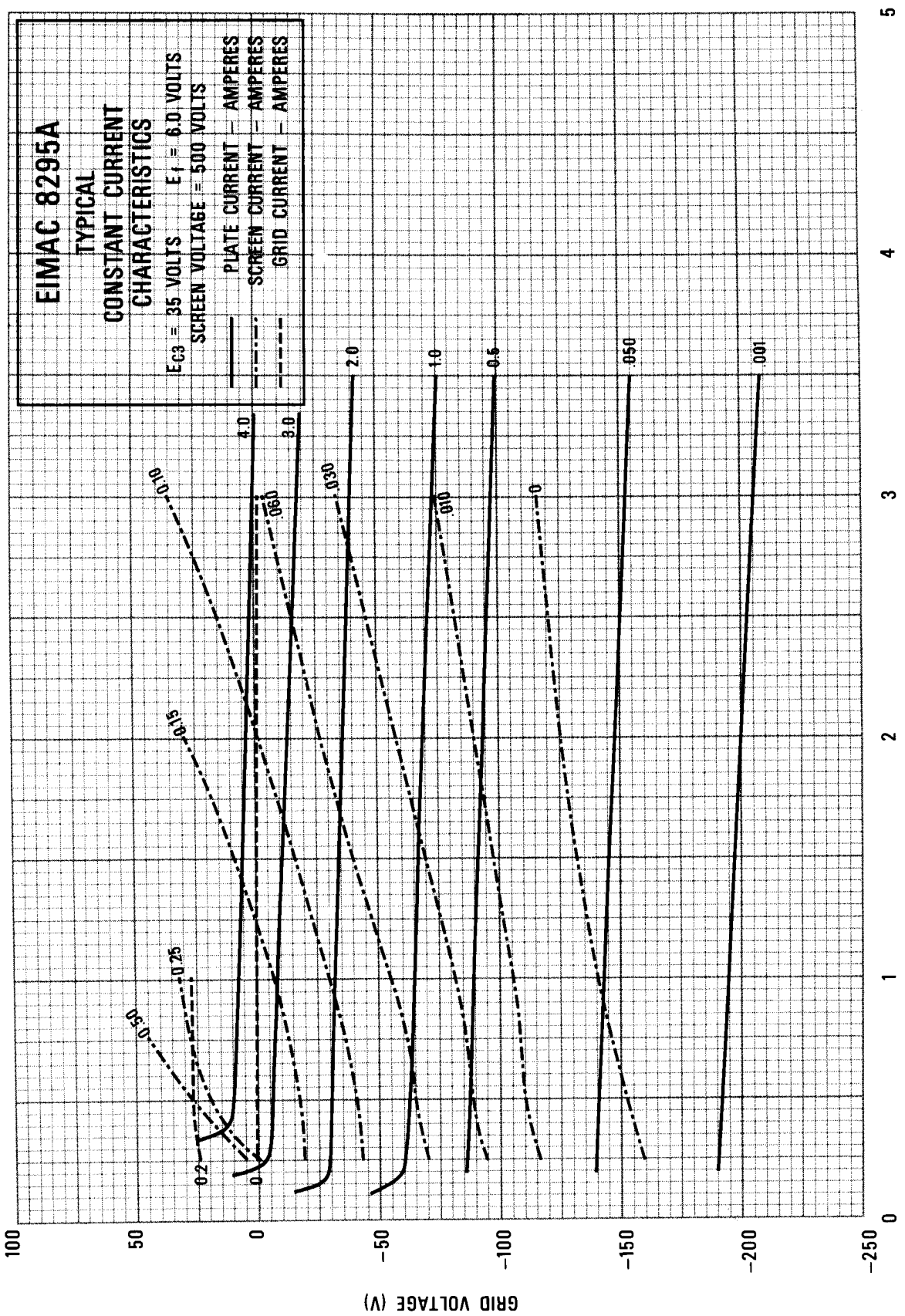
DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	3.458	3.832	87.83	97.33
B	3.968	4.032	100.79	102.41
C	3.485	3.515	88.52	89.28
E	1.615	1.630	41.02	41.40
F	.655	.719	16.64	18.26
G	1.395	1.645	35.43	41.78
H	1.468	1.532	37.29	38.91
J	.593	.657	15.06	16.69
K	1.056	1.219	26.82	30.96
L	.438	.562	11.13	14.27
M	.559	.573	14.20	14.55
N	.400	— —	10.16	— —
P	— —	.125	— —	3.18
T	.250	— —	6.35	— —
V	.220	— —	5.59	— —
W	.056	.062	1.42	1.57
X	.120	.127	3.05	3.23
REFERENCE DIMENSIONS				
D	51°			
Q	.125		3.18	
R	52°			
S	.125		3.18	
U	.250		6.35	
Y	1.000		25.40	



PIN CONNECTIONS	
PIN NO.	ELEMENT
1	k
2	g1
3	h
4	k
5	h
6	g1
7	k
CENTER PIN	INT. CON.
LOWER RING	g2
UPPER RING	g3
CAP	a


EIMAC 8295A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
Ec3 = 0 VOLTS Ef = 6.0 VOLTS
SCREEN VOLTAGE = 500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
4.0
3.0
2.0
1.0
0.5
.050
.001
.060
.030
.010
0
0.10
0.15
0.50
0.2
100
50
0
−50
−100
−150
−200
−250
0
1
2
3
4
5
GRID VOLTAGE (V)
PLATE VOLTAGE – (KV)

CURVE #3767


EIMAC 8295A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
E_{G3} = 35 VOLTS E_f = 6.0 VOLTS
SCREEN VOLTAGE = 500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
4.0
3.0
2.0
1.0
0.5
0
.050
.030
.010
.001
0.10
0.15
0.25
0.3
0.2
.060
100
50
0
−50
−100
−150
−200
−250
0
1
2
3
4
5
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE #3770

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

8296 / 4X150R / 8297 / 4X150S

RADIAL-BEAM POWER TETRODE



The Eimac 8296/4X150R and 8297/4X150S are compact radial-beam tetrodes designed for use as amplifiers, oscillators, or frequency multipliers (up to 500 megacycles) in applications where shock and/or vibration preclude the use of non-ruggedized types. The 8296/4X150R is designed to operate with a heater voltage of 6.0 volts, while the 8297/4X150S is designed for operation at a heater voltage of 26.5 volts. Otherwise the two tubes have identical characteristics.

The 8296/4X150R and 8297/4X150S will replace the 4X150A and 4X150D in almost all applications since they are electrically identical except for a slight increase in heater current and a small increase in input and output capacitance limits. The 8296/4X150R and 8297/4X150S will operate with maximum rated plate and screen voltages applied in equipments where shock and/or vibration is experienced. See Shock and Vibration section on page three for details.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide-Coated, Unipotential				
Heating Time	30	60		seconds
Cathode-to-Heater Potential			±150	volts
Heater: Voltage 4X150R		6.0		
Current 4X150R	2.4		3.0	amperes
Voltage 4X150S		26.5		volts
Current 4X150S	0.56		0.68	ampere
Amplification Factor (Grid-to-Screen)		5		

Direct Interelectrode Capacitances, Grounded Cathode:*	Min.	Max.
Input	16.25	18.75 uuf
Output	4.0	4.8 uuf
Feedback		0.06 uuf
Frequency for Maximum Ratings		150 mc
Highest Useful Frequency		500 mc

*In Shielded Fixture

MECHANICAL

Base	JEDEC B8-236
Maximum Operating Temperatures:	
Base Seals	250° C
Anode Seal	200° C
Anode Core	250° C
Recommended Socket	Eimac SK-600 series
Operating Position	Any
Maximum Dimensions:	
Height	2.414 inches
Diameter	1.640 inches
Cooling	Forced Air
Net Weight	4 ounces
Shipping Weight (Approximate)	1.6 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony
(Key-down conditions)

MAXIMUM RATINGS

D-C PLATE VOLTAGE:	
Up to 150 megacycles	2000 MAX. VOLTS
150 to 500 megacycles	1250 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION

	Frequencies up to 150 Mc.				500 Mc.†
D-C Plate Voltage	500	1000	1500	2000	1250 volts
D-C Screen Voltage	250	250	250	250	250 volts
D-C Grid Voltage	—90	—90	—90	—90	—80 volts
D-C Plate Current	250	250	250	250	200 ma
D-C Screen Current*	45	38	21	19	7 ma
D-C Grid Current*	35	31	28	26	10 ma
Peak R-F Grid Voltage*	114	114	112	112	.... volts
Driving Power	4.0	3.5	3.2	2.9	10 watts
Plate Input Power	125	250	375	500	250 watts
Plate Output Power	70	190	280	390	140 watts

*Approximate values.
†The typical performance figures for 500-megacycle operation were obtained by direct measurement in operating equipment. The output power is useful output power measured at the load. The driving power is the total power taken by the tube and a practical resonant circuit.

NOTE: Heater voltage was reduced to 5.5 volts and 24.3 volts for the 4X150R and 4X150S respectively.

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PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier Conditions)

MAXIMUM RATINGS

D-C PLATE VOLTAGE:	
Up to 150 megacycles	1600 MAX. VOLTS
150 to 500 megacycles	1000 MAX. VOLTS
D-C SCREEN VOLTAGE	300 MAX. VOLTS
D-C GRID VOLTAGE	—250 MAX. VOLTS
D-C PLATE CURRENT	200 MAX. MA
PLATE DISSIPATION	165 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 150 megacycles)

D-C Plate Voltage	500	1000	1600 volts
D-C Screen Voltage	250	250	250 volts
D-C Grid Voltage	—150	—150	—150 volts
D-C Plate Current	200	200	200 ma
D-C Screen Current*	25	20	18 ma
D-C Grid Current*	23	21	21 ma
Peak R-F Grid Input Voltage*	173	172	172 volts
Driving Power	4.0	3.6	3.6 watts
Plate Input Power	100	200	320 watts
Plate Output Power	47	140	250 watts

*Approximate values.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (per tube)

D-C PLATE VOLTAGE	2000 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

D-C Plate Voltage	1000	1500	2000 volts
D-C Screen Voltage	350	350	350 volts
D-C Grid Voltage[1]	—55	—55	—55 volts
Zero-Signal D-C Plate Current	200	200	200 ma
Max-Signal D-C Plate Current	500	500	500 ma
Max-Signal D-C Screen Current	20	16	10 ma
Effective Load, Plate to Plate	3500	6200	9500 ohms
Peak A-F Grid Input Voltage (per tube)*	50	50	50 volts
Driving Power	0	0	0 watts
Max-Signal Plate Output Power	240	430	600 watts

*Approximate values.

[1]Adjust grid bias to obtain listed zero-signal plate current.

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1 (Carrier Conditions)

MAXIMUM RATINGS

D-C PLATE VOLTAGE:	
Up to 150 megacycles	2000 MAX. VOLTS
150 to 500 megacycles	1250 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 150 Mc)

D-C Plate Voltage	1000	1500	2000 volts
D-C Screen Voltage	350	350	350 volts
D-C Grid Voltage[1]	—55	—55	—55 volts
Zero-Signal D-C Plate Current	100	100	100 ma
D-C Plate Current	150	150	150 ma
D-C Screen Current*	—3	—4	—4 ma
Peak R-F Grid Voltage*	25	25	25 volts
Plate Output Power	30	50	65 watts

*Approximate values.

[1]Adjust grid bias to obtain listed zero-signal plate current.

RADIO-FREQUENCY LINEAR AMPLIFIER, SSB

Class-AB_1 (Single-Tone Conditions)

MAXIMUM RATINGS

D-C PLATE VOLTAGE:	
Up to 150 megacycles	2000 MAX. VOLTS
150 to 500 megacycles	1250 MAX. VOLTS
D-C SCREEN VOLTAGE	400 MAX. VOLTS
D-C PLATE CURRENT	250 MAX. MA
PLATE DISSIPATION	250 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	2 MAX. WATTS

TYPICAL OPERATION (Frequencies up to 150 megacycles)

D-C Plate Voltage	1000	1500	2000 volts
D-C Screen Voltage	350	350	350 volts
D-C Grid Voltage[1]	—55	—55	—55 volts
Peak R-F Grid Voltage*	50	50	50 volts
Zero-Signal D-C Plate Current	100	100	100 ma
Single-Tone D-C Plate Current	250	250	250 ma
Two-Tone D-C Plate Current	190	190	190 ma
Single Tone D-C Screen Current*	10	8	5 ma
Two-Tone D-C Screen Current*	2	—1	—2 ma
R-F Load Impedance	1750	3100	4750 ohms
Single-Tone Plate Input Power	250	375	500 watts
Single-Tone Plate Output Power	120	215	300 watts

*Approximate values.

[1]Adjust to obtain listed zero-signal plate current.

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance for circuit losses, either input or output, has been made.

In class-C operation, adjustment of the r-f grid drive to obtain listed plate current at the listed grid bias, screen voltage, and plate voltage is assumed. Resultant screen and grid currents will vary from tube to tube, but little change in output power will be noted.

In class-AB_1 linear operation, screen current will also vary from tube to tube but is a useful indicator of relative linearity. In general, less screen current means better linearity, providing other conditions are held constant. The same degree of linearity will be obtained from different tubes if loading and drive are adjusted to give the same plate and screen currents, although output power may vary from tube to tube.

APPLICATION

MECHANICAL

Mounting—The 4X150R and 4X150S may be operated in any position. An Eimac Air-System Socket, SK-600 series, or a socket having equivalent characteristics, is required. Sockets are available with or without built-in screen capacitors and may be obtained with either grounded or ungrounded cathode terminals.

Cooling—Sufficient forced-air cooling must be provided for the anode, base seals, and body seals to maintain operating temperatures below the rated maximum values. Air requirements to maintain anode core temperatures at 200°C with an inlet air temperature of 50°C are tabulated below. These requirements apply when a socket of the Eimac SK-600 series and an Eimac SK-606 chimney are used with air flow in the base to anode direction.

	SEA LEVEL		10,000 FEET	
Plate Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
200	5.0	0.52	7.3	0.76
250	6.4	0.82	9.3	1.20

The blower selected in a given application must be capable of supplying the desired airflow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters. The blower must be designed to deliver the air at the desired altitude.

At 500 Mc or below, base-cooling air requirements are satisfied automatically when the tube is operated in an Eimac Air-System Socket and the recommended air-flow rates are used. Experience has shown that if reliable long-life operation is to be obtained, the cooling air-flow must be maintained during standby periods when only the heater voltage is applied to the tube. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

Shock and Vibration—The 4X150R and 4X150S are two Eimac tube types unique in that shock and vibration testing are performed with *maximum rated plate and screen voltages* applied. Two samples of production tubes are randomly selected periodically and tested under the conditions outlined below.

With *maximum rated plate and screen voltages* applied, each of the tubes in this sample is subjected to six shocks of 90 G (minimum) half-sine-wave motion, with a duration of 11±2 milliseconds, in each of the three major axes (X1, X2, and Y1).

With *maximum rated plate and screen voltages* applied and with control-grid voltage adjusted to allow the flow of 100 ma through a plate load resistor of 4900 ohms, each of the tubes in this sample is vibrated in the three major axes throughout the range of 5-750-5 cps in a minimum time of six minutes per axis. The vibration level is maintained at 10 G from 28 cps to 750 cps and at 0.25 inch D.A. from 5 cps to 28 cps. During this test noise voltage developed across the plate load resistor cannot exceed 30 volts rms. Sufficient plate power-supply voltage (2500 volts) is employed to assure that a minimum of 2000 volts appears at the plate of the tube under test even though 490 volts drop across the plate load resistor results from d-c plate-current flow.

The equipment designer is cautioned to provide adequate tube support to prevent relative motion between tube and socket in equipments where shock and/or vibration are anticipated.

ELECTRICAL

Heater—The rated heater voltage for the 4X150R and 4X150S is 6.0 volts and 26.5 volts respectively, and the voltage should be maintained as closely as practicable. Short-time changes of + 10% will not damage the tube, but variations in performance must be expected. The heater voltage must be maintained with ± 5% to minimize these variations and to obtain maximum tube life.

At frequencies above approximately 300 megacycles, transit-time effects begin to influence the cathode temperature. The amount of driving power diverted to heating the cathode by back-bombardment will depend upon frequency, plate current, and driving power. When the tube is driven to maximum input as a "straight-through" class-C amplifier, the heater voltage should be reduced according to the table below:

Frequency, Mc	4X150R	4X150S
300 and lower	6.00 volts	26.5 volts
301 to 400	5.75 volts	25.5 volts
401 to 500	5.50 volts	24.3 volts

Cathode—The cathode of each type is connected to the four even-numbered base pins to provide a low-inductance path, or permit separation of input and output circuits if required.

Rated heater voltage should be applied before other operating voltages are applied.

Heater-to-cathode maximum voltage is ±150 volts.

Control-Grid—Maximum rated d-c bias voltage is −250 volts. D-C resistance, grid-to-cathode, should be no more than 100,000 ohms.

Screen-Grid—Maximum screen dissipation for each type is 12 watts, normally computed by multiplying d-c screen voltage by the average screen current. This computation is essentially correct except in the case of heavy plate loading when secondary-emission current may mask the normal screen current.

All tetrodes, under some conditions of loading and drive, will exhibit secondary emission from the screen which changes the net current to the screen and may even cause the screen current meter to reverse. Normally, secondary emission is harmless provided the screen voltage is stable. To insure stable screen voltage, it is recommended that a bleeder resistor calculated to pass 15 ma from screen to ground be used.

Plate Dissipation—The maximum plate dissipation for either type is 250 watts. The usual single-sideband voice signal is complex and full peak envelope power

shown in Typical Operating Conditions may be developed without exceeding this plate dissipation. Single-tone testing for short periods with greater than 250 watts plate dissipation is permissible.

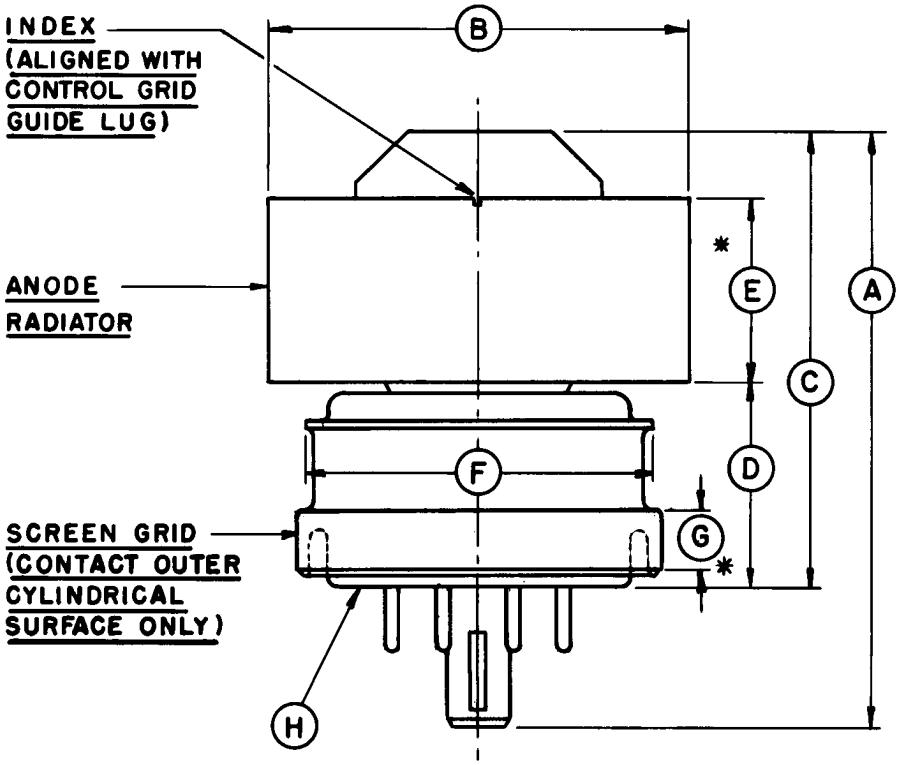
Multiple Operation—To obtain maximum power with minimum distortion from tubes operated in multiple it is desirable to adjust individual screen or grid-bias voltages so the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual d-c plate currents will be approximately equal for full input signal for class-AB_1 operation.

Special Application—If it is desired to use the 4X150R or the 4X150S under conditions widely different from those given here, consult the Power Grid Tube Marketing Department, Eitel-McCullough, Inc., San Carlos, California, or any of our regional offices or representatives.

PIN NO. 1. SCREEN GRID
PIN NO. 2. CATHODE
PIN NO. 3. HEATER
PIN NO. 4. CATHODE
PIN NO. 5. I.C. DO NOT USE FOR EXTERNAL CONNECTION
PIN NO. 6. CATHODE
PIN NO. 7. HEATER
PIN NO. 8. CATHODE
CENTER PIN – CONTROL GRID

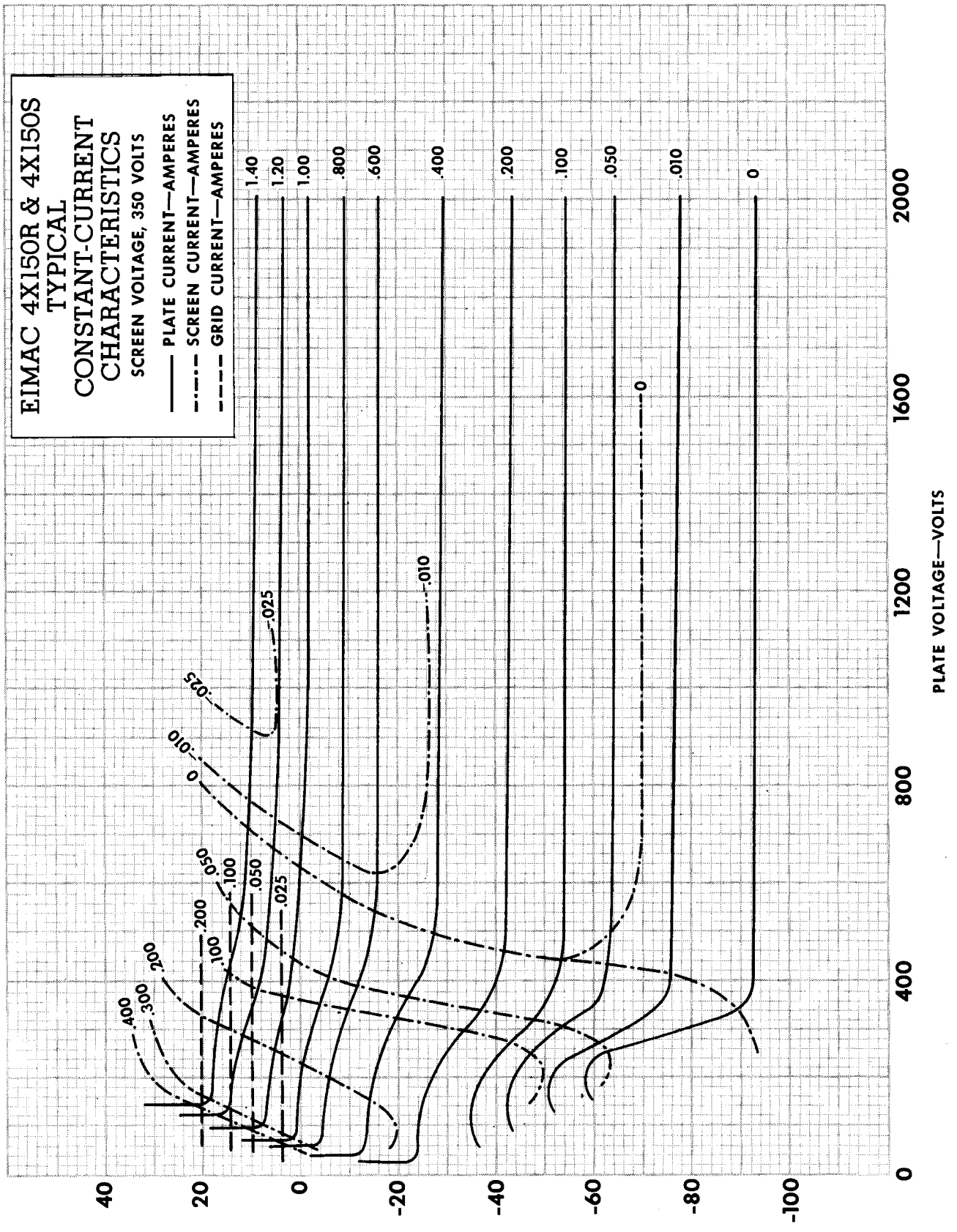
DIMENSIONS IN INCHES

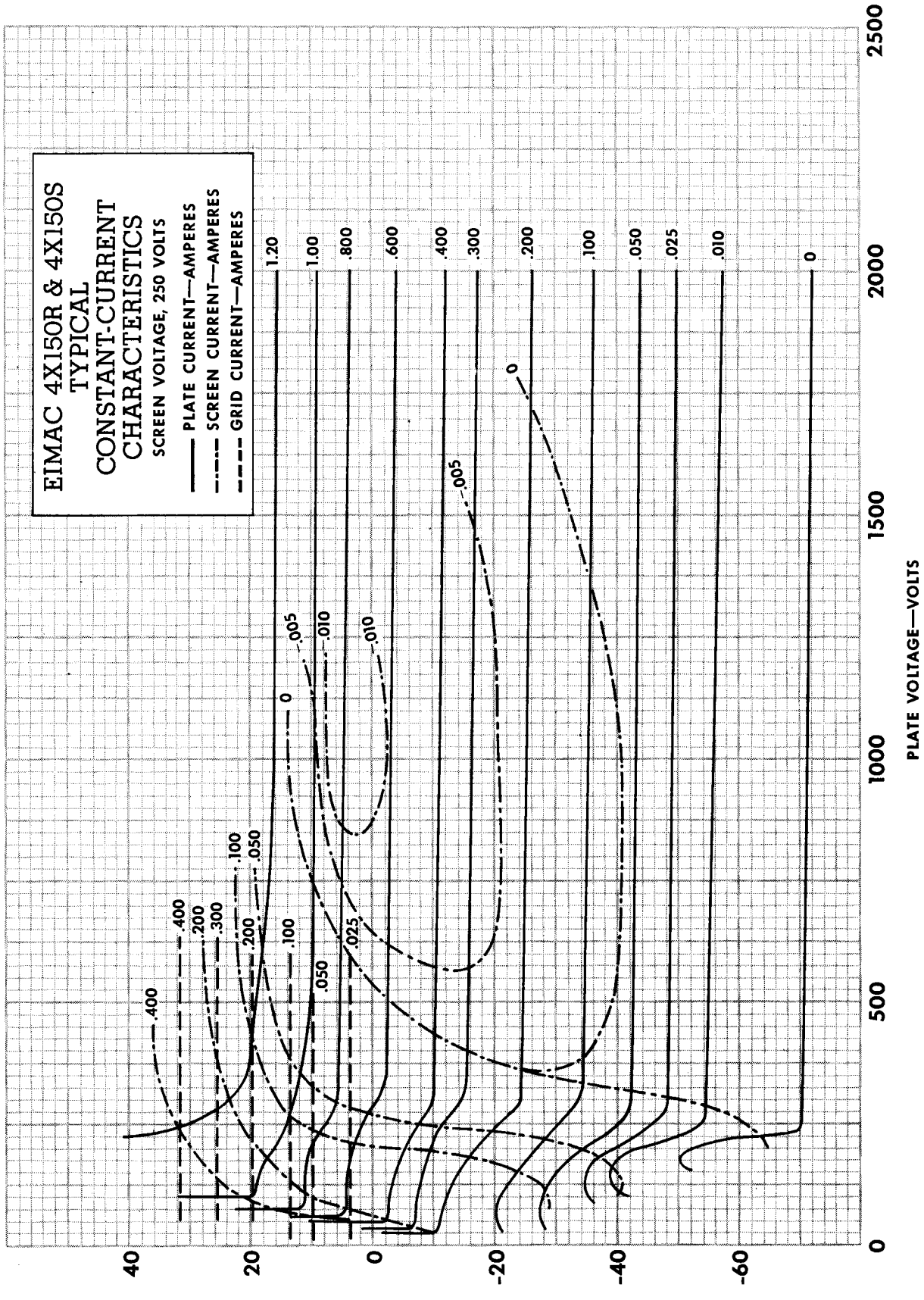
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	2.224	2.414	
B	1.610	1.640	
C	1.710	1.860	
D	.750	.810	
E	.710	.790	
F		1.406	
G	.187		
H	BASE : B8-236 (JEDEC DESIGNATION)		



DIMENSIONS IN INCHES

* CONTACT SURFACE


EIMAC 4X150R & 4X150S
TYPICAL
CONSTANT-CURRENT
CHARACTERISTICS
SCREEN VOLTAGE, 350 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
1.40
1.20
1.00
.800
.600
.400
.200
.100
.050
.025
.010
0
.025
.010
0
.050
.100
.050
.025
.200
.100
.200
.300
.400
40
20
0
-20
-40
-60
-80
-100
0
400
800
1200
1600
2000
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—VOLTS


EIMAC 4X150R & 4X150S
TYPICAL
CONSTANT-CURRENT
CHARACTERISTICS
SCREEN VOLTAGE, 250 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
1.20
1.00
.800
.600
.400
.300
.200
.100
.050
.025
.010
0
.005
.010
.005
0
.400
.200
.300
.200
.100
.050
.025
.400
40
20
0
-20
-40
-60
0
500
1000
1500
2000
2500
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—VOLTS

TECHNICAL DATA

8321 / 4CX350A
8322 / 4CX350F

RADIAL-BEAM POWER TETRODES

The Eimac 8321/4CX350A and 8322/4CX350F are compact radial beam tetrodes with maximum plate dissipation of 350 watts and are intended for Class-AB, audio or rf amplifier service. These tubes are externally identical to the 4CX250B but contain rugged internal construction features. Amplification factor and cathode area have been increased over the 4CX250B to give higher transconductance and figure of merit.



The 8321/4CX350A and 8322/4CX350F differ only in heater voltage and current; the 8321/4CX350A is used at 6.0 volts while the 8322/4CX350F is rated at 26.5 volts. Both types are of ceramic and metal construction and are recommended for new equipment design.

GENERAL CHARACTERISTICS

ELECTRICAL

		Min.	Nom.	Max.	
Cathode:	Oxide-Coated, Unipotential				
	Heating Time	30		60	secs
	Cathode-to-Heater Potential			±150	volts
Heater:	4CX350A Voltage		6.0		volts
	4CX350A Current	2.9		3.6	amps
	4CX350F Voltage		26.5		volts
	4CX350F Current	0.66		0.81	amps

	Min.	Nom.	Max.	
Amplification Factor (Grid-to-Screen)		13		
Transconductance (I_b = 150 mA)		22,000		umhos
Direct Interelectrode Capacitances, Grounded Cathode:				
Input	22.2		26.2	uuf
Output	5.0		6.0	uuf
Feedback			0.05	uuf
Direct Interelectrode Capacitances, Grounded Grid and Screen:				
Input	17.9		21.9	uuf
Output	5.0		6.0	uuf
Feedback			0.01	uuf

MECHANICAL

Base	Special 9-pin	
Maximum Operating Temperatures:		
Ceramic-to-Metal Seals	250°	C
Anode Core	250°	C
Recommended Socket	Eimac SK-600 Series	
Operating Position	Any	
Maximum Dimensions:		
Height	2.464	inch
Seated Height	1.910	inch
Diameter	1.640	inch
Cooling	Forced air	
Net Weight	4	ounces
Shipping Weight (approximate)	1.6	pounds

(Effective 6-15-65) c 1968 by Varian

Printed in U.S.A.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per tube)

DC PLATE VOLTAGE	2500 MAX. VOLTS
DC SCREEN VOLTAGE	400 MAX. VOLTS
DC PLATE CURRENT	300 MAX. MA
PLATE DISSIPATION	350 MAX. WATTS
SCREEN DISSIPATION	8 MAX. WATTS
GRID CURRENT	2 MAX. MA

*Approximate values.

[1]Adjust grid bias to obtain listed zero-signal plate current.

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

DC Plate Voltage	1000	1500	2200 volts
DC Screen Voltage	400	400	400 volts
DC Grid Voltage[1]	—27	—27	—27 volts
Zero-Signal DC Plate Current	200	200	200 mA
Max-Signal DC Plate Current	520	530	580 mA
Max-Signal DC Screen Current	—8	—10	—6 mA
Effective Load, Plate to Plate	2600	5000	7800 ohms
Peak AF Grid Input Voltage (per tube)*	21	21	50 volts
Driving Power	0	0	0 watts
Max-Signal Plate Input Power	560	800	1260 watts
Max Signal Plate Output Power	190	400	770 watts

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1 (Single-Sideband Suppressed-Carrier Operation)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2500 MAX. VOLTS
DC SCREEN VOLTAGE	400 MAX. VOLTS
DC PLATE CURRENT	300 MAX. MA
PLATE DISSIPATION	350 MAX. WATTS
SCREEN DISSIPATION	8 MAX. WATTS
GRID CURRENT	2 MAX. MA

*Approximate values

[1]Adjust grid bias to obtain listed zero-signal plate current.

TYPICAL OPERATION (Peak-envelope conditions except where noted)

DC Plate Voltage	1000	1500	2200 volts
DC Screen Voltage	400	400	400 volts
DC Grid Voltage[1]	—27	—27	—27 volts
Zero-Signal DC Plate Current	100	100	100 mA
Peak RF Grid Voltage*	21	21	25 volts
DC Plate Current	260	265	290 mA
DC Screen Current*	—4	—5	—3 mA
Plate Input Power	260	400	630 watts
Plate Output Power	95	200	385 watts
Two-Tone Average DC Plate Current	210	215	195 mA
Two-Tone Average DC Screen Current*	—7	—8	—3 mA
Resonant Load Impedance	1300	2500	3900 ohms

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves. No allowance is made for circuit losses of any kind. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf driving voltage is applied.

APPLICATION

MECHANICAL

MOUNTING — The 4CX350A and 4CX350F may be operated in any position. An Eimac Air-System Socket, SK-600 series, or a socket having equivalent characteristics, is required. Sockets are available with or without built-in screen by-pass capacitors and may be obtained with either grounded or ungrounded cathode terminals.

COOLING — Sufficient cooling must be provided for the anode, base seals and body seals to maintain operating temperatures below the rated maximum values. Air requirements to maintain seal temperatures at 225°C in 50°C ambient air are tabulated on page 3. These requirements apply when the Eimac SK-600 or SK-610 socket is used with the SK-606 chimney and air-flow in the base-to-anode direction.

At 500 mc or below, base-cooling air requirements are satisfied automatically when the tube is operated in an Eimac Air-System Socket and the recommended air-flow rates are used. Experience has shown that if reliable long-life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt, which might interfere with effective cooling.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown below, plus any drop encountered in ducts and filters. The blower must be designed to deliver the air at the desired altitude.

MINIMUM COOLING AIR-FLOW REQUIREMENTS				
	SEA LEVEL		10,000 FEET	
Plate Dissipation (Watts)	Air-Flow (CFM)	Pressure Drop (Inches of water)	Air-Flow (CFM)	Pressure Drop (Inches of water)
250	5.3	0.6	7.7	0.85
300	6.5	0.9	9.5	1.25
350	7.8	1.2	12.0	1.9

If cooling methods other than forced air are used, if the recommended air-flow rates are not supplied or if there is any doubt that the cooling is adequate, it should be borne in mind that operating temperature is the sole criterion of cooling effectiveness. One method of measuring the surface temperatures is by the use of a temperature-sensitive lacquer. When temperature-sensitive materials are used, extremely thin applications must be used to avoid interference with the transfer of heat from the tube to the air stream, which would cause inaccurate indications.

VIBRATION — These tubes are capable of satisfactorily withstanding ordinary shock and vibration, such as encountered in shipment and normal handling. The tubes will function well in automobile and truck mobile installations and similar environments.

ELECTRICAL

HEATER — The rated heater voltages for the 4CX350A and 4CX350F are 6.0 volts and 26.5 volts respectively and these voltages should be maintained as closely as practicable. Short-time variations of the voltage of ±10% of the rated value will not damage the tube, but variations in performance must be expected. The heater voltage should be maintained within ±5% of its rated value to minimize variations in performance and to obtain maximum tube life.

CATHODE OPERATION — The cathode is internally connected to the four even-numbered base pins, and all four of the corresponding socket terminals should be used to make connection to the external circuits. At radio frequencies it is important to keep the cathode leads short and direct and to use conductors with large areas to minimize the inductive reactances in series with the cathode leads.

It is recommended that rated heater voltage be applied for a minimum of 30 seconds before other operating voltages are applied. Where the circuit design requires the cathode and heater to be operated at different potentials, the rated maximum heater-to-cathode voltage is 150 volts regardless of polarity.

CONTROL-GRID OPERATION — The grid dissipation rating of the 4CX350A and 4CX350F is zero watt. The design features which make the tubes capable of maximum power operation without driving the grid into the positive region also make it necessary to avoid positive grid operation. The grid current rating of 2.0 milliamperes allows the flow of positive grid current for peak-signal monitoring purposes.

SCREEN-GRID OPERATION — The maximum rated power dissipation for the screen grid is 8 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

When signal voltages appear between screen and cathode, as in the case of screen-modulated amplifiers or cathode-driven tetrode amplifiers, the peak screen-to-cathode voltage is the sum of the d-c screen voltage and the peak ac or rf signal voltage applied to screen or cathode.

Protection for the screen can be provided by an overcurrent relay and by interlocking the screen supply so that the plate voltage must be applied before screen voltage can be applied.

The screen current may reverse under certain conditions, and produce negative current indications on the screen milliameter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind, so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor or shunt regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per connected screen. An electron tube series regulator can be used only when an adequate bleeder resistor is provided.

PLATE OPERATION — The maximum rated plate-dissipation power is 350 watts. The maximum dissipation rating may be exceeded for brief periods during circuit adjustment without damage to the tube.

At frequencies up to approximately 30 megacycles the top cap on the anode cooler may be used for a plate terminal. At higher frequencies a circular clamp or spring-finger collect encircling the cylindrical outer surface of the anode cooler should be used.

MULTIPLE OPERATION — Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide for individual metering and individual adjustment of the bias or screen voltage to equalize the inputs.

Where overload protection is provided, it should be capable of protecting the surviving tube/s in the event that one tube should fail.

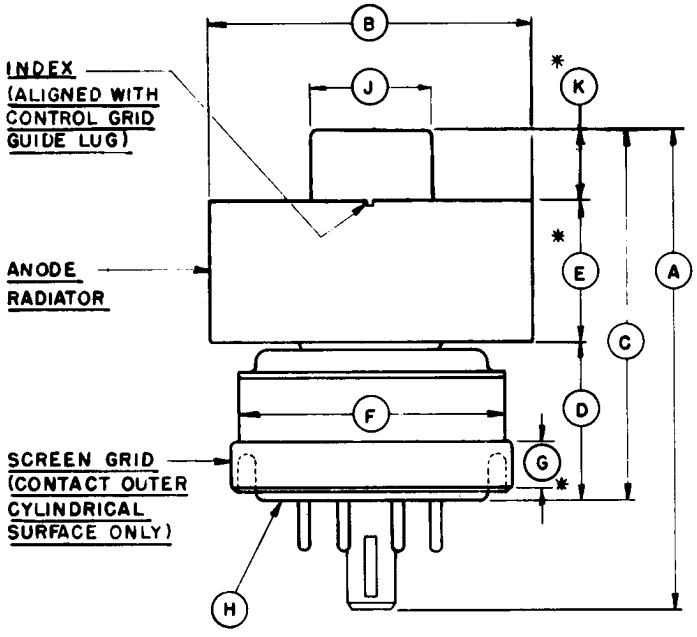
UHF OPERATION — The 4CX350A and 4CX350F are useful in the UHF region. UHF operation should be conducted with heavy plate loading, minimum bias and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

Some of the added circuit loss observed in UHF operation is in the base insulator of the tube. It is sometimes necessary to use more than the recommended minimum air-flow rates to maintain safe operating base temperatures at UHF.

These tubes may be used in frequency multiplier applications. Such operation results in low plate efficiency and requires high driving voltages. If the frequency multiplier is used as an output power stage, it is preferable to operate the final tube as a frequency doubler rather than a frequency tripler.

SPECIAL APPLICATIONS — If it is desired to operate these tubes under conditions widely different from those given here, write to Application Engineering Department, Eimac, Division of Varian, San Carlos, California for information and recommendations.

PIN NO. 1. SCREEN GRID
PIN NO. 2. CATHODE
PIN NO. 3. HEATER
PIN NO. 4. CATHODE
PIN NO. 5. I.C. DO NOT USE FOR EXTERNAL CONNECTION
PIN NO. 6. CATHODE
PIN NO. 7. HEATER
PIN NO. 8. CATHODE
CENTER PIN - CONTROL GRID

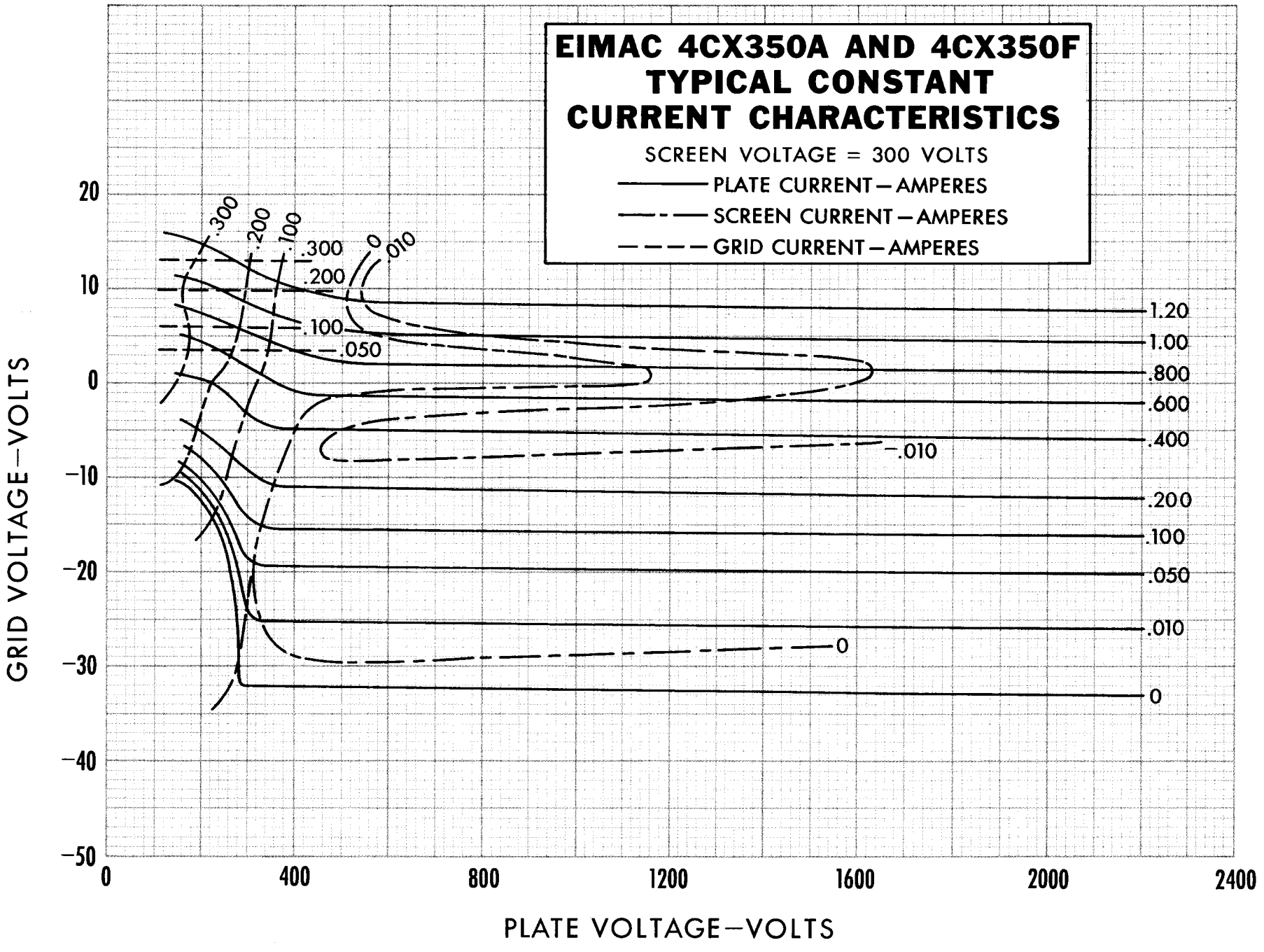


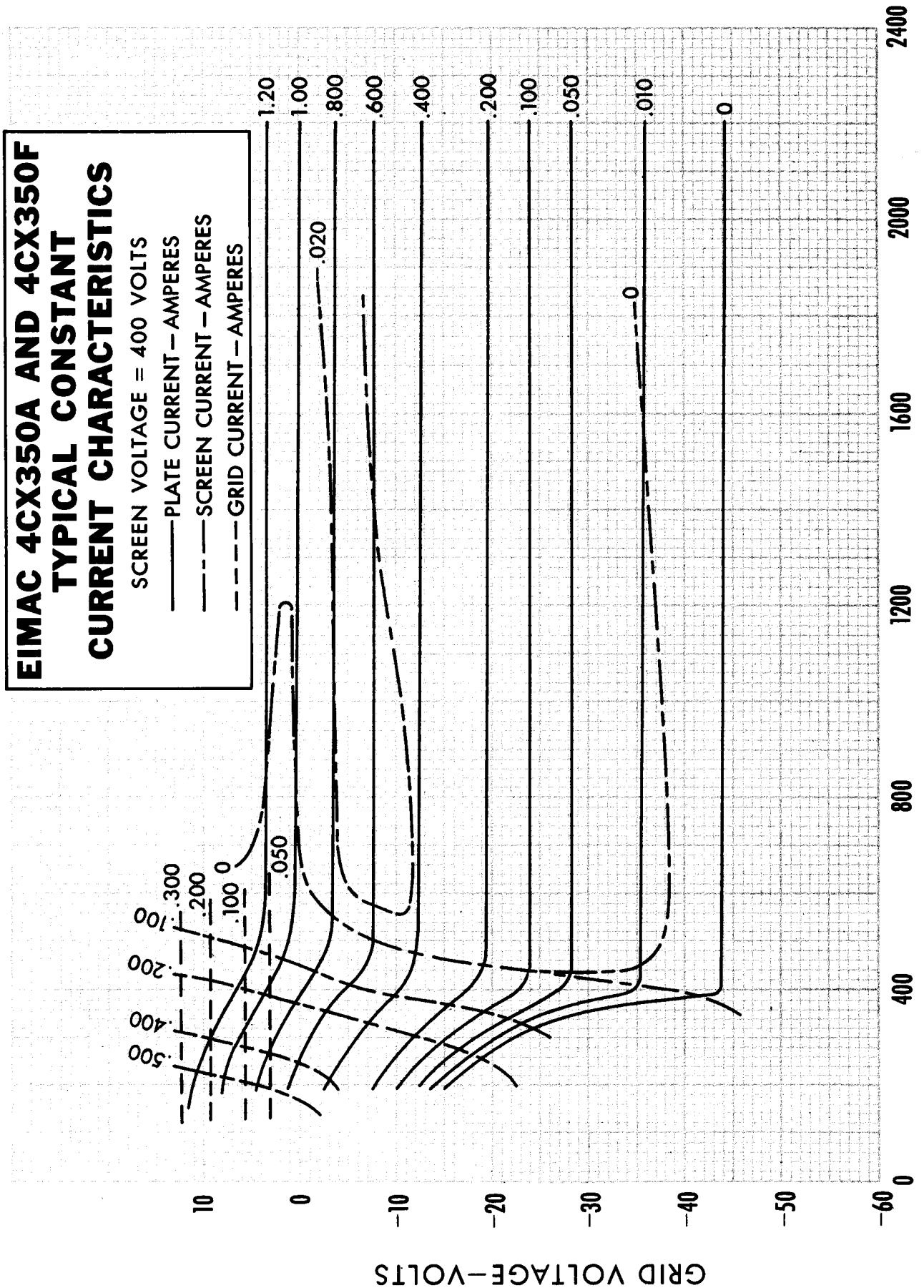
DIMENSIONS IN INCHES

DIMENSIONAL DATA

DIM.	MIN.	MAX.	REF.
A	2.324	2.464	
B	1.610	1.640	
C	1.810	1.910	
D	.750	.810	
E	.710	.790	
F		1.406	
G	.187		
H	BASE: B8-236 (JEDEC DESIGNATION)		
J	.559	.573	
K	.240		

NOTES
1. * CONTACT SURFACE
2. REF. DIMENSIONS ARE FOR INFORMATION ONLY & ARE NOT REQUIRED FOR INSP PURPOSES.


EIMAC 4CX350A AND 4CX350F
TYPICAL CONSTANT
CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 300 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – VOLTS
20
10
0
−10
−20
−30
−40
−50
0
400
800
1200
1600
2000
2400
.300
.200
.100
.300
.200
.100
.050
0
.010
1.20
1.00
.800
.600
.400
.010
.200
.100
.050
.010
0
0


EIMAC 4CX350A AND 4CX350F
TYPICAL CONSTANT
CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 400 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
1.20
1.00
.800
.600
.400
.200
.100
.050
.020
.010
0
0
0
.050
.100
.200
.300
100
200
400
500
10
0
−10
−20
−30
−40
−50
−60
0
400
800
1200
1600
2000
2400
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—VOLTS

TECHNICAL DATA

8349
4CX35,000C

RADIAL-BEAM
POWER TETRODE

The EIMAC 8349/4CX35,000C is a ceramic/metal, forced-air cooled power tetrode intended for use at the 50 to 150 kilowatt output power level. It is recommended for use as a Class-C rf amplifier or oscillator, a Class-AB rf linear amplifier, or a Class-AB push-pull af amplifier or modulator. The 8349/4CX35,000C is also useful as a plate and screen modulated Class-C rf amplifier.

The forced-air cooled anode is rated at 35 kilowatts maximum dissipation.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	10.0	V
Current, at 10.0 volts	295	A
Amplification Factor (Average):		
Grid to Screen	4.5	
Direct Interelectrode Capacitances (grounded cathode)[2]		
Cin	440	pF
Cout	55	pF
Cgp	2.3	pF
Frequency of Maximum Rating:		
CW	30	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	17.34 in; 440.4 mm
Diameter	9.75 in; 247.7 mm
Net Weight	50 lb; 22.7 kg
Operating Position	Vertical, base up or down
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Forced Air
Base	Special, graduated rings
Recommended Socket	EIMAC SK-1500

(Revised 12-1-70) © 1963, 1967, 1970 by Varian

Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB

MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	15.0	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage [1]	-400	Vdc
Zero-Signal Plate Current	1.0	Adc
Single Tone Plate Current	5.7	Adc
Single-Tone Screen Current [2]	0.9	Adc
Peak rf Grid Voltage [2]	250	v
Peak Driving Power [2]	0	w
Plate Dissipation	30	kW
Plate Output Power	55	kW
Resonant Load Impedance	1280	Ω

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	10.0	15.0	19.0	kVdc
Screen Voltage	750	750	750	Vdc
Grid Voltage	-425	-480	-550	Vdc
Plate Current	7.5	6.8	6.96	Adc
Screen Current [1]	0.84	0.51	0.80	Adc
Grid Current [1]	0.29	0.23	0.35	Adc
Peak rf Grid Voltage [1]	600	660	730	v
Calculated Driving Power [1]	180	150	258	W
Plate Dissipation	19.3	19.0	21.0	kW
Plate Output Power	55.5	82.5	110	kW

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	14,000	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION [1]	23,000	WATTS
SCREEN DISSIPATION [2]	1750	WATTS
GRID DISSIPATION [2]	500	WATTS

1. Corresponds to 35,000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	12.0	kVdc
Screen Voltage	750	Vdc
Grid Voltage	-600	Vdc
Plate Current	5.4	Adc
Screen Current [1]	0.52	Adc
Grid Current [1]	0.16	Adc
Peak af Screen Voltage [2] (100% modulation)	500	v
Peak rf Grid Voltage [1]	740	v
Calculated Driving Power	125	W
Plate Dissipation	13.2	kW
Plate Output Power	55.0	kW
Resonant Load Impedance	1120	Ω

1. Approximate value.
2. Approximate value, depending upon degree of driver modulation.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB, Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube):

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	12.0	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage[1/3]	-400	Vdc
Zero-Signal Plate Current	3.0	Adc
Max Signal Plate Current	9.2	Adc
Max Signal Screen Current[1]	1.8	Adc
Peak af Grid Voltage[2]	280	v
Max Signal Plate Dissipation[2]	20	kW
Plate Output Power	70	kW
Load Resistance (plate to plate)	2860	Ω

2. Per Tube
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 10.0 volts	280	310	A
Interelectrode Capacitances (grounded cathode connection)[2]			
Cin	410	470	pF
Cout	50	60	pF
Cgp	1.5	3.2	pF

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX35,000C must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC sockets, type SK-1500, and SK-1510 have been designed especially for the concentric base terminals of the 4CX35,000C.

COOLING - The maximum temperature rating for the external surfaces of the 4CX35,000C is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C.

Air-flow requirements to maintain core temperature at 225°C in 40° ambient air are tabulated below (for operation below 30 megahertz.) These data are for air flowing in the base-to-anode direction.

	Base-to-Anode Air Flow			
	Sea Level		10,000 Feet	
Plate Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
15,000	554	1.2	795	1.7
20,000	820	2.1	1100	3.0
25,000	1140	3.6	1665	5.2
30,000	1465	5.0	2140	7.4
35,000	1800	7.2	2630	10.3

* Since the power dissipated by the filament represents about 3000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 2250 watts, allowance has been made in preparing this tabulation for an additional 5250 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

Separate cooling of the tube base is required and is accomplished by directing approximately 120 cfm of air horizontally through the socket from the side. It is preferable to direct this air through three equally spaced ducts.

The well in the center of the baseplate of the tube is a critical area which requires cooling to maintain envelope temperatures less than 250°C. For most applications, 1 to 2 CFM of air directed through the center of the socket is sufficient for this purpose.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

FILAMENT OPERATION - The peak emission at rated filament voltage of the EIMAC 4CX35,000C is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CX35,000C by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CX35,000C. At some point in filament voltage there will be a noticeable reduction in plate current, or power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appears to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked to maintain proper operation.

Filament starting current must be limited to a maximum of 900 amperes.

Voltage between filament and the base plates of tube and SK-1500 socket, must not exceed 100 volts.

GRID OPERATION - The 4CX35,000C grid has a maximum dissipation rating of 500 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible. The maximum grid circuit resistance should not exceed 100,000 ohms per tube.

SCREEN OPERATION - The power dissipated by the screen of the 4CX35,000C must not exceed 1750 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 1750 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX35,000C is 35,000 watts. When the 4CX35,000C is operated as a plate-modulated rf amplifier, under carrier conditions, the maximum plate dissipation is 23,000 watts.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capaci-

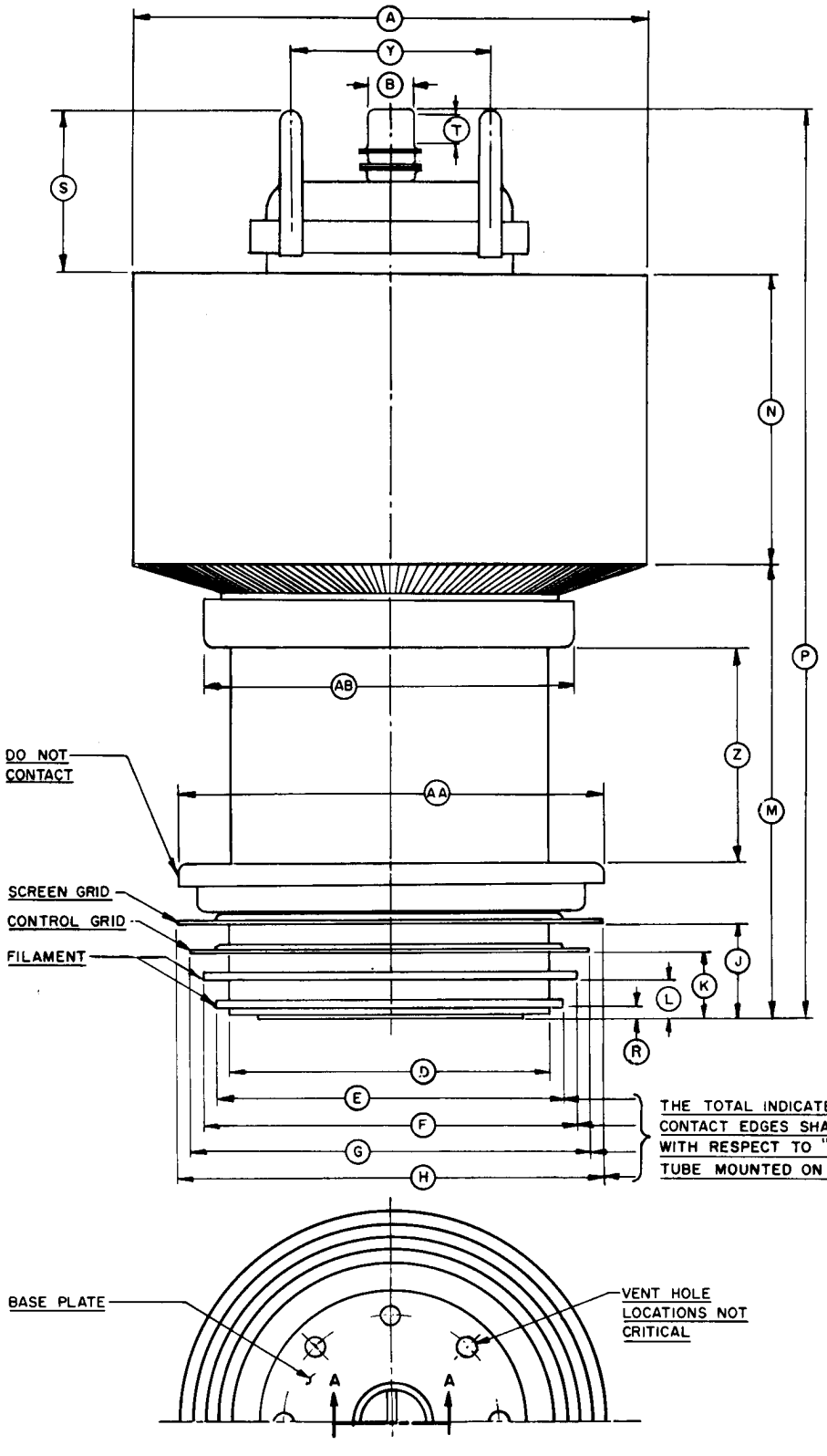
tance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

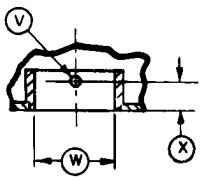
HIGH VOLTAGE - Normal operating voltages used with the 4CX35,000C are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CX35,000C, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

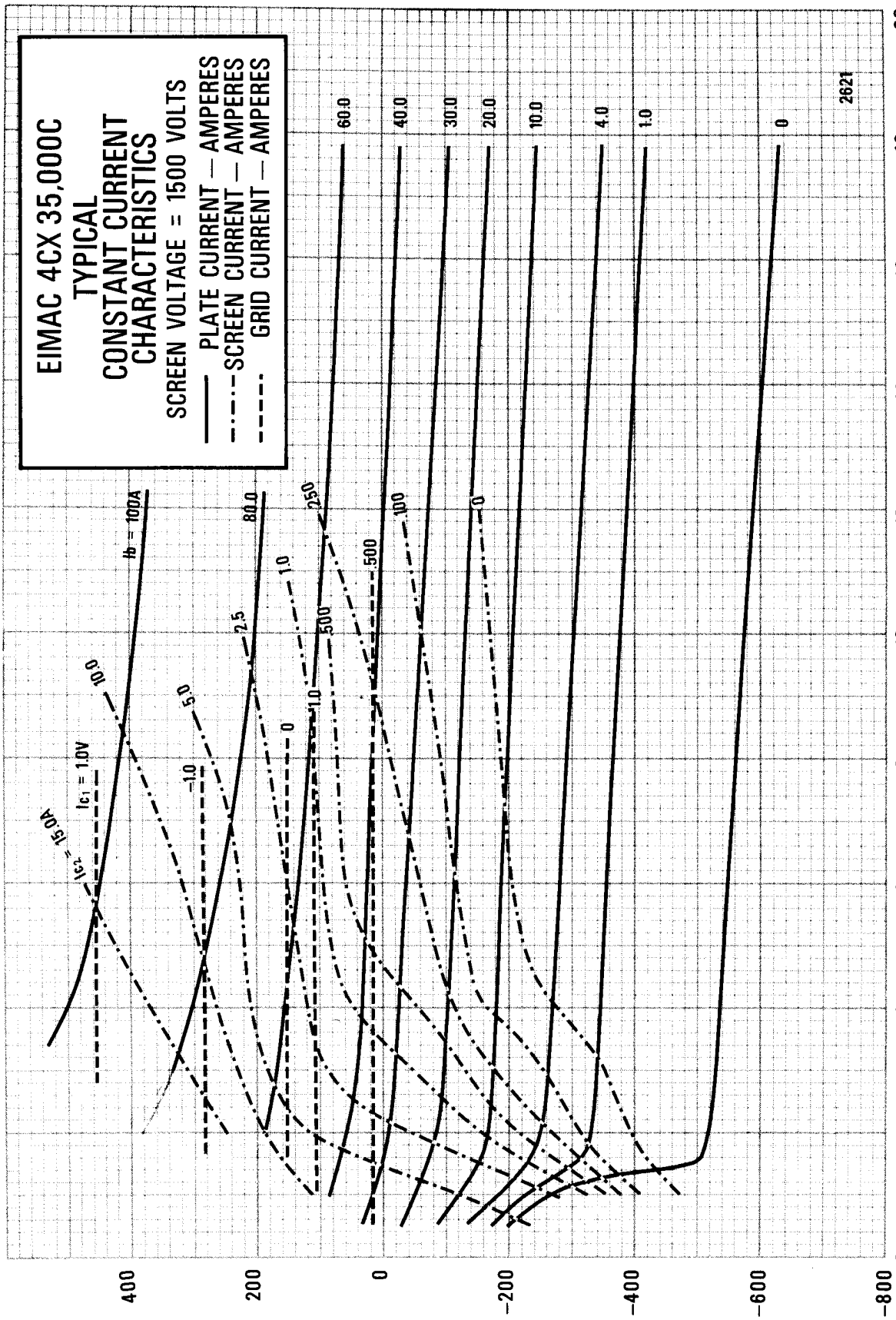
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.

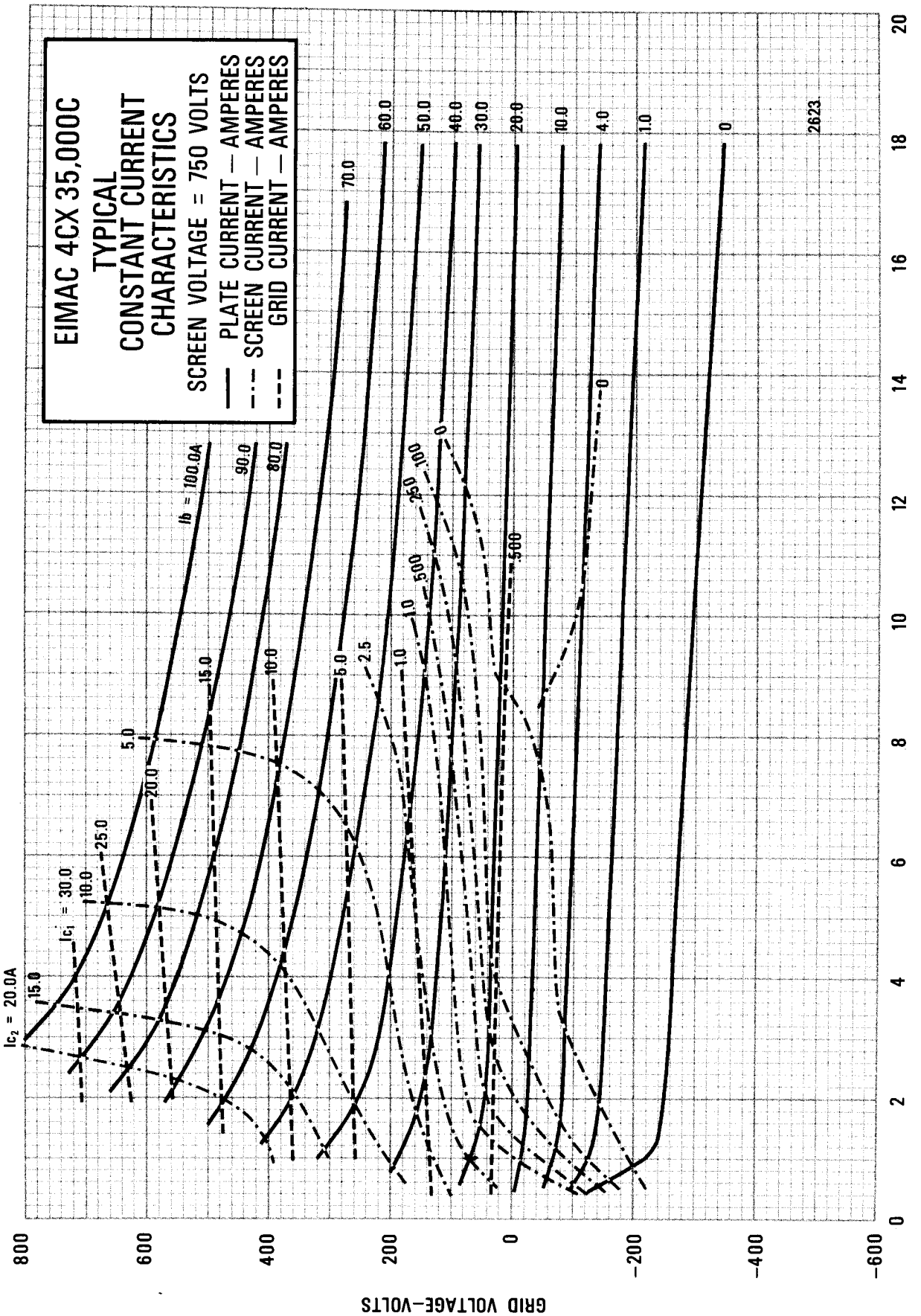




SECTION A–A
ROTATED 180°

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	9.500	9.750	241.30	247.65
B	0.860	0.890	21.84	22.60
D	5.980	6.020	151.89	152.91
E	6.510	6.560	165.35	166.62
F	6.980	7.020	177.29	178.31
G	7.480	7.520	189.99	191.01
H	7.975	8.015	202.57	203.58
J	1.750	1.800	44.45	45.72
K	1.220	1.270	30.99	32.26
L	0.690	0.740	17.53	18.80
M	8.442	8.692	214.43	220.78
N	5.375	5.625	136.52	142.88
P	17.070	17.340	433.58	440.44
R	0.173	0.213	4.40	5.41
S	3.062 (1)		77.77 (1)	
T	0.485	0.515	12.32	13.08
V	— —	0.135	— —	3.43
W	1.250	1.270	31.75	32.26
X	0.490	0.530	12.45	13.46
Y	4.500 (1)		114.30 (1)	
Z	3.750 (1)		95.25 (1)	
AA	8.000 (1)		203.20 (1)	
AB	6.875 (1)		174.63 (1)	

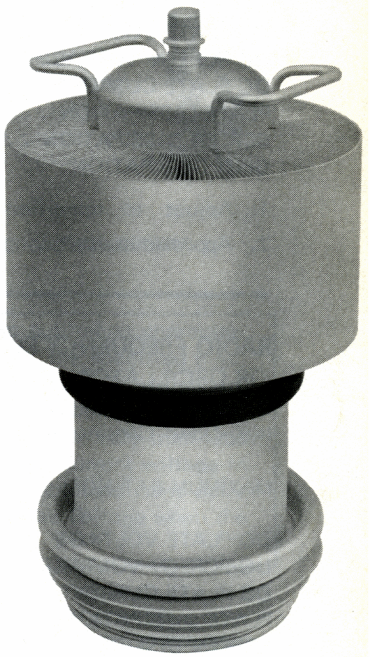

EIMAC 4CX 35,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
I_b = 100A
I_{c2} = 15.0A
I_{c1} = 1.0V
10.0
5.0
-1.0
2.5
80.0
0
1.0
250
1.0
500
100
500
0
60.0
40.0
30.0
20.0
10.0
4.0
1.0
0
2621
400
200
0
-200
-400
-600
-800
0
2
4
6
8
10
12
14
16
18
20
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—KILOVOLTS


EIMAC 4CX 35,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—KILOVOLTS
Ic2 = 20.0A
Ic1 = 30.0
Ib = 100.0A
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
4.0
1.0
0
2623
15.0
25.0
5.0
20.0
15.0
10.0
5.0
2.5
1.0
1.0
.500
.250
.100
.500
800
600
400
200
0
-200
-400
-600
0
2
4
6
8
10
12
14
16
18
20

TECHNICAL DATA

8349
4CX35,000C

RADIAL-BEAM
POWER TETRODE



The EIMAC 8349/4CX35,000C is a ceramic/metal, forced-air cooled power tetrode intended for use at the 50 to 150 kilowatt output power level. It is recommended for use as a Class-C rf amplifier or oscillator, a Class-AB rf linear amplifier, or a Class-AB push-pull af amplifier or modulator. The 8349/4CX35,000C is also useful as a plate and screen modulated Class-C rf amplifier.

The forced-air cooled anode is rated at 35 kilowatts maximum dissipation.

GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	10.0 V
Current, at 10.0 volts	295 A
Amplification Factor (Average):	
Grid to Screen	4.5
Direct Interelectrode Capacitances (grounded cathode)[2]	
Cin	440 pF
Cout	55 pF
Cgp	2.3 pF
Frequency of Maximum Rating:	
CW	30 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	17.34 in; 440.4 mm
Diameter	9.75 in; 247.7 mm
Net Weight	50 lb; 22.7 kg
Operating Position	Vertical, base up or down
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Forced Air
Base	Special, graduated rings
Recommended Socket	EIMAC SK-1500 Series

(Revised 9-1-75) © 1963, 1967, 1970, 1975 by Varian

Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB

MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	15.0	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage [1]	-400	Vdc
Zero-Signal Plate Current	1.0	Adc
Single Tone Plate Current	5.7	Adc
Single-Tone Screen Current [2]	0.9	Adc
Peak rf Grid Voltage [2]	250	v
Peak Driving Power [2]	0	w
Plate Dissipation	30	kW
Plate Output Power	55	kW
Resonant Load Impedance	1280	Ω

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM
(Key-Down Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	10.0	15.0	19.0	kVdc
Screen Voltage	750	750	750	Vdc
Grid Voltage	-425	-480	-550	Vdc
Plate Current	7.5	6.8	6.96	Adc
Screen Current [1]	0.84	0.51	0.80	Adc
Grid Current [1]	0.29	0.23	0.35	Adc
Peak rf Grid Voltage [1]	600	660	730	v
Calculated Driving Power [1]	180	150	258	W
Plate Dissipation	19.3	19.0	21.0	kW
Plate Output Power	55.5	82.5	110	kW

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	14,000	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION [1]	23,000	WATTS
SCREEN DISSIPATION [2]	1750	WATTS
GRID DISSIPATION [2]	500	WATTS

1. Corresponds to 35,000 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	12.0	kVdc
Screen Voltage	750	Vdc
Grid Voltage	-600	Vdc
Plate Current	5.4	Adc
Screen Current [1]	0.52	Adc
Grid Current [1]	0.16	Adc
Peak af Screen Voltage [2] (100% modulation)	500	v
Peak rf Grid Voltage [1]	740	v
Calculated Driving Power	125	W
Plate Dissipation	13.2	kW
Plate Output Power	55.0	kW
Resonant Load Impedance	1120	Ω

1. Approximate value.
2. Approximate value, depending upon degree of driver modulation.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR
Class AB, Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube):

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	12.0	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage[1/3]	-400	Vdc
Zero-Signal Plate Current	3.0	Adc
Max Signal Plate Current	9.2	Adc
Max Signal Screen Current[1]	1.8	Adc
Peak af Grid Voltage[2]	280	v
Max Signal Plate Dissipation[2]	20	kW
Plate Output Power	70	kW
Load Resistance (plate to plate)	2860	Ω

2. Per Tube
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 10.0 volts	280	310	A
Interelectrode Capacitances (grounded cathode connection)[2]			
Cin	410	470	pF
Cout	50	60	pF
Cgp	1.5	3.2	pF

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX35,000C must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC sockets, type SK-1500, and SK-1510 have been designed especially for the concentric base terminals of the 4CX35,000C.

COOLING - The maximum temperature rating for the external surfaces of the 4CX35,000C is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C.

Air-flow requirements to maintain core temperature at 225°C in 40° ambient air are tabulated below (for operation below 30 megahertz.) These data are for air flowing in the base-to-anode direction.

	Base-to-Anode Air Flow			
	Sea Level		10,000 Feet	
Plate Dissipation* (Watts)	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
15,000	440	1.0	635	1.44
20,000	650	2.0	935	2.9
25,000	975	3.8	1400	5.5
30,000	1300	6.0	1870	8.6
35,000	1760	9.6	2535	13.8

* Since the power dissipated by the filament represents about 3000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 2250 watts, allowance has been made in preparing this tabulation for an additional 5250 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

Separate cooling of the tube base is required and is accomplished by directing approximately 120 cfm of air horizontally through the socket from the side. It is preferable to direct this air through three equally spaced ducts.

The well in the center of the baseplate of the tube is a critical area which requires cooling to maintain envelope temperatures less than 250°C. For most applications, 1 to 2 CFM of air directed through the center of the socket is sufficient for this purpose.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

FILAMENT OPERATION - The peak emission at rated filament voltage of the EIMAC 4CX35,000C is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CX35,000C by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CX35,000C. At some point in filament voltage there will be a noticeable reduction in plate current, or power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appears to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked to maintain proper operation.

Filament starting current must be limited to a maximum of 900 amperes.

Voltage between filament and the base plates of tube and SK-1500 socket, must not exceed 100 volts.

GRID OPERATION - The 4CX35,000C grid has a maximum dissipation rating of 500 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible. The maximum grid circuit resistance should not exceed 100,000 ohms per tube.

SCREEN OPERATION - The power dissipated by the screen of the 4CX35,000C must not exceed 1750 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 1750 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX35,000C is 35,000 watts. When the 4CX35,000C is operated as a plate-modulated rf amplifier, under carrier conditions, the maximum plate dissipation is 23,000 watts.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capaci-

tance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

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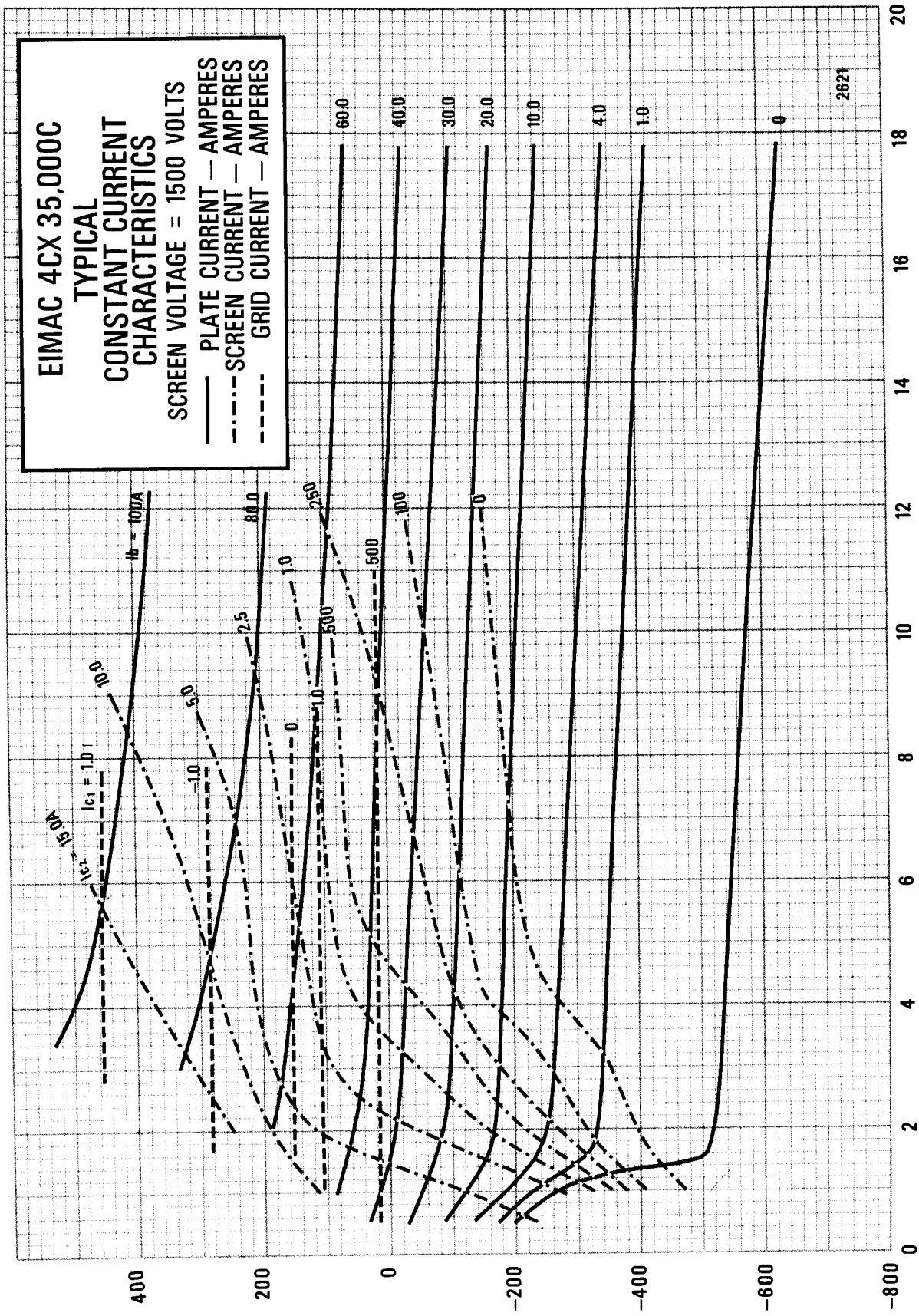
FAULT PROTECTION - In addition to normal cooling airflow interlock and plate and screen over-current interlocks, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high plate voltage.

In all cases some protective resistance, at least one or two ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur. Where stored energy is high, it is recommended that some form of electronic crowbar be used which will discharge power supply capacitors in as short a time as possible following indication of start of a plate arc.

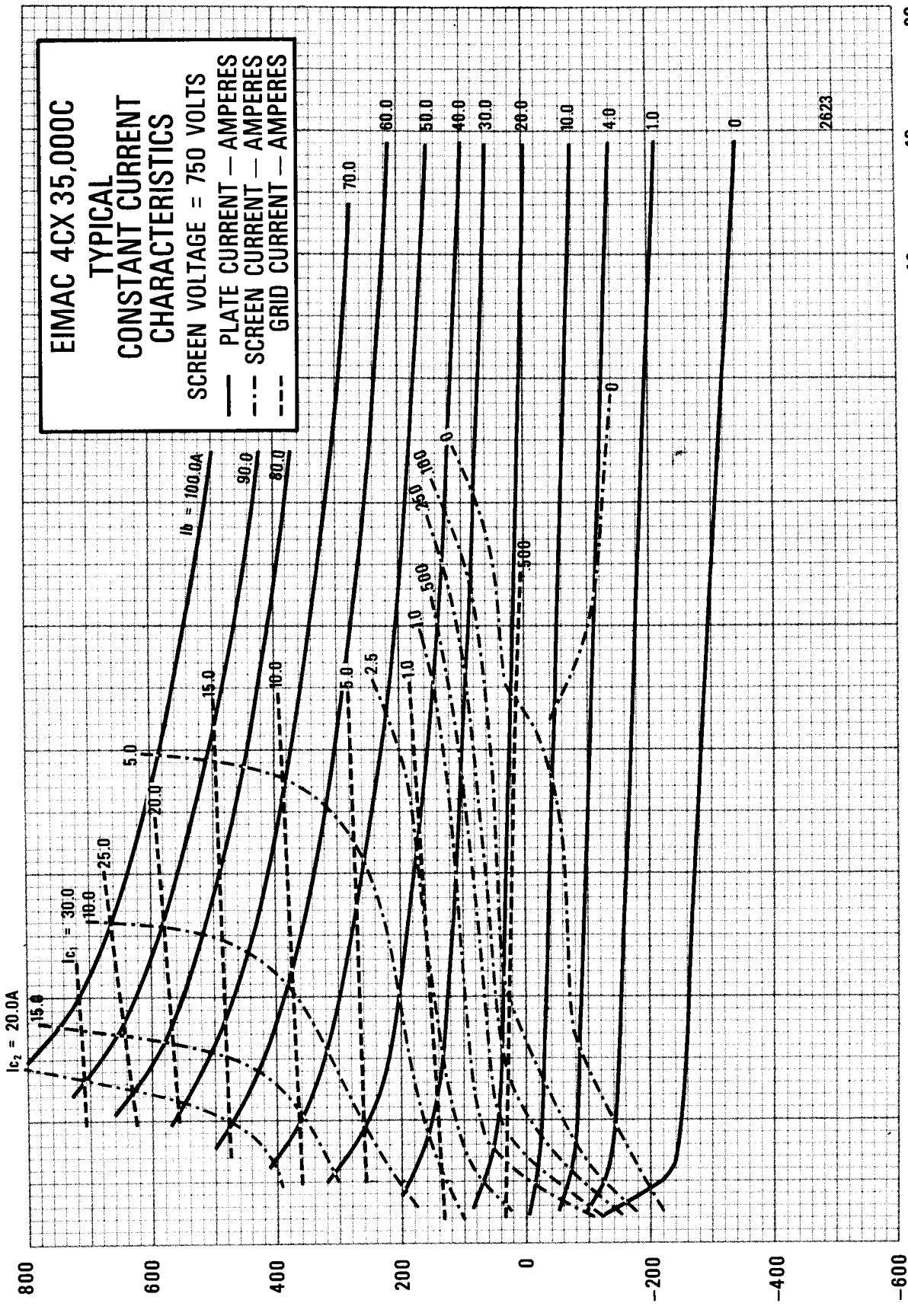
X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The 4CX35,000C, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

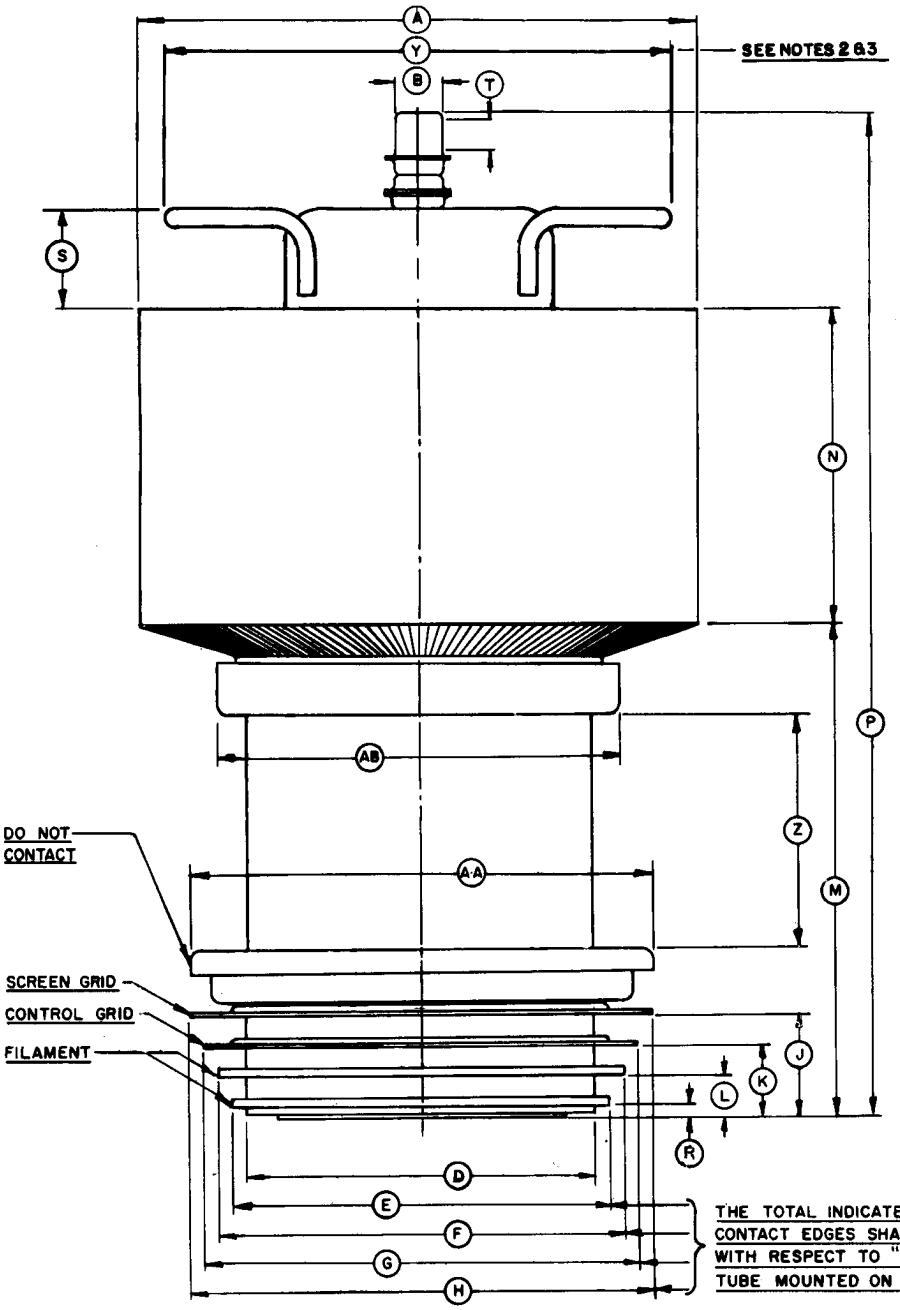
Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

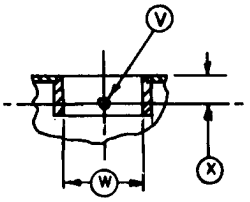
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


EIMAC 4CX 35,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
60.0
40.0
30.0
20.0
10.0
4.0
1.0
0
2621
PLATE VOLTAGE—KILOVOLTS
GRID VOLTAGE—VOLTS

#2621


EIMAC 4CX 35,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—KILOVOLTS
#2623
2623





SECTION A–A

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	9.500	9.750	241.30	247.65
B	0.860	0.890	21.84	22.60
D	5.980	6.020	151.89	152.91
E	6.510	6.560	165.35	166.62
F	6.980	7.020	177.29	178.31
G	7.480	7.520	189.99	191.01
H	7.975	8.015	202.57	203.58
J	1.750	1.800	44.45	45.72
K	1.220	1.270	30.99	32.26
L	0.690	0.740	17.53	18.80
M	8.442	8.692	214.43	220.78
N	5.375	5.625	136.52	142.88
P	17.070	17.340	433.58	440.44
R	0.173	0.213	4.40	5.41
S	1.750		44.45	
T	0.485	0.515	12.32	13.08
V	— —	0.135	— —	3.43
W	1.250	1.270	31.75	32.26
X	0.490	0.530	12.45	13.46
Y	— —	8.750	— —	222.25
Z	3.750		95.25	
AA	8.000		203.20	
AB	6.875		174.63	

NOTES:
1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. DIM. Y IS MAXIMUM DIA. ACROSS CORNERS
3. HANDLE LATERAL AXIS ORIENTATION WITH BASE LOCK PIN IS AS SHOWN.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

8350
4CW50,000C

RADIAL-BEAM POWER TETRODE



The Eimac 8350/4CW50,000C is a ceramic-metal, water cooled power tetrode intended for use at the 50 to 150 kilowatt output power level. It is recommended for use as a Class-C rf amplifier or oscillator, a Class-AB, rf linear amplifier or a Class-AB, push-pull af amplifier or modulator. The 8350/4CW50,000C is also useful as a plate and screen modulated Class-C rf amplifier.

The water cooled anode is rated at 50 kilowatts of plate dissipation with low water flow requirements.

GENERAL CHARACTERISTICS

ELECTRICAL

Filament:	Thoriated Tungsten		
	Voltage	10	volts
	Current	300	amps
	Amplification Factor (Grid-Screen) (average)	4.5	

Direct Interelectrode Capacitances, Grounded Cathode:

Input	430	uuf
Output	45	uuf
Feedback	2.3	uuf

Frequency for Maximum Ratings:	30	Mc

MECHANICAL

Base	Special, graduated rings
Maximum Seal Temperature	250°C
Maximum Anode Core Temperature	250°C
Recommended Socket	Eimac, SK-1500
Operating Position	Vertical, base up or down
Maximum Dimensions:	
Height	16.5 inches
Diameter	8.02 inches
Cooling	Water and Forced air
Net Weight	60 pounds
Shipping Weight- (approximately)	85 pounds

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	20,000 MAX. VOLTS
DC SCREEN VOLTAGE	2500 MAX. VOLTS
DC PLATE CURRENT	15.0 MAX. AMPS
PLATE DISSIPATION	50,000 MAX. WATTS
SCREEN DISSIPATION	1750 MAX. WATTS
GRID DISSIPATION	500 MAX. WATTS

TYPICAL OPERATION

DC Plate Voltage	10	15	20	kV
DC Screen Voltage	750	750	750	volts
DC Grid Voltage	-420	-480	-540	volts
DC Plate Current	10.7	10.5	9.7	amps
DC Screen Current	2.25	2.1	1.65	amps
DC Grid Current	1.2	1.15	.89	amps
Peak RF Grid Voltage	680	740	790	volts
Driving Power	815	850	705	volts
Plate Dissipation	23	32	30	kW
Plate Output Power	84	124	165	kW

Note: Maximum plate voltage and plate current cannot be applied simultaneously without exceeding dissipation ratings.

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PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier conditions except where noted)

MAXIMUM RATINGS

DC PLATE VOLTAGE	15,000 MAX. VOLTS
DC SCREEN VOLTAGE	2000 MAX. VOLTS
DC PLATE CURRENT	15.0 MAX. AMPS
PLATE DISSIPATION*	33,000 MAX. WATTS
SCREEN DISSIPATION	1750 MAX. WATTS
GRID DISSIPATION	500 MAX. WATTS

*Corresponds to 50,000 watts at 100 percent sinewave modulation

TYPICAL OPERATION

DC Plate Voltage	10	12.5	15	kV
DC Screen Voltage	750	750	750	volts
Peak AF Screen Voltage (For 100% modulation)	705	675	745	volts
DC Grid Voltage	-490	-500	-510	volts
DC Plate Current	7.4	8.15	8.95	amps
DC Screen Current	1.2	1.4	1.55	amp
DC Grid Current	.470	.650	.790	amp
Peak RF Grid Voltage	670	710	730	volts
Grid Driving Power	315	460	570	watts
Plate Dissipation	14	18.5	24	kW
Plate Output Power	60	83.5	110	kW

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	20,000 MAX. VOLTS
DC SCREEN VOLTAGE	2500 MAX. VOLTS
DC PLATE CURRENT	15.0 MAX. AMPS
PLATE DISSIPATION	50,000 MAX. WATTS
SCREEN DISSIPATION	1750 MAX. WATTS
GRID DISSIPATION	500 MAX. WATTS

* Per Tube

**Approximate value

TYPICAL OPERATION (Two Tubes)

DC Plate Voltage	10	15	20	kV
DC Screen Voltage	1.5	1.5	1.5	kV
DC Grid Voltage	-280	-320	-360	volts
Max-Signal Plate Current	18.4	16.4	17.3	amps
Zero-Signal Plate Current	6.0	4.0	3.0	amps
Max-Signal Screen Current**	.780	.550	.500	amp
Zero-Signal Screen Current	0	0	0	amps
Peak AF Driving Voltage*	260	300	340	volts
Driving Power	0	0	0	watts
Load Resistance, Plate-to-Plate	1140	1980	2590	ohms
Max-Signal Plate Dissipation*	35	38	48	kW
Max-Signal Plate Output Power	114	170	250	kW

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	20,000 MAX. VOLTS
DC SCREEN VOLTAGE	2500 MAX. VOLTS
DC PLATE CURRENT	15.0 MAX. AMPS
PLATE DISSIPATION	50,000 MAX. WATTS
SCREEN DISSIPATION	1750 MAX. WATTS
GRID DISSIPATION	500 MAX. WATTS

*Approximate value

TYPICAL OPERATION, Peak-Envelope or Modulation-Crest Conditions.

DC Plate Voltage	10	15	20	kV
DC Screen Voltage	1.5	1.5	1.5	kV
DC Grid Voltage	-280	-320	-360	volts
Max-Signal Plate Current	9.2	8.2	8.65	amps
Zero-Signal Plate Current	3.0	2.0	1.5	amp
Max-Signal Screen Current*	.390	.275	.250	amp
Peak RF Grid Voltage	260	300	340	volts
Driving Power	0	0	0	watts
Plate Dissipation	35	38	48	kW
Plate Output Power	57	85	125	kW
Resonant Load Impedance	570	990	1295	ohms

NOTE: "TYPICAL OPERATION" data are obtained by calculation from published characteristic curves and confirmed by direct tests. No allowance is made for circuit losses of any kind. Adjustment of the RF grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct RF driving voltage is applied.

APPLICATION

MECHANICAL

MOUNTING – The 4CW50,000C must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET –The Eimac SK-1500 socket is recommended for use with the 4CW50,000C. Base cooling is accomplished by directing 50-100 CFM of air horizontally into the socket from the side. Temperature of the ceramic-metal seals must be limited to 250°C.

COOLING –Anode cooling is accomplished by circulating water through the integral anode-water jacket. A new more efficient design assures adequate cooling with low water flow rates. The table below lists minimum cooling water requirements at various dissipation levels.

Plate Dissipation* (kilowatts)	Water Flow GPM
20	7.2
30	10.2
40	12.9
50	15.2

*Since the power dissipated by the filament represents about 3000 watts and since grid-plus screen dissipation can, under some conditions, represent another 2250 watts, allowance has been made in preparing this tabulation for an additional 5250 watts dissipation.

The cooling table above assumes a water temperature rise of 20°C. Under no circumstances should the outlet water temperature exceed 70°C. Inlet water pressure should not exceed 75 psi. The pressure drop across the anode at full flow is less than 5 psi.

When the tube is mounted in the anode-up position, cooling water must enter the anode-water jacket through the outer connector; the outlet being the center connector; when the tube is mounted in an inverted position (base up) these connections are reversed, that is, the inlet connection is on the center water fitting and the water outlet is connected to the outer anode fitting.

Water flow must be started before applying any voltages to the tube. Water-flow and water temperature interlock switches are suggested for incorporation in any system to prevent tube damage due to inadequacy of flow. It is not necessary to continue water flow after the removal of all power.

ELECTRICAL

FILAMENT OPERATION –The rated filament voltage for the 4CW50,000C is 10.0 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than plus or minus 5 percent from the rated value.

ELECTRODE DISSIPATION RATINGS –The maximum dissipation ratings for the 4CW50,000C must be respected to avoid damage to the tube. An exception is the plate dissipation, which may be permitted to rise above the rated maximum during brief periods, such as may occur during tuning.

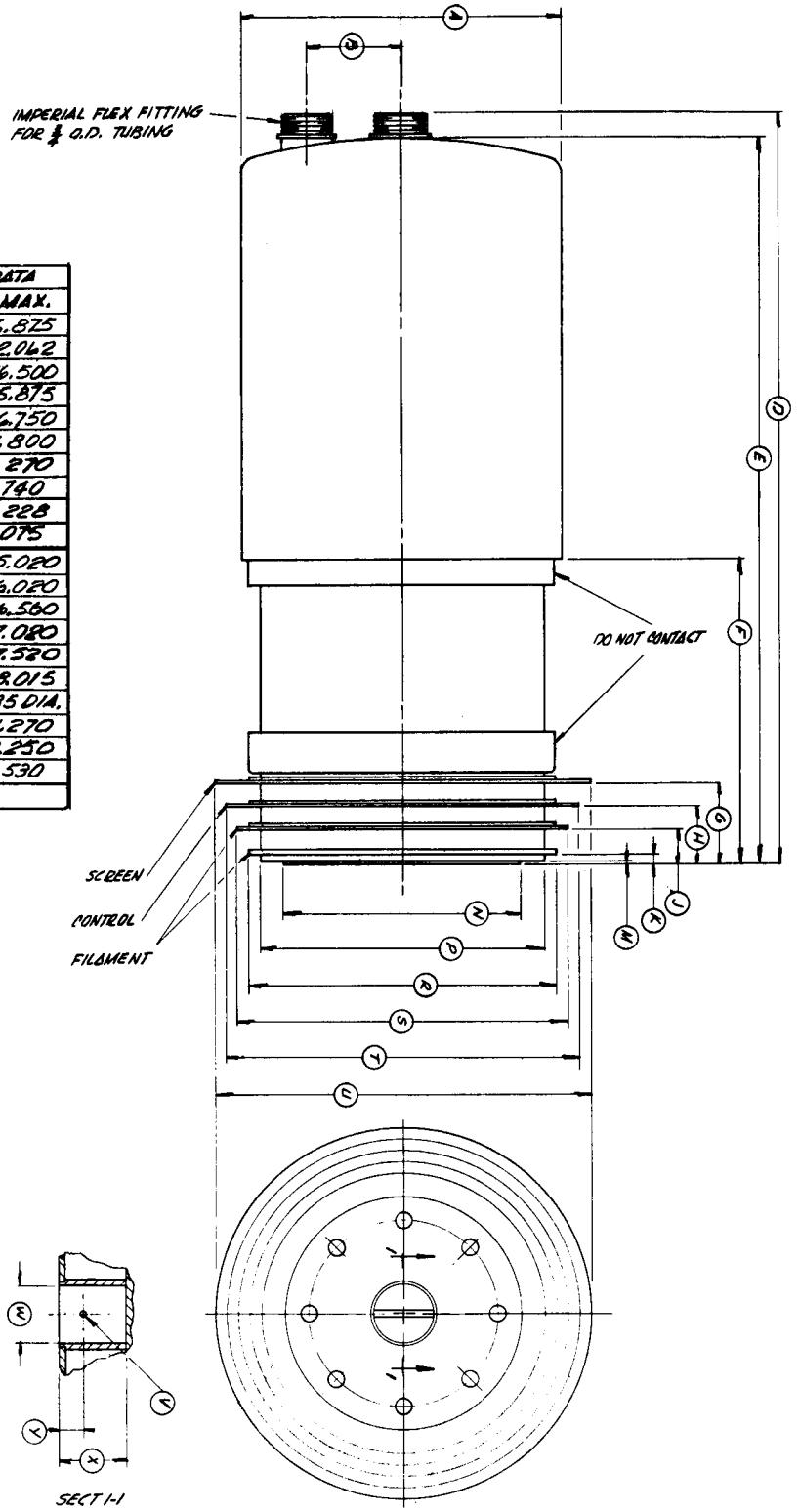
PLATE DISSIPATION – The plate-dissipation rating for the 4CW50,000C is 50,000 watts for most applications, but for Class C plate modulated applications, the maximum allowable dissipation is 33,000 watts for carrier conditions.

CONTROL-GRID OPERATION – The 4CW50,000C control grid has a maximum dissipation rating of 500 watts. Grid dissipation is the product of dc grid current and peak positive grid voltage. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible. The maximum grid circuit resistance should not exceed 100,000 ohms per tube.

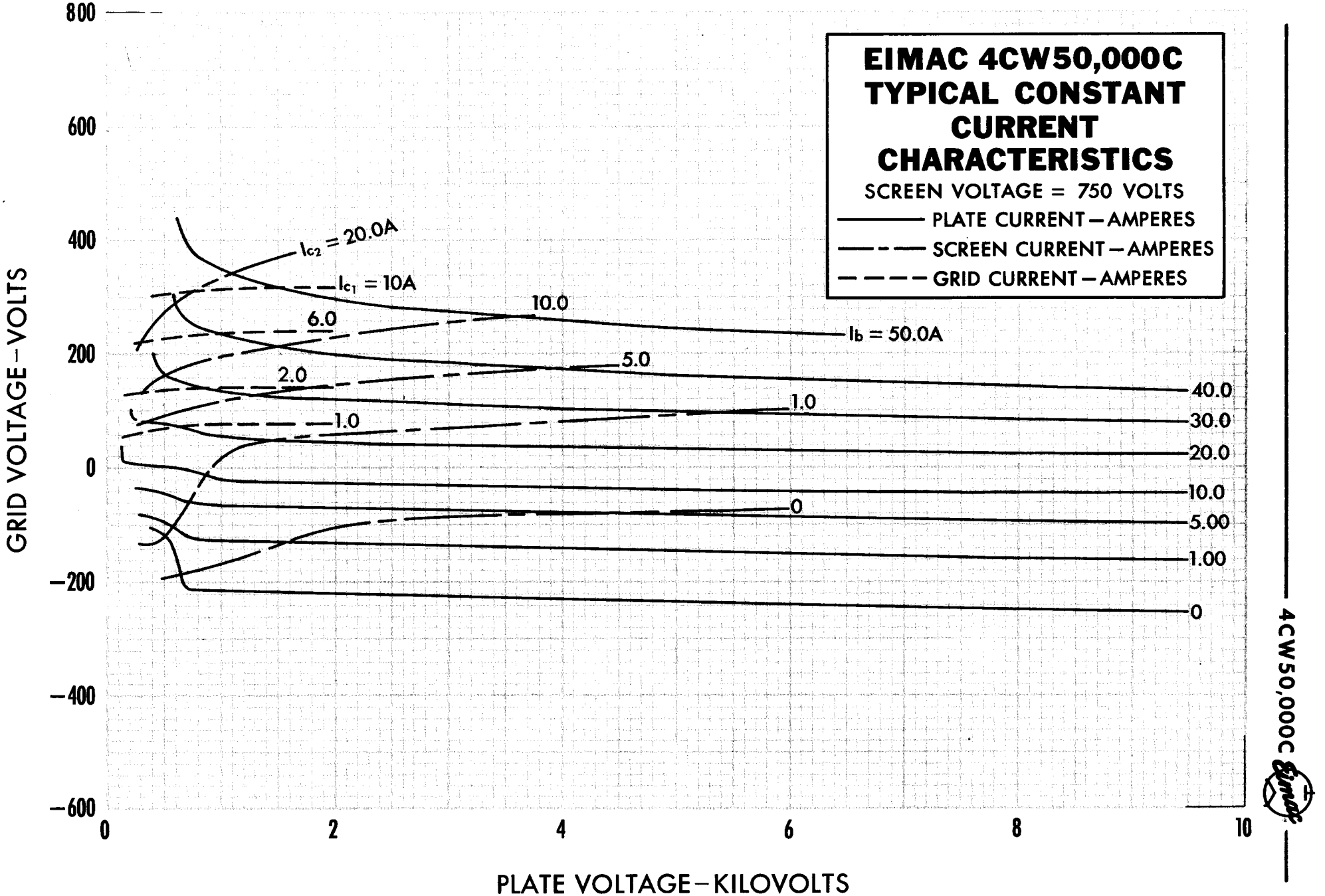
SCREEN-GRID OPERATION – The power dissipated by the screen of the 4CW50,000C must not exceed 1750 watts. Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

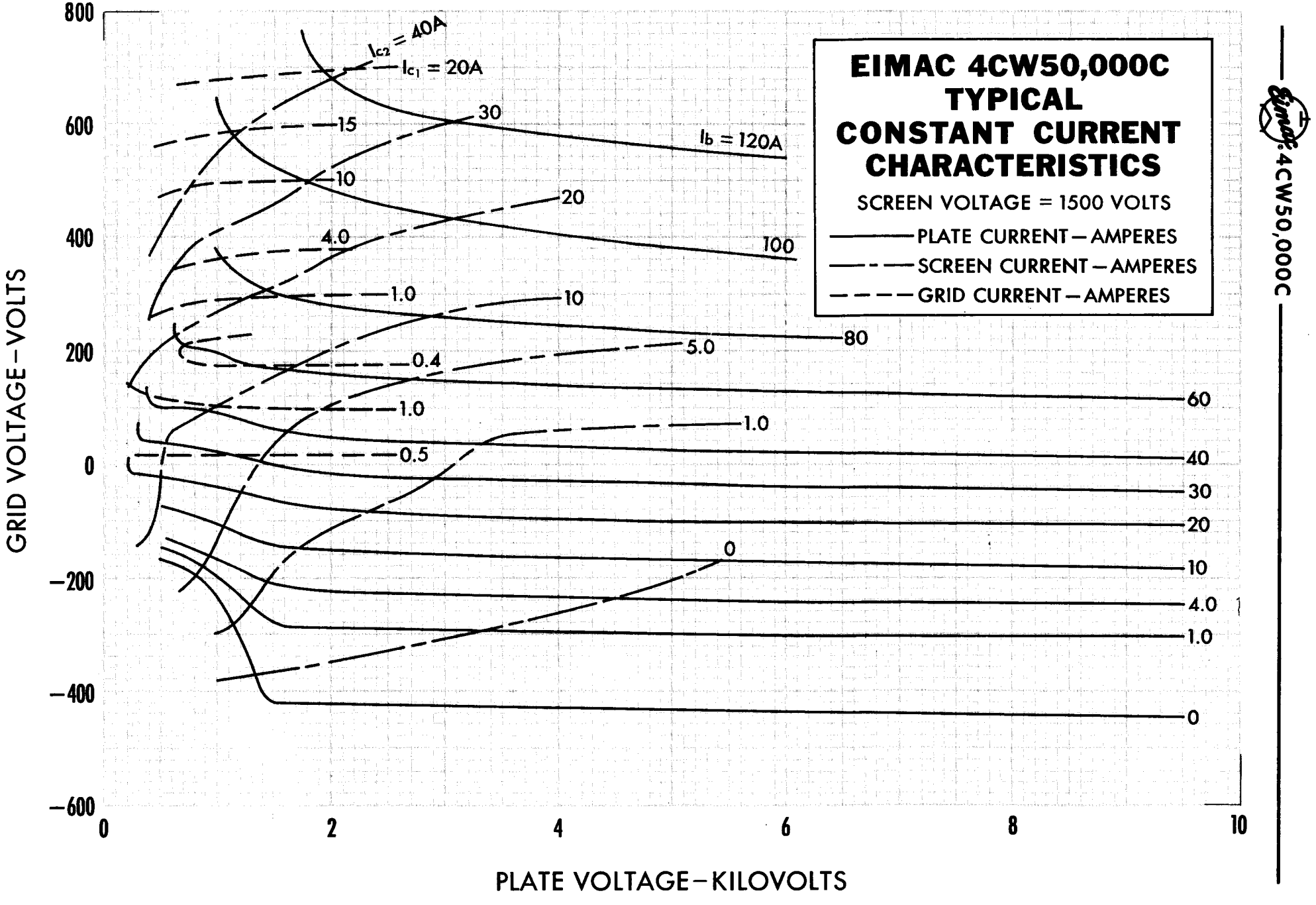
Screen Dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 1750 watts in the event of circuit failure.

SPECIAL APPLICATIONS – If it is desired to operate this tube under conditions widely different from those given here, write to the Power Grid Tube Marketing Department, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California for information and recommendations.



DIMENSION DATA		
REF	MIN.	MAX.
A	6.750	6.875
B	1.968	2.062
D	16.000	16.500
E	15.500	15.875
F	6.500	6.750
G	1.750	1.800
H	1.220	1.270
J	.690	.740
K	.188	.228
M	.045	.075
N	4.980	5.020
P	5.980	6.020
R	6.510	6.560
S	6.980	7.080
T	7.480	7.520
U	7.975	8.015
V		.135 DIA.
W	1.250	1.270
X		1.250
Y	.490	.530


EIMAC 4CW50,000C
TYPICAL CONSTANT
CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
800
600
400
200
0
–200
–400
–600
GRID VOLTAGE – VOLTS
0
2
4
6
8
10
PLATE VOLTAGE – KILOVOLTS
I_{c_2} = 20.0A
I_{c_1} = 10A
I_b = 50.0A
10.0
6.0
5.0
2.0
1.0
1.0
0
40.0
30.0
20.0
10.0
5.00
1.00
0
4CW50,000C
Eimac


EIMAC 4CW50,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
I_{c2} = 40A
I_{c1} = 20A
I_b = 120A
30
15
10
20
4.0
100
1.0
10
80
5.0
0.4
60
1.0
1.0
0.5
40
30
20
0
10
4.0
1.0
0
800
600
400
200
0
−200
−400
−600
0
2
4
6
8
10
GRID VOLTAGE – VOLTS
PLATE VOLTAGE – KILOVOLTS
Eimac 4CW50,000C

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8352
4CX1000K
CERAMIC
POWER TETRODE

The Eimac 8352/4CX1000K is a ceramic and metal, forced-air cooled, radial-beam tetrode with a rated maximum plate dissipation of 1000 watts. It is a low-voltage, high-current tube specifically designed for Class-AB_1 rf linear-amplifier applications where its high gain and low distortion characteristics may be used to advantage. The 8352/4CX1000K is similar to the 8168/4CX1000A but contains a solid screen ring that improves isolation between input and output circuits and permits use of the tube in UHF service.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide Coated, Unipotential				
Heating Time	3			minutes
Heater: Voltage		6.0		volts
Current	8.1		9.9	amperes
Transconductance (I_b=1.0 ampere)		37,000		umhos
Direct Interelectrode Capacitances, Grounded Cathode:*				
Input	77		90	uuf
Output	11		13	uuf
Feedback			0.022	uuf

Direct Interelectrode Capacitances, Grounded Grid and Screen:*	Min.	Nom.	Max.	
Input	32.5		38.0	uuf
Output	11		13	uuf
Feedback			0.004	uuf
Maximum Useable Frequency			400	Mc

*In shielded fixture.

MECHANICAL

Base	Special, breechblock terminal surfaces
Maximum Operating Temperatures:	
Ceramic-to-Metal Seals	250° C
Anode Core	250° C
Recommended Socket	Eimac SK-820 or SK-830
Operating Position	Any
Maximum Over-All Dimensions:	
Height	4.8 inches
Diameter	3.37 inches
Net Weight	27 ounces

RADIO-FREQUENCY LINEAR AMPLIFIER—Class AB or B

(Single Side-Band Suppressed-Carrier Operation)

MAXIMUM RATINGS

DC PLATE VOLTAGE	3000 MAX. WATTS
DC SCREEN VOLTAGE	400 MAX. VOLTS
DC PLATE CURRENT	1.0 MAX. AMP
PLATE DISSIPATION	1000 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	0 MAX. WATTS

TYPICAL OPERATION (Frequencies below 30 Mc)

DC Plate Voltage	2000	2500	3000 volts
DC Screen Voltage	325	325	325 volts
DC Grid Voltage[1]	—60	—60	—60 volts
Zero-Signal DC Plate Current	250	250	250 mA
Single-Tone DC Plate Current	890	885	875 mA
Two-Tone Average DC Plate Current	645	650	635 mA
Zero-Signal DC Screen Current*	8	6	5 mA
Single-Tone DC Screen Current*	35	35	35 mA
Two-Tone Average DC Screen Current*	10	8	8 mA
Plate Output Power	930	1300	1630 watts

*Approximate values.

[1]Adjust grid bias to obtain listed zero-signal plate current.

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AUDIO AMPLIFIER OR MODULATOR Class AB$_1$

MAXIMUM RATINGS	
DC PLATE VOLTAGE	3000 MAX. VOLTS
DC SCREEN VOLTAGE	400 MAX. VOLTS
DC PLATE CURRENT	1.0 MAX. AMP
PLATE DISSIPATION	1000 MAX. WATTS
SCREEN DISSIPATION	12 MAX. WATTS
GRID DISSIPATION	0 MAX. WATTS

TYPICAL OPERATION (Sinusoidal wave, two tubes unless noted)

DC Plate Voltage	2000	2500	3000 volts
DC Screen Voltage	325	325	325 volts
DC Grid Voltage[1]	—60	—60	—60 volts
Zero-Signal DC Plate Current	500	500	500 mA
Max-Signal DC Plate Current	1.78	1.77	1.75 amps
Zero-Signal DC Screen Current*	16	12	10 mA
Max-Signal DC Screen Current*	70	70	70 mA
Effective Load, Plate to Plate	2040	2850	3680 ohms
Driving Power	0	0	0 watts
Max-Signal Plate Output Power	1860	2600	3260 watts

*Approximate values.

[1]Adjust grid bias to obtain listed zero-signal plate current.

"TYPICAL OPERATION" data are obtained by calculation from published characteristic curves; NO ALLOWANCE is made for circuit losses. Adjustment of the grid bias to obtain the specific zero-signal plate current is assumed. The screen voltage required to obtain the listed value of maximum plate current, without drawing grid current, MAY VARY from the typical values shown. These conditions are valid to approximately 100 Mc. at higher frequencies, power output will be lower due to tube and circuit losses.

APPLICATION

MECHANICAL

Cooling—Sufficient cooling must be provided for the anode and ceramic-to-metal seals to maintain operating temperatures below the rated maximum values:

Ceramic-to-Metal Seals	250°C
Anode Core	250°C

A flow rate of 25 cubic feet per minute will be adequate for operation at maximum rated plate dissipation at sea level and with inlet air temperatures up to 40°C. Under these conditions, 25 cfm of air flow corresponds to a pressure difference across the tube and socket of 0.2 inch of water column. Experience has shown that if reliable long-life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube.

At higher altitudes and at UHF increased air flow will be required. For example, at an altitude of 10,000 feet, a flow rate of 37 cfm will be required and will be obtained with a pressure drop across tube and socket of 0.3 inch of water column. In selecting a blower for use at high altitudes, care must be taken to assure that the blower is designed to deliver the desired volume of air at the corresponding pressure drop and *at the particular altitude.*

In cases where there is any doubt regarding the adequacy of the supplied cooling, it should be borne in mind that operating temperature is the sole criterion of cooling effectiveness. Surface temperatures may be easily and effectively measured by using one of the several temperature-sensitive paints or sticks available from various chemical or scientific-equipment suppliers. When these materials are used, extremely thin applications must be made to avoid interference with the transfer of heat from the tube to the air stream, which would cause inaccurate indications.

ELECTRICAL

Heater—The rated heater voltage for the 4CX1000K is 6.0 volts. The voltage, as measured at the socket, should be maintained at this value to minimize variations in operation and to obtain maximum tube life. In no case should the voltage be allowed to exceed 5% above or below the rated value.

The cathode and one side of the heater are internally connected.

It is recommended that the heater voltage be applied for a period of not less than 3 minutes before other operating voltages are applied. From an initial cold condition, tube operation will stabilize after a period of approximately 5 minutes.

Control Grid Operation—The grid dissipation rating of the 4CX1000K is zero watts. The design features which make the tube capable of maximum power operation without driving the grid into the positive region also make it necessary to avoid positive-grid operation.

Although the average grid-current rating is zero, peak grid currents of less than five milliamperes as read on a five-milliamperes meter may be permitted to flow for peak-signal monitoring purposes.

Screen Grid Operation—Tetrode tubes may exhibit reversed screen current to a greater or lesser degree depending on individual tube design. This characteristic is prominent in the 4CX1000K and, under some operating conditions, indicated negative screen currents in the order of 25 milliamperes may be encountered.

The maximum rated power dissipation for the screen grid in the 4CX1000K is 12 watts and the screen power should be kept below this level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative. In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage. Experience has shown that the screen will operate within the limits established for this tube if the indicated screen current, plate voltage and drive voltage approximate the 'Typical Operation" values.

The screen supply voltage must be maintained constant for any values of negative and positive screen currents that may be encountered. Dangerously high plate currents may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished in several different ways. A bleeder resistor may be connected from screen to cathode; a combination of VR tubes may be connected from screen to cathode; or an electron-tube regulator circuit may be used in the

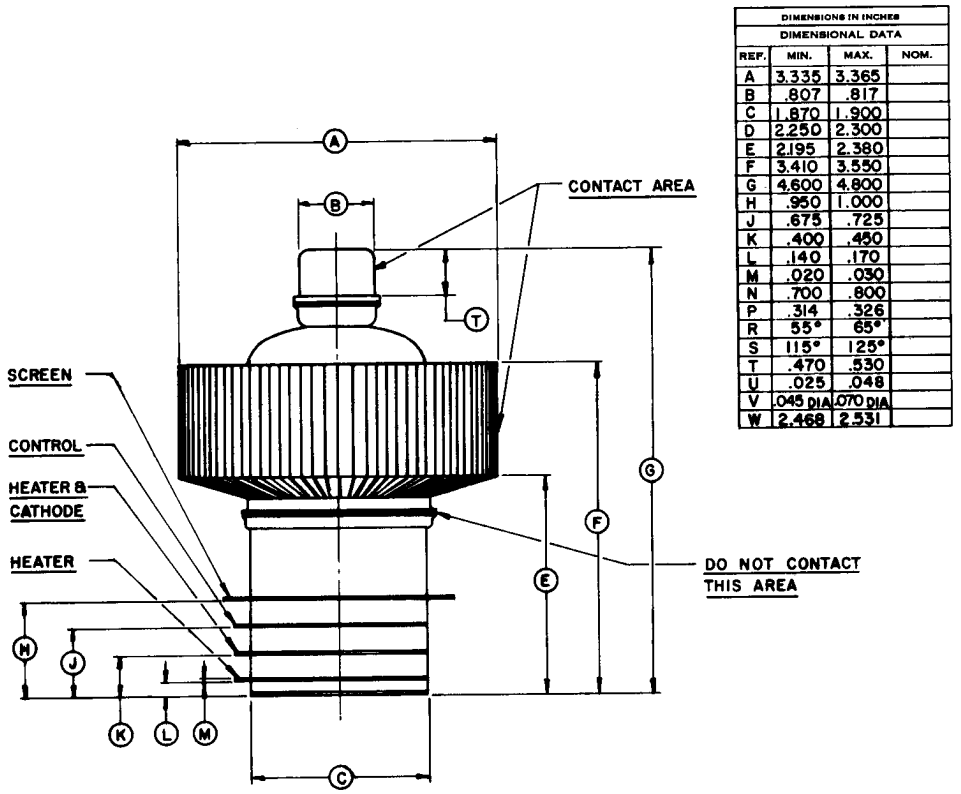
screen supply. It is absolutely essential to use a bleeder if a series electron-tube regulator is employed. The screen bleeder current should approximate 70 milliamperes to adequately stabilize the screen voltage. It should be observed that this bleeder power may be usefully employed to energize low-power stages of the transmitter.

Plate Operation—The maximum rated plate dissipation power is 1000 watts. Except for brief periods during circuit adjustments, this maximum value should not be exceeded.

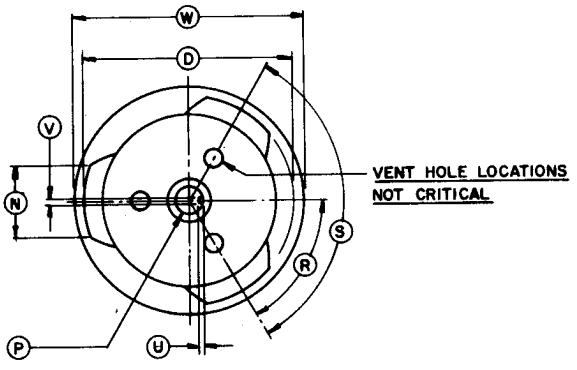
The top cap on the anode cooler may be used as a plate terminal at low frequencies or a circular clamp or spring-finger collet encircling the cylindrical outer surface of the anode cooler may be used at high frequencies.

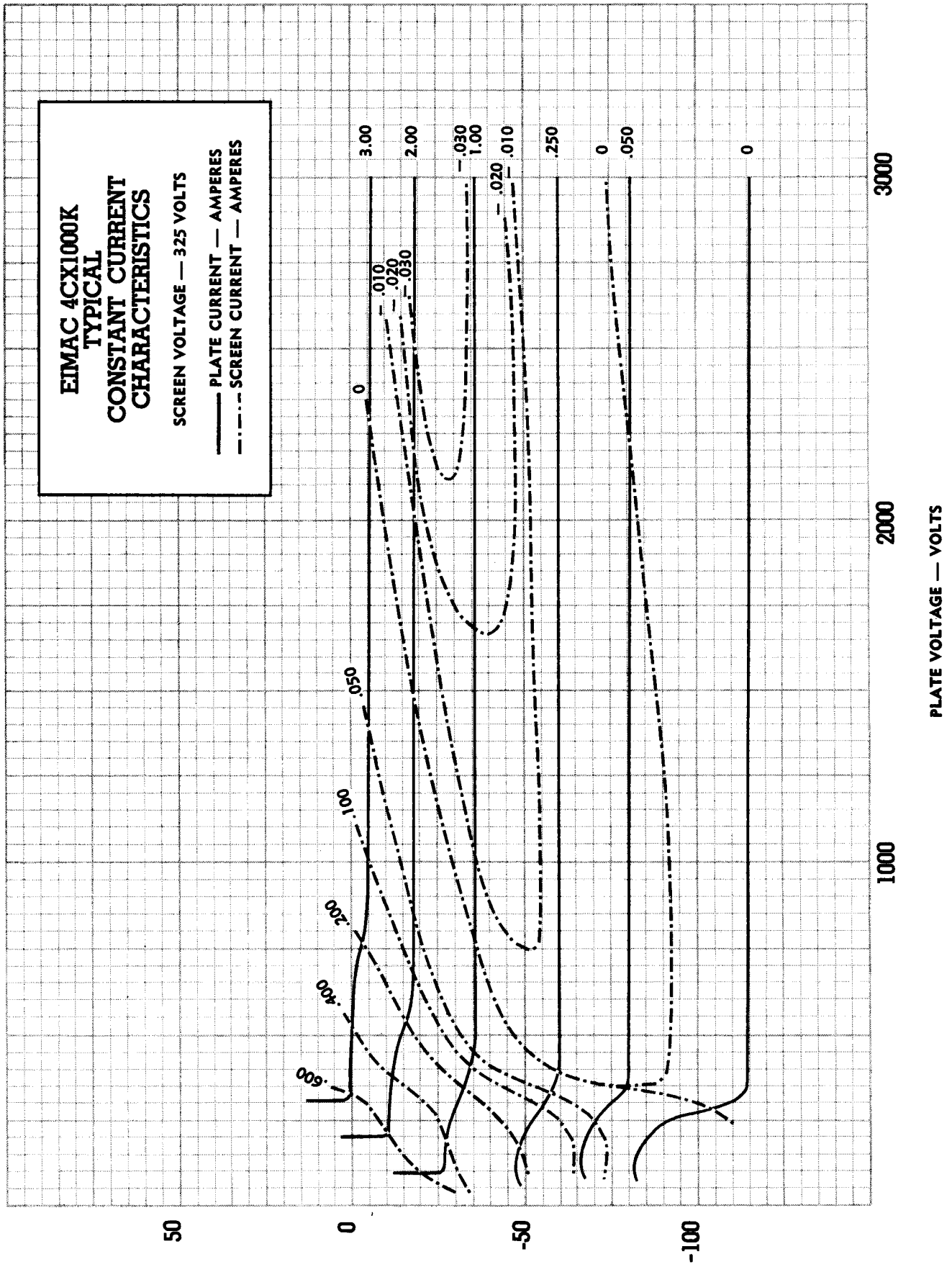
Points of electrical contact with the anode cooler should be kept clean and free of oxide to minimize radio-frequency losses. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

Special Applications — If it is desired to operate this tube under conditions different from those given here, write to the Power Grid Tube Marketing, EIMAC, Division of Varian, San Carlos California, for information and recommendations.

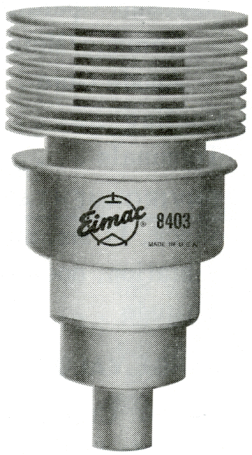


DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	3.335	3.365	
B	.807	.817	
C	1.870	1.900	
D	2.250	2.300	
E	2.195	2.380	
F	3.410	3.550	
G	4.600	4.800	
H	.950	1.000	
J	.675	.725	
K	.400	.450	
L	.140	.170	
M	.020	.030	
N	.700	.800	
P	.314	.326	
R	55°	65°	
S	115°	125°	
T	.470	.530	
U	.025	.048	
V	.045 DIA	.070 DIA	
W	2.468	2.531	




EIMAC 4CX1000K
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 325 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
3.00
2.00
1.00
.250
0
.050
.030
.020
.010
.100
.200
.400
.600
50
0
-50
-100
1000
2000
3000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

The EIMAC Type 8403 is a planar triode featuring frequency stability and an arc resistant cathode of high emission capability assuring stable operation under adverse conditions involving a wide ambient temperature range and varying plate dissipation. This construction, in combination with the proper plate series impedance, reduces to a minimum the possibility of cathode failures due to voltage surges. Other features of this type include high transconductance, high mu, and low interelectrode capacitances coupled with the great mechanical strength of metal/ceramic construction. The cathode is an indirectly heated disc requiring only minimal heater power. The design of the tube permits operation from low frequencies up to 3.0 GHz as a grid-pulsed, plate-pulsed, or CW oscillator, amplifier, or frequency multiplier.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	6.3 ± 0.3 V
Current, at 6.3 volts	1.3 A
Transconductance (Average):	
I_b = 160 mA (200 mA/cm^2)	30 mmhos
Amplification Factor (Average):	80
Direct Interelectrode Capacitance (grounded cathode) [2]	
Cin	8.0 pF
Cout (maximum)	0.065 pF
Cgp	3.1 pF
Cut-off Bias (maximum)[3]	-30 V max
Frequency of Maximum Rating:	
CW	2500 MHz
Plate or Grid-Pulsed	3000 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.
3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

(Effective 12-1-71) © by Varian

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MECHANICAL

Maximum Overall Dimensions:	
Length	2.386 in; 60.60 mm
Diameter	1.264 in; 32.11 mm
Net Weight	2.04 oz; 58 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Forced Air
Terminals	Coaxial, special

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axis	10 G
Altitude	60,000 ft.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.3 volts	1.20	1.40	A
Cathode Warmup Time	60	---	sec.
Interelectrode Capacitance [1]			
Cin	7.5	9.0	pF
Cout	---	0.065	pF
Cgp	2.95	3.25	pF

1. Capacitance value for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE(grid pulsed)	2500	VOLTS
PEAK PULSE PLATE VOLTAGE (plate pulsed)	3500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	250	VOLTS
PULSE PLATE CURRENT	5.0	AMPERES
PULSE GRID CURRENT	2.0	AMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling [1]	100	WATTS
GRID DISSIPATION (Average)	2.0	WATTS
FREQUENCY	3.0	GHz
PULSE DURATION [2]	6.0	μs
DUTY FACTOR [2]	.0033	

OPERATING CONDITIONS for 8403 in Representative Application

GRID PULSED OSCILLATOR

Frequency	1.09	GHz
Heater Voltage	6.3	V
DC Plate Voltage	2000	Vdc
DC Grid Voltage	-150	Vdc
Peak Video Plate Current	4.0	a
Peak Video Grid Current	1.0	a
Useful Power Output (Approx.)	1000	w
Pulse Duration	0.5	μs
Duty Factor	.005	

1. Using EIMAC radiator PN 158601.

2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake, City, Utah.

CW RF POWER AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	2500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-400	VOLTS
Grid positive to cathode	30	VOLTS
DC PLATE CURRENT	150	MILLIAMPERES
DC GRID CURRENT	45	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Forced air cooling[1]	100	WATTS
GRID DISSIPATION (Average)	2	WATTS
FREQUENCY	2.5	GHz

OPERATING CONDITIONS for 8403 in Representative Application

GROUNDED GRID CW OSCILLATOR

Frequency	2500	GHz
Heater Voltage	6.0	V
DC Plate Voltage	900	Vdc
DC Grid Voltage (Approx.)	-20	Vdc
DC Plate Current	140	mAdc
DC Grid Current	15	mAdc
Useful CW Power Output	25	W

1. Using EIMAC radiator PN 158601.

PULSE MODULATOR AND PULSE AMPLIFIER SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000	VOLTS
PEAK PLATE VOLTAGE	3500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	+150	VOLTS
PULSE CATHODE CURRENT	7.5	AMPERES
DC PLATE CURRENT	150	MILLIAMPERES

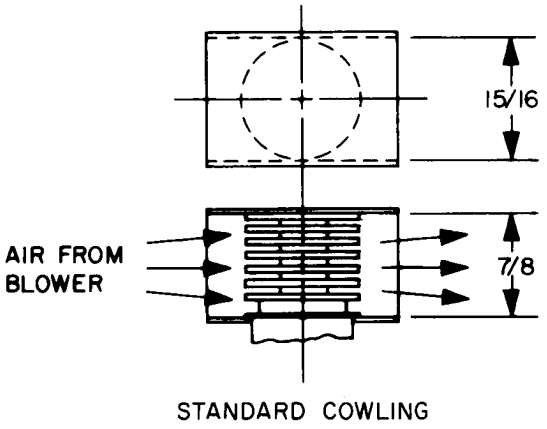
AVERAGE PLATE DISSIPATION		
Forced Air Cooling 1.	100	WATTS
GRID DISSIPATION (average)	1.5	WATTS
PULSE DURATION[2]	6.0	μs
CUT-OFF MU	60	
DUTY	.0033	

1. Using EIMAC radiator PN 158601.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

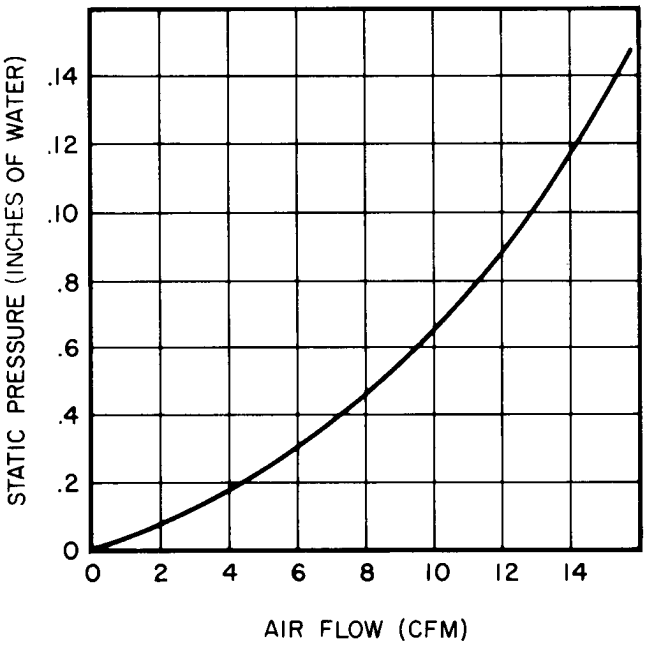
APPLICATION

For general application information please refer to the Planar Triode Operating Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube type. For unusual and special applications consult the nearest Varian Electron Tube Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

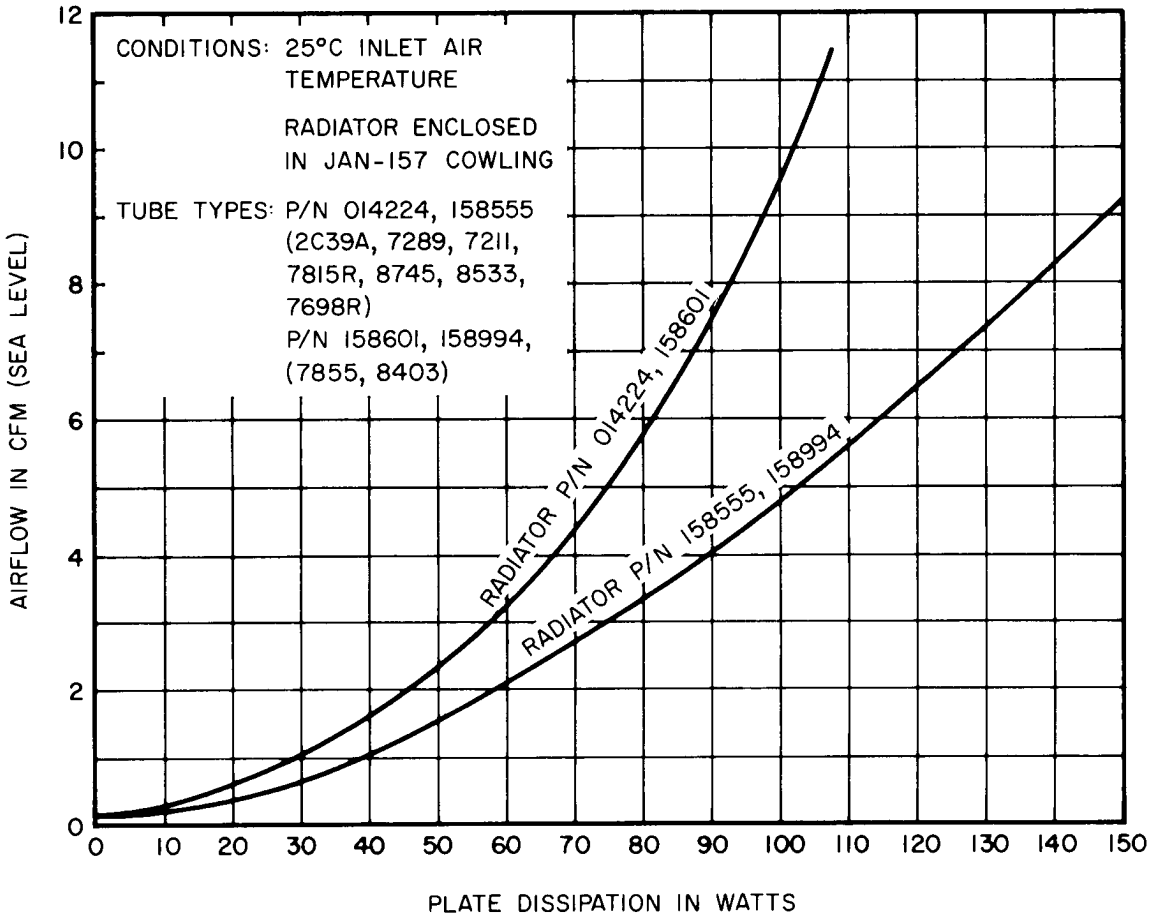
AIRFLOW VS STATIC PRESSURE WITH STANDARD COWLING JAN-157

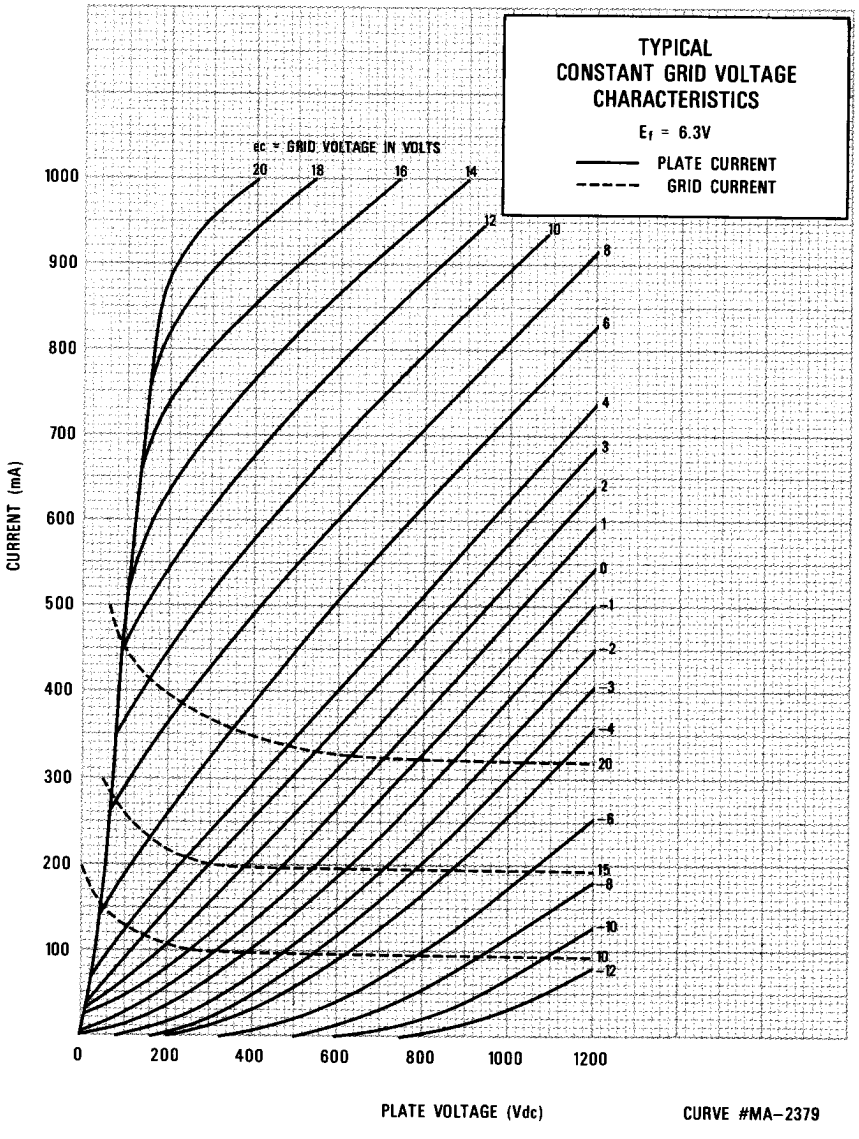


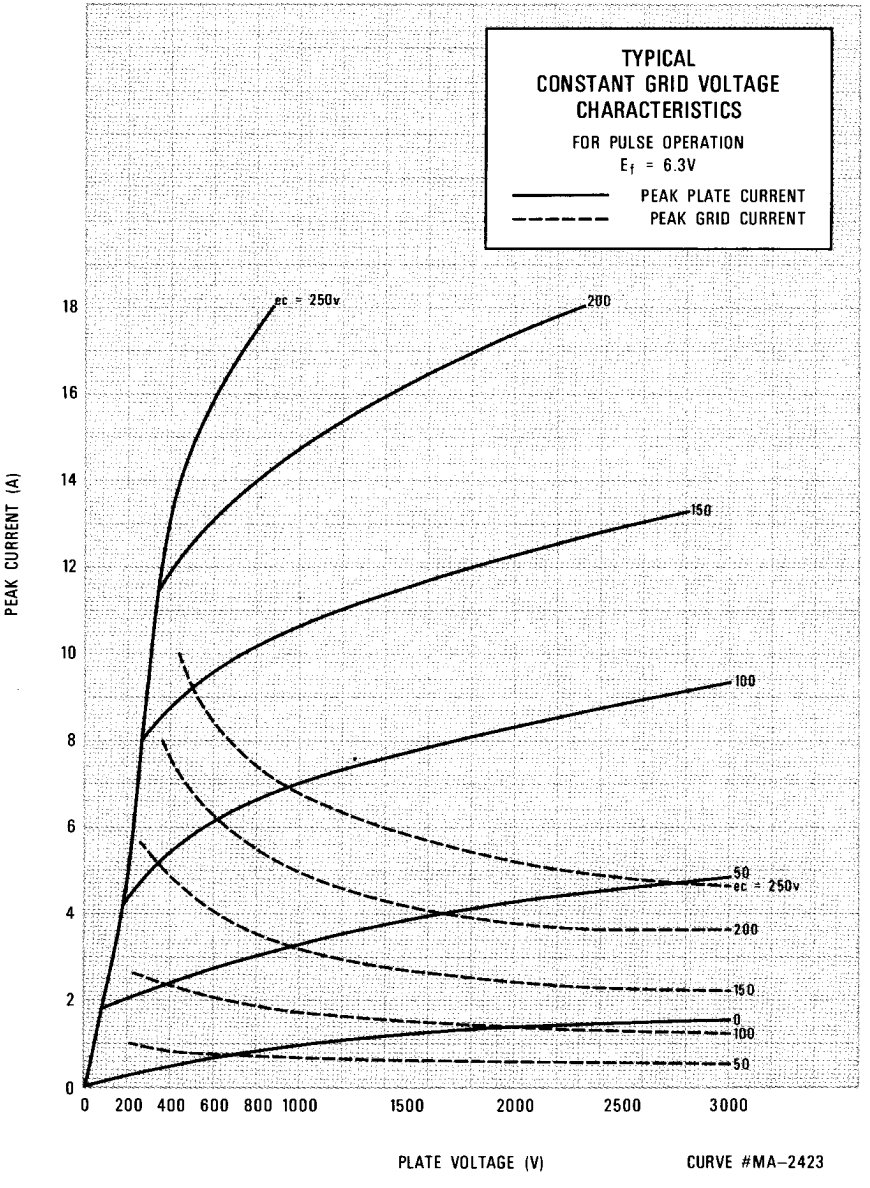
STANDARD COWLING (JAN-157)

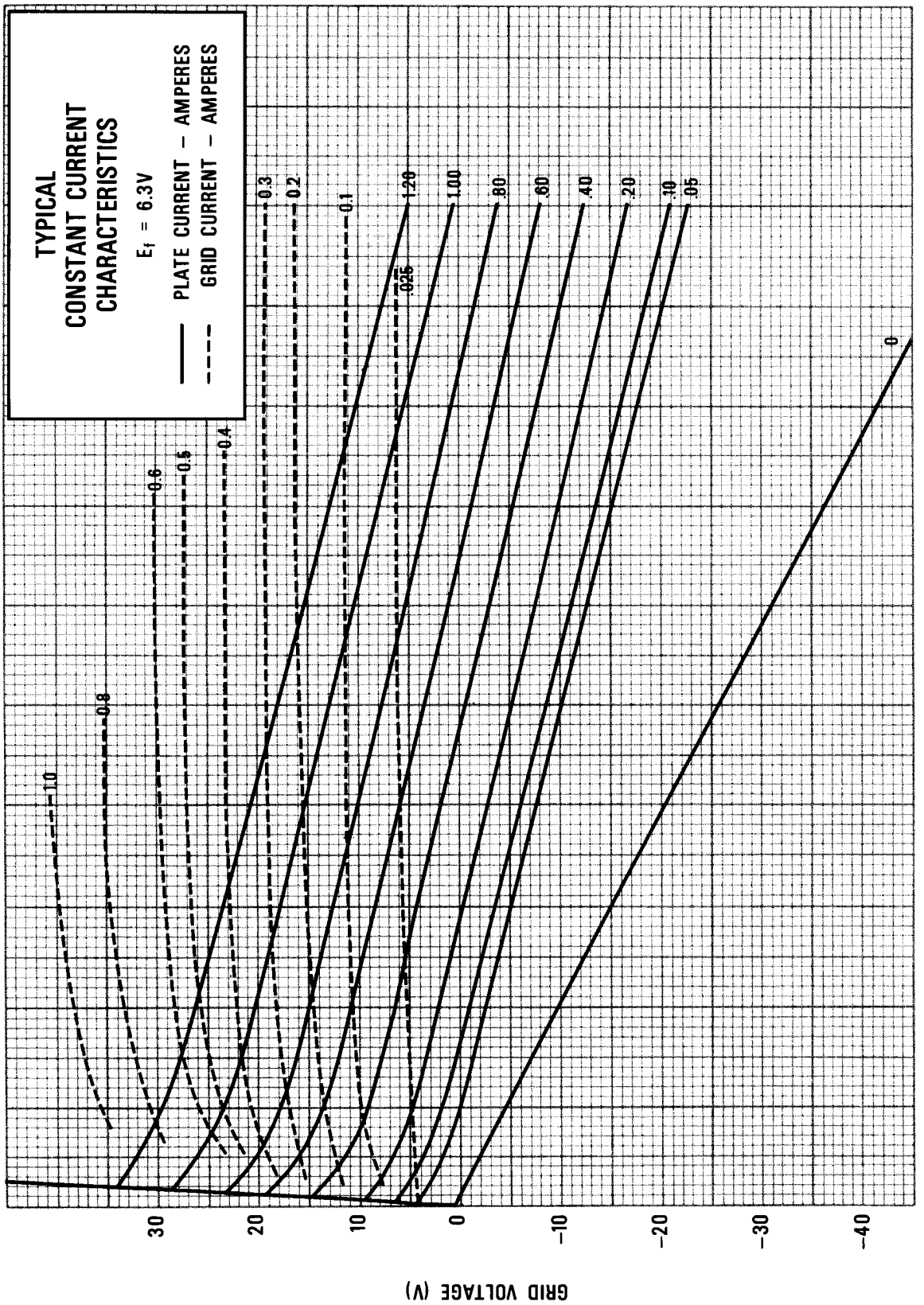


MAXIMUM PLATE DISSIPATION VS COOLING AIRFLOW

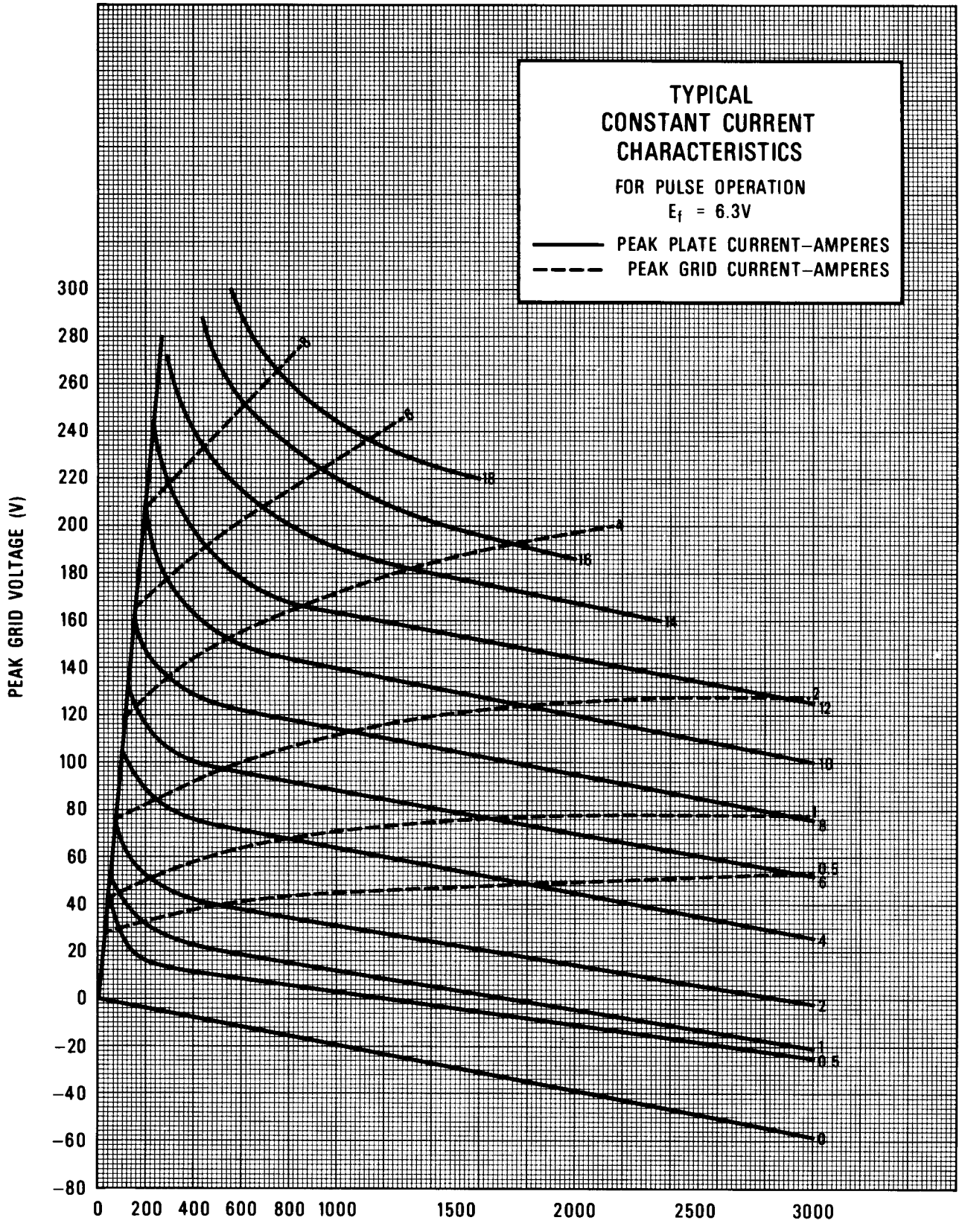


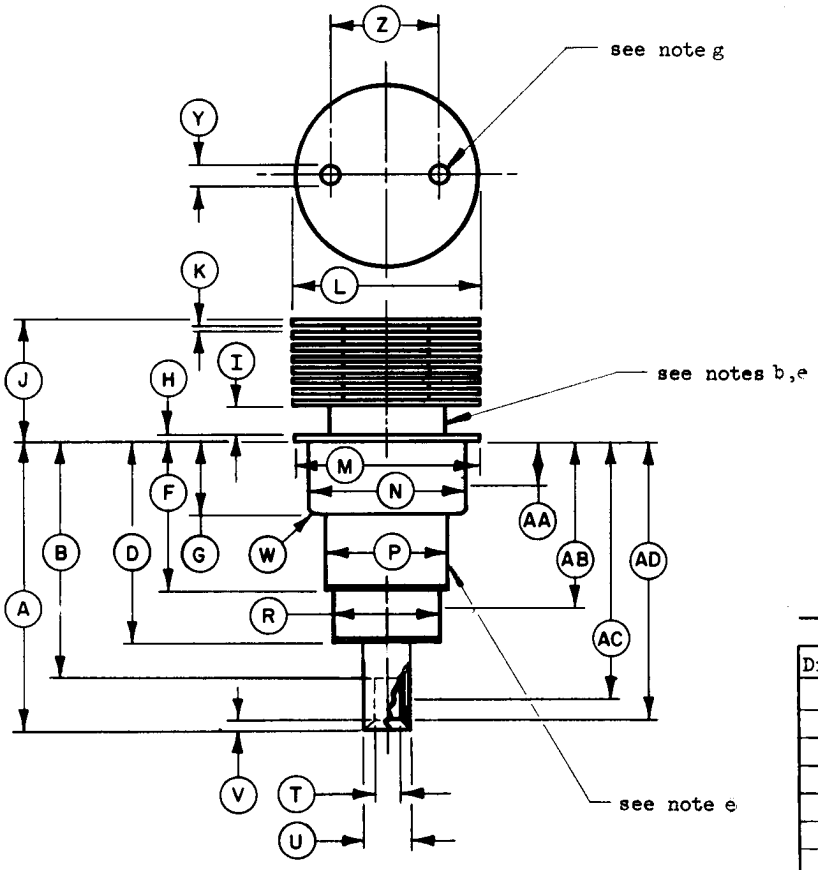

TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
E_f = 6.3V
PLATE CURRENT
GRID CURRENT
ec = GRID VOLTAGE IN VOLTS
20
18
16
14
12
10
8
6
4
3
2
1
0
-1
-2
-3
-4
20
-6
15
-8
-10
10
-12
CURRENT (mA)
1000
900
800
700
600
500
400
300
200
100
0
200
400
600
800
1000
1200
PLATE VOLTAGE (Vdc)
CURVE #MA-2379


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PEAK PLATE CURRENT
PEAK GRID CURRENT
ec = 250v
200
150
100
50
ec = 250v
200
150
0
100
50
PEAK CURRENT (A)
18
16
14
12
10
8
6
4
2
0
0
200
400
600
800
1000
1500
2000
2500
3000
PLATE VOLTAGE (V)
CURVE #MA-2423



CURVE #MA–2380


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PEAK PLATE CURRENT–AMPERES
PEAK GRID CURRENT–AMPERES
PEAK GRID VOLTAGE (V)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
–20
–40
–60
–80
0
200
400
600
800
1000
1500
2000
2500
3000
PLATE VOLTAGE (V)
CURVE #MA–2422



ELECTRODE CONTACT DIMS. (see note a,f)				
Dim. in Inches		Dim.	Dim. in Millim.	
Min.	Max.		Min.	Max.
.035	.361	AA	.89	9.17
1.021	1.101	AB	25.93	27.97
1.219	1.413	AC	30.96	35.89
1.160	1.500	AD	29.46	38.10

DIMENSIONAL DATA (Note a)					
Dim. in Inches			Dim. in Millimeters		
Min.	Max.	Dim.	MIN.	MAX.	
1.500	1.560	A	38.10	39.62	
	1.214	B		30.84	
1.125	1.165	D	28.58	29.59	
.800	.840	F	20.32	21.34	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
.125	.185	I	3.18	4.70	
.766	.826	J	19.46	20.98	
.025	.046	K	.64	1.17	
1.234	1.264	L	31.34	32.11	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	
.752	.792	P	19.10	20.12	
.655	.665	R	16.64	16.89	
.213	.223	T	5.41	5.66	
.315	.325	U	8.00	8.26	
	.086	V		2.18	
	.100	W		2.54	
.105	.145	Y	2.67	3.68	
.650	.850	Z	16.51	21.59	

NOTES:

a. Metric equivalents, to the nearest .01 mm, are given for general information only & are based on 1 inch = 25.4 mm.

b. This surface to be used to measure anode shank temperature.

c. Eccentricity of contact surfaces shall be gaged from center line of reference & shall be as follows:

Contact Surface	TIR Max.	Reference
Anode	.020	Cathode
Grid	.020	Cathode
Heater	.012	Cathode

d. Dias. N,R,T & U shall apply throughout entire lenght as defined by dims. AA,AB,AC,AD respectively.

e. This surface shall not be used for clamping or locating.

f. Electrode Contact dims. are for socket design purposes & are not intended for inspection purposes.

g. Holes for tube extractor thru top fin only

TECHNICAL DATA

8438
4-400A

RADIAL BEAM
POWER TETRODE

The EIMAC 8438/4-400A is a compact, ruggedly constructed power tetrode having a maximum plate dissipation rating of 400 watts. It is intended for use as an amplifier, oscillator or modulator. The low grid-plate capacitance of this tetrode coupled with its low driving-power requirement allows considerable simplification of the associated circuit and driver stage.

The 8438/4-400A is cooled by radiation from the plate and by circulation of forced-air through the base, around the envelope, and over the plate seal. Cooling can be greatly simplified by using an EIMAC SK-400 Series Air System Socket and its accompanying glass chimney. This socket is designed to maintain the correct balance of cooling air between the component parts of the tube.[3]



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	5.0 ± 0.25	V
Current, at 5.0 volts	14.5	A
Transconductance (Average):		
I_b = 100 mA, E_{c2} = 500 volts	4000	μmhos
Amplification Factor (Average):		
Grid to Screen	5.1	
Direct Interelectrode Capacitances (grounded filament)[2]		
Input	12.5	pF
Output	4.7	pF
Feedback	0.12	pF
Frequency of Maximum Rating:		
CW	110	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. In Shielded Fixture.
3. Guarantee applies only when the 4-400A is used as specified with adequate air in the SK-400 or SK-410 Air-System Socket and associated chimney or equivalent.

MECHANICAL

Maximum Overall Dimensions:	
Length	6.375 in; 161.93 mm
Diameter	3.563 in; 90.50 mm

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Printed in U.S.A.

Net Weight	9.0 oz; 255 gm
Operating Position	Vertical, base down or up
Maximum Operating Temperature:	
Plate Seal	225°C
Base Seals	200°C
Cooling	Radiation and forced air
Base	Special 5-pin
Recommended Socket	EIMAC SK-400 Series
Recommended Chimney	EIMAC SK-406
Recommended Heat-Dissipating Connectors:	
Plate	HR-6

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN
Class AB_1

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	800	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Frequencies to 75 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	3000	Vdc
Screen Voltage	750	Vdc
Grid Voltage[1]	-130	Vdc
Zero-Signal Plate Current	80	mAdc
Single Tone Plate Current	290	mAdc
Single-Tone Screen Current[2]	13	mAdc
Useful Output Power	470	W
Resonant Load Impedance	5000	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM Telephony (Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Frequencies to 75 MHz)

Plate Voltage	2500	3000	4000	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-200	-220	-220	Vdc
Plate Current	350	350	350	mAdc
Screen Current[1]	46	46	40	mAdc
Screen Dissipation	23	23	20	W
Grid Current[1]	18	19	18	mAdc
Peak rf Grid Voltage[1]	300	320	320	v
Grid Dissipation	1.8	1.9	1.8	W
Calculated Driving Power[2]	5.4	6.1	5.8	W
Plate Input Power	875	1050	1400	W
Plate Dissipation	235	250	300	W
Plate Output Power	640	800	1100	W

1. Approximate value.
2. Driving Power increases with frequency. At 75 MHz driving power is approximately 12 watts.

TYPICAL OPERATION (110 MHz, two tubes)

Plate Voltage	3500	4000	Vdc
Screen Voltage	500	500	Vdc
Grid Voltage	-170	-170	Vdc
Plate Current	500	540	mAdc
Screen Current	34	31	mAdc
Grid Current	20	20	mAdc
Driving Power[1]	20	20	W
Plate Output Power[1]	1300	1600	W
Useful Output Power	1160	1440	W

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	3200	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	0.275	AMPERE
PLATE DISSIPATION[1]	270	WATTS
SCREEN DISSIPATION[2]	35	WATTS
GRID DISSIPATION[2]	10	WATTS

1. Corresponds to 400 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 75 MHz)

Plate Voltage	2000	2500	3000	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-220	-220	-220	Vdc
Plate Current	275	275	275	mAdc
Screen Current[1]	30	28	26	mAdc
Screen Dissipation	15	14	13	W
Grid Current[1]	12	12	12	mAdc
Grid Dissipation	1.1	1.1	1.1	W
Peak af Screen Voltage[1] (100% modulation)	350	350	350	v
Peak rf Grid Voltage[1]	290	290	290	v
Calculated Driving Power[1]	3.5	3.5	3.5	W
Plate Input Power	550	688	825	W
Plate Dissipation	170	178	195	W
Plate Output Power	380	510	630	W

1. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB, Grid Driven
(Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	800	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Two Tubes) Class AB_1

Plate Voltage	2500	3000	3500	4000	Vdc
Screen Voltage	750	750	750	750	Vdc
Grid Voltage[1/4]	-130	-137	-145	-150	Vdc
Zero-Signal Plate Current	190	160	140	120	mAdc
Max. Signal Plate Current	635	635	610	585	mAdc
Zero-Signal Screen Current	0	0	0	0	mAdc
Max. Signal Screen Current[1]	28	26	32	40	mAdc
Peak af Grid Voltage[2]	130	137	145	150	v
Peak Driving Power[3]	0	0	0	0	w
Max Signal Plate Dissipation[2]	370	400	400	400	W

MAXIMUM RATINGS (Frequencies to 30 MHz, Intermittent Service

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	0.275	AMPERE
PLATE DISSIPATION[1]	270	WATTS
SCREEN DISSIPATION[2]	35	WATTS
GRID DISSIPATION[2]	10	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz, Intermittent Service)

Plate Voltage	2000	2500	3000	3650	Vdc
Screen Voltage	500	500	500	500	Vdc
Grid Voltage	-220	-220	-220	-225	Vdc
Plate Current	275	275	275	275	mAdc
Screen Current[1]	30	28	26	23	mAdc
Screen Dissipation	15	14	13	12	W
Grid Current[1]	12	12	12	13	mAdc
Grid Dissipation	1.1	1.1	1.1	1.2	W
Peak Screen Voltage (100% modulation)	350	350	350	350	v
Peak rf Grid Voltage[1]	290	290	290	315	v
Calculated Driving Power[1]	3.5	3.5	3.5	4.0	W
Plate Input Power	550	688	825	1000	W
Plate Dissipation	170	178	195	235	W
Plate Output Power	380	510	630	765	W

Plate Output Power	850	1100	1330	1540	W
Load Resistance (plate to plate)	6800	8900	11,500	14,000	Ω

TYPICAL OPERATION (Two Tubes) Class AB_2

Plate Voltage	2500	3000	3500	4000	Vdc
Screen Voltage	500	500	500	500	Vdc
Grid Voltage[1/4]	-75	-80	-85	-90	Vdc
Zero-Signal Plate Current	190	160	140	120	mAdc
Max. Signal Plate Current	700	700	700	638	mAdc
Zero-Signal Screen Current	0	0	0	0	mAdc
Max. Signal Screen Current	50	40	38	32	mAdc
Peak af Grid Voltage[2]	133	140	145	140	v
Peak Driving Power[3]	8.6	9.0	10.2	7.0	W
Max. Signal Plate Dissipation[2]	320	363	400	400	W
Plate Output Power	1110	1375	1650	1750	W
Load Resistance (plate to plate)	7200	9100	10,800	14,000	Ω

1. Approximate value.
2. Per tube.
3. Nominal drive power is one-half peak power.
4. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 5.0 volts	13.5	14.7	A
Interelectrode Capacitances [1](grounded filament connection):			
Input	10.7	14.5	pF
Output	4.2	5.6	pF
Feedback	----	0.17	pF

1. In Shielded Fixture.

APPLICATION

MECHANICAL

MOUNTING - The 4-400A must be mounted vertically, base up or down. The socket must be constructed so as to allow an unimpeded flow of air through the holes in the base of the tube and must also provide clearance for the glass tip-off which extends from the center of the base. The metal tube-base shell should be grounded by means of suitable spring fingers. The above requirements are met by the EIMAC SK-400 and SK-410 Air-System Sockets. A flexible connecting strap should be provided between the EIMAC HR-6 cooler on the plate terminal and the external plate circuit. The tube must be protected from severe vibration and shock.

COOLING - Adequate forced-air cooling must be provided to maintain the base seals at a temperature below 200°C, and the plate seal at a temperature below 225°C.

When the EIMAC SK-400 or SK-410 Air-System Socket is used, a minimum air flow of 14 cubic feet per minute at a static pressure of 0.25 inches of water or less, as measured in the socket or plenum chamber at sea level, is required to provide adequate cooling under all conditions of operation. Seal temperature limitations may require that cooling air be supplied to the tube even when the filament alone is on during standby periods.

In the event an Air-System Socket is not used, provision must be made to supply equivalent cooling of the base, the envelope, and the plate lead.

Tube temperatures may be measured with a temperature sensitive paint, spray or crayon, such as manufactured by Tempil Division, Big Three Industrial Gas & Equipment Co., Hamilton Blvd., So. Plainfield, N.J. 07080.

ELECTRICAL

FILAMENT VOLTAGE - For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated voltage of 5.0 volts. Variations in filament voltage must be kept within the range from 4.75 to 5.25 volts.

BIAS VOLTAGE - The dc bias voltage for the 4-400A should not exceed 500 volts. If grid resistor bias is used, suitable means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation, and the grid resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In operation above 50 MHz, it is advisable to keep the bias voltage as low as is practicable.

SCREEN VOLTAGE - The dc screen voltage for the 4-400A should not exceed 800 volts. The screen voltages shown under Typical Operation are representative voltages for the type of operation involved.

PLATE VOLTAGE - The plate-supply voltage for the 4-400A should not exceed 4000 volts in CW and audio applications. In plate-modulated telephony service the dc plate-supply voltage should not exceed 3200 volts, except below 30 MHz, intermittent service, where 4000 volts may be used.

GRID DISSIPATION - Grid dissipation for the 4-400A should not be allowed to exceed 10 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{gk} \times I_c$$

where P_g = Grid dissipation

e_{gk} = Peak positive grid to cathode voltage, and

I_c = dc grid current

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid.

SCREEN DISSIPATION - The power dissipated by the screen of the 4-400A must not exceed 35 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 35 watts in event of circuit failure.

PLATE DISSIPATION - Under normal operating conditions, the plate dissipation of the 4-400A should not be allowed to exceed 400 watts. The anode of the 4-400A operates at a visibly red color at its maximum rated dissipation of 400 watts.

In plate modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 270 watts. The plate dissipation will rise to 400 watts under 100% sinusoidal modulation.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

PULSE SERVICE - For pulse service, the EIMAC 4PR400A should be used.

MULTIPLE OPERATION - To obtain maximum power output with minimum distortion from tubes operated in multiple, it is desirable to adjust individual screen or grid bias voltages so that the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual dc plate currents will be approximately equal for full input signal for class AB_1 operation.

CAUTION - GLASS IMPLOSION - The EIMAC 4-400A is pumped to a very high vacuum, which is contained by a glass envelope. When handling a glass tube, remember that glass is a relatively fragile material, and accidental breakage can result at any time. Breakage will result in flying glass fragments, so safety glasses, heavy clothing, and leather gloves are recommended for protection.

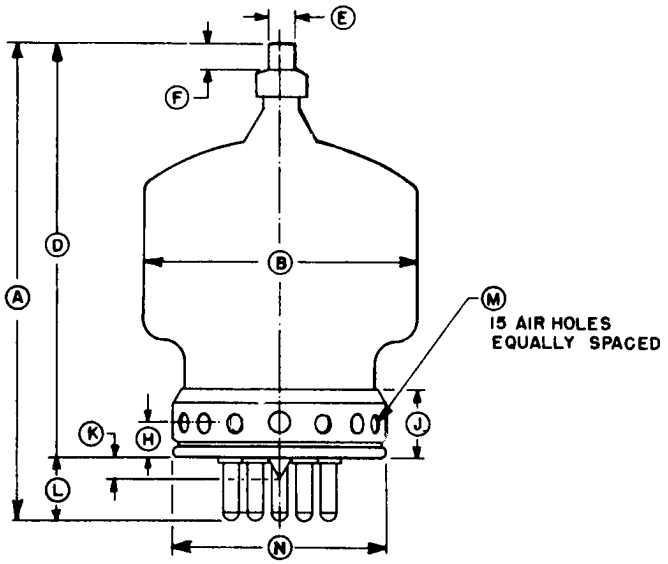
CAUTION-HIGH VOLTAGE - Operating voltage for the 4-400A can be deadly, so the equipment must be designed properly and operating precautions must be followed. Design equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high voltage circuits and terminals, with interlock switches to open the primary circuits of the power supply and to discharge high voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

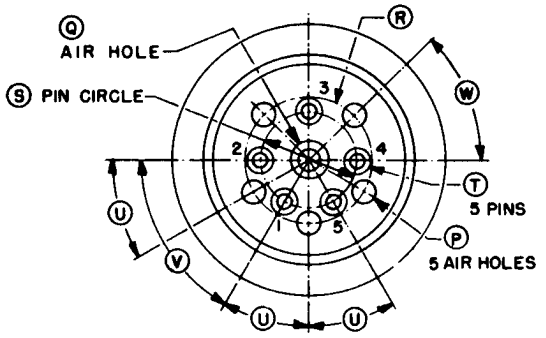
SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

DIMENSIONAL DATA

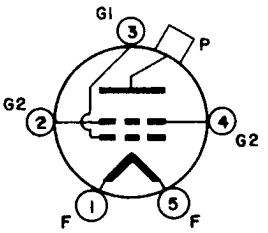
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	5.875	6.375	--	149.23	161.93	--
B	--	3.563	--	--	90.50	--
D	5.125	5.625	--	130.18	142.88	--
E	0.350	0.365	--	8.89	9.27	--
F	0.328	--	--	8.33	--	--
H	--	--	0.438	--	--	11.13
J	--	0.969	--	--	24.61	--
K	--	0.250	--	--	6.35	--
L	--	--	0.750	--	--	19.05
M	--	--	0.250	--	--	6.35
N	--	2.750	--	--	69.85	--
P	--	--	0.312	--	--	7.92
Q	--	--	0.500	--	--	12.70
R	--	--	1.625	--	--	41.28
S	--	--	1.250	--	--	31.75
T	0.185	0.191	--	4.70	4.85	--
U	--	--	30°	--	--	30°
V	--	--	60°	--	--	60°
W	--	--	45°	--	--	45°

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



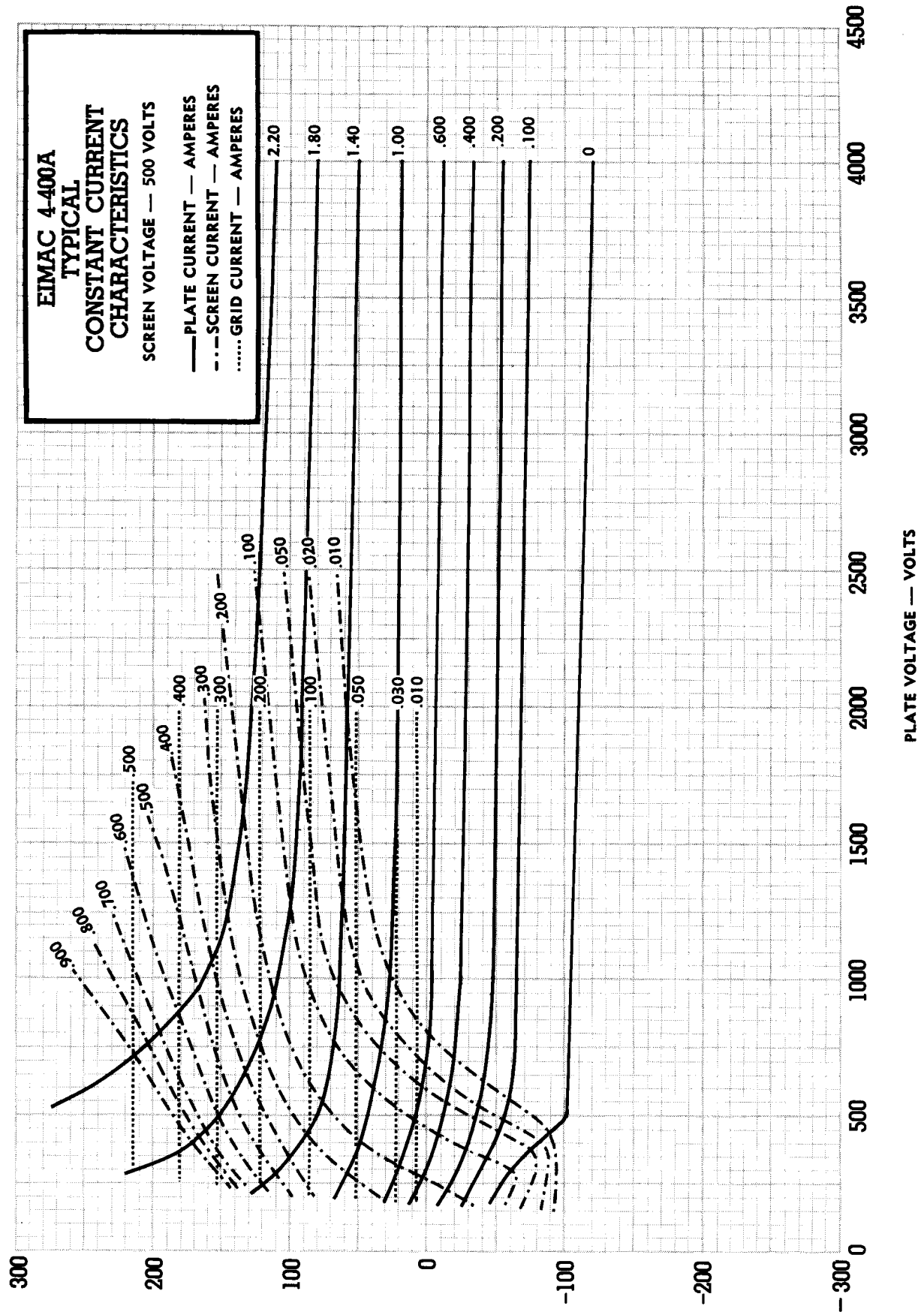


BOTTOM VIEW



NOTE:

Base pins T and tubulation K are so alined that they can be freely inserted in a gage ¼ inch (6.35 mm) thick with hole diameters of .204 (5.18 mm) and .500 (12.70 mm), respectively, located on the true centers by the given dimensions S, U, V.


EIMAC 4-400A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
——PLATE CURRENT — AMPERES
-·-·SCREEN CURRENT — AMPERES
.....GRID CURRENT — AMPERES
2.20
1.80
1.40
1.00
.600
.400
.200
.100
0
.100
.050
.020
.010
.030
.010
.050
.800
.700
.600
.500
.500
.400
.400
.300
.300
.200
.200
.100
.500
.800
.900
300
200
100
0
-100
-200
-300
0
500
1000
1500
2000
2500
3000
3500
4000
4500
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

8533

TECHNICAL DATA

PLANAR TRIODE

The EIMAC Type 8533 is a planar triode designed for use as a grid- or plate-pulsed oscillator, amplifier, frequency multiplier, or switch tube at high plate voltages. The tube will operate from low frequencies up to 3.0 GHz. The extended grid-to-anode insulator and a matrix cathode of the arc resistant extended interface type permit reliable operation up to 8 kVdc in RF applications. Other features of this tube type include high transconductance, high mu, and high current capability coupled with great mechanical strength permitting operation at elevated temperatures. The compact metal and ceramic coaxial construction coupled with low interelectrode capacitances make this tube well suited for operation in line type circuits at lower frequencies as well as in cavity resonators at the higher frequencies. The cathode is an indirectly heated disc requiring only minimal heater power.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	6.3 ± 0.3 V
Current, at 6.3 volts	1.3 A
Transconductance (Average):	
I_b = 160 mA (200 mA/cm^2)	30 mmhos
Amplification Factor (Average):	145
Direct Interelectrode Capacitance (grounded cathode)[2]	
Cin	8.0 pF
Cout	0.06 pF
Cgp	1.65 pF
Cut-off Bias[3]	-30 V max.
Frequency of Maximum Rating:	
CW	3000 MHz
Plate or Grid-Pulsed	3000 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design..
2. Capacitance values are for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature,the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.
3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

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MECHANICAL

Maximum Overall Dimensions:	
Length	2.701 in; 68.60 mm
Diameter	1.264 in; 32.11 mm
Net Weight	63 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Forced Air
Terminals	Coaxial, special

ENVIRONMENTAL

Shock: 11 ms, non-operating	60 G
Vibration: Operating, All Axis	10 G
Altitude: max., in suitably designed circuit	60,000 ft.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.3 volts	1.20	1.40	A
Cathode Warmup Time	60	---	sec.
Interelectrode Capacitance[1] (grounded cathode connection)			
Cin	7.00	9.00	pF
Cout	---	0.06	pF
Cgp	1.50	1.80	pF

1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE (grid pulsed)	8000	VOLTS
PEAK PULSE PLATE VOLTAGE (plate pulsed)	10,000	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	150	VOLTS
PULSE PLATE CURRENT	5.0	AMPERES
PULSE GRID CURRENT	2.5	AMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	100	WATTS
GRID DISSIPATION (Average)	1.5	WATTS
FREQUENCY	3.0	GHz
PULSE DURATION[2]	6.0	μs
DUTY FACTOR[2]	.0033	

1. Using EIMAC radiator PN 014224.

2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

PULSE MODULATOR AND PULSE AMPLIFIER SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	8000	VOLTS
PEAK PLATE VOLTAGE	10,000	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	150	VOLTS
PULSE CATHODE CURRENT	7.5	AMPERES
DC PLATE CURRENT	150	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	100	WATTS
GRID DISSIPATION (Average)	1.5	WATTS
PULSE DURATION[2]	6.0	μs
DUTY FACTOR[2]	.0033	
CUT-OFF MU	90	

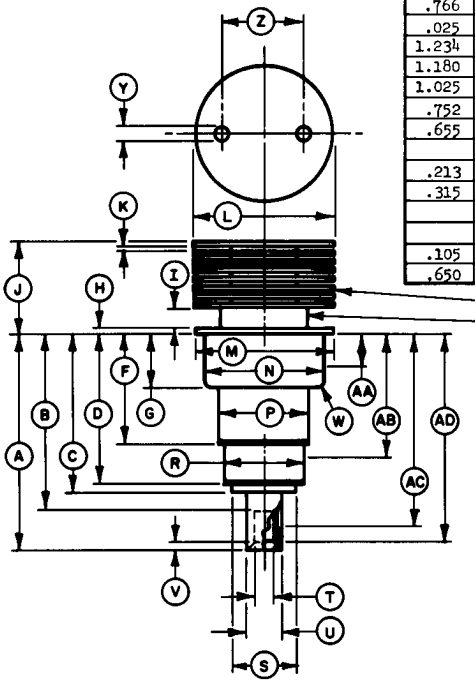
1. Using EIMAC radiator PN 014224.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

APPLICATION

For general application information please refer to the Planar Triode Operating Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube type. For unusual and special applications consult the nearest Varian Electron Tube Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

ELECTRODE CONTACT DIMENSION				
DIM	MIN.	MAX.	MIN.	MAX.
AA	.035	.361	.89	9.17
AB	1.185	1.265	30.10	32.14
AC	1.534	1.728	38.96	43.89
AD	1.475	1.815	37.47	46.10
	DIM. IN INCHES		DIM. IN MILLIMETERS	

DIMENSION DATA					
DIM. IN INCHES			DIM. IN MILLIMETERS		
MIN.	MAX.	DIM	MIN.	MAX.	NOTES
1.815	1.875	A	46.10	47.62	
	1.534	B		38.96	
	1.475	C		37.46	
1.289	1.329	D	32.74	33.76	
.970	1.010	F	24.64	25.65	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
.125	.185	I	3.18	4.70	
.766	.826	J	19.46	20.98	
.025	.046	K	.64	1.17	
1.234	1.264	L	31.34	32.11	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	e
.752	.792	P	19.10	20.12	
.655	.665	R	16.64	16.89	
	.545	S		13.84	
.213	.223	T	5.41	5.66	e
.315	.325	U	8.00	8.26	e
	.086	V		2.18	
	.100	W		2.54	
.105	.145	Y	2.67	3.68	c
.650	.850	Z	16.51	21.59	



NOTES:

a. METRIC EQUIVALENTS, TO THE NEAREST .01 mm, ARE GIVEN FOR GENERAL INFORMATION ONLY & ARE BASED ON 1 inch = 25.4 mm.

b. THIS SURFACE SHALL BE USED TO MEASURE ANODE SHANK TEMPERATURE.

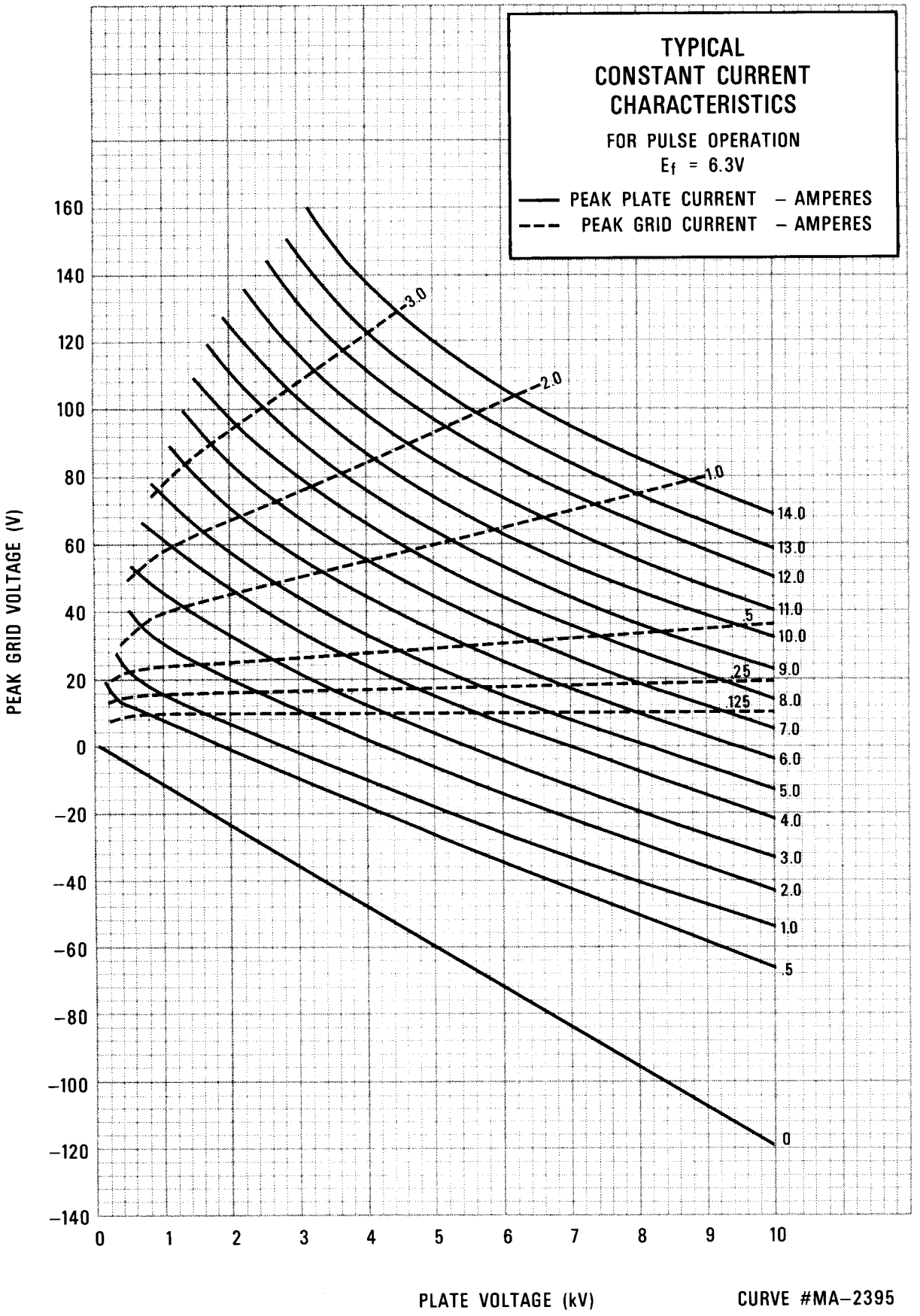
c. HOLES FOR EXTRACTOR THROUGH TOP FIN ONLY.

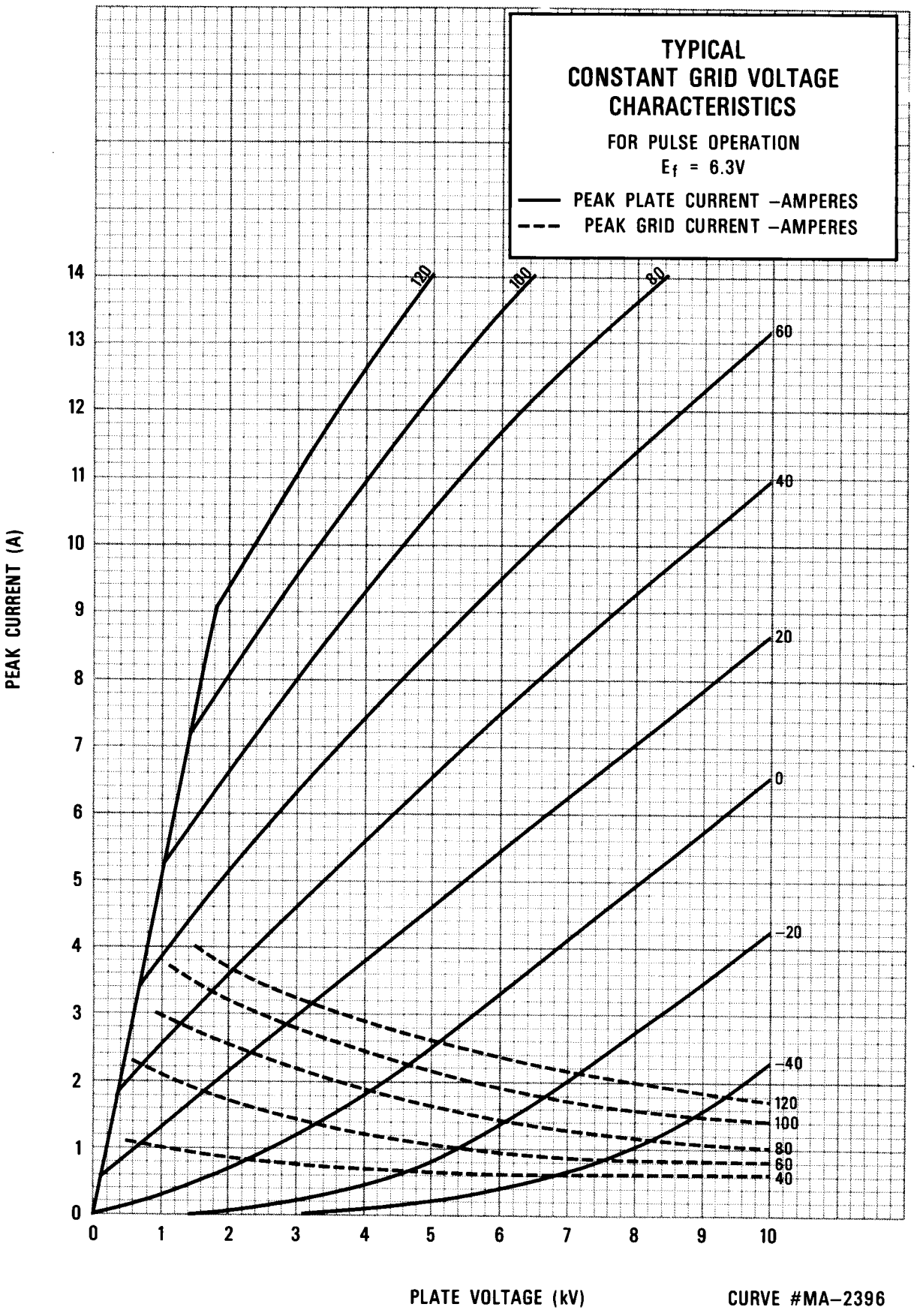
d. ECCENTRICITY OF CONTACT SURFACES SHALL BE GAGED FROM CENTER LINE OF REFERENCE & SHALL BE AS FOLLOWS:

CONTACT SURFACE	TIR(MAX)	REFERENCE
ANODE	.020	CATHODE
GRID	.020	CATHODE
HEATER	.012	CATHODE

e. DIA'S N, R, T & U SHALL APPLY THROUGHOUT ENTIRE LENGTH AS DEFINED BY DIM'S AA, AB, AC & AD RESPECTIVELY.

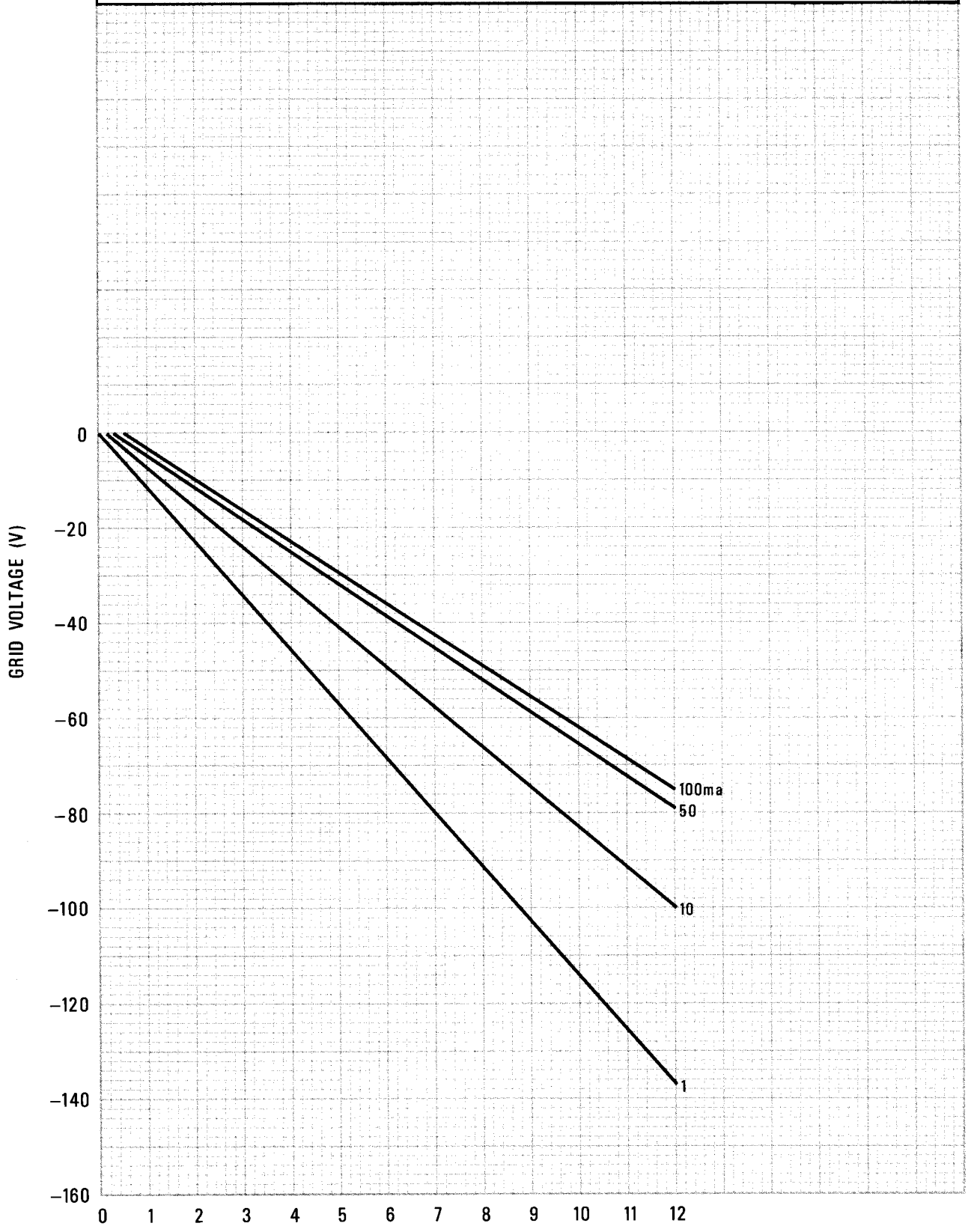
f. THIS SURFACE SHALL NOT BE USED FOR CLAMPING OR LOCATING.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PEAK PLATE CURRENT – AMPERES
PEAK GRID CURRENT – AMPERES
PEAK GRID VOLTAGE (V)
160
140
120
100
80
60
40
20
0
−20
−40
−60
−80
−100
−120
−140
0
1
2
3
4
5
6
7
8
9
10
PLATE VOLTAGE (kV)
3.0
2.0
1.0
.5
.25
.125
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.5
0
CURVE #MA–2395


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PEAK PLATE CURRENT –AMPERES
PEAK GRID CURRENT –AMPERES
PEAK CURRENT (A)
PLATE VOLTAGE (kV)
CURVE #MA–2396
120
100
80
60
40
20
0
–20
–40
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14

TYPICAL CONSTANT PLATE CURRENT CHARACTERISTICS

NEGATIVE GRID REGION E_f = 6.3V



CURVE #MA-2397

8560A

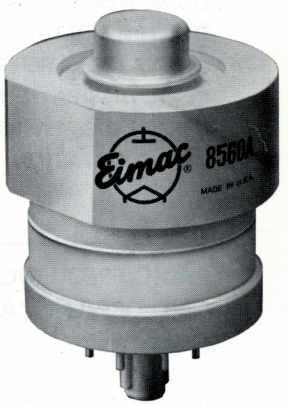
TECHNICAL DATA

CONDUCTION-COOLED
RADIAL-BEAM
POWER TETRODE

The 8560A is a ceramic/metal conduction-cooled, external-anode radial-beam tetrode intended for use as an rf amplifier or oscillator or in audio amplifier or modulator service.

The 8560A has electrical characteristics which are similar but not identical to the 7203/4CX250B.

Anode dissipation is limited only by heat-sink capability, and the tube is designed for operation at a heater voltage of 6.0 volts.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	6.0 ± 0.3 V
Current, at 6.0 volts	2.6 A
Cathode-Heater Potential, Maximum	±150 V
Amplification Factor (Average):	
Grid-to-screen	5
Direct Interelectrode Capacitances (Grounded Cathode)[2]	
Cin	16.5 pF
Cout	4.6 pF
Cgp	0.04 pF
Frequency of Maximum Rating:	
CW	500 MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	2.445 in; 62.1 mm
Diameter	1.630 in; 41.4 mm
Net Weight	8.2 oz; 235 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals and Anode Core	250°C
Cooling: Conduction Cooled	
Recommended Beryllium Oxide thermal link	EIMAC SK-1920
Recommended Socket	EIMAC SK-660 Series
Base	Special 9-Pin JEDEC B8-236

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RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN (SSB)

Class AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC GRID VOLTAGE	-250 VOLTS
DC PLATE CURRENT	0.25 AMPERE
PLATE DISSIPATION	See COOLING NOTE
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage [1]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Single Tone Plate Current	250	250	250	mAdc
Two-Tone Plate Current	190	190	190	mAdc
Single-Tone Screen Current [2]	10	8	5	mAdc
Two-Tone Screen Current [2]	2	-1	-2	mAdc
Single-Tone Grid Current [2]	0	0	0	mAdc
Peak rf Grid Voltage [2]	50	50	50	v
Plate Output Power	120	215	300	W
Resonant Load Impedance	2000	3000	4000	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN, CARRIER CONDITIONS

Class AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 VOLTS
DC SCREEN VOLTAGE	400 VOLTS
DC GRID VOLTAGE	-250 VOLTS
DC PLATE CURRENT	0.25 AMPERE
PLATE DISSIPATION	See COOLING NOTE
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)
Class AB_1, Grid Driven

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage [1]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Carrier Plate Current	150	150	150	mAdc
Carrier Screen Current	-3	-4	-4	mAdc
Peak rf Grid Voltage [2]	25	25	25	v
Plate Output Power	30	50	65	W

1. Adjust to specified zero-signal dc plate current

2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2000 VOLTS
DC SCREEN VOLTAGE	300 VOLTS
DC GRID VOLTAGE	-250 VOLTS
DC PLATE CURRENT	0.25 AMPERE
PLATE DISSIPATION	See COOLING NOTE
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)					500 MHz	
Plate Voltage	500	1000	1500	2000	2000	Vdc
Screen Voltage	250	250	250	250	300	Vdc
Grid Voltage	-90	-90	-90	-90	-90	Vdc
Plate Current	250	250	250	250	250	mAdc
Screen Current [1]	45	38	21	19	10	mAdc
Grid Current [1]	35	31	28	26	25	mAdc
Peak rf Grid Voltage [1]	114	114	112	112	---	v
Measured Driving Power [1]	4.0	3.5	3.2	2.9	---	W
Plate Input Power	125	250	375	500	500	W
Plate Output Power	70	190	280	390	225	W
Heater Voltage	6.0	6.0	6.0	6.0	5.5	V

1. Approximate value.

COOLING NOTE: When using the SK-1920 BeO thermal link between the anode and heat sink, the maximum allowable thermal gradient from the hottest part of the anode to the heat sink is 1.9°C per watt of anode dissipation. Example: Maximum anode temperature = 250°C; maximum heat sink temperature for 200 watts of anode dissipation is then $250°C - \frac{200\,W}{1.9°C/W} = 145°C$

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	1500	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.20	AMPERE
PLATE DISSIPATION[1]	See COOLING NOTE	
SCREEN DISSIPATION[2]	12	WATTS
GRID DISSIPATION[2]	2	WATTS

1. Corresponds to 250 watts at 100% sine-wave modulation.

2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 175 MHz)

Plate Voltage	500	1000	1500	Vdc
Screen Voltage	250	250	250	Vdc
Grid Voltage	-100	-100	-100	Vdc
Plate Current	200	200	200	mAdc
Screen Current[3]	31	22	20	mAdc
Grid Current[3]	15	14	14	mAdc
Peak rf Grid Voltage	118	117	117	v
Calculated Driving Power	1.8	1.7	1.7	W
Plate Input Power	100	200	300	W
Plate Output Power	60	145	235	W

3. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB , Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	See COOLING NOTE	
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Approximate value.
2. Per Tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage[1,3]	-55	-55	-55	Vdc
Zero-Signal Plate Current	200	200	200	mAdc
Max Signal Plate Current	500	500	500	mAdc
Max Signal Screen Current[1]	20	16	10	mAdc
Max Signal Grid Current[1]	0	0	0	mAdc
Peak af Grid Voltage[2]	50	50	50	v
Peak Driving Power	0	0	0	w
Plate Input Power	500	750	1000	W
Plate Output Power	240	430	600	W
Load Resistance (plate to plate)	3500	6200	9500	Ω

3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater Current, at 6.0 volts	2.3	2.9	A
Interelectrode Capacitances (grounded cathode) [1]			
Cin	14.2	17.2	pF
Cout	4.0	5.0	pF
Cgp	---	0.06	pF
Cathode Warmup Time	30	---	sec

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with EIA Standard RS-191. (See APPLICATION NOTE on Capacitance)

APPLICATION

MOUNTING & SOCKETING - The 8560A may be mounted in any position, but its mounting is normally controlled by the heat sink configuration and location. Where possible, the socket can be mounted on a bracket which in turn is mounted to the heat sink so that the one sink will act for removal of heat from the tube anode and also the tube base. The EIMAC SK-1920 beryllium oxide (BeO) thermal link is available for use between the tube anode and the heat sink. BeO is a ceramic material which exhibits high thermal conductance, similar to aluminum, and high electrical resistance and low loss typical of ceramics. Properly installed, it provides a low thermal resistance path allowing the anode heat to be transferred to the heat sink, while providing electrical isolation between the anode and the sink.

The EIMAC SK-660 series of sockets are designed for use in heat-sink applications. The SK-660 and SK-660A both use a high-alumina ceramic body, while the SK-661 and the SK-661A use a BeO body. The SK-661A includes a bracket which is adaptable to some heat-sink design applications.

VIBRATION & SHOCK - The 8560A is capable of satisfactorily withstanding ordinary shock and vibration, such as encountered in shipment and normal handling. The tube will function well in automobile and truck mobile installations and similar environments. However, when shock and vibration more severe than this are expected, it is suggested that other, more rugged, EIMAC tube types be considered.

COOLING - This tube is designed for use in a conduction-cooled system, where the anode is in direct intimate contact with a heat sink, or coupled to the heat sink by means of a Be0 thermal link. The heat sink in turn can be cooled by natural (free) convection, forced-air convection, liquid cooling, or a combination of these methods. The design choice is determined by the tube application, but in all cases the cooling system must maintain the anode and the ceramic/metal seal temperatures below 250°C.

Intimacy of contact and pressure are two factors which will effect transfer of heat from the tube anode to the heat sink, whether direct or through a thermal link such as the EIMAC SK-1920. A good thermally conductive compound should be used in the interface between mating parts to reduce thermal resistance of the joints. Examples of commercially available thermal joint compound are:

WAKEFIELD 120 - Wakefield Engineering Co., Wakefield, Mass. 01880.

DOW CORNING 340 - Dow Corning Corp., Midland, Mich. 48640

ASTRODYNE THERMAL BOND 312 - Astrodyne Inc., Burlington, Mass. 01803.

G.E. INSULGREASE G641 - G.E. Company, Cleveland, Ohio 44117.

The method of fastening the tube to the heat sink should provide reasonable compression to reduce interface thermal resistance. When it is desired to insulate the anode from the heat sink, the EIMAC SK-1920 thermal link is recommended, as it is the correct size and thickness to match the physical and electrical characteristics of the 8560A tube.

Socketing is accomplished with one of the units mentioned earlier, mounted so as to provide a path for heat from the base of the tube to a heat-sink surface. The designer is cautioned to allow for some lateral movement in the socket mount, and to make sure the anode (or anode/thermal link combination) is flat against the heat sink before the socket mounts are tightened, or heat transfer may be seriously affected.

In all cases, temperature of the tube anode and the ceramic/metal seals is the limiting factor, and the equipment designer is encouraged to use temperature-sensitive paint or other temperature-sensing devices in connection with any equipment design before the layout is finalized.

HEATER - The rated heater voltage for the 8560A is 6.0 volts and should be maintained as closely as practical. Short-time changes of ±10% will not damage the tube, but variations in performance must be expected. The heater voltage must be maintained within ±5% to minimize these variations and to obtain maximum tube life.

At frequencies above approximately 300 MHz, transit-time effects begin to influence the cathode temperature. The amount of driving power diverted to heating the cathode by back-bombardment will depend on frequency, plate current, and driving power. When the tube is driven to maximum input as a Class-C amplifier, the heater voltage should be reduced according to the following table:

Frequency (MHz)	Ef (Volts)
300 or lower	6.00
301 to 400	5.75
401 to 500	5.50

CATHODE OPERATION - The oxide coated unipotential cathode must be protected against excessively high emission currents. The maximum rated dc input current is 200 mA for plate-modulated operation and 250 mA for all other types of operation except pulse.

The cathode is internally connected to the four even-numbered base pins and all four of the corresponding socket terminals should be used to make connection to the external circuits. At radio frequencies it is important to keep the cathode leads short and direct and to use conductors with large areas to minimize the inductive reactances in series with the cathode leads.

It is recommended that rated heater voltage be applied for a minimum of 30 seconds before other operating voltages are applied. Where the circuit design requires the cathode and heater to be operated at different potentials, the rated maximum heater-to-cathode voltage is 150 volts regardless of polarity.

GRID OPERATION - The maximum rated dc grid bias voltage is -250 volts and the maximum grid dissipation rating is 2.0 watts. In ordinary audio and radio-frequency amplifiers the grid dissipation usually will not approach the maximum rating. At operating frequencies above the 100 MHz region, driving-power requirements for amplifiers increase noticeably. At 500 MHz as much as 20 watts of driving power may have to be supplied. However, most of the driving power is absorbed in circuit losses other than grid dissipation, so that grid dissipation is increased only slightly. Satisfactory 500 MHz operation of the tube in a stable amplifier is indicated by grid-current values below approximately 15 mA.

The grid voltage required by different tubes may vary between limits approximately 20% above and below the center value, and means should be provided in the equipment to accommodate such variation. It is especially important that variations between individual tubes be compensated when tubes are operated in parallel or push-pull circuits, to assure equal load sharing.

The maximum permissible grid-circuit resistance per tube is 100,000 ohms.

SCREEN OPERATION - The maximum rated power dissipation for the screen is 12 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

When signal voltages appear between screen and cathode, as in the case of screen-modulated amplifiers or cathode-driven tetrode amplifiers, the peak screen-to-cathode voltage is the sum of the dc screen voltage and the peak ac or rf signal voltage applied to screen or cathode.

Protection for the screen should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be applied before screen voltage can be applied.

The screen current may reverse under certain conditions and produce negative current indications on the screen milliammeter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor, gaseous voltage regulator tubes, or an electron tube *shunt* regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per connected screen. An electron tube *series* regulator can be used only when an adequate bleeder resistor is provided.

Self-modulation of the screen in plate-modulated tetrode amplifiers using these tubes may not be satisfactory because of the screen-voltage screen-current characteristics. Screen modulation from a tertiary winding on the modulation transformer or by means of a small separate modulator tube will usually be more satisfactory. Screen-voltage modulation factors between 0.75 and 1.0 will result in 100% modulation for plate-modulated rf amplifiers using the 8560A.

PLATE OPERATION - The maximum rated plate dissipation power is 250 watts. In plate-modulated applications the carrier plate dissipation power must be limited to 165 watts to avoid exceeding the plate dissipation rating with 100% sine wave modulation. The maximum dissipation rating may be exceeded for brief periods during circuit adjustment without damage to the tube.

MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide individual metering and individual adjustment of bias or screen voltage to equalize the inputs.

Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event that one tube fails.

VHF OPERATION - The 8560A is suitable for use in the VHF region. Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

DANGER-BERYLLIUM OXIDE CERAMICS (BeO) Do not alter, grind, lap, fire, chemically clean, or perform any other operation on the SK-1920 Beryllium Oxide thermal link used with the 8560A or any other equivalent section of BeO used with the 8560A. Normal use of Beryllium Oxide ceramics parts is not hazardous, but the user is cautioned that breathing small quantities of the dust or fumes from Beryllium Oxide can seriously injure or kill.

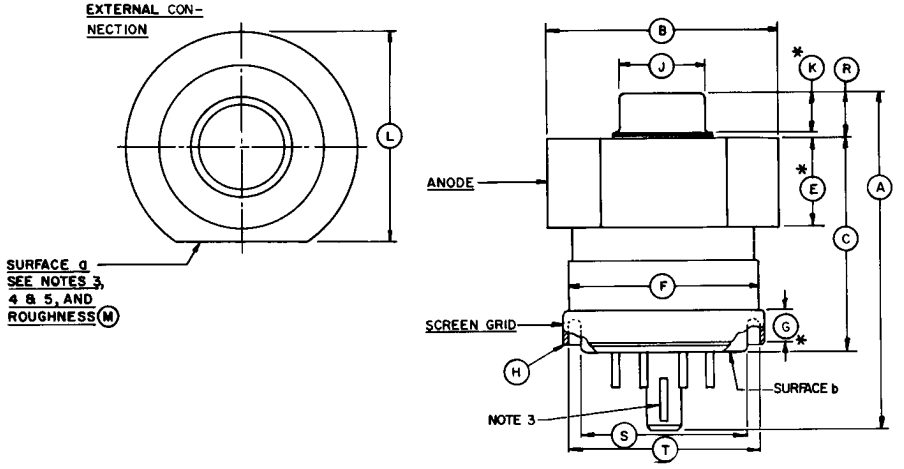
HIGH VOLTAGE - The 8560A operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS-If it is desired to operate these tubes under conditions widely different from those given here, write to Application Engineering Dept., EIMAC Division of Varian, San Carlos, Calif. 94070 for information and recommendations.

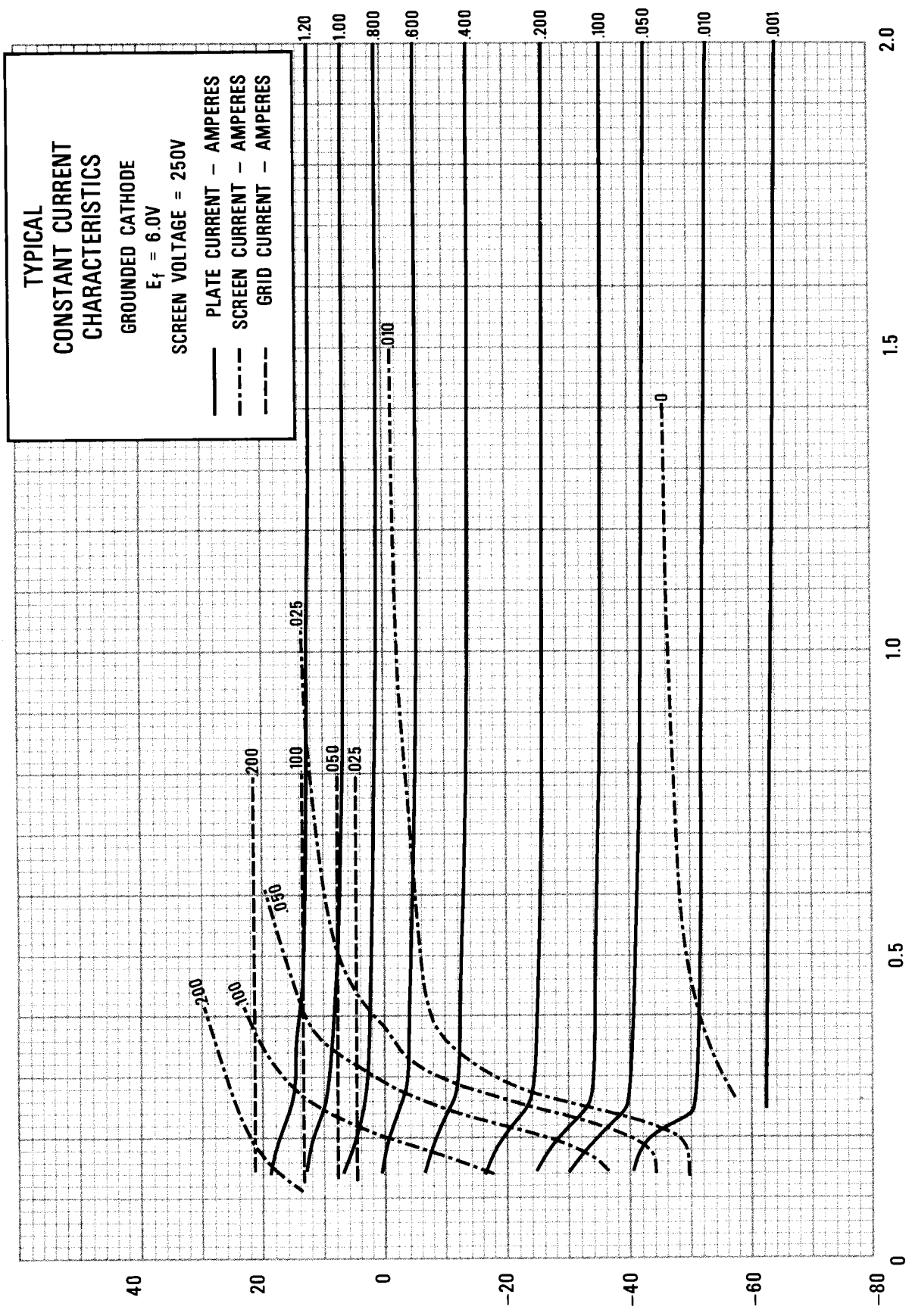
PIN NO. 1 SCREEN GRID
PIN NO. 2 CATHODE
PIN NO. 3 HEATER
PIN NO. 4 CATHODE
PIN NO. 5 I.C. DO NOT USE FOR EXTERNAL CONNECTION
PIN NO. 6 CATHODE
PIN NO. 7 HEATER
PIN NO. 8 CATHODE
CENTER PIN – CONTROL GRID



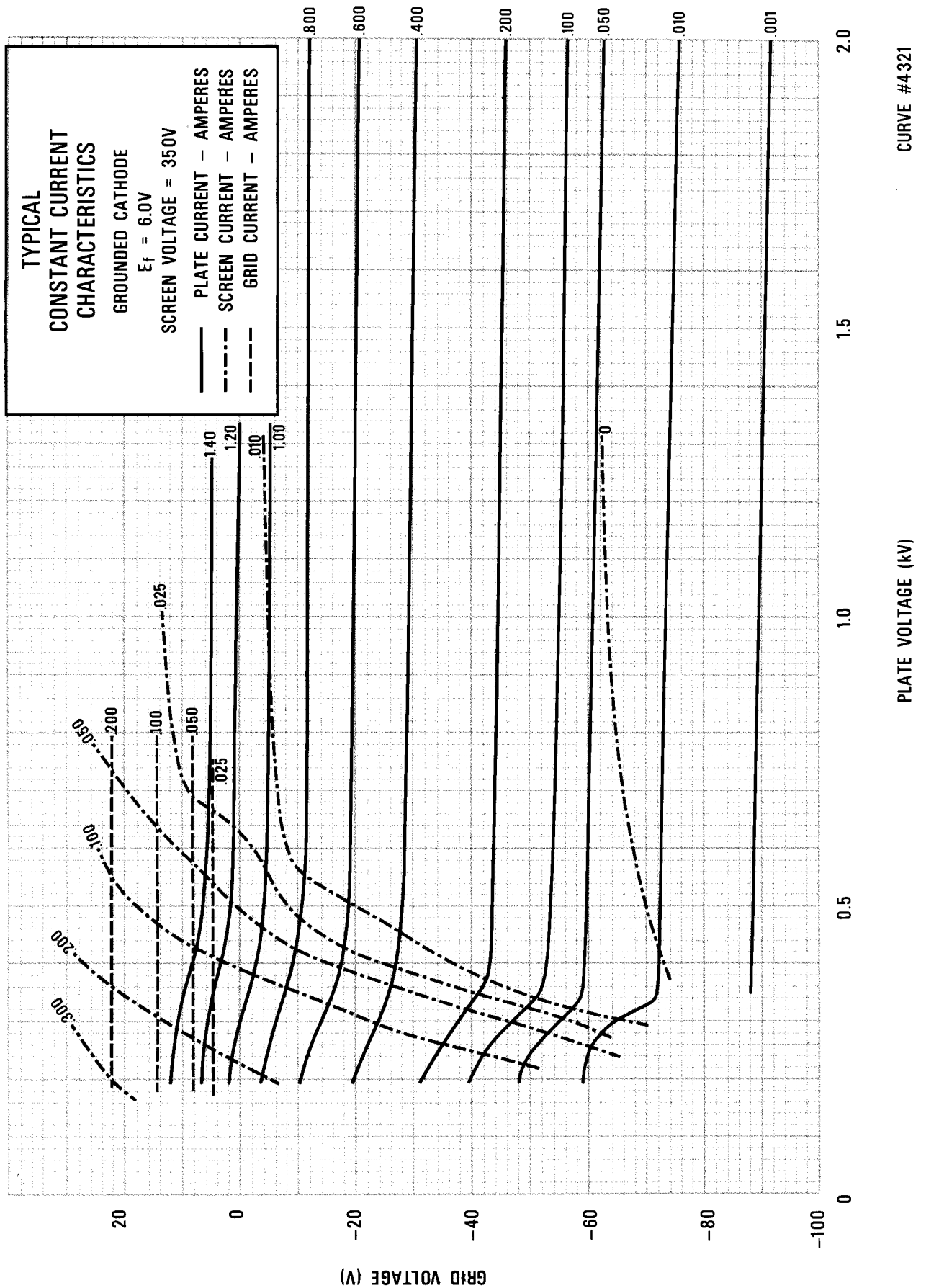
DIMENSIONAL DATA

DIM.	INCHES MIN.	INCHES MAX.	INCHES REF	MILLIMETERS MIN.	MILLIMETERS MAX.	MILLIMETERS REF
A	2.305	2.445	- -	58.55	62.10	- -
B	1.620	1.630	- -	41.15	41.40	- -
C	1.530	1.590	- -	38.86	40.39	- -
D	- -	- -	- -	- -	- -	- -
E	0.660	0.740	- -	16.76	18.80	- -
F	- -	1.406	- -	- -	35.71	- -
G	0.187	- -	- -	4.75	- -	- -
H	BASE: B8-236 (JEDEC DESIGNATION)					
J	0.559	0.572	- -	14.20	14.53	- -
K	0.240	- -	- -	6.10	- -	- -
L	1.525	1.540	- -	38.74	39.12	- -
M	- -	32AA	- -	- -	32AA	- -
N	89°	91°	- -	89°	91°	- -
P	88°	92°	- -	88°	92°	- -
R	0.270	0.310	- -	6.86	7.87	- -
S	- -	1.194	- -	- -	30.33	- -
T	1.338	- -	- -	33.98	- -	- -

NOTES:
1. * CONTACT SURFACE.
2. REF. DIMS. ARE FOR INF. ONLY AND ARE NOT REQD. FOR INSP PURPOSES.
3. SUR. a TO BE PERP. TO INDEX KEY LATERAL AXIS WITHIN (P) LIMITS AND ON SAME SIDE.
4. SUR a MUST BE FLAT WITHIN .001 & PERP. TO SUR. b WITHIN (N) LIMITS.
5. SUR. a TO BE FREE OF ANY CODING & LABELING.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 6.0V
SCREEN VOLTAGE = 250V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
1.20
1.00
.800
.600
.400
.200
.100
.050
.010
.001
.025
.050
.100
.200
.010
0
.025
.050
.100
.200
40
20
0
−20
−40
−60
−80
0
0.5
1.0
1.5
2.0
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)

CURVE #4320


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 6.0V
SCREEN VOLTAGE = 350V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
.800
.600
.400
.200
.100
.050
.010
.001
1.40
1.20
.010
1.00
.025
.060
.200
.100
.050
.025
.100
.200
.300
0
GRID VOLTAGE (V)
20
0
-20
-40
-60
-80
-100
0
0.5
1.0
1.5
2.0
PLATE VOLTAGE (kV)
CURVE #4321

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8590
4CPX250K

RADIAL BEAM TETRODE

The EIMAC 8590/4CPX250K is a compact forced-air cooled, external anode radial beam tetrode, intended for wideband grid-pulsed radio frequency amplifier and pulse modulator service.

The 8590/4CPX250K has a maximum anode dissipation of 250 watts and is capable of delivering pulse output power in excess of 10 kW with 10 db gain when cathode driven at 450 MHz.

The tube is of coaxial construction and especially designed for cavity operation.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3	V
Current, at 6.0 volts	2.5	A
Amplification Factor (Average):		
Grid to Screen	5	
Direct Interelectrode Capacitances (Grounded grid)[2]		
Input	14.0	pF
Output	4.1	pF
Feedback	.006	pF
Frequency of Maximum Rating:		
CW	500	MHz
Plate or Grid-Pulsed	500	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. In Shielded Fixture.

MECHANICAL

Maximum Overall Dimensions:	
Length	2.81 in; 71.37 mm
Diameter	1.64 in; 41.66 mm
Net Weight	4 oz; 114 gm
Operating Position	Any

(Effective 4-1-70) © 1970 by Varian Printed in U.S.A.

MECHANICAL

Maximum Operating Temperature:	
Ceramic/Metal Seals	250 °C
Anode Core	250 °C
Cooling	Forced-Air
Base	Coaxial
Socketing: EIMAC collets are available as follows:	
Heater pin connection	EIMAC Part No. 008290
Cathode connection	EIMAC Part No. 008291
Control grid connection	EIMAC Part No. 008292
Anode connection	EIMAC Part No. 008294
Screen grid connection	EIMAC Part No. 882931

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	2500 VOLTS
DC SCREEN VOLTAGE	500 VOLTS
DC GRID VOLTAGE	-250 VOLTS
DC PLATE CURRENT	0.250 AMPERE
PLATE DISSIPATION	250 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION

Plate Voltage	1000	1500	2000	2500	Vdc
Screen Voltage	250	250	250	250	Vdc
Grid Voltage	-90	-90	-90	-90	Vdc
Plate Current	250	250	250	250	mAdc
Screen Current [1]	38	21	19	16	mAdc
Grid Current [1]	31	28	26	25	mAdc
Peak rf Grid Voltage [1]	114	112	112	111	v
Calculated Driving Power [1]	3.5	3.2	2.9	2.8	W
Plate Input Power	250	375	500	625	W
Plate Output Power	190	280	390	500	W

1. Approximate value.

PULSE MODULATOR SERVICE

MAXIMUM RATINGS

DC PLATE VOLTAGE	7000 VOLTS
DC SCREEN VOLTAGE	750 VOLTS
DC GRID VOLTAGE	-400 VOLTS
PEAK PLATE CURRENT	6.0 AMPERES
PULSE DURATION	(See Derating Chart)
DUTY FACTOR	(See Derating Chart)
PLATE DISSIPATION	250 WATTS
SCREEN DISSIPATION	12 WATTS
GRID DISSIPATION	2 WATTS

TYPICAL OPERATION

Plate Voltage	6000	Vdc
Screen Voltage	750	Vdc
Grid Voltage	-275	Vdc
Peak Drive Voltage [1]	280	v
Peak Plate Current	3.5	a
Peak Screen Current [1]	0.4	a
Peak Input Power	21.0	kW
Peak Output Power	17.5	kW
Peak Output Voltage	5000	kv
Pulse Duration	250	μs
Duty Factor	0.005	

1. Approximate value .

RF POWER AMPLIFIER

Class B or C, Grid and Screen Pulsed

MAXIMUM RATINGS

DC PLATE VOLTAGE	5500	VOLTS
PEAK DC SCREEN VOLTAGE	1000	VOLTS
DC GRID VOLTAGE	-250	VOLTS
PEAK PLATE CURRENT[1]	6.0	AMPERES
PULSE DURATION	(See Derating Chart)	
DUTY FACTOR	(See Derating Chart)	
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Peak anode current may be considered as average during the pulse and should be limited to 6.0 amperes. With a pulse length longer than 80 μs, or a duty factor higher than 0.0016, peak current should be reduced in accordance with the data shown on the Derating Chart for Anode Current. For longer pulse duration or larger duty factor, consult EIMAC Division of Varian.

TYPICAL OPERATION (Frequencies to 500 MHz)
Class B, Grounded Grid (Measured Values)

Plate Voltage	5500	Vdc
Screen Voltage (Pulsed)	1000	v
Grid Voltage	-200	Vdc
Peak Grid Voltage[2]	255	v
Peak Driving Power[2]	1000	w
Peak Output Power (Useful)	10	kW
Pulse Duration	250	μs
Duty Factor	0.005	

2. Approximate value .

NOTE: TYPICAL OPERATION data are obtained by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	2.3	3.0	A
Cathode Warmup Time	30	---	sec.
Interelectrode Capacitances[1] (Grounded Grid Connection)			
Input	12.0	16.0	pF
Output	3.90	4.35	pF
Feedback	---	0.01	pF

1. Capacitance values are for a cold tube as measured in a shielded fixture.

APPLICATION

MOUNTING - The 8590/4CPX250K may be mounted in any position. The concentric arrangement of the electrode terminals permits the use of the tube in coaxial line or cavity-type circuits to advantage. Connections to the contact surfaces should be made by means of spring finger collets which have sufficient pressure to maintain a good electrical contact at all fingers. Points of electrical contact should be kept clean and free of oxidation to minimize rf losses.

HEATER - The rated heater voltage for the 8590/4CPX250K is 6.0 volts, as measured at the base of the tube, and variations should be restricted to plus or minus 0.3 volt for long tube life and consistent performance. At frequencies above approximately 300 MHz under Class C Telegraphy conditions, it may be necessary to reduce heater voltage to compensate for rf transit-time heating of the cathode. This type of back-heating is a function of frequency, grid current, grid bias, anode current, duty cycle, and circuit design and adjustment. The following heater operation voltages are recommended for straight-through CW amplifier operation:

Frequency (MHz)	Heater Voltage
300 or lower	6.00
301 to 400	5.75
401 to 500	5.50

COOLING - Sufficient forced-air cooling must be provided to maintain the anode core and seal temperatures within maximum ratings. Special care must be observed to insure that there is adequate cooling in the area of the coaxial filament and grid terminals. With an anode dissipation of 250 watts and an incoming air temperature of 50°C at sea level, a minimum air flow of 4.8 cfm must be passed through the anode cooler, with a resultant pressure drop of approximately 0.25 inch of water. Air should normally be directed in a base-to-anode direction in order to minimize base cooling problems. In cases where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial. Air flow should be applied before or simultaneously with the application of electrode voltages (including heater voltage), and may be removed simultaneously with them.

CATHODE WARMUP TIME - Heater voltage should be applied for a minimum of 30 seconds before the application of other electrode voltages to allow proper conditioning of the cathode surface.

CATHODE OPERATION - The oxide-coated unipotential cathode must be protected against excessively high emission current. The DERATING CHART FOR ANODE CURRENT shows the current capability of the 8590/4CPX250K anode at various pulse durations and duty factors. To use this chart, enter with pulse duration and note the intersection with the desired peak anode current. At this intersection read off the values of maximum duty and/or pulse repetition rate.

Under a given set of operating conditions, element dissipation may limit the maximum permissible duty to a smaller value than anode current considerations alone would dictate. It will usually be found that screen grid dissipation is the limiting factor with large plate voltage swings and that plate dissipation limits the maximum duty with small plate voltage swings.

CONTROL GRID OPERATION - The average power dissipated by the control grid must not exceed two watts. The control grid dissipation can be computed as the product of average grid current, and peak positive grid to cathode voltage.

SCREEN GRID OPERATION - The average power dissipated by the screen grid must not exceed twelve watts. Screen grid dissipation is the product of dc screen voltage, average screen current during the pulse, and duty factor.

The screen grid current may reverse under certain operating conditions and produce negative current indications on the screen milliammeter. This is a normal characteristic of most tetrodes. The screen grid power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen grid under all conditions. A current path from screen to cathode must be provided by a bleeder resistor, gaseous voltage regulator, or an electron tube shunt regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per tube. A series pass tube regulated power supply can be used only when an adequate bleeder resistor is provided. Protection for the screen grid should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be applied before screen voltage can be applied.

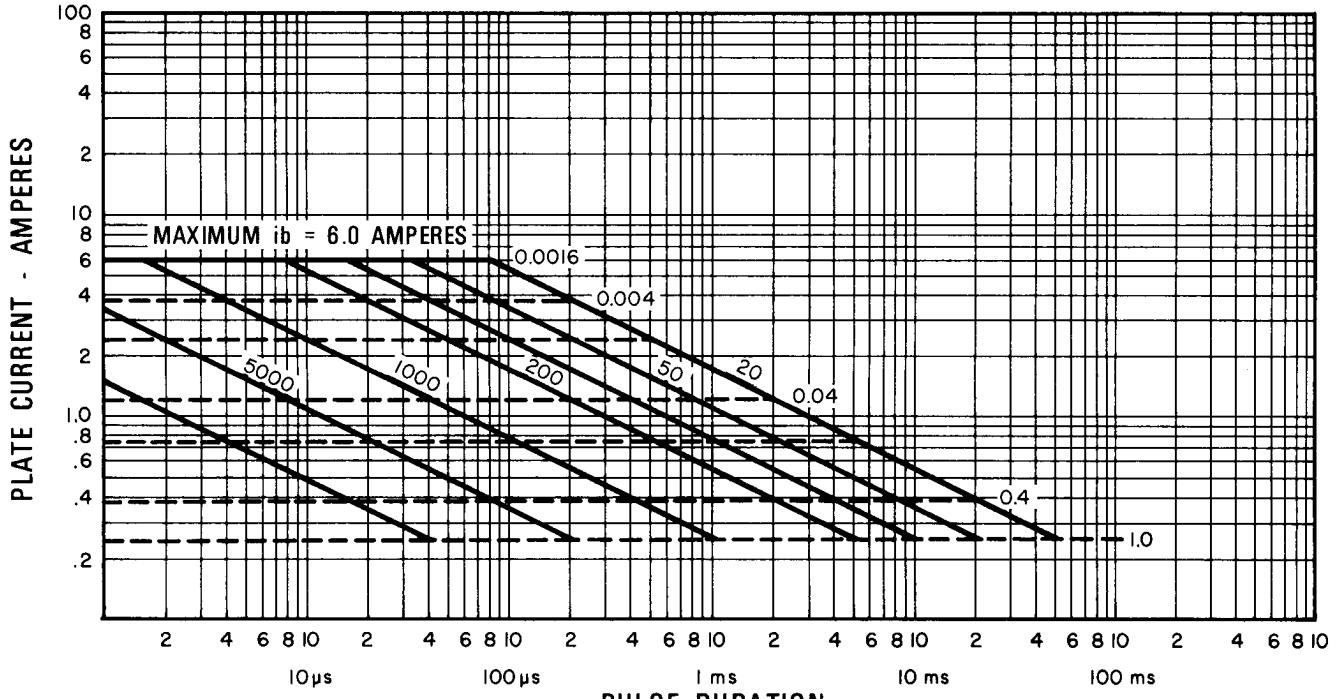
PULSE MODULATOR PLATE OPERATION - Average plate dissipation may be calculated as the product of average plate current during the pulse, minimum anode voltage, and duty factor. Excessive average dissipation is likely to occur with high values of minimum anode voltage. The calculated value of plate dissipation may well be below 250 watts based on a rectangular pulse but excessive dissipation will result if pulse rise and fall times slow down the plate voltage swing and allow plate current to flow for longer periods in the high anode voltage region.

UHF OPERATION - Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide individual metering and individual adjustments of bias and/or screen grid voltage to equalize the plate currents. Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event that any tube fails.

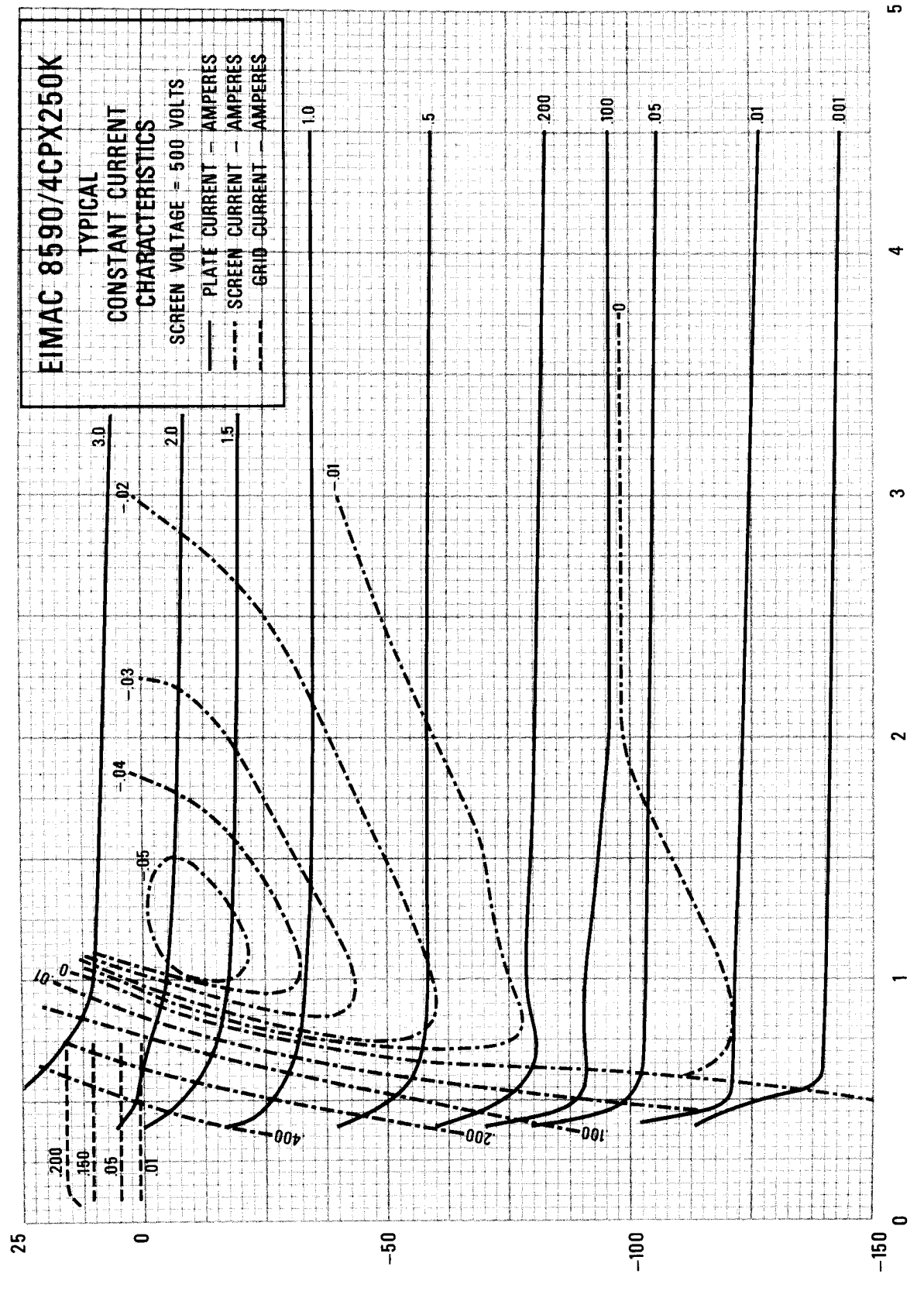
SPECIAL APPLICATION

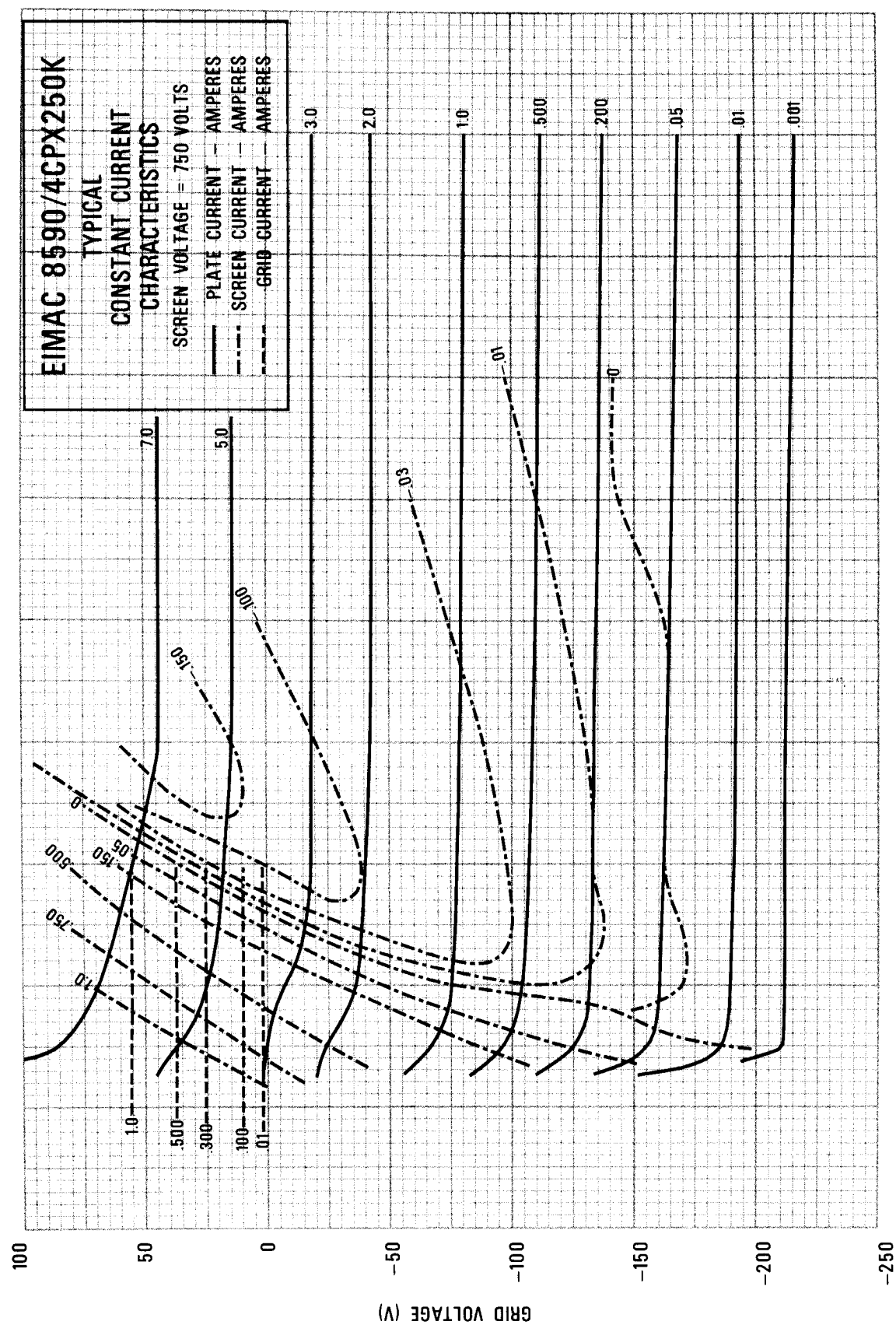
If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



TYPE 8590/4CPX250K – DERATING CHART FOR ANODE CURRENT
(AVERAGE DURING PULSE)

SOLID LINES REPRESENT CONSTANT REPETITION RATES
DASHED LINES REPRESENT CONSTANT DUTIES
DO NOT EXTRAPOLATE ABOVE OR TO THE RIGHT OF BOLD LINES

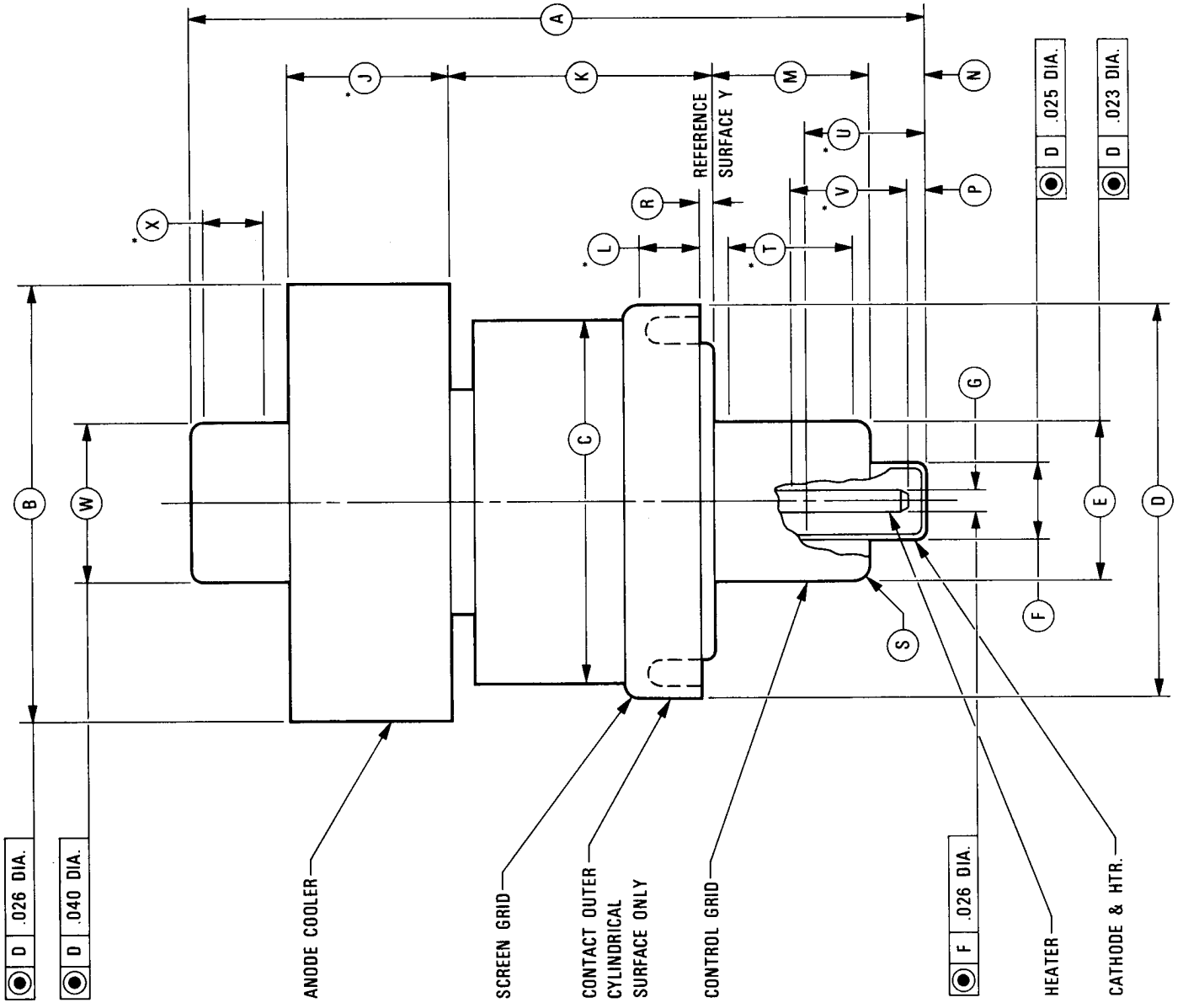

EIMAC 8590/4CPX250K
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE #3539


EIMAC 8590/4CPX250K
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE #3540

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	2.813	—	71.45
B	1.615	1.640	41.02	41.66
C	—	1.406	—	35.71
D	1.415	1.435	35.94	36.45
E	0.588	0.597	14.94	15.16
F	0.318	0.325	8.08	8.26
G	0.091	0.095	2.31	2.41
J	0.585	0.665	14.86	16.89
K	0.900	0.950	22.86	24.13
L	0.187	—	4.75	—
M	0.520	0.560	13.21	14.22
N	0.235	0.265	5.97	6.73
P	0.032	0.082	0.83	2.08
R	—	0.040	—	0.102
S	—	0.171	—	0.434
T	0.388	—	9.86	—
U	0.406	—	10.31	—
V	0.468	—	11.89	—
W	0.559	0.573	14.20	14.55
X	0.240	—	6.10	—

NOTES:

1. * INDICATES CONTACT SURFACE.
2. THE TUBE WILL BE ROTATED ON DIAMETER D WHEN ECCENTRICITY IS BEING MEASURED.
3. SURFACE Y MUST BE PERPENDICULAR TO THE MEASURING PLATFORM WHEN ECCENTRICITY IS BEING MEASURED.
4. AVERAGE DIAMETER OF E SHALL BE AS NOTED, & MAY BE OUT OF ROUND A TOTAL OF 0.006 (0.15 mm). AVERAGE DIAMETER OF F SHALL BE AS NOTED, AND MAY BE OUT OF ROUND A TOTAL OF 0.006 (0.15 mm).

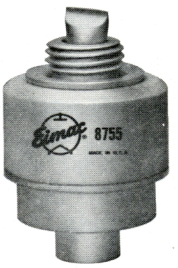


8755/8755A

HIGH-MU
PLANAR TRIODE

The 8755/8755A is a miniature, ceramic/metal, rugged planar triode for advanced airborne and space applications up to 3.0 GHz.

The 8755/8755A may be used as an amplifier, oscillator, or frequency multiplier in the grid- or plate-pulsed mode, as well as a modulator or regulator tube. In addition to low interelectrode capacitances, high transconductance and amplification factor, the 8755/8755A has an anode designed to produce frequency stability, and an arc-resistant cathode, both assuring stable, reliable and long-life operation under adverse conditions.



The 8755/8755A is supplied without radiator and may be conduction, convection, heat sink, or liquid cooled. Radiators for forced-air cooling, permitting an anode dissipation up to 150 watts, can be furnished on separate order.

The 8755/8755A is especially designed for applications where high rf pulse power is required. It can also be readily used in switch tube applications up to 8 kV dc.

The 8755A is identical to the 8755 in all respects except that the 8755A is furnished with a spewing shield. With this, this tube will exhibit longer life in the same applications and should be used where long tube life is of major concern.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 ± 0.3	V
Current, at 6.3 volts	1.30	A
Transconductance (Average):		
I_b = 160 mA (200 mA/cm^2)	38	mmhos
Amplification Factor (Average):	135	
Direct Interelectrode Capacitances (Grounded Cathode)[2]		
Cgk	9.5	pF
Cpk	0.06	pF
Cgp	1.05	pF
Cut-off Bias[3]	-20	V max.

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the results of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.
3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

(Revised 6-1-71) © by Varian Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:	
Length	1.37 in; 34.75 mm
Diameter	0.785 in; 19.94 mm
Net Weight	0.56 oz; 16 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Conduction, convection, forced-air[1] or liquid
Terminals	Coaxial, special

1. Using one of the EIMAC radiators shown on the cooling curves.

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axes 55 to 500 Hz	10 G
Altitude, max (in a suitably designed circuit)	70,000 ft.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE (GRID PULSED)	8000	VOLTS
PEAK PULSE PLATE VOLTAGE (PLATE PULSED)	10,000	VOLTS
DC GRID VOLTAGE	-200	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-700	VOLTS
Grid positive to cathode	150	VOLTS
PULSE PLATE CURRENT	5.0	AMPERES
PULSE GRID CURRENT	2.5	AMPERES
PLATE DISSIPATION[1]	150	WATTS
GRID DISSIPATION	1.5	WATTS
FREQUENCY	3.0	GIGAHERTZ
PULSE DURATION[2]	6	μsec
DUTY FACTOR[2]	.0033	

TYPICAL OPERATION
Grid-Pulsed rf Power Amplifier (1182 MHz)

DC Plate Voltage	1750	Vdc
Peak Plate Current	1.0	a
DC Grid Voltage Approx.	-20	V
Peak Grid Current	1.7	a
Filament Voltage	5.6	V
Useful Power Output (Approx.)	650	w
Plate Efficiency	37%	
RF Input Power	65	w
Gain	10	db

1. Using one of the EIMAC radiators shown on the cooling curves.
2. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube and Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

PULSE MODULATOR OR PULSE AMPLIFIER SERVICE

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE	8000	VOLTS
PEAK PLATE VOLTAGE	10,000	VOLTS
DC GRID VOLTAGE	-200	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	150	VOLTS
PULSE CATHODE CURRENT	7.5	AMPERES
DC PLATE CURRENT	150	MILLIAMPERES
PLATE DISSIPATION[1]	150	WATTS
GRID DISSIPATION	1.5	WATTS
PULSE DURATION[2]	6	μs
DUTY FACTOR[2]	.0033	
CUT-OFF MU	90	

1. Using one of the EIMAC radiators shown on the cooling curves.
2. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube and Device Field Office, or the Product Manager EIMAC Division of Varian, Salt Lake City, Utah.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Heater: Current at 6.3 volts	1.20	1.40	A
Cathode Heating Time	60	---	sec.
Interelectrode Capacitances [1] (grounded cathode connection)			
Cgk	8.5	10.5	pF
Cpk	---	0.06	pF
Cgp	0.9	1.2	pF

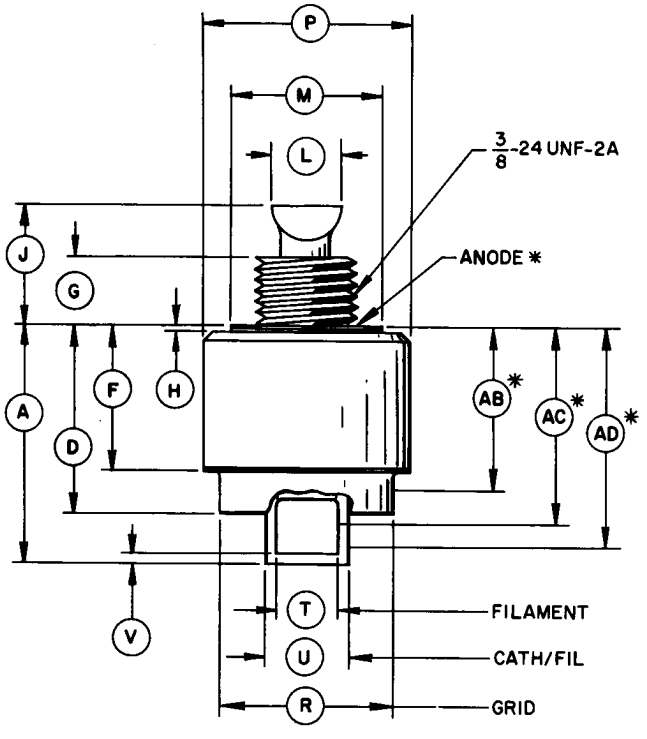
1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

APPLICATION

COOLING - The 8755/8755A can be cooled by conduction, convection, forced-air or liquid cooling. The tube is designed to permit high-temperature operation up to the limit indicated. However, if long life is the prime objective, tube terminal and seal temperatures should be kept well below 250°C. If forced-air cooling is provided, auxiliary air flow, apart from the air flowing through the radiator, should be provided to cool the tube envelope and other tube terminals.

Some conduction cooling is always provided through the contact terminals. However, these terminals usually exhibit poor heat transfer, often having a temperature gradient across them as high as 50°C. Cooling curves are given for the three radiators which are suitable for use with the 8755/8755A.

For further details on cooling or other aspects of tube operation, refer to EIMAC bulletin #15, "Operating Data for Planar Triodes."



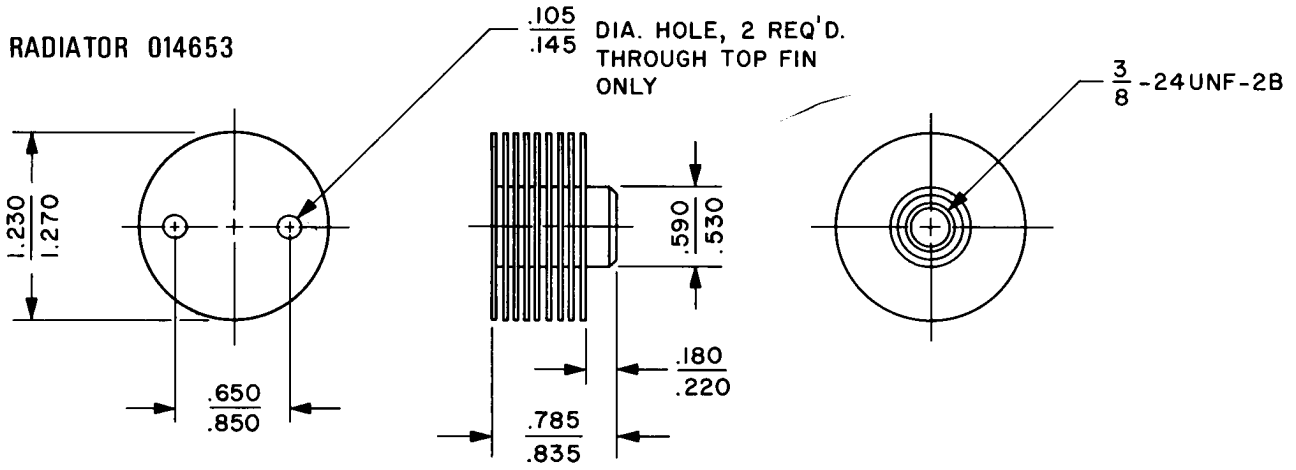
DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	- -	1.020	- -	- -	25.91	- -
D	0.740	0.800	- -	18.80	20.32	- -
F	- -	0.570	- -	- -	14.48	- -
G	0.150	0.170	- -	3.81	4.32	- -
H	- -	0.040	- -	- -	1.02	- -
J	- -	0.350	- -	- -	8.89	- -
L	- -	0.260	- -	- -	6.60	- -
M	0.545	0.570	- -	13.84	14.48	- -
P	0.775	0.785	- -	19.69	19.94	- -
R	0.650	0.670	- -	16.51	17.02	- -
T	0.210	0.225	- -	5.33	5.72	- -
U	0.310	0.330	- -	7.87	8.38	- -
V	- -	0.040	- -	- -	1.02	- -
AB	0.590	0.740	- -	14.99	18.80	- -
AC	0.760	0.885	- -	19.30	22.48	- -
AD	0.800	0.975	- -	20.32	24.77	- -

NOTES

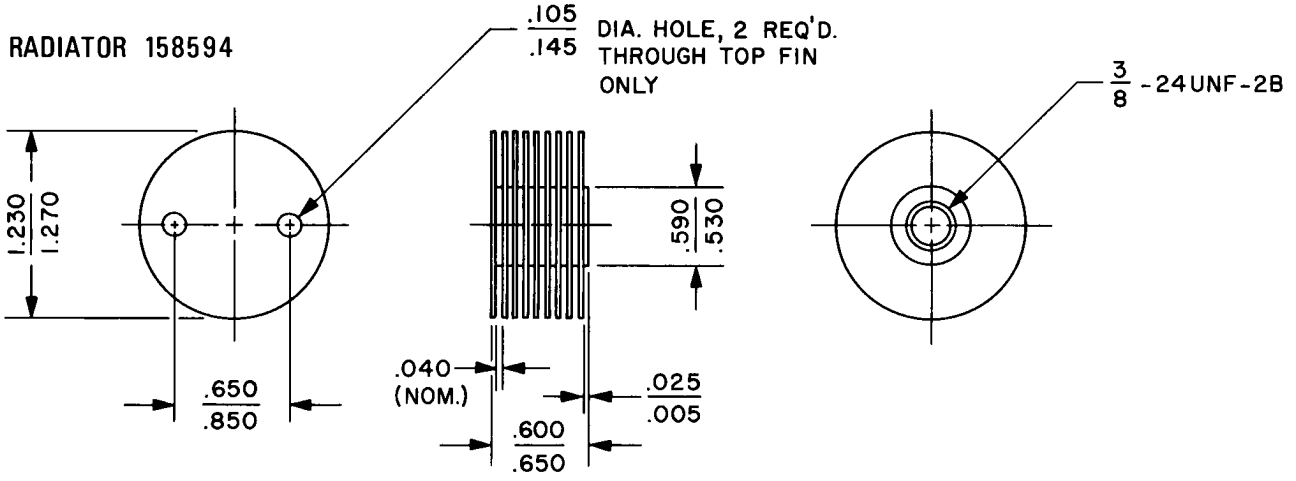
1. REF. DIMS. ARE FOR INFO. ONLY AND ARE NOT REQ'D. FOR IN-SPECTION PURPOSES.
2. (*) CONTACT SURFACE.
3. ANODE FLANGE IS ELECTRICAL CONTACT. STUD IS FOR HEAT TRANSFER.

EIMAC RADIATORS

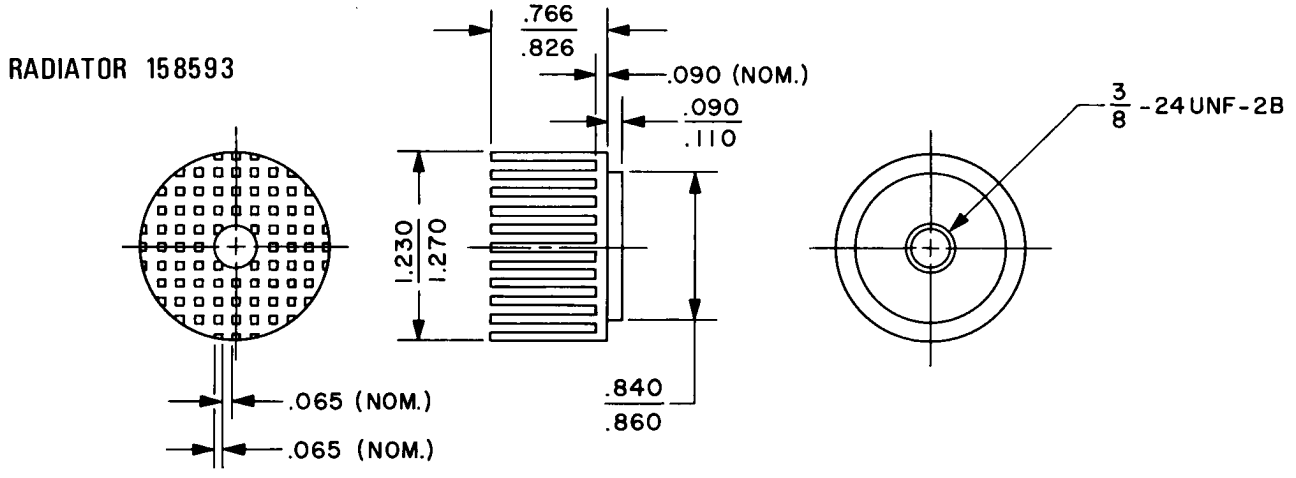
RADIATOR 014653



RADIATOR 158594



RADIATOR 158593



COMBINED CORRECTION FACTORS FOR INLET AIR TEMPERATURE AND ALTITUDE

(RELATIVE TO 25°C AND SEA LEVEL)

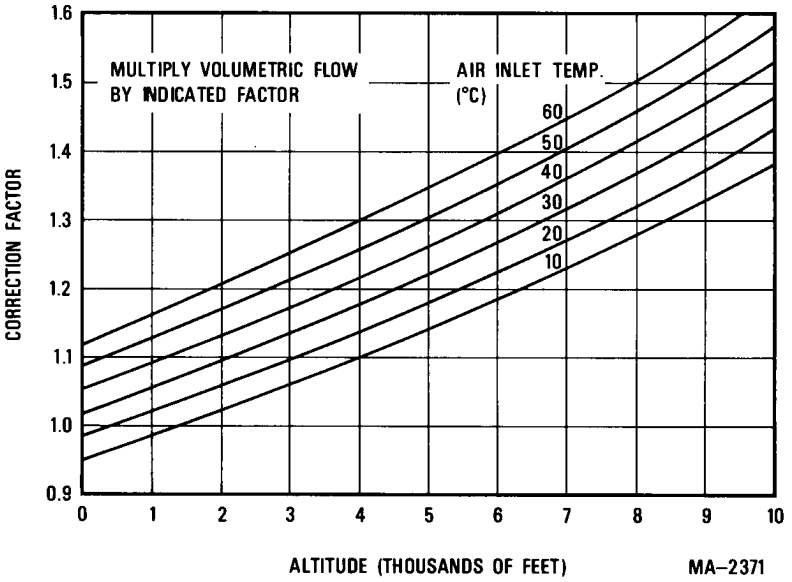
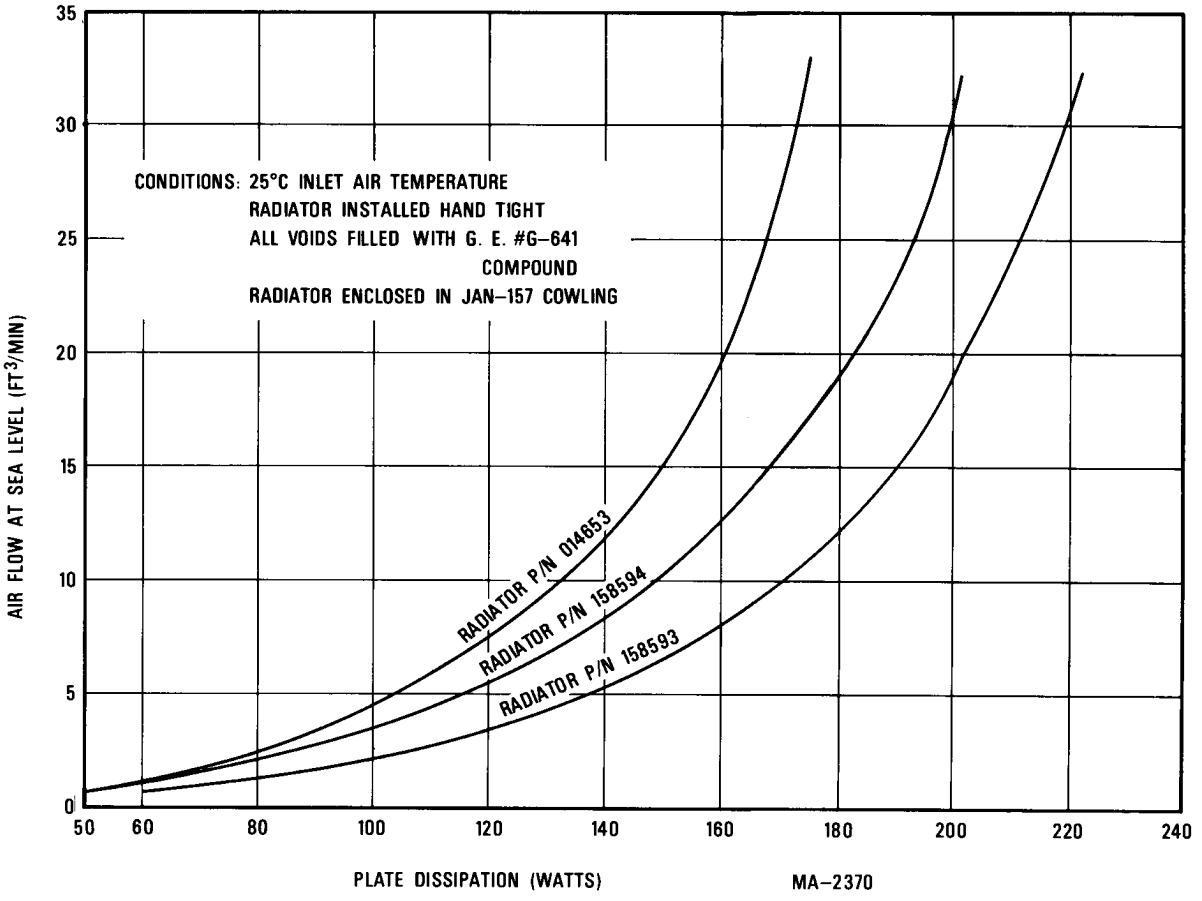
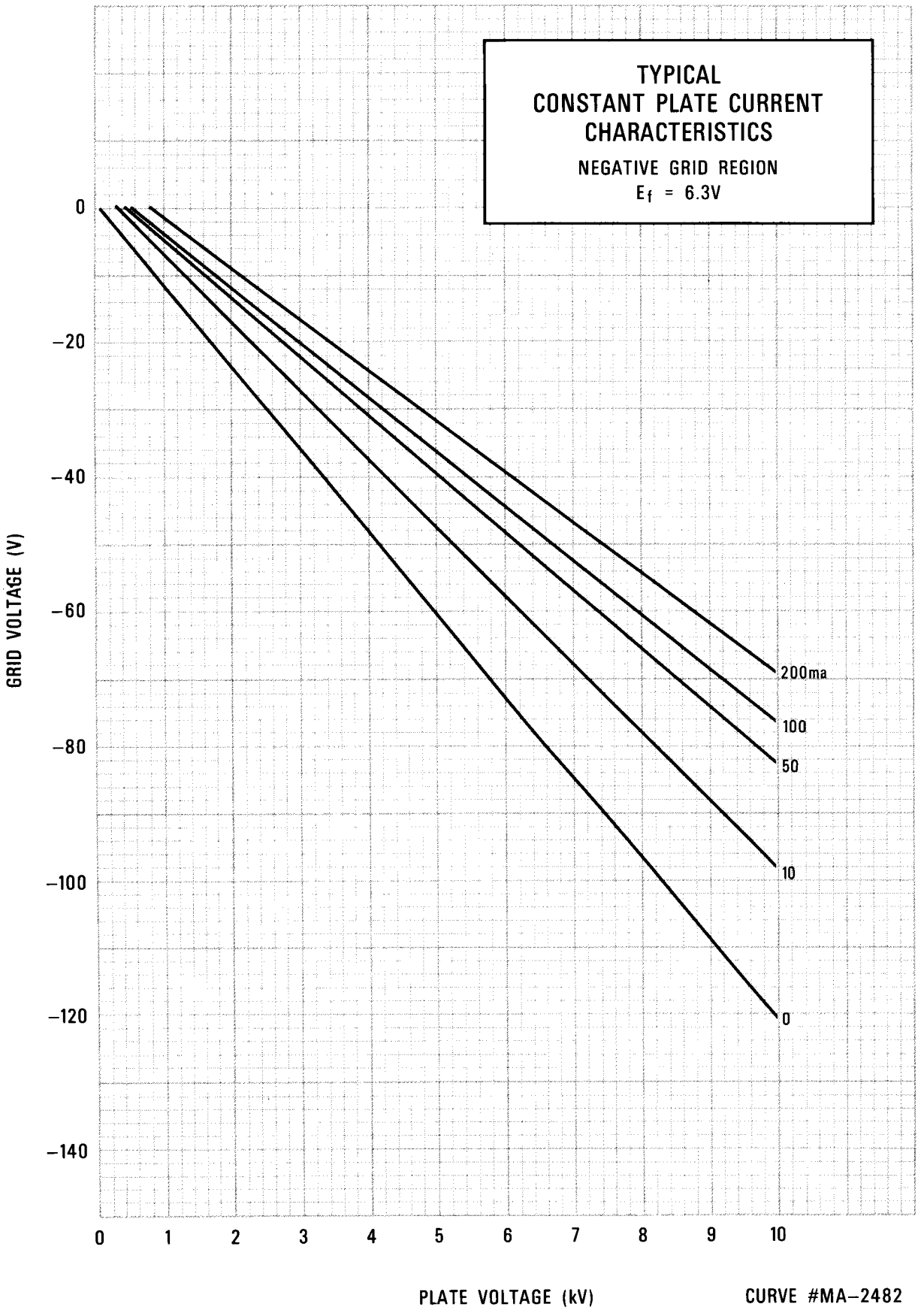
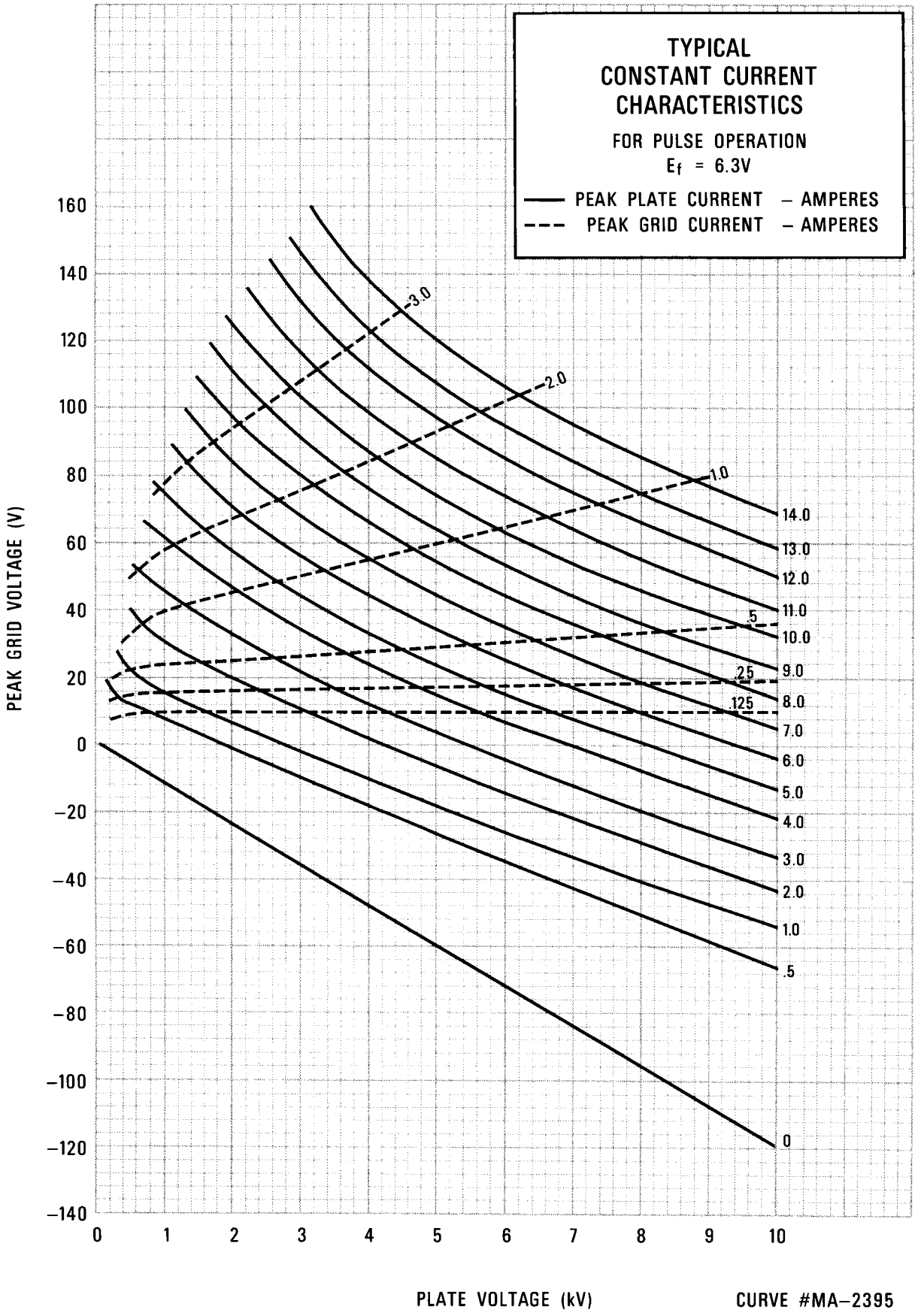
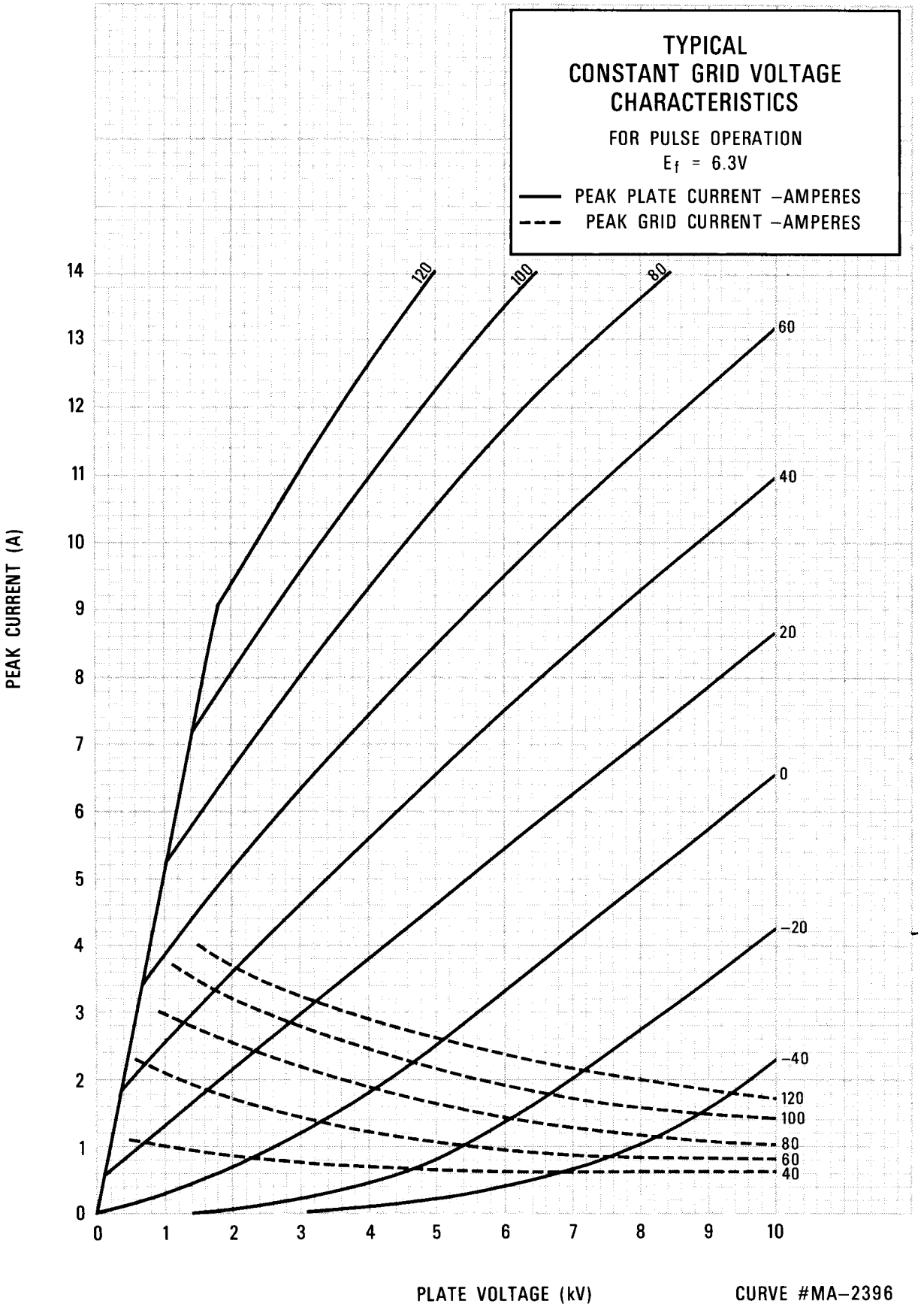


PLATE DISSIPATION VARIATION WITH COOLING AIR FLOW




TYPICAL
CONSTANT PLATE CURRENT
CHARACTERISTICS
NEGATIVE GRID REGION
E_f = 6.3V
0
−20
−40
−60
−80
−100
−120
−140
GRID VOLTAGE (V)
200ma
100
50
10
0
0
1
2
3
4
5
6
7
8
9
10
PLATE VOLTAGE (kV)
CURVE #MA−2482


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PEAK PLATE CURRENT – AMPERES
PEAK GRID CURRENT – AMPERES
PEAK GRID VOLTAGE (V)
160
140
120
100
80
60
40
20
0
−20
−40
−60
−80
−100
−120
−140
0
1
2
3
4
5
6
7
8
9
10
PLATE VOLTAGE (kV)
-3.0
-2.0
1.0
.5
.25
.125
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.5
0
CURVE #MA–2395


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PEAK PLATE CURRENT –AMPERES
PEAK GRID CURRENT –AMPERES
PEAK CURRENT (A)
PLATE VOLTAGE (kV)
CURVE #MA–2396
120
100
80
60
40
20
0
–20
–40

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8757

HIGH-MU PLANAR TRIODE

The 8757 is a miniature, frequency-stable, ceramic/metal, rugged planar triode for advanced airborne and space applications up to 3.5 GHz.

The 8757 may be used as an amplifier, oscillator, or frequency multiplier in the CW, grid- or plate-pulsed mode, as well as a modulator or regulator tube. In addition to low interelectrode capacitances, high transconductance and amplification factor, the 8757 has an anode designed to produce exceptional frequency stability and an arc-resistant cathode, both assuring stable, reliable and long-life operation under adverse conditions.



The 8757 is supplied without radiator and may be conduction, convection, heat sink, or liquid cooled. Radiators for forced-air cooling permitting an anode dissipation up to 150 watts, can be furnished on separate order.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 ± 0.3	V
Current, at 6.3 volts	1.30	A
Transconductance (Average):		
I_b = 160 mA (200 mA/cm^2)	38	mmhos
Amplification Factor (Average):	75	
Direct Interelectrode Capacitances (Grounded Cathode)[2]		
Grid-Cathode	9.0	pF
Plate-Cathode	0.06	pF
Grid-Plate	1.65	pF
Cut-off Bias[3]	-30	V max.

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the results of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

(Effective 3-3-70) © 1969 by Varian Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:

Length	1.30 in; 33.02 mm
Diameter	0.785 in; 19.94 mm
Net Weight	0.56 oz; 16 gm
Operating Position	Any

Maximum Operating Temperature:

Ceramic/Metal Seals	250 °C
Anode Core	250 °C
Cooling	Conduction, convection, forced-air[1] or liquid
Terminals	Coaxial, special

1. Using one of the EIMAC radiators shown on the cooling curves.

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axes 55 to 500 Hz	10 G
Altitude, max (in a suitably designed circuit)	70,000 ft.

CW RF POWER AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE	2500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-400	VOLTS
Grid positive to cathode	30	VOLTS
DC PLATE CURRENT	250	MILLIAMPERES
DC GRID CURRENT	45	MILLIAMPERES
PLATE DISSIPATION[1]	150	WATTS
GRID DISSIPATION	1.5	WATTS
FREQUENCY	3.0	GIGAHERTZ

1. Using one of the EIMAC radiators shown on the cooling curves.

2. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube and Devices Field Office, or the Product Manager, Eimac-Division of Varian, Salt Lake City, Utah.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE (GRID PULSED)	3000	VOLTS
PEAK PULSE PLATE VOLTAGE (PLATE PULSED)	3500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID CATHODE VOLTAGE		
GRID NEGATIVE TO CATHODE	-700	VOLTS
GRID POSITIVE TO CATHODE	175	VOLTS
PULSE PLATE CURRENT	5.0	AMPERES
PULSE GRID CURRENT	2.5	AMPERES
PLATE DISSIPATION[1]	150	WATTS
GRID DISSIPATION	1.5	WATTS
FREQUENCY	3.5	GIGAHERTZ
PULSE DURATION[2]	6	μsec
DUTY FACTOR[2]	.0033	

TYPICAL OPERATION

Grid-Pulsed r-f Power Oscillator (3.5 GHz)

DC Plate Voltage	2500	Vdc
Peak Plate Current	5.0	a
DC Grid Voltage Approx.	-70	V
Peak Grid Current	1.7	a
Filament Voltage	6.0	V
Useful Power Output Approx.	3000	w
Plate Efficiency	25%	

PULSE MODULATOR OR PULSE AMPLIFIER SERVICE

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE	3000	VOLTS
PEAK PLATE VOLTAGE	3500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	150	VOLTS
PULSE CATHODE CURRENT	7.5	AMPERES
DC PLATE CURRENT	150	MILLIAMPERES
PLATE DISSIPATION[1]	150	WATTS
GRID DISSIPATION	1.5	WATTS
PULSE DURATION[2]	6	μs
DUTY FACTOR[2]	.0033	
CUT-OFF MU	60	

1. Using one of the EIMAC radiators shown on the cooling curves.

2. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube and Device Field Office, or the Product Manager Eimac-Division of Varian, Salt Lake City, Utah.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.3 volts	1.20	1.40	A
Cathode Heating Time	60	---	sec.
Interelectrode Capacitances[1] (grounded cathode connection)			
Grid-Cathode	8.5	9.5	pF
Plate-Cathode	---	0.06	pF
Grid-Plate	1.5	1.8	pF

1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

APPLICATION

COOLING - The 8757 can be cooled by conduction, convection, forced-air or liquid cooling. The tube is designed to permit high-temperature operation up to the limit indicated. However, if long life is the prime objective, tube terminal and seal temperatures should be kept well below 250°C. If forced-air cooling is provided, auxiliary air flow, apart from the air flowing through the radiator, should be provided to cool the tube envelope and other tube terminals. Some conduction cooling is always provided through the contact terminals. However, these terminals usually exhibit poor heat transfer, often having a temperature gradient across them as high as 50° C. Cooling curves are given for the three radiators which are suitable for use with the 8757.

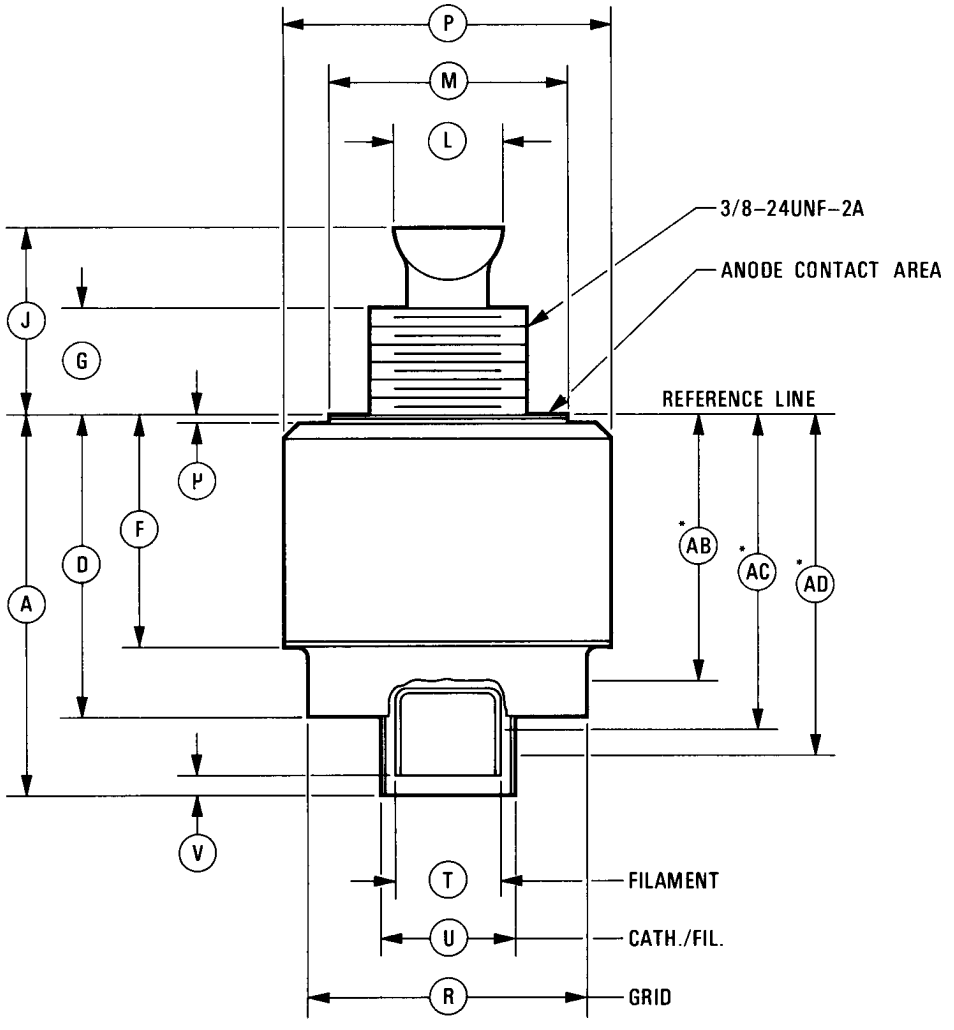
For operating information refer to EIMAC bulletin #15, "Operating Data for Planar Triodes."

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A		.950		24.13
D	.690	.730	17.53	18.54
F		.500		12.70
G	.150	.170	3.81	4.32
H		.040		1.02
J		.350		8.89
L		.260		6.04
M	.545	.570	13.84	14.48
P	.775	.785	19.69	19.94
R	.650	.670	16.51	17.02
T	.210	.225	5.33	5.72
U	.310	.330	7.87	8.38
V		.040		1.02
(*) CONTACT SURFACES				
AB	.595* ±.075		15.11* ±1.91	
AC	.752* ±.062		19.10* ±1.57	
AD	.817* ±.087		20.75* ±2.21	

NOTES:

1. ANODE FLANGE IS ELECTRICAL CONTACT. STUD IS FOR HEAT TRANSFER.
2. (*) DISTANCE FROM REFERENCE SURFACE TO THE CENTER OF CONTACT AREA.
3. METRIC EQUIVALENTS ARE TO THE NEAREST .01 mm, ARE GIVEN FOR GENERAL INFORMATION ONLY, AND ARE BASED ON 1 INCH = 25.4 mm.
4. CONCENTRICITY BETWEEN GRID TERMINAL AND CATHODE/HEATER TERMINAL RESPECTIVELY TO THE ANODE STUD TO BE 0.020 TIR MAX. MEASUREMENT TO BE MADE WITH EIMAC GAGE JA-21685G WHICH MUST SEAT AGAINST THE ANODE FLANGE.

FIGURE 1



EIMAC RADIATORS

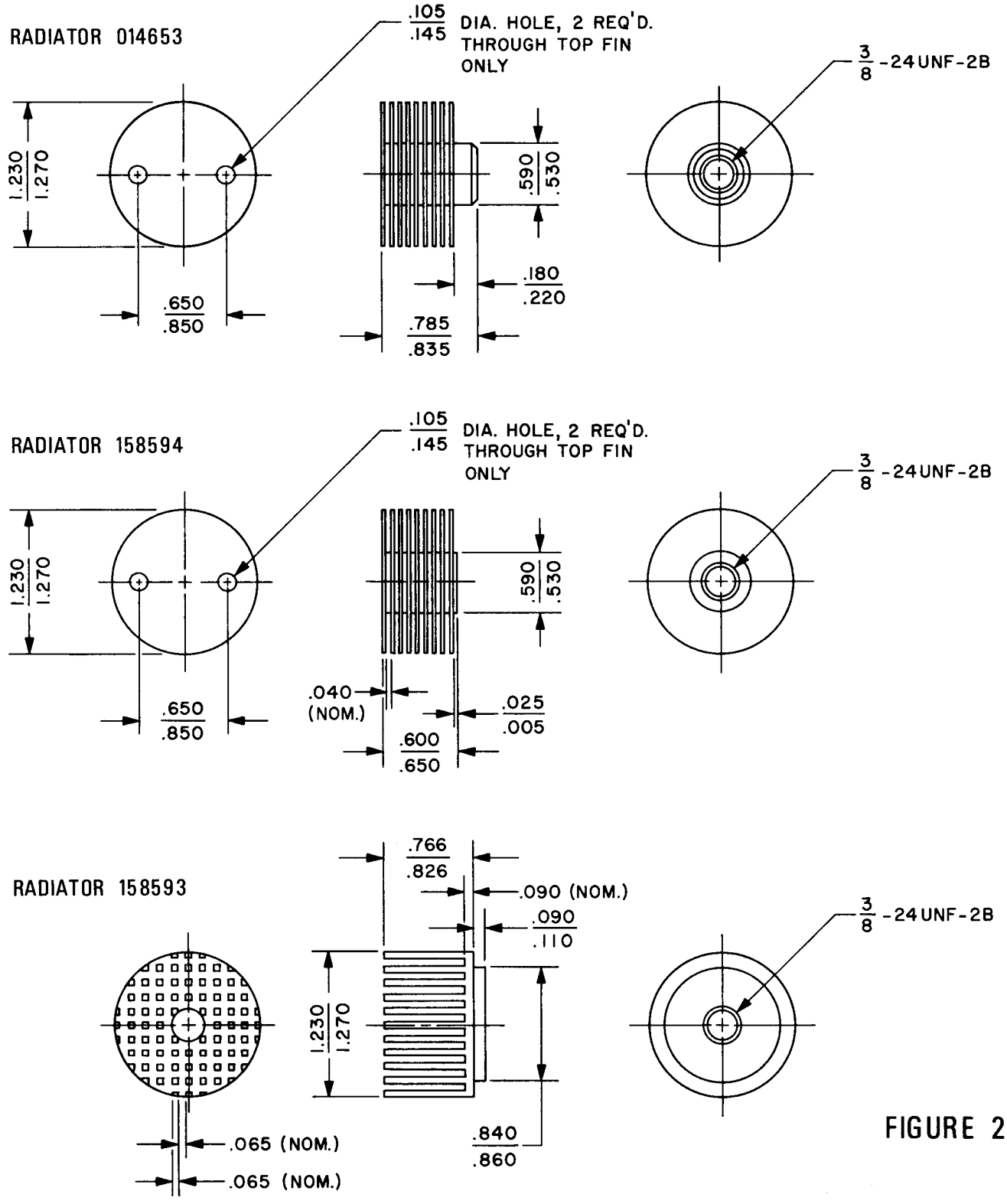


FIGURE 2

FIGURE 3

COMBINED CORRECTION FACTORS FOR INLET AIR TEMPERATURE AND ALTITUDE

(RELATIVE TO 25°C AND SEA LEVEL)

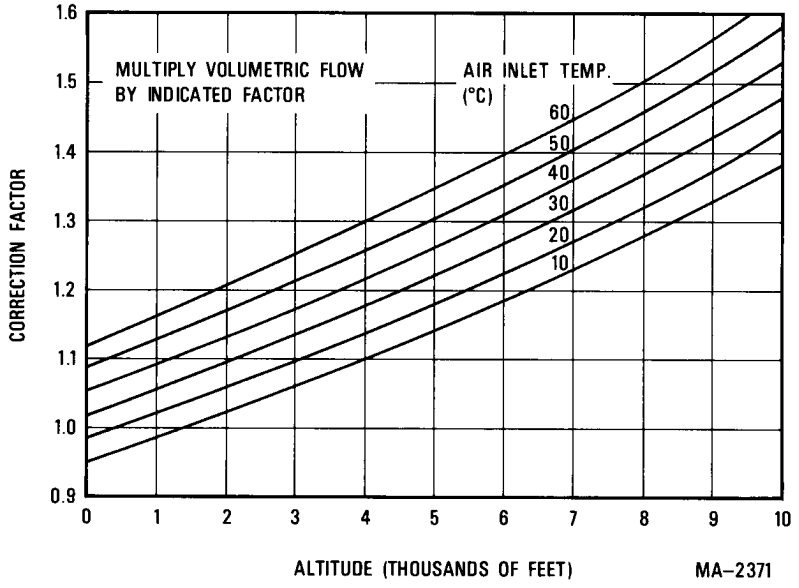
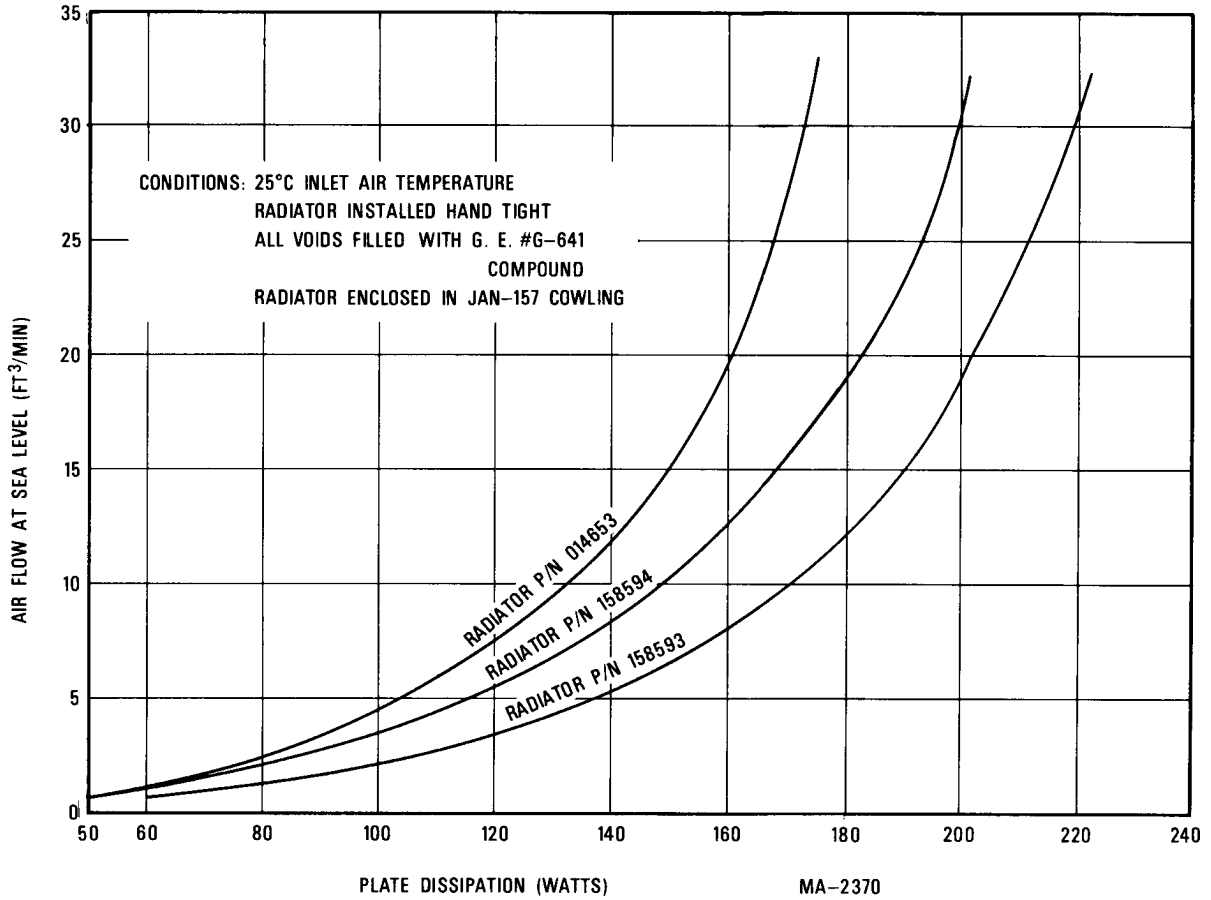
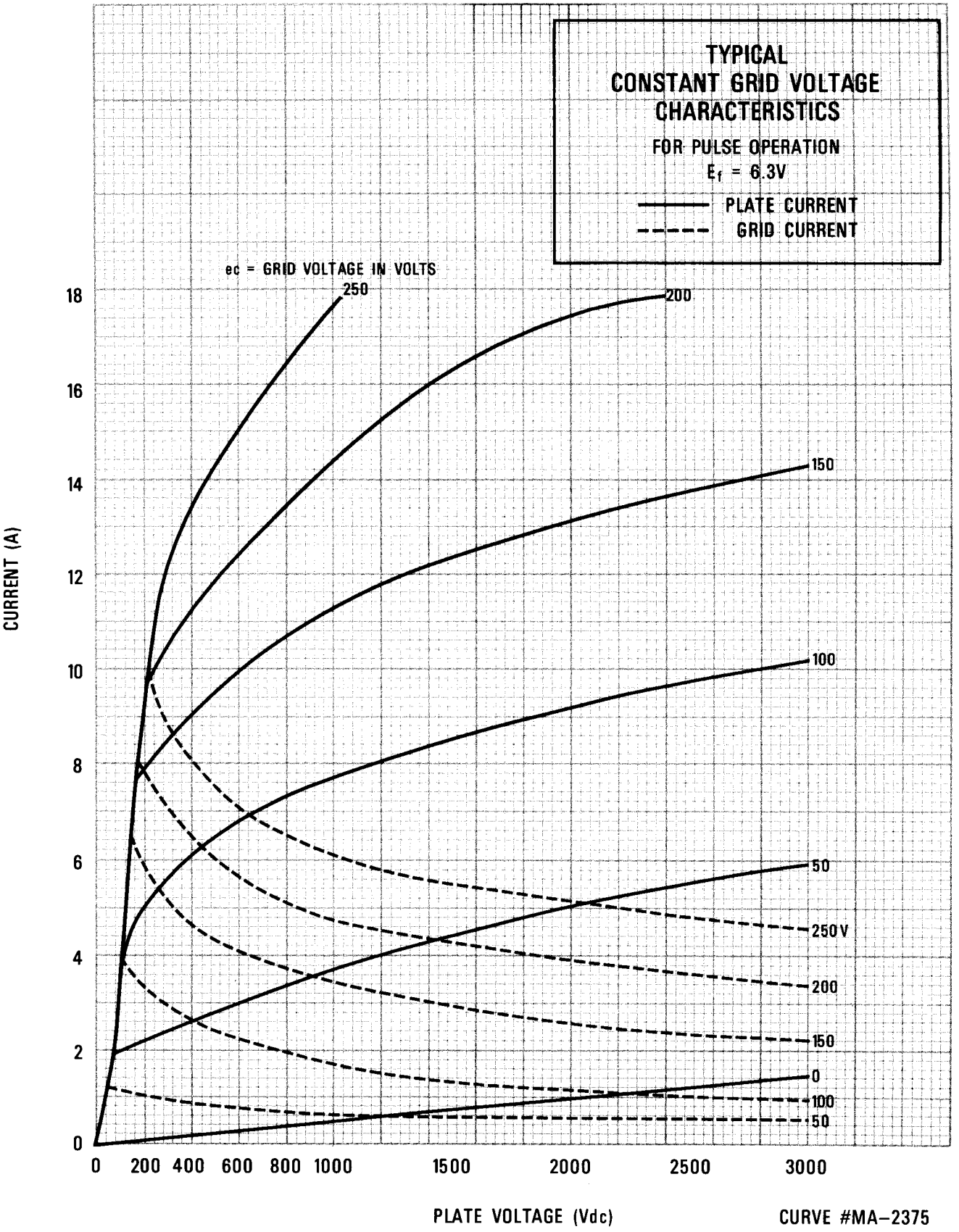
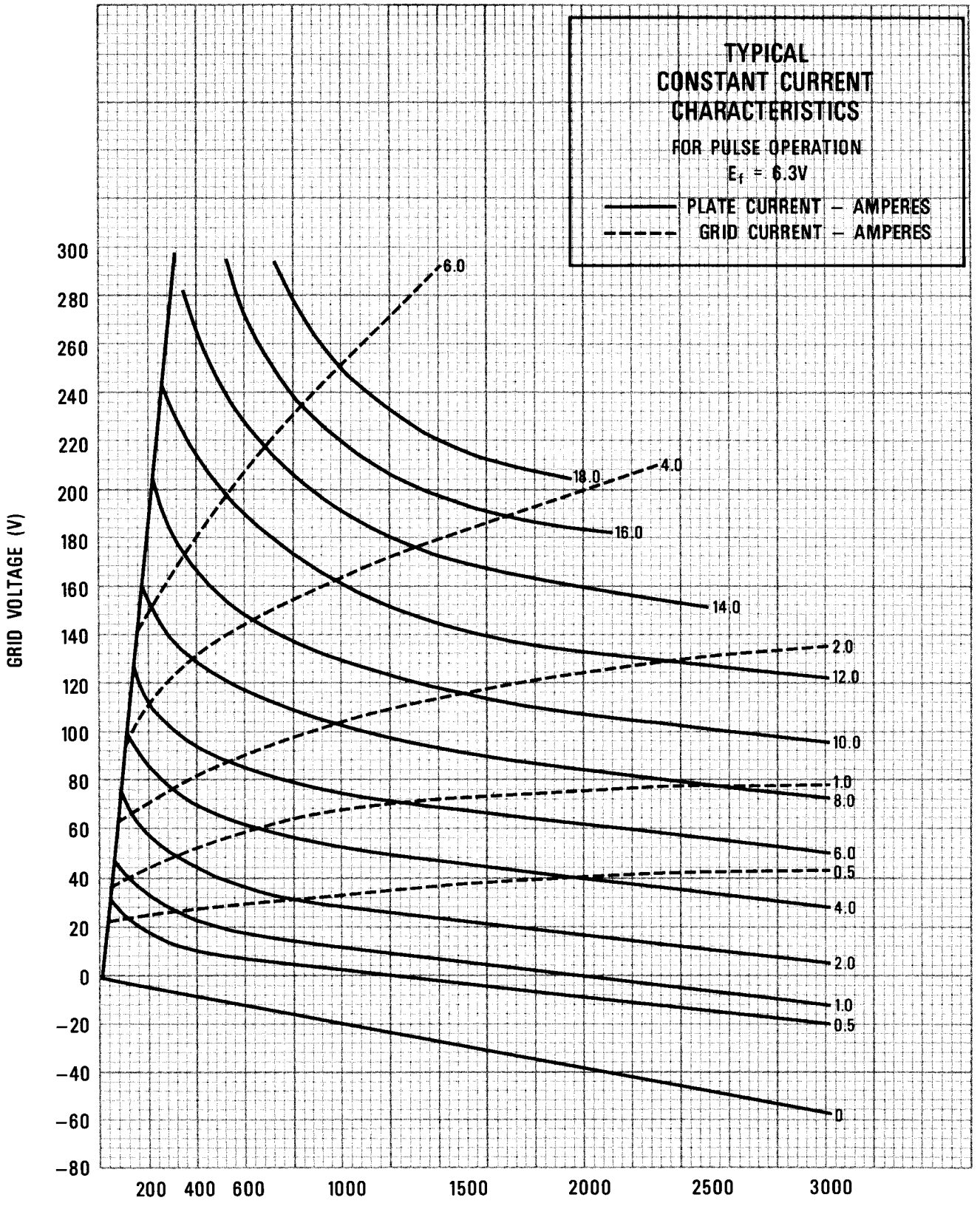


FIGURE 4

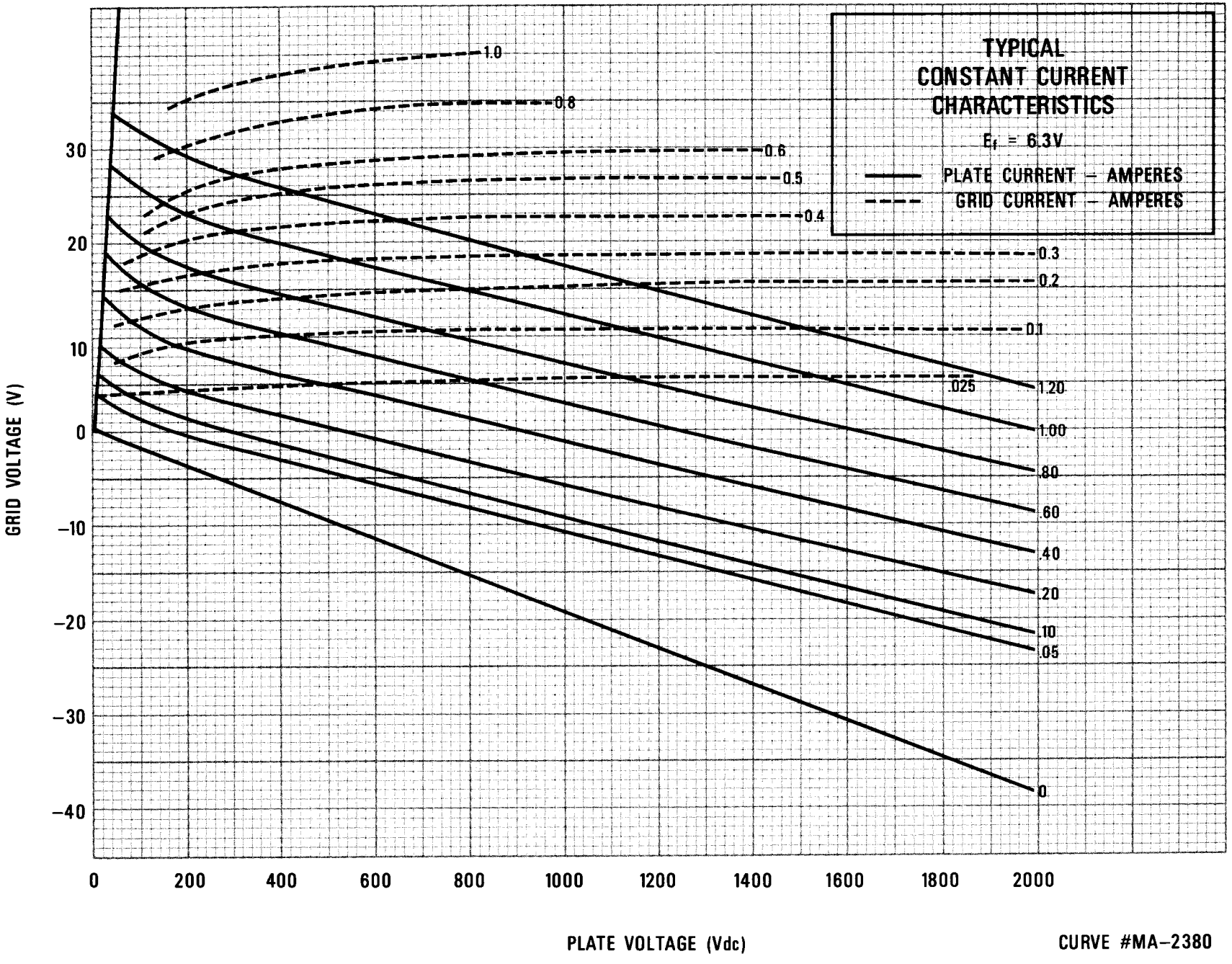
PLATE DISSIPATION VARIATION WITH COOLING AIR FLOW




TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PLATE CURRENT
GRID CURRENT
ec = GRID VOLTAGE IN VOLTS
250
200
150
100
50
250V
200
150
100
50
0
CURRENT (A)
0
2
4
6
8
10
12
14
16
18
0
200
400
600
800
1000
1500
2000
2500
3000
PLATE VOLTAGE (Vdc)
CURVE #MA-2375

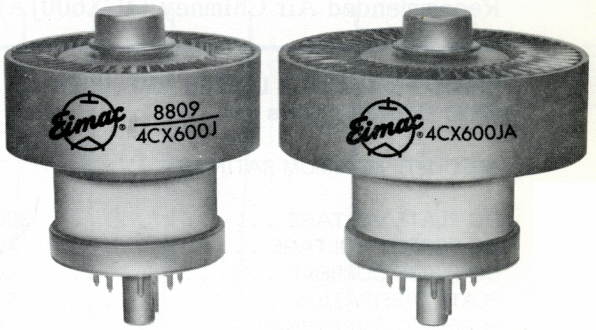


CURVE #MA–2374


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
E_f = 6.3V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
1.0
0.8
0.6
0.5
0.4
0.3
0.2
0.1
.025
1.20
1.00
.80
.60
.40
.20
.10
.05
0
GRID VOLTAGE (V)
30
20
10
0
−10
−20
−30
−40
0
200
400
600
800
1000
1200
1400
1600
1800
2000
PLATE VOLTAGE (Vdc)
CURVE #MA–2380

TECHNICAL DATA

8809
4CX600J
8921
4CX600JA
ULTRA LINEAR POWER TETRODE



The EIMAC 8809/4CX600J is a ceramic/metal, forced-air cooled, radial beam tetrode with a rated maximum plate dissipation of 600 watts. It is a low-voltage, high-current tube specifically designed for exceptionally low intermodulation distortion and low grid interception. The low distortion characteristics make the 8809/4CX600J especially suitable for radio-frequency and audio-frequency linear amplifier service.

The 8921/4CX600JA has a larger anode cooler for reduced cooling air pressure-drop. It is electrically identical to the 4CX600J.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	6.0 ± .3 V
Current, at 6.0 volts	5.4 A
Cathode-Heater Potential (maximum)	±150 V
Transconductance (Average):	
I_b = 0.3 Adc, E_{c2} = 350 Vdc	27,000 μmhos
Direct Interelectrode Capacitance (grounded cathode)[2]	
Cin	50.0 pF
Cout	6.3 pF
Cgp	.13 pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	4CX600J	4CX600JA
Length	2.71 in; 68.8 mm	2.71 in; 68.8 mm
Diameter	2.08 in; 52.8 mm	2.52 in; 64.0 mm
Net Weight	7.7 oz; 218 gm	9.0 oz; 255 gm
Operating Position		Any
Maximum Operating Temperature:		
Ceramic/Metal Seals		250°C
Anode Core		250°C

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Printed in U.S.A.

Cooling	Forced air
Base	JEDEC B8-236
Recommended Air System Socket	SK-607
Recommended Air Chimney (4CX600J)	SK-646
Recommended Air Chimney (4CX600JA)	SK-656

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN Class AB

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	3000	VOLTS
DC SCREEN VOLTAGE	450	VOLTS
DC PLATE CURRENT	0.6	AMPERE
PLATE DISSIPATION	600	WATTS
SCREEN DISSIPATION	15	WATTS
GRID DISSIPATION	1	WATT

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB, Grid Driven, Peak Envelope or Modulation Crest Conditions.

Plate Voltage	2000	2000	2500	Vdc
See Notes	---	(4)	(5&6)	
Screen Voltage	350	350	350	Vdc
Grid Voltage 1	-41	-41	-41	Vdc
Zero-Signal Plate Current	300	200	175	mAdc
Single-Tone Plate Current	500	497	680	mAdc
Two-Tone Plate Current	350	365	475	mAdc
Single-Tone Screen Current 3	5	16	30	mAdc
Two-Tone Screen Current 3	-2	3	10	mAdc
Single-Tone Grid Current 3	0	0	0.5	mAdc
Two-Tone Grid Current 3	0	0	0.2	mAdc
Peak rf Grid to Ground Voltage 3.	32	39.5	70	v
Single-Tone Useful Output Power	550	553	1100	W
Resonant Load Impedance	2000	2000	2000	Ω
Intermodulation Distortion Products 2				
3rd Order	-43	-46	-40	db
5th Order	-43	-51	-40	db

1. Adjust to specified zero-signal dc plate current.
2. The intermodulation distortion products will be as specified or better for all levels from zero-signal to maximum outout power and are referenced against one tone of a two equal tone signal.
3. Approximate values.
4. Cathode resistor 11 ohms, bypassed by 4000 pF.
5. Cathode resistor 11 ohms, no bypass capacitor.
6. Complex signal such that dc plate current maximum rating of 600 mA not exceeded.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	3000	VOLTS
DC SCREEN VOLTAGE	450	VOLTS
DC PLATE CURRENT	.6	AMPERE
PLATE DISSIPATION	600	WATTS
SCREEN DISSIPATION	15	WATTS
GRID DISSIPATION	1	WATT

TYPICAL OPERATION (Two Tubes) Class AB1

Plate Voltage	2000	2500	2800	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage 1/3	-52	-52	-52	Vdc
Zero-Signal Plate Current	200	200	200	mAdc
Max. Signal Plate Current	1.13	1.14	1.14	Adc
Zero-Signal Screen Current	-1	-2	0	mAdc
Max. Signal Screen Current	52	48	52	mAdc
Peak af Grid Voltage 2	46	46	46	v
Plate Output Power	1430	1720	1985	W
Load Resistance(plate to plate)	3850	4200	4800	Ω

1. Approximate value.
2. Per Tube.
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	5.0	5.8	A
Cathode Warmup Time	5	--	minutes

Interelectrode Capacitances[1] (grounded cathode connection)	Min.	Max.
Cin	46.0	54.0 pF
Cout	5.7	7.0 pF
Cgp	---	.2 pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

COOLING - The maximum temperature rating for the anode core of the 4CX600J is 250°C. Sufficient forced air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air flow requirements to maintain seal temperature at 225°C in ambient air are tabulated below (for operation below 30 megahertz), for the tube mounted in the recommended air-system socket and chimney, and air flowing in the base-to-anode direction.

Since the power dissipated by the heater represents about 33 watts and since grid plus screen dissipation can represent additional power, allowance has been made in preparing this tabulation for an additional 40 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown below plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling.

Plate Dissipation Watts	4CX600J			
	Sea Level		10,000 FEET	
	Air Flow CFM	Press.Drop in. water	Air Flow CFM	Press.Drop in. water
300	7.0	.3	10.2	.45
450	12.2	.53	17.7	.78
600	26.5	.81	38.7	1.18
	4CX600JA			
300	7.0	.08	10.2	.11
450	12.2	.13	17.7	.19
600	26.5	.21	38.7	.30

HEATER - The rated heater voltage for these tubes is 6.0 volts. The voltage, as measured at the socket, should be maintained at this value to minimize variations in operation and to obtain maximum tube life. In no case should the voltage be allowed to exceed 5% above the rated value except for short periods.

It is recommended that the heater voltage be applied for a period of not less than 5 minutes before other operating voltages are applied.

Refer to the EIMAC Division of Varian for special instructions if it is necessary to reduce cathode warmup time.

GRID OPERATION - The grid dissipation rating of these tubes is 1 watt. The design features which make these such extremely linear tubes also contribute to very low grid interception. The grid may be driven into the positive grid region in the typical operation of the tube.

SCREEN OPERATION - Tetrode tubes may exhibit reversed screen current to a greater or lesser degree depending on the individual tube. The 4CX600J and 4CX600JA, under some operating conditions, may indicate negative screen currents in the order of 10 milliamperes.

The maximum rated power dissipation for the screen grid is 15 watts and the screen power should be kept below this level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative. In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage. Experience has shown that the screen will operate within the limits established for this tube if the indicated screen current, plate voltage and drive voltage approximate the "Typical Operation" values.

The screen supply voltage must be maintained constant for any values of negative and positive screen currents that may be encountered. Dangerously high plate currents may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished in several different ways. A bleeder resistor may be connected from screen to cathode; a zener regulator may be connected from

screen to cathode; or an electron-tube regulator circuit may be used in the screen supply. It is absolutely essential to use a bleeder if a series regulator is employed. The screen bleeder current should approximate 20 milliamperes to adequately stabilize the screen voltage. It should be observed that this bleeder power may be usefully employed to energize low-power stages of the transmitter.

PLATE OPERATION - The maximum rated plate dissipation power is 600 watts. Except for brief periods during circuit adjustments, this maximum value should not be exceeded.

The top cap on the anode cooler may be used as a plate terminal at low frequencies or a circular clamp or spring-finger collet encircling the cylindrical outer surface of the anode cooler may be used at high frequencies.

Points of electrical contact with the anode cooler should be kept clean and free of oxide to minimize radio-frequency loses. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

INTERMODULATION DISTORTION - The typical radio frequency linear amplifier operating conditions, including the distortion data, are based on actual operation in a grid-driven amplified. Because the 4CX600J and 4CX600JA have very low grid interception it is possible to drive the grid positive with minimum adverse effects upon the distortion level or upon the driver. Class AB2 linear amplifier operation is therefore possible and recommended. It is also recommended that a low impedance driver be used and that the input of the 4CX600J or 4CX600JA be swamped with a 1000 ohm resistor from grid to cathode so as to provide an almost constant load to the driver.

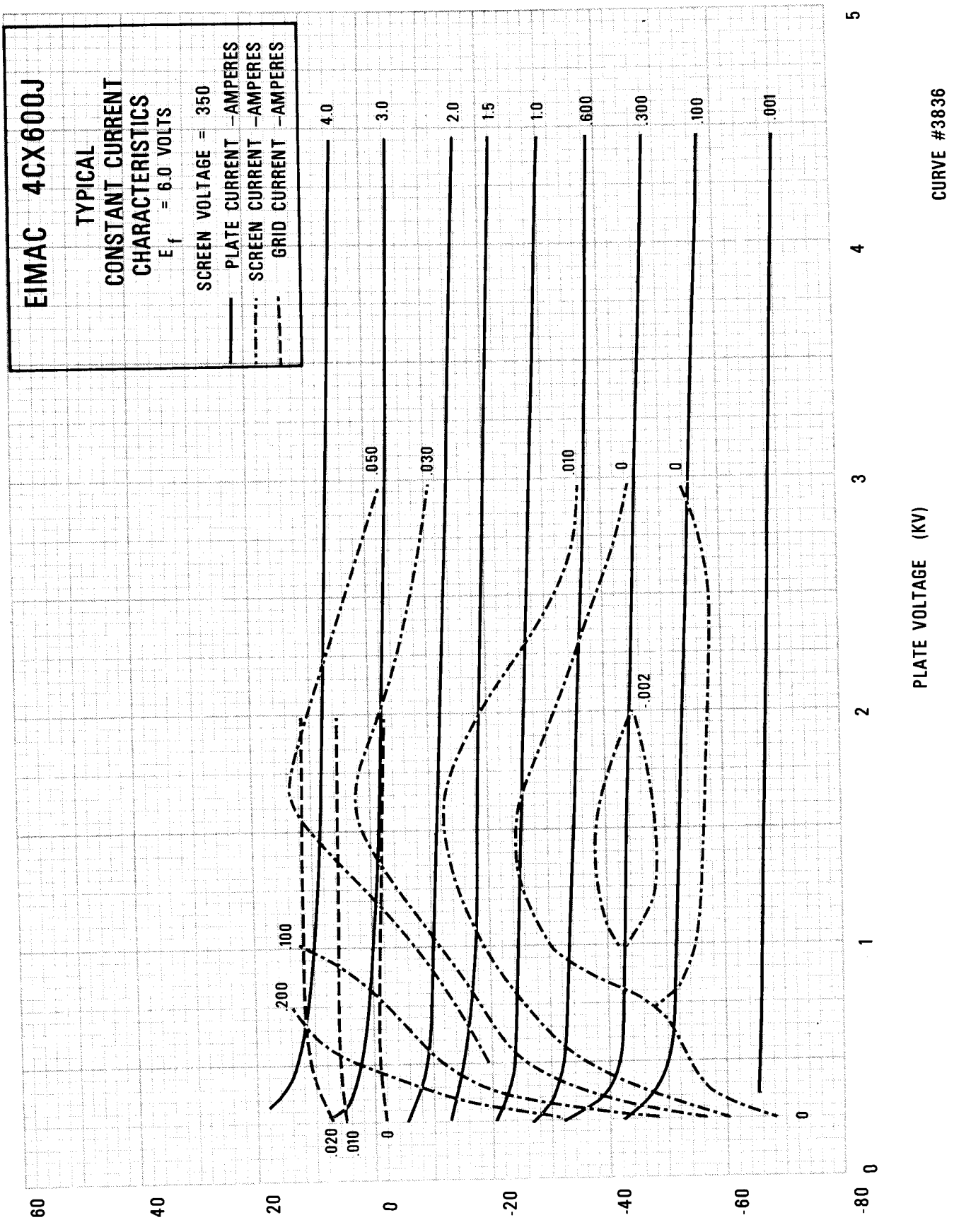
In general, linearity is improved as grid bias value is shifted toward Class A operation. Linearity may also be improved without sacrifice of efficiency by use of cathode resistors bypassed for rf, or with no bypass capacitor. See "Radio Frequency Linear Amplifier, Typical Operation".

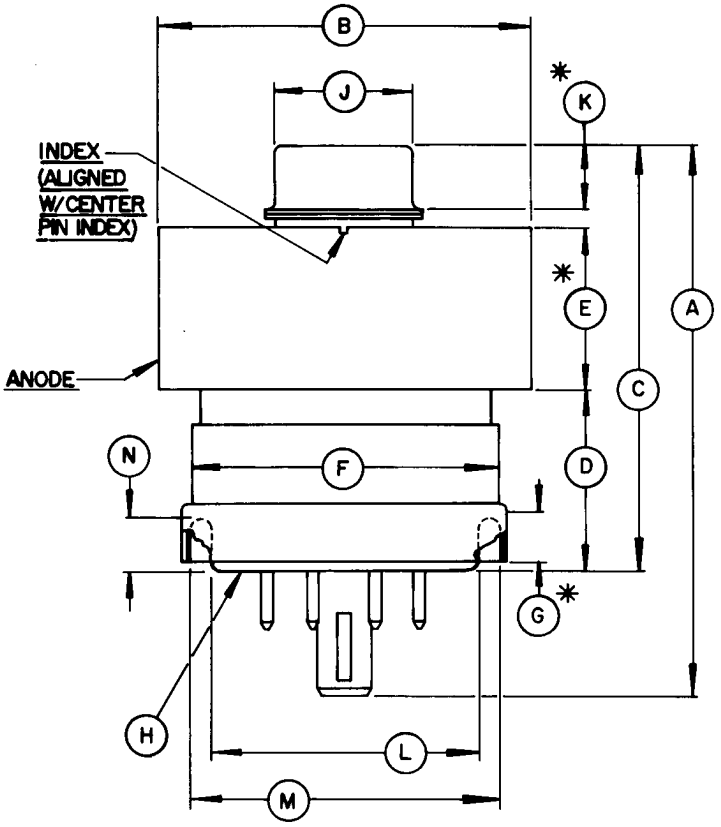
CAUTION-HIGH VOLTAGE - Operating voltage for the 4CX600J and 4CX600JA can be deadly, so the equipment must be designed properly and operating precautions must be followed. Design equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high voltage circuits and terminals, with interlock switches to open the primary circuits of the power supply and to discharge high voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

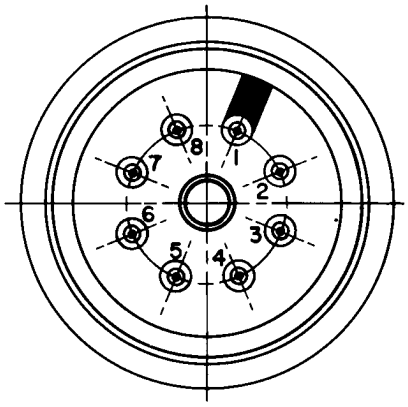
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.


EIMAC 4CX600J
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
E_f = 6.0 VOLTS
SCREEN VOLTAGE = 350
PLATE CURRENT —AMPERES
SCREEN CURRENT —AMPERES
GRID CURRENT —AMPERES
4.0
3.0
2.0
1.5
1.0
.600
.300
.100
.001
.050
.030
.010
0
.002
.200
.100
.020
.010
0
60
40
20
0
-20
-40
-60
-80
0
1
2
3
4
5
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE #3836



8809/4CX600J DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	2.507	2.707	63.68	68.76
B	2.050	2.080	52.07	52.83
C	1.973	2.173	50.11	55.19
D	0.910	1.030	23.11	26.16
E	0.710	0.790	18.03	20.07
F	--	1.406	--	35.71
G	0.187	--	4.75	--
H	BASE: B8-236 (JEDEC DESIGNATION)			
J	0.559	0.573	14.20	14.55
K	0.240	--	6.10	--
L	1.175	1.190	29.85	30.23
M	1.325	1.360	33.66	34.54
N	0.205	--	5.21	--
8921/4CX600JA				
B	2.485	2.515	63.00	63.80
ALL ELSE SAME AS ABOVE				



PIN DATA
PIN 1 &/OR BASE RING-SCREEN GRID
PINS 2,4,7-CONTROL GRID
PINS 3,6,8-CATHODE
PIN 5-HEATER
CENTER PIN-HEATER

TECHNICAL DATA

8847
8847A

HIGH-MU PLANAR TRIODES

The 8847 and 8847A are miniature, ceramic/metal, rugged planar triodes for advanced airborne and space applications up to 3.5 GHz.

The 8847A is identical to the 8847 in all respects except that the required heater power is reduced by 25%. The tube should be used where input power consumption and heat dissipation are of major concern.



Either tube may be used as an amplifier, oscillator, or frequency multiplier in the CW, grid- or plate-pulsed mode, as well as a modulator or regulator tube. In addition to low interelectrode capacitances, high transconductance and amplification factor, the 8847 and 8847A have an anode designed to enhance frequency stability and an arc-resistant cathode, both assuring stable, reliable and long-life operation under adverse conditions.

The 8847 and 8847A are supplied without radiator and may be conduction, convection, heat sink, or liquid cooled. Radiators for forced-air cooling permitting an anode dissipation up to 150 watts, can be furnished on separate order.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	6.3 ± 0.3 V
8847 Current, at 6.3 volts	1.30 A
8847A Current, at 6.0 volts	0.95 A
Transconductance (Average):	
I_b = 160 mA (200 mA/cm²)	38 mmhos
Amplification Factor (Average):	75
Direct Interelectrode Capacitances (Grounded Cathode)[2]	
Grid-Cathode	9.5 pF
Plate-Cathode	0.06 pF
Grid-Plate	1.40 pF
Cut-off Bias [3]	-30 V max.

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment.

2. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

(Effective 6-1-70) © 1970 by Varian Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:

Length	1.370 in; 34.75 mm
Diameter	0.785 in; 19.94 mm
Net Weight	0.56 oz; 16.0 gm
Operating Position	Any

Maximum Operating Temperature:

Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Conduction, convection, forced-air[1] or liquid
Terminals	Coaxial, special

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axes 55 to 500 Hz	10 G
Altitude, max (in suitable designed circuit)	70,000 ft.

CW RF POWER AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE	2500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-400	VOLTS
Grid positive to cathode	30	VOLTS
DC PLATE CURRENT	250	MILLIAMPERES
DC GRID CURRENT	45	MILLIAMPERES
PLATE DISSIPATION[1]	150	WATTS
GRID DISSIPATION	1.5	WATTS
FREQUENCY	3.0	GIGAHERTZ

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE(GRID PULSED)	3000	VOLTS
PEAK PULSE PLATE VOLTAGE (PLATE PULSED)	3500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-700	VOLTS
Grid positive to cathode	175	VOLTS
PULSE PLATE CURRENT	5.0	AMPERES
PUSLE GRID CURRENT	2.5	AMPERES
PLATE DISSIPATION[1]	150	WATTS
GRID DISSIPATION	1.5	WATTS
FREQUENCY	3.5	GIGAHERTZ
PULSE DURATION[2]	6	μsec
DUTY FACTOR[2]	.0033	

1. Using one of the EIMAC radiators shown on the cooling curves.

2. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube and Devices Field Office, or the Product Manager, Eimac-Division of Varian, Salt Lake City, Utah.

REPRESENTATIVE OPERATION

Grid-Pulsed rf Power Oscillator (1.6 GHz)

DC Plate Voltage	3000	Vdc
Peak Plate Current	3.0	a
DC Grid Voltage (Approx.)	-90	V
Peak Grid Current	1.0	a
Filament Voltage	6.3	V
Useful Power Output (Approx.)	3000	w
Bandwidth (1db)	40	MHz
Plate Efficiency	33%	

PULSE MODULATOR OR PULSE AMPLIFIER SERVICE

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE	3500	VOLTS
PEAK PLATE VOLTAGE	4000	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	150	VOLTS
PULSE CATHODE CURRENT	7.5	AMPERES
DC PLATE CURRENT	150	MILLIAMPERES
PLATE DISSIPATION[1]	150	WATTS
GRID DISSIPATION	1.5	WATTS
PULSE DURATION	6	μs
DUTY FACTOR	.0033	
CUT-OFF MU	60	

1. Using one of the EIMAC radiators shown on the cooling curves.
2. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube and Device Field Office, or the Product Manager Eimac-Division of Varian, Salt Lake City, Utah.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater current at 6.3 volts (8847)	1.20	1.40	A
Heater current at 6.0 volts (8847A)	0.85	1.05	A
Cathode Heating Time	60	---	sec.
Interelectrode Capacitances[1] (grounded cathode connection)			
Grid-Cathode	8.5	10.5	pF
Plate-Cathode	---	0.06	pF
Grid-Plate	1.2	1.6	pF

1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

APPLICATION

COOLING - The 8847 and 8847A can be cooled by conduction, convection, forced-air or liquid cooling. The tubes are designed to permit high-temperature operation up to the limit indicated. However, if long life is the prime objective, tube terminal and seal temperatures should be kept well below 250°C. If forced-air cooling is provided, auxiliary air flow, apart from the air flowing through the radiator, should be provided to cool the tube envelope and other tube terminals. Some conduction cooling is always provided through the contact terminals. However, these terminals usually exhibit poor heat transfer, often having a temperature gradient across them as high as 50°C. Cooling curves are given for the three radiators which are suitable for use with the 8847 and 8847A.

For further details on cooling or other aspects of tube operation, refer to the "Application Notes for Planar Triodes" bulletin which can be obtained on request.

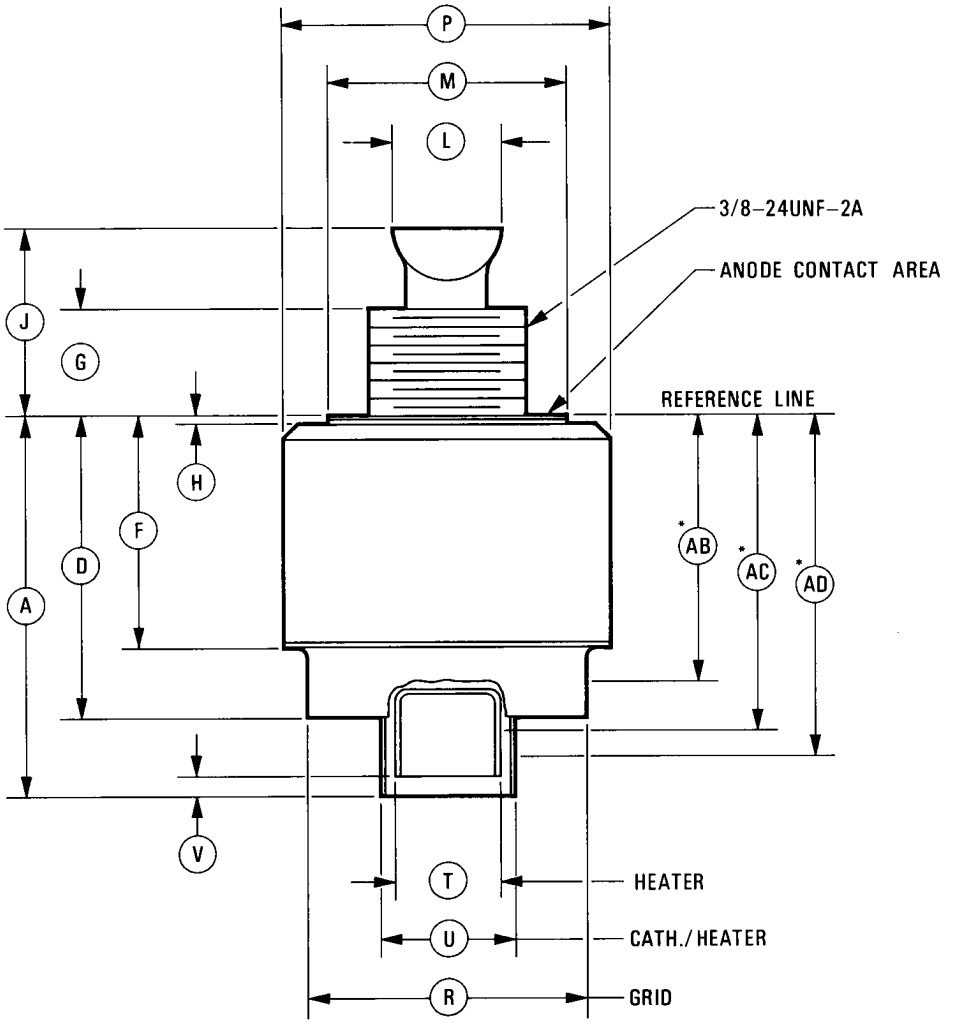
DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	--	1.020	--	--	25.91	--
D	0.740	0.800	--	18.80	20.32	--
F	--	0.570	--	--	14.48	--
G	0.150	0.170	--	3.81	4.32	--
H	--	0.040	--	--	1.02	--
J	--	0.350	--	--	8.90	--
L	--	0.260	--	--	6.60	--
M	0.545	0.570	--	13.84	14.48	--
P	0.775	0.785	--	19.69	19.94	--
R	0.650	0.670	--	16.51	17.02	--
T	0.210	0.225	--	5.33	5.72	--
U	0.310	0.330	--	7.87	8.38	--
V	--	0.040	--	--	1.07	--
AB	0.590	0.740	--	14.99	18.80	--
AC	0.760	0.885	--	19.30	22.48	--
AD	0.800	0.975	--	20.32	24.77	--

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.

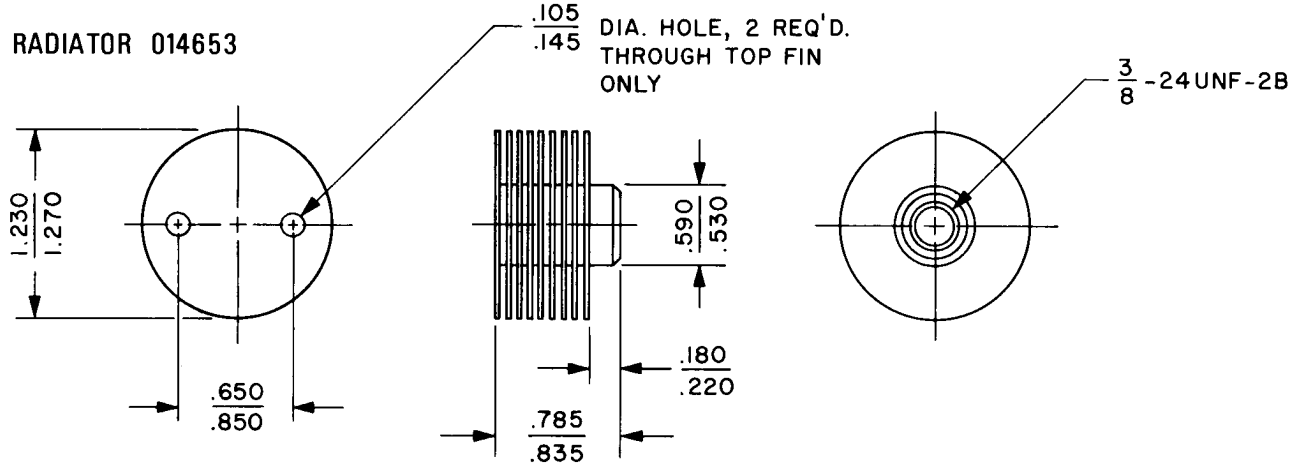
NOTES:

1. ANODE FLANGE IS ELECTRICAL CONTACT. STUD IS FOR HEAT TRANSFER.
2. (*) DISTANCE FROM REFERENCE SURFACE TO THE CENTER OF CONTACT AREA.
3. METRIC EQUIVALENTS ARE TO THE NEAREST .01 mm, ARE GIVEN FOR GENERAL INFORMATION ONLY, AND ARE BASED ON 1 INCH = 25.4 mm.
4. CONCENTRICITY BETWEEN GRID TERMINAL AND CATHODE/HEATER TERMINAL RESPECTIVELY TO THE ANODE STUD TO BE 0.020 TIR MAX. MEASUREMENT TO BE MADE WITH EIMAC GAGE JA-21685G WHICH MUST SEAT AGAINST THE ANODE FLANGE.

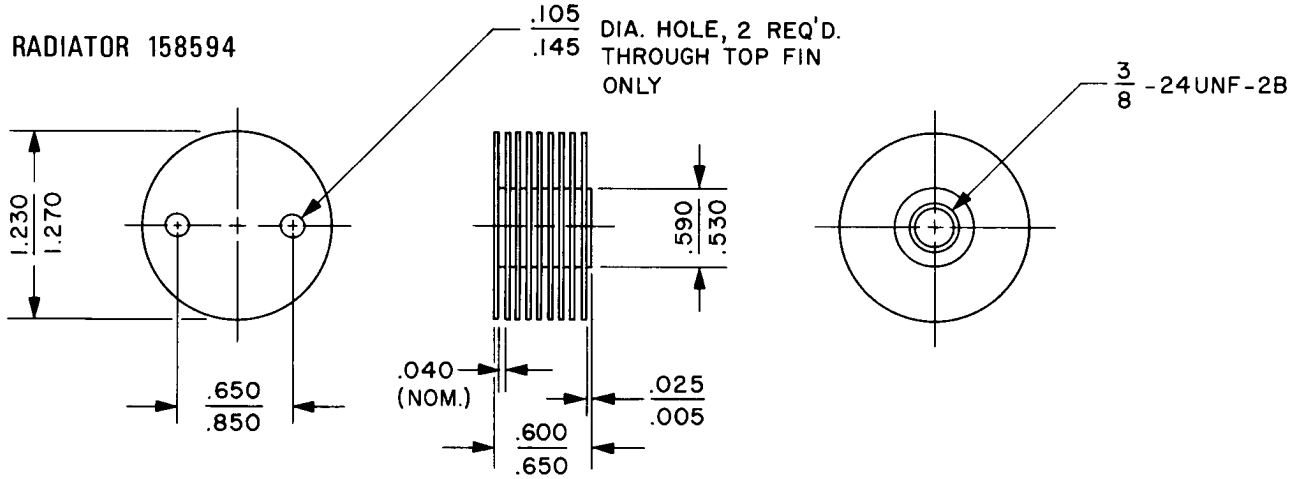


EIMAC RADIATORS

RADIATOR 014653



RADIATOR 158594



RADIATOR 158593

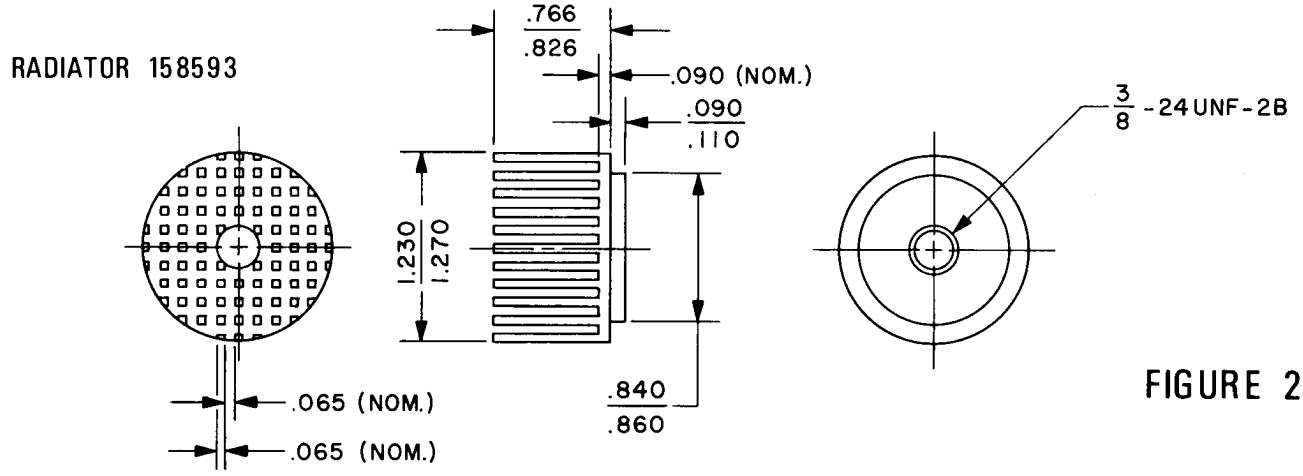


FIGURE 2

FIGURE 3

COMBINED CORRECTION FACTORS FOR INLET AIR TEMPERATURE AND ALTITUDE

(RELATIVE TO 25°C AND SEA LEVEL)

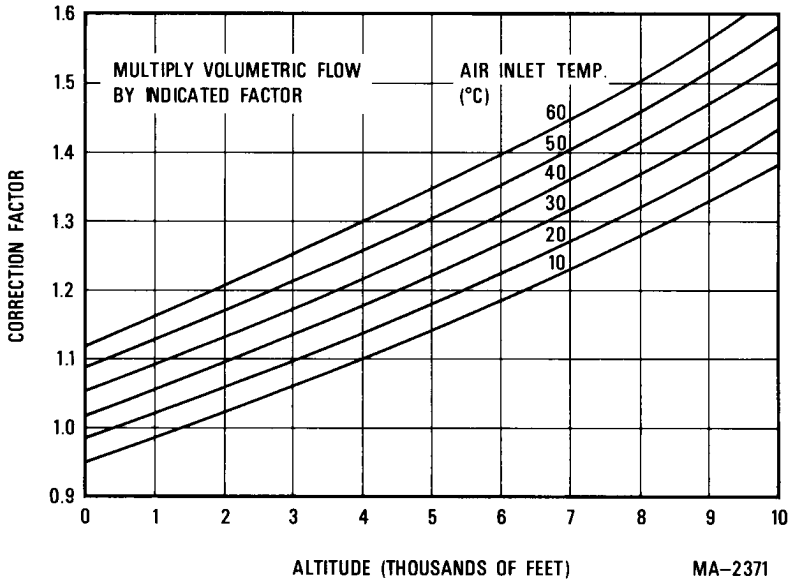
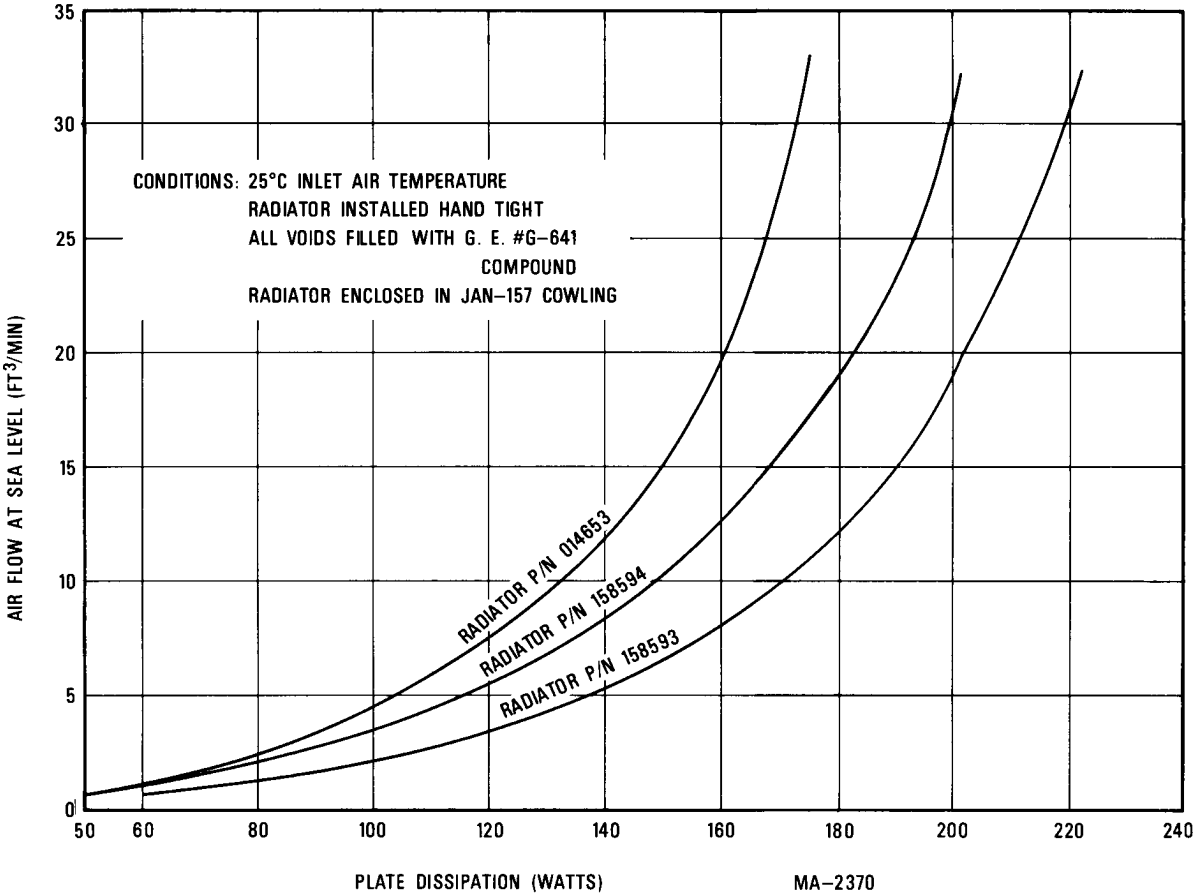
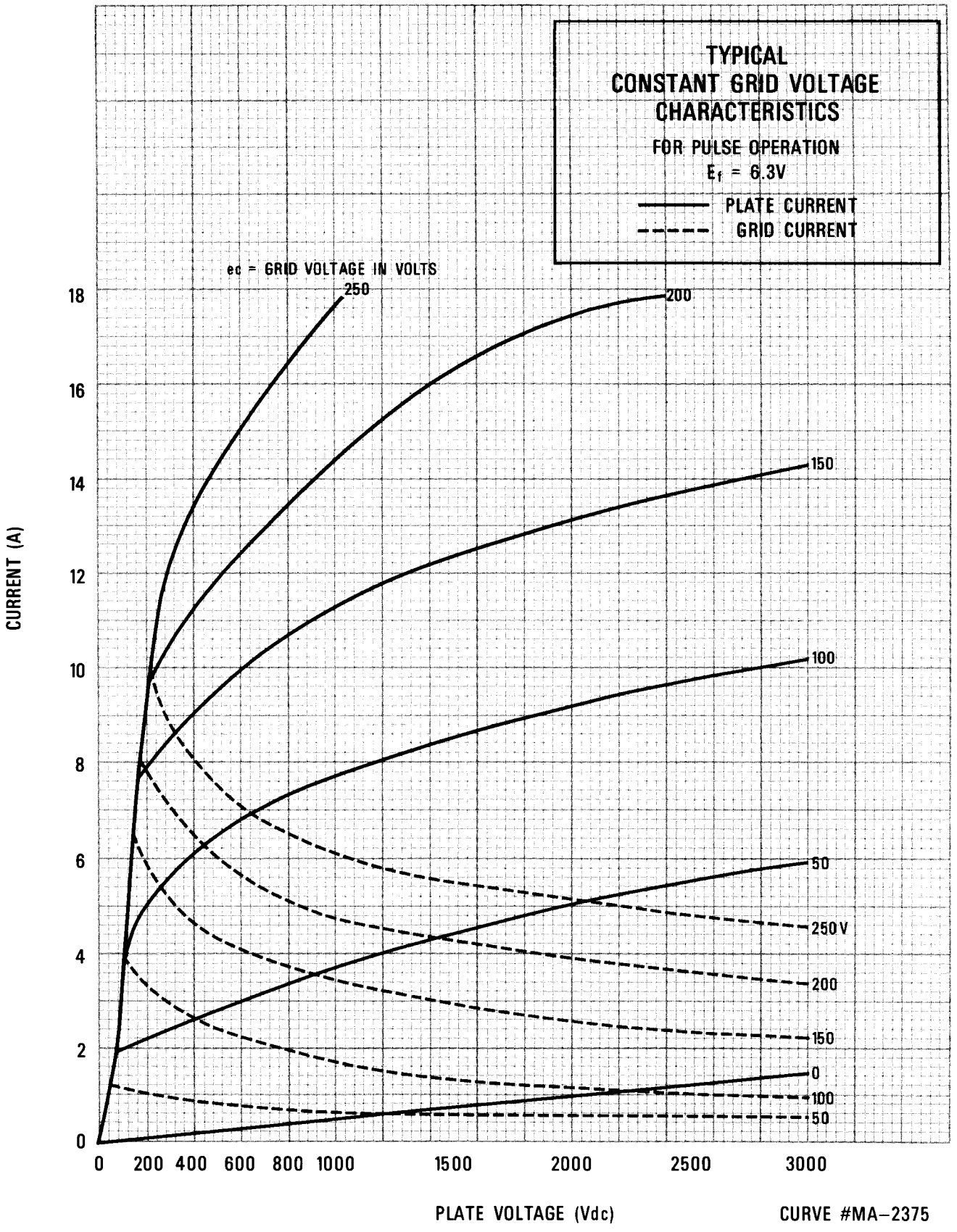
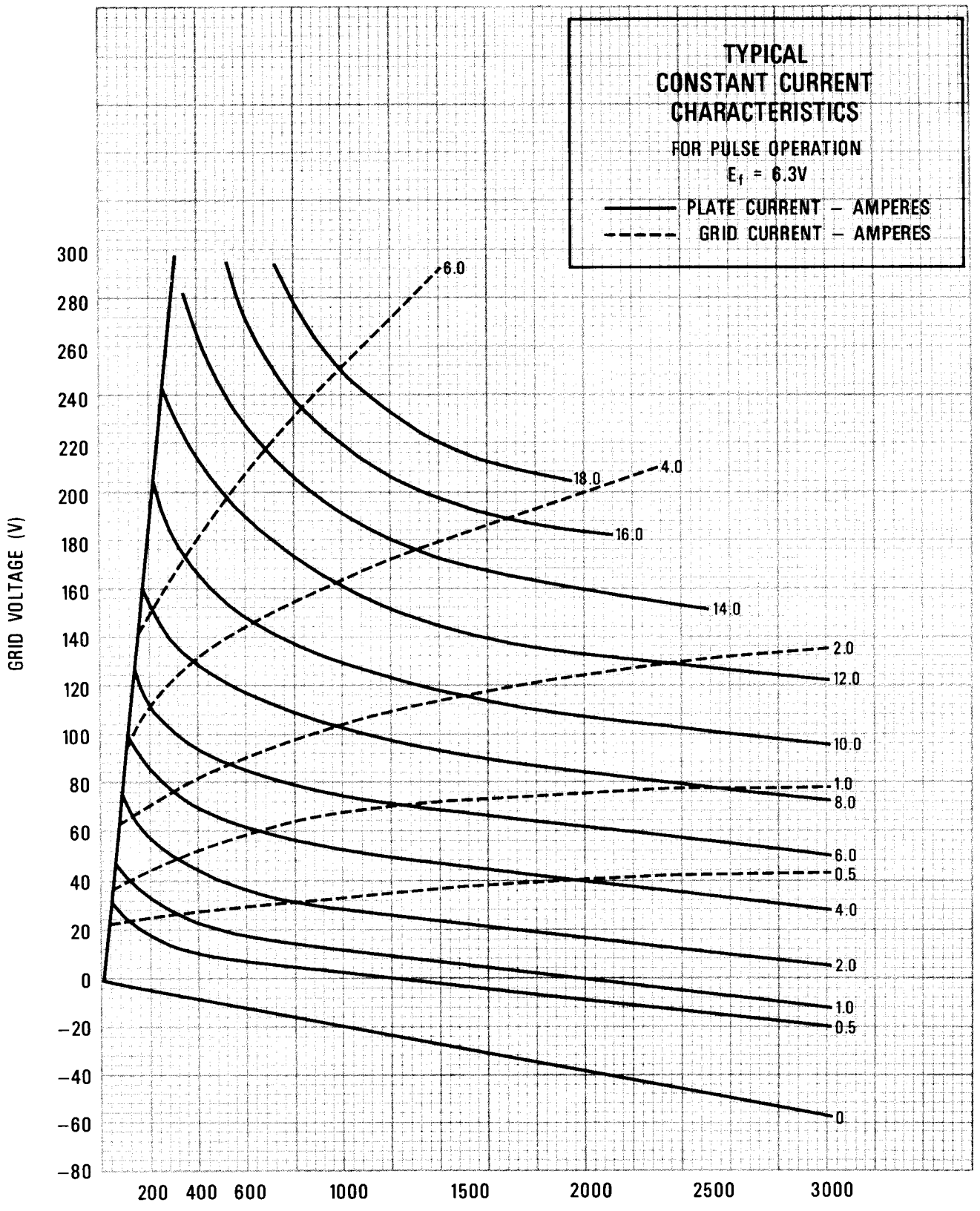


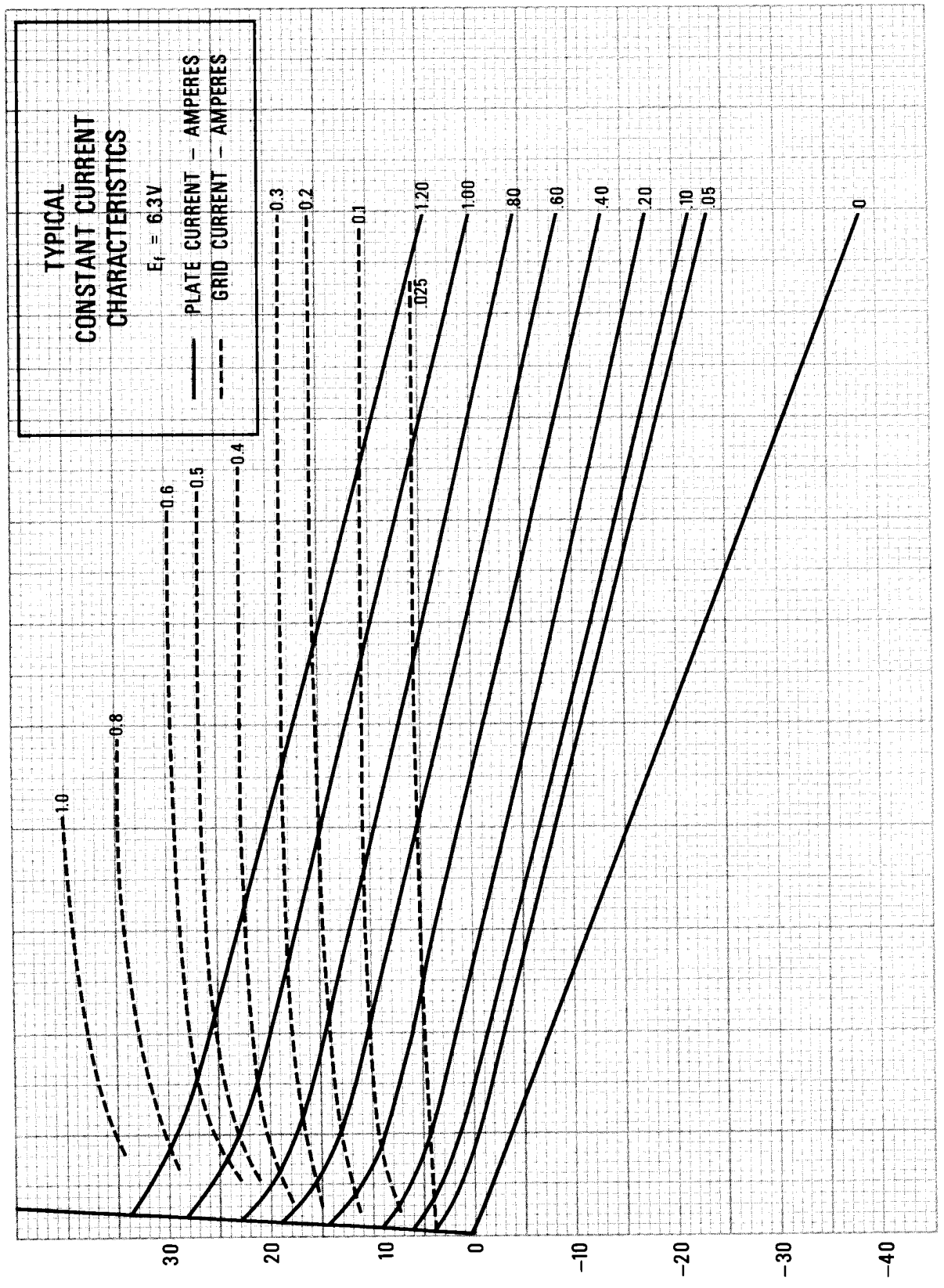
FIGURE 4

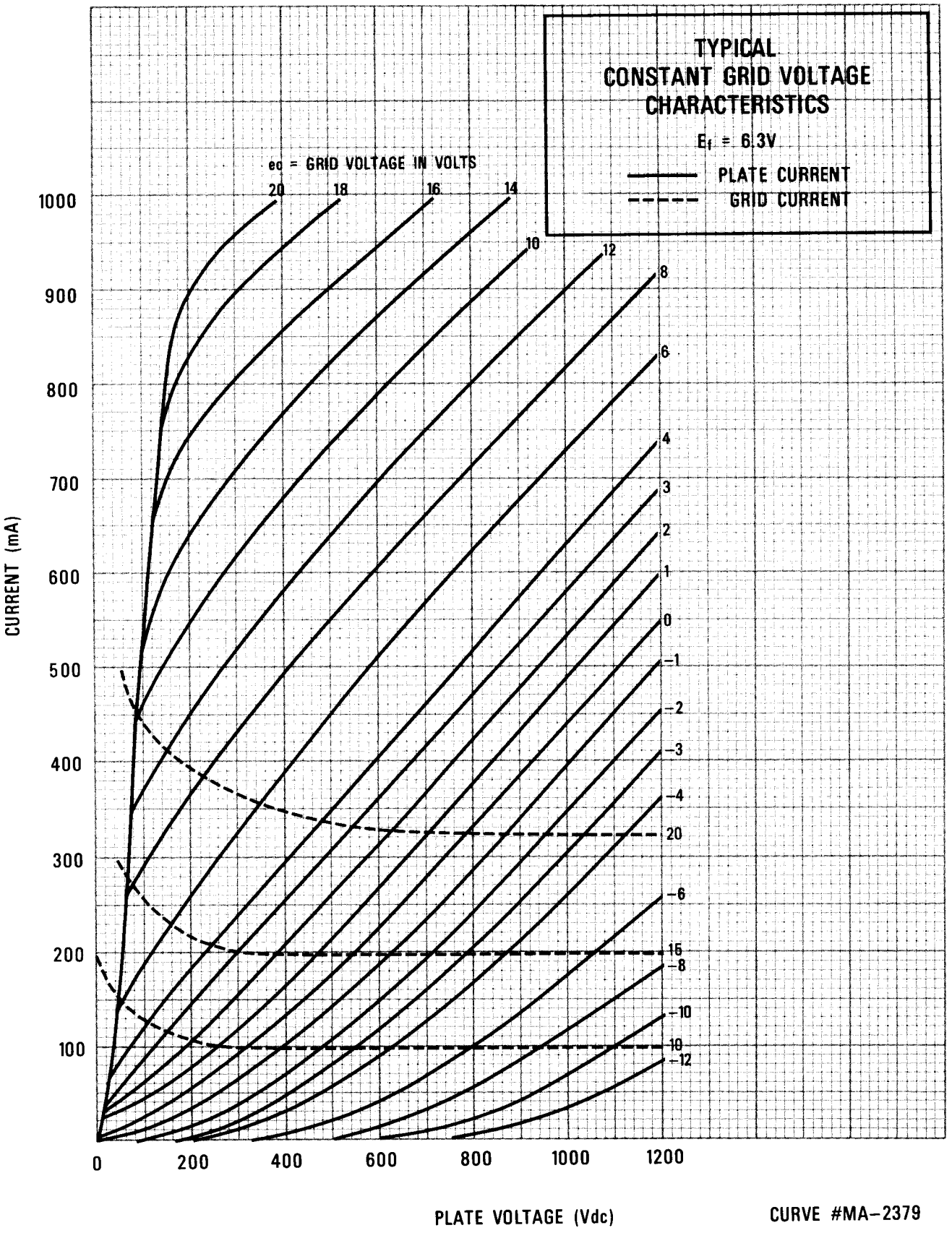
PLATE DISSIPATION VARIATION WITH COOLING AIR FLOW




TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PLATE CURRENT
GRID CURRENT
ec = GRID VOLTAGE IN VOLTS
250
200
150
100
50
250V
200
150
100
50
0
CURRENT (A)
0
2
4
6
8
10
12
14
16
18
0
200
400
600
800
1000
1500
2000
2500
3000
PLATE VOLTAGE (Vdc)
CURVE #MA-2375


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
−20
−40
−60
−80
200
400
600
1000
1500
2000
2500
3000
PLATE VOLTAGE (Vdc)
6.0
4.0
18.0
16.0
14.0
2.0
12.0
10.0
1.0
8.0
6.0
0.5
4.0
2.0
1.0
0.5
0
CURVE #MA–2374

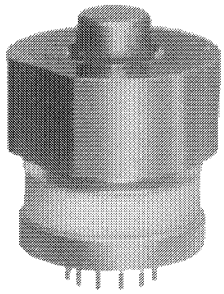

TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
E_f = 6.3V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
1.0
0.8
0.6
0.5
0.4
0.3
0.2
0.1
.025
1.20
1.00
.80
.60
.40
.20
.10
.05
0
30
20
10
0
−10
−20
−30
−40
0
200
400
600
800
1000
1200
1400
1600
1800
2000
GRID VOLTAGE (V)
PLATE VOLTAGE (Vdc)
CURVE #MA–2380



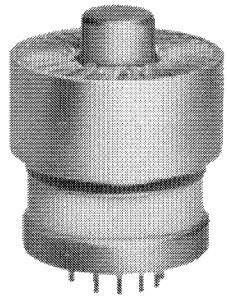
CURVE #MA-2379

8873
8874
8875
HIGH-MU TRIODES

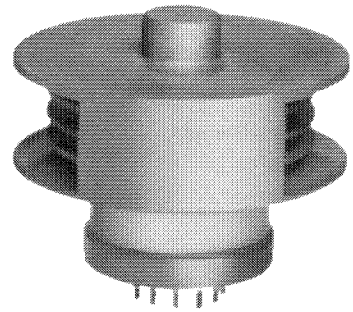
TECHNICAL DATA



8873



8874



8875

The EIMAC 8873, 8874, and 8875 are compact external-anode ceramic/metal triodes intended for use in Class AB or C amplifiers in radio-frequency applications. The three types differ only in method of cooling and anode dissipation: the anode of the 8873 is designed for conduction cooling and is rated for 200 watts; the 8875 anode has a transverse cooler for forced-air cooling and is rated for 300 watts; and the 8874 requires axial-flow forced-air cooling and is rated for 400 watts. Grounded-grid operation is attractive since a power gain as high as twenty times can be obtained with these types in a cathode-driven circuit.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater Voltage	6.3 ± 0.3 V
Heater Current, at 6.3 volts	3.0 A
Cathode-Heater Potential (maximum)	±150 V
Tranconductance, average	
Ib = 250 mAdc	29,000 μmhos
Direct Interelectrode Capacitances, (cathode grounded, in shielded fixture)[2]	
Cin	20.5 pF
Cout	0.03 pF
Cgp	6.0 pF
Direct Interelectrode Capacitances, (grid grounded, in shielded fixture)[2]	
Cin	20.5 pF
Cout	6.0 pF
Cpk	0.03 pF
Ck-htr	6.0 pF
Frequency of Maximum Rating:	
CW	500 MHz

1. Characteristics and operating values are based upon peformance tests. These figures may change without notice as the result of additional data or product refinement. Varian, EIMAC Division should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

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MECHANICAL

Maximum Overall Dimensions:

	TYPE 8873	TYPE 8874	TYPE 8875
Length	2.14 in. 54.41 mm	2.14 in. 54.41 mm	2.18 in. 55.50 mm
Diameter	1.64 in. 41.66 mm	1.64 in. 41.66 mm	2.52 in. 64.01 mm
Net Weight	8.50 oz. 240.9 gm	4.30 oz. 121.9 gm	8.60 oz. 243.8 gm
Operating Position	Any	Any	Any

Cooling: (Type 8873)
Conduction cooled. Recommended Beryllium Oxide thermal link ..... EIMAC SK-1920
(Type 8874)
Air flow at 50°C and sea level ..... 8.6 ft^3/Min.
Pressure Drop, across tube anode cooler at 8.6 ft^3/Min ..... 0.37 in H_2O
(Type 8875)
Air flow at 25°C and sea level, and
Pressure Drop across tube anode cooler } See Application Section, Cooling 8875
Operating Temperature, Maximum, all three types,
Ceramic/Metal seals and Anode Core ..... 250°C
Base: (all types) ..... Large Wafer Elevenar 11-Pin with Ring (JEDEC No. E11-81)
Recommended Socket ..... E.F. Johnson #124-311-100*
Available grid Collet, for base grid ring contact ..... EIMAC Part No. 882931

*NOTE: The E.F. Johnson socket is available from EIMAC as Part No. 154353.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.
Heater Current, at 6.3 volts	2.8	3.4 A
Cathode Warmup Time	60	--- sec.
Plate Current (Ef = 6.3 V, Eb = 1000 Vdc, Ec = 0 Vdc)	35	80 mAdc
Grid Cut-off (Ef = 6.3 V, Eb = 2000 Vdc, Ib = 1.0 mAdc)	---	-16 Vdc
Interelectrode Capacitances (cathode grounded, in shielded fixture)[1]		
Cin	18.0	23.0 pF
Cout	---	0.04 pF
Cgp	5.0	7.0 pF
Interelectrode Capacitances (grid grounded, in shielded fixture)[1]		
Cin	18.0	23.0 pF
Cout	5.0	7.0 pF
Cpk	---	0.04 pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN

Class AB_2

MAXIMUM RATINGS:

DC PLATE VOLTAGE	2200	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION (nominal values)		
TYPE 8873 (with heat sink)	200	WATTS
TYPE 8874	400	WATTS
TYPE 8875	300	WATTS
GRID DISSIPATION	5	WATTS

TYPICAL OPERATION
Class AB_2 (Cathode driven) Peak Envelope Modulation
Crest or Key-Down Conditions[1]

Frequency	30	150	432	MHz
Plate Voltage	2000	2000	2000	Vdc
Cathode Voltage	8.2	9.8	8.2	Vdc
Zero-Signal Plate Current	22	10	22	mAdc
Single-Tone IVS Plate Current[2]	500	400	500	mAdc
Two-Tone Plate Current[3]	312	245	300	mAdc
Single-Tone Grid Current[4]	30	23	98	mAdc
Two-Tone Grid Current[4]	12	10	39	mAdc
Peak rf Grid/Cathode Voltage[4]	67	50	67	v
Peak Driving Power[4]	26	17.5	27	w
Peak Power Input	1000	800	1000	W
Useful Output Power[4]	587	526	505	W
Resonant Load Impedance	2140	--	--	Ω
Intermodulation Distortion[5]				
3rd Order	-35	--	--	dB
5th Order	-36	--	--	dB

1. Short-term duty should not exceed 50%. During brief test periods, "on" time must be kept as short as possible, with sufficient "off" time to allow for tube cooling.
2. Key down condition. With 50% duty, current will be half the value shown.
3. Two equal-tone modulation. During brief test periods, allow sufficient "off" time for tube cooling. Values will be lower with voice modulation for the same PEP level.
4. Approximate values.
5. The intermodulation distortion products are referenced against one tone of a two equal-tone signal.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM
(Key-Down Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	2200	VOLTS
DC GRID VOLTAGE	-100	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION (nominal values)		
TYPE 8873 (with heat sink)	200	WATTS
TYPE 8874	400	WATTS
TYPE 8875	300	WATTS
GRID DISSIPATION	5	WATTS

TYPICAL OPERATION (Frequencies to 110 MHz)

Plate Voltage	2000	Vdc
Grid Voltage[1]	-10	Vdc
Plate Current	250	mAdc
Grid Current[1]	40	mAdc
Measured Driving Power	9	WATTS
Plate Input Power	500	WATTS
Plate Dissipation	195	WATTS
Useful Output Power	305	WATTS

1. Approximate value.

PULSE MODULATOR OR REGULATOR

MAXIMUM RATINGS:

DC PLATE VOLTAGE	3500	VOLTS
PEAK ANODE CURRENT	6	AMPERE
GRID DISSIPATION	5	WATTS

PLATE DISSIPATION (nominal values):

TYPE 8873 (with heat sink)	200	WATTS
TYPE 8874	400	WATTS
TYPE 8875	300	WATTS

APPLICATION

MOUNTING & SOCKETING - The 8873, 8874, and 8875 may be mounted in any position. Sockets such as E.F. Johnson #124-311-100, or equivalent, may be used as long as there are no unusual circumstances which would allow the ceramic/metal anode and base seal temperatures to exceed 250°C. The internal construction of these tubes is such that heat transfer to the tube base is minimized, but in operation there is some heat flow from the tube base to the socket. Mounting should be such that free movement of air past the base by convection is possible, or, if forced-air cooling is being provided for the anode, some of this air may be bled off to provide for some circulation past the tube base.

The 8873 mounting is normally controlled by its heat sink configuration and location. Where possible, the socket can be mounted on a bracket which in turn is mounted to the heat sink so that the one sink will act for removal of heat from the tube anode and also the tube base. The EIMAC SK-1920 beryllium oxide (BeO) thermal link is available for use between the 8873 anode and the heat sink. BeO is a ceramic material which exhibits high thermal conductance, similar to aluminum, and high electrical resistance and low loss typical of ceramics. Properly installed, it provides a low thermal resistance path allowing the anode heat to be transferred to the heat sink, while providing electrical isolation between the anode and the sink.

The 8874 requires forced-air cooling for its anode, which can often be accomplished most easily by means of a pressurized anode-compartment chassis, with air passing through the anode cooler and then exhausting. In such an installation, some air can be bled past the socket mount to provide base cooling if this is required.

The 8875 has a large transverse cooler on its anode, requiring forced-air cooling directed crossways.

HEATER/CATHODE OPERATION - The rated heater voltage for the 8873, 8874, and 8875 is 6.3 volts, as measured at the base of the tube, and variations should be restricted to plus or minus 0.3 volt for long life and consistent performance. At frequencies above approximately 300 MHz it may be necessary to reduce heater voltage to compensate for rf transit-time heating of the cathode after dynamic operation of the tube has started. The back heating is a function of frequency, grid current, grid-bias, anode current, duty cycle, and circuit design and adjustment. The following heater operating voltages are recommended:

Frequency (MHz)	Heater Voltage
300 or lower	6.3
301 to 400	6.0
401 to 500	5.7

The potential between the heater and the cathode should be limited to plus or minus 150 Vdc.

CATHODE WARMUP TIME - In normal service it is recommended that the heater voltage be applied for a minimum of 60 seconds before anode voltage and drive boltage are applied, to allow proper conditioning of cathode surface.

If it is desired to apply anode voltage simultaneously with heater voltage, enough bias voltage must also be applied so that no conduction can take place until drive voltage is applied after the full 60 seconds of warmup time.

ANODE CURRENT RATING AND TUNEUP PROCEDURE - The 8873, 8874, and 8875 are rated for 350 mAdc of continuous anode current. In intermittent voice (A3J emission) and interrupted carrier keying (A1 emission) service, which would be normal single-sideband-suppressed-carrier or keyed CW operation, and where short-term duty does not exceed 50%, the dc anode current (per tube) may be 500 mA during the "on" time. With 50% duty, the average current (per tube) would be 250 mA. During very short test periods, the tubes may be operated at full 500 mA value but care must be taken to keep the "on" time as short as possible, with sufficient "off" time to allow for tube cooling.

Initial tuneup should preferable be done with reduced anode voltage and drive, and if done at the correct values, little or no retuning will be necessary when switching to full operating level. For the 2000 volt Intermittent Voice Service (IVS) condition, tuneup is recommended at 1500 volts and reduced grid drive. When anode voltage and drive are then raised, the full one kilowatt PEP IVS condition will be achieved with little or no retuning required.

COOLING - 8873 - This tube is designed for use in a conduction-cooled system by using a beryllium oxide (BeO) thermal link between the anode and the heat sink. The heat sink in turn can be cooled by natural (free) convection, forced-air convection, liquid cooling, or a combination of these methods. The design choice is determined by the tube application, but in all cases the cooling system must maintain the anode and the ceramic-metal seal temperatures below 250°C.

Intimacy of contact and pressure are two factors which will effect transfer of heat from the tube anode through the BeO thermal link to the heat

sink. A good thermally conductive compound should be used in the interface (between anode and BeO, and between BeO and heat sink) to reduce the thermal resistance of the joint. Examples of commercially available thermal joint compound are:

WAKEFIELD 120 - Wakefield Engineering Co., Wakefield, Mass. 01880
DOW CORNING 340 - Dow Corning Corp., Midland, Michigan 48640
ASTRODYNE THERMAL BOND 312 - Astrodyne Inc., Burlington, Mass 01803
G.E. INSULGREASE G641 - G.E. Company, Cleveland, Ohio 44117

The method of fastening the tube to the heat sink should provide reasonable compression to reduce interface thermal resistance. A device such as the DE-STA-CO toggle clamp, modified by replacing the rubber nose with a ½-inch ceramic insulator, can provide a simple means of holding the tube securely and providing adequate compression.

The EIMAC SK-1920 BeO thermal link is recommended for use between the tube anode and the heat sink, as it is the correct size and thickness to match the physical and electrical characteristics of the 8873 tube.

IMPORTANT - BEFORE HANDLING OR ATTEMPTING TO USE ANY BERYLLIUM OXIDE THERMAL LINK CAREFULLY READ THE MATERIAL ON PAGE 6 REGARDING THIS MATERIAL.

A heat sink capable of handling 200 watts of continuous dissipation from the 8873 can be made with a section of finned aluminum alloy extrusion, such as Wakefield A-2494, or equivalent, cut to approximately 8 inches by 4 inches, backed with a ⅛-inch copper plate the same size. Thermal joint compound is used between the copper plate and the flat aluminum surface, with the two secured together at enough points to assure good continuous contact. The backed extrusion is mounted so as to allow for free air convection around the fins. The tube is then mounted, with the EIMAC SK-1920 thermal link, in the approximate center of the copper surface, with thermal joint compound again used between the tube anode and the BeO link, and between the BeO link and the copper. A device such as the modified DE-STA-CO toggle clamp is used to hold the tube securely in place.

Socketing is accomplished with one of the units mentioned earlier, mounted so as to allow for free air convection around the base of the tube and the socket, and on a bracket which returns to the same heat sink if possible. The designer is cautioned to allow for some lateral movement in the socket mount, and to make sure the anode is flat against the BeO thermal link so that good conduction contact exists before the socket mounts are tightened down. If the tube anode, the thermal link, and the heat sink are not making good flat contact, heat transfer will be seriously affected.

If unusually high ambient temperatures are expected, or more than 200 watts capability is required, a small fan can be used to move air past the sink cooling fins. With any conduction-cooled power tube, dissipation capability is almost completely dependent on the ability of the heat-sink system to carry heat away and the temperature limitations of the tube itself. Thus the 200-watt dissipation rating of the 8873 is a nominal value only, as illustrated by the fact that the same tube, with an axial-flow air radiator installed (the 8874) is rated for 400 watts of dissipation under specified cooling conditions.

In all cases, temperature of the tube anode and the ceramic/metal seals is the limiting factor, and the equipment designer is encouraged to use temperature-sensitive paint or other temperature-sensing devices in connection with any equipment design before the layout is finalized.

8874 -Forced-air cooling must be provided to maintain the anode core and seal temperatures within maximum rating. The cooling data shown is for sea level, with cooling air at 50°C, and is sufficient to limit tube temperatures to 225°C. The pressure drop figures shown are for the anode cooler only, as would be the case with a pressurized anode compartment of an equipment, where air would be required to pass through the anode cooler and then through an insulated duct to the outside of the cabinet. Some air from the pressurized anode compartment can be bled by the socket for base cooling, either by means of a somewhat oversize socket-mounting hole, or a series of small holes drilled in the chassis near the edges of the socket, in order to provide a small amount of air circulation around the base pins of the tube.

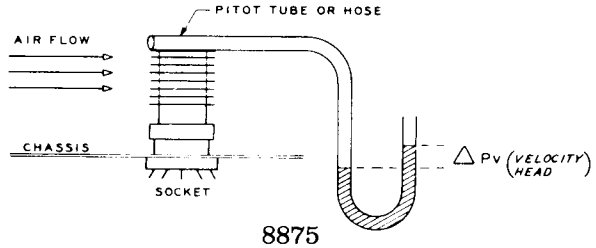
8874

Anode Diss.	Air Flow (CFM)	Approx. Press. Drop (In. H_20)
200W	4.0	0.11
300W	6.0	0.22
400W	8.6	0.37

8875 - Forced-air cooling must be provided to maintain the anode core and seal temperatures within the maximum rating. Cooling data is shown for sea level, with cooling air at 25°C.

These figures are for the case where the cooling air is supplied from a small general-purpose fan in close proximity to the tube and directing air across the tube and through the anode cooler.

The recommended cooling is sufficient to limit tube temperatures to 225°C. The required air velocity can be checked with a simple manometer, as shown in the accompanying figure.



8875

Anode Diss.	Cooling Air Velocity	Vel. Head (Δ Pv) Inches of H_20
200W	870 Ft/Min.	0.045
300W	1600 Ft/Min.	0.16

With all three tube types, the equipment designer is cautioned that it is not good practice to operate at, or close to, the absolute maximum temperature ratings for the metal/ceramic seals. Where long life and consistent performance are factors, cooling in excess of the minimum requirements outlined here is normally beneficial.

DANGER - BERYLLIUM OXIDE CERAMICS (Be0) Do not alter, grind, lap, fire, chemically clean, or perform any other operation on the SK-1920 Beryllium Oxide thermal link used with the 8873, or any other equivalent section of Be0 used with the 8873. Normal use of Be0 ceramics has never been considered hazardous, but the user should avoid any operation which would create Be0 dust particles in the air, or fumes, which could be breathed, as these are considered dangerous.

It should be noted that none of these three tubes contains any Be0 in the envelope, or internally. Only the SK-1920 thermal link is made of Be0, because of its insulating qualities combined with its high thermal conductivity.

HIGH VOLTAGE - The 8873, 8874, and 8875 operate at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

OUTPUT CAPACITANCE - The interelectrode capacitance figures given in the General Characteristics are measured in a shielded fixture and do not include additonal external capacitance. Including the stray capacitance between the anode and the heat sink used with the 8873 tube will typically raise the output capacitance to somewhat more than double the measured internal value.

INTERMODULATION DISTORTION - Typical Operating Conditions, with distortion values included, are the result of data taken during actual operation a 2 Megahertz. Intermodulation values listed are those measured at the full peak envelope power noted and are referenced against one tone of a two-equal tone signal.

INPUT CIRCUIT - When any of these types is operated as a grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a "Q" of five or more.

FAULT PROTECTION - All power tubes operate at voltages which can cause severe damage in the event of an internal arc, especially in those cases where large amounts of stored energy or follow-on current are involved.
Some means of protection is advised in all cases, and it is recommended that a series resistor of 25 to 50 ohms be used in the anode circuit to limit

peak current and provide a means of dissipating the energy in the event of a tube or circuit arc. For an oxide-cathode type such as these tubes are a maximum of 4 joules total energy should be permitted to be dumped into an internal arc. Amounts in excess of this may permanently damage the cathode or the grid structure.
Additional information is found in EIMAC's Application Bulletin #17 titled "FAULT PROTECTION", available on request.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, Varian, EIMAC Division, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of power tubes involves one or more of the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE - Normal operating voltages can be deadly.

b. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE AFFECTED.

c. X-RAY RADIATION - High voltage tubes can produce dangerous and possibly fatal x-rays.

d. BERYLLIUM OXIDE POISONING - Dust or fumes from BeO ceramics used as thermal links with some conduction-cooled power tubes are highly toxic and can cause serious injury or death.

e. GLASS EXPLOSION - Many electron tubes have glass envelopes. Breaking the glass can cause an implosion, which will result in an explosive scattering of glass particles. Handle glass tubes carefully.

f. HOT WATER - Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

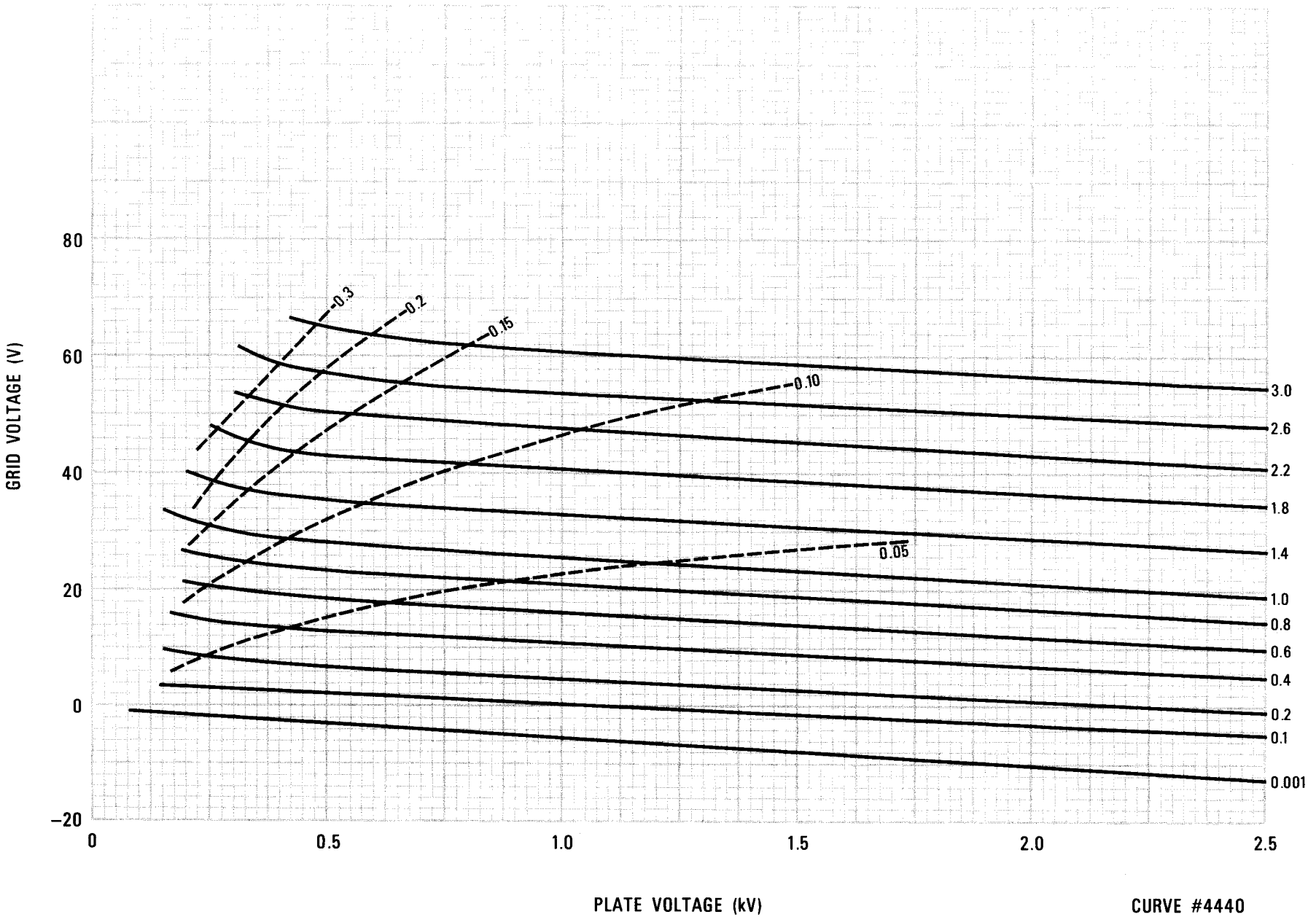
g. HOT SURFACES - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred degrees centigrade and cause serious burns if touched.

Please review the detailed operating hazards sheet enclosed with each tube or request a copy from the address shown below: Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070.

TYPICAL CONSTANT CURRENT CHARACTERISTICS

GROUNDED CATHODE

——— PLATE CURRENT – AMPERES - - - - GRID CURRENT – AMPERES

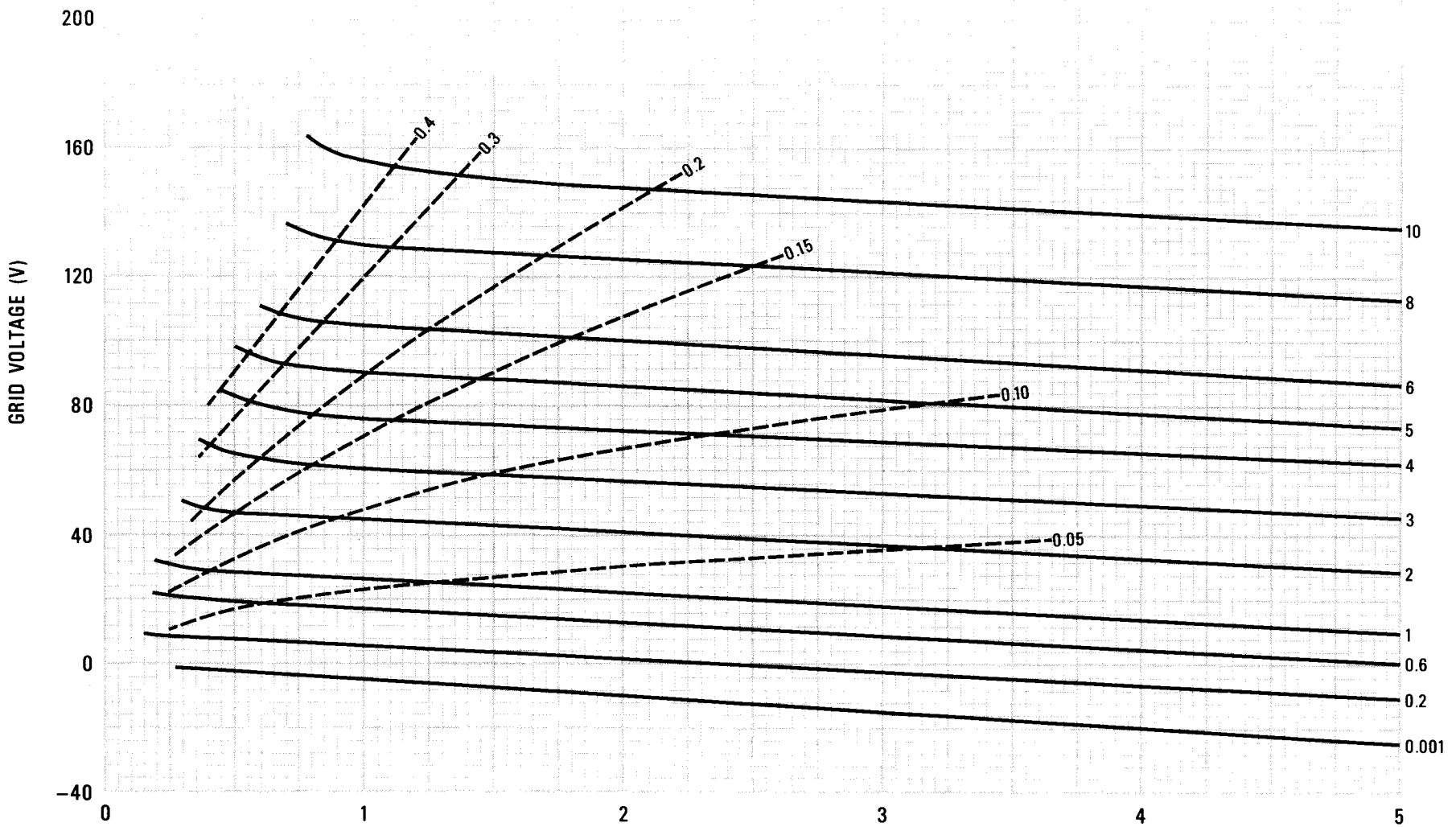


CURVE #4440

TYPICAL CONSTANT CURRENT CHARACTERISTICS

GROUNDED CATHODE

——— PLATE CURRENT – AMPERES - - - - GRID CURRENT – AMPERES

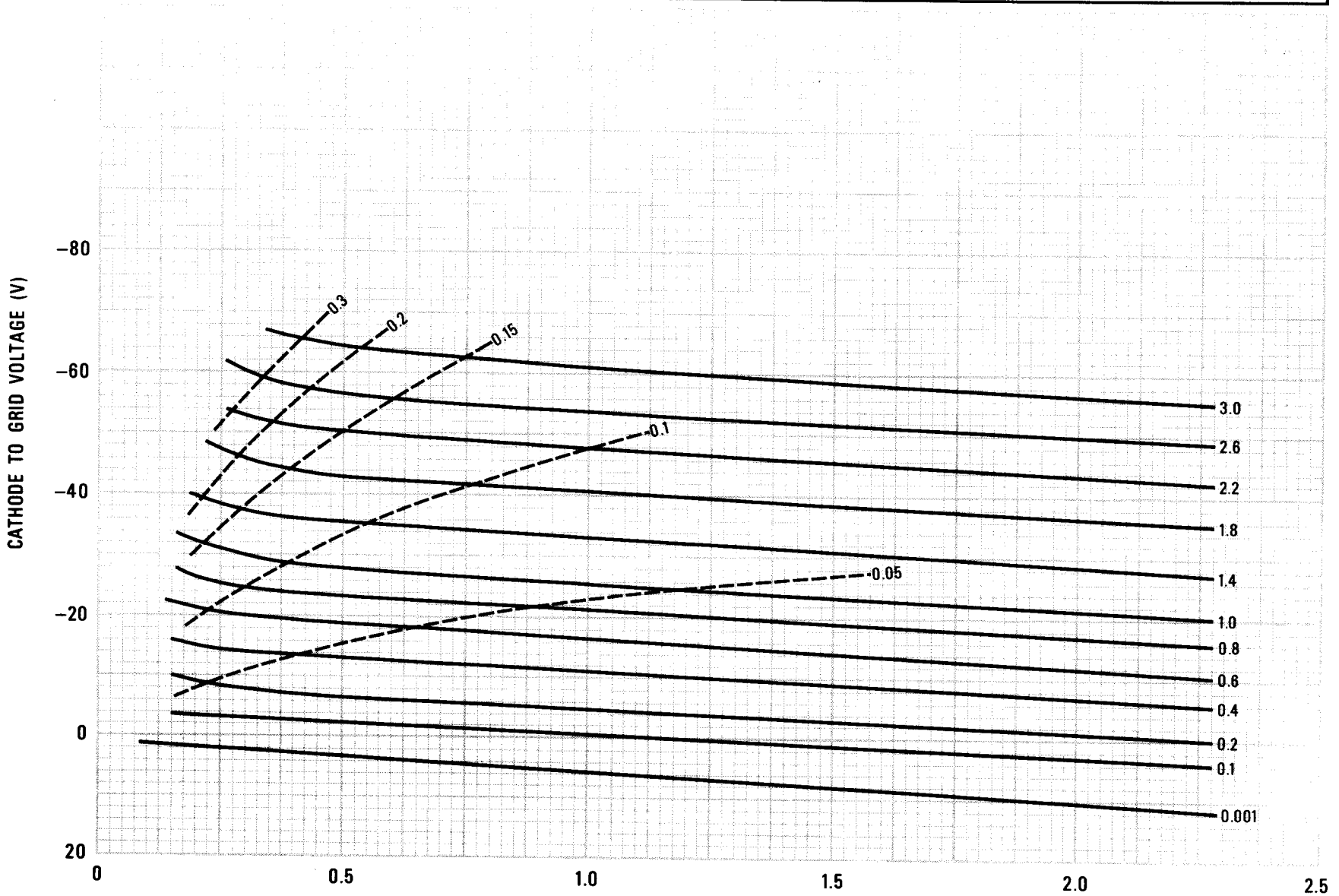


CURVE #4441

TYPICAL CONSTANT CURRENT CHARACTERISTICS

GROUNDED GRID

——— PLATE CURRENT – AMPERES - - - - GRID CURRENT – AMPERES

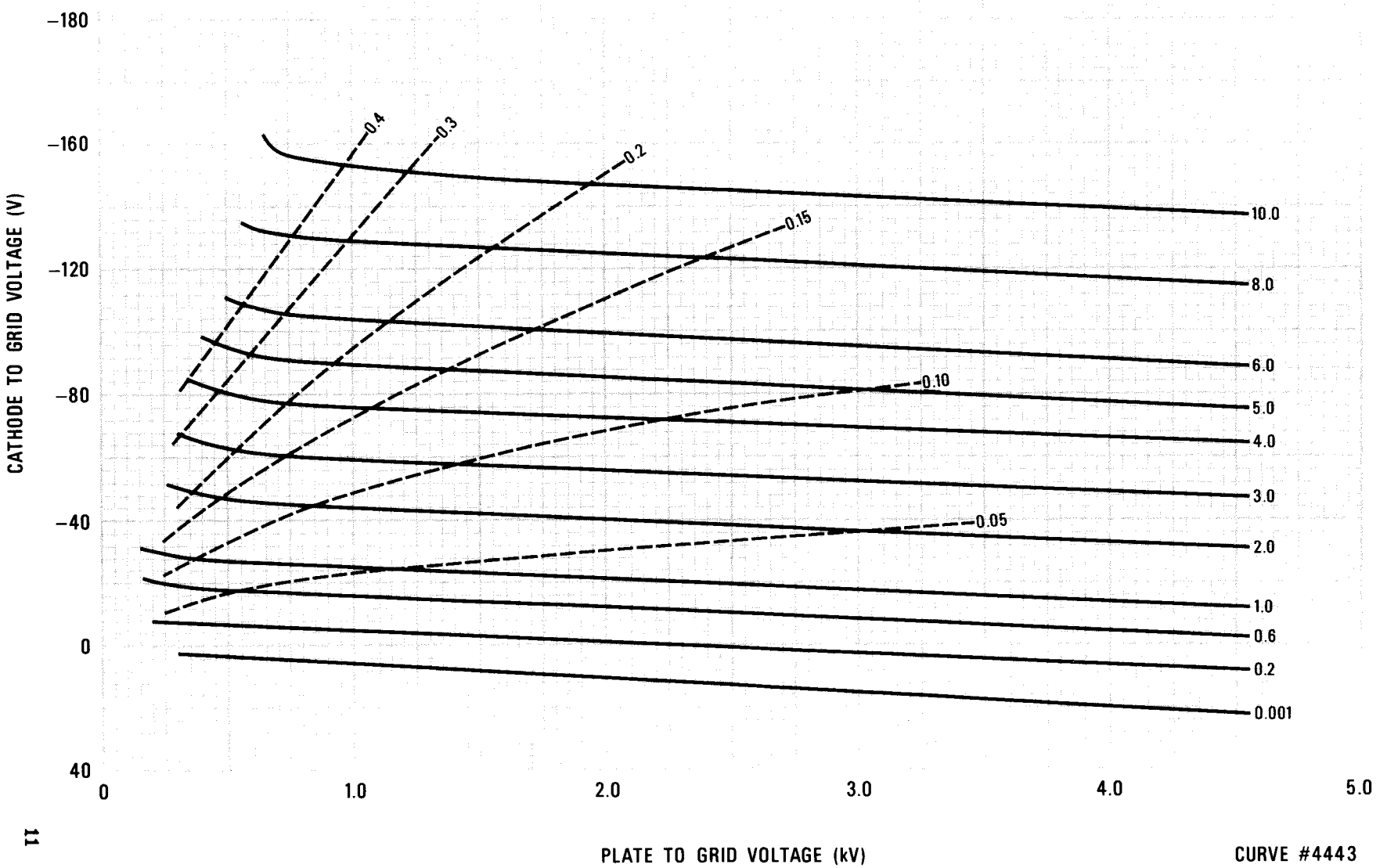


CURVE #4442

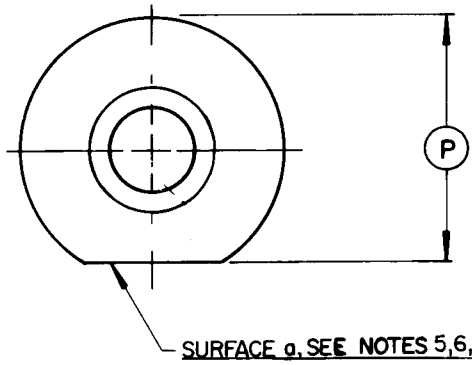
TYPICAL CONSTANT CURRENT CHARACTERISTICS

GROUNDED GRID

PLATE CURRENT – AMPERES ---- GRID CURRENT – AMPERES

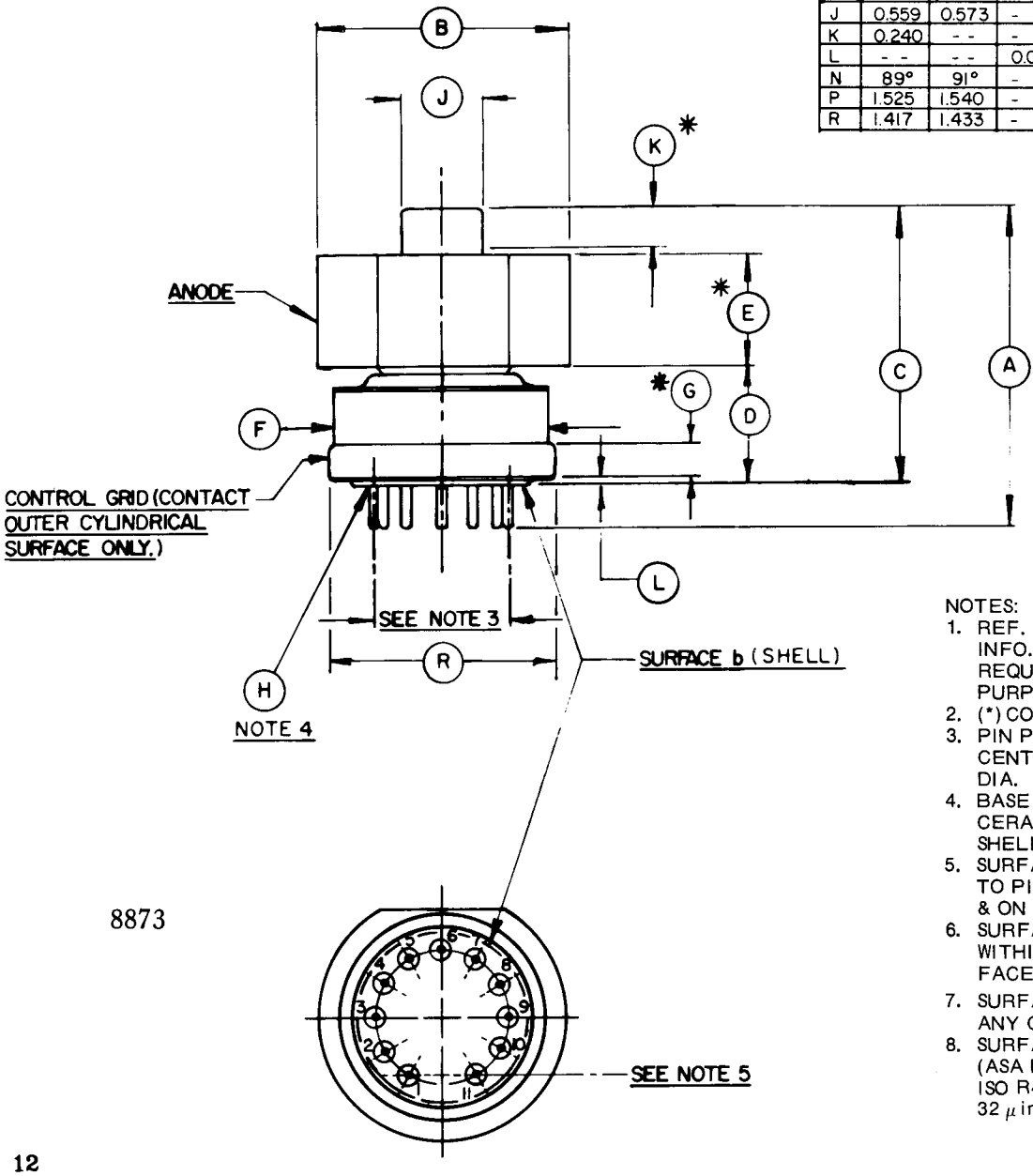


CURVE #4443



PIN NO. 1 CATHODE
PIN NO. 2 CATHODE
PIN NO. 3 CATHODE
PIN NO. 4 CONTROL GRID
PIN NO. 5 HEATER
PIN NO. 6 HEATER
PIN NO. 7 CONTROL GRID
PIN NO. 8 CATHODE
PIN NO. 9 CATHODE
PIN NO. 10 CATHODE
PIN NO. 11 CONTROL GRID

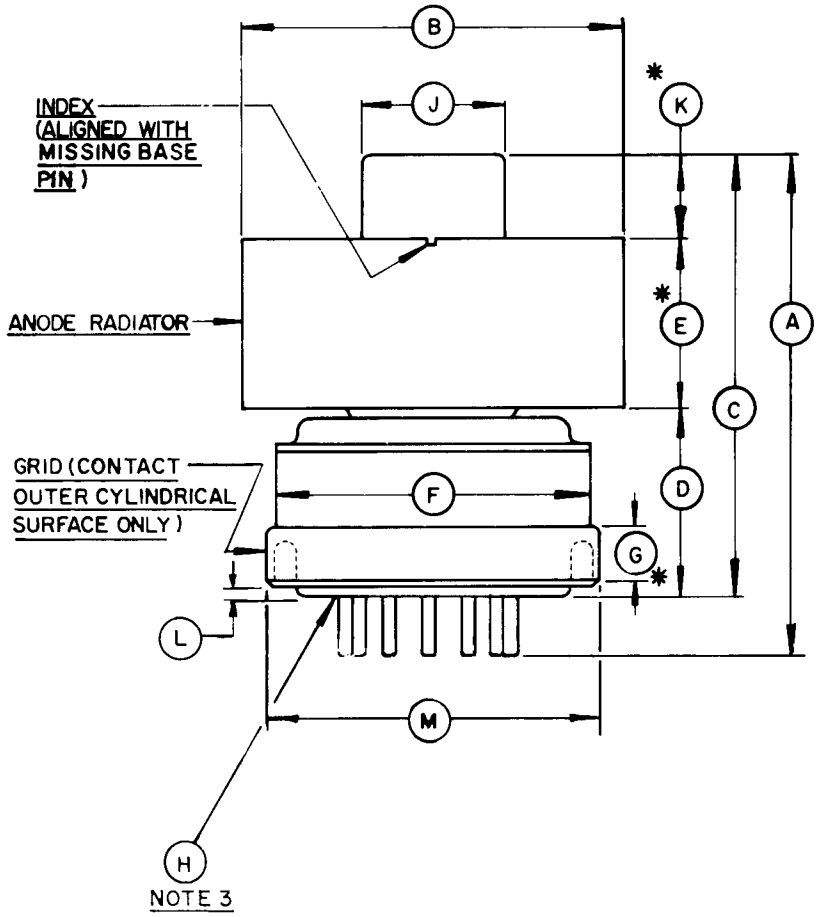
DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	2.002	2.142	- -	50.85	54.41	- -
B	1.610	1.640	- -	40.89	41.66	- -
C	1.810	1.910	- -	45.97	48.51	- -
D	0.750	0.810	- -	19.05	20.57	- -
E	0.710	0.790	- -	18.03	20.07	- -
F	- -	1.406	- -	- -	35.71	- -
G	0.187	- -	- -	4.75	- -	- -
H	BASE E11-81 (JEDEC DESIGNATION)					
J	0.559	0.573	- -	14.20	14.55	- -
K	0.240	- -	- -	6.10	- -	- -
L	- -	- -	0.027	- -	- -	0.69
N	89°	91°	- -	89°	91°	- -
P	1.525	1.540	- -	38.73	39.12	- -
R	1.417	1.433	- -	35.99	36.40	- -



NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACE.
3. PIN PITCH DIA. TO BE CONCENTRIC TO B WITHIN .040 DIA.
4. BASE IS BASIC JEDEC EXCEPT CERAMIC WAFER IS INSIDE SHELL.
5. SURFACE a TO BE PARALLEL TO PINS I & II AXIS WITHIN 2° & ON OPPOSITE SIDE.
6. SURFACE a MUST BE FLAT WITHIN .001 & PERP. TO SURFACE b WITHIN N LIMITS.
7. SURFACE a TO BE FREE OF ANY CODING OR LABELING.
8. SURFACE a ROUGHNESS (ASA B46.1-1962 OR ISO R468-66) — 32 μin. 6.8 μm.

PIN No.1: CATHODE
PIN No.2: CATHODE
PIN No.3: CATHODE
PIN No.4: GRID
PIN No.5: HEATER
PIN No.6: HEATER
PIN No.7: GRID
PIN No.8: CATHODE
PIN No.9: CATHODE
PIN No.10: CATHODE
PIN No.11: GRID

DIM	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	2.002	2.142	- -	50.85	54.41	- -
B	1.610	1.640	- -	40.89	41.66	- -
C	1.810	1.910	- -	45.97	48.51	- -
D	0.750	0.810	- -	19.05	20.57	- -
E	0.710	0.790	- -	18.03	20.07	- -
F	- -	1.406	- -	- -	35.71	- -
G	0.187	- -	- -	4.75	- -	- -
H	BASE: E11-81 (JEDEC DESIGNATION)					
J	0.559	0.573	- -	14.20	14.55	- -
K	0.240	- -	- -	6.10	- -	- -
L	- -	- -	0.027	- -	- -	0.69
M	1.417	1.433	- -	35.99	36.40	- -

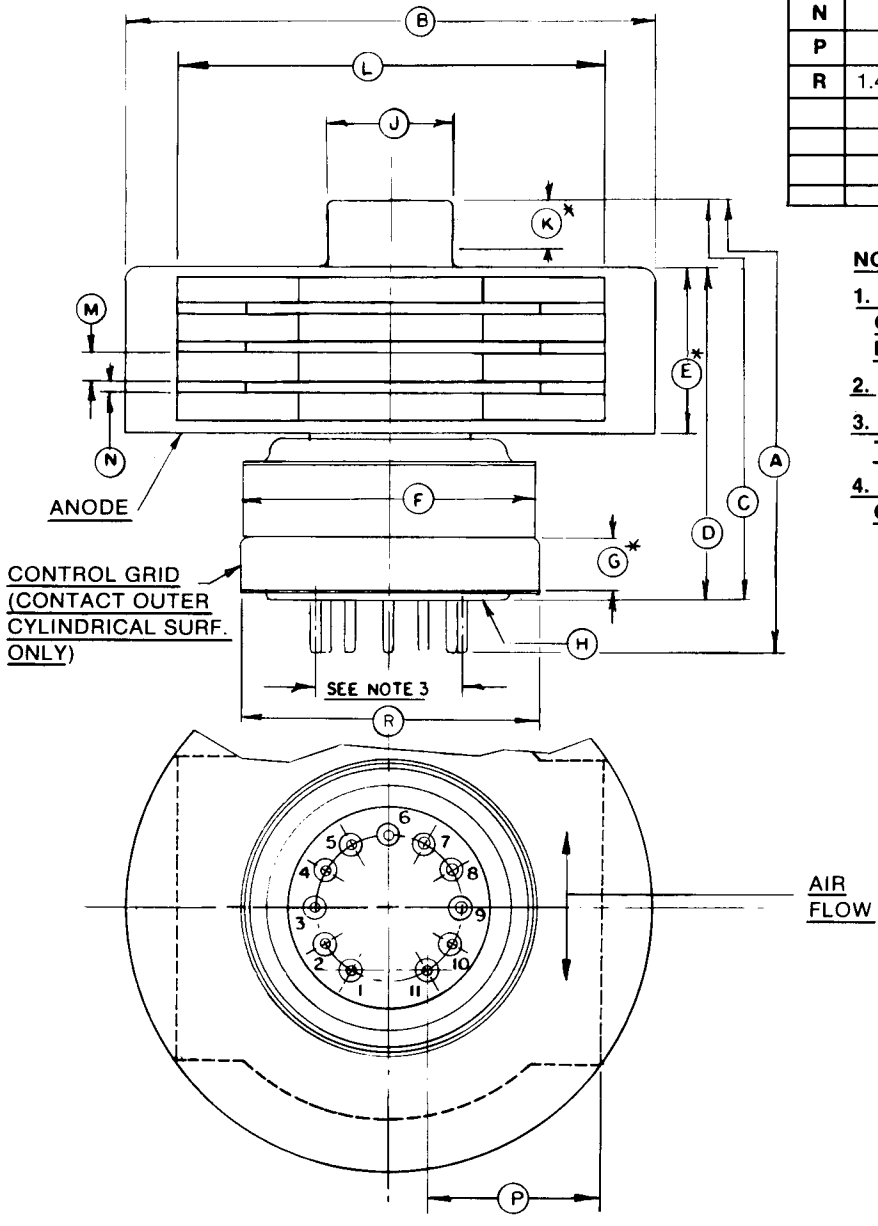


NOTES:
1. REF. DIMS. ARE FOR INFO. ONLY AND ARE NOT REQD. FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACES.
3. BASE IS BASIC JEDEC EXCEPT CERAMIC WAFER IS INSIDE SHELL

8874

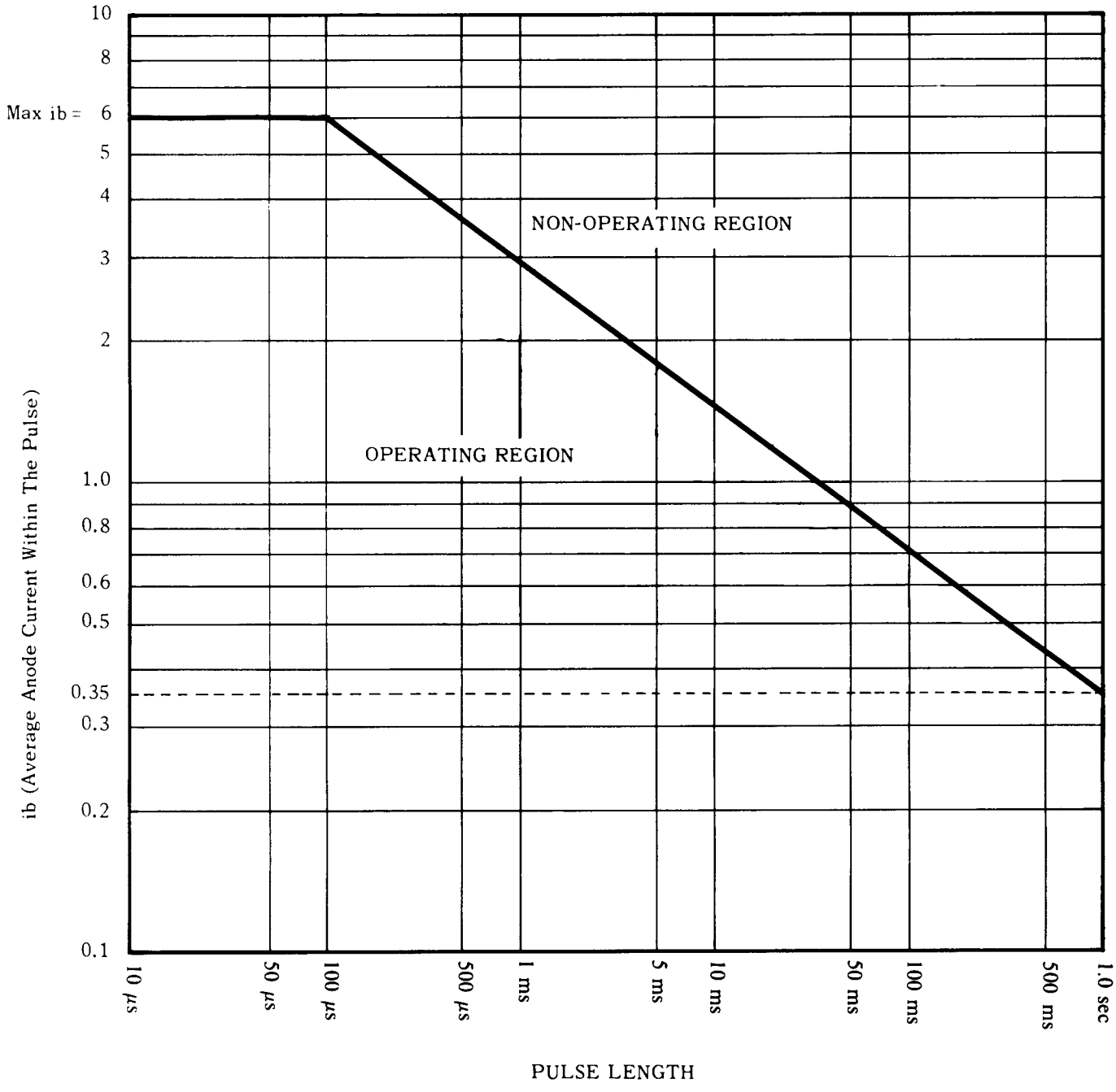
PIN No. 1, 2, 3, 8, 9, 10 CATHODE
PIN No. 4, 7, 11 CONTROL GRID
PIN No. 5, 6 HEATER

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A		2.185			55.50	
B	2.480	2.520		62.99	64.01	
C	1.867	1.997		47.42	50.72	
D	1.544	1.674		39.22	42.52	
E	.780	.860		19.81	21.48	
F			1.406			35.71
G	.187			4.75		
H	BASE E11-81 (JEDEC DESIGNATION)					
J	.559	.573		14.20	14.55	
K	.240			6.10		
L		2.050			52.07	
M			.135			3.43
N			.050			1.27
P			.838			21.28
R	1.417	1.433		35.99	36.40	



NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACE.
3. PIN PITCH DIA. TO BE CONCENTRIC TO B WITHIN .040 DIA.
4. BASE IS BASIC JEDEC EXCEPT CERAMIC WAFER IS INSIDE SHELL.



Pulse anode current (ib) capability is dependent on pulse length (tp) and duty factor (Du). Maximum ib for a given tp is shown; maximum Du may then be derived from the relationship: $0.350 = ib \sqrt{Du}$

PULSE DERATING CHART, TYPES 8873, 8874, 8875

PULSE MODULATOR OR REGULATOR SERVICE

8876

TECHNICAL DATA

RADIAL-BEAM
POWER TETRODE

The 8876 is a ceramic/metal forced-air cooled, external-anode radial-beam tetrode with a maximum plate dissipation rating of 250 watts and a maximum input-power rating of 500 watts. The 8876 is designed for very long life and reliable performance in oscillator, amplifier, or modulator service. In most applications, it may be used as a direct replacement for the 7203/4CX250B, with only minor circuit retuning required.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3	V
Current, at 6.0 volts	2.4	A
Cathode-Heater Potential, maximum	±150	V
Amplification Factor (Average):		
Grid to Screen	5	
Direct Interelectrode Capacitances (grounded cathode)[2]		
Cin	17.0	pF
Cout	4.5	pF
Cgp	0.04	pF
Direct Interelectrode Capacitances (grounded grid and screen)[2]		
Cin	13.6	pF
Cout	4.5	pF
Cpk	0.01	pF
Frequency of Maximum Rating:		
CW	500	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	2.46 in; 62.5 mm
Diameter	1.64 in; 41.7 mm
Net Weight	4 oz; 113 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C

(Effective 6-15-71) © 1971 Varian Printed in U.S.A.

Cooling	Forced Air
Base	Special 9-pin JEDEC-B8-236
Recommended Socket	EIMAC SK-600 Series
Recommended Chimney	EIMAC SK-600 Series

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN (SSB)

Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage[1]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Single Tone Plate Current	250	250	250	mAdc
Two-Tone Plate Current	190	190	190	mAdc
Single-Tone Screen Current[2]	10	8	5	mAdc
Two-Tone Screen Current[2]	2	-1	-2	mAdc
Single-Tone Grid Current[2]	0	0	0	mAdc
Peak rf Grid Voltage[2]	50	50	50	v
Plate Output Power	120	215	300	W
Resonant Load Impedance	2000	3000	4000	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN, CARRIER CONDITIONS

Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)
Class AB_1, Grid Driven

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage[1]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Carrier Plate Current	150	150	150	mAdc
Carrier Screen Current	-3	-4	-4	mAdc
Peak rf Grid Voltage[2]	25	25	25	v
Plate Output Power	30	50	65	W

1. Adjust to specified zero-signal dc plate current.
2. Approximate value

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(Key-Down Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)					500 MHz
Plate Voltage	500	1000	1500	2000	2000 Vdc
Screen Voltage	250	250	250	250	300 Vdc
Grid Voltage	-90	-90	-90	-90	-90 Vdc
Plate Current	250	250	250	250	250 mAdc
Screen Current[1]	45	38	21	19	10 mAdc2
Grid Current[1]	35	31	28	26	25 mAdc2
Peak rf Grid Voltage[1]	114	114	112	112	--- v
Measured Driving Power[1]	4.0	3.5	3.2	2.9	--- W
Plate Input Power	125	250	375	500	500 W
Plate Output Power	70	190	280	390	300 W[2]
Heater Voltage	6.0	6.0	6.0	6.0	5.7 V

1. Approximate value.
2. Measured values for a typical cavity amplifier circuit.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	1500	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.20	AMPERE
PLATE DISSIPATION[1]	165	WATTS
SCREEN DISSIPATION[2]	12	WATTS
GRID DISSIPATION[2]	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)

Plate Voltage	500	1000	1500	Vdc
Screen Voltage	250	250	250	Vdc
Grid Voltage	-100	-100	-100	Vdc
Plate Current	200	200	200	mAdc
Screen Current[3]	31	22	20	mAdc
Grid Current[3]	15	14	14	mAdc
Peak rf Grid Voltage[3]	118	117	117	v
Calculated Driving Power	1.8	1.7	1.7	W
Plate Input Power	100	200	235	W

1. Corresponds to 250 watts at 100% sine-wave modulation.
2. Average, with or without modulation.
3. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB , Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Approximate value

TYPICAL OPERATION (Two Tubes)

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage[1/3]	-55	-55	-55	Vdc
Zero-Signal Plate Current	200	200	200	mAdc
Max Signal Plate Current	500	500	500	mAdc
Max Signal Screen Current[1]	20	16	10	mAdc
Max Signal Grid Current[1]	0	0	0	mAdc
Peak af Grid Voltage[2]	50	50	50	v
Peak Driving Power	0	0	0	W
Plate Input Power	500	750	1000	W
Plate Output Power	240	430	600	W
Load Resistance (plate to plate)	3500	6200	9500	Ω

2. Per tube.
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.		Max.	
Heater: Current at 6.0 volts	2.2	---	2.7	A
Cathode Warmup Time	60	---	---	sec.
Interelectrode Capacitances[1] (grounded cathode connection)				
Cin	15.0	---	18.0	pF
Cout	4.0	---	5.0	pF
Cgp	---	---	0.06	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 8876 may be operated in any position. An EIMAC Air-System Socket, SK-600 series, or a socket having equivalent characteristics, is required. Sockets are available with or without built-in screen capacitors and may be obtained with either grounded or ungrounded cathode terminals.

COOLING - Sufficient forced-air cooling must be provided for the anode, base seals, and body seals to maintain operating temperatures below the rated maximum values. Air requirements to maintain anode core temperatures at 200°C with an inlet air temperature of 50°C are tabulated below. These requirements apply when a socket of the EIMAC SK-600 series and an EIMAC SK-606 chimney are used with air flow in the base to anode direction.

SEA LEVEL			10,000 FEET	
Plate Dissipation(watts)	Air Flow (CFM)	Pressure Drop(In.of water)	Air Flow (CFM)	Pressure Drop(In.of water)
200	5.0	0.52	7.3	0.76
250	6.4	0.82	9.3	1.20

The blower selected in a given application must be capable of supplying the desired airflow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters. The blower must be designed to deliver the air at the desired altitude.

At 500 MHz or below, base cooling air requirements are satisfied automatically when the tube is operated in an EIMAC Air-System Socket and the recommended air flow rates are used. Experience has shown that if reliable long life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

VIBRATION - This tube is designed to provide reliable service under ordinary shock and vibration conditions, such as encountered in mobile installations. However, when severe shock, or high-level and high-frequency vibration are expected, it is suggested that the EIMAC 4CX300A or 4CX250R be employed.

ELECTRICAL

HEATER - The rated heater voltage for the 8876 is 6.0 volts and the voltage must be maintained within ±5% to obtain good tube life and stable performance. Regulation to a tolerance better than ±5% normally will be beneficial as regards life expectancy.

At frequencies above approximately 300 MHz transit-time effects begin to influence the cathode temperature. The amount of driving power diverted to heating the cathode by back-bombardment will depend upon frequency, plate current, and driving power. When the tube is driven to maximum input as a class-C amplifier, the heater voltage should be reduced according to the table below;

300 MHz or lower	6.00 volts
301 to 400 MHz	5.85 volts
401 to 500 MHz	5.70 volts

CATHODE OPERATION - The oxide coated unipotential cathode must be protected against excessively high emission currents. The maximum rated dc input current is 200 mA for plate-modulated operation and 250 mA for all other types of operation except pulse.

The cathode is internally connected to the four even-numbered base pins and all four of the corresponding socket terminals should be used to make connection to the external circuits. At radio frequencies it is important to keep the cathode leads short and direct and to use conductors with large areas to minimize the inductive reactances in series with the cathode leads.

It is recommended that rated heater voltage be applied for a minimum of 60 seconds before other operating voltages are applied. If faster warmup is required, an over-voltage of 8.0 volts may be applied to the heater and held for 30 seconds, at which time the voltage must be reduced to the rated value. Full operating cathode temperature is reached in 30 seconds with this technique. From a cold start, it is imperative that the over-voltage be held not over 30 seconds, and if the tube has not completely cooled since previous use, a shorter period of over-voltage must be used.

Where the circuit design requires the cathode and heater to be operated at different potentials, the rated maximum heater-to-cathode voltage is 150 volts regardless of polarity.

GRID OPERATION - The maximum rated dc grid bias voltage is -250 volts and the maximum grid dissipation rating is 2.0 watts. In ordinary audio and radio-frequency amplifiers the grid dissipation usually will not approach the maximum rating. At operating frequencies above the 100 MHz region, driving power requirements for amplifiers increase noticeably. At 500 MHz as much as 20 watts of driving power may have to be supplied. However, most of the driving power is absorbed in circuit losses other than grid dissipation, so that grid dissipation is increased only slightly. Satisfactory 500 MHz operation of the tube in a stable amplifier is indicated by grid-current values below approximately 15 mA.

The grid voltage required by different tubes may vary between limits approximately 20% above and below the center value, and means should be provided in the equipment to accommodate such variation. It is especially important that variations between individual tubes be compensated when tubes are operated in parallel or push-pull circuits, to assure equal load sharing.

The maximum permissible grid-circuit resistance per tube is 100,000 ohms.

SCREEN OPERATION - The maximum rated power dissipation for the screen is 12 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

When signal voltages appear between screen and cathode, as in the case of screen-modulated amplifiers or cathode-driven tetrode amplifiers, the peak screen-to-cathode voltage is the sum of the dc screen voltage and the peak ac or rf signal voltage applied to screen or cathode.

Protection for the screen should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be applied before screen voltage can be applied.

The screen current may reverse under certain conditions and produce negative current indications on the screen milliammeter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor, gaseous voltage regulator tubes, or an electron tube *shunt* regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per connected screen. An electron tube *series* regulator can be used only when an adequate bleeder resistor is provided.

Self-modulation of the screen in plate-modulated tetrode amplifiers using these tubes may not be satisfactory because of the screen-voltage screen-current characteristics. Screen modulation from a tertiary winding on the modulation transformer or by means of a small separate modulator tube will usually be more satisfactory. Screen-voltage modulation factors between 0.75 and 1.0 will result 100% modulation for plate-modulated rf amplifiers using the 8876.

PLATE OPERATION - The maximum rated plate dissipation power is 250 watts. In plate-modulated applications the carrier plate dissipation power must be limited to 165 watts to avoid exceeding the plate dissipation rating with 100% sine wave modulation. The maximum dissipation rating may be exceeded for brief periods during circuit adjustment without damage to the tube.

MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide individual metering and individual adjustment of bias or screen voltage to equalize the inputs.

Where overload protection is provided, it should be capable of protecting the surviving tube (s) in the event that one tube fails.

VHF OPERATION - The 8876 is suitable for use in the VHF region. Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

HIGH VOLTAGE - Normal operating voltages used with the 8876 are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

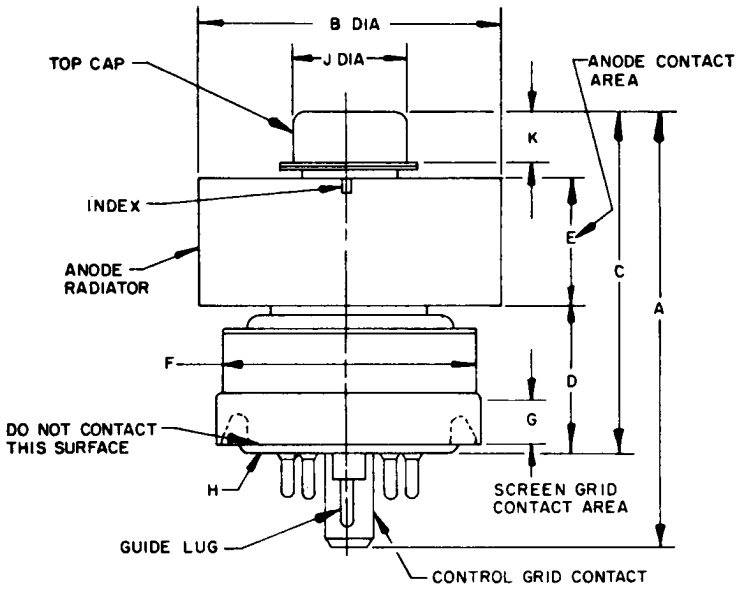
INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

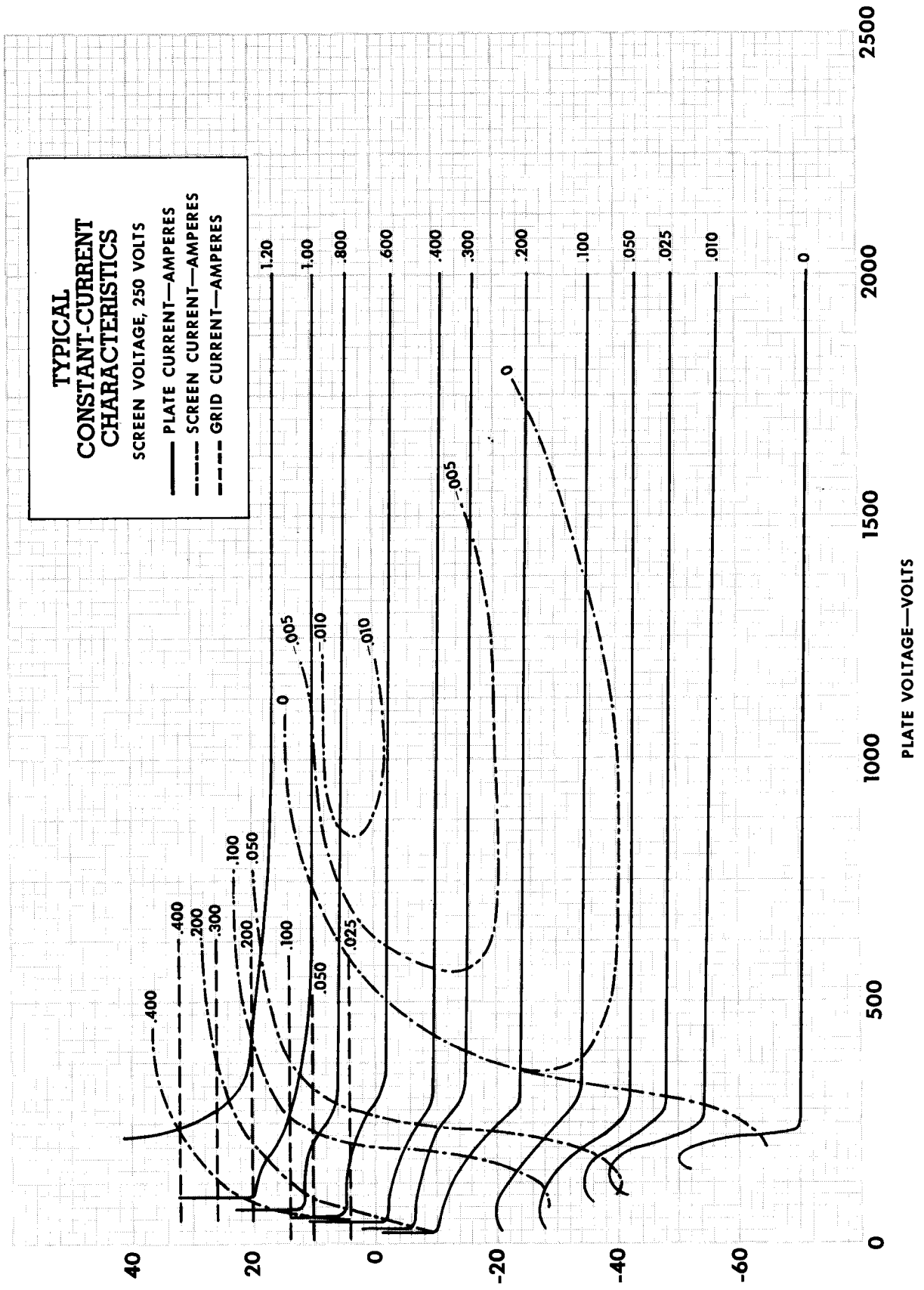
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

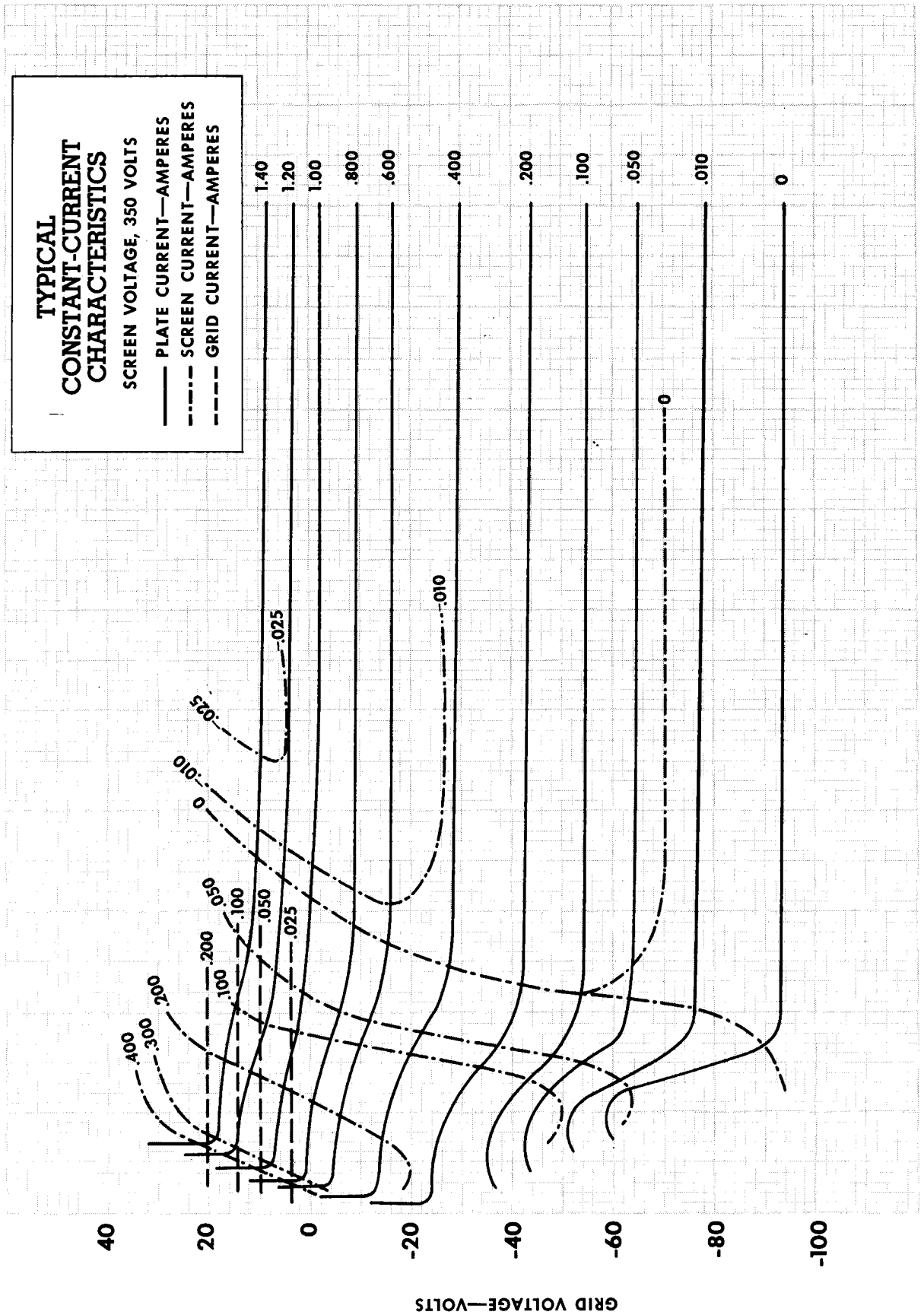
SPECIAL APPLICATIONS - If it is desired to operate these tubes under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, San Carlos, Calif. 94070 for information and recommendations.

PIN DESIGNATION	
PIN NO. 1	SCREEN GRID
PIN NO. 2	CATHODE
PIN NO. 3	HEATER
PIN NO. 4	CATHODE
PIN NO. 5	I.C. DO NOT USE FOR EXTERNAL CONNECTION.
PIN NO. 6	CATHODE
PIN NO. 7	HEATER
PIN NO. 8	CATHODE
CENTER PIN	CONTROL GRID

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	2.342	2.464	59.03	62.59
B	1.610	1.640	40.89	41.66
C	1.810	1.910	45.97	48.51
D	0.750	0.810	19.05	20.57
E	0.710	0.790	18.03	20.07
F	--	1.406	--	35.71
G	0.187	--	4.75	--
H	BASE: B8-236 (JEDEC DESIGNATION)			
J	0.559	0.573	14.20	14.55
K	0.240	--	6.10	--




TYPICAL
CONSTANT-CURRENT
CHARACTERISTICS
SCREEN VOLTAGE, 250 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
1.20
1.00
.800
.600
.400
.300
.200
.100
.050
.025
.010
0
.005
.010
.005
0
.400
.400
.200
.300
.200
.100
.050
.025
40
20
0
-20
-40
-60
0
500
1000
1500
2000
2500
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—VOLTS

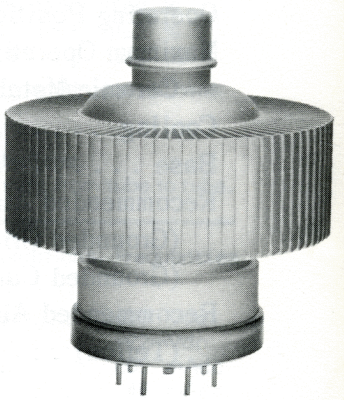

TYPICAL
CONSTANT-CURRENT
CHARACTERISTICS
SCREEN VOLTAGE, 350 VOLTS
PLATE CURRENT—AMPERES
SCREEN CURRENT—AMPERES
GRID CURRENT—AMPERES
1.40
1.20
1.00
.800
.600
.400
.200
.100
.050
.025
.010
0
.400
.300
.200
.100
.050
.025
.010
.025
0
40
20
0
-20
-40
-60
-80
-100
0
400
800
1200
1600
2000
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—VOLTS

TECHNICAL DATA

8877
3CX1500A7

HIGH-MU
POWER TRIODE

The EIMAC 8877/3CX1500A7 is a rugged ceramic/metal power triode designed for use as a cathode driven Class AB_2 or Class B amplifier, in audio or rf applications including the UHF band, or as a cathode driven plate modulated Class C rf amplifier. As a linear amplifier, high power gain may be obtained without sacrifice of low intermodulation characteristics.



Low grid interception and high amplification factor combine to make the 8877/3CX1500A7 drive power requirements exceptionally low for a tube of this power capacity.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	5.0 ± 0.25	V
Current, at 5.0 volts	10.5	A
Transconductance (Average):		
I_b = 1.0 Adc	55,000	μmhos
Amplification Factor (Average)	200	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	38.5	pF
Cout	0.1	pF
Cgp	10	pF
Direct Interelectrode Capacitance (grounded grid)[2]		
Cin	38.5	pF
Cout	10	pF
Cpk	0.1	pF
Ck-htr	9.7	pF
Frequency of Maximum Rating:		
CW	250	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

(Revised 7-1-75) © 1970, 1971, 1973, 1975 by Varian Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:	
Length	4.02 in;102.16 mm
Diameter	3.38 in; 85.85 mm
Net Weight	25.0 oz; 708.8 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals, Anode Core	250°C
Cooling	Forced Air
Base	Special 7-pin
Recommended Air System Socket	
(Grounded Grid)	SK-2210
(Grounded Cathode)	SK-2200
Recommended Air Chimney	
(Teflon)	SK 2216

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 5.0 volts	9.5	11.5	A
Cathode Warmup Time	90	---	sec
Interelectrode Capacitance (grounded grid circuit)[1]			
Cin	36.0	41.0	pF
Cout	9.2	11.2	pF
Cpk	---	0.2	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
GRID DISSIPATION	25	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB2 Cathode Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	2700	3500	Vdc
Cathode Voltage[1]	+8.2	+8.2	Vdc
Zero-Signal Plate Current[3]	92	182	mAdc
Single-Tone Plate Current	740	1000	mAdc
Two-Tone Plate Current	480	675	mAdc
Single-Tone Grid Current[3]	40	74	mAdc
Two-Tone Grid Current[3]	16	25	mAdc
Peak rf Cathode Voltage[3]	68	81	v
Peak Driving Power[3]	40	64	w
Single-Tone Useful Output Power[3]	1085	2075	W
Resonant Load Impedance	1820	2000	Ω
Intermodulation Distortion Products[2]			
3rd Order	-40	-38	dB
5th Order	-41	-41	dB

1. Positive cathode bias provided by zener diode.
2. The intermodulation distortion products are referenced against one tone of a two equal tone signal.
3. Approximate values.

TYPICAL OPERATION (220 MHz)
Class AB_2 Cathode Driven

Plate Voltage	2500	Vdc
Cathode Voltage[1]	+8.2	Vdc
Plate Current	1000	mAdc
Grid Current[2]	10	mAdc
Useful Output Power[2]	1520	W
Driving Power[2]	57	W
Power Gain[2]	14	dB

1. Positive cathode bias provided by zener diode.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER

Class B Telegraphy or FM

(Continuous Operating Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
DC PLATE CURRENT	1.0	AMPERE
PLATE DISSIPATION	1500	WATTS
GRID DISSIPATION	25	WATTS

TYPICAL OPERATION (88-108 MHz) Measured Values
Class B, Cathode Driven

Plate Voltage	2000	2500	3000	4000	Vdc
Cathode Voltage[1,2]	+9	+12	+15	+20	Vdc
Plate Current	1.0	1.0	1.0	1.0	Adc
Grid Current[2]	60	58	42	25	mAdc
Driving Power[2]	64	54	65	78	W
Useful Power Output[3]	1330	1670	1960	2600	W
Efficiency[4]	66.5	66.7	65.5	65.2	%
Power Gain[4]	13.2	14.2	14.8	15.3	dB

1. For measured case, idling anode current was set for 10 mAdc.
2. Approximate.
3. Approximate, delivered to the load.
4. For the measured case; may vary from tube to tube.

RADIO FREQUENCY POWER AMPLIFIER

Class C - Cathode Driven, Plate Modulated

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3200	VOLTS
DC PLATE CURRENT	0.8	AMPERE
PLATE DISSIPATION	1000	WATTS
GRID DISSIPATION	25	WATTS

TYPICAL OPERATION Carrier Conditions, Frequencies to 30 MHz, Cathode Driven

Plate Voltage	2400	Vdc
Cathode Voltage[1]	+22	Vdc
Plate Current[2]	600	mAdc
Grid Current[2]	45	mAdc
Plate Load Resistance	2000	Ω
Driving Power[3]	41	W
Plate Output Power	1000	W
Power Gain	14	dB

1. Bias may be obtained from a fixed supply of 15.8 volts in series with a 9.5 ohm resistor. The resistor & supply should be bypassed for audio frequencies.
2. Approximate.
3. Approximate, and driver must be modulated approximately 83%.

APPLICATION

MECHANICAL

MOUNTING - The 8877/3CX1500A7 may be mounted in any position.

SOCKET - The grid of the 8877/3CX1500A7 terminates in the cylindrical grid ring about the base of the tube. This may be contacted by multiple clips or flexible finger stock. Connections to the heater and cathode are made via the 7-pin base.

COOLING - The maximum temperature limit for external tube surfaces and the anode core is 250°C. Tube life is prolonged if these areas are maintained at lower temperatures. For full 1500 watt anode dissipation 38.0 cfm of air is required at a back pressure of 0.60 inches to hold tube temperature below 225°C with 50°C ambient temperature at sea level. At frequencies higher than 30 MHz, or at high altitudes, the air quantity must be increased.

Base-to-Anode Air Flow (sea level)		
Anode Dissipation (watts)	Air Flow (CFM)	Pressure Drop In./H 0
500	7.5	0.10
1000	22.5	0.20
1500	35.0	0.41
Base-to-Anode Air Flow (10,000 ft.)		
Anode Dissipation (watts)	Air Flow (CFM)	Pressure Drop In./H 0
500	11.0	0.15
1000	32.5	0.29
1500	51.0	0.60

Note: 1) Tube mounted in SK-2200 Socket with SK-2216 Chimney.

2) An allowance of 25 watts has been made for grid dissipation and 50 watts for filament power.

ELECTRICAL

FILAMENT OPERATION - Rated filament voltage for the 8877/3CX1500A7 is 5.0 volts. Filament voltage, as measured at the socket optimum performance and maximum tube life. In no case should it be allowed to deviate from 5.0 volts by more than plus or minus five per cent.

INPUT CIRCUIT - When the 8877/3CX1500A7 is operated as a cathode driven rf amplifier, the use of a resonant circuit in the cathode is recommended. For best results with a single-ended amplifier it is suggested that the cathode tank circuit operate at a Q of two or more.

ZERO-BIAS OPERATION - Operation at zero-bias is not recommended with plate potentials over 3000 volts, since plate dissipation may be exceeded. Higher plate voltage may be used with the proper protective bias.

HIGH VOLTAGE - The 3CX1500A7 operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

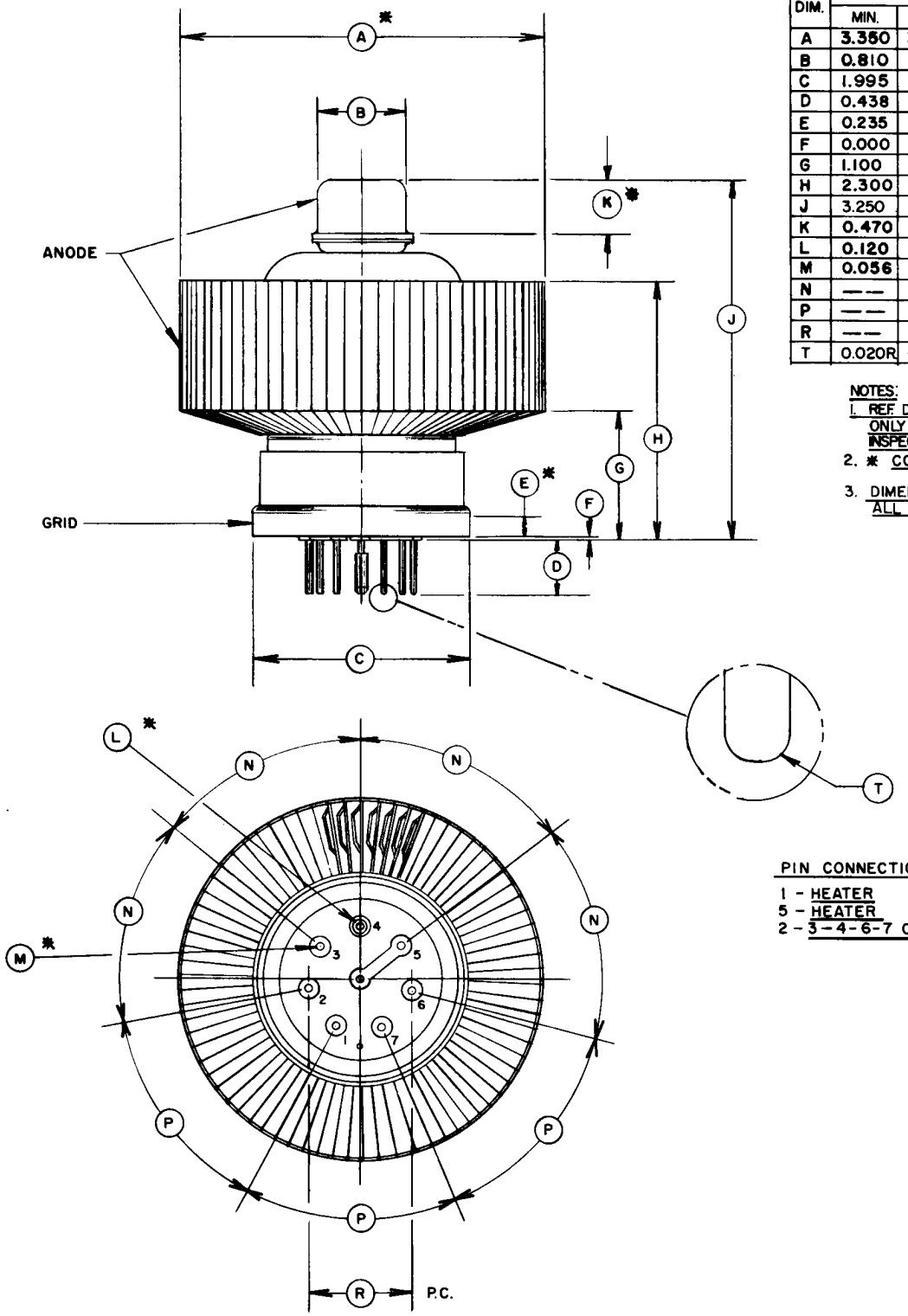
INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.

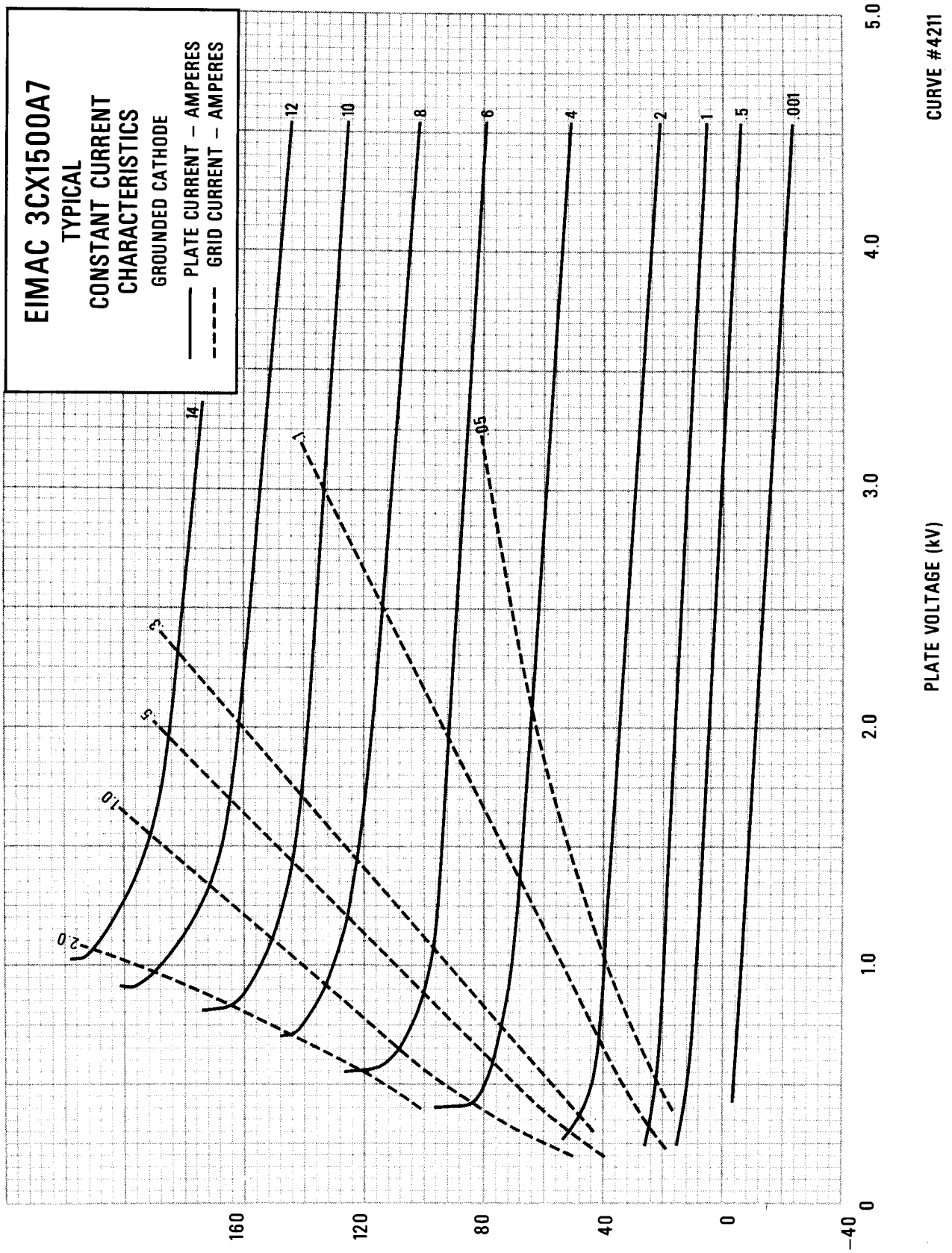
DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.350	3.380	— —	85.09	85.85	— —
B	0.810	0.820	— —	20.57	20.83	— —
C	1.995	2.015	— —	50.67	51.18	— —
D	0.438	0.562	— —	11.13	14.27	— —
E	0.235	— —	— —	5.97	— —	— —
F	0.000	0.040	— —	0.00	1.02	— —
G	1.100	1.225	— —	27.94	31.12	— —
H	2.300	2.425	— —	58.42	61.60	— —
J	3.250	3.420	— —	82.55	86.87	— —
K	0.470	0.530	— —	11.94	13.46	— —
L	0.120	0.127	— —	3.05	3.23	— —
M	0.056	0.062	— —	1.42	1.57	— —
N	— —	— —	51°	— —	— —	51°
P	— —	— —	52°	— —	— —	52°
R	— —	— —	1.000	— —	— —	25.40
T	0.020R	— —	— —	0.51R	— —	— —

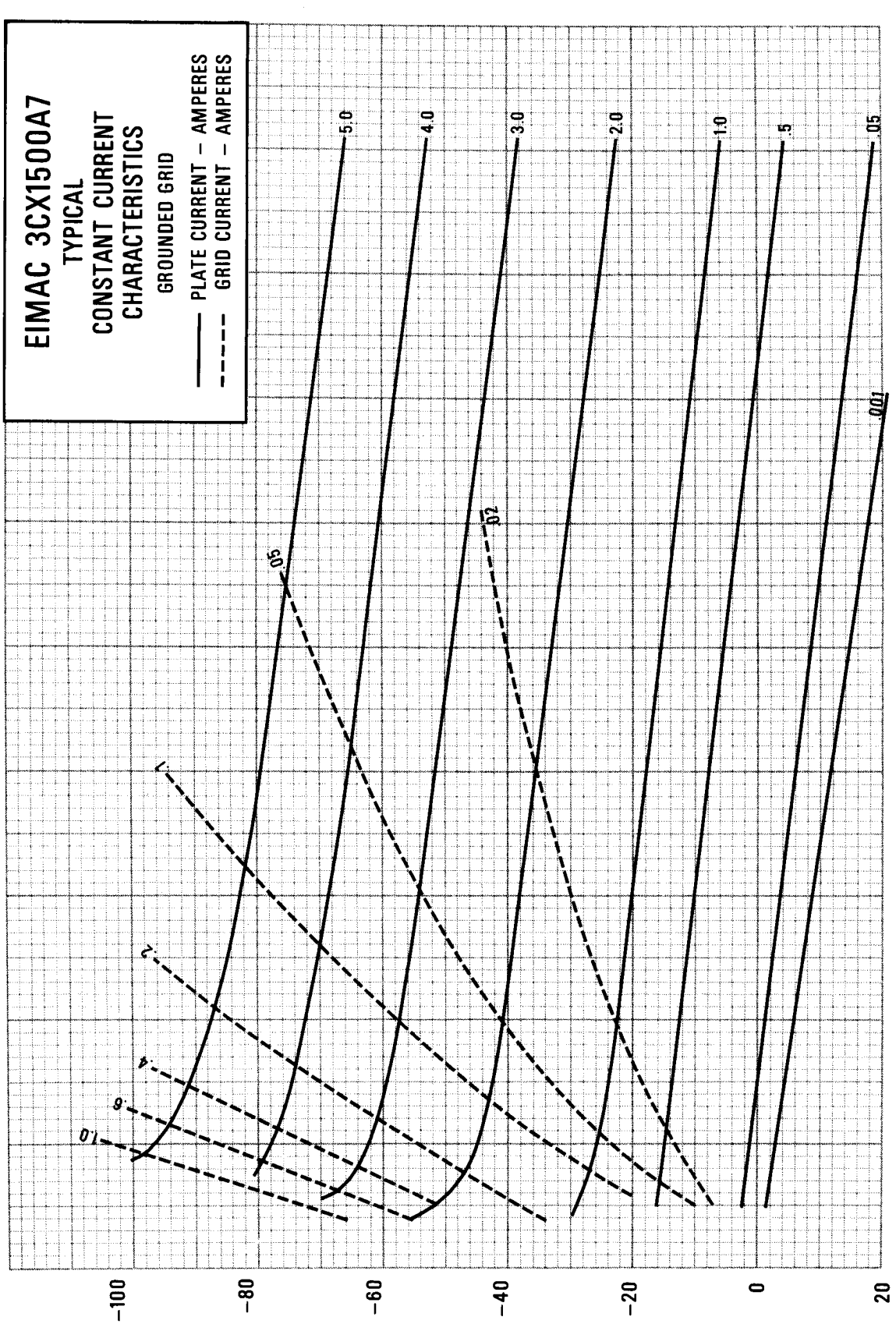
NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACE.
3. DIMENSION T APPLIES TO ALL BUT CENTER PIN.



PIN CONNECTIONS

1 - HEATER
5 - HEATER
2 - 3 - 4 - 6 - 7 CATHODE


EIMAC 3CX1500A7
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
14
12
10
8
6
4
2
1
.5
.1
.05
.001
3
1.5
1.0
2.0
GRID VOLTAGE (V)
160
120
80
40
0
-40
0
1.0
2.0
3.0
4.0
5.0
PLATE VOLTAGE (kV)
CURVE #4211


EIMAC 3CX1500A7
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
5.0
4.0
3.0
2.0
1.0
.5
.05
.001
.05
.02
1
2
4
6
10
CATHODE TO GRID VOLTAGE (V)
-100
-80
-60
-40
-20
0
20
0
1.0
2.0
3.0
4.0
5.0
PLATE TO GRID VOLTAGE (KV)

CURVE #4250

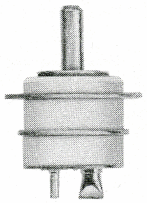
TECHNICAL DATA

PRELIMINARY DATA

8892

PLANAR TRIODE

The 8892 is a compact, rugged ceramic/metal planar triode intended for CW use or as a plate- or grid-pulsed oscillator or amplifier. It features high power output, high plate efficiency and excellent frequency stability under severe environmental conditions. The construction of the 8892 readily lends itself to cavity circuit operation resulting in an extremely compact rf source. The 8892 is capable of providing in excess of 1 kW peak power at 6 GHz.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 (±5%)	V
Current, at 6.3 volts	0.65	A
Cathode Heating Time	60	sec.
Transconductance (Average)	30	mmhos
Amplification Factor (Average)	60	
Direct Interelectrode Capacitance, without heater voltage		
Grid-Cathode	5.00	pF
Grid-Plate	1.60	pF
Plate-Cathode (maximum)	0.06	pF
Plate Dissipation (maximum)[2]	50	W
Grid Dissipation (maximum)	1.5	W

1. The data presents the nominal design objectives for this product and the characteristics and specifications of this type are subject to change. The device is now under development and is made available for experimental purposes only. For the most recent information concerning the status of this development, please contact your nearest Varian Electron Tube and Device Field Office or the Product Manager, Eimac Division of Varian, Salt Lake City, Utah.

2. With forced air cooling or appropriate conduction and/or convection cooling.

MECHANICAL

Maximum Overall Dimensions:	
Length	1.059 in; 26.90 mm
Diameter	0.758 in; 19.3 mm
Net Weight	0.25 oz; 7.0 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Cooling	Conduction and Forced Air

(Effective 9-1-70) © by Varian

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RF OSCILLATOR
Class C, Pulsed

ABSOLUTE MAXIMUM RATINGS:

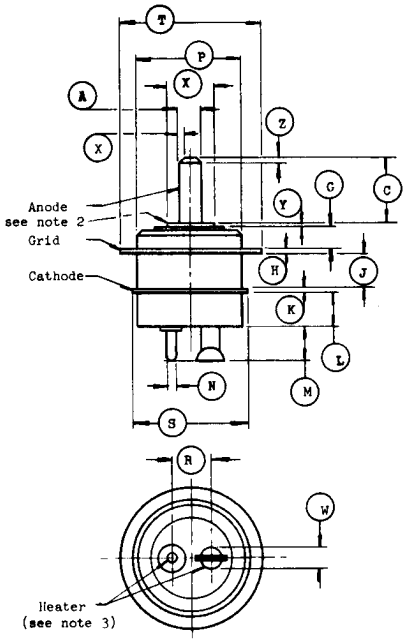
DC PLATE VOLTAGE	2.0	kVdc
PEAK PLATE VOLTAGE	2.5	kv
DC PLATE CURRENT	100	mAdc
DC GRID CURRENT	30	mAdc
PEAK PLATE CURRENT	3.0	a
PEAK GRID CURRENT	1.2	a
DC GRID VOLTAGE	-100	Vdc
PULSE DURATION[1]	3.0	μs
DUTY FACTOR[1]	.0025	
PEAK HEATER-CATHODE VOLTAGE[2]	±50	V
FREQUENCY	6.0	GHz

1. For applications requiring longer pulse duration and/or higher duty factor, please consult the Product Manager, EIMAC-Division of Varian, Salt Lake City, Utah.
2. The heater is electrically isolated from the cathode.

APPLICATION

The cathode and grid flanges should not be altered in any way such as by machining or filing, since final seal could be damaged. Maximum torque applied to flanges during installation should not exceed 15 inch pounds.
For optimum rf performance, the anode line should make good rf contact on the anode area indicated in the outline drawing.

Soldered connections may be made to the anode stud, grid or cathode flanges, and heater contacts where adequate heat sinking and good soldering practices are followed to minimize the heat applied to the tube and the thermal gradient across the metal to ceramic brazed areas.



DIMENSIONAL DATA

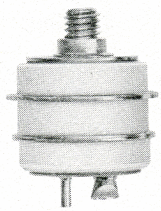
DIM.	INCHES MIN	INCHES MAX	INCHES REF	MILLIMETERS MIN	MILLIMETERS MAX	MILLIMETERS REF
A	0.122	0.128	--	3.10	3.25	--
C	0.325	0.335	--	8.26	8.51	--
G	0.120	0.130	--	3.05	3.30	--
H	0.025	0.031	--	0.64	0.79	--
J	0.167	0.177		4.24	4.50	
K	0.025	0.031	--	0.64	0.79	--
L	0.170	0.185	--	4.32	4.70	--
M	0.170	0.190	--	4.32	4.83	--
N	0.047	0.053	--	1.19	1.35	--
P	0.535	0.565	--	13.59	14.35	--
R	0.185	0.215	--	4.70	5.46	--
S	0.598	0.608	--	15.19	15.44	--
T	0.748	0.758	--	19.00	19.25	--
W	--	--	0.100	--	--	2.54
X	0.250	0.260	--	6.35	6.60	--
Y	--	0.020	--	--	0.51	--

Note:
1. Ref. Dims. are for info. only & are not req'd. for inspection purposes.
2. For optimum rf performance the Anode line should make rf contact at this point on the Anode Cup.
3. Heater is electrically isolated from cathode.

8893

PLANAR TRIODE

The 8893 is a compact, rugged ceramic/metal planar triode intended for CW use or as a plate- or grid-pulsed oscillator or amplifier. It features high power output, high plate efficiency and excellent frequency stability under severe environmental conditions. The construction of the 8893 readily lends itself to cavity circuit operation resulting in an extremely compact rf source.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 (±5%)	V
Current, at 6.3 volts	1.3	A
Cathode Heating Time	60	sec.
Transconductance (Average)	30	mmhos
Amplification Factor (Average)	60	
Direct Interelectrode Capacitance, without heater voltage		
Grid-Cathode	8.00	pF
Grid-Plate	2.35	pF
Plate-Cathode (maximum)	0.10	pF
Plate Dissipation (maximum)[2]	100	W
Grid Dissipation (maximum)	1.5	W

1. The data presents the design objectives for this product and the characteristics and specifications of this type are subject to change. The device is now under development and is made available for experimental purposes only. For the most recent information concerning the status of this development, please contact your nearest Varian Electron Tube and Device Field Office or the Product Manager, Eimac Division of Varian, Salt Lake City, Utah.

2. With forced air cooling or appropriate conduction and/or convection cooling.

MECHANICAL

Maximum Overall Dimensions:	
Length	1.074 in; 27.30 mm
Diameter	0.758 in; 19.30 mm
Net Weight	0.35 oz; 10.0 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Cooling	Forced Air

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RF OSCILLATOR
Class C, Pulsed

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	2.0	kVdc
PEAK PLATE VOLTAGE	3.5	kv
DC PLATE CURRENT	150	mAdc
DC GRID CURRENT	45	mAdc
PEAK PLATE CURRENT	5.0	a
PEAK GRID CURRENT	1.5	a
DC GRID VOLTAGE	-100	Vdc
PULSE DURATION[1]	6.0	μs
DUTY FACTOR[1]	.004	
PEAK HEATER-CATHODE VOLTAGE[2]	±50	V
FREQUENCY	4.0	GHz

1. For applications requiring longer pulse duration and/or higher duty factor, please consult the Product Manager, EIMAC-Division of Varian, Salt Lake City, Utah.
2. The heater is electrically isolated from the cathode.

REPRESENTITIVE OPERATION (Grid-Pulsed Oscillator)

Frequency	2.5	GHz
Heater Voltage	6.3	V
Heater Current	1.3	A
Duty Factor	0.01	maximum
Pulse Width	30	microseconds maximum
Peak Plate Voltage	1.5	kv
Peak Plate Current	3a	maximum
Power Output (useful)	1	kw, minimum

APPLICATION

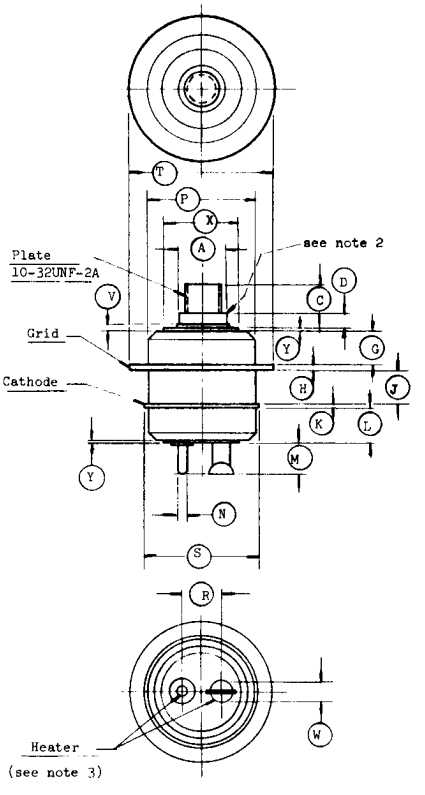
The cathode and grid flanges should not be altered in any way such as by machining or filing, since final seal could be damaged. Maximum torque applied to flanges during installation should not exceed 15 inch pounds.

For optimum rf performance, the anode line should make good rf contact on the anode area indicated in the outline drawing.

For further details on cooling or other aspects of tube operation, refer to the "Application Notes for Planar Triodes" bulletin which can be obtained on request.

DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	0.247	0.253	- -	6.27	6.43	- -
C	0.120	0.160	- -	3.05	4.06	- -
D	0.070	0.090	- -	1.78	2.29	- -
G	0.182	0.192	- -	4.62	4.88	- -
H	0.025	0.031	- -	0.64	0.79	- -
J	0.170	0.180	- -	4.32	4.57	- -
K	0.025	0.031	- -	0.64	0.79	- -
L	0.170	0.180	- -	4.32	4.57	- -
M	0.170	0.190	- -	4.32	4.83	- -
N	0.047	0.053	- -	1.19	1.35	- -
P	0.635	0.665	- -	16.13	16.89	- -
R	0.186	0.214	- -	4.72	5.44	- -
S	0.696	0.708	- -	17.73	17.98	- -
T	0.748	0.758	- -	19.00	19.25	- -
V	- -	0.040	- -	- -	1.02	- -
W	- -	- -	0.100	- -	- -	2.54
X	0.545	0.570	- -	13.84	14.48	- -
Y	- -	0.020	- -	- -	0.51	- -



Notes: 1. Ref Dims. are for info. only and are not reqd for insp. purposes.
2. For optimum rf performance the Anode line should make rf contact at this point on the Anode Cup.
3. Heater is electrically isolated from cathode.

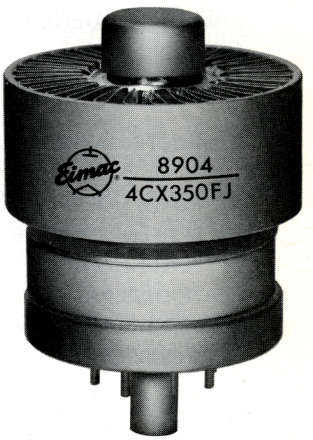
TECHNICAL DATA

8904
4CX350FJ

RADIAL BEAM
POWER TETRODE

The EIMAC 8904/4CX350FJ is a compact radial-beam tetrode with a maximum plate dissipation of 350 watts, intended for Class AB linear rf amplifier service. The tube has rugged internal construction features.

The 8904/4CX350FJ may be used as an exact replacement for the 8322/4CX350F in most applications, requiring only minor circuit adjustment and retuning. The tube has improved intermodulation distortion characteristics. It contains a 26.5 volt heater, and is recommended for new equipment designs.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide-coated, Unipotential

Voltage	26.5 ± 1.3 V
Current, at 26.5 volts	0.65 A

Transconductance (Average):

I_b = 150 mAdc	22,000 μmhos

Amplification Factor (Average):

Grid to Screen	17

Direct Interelectrode Capacitances (grounded cathode)[2]

Cin	22.0 pF
Cout	5.9 pF
Cgp	0.033 pF

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special 9-pin, JEDEC B8-236
Recommended Air-System Socket	EIMAC SK-600 Series
Recommended Air Chimney	EIMAC SK-600 Series
Maximum Overall Dimensions:	
Length	2.46 in; 62.59 mm
Diameter	1.64 in; 41.65 mm
Operating Position	Any
Cooling	Forced Air

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Net Weight (Approximate)	4 oz; 113 gm
Shipping Weight (Approximate)	1.6 lb; 3.5 kg
Maximum Operating Temperature:	
Anode Core and metal/ceramic seals	250°C

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN
Class AB 1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	2500	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC PLATE CURRENT	300	MA
PLATE DISSIPATION	350	WATTS
SCREEN DISSIPATION	8	WATTS
GRID CURRENT	2	MA

1. Adjust to specified Zero-Signal Plate Current.
2. Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	1400	2200	Vdc
Screen Voltage	300	400	Vdc
Grid Voltage [1]	-14	-19	Vdc
Zero-Signal Plate Current	80	100	mAdc
Single-Tone Plate Current	165	227	mAdc
Single-Tone Screen Current [2]	6	8	mAdc
Useful Output Power [3]	100	250	W
Resonant Load Impedance	3600	5000	Ω
Intermodulation Distortion [4]			
3rd Order Products	-45	-40	dB
5th Order Products	-50	-45	db

3. Power delivered to the load.
4. The IMD products are referenced against one tone of a two-equal-tone signal.

NOTE: TYPICAL OPERATION data is obtained from direct measurement. Adjustment of the rf grid voltage to obtain the specified bias, screen, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in screen current, which is incidental and which will vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct screen grid voltage in the presence of the variations in current.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Heater: Current at 26.5 volts	0.50	0.81	A
Interelectrode Capacitances[1] (grounded cathode):			
Cin	20.0	24.0	pF
Cout	5.6	6.2	pF
Cgp	---	0.038	pF

APPLICATION

MECHANICAL

MOUNTING - The 4CX350FJ may be operated in any position. An EIMAC Air-System Socket, SK-600 series, or a socket having equivalent characteristics, is required. Sockets are available with or without built-in screen bypass capacitors and may be obtained with either grounded or ungrounded cathode terminals. Air chimneys are also available for these sockets, including a unit which securely clamps the tube into place in the socket for applications where environmental stress is anticipated.

COOLING - Sufficient cooling must be provided for the anode, base seals, and body seals to maintain operating temperatures below the rated maximum value. Air requirements to maintain seal temperatures at 225°C in 50°C ambient air are shown. These values apply when the EIMAC

SK-600 or SK-610 socket is used with the SK-606 chimney, with air flowing in the base-to-anode direction.

Minimum Cooling Air Flow Requirements				
Plate Dissipation (watts)	Sea Level		10,000 Feet	
	Air Flow (cfm)	Approx. Press.drop, In. H_2O	Air Flow (cfm)	Approx. Press.drop, In. H_2O
250	5.3	0.6	7.7	0.85
300	6.5	0.9	9.5	1.25
350	7.8	1.2	12.0	1.90

Experience has shown that if reliable long-life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt, which may interfere with effective cooling.

The blower selected in any given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown, plus any drop encountered in ducts and filters, and the blower must be designed to deliver the air at the desired altitude.

It should be borne in mind that operating temperature is the sole criterion of cooling effectiveness. One method of measuring the surface temperature is by the use of a temperature-sensitive lacquer or paint. When these materials are used, thin applications must be used to avoid interference with the transfer of heat from the tube to the air stream, which would cause inaccurate indications.

SHOCK AND VIBRATION - The 4CX350FJ is recommended for applications where environmental stress is anticipated and reliable operation must be maintained under these circumstances. The tube is routinely tested at a vibration level of 10 G, over the frequency range of 28 to 750 Hertz, with full operating voltages applied, and also tested under 90 G long-duration (11 milliseconds) shock conditions, also with voltages applied. When shock or vibration stressing is expected, it is extremely important that relative motion between socket and tube be prevented or restricted by clamping the tube into place. This may be done with EIMAC Air-System Socket SK-620 or SK-630 and the EIMAC SK-636B chimney, which includes a clamping mechanism.

ELECTRICAL

HEATER - The heater voltage for the 4CX350FJ is 26.5 volts and should be maintained as closely as possible. Short-time variations of ±10% of the rated value will not damage the tube, but voltage should be maintained within ±5% of rated value to minimize variations in performance and to obtain maximum life.

CATHODE OPERATION - The cathode is internally connected to the four even-numbered base pins, and all four corresponding socket terminals should be used to make connection to the external circuits. At radio frequencies it is important to keep cathode leads short and direct and to use conductors with large areas to minimize inductive reactance in series with the cathode leads.

It is recommended that rated heater voltage be applied for a minimum of 60 seconds before other operating voltages are applied. Where the circuit design requires the cathode and heater to be operated at different potentials, the rated maximum heater-to-cathode voltage is 150 volts, regardless of polarity.

STANDBY OPERATION - When equipment is designed for very low-duty operation, where standby periods of many hours or even days at one time are anticipated, it is good engineering practice to include circuitry for reduction of the heater voltage of an oxide-cathode tube during the standby periods. This will greatly minimize the release of sublimation products within the tube. A reduction in heater voltage of 10% from the nominal value is recommended during such long standby periods, with simultaneous switching to normal voltage when the equipment is switched from STANDBY to OPERATE. A reduction in heater voltage of more than 10% is possible if operation is not attempted for several seconds after switching from the STANDBY to the OPERATE mode.

CONTROL-GRID OPERATION - The grid dissipation rating of the 4CX350FJ is zero watts. The grid current rating of 2.0 milliamperes allows the flow of positive grid current for peak-signal monitoring purposes.

SCREEN-GRID OPERATION - The maximum rated power dissipation for the screen grid of the

4CX350FJ is 8.0 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative. In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

If tuning of a linear amplifier circuit is to be done under single-tone conditions, extra care should be exercised to be sure the screen dissipation rating is not exceeded, as this is often the limiting factor during this type of operation.

Protection for the screen can be provided by an over-current relay and by interlocking the screen supply so the plate voltage must be applied before screen voltage can be applied.

The screen current may reverse under certain conditions and produce negative current indications on the screen milliameter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind, so that the correct operating voltage will be maintained on the screen under all conditions. A current path from the screen to cathode must be provided by a bleeder resistor or shunt regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per connected screen. A series regulator circuit can be used only when an adequate bleeder resistor is provided.

PLATE OPERATION - The maximum rated plate-dissipation power for the 4CX350FJ is 350 watts. The maximum dissipation rating may be exceeded for brief periods during circuit adjustment without damage to the tube.

At frequencies up to approximately 30 Megahertz the top cap on the anode cooler may be used for a plate terminal. At higher frequencies a circular clamp or spring-finger collet encircling the outer surface of the anode cooler should be used.

MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide for individual metering and individual adjustment of the bias or screen voltage to equalize inputs. Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event one tube should fail.

UHF OPERATION - The 4CX350FJ is useful in the UHF region. Operation at these frequencies should be conducted with heavy plate loading and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

HIGH VOLTAGE - The 4CX350FJ operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-

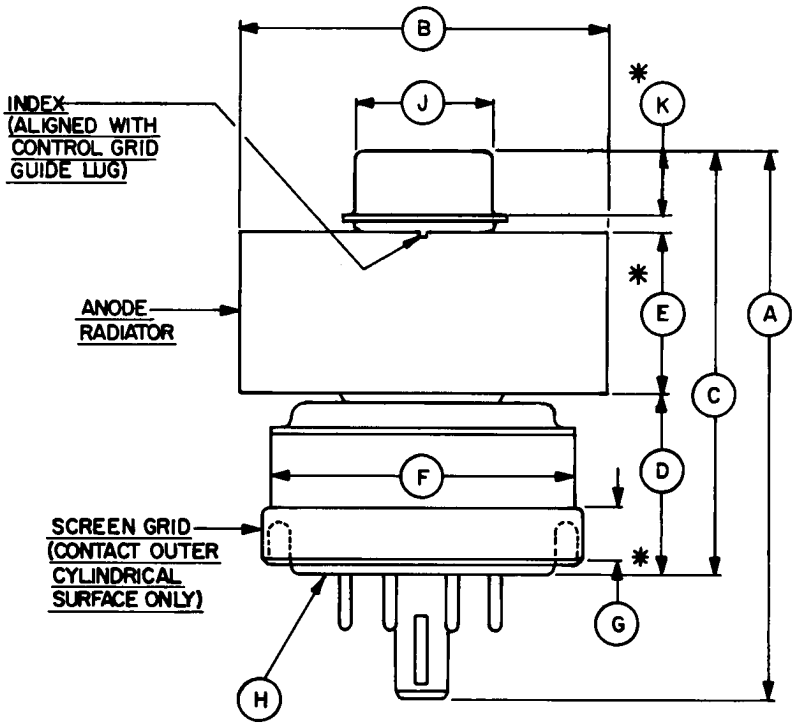
voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

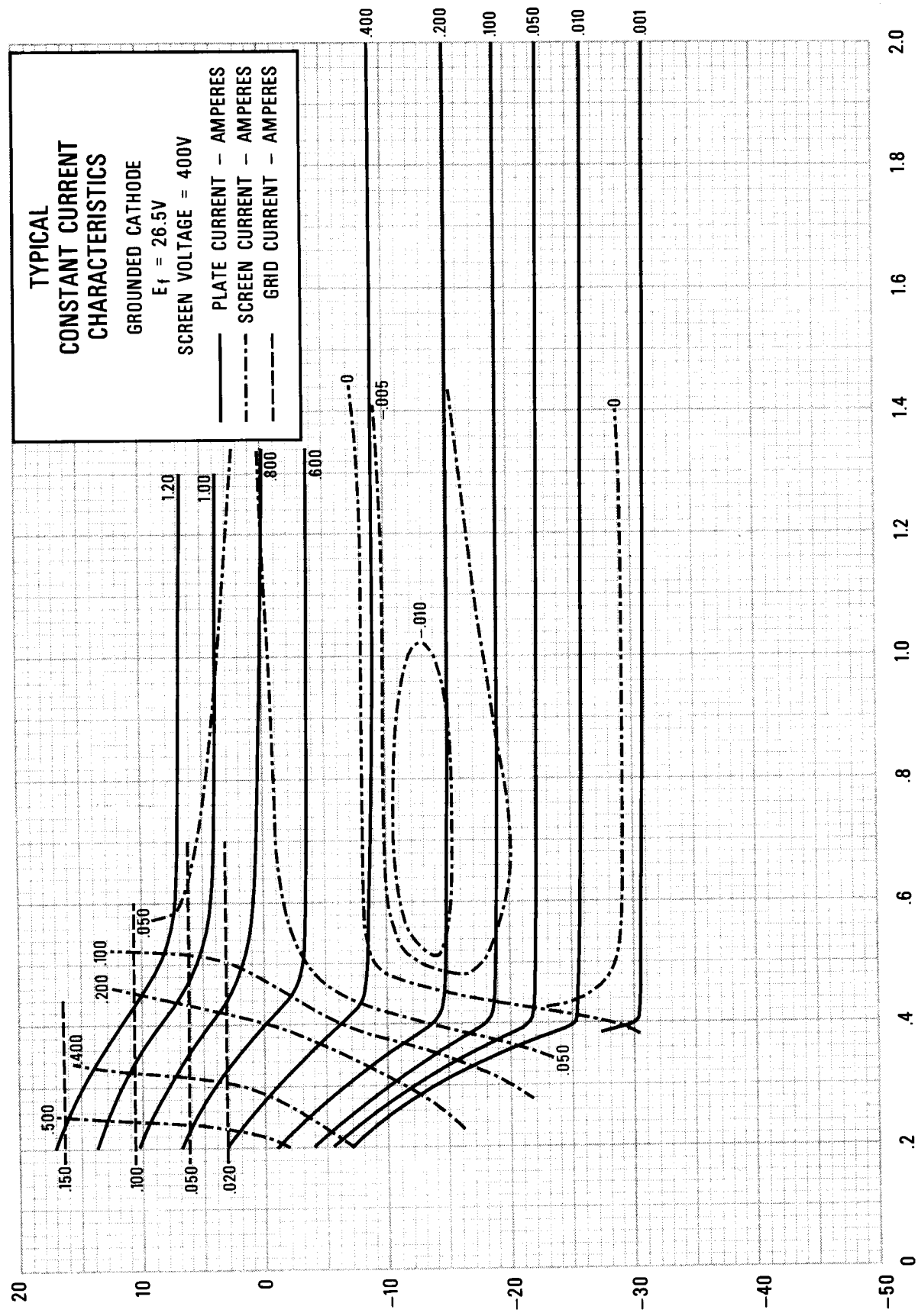
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, CA 94070, for information and recommendations.

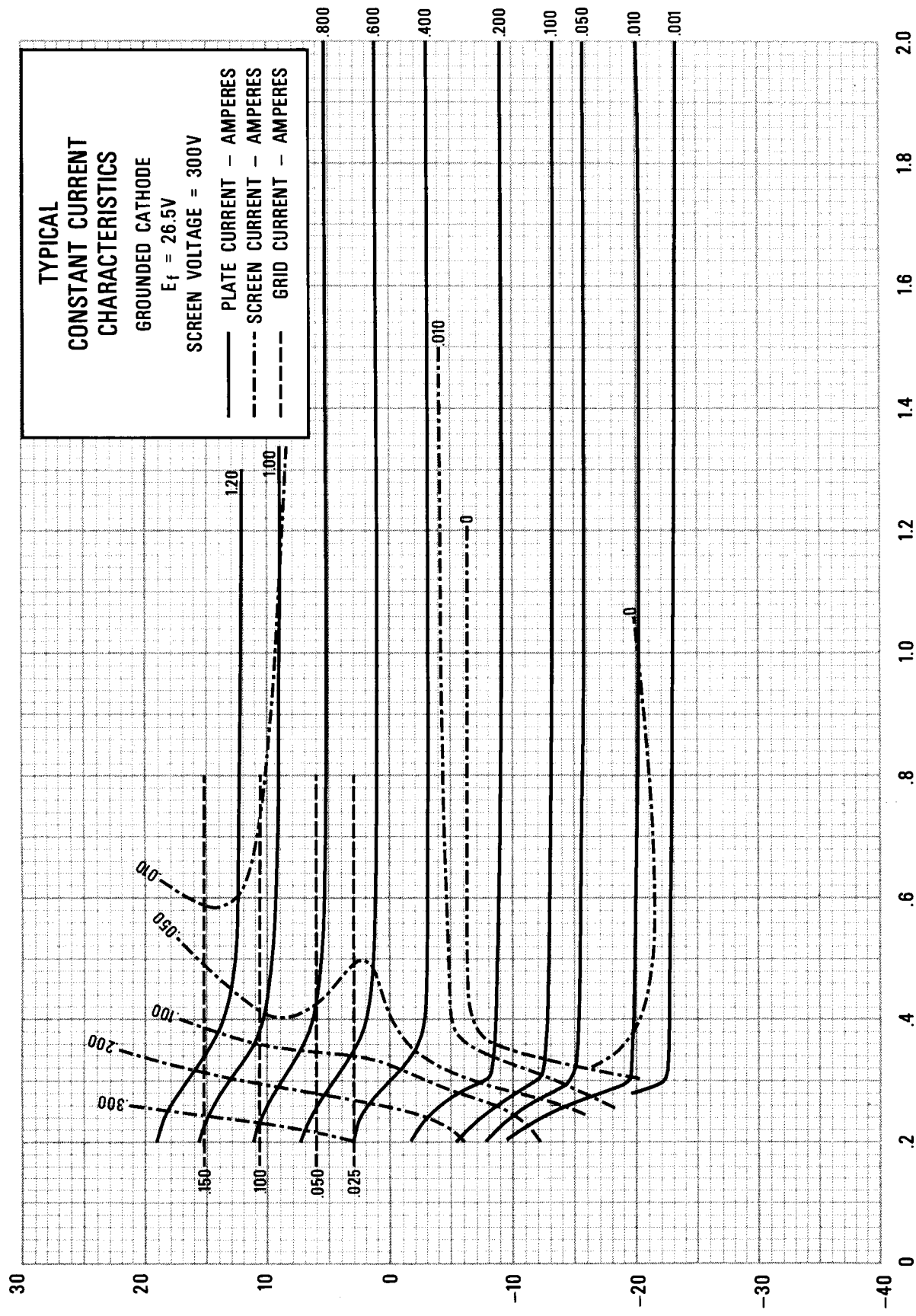
PIN No. 1: SCREEN GRID
PIN No. 2: CATHODE
PIN No. 3: HEATER
PIN No. 4: CATHODE
PIN No. 5: I.C. DO NOT USE FOR EXTERNAL CONNECTION
PIN No. 6: CATHODE
PIN No. 7: HEATER
PIN No. 8: CATHODE
CENTER PIN: CONTROL GRID

DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	2.324	2.464	59.03	62.59
B	1.610	1.640	40.89	41.66
C	1.810	1.910	45.97	48.51
D	0.750	0.810	19.05	20.57
E	0.710	0.790	18.03	20.07
F	--	1.406	--	35.71
G	0.187	--	4.75	--
H	BASE: B8-236 (JEDEC DESIGNATION)			
J	0.559	0.573	14.20	14.55
K	0.240	--	6.10	--

NOTES:
1. REF. DIMS. ARE FOR INFO. ONLY AND ARE NOT REQD. FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACE




TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 26.5V
SCREEN VOLTAGE = 400V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #4335


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 26.5V
SCREEN VOLTAGE = 300V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
800
600
400
200
100
050
010
001
120
100
010
0
0
300
200
100
050
010
150
100
050
025
30
20
10
0
−10
−20
−30
−40
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)

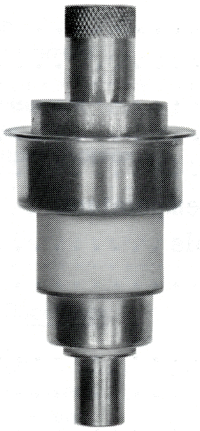
CURVE #4336

TECHNICAL DATA

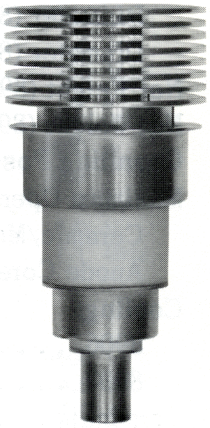
8906
8907

PLANAR TRIODES

The EIMAC 8906 (formerly Y-572) and 8907 (formerly Y-581) are rugged ceramic/metal planar triodes designed for use as a CW, grid- or plate-pulsed oscillator or frequency multiplier up to 3 GHz, as well as for pulse modulator or voltage regulator service. The 8906 is supplied with a knob intended for conduction-convection cooling and the 8907 is supplied with radiator (P/N 014224) for forced air cooling. Except for the plate dissipation ratings, the characteristics of both tube types are identical.



8906



8907

An outstanding feature of these tubes is the low heater power requirement for such high current capability. Either type can normally be used in place of the 7815, 7815R and 8745 at the same heater voltage where higher current capability and/or longer life is desired. Replacement of the above tube types with either the 8906 or 8907 is possible in most cases. The tubes can also replace the 7211/7698 (or 7698R) when a 25% lower heater power requirement is desired. In addition, the 8906 and 8907 have the preferred features of the 7815 and 7211 type family: high-Mu, high transconductance, great mechanical strength, low interelectrode capacitance, high current capability and increased grid-to-anode insulator length. The cathode is of the arc resistant extended interface type, well proven in airline type applications, assuring reliable, long-life operation under adverse conditions.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3	V
Current, at 6.0 volts	1.00	A
Transconductance (Average):		
I_b = 160 mA (200 mA/cm^2)	38	mmhos
Amplification Factor (Average)	80	
Direct Interelectrode Capacitances (grounded cathode)[2]		
Grid-Cathode	8.00	pF
Grid-Plate	1.98	pF
Plate-Cathode	0.06	pF
Cut-off Bias[3]	-30	V max.

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MECHANICAL

Maximum Overall Dimensions:	
Length	2.701 in; 68.60 mm
Diameter (8906)	1.195 in; 30.35 mm
Diameter (8907)	1.264 in; 32.11 mm
Net Weight (8906)	1.8 oz; 48 gm
Net Weight (8907)	2.2 oz; 63 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling:	
8906	Conduction and Convection
8907	Forced Air
Terminals	Coaxial, Special

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axes, 55 to 500 Hz	10 G
Altitude, max (in a suitable designed circuit)	70,000 ft

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

CW RF POWER AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	2500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
GRID NEGATIVE TO CATHODE	-400	VOLTS
GRID POSITIVE TO CATHODE	30	VOLTS
DC PLATE CURRENT	150	MILLIAMPERES
DC GRID CURRENT	45	MILLIAMPERES
PLATE DISSIPATION		
8906	10	WATTS
8907	100	WATTS
GRID DISSIPATION	1.5	WATTS
FREQUENCY	2.5	GIGAHERTZ

REPRESENTATIVE OPERATION

Grounded Grid CW r-f Power Amplifier

DC Plate Voltage	630	Vdc
DC Cathode Current	140	mAdc
DC Grid Voltage (Approx.)	-5	Vdc
DC Grid Current	25	mAdc
Drive Power (Approx.)	4	W
Useful CW Power Output	45	W
Heater Voltage	6.0	V
Frequency	700	MHz

Grounded Grid CW r-f Oscillator

DC Plate Voltage	1000	Vdc
DC Plate Current	140	mAdc
DC Grid Voltage (Approx.)	-20	Vdc
DC Grid Current (Approx.)	30	mAdc
Useful CW Power Output	30	W
Heater Voltage	5.0	V
Frequency	2.5	GHz

RF POWER AMPLIFIER OR OSCILLATOR
Grid- or Plate-Pulsed

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE (Grid-Pulsed)	3500	VOLTS
PEAK PULSE PLATE VOLTAGE (Plate-Pulsed)	4500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
GRID NEGATIVE TO CATHODE	-700	VOLTS
GRID POSITIVE TO CATHODE	200	VOLTS
PULSE PLATE CURRENT	5.0	AMPERES
PULSE GRID CURRENT	2.5	AMPERES
PLATE DISSIPATION		
8906	10	WATTS
8907	100	WATTS
GRID DISSIPATION	1.5	WATTS
FREQUENCY	3.0	GIGAHERTZ
PULSE DURATION [1]	6	μs
DUTY FACTOR [1]	0033	

REPRESENTATIVE OPERATION
Grid-Pulsed r-f Amplifier

DC Plate Voltage	2200	Vdc
Peak Video Plate Current	2.5	a
DC Grid Voltage	-50	Vdc
Peak Video Grid Current	1.0	a
Pulse Drive Power	400	w
Useful Power Output (Approx.)	2500	w
Duty Factor	.002	
Pulse Width	3	μs
Heater Voltage	6.0	V
Frequency	1.1	GHz

Plate-Pulsed r-f Oscillator

Peak Plate Voltage	3500	v
Peak Video Plate Current	4.8	a
Peak Video Grid Current	1.5	a
Useful Power Output	3000	w
Duty Factor	.0025	
Pulse Width	3	μs
Heater Voltage	5.8	V
Frequency	3.0	GHz

PULSE MODULATOR OR PULSE AMPLIFIER SERVICE

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	3500	VOLTS
PEAK PLATE VOLTAGE	4500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
GRID NEGATIVE TO CATHODE	-750	VOLTS
GRID POSITIVE TO CATHODE	150	VOLTS
PULSE CATHODE CURRENT	7.5	AMPERES
DC PLATE CURRENT	150	MILLIAMPERES
PLATE DISSIPATION		
8906	10	WATTS
8907	100	WATTS
GRID DISSIPATION	1.5	WATTS
PULSE DURATION	6	μs
DUTY FACTOR [1]	0033	
CUT-OFF MU [1]	60	

1. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube and Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

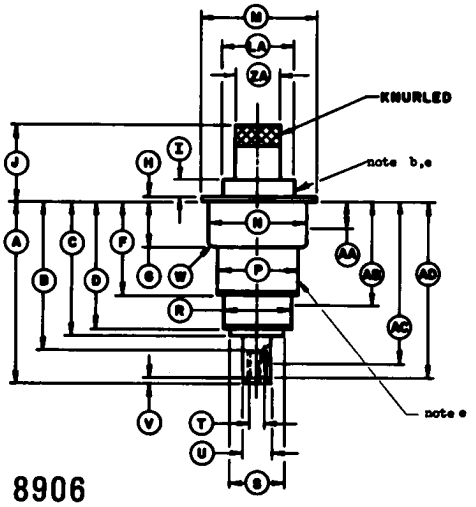
RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	0.90	1.05	A
Cathode Heating Time	60	---	sec
Interelectrode Capacitances [1] (grounded cathode connection)			
Grid-Cathode	7.0	9.0	pF
Plate-Cathode	---	0.06	pF
Grid-Plate	1.86	2.10	pF

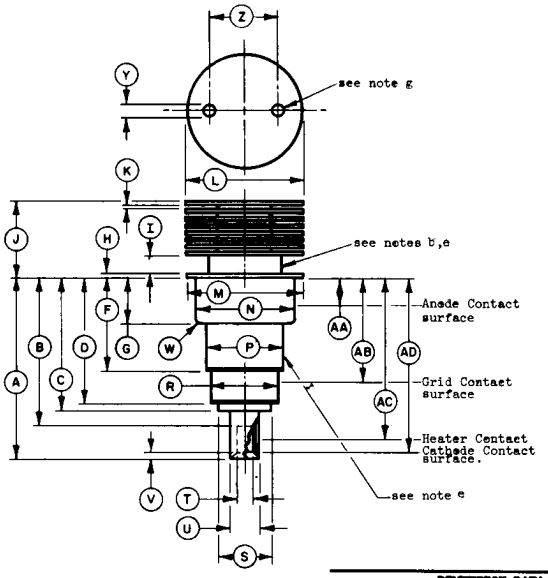
1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

APPLICATION

For general application information please refer to the bulletin "Operating Instructions for Planar Triodes". The operating instructions should be consulted prior to the designing of new requirements around the above tube types. Higher plate dissipation of up to 150 watts is possible with the 8906 and 8907 tube type when using radiator P/N 158555. If this is required the tube order should call for the tube type Y-602. For unusual and special application consult the nearest Varian Electron Tube and Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.



8906



8907

DIMENSION DATA (Note a)					
Dim. in Inches		Dim. in Millimeters			
Min.	Max	Dim.	MIN.	MAX.	Notes
1.815	1.875	A	46.10	47.62	
	1.534	B		38.96	
	1.475	C		37.46	
1.289	1.329	D	32.74	33.76	
.970	1.010	F	24.64	25.65	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
.125	.185	I	3.18	4.70	
.766	.826	J	19.46	20.98	
.025	.040	K	.64	1.17	
1.234	1.264	L	31.34	32.11	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	c,d
.752	.792	P	19.20	20.12	
.655	.665	R	16.64	16.89	c,d
	.545	S		13.84	
.213	.223	T	5.41	5.66	c,d
.315	.325	U	8.00	8.26	c,d
	.086	V		2.18	
	.100	W		2.54	
.105	.145	Y	2.67	3.68	
.650	.850	Z	16.51	21.59	

ELECTRODE CONTACT AREA (Note e,f)				
Dim. in Inches			Dim. in Millimeters	
Dim.	Min.	Max.	Min.	Max.
AA	.035	.361	.89	9.17
AB	1.185	1.265	30.10	32.14
AC	1.534	1.728	38.96	43.89
AD	1.475	1.815	37.47	46.10

DIMENSION DATA (Note a)					
DIM. IN INCHES		DIM. IN MILLIMETERS			
MIN.	MAX.	DIM.	MIN.	MAX.	NOTES
1.815	1.875	A	46.10	47.62	
	1.534	B		38.96	
	1.475	C		37.46	
1.289	1.329	D	32.74	33.76	
.970	1.010	F	24.64	25.65	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
	.185	I		4.70	
.766	.826	J	19.46	20.98	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	d
.752	.792	P	19.10	20.12	
.655	.665	R	16.64	16.89	d
	.545	S		13.84	
.213	.223	T	5.41	5.66	d
.315	.325	U	8.00	8.26	d
	.086	V		2.18	
	.100	W		2.54	
.840	.860	LA	21.34	21.84	
.427	.447	ZA	10.85	11.35	

NOTES:

a. Metric equivalents, to the nearest .01 mm, are given for general information only & are based on 1 inch = 25.4 mm.

b. This surface shall be used to measure Anode Shank temperature.

c. Eccentricity of contact surfaces shall be gaged from center line of reference & shall be as follows; note 2 shall apply:

Contact Surface	TIR Max.	Reference
Anode	.020	Cathode
Grid	.020	Cathode
Heater	.012	Cathode

d. Dias. N,R,T,U shall apply throughout entire contact area as defined by dims. AA,AB, AC,AD respectively.

e. This surface shall not be used for clamping or locating.

f. Electrode Contact Dims. are given for socket design purposes & are not intended for inspection purposes.

Notes:

a. Metric equivalents to the nearest .01 mm, are given for general information only & are based on 1 inch= 25.4 mm.

b. This surface shall be used to measure anode shank temp.

c. Eccentricity of contact surfaces shall be gaged from center line of reference & shall be as follows:

Contact Surface	TIR Max.	Reference
Anode	.020	Cathode
Grid	.020	Cathode
Heater	.012	Cathode

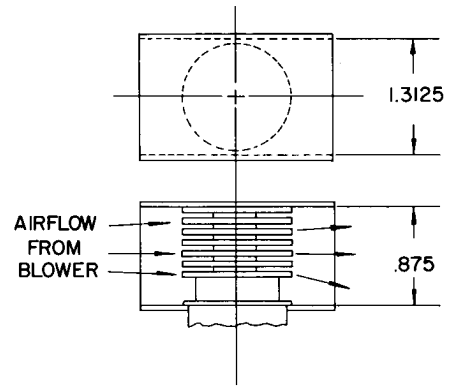
d. Dias. N,R,T & U shall apply throughout entire lenght as defined be dims. AA,AB,AC & AD respectively.

e. This surface shall not be used for clamping or locating.

f. Electrode Contact dims. are given for socket design purposes & are not intended for inspection purposes.

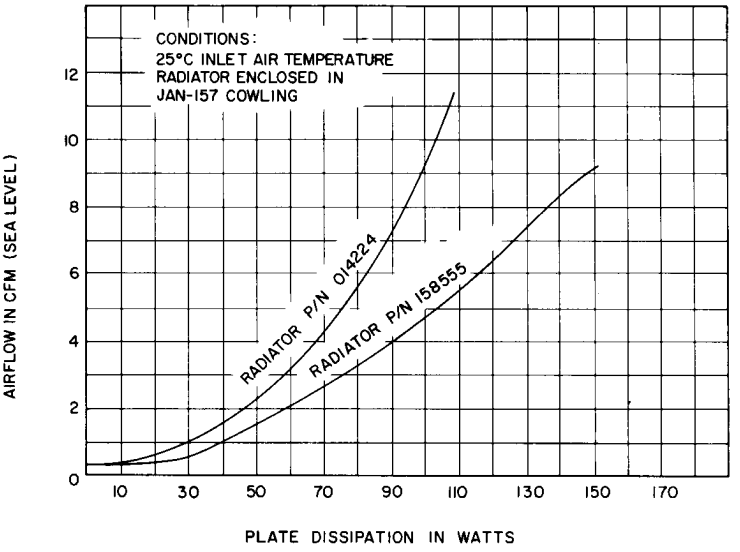
g. Holes for Tube Extractor thru top fin only.

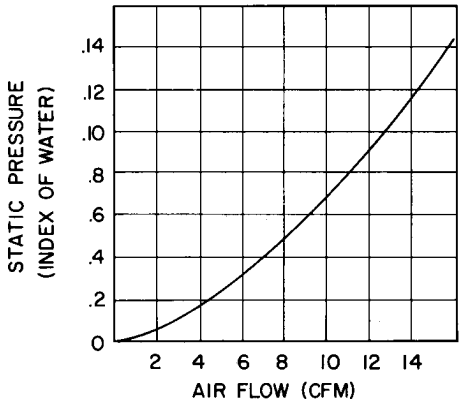
AIRFLOW vs STATIC PRESSURE WITH
STANDARD COWLING JAN-157



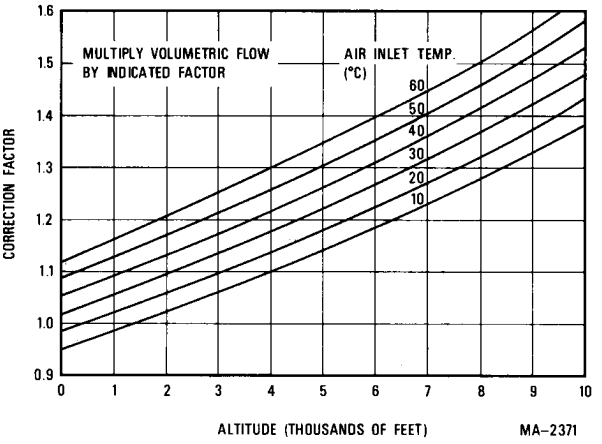
-STANDARD COWLING-

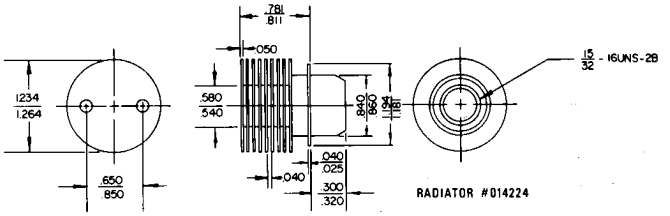
MAXIMUM PLATE DISSIPATION vs COOLING AIRFLOW



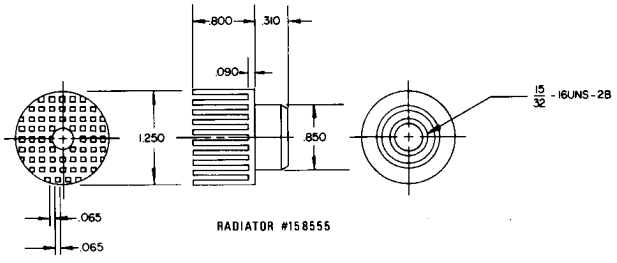


COMBINED CORRECTION FACTORS FOR INLET AIR TEMPERATURE
AND ALTITUDE
(RELATIVE TO 25°C AND SEA LEVEL)

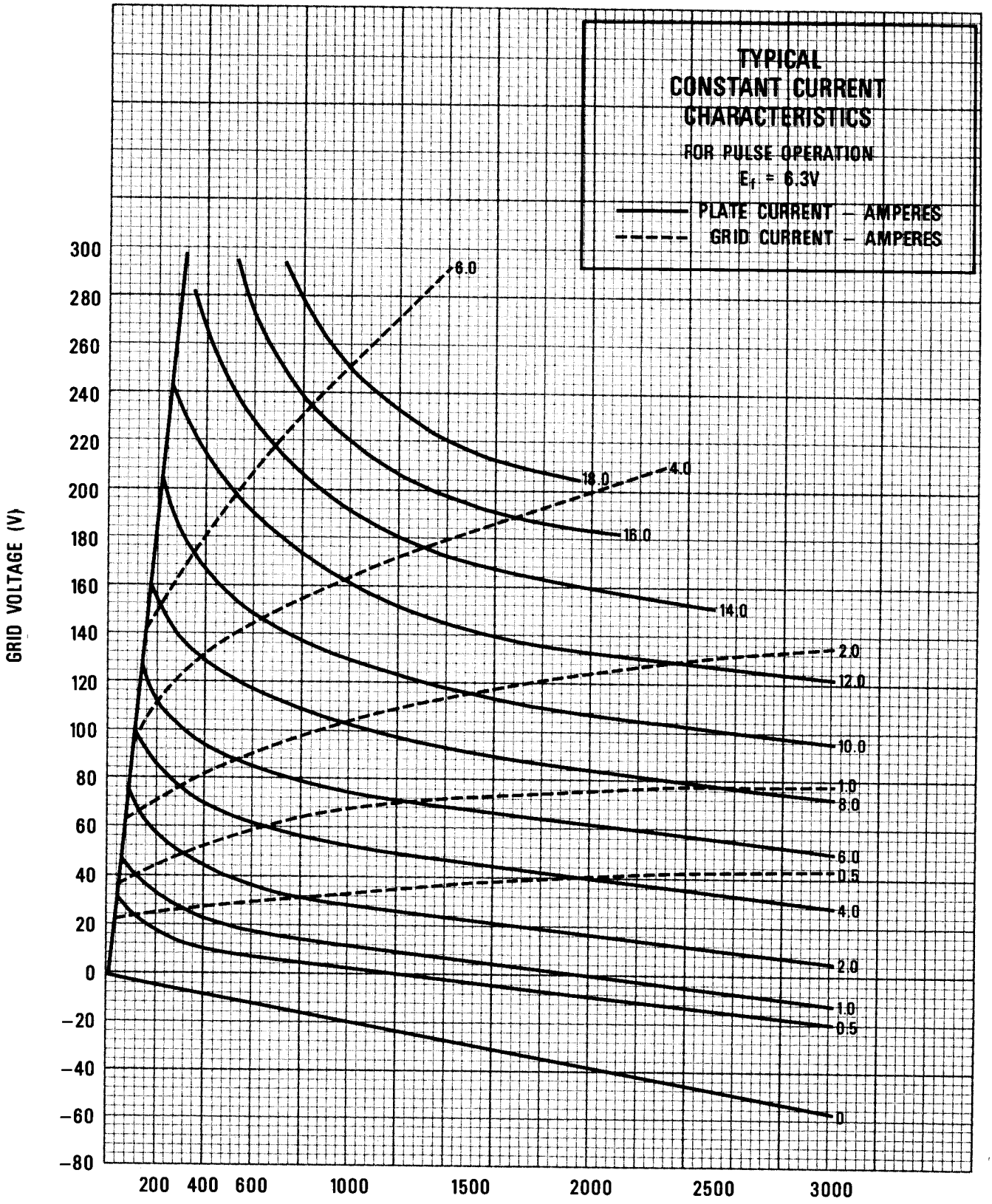


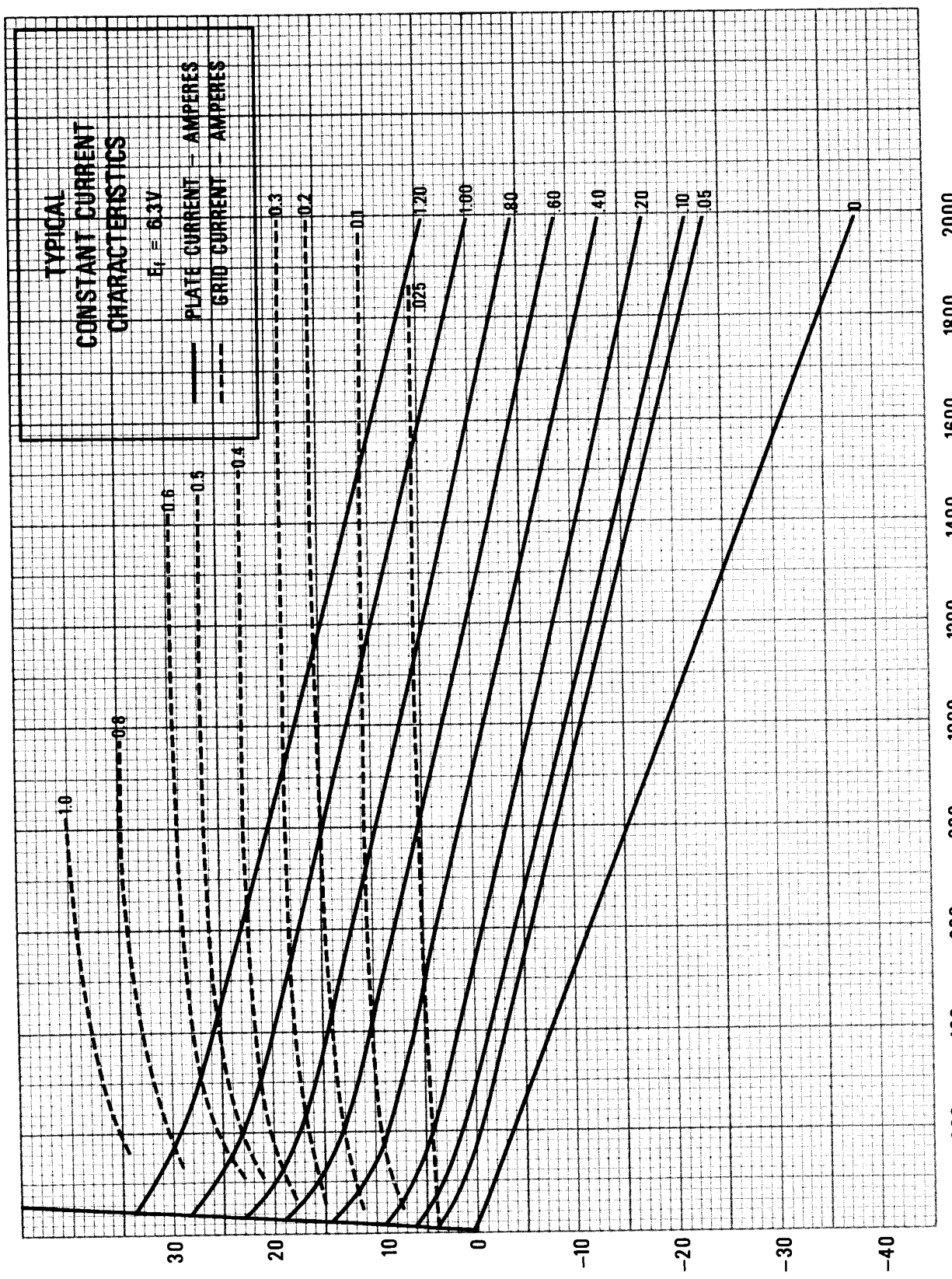


RADIATOR #014224

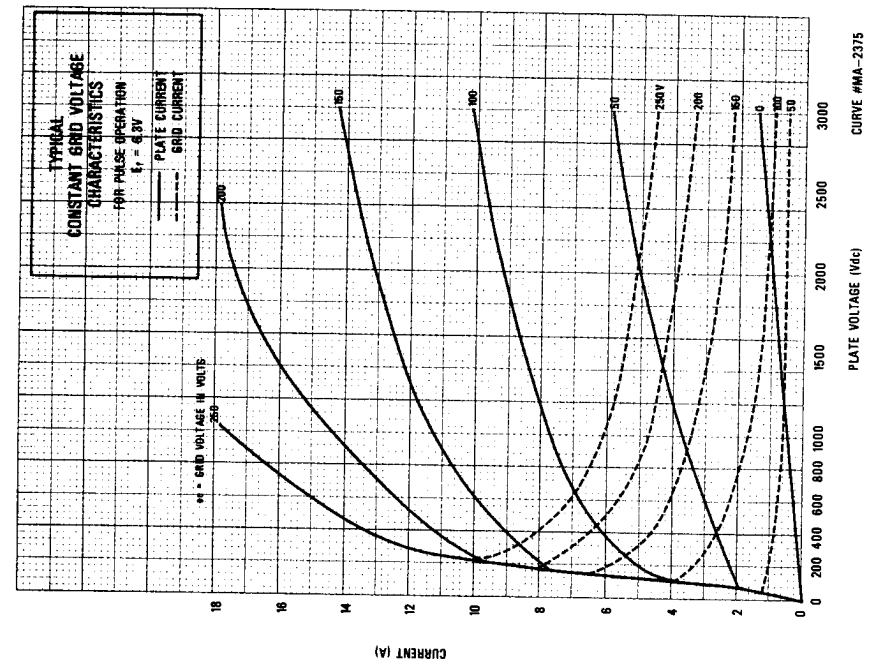


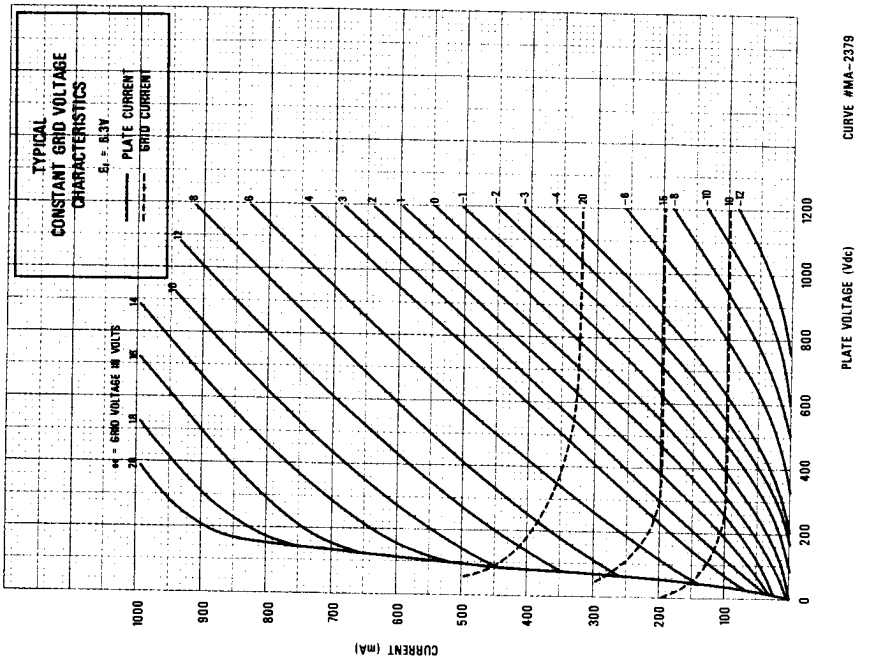
RADIATOR #158555


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
−20
−40
−60
−80
200
400
600
1000
1500
2000
2500
3000
PLATE VOLTAGE (Vdc)
6.0
4.0
18.0
16.0
14.0
2.0
12.0
10.0
1.0
8.0
6.0
0.5
4.0
2.0
1.0
0.5
0
CURVE #MA–2374



CURVE #MA–2380

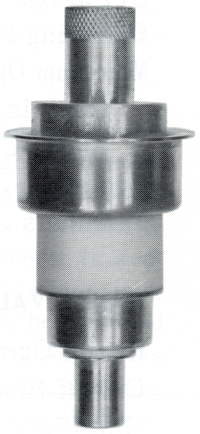

TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
Ef = 6.3V
PLATE CURRENT
GRID CURRENT
eg - GRID VOLTAGE IN VOLTS
250
200
150
100
50
0
-50
-100
250V
200
150
100
50
0
CURRENT (A)
PLATE VOLTAGE (Vdc)
CURVE #MA-2375


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
Ef = 6.3V
PLATE CURRENT
GRID CURRENT
eg - GRID VOLTAGE IN VOLTS
24
18
16
14
12
10
8
6
4
3
2
1
0
-1
-2
-3
-4
-20
-8
-15
-6
-10
-12
CURRENT (mA)
PLATE VOLTAGE (Vdc)
CURVE #MA-2379

TECHNICAL DATA

8906AL
Y572AL

PLANAR TRIODE



The EIMAC 8906AL/Y572AL is a ceramic/metal planar triode specially processed and tested to assure high reliability in airborne service. Evaluation of this tube is based upon operating conditions in grid- or plate-pulsed oscillator service (transponder) and in grid- or plate-pulsed amplifier service in distance measuring equipment (DME). The testing emphasizes cathode emission capability at reduced heater voltage and high voltage hold-off, both features which are demanded in airline service.

The 8906AL/Y572AL is derived from the 7815AL/7211/7698 family. This new improved tube also contains the features of the original types, including rugged ceramic/metal construction, low interelectrode capacitance, high transconductance and high mu. The longer grid-anode ceramic insulator of the earlier type is used, making the 8906AL/Y572AL especially suited for high altitude airborne operation. The 8906AL/Y572AL has a 60% larger cathode area than the 7815/7815AL thus lowering cathode current loading per unit area yet maintaining as high or higher current capability.

In addition to these features, this tube also incorporates the arc-resistant cathode which assures stable operation under adverse conditions and which minimizes catastrophic failure due to arc-over during circuit malfunction. The tube is useable from dc to 3 GHz.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	5.7 (±2%)	V
Current, at 5.7 volts	0.95	A
Transconductance (Average):		
I_b= 100 mAdc, E_b = 600 Vdc	30	mmhos
Amplification Factor (Average)	80	
Direct Interelectrode Capacitance (grounded cathode)[2], without heater voltage:		
Grid-Cathode	8.00	pF
Grid-Plate	1.98	pF
Plate-Cathode (maximum)	0.060	pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this infomation for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture.

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MECHANICAL

Maximum Overall Dimensions:	
Length	2.701 in; 68.60 mm
Diameter	1.195 in; 30.35 mm
Net Weight	1.8 oz; 48 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Conduction and Convection
Terminals	Special

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Heater Current at 5.7 volts	0.87	1.02	A
Cut-off Bias[1]	---	-25	V
Grid-Plate Capacitance[2]	1.85	2.10	pF
Grid-Cathode Capacitance[2]	7.00	9.00	pF
Plate-Cathode Capacitance	---	0.060	pF

1. Measured with 1 mA plate current and a plate voltage of 1000 Vdc.
2. Capacitance values as measured with a cold tube and in a shielded socket. When the cathode is heated to the proper temperature the grid-cathode capacitance will increase by approximately 1 pF due to thermal expansion of the cathode support.

RF POWER AMPLIFIER OR OSCILLATOR

Grid- or Plate-Pulsed

MAXIMUM RATINGS, ABSOLUTE VALUES

DC PLATE VOLTAGE	3500	VOLTS
PEAK PULSE PLATE VOLTAGE		
PLATE PULSED	4500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	750	VOLTS
Grid positive to cathode	250	VOLTS
PULSE PLATE CURRENT	5.0	AMPERE
PULSE GRID CURRENT	2.5	AMPERE
DC CATHODE CURRENT	200	MILLIAMPERES
AVERAGE PLATE DISSIPATION[1]		
Conduction and Convection	10	WATTS
GRID DISSIPATION (Average)	2	WATTS
DUTY FACTOR[2]	.0033	
PULSE DURATION[2]	6	μs
FREQUENCY	3	GHz

1. Higher plate dissipation is permissible when EIMAC radiator (P/N 014224) is used.
2. For longer pulse duration or higher duty cycle, consult the nearest Varian Electron Tube and Device Group Sales Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

OPERATING CONDITIONS FOR THE 8906AL/Y572AL in REPRESENTATIVE APPLICATION.

Grid-Pulsed Oscillator

Frequency	1.090	GHz
Heater Voltage	5.7	V
DC Plate Voltage	2000	Vdc
DC Grid Voltage	-75	Vdc
Peak Plate Current	1.1	a
Peak Grid Current	0.8	a
Pulse Duration	0.5	μs
Duty	0.001	
Useful Power Output (Approx.)	850	w

Plate-Pulsed Amplifier

Frequency	1.1	GHz
Heater Voltage	5.7	V
Peak Plate Pulse Voltage	2000	v
DC Grid Voltage	-45	Vdc
Peak Plate Current	2.0	a
Peak Grid Current	1.0	a
Pulse Duration	3.5	μs
Duty	0.001	
Driving Power	300	w
Useful Power Output (Approx.)	2000	w
Gain	8	db
Plate Efficiency	50%	

APPLICATION

MECHANICAL

MOUNTING - The important dimensions of the tube are carefully controlled with respect to the reference surface as shown on the outline drawing. The reference surface is intended to serve as a tube stop and the location of the tube in the circuit should therefore be determined by this surface coming in positive contact with a precisely positioned member of the socket or cavity. Adherence to this practice will assure both mechanical and electrical interchangeability of all tubes of a given type. If a non-designated surface is used as a tube stop, faulty positioning of the tube in the cavity and possible imcomplete electrical contact can result in improper tuning, reduced power output and damage to the cavity, tube or both. Contact surfaces, with reference to the designated tube stop are shown in the outline drawing. Electrical contact to the cathode, grid, anode and also the heater should be restricted to these designated contact areas.

Dimensions should never be taken from sample tubes. Dimensional changes due to normal variations in undimensioned surfaces may occur within the limits specified on the outline drawing. Use of nondesignated electrical contact surfaces might therefore result in incomplete contact or mechanical interference, causing changes in cavity tuning.

Electrical contact should be made by spring finger collets bearing against the previously described contact areas. If connections are employed which do not provide multiple contacts to the designated contact areas, concentration of RF current will result in loss of output power, especially at higher frequencies. The spring contacts used should exert a firm pressure without gouging the plated contact surface. This latter phenomena can result in loose particles of material which can cause arcing or unstable operation of the cavity.

If the tubes are used in applications which call for severe shock or vibration the tube may be clamped in place by the knob or radiator, exerting pressure only on this part of the tube and against the tube stop. No other portion of the tube should be subject to any clamping force. In particular, electrical contacts which utilize setscrews or rigid clamps should be avoided. Such contact schemes can distort the contact surfaces causing undue stress in the metal-to-ceramic seal area which may result in a vacuum leak. Soldered electrical connections can be made, however great care should be taken during the solder operation to avoid fracture of the seal area due to thermal shock. All contact surfaces should be kept clean to minimize losses.

COOLING - The EIMAC planar triodes are designed to operate at envelope and anode temperatures of up to the maximum rated value of 250°C. However, performance and long-term reliability of any component are improved when it is kept as cool as technically feasible. Therefore, it is recommended that sufficient cooling be provided to keep the anode and seal areas well below the specified maximum temperature, where long tube life and high reliability are of great importance.

The maximum plate dissipation of the 8906AL/Y572AL is 10 watts average power. This can be accomplished by conduction, natural convection or forced air convection cooling. The maximum plate dissipation in pulse service is 45 watts average when furnished with EIMAC radiator (P/N 014224) and forced air cooling is employed at that level. When forced air cooling is used, it is recommended that additional airflow, apart from that flowing through the radiator be used to cool the tube envelope and other tube terminals. A certain amount of conduction cooling is usually inherent in the contact finger configuration. It should be noted, however, that spring fingers provide poor heat conduction and measurements have shown a temperature difference as much as 50°C between the contact finger and contact area.

It is suggested that in all new applications the envelope temperature be measured, especially if the tube is used close to the upper temperature limit. The temperature can easily be determined by the use of Tempilaq paint (Tempil Division, Big Three Industrial Gas & Equipment Co. Hamilton Blvd., So. Plainfield, N.J. 07080. or Temp-Plate stickers (Pydrodyne, Inc., 1001 Colorado St., Santa Monica, California 90404.)

ELECTRICAL

HEATER VOLTAGE - The rated heater voltage for the 8906AL/Y572AL is 5.7 volts and should be controlled within ±2% to obtain maximum tube life and to minimize variations in circuit performance. The rated heater voltage is optimum for most existing airborne applications such as DME

and transponder systems. However, there are other applications where a different heater voltage than the nominal should be used to obtain the longest possible tube life. Depending on pulse width, power output and frequency of oscillation used a different heater voltage may be better for long reliable life. Electron transit time is not necessarily small with respect to the period of oscillation and the amount of driving power diverted will contribute to the cathode heating by electron bombardment.

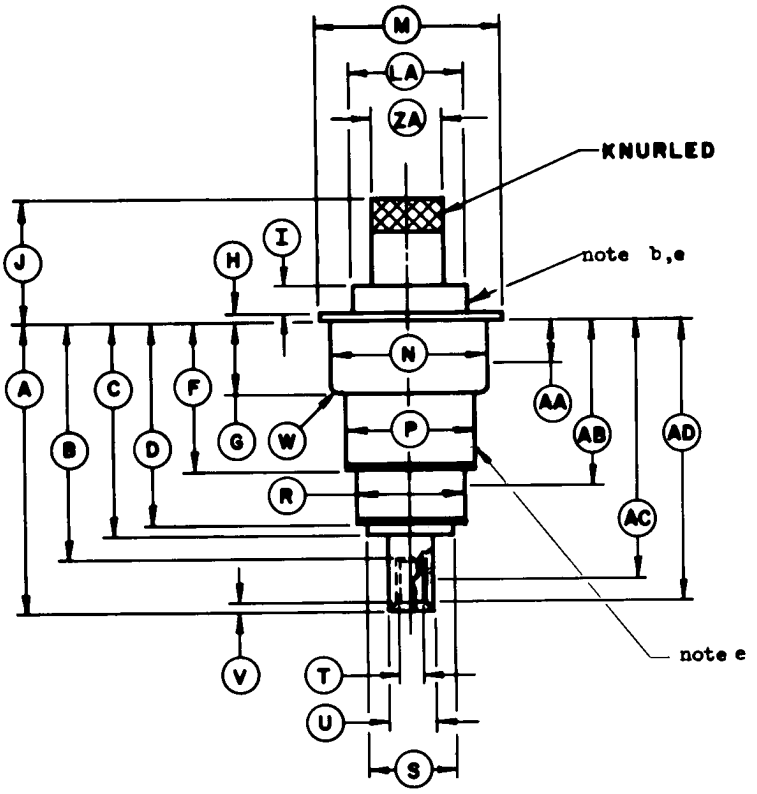
The proper adjustment of the heater voltage must be made to compensate for this additional heating, which depends on operating frequency and duty cycle employed.

INTERELECTRODE CAPACITANCES - As indicated, the capacitance values are shown for measurements made with no heater voltage. The cathode to grid and cathode to plate capacitance will increase with the application of the heater voltage, due to the thermal expansion of the cathode support. Typically, the increase in the grid to cathode capacitance will be 15%, or more, depending on the heater voltage. Since the heater voltage can vary depending on use, data taken without heater voltage is more useful for control of tube-to-tube uniformity. The grid to anode capacitance is not effected by the application of the heater voltage.

CIRCUIT TUNING - Especially under grid pulse conditions, it is important that the tube does not lose bias or momentarily go into a CW mode. Either of these events may result in tube failure. It is suggested that provision be made for initial circuit tune-up at reduced anode voltage and for extra tube protection when the circuit adjustment is critical. The average grid dissipation capability for this tube is 2.0 watts. For many applications the limiting factor is often not anode dissipation or cathode emission capability, but grid dissipation. If pulse width control is lost in pulse applications the grid can exceed safe operating temperatures in 50 ms or less. Appropriate circuit protection during tune up is therefore recommended.

CATHODE OPERATION - The 8906AL/Y572AL contains an arc-resistant cathode. Performance in the field and laboratory indicates this tube is capable of withstanding some abuse due to high voltage arcs, however, poor circuit adjustment in the field may result in shortened tube life. It is, therefore, suggested that wherever feasible, the plate supply be designed such that its impedance limits the short circuit current to within five to ten times the maximum forward current. For pulse service the peak current should be limited to the values listed. Higher pulse width and duty cycles than given can be obtained with proper derating of the current. For this and special applications it is recommended that the user request additional information pertaining to his special application from the nearest Varian Electron Tube and Devices Field Office, or the Product Manager, Eimac Division of Varian, Salt Lake City, Utah.

For general application information please refer to the Planar Triode Operating Instructions.



ELECTRODE CONTACT AREA (see note a,f)				
DIM.	MIN.	MAX.	MIN.	MAX.
AA	.035	.361	.89	9.17
AB	1.185	1.265	30.10	32.14
AC	1.534	1.728	38.96	43.89
AD	1.475	1.815	37.47	46.10
	DIM. IN INCHES		DIM. IN MILLIMETERS	

DIMENSION DATA (Note a)					
DIM. IN INCHES		DIM.	DIM. IN MILLIMETERS		
MIN.	MAX.		MIN.	MAX.	NOTES
1.815	1.875	A	46.10	47.62	
	1.534	B		38.96	
	1.475	C		37.46	
1.289	1.329	D	32.74	33.76	
.970	1.010	F	24.64	25.65	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
	.185	I		4.70	
.766	.826	J	19.46	20.98	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	d
.752	.792	P	19.10	20.12	
.655	.665	R	16.64	16.89	d
	.545	S		13.84	
.213	.223	T	5.41	5.66	d
.315	.325	U	8.00	8.26	d
	.086	V		2.18	
	.100	W		2.54	
.840	.860	LA	21.34	21.84	
.427	.447	ZA	10.85	11.35	

NOTES:

a.. Metric equivalents, to the nearest .01 mm, are given for general information only & are based on 1 inch = 25.4 mm.

b. This surface shall be used to measure Anode Shank temperature.

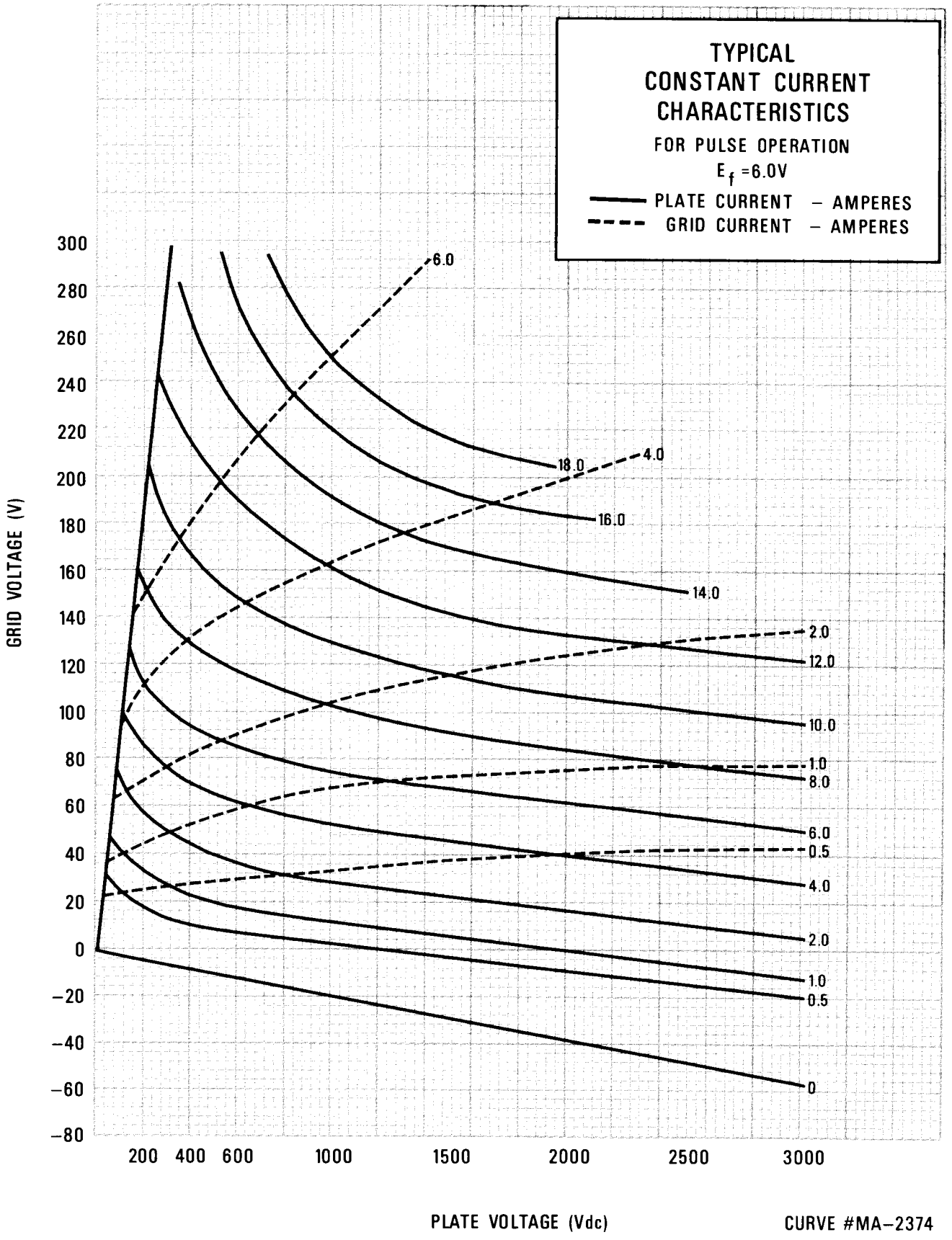
c. Eccentricity of contact surfaces shall be gaged from center line of reference & shall be as follows; note 2 shall apply:

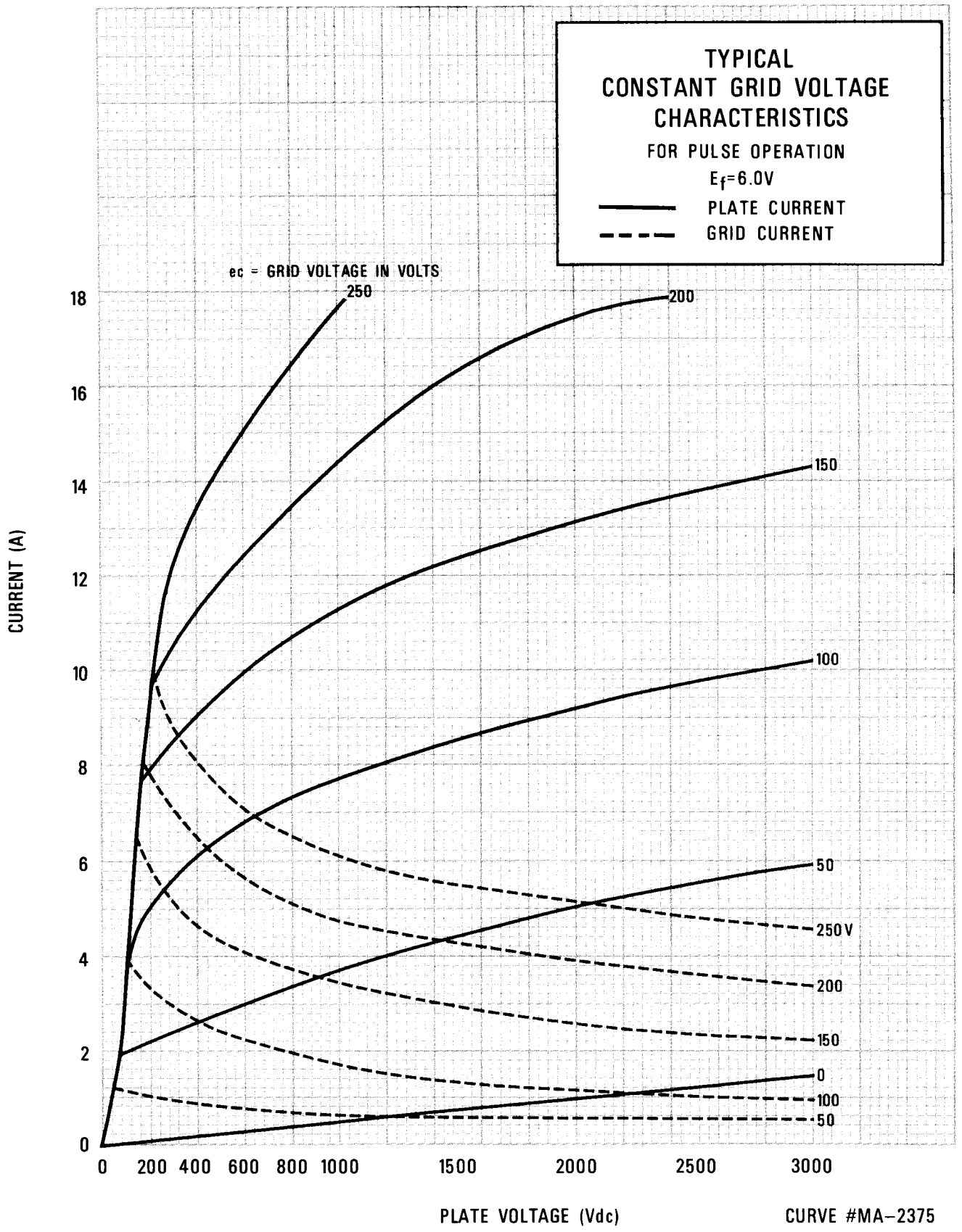
Contact Surface	TIR Max.	Reference
Anode	.020	Cathode
Grid	.020	Cathode
Heater	.012	Cathode

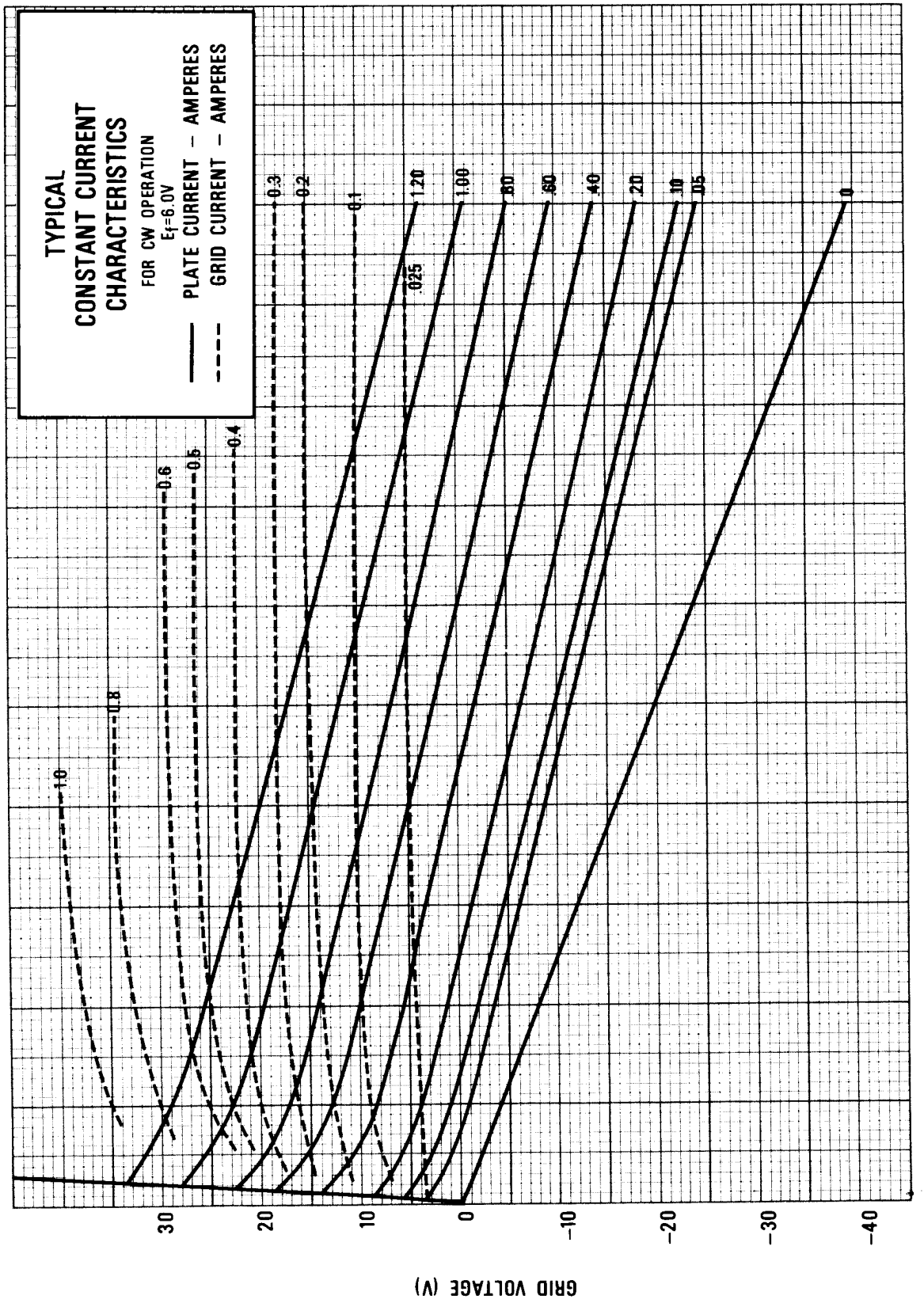
d. Dias. N,R,T,U shall apply throughout entire contact area as defined by dims. AA,AB, AC,AD respectively.

e. This surface shall not be used for clamping or locating.

f. Electrode Contact Dims. are given for socket design purposes & are not intended for inspection purposes.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f =6.0V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
–20
–40
–60
–80
200
400
600
1000
1500
2000
2500
3000
PLATE VOLTAGE (Vdc)
6.0
18.0
4.0
16.0
14.0
2.0
12.0
10.0
1.0
8.0
6.0
0.5
4.0
2.0
1.0
0.5
0
CURVE #MA–2374


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
E_f=6.0V
PLATE CURRENT
GRID CURRENT
ec = GRID VOLTAGE IN VOLTS
250
200
150
100
50
250V
200
150
0
100
50
CURRENT (A)
0
2
4
6
8
10
12
14
16
18
0
200
400
600
800
1000
1500
2000
2500
3000
PLATE VOLTAGE (Vdc)
CURVE #MA-2375



CURVE #MA-2380

8909
4CX5000J

RADIAL-BEAM
POWER TETRODE

The EIMAC 8909/4CX5000J is a compact, high-power, ceramic/metal, forced-air cooled tetrode with a rated maximum plate dissipation of 6000 watts. It incorporates rugged internal construction features, including a mesh filament/cathode.

The 8909/4CX5000J is specifically designed for exceptionally low intermodulation distortion in radio-frequency linear amplifier service.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	7.5 ± 0.37 V
Current, at 7.5 volts	103 A
Amplification Factor (Average):	
Grid to Screen	4.5
Direct Interelectrode Capacitance (grounded filament)[2]	
Cin	120 pF
Cout	20.5 pF
Cgp	0.7 pF
Direct Interelectrode Capacitance (grounded grid)[2]	
Cin	56 pF
Cout	21.5 pF
Cpk	0.10 pF
Frequency of Maximum Rating:	
CW	100 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	9.125 in; 231.77 mm
Diameter	4.938 in; 125.43 mm
Net Weight	9.5 lb; 4.31 kg
Operating Position	Axis vertical, base up or down

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Maximum Operating Temperature:	
Ceramic/Metal Seals or Anode Core	250°C
Cooling	Forced Air
Base	Special concentric
Recommended Air System Socket	SK-300 or SK-300A
Recommended (Air) Chimney	SK-306

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN
Class AB_1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7500	VOLTS
DC SCREEN VOLTAGE	1500	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	6000	WATTS
SCREEN DISSIPATION	250	WATTS
GRID DISSIPATION	75	WATTS

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.
3. Useful power is that delivered to the load.
4. Referenced against one tone of a two equal-tone signal.

TYPICAL OPERATION (Frequencies to 100 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	4050	Vdc
Screen Voltage	800	Vdc
Grid Voltage [1]	-155	Vdc
Zero-Signal Plate Current	750	mAdc
Single-Tone Plate Current	1.65	Adc
Single-Tone Screen Current [2]	67	mAdc
Peak rf Grid Voltage [2]	140	v
Single-Tone Plate Dissipation	3300	W
Useful Power Output (PEP) [3]	3150	W
Load Impedance	1350	Ω
Intermod. Distortion Products [4]:		
3rd Order	-41	dB
5th Order	-44	dB

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in screen current. The screen current which results when the desired plate current is obtained is incidental and varies from tube to tube. This current variation causes no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Filament: Current at 7.5 volts	98	108	A
Interelectrode Capacitances [1] (grounded filament connection)			
Cin	113	127	pF
Cout	18	23	pF
Cgp	---	1.0	pF
Interelectrode Capacitances [1] (grounded grid connection)			
Cin	51	61	pF
Cout	19	24	pF
Cpk	---	0.16	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX5000J must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC SK-300A Air-System Socket is designed especially for the concentric base terminals of the 4CX5000J. The use of recommended air-flow rates through this socket

provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through an Air Chimney, the SK-306, into the anode cooling fins. The SK-300 socket may be used instead of the SK-300A, but its use will result in a slightly less efficient cooling system at high dissipation levels.

COOLING - The maximum temperature rating for the external surfaces of the 4CX5000J is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Sea level airflow requirements to maintain seal temperatures at 200°C in 50°C ambient air are tabulated below (for operation below 30 megacycles).

	SK-300A Socket		SK-300 Socket	
Plate Dissipation (Watts)	Air Flow (CFM)	Pressure Drop(Inches of water)	Air Flow (CFM)	Pressure Drop(Inches of water)
2000	75	0.4	75	0.4
3000	105	0.7	100	0.7
4000	145	1.1	135	1.2
5000	190	1.5	165	1.8
6000	230	2.0	200	2.5

Since the power dissipated by the filament represents about 770 watts and since grid-plus screen dissipation can, under some conditions, represent another 200 to 300 watts, allowance has been made in preparing this tabulation for an additional 1200 watts dissipation.

At higher altitudes, higher frequencies, or higher ambient temperatures the flow rate must be increased to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using maximum rated temperatures as the criteria for satisfactory cooling.

IMPACT AND VIBRATION - The 4CX5000J is designed to operate under shock and vibration conditions which might disable a less rugged tube. Production tubes are subjected to testing to insure ability to withstand 15 G impact at 11 milliseconds duration and 2 G vibratory acceleration over the range of 5 to 55 Hz.

ELECTRICAL

FILAMENT VOLTAGE - The rated filament voltage for the 4CX5000J is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than 5 percent from the rated value.

GRID DISSIPATION - The 4CX5000J control grid has a maximum dissipation rating of 75 watts. Precautions should be observed to avoid exceeding this rating. Grid dissipation is approximately the product of dc grid current and peak positive grid voltage. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible.

SCREEN DISSIPATION - The power dissipated by the screen of the 4CX5000J must not exceed 250 watts.

Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 250 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX5000J is 6000 watts. Plate dissipation may be permitted to rise above the maximum rating during brief periods, such as may occur during tuning.

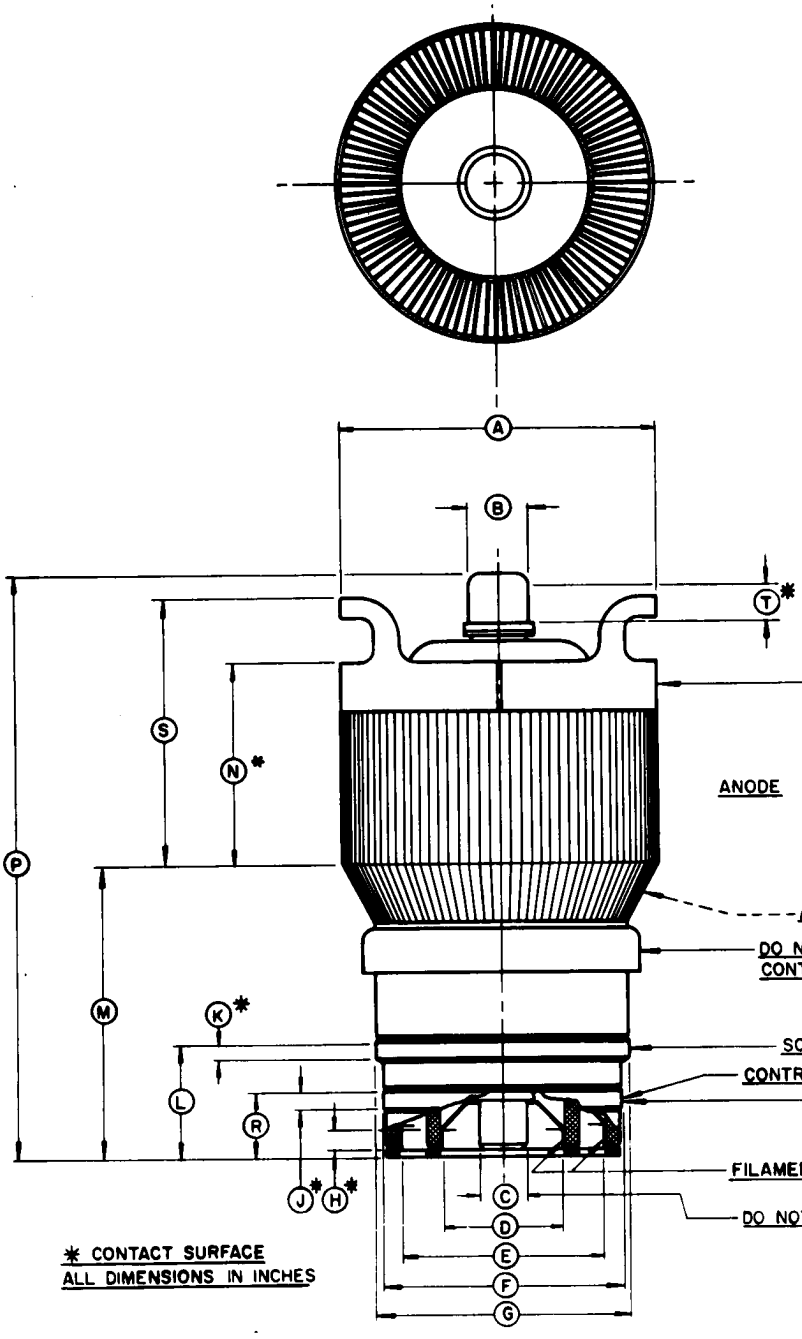
HIGH VOLTAGE - The 4CX5000J operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and

wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

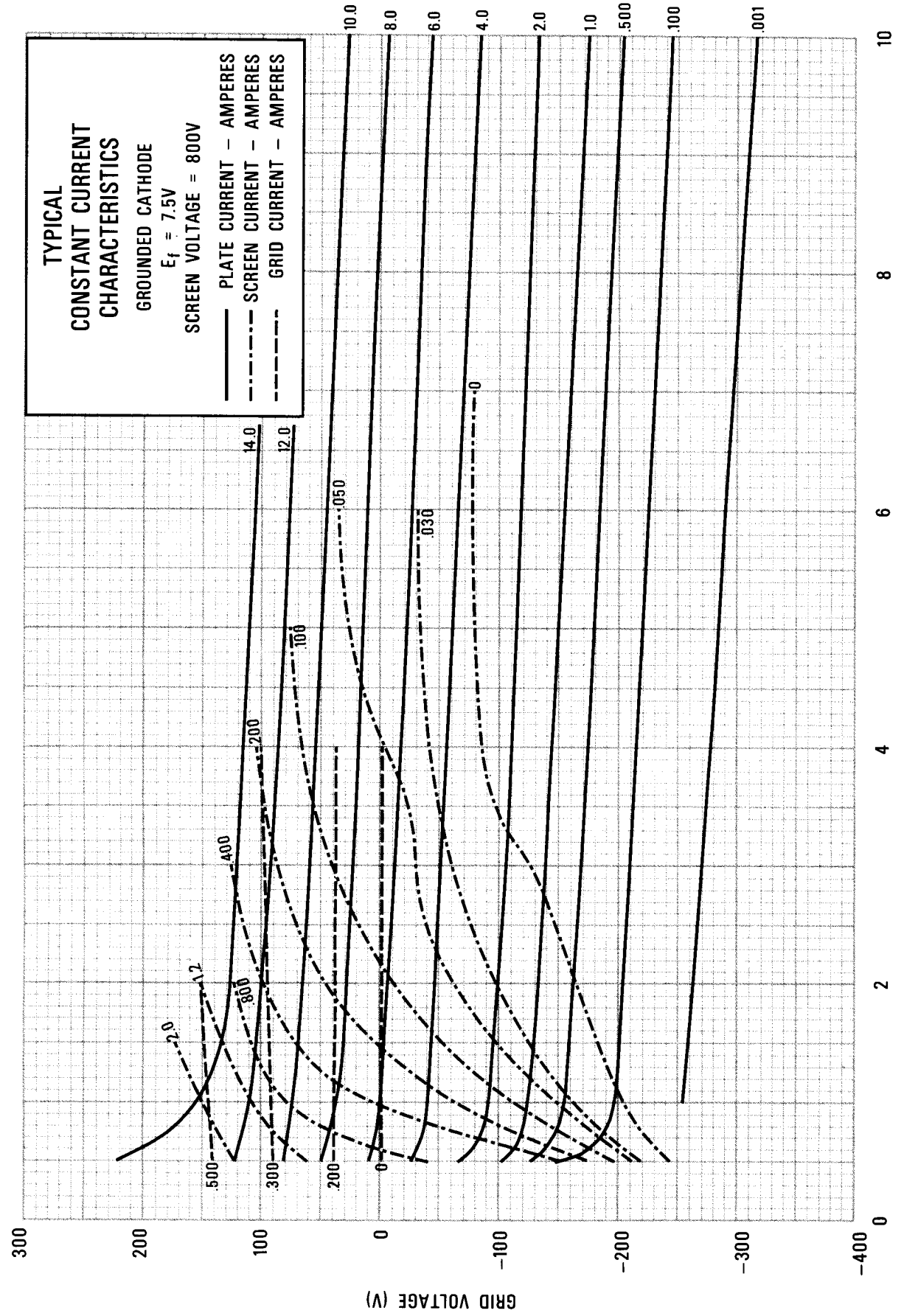
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.



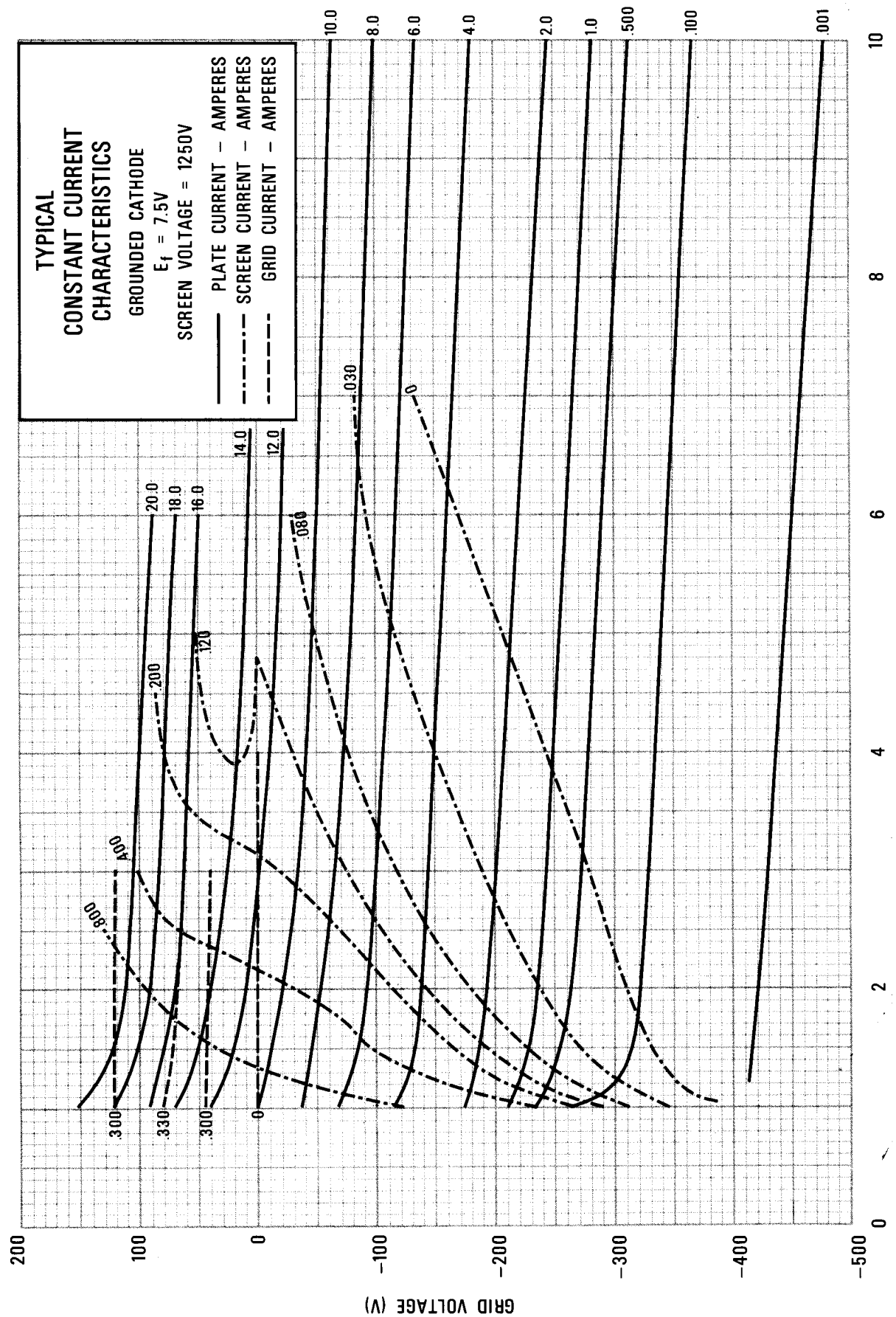
DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF	MIN.	MAX.	REF
A	4.812	4.938	--	122.22	125.43	--
B	0.855	0.895	--	21.72	22.73	--
C	0.720	0.760	--	18.29	19.30	--
D	1.896	1.936	--	48.16	49.17	--
E	3.133	3.173	--	79.58	80.59	--
F	3.792	3.832	--	96.32	97.33	--
G	3.980	4.020	--	101.09	102.11	--
H	0.188	--	--	4.78	--	--
J	0.188	--	--	4.78	--	--
K	0.188	--	--	4.78	--	--
L	1.764	1.826	--	44.81	46.38	--
M	4.188	4.563	--	106.38	115.90	--
N	2.875	3.250	--	73.03	82.55	--
P	8.625	9.125	--	219.08	231.78	--
R	0.986	1.050	--	25.04	26.67	--
S	3.875	4.250	--	98.43	107.95	--
T	0.375	--	--	9.53	--	--
U						
V						
W						
X						
Y						
Z						

NOTES:
1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 7.5V
SCREEN VOLTAGE = 800V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
10.0
8.0
6.0
4.0
2.0
1.0
.500
.100
.001
14.0
12.0
.050
.030
0
.200
.100
.400
.12
.80
2.0
.500
.300
.200
0
300
200
100
0
−100
−200
−300
−400
0
2
4
6
8
10
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)

CURVE #4337


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 7.5V
SCREEN VOLTAGE = 1250V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
10.0
8.0
6.0
4.0
2.0
1.0
.500
.100
.001
.030
0
.080
.120
.200
.400
.800
20.0
18.0
16.0
14.0
12.0
.300
.330
.300
0
200
100
0
−100
−200
−300
−400
−500
0
2
4
6
8
10
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)

CURVE #4339

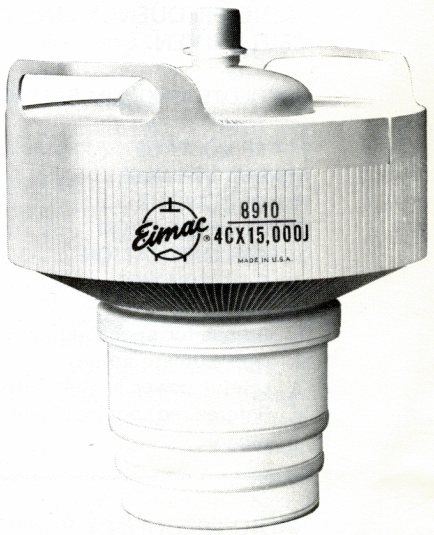
8910
4CX15,000J

RADIAL BEAM
POWER TETRODE

TECHNICAL DATA

The EIMAC 8910/4CX15,000J is a ceramic/metal, forced-air cooled power tetrode intended for use in audio or radio frequency applications. The internal structure features a mesh filament and a mechanical design which assures good strength and high rf operating efficiency.

Full ratings on the 8910/4CX15,000J apply to 110 MHz, and it is especially recommended for radio frequency linear amplifier service.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament; Thoriated Tungsten Mesh		
Voltage	7.5 ± 0.3	V
Current, at 7.5 volts	160	A
Amplification Factor, average		
Grid to Screen	4.5	
Direct Interelectrode Capacitances (cathode grounded);[2]		
Cin	160.0	pF
Cout	26.5	pF
Cgp	1.5	pF
Direct Interelectrode Capacitances (grid and screen grounded):[2]		
Cin	67.0	pF
Cout	27.5	pF
Cpk	0.2	pF
Maximum Frequency Ratings		
CW	110	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	9.375 in; 238.13 mm
Diameter	7.580 in; 192.53 mm
Net Weight	12.8 lb; 5.81 kg
Operating Position	Axis vertical, base up or down
Cooling	Forced air
Operating Temperature, maximum	
Ceramic/Metal Seals and Anode Core	250°C

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Base	Special, concentric
Recommended Air System Socket	SK-300A
Recommended Air Chimney	SK-316

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN, Class AB

ABSOLUTE MAXIMUM RATINGS

PLATE VOLTAGE	10.0	kVdc
SCREEN VOLTAGE	2.0	kVdc
PLATE CURRENT	6.0	Adc
PLATE DISSIPATION	15.0	kW
SCREEN DISSIPATION	450	W
GRID DISSIPATION	200	W

1. Adjust for specified zero-signal plate current.
2. Approximate value.
3. Useful power is that delivered to the load.
4. Referenced against one tone of a two equal-tone signal.

TYPICAL OPERATION
Peak Envelope or Modulation Crest Conditions
Class AB1

Plate Voltage	7500	Vdc
Screen Voltage	1250	Vdc
Grid Voltage [1]	-250	Vdc
Zero-Signal Plate Current	1.25	Adc
Single-Tone Plate Current	2.90	Adc
Single-Tone Screen Current[2]	200	mAdc
Peak rf Grid Voltage[2]	200	v
Plate Dissipation	8300	W
Single-Tone Useful Power Out[3]	12	kW
Resonant Load Impedance	1450	Ω
Intermod. Distortion Products [4]		
3rd Order	-41	dB
5th Order	-41	dB

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM Telephony
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

PLATE VOLTAGE	10.0	kVdc
SCREEN VOLTAGE	2.0	kVdc
PLATE CURRENT	5.0	Adc
PLATE DISSIPATION	15.0	kW
SCREEN DISSIPATION	450	W
GRID DISSIPATION	200	W

TYPICAL OPERATION

Plate Voltage	7,500	10,000	Vdc
Screen Voltage	750	750	Vdc
Grid Voltage	-510	-550	Vdc
Plate Current	4.65	4.55	Adc
Screen Current [1]	0.59	0.54	Adc
Grid Current [1]	0.30	0.27	Adc
Peak rf Grid Voltage [1]	730	790	v
Calculated Driving Power	220	220	W
Plate Dissipation	8.1	9.0	kW
Plate Output Power	26.7	36.5	kW

1. Approximate value

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER
GRID DRIVEN, Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

PLATE VOLTAGE	8.0	kVdc
SCREEN VOLTAGE	1.5	kVdc
PLATE CURRENT	4.0	Adc
PLATE DISSIPATION	10.0	kW
SCREEN DISSIPATION	450	W
GRID DISSIPATION	200	W

TYPICAL OPERATION

Plate Voltage	6,000	8,000	Vdc
Screen Voltage	750	750	Vdc
Grid Voltage	-600	-640	Vdc
Plate Current	3.75	3.65	Adc
Screen Current [1]	0.45	0.43	Adc
Grid Current [1]	0.18	0.18	Adc
Peak af Screen Voltage [1]			
100% modulation	740	710	v
Peak rf Grid Voltage [1]	800	840	v
Calculated Driving Power	150	150	W
Plate Dissipation	5.1	5.8	kW
Plate Output Power	17.4	23.5	kW

1. Approximate value

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR
GRID DRIVEN, Class AB_1 (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

PLATE VOLTAGE	10.0	kVdc
SCREEN VOLTAGE	2.0	kVdc
PLATE CURRENT	6.0	Adc
PLATE DISSIPATION	15.0	kW
SCREEN DISSIPATION	450	W
GRID DISSIPATION	200	W

TYPICAL OPERATION (Two Tubes)

Plate Voltage	7,500	10,000	Vdc
Screen Voltage	1,500	1,500	Vdc
Grid Voltage [1]	-350	-370	Vdc
Zero-Signal Plate Current	1.00	1.00	Adc
Maximum Signal Plate Current	8.80	8.50	Adc
Maximum Signal Screen Current [2]	0.34	0.30	Adc
Peak af Grid Voltage [2]	330	340	v
Maximum Signal Plate Dissipation	12.2	14.0	kW
Plate Output Power	41.6	57.0	kW
Load Resistance (plate to plate)	1.730	2.520	Ω

1. Adjust for specified zero-signal plate current.
2. Approximate value.

TYPICAL OPERATION values are obtained by calculations from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to produce the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Heater Current, at 7.5 volts	148	168	A
Interelectrode Capacitances, cathode grounded [1]			
Cin	154.0	167.0	pF
Cout	24.0	29.0	pF
Cgp	----	2.0	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX15,000J must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

SOCKET - The EIMAC Air-System Socket Type SK-300A is designed especially for the concentric base terminals of the 4CX15,000J. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through the SK-316 Air Chimney, into the anode cooling fins.

COOLING - The maximum temperature rating for the external surfaces of the 4CX15,000J is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Air-flow requirements to maintain seal temperatures at 225°C in 50°C ambient air are tabulated below (for operation below 30 megahertz). This data is for the tube mounted in an SK-300A socket with an SK-316 chimney.

SEA LEVEL			10,000 FEET	
Plate Dissipation * (Watts)	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
7,500	230	.7	336	1.0
12,500	490	2.7	710	4.1
15,000	645	4.6	945	7.0

* Since the power dissipated by the filament represents about 1000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 600 watts, allowance has been made in preparing this tabulation for an additional 1600 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

IMPACT AND VIBRATION - The 4CX15,000J is designed to operate under shock and vibration conditions which might disable a less rugged tube. Production tubes are subjected to testing to insure ability to withstand 15 G impact at 11 milliseconds duration and 2 G vibratory acceleration over the range of 5 to 55 Hz.

ELECTRICAL

FILAMENT OPERATION - The rated filament voltage for the 4CX15,000J is 7.5 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than plus or minus five percent from the rated value.

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings for the 4CX15,000J must be respected to avoid damage to the tube. An exception is the plate dissipation which may be permitted to rise above the rated maximum during brief periods, such as may occur during tuning.

GRID OPERATION - The 4CX15,000J control grid has a maximum dissipation rating of 200 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible. The maximum grid circuit resistance should not exceed 100,000 ohms per tube.

SCREEN OPERATION - The power dissipated by the screen of the 4CX15,000J must not exceed 450 watts.

Screen dissipation, in cases where there is no AC applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 450 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CX15,000J is 15,000 watts.

When the 4CX15,000J is operated as a plate-modulated rf power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 10,000 watt maximum plate dissipation rating will be exceeded.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing win-

dows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as this, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry---the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

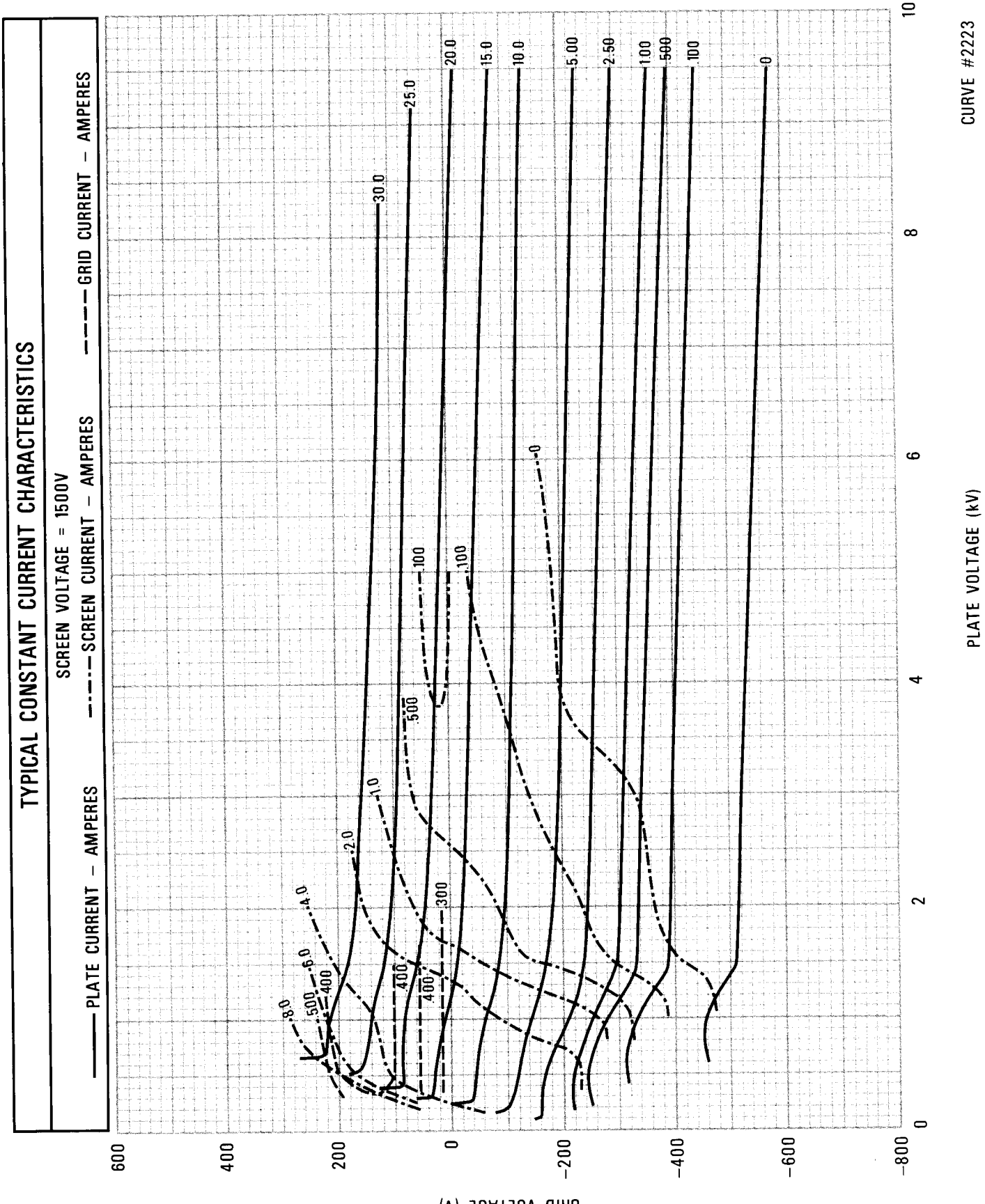
INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground".

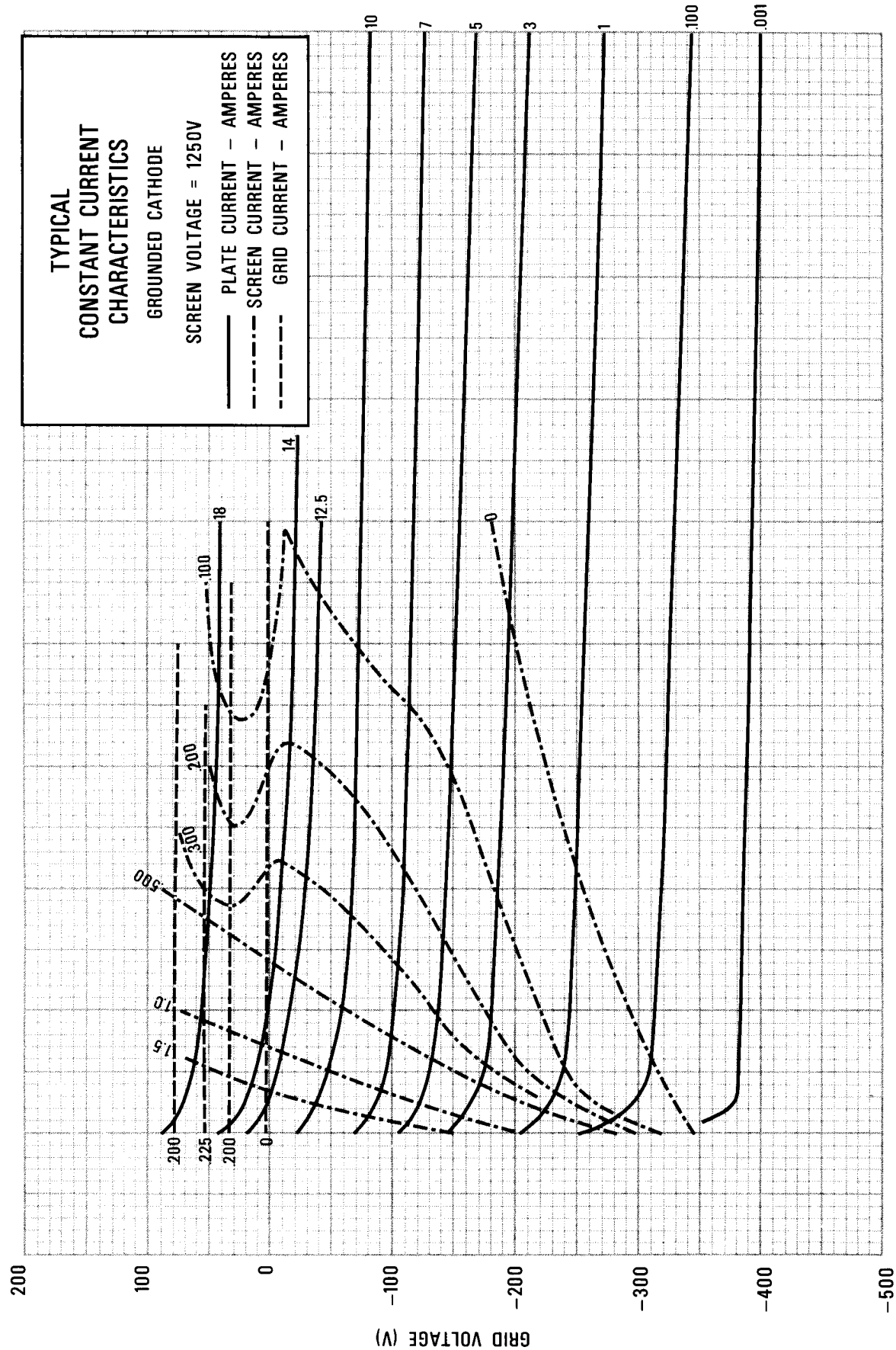
The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to the Application Engineering Dept., Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California, 94070 for information and recommendations.

E_{c2} = 1500V

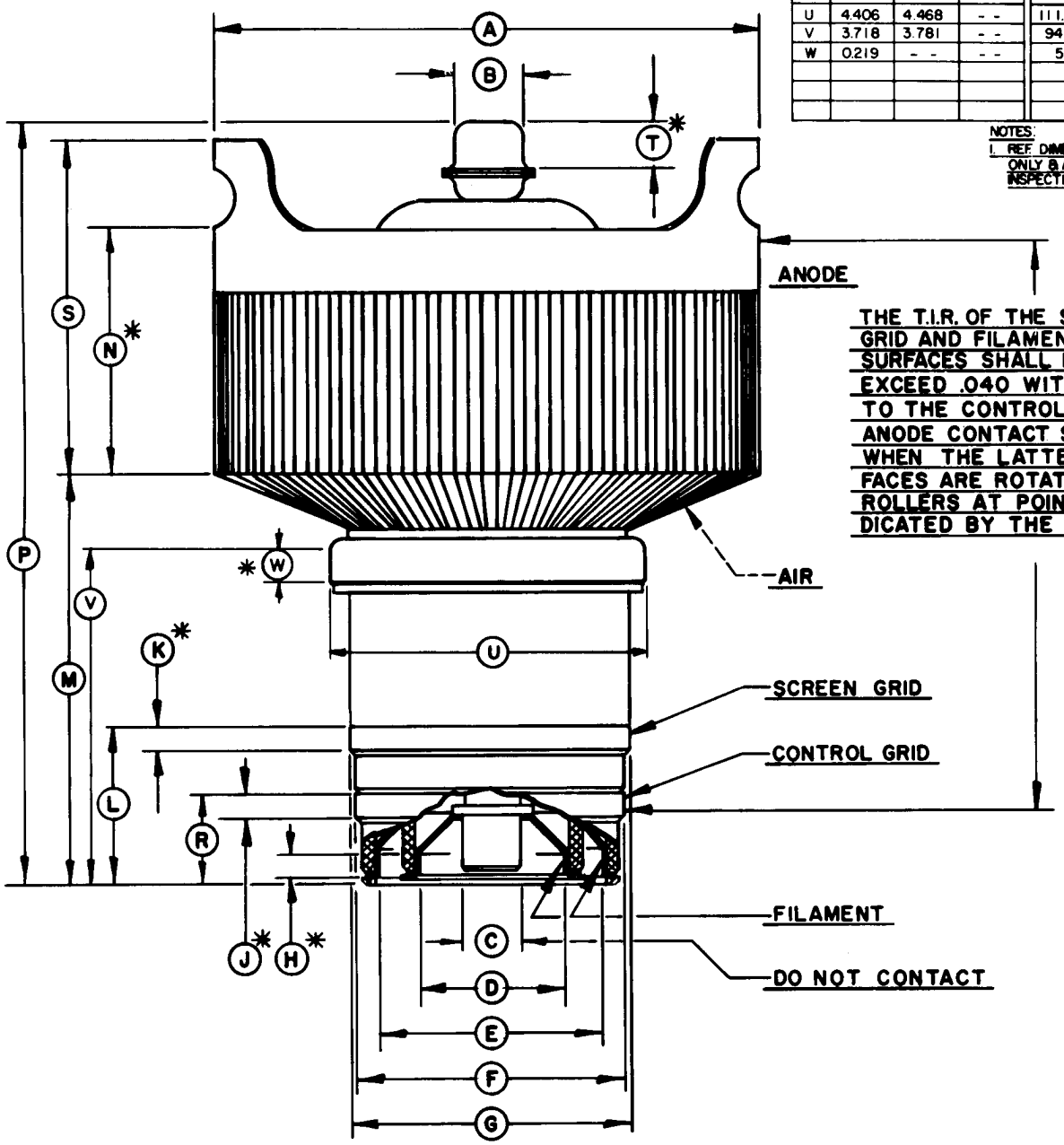

TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 1500V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #2223
600
400
200
0
-200
-400
-600
-800
0
2
4
6
8
10
30.0
25.0
20.0
15.0
10.0
5.00
2.50
1.00
.500
.100
0
8.0
6.0
4.0
2.0
1.0
.500
.400
.300
.100
0


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 1250V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #3910

DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	7.460	7.580	- -	189.48	192.53	- -
B	0.855	0.895	- -	21.72	22.73	- -
C	0.720	0.760	- -	18.29	19.30	- -
D	1.896	1.936	- -	46.63	49.17	- -
E	3.133	3.173	- -	79.58	80.59	- -
F	3.792	3.832	- -	96.32	97.33	- -
G	3.980	4.020	- -	101.09	102.11	- -
H	0.188	- -	- -	4.78	- -	- -
J	0.188	- -	- -	4.78	- -	- -
K	0.188	- -	- -	4.78	- -	- -
L	1.764	1.826	- -	44.81	46.38	- -
M	4.659	4.783	- -	118.34	121.49	- -
N	2.412	2.788	- -	61.26	70.82	- -
P	9.000	9.375	- -	228.60	238.13	- -
R	0.986	1.050	- -	25.04	26.67	- -
S	3.560	3.684	- -	90.42	93.57	- -
T	0.375	- -	- -	9.53	- -	- -
U	4.406	4.468	- -	111.91	113.49	- -
V	3.718	3.781	- -	94.44	96.04	- -
W	0.219	- -	- -	5.56	- -	- -

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



* CONTACT SURFACE

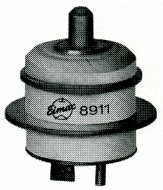
PRELIMINARY DATA

8911

PLANAR TRIODE

TECHNICAL DATA

The 8911 (formerly X2153) is a compact, rugged ceramic/metal planar triode intended for CW plate- or grid-pulsed oscillator, amplifier, or frequency multiplier use. It features high power output, high plate dissipation and excellent frequency stability under severe environmental conditions. The construction of the 8911 readily lends itself to cavity circuit operation resulting in an extremely compact rf source. The 8911 is capable of providing in excess of 1 kw peak power at 6 GHz.



Actual Size

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 ± 5%	V
Current, at 6.3 volts	0.65	A
Cathode Heating Time	60	sec.
Transconductance (Average)	30	mmhos
Amplification Factor (Average)	60	
Direct Interelectrode Capacitance, without heater voltage		
Grid-Cathode	5.00	pF
Grid-Plate	1.50	pF
Plate-Cathode (maximum)	0.06	pF
Plate Dissipation (maximum)[2]	50	W
Grid Dissipation (maximum)	1.5	W

1. The data presents the nominal design objectives for this product and the characteristics and specifications of this type are subject to change. The device is now under development and is made available for experimental purposes only. For the most recent information concerning the status of this development, please contact your nearest Varian Electron Tube and Device Field Office or the Product Manager, Eimac Division of Varian, Salt Lake City, Utah.

2. With forced air cooling or appropriate conduction and/or convection cooling.

MECHANICAL

Maximum Overall Dimensions:	
Length	0.943 in; 23.95 mm
Diameter	0.758 in; 19.25 mm
Net Weight	0.25 oz; 7.0 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Cooling	Conduction and Forced Air

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RF OSCILLATOR
Class C, Pulsed

ABSOLUTE MAXIMUM RATINGS:

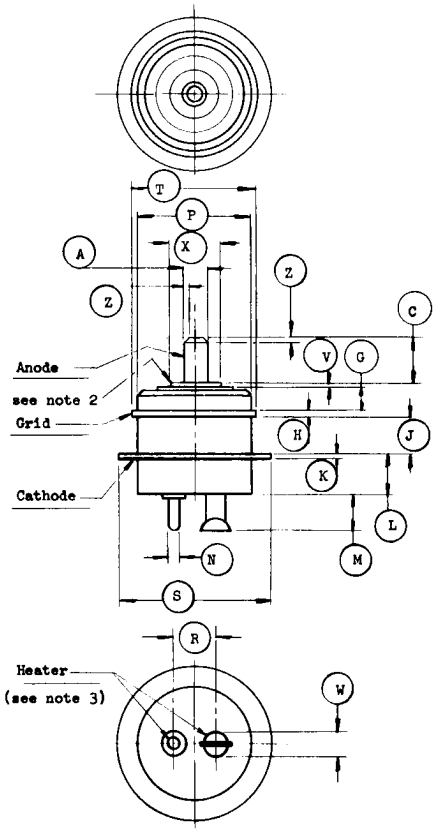
DC PLATE VOLTAGE	2.0	kVdc
PEAK PLATE VOLTAGE	3.0	kv
DC PLATE CURRENT	100	mAdc
DC GRID CURRENT	30	mAdc
PEAK PLATE CURRENT	3.0	a
PEAK GRID CURRENT	1.2	a
DC GRID VOLTAGE	-100	Vdc
PULSE DURATION[1]	3.0	μs
DUTY FACTOR[1]	.0025	
PEAK HEATER-CATHODE VOLTAGE[2]	±50	v
FREQUENCY	6.0	GHz

1. For applications requiring longer pulse duration and/or higher duty factor, please consult the Product Manager, EIMAC-Division of Varian, Salt Lake City, Utah.
2. The heater is electrically isolated from the cathode.

APPLICATION

The cathode and grid flanges should not be altered in any way such as by machining or filing, since final seal could be damaged. Maximum torque applied to flanges during installation should not exceed 15 inch pounds.
For optimum rf performance, the anode line should make good rf contact on the anode area indicated in the outline drawing.

Soldered connections may be made to the anode stud, grid or cathode flanges, and heater contacts where adequate heat sinking and good soldering practices are followed to minimize the heat-applied to the tube and the thermal gradient across the metal to ceramic brazed areas.
For operating information refer to EIMAC bulletin #15, "Operating Instructions for Planar Triodes".



DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	0.122	0.128	--	3.10	3.25	--
B	0.200	0.210	--	5.08	5.33	--
C	0.120	0.130	--	3.05	3.30	--
H	0.025	0.031	--	0.64	0.79	--
J	0.167	0.177	--	4.24	4.50	--
K	0.025	0.031	--	0.64	0.79	--
L	0.170	0.185	--	4.32	4.70	--
M	0.170	0.190	--	4.32	4.83	--
N	0.047	0.053	--	1.19	1.35	--
P	0.535	0.565	--	13.59	14.35	--
R	0.185	0.215	--	4.70	5.46	--
S	0.748	0.758	--	19.00	19.30	--
T	0.598	0.608	--	15.19	15.44	--
V	--	0.020	--	--	0.51	--
W	--	--	0.100	--	--	2.54
X	0.250	0.260	--	6.35	6.60	--
Z	--	--	0.030	--	--	0.76

DIMENSIONAL DATA

Notes:
1. Ref. dims. are for info. only & are not required for insp. purposes.
2. For optimum rf performance the Anode Line should contact the Anode Cup at this point.
3. Heater is electrically isolated from Cathode.

PRELIMINARY DATA

8912

PLANAR TRIODE

TECHNICAL DATA

The 8912 (formerly X2154) is a compact, rugged ceramic/metal planar triode intended for CW plate- or grid-pulsed oscillator, amplifier, or frequency multiplier use. It features high power output, high plate dissipation and excellent frequency stability under severe environmental conditions. The construction of the 8912 readily lends itself to cavity circuit operation resulting in an extremely compact rf source. The 8912 is capable of providing in excess of 1 kw peak power at 6 GHz.



Actual Size

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 ± 5%	V
Current, at 6.3 volts	0.65	A
Cathode Heating Time	60	sec.
Transconductance (Average)	30	mmhos
Amplification Factor (Average)	85	
Direct Interelectrode Capacitance, without heater voltage		
Grid-Cathode	5.00	pF
Grid-Plate	1.50	pF
Plate-Cathode (maximum)	0.06	pF
Plate Dissipation (maximum)[2]	50	W
Grid Dissipation (maximum)	1.5	W

1. The data presents the nominal design objectives for this product and the characteristics and specifications of this type are subject to change. The device is now under development and is made available for experimental purposes only. For the most recent information concerning the status of this development, please contact your nearest Varian Electron Tube and Device Field Office or the Product Manager, Eimac Division of Varian, Salt Lake City, Utah.

2. With forced air cooling or appropriate conduction and/or convection cooling.

MECHANICAL

Maximum Overall Dimensions:	
Length	1.013 in; 25.73 mm
Diameter	0.608 in; 15.44 mm
Net Weight	0.25 oz; 7.0 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Cooling	Conduction and Forced Air

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RF OSCILLATOR
Class C, Pulsed

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	2.0 kVdc
PEAK PLATE VOLTAGE	2.5 kv
DC PLATE CURRENT	100 mAdc
DC GRID CURRENT	30 mAdc
PEAK PLATE CURRENT	3.0 a at .0025 DUTY
	1.5 a at .01 DUTY
PEAK GRID CURRENT	1.2 a at .0025 DUTY
	0.7 a at .01 DUTY
DC GRID VOLTAGE	-100 Vdc
PULSE DURATION[1]	3.0 μs
DUTY FACTOR[1]	.01
PEAK HEATER-CATHODE VOLTAGE[2]	±50 v
FREQUENCY	6.0 GHz

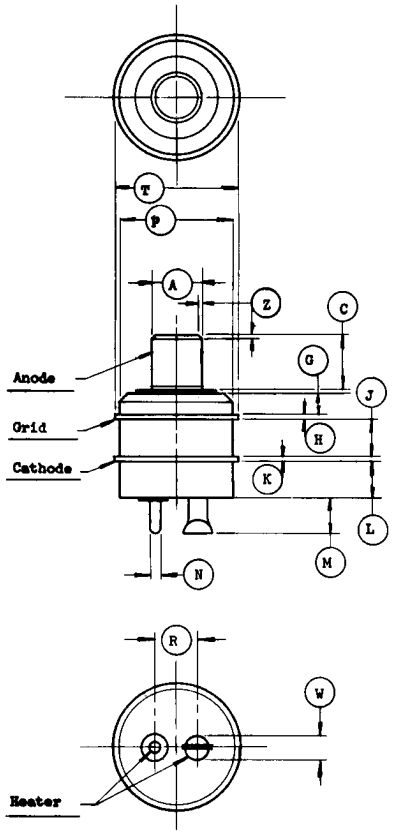
1. For applications requiring longer pulse duration and/or higher duty factor, please consult the Product Manager, EIMAC-Division of Varian, Salt Lake City, Utah.

2. The heater is electrically isolated from the cathode.

APPLICATION

The cathode and grid flanges should not be altered in any way such as by machining or filing, since final seal could be damaged. Maximum torque applied to flanges during installation should not exceed 15 inch pounds.
For optimum rf performance, the anode line should make good rf contact on the anode area indicated in the outline drawing.

Soldered connections may be made to the anode stud, grid or cathode flanges, and heater contacts where adequate heat sinking and good soldering practices are followed to minimize the heat applied to the tube and the thermal gradient across the metal to ceramic brazed areas. For operating information refer to EIMAC bulletin #15, "Operating Instructions for Planar Triodes".



DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	0.245	0.260	--	6.22	6.60	--
C	0.240	0.255	--	6.10	6.48	--
G	0.120	0.155	--	3.05	3.93	--
H	0.025	0.031	--	0.64	0.79	--
J	0.167	0.177	--	4.24	4.50	--
K	0.025	0.031	--	0.64	0.79	--
L	0.170	0.185	--	4.32	4.70	--
M	0.170	0.190	--	4.32	4.83	--
N	0.047	0.053	--	1.19	1.35	--
P	0.535	0.565	--	13.59	14.35	--
R	0.185	0.215	--	4.70	5.46	--
T	0.598	0.608	--	15.19	15.44	--
W	--	--	0.100	--	--	2.54

DIMENSIONAL DATA

Note;
1. Ref. Dims. are for info. only and are not req'd. for inspection purposes.

8930

TECHNICAL DATA

RADIAL BEAM
POWER TETRODE

The EIMAC 8930 is a compact, high-perveance tetrode with a maximum plate dissipation of 350 watts. It is electrically identical to the EIMAC 7589W/4CX250R but the larger anode radiator assembly allows higher dissipation with low air flow and pressure drop characteristics.

The tube has rugged internal construction features for reliable operation under heavy shock or vibration conditions.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide-coated, Unipotential	
Voltage	6.0 ± 0.3 V
Current, at 6.0 volts	2.6 A
Frequency of Maximum Rating	500 MHz
Amplification Factor (Average):	
Grid to Screen	5
Direct Interelectrode Capacitances (grounded cathode)[2]	
Cin	17.5 pF
Cout	4.9 pF
Cgp	0.04 pF

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special 9-pin, JEDEC B8-236
Recommended Air-System Socket	EIMAC SK-600 Series
Recommended Air-System Chimney	EIMAC SK-646
Maximum Overall Dimensions:	
Length	2.46 in; 62.59 mm
Diameter	2.08 in; 52.83 mm
Operating Position	Any
Cooling	Forced Air
Net Weight (Approximate)	5.5 oz; 156 gm
Maximum Operating Temperature:	
Anode Core & Ceramic/Metal Seals	250°C

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RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN Class AB (SSB)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	2400	VOLTS
DC SCREEN VOLTAGE	500	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	350	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Approximate; adjust for specified zero-signal plate current.
2. Approximate; should be held above Absolute Maximum rating of 250 mAdc only for brief periods of tuning.
3. Approximate; rated screen dissipation should not be exceeded.
4. Approximate value.
5. The Intermodulation Distortion Products are referenced against one tone of a two equal tone signal.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	2000	Vdc
Screen Voltage	350	Vdc
Grid Voltage [1]	-63	Vdc
Zero-Signal Plate Current	90	mAdc
One-Tone Plate Current [2]	290	mAdc
Two-Tone Plate Current [4]	205	mAdc
One-Tone Screen Current [3]	30	mAdc
Two-Tone Screen Current [4]	7	mAdc
One-Tone Useful Output Power	350	W
Resonant Load Impedance	4000	Ω
Intermodulation Distortion Products [5]		
3rd Order	-27	dB
5th Order	-30	dB

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN, CARRIER CONDITIONS Class AB

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	2400	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	350	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Approximate; adjust for specified value of zero-signal plate current.
2. Approximate value.

TYPICAL OPERATION (Measured data at 400 MHz)
Class AB_1, Grid Driven

Plate Voltage	2000	Vdc
Screen Voltage	400	Vdc
Grid Voltage [1]	-85	Vdc
Zero-Signal Plate Current	70	mAdc
Plate Current, 65 W Carrier [2]	170	mAdc
Plate Current, 65 W Carrier [2] Modulated 90%	200	mAdc
Screen Current, 65 W Carrier	-10	mAdc
Peak Screen Current, 65 W Carrier Modulated 90% [2]	30	mAdc
Driving Power, 65 W Carrier	4	W

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	2400	VOLTS
DC SCREEN VOLTAGE	500	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	350	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Approximate; adjust for specified value of zero-signal plate current.
2. Approximate value.

TYPICAL OPERATION (Two Tubes)
Class AB_1

Plate Voltage	2000	Vdc
Screen Voltage	350	Vdc
Grid Voltage [1]	-66	Vdc
Zero Signal Plate Current	140	mAdc
Max. Signal Plate Current	500	mAdc
Zero Signal Screen Current [2]	-4	mAdc
Max. Signal Screen Current [2]	+4	mAdc
Peak Driving Power	0	W
Load Resistance (plate-to-plate)	8000	Ω
Power Output (Trans. Eff. = 95%) [2]	595	W

ABSOLUTE MAXIMUM RATINGS FOR OTHER TYPES OF OPERATION

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy or FM

DC PLATE VOLTAGE	2400	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	350	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER, GRID DRIVEN Class C Telephony (Carrier Conditions)

DC PLATE VOLTAGE	1800	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC PLATE CURRENT	0.20	AMPERE
PLATE DISSIPATION	280	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

NOTE: TYPICAL OPERATION data is obtained from direct measurement. Adjustment of the rf grid voltage to obtain the specified bias, screen, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in screen current, which is incidental and which will vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct screen grid voltage in the presence of the variations in current.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Heater: Current at 6.0 volts	2.3	2.9	A
Interelectrode Capacitances[1](grounded cathode):			
Cin	16.0	18.5	pF
Cout	4.2	5.2	pF
Cgp	---	0.06	pF

1. In a shielded fixture (see INTERELECTRODE CAPACITANCE)

APPLICATION

MECHANICAL

MOUNTING - The 8930 may be operated in any position. An EIMAC Air-System Socket, SK-600 series, or a socket having equivalent characteristics, is required. Sockets are available with or without built-in screen bypass capacitors and may be obtained with either grounded or ungrounded cathode terminals. The SK-646 Air Chimney is also available.

When environmental stress (such as shock and/or vibration) is anticipated, special attention should be given to securing the tube, to prevent relative motion between the tube and socket during stress, as such motion could effect both the electrical and mechanical performance.

COOLING - Sufficient cooling must be provided for the anode, base seals, and body seals to maintain operating temperatures below the rated maximum value. Air requirements to maintain seal temperatures at 225°C in 50°C ambient air are shown. These values apply when the EIMAC SK-600 or SK-610 socket is used with the SK-646 chimney, with air flowing in the base-to-anode direction.

Minimum Cooling Air Flow Requirements				
Plate Dissipation (watts)	Sea Level		10,000 Feet	
	Air Flow (cfm)	Approx. Press.drop, In. H_2O	Air Flow (cfm)	Approx. Press.drop, In. H_2O
250	4.5	0.35	6.5	0.51
300	5.8	0.56	8.5	0.82
350	7.0	0.85	10.2	1.24

Experience has shown that if reliable long-life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt, which may interfere with effective cooling.

The blower selected in any given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown, plus any drop encountered in ducts and filters, and the blower must be designed to deliver the air at the desired altitude.

It should be borne in mind that operating temperature is the sole criterion of cooling effectiveness. One method of measuring the surface temperature is by the use of a temperature-sensitive lacquer or paint. When these materials are used, thin applications must be used to avoid interference with the transfer of heat from the tube to the air stream, which would cause inaccurate indications.

SHOCK AND VIBRATION - The 8930 is recommended for applications where environmental stress is anticipated and reliable operation must be maintained under these circumstances. The tube structure is routinely tested at a vibration level of 10 G, over the frequency range of 28 to 2000 Hz, with full operating voltages applied, and also tested under 90 G long-duration (11 milliseconds) shock conditions, also with voltages

applied. When shock or vibration stressing is expected, it is extremely important that relative motion between socket and tube be prevented or restricted by clamping the tube into place.

ELECTRICAL

HEATER - The heater voltage for the 8930 is 6.0 volts and should be maintained within ±5% of rated value to minimize variations in performance and maximum life.

Above approximately 300 MHz some transit-time heating of the cathode will occur, and heater voltage should be lowered. For operation in the 300 to 400 MHz range, heater voltage should be 5.75 volts; in the 400 to 500 MHz range, 5.5 volts. Under no circumstances should heater voltage be allowed lower than 5.4 volts.

CATHODE OPERATION - The cathode is internally connected to the four even-numbered base pins, and all four corresponding socket terminals should be used to make connection to the external circuits. At radio frequencies it is important to keep cathode leads short and direct and to use conductors with large areas to minimize inductive reactance in series with the cathode leads.

It is recommended that rated heater voltage be applied for a minimum of 30 seconds before other operating voltages are applied. Where the circuit design requires the cathode and heater to be operated at different potentials, the rated maximum heater-to-cathode voltage is 150 volts, regardless of polarity.

STANDBY OPERATION - When equipment is designed for very low-duty operation, where standby periods of many hours or even days at one time are anticipated, it is good engineering practice to include circuitry for reduction of the heater voltage of an oxide-cathode tube during the standby periods. This will greatly minimize the release of sublimation products within the tube. A reduction in heater voltage of 10% from the nominal value is recommended during such long standby periods, with simultaneous switching to normal voltage when the equipment is switched from STANDBY to OPERATE. A reduction in heater voltage of more than 10% is possible if operation is not attempted for several seconds after switching from the STANDBY to the OPERATE mode.

CONTROL GRID - The grid is rated for a maximum dissipation of 2 watts. The maximum dc bias voltage rating is -250 volts.

SCREEN-GRID OPERATION - The maximum rated power dissipation for the screen grid of the 8930 is 12 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero or negative. In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

If tuning of a linear amplifier circuit is to be done under single-tone conditions, extra care should be exercised to be sure the screen dissipation rating is not exceeded, as this is often the limiting factor during this type of operation.

Protection for the screen can be provided by an over-current relay and by interlocking the screen supply so the plate voltage must be applied before screen voltage can be applied.

The screen current may reverse under certain conditions and produce negative current indications on the screen milliameter. This is a normal characteristic of most tetrodes. The screen power supply should be designed with this characteristic in mind, so that the correct operating voltage will be maintained on the screen under all conditions. A current path from the screen to cathode must be provided by a bleeder resistor or shunt regulator connected between screen and cathode and arranged to pass approximately 15 milliamperes per connected screen. A series regulator circuit can be used only when an adequate bleeder resistor is provided.

PLATE OPERATION - The maximum rated plate-dissipation power for the 8930 is 350 watts. The maximum dissipation rating may be exceeded for brief periods during circuit adjustment without damage to the tube.

At frequencies up to approximately 30 Megahertz the top cap on the anode cooler may be used for a plate terminal. At higher frequencies a circular clamp or spring-finger collet encircling the outer surface of the anode cooler should be used.

MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide for individual metering and individual adjustment of the bias or screen voltage to equalize inputs. Where overload protection is provided, it should be capable of protecting the surviving tube(s) in the event one tube should fail.

UHF OPERATION - The 8930 is useful in the UHF region. Operation at these frequencies should be conducted with heavy plate loading and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

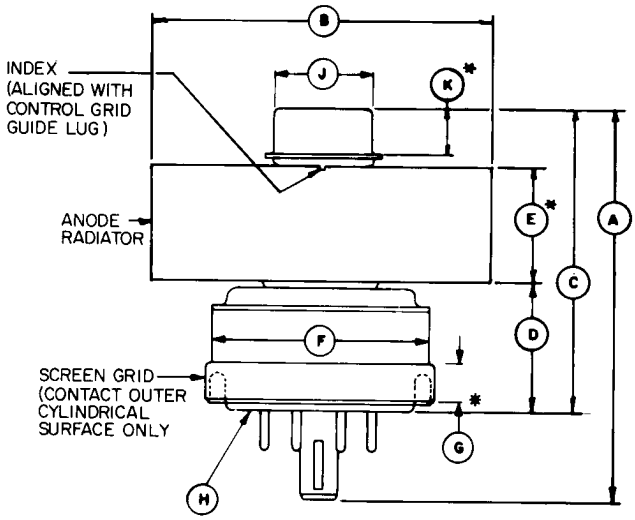
INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

HIGH VOLTAGE - The 8930 operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

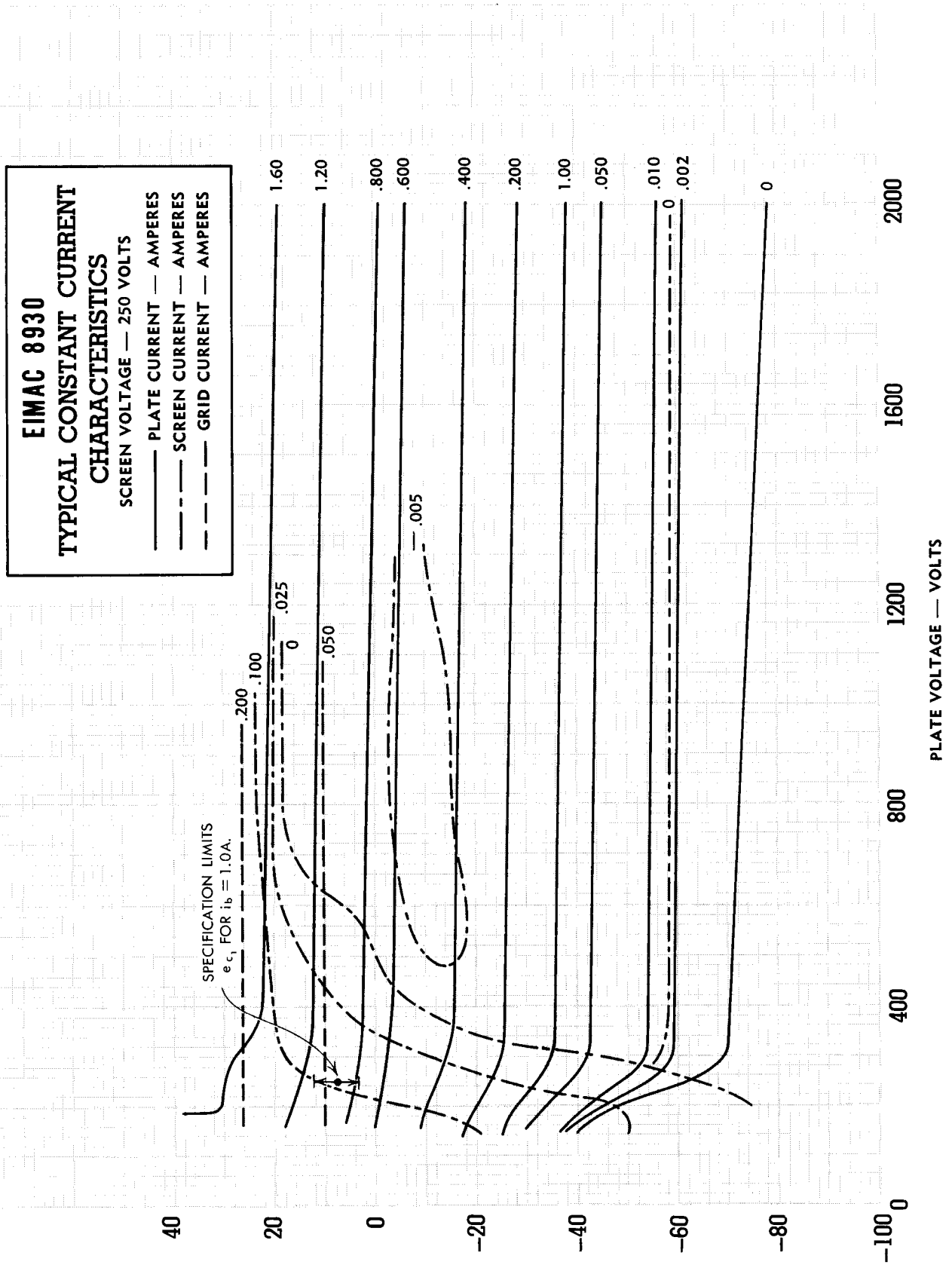
RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

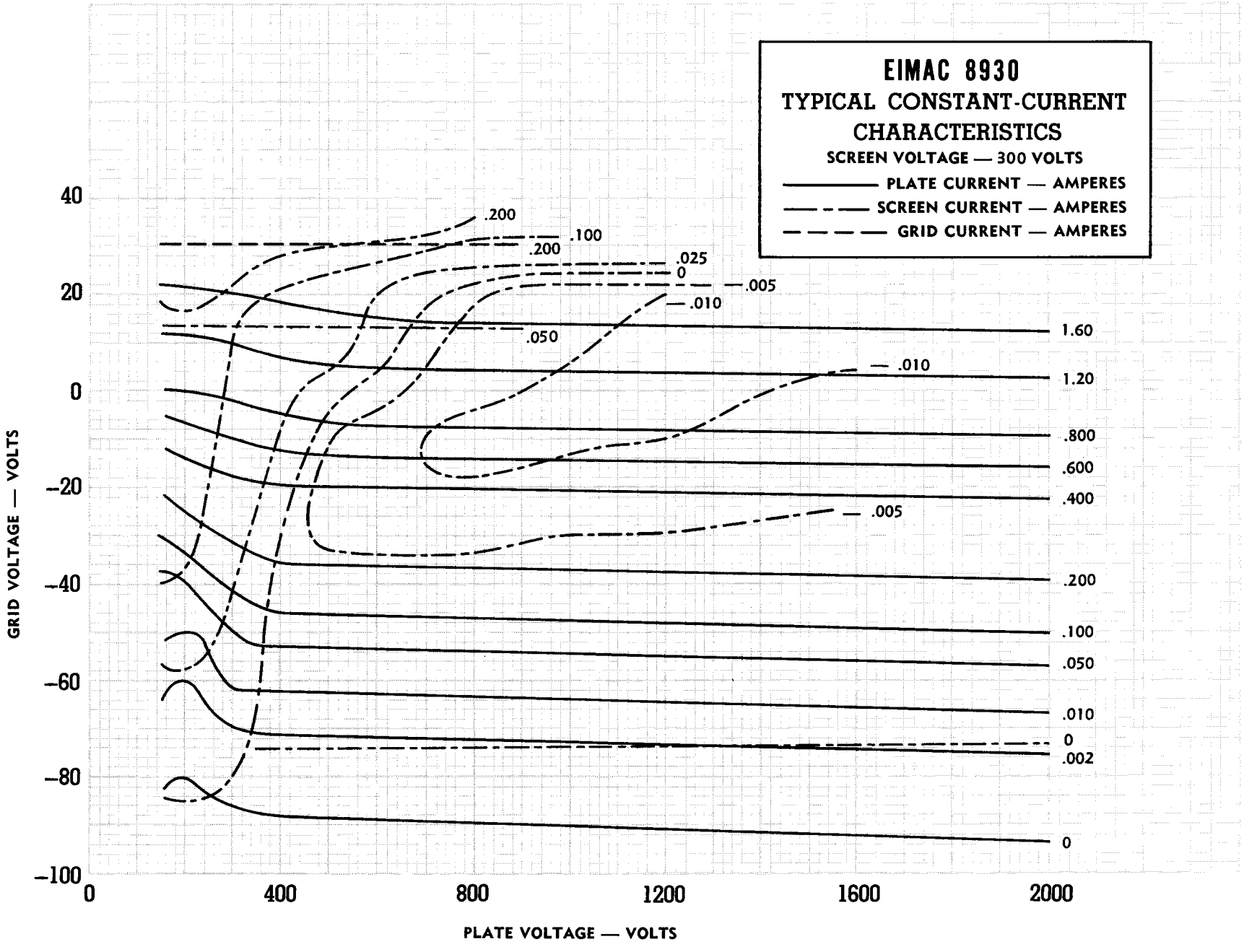
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, CA 94070, for information and recommendations.

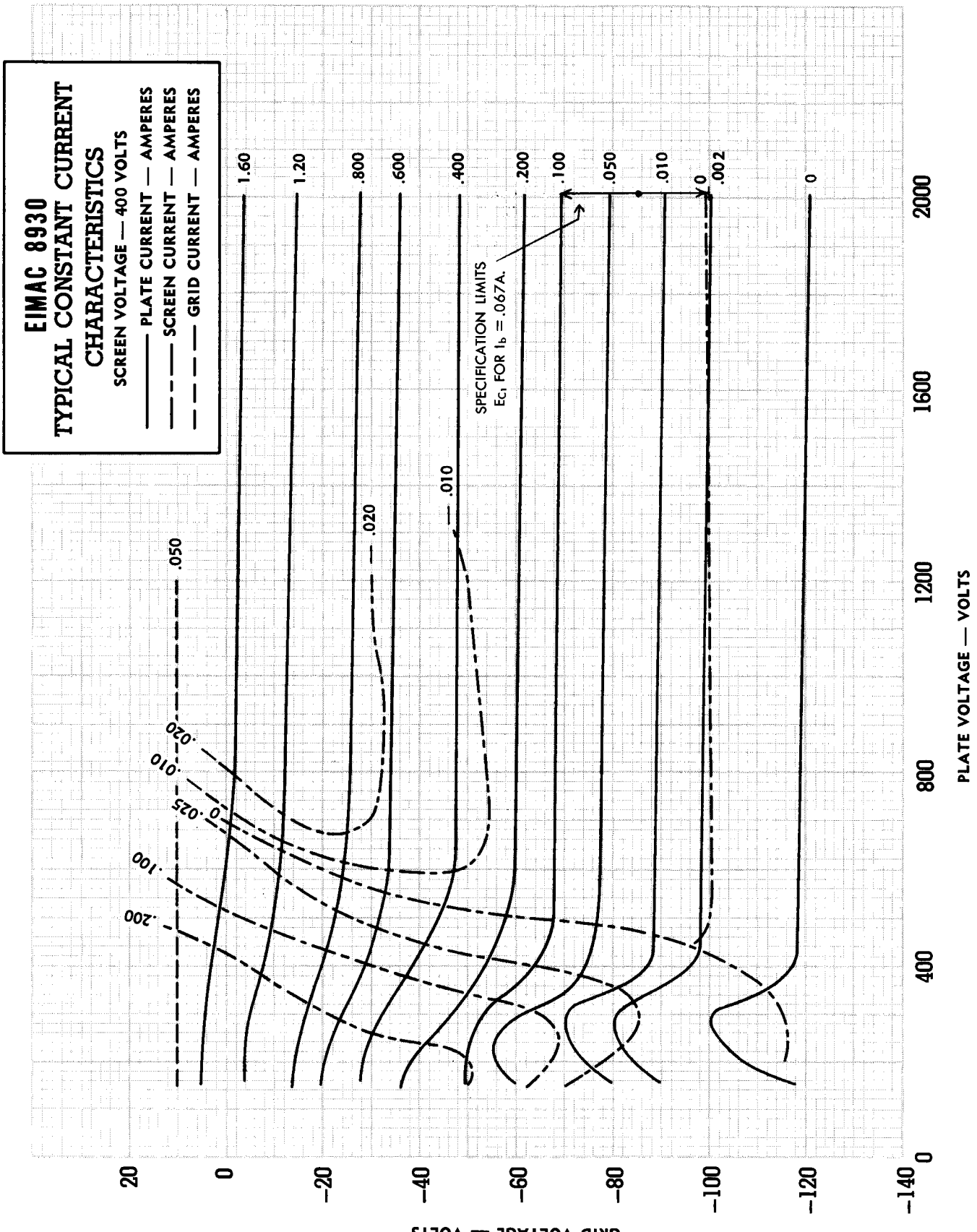


DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	2.324	2.464	- -	59.03	62.58	- -
B	2.050	2.080	- -	52.07	52.83	- -
C	1.810	1.910	- -	45.97	48.51	- -
D	0.750	0.810	- -	19.05	20.57	- -
E	0.710	0.790	- -	18.03	20.07	- -
F	- -	1.406	- -	- -	35.71	- -
G	0.187	- -	- -	4.75	- -	- -
H	BASE: B8-236 (JEDEC DESIGNATION)					
J	0.559	0.573	- -	14.20	14.55	- -
K	0.240	- -	- -	6.10	- -	- -

(*) CONTACT SURFACE


EIMAC 8930
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE — 250 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
SPECIFICATION LIMITS
e_{c_1} FOR i_b = 1.0A.
1.60
1.20
.800
.600
.400
.200
1.00
.050
.010
.002
0
.005
.025
.100
.200
.050
40
20
0
−20
−40
−60
−80
−100
0
400
800
1200
1600
2000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS


EIMAC 8930
TYPICAL CONSTANT-CURRENT CHARACTERISTICS
SCREEN VOLTAGE — 300 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS
40
20
0
-20
-40
-60
-80
-100
0
400
800
1200
1600
2000
.200
.100
.200
.025
0
.005
.010
.050
1.60
.010
1.20
.800
.600
.400
.005
.200
.100
.050
.010
0
.002
0


EIMAC 8930
TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE — 400 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
1.60
1.20
.800
.600
.400
.200
.100
.050
.010
0
.002
0
.050
.020
.010
0
.025
.100
.200
.010
.020
SPECIFICATION LIMITS
Ec1 FOR Ib = .067A.
20
0
-20
-40
-60
-80
-100
-120
-140
0
400
800
1200
1600
2000
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS

8933

TECHNICAL DATA

PLANAR TRIODE

The 8933 is a miniature, ceramic/metal, rugged planar triode for advanced airborne and space applications up to 3.0 GHz.



The 8933 may be used as an amplifier, oscillator, or frequency multiplier in the grid- or plate-pulsed mode as well as a modulator or regulator tube. In addition to low interelectrode capacitance, high transconductance and amplification factor, the 8933 has an arc-resistant cathode, and a spewing shield, assuring stable, reliable, and long-life operation under adverse conditions.

The 8933 is supplied without radiator and may be conduction, convection, heat sink, or liquid cooled. Radiators for forced air cooling permitting an anode dissipation up to 150 watts can be furnished on separate order.

The 8933 is especially designed for applications where high RF pulse power is required. It can also be readily used in switch tube applications up to 8 kV dc.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 ± 0.3	V
Current, at 6.3 volts	1.30	A
Transconductance (Average):		
I_b = 160 mA	38	mmhos
Amplification Factor (Average):	120	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	9.5	pF
Cout	0.06	pF
Cgp	1.40	pF
Cut-off Bias[3]	-30	V max
Frequency of Maximum Rating:		
Plate or Grid-Pulsed	3.0	GHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

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MECHANICAL

Maximum Overall Dimensions:	
Length	1.50 in; 38.10 mm
Diameter	.950 in; 24.13 mm
Net Weight	0.7 oz; 19.3 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250 °C
Cooling	Conduction, convection, forced air, or liquid

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.3 volts	1.20	1.40	A
Cathode Warmup Time	60	---	sec.
Interelectrode Capacitance [1] (grounded cathode connection)			
Cin	8.5	11.0	pF
Cout	---	0.06	pF
Cgp	1.30	1.55	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE(grid pulsed)	8000	VOLTS
PEAK PULSE PLATE VOLTAGE		
(plate pulsed)	10,000	VOLTS
DC GRID VOLTAGE	-300	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	175	VOLTS
PULSE PLATE CURRENT	5.0	AMPERES
PULSE GRID CURRENT	2.5	AMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling [1]	150	WATTS
GRID DISSIPATION (Average)	1.5	WATTS
FREQUENCY	3.0	GHz
PULSE DURATION [2]	6.0	μs
DUTY FACTOR [2]	.0033	

OPERATING CONDITIONS for 8933 in Representative Application

GRID PULSED AMPLIFIER	Driver	Amp	
Frequency	1030	1030	GHz
Heater Voltage	5.8	5.8	V
DC Plate Voltage	4700	5000	Vdc
DC Grid Voltage	-70	-70	Vdc
Peak Video Plate Current	1.5	3.3	a
Peak Video Grid Current	0.25	1.1	a
Pulse Drive Power(approx.)	300	2000	w
Useful Power Output(approx.)	3250	8000	w
Gain	10.4	6.0	dB
Plate Efficiency	46	48	%

1. Using proper EIMAC radiator.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

PULSE MODULATOR AND PULSE AMPLIFIER SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	8000	VOLTS
PEAK PLATE VOLTAGE	10,000	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	100	VOLTS
PULSE CATHODE CURRENT	7.5	AMPERES
DC PLATE CURRENT	150	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling [1]	150	WATTS
GRID DISSIPATION (Average)	1.5	WATTS
PULSE DURATION [2]	6.0	μs
CUT-OFF MU	85	

1. Using proper EIMAC radiator.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

APPLICATION

For general application information please refer to the Planar Triode Operating Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube type. For unusual and special applications consult the nearest Varian Electron Tube Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	- -	1.160	- -	- -	29.46	- -
B	- -	0.960	- -	- -	24.38	- -
C	- -	0.895	- -	- -	22.73	- -
D	0.825	0.875	- -	20.96	22.23	- -
E	0.702	0.740	- -	17.83	18.80	- -
F	0.655	0.684	- -	16.64	17.37	- -
G	0.150	0.190	- -	3.81	4.83	- -
H	- -	0.040	- -	- -	1.02	- -
J	- -	0.340	- -	- -	8.64	- -
K	0.537	0.554	- -	13.64	14.07	- -
L	- -	0.260	- -	- -	6.60	- -
M	0.545	0.570	- -	13.84	14.48	- -
N	- -	0.200	- -	- -	5.08	- -
P	0.775	0.785	- -	19.69	19.94	- -
R	0.595	0.607	- -	15.11	15.42	- -
S	0.935	0.950	- -	23.75	24.13	- -
T	0.235	0.265	- -	5.97	6.73	- -
U	0.440	0.460	- -	11.18	11.68	- -
AA	- -	- -	0.925	- -	- -	23.50
AB	- -	- -	0.778	- -	- -	19.76
AC	- -	- -	0.598	- -	- -	15.19

Notes:

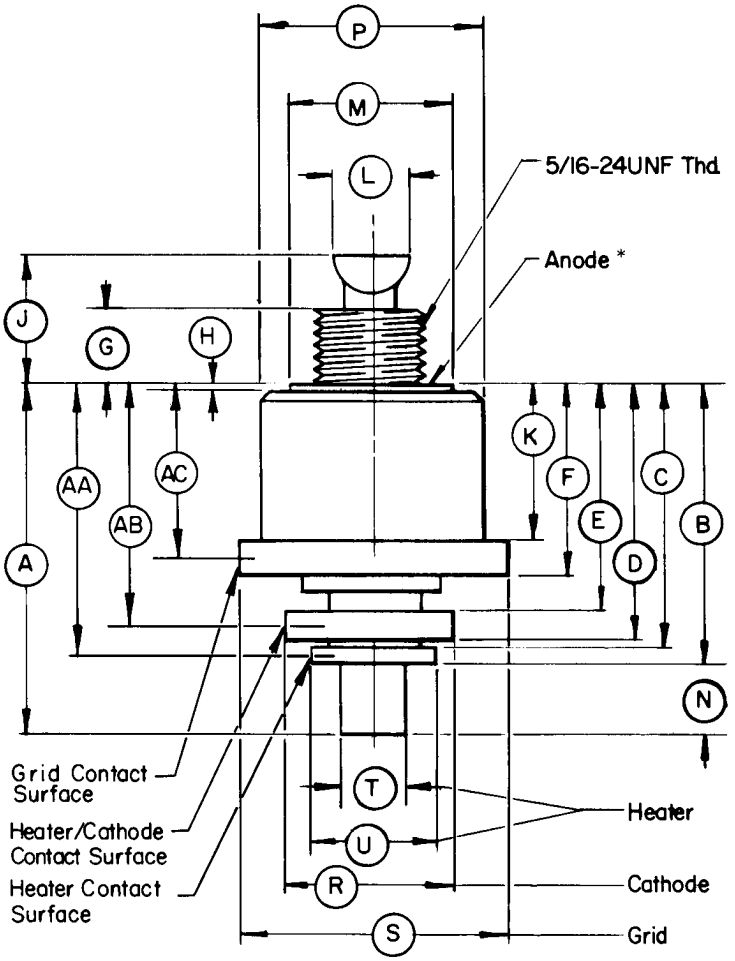
A. Reference Dimensions are for information only and are not required for inspection purposes.

B. Anode Flange is for electrical contact; Stud is for heat transfer.

C.* Total indicated runout (TIR) of Contact Surfaces shall be gaged from centerline of reference & shall be as follows:

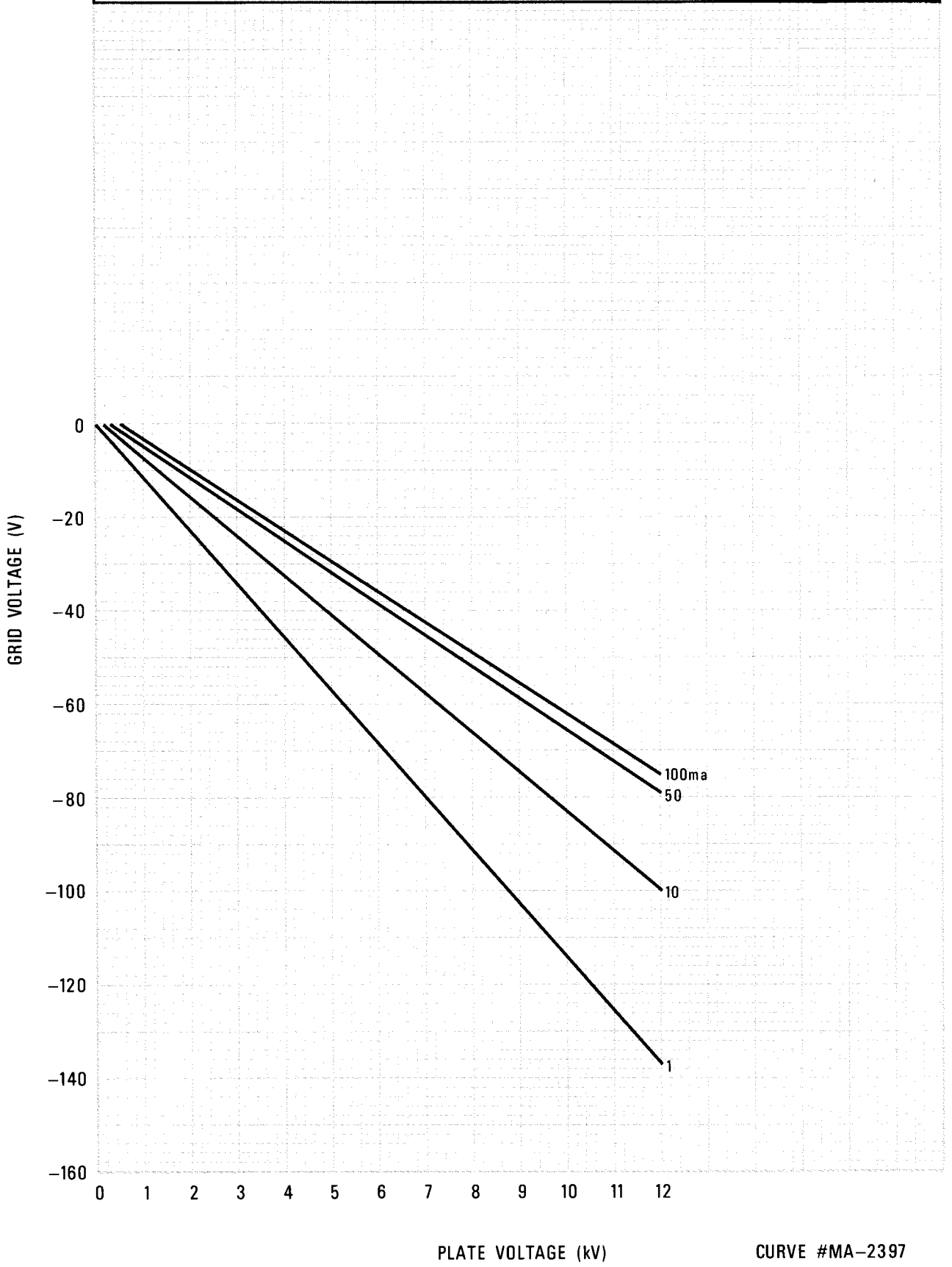
CONTACT SURF.	TIR(Max.)	Ref.
Grid	.020	Anode
Heater	.020	Anode
Cathode	.020	Anode

D. Electrode Contact Dimensions are given for socket design purposes & are not intended for inspection purposes.

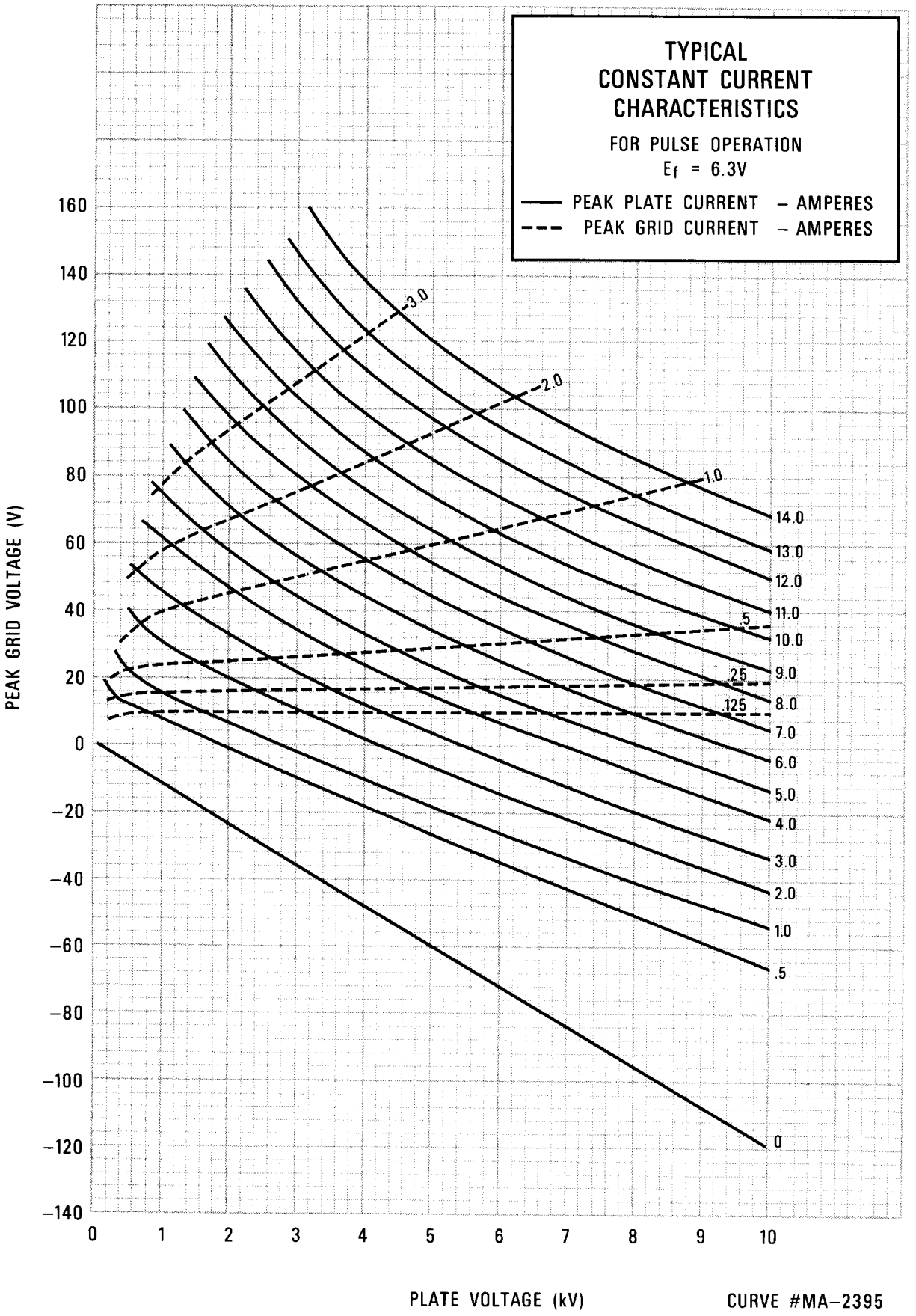


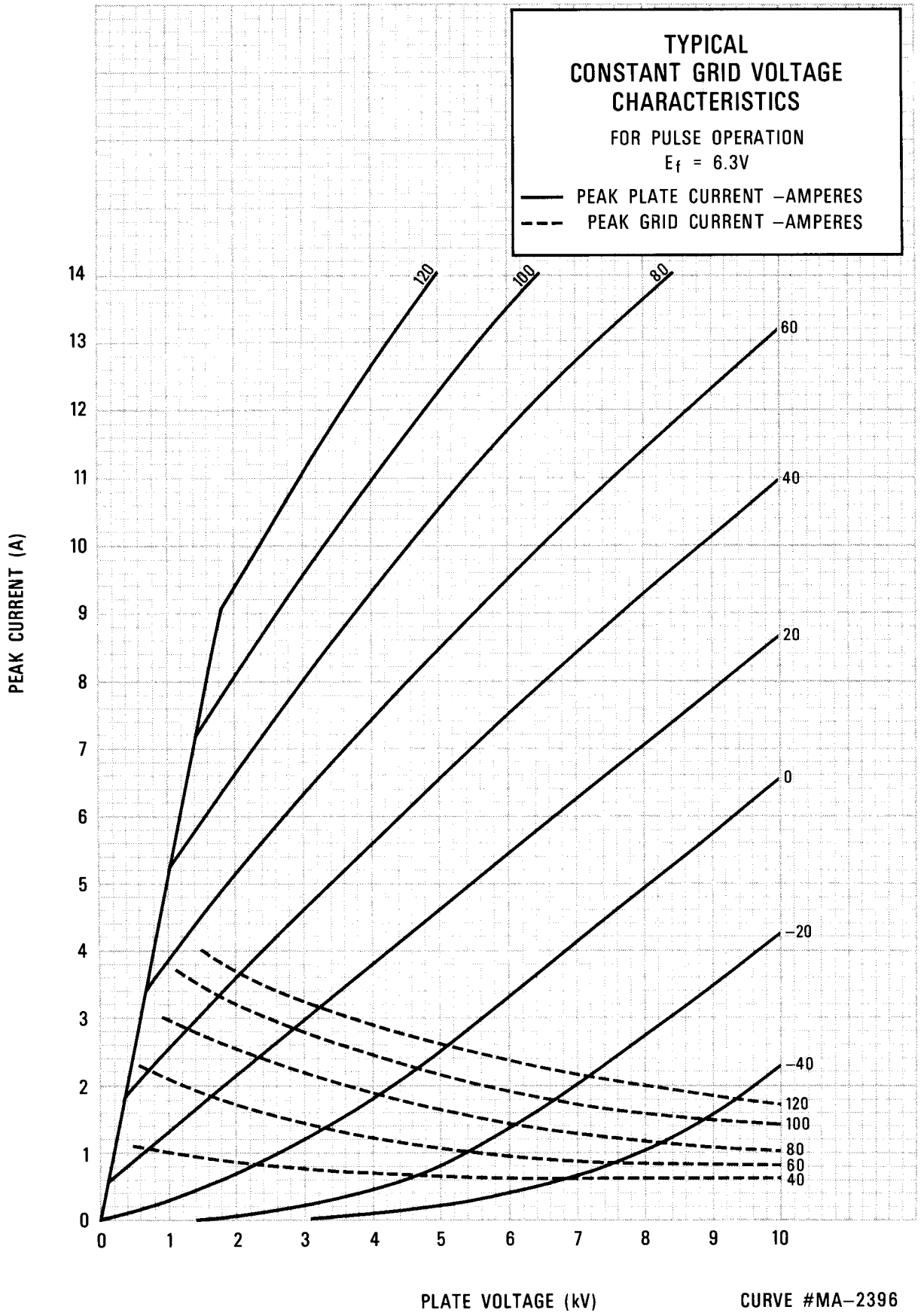
TYPICAL CONSTANT PLATE CURRENT CHARACTERISTICS

NEGATIVE GRID REGION E_f = 6.3V



CURVE #MA-2397


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PEAK PLATE CURRENT – AMPERES
PEAK GRID CURRENT – AMPERES
PEAK GRID VOLTAGE (V)
160
140
120
100
80
60
40
20
0
−20
−40
−60
−80
−100
−120
−140
0
1
2
3
4
5
6
7
8
9
10
PLATE VOLTAGE (kV)
3.0
2.0
1.0
.5
.25
.125
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.5
0
CURVE #MA–2395


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PEAK PLATE CURRENT –AMPERES
PEAK GRID CURRENT –AMPERES
PEAK CURRENT (A)
PLATE VOLTAGE (kV)
CURVE #MA–2396
120
100
80
60
40
20
0
–20
–40
120
100
80
60
40
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14

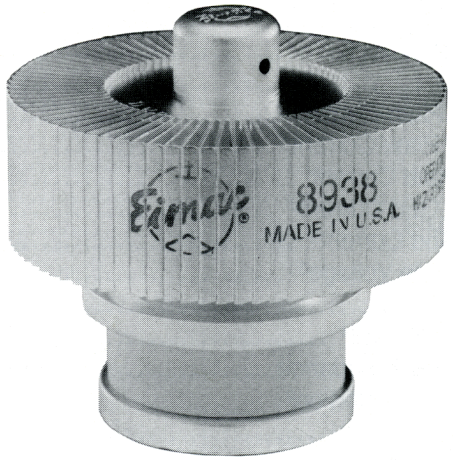
TECHNICAL DATA

8938
UHF
HIGH-MU
POWER TRIODE

The **EIMAC 8938** is a rugged coaxial-base ceramic and metal power triode designed for use as a cathode driven Class AB_2 or Class C amplifier.

It is recommended for VHF or UHF service as a linear amplifier, power amplifier or pulse amplifier. Linearity and power gain are both excellent due to the low ratio of grid to plate current, and the relatively high amplification factor. Low grid interception of available emission current is due to the beam forming geometry of the special grid and cathode design.

The 8938 is a practical size for use in ground based or mobile equipment in CW or PEP power levels of 1 to 2.5 kW. It is useful at frequencies higher than the upper frequency of maximum ratings, 500 MHz.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential

Heater: Voltage	5.0 ± 0.25 Volts
Current @ 5.0 Volts	10.5 Amperes
Transconductance (Average):	
I_b = 1.0 Adc	55,000 μmhos
Amplification Factor (Average)	125
Direct Interelectrode Capacitance (Grounded Grid)[2]	
Cin	39 pF
Cout	13 pF
Cgp	0.14 pF
Ck-htr	12.8 pF
Frequency of Maximum Rating (CW)	500 MHz

[1]Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. **Varian EIMAC** should be consulted before using this information for final equipment design.

[2]Capacitance values are for a cold tube as measured in a special shielded fixture.

varian
eimac salt lake division
1678 South Pioneer Road / Salt Lake City, Utah 84104 / (801) 972-5000

Effective 3/15/89
Printed in USA

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN (Class AB_2)

TYPICAL OPERATION
(Frequencies to 30 MHz)
Class AB_2 Cathode Driven, Peak Envelope or
Modulation Crest Conditions

Plate Voltage	3500 Vdc
Grid Voltage[1]	-20 Vdc
Zero-Signal Plate Current	300 mAdc
Single-Tone Plate Current	970 mAdc
Two-Tone Plate Current	715 mAdc
Single-Tone Grid Current[3]	39 mAdc
Two-Tone Grid Current[3]	12 mAdc
Peak rf Cathode Voltage[3]	71 Volts
Driving Power[3]	50 Watts
Useful Output Power[4]	2030 Watts
Resonant Load Impedance	2200 Ohms
Intermodulation Distortion[2]	
3rd Order Products	-44 dB
5th Order Products	-44 dB

[1]Positive cathode bias provided by zener diode.
[2]The intermodulation distortion products are referenced against one tone of a two equal tone signal.
[3]Approximate value.
[4]Delivered to the load.

ABSOLUTE MAXIMUM RATINGS

DC Plate Voltage	4000 Volts
DC Plate Current	1.0 Ampere
Plate Dissipation	1500 Watts
Grid Dissipation	25 Watts

RADIO FREQUENCY POWER AMPLIFIER (Class B or C)

TYPICAL OPERATION
(Cathode Driven Amplifier)

Frequency of Operation	400 MHz
Heater Voltage	4.3 Volts
DC Plate Voltage	3000 Volts
DC Grid Voltage	-31 Volts
DC Plate Current	1.0 Ampere
DC Grid Current	5 mA
Measured Driving Power	83 Watts
Useful Output Power	1570 Watts
Power Gain	12.8 dB

ABSOLUTE MAXIMUM RATINGS

DC Plate Voltage	4000 Volts
DC Plate Current	1.0 Ampere
Plate Dissipation	1500 Watts
Grid Dissipation	25 Watts

MECHANICAL

Maximum Overall Dimensions:
- Length ..... 3.57 in; 91.00 mm
- Diameter ..... 3.38 in; 85.85 mm

Net Weight ..... 25 oz.; 709 gm
Operating Position ..... Any

Maximum Operating Temperature:
- Ceramic/Metal Seals ..... 250°C
- Anode Core ..... 250°C

Cooling ..... Forced Air
Base ..... Coaxial
Socket (Grounded Grid) ..... EIMAC SK-2220

APPLICATION

MECHANICAL

MOUNTING - The EIMAC 8938 may be mounted in any position.

SOCKET - The EIMAC SK-2220 socket is designed for use with the 8938 tube, making contact to the two heater terminals, the cathode, and the grid terminal. The grid is grounded to the frame of the socket.

Individual contact collets are also available from EIMAC to fit the 8938 as follows:

TUBE ELEMENT	EIMAC PART NUMBER
Anode	135304
Grid	135305
Cathode	135306
Heater	135307
Heater (Center Pin)	135310

These collets are described by EIMAC drawing SK-2221-60.

COOLING - The maximum temperature limit for all external tube surfaces and the anode core is 250°C. Tube life is prolonged, however, if these areas are maintained at a lower temperature. The cooling data shown is for the anode cooler only and the flow rates indicated will hold tube temperature below 225°C with 50°C ambient temperature at sea level at low frequencies. At frequencies above 30 MHz, or at higher altitudes, the air quantity must be increased. A small amount of additional cooling air is required around the base of the tube to maintain seal and envelope temperatures in this area within ratings.

Anode Dissipation Watts	SEA LEVEL		10,000 FEET	
	Air Flow CFM	Pressure Drop Inches	Air Flow CFM	Pressure Drop Inches
500	12.8	.08	18.7	.11
1000	27.6	.24	40.0	.35
1500	50.0	.70	73.0	1.01

Note: An allowance has been made for 25 watts of grid dissipation and 50 watts of heater power.

ELECTRICAL

FILAMENT OPERATION - Rated filament voltage for the 8938 is 5.0 Volts. For CW operation at the higher end of the frequency range of the 8938, it is advisable to reduce the heater voltage by a small percentage. For a CW or average power output of 1 kW or more at 400 MHz, it is recommended that heater voltage be reduced to 4.3 Volts. At frequencies between 400 and 200 MHz, nominal heater voltage, for the power level above, should be obtained from a straight line curve defined by 4.3 Volts at 400 MHz and 5.0 Volts at 200 MHz.

In equipment intended for a broad range of frequencies, a fixed compromise heater voltage is suggested. This may be the lowest heater voltage which provides adequate cathode emission current at the lower end of the frequency range, and should be between 4.3 and 5.0 Volts.

GRID OR CATHODE BIAS - It is convenient in linear amplifier service to use a zener diode or series of zener

diodes in the cathode circuit if bias is required. The power loss is small because linear amplifier bias will generally be less than 25 Volts. Conventional grid bias sources may be used for CW or pulse applications.

UHF OPERATION - The 8938 provides very high gain at UHF with simple cavity designs, as a result of beam focusing action of a series of strip electron guns in the cathode grid region, which produces very high mu with unusually low grid interception.

Use of a high mu triode in the cathode driven configuration at UHF simplifies circuitry in many ways.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between the tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and military services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube terminals or leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

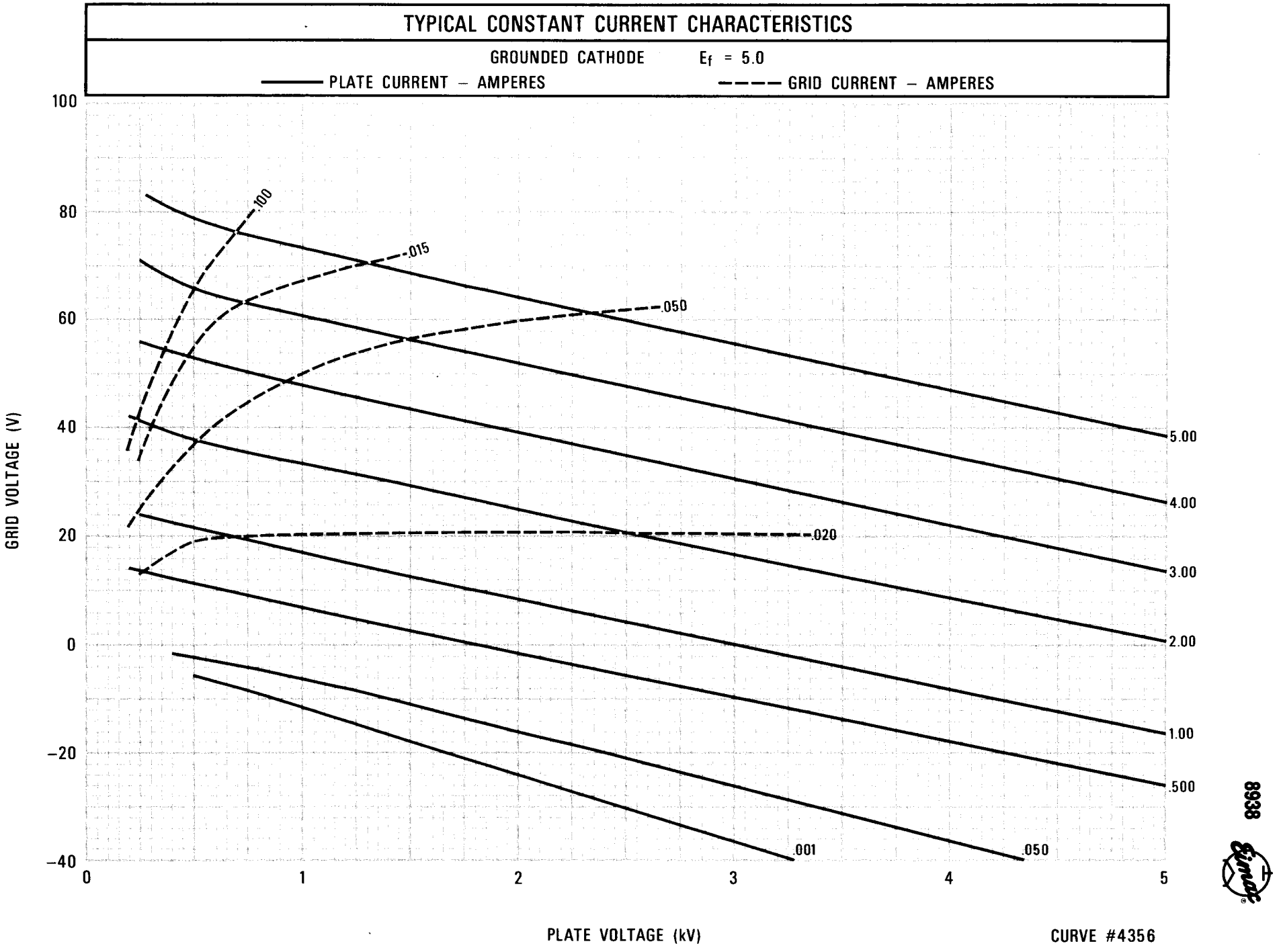
FAULT PROTECTION - It is good practice to protect the tube from internal damage caused by an internal arc which may occur at high anode voltage.

RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE AFFECTED.

HOT SURFACES - When the tube is used in air and air cooled, external surfaces of the tube may reach temperatures up to 200 degrees C and higher. In addition to the anode, the cathode insulator and cathode/heater surfaces may remain hot for an extended time after the tube is shut off. To prevent serious burns, take care to avoid any bodily contact with these surfaces both during, and for a reasonable cool down period after, tube operation.

CAUTION - HIGH VOLTAGE - *Operating voltage for the 8938 can be deadly, so the equipment must be designed properly and operating precautions must be followed. Design equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high voltage circuits and terminals, with interlock switches to open the primary circuits of the power supply and to discharge high voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that* ***HIGH VOLTAGE CAN KILL.***

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions different from those given here, write to the Power Grid Tube Marketing Department, Varian EIMAC, 1678 South Pioneer Road, Salt Lake City, UT 84104, for information and recommendations.



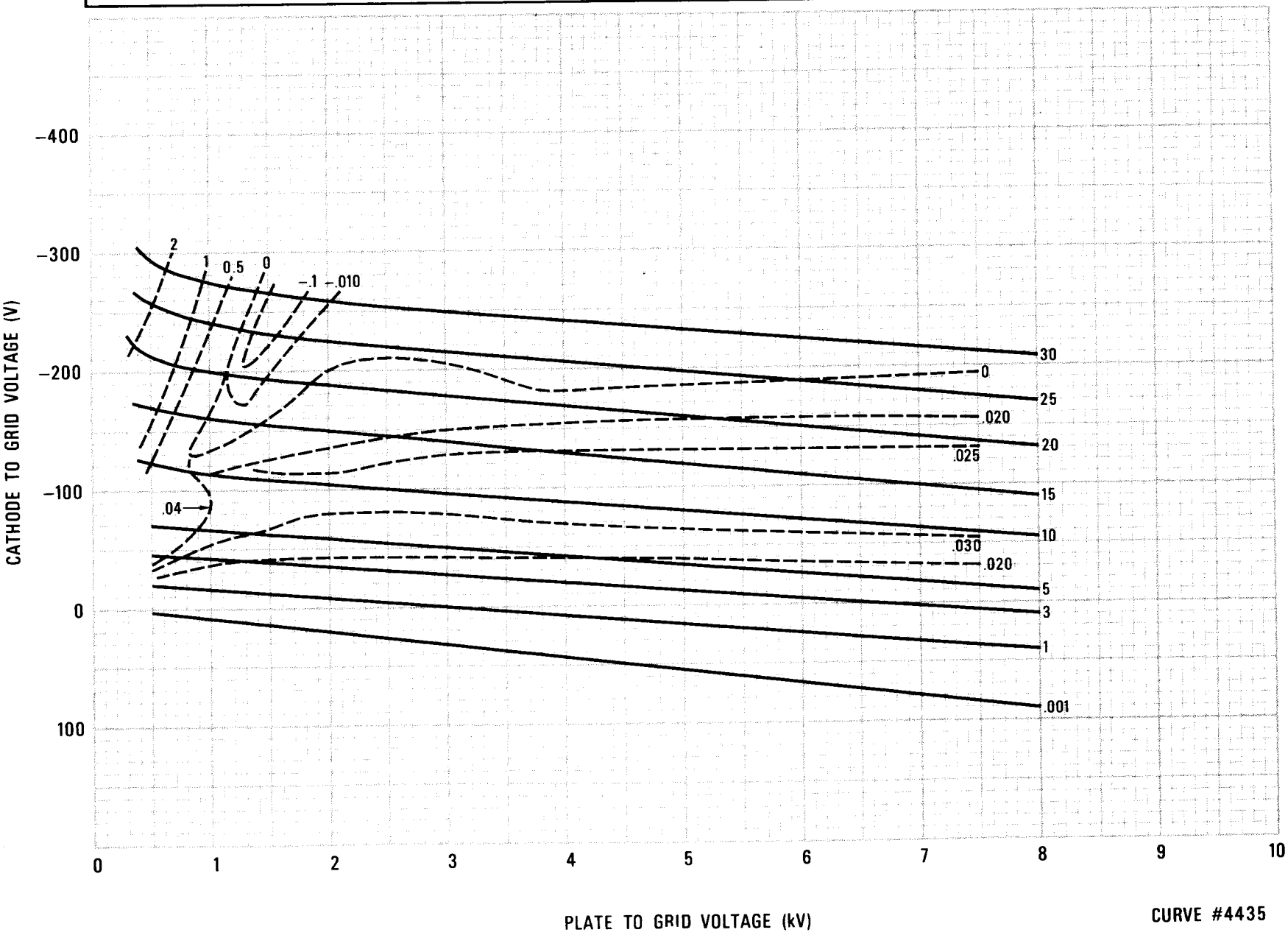
CURVE #4356

8938

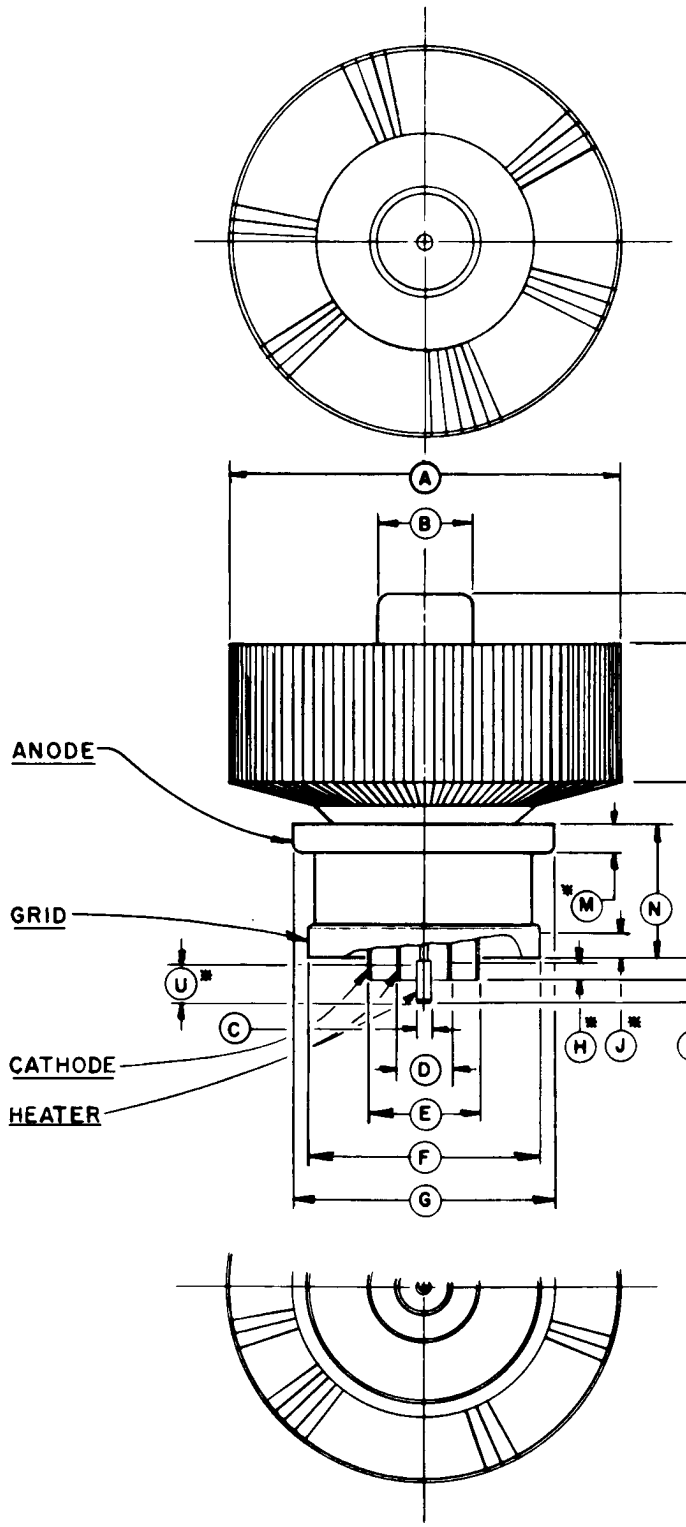
TYPICAL CONSTANT CURRENT CHARACTERISTICS

GROUNDED GRID E_f = 5V

PLATE CURRENT – AMPERES — GRID CURRENT – AMPERES



CURVE #4435

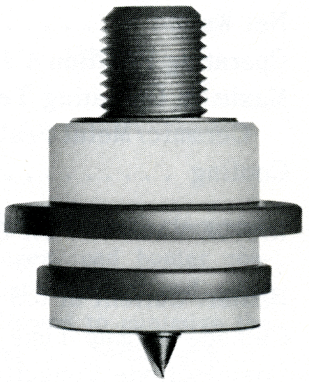


DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.350	3.380	- -	85.09	85.85	- -
B	.810	.820	- -	20.57	20.83	- -
C	.120	.127	- -	3.05	3.23	- -
D	.477	.487	- -	12.12	12.37	- -
E	.965	.975	- -	24.51	24.76	- -
F	1.995	2.015	- -	50.67	51.18	- -
G	2.245	2.255	- -	57.02	57.28	- -
H	.235	- -	- -	5.97	- -	- -
J	.235	- -	- -	5.97	- -	- -
K	.170	.200	- -	4.32	5.08	- -
L	.370	.400	- -	9.40	10.16	- -
M	.235	- -	- -	5.97	- -	- -
N	1.110	1.170	- -	28.19	29.72	- -
P	1.400	1.530	- -	35.56	38.86	- -
R	2.600	2.730	- -	66.04	69.34	- -
S	3.015	3.175	- -	76.58	80.64	- -
T	.380	.480	- -	9.65	12.19	- -
U	.350	- -	- -	8.89	- -	- -

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACE.
3. DIMENSIONS C,D,E TO BE CONCENTRIC WITH F & G WITHIN .015 DIA.
4. DIMENSIONS A & B TO BE CONCENTRIC WITH F & G WITHIN .040 DIA.

8940

PLANAR TRIODE



The 8940 is a planar triode of ceramic/metal construction and rugged design to be used in advanced airborne, ground, and space applications up to 2.5 GHz.

The 8940 may be used as an amplifier, oscillator, or frequency multiplier in the CW as well as the grid or plate-pulsed mode, or as a modulator or series regulator tube. In addition to the low interelectrode capacitance, high transconductance and amplification factor, the tube has an arc-resistant cathode and a vaporization shield to assure stable and reliable long life operation under adverse conditions.

The 8940 is normally supplied without a radiator and may be conduction, convection, heat-sink, or liquid cooled. Liquid cooling can be done by submersion of the tube in an insulating medium such as FC-75. Radiators for forced-air cooling as well as heat-sink adaptors permitting anode dissipation up to 750 watts are available as separate items.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	6.3 ± 0.3 V
Current, at 6.3 volts	2.25 A
Transconductance (Average):	
I_b = 160 mA	100 mmhos
Amplification Factor (Average):	65
Direct Interelectrode Capacitance (grounded cathode) [2]	
Cin	16.0 pF
Cout	0.11 pF
Cgp	3.8 pF
Cut-off Bias [3]	-50 V max
Frequency of Maximum Rating:	
Plate or Grid-Pulsed	2.5 GHz
CW	2.0 GHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 2 pF due to thermal expansion of the cathode.

3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

(Effective 10-15-75) © 1975 by Varian Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:	
Length	1.985 in; 50.4 mm
Diameter	1.365 in; 34.6 mm
Net Weight	1.96 oz; 56 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Cooling	Conduction, convection, forced air, or liquid

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.3 volts	2.05	2.50	A
Cathode Warmup Time	90	---	sec.
Interelectrode Capacitance[1] (grounded cathode connection)			
Cin	13.5	17.0	pF
Cout	---	0.11	pF
Cgp	3.3	4.2	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE(grid pulsed)	4000	VOLTS
PEAK PULSE PLATE VOLTAGE (plate pulsed)	6500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	500	VOLTS
Grid positive to cathode	200	VOLTS
PULSE PLATE CURRENT	12	AMPERES
PULSE GRID CURRENT	4	AMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	750	WATTS
GRID DISSIPATION (Average)	2	WATTS
FREQUENCY	2.5	GHz
PULSE DURATION[2]	6	μs
DUTY FACTOR[2]	.0033	

OPERATING CONDITIONS for 8940 in Respresentative Application

	Grid Pulsed Amplifier		Grid Pulsed OSC	Plate Pulsed OSC	
Frequency	1.3	1.2	1.03	1.65	GHz
Heater Voltage	6.3	6.3	6.3	6.3	V
DC Plate Voltage	4000	3500	3850	5000	Vdc
DC Grid Voltage	-50	-75	-80	--	Vdc
Peak Video Plate Current	3.0	3.0	6.0	6.0	a
Peak Video Grid Current	0.7	0.5	1.8	2.0	a
Pulse Drive Power(approx.)	600	600	--	--	w
Useful Power Output(")	6000	4000	11,500	10,000	w
Pulse Duration	500	3.5	5.0	5.0	μs
Duty Factor	0.01	0.04	.001	.001	
Bandwidth	75	10	--	--	MHz

1. Using EIMAC Radiator Part No. 158096.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

PULSE MODULATOR AND PULSE AMPLIFIER SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000	VOLTS
PEAK PLATE VOLTAGE	6500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	500	VOLTS
Grid positive to cathode	100	VOLTS
PULSE CATHODE CURRENT	16	AMPERES
DC PLATE CURRENT	600	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	750	WATTS
GRID DISSIPATION (Average)	2.0	WATTS
PULSE DURATION[2]	6	μs
CUT-OFF MU	35	

1. Using EIMAC Radiator Part No. 158096.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

CW RF POWER AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	4000 VOLTS
DC GRID VOLTAGE	-200 VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE	
Grid negative to cathode	350 VOLTS
Grid positive to cathode	30 VOLTS
DC PLATE CURRENT	0.6 AMPERE
DC GRID CURRENT	0.07 AMPERE
AVERAGE PLATE DISSIPATION	
Forced-Air Cooling [1]	750 WATTS
GRID DISSIPATION (Average)	2.0 WATTS

1. Using EIMAC Radiator Part No. 158096.

APPLICATION

For general application information please refer to the Planar Triode Operating Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube type. For unusual and special applications consult the nearest Varian Electron Tube Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

The cathode and grid flanges should not be altered in any way such as by machining or filing, since the final seal could be damaged. Maximum torque applied to flanges during installation should not exceed 15 inch pounds.

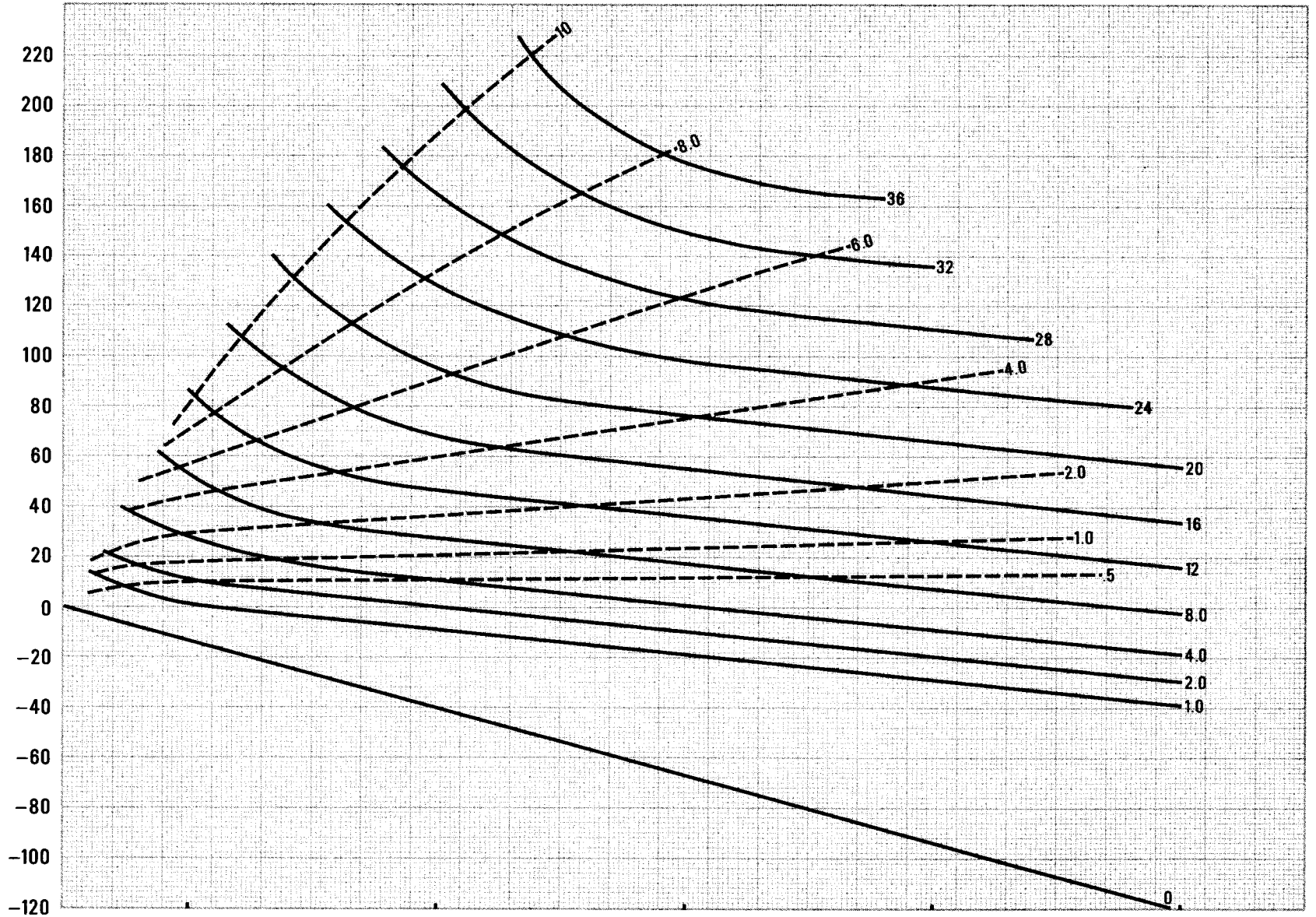
For optimum RF performance, the anode line should make good contact on the anode area indicated on the outline drawing.

Soldered connections may be made to the anode stud, grid or cathode flanges, and heater contacts where adequate heat sinking and good soldering practices are followed to minimize the heat applied to the tube and the thermal gradient across the metal to ceramic brazed areas. If forced air cooling is provided, auxiliary air flow, apart from the air flowing through the radiator, should be provided to cool the tube envelope and other tube terminals. Some conduction cooling is always provided through the contact terminals. However, these terminals usually exhibit poor heat transfer, often having a temperature gradient across them as high as 50°C.

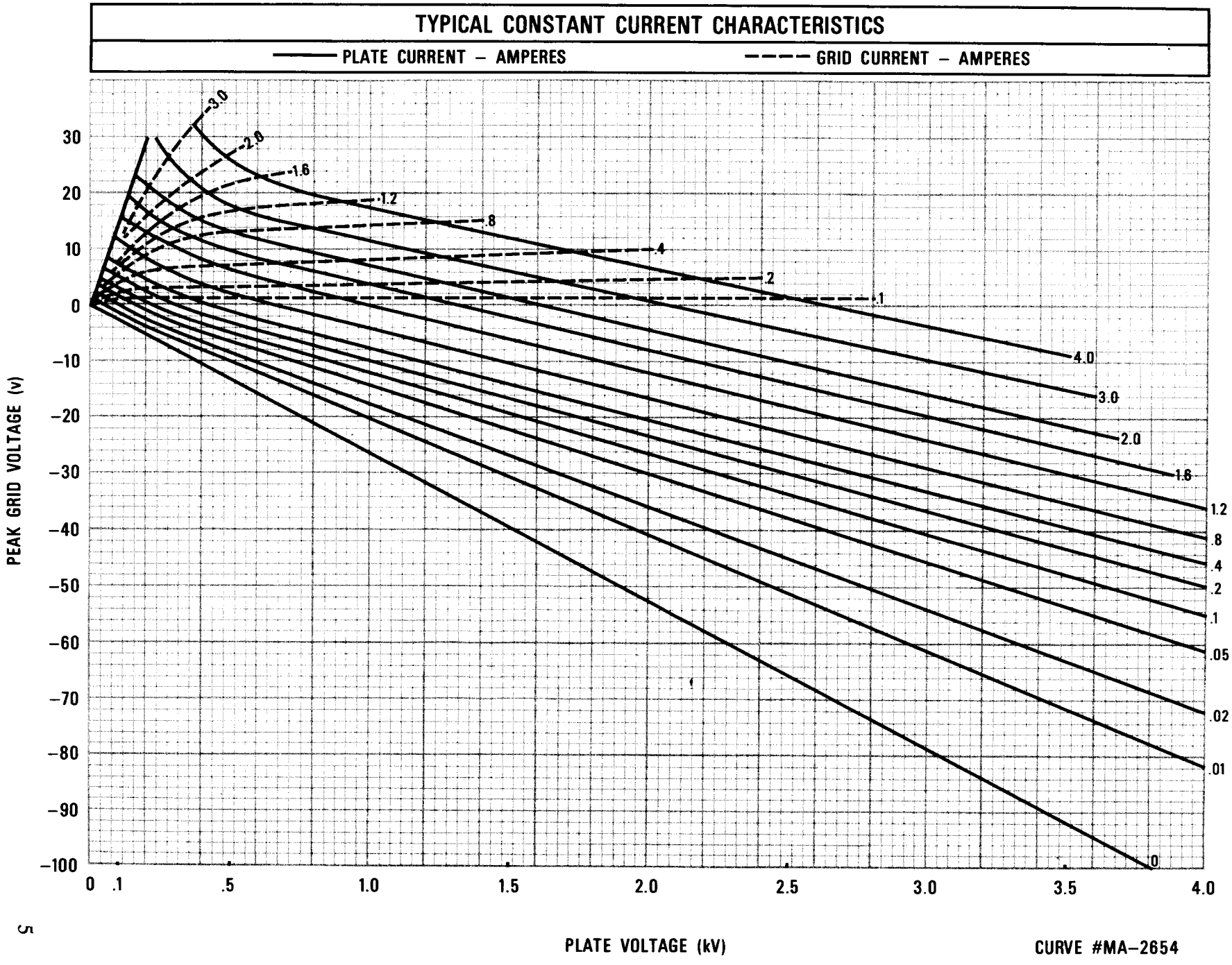
TYPICAL CONSTANT CURRENT CHARACTERISTICS

FOR PULSE OPERATION

PLATE CURRENT – AMPERES — GRID CURRENT – AMPERES



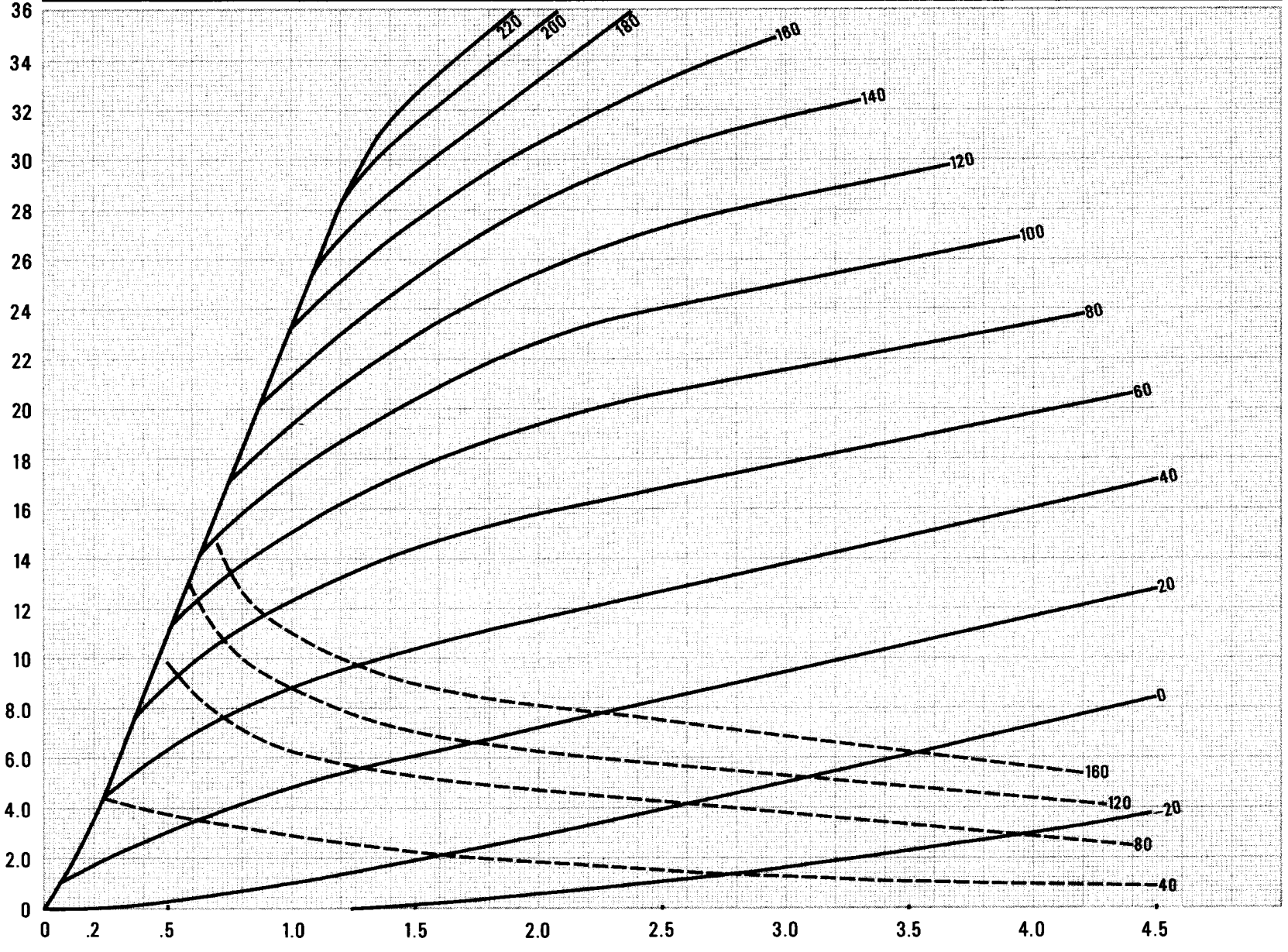
CURVE #MA–2594


TYPICAL CONSTANT CURRENT CHARACTERISTICS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
PEAK GRID VOLTAGE (v)
30
20
10
0
−10
−20
−30
−40
−50
−60
−70
−80
−90
−100
0
.1
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
PLATE VOLTAGE (kV)
CURVE #MA–2654
3.0
2.0
1.6
1.2
.8
.4
.2
.1
4.0
3.0
2.0
1.6
1.2
.8
.4
.2
.1
.05
.02
.01
0

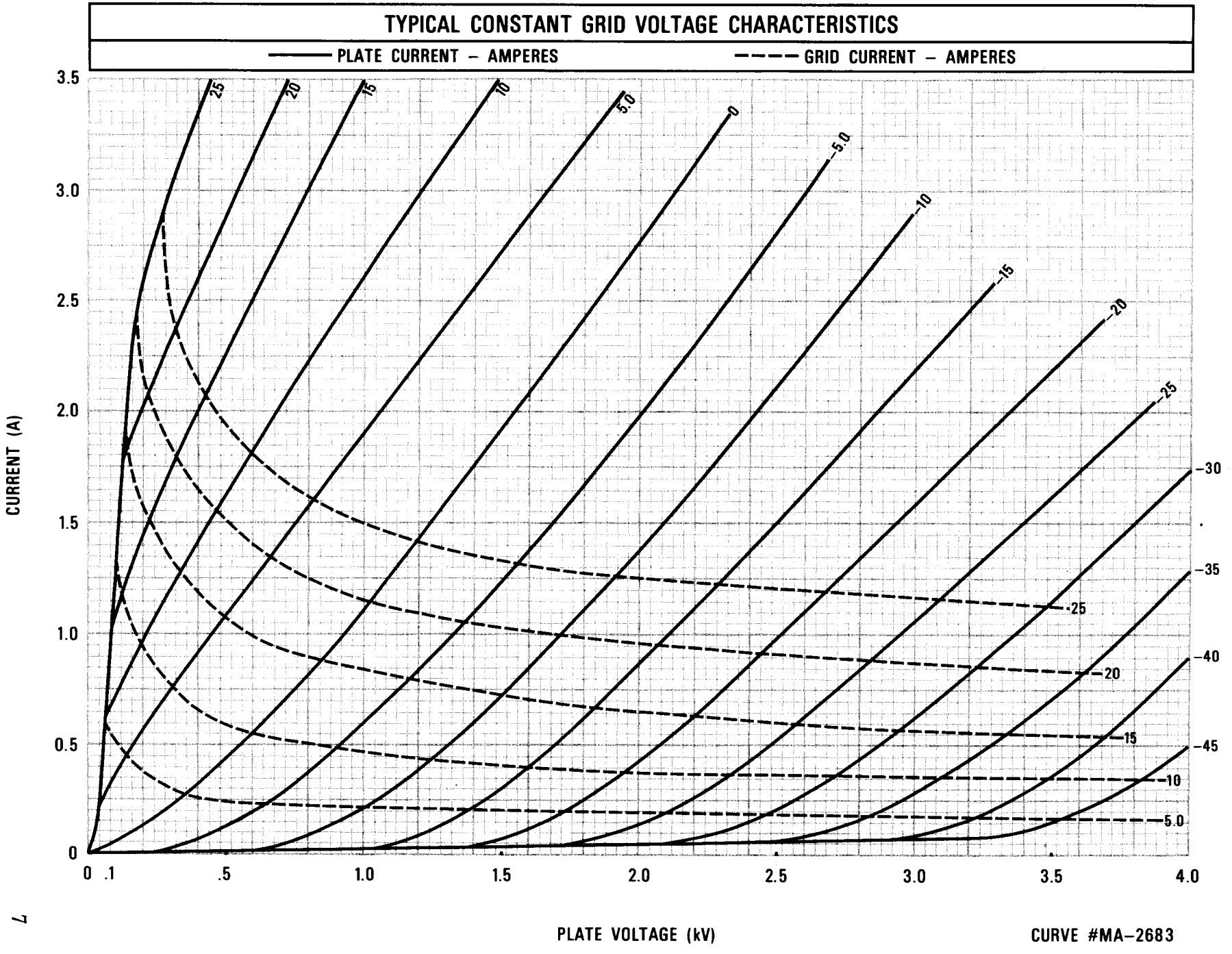
TYPICAL CONSTANT GRID VOLTAGE CHARACTERISTICS

FOR PULSE OPERATION

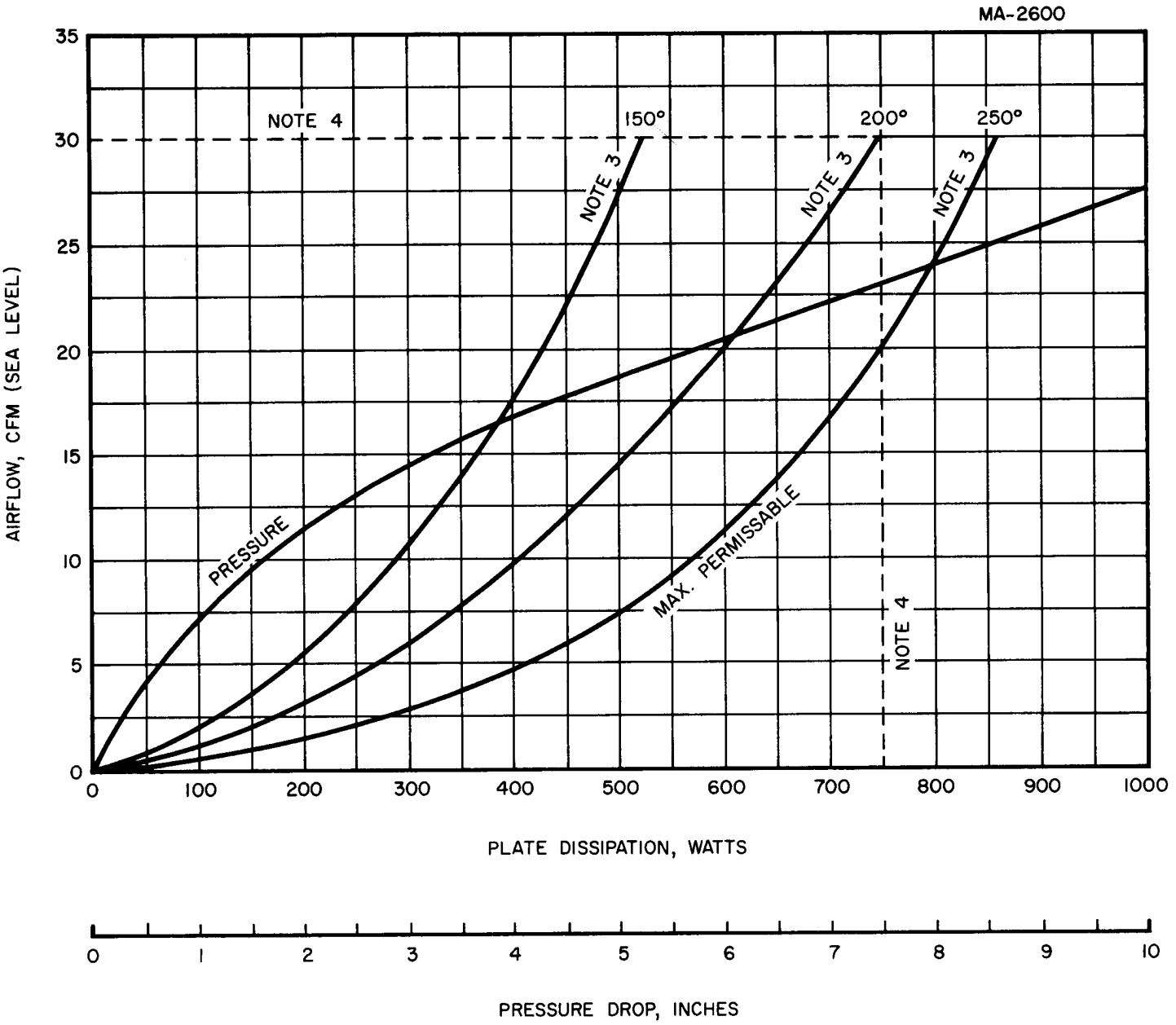
——— PLATE CURRENT – AMPERES - - - - GRID CURRENT – AMPERES

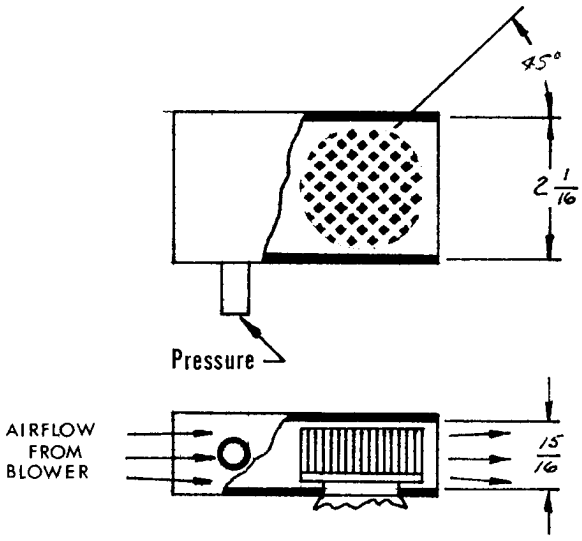


CURVE #MA–2682


TYPICAL CONSTANT GRID VOLTAGE CHARACTERISTICS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
CURRENT (A)
PLATE VOLTAGE (kV)
CURVE #MA–2683
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0
.1
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
25
20
15
10
5.0
0
-5.0
-10
-15
-20
-25
-30
-35
-40
-45
-25
-20
-15
-10
-5.0

AIR COOLING DATA FOR 8940





– COWLING DETAIL –

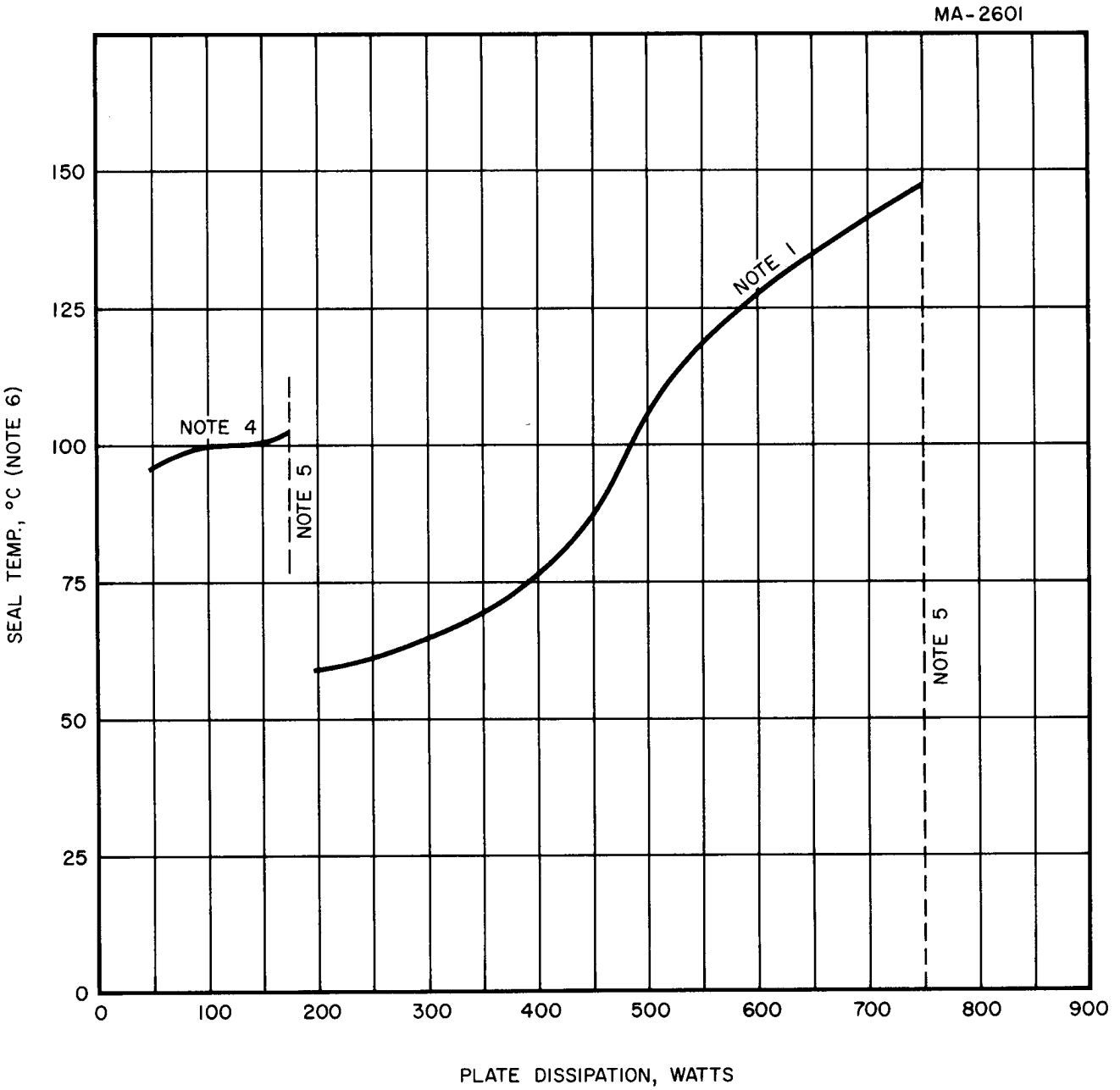
1. Inlet Air at 20°C

2. Use Radiator No. 158096 (Copper–Pin) in Cowling as shown.

3. Temp. measured at Anode Cup–Plate Insulator Seal.

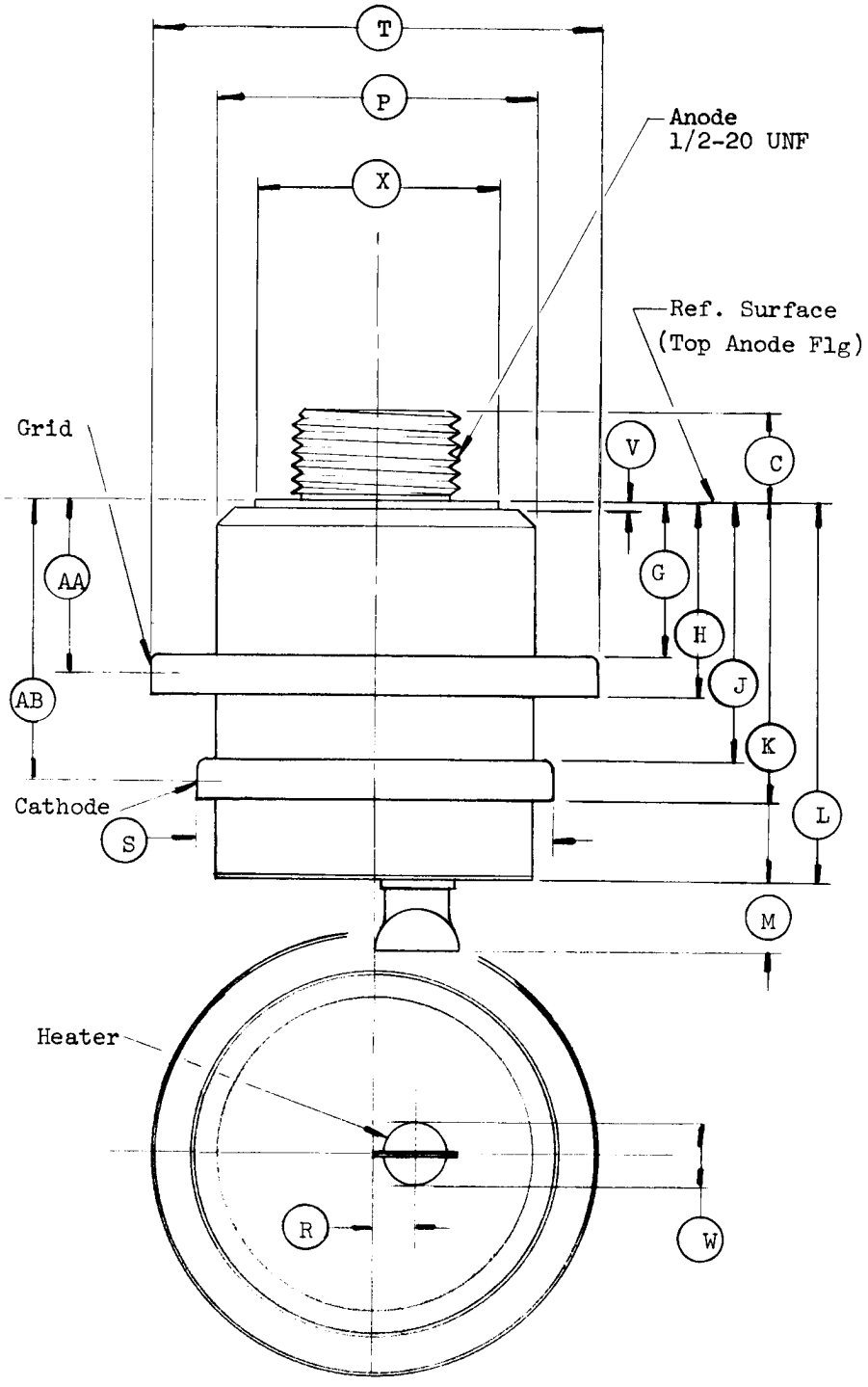
4. Describes Typical MAX. CW Operating Point.

COOLING DATA FOR 8940 IN FC 75 DIELECTRIC COOLANT



NOTES:

1. USE RADIATOR 158096 (Copper - Pin)
2. TUBE AXIS VERTICAL IN LIQUID.
3. LIQUID AMBIENT TEMPERATURE 40°C.
4. TUBE W/O COOLER STUD COOLING ONLY.
5. MAX. CW RATING - CONTACT PLANAR MGR. EIMAC, SLC ON INTERMEDIATE OR HIGHER POWERS THAN SHOWN.
6. SEAL TEMPERATURE IS MEASURED AT PLATE TO ANODE INSULATOR FLANGE (SEE 'V' ON OUTLINE DWG.)



DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
C	0.500	0.600	- -	12.70	15.24	- -
G	0.385	0.410	- -	9.78	10.41	- -
H	0.510	0.545	- -	12.95	13.84	- -
J	0.655	0.710	- -	16.64	18.03	- -
K	- -	0.845	- -	- -	21.46	- -
L	0.930	1.010	- -	23.62	25.65	- -
M	0.300	0.375	- -	7.62	9.52	- -
P	0.940	0.965	- -	23.88	24.51	- -
R	0.090	0.110	- -	2.29	2.79	- -
S	1.065	1.085	- -	27.05	27.56	- -
T	1.345	1.365	- -	34.19	34.67	- -
V	- -	0.035	- -	- -	0.89	- -
W	- -	- -	0.190	- -	- -	4.83
X	0.740	0.770	- -	18.80	19.56	- -
AA	(see note 2,3)		0.460	- -	- -	11.68
AB	(see note 2,3)		0.750	- -	- -	19.05

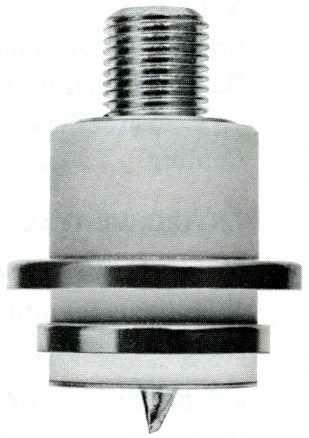
NOTES:

1. Ref. Dims. are for info. only & are not req'd for inspection purposes.
2. Contact Surface dims. AA & AB are for cavity design purposes only & are not intended as inspection criteria
3. Contact surfaces are ± .030 around dim. indicated.
4. TIR of Contact Surfaces are specified in individual Tube Electrical Specs.

8941/Y690

TECHNICAL DATA

PLANAR TRIODE



The 8941 is a planar triode of ceramic/metal construction designed for use in airborne, ground and space applications as a grid or plate pulsed oscillator, amplifier, or frequency multiplier at frequencies up to 2.0 GHz. The extended grid to cathode insulator permits reliable operation in some applications to 12 KV[1]. The other special features of this tube include high transconductance, high mu and high current capability from an arc-resistant, extended interface matrix cathode.

The tube is normally supplied without radiator and may be conduction, convection, heat sink or liquid cooled such as immersion in an insulating medium (eg. FC-75). Radiators for forced-air cooling as well as heat sink adapters permitting anode dissipations up to 750 watts are available as separate items.

The Y-690 is an 8941 which has been specially processed for series regulator and switch tube service and will operate in some applications to 15 KV[1]. Solder tabs are available on special request permitting attachment of flying leads for grid, cathode and heater connections.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 ± 0.3	V
Current, at 6.3 volts	2.25	A
Transconductance (Average):		
I_b = 160 mA	75	mmhos
Amplification Factor (Average):	200	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	14.0	pF
Cout	0.11	pF
Cgp	2.5	pF
Cut-off Bias[3]	-20	V max.
Frequency of Maximum Rating:		
CW	2000	MHz
Plate or Grid-Pulsed	2000	MHz

1. Characteristics and operating values are based upon performance tests and environmental conditions. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 2 pF due to thermal expansion of the cathode.

3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

(Effective 10-15-75) © 1975 by Varian Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:	
Length	2.235 in; 56.77 mm
Diameter	1.365 in; 34.60 mm
Net Weight	1.96 oz; 56 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250° C
Cooling	Conduction, convection, liquid or forced air

ENVIRONMENTAL

Shock: 11 ms, non-operating	60 G
Vibration: Operating, All Axis	10 G
Altitude; max., in suitably designed circuit	60,000 ft.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Heater: Current at 6.3 volts	2.05	2.50	A
Cathode Warmup Time	90	---	sec.
Interelectrode Capacitance[1] (grounded cathode connection)			
Cin	12.5	16.5	pF
Cout	---	0.11	pF
Cgp	2.0	3.0	pF

1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 2 pF due to thermal expansion of the cathode.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE (grid pulsed)	10,000	VOLTS
PEAK PULSE PLATE VOLTAGE (plate pulsed)	12,000	VOLTS
DC GRID VOLTAGE	-350	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	175	VOLTS
PULSE PLATE CURRENT	12	AMPERES
PULSE GRID CURRENT	3.0	AMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	750	WATTS
GRID DISSIPATION (Average)	2.0	WATTS
FREQUENCY	2.0	GHz
PULSE DURATION[2]	6.0	μs
DUTY FACTOR[2]	.0033	

1. Using EIMAC radiator PN 158096.

Operating Conditions for 8941 in representative applications:

	Cathode Biased, rf Pulsed Amplifier[3]	Grid Pulsed Amplifier	
Frequency	1850	1090	MHz
Heater Voltage	6.3	6.3	V
DC Plate Voltage	4500	5000	Vdc
DC Grid Voltage	-40	-60	Vdc
Peak Video Plate Current	3.1	4.0	a
Peak Video Grid Current	.6	.75	a
Useful Power Output	4.2	10.0	kw (peak)
Pulse Duration	3.0	3.0	μs
Duty Cycle	0.04	0.001	
Gain	11.5	12.0	dB
Bandwidth	20	---	MHz

2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

3. No gate pulse used.

PULSE MODULATOR AND PULSE AMPLIFIER SERVICE (Type Y-690)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	15,000	VOLTS
PEAK PLATE VOLTAGE	18,000	VOLTS
DC GRID VOLTAGE	-350	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	100	VOLTS
PULSE CATHODE CURRENT	16	AMPERES
DC PLATE CURRENT	600	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	750	WATTS
GRID DISSIPATION (Average)	2	WATTS
PULSE DURATION[2]	6.0	μs
DUTY FACTOR[2]	.0033	
CUT-OFF MU	90	

1. Using EIMAC radiator PN 158096.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

APPLICATION

For general application information please refer to the Planar Triode Operazing Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube type. For unusual and special applications consult the nearest Varian Electron Tube Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

The cathode and grid flanges should not be altered in any way such as be machining or filing, since the final seal could be damaged. Maximum torque applied to flanges during installation should not exceed 15 inch pounds.

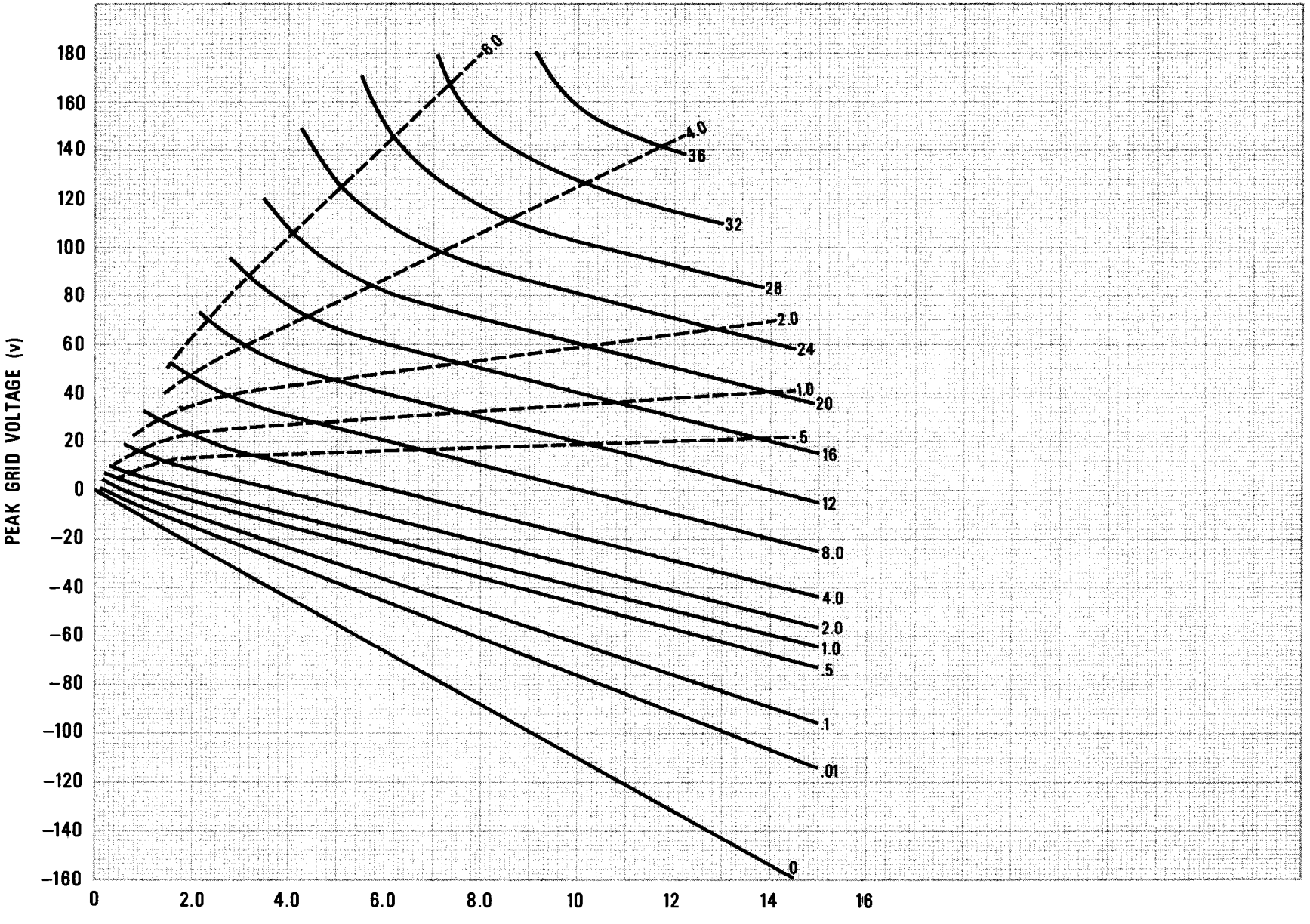
For optimum RF performance, the anode line should make good contact on the anode area indicated on the outline drawing.

Soldered connections may be made to the anode stud, grid or cathode flanges, and heater contacts where adequate heat sinking and good soldering practices are followed to minimize the heat applied to the tube and the thermal gradient across the metal to ceramic brazed areas. If forced air cooling is provided, auxiliary air flow, apart from the air flowing through the radiator, should be provided to cool the tube envelope and other tube terminals. Some conduction cooling is always provided through the contact terminals. However, these terminals usually exhibit poor heat transfer, often having a temperature gradient across them as high as 50°C.

TYPICAL CONSTANT CURRENT CHARACTERISTICS

FOR PULSE OPERATION

——— PLATE CURRENT – AMPERES – – – – GRID CURRENT – AMPERES

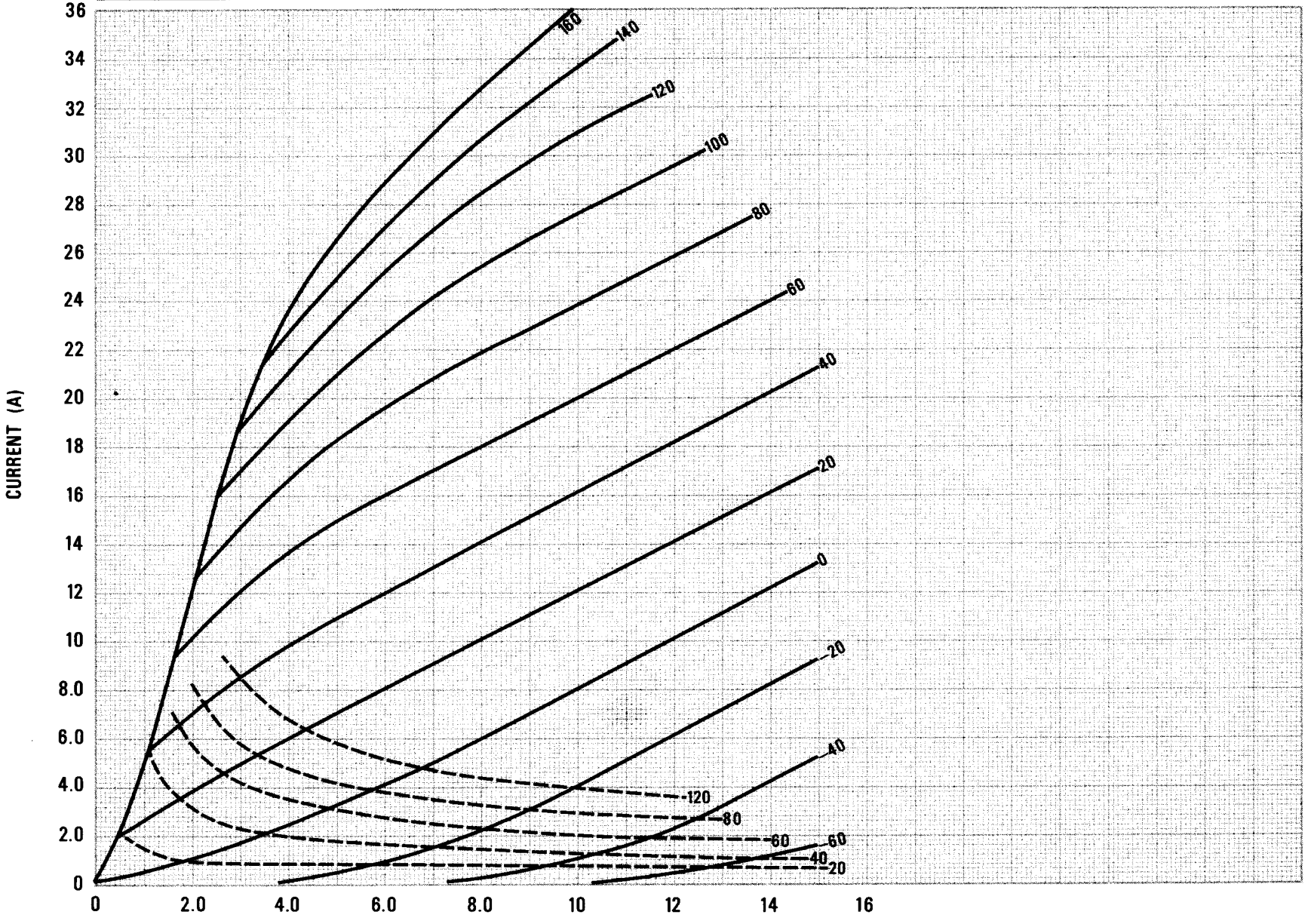


CURVE #MA–2595

TYPICAL CONSTANT GRID VOLTAGE CHARACTERISTICS

FOR PULSE OPERATION

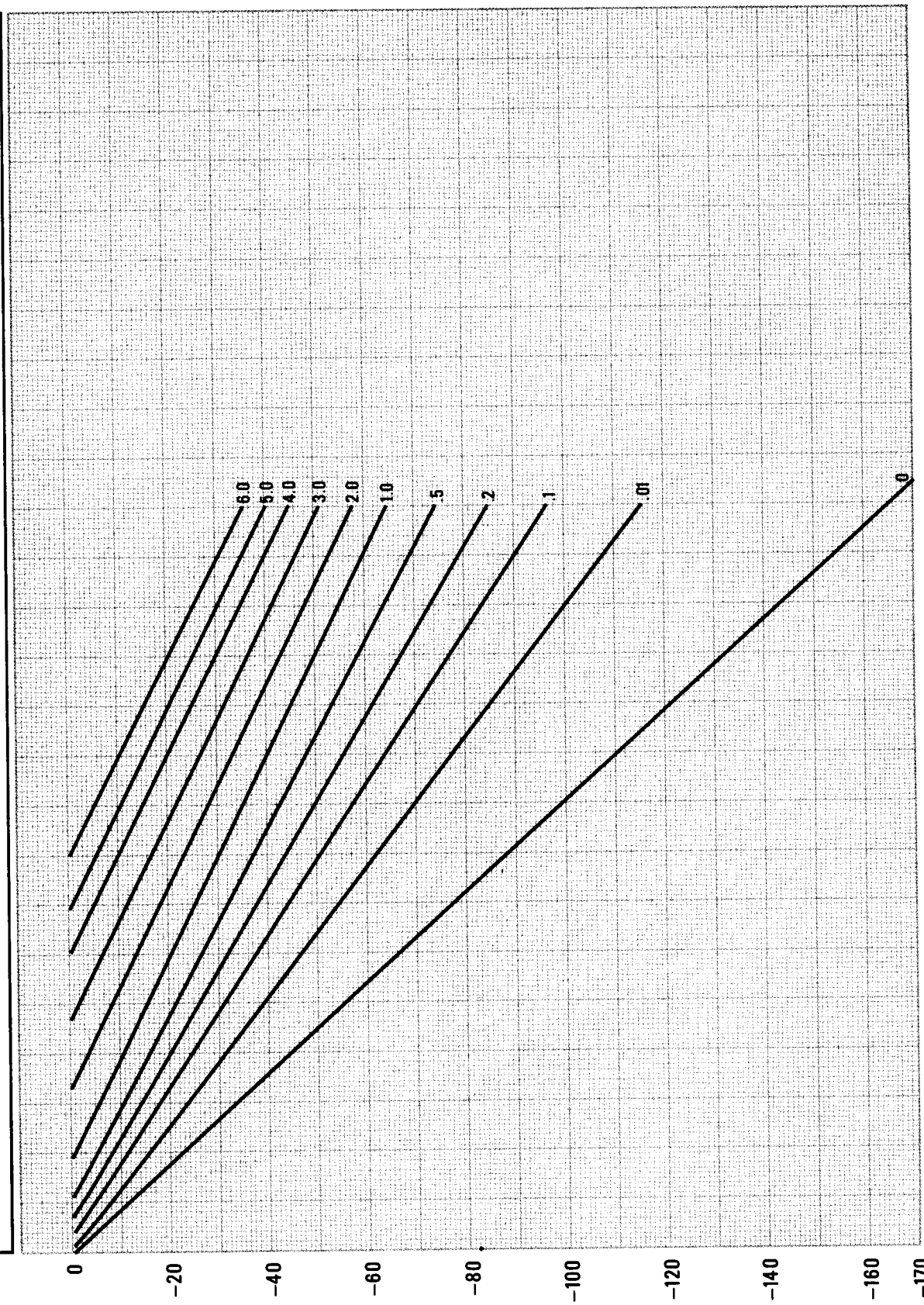
——— PLATE CURRENT – AMPERES – – – – GRID CURRENT – AMPERES



CURVE #MA–2692

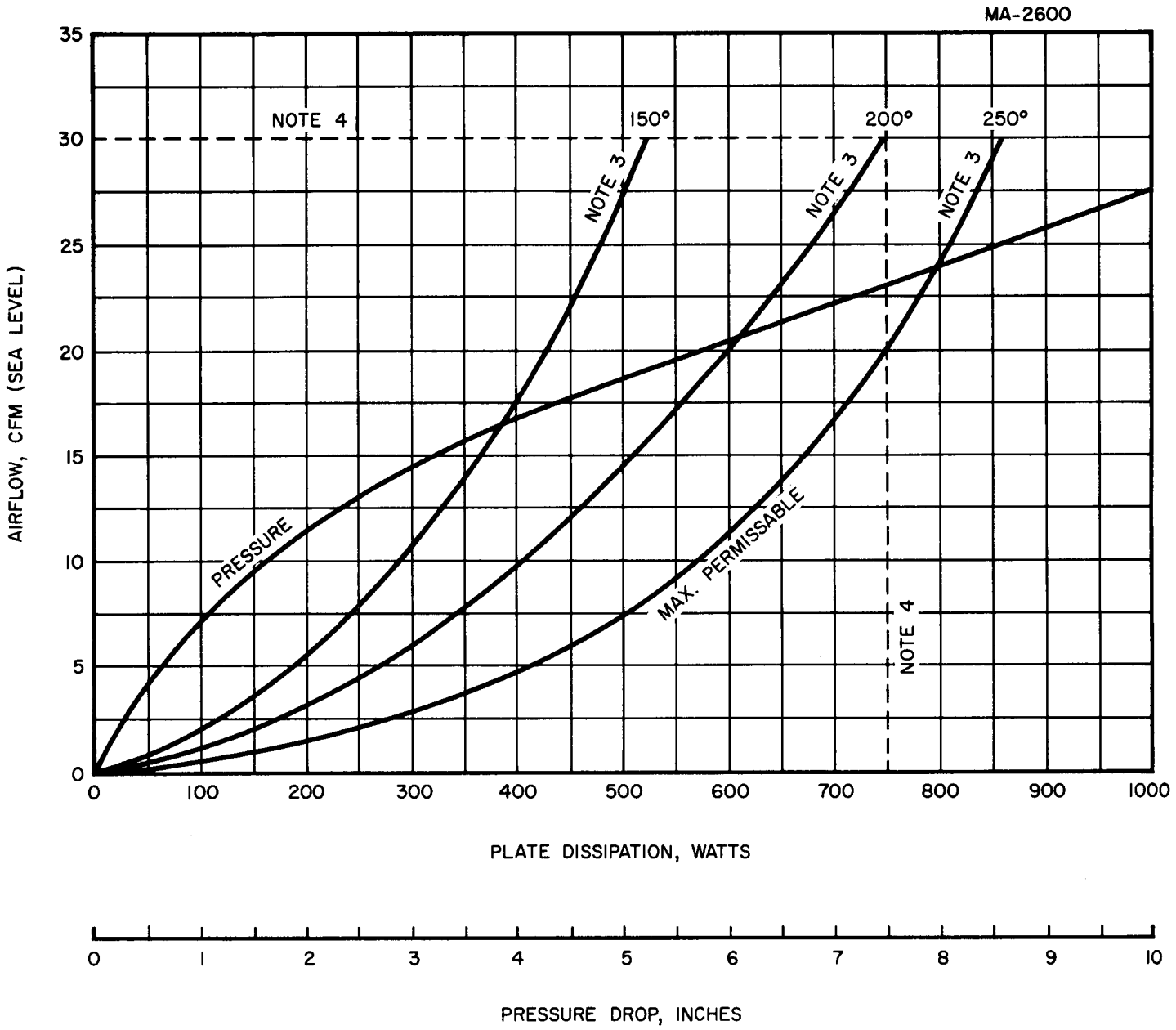
TYPICAL CONSTANT PLATE CURRENT CHARACTERISTICS

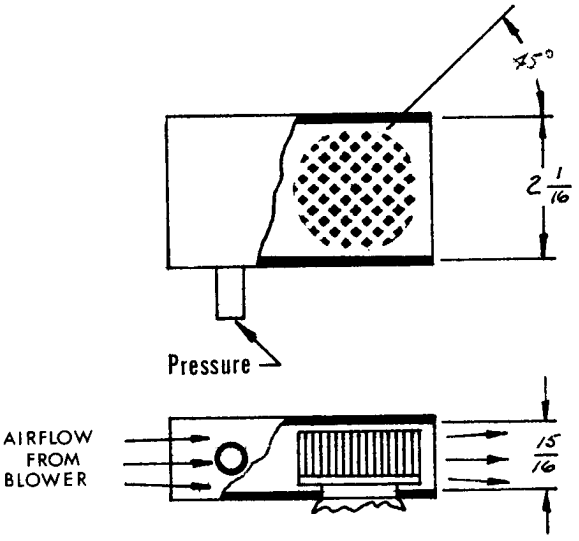
NEGATIVE GRID VOLTAGE REGION



CURVE #MA-2691

AIR COOLING DATA FOR 8941





– COWLING DETAIL –

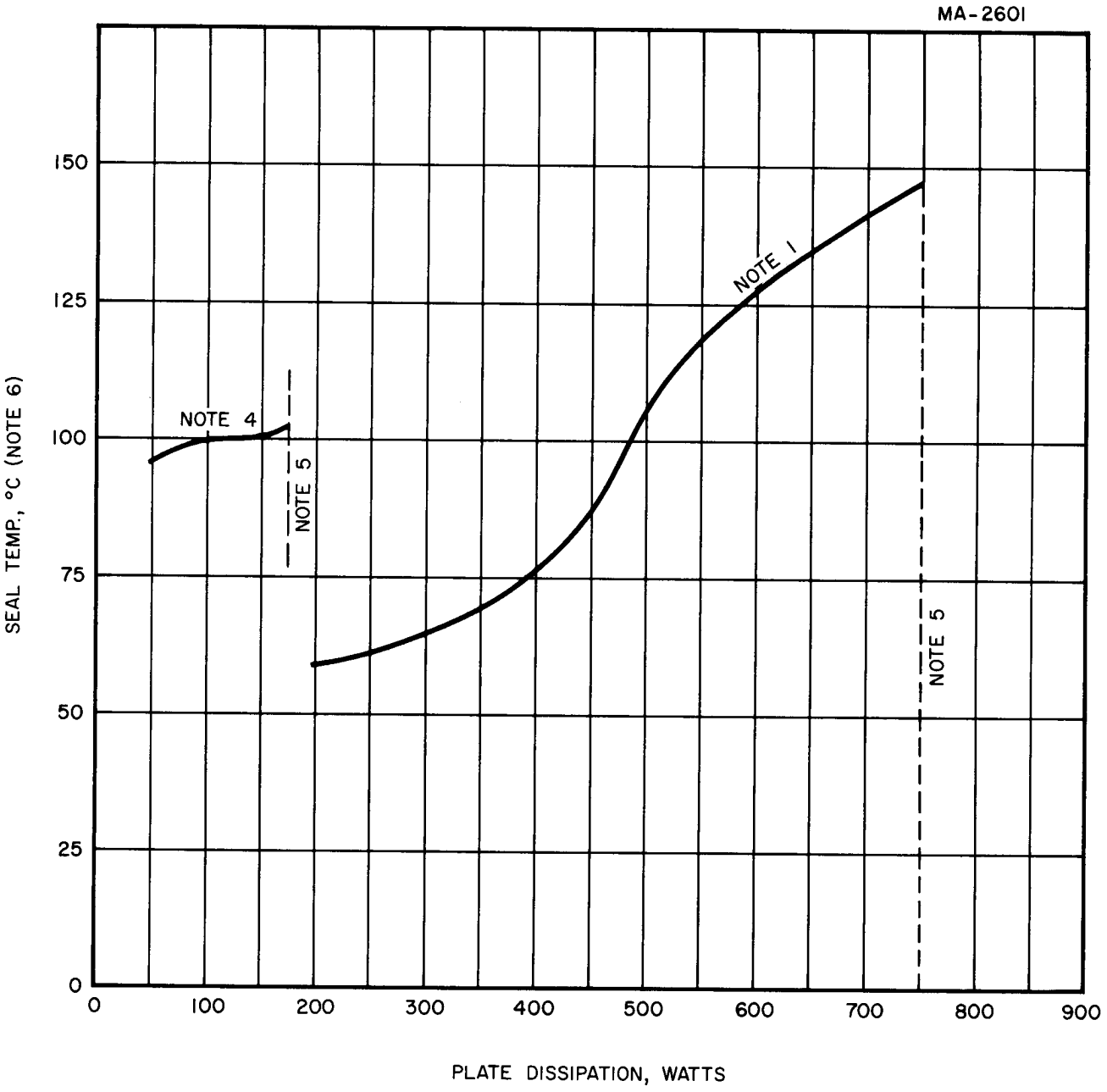
1. Inlet Air at 20° C

2. Use Radiator No. 158096 (Copper–Pin) in Cowling as shown.

3. Temp. measured at Anode Cup–Plate Insulator Seal.

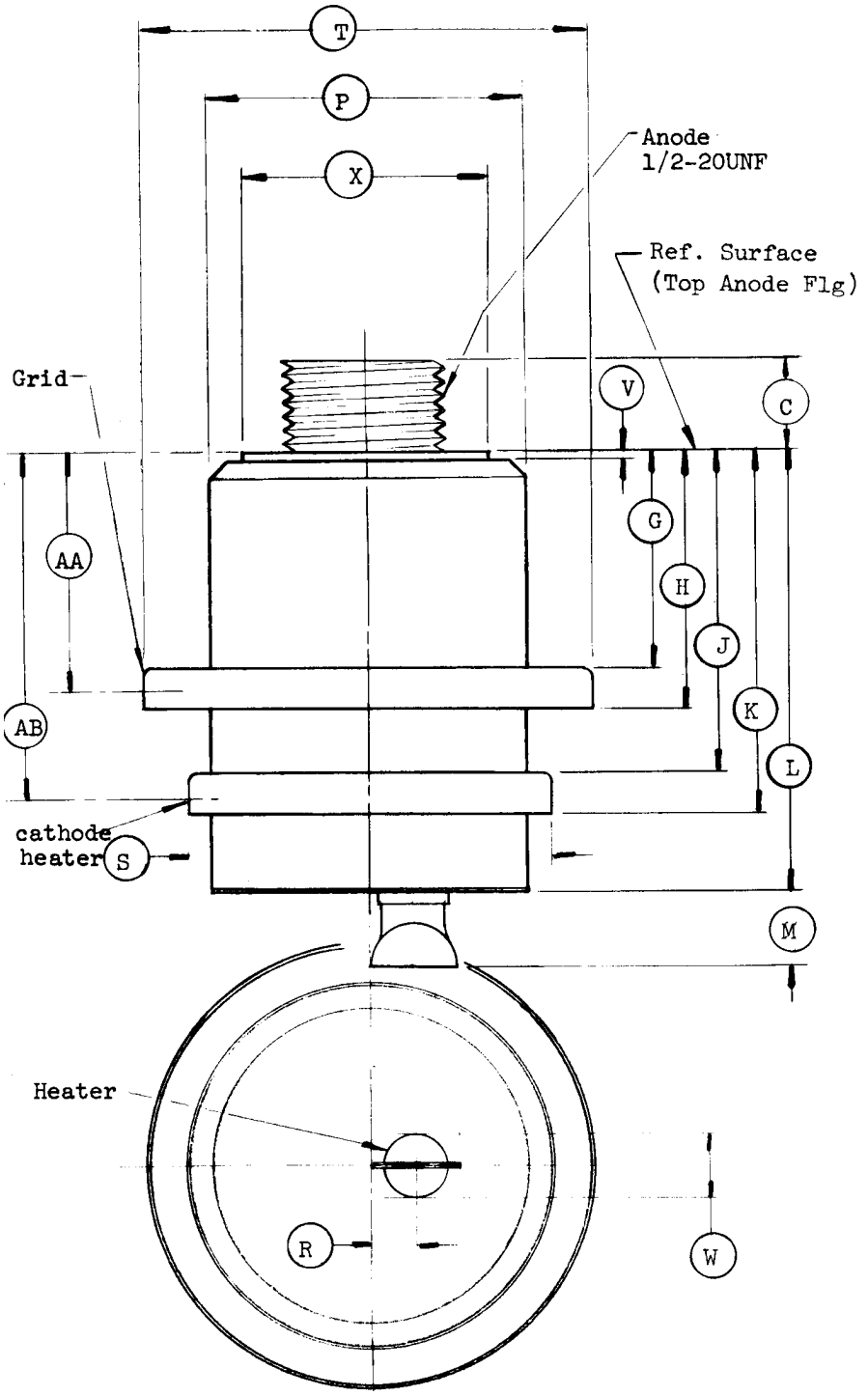
4. Describes Typical MAX. CW Operating Point.

COOLING DATA FOR 8941 IN FC 75 DIELECTRIC COOLANT



NOTES:

1. USE RADIATOR 158096 (Copper - Pin)
2. TUBE AXIS VERTICAL IN LIQUID.
3. LIQUID AMBIENT TEMPERATURE 40°C.
4. TUBE W/O COOLER STUD COOLING ONLY.
5. MAX. CW RATING - CONTACT PLANAR MGR. EIMAC, SLC ON INTERMEDIATE OR HIGHER POWERS THAN SHOWN.
6. SEAL TEMPERATURE IS MEASURED AT PLATE TO ANODE INSULATOR FLANGE (SEE 'V' ON OUTLINE DWG.)



DIM	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
C	0.500	0.600	- -	12.70	15.24	- -
G	0.635	0.660	- -	16.13	16.76	- -
H	0.760	0.795	- -	19.30	20.19	- -
J	0.905	0.960	- -	22.99	24.38	- -
K	- -	1.095	- -	- -	27.81	- -
L	1.180	1.260	- -	29.97	32.00	- -
M	0.300	0.375	- -	7.62	9.52	- -
P	0.940	0.965	- -	23.88	24.51	- -
R	0.090	0.110	- -	2.29	2.79	- -
S	1.065	1.085	- -	27.05	27.56	- -
T	1.345	1.365	- -	34.16	34.67	- -
V	- -	0.035	- -	- -	0.89	- -
W	- -	- -	0.190	- -	- -	4.83
X	0.760	0.815	- -	19.30	20.70	- -
AA	(see note 2,3)		0.710	- -	- -	18.03
AB	(see note 2,3)		1.000	- -	- -	25.40

NOTES:

1. Ref. Dims .are for info only & are not req'd for inspection purposes.
2. Contact Surface Dims. AA & AB are for cavity design purposes only & are not intended as inspection criteria
3. Contact Surfaces are ± .030 around dim. indicated.
4. TIR of Contact Surfaces are specified in individual Tube Electrical Specs.

8954

TECHNICAL DATA

VOLTAGE REGULATOR
OR SWITCH TUBE
POWER TETRODE

The EIMAC 8954 is designed for switch-tube (or modulator) and voltage regulator service, with anode current up to 8 amperes with short pulses (to 2 microseconds) and derated values of anode current at longer pulse lengths.

The tube has an oxide cathode and all electrical connections are made to solder tabs which are integral to the tube elements.

The 8954 is supplied bare-anode and is intended to be cooled by heat sink, or liquid immersion, or a combination, and is nominally rated for 600 watts of anode dissipation.

The tube is rated to operate at 5.5 kVdc in air, at sea level, or 7.5 kVdc in an insulating oil environment. The tube is designed to withstand brief fault conditions which may raise the instantaneous anode voltage to 12 kv.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater	6.0 V
Current	5.6 A
Cathode Heating Time (Minimum)	2.0 Min.
Direct Interelectrode Capacitance (Grounded Cathode)[2]	
Cin	50 pF
Cout	6.2 pF
Cgp	0.14 pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special, With Solder-Tab Terminals
Operating Position	Any
Maximum Operating Temperatures: Anode Core & Ceramic/Metal Seals	250°C
Cooling	Heat Sink/Liquid Immersion

(Effective 6-1-74) © 1974 by Varian Printed in U.S.A.

Maximum Overall Dimensions:

Length	2.52 In; 64.01 mm
Diameter	1.77 In; 44.96 mm
Net Weight	6.0 Oz; 170 gms

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 Volts	5.0	6.3	A
Cathode Warmup Time	120	---	Sec
Interelectrode Capacitances (grounded cathode circuit)[1]			
Cin	40.0	60.0	pF
Cout	5.2	7.2	pF
Cgp	----	0.15	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

PULSE MODULATOR OR SWITCH TUBE SERVICE

ABSOLUTE MAXIMUM RATINGS:

	In Air	In Oil	
HEATER VOLTAGE	6.0±5%	6.0±5%	VOLTS
DC PLATE VOLTAGE	5.5	7.5	KILOVOLTS
PEAK POSITIVE PLATE VOLTAGE	12	12	KILOVOLTS
DC SCREEN VOLTAGE	800	800	VOLTS
DC GRID VOLTAGE	-200	-200	VOLTS

	In Air	In Oil	
PEAK PLATE CURRENT[1]	8.0	8.0	AMPERES
PULSE LENGTH AND DUTY[1]	See Derating Chart		
PLATE DISSIPATION[2]	600	600	WATTS
SCREEN DISSIPATION	15	15	WATTS
GRID DISSIPATION	4	4	WATTS

1. Pulse length, peak current, and duty are inter-related. See DERATING CHART.
2. 600 W nominal; capability is dependent on cooling technique and design.

APPLICATION

MECHANICAL

MOUNTING - The 8954 may be operated in any position, with mounting normally controlled by the anode heat-sink configuration and location. No socket is required since all electrical connections are made to solder tabs which are integral to the tube elements.

COOLING - The tube is designed for use in a conduction-cooled or liquid-immersion-cooled system, where tube anode heat is transferred to a heat sink or the liquid dielectric coolant. Anode dissipation is normally limited only by the allowable temperature rise for the anode ceramic/metal seal and the anode core. In all cases, however, the cooling system must maintain the anode and ceramic/metal seal temperatures below 250°C, and in cases where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial.

In an air mounted heat-sink system, intimacy of contact between the anode surface and the sink is a factor which will effect heat transfer, and the designer is encouraged to use temperature-sensitive paint or other temperature-sensing devices in connection with any equipment design before the layout is finalized. In such a system, some air circulation around the base of the tube may also be required to maintain these ceramic/metal seals and the connection points at the solder tabs within the allowable temperature range.

ELECTRICAL

HEATER/CATHODE OPERATION - The rated heater voltage for the 8954 is 6.0 volts, as measured at the base of the tube, and variations should be restricted to plus or minus 0.3 volt for long life and consistent performance. One side of the heater is internally connected to the cathode. Heater voltage should be applied for a minimum of two minutes before high voltage is applied to the other tube elements, to allow the cathode to reach operating temperature.

ANODE CURRENT - For pulse service, either as a switch tube or modulator, or for voltage regulator applications, an anode current (during the

pulse) of 8 amperes is available with short pulses (up to 2 μs). Peak current capability, pulse length, and duty factor are inter-related and for pulse durations longer than 2 μs the DERATING CHART should be consulted. For very long pulses (1 millisecond or longer) or pure dc service, the anode current should be limited to 0.6 ampere.

HIGH VOLTAGE - For air operation, anode voltage should not exceed 5.5 kVdc at sea level. This value allows some safety factor, but at higher altitudes a reduction in voltage may be required to preclude the possibility of external tube flash-over, and the external insulating surfaces of the tube must be kept clean and free of dirt or any accumulation of grime to minimize the possibility of external breakdown. When the tube is immersed in a liquid dielectric coolant with suitable insulating properties, the allowable anode voltage is 7.5 kVdc at any altitude.

The operating voltages for this tube must be considered as potentially lethal and the equipment must be designed properly and operating precautions must be followed. The equipment must include safety enclosures for the high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors or covers are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL .

PLATE SURGE-LIMITING IMPEDANCE - Beam-power tetrodes, such as the 8954, are built with closely spaced electrodes. This results in high voltage gradients even at normal operating voltages. A high-energy arcover between electrodes may be destructive, and therefore a series impedance in the anode lead is recommended, or the anode supply should be designed so that it has sufficient self impedance, to limit the short-circuit current to 10 times the maximum pulse-current rating. Normal overload protection techniques should also be used, not only in the anode circuit but also in the screen grid circuit, to prevent tube damage in the event of a fault condition.

GRID OPERATION - The maximum rated dc grid bias voltage is -200 Vdc and the maximum grid dissipation rating is 4 watts. In normal applications the grid dissipation will not approach the maximum rating.

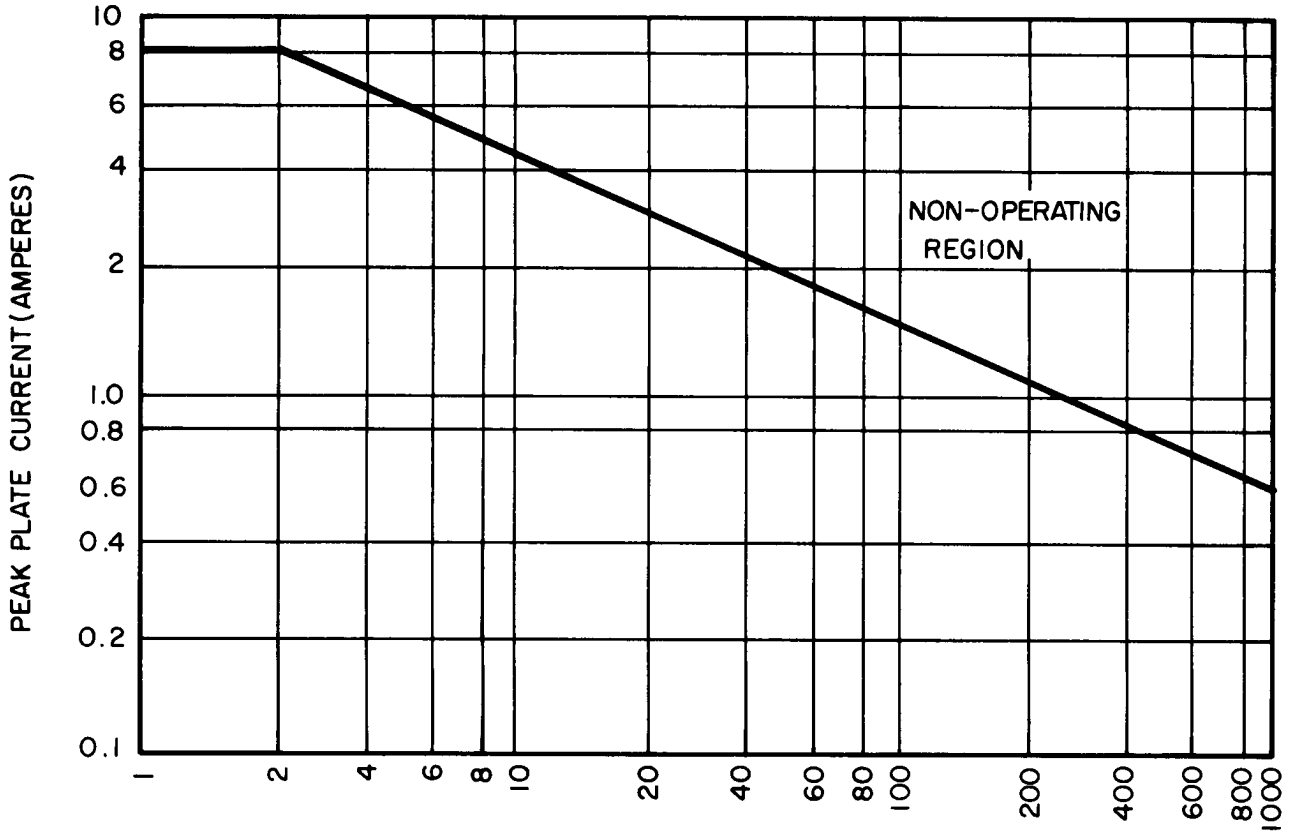
SCREEN OPERATION - The maximum rated power dissipation for the screen grid is 15 watts, and the average screen input power should be kept below this level.

It is a normal characteristic of most tetrodes for the screen current to instantaneously reverse with some combinations of element voltages and currents. The screen power supply should be designed with this in mind so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode must be provided by a bleeder resistor or shunt regulator connected between screen and cathode. A series regulator circuit can be used only when an adequate bleeder resistor is provided.

Over-current protection should be provided for the screen and it may be desirable to interlock the screen power supply so that plate voltage must be on before screen voltage can be applied.

PLATE OPERATION - The anode of the 8954 is nominally rated for 600 watts of dissipation capability. This capability is dependent on a properly designed heat sink, or the use of liquid-immersion cooling with a dielectric fluid of suitable characteristics, or a combination of both. Average anode dissipation may be calculated as the product of pulse anode current, pulse tube-voltage drop during conduction, and the duty factor. Actual dissipation may often exceed the calculated value if pulse rise and fall times are appreciable compared to pulse duration. This occurs because long rise and fall times slow down the plate voltage swing and allow plate current to flow for longer periods in the high tube-voltage-drop region.

SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to: Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

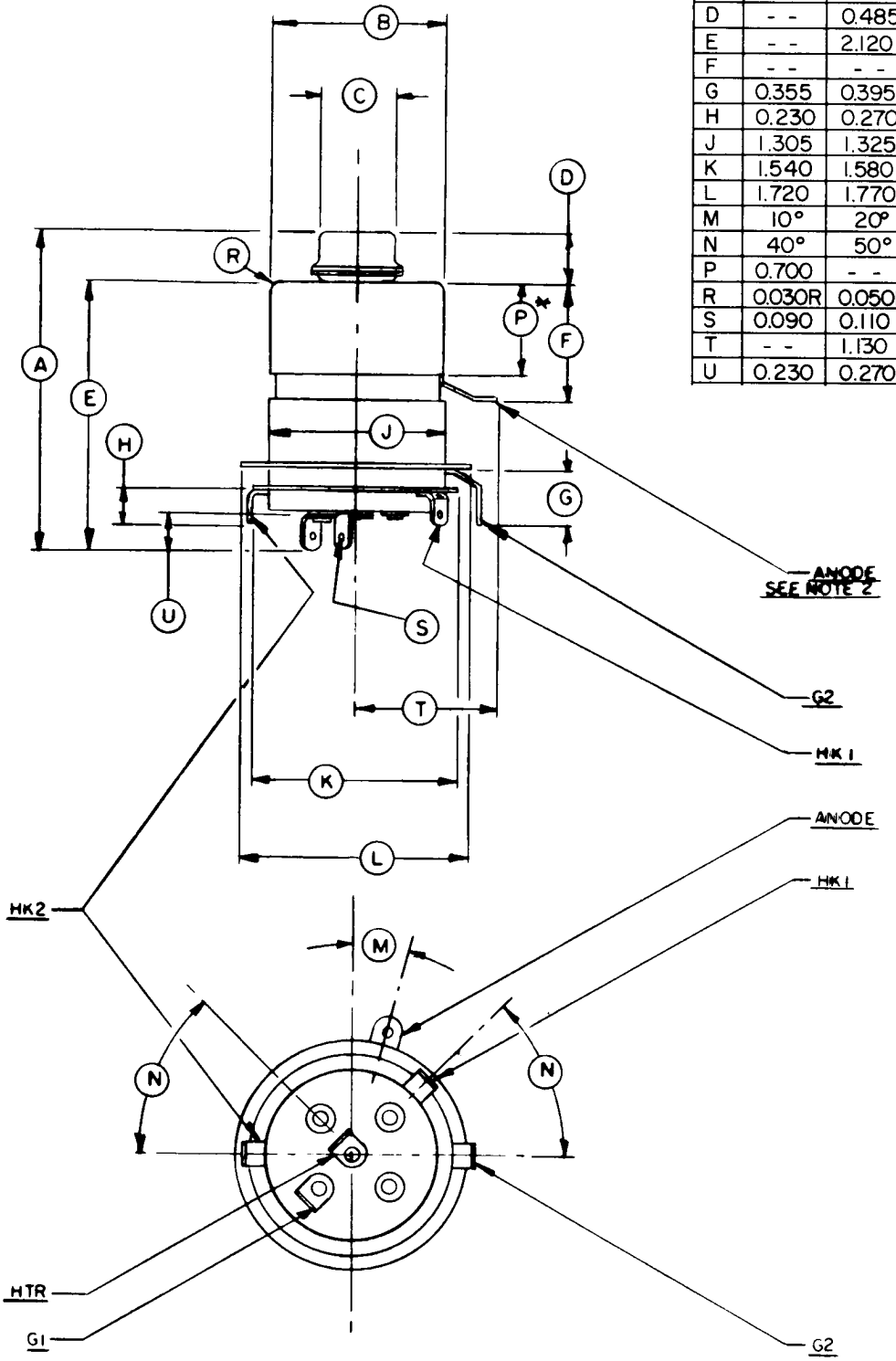


PEAK (PULSE) PLATE CURRENT CAPABILITY IS DEPENDENT ON PULSE DURATION (tp) AND DUTY FACTOR (Du). MAXIMUM PEAK PLATE CURRENT FOR A GIVEN PULSE DURATION IS SHOWN. MAXIMUM DUTY MAY THEN BE DERIVED FROM THE RELATIONSHIP:

$$0.6 = ib\sqrt{Du}$$

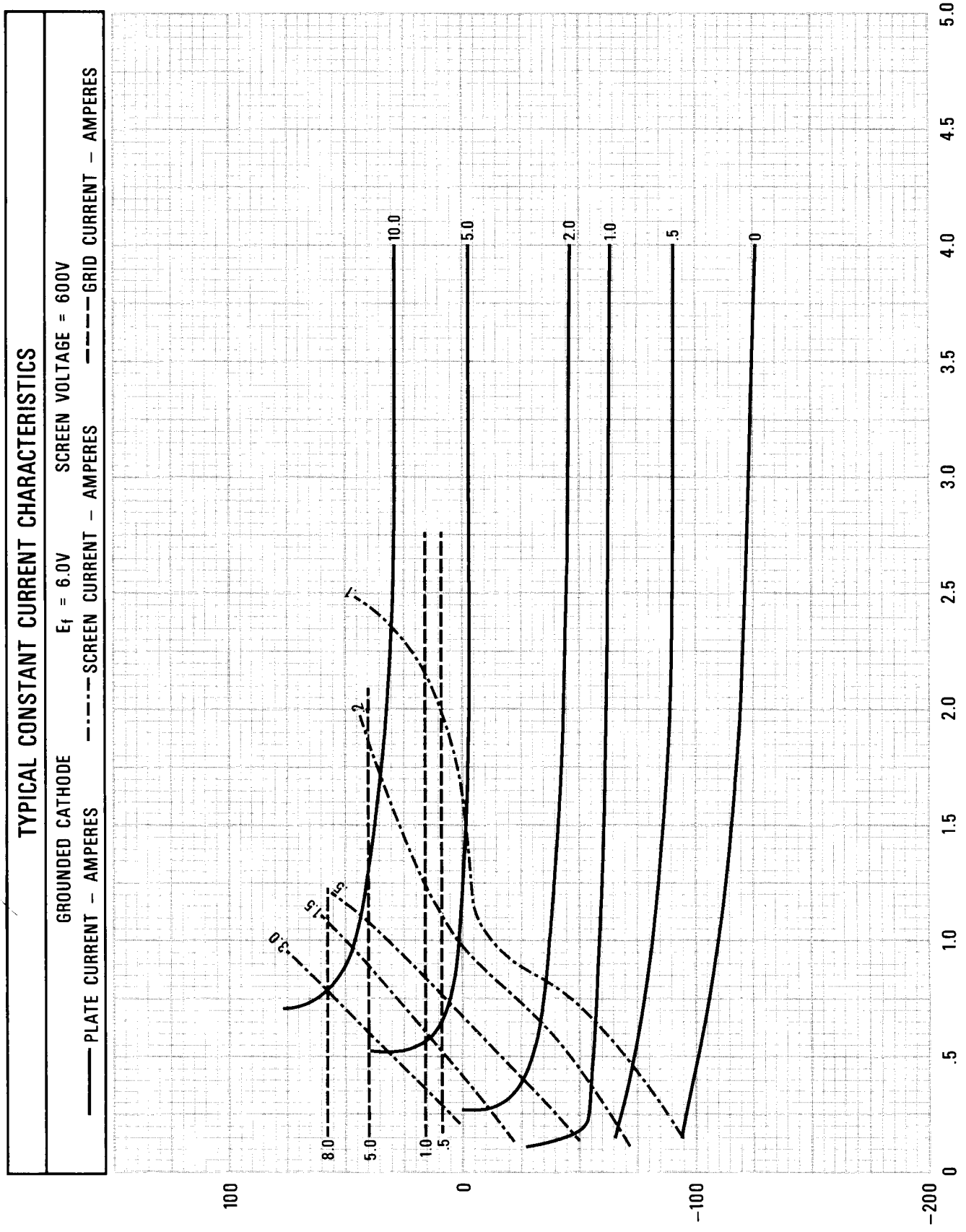
PULSE DE-RATING DATA, TYPE 8954

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	- -	- -	2.500	- -	- -	63.50
B	1.298	1.302	- -	32.96	33.07	- -
C	0.559	0.573	- -	14.19	14.55	- -
D	- -	0.485	- -	- -	12.31	- -
E	- -	2.120	- -	- -	53.84	- -
F	- -	- -	0.887	- -	- -	22.52
G	0.355	0.395	- -	9.01	10.03	- -
H	0.230	0.270	- -	5.84	6.85	- -
J	1.305	1.325	- -	33.14	33.65	- -
K	1.540	1.580	- -	39.11	40.13	- -
L	1.720	1.770	- -	43.68	44.95	- -
M	10°	20°	- -	10°	20°	- -
N	40°	50°	- -	40°	50°	- -
P	0.700	- -	- -	17.78	- -	- -
R	0.030R	0.050R	- -	0.76R	1.27R	- -
S	0.090	0.110	- -	2.28	2.79	- -
T	- -	1.130	- -	- -	28.70	- -
U	0.230	0.270	- -	5.84	6.85	- -



NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. ANODE TAB IS ROTATED 75°. SEE BOTTOM VIEW FOR TAB ORIENTATION.
3. (*) CONTACT SURFACE.

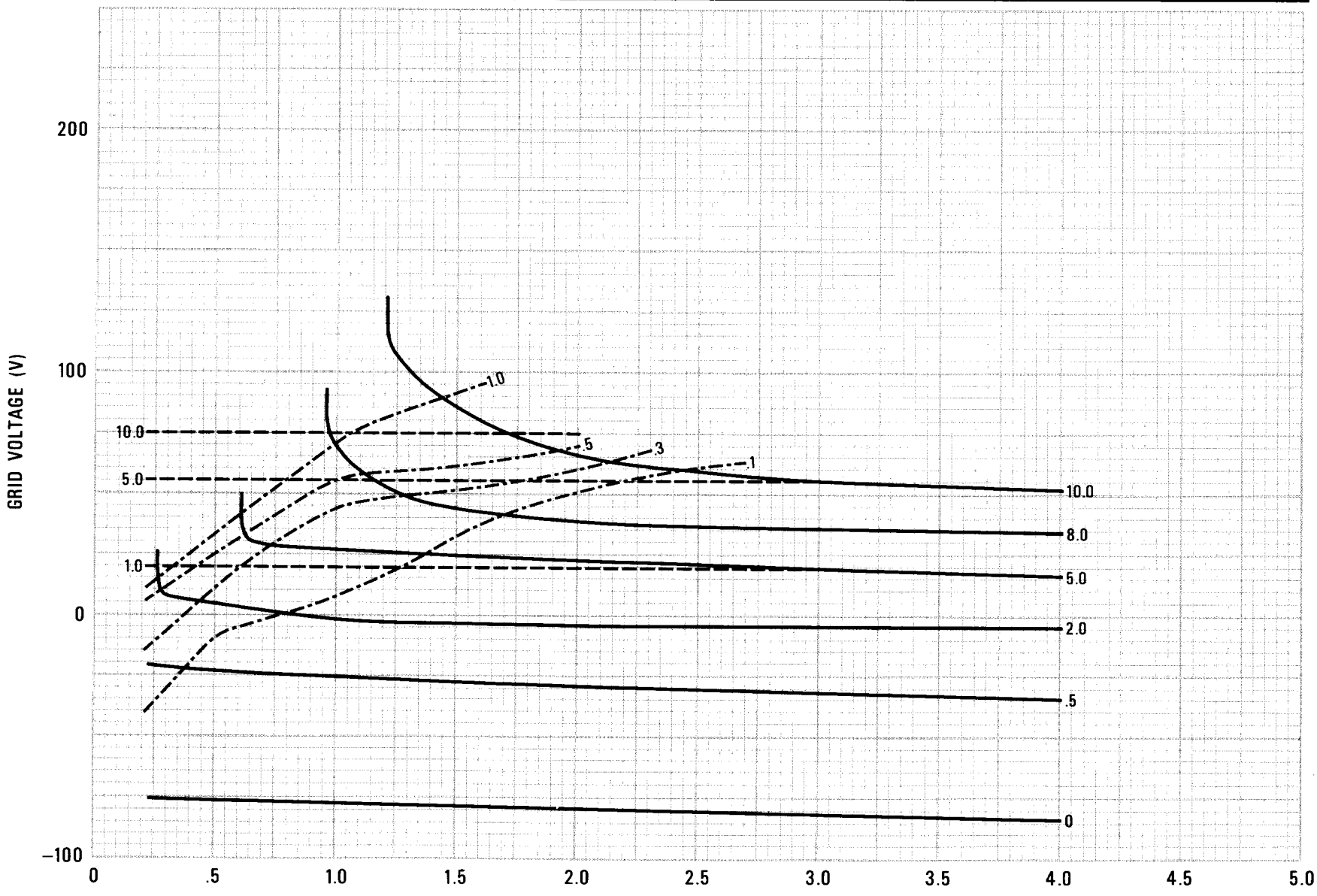

TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
E_f = 6.0V
SCREEN VOLTAGE = 600V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
100
0
−100
−200
8.0
5.0
1.0
.5
3.0
1.5
.5
2
1
10.0
5.0
2.0
1.0
.5
0
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
PLATE VOLTAGE (kV)

CURVE #4516

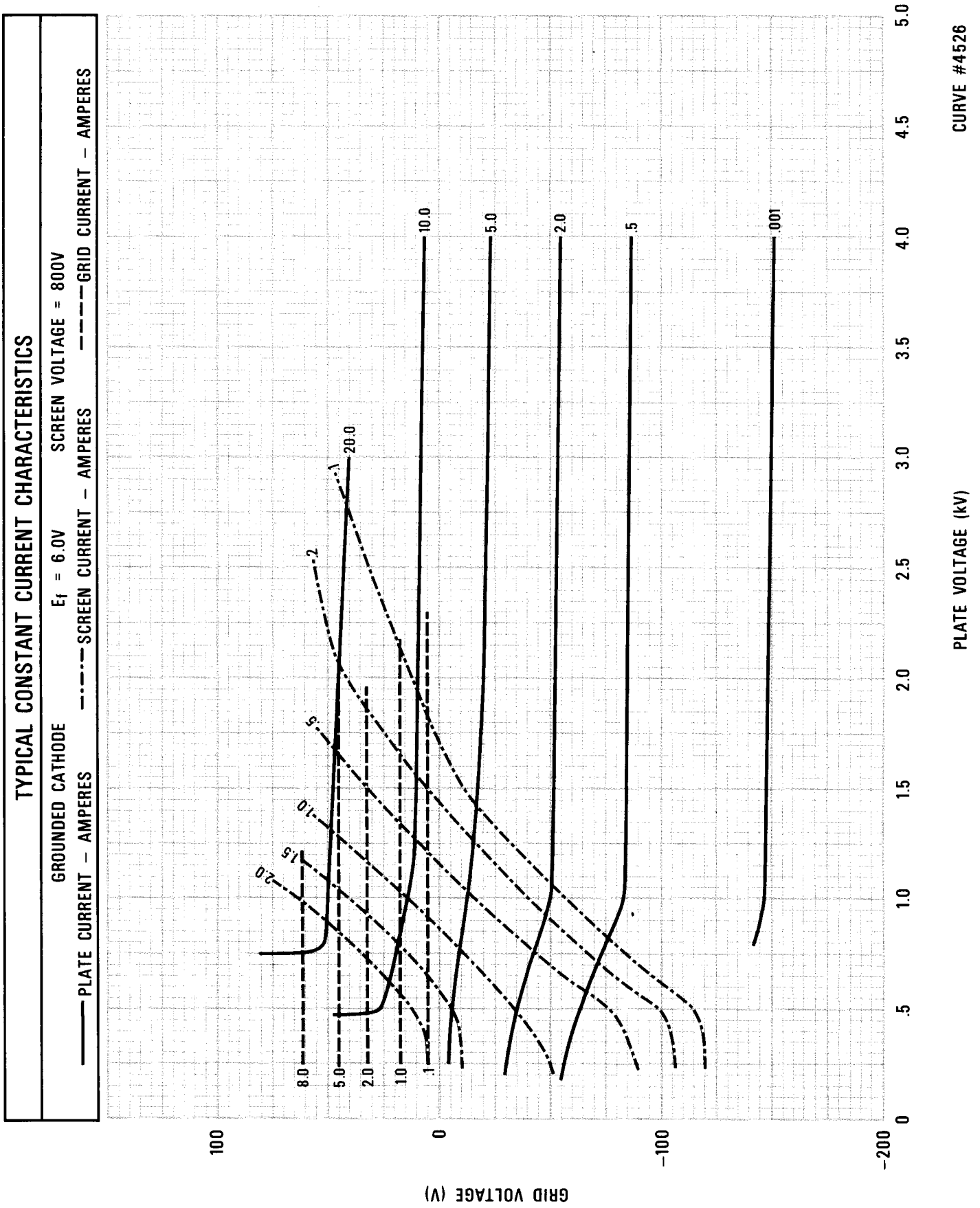
TYPICAL CONSTANT CURRENT CHARACTERISTICS

GROUNDED CATHODE E_f = 6.0V SCREEN VOLTAGE = 400V

PLATE CURRENT – AMPERES — SCREEN CURRENT – AMPERES — GRID CURRENT – AMPERES



CURVE #4518


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
E_f = 6.0V
SCREEN VOLTAGE = 800V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
100
0
−100
−200
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
PLATE VOLTAGE (kV)
CURVE #4526
8.0
5.0
2.0
1.0
.1
20.0
.1
.2
.5
1.0
1.5
2.0
10.0
5.0
2.0
.5
.001

TECHNICAL DATA

8957
4CX250BC

RADIAL-BEAM
POWER TETRODE

The 8957/4CX250BC is a ceramic/metal, forced-air cooled, external-anode radial-beam tetrode with a maximum plate dissipation rating of 250 watts and a maximum input power rating of 500 watts. It is intended for use as an oscillator, amplifier, or modulator.

The 8957/4CX250BC is especially recommended as a premium-quality replacement for the 7203/4CX250B, in applications where long life and consistent performance are of prime concern and the closer heater voltage tolerance and increased cathode warmup time are acceptable.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3	V
Current, at 6.0 volts	2.4	A
Cathode-Heater Potential, maximum	±150	V
Amplification Factor (Average):		
Grid to Screen	5	
Direct Interelectrode Capacitances (grounded cathode) [2]		
Cin	15.7	pF
Cout	4.5	pF
Cgp	0.04	pF
Direct Interelectrode Capacitances (grounded grid and screen) [2]		
Cin	13.0	pF
Cout	4.5	pF
Cpk	0.01	pF
Frequency of Maximum Rating:		
CW	500	MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:		
Length	2.46 in; 62.5	mm
Diameter	1.64 in; 41.7	mm
Net Weight	4 oz; 113	gm
Operating Position	Any	

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Maximum Operating Temperature:

Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Forced Air
Base	Special 9-pin JEDEC-B8-236
Recommended Socket	EIMAC SK-600 Series
Recommended Chimney	EIMAC SK-600 Series

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN (SSB)

Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage [1]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Single Tone Plate Current	250	250	250	mAdc
Two-Tone Plate Current	190	190	190	mAdc
Single-Tone Screen Current [2]	18	16	13	mAdc
Two-Tone Screen Current [2]	8	5	3	mAdc
Single-Tone Grid Current [2]	0	0	0	mAdc
Peak rf Grid Voltage [2]	50	50	50	v
Plate Output Power	120	215	300	W
Resonant Load Impedance	2000	3000	4000	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN, CARRIER CONDITIONS

Class AB_1

MAXIMUM RATINGS:

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)
Class AB1, Grid Driven

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage [1]	-55	-55	-55	Vdc
Zero-Signal Plate Current	100	100	100	mAdc
Carrier Plate Current	150	150	150	mAdc
Carrier Screen Current	5	4	4	mAdc
Peak rf Grid Voltage [2]	25	25	25	v
Plate Output Power	30	50	65	W

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM
(Key-Down Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)					500 MHz	
Plate Voltage	500	1000	1500	2000	2000	Vdc
Screen Voltage	250	250	250	250	300	Vdc
Grid Voltage	-90	-90	-90	-90	-90	Vdc
Plate Current	250	250	250	250	250	mAdc [2]
Screen Current [1]	45	40	27	25	16	mAdc [2]
Grid Current [1]	35	31	28	26	25	mAdc
Peak rf Grid Voltage [1]	114	114	112	112	---	v
Measured Driving Power [1]	4.0	3.5	3.2	2.9	---	W
Plate Input Power	125	250	375	500	500	W
Plate Output Power	70	190	280	390	300	W [2]
Heater Voltage	6.0	6.0	6.0	6.0	5.7	V

1. Approximate value.
2. Measured values for a typical cavity amplifier circuit.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class C Telephony (Carrier Conditions)

MAXIMUM RATINGS:

DC PLATE VOLTAGE	1500	VOLTS
DC SCREEN VOLTAGE	300	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.20	AMPERE
PLATE DISSIPATION[1]	165	WATTS
SCREEN DISSIPATION[2]	12	WATTS
GRID DISSIPATION[2]	2	WATTS

TYPICAL OPERATION (Frequencies to 175 MHz)

Plate Voltage	500	1000	1500	Vdc
Screen Voltage	250	250	250	Vdc
Grid Voltage	-100	-100	-100	Vdc
Plate Current	200	200	200	mAdc
Screen Current[3]	37	30	27	mAdc
Grid Current[3]	15	14	14	mAdc
Peak rf Grid Voltage[3]	118	117	117	v
Calculated Driving Power	1.8	1.7	1.7	W
Plate Input Power	100	200	300	W
Plate Output Power	60	145	235	W

1. Corresponds to 250 watts at 100% sine-wave modulation.
2. Average, with or without modulation.
3. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB , Grid Driven (Sinusoidal Wave)

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	2000	VOLTS
DC SCREEN VOLTAGE	400	VOLTS
DC GRID VOLTAGE	-250	VOLTS
DC PLATE CURRENT	0.25	AMPERE
PLATE DISSIPATION	250	WATTS
SCREEN DISSIPATION	12	WATTS
GRID DISSIPATION	2	WATTS

1. Approximate value.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	1000	1500	2000	Vdc
Screen Voltage	350	350	350	Vdc
Grid Voltage[1/3]	-55	-55	-55	Vdc
Zero-Signal Plate Current	200	200	200	mAdc
Max Signal Plate Current	500	500	500	mAdc
Max Signal Screen Current[1]	26	22	16	mAdc
Max Signal Grid Current[1]	0	0	0	mAdc
Peak af Grid Voltage[2]	50	50	50	v
Peak Driving Power	0	0	0	w
Plate Input Power	500	750	1000	W
Plate Output Power	240	430	600	W
Load Resistance (plate to plate)	3500	6200	9500	Ω

2. Per tube.
3. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data is obtained by direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In Class C service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.		Max.	
Heater: Current at 6.0 volts	2.2	---	2.7	A
Cathode Warmup Time, with Heater Voltage at 6.0 volts	60	---	---	sec.
Interelectrode Capacitances[1] (grounded cathode connection)				
Cin	14.2	---	17.2	pF
Cout	4.0	---	5.0	pF
Cgp	---	---	0.06	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

MOUNTING - The 4CX250BC may be operated in any position. An EIMAC Air-System Socket, SK-600 series, or a socket having equivalent characteristics, is required. Sockets are available with or without built-in screen capacitors and may be obtained with either grounded or ungrounded cathode terminals. SK-600 series Air Chimneys are also available.

COOLING - Sufficient forced-air cooling must be provided for the anode, base seals, and body seals to maintain operating temperatures below the rated maximum values. Air requirements to maintain anode core temperatures at 225°C with an inlet air temperature of 50°C are tabulated below. These requirements apply when a socket of the EIMAC SK-600 series and an EIMAC SK-606 chimney are used with air flow in the base to anode direction.

SEA LEVEL			10,000 FEET	
Plate Dissipation (Watts)	Air Flow (CFM)	Pressure Drop(In. of water)	Air Flow (CFM)	Pressure Drop(In. of water)
200	4.2	0.4	6.1	0.6
250	5.7	0.7	8.2	1.0

The blower selected in a given application must be capable of supplying the desired airflow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters. The blower must be designed to deliver the air at the desired altitude.

At 500 MHz or below, base cooling air requirements are satisfied automatically when the tube is operated in an EIMAC Air-System Socket and the recommended air flow rates are used. Experience has shown that if reliable long life operation is to be obtained, the cooling air flow must be maintained during standby periods when only the heater voltage is applied to the tube. The anode cooler should be inspected periodically and cleaned when necessary to remove any dirt which might interfere with effective cooling.

VIBRATION - This tube is designed to provide reliable service under ordinary shock and vibration conditions, such as encountered in mobile installations. However, when severe shock, or high-level and high-frequency vibration are expected, it is suggested that the EIMAC 7580W/4CX250R be employed.

ELECTRICAL

HEATER - The nominal heater voltage for the 4CX250BC is 6.0 volts when the voltage regulation is held to ±5%, and operation at this voltage and regulation will provide good life and stable performance. Regulation to a tolerance better than ±5% normally will be beneficial as regards life expectancy, and if variation can be held to ±1%, then the voltage may be reduced to as low as 5.7 volts, for greatest life expectancy. When this is done, however, voltage should be set and monitored with a voltmeter of high accuracy, which should be of the true-rms responding type.

Cathode peak current capability is dependent on cathode temperature, which is controlled by the heater operating voltage. Individual testing of the 4CX250BC assures adequate emission characteristics for normal rf or audio applications with heater voltage as low as 5.7 volts. Operation with the voltage lower than 5.7 volts should not be attempted at frequencies below UHF or cathode damage may result.

For pulse service, the full nominal value of 6.0 volts should be used on the heater.

At frequencies above approximately 300 MHz transit-time effects begin to influence the cathode temperature. The amount of driving power diverted to heating the cathode by back-bombardment will depend on frequency and operating conditions. When the tube is driven to a maximum input as a Class C amplifier, the heater voltage should be reduced in general accordance with the table below:

	Volt. Reg. to ±5%	Volt. Reg. to ±1%
300 MHz or lower	6.00 V	5.70 V
301 to 400 MHz	5.85 V	5.60 V
401 to 500 MHz	5.70 V	5.50 V

CATHODE OPERATION - The oxide coated unipotential cathode must be protected against excessively high emission current. The maximum rated dc input current (anode) is 200 mAdc for plate-modulated operation and 250 mAdc for all other types of operation except pulse.

The cathode is internally connected to the four even-numbered base pins and all four of the corresponding socket terminals should be used to make connection to the external circuits. At radio frequencies it is important to keep the cathode leads short and direct and to use conductors with large areas to minimize the inductive reactances in series with the cathode leads.

It is recommended that rated heater voltage be applied for a minimum of 60 seconds before other operating voltages are applied. If reduced heater voltage is being used, with close voltage regulation, a warmup time of longer than 60 seconds should be allowed. If the 4CX250BC is used as a replacement for the 7203/4CX250B, adjustment of the warmup time-delay relay may be required, since some equipments designed for the 4CX250B used a time delay setting as short as 30 seconds.

Where the circuit design requires the cathode and heater to be operated at different potentials, the rated maximum heater-to-cathode voltage is 150 volts, regardless of the polarity.

GRID OPERATION - The maximum rated dc grid bias voltage is -250 volts and the maximum grid dissipation rating is 2.0 watts. In ordinary audio and radio-frequency amplifiers the grid dissipation usually will not approach the maximum rating. At operating frequencies above the 100 MHz region, driving power requirements for amplifiers increase noticeably. At 500 MHz as much as 20 watts of driving power may have to be supplied. However, most of the driving power is absorbed in circuit losses other than grid dissipation, so that grid dissipation is increased only slightly. Satisfactory 500 MHz operation of the tube in a stable amplifier is indicated by grid-current values below approximately 25 mA.

The grid voltage required by different tubes may vary between limits approximately 20% above and below the center value, and means should be provided in the equipment to accommodate such variation. It is especially important that variations between individual tubes be compensated when tubes are operated in parallel or push-pull circuits, to assure equal load sharing.

This maximum permissible grid-circuit resistance per tube is 100,000 ohms.

SCREEN OPERATION - The maximum rated power dissipation for the screen is 12 watts, and the screen input power should be kept below that level. The product of the peak screen voltage and the indicated dc screen current approximates the screen input power except when the screen current indication is near zero.

In the usual tetrode amplifier, where no signal voltage appears between cathode and screen, the peak screen voltage is equal to the dc screen voltage.

When signal voltages appear between screen and cathode, as in the case of screen-modulated amplifiers or cathode-driven tetrode amplifiers, the peak screen-to-cathode voltage is the sum of the dc screen voltage and the peak ac or rf signal voltage applied to screen or cathode.

Protection for the screen should be provided by an over-current relay and by interlocking the screen supply so that plate voltage must be applied before screen voltage can be applied.

It is a normal characteristic of most tetrodes for the screen current to reverse under certain operating conditions, producing a negative current indication on the screen milliammeter. Though there is considerably less likelihood of this happening with the 4CX250BC than with similar types, the screen power supply should be designed with this characteristic in mind so that the correct operating voltage will be maintained on the screen under all conditions. A current path from screen to cathode should be provided by a bleeder resistor or a suitable regulating device, arranged to pass a minimum of 5 milliamperes per connected screen.

PLATE OPERATION - The maximum rated plate dissipation power is 250 watts. In plate-modulated applications the carrier plate dissipation power must be limited to 165 watts to avoid exceeding the plate dissipation rating with 100% sine wave modulation. The maximum dissipation rating may be exceeded for brief periods during circuit adjustment without damage to the tube.

MULTIPLE OPERATION - Tubes operating in parallel or push-pull must share the load equally. It is good engineering practice to provide individual metering and individual adjustment of bias or screen voltage to equalize the inputs.

Where overload protection is provided, it should be capable of protecting the surviving tube (s) in the event that one tube fails.

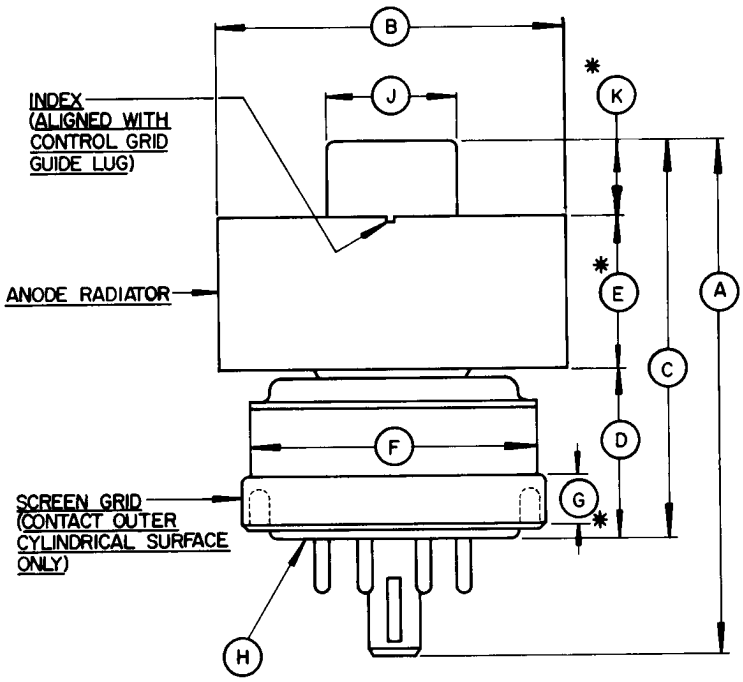
VHF OPERATION - The 4CX250BC is suitable for use in the VHF region. Such operation should be conducted with heavy plate loading, minimum bias, and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

HIGH VOLTAGE - Normal operating voltages used with the 4CX250BC are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - If it is desired to operate these tubes under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, San Carlos, Calif. 94070 for information and recommendations.



DIMENSIONAL DATA/						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	2.324	2.464	- -	59.03	62.59	- -
B	1.610	1.640	- -	40.89	41.66	- -
C	1.810	1.910	- -	46.00	48.51	- -
D	0.750	0.810	- -	19.05	20.57	- -
E	0.710	0.790	- -	18.03	20.07	- -
F	- -	1.406	- -	- -	35.71	- -
G	0.187	- -	- -	4.75	- -	- -
H	BASE: B8-236 (JEDEC DESIGNATION)					
J	0.559	0.573	- -	14.20	14.55	- -
K	0.240	- -	- -	6.10	- -	- -

NOTES:
1. REF DIMS. ARE FOR INFO ONLY AND ARE NOT REQD. FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACES.

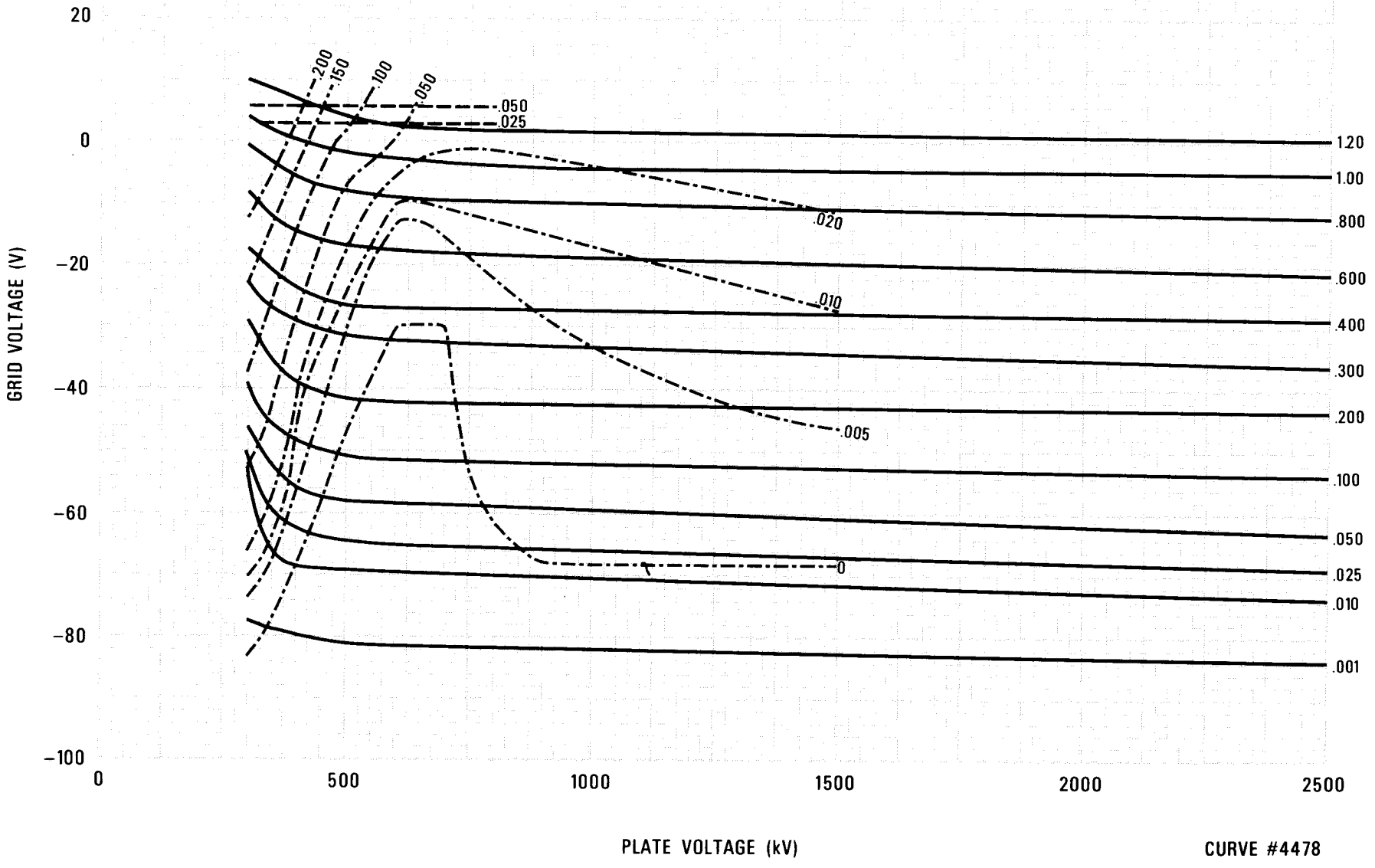
PIN DESIGNATION

PIN NO. 1	SCREEN GRID
PIN NO. 2	CATHODE
PIN NO. 3	HEATER
PIN NO. 4	CATHODE
PIN NO. 5	I.C. DO NOT USE FOR EXTERNAL CONNECTION.
PIN NO. 6	CATHODE
PIN NO. 7	HEATER
PIN NO. 8	CATHODE
CENTER PIN	CONTROL GRID

TYPICAL CONSTANT CURRENT CHARACTERISTICS

GROUNDED CATHODE E_f = 6.0V SCREEN VOLTAGE = 350V

PLATE CURRENT – AMPERES — SCREEN CURRENT – AMPERES — GRID CURRENT – AMPERES

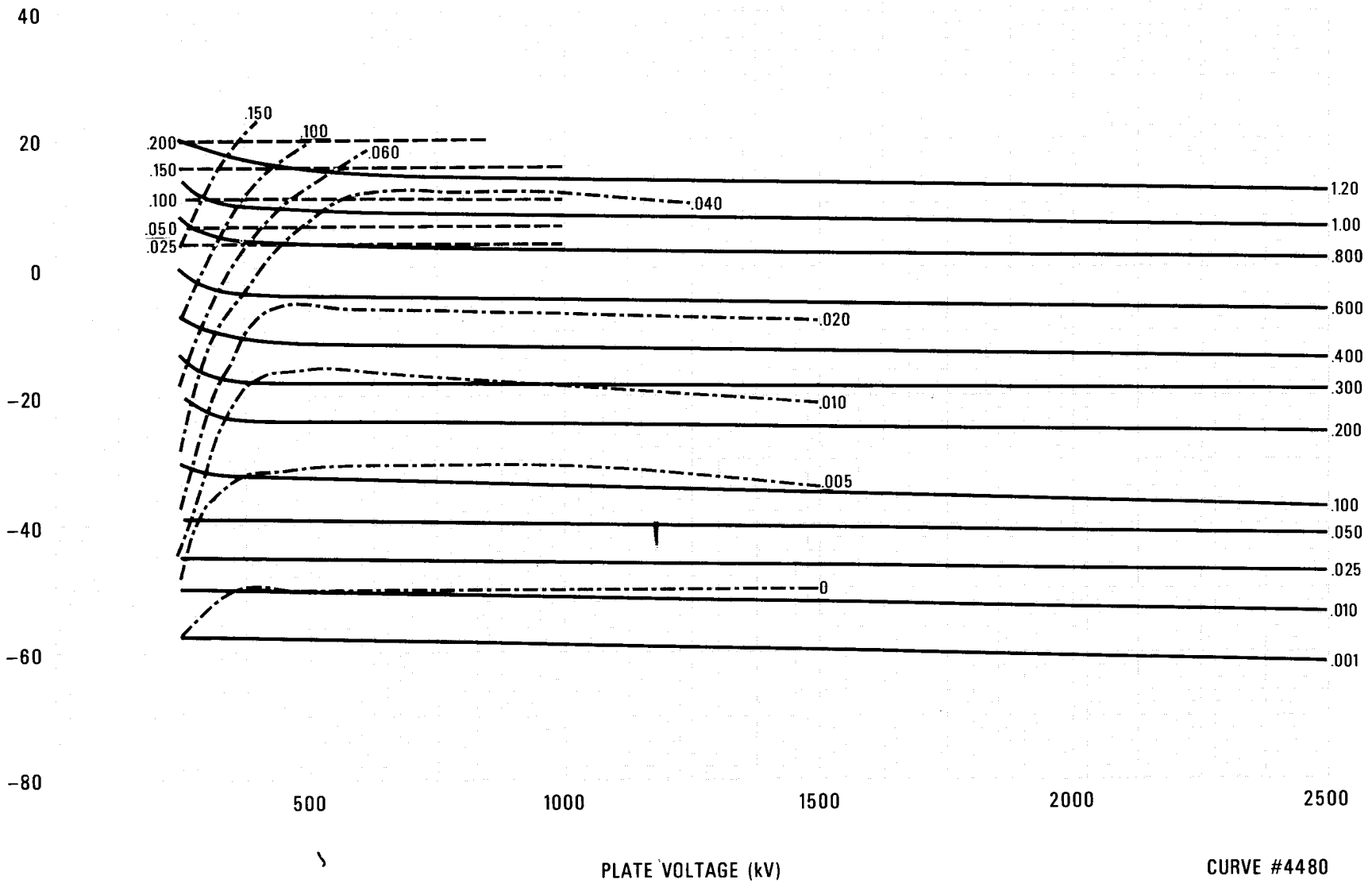


CURVE #4478

TYPICAL CONSTANT CURRENT CHARACTERISTICS

GROUNDED CATHODE E_f = 6.0V SCREEN VOLTAGE = 250V

——— PLATE CURRENT – AMPERES -·-·- SCREEN CURRENT – AMPERES – – – – GRID CURRENT – AMPERES



CURVE #4480

8959

HIGH-POWER
WATER-COOLED
TETRODE

TECHNICAL DATA



The EIMAC 8959 is a ceramic/metal high power tetrode for applications requiring tube outputs from 100 to 250 kilowatts. It is ideal for use as a Class C rf amplifier or oscillator, a Class AB rf linear amplifier, or a Class AB push-pull audio amplifier or modulator, as well as a plate and screen modulated Class C rf amplifier.

In pulse modulator service it can deliver a peak output of 4 megawatts.

The tube is characterized by low input and feedback capacitances and low internal lead inductances. Its rugged mesh thoriated tungsten filament provides ample emission for long operating life.

The water-cooled anode dissipates 100 kilowatts when used with an EIMAC SK-2100 series water jacket.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh	
Voltage	15.5 ± 0.75 V
Current, @ 15.5 V	215 A
Direct Interelectrode Capacitances (Grounded Cathode)	
Cin	370 pF
Cout	60 pF
Cgp	1.0 pF
Direct Interelectrode Capacitances (Grounded Grid)	
Cin	175 pF
Cout	60 pF
Cpk	0.35 pF
Frequency of Maximum Rating, CW	108 MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

MECHANICAL

Maximum Overall Dimensions	See Outline Drawing
Net Weight (approximate): Tube Only	38.5 lb; 17.5 kg
Tube and Water Jacket SK-2110	47.0 lb; 21.4 kg
Operating Position	Vertical, base up or down
Anode Cooling (EIMAC SK-2100 series water jacket required, to be ordered separately)	Water
Base Cooling	Forced Air

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Maximum Operating Temperature: Ceramic/Metal Seals and Envelope . . . . . 250°C
Recommended Air-System Socket . . . . . EIMAC SK-2000 Series
Base . . . . . Special Coaxial

RADIO FREQUENCY LINEAR AMPLIFIER

Class AB, Grid Driven

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	20	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC PLATE CURRENT	16	AMPERES
PLATE DISSIPATION	100	KILOWATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Adjust for specified zero-signal plate current.
2. Approximate value.

TYPICAL OPERATION
Class AB_1, Grid Driven
Peak Envelope or Modulation Crest Conditions

Plate Voltage	18	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage [1]	-320	Vdc
Zero-Signal Plate Current	4.0	Adc
Single-Tone Plate Current	13.5	Adc
Peak rf Grid Voltage [2]	300	v
Plate Dissipation [2]	75	kW
Plate Output Power [2]	168	kW
Resonant Load Impedance	697	Ω

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR - Class C Telegraphy or FM

(Key-down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	20	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC PLATE CURRENT	16	AMPERES
PLATE DISSIPATION	100	KILOWATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate value

TYPICAL OPERATION

Plate Voltage	20	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage	-800	Vdc
Plate Current	15.2	Adc
Screen Current [1]	570	mAdc
Grid Current [1]	125	mAdc
Peak rf Grid Voltage [1]	900	v
Driving Power (calculated)	120	W
Plate Dissipation [1]	54	kW
Plate Output Power [1]	220	kW
Resonant Load Impedance	575	Ω

PLATE MODULATED RADIO FREQUENCY AMPLIFIER, GRID DRIVEN

Class C Telephony - Carrier Conditions

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	17.5	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC PLATE CURRENT	16	AMPERES
PLATE DISSIPATION [2]	67	KILOWATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.
2. Corresponds to 100 kW at 100% sine-wave modulation.

TYPICAL OPERATION

Plate Voltage	15	kVdc
Screen Voltage	750	Vdc
Grid Voltage	-600	Vdc
Plate Current	11.7	Adc
Screen Current [1]	875	mAdc
Grid Current [1]	660	mAdc
Peak Audio Screen Voltage for 100% Modulation	750	v
Peak rf Grid Voltage [1]	800	v
Driving Power (calculated)	530	W
Plate Dissipation [1]	35	kW
Plate Output Power [1]	140	kW
Resonant Load Impedance	620	Ω

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR, GRID DRIVEN

Class AB_1, Sinusoidal Wave

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	20	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC PLATE CURRENT	16	AMPERES
PLATE DISSIPATION	100	KILOWATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Adjust for specified zero-signal plate current.
2. Approximate value.

TYPICAL OPERATION (2 Tubes)

Plate Voltage	15	kVdc
Screen Voltage	1.5	kVdc
Grid Voltage [1]	-345	Vdc
Zero-Signal Plate Current	6.0	Adc
Max. Signal Plate Current	19.5	Adc
Max. Signal Screen Current [2]	830	mAdc
Peak Audio Grid Voltage/Tube [2]	275	v
Max. Signal Plate Diss./Tube [2]	46	kW
Plate Output Power [2]	200	kW
Load Resistance, plate/plate	1825	Ω

PULSE MODULATOR SERVICE

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	40	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
PEAK CATHODE CURRENT	200	AMPERES
PLATE DISSIPATION [1] (DURING PULSE)	1.0	MEGAWATT
PLATE DISSIPATION (AVERAGE)	100	KILOWATTS
SCREEN DISSIPATION (AVERAGE)	1750	WATTS
GRID DISSIPATION (AVERAGE)	500	WATTS
PULSE LENGTH	10	MILLISECONDS

TYPICAL OPERATION

Plate Voltage	40	kVdc
Plate Current, pulse	110	a
Screen Voltage	2.5	kVdc
Screen Current, pulse [2]	12	a
Grid Voltage	-1.2	kVdc
Grid Current, pulse [2]	400	ma
Positive Grid Voltage, pulse [2]	110	v
Duty Factor	6	%
Output Voltage, pulse [2]	37	kv
Input Power, pulse	4.4	Mw
Output Power, pulse [2]	4.1	Mw
Cathode Current, pulse [2]	122	a

1. Power dissipated during rise and fall time neglected.
2. Approximate value.

TYPICAL OPERATION values are obtained by calculations from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to produce the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament Current, at 15.5 volts	200	230	A
Cutoff Bias, at E_b = 25 kVdc, E_{c2} = 1500 Vdc, I_b = 10 mAdc	---	-625	Vdc
Interelectrode Capacitances (measurement without shielded fixture)			
Grounded Cathode Connection:			
Cin	350	390	pF
Cout	55	65	pF
Cgp	---	1.2	pF
Grounded Grid Connection:			
Cin	160	190	pF
Cout	55	65	pF
Cpk	---	0.5	pF

APPLICATION

MOUNTING - The 8959 must be mounted with its major axis vertical. The tube base may be either up or down, at the discretion of the circuit designer.

SOCKETING - An EIMAC SK-2000 Series Socket, or equivalent, is recommended.

ANODE WATER JACKET - An EIMAC SK-2100 or SK-2110 Water Jacket must be used to provide anode cooling. To achieve an anode dissipation of 100 kilowatts, the water jacket must be installed over the tube anode and adequate water flow provided.

COOLING - Anode cooling is accomplished by circulating water through an SK-2100 series Water Jacket. Insufficient water flow will cause the anode temperature to rise to levels which will shorten tube life. Also, if the coolant lines become clogged, enough steam pressure may be generated to rupture the water jacket and destroy the tube. The following table lists the minimum cooling water requirements at various dissipation levels with a maximum inlet water temperature of 50°C.

Anode Dissipation (kW)	Minimum Water Flow (gpm)	Approximate Pressure Drop (psi)
20	5.0	2.8
40	9.0	5.8
60	12.5	9.3
80	16.5	14.2
100	20.0	19.2

Note: Since the filament dissipates about 3500 watts, and the grid-plus-screen can, under some conditions, dissipate another 2250 watts, the table allows for an additional dissipation of 5750 watts.

Outlet water temperature must never exceed 70°C and inlet water pressure should be limited to 80 psi. Direction of water flow is optional.

Tube life can be seriously affected by the condition of the cooling water. If it becomes ionized, copper-oxide deposits form on the inside of the water jacket causing localized anode heating and eventual tube failure.

To insure minimum electrolysis, and power loss, the water resistance at 20°C should be greater than 50,000 ohms/cm^3, preferably 250,000 ohms/cm^3 or higher. The relative water resistance can be continuously monitored by measuring the leakage current through a short section of the insulating hose, using metal nipples or fittings as electrodes.

Auxiliary forced-air cooling, of the tube base is required to maintain filament- and grid-seal temperatures below 250°C. An air flow of approximately 120 ft^3/min at 50°C maximum and sea level should be directed, through an EIMAC SK-2000 Series Socket or equivalent, toward the filament- and grid-seal areas.

Both anode and base cooling should be applied before or simultaneously with the application of electrode voltages, including the filament. Base cooling should continue for about three minutes after the removal of electrode voltages to allow the tube to cool properly.

FILAMENT OPERATION - At rated filament voltage, the peak emission of the 8959 is many times greater than the amount needed for communication service. Reducing the filament voltage decreases the filament temperature. A small decrease in filament temperature substantially increases filament life. The correct value of filament-voltage should be determined for the particular applications. First, gradually reduce the filament voltage to the point where there is a noticeable reduction in plate current or power output, or an increase in distortion. Then increase the voltage several tenths of a volt above the value where performance degradation occurred; this is the proper operating voltage. Filament voltage should always be measured at the tube base or socket using an rms responding meter. The above procedure should be performed periodically to assure optimum tube life.

GRID OPERATION - The maximum control-grid dissipation is 500 watts, determined approximately by the product of grid current and peak positive grid voltage.

Under some operating conditions, the control grid may exhibit a negative-resistance characteristic. This may occur when, with high screen-grid voltage, increasing the drive voltage decreases the grid current. As a result, large values of instantaneous negative grid current can be produced, causing the amplifier to become regenerative. Because this may happen, the driver stage must be designed to tolerate this condition. One technique is to swamp the driver so that the change in load, due to secondary grid emission, is a small percentage of the total driver load.

SCREEN OPERATION - The maximum screen-grid dissipation is 1750 watts. With no ac applied to the screen, dissipation is simply the product of dc screen voltage and dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current.

Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since the screen dissipation rating will be exceeded. Suitable protective circuitry should be provided.

The 8959 may exhibit reverse screen current to a greater or lesser degree depending on operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, or an electron-tube regulator circuit may be employed in the screen supply. A bleeder resistor must be used if a series electron-tube regulator is employed.

PLATE DISSIPATION - The rated plate dissipation of 100 kilowatts, attainable with water cooling, provides a large margin of safety in most applications. This rating may be exceeded briefly during tuning. When the 8959 is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions should be limited to 67 kilowatts.

FAULT PROTECTION - In addition to the normal plate-overcurrent interlock, screen-current interlock, and coolant-flow interlock, it is good practice to protect the tube from internal damage caused by an internal plate arc which may occur at high plate voltages.

A protective resistance of 5 to 25 ohms should always be connected in series with each tube anode, to absorb power-supply stored energy if a plate arc should occur. An electronic crowbar, which will discharge power-supply capacitors in a few microseconds after the start of a plate arc, is recommended.

OPERATING HAZARDS

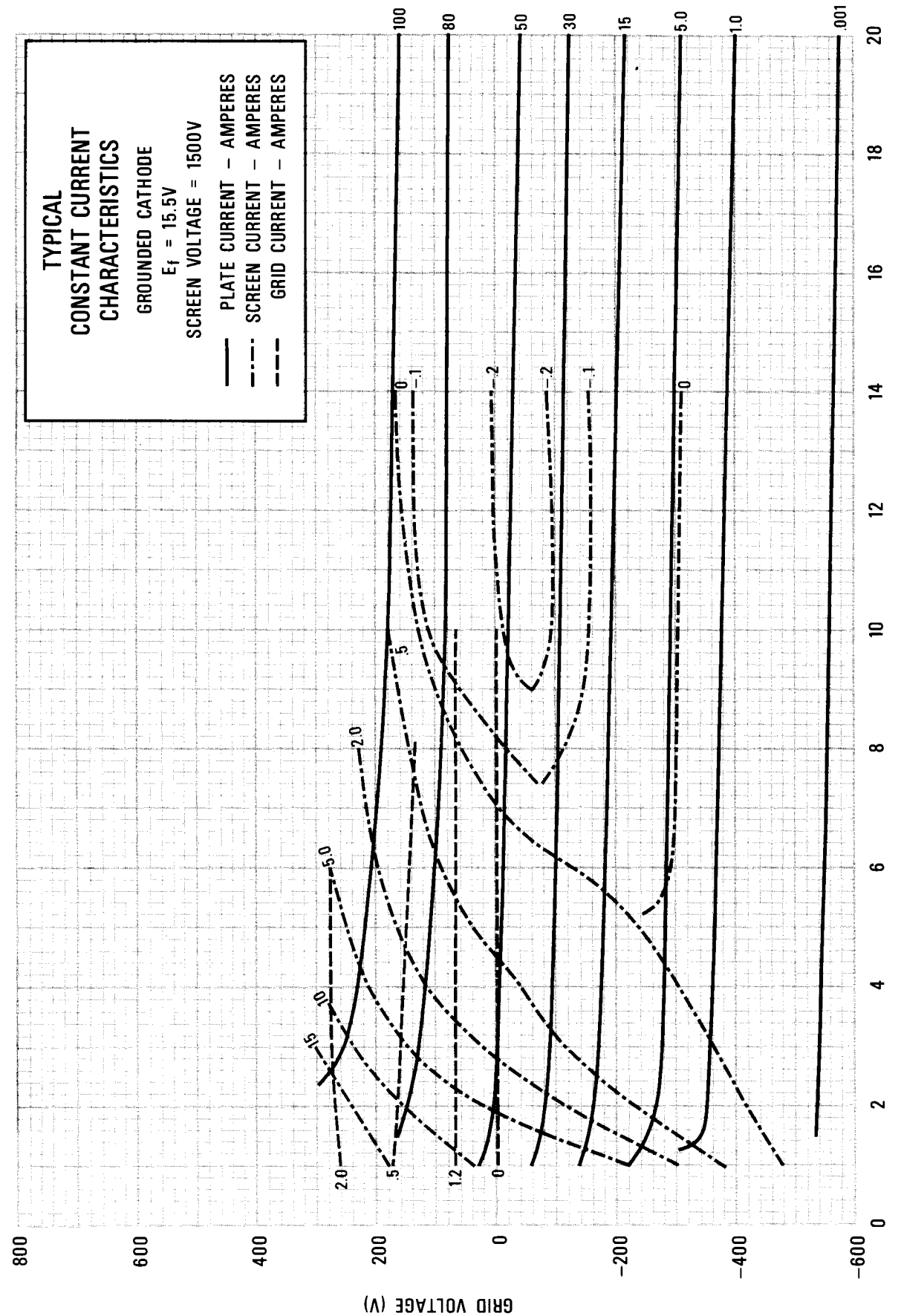
Read the following and take all necessary precautions to safeguard personnel. Safe operating conditions are the responsibility of the equipment designer and the user.

HIGH VOLTAGE - This tube operates at voltages which can be deadly. Equipment must be designed so personnel cannot come in contact with operating voltages. Enclose high-voltage circuits and terminals and provide fail-safe interlocking switch circuits to open the primary circuits of the power supply and to discharge high-voltage condensers whenever access into the enclosure is required.

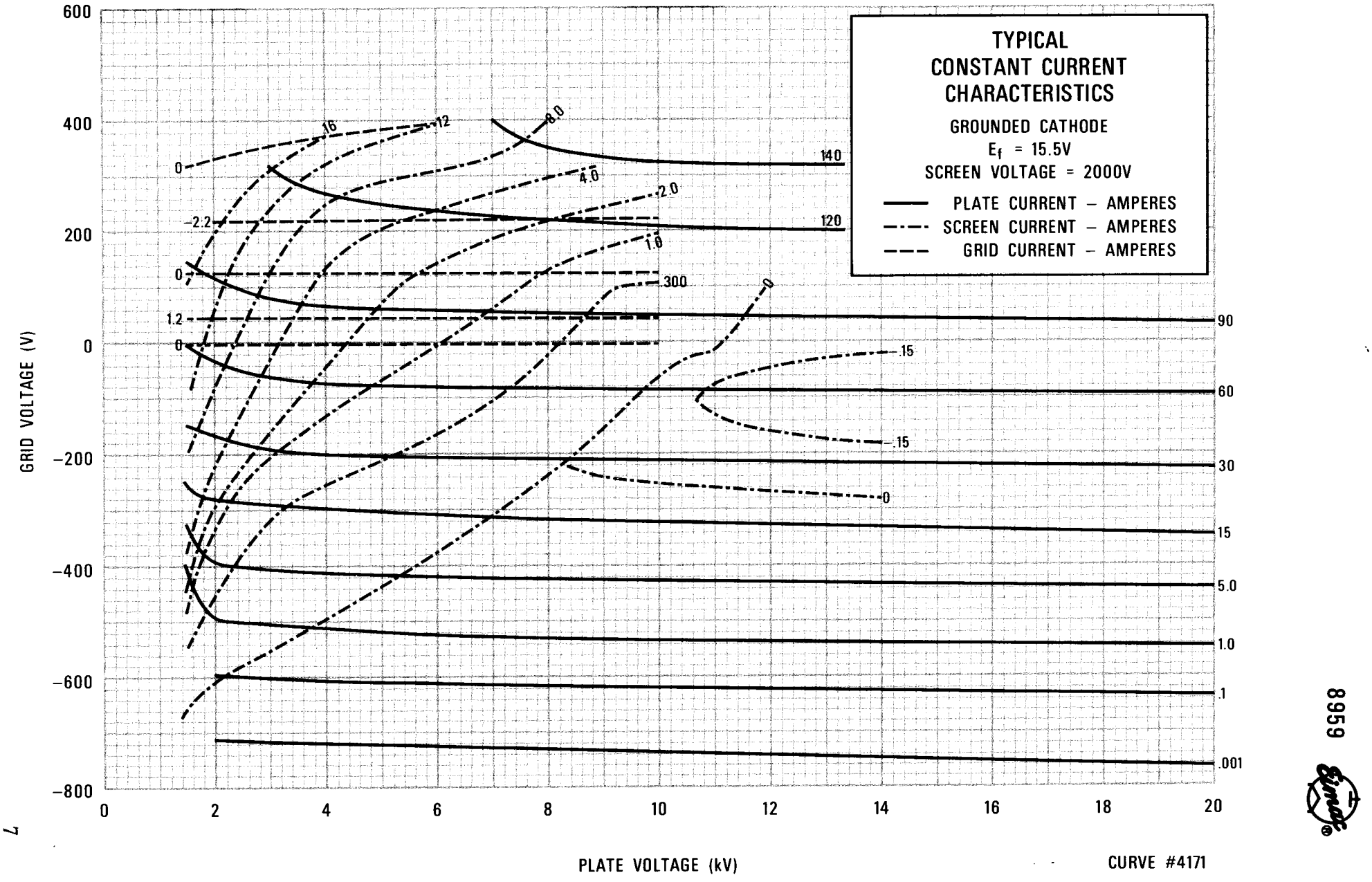
X-RAY RADIATION - The EIMAC 8959, operating at its rated voltages and currents, is a potential X-ray hazard. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to changes in leakage paths or emission characteristics as they are affected by high voltage. Only limited shielding is afforded by the tube envelope. Additional X-ray shielding must be provided on all sides of the tube to provide adequate protection to operating personnel throughout the tube's life. When this tube is used as a pulse modulator, shielding of the pulse transformer may also be necessary. X-ray caution signs or labels must be permanently attached to equipment using this tube directing operating personnel never to operate this device without X-ray shielding in place.

RADIO FREQUENCY RADIATION - Exposure of the human body to rf radiation becomes increasingly more hazardous as the power level and/or frequency are increased. Exposure to high-power rf radiation must be strictly prevented at any frequency.

Equipment must be designed to fully safeguard all personnel from these hazards. Labels and caution notices must be provided on equipment and in manuals clearly warning of these hazards.

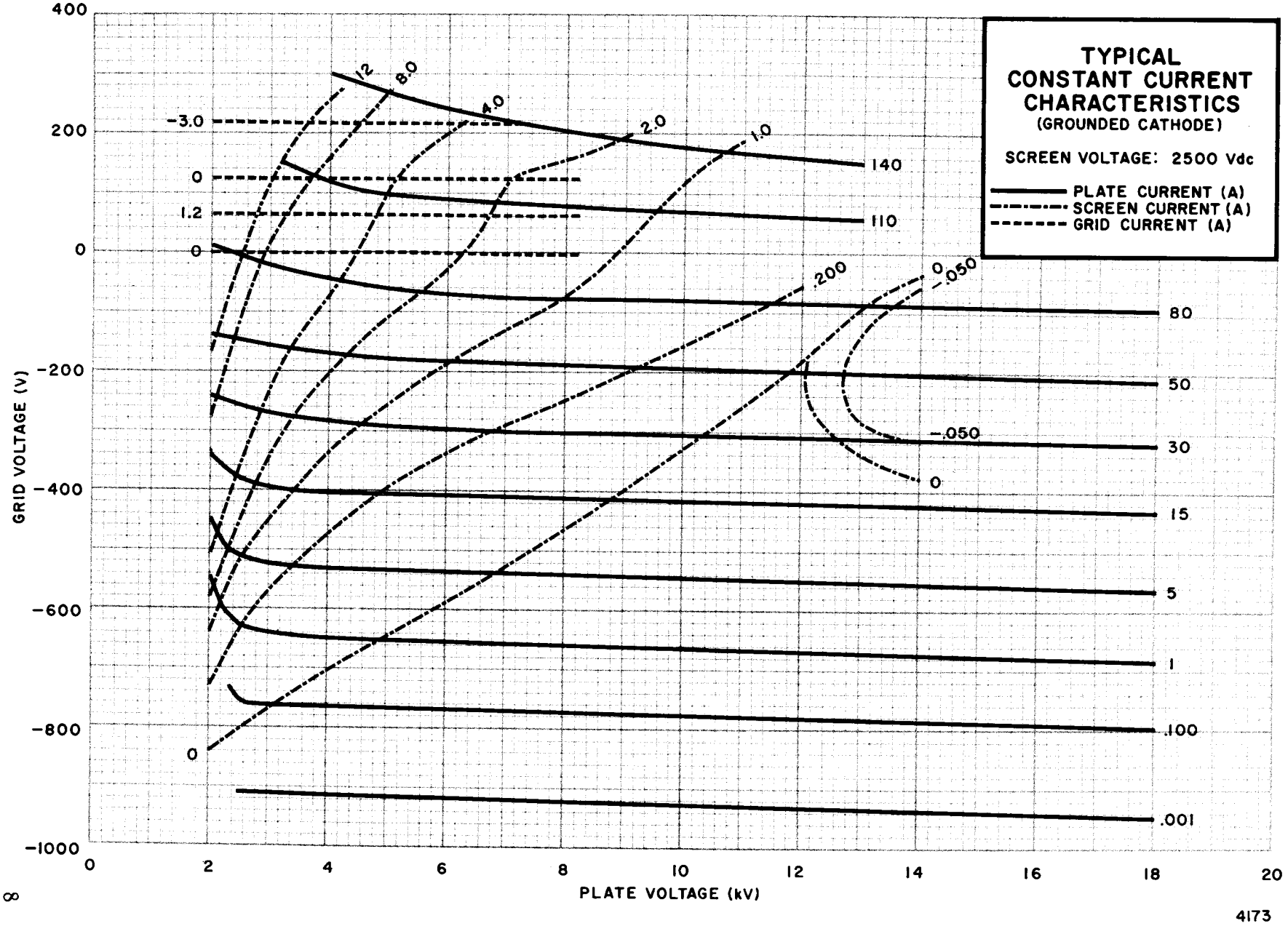

TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 15.5V
SCREEN VOLTAGE = 1500V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
800
600
400
200
0
−200
−400
−600
0
2
4
6
8
10
12
14
16
18
20
100
80
50
30
15
5.0
1.0
.001
0
−.1
−.2
−.5
−1.0
−2.0
−5.0
−10
−15

CURVE #4169



CURVE #4171

8959


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
(GROUNDED CATHODE)
SCREEN VOLTAGE: 2500 Vdc
PLATE CURRENT (A)
SCREEN CURRENT (A)
GRID CURRENT (A)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
400
200
0
-200
-400
-600
-800
-1000
0
2
4
6
8
10
12
14
16
18
20
12
8.0
4.0
2.0
1.0
-3.0
0
1.2
0
140
110
80
50
30
15
5
1
.100
.001
.200
0
-.050
-.050
0
0
4173

8959

TECHNICAL DATA

* 8973

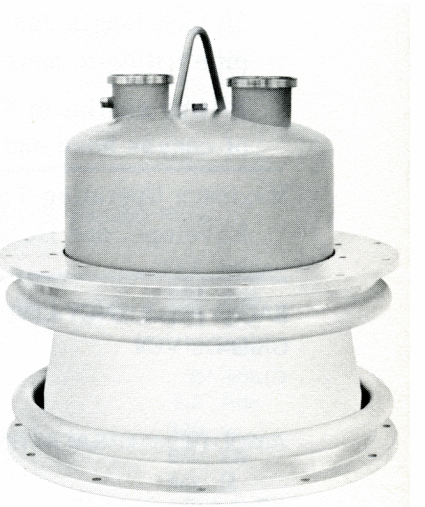
WATER-COOLED POWER TETRODE

* Previous designation was X-2170

The EIMAC 8973 is a ceramic/metal, water-cooled power tetrode designed for very-high-powered medium-frequency or high-frequency broadcast service and very-low-frequency communication in the half-megawatt power range.

The 8973 has a thoriated-tungsten mesh filament mounted on water-cooled supports. The maximum anode dissipation rating is 650 kilowatts steady state.

Large-diameter coaxial terminals are used for the control grid and the rf filament terminals. Filament power and filament support cooling-water connections are made through special couplings.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten Mesh		
Voltage	18.5 ± 0.9	V
Current at 18.5 V	650	A
Amplification Factor (Average), Grid to Screen	4.5	
Direct Interelectrode Capacitance (grounded cathode):[2]		
Cin	1000	pF
Cout	165	pF
Cgp	5	pF

Frequency of Operation: useful to 100 MHz.

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values shown are nominal, measured with no special shielding.

MECHANICAL

Maximum Overall Dimensions:	
Length	18.75 in; 47.62 cm
Diameter	17.03 in; 43.26 cm
Net Weight	153 lbs; 69.5 kg
Operating Position	Vertical, base down
Cooling	Water and Forced Air
Base Terminals	Special

(Effective 7-1-78) © 1978 by Varian Printed in U.S.A.

Recommended Filament Connectors (not supplied with tube):

Filament Power/Water Connector (2 required)	EIMAC SK-2310
Filament rf Connector (1 required)	EIMAC SK-2315

Recommended Anode Cooling Water Connectors (not supplied with tube):

Note: 2 SK-2320 or SK-2321 connectors are required per tube.

Complete fitting, with knurled nut, replaceable electrolytic target, 20-inch length canvas hose, corona shield, and 2-1/2-inch female pipe fitting to mate to rigid pipe	EIMAC SK-2320
Fitting similar to SK-2320 but does not include the 20-inch length of canvas hose and pipe fitting	EIMAC SK-2321

Maximum Operating Temperature: Envelope, and Ceramic/Metal Seals	200 °C

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	22.5 KILOVOLTS
DC SCREEN VOLTAGE	2.5 KILOVOLTS
DC PLATE CURRENT	65 AMPERES
PLATE DISSIPATION	650 KILOWATTS
SCREEN DISSIPATION	7.5 KILOWATTS
GRID DISSIPATION	2.0 KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_1, Peak Envelope Conditions

Plate Voltage	20.0 kVdc
Screen Voltage	1500 Vdc
Grid Voltage [1]	-360 Vdc
Zero Signal Plate Current	10 Adc
Single Tone Plate Current	45 Adc
Single Tone Screen Current [2]	2.0 Adc
Peak rf Grid Voltage [2]	360 v
Plate Dissipation	250 kW
Plate Load Resistance	264 Ω
Plate Power Output	610 kW

1. Adjust to specified zero-signal plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy or FM

(Key-down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	22.5 KILOVOLTS
DC SCREEN VOLTAGE	2.5 KILOVOLTS
DC PLATE CURRENT	65 AMPERES
PLATE DISSIPATION	650 KILOWATTS
SCREEN DISSIPATION	7.5 KILOWATTS
GRID DISSIPATION	2.0 KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	21.0 kVdc
Screen Voltage	2.5 Vdc
Grid Voltage	-600 Vdc
Plate Current	63 Adc
Screen Current [1]	9 Adc
Grid Current [1]	3.5 Adc
Calculated Driving Power	3.5 kW
Plate Dissipation [1]	273 kW
Plate Load Resistance	166 Ω
Plate Power Output	1050 kW

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	17.5	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC PLATE CURRENT	50	AMPERES
PLATE DISSIPATION	400	KILOWATTS
SCREEN DISSIPATION	7.5	KILOWATTS
GRID DISSIPATION	2.0	KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	17.5	kVdc
Screen Voltage	800	Vdc
Grid Voltage	-800	Vdc
Plate Current	50	Adc
Screen Current [1]	4	Adc
Grid Current [1]	2.2	Adc
Pk. Screen Voltage (100% Mod)	800	v
Pk. rf Grid Voltage	1060	v
Calculated Driving Power	2400	W
Plate Dissipation	175	kW
Plate Load Resistance	165	Ω
Plate Output Power	700	kW

1. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR
Class AB

ABSOLUTE MAXIMUM RATINGS (per tube):

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC PLATE CURRENT	65	AMPERES
PLATE DISSIPATION	650	KILOWATTS
SCREEN DISSIPATION	7.5	KILOWATTS
GRID DISSIPATION	2.0	KILOWATTS

1. Adjust for stated zero-signal plate current.
2. Approximate value.

TYPICAL OPERATION Two Tubes - Sinusoidal Wave

Plate Voltage	17.5	kVdc
Screen Voltage	1500	Vdc
Grid Voltage [1]	-400	Vdc
Zero Signal Plate Current	5	Adc
Max. Signal Plate Current	78	Adc
Max Signal Screen Current 2	2.8	Adc
Pk. Audio Freq. Grid Voltage 3	370	v
Max. Signal Plate Dissipation 3	550	kW
Plate-Plate Load Resistance	444	Ω
Plate Output Power 4	950	kW

3. Per Tube.
4. Suitable to modulate a carrier power of 1.25 Megawatts.

NOTE: TYPICAL OPERATION data are obtained by calculation from the published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power then the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current.

APPLICATION

MECHANICAL

MOUNTING - The 8973 must be mounted vertically, base down. The full weight of the tube should rest on the main screen-grid contact flange at the base of the tube, and all lifting of the tube should be done with the lifting eye which is attached to the top of the anode cooling jacket.

COOLING - Minimum cooling water requirements for the anode are shown in the table, for an outlet water temperature not to exceed 70° C and an inlet water temperature of 50° C. System pressure should not exceed 100 psi. High-purity water must be used to minimize power loss, corrosion of metal fittings, and loss of anode dissipation capability. Water resistivity must be maintained at 1 megohm/cm (at 25° C) or better for long-term operation. EIMAC Application Bulletin #16 should be consulted for details on maintenance of water quality standards and use of a water purification loop in the installation. Since the anode is normally at high potential to ground, water connections to the anode are made through insulating tubing, with long enough sections that column resistance is above 4 megohms per 1000 plate supply volts, or 10 megohms total, whichever is less.

Anode Dissipation (kW)	Water Flow (gpm)	Apprx. Jacket Press. Drop (psi)
250	120	20
450	165	30
650	200	40

The tube base requires air cooling, with a minimum of 50 cfm of air at 50° C maximum at sea level, directed toward the base seal areas from a general purpose fan.

Water cooling of the filament and screen grid supports is also required, with inlet water temperature not to exceed 50° C. Each of the 2 filament connectors includes both an inlet and outlet line, with the proper section for the inlet water shown on the outline drawing. Minimum flow for the F1 connector is 2.0 gpm, at an approximate pressure drop of 12 psi. Minimum flow for the F2 connector is 4.0 gpm, at an approximate pressure drop of 50 psi. The screen grid cooling water is fed by means of 1/4-18 NPT tapped holes shown on the outline drawing, with a minimum flow of 2.0 gpm required, at an approximate pressure drop of 12 psi.

All cooling must be applied before or simultaneously with the application of electrode voltages, including the filament, and should be maintained for at least two minutes after all voltages are removed to allow for tube cooldown.

As regards base air cooling, temperatures of the ceramic/metal seals and the lower envelope areas are the controlling and final limiting factor. Temperature-sensitive paints are available for use in checking temperatures in these areas before equipment design and air-cooling arrangements are finalized.

ELECTRICAL

FILAMENT OPERATION - Filament turn-on and turn-off should be programmed in accordance with a special procedure. Filament voltage should be smoothly increased from zero to the operating level over a period of two minutes, and a motor-driven VARIAC or POWERSTAT is suggested. Inrush current must never be allowed to exceed twice the normal operating current. Turnoff procedure should be a smooth decrease from the operating voltage to zero over a period of two minutes, such as would be provided by a motor-driven VARIAC, POWERSTAT or solid-state regulator circuit.

Filament voltage should be measured at the tube base with an accurate meter. When operating at the nominal voltage, variations of ±5% are tolerable and should have little effect on the electrical performance of the tube. When very long life and consistent performance are factors, the filament voltage can often be reduced to a lower value than the nominal, but should be regulated and held to ±1% when this is done. To achieve a regulated voltage and still have it adjustable a typical procedure would involve a one-to-one regulating transformer feeding a variable-ratio transformer, which in turn feeds the filament transformer. The equipment is first operated with nominal filament voltage, and when stable operation is achieved the voltage is then reduced in small steps, until a point is reached where performance of the tube is clearly affected. The voltage is then raised a few tenths of a volt above this level for operation. Periodically the procedure should be repeated and the operating value of filament voltage readjusted if necessary. This value is normally 16.5 to 17.0 volts rms (initially).

Where hum is an important system consideration it may be necessary to operate the filaments with dc rather than ac power, or provide suitable hum-bucking circuits.

Care should be exercised to keep any rf power out of the filament of the tube, as this can cause excessive operating temperatures. A HEWLETT-PACKARD Vector Impedance meter is useful in detecting the presence of impedance that will support rf buildups in the filament "backcavity" circuit.

VACION PUMP OPERATION - The tube is supplied with an ion pump and magnet, mounted inside the filament structure at the base (stem). A power supply (Varian Part #921-0015) and 8-foot cable (Varian Part #924-0020) are required for operation.

It is reommended that the VACION pump be operated continuously if possible; otherwise it should be operated at least once a year until the indicator meter shows 1.0 μA or less of current.

ABSOLUTE MAXIMUM RATINGS - The values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings, the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply voltage variation, load variation, or manufacturing variations in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

GRID OPERATION - The 8973 control grid is rated at 2000 watts of dissipation. Protective measures should be included in the circuitry to insure that this rating is not exceeded. Control grid

dissipation is the approximate product of the dc grid current and peak positive grid voltage.

SCREEN GRID OPERATION - Base cooling (air and water) must be on and at the correct level before tube operation is started. The power applied to the screen grid must not exceed 7500 watts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is the product of rms screen current and rms screen voltage.

Plate voltage, plate load, or grid bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective circuitry must be provided to remove screen power in case of such a fault condition. Tetrode tubes may exhibit reversed screen current to a greater or lesser degree depending on individual tube design and operating conditions. The screen supply voltage must be maintained constant for any values of negative or positive screen currents that may be encountered. Dangerously high plate currents may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished by use of a shunt regulator circuit in the screen voltage supply, bleeder resistors, or other suitable techniques.

PLATE OPERATION - The maximum dissipation rating of the 8973 is 650 kilowatts with water cooling. When used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 400 kilowatts.

Specified anode dissipation ratings assume 10 kilovolts maximum anode voltage during conduction. If full rated dissipation at a tube drop greater than this value for periods greater than 200 milliseconds is desired, contact EIMAC's Power Grid Tube Application Engineering Office.

FAULT PROTECTION - To assure nondestruction of tube elements from high-energy power supplies, during a fault condition, all supplies must be checked for proper operation of their protective circuits. An approved method to meet the tube protection criteria would be the use of foil, solder wire, or small diameter wire to produce a controlled short on the power supply. The simplest technique is to short the plate to cathode, screen grid to cathode, control grid to cathode, and screen grid to anode (individually, one at a time) using a vacuum relay through a section of #30 AWG copper wire, which should be approximately inches long. The wire will remain intact if the power supply protective circuitry is operating properly. An electronic crowbar will be required on the anode supply, and may be required on the other electrode supplies if the test outlined above is not passed. See EIMAC Application Bulletin #17 for further details.

Properly rated spark gaps should be located between the screen grid and cathode, and between the control grid and cathode, to meet over-voltage protection criteria. A series resistance of 10 to 50 ohms is recommended in the screen and control grid power supply leads.

HIGH VOLTAGE - Normal operating voltages used with the 8973 are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supplies and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

LOAD VSWR - The load VSWR should be monitored and the detected signal used to operate the interlock system to remove the plate voltage within 20 milliseconds after a fault occurs. In the case of high stored energy in the load system, care must be taken to avoid excessive return energy from damaging the tube and associated circuit components.

X-RADIATION - High-vacuum tubes operating at voltages in excess of 15 kilovolts produce progressively more dangerous X-Radiation as the voltage is increased. The 8973, operating at its rated voltages and currents, is a potential X-Ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-Radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-Ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-Radiation level should be made, and the tube should never be operated without adequate shielding in place when voltages above 15 kilovolts are in use. Lead glass, which attenuates X-Radiation, is available for viewing windows. If there is any doubt as to the requirements for or the adequacy of shielding, an expert in this field should be contacted to perform an X-Radiation survey of

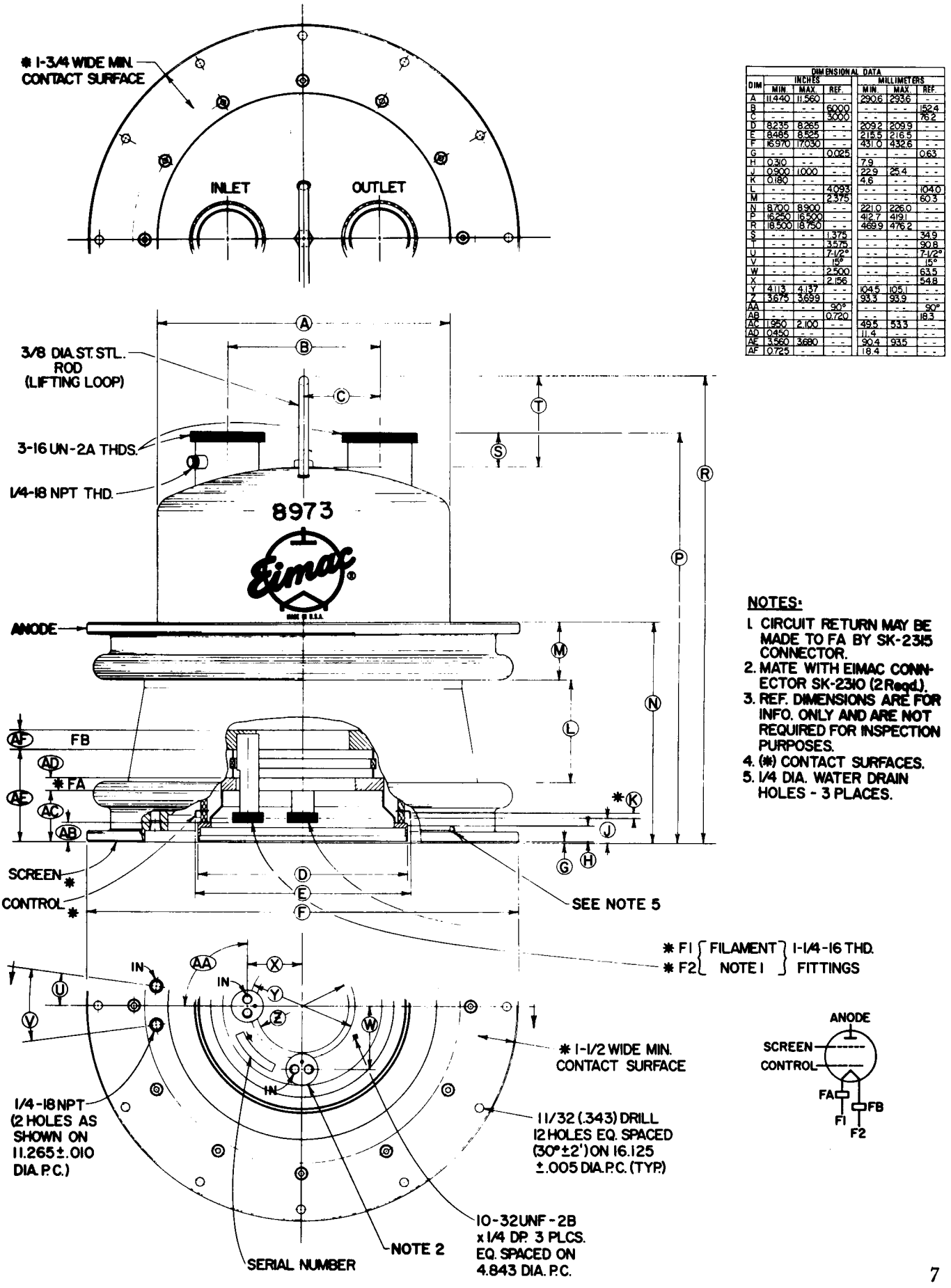
the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-Radiation exposure.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

ELECTRODE RF TUNING CHARACTERISTICS - Typical electrode tuning characteristics may be obtained by contacting the EIMAC Power Grid Tube Application Engineering Office.

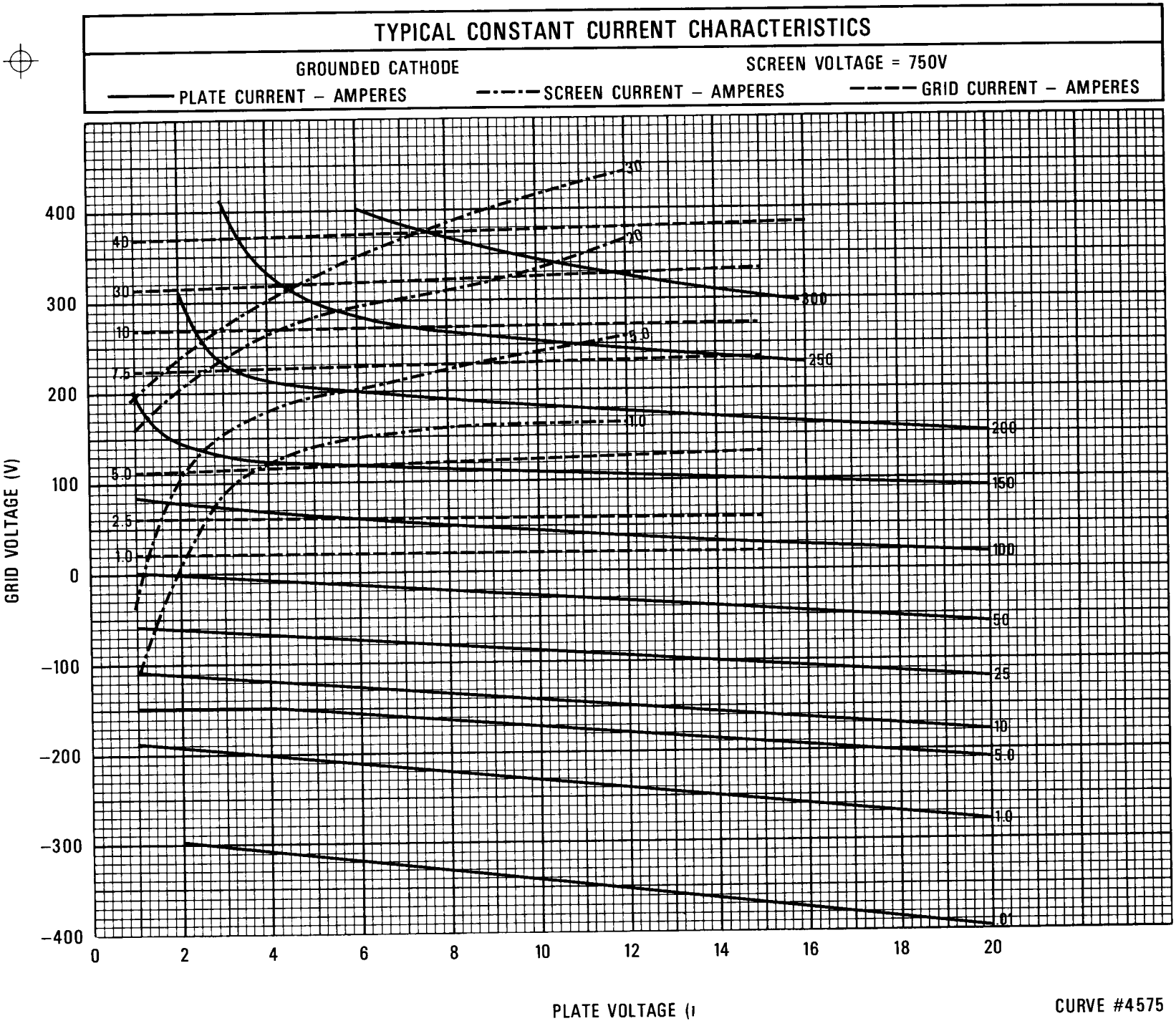
SPECIAL APPLICATIONS - Where it is desired to operate this tube under conditions widely different from those listed here, write to: Product Line Manager, High Power Tubes, Varian EIMAC Division, 301 Industrial Way, San Carlos, CA 94070.

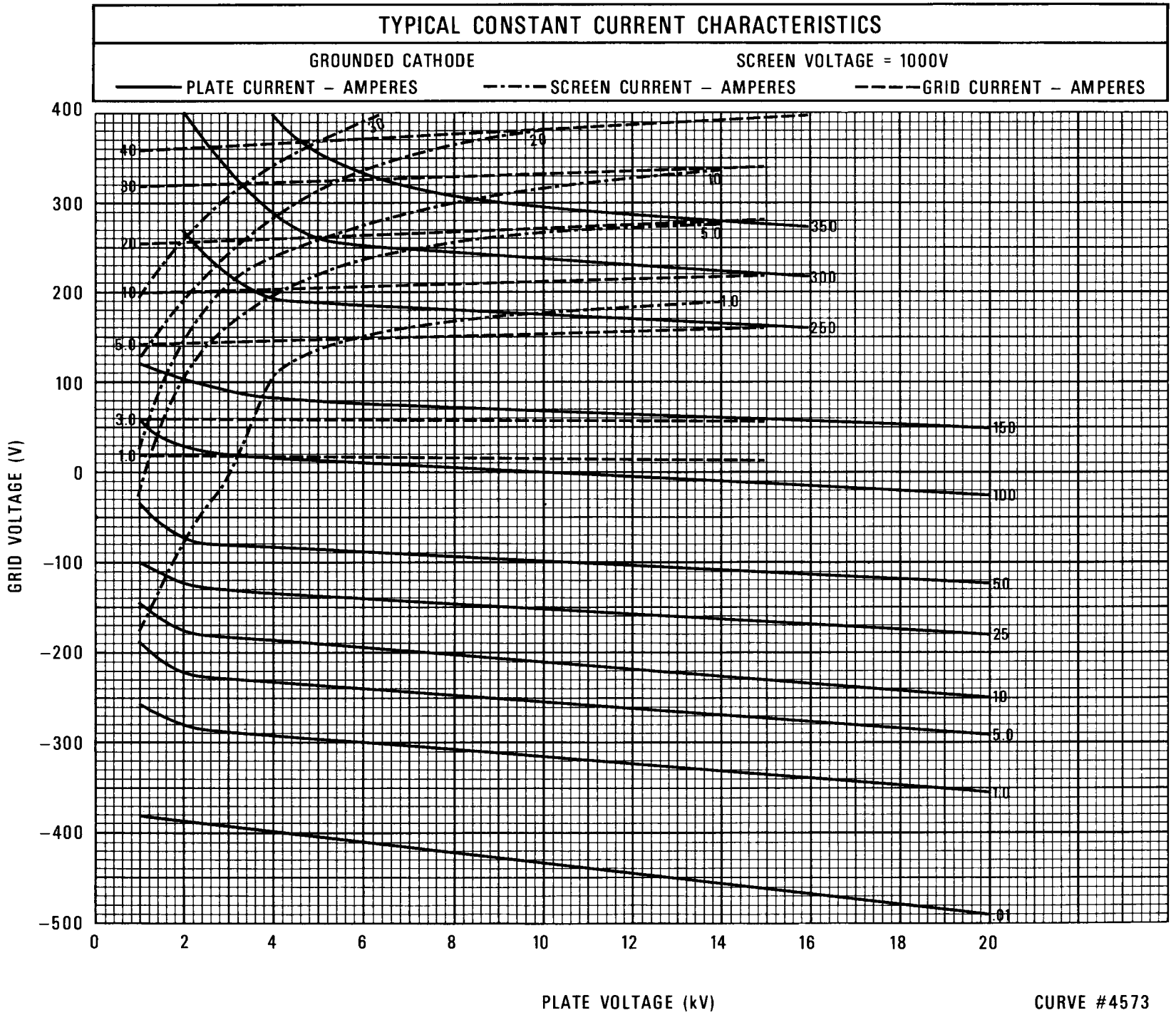


DIM	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	11.440	11.560		290.6	293.6	- -
B	- -	- -	6.000	- -	- -	152.4
C	- -	- -	3.000	- -	- -	76.2
D	8.235	8.265	- -	209.2	209.9	- -
E	8.485	8.525	- -	215.5	216.5	- -
F	16.970	17.030	- -	431.0	432.6	- -
G	- -	- -	0.025	- -	- -	0.63
H	0.310	- -	- -	7.9		
J	0.900	1.000	- -	22.9	25.4	- -
K	0.180	- -	- -	4.6	- -	- -
L	- -	- -	4.093	- -	- -	104.0
M	- -	- -	2.375	- -	- -	60.3
N	8.700	8.900	- -	221.0	226.0	- -
P	16.250	16.500	- -	412.7	419.1	- -
R	18.500	18.750	- -	469.9	476.2	- -
S	- -	- -	1.375	- -	- -	34.9
T	- -	- -	3.575	- -	- -	90.8
U	- -	- -	7-1/2°	- -	- -	7-1/2°
V	- -	- -	15°	- -	- -	15°
W	- -	- -	2.500	- -	- -	63.5
X	- -	- -	2.156	- -	- -	54.8
Y	4.113	4.137	- -	104.5	105.1	- -
Z	3.675	3.699	- -	93.3	93.9	- -
AA	- -	- -	90°	- -	- -	90°
AB	- -	- -	0.720	- -	- -	18.3
AC	1.950	2.100	- -	49.5	53.3	- -
AD	0.450	- -	- -	11.4	- -	- -
AE	3.560	3.680	- -	90.4	93.5	- -
AF	0.725	- -	- -	18.4	- -	- -

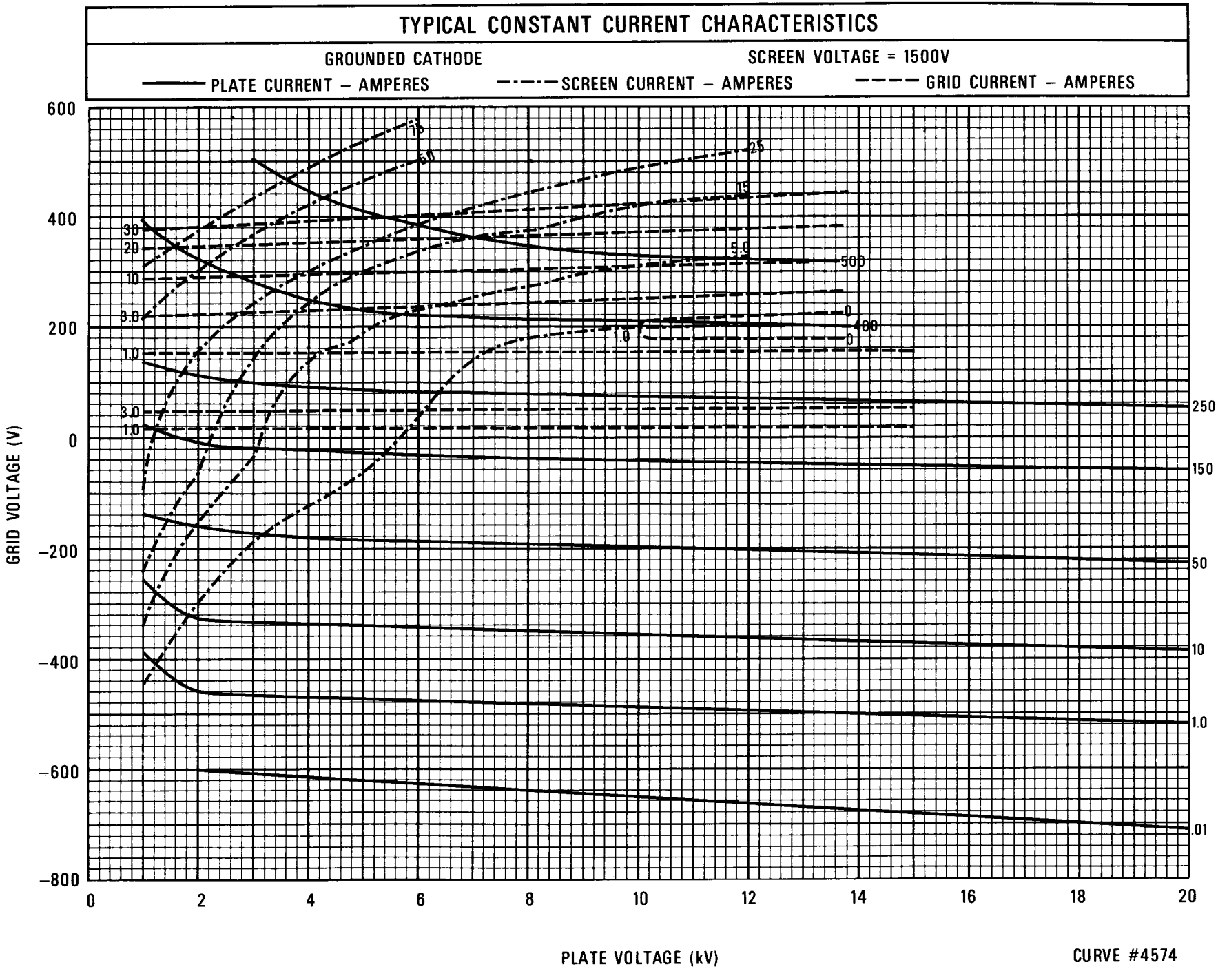
NOTES:

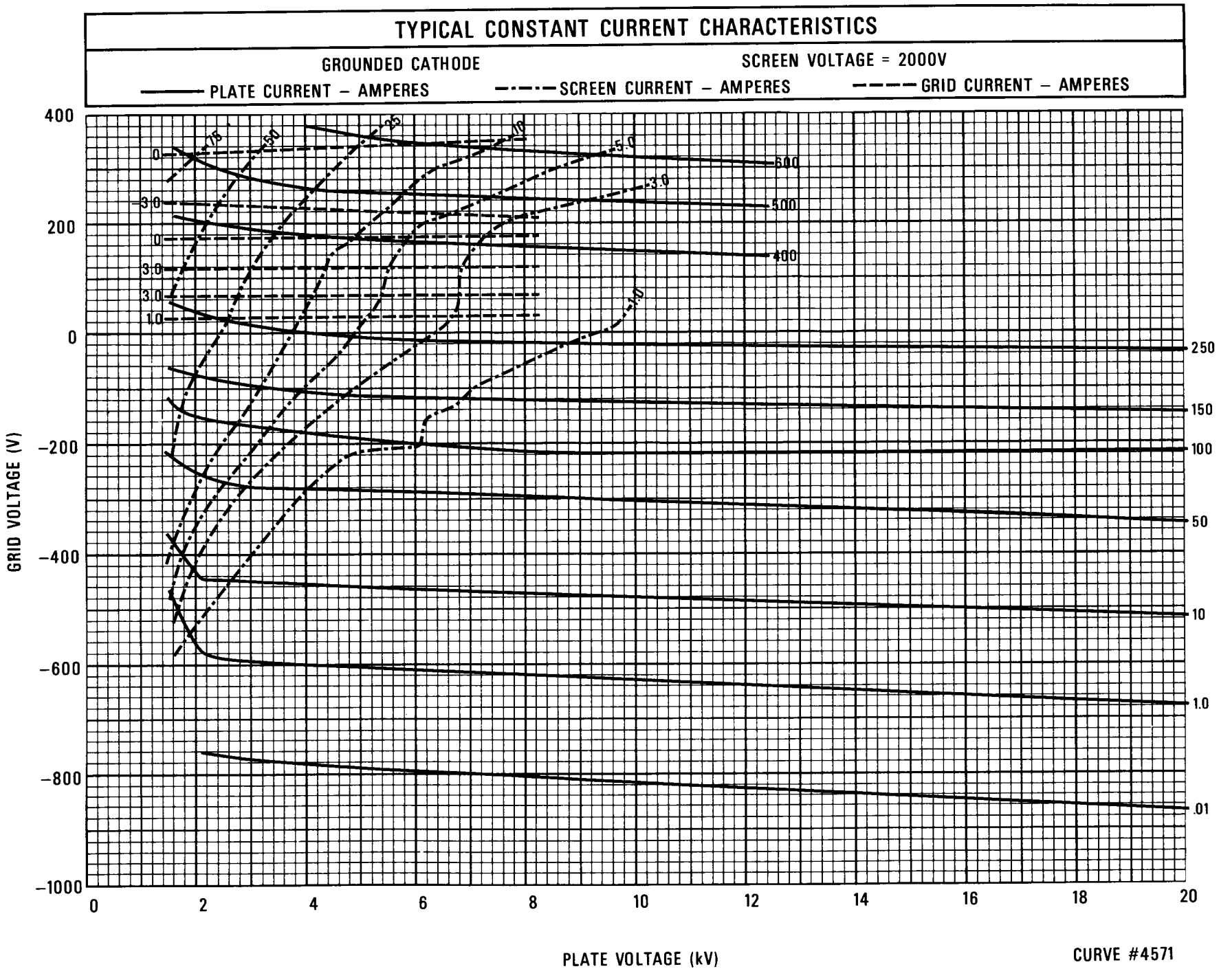
1. CIRCUIT RETURN MAY BE MADE TO FA BY SK-2315 CONNECTOR.
2. MATE WITH EIMAC CONNECTOR SK-2310 (2 Reqd.).
3. REF. DIMENSIONS ARE FOR INFO. ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.
4. (*) CONTACT SURFACES.
5. 1/4 DIA. WATER DRAIN HOLES - 3 PLACES.


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 750V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
400
300
200
100
0
−100
−200
−300
−400
0
2
4
6
8
10
12
14
16
18
20
PLATE VOLTAGE (
40
30
20
10
7.5
5.0
2.5
1.0
300
250
200
150
100
50
25
10
5.0
1.0
.01
CURVE #4575


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 1000V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
400
300
200
100
0
−100
−200
−300
−400
−500
0
2
4
6
8
10
12
14
16
18
20
PLATE VOLTAGE (kV)
40
30
20
10
6.0
3.0
1.0
350
300
250
150
100
50
25
10
5.0
1.0
.01

CURVE #4573


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 1500V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
600
400
200
0
−200
−400
−600
−800
0
2
4
6
8
10
12
14
16
18
20
PLATE VOLTAGE (kV)
75
50
25
15
9.0
500
0
400
0
1.0
30
20
10
3.0
1.0
3.0
1.0
250
150
50
10
1.0
.01
CURVE #4574


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
SCREEN VOLTAGE = 2000V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
400
200
0
-200
-400
-600
-800
-1000
0
2
4
6
8
10
12
14
16
18
20
PLATE VOLTAGE (kV)
.75
.50
.25
.10
5.0
3.0
1.0
0
-30
-10
-30
-30
-10
600
500
400
250
150
100
50
10
1.0
.01
CURVE #4571

TECHNICAL DATA

8974 WATER COOLED POWER TETRODE

The EIMAC 8974 is a ceramic/metal, water-cooled power tetrode designed for very-high-power medium and high frequency broadcast service in the megawatt power range.

The 8974 has a two-section thoriated-tungsten mesh filament mounted on water-cooled supports. The two sections may be fed from an ac or dc power source. The maximum anode dissipation rating is 1500 kilowatts steady state.

Large-diameter coaxial terminals are used for the control grid and the rf filament terminals. Filament power and filament support cooling-water connections are made through three special connectors. Anode cooling water connections are made with available hand-tightened fittings with O-ring seals.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten Mesh, two-section	
Voltage, per section (See FILAMENT OPERATION note)	18.5 ± 0.9 V
Current @ 18.5 volts, per section (nominal)	650 A
Maximum Frequency for Full Ratings (CW)	30 MHz
Amplification Factor, Average, Grid to Screen	4.5
Direct Interelectrode Capacitances (grounded cathode)[2]	
Cin	1600 pF
Cout	260 pF
Cgp	7.5 pF
Direct Interelectrode Capacitances (grounded grid)[2]	
Cin	690 pF
Cout	265 pF
Cpk	1.5 pF

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. VARIAN EIMAC should be consulted before using this information for final equipment design.
2. Capacitance values shown are nominal, measured with no special shielding, in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Net Weight	175 lb; 80 kg
Operating Position	Vertical, Base Down
Cooling	Water and Forced Air
Maximum Overall Dimensions:	
Length	25.50 in; 64.78 cm
Diameter	17.03 in; 43.26 cm
Maximum Operating Temperature, Envelope and Ceramic/Metal Seals	200 °C
Recommended Filament Power Connector (not supplied with tube):	
Filament Power/Water Connector (3 required)	EIMAC SK-2310
Filament rf Connector (1 required)	EIMAC SK-2315
Recommended Anode Cooling Water Connectors (not supplied with tube)	EIMAC SK-2320, SK-2321
Note: 2 connectors are required per tube	SK-2322 or SK-2323

396300 (Effective March 1986 - supersedes March 1984)
VA4896

Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	125	AMPERES
PLATE DISSIPATION	1500	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)
CLASS AB1, Peak Envelope Conditions

Plate Voltage	20.0	kVdc
Screen Voltage	1500	Vdc
Grid Voltage **	-380	Vdc
Zero Signal Plate Current	20	Adc
Single Tone Plate Current	86.5	Adc
Single Tone Screen Current *	3.8	Adc
Peak rf Grid Voltage *	380	v
Plate Dissipation *	505	kW
Plate Load Resistance	132.2	Ohms
Plate Power Output *	1225	kW
Efficiency *	70.8	%

* Approximate value.
** Adjust for specified value of zero-signal plate current.

RADIO FREQUENCY POWER AMPLIFIER
Class C Telegraphy or FM
(Key-down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	125	AMPERES
PLATE DISSIPATION	1500	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

* Approximate Value

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	21.5	kVdc
Screen Voltage	1000	Vdc
Grid Voltage	-700	Vdc
Plate Current	125	Adc
Screen Current *	12	Adc
Grid Current *	7.2	Adc
Calculated Driving Power	7.0	kW
Plate Dissipation *	530	kW
Screen Dissipation *	12	kW
Grid Dissipation *	1.9	kW
Plate Load Resistance	85.5	Ohms
Plate Power Output *	2158	kW
Efficiency *	80.1	%

PLATE MODULATED RADIO FREQUENCY POWER
AMPLIFIER Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17.5	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	100	AMPERES
PLATE DISSIPATION	1000	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

* Approximate value
\# 1500 kW at 100% sine-wave modulation

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	17.5	kVdc
Screen Voltage	1000	Vdc
Grid Voltage	-1000	Vdc
Plate Current	95	Adc
Screen Current *	8	Adc
Grid Current *	4.4	Adc
Peak Screen Voltage (100% modulation)	1000	v
Peak rf Grid Driving Voltage *	1280	v
Calculated Driving Power	6465	W
Plate Dissipation *	279	kW
Screen Dissipation *	8.0	kW
Grid Dissipation *	2.05	kW
Plate Load Resistance	85.6	Ohms
Plate Output Power *	1384	kW
Efficiency *	83.3	%

AUDIO FREQUENCY POWER AMPLIFIER OR
MODULATOR Class AB

ABSOLUTE MAXIMUM RATINGS (per tube):

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	125	AMPERES
PLATE DISSIPATION	1500	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

TYPICAL OPERATION (Two Tubes - Sinusoidal wave)

Plate Voltage	17.5	kVdc
Screen Voltage	1500	Vdc
Grid Voltage **	-455	Vdc
Zero-Signal Plate Current	10	Adc
Max.Signal Plate Current	146.2	Adc
Max.Signal Screen Current *	7.8	Adc
Peak Audio Freq.Grid Voltage #	455	v
Max.Signal Plate Dissipation #	272	kW
Plate/Plate Load Resistance	238.5	Ohms
Plate Output Power *	2015	kW

* Approximate value.
** Adjust for stated zero-signal plate current. # Per tube.

RADIO FREQUENCY POWER AMPLIFIER
Doherty Amplifier Service

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	125	AMPERES
PLATE DISSIPATION	1500	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4	KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Peak Tube - Peak of Modulation

Plate Voltage	19.0	kVdc
Screen Voltage	1600	Vdc
Grid Voltage *	-1.8	kVdc
Peak Grid Drive Voltage *	2220	v
Peak Grid Drive Power *	10	kw
Peak Plate Power Out *	2750	kw
Plate Load Resistance	51.5	Ohms

* Approximate value.

Carrier Tube - Carrier Conditions

Plate Voltage	19.0	kVdc
Screen Voltage	1600	Vdc
Grid Voltage *	-400	Vdc
Grid Current *	0.14	Adc
Screen Current *	7.3	Adc
Plate Current	101	Adc
Peak Grid Driving Voltage *	443	v
Grid Driving Power *	65	W
Plate Power Output *	1380	kW
Plate Dissipation *	510	kW
Plate Efficiency *	71	%
Plate Load Resistance	102	Ohms

Carrier Tube - Peak of Modulation

Peak Grid Drive Voltage *	668	v
Peak Grid Driving Power *	1090	w
Plate Power Output *	2750	kW
Plate Load Resistance	51.5	Ohms

Actual Load Resistance at Combining Point = 25.7 Ohms
Screen dissipation averaged over a sinusoidal modulation cycle - Modulation Index 1

Carrier Tube	14.0	kW
Peak Tube	8.5	kW

TYPICAL OPERATION values are obtained by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltages in the presence of the current variations.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	Unit
Filament Current, Per Section, at 18.5 Volts ac	600	700	Aac
Interelectrode Capacitance (grounded cathode) [1]			
Cin	1525	1675	pF
Cout	230	290	pF
Cgp	---	10	pF
Interelectrode Capacitance (grounded grid) [1]			
Cin	650	730	pF
Cout	235	295	pF
Cpk	---	2.5	pF

1 Measured with no special shielding, in accordance with Electronic Industries Association Standard RS-191.

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	125	AMPERES
PLATE DISSIPATION	1500	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)
CLASS AB1, Peak Envelope Conditions

Plate Voltage	20.0	kVdc
Screen Voltage	1500	Vdc
Grid Voltage **	-380	Vdc
Zero Signal Plate Current	20	Adc
Single Tone Plate Current	86.5	Adc
Single Tone Screen Current *	3.8	Adc
Peak rf Grid Voltage *	380	v
Plate Dissipation *	505	kW
Plate Load Resistance	132.2	Ohms
Plate Power Output *	1225	kW
Efficiency *	70.8	%

* Approximate value.
** Adjust for specified value of zero-signal plate current.

RADIO FREQUENCY POWER AMPLIFIER
Class C Telegraphy or FM
(Key-down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	125	AMPERES
PLATE DISSIPATION	1500	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

* Approximate Value

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	21.5	kVdc
Screen Voltage	1000	Vdc
Grid Voltage	-700	Vdc
Plate Current	125	Adc
Screen Current *	12	Adc
Grid Current *	7.2	Adc
Calculated Driving Power	7.0	kW
Plate Dissipation *	530	kW
Screen Dissipation *	12	kW
Grid Dissipation *	1.9	kW
Plate Load Resistance	85.5	Ohms
Plate Power Output *	2158	kW
Efficiency *	80.1	%

PLATE MODULATED RADIO FREQUENCY POWER
AMPLIFIER Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17.5	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	100	AMPERES
PLATE DISSIPATION	1000	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

* Approximate value
\# 1500 kW at 100% sine-wave modulation

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	17.5	kVdc
Screen Voltage	1000	Vdc
Grid Voltage	-1000	Vdc
Plate Current	95	Adc
Screen Current *	8	Adc
Grid Current *	4.4	Adc
Peak Screen Voltage (100% modulation)	1000	v
Peak rf Grid Driving Voltage *	1280	v
Calculated Driving Power	6465	W
Plate Dissipation *	279	kW
Screen Dissipation *	8.0	kW
Grid Dissipation *	2.05	kW
Plate Load Resistance	85.6	Ohms
Plate Output Power *	1384	kW
Efficiency *	83.3	%

AUDIO FREQUENCY POWER AMPLIFIER OR
MODULATOR Class AB

ABSOLUTE MAXIMUM RATINGS (per tube):

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	125	AMPERES
PLATE DISSIPATION	1500	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

TYPICAL OPERATION (Two Tubes - Sinusoidal wave)

Plate Voltage	17.5	kVdc
Screen Voltage	1500	Vdc
Grid Voltage **	-455	Vdc
Zero-Signal Plate Current	10	Adc
Max.Signal Plate Current	146.2	Adc
Max.Signal Screen Current *	7.8	Adc
Peak Audio Freq.Grid Voltage #	455	v
Max.Signal Plate Dissipation #	272	kW
Plate/Plate Load Resistance	238.5	Ohms
Plate Output Power *	2015	kW

* Approximate value.
** Adjust for stated zero-signal plate current. # Per tube.

RADIO FREQUENCY POWER AMPLIFIER
Doherty Amplifier Service

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	125	AMPERES
PLATE DISSIPATION	1500	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4	KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Peak Tube - Peak of Modulation

Plate Voltage	19.0	kVdc
Screen Voltage	1600	Vdc
Grid Voltage *	-1.8	kVdc
Peak Grid Drive Voltage *	2220	v
Peak Grid Drive Power *	10	kw
Peak Plate Power Out *	2750	kw
Plate Load Resistance	51.5	Ohms

* Approximate value.

Carrier Tube - Carrier Conditions

Plate Voltage	19.0	kVdc
Screen Voltage	1600	Vdc
Grid Voltage *	-400	Vdc
Grid Current *	0.14	Adc
Screen Current *	7.3	Adc
Plate Current	101	Adc
Peak Grid Driving Voltage *	443	v
Grid Driving Power *	65	W
Plate Power Output *	1380	kW
Plate Dissipation *	510	kW
Plate Efficiency *	71	%
Plate Load Resistance	102	Ohms

Carrier Tube - Peak of Modulation

Peak Grid Drive Voltage *	668	v
Peak Grid Driving Power *	1090	w
Plate Power Output *	2750	kW
Plate Load Resistance	51.5	Ohms

Actual Load Resistance at Combining Point = 25.7 Ohms
Screen dissipation averaged over a sinusoidal modulation cycle - Modulation Index 1

Carrier Tube	14.0	kW
Peak Tube	8.5	kW

TYPICAL OPERATION values are obtained by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltages in the presence of the current variations.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	Unit
Filament Current, Per Section, at 18.5 Volts ac	600	700	Aac
Interelectrode Capacitance (grounded cathode) [1]			
Cin	1525	1675	pF
Cout	230	290	pF
Cgp	---	10	pF
Interelectrode Capacitance (grounded grid) [1]			
Cin	650	730	pF
Cout	235	295	pF
Cpk	---	2.5	pF

1 Measured with no special shielding, in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

INITIAL UNPACKING - To insure the safety of the tube, the following unpacking instructions should be followed:

1. The shippping crate is opened by removing the four hex-head bolts just above the carrying handles.
2. Attach a lifting hoist to the lifting loop and raise slightly to support the weight of the tube.
3. Remove 8 bolts securing the mounting brackets to the corner flanges.
4. Lift the tube and place on blocks or on a stand so that its weight is supported by the lower flange.
5. Remove the mounting brackets from the tube by removing the eight hex bolts and nuts.

MOUNTING - The 8974 must be mounted vertically, base down. The full weight of the tube should rest on the screen-grid contact flange at the base of the tube, and all lifting of the tube should be done with the lifting eye which is attached to the top of the anode cooling jacket.

ANODE COOLING - Tube life can be seriously compromised by cooling water condition. If it becomes contaminated, deposits will form on the inside of the water jacket, causing localized anode heating and eventual tube failure. To insure minimum electrolysis and power loss, the water resistance at 25 Deg C should always be one megohm per cubic centimeter or higher. Relative water resistance can be continuously monitored in the reservoir by readily available instruments.

Minimum water flow requirements for the anode are shown in the table for an outlet water temperature not to exceed 70°C and with an inlet water temperature of 50°C. System pressure should not exceed 100 psi.

Anode Dissipation (kW)	Water Flow (gpm)	Approx.Jacket Press. Drop (psi)
Fil.Only	35	5
500	130	25
1000	250	75
1500	300	100

High velocity water flow is required to maintain high thermal efficiency. Cooling water must be well filtered, with effectivness the equivalent of a 100-mesh screen, to eliminate any solid material and avoid the possibility of blockage of any cooling passages, as this would immediately affect cooling efficiency and could produce localized anode overheating and failure of the tube.

EIMAC Application Bulletin #16, WATER PURITY REQUIREMENTS IN LIQUID COOLING SYSTEMS, is available on request, and contains considerable detail on purity requirements and maintenance systems.

BASE COOLING - The tube base requires air cooling with a minimum of 50 cfm of air at 50°C maximum at sea level, directed toward the base seal areas from a general purpose fan. At higher frequencies considerably greater flow may be required. It should be noted that temperatures of the ceramic/metal seals and the lower envelope areas are the controlling and final limiting factor.

Temperature-sensitive paints are available for use in checking temperatures in these areas before equipment design and air-cooling arrangements are finalized. Additional detail is given in EIMAC Application Bulletin #20, available on request.

Water cooling of the filament and screen grid supports is also required, with inlet water temperature not to exceed 50°C. Each of the three filament connectors includes both an inlet and an outlet line, with the proper connector for the inlet water shown on the tube outline drawing. Minimum flow for the F1 and F3 connectors is 1.0 gpm, at an approximate pressure drop of 15 psi. Minimum flow for the F2 connector is 4.0 gpm, at an approximate pressure drop of 55 psi. The screen grid cooling water is fed by means of 1/4-18 NPT tapped holes shown on the tube outline drawing, with a minimum flow of 2.0 gpm required, at an approximate pressure drop of 25 psi.

ALL COOLING MUST BE APPLIED BEFORE OR SIMULTANEOUSLY WITH THE APPLICATION OF ELECTRODE VOLTAGES, INCLUDING THE FILAMENT, AND SHOULD NORMALLY BE MAINTAINED FOR SEVERAL MINUTES AFTER ALL VOLTAGES ARE REMOVED TO ALLOW FOR TUBE COOLDOWN.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

FILAMENT OPERATION - Filament turn-on and turn-off should be programmed. Filament voltage should be smoothly increased from zero to the operating level over a period of two minutes, and a motor-driven continuously variable autotransformer (such as a VARIAC® or a POWERSTAT®) is suggested. Inrush current must never be allowed to exceed twice normal operating current. Normal turnoff procedure should be a smooth decrease from the operating voltage to zero over a period of two minutes.

Filament life will be substantially improved if the filament is maintained at a standby voltage of 3.5 to 4.0 volts per section when the tube is not in use. It is recommended the filament be cycled up from and down to this standby level (rather than to 0 volts) in the manner indicated above in order to maximize filament life. A minimum cooling water flow of at least 1.0 gpm is required through all cooling circuits (including the anode) during standby operation.

At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in

filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The filament voltage should then be increased several tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked after 24 hours. Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations. A filament voltage of 17.5 volts per section is adequate for most applications.

Filament voltage should be measured at the tube base, using an accurate rms-responding meter. Periodically throughout the life of the tube the procedure outlined above for voltage reduction should be repeated, resetting voltage as required, to assure best tube life.

EIMAC Application Bulletin #18, titled "EXTENDING TRANSMITTER TUBE LIFE", contains detailed information and is available on request.

Where hum is an important system consideration it is permissible to operate the filaments with dc rather than ac power. Contact Varian EIMAC Application Engineering for special precautions when using a dc filament supply.

Care should be exercised to keep any rf power out of the filament of the tube, as this can cause excessive operating temperatures. Both sides of the filament must be bypassed to assure monopotential operation. It should be ascertained that no resonance exists in the filament circuit which could be excited during operation.

This tube is designed for commercial service, with one off/on filament cycle per day. If additional cycling is anticipated it is recommended the user contact Application Engineering at VARIAN EIMAC for additional information.

VACION® PUMP OPERATION - The tube is supplied with an ion pump and magnet, mounted on the filament structure at the base (stem). A power supply (Varian Part #921-0015) and an 8-foot cable (Varian Part #924-0020) are required for operation. The primary function of this device is to allow monitoring of the condition of the tube vacuum, as shown by an ion current meter.

With an operational tube it is recommended the VACION pump be operated full time so tube vacuum may be monitored on a continuous basis. A reading of less than 10 uAdc should be considered as normal, indicating excellent tube vacuum. In addition to other interlock circuitry it is recommended that full advantage be taken of the VACION pump readout by providing circuitry which will shut down all power to the tube in the event the readout current exceeds 50 uAdc. In the event of such a shutdown, the VACION pump should be operated alone until vacuum recovery is indicated by a reading of 10 uAdc or less, at which point the tube may again be made operational. If the vacuum current rises again it should be considered as indicating a circuit problem such that some tube element may be over-dissipating and outgassing.

In the case of a spare tube (non-operational) it is recommended the VACION pump be operated continuously if possible. Otherwise it should be operated periodically to check the condition of tube vacuum, and operated as long as necessary to achieve a reading of 10 uAdc or better.

Figure 1 shows the relationship between tube vacuum and the ion current reading. Electrode voltages should never be applied if a reading of 50 uAdc or higher is obtained. Filament voltage should never be applied with a VacIon pump current of 1.0 mA or higher. In the event poor vacuum cannot be improved by operation of the VACION pump the user should contact EIMAC and review the case with an Applications Engineering specialist.

PLATE OPERATION - The plate dissipation maximum rating of 1500 kilowatts provides a large margin of safety for most applications. The rating may be exceeded for very brief periods during setup or tuning. When used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 1000 kilowatts.

Operation with significant plate current under some conditions of high instantaneous anode voltage (such as regulator service or low power and low impedance "tuning" conditions) can, as a result of the screen and grid voltages chosen, lead to anode damage and subsequent failure. If operation under such conditions is necessary EIMAC Application Engineering should be contacted for assistance in selection of operating parameters.

GRID OPERATION - The maximum grid dissipation is 4000 watts and protective measures should be taken to insure that this rating is not exceeded. Grid dissipation is approximately equal to the product of dc grid current and peak positive grid voltage. A protective spark gap device should be connected between the control grid and the cathode to guard against excessive voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 15,000 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. Suitable protective circuitry must be provided to remove screen power in case of a fault condition. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

Tetrode tubes may exhibit reversed screen current to a greater or lesser degree depending on individual tube design and operating conditions. The screen supply voltage must be maintained constant for any values of negative or positive screen currents which may be encountered. Dangerously high plate currents may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished by use of a shunt regulator circuit in the screen voltage supply, bleeder resistors, or other suitable techniques.

PULSE OPERATION - The thermal time constants of the internal tube elements vary from a few milliseconds in the case of the grids to about 200 milliseconds for the anode. In many applications the meaning of duty as applied to a pulse chain is lost because the interpulse period is very long. For pulse lengths greater than 10 milliseconds, where the interpulse period is more than 10 times the pulse duration, the element dissipations and required cooling are governed by the watt-seconds during the pulse. Provided the watt-seconds are less than the listed maximum dissipation rating and sufficient cooling is supplied, tube life will be protected. To maintain high cooling efficiency the anode water flow must be sufficient to insure turbulent flow. EIMAC has determined that a minimum flow of 35 gpm (130 lpm) is required.

FAULT PROTECTION - In addition to the normal plate over-current interlock and coolant interlock, the tube must be protected from internal damage caused by any arc which may occur. A protective resistance should always be connected in series with the grid and anode to help absorb power supply stored energy if an arc should occur. An electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, is recommended. The protection test for each supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-inch length of #30 AWG copper wire. The wire will remain intact if protection is adequate. As noted in GRID OPERATION and SCREEN OPERATION a protective spark gap should be connected from grid to ground and from screen grid to ground.

EIMAC Application Bulletin #17 titled FAULT PROTECTION contains considerable detail, and is available on request.

LOAD VSWR - The load VSWR should be monitored and the detected signal used to operate the interlock system to remove plate voltage within 20 milliseconds after a fault occurs. In the case of high stored energy in the load system, care must be taken to avoid excessive return energy from damaging the tube and associated circuit components.

X-RADIATION HAZARD - High-vacuum tubes operating at voltages higher than 15 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential X-ray source. Only limited shielding is afforded by the tube envelope. Moreover, the X-radiation level may increase significantly with tube aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by the high voltage. X-ray shielding may be required on all sides of tubes operating at these voltages to provide adequate protection throughout the life of the tube. Periodic checks on the X-ray level should be made, and the tube should never be operated without required shielding in place. If there is any question as to the need for or the adequacy of shielding, an expert in this field should be contacted to perform an equipment X-ray survey.

In cases where shielding has been found to be required operation of the equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

INTERELECTRODE RF TUNING CHARACTERISTICS - Typical interelectrode tuning characteristics may be obtained by contacting VARIAN EIMAC Power Grid Tube Application Engineering.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis from the tube terminals and associated wiring. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. The test is performed on a cold tube, and in the case of the 8974, with no special shielding. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown in the test specification or technical data are taken in accordance with Standard RS-191.

The equipment designer is cautioned to make allowance for the capacitance values, including tube-to-tube variation and strays, which will exist in any normal application. Measurements should be taken with mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to VARIAN EIMAC; attn: Applications Engineering; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

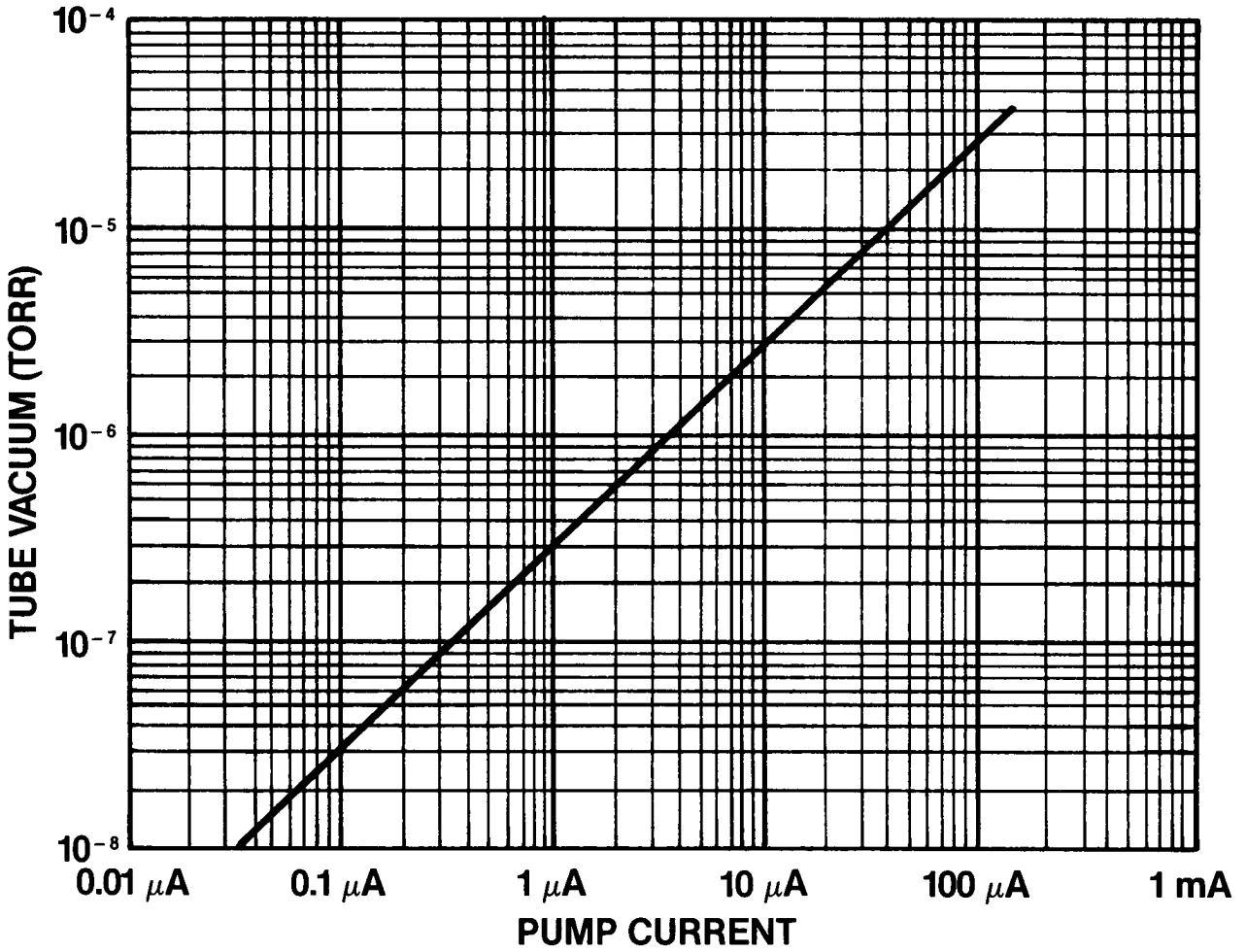


Figure 1 - Tube Vacuum VS Ion Current

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

b. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. CARDIAC PACEMAKERS MAY BE EFFECTED.

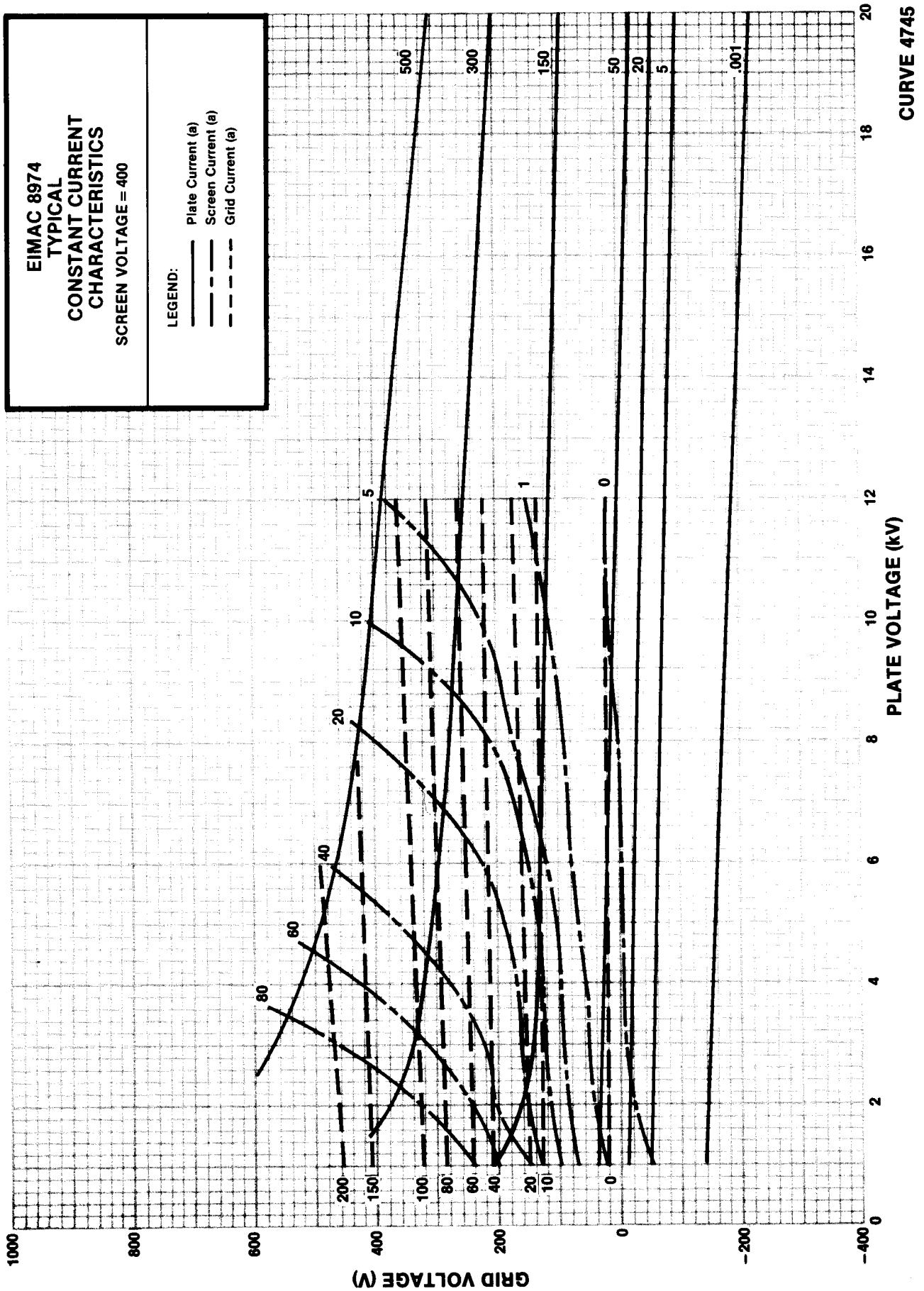
c. X-RADIATION - High voltage tubes can produce dangerous and possibly fatal X-Rays.

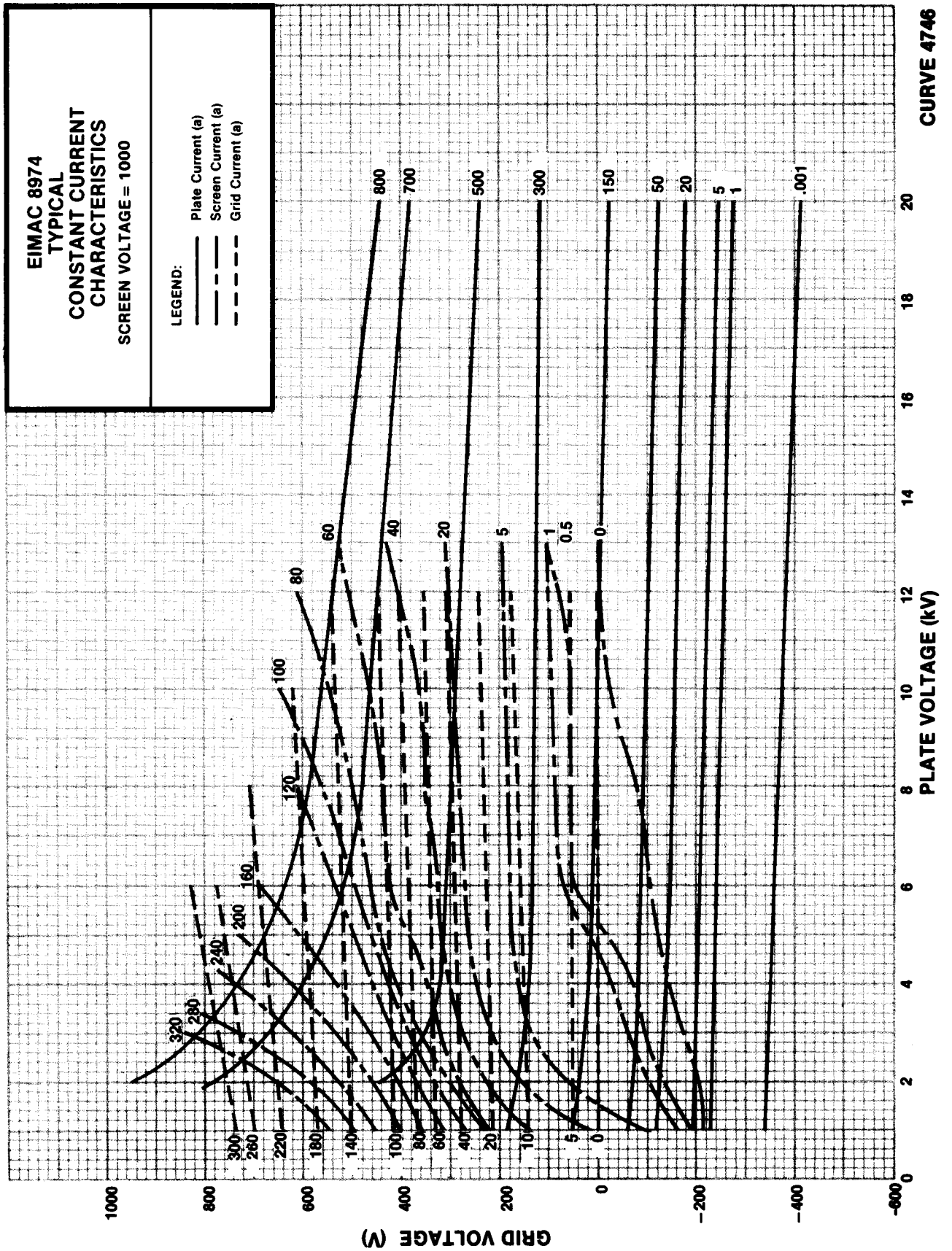
d. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - Personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

e. HOT WATER - Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

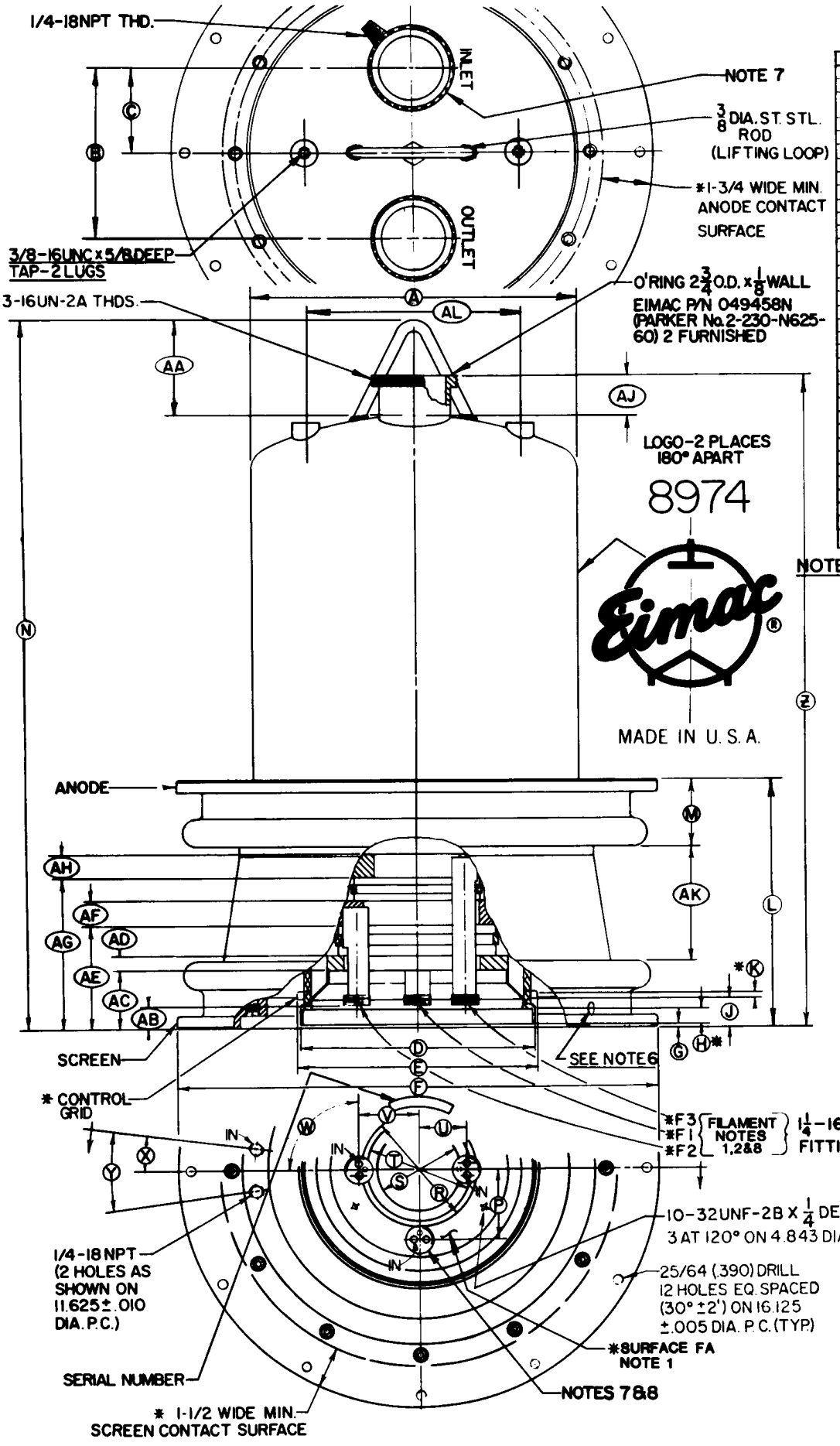
f. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred Degrees C and cause serious burns if touched for several minutes after all power is removed.

Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: VARIAN EIMAC, Power Grid Tube Division, 301 Industrial Way, San Carlos CA 94070.


EIMAC 8974
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 400
LEGEND:
Plate Current (a)
Screen Current (a)
Grid Current (a)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE 4745


EIMAC 8974
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1000
LEGEND:
Plate Current (a)
Screen Current (a)
Grid Current (a)
CURVE 4746
PLATE VOLTAGE (kV)
GRID VOLTAGE (V)
0
2
4
6
8
10
12
14
16
18
20
1000
800
600
400
200
0
-200
-400
-600
800
700
500
300
150
50
20
5
1
.001
60
40
20
5
1
0.5
0
80
100
120
160
200
240
280
320
300
260
220
180
140
100
80
60
40
20
10
5
0

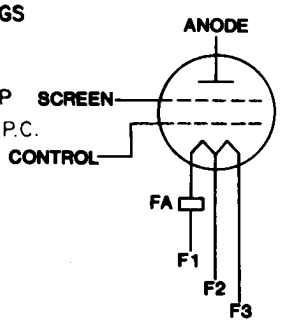
8974



DIMENSIONAL DATA							
	INCHES			MILLIMETERS			
DIM	MIN	MAX	REF	MIN	MAX	REF
A	11.440	11.560		290.58	293.62	
B			6.000			152.40
C			3.000			76.20
D	8.235	8.265		209.17	209.93	
E	8.485	8.525		215.52	216.54	
F	16.970	17.030		431.04	432.56	
G			.025			.635
H	.310			7.87		
J	.900	1.000		22.86	25.40	
K	.180			4.57		
L	8.700	8.900		220.98	226.06	
M			2.375			60.32
N			25.312			642.92
P			2.500			63.50
R	4.113	4.137		104.47	105.06	
S	2.988	3.012		75.89	76.50	
T	3.675	3.699		93.34	93.96	
U			1.687			42.85
V			2.156			54.76
W			90°			
X			7-1/2°			
Y			15°			
Z	22.857	23.305		580.57	591.95	
AA			3.575			90.80
AB			.720			18.29
AC	1.950	2.100		49.53	53.34	
AD	.450			11.43		
AE	3.560	3.680		90.42	93.47	
AF	.725			18.42		
AG	5.300	5.450		134.62	138.43	
AH	.725			18.42		
AJ			1.375			34.92
AK			4.095			103.96
AL			8.000			203.20

NOTES:

1. CIRCUIT RETURN MAY BE MADE TO FA BY SK-2315 CONNECTOR.
2. MATE WITH EIMAC CONNECTOR SK-2310
3. DC RETURN SHOULD BE MADE TO F_2
4. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
5. (*) CONTACT SURFACES
6. 1/4 DIA. WATER DRAIN HOLE - 3 PLACES.
7. WATER INLET ON JACKET & WATER FITTING F1, ARE TO BE IN LINE & ON SAME SIDE OF TUBE.
8. A TUBE OF ANTI-SEIZE THREAD LUBRICANT IS PROVIDED WITH TUBE TO PREVENT GALLING OF FILAMENT CONNECTOR THREADS, SEE INSTR. SHEET E14-1.2 ATTACHED TO TUBE.



See new data sheet Feb 91.

8989
4CX12,000A

VHF
RADIAL BEAM
POWER TETRODE

TECHNICAL DATA

The EIMAC 8989 is a ceramic/metal power tetrode intended for use in audio or radio frequency applications. It features a type of internal mechanical structure which results in high rf operating efficiency. Low rf losses in this structure permit operation at full ratings up to 220 MHz.

The 8989 has a gain of over 18 dB in FM broadcast service, and is also recommended for radio-frequency linear power amplifier service, and for VHF television linear amplifier service. The anode is rated for 15 kilowatts of dissipation with forced-air cooling and incorporates a highly efficient cooler of new design.

GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	7.5 ± 0.37	V
Current @ 7.5 volts	120	A
Amplification Factor, average		
Grid to Screen	6.7	
Direct Interelectrode Capacitances (grounded cathode):		
Cin	160	pF
Cout	18.5	pF
Cgp	1.0	pF
Direct Interelectrode Capacitances (grid and screen grounded):		
Cin	70	pF
Cout	18.6	pF
Cpk	0.1	pF
Frequency of Maximum Ratings (CW)	220	MHz

1 Characteristics and operating values are based on calculations and measured data. These figures may change without notice as a result of data or product refinement. Varian EIMAC Division should be consulted before using this information for final equipment design.

(Revised 3 Feb 81 - supersedes Dec 78)

MECHANICAL

Maximum Overall Dimensions:	
Length (height)	9.84 in; 24.99 cm
Diameter	7.76 in; 19.71 cm
Net Weight (approximate)	14 lbs; 6.4 kg
Operating Position	Axis vertical, base up or down
Cooling	Forced Air
Operating Temperature, Maximum:	
Ceramic/Metal Seals & Anode Core	250 °C
Base	Special, concentric
Recommended Air System Socket	EIMAC SK-300A
Recommended Air Chimney	EIMAC SK-336

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM

(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	10.0	KILOVOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	3.5	AMPERES
PLATE DISSIPATION	15.0	KILOWATTS
SCREEN DISSIPATION	300	WATTS
GRID DISSIPATION	150	WATTS

TYPICAL OPERATION (frequencies to 30 MHz)

Plate Voltage	9.0	kVdc
Screen Voltage	750	Vdc
Grid Voltage	-250	Vdc
Plate Current	2.83	Adc
Screen Current [1]	135	mAdc
Grid Current [1]	63	mAdc
Peak rf Grid Voltage [1]	335	v
Calculated Drive Power	23	W
Plate Dissipation [1]	5.47	kW
Plate Output Power [1]	20	kW
Load Impedance	1590	Ω

1 Approximate value

TYPICAL OPERATION, COMMERCIAL FM SERVICE

(measured values at frequency shown, in EIMAC cavity amplifier)

Frequency of Operation	90.5	108.1	MHz
Plate Voltage	9.95	10.0	kVdc
Screen Voltage	600	800	Vdc
Grid Voltage	-300	-300	Vdc
Plate Current	3.08	2.81	Adc
Screen Current	200	130	mAdc
Grid Current	41	32	mAdc
Driving Power	245	275	W
Useful Power Output [1]	22.9	22.5	kW
Efficiency	74.7	80.2	%
Gain	19.7	19.1	dB

1 Delivered to the load

APPLICATION

MOUNTING - The 8989 must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the circuit designer.

SOCKET & CHIMNEY - The EIMAC air-system socket SK-300A and air chimney SK-336 are recommended for use with the 8989. The use of the recommended air flow through this socket provides effective forced-air cooling of the tube base, with air then guided through the anode cooling fins by the air chimney.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250°C, and sufficient forced-air cooling must be used in all applications to keep the temperature of the anode (at the base of the cooling fins) and the temperature of the ceramic/metal seals comfortably below the rated maximum.

The cooling characteristics of the tube are shown in the attached graph. The designer is cauted to keep in mind that this is ABSOLUTE data, with pure dc power, with no safety factors added, and the pressure drop figures make no allowance for losses in filters, ducting, and the like.

It is considered good engineering practice to design for maximum anode core temperature of 225°C, and temperature-sensitive paints are available for checking tube temperatures before any design is finalized. It is also considered good practice to add a 15% safety factor to the indicated airflow, and allow for variables such as dirty air filters, rf seal heating at VHF, and the fact that the anode cooling fins may not be clean if the tube has been in service for some length of time. Special cooling is required in the center of the stem (base), by means of special air directors or some other provision. An air interlock system should be incorporated into the design to

automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.

Air flow must be applied before or simultaneously with the application of power, including the tube filament, and should normally be maintained for a short period of time after all power is removed to allow for tube cool-down.

FILAMENT OPERATION - The rated nominal filament voltage for the 8989 is 7.5 volts, as measured at the socket or tube base. Variation in voltage should be maintained within plus or minus five percent. During application of filament voltage the inrush current should be limited to no more than twice normal current.

The peak emission capability at nominal filament voltage is normally more than that required for communication service. A small decrease in filament temperature due to reduction in filament voltage can increase tube life by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely effect equipment operation. This is done by measuring some important parameter of performance (such as power output or distortion) while filament voltage is reduced. At some point in filament voltage there will be a noticeable change in the operating parameter being monitored, and the operating filament voltage must be slightly higher than the level at which deterioration was noted. When filament voltage is to be reduced in this manner it should be regulated and held to plus or minus one percent, and the actual operating value should be checked periodically to maintain proper operation.

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings for the 8989 must be respected to avoid damage to the tube. An exception is the plate dissipation, which may be permitted to rise above the rated maximum during brief periods, such as may occur during tuning.

GRID OPERATION - The 8989 control grid has a maximum dissipation rating of 150 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should normally be kept near the values shown in the TYPICAL OPERATION section of the data sheet whenever possible.

SCREEN OPERATION - The power dissipated by the screen grid of the 8989 must not exceed 300 watts. Screen dissipation, in cases where there is no ac applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend on loading, driving power, and the carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with the filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 300 watts in the event of circuit failure. Energy limiting circuitry (which will activate if there is a fault condition) and spark gap over-voltage protection are recommended as good engineering practice.

The 8989 may exhibit reversed (negative) screen current under some operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen currents which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, and this is absolutely essential if a series electronic regulator is employed.

FAULT PROTECTION - In addition to normal plate overcurrent interlock and screen current interlock, it is good practice to protect the tube from internal damage which could result from a plate arc at high voltage. In all cases some protective resistance, 10 to 50 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a tube arc should occur. If power supply stored energy is very high, some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a tube arc is recommended.

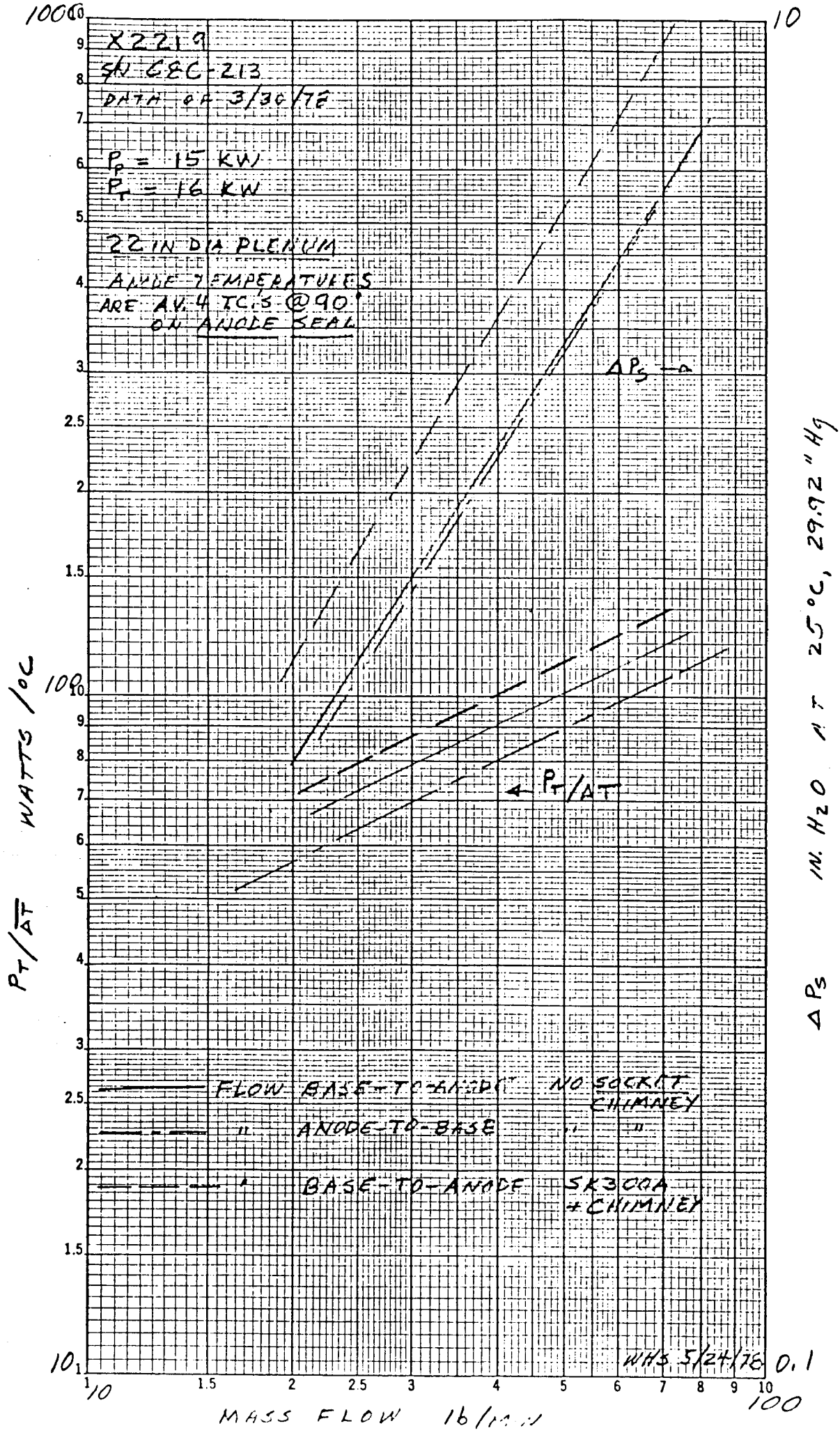
EIMAC APPLICATION BULLETIN #17 titled "FAULT PROTECTION" is available on request and includes detailed information on this subject.

HIGH VOLTAGE - Normal operating voltages used with the 8989 are deadly and the equipment must be designed properly and operating precautions must be followed. All equipment must be designed so that no one can come into contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminate any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different tube manufacturers. The capacitance values shown in the manufacturer's technical data, or test specification, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

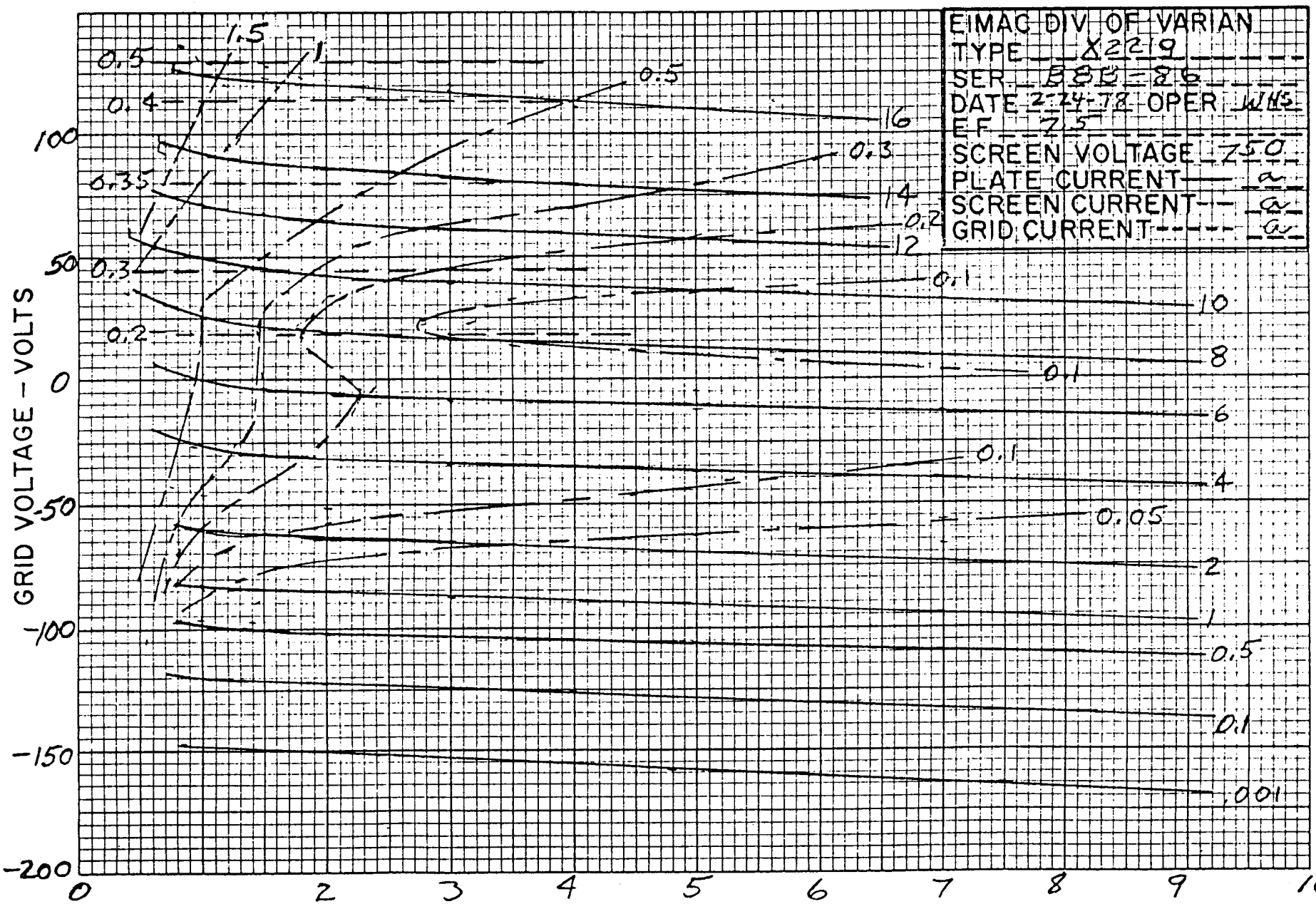
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those listed here, write to Application Engineering, Power Grid Tube Division, Varian EIMAC Division, 301 Industrial Way, San Carlos, CA 94070 for recommendations.



K+E LOGARITHMIC 359-103
KEUFFEL & ESSER CO. MADE IN U.S.A.
2 X 1 CYCLES

TUBE NO. _____ PLOTTED BY _____ DATE _____
COORDINATES: EIMAC 7 X 10 8-17-54

GROUNDED CATHODE
CONSTANT CURRENT CHARACTERISTICS

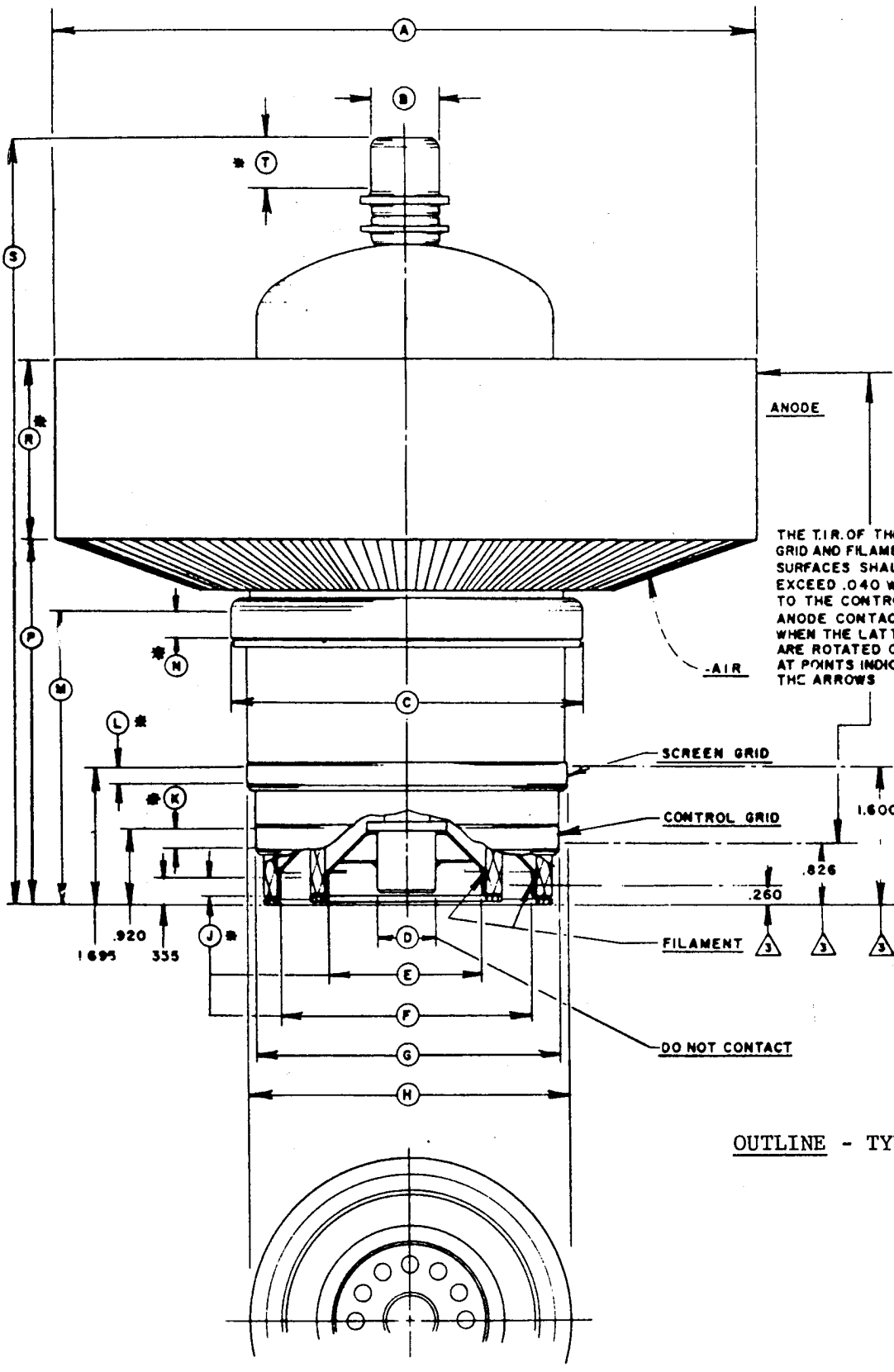


4046

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	7.700	7.760				
B	.855	.895				
C	4.406	4.468				
D	.600	.760				
E	1.896	1.936				
F	3.133	3.173				
G	3.792	3.832				
H	3.980	4.020				
J	.188					
K	.188					
L	.188					
M	3.718	3.781				
N	.219					
P	4.593	4.656				
R	2.100	2.200				
S	9.465	9.840				
T	.500					

NOTES

1. REF. DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES
2. ✱ CONTACT SURFACE.
3. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES



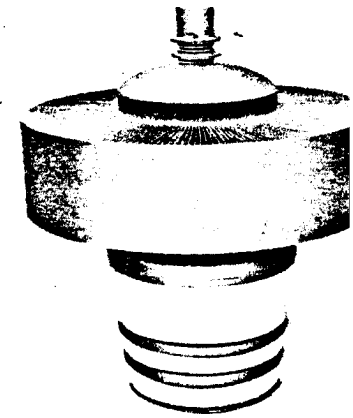
OUTLINE - TYPE 8989/4CX12,000A

TECHNICAL DATA

8990
4CX20,000A
8990A

VHF
RADIAL BEAM
POWER TETRODE

The EIMAC 8990/4CX20,000A is a ceramic/metal power tetrode intended for use in audio or radio-frequency applications. It features a type of internal mechanical structure which results in high rf operating efficiency. Low rf losses in this structure permit operation at full ratings up to 110 MHz.



The 8990/4CX20,000A has a gain of over 18 dB in FM broadcast service, and is also recommended for radio-frequency linear power amplifier service, and for VHF television linear amplifier service. The anode is rated for 20 kW of dissipation with forced-air cooling and incorporates a highly efficient cooler of new design.

The 8990A is recommended for high-level, plate modulated amplifier service.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	10.0 ± 0.5	V
Current, at 10.0 volts	140	A
Amplification Factor, average		
Grid to Screen	6.7	
Direct Interelectrode Capacitances (cathode grounded):[2]		
Cin	190	pF
Cout	23.5	pF
Cgp	1.5	pF
Direct Interelectrode Capacitances (grid and screen grounded):[2]		
Cin	83	pF
Cout	24.5	pF
Cpk	0.2	pF
Frequency of Maximum Ratings (CW)	110	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	9.840 in; 24.99 cm
Diameter	8.800 in; 22.35 cm
Net Weight (Approximate)	14.0 lbs; 6.35 kg
Operating Position	Axis vertical, base up or down
Cooling	Forced air
Operating Temperature, maximum	
Ceramic/Metal Seals and Anode Core	250°C
Base	Special, concentric
Recommended Air System Socket	SK-320
Recommended Air Chimney	SK-326

4402 (Effective 20 October 1980)

Printed in U.S.A.

Varian / EIMAC Division / 301 Industrial Way / San Carlos / California 94070
Telephone: (415) 592-1221 Twx: 910 376-4893

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	20,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION (frequencies to 30 MHz)

Plate Voltage	7.5	9.0	kVdc
Screen Voltage	750	900	Vdc
Grid Voltage	-200	-250	Vdc
Plate Current	3.68	4.01	Adc
Screen Current[1]	208	222	mAdc
Grid Current[1]	91	88	mAdc
Peak rf Grid Voltage[1]	265	300	v
Calculated Drive Power	24.1	26.4	W
Plate Dissipation[1]	5.84	7.93	kW
Plate Output Power[1]	21.8	28.2	kW
Load Impedance	1062	1136	Ω

[1] Approximate value

TYPICAL OPERATION, COMMERCIAL FM SERVICE
(measured values at frequency shown, in EIMAC CV-2200 cavity amplifier)

Frequency of Operation	88.3	107.7	MHz
Plate Voltage	9.0	9.0	kVdc
Screen Voltage	800	800	Vdc
Grid Voltage	-400	-300	Vdc
Plate Current	4.08	4.15	Adc
Screen Current	200	200	mAdc
Grid Current	40	38	mAdc
Drive Power	325	360	W
Useful Power Output[1]	28.75	28.9	kW
Efficiency	80.5	77.4	%
Gain	19.5	19.0	dB

[1] Delivered to the load

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER
8990A RECOMMENDED

GRID DRIVEN Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC GRID VOLTAGE	-1,000	VOLTS
DC PLATE CURRENT	5	AMPERES
PLATE DISSIPATION	13.5	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION

Plate Voltage	7,800	Vdc
Screen Voltage	750	Vdc
Grid Voltage	-300	Vdc
Peak af screen voltage (100% modulation)	750	v
Plate Current	4.6	Adc
Screen Current[1]	220	mAdc
Grid Current[1]	108	mAdc
Calculated Driving Power	35	W
Plate Impedance	845	Ω
Plate Output Power	29	kW
Plate Dissipation	6880	W

[1] Approximate

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

GRID DRIVEN, Class AB1
(sinusoidal wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2,500	VOLTS
DC PLATE CURRENT	6	AMPERES
PLATE DISSIPATION	20	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION (2 tubes)

Plate Voltage	7,800	7,800	7800	Vdc
Screen Voltage	500	750	1500	Vdc
Grid Voltage[1]	-70	-125	-250	Vdc
Zero Signal Plate Current	0.75	0.75	1.0	Adc
Max. Signal Plate Current	3.4	5.2	9.2	Adc
Max. Signal Screen Current[2]	90	220	600	mAdc
Peak Grid Voltage[2]	65	115	200	v
Max. Signal Plate Dissipation[3]	6	7	13.5	kW
Plate Output Power	14.5	26	44	kW
Load Impedance p/p	6,300	3,500	1600	Ω

[1] Adjust for specified zero-signal plate current.
[2] Approximate value
[3] Per tube

TYPICAL OPERATION values are obtained by calculations from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to produce the required bias voltage when the correct rf grid voltage is applied.

APPLICATION

MOUNTING – The 8990 must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the circuit designer.

SOCKET & CHIMNEY – The EIMAC air-system socket SK-320 and air chimney SK-326 are designed especially for use with the 8990. The use of the recommended air flow through this socket provides effective forced-air cooling of the base, with air then guided through the anode cooling fins by the air chimney.

COOLING – The maximum temperature rating for the external surfaces of the tube is 250°C, and sufficient forced-air cooling must be used in all applications to keep the temperature of the anode (at the base of the cooling fins) and the temperature of the ceramic/metal seals comfortably below the rated maximum.

The cooling characteristics of the anode are shown in the attached graph, for power levels from 7.5 kW to 20 kW dissipation. The designer is cautioned to keep in mind that is ABSOLUTE data, with pure dc power, with no safety factors added, and the pressure drop figures make no allowance for losses in filters, ducting, and the like.

It is considered good engineering practice to design for a maximum anode core temperature of 225°C, and temperature sensitive paints are available for checking base and seal temperatures before any design is finalized. It is also considered good practice to add a 15% safety factor to the indicated airflow, and allow for variables such as dirty air filters, rf seal heating at VHF, and the fact that the anode coolings fins may not be clean if the tube has been in service for some length of time. Special attention is required in cooling the center of the stem (base), by means of special directors or some other provision. An air interlock system should be incorporated into the design to automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.

Air flow must be applied before or simultaneously with the application of power, including the tube filament, and should normally be maintained for a short period of time after all power is removed to allowed for tube cooldown.

FILAMENT OPERATION – The rated nominal filament voltage for the 8990 is 10.0 volts, as measured at the socket or tube base. Variation in voltage should be maintained within plus or minus five percent. During application of filament voltage the inrush current should be limited to no more than twice normal current.

The peak emission capability at nominal filament voltage is normally more than that required for communication service. A small decrease in filament temperature due to reduction in filament voltage can increase tube life by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not adversely affect equipment operation. This is done by measuring some important parameter of performance (such as plate current, power output, or distortion) while filament voltage is reduced. At some point in filament voltage there will be a noticeable change in the operating parameter being monitored, and the operating filament voltage must be slightly higher than the level at which deterioration was noted. When filament voltage is to be reduced in this manner it should be regulated and held to plus or minus one percent, and the actual operating value should be checked periodically to maintain proper operation.

ELECTRODE DISSIPATION RATINGS – The maximum dissipation ratings for the 8990 must be respected to avoid damage to the tube. An exception is the plate dissipation which may be permitted to rise above the rated maximum during brief periods (10 seconds maximum) such as may occur during tuning.

GRID OPERATION – The 8990 control grid has a maximum dissipation rating of 200 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should normally be kept near the values shown in the TYPICAL OPERATION section of the data sheet whenever possible.

SCREEN OPERATION – The power dissipated by the screen of the 8990 must not exceed 450 watts. Screen dissipation, in cases where there is no ac applied to the screen is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with the filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 450 watts in the event of circuit failure. Energy limiting circuitry (which will activate if there is a fault condition) and spark gap over-voltage protection are recommended as good engineering practice.

The 8990 may exhibit reversed (negative) screen current under some operating conditions.

The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, to assure that net screen supply current is always positive. This is absolutely essential if a series electronic regulator is employed.

FAULT PROTECTION – In addition to normal plate overcurrent interlock and screen current interlock it is good practice to protect the tube from internal damage which could result from a plate arc at high voltage. In all cases some protective resistance, 10 to 50 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a tube arc should occur. If power supply stored energy is high some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a tube arc is recommended.

HIGH VOLTAGE – Normal operating voltages used with the 8990 are deadly and the equipment must be designed properly and operating precautions must be followed. All equipment must be designed so that no one can come into contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE – The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminate any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS – If it is desired to operate this tube under conditions widely different from those listed here, write to Application Engineering, Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, CA 94070 for recommendations.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of power tubes involves one or more of the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE – Normal operating voltages can be deadly.

b. RF RADIATION – Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE AFFECTED.

c. X-RAY RADIATION – High voltage tubes can produce dangerous and possibly fatal x-rays.

d. BERYLLIUM OXIDE POISONING – Dust or fumes from BeO ceramics used as thermal links with some conduction-cooled power tubes are highly toxic and can cause serious injury or death.

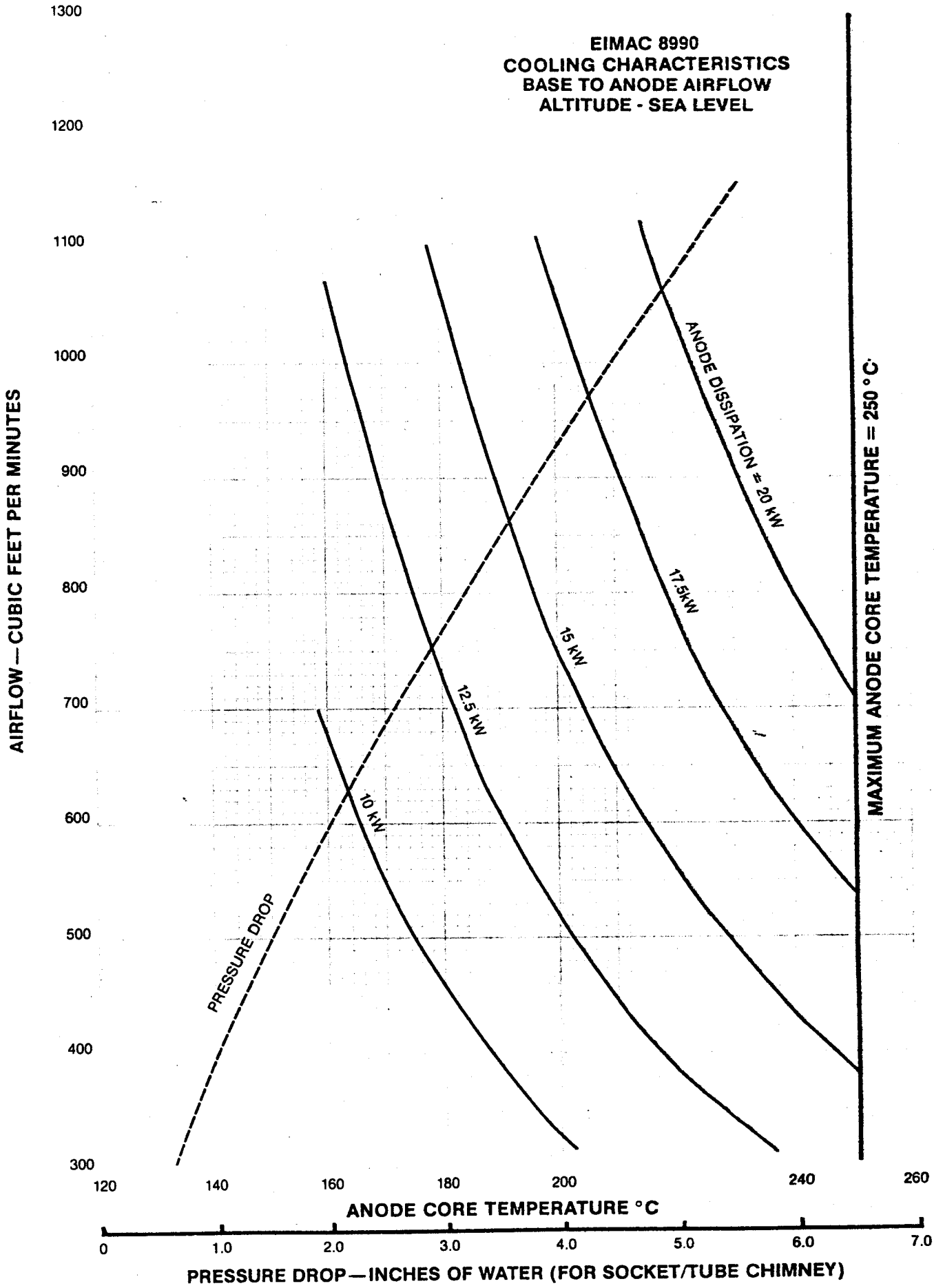
e. GLASS EXPLOSION – Many electron tubes have glass envelopes. Breaking the glass can cause an implosion, which will result in an explosive scattering of glass particles. Handle glass tubes carefully.

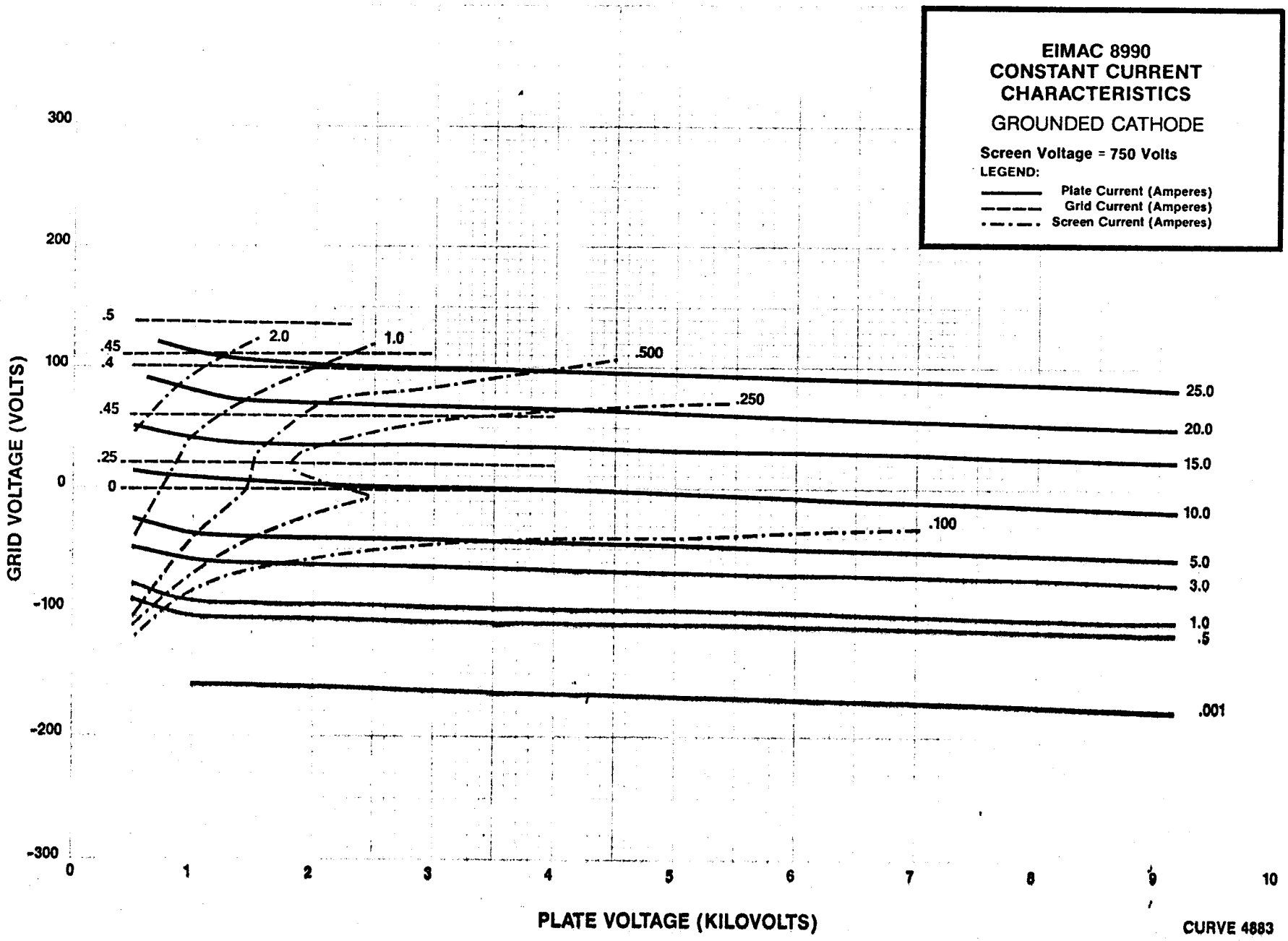
f. HOT WATER – Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

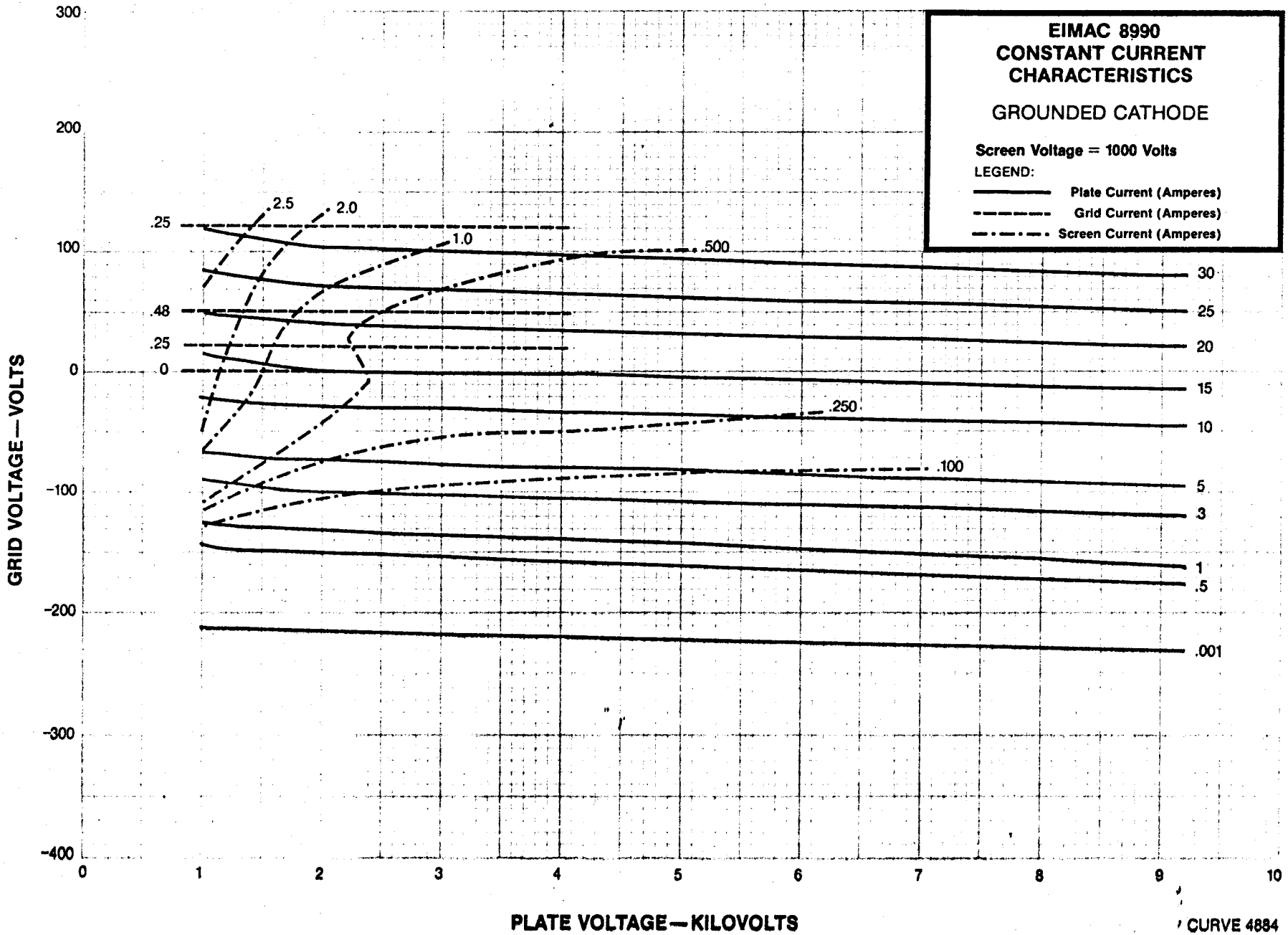
g. HOT SURFACES – Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred degrees centigrade and cause serious burns if touched.

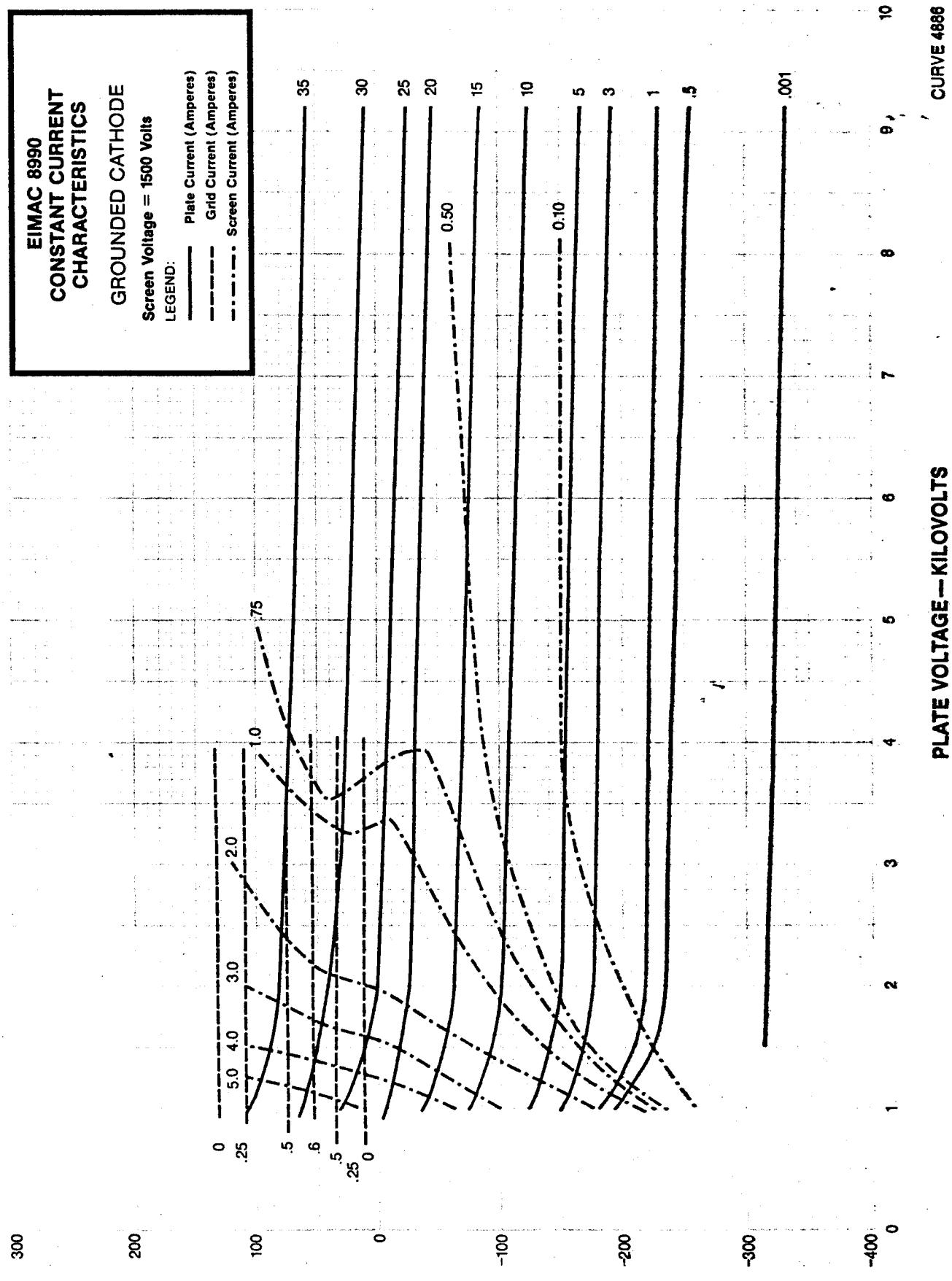
Please review the detailed operating hazards sheet enclosed with each tube or request a copy from the address shown below: Power Grid Tube Division, Varian, EIMAC division, 301 Industrial Way, San Carlos, California 94070.

CURVE 4800


EIMAC 8990
COOLING CHARACTERISTICS
BASE TO ANODE AIRFLOW
ALTITUDE - SEA LEVEL
AIRFLOW—CUBIC FEET PER MINUTES
1300
1200
1100
1000
900
800
700
600
500
400
300
ANODE DISSIPATION = 20 KW
17.5kW
15 KW
12.5 KW
10 KW
PRESSURE DROP
MAXIMUM ANODE CORE TEMPERATURE = 250 °C
120
140
160
180
200
240
260
ANODE CORE TEMPERATURE °C
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
PRESSURE DROP—INCHES OF WATER (FOR SOCKET/TUBE CHIMNEY)

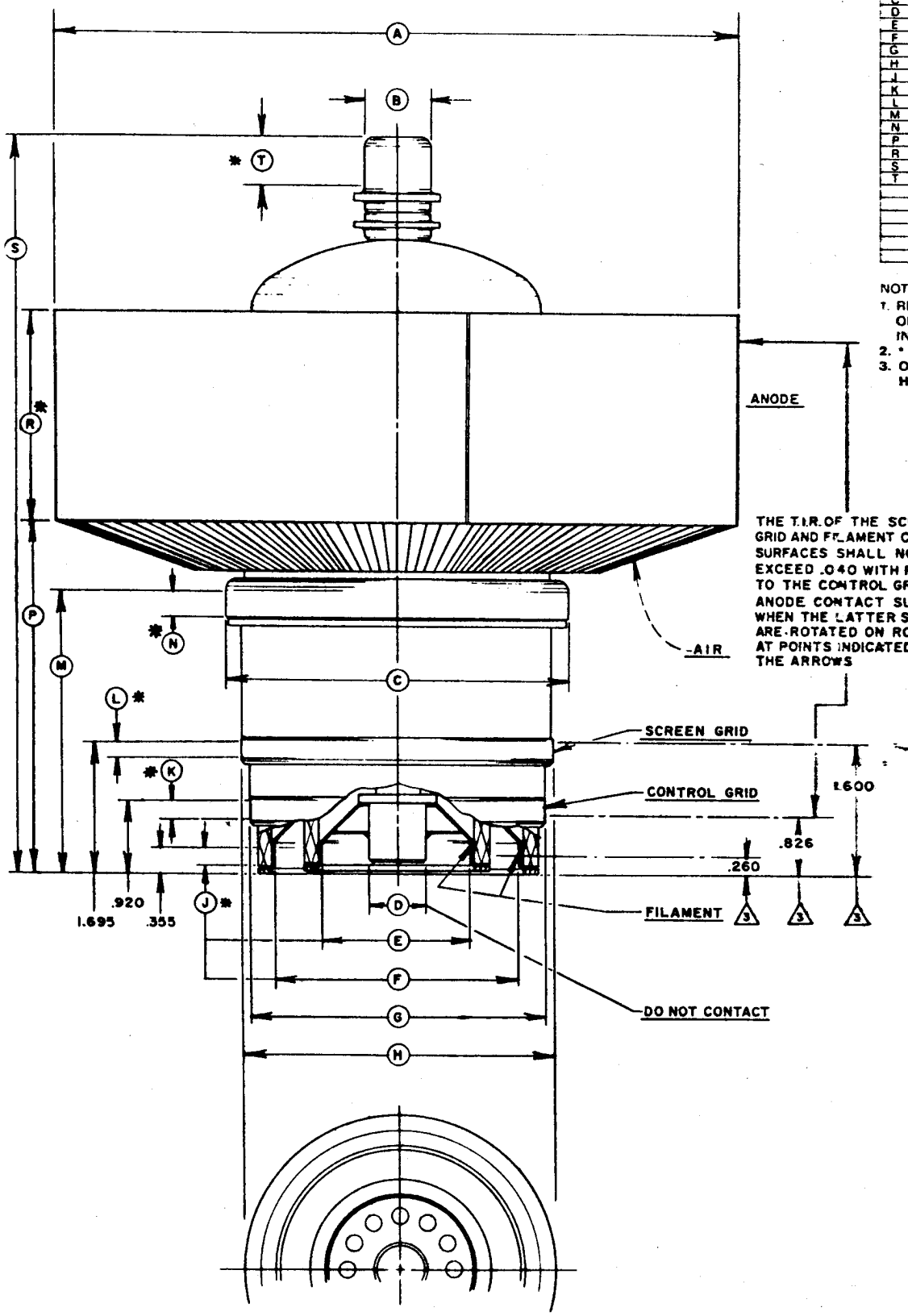

EIMAC 8990
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
Screen Voltage = 750 Volts
LEGEND:
Plate Current (Amperes)
Grid Current (Amperes)
Screen Current (Amperes)
GRID VOLTAGE (VOLTS)
300
200
100
0
-100
-200
-300
0
1
2
3
4
5
6
7
8
9
10
PLATE VOLTAGE (KILOVOLTS)
.5
.45
.4
.45
.25
0
2.0
1.0
.500
.250
.100
25.0
20.0
15.0
10.0
5.0
3.0
1.0
.5
.001
CURVE 4883


EIMAC 8990
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
Screen Voltage = 1000 Volts
LEGEND:
Plate Current (Amperes)
Grid Current (Amperes)
Screen Current (Amperes)
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—KILOVOLTS
CURVE 4884
300
200
100
0
-100
-200
-300
-400
0
1
2
3
4
5
6
7
8
9
10
2.5
2.0
1.0
.500
.250
.100
.25
.48
.25
0
30
25
20
15
10
5
3
1
.5
.001


EIMAC 8990
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
Screen Voltage = 1500 Volts
LEGEND:
Plate Current (Amperes)
Grid Current (Amperes)
Screen Current (Amperes)
35
30
25
20
15
10
5
3
1
.5
.001
0.50
0.10
.75
1.0
2.0
3.0
4.0
5.0
0
.25
.5
.6
.5
.25
0
300
200
100
0
-100
-200
-300
-400
0
1
2
3
4
5
6
7
8
9
10
GRID VOLTAGE—VOLTS
PLATE VOLTAGE—KILOVOLTS
CURVE 4886

DIM	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
	MIN	MAX	REF	MIN	MAX	REF
A	8.670	8.800		220.22	223.52	
B	.855	.895		21.72	22.73	
C	4.406	4.468		111.91	113.49	
D	.600	.760		15.24	19.30	
E	1.896	1.936		48.16	49.17	
F	3.133	3.173		79.58	80.59	
G	3.792	3.832		96.32	97.33	
H	3.980	4.020		101.09	102.11	
J	.188			4.78		
K	.188			4.78		
L	.188			4.78		
M	3.718	3.781		94.44	96.04	
N	.219			5.56		
P	4.593	4.656		116.66	118.26	
R	2.705	2.825		68.71	71.76	
S	9.465	9.840		240.41	249.94	
T	.500			12.70		

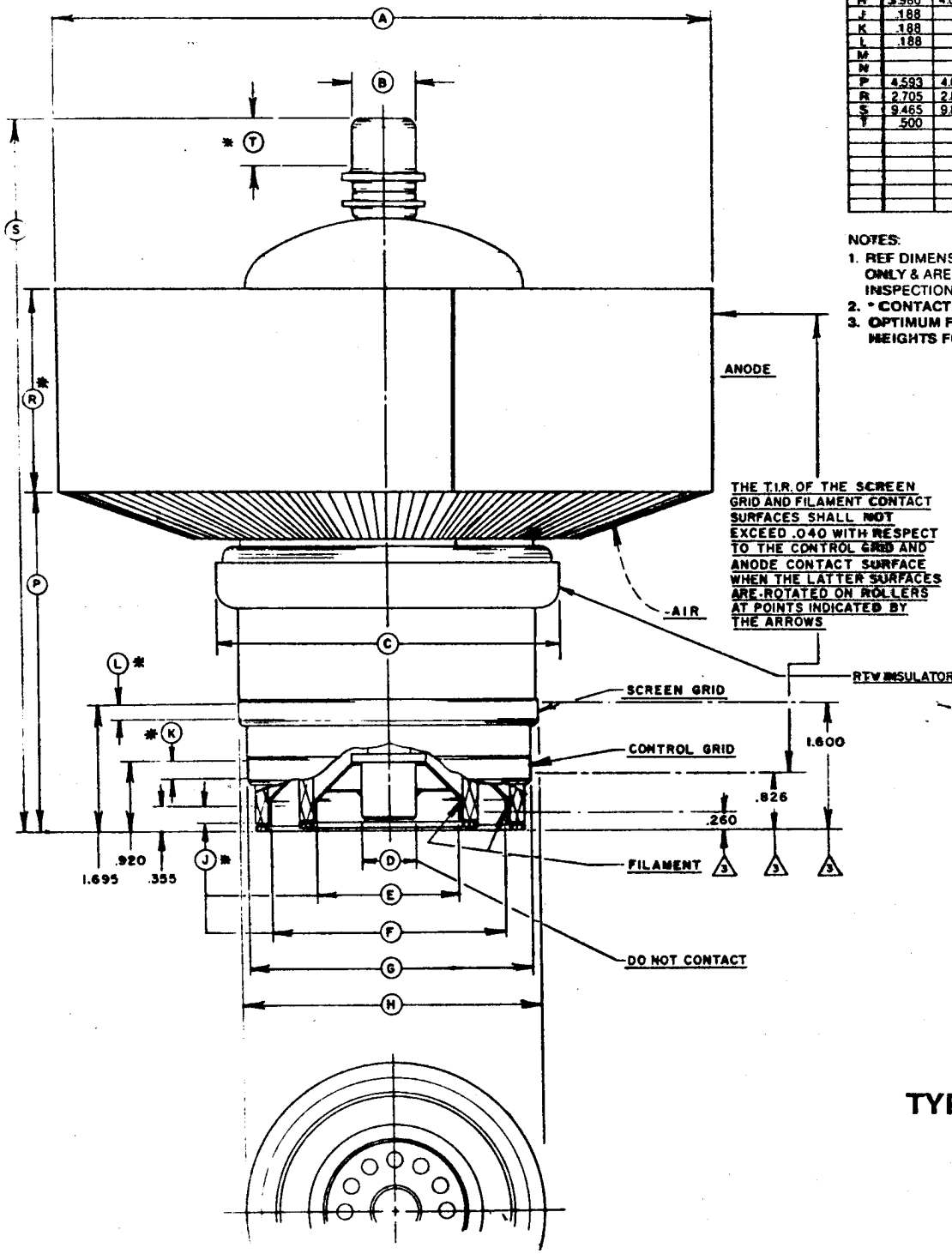
NOTES:
1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACE.
3. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES.



TYPE 8990

	DIMENSIONAL DATA					
	INCHES			MILLIMETERS		
DIM	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	8.670	8.800		220.22	223.52	
B	.855	.895		21.72	22.73	
C	4.593	4.656		116.66	118.26	
D	.600	.760		15.24	19.30	
E	1.896	1.936		48.16	49.17	
F	3.133	3.173		79.58	80.59	
G	3.792	3.832		96.32	97.33	
H	3.980	4.020		101.09	102.11	
J	.188			4.78		
K	.188			4.78		
L	.188			4.78		
M						
N						
P	4.593	4.656		116.66	118.26	
R	2.705	2.825		68.71	71.76	
S	9.465	9.840		240.41	249.94	
T	.500			12.70		

NOTES:
1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACE.
3. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES.

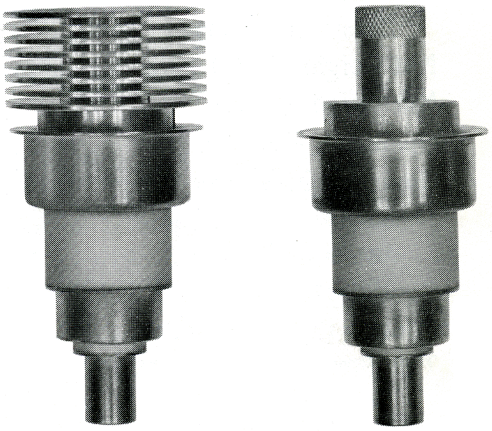


TYPE 8990A

TECHNICAL DATA

7211
7698

PLANAR TRIODES



7211 7698

The EIMAC 7211 and 7698 are rugged ceramic/metal planar triodes designed for use in CW, grid- or plate-pulsed oscillator, amplifier or frequency multiplier service up to 3 GHz. The tubes may also be used in pulse modulator or voltage regulator service. The 7211 is normally supplied with an air cooled radiator for forced air cooling, while the 7698 is supplied without radiator and is intended for conduction-convection cooling as found in many pulsed type applications. Except for the plate dissipation ratings and outline, the characteristics of both tube types are identical.

The 7211 and 7698 feature high mu, high transconductance, great mechanical strength and low interelectrode capacitances, as well as high current capability and increased grid-anode insulator length. Both tubes have an arc-resistant, extended interface cathode, well proven in airline applications, assuring reliable and long life operation under adverse conditions.

Note: The data for the 7211 also applies to the EIMAC 7698R in all respects.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 ± 0.3	V
Current, at 6.3 volts	1.30	A
Transconductance (Average):		
I_b= 160 mAdc, (200mA/cm^2)	38	mmhos
Amplification Factor (Average)	80	
Direct Interelectrode Capacitance (grounded cathode)[2], without heater voltage:		
Grid-Cathode	8.0	pF
Grid-Plate	2.25	pF
Plate-Cathode (maximum)	0.06	pF
Cut-off Bias[3] (maximum)	-30	V

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.
3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

(Effective 11-15-70) © 1970 by Varian Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:	
Length	2.701 in; 68.60 mm
Diameter (7698)	1.195 in; 30.35 mm
Diameter (7211)	1.264 in; 32.11 mm
Net Weight (7698)	1.8 oz; 48 gm
Net Weight (7211)	2.2 oz; 63 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling (7698)	Conduction and Convection
Cooling (7211)	Forced Air
Terminals	Coaxial, special

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axes 55 to 500 Hz	10 G
Altitude, max (in a suitably designed circuit)	70,000 ft.

CW RF POWER AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	2500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-400	VOLTS
Grid positive to cathode	30	VOLTS
DC PLATE CURRENT	150	MILLIAMPERES
DC GRID CURRENT	45	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Conduction and Convection (7698)	10	WATTS
Forced Air Cooling[1] (7211)	100	WATTS
GRID DISSIPATION (Average)	2	WATTS
FREQUENCY	2.5	GHz

1. Using EIMAC radiator PN 014224.

OPERATING CONDITIONS FOR 7211 AND 7698 IN REPRESENTATIVE APPLICATION

Grounded Grid CW Power Amplifier

Frequency	700	MHz
Heater Voltage	6.3	V
DC Plate Voltage	630	Vdc
DC Grid Voltage (approx)	-5	Vdc
DC Cathode Current	140	mAdc
DC Grid Current	25	mAdc
Drive Power (approx)	4	W
Useful CW Power Output	45	W

Grounded Grid CW Oscillator

Frequency	2.5	GHz
Heater Voltage	5.0	V
DC Plate Voltage	1000	Vdc
DC Grid Voltage (approx)	-20	Vdc
DC Plate Current	140	mAdc
DC Grid Current	30	mAdc
Useful CW Power Output	30	W

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE (GRID PULSED)	2500	VOLTS
PEAK PULSE PLATE VOLTAGE (PLATE PULSED)	3500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-700	VOLTS
Grid positive to cathode	250	VOLTS
PULSE PLATE CURRENT	5.0	AMPERES
PULSE GRID CURRENT	2.5	AMPERES
AVERAGE PLATE DISSIPATION		
Conduction and Convection (7698)	10	WATTS
Forced Air Cooling[1] (7211)	100	WATTS
GRID DISSIPATION (Average)	2	WATTS
FREQUENCY	3.0	GHz
PULSE DURATION [2]	6	μs
DUTY FACTOR [2]	.0033	

OPERATING CONDITIONS FOR 7211 AND 7698 IN REPRESENTATIVE APPLICATION

Grid Pulsed Amplifier

Frequency	1.1	GHz
Heater Voltage	6.3	V
DC Plate Voltage	2200	Vdc
DC Grid Voltage	-50	Vdc
Peak Video Plate Current	2.5	a
Peak Video Grid Current	1.0	a
Pulse Drive Power (approx)	400	w
Useful Power Output (approx)	2500	w
Pulse Duration	3	μs
Duty Factor	.002	

Plate Pulsed Oscillator

Frequency	3.0	GHz
Heater Voltage	5.8	V
Peak Plate Voltage	3500	v
Peak Video Plate Current	4.8	a
Peak Video Grid Current	1.5	a
Useful Power Output (approx)	3000	w
Pulse Duration	3	μs
Duty Factor	.0025	

1. Using Eimac radiator PN 014224.
2. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

PULSE MODULATOR OR PULSE AMPLIFIER SERVICE

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	2500	VOLTS
PEAK PLATE VOLTAGE	3500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-700	VOLTS
Grid positive to cathode	150	VOLTS

1. Using EIMAC radiator PN 014224.

PULSE CATHODE CURRENT	7.5	AMPERES
DC PLATE CURRENT	150	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Conduction and Convection (7698)	.10	WATTS
Forced Air Cooling[1] (7211)	100	WATTS
GRID DISSIPATION (Average)	2	WATTS
PULSE DURATION[2]	6	μs
DUTY FACTOR[2]	.0033	
CUT-OFF MU	60	

2. For application requiring long pulse duration and/or higher dury cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

RANGE VALUES FOR EQUIPMENT DESIGN

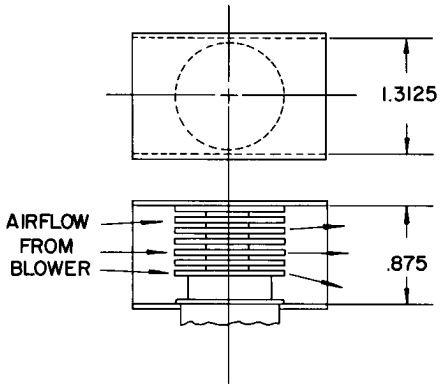
	Min.	Max.	
Heater: Current at 6.3 volts	1.20	1.40	A
Cathode Heating Time	60	---	sec.
Interelectrode Capacitances[1] (grounded cathode connection)			
Grid-Cathode	7.0	9.0	pF
Plate-Cathode	---	0.06	pF
Grid-Plate	2.10	2.40	pF

1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

APPLICATION

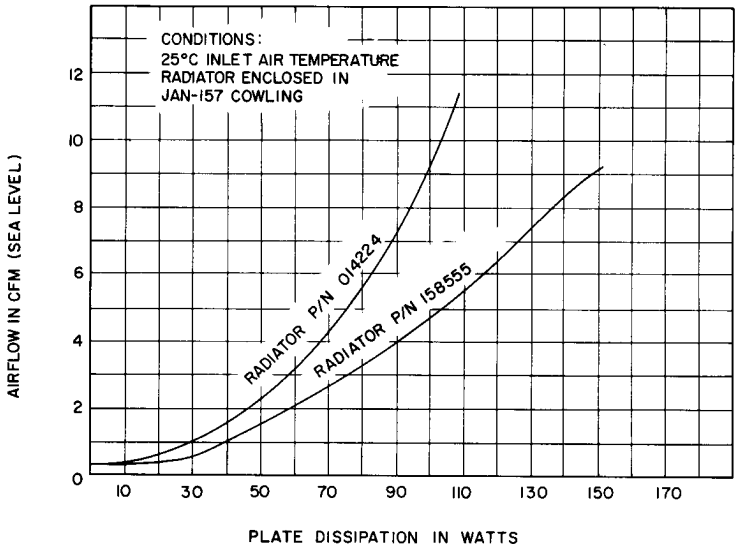
For general application information please refer to the Planar Triode Operating Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube types. Plate dissipation of up to 150 watts is possible with the 7211/7698 tube type when using radiator P/N 158555. If this is required the tube order should include a reference to the different radiator part number. For unusual and special application consult the nearest Varian Electron Tube and Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake, City, Utah.

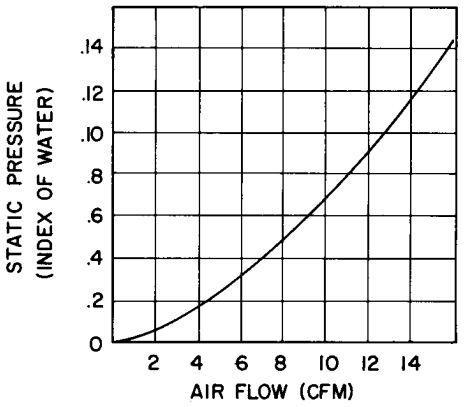
AIRFLOW vs STATIC PRESSURE WITH STANDARD COWLING JAN-157



-STANDARD COWLING-

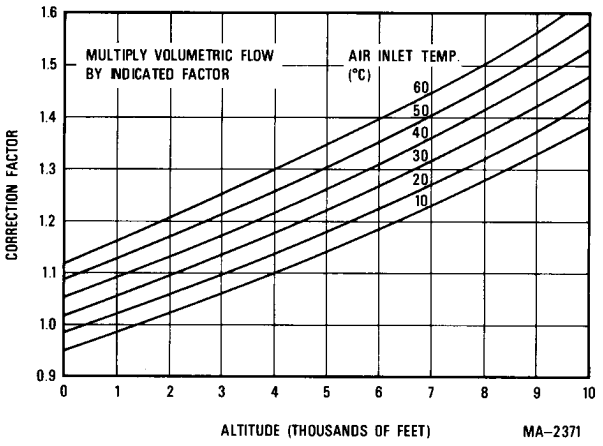
MAXIMUM PLATE DISSIPATION vs COOLING AIRFLOW

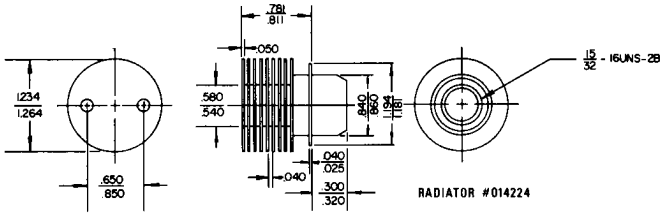




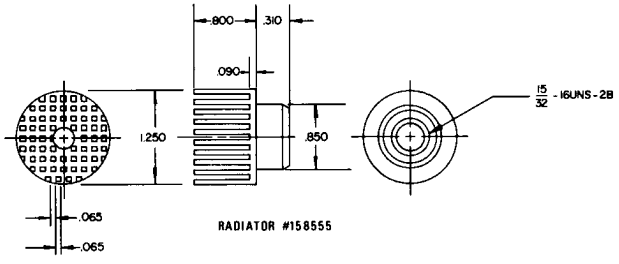
COMBINED CORRECTION FACTORS FOR INLET AIR TEMPERATURE AND ALTITUDE

(RELATIVE TO 25°C AND SEA LEVEL)

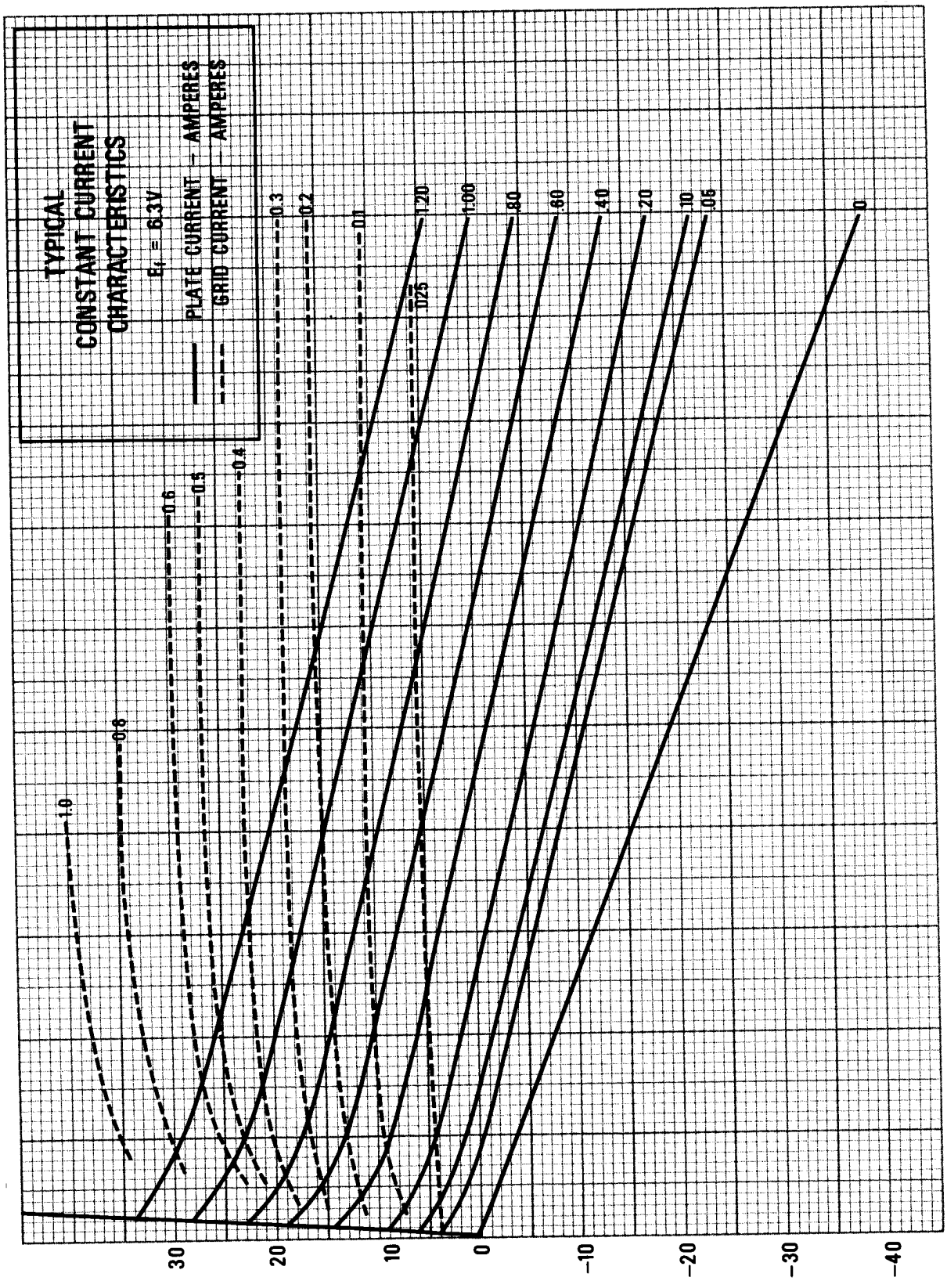




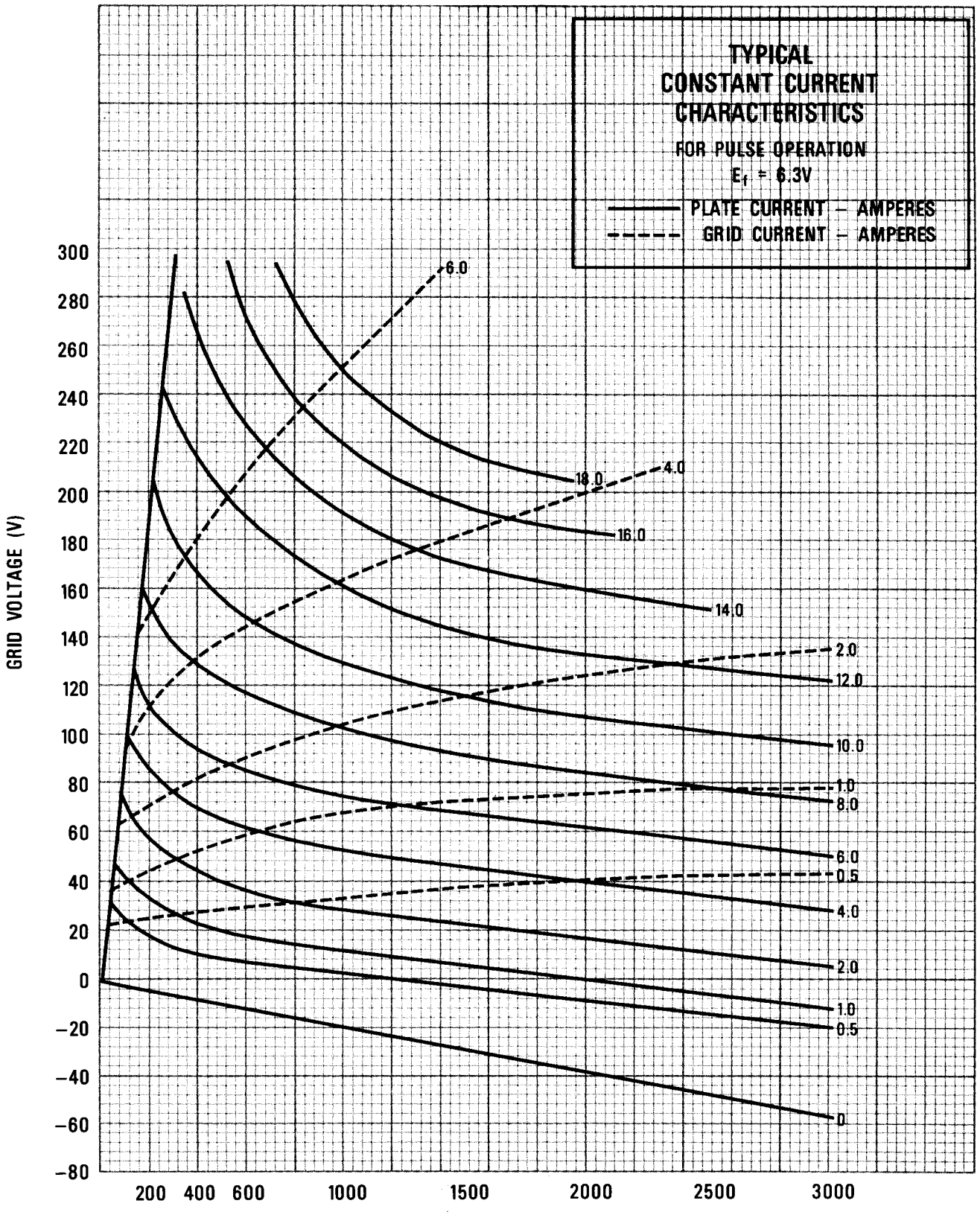
RADIATOR #014224



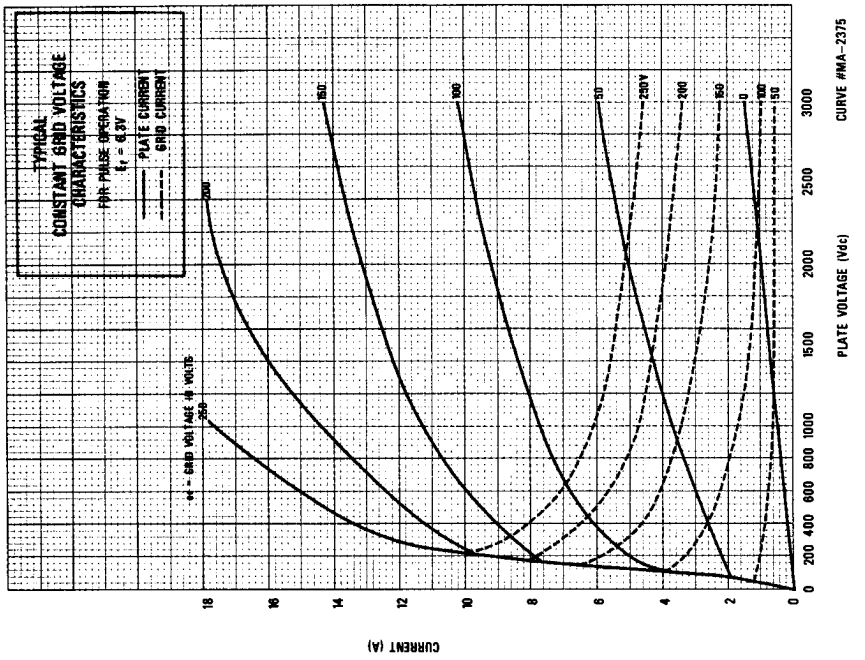
RADIATOR #158555

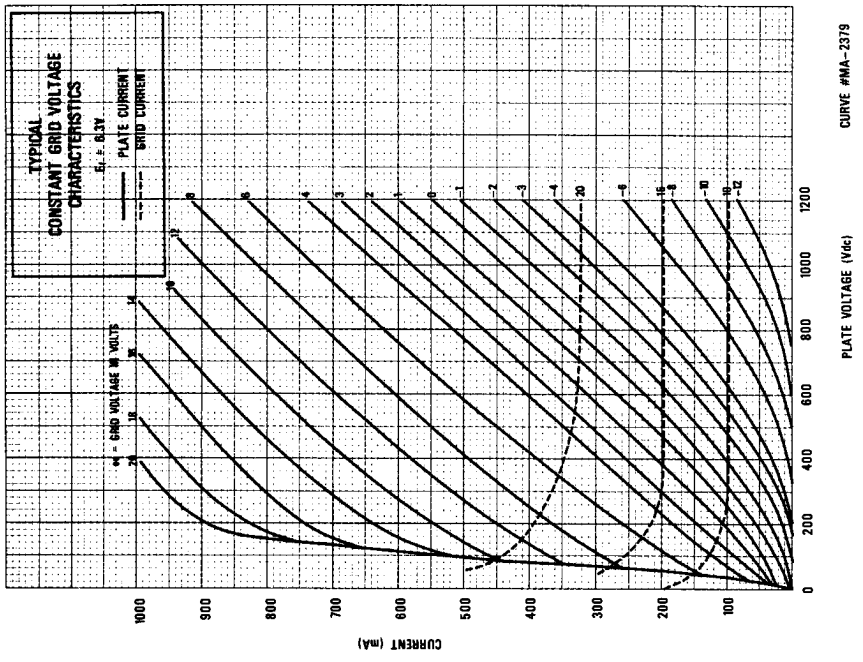


CURVE #MA-2380



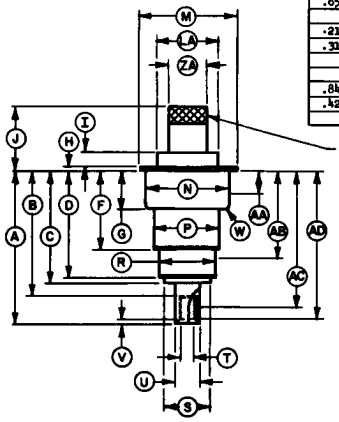
CURVE #MA–2374


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PLATE CURRENT
GRID CURRENT
e_c = GRID VOLTAGE IN VOLTS
250
200
150
100
50
250V
200
150
0
100
150
CURRENT (A)
PLATE VOLTAGE (Vdc)
CURVE #MA-2375


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
E_f = 6.3V
PLATE CURRENT
GRID CURRENT
e_c = GRID VOLTAGE IN VOLTS
20
18
16
14
12
10
8
6
4
3
2
1
0
-1
-2
-3
-4
-6
-8
-10
-12
CURRENT (mA)
PLATE VOLTAGE (Vdc)
CURVE #MA-2379

ELECTRODE CONTACT AREA				
DIM	MIN.	MAX.	MIN.	MAX.
AA	.035	.361	.89	9.17
AB	1.185	1.265	30.10	32.14
AC	1.534	1.728	38.96	43.89
AD	1.475	1.815	37.47	46.10
	DIM. IN INCHES		DIM. IN MILLIMETERS	

DIMENSION DATA					
DIM. IN INCHES			DIM. IN MILLIMETERS		
MIN.	MAX.	DIM	MIN.	MAX.	NOTES
1.185	1.875	A	46.10	47.62	
	1.534	B		38.96	
	1.475	C		37.46	
1.289	1.329	D	32.74	33.76	
.970	1.010	F	24.64	25.65	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
	.185	I		4.70	
.766	.826	J	19.46	20.98	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	c
.752	.792	P	19.10	20.12	d
.655	.665	R	16.64	16.89	c
	.545	S		13.84	
.213	.223	T	5.41	5.66	c
.315	.325	U	8.00	8.26	c
	.086	V		2.18	
	.100	W		2.54	
.840	.860	LA	21.34	21.84	
.427	.447	ZA	10.75	11.35	



NOTES:

a. METRIC EQUIVALENTS, TO THE NEAREST .01 mm, ARE FOR GENERAL INFORMATION ONLY & ARE BASED UPON 1 inch = 25.4 mm.

b. ECCENTRICITY OF CONTACT SURFACES SHALL BE GAGED FROM CENTER LINE OR REFERENCE & SHALL BE AS FOLLOWS:

CONTACT SURFACE	TIR(MAX)	REFERENCE
ANODE	.020	CATHODE
GRID	.020	CATHODE
HEATER	.012	CATHODE

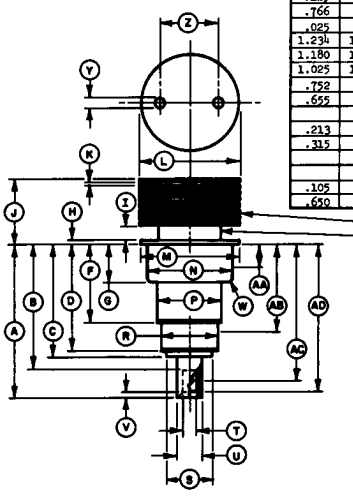
c. DIA'S N, R, T, & U SHALL APPLY THROUGHOUT ENTIRE LENGTH AS DEFINED BY DIM'S AA, AB, AC & AD RESPECTIVELY.

d. THIS SURFACE SHALL NOT BE USED FOR CLAMPING OR LOCATING.

7698

ELECTRODE CONTACT DIMENSION				
DIM	MIN.	MAX.	MIN.	MAX.
AA	.035	.361	.89	9.17
AB	1.185	1.265	30.10	32.14
AC	1.534	1.728	38.96	43.89
AD	1.475	1.815	37.47	46.10
	DIM. IN INCHES		DIM. IN MILLIMETERS	

DIMENSION DATA					
DIM. IN INCHES			DIM. IN MILLIMETERS		
MIN.	MAX.	DIM	MIN.	MAX.	NOTES
1.185	1.875	A	46.10	47.62	
	1.534	B		38.96	
	1.475	C		37.46	
1.289	1.329	D	32.74	33.76	
.970	1.010	F	24.64	25.65	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
.125	.185	I	3.18	4.70	
.766	.826	J	19.46	20.98	
.025	.046	K	.64	1.17	
1.234	1.264	L	31.34	32.11	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	e
.752	.792	P	19.10	20.12	
.655	.665	R	16.64	16.89	
	.545	S		13.84	
.213	.223	T	5.41	5.66	e
.315	.325	U	8.00	8.26	e
	.086	V		2.18	
	.100	W		2.54	
.105	.145	Y	2.67	3.68	c
.650	.850	Z	16.51	21.59	



NOTES:

e. METRIC EQUIVALENTS, TO THE NEAREST .01 mm, ARE GIVEN FOR GENERAL INFORMATION ONLY & ARE BASED ON 1 inch = 25.4 mm.

b. THIS SURFACE SHALL BE USED TO MEASURE ANODE SHANK TEMPERATURE.

c. HOLES FOR EXTRACTOR THROUGH TOP FIN ONLY.

d. ECCENTRICITY OF CONTACT SURFACES SHALL BE GAGED FROM CENTER LINE OF REFERENCE & SHALL BE AS FOLLOWS:

CONTACT SURFACE	TIR(MAX)	REFERENCE
ANODE	.020	CATHODE
GRID	.020	CATHODE
HEATER	.012	CATHODE

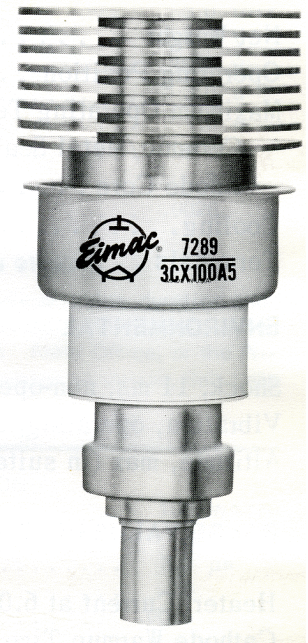
e. DIA'S N, R, T & U SHALL APPLY THROUGHOUT ENTIRE LENGTH AS DEFINED BY DIM'S AA, AB, AC & AD RESPECTIVELY.

f. THIS SURFACE SHALL NOT BE USED FOR CLAMPING OR LOCATING.

7211

7289
3CX100A5

PLANAR TRIODE



The EIMAC Type 7289/3CX100A5 is a rugged ceramic/metal planar triode designed for use in CW, grid- or plate-pulsed oscillator, amplifier or frequency multiplier service up to 3 GHz. The tube may also be used in pulse modulator or voltage regulator service. The 7289 is supplied with an air cooled radiator for forced air cooling.

The 7289 features high mu, high transconductance, great mechanical strength and low interelectrode capacitance.

Note: The data for the 7289/3CX100A5 also apply to the 2C39A and 2C39WA in all respects, except that filament voltage for 2C39A is 6.3 volts.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	6.0 ± 0.3 V
Current, at 6.0 volts	1.0 A
Transconductance (Average):	
I_b = 70 mA, E_b = 600 Vdc	25 mmhos
Amplification Factor (Average)	100
Direct Interelectrode Capacitance (grounded cathode) [2]	
Cin	6.30 pF
Cout	.035 pF
Cgp	2.00 pF
Cut-off bias[3]	-25 V max

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.
3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

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MECHANICAL

Maximum Overall Dimensions	
Length	2.701 in; 68.60 mm
Diameter	1.264 in; 32.11 mm
Net Weight	2.2 oz; 63 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Forced Air
Terminals	Coaxial, special

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axis, 55 to 500 Hz	10 G
Altitude, max (in suitably designed circuit)	60,000 ft.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	0.90	1.05	A
Cathode Warmup Time	60	---	sec.
Interelectrode Capacitance[1] (grounded cathode connection)			
Cin	5.60	7.00	pF
Cout	---	0.95	pF
Cgp	1.95	2.15	pF

1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

CW RF POWER AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	1000	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-400	VOLTS
Grid positive to cathode	30	VOLTS
DC PLATE CURRENT	100	MILLIAMPERES
DC GRID CURRENT	50	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Forced air cooling[1]	100	WATTS
GRID DISSIPATION (Average)	2	WATTS
FREQUENCY	2.5	GHz

1. Using EIMAC radiator PN 014224.

OPERATING CONDITIONS FOR 7289 IN REPRESENTATIVE APPLICATION

GROUNDED GRID CW POWER AMPLIFIER

Frequency	500	MHz
Heater Voltage	6.0	V
DC Plate Voltage	900	Vdc
DC Grid Voltage (approx.)	-40	Vdc
DC Cathode Current	90	mAdc
DC Grid Current	25	mAdc
Drive Power (approx.)	6	W
Useful CW Power Output	40	W

GROUNDED GRID CW OSCILLATOR

Frequency	2.5	GHz
Heater Voltage	5.0	V
DC Plate Voltage	900	Vdc
DC Grid Voltage (approx.)	-20	Vdc
DC Plate Current	90	mAdc
DC Grid Current	10	mAdc
Useful CW Power Output	17	W

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE (grid pulsed)	1000	VOLTS
PEAK PULSE PLATE VOLTAGE (plate pulsed)	3500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-700	VOLTS
Grid positive to cathode	250	VOLTS
PULSE PLATE CURRENT	3.0	AMPERES
PULSE GRID CURRENT	1.8	AMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	100	WATTS
GRID DISSIPATION (Average)	2	WATTS
FREQUENCY	3.0	GHz
PULSE DURATION[2]	3	μs
DUTY FACTOR[2]	.0025	

Operating Conditions for 7289 in Representative Application.

PLATE PULSED OSCILLATOR

Frequency	3.0	GHz
Heater Voltage	5.8	V
Peak Plate Voltage	3500	v
Peak Video Plate Current	3.0	a
Peak Video Grid Current	1.8	a
Useful Power output (approx.)	1600	w
Pulse Duration	3	μs
Duty Factor	.0025	

1. Using EIMAC radiator PN 014224.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

PULSE MODULATOR AND PULSE AMPLIFIER SERVICE

ABSOLUTE MAXIMUM RATINGS

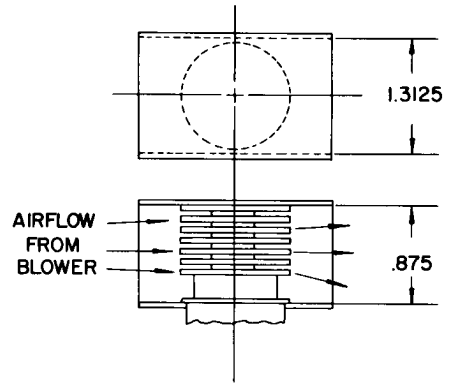
DC PLATE VOLTAGE	1000	VOLTS
PEAK PLATE VOLTAGE	1200	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-700	VOLTS
Grid positive to cathode	150	VOLTS
PULSE CATHODE CURRENT	4.8	AMPERES
DC PLATE CURRENT	100	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	100	WATTS
GRID DISSIPATION (Average)	2	WATTS
PULSE DURATION[2]	3.0	μs
CUT-OFF Mu	70	
DUTY FACTOR	.0025	

1. Using EIMAC radiator PN 014224.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

APPLICATION

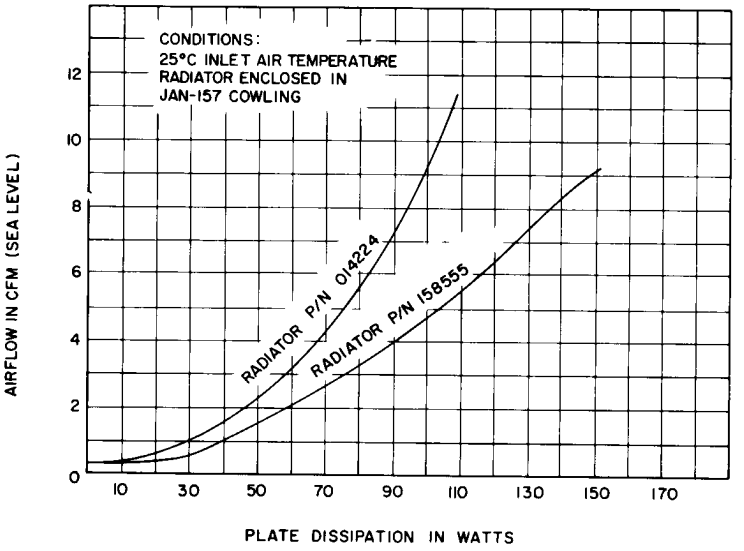
For general application information please refer to the Planar Triode Operating Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube type. Plate dissipation of up to 150 watts is possible with the 7289 tube type when using radiator P/N 158555. If this is required the tube order should include reference to the different radiator part number. For unusual and special application consult the nearest Varian Electron Tube and Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

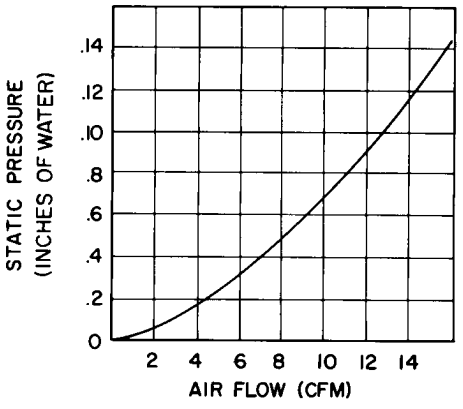
AIRFLOW vs STATIC PRESSURE WITH
STANDARD COWLING JAN-157



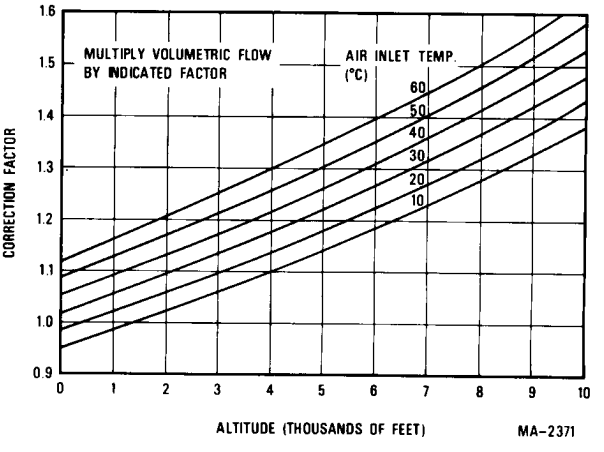
-STANDARD COWLING-

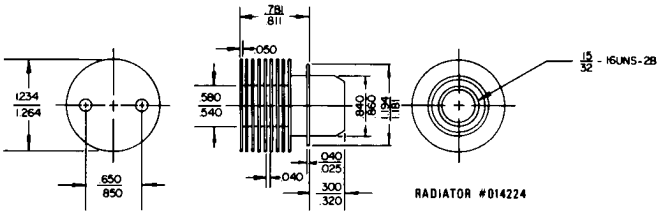
MAXIMUM PLATE DISSIPATION vs COOLING AIRFLOW

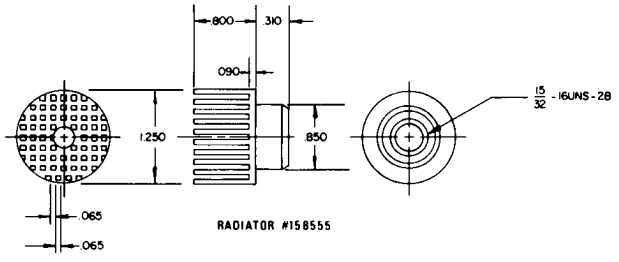


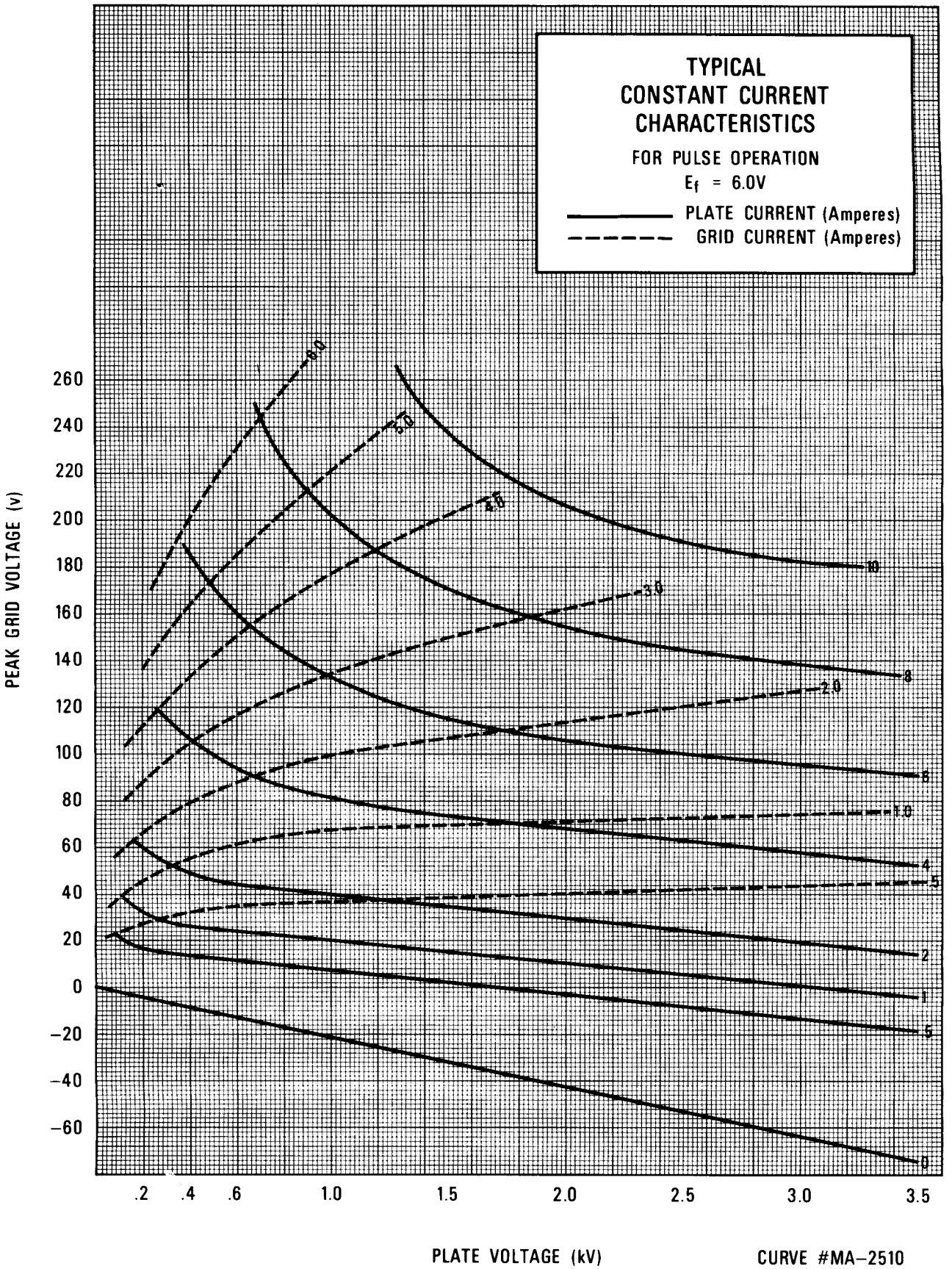


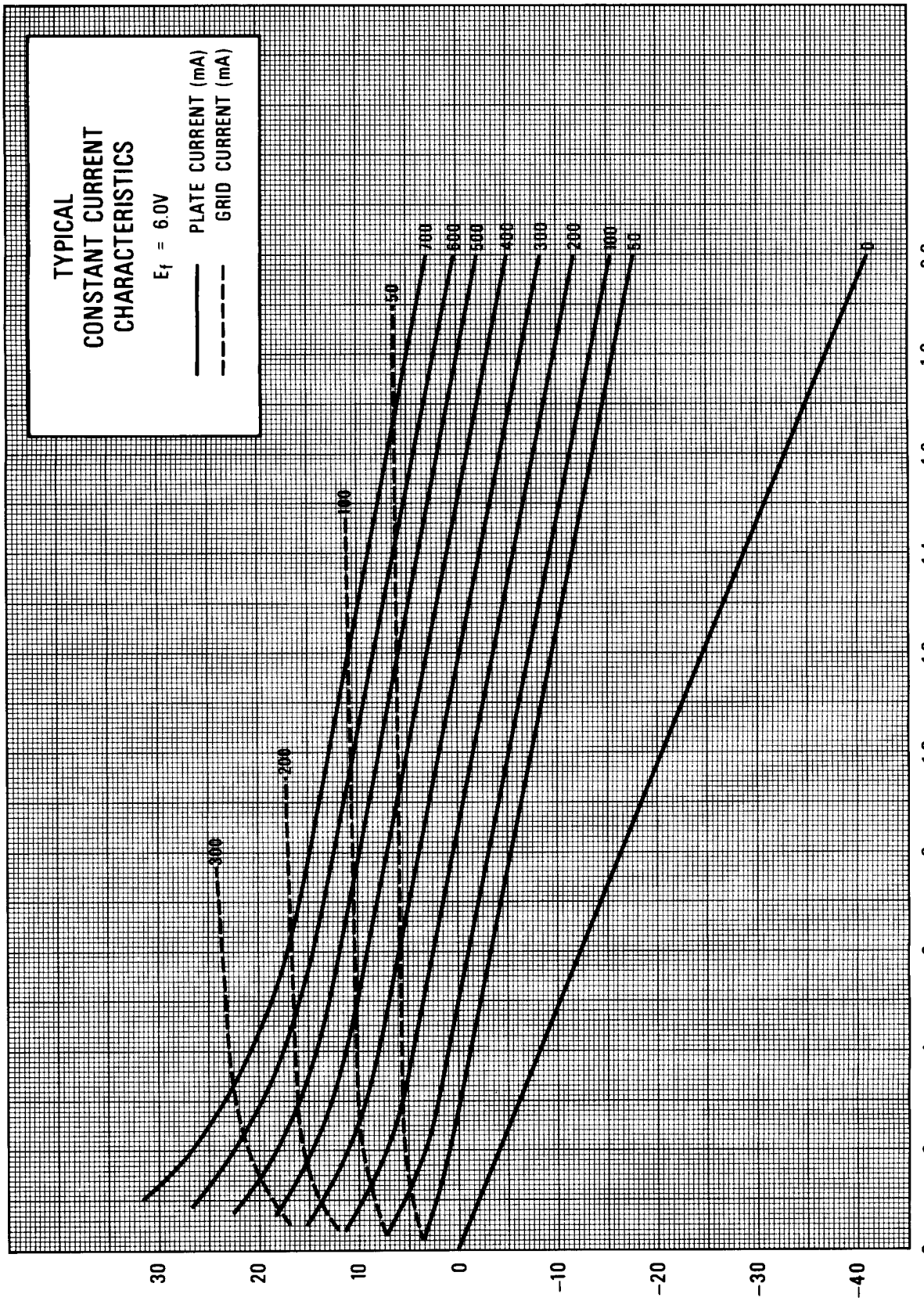
COMBINED CORRECTION FACTORS FOR INLET AIR TEMPERATURE
AND ALTITUDE
(RELATIVE TO 25°C AND SEA LEVEL)



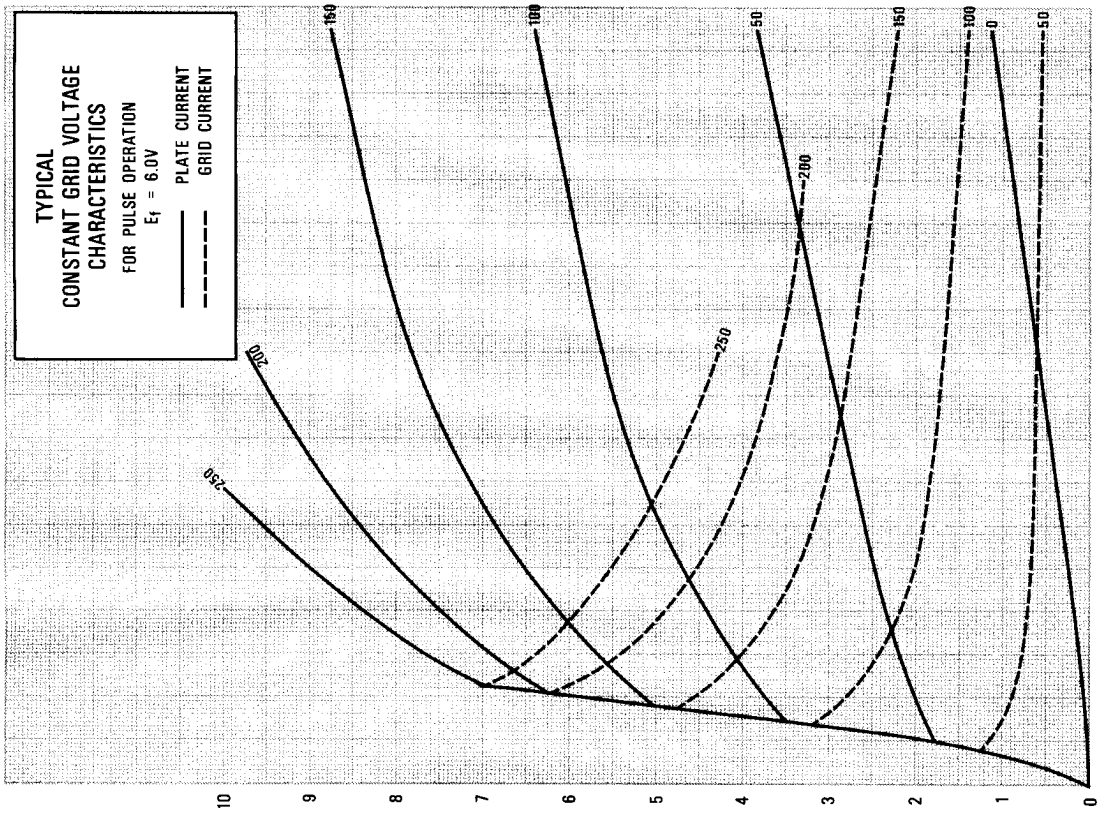


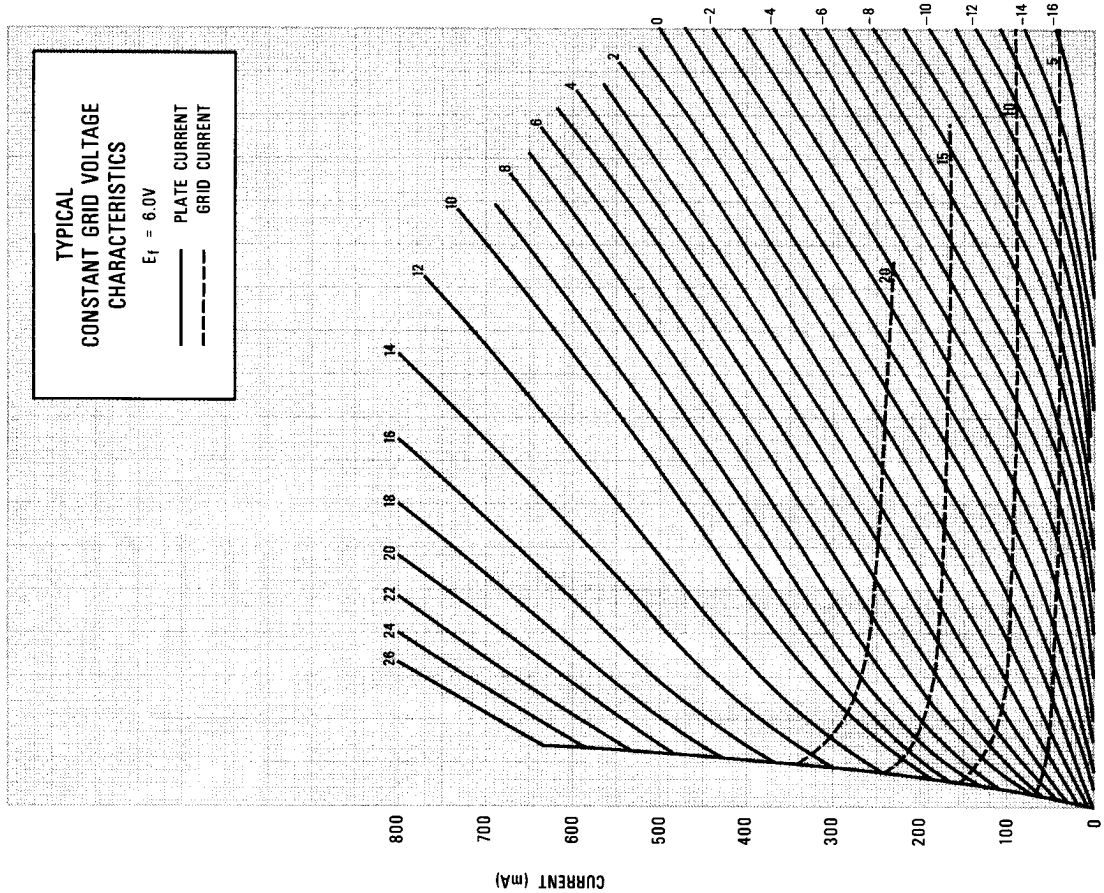


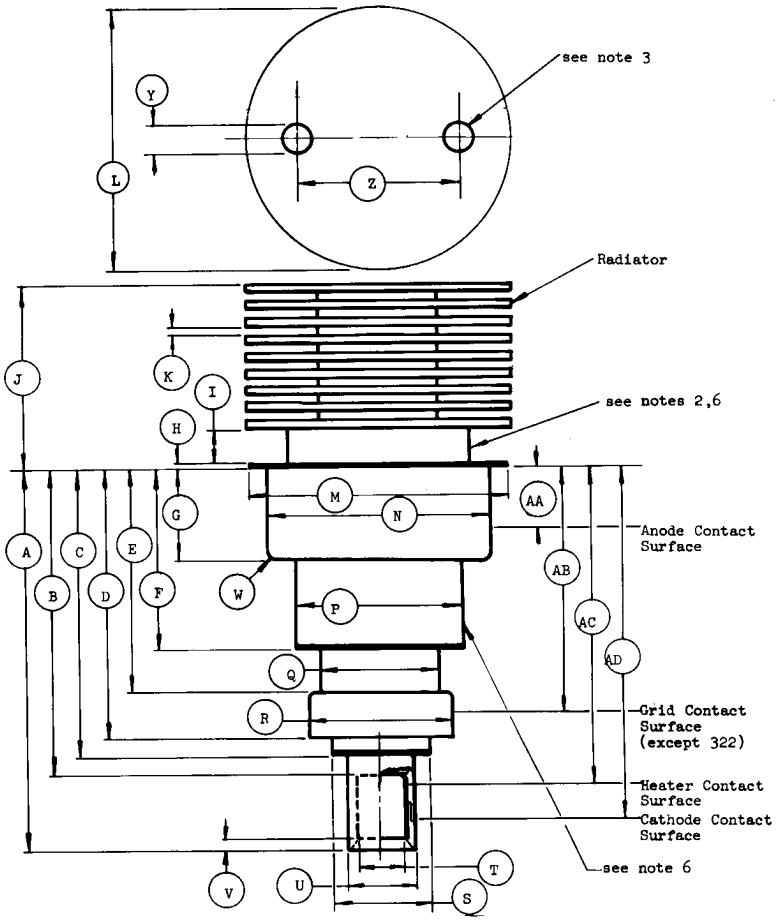

TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.0V
PLATE CURRENT (Amperes)
GRID CURRENT (Amperes)
PEAK GRID VOLTAGE (v)
260
240
220
200
180
160
140
120
100
80
60
40
20
0
−20
−40
−60
6.0
5.0
4.0
3.0
2.0
1.0
10
8
6
4
5
2
1
.5
0
.2
.4
.6
1.0
1.5
2.0
2.5
3.0
3.5
PLATE VOLTAGE (kV)
CURVE #MA−2510



CURVE #MA-2511


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.0V
PLATE CURRENT
GRID CURRENT
PEAK CURRENT (A)
PLATE VOLTAGE (kV)
CURVE #MA-2509


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
E_f = 6.0V
PLATE CURRENT
GRID CURRENT
CURRENT (mA)
PLATE VOLTAGE (kV)
CURVE #MA-2512



ELECTRODE CONTACT AREA					DIMENSIONAL DATA						
Dim. in Inches		Dim.	Dim. in Millim.		Dim. in Inches			Dim. in Millimeters			
Min.	Max.		Min.	Max.	Min.	Max.	Ref.	Dim.	MIN.	MAX.	Ref.
.035	.361	AA	.89	9.17	1.815	1.875		A	46.10	47.62	
1.185	1.265	AB	30.10	32.14		1.534		B		38.96	
1.534	1.728	AC	38.96	43.89		1.475		C		37.46	
1.475	1.815	AD	37.47	46.10	1.289	1.329		D	32.74	33.76	
					1.085	1.135		E	27.56	28.83	
					.880	.920		F	22.35	23.37	
					.462	.477		G	11.73	12.12	
						.040		H		1.02	
					.125	.185		I	3.18	4.70	
					.766	.826		J	19.46	20.98	
					.025	.046		K	.64	1.17	
					1.234	1.264		L	31.34	32.11	
					1.180	1.195		M	29.97	30.35	
					1.025	1.035		N	26.04	26.29	
					.752	.792		P	19.20	20.12	
					.541	.561		Q	13.74	14.25	
					.655	.665		R	16.64	16.89	
						.545		S		13.84	
					.213	.223		T	5.41	5.66	
					.315	.325		U	8.00	8.26	
						.100		W		2.54	
					.105	.145		Y	2.67	3.68	
					.650	.850		Z	16.51	21.59	
						.086		V		2.18	

NOTES:
1. Metric equivalents to the nearest .01 mm, are given for general information only & are based on 1 inch = 25.4 mm.
2. This surface shall be used to measure Anode shank temperatire.
3. Holes for extractor thru top fin only.
4. Eccentricity of contact surfaces shall be gaged from center line of reference & shall be as follows:

Contact Surface	TIR Max.	Reference
Anode	.020	Cathode
Grid	.020	Cathode
Heater	.012	Cathode

5. Dias. N,R,T & U shall apply throughout entire lenght as defined by dims. AA,AB,AC & AD respectively.
6. This surface shall not be used for clamping or locating.
7. Electrode Contact dims. are given for socket design purposes & are not intended for inspection purposes.

7815
7815R

PLANAR TRIODES



7815 7815R

The EIMAC 7815 and 7815R are rugged ceramic/metal planar triodes designed for use in CW, grid- or plate-pulsed oscillator, amplifier or frequency multiplier service up to 3 GHz. The tubes may also be used in pulse modulator or voltage regulator service. The 7815R is normally supplied with an air cooled radiator for forced air cooling, while the 7815 is supplied without radiator and is intended for conduction-convection cooling as found in many pulsed type applications. Except for the plate dissipation ratings and outline, the characteristics of both tube types are identical.

The 7815 and 7815R feature high mu, high transconductance, great mechanical strength and low interelectrode capacitances, as well as high current capability and increased grid-anode insulator length. Both tubes have an arc-resistant, extended interface cathode, well proven in airline applications, assuring reliable and long life operation under adverse conditions.

Note: This data sheet also covers the 3CPN10A5 (same as 7815) and 3CPX100A5 (same as 7815R).

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.0 ± 0.3	V
Current, at 6.0 volts	1.00	A
Transconductance (Average):		
I_b = 70 mAdc, (E_b = 600 Vdc)	25	mmhos
Amplification Factor (Average)	100	
Direct Interelectrode Capacitance (grounded cathode)[2], without heater voltage:		
Cin	6.3	pF
Cgp	1.98	pF
Cout	0.035	pF
Cut-off Bias[3] (maximum)	-25	V

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.
3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

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MECHANICAL

Maximum Overall Dimensions:	
Length	2.701 in; 68.60 mm
Diameter (7815)	1.195 in; 30.35 mm
Diameter (7815R)	1.264 in; 32.11 mm
Net Weight (7815)	1.8 oz; 48 gm
Net Weight (7815R)	2.2 oz; 63 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling (7815)	Conduction and Convection
Cooling (7815R)	Forced Air
Terminals	Coaxial, special

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axes 55 to 500 Hz	10 G
Altitude, max (in a suitably designed circuit)	70,000 ft.

CW RF POWER AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	2500 VOLTS
DC GRID VOLTAGE	-150 VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE	
Grid negative to cathode	-400 VOLTS
Grid positive to cathode	30 VOLTS
DC PLATE CURRENT	100 MILLIAMPERES
DC GRID CURRENT	50 MILLIAMPERES
AVERAGE PLATE DISSIPATION	
Conduction and Convection (7815)	10 WATTS
Forced Air Cooling (7815R)	100 WATTS
GRID DISSIPATION (Average)	2 WATTS
FREQUENCY	2.5 GHz

OPERATING CONDITIONS FOR 7815 AND 7815R IN REPRESENTATIVE APPLICATION

Grounded Grid CW Power Amplifier

Frequency	500 MHz
Heater Voltage	6.0 V
DC Plate Voltage	900 Vdc
DC Grid Voltage (approx)	-40 Vdc
DC Cathode Current	90 mAdc
DC Grid Current	25 mAdc
Drive Power (approx)	6 W
Useful CW Power Output	40 W

Grounded Grid CW Oscillator

Frequency	2.5 GHz
Heater Voltage	5.0 V
DC Plate Voltage	900 Vdc
DC Grid Voltage (approx)	-20 Vdc
DC Plate Current	90 mAdc
DC Grid Current	10 mAdc
Useful CW Power Output	17 W

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE (GRID PULSED)	2500 VOLTS
PEAK PULSE PLATE VOLTAGE (PLATE PULSED)	3500 VOLTS
DC GRID VOLTAGE	-150 VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE	
Grid negative to cathode	-700 VOLTS
Grid positive to cathode	250 VOLTS
PULSE PLATE CURRENT	3.0 AMPERES
PULSE GRID CURRENT	1.8 AMPERES
AVERAGE PLATE DISSIPATION	
Conduction and Convection (7815)	10 WATTS
Forced Air Cooling (7815R)	100 WATTS
GRID DISSIPATION (Average)	2 WATTS
FREQUENCY	3.0 GHz
PULSE DURATION[1]	6 μs
DUTY FACTOR[1]	.0033

OPERATING CONDITIONS FOR 7815 AND 7815R IN REPRESENTATIVE APPLICATION

Grid Pulsed Amplifier

Frequency	1.1	GHz
Heater Voltage	6.0	V
DC Plate Voltage	2200	Vdc
DC Grid Voltage	-45	Vdc
Peak Video Plate Current	1.9	a
Peak Video Grid Current	1.1	a
Pulse Drive Power (approx)	400	w
Useful Power Output (approx)	2000	w
Pulse Duration	3	μs
Duty Factor	.002	

Plate Pulsed Oscillator

Frequency	3.0	GHz
Heater Voltage	5.8	V
Peak Plate Voltage	3500	v
Peak Video Plate Current	3.0	a
Peak Video Grid Current	1.8	a
Useful Power Output (approx)	1600	w
Pulse Duration	3	μs
Duty Factor	.0025	

1. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

PULSE MODULATOR OR PULSE AMPLIFIER SERVICE

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	2500	VOLTS
PEAK PLATE VOLTAGE	3500	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-700	VOLTS
Grid positive to cathode	150	VOLTS
PULSE CATHODE CURRENT	4.8	AMPERES
DC PLATE CURRENT	100	MILLIAMPERES
AVERAGE PLATE DISSIPATION		
Conduction and Convection (7815)	10	WATTS
Forced Air Cooling (7815R)	100	WATTS
GRID DISSIPATION (Average)	2	WATTS
PULSE DURATION [1]	6	μs
DUTY FACTOR [1]	.0033	
CUT-OFF MU	70	

1. For application requiring long pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

RANGE VALUES FOR EQUIPMENT DESIGN

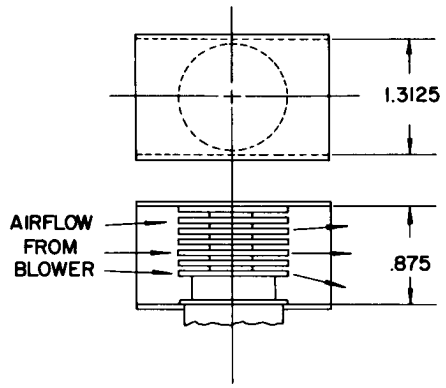
	Min.	Max.	
Heater: Current at 6.0 volts	0.90	1.05	A
Cathode Heating Time	60	---	sec.
Interelectrode Capacitances [1] (grounded cathode connection)			
Cin	5.60	7.00	pF
Cout	---	0.035	pF
Cgp	1.85	2.10	pF

1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

APPLICATION

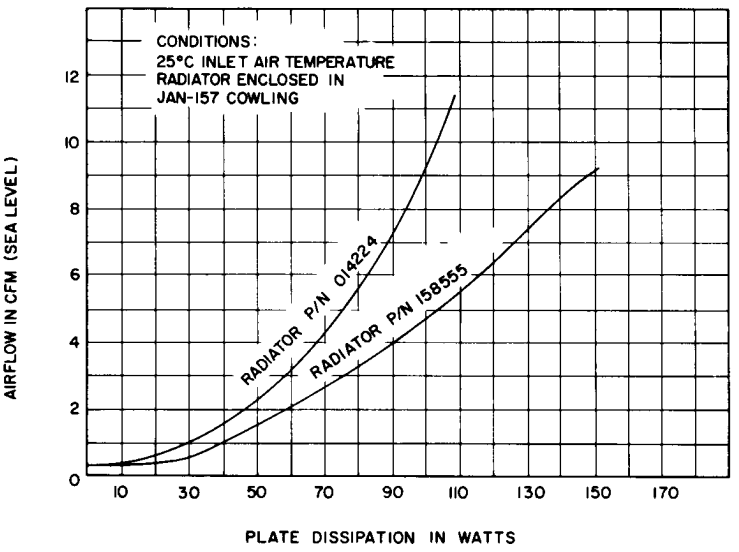
For general application information please refer to the Planar Triode Operating Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube types. Plate dissipation of up to 150 watts is possible with the 7815/7815R tube type when using radiator P/N 158555. If this is required the tube order should include a reference the different radiator part number. For unusual and special application consult the nearest Varian Electron Tube and Device Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake, City, Utah.

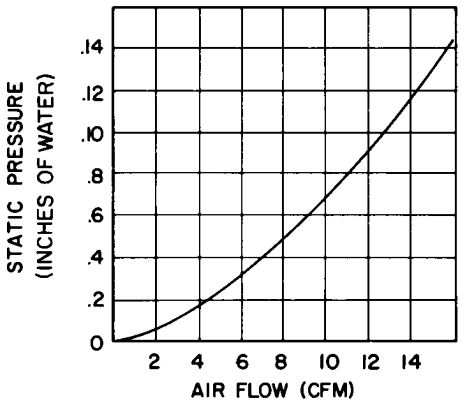
AIRFLOW vs STATIC PRESSURE WITH STANDARD COWLING JAN-157



-STANDARD COWLING-

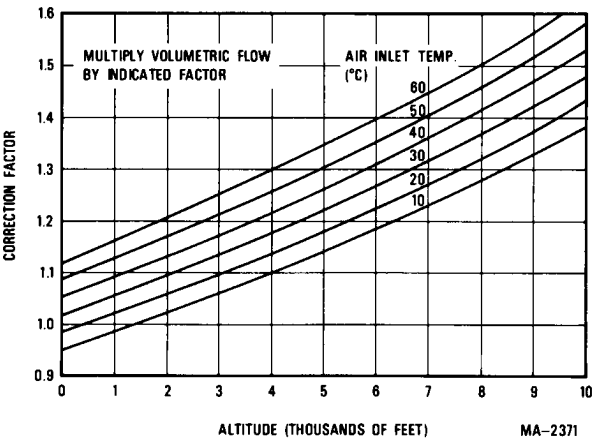
MAXIMUM PLATE DISSIPATION vs COOLING AIRFLOW

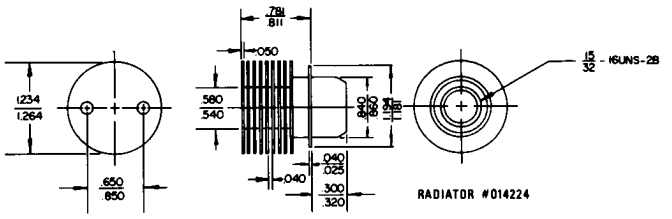


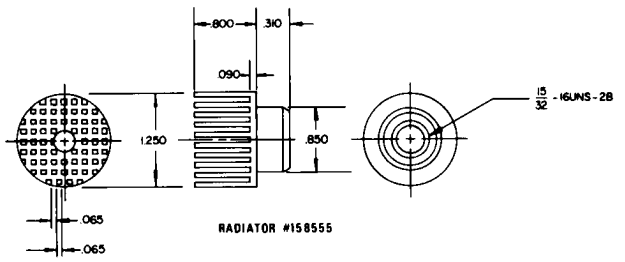


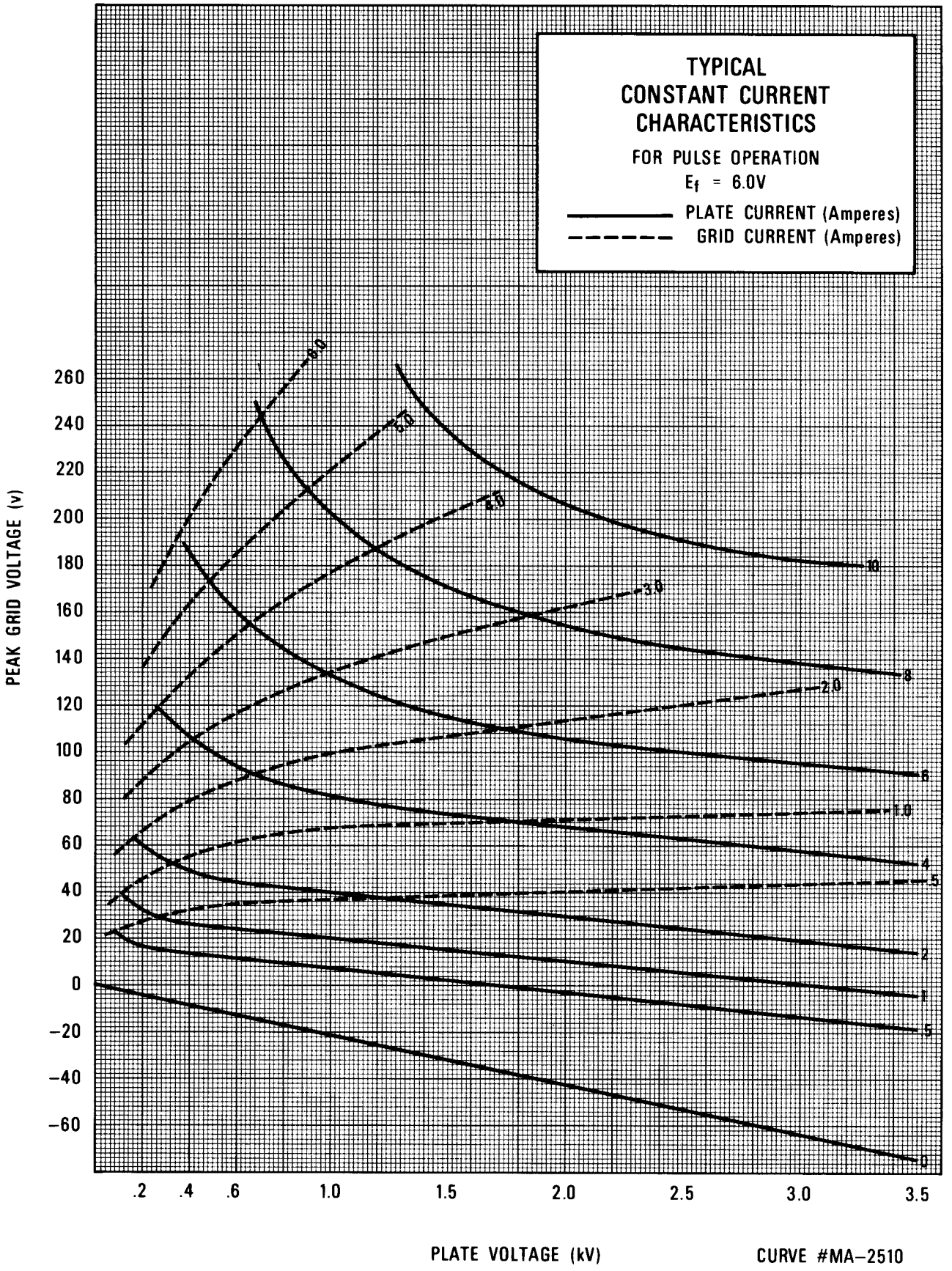
COMBINED CORRECTION FACTORS FOR INLET AIR TEMPERATURE AND ALTITUDE

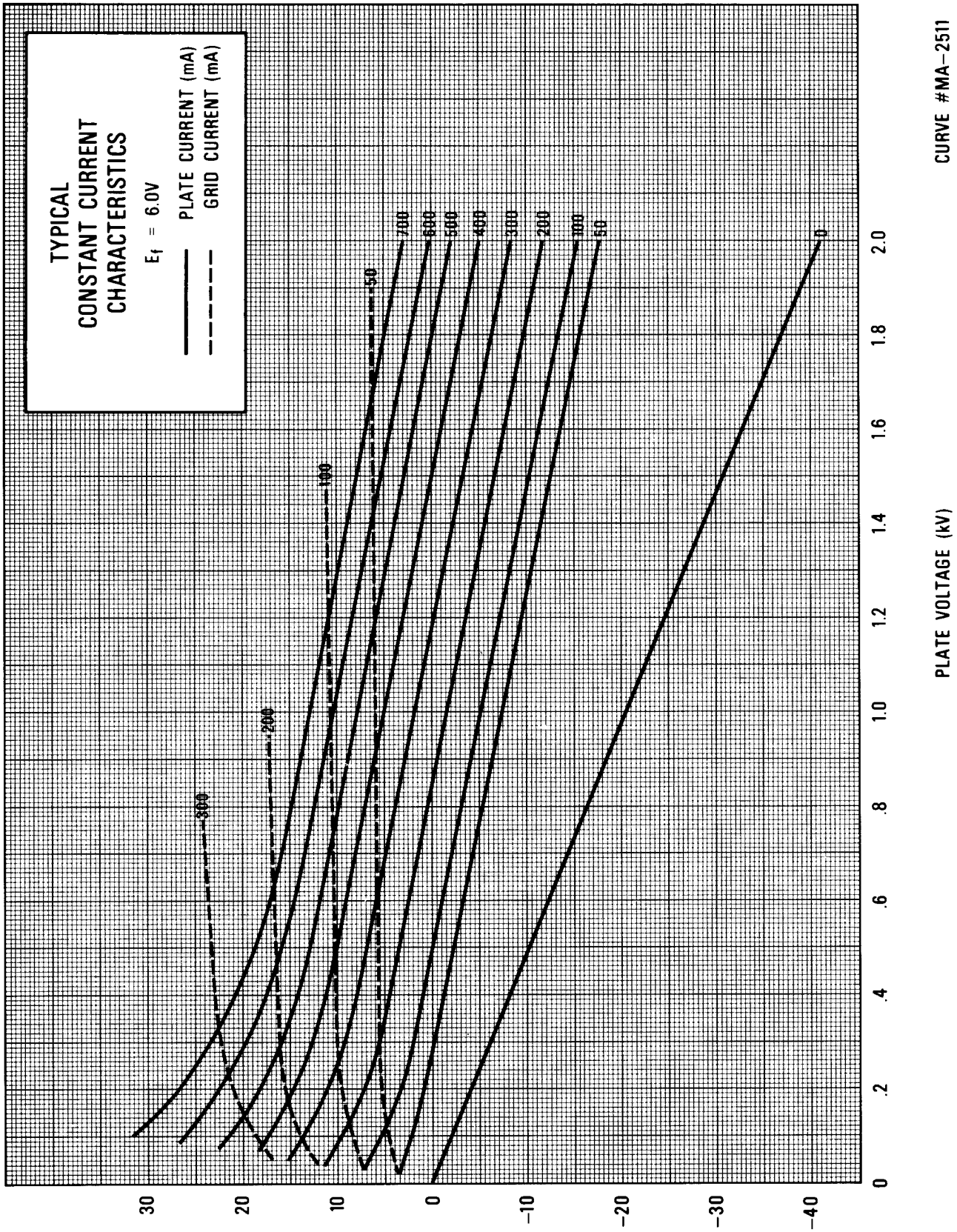
(RELATIVE TO 25°C AND SEA LEVEL)

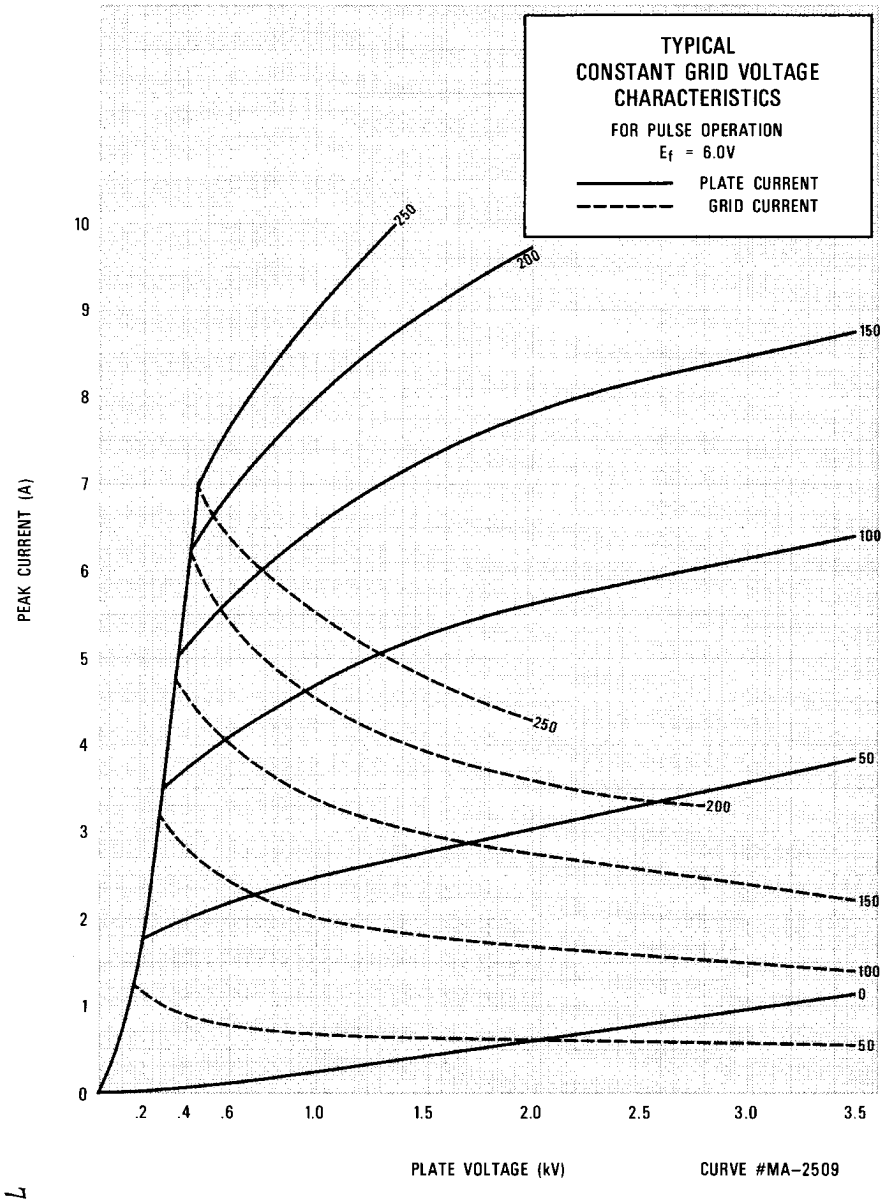


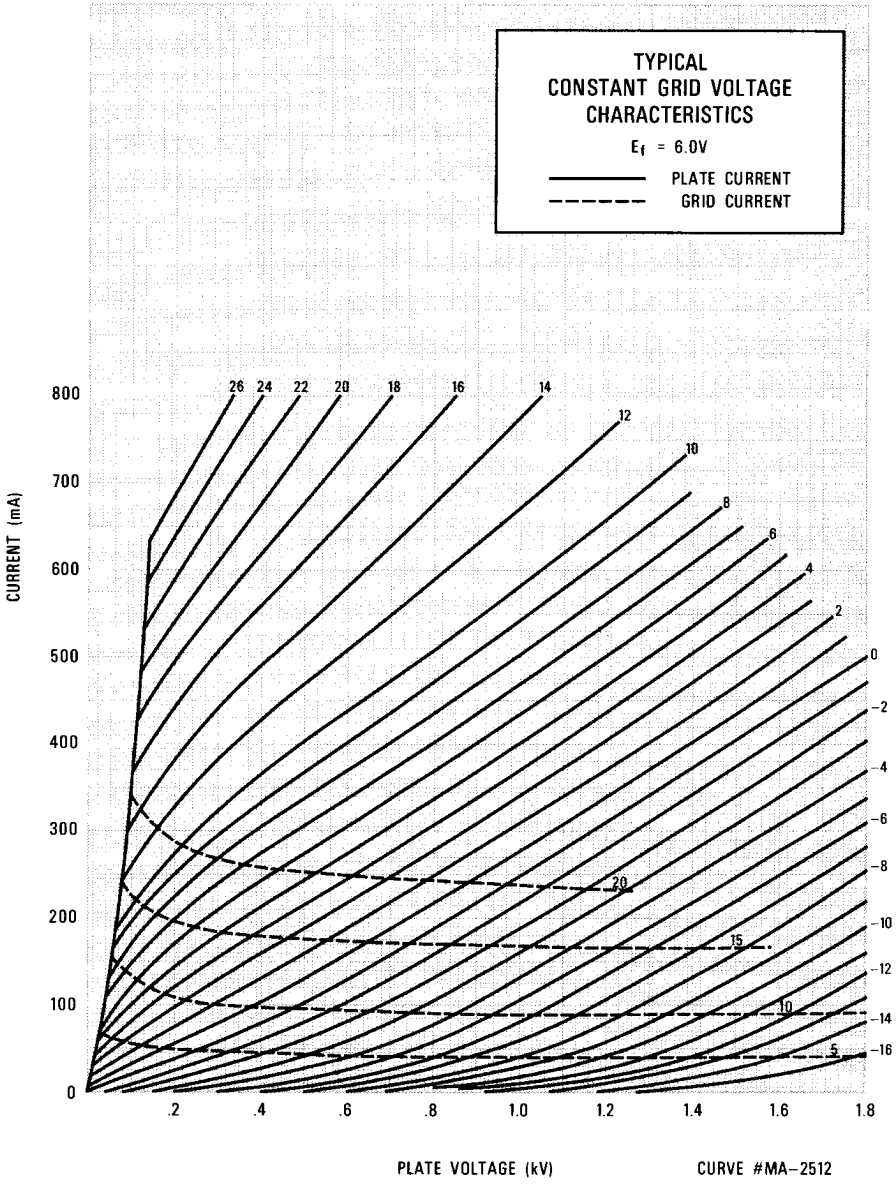


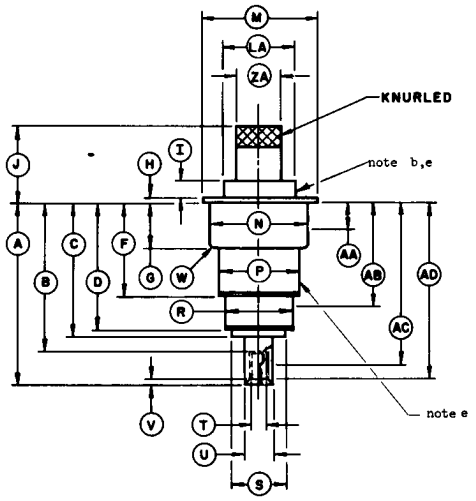



TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.0V
PLATE CURRENT (Amperes)
GRID CURRENT (Amperes)
PEAK GRID VOLTAGE (v)
260
240
220
200
180
160
140
120
100
80
60
40
20
0
−20
−40
−60
.2
.4
.6
1.0
1.5
2.0
2.5
3.0
3.5
PLATE VOLTAGE (kV)
CURVE #MA−2510
6.0
5.0
4.0
3.0
2.0
1.0
.5
10
8
6
4
5
2
1
.5
0


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
E_f = 6.0V
PLATE CURRENT (mA)
GRID CURRENT (mA)
700
600
500
400
300
200
100
50
0
100
200
300
30
20
10
0
−10
−20
−30
−40
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #MA-2511


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.0V
PLATE CURRENT
GRID CURRENT
PEAK CURRENT (A)
PLATE VOLTAGE (kV)
CURVE #MA-2509


TYPICAL
CONSTANT GRID VOLTAGE
CHARACTERISTICS
E_f = 6.0V
PLATE CURRENT
GRID CURRENT
CURRENT (mA)
PLATE VOLTAGE (kV)
CURVE #MA-2512



7815

ELECTRODE CONTACT AREA (see note a,f)				
DIM.	MIN.	MAX.	MIN.	MAX.
AA	.035	.361	.89	9.17
AB	1.185	1.265	30.10	32.14
AC	1.534	1.728	38.96	43.89
AD	1.475	1.815	37.47	46.10
	DIM. IN INCHES		DIM. IN MILLIMETERS	

DIMENSION DATA (Note a)					
DIM. IN INCHES		DIM.	DIM. IN MILLIMETERS		
MIN.	MAX.		MIN.	MAX.	NOTES
1.815	1.875	A	46.10	47.62	
	1.534	B		38.96	
	1.475	C		37.46	
1.289	1.329	D	32.74	33.76	
.970	1.010	F	24.64	25.65	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
	.185	I		4.70	
.766	.826	J	19.46	20.98	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	d
.752	.792	P	19.10	20.12	
.655	.665	R	16.64	16.89	d
	.545	S		13.84	
.213	.223	T	5.41	5.66	d
.315	.325	U	8.00	8.26	d
	.086	V		2.18	
	.100	W		2.54	
.840	.860	LA	21.34	21.84	
.427	.447	ZA	10.85	11.35	

NOTES:

a. Metric equivalents, to the nearest .01 mm, are given for general information only & are based on 1 inch = 25.4 mm.

b. This surface shall be used to measure Anode Shank temperature.

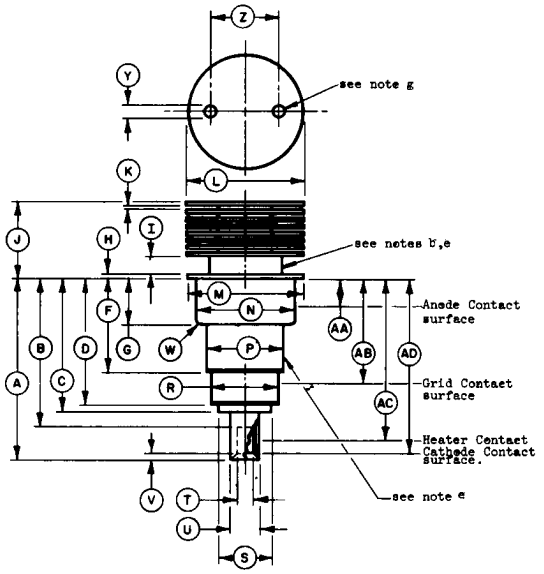
c. Eccentricity of contact surfaces shall be gaged from center line of reference & shall be as follows; note 2 shall apply:

Contact Surface	TIR Max.	Reference
Anode	.020	Cathode
Grid	.020	Cathode
Heater	.012	Cathode

d. Dias. N,R,T,U shall apply throughout entire contact area as defined by dims. AA,AB, AC,AD respectively.

e. This surface shall not be used for clamping or locating.

f. Electrode Contact Dims. are given for socket design purposes & are not intended for inspection purposes.



7815R

ELECTRODE CONTACT AREA (Note a,f)				
	Dim. in Inches		Dim. in Millimeter	
Dim.	Min.	Max.	Min.	Max.
AA	.035	.361	.89	9.17
AB	1.185	1.265	30.10	32.14
AC	1.534	1.728	38.96	43.89
AD	1.475	1.815	37.47	46.10

DIMENSION DATA (Note a)					
Dim. in Inches			Dim. in Millimeters.		
Min.	Max	Dim.	MIN.	MAX.	Notes
1.815	1.875	A	46.10	47.62	
	1.534	B		38.96	
	1.475	C		37.46	
1.289	1.329	D	32.74	33.76	
.970	1.010	F	24.64	25.65	
.462	.477	G	11.73	12.12	
	.040	H		1.02	
.125	.185	I	3.18	4.70	
.766	.826	J	19.46	20.98	
.025	.046	K	.64	1.17	
1.234	1.264	L	31.34	32.11	
1.180	1.195	M	29.97	30.35	
1.025	1.035	N	26.04	26.29	c,d
.752	.792	P	19.20	20.12	
.655	.665	R	16.64	16.89	c,d
	.545	S		13.84	
.213	.223	T	5.41	5.66	c,d
.315	.325	U	8.00	8.26	c,d
	.086	V		2.18	
	.100	W		2.54	
.105	.145	Y	2.67	3.68	
.650	.850	Z	16.51	21.59	

Notes:

a. Metric equivalents to the nearest .01 mm, are given for general information only & are based on 1 inch= 25.4 mm.

b. This surface shall be used to measure anode shank temp.

c. Eccentricity of contact surfaces shall be gaged from center line of reference & shall be as follows:

Contact Surface	TIR Max.	Reference
Anode	.020	Cathode
Grid	.020	Cathode
Heater	.012	Cathode

d. Dias. N,R,T & U shall apply throughout entire lenght as defined be dims. AA,AB,AC & AD respectively.

e. This surface shall not be used for clamping or locating.

f. Electrode Contact dims. are given for socket design purposes & are not intended for inspection purposes.

g. Holes for Tube Extractor thru top fin only.

TECHNICAL DATA

8238
3CX3000A1
LOW-MU TRIODE

The Eimac 8238/3CX3000A1 is a low-mu forced-air cooled power triode intended for use as an audio amplifier or modulator. The maximum rated plate dissipation is 3000 watts.

Available high plate current under Class AB_1 operating conditions permits high power gain with a minimum of distortion.

The ceramic envelope is rugged and permits high temperature processing leading to reliable service.



GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated Tungsten				
Voltage		7.5		V
Current	49		54	A
Amplification Factor	4.3		5.6	
Direct Interelectrode Capacitances (Average)				
Grid-Plate		17		pF
Grid-Filament		29		pF
Plate-Filament		2.5		pF
Transconductance (I_b = 1.0 A, E_b = 3000V)		11,000		umhos

MECHANICAL

Base	See outline drawing
Mounting Position	Vertical, base down or up
Cooling	Forced Air
Maximum Temperatures:	
Grid and Filament Seals	250°C
Anode Cooler Core	250°C
Maximum Diameter	4.16 in.
Maximum Height	8.59 in.
Net Weight	6.25 lbs.
Shipping Weight	16 lbs.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per tube)

DC PLATE VOLTAGE	6000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	3000	WATTS
GRID DISSIPATION	50	WATTS

*Adjust to stated Zero-Signal DC Plate Current. Can be expected to vary ±15%. Effective grid-current resistance must not exceed 200,000 ohms.

TYPICAL OPERATION (Sinusoidal wave, two tubes)

Class AB_1

DC Plate Voltage	4.0	5.5	kV
DC Grid Voltage (Approx)*	-750	-1070	Volts
Zero-Signal DC Plate Current	500	500	mA
Max-Signal DC Plate Current	2.75	2.2	Amps
Effective Load, Plate-to-Plate	2120	4000	Ohms
Peak AF Grid Input Voltage (per tube)	750	1070	Volts
Max-Signal Driving Power	0	0	Watts
Max-Signal Plate Input Power	11.0	13.1	kW
Max-Signal Plate Dissipation (per tube)	2.75	2.55	kW
Max-Signal Plate Output Power	5.5	8.25	kW

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APPLICATION

MECHANICAL

Mounting: The 3CX3000A1 must be mounted vertically with its base up or down at the convenience of the designer. The filament connections should be made through spring collets and care must be taken not to impart strain to the terminals or base assembly.

The tube must be protected from severe shock and vibration during shipment and operation.

Cooling: Sufficient forced air cooling must be provided to maintain seal and anode core temperature at 250°C or below. Air-flow must be started when filament power is applied and it is advisable to continue air-cooling for two minutes after all voltages are removed.

The table below lists minimum air-flow requirements to maintain tube temperatures below 250°C with air flowing in both the base-to-anode and anode-to-base directions. This tabulation presumes air at 50°C and sea level. A separate supply of approximately 3 cubic feet per minute, directed into the filament structure is also required to maintain rated filament seal temperatures. This is best accomplished using a small diameter insulating tubing directed into the stem, between the filament seals.

	MINIMUM COOLING AIR-FLOW REQUIREMENTS			
	BASE-TO-ANODE FLOW		ANODE-TO-BASE FLOW	
Plate Dissipation (Watts)	AIR-FLOW (CFM)	PRESSURE DROP (inches of water)	AIR-FLOW (CFM)	PRESSURE DROP (inches of water)
1000	32	0.49	39	0.65
2000	67.5	1.52	85	2.16
3000	106	3.15	138	4.55

NOTE:
An extra 450 watts have been added to these plate dissipation figures in preparing this tabulation, to compensate for grid and filament dissipation.

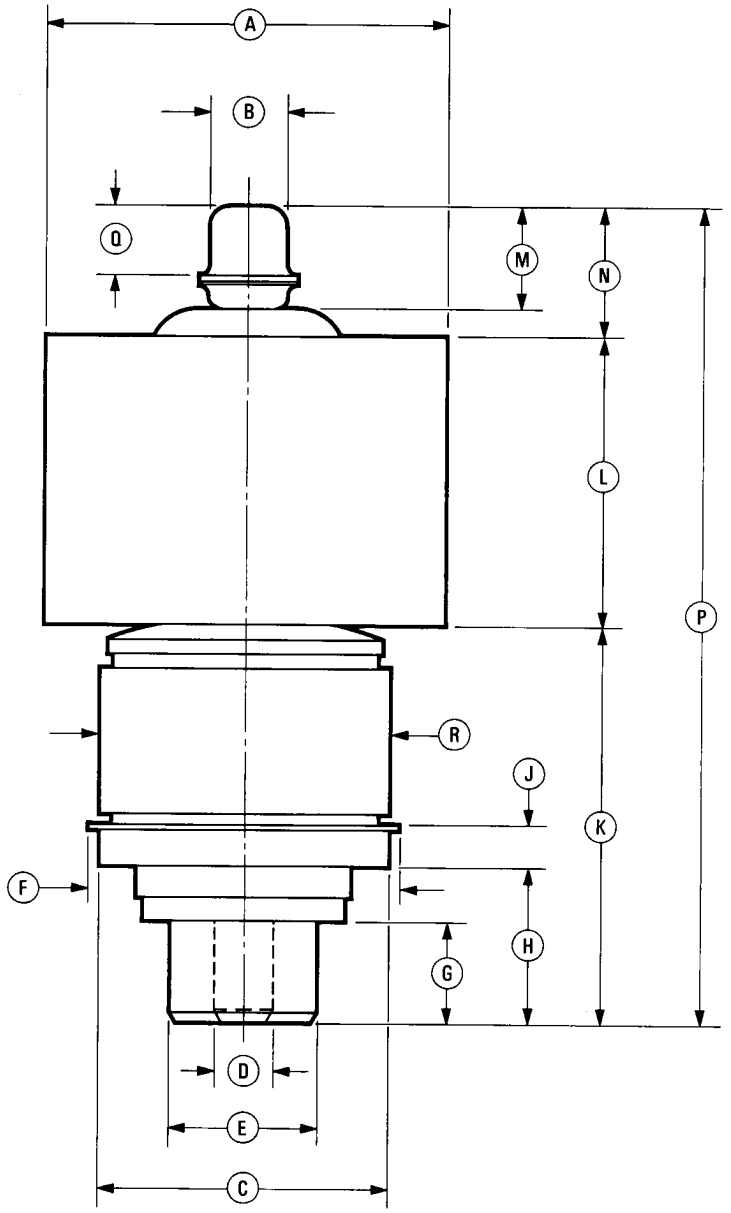
For operation at high altitudes or higher ambient temperatures, these quantities should be increased. In all cases it is suggested that actual temperatures be measured to insure adequate cooling.

ELECTRICAL

Filament: The rated filament voltage for the 3CX3000A1 is 7.5 volts and should not be exceeded by more than five percent if maximum tube life is to be realized. Reduction of filament voltage to about 7.2 volts will actually enhance tube life and provision should be made for this adjustment where the lower emission can be tolerated.

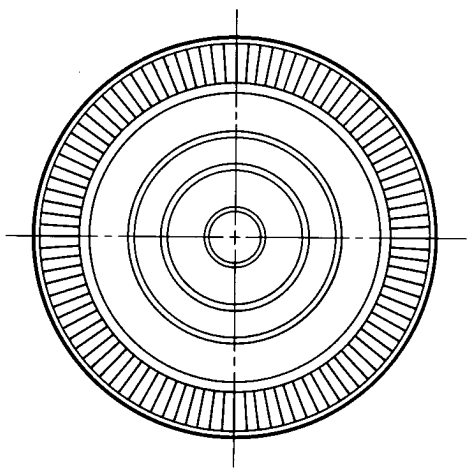
Grid Operation: The grid dissipation rating of the 3CX3000A1 is 50 watts. This is the product of the peak positive grid voltage and average dc grid current. When tubes are used in parallel in amplifier or modulator service, provision should be made for individual adjustment of bias voltage, in order to match the tubes.

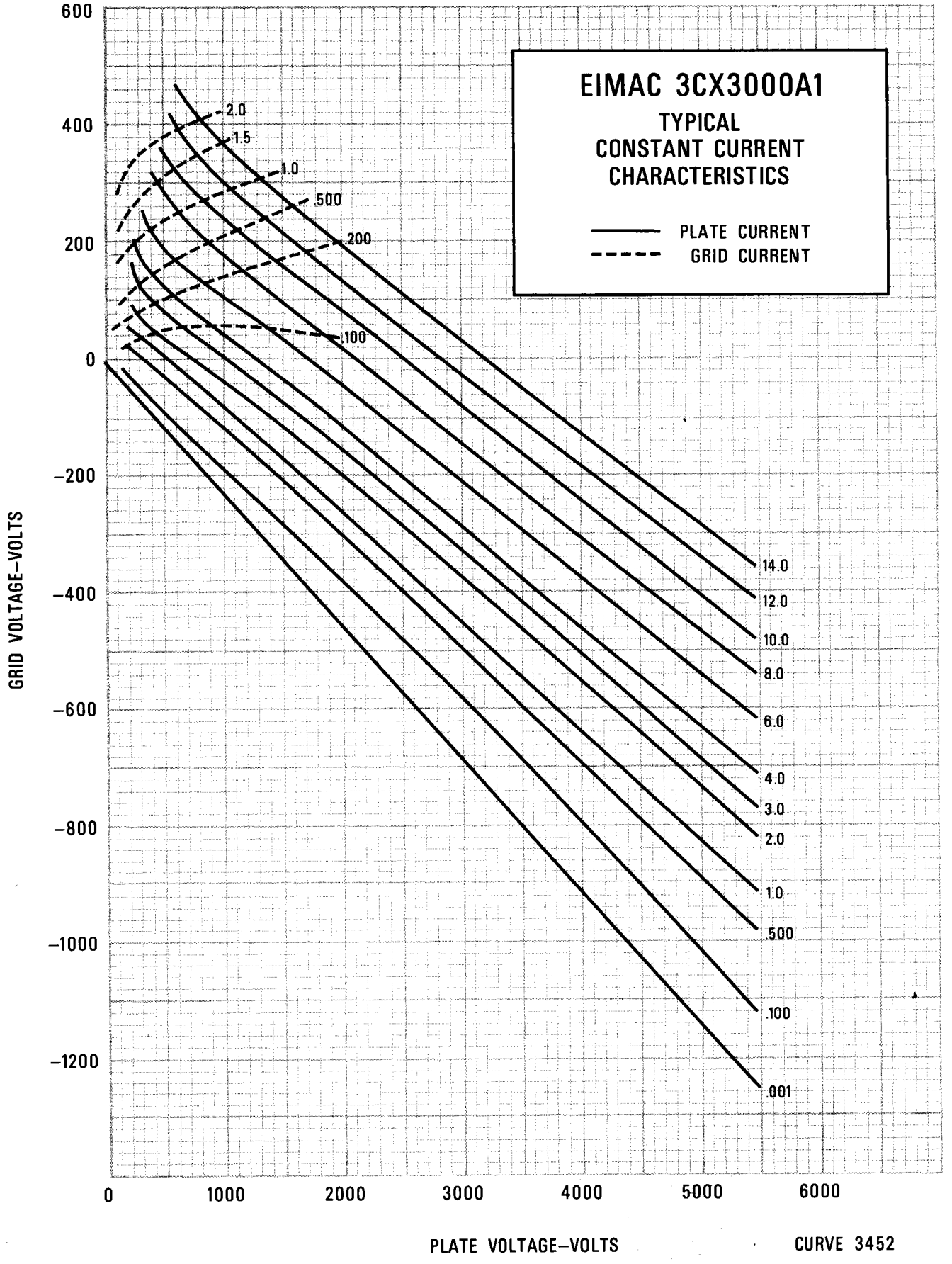
Special Applications: If it is desired to operate the tube under conditions widely different from those given here, write to Eimac Division of Varian Assoc., 301 Industrial Way, San Carlos, California, for information and recommendations.



DIMENSIONS IN INCHES

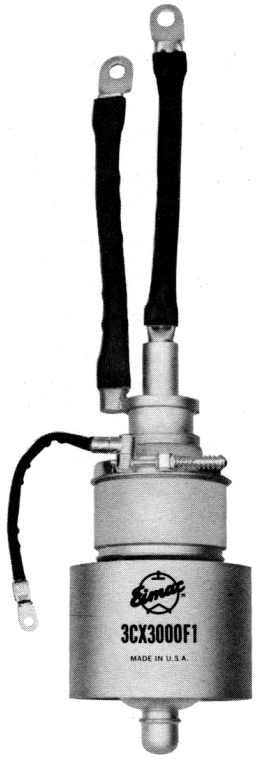
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	4 3/32	4 5/32	
B	25/32	27/32	
C	2.990	3.010	
D	.615	.635	
E	1.490	1.510	
F		3 5/8	
G	13/16	15/16	
H	1 3/8	1 5/8	
J	25/64	27/64	
K	3 7/8	4 1/4	
L	2 15/16	3 1/16	
M	1	1 1/8	
N	1 3/16	1 11/16	
P	8	9	
Q	11/16	13/16	
R	2.998	3.002	




EIMAC 3CX3000A1
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
2.0
1.5
1.0
.500
.200
.100
14.0
12.0
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.500
.100
.001
600
400
200
0
-200
-400
-600
-800
-1000
-1200
0
1000
2000
3000
4000
5000
6000
GRID VOLTAGE-VOLTS
PLATE VOLTAGE-VOLTS
CURVE 3452

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8239
3CX3000F1
LOW-MU TRIODE



The Eimac 8239/3CX3000F1 is a low-mu forced-air cooled power triode intended for use as an audio amplifier or modulator. The maximum rated plate dissipation is 3000 watts.

Two 3CX3000F1s in class-AB_1 audio service will deliver up to 10 kilowatts maximum-signal plate output power at 6000 plate volts without drawing grid current.

The 3CX3000F1 is provided with "flying leads" for filament and grid connections.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	*Nom.*	*Max.*	
Filament: Thoriated Tungsten				
Voltage		7.5		V
Current	48		53	A
Amplification Factor	4.3		5.6	
Direct Interelectrode Capacitances (Average)				
Grid-Plate		17		pF
Grid-Filament		29		pF
Plate-Filament		2.5		pF
Transconductance (I_b = 1.0A, E_b = 3000V)		11,000		umhos

MECHANICAL

Base	See outline drawing
Mounting Position	Vertical, base down or up
Cooling	Forced Air
Maximum Temperatures:	
Grid and Filament Seals	250°C
Anode Cooler Core	250°C
Maximum Diameter	4.16 in.
Net Weight	7.5 lbs.
Shipping Weight	17 lbs.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per tube)

DC PLATE VOLTAGE	6000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	3000	WATTS
GRID DISSIPATION	50	WATTS

*Adjust to stated Zero-Signal DC Plate Current. Can be expected to vary ±15%. Effective grid-current resistance must not exceed 200,000 ohms.

TYPICAL OPERATION (Sinusoidal wave, two tubes)

Class AB_1

DC Plate Voltage	4.0	5.5	kV
DC Grid Voltage (Approx)*	-750	-1070	Volts
Zero-Signal DC Plate Current	500	500	mA
Max-Signal DC Plate Current	2.75	2.2	Amps
Effective Load, Plate-to-Plate	2120	4000	Ohms
Peak AF Grid Input Voltage (per tube)	750	1070	Volts
Max-Signal Driving Power	0	0	Watts
Max-Signal Plate Input Power	11.0	13.1	kW
Max-Signal Plate Dissipation (per tube)	2.75	2.55	kW
Max-Signal Plate Output Power	5.5	8.25	kW

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APPLICATION

MECHANICAL

Mounting: The 3CX3000F1 must be mounted vertically with its base up or down at the convenience of the designer. The base is fitted with heavy filament leads to facilitate connections. These leads should be arranged to prevent mechanical stress on the filament structure. The grid is also fitted with a flying lead.

The tube must be protected from severe shock and vibration during shipment and operation.

Cooling: Sufficient forced air cooling must be provided to maintain seal temperature at 250°C or below. Air-flow must be started when filament power is applied and it is advisable to continue air-cooling for two minutes after all voltages are removed.

The table below lists minimum air-flow requirements to maintain tube temperatures below 250°C with air flowing in both the base-to-anode and anode-to-base directions. This tabulation presumes air at 50°C and sea level. A separate supply of approximately 3 cubic feet per minute, directed into the filament structure is also required to maintain rated filament seal temperatures. This is best accomplished using a small diameter insulating tubing directed into the stem, between the filament seals.

	MINIMUM COOLING AIR-FLOW REQUIREMENTS			
	BASE-TO-ANODE FLOW		ANODE-TO-BASE FLOW	
Plate Dissipation (Watts)	AIR-FLOW (CFM)	PRESSURE DROP (inches of water)	AIR-FLOW (CFM)	PRESSURE DROP (inches of water)
1000	32	0.49	39	0.65
2000	67.5	1.52	85	2.16
3000	106	3.15	138	4.55

NOTE:
An extra 450 watts have been added to these plate dissipation figures in preparing this tabulation, to compensate for grid and filament dissipation.

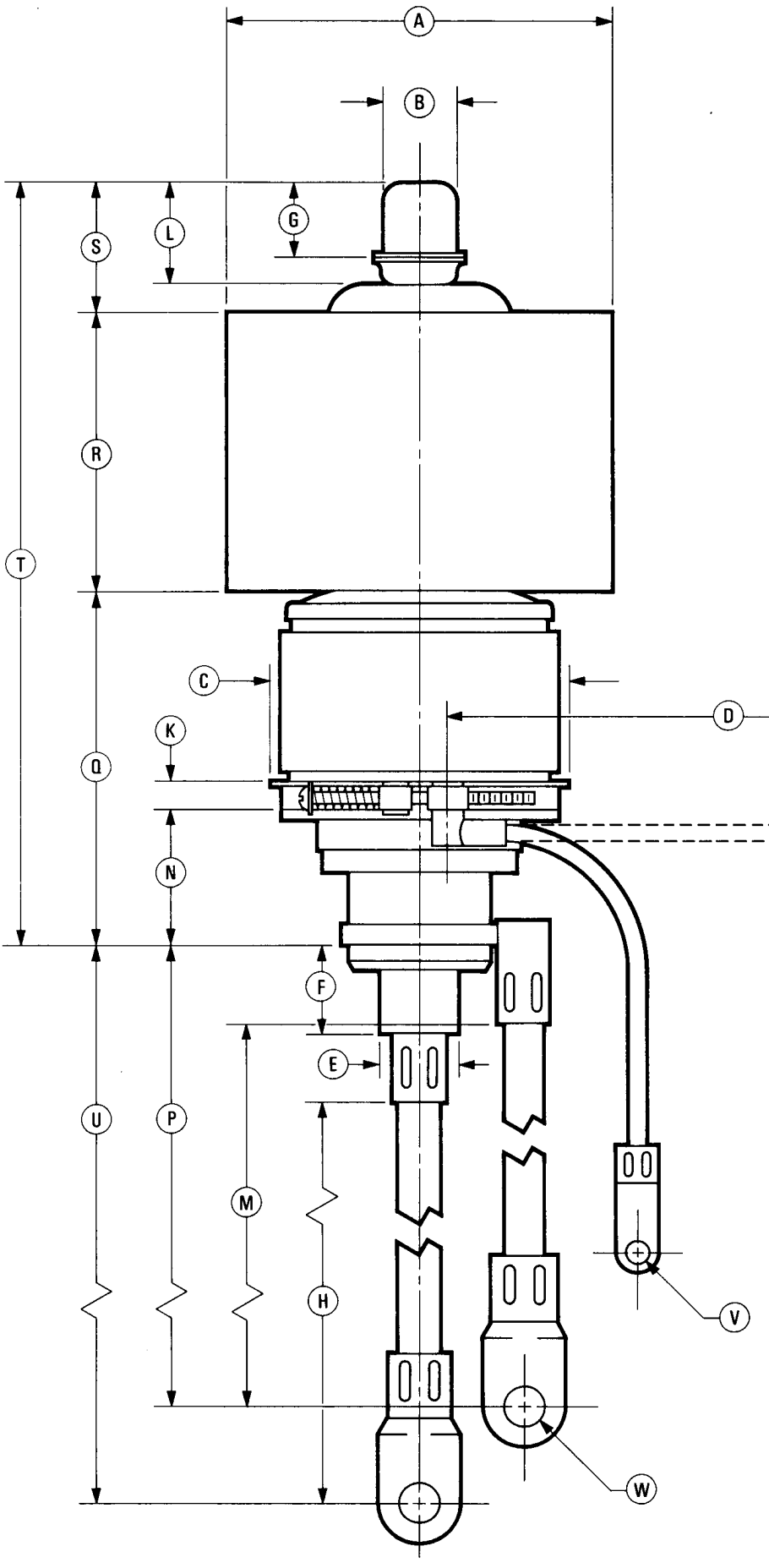
For operation at high altitudes or higher ambient temperatures, these quantities should be increased. In all cases it is suggested that actual temperatures be measured to insure adequate cooling.

ELECTRICAL

Filament: The rated filament voltage for the 3CX3000F1 is 7.5 volts and should not be exceeded by more than five percent if maximum tube life is to be realized. Reduction of filament voltage to about 7.2 volts will actually enhance tube life and provision should be made for this adjustment where the lower emission can be tolerated.

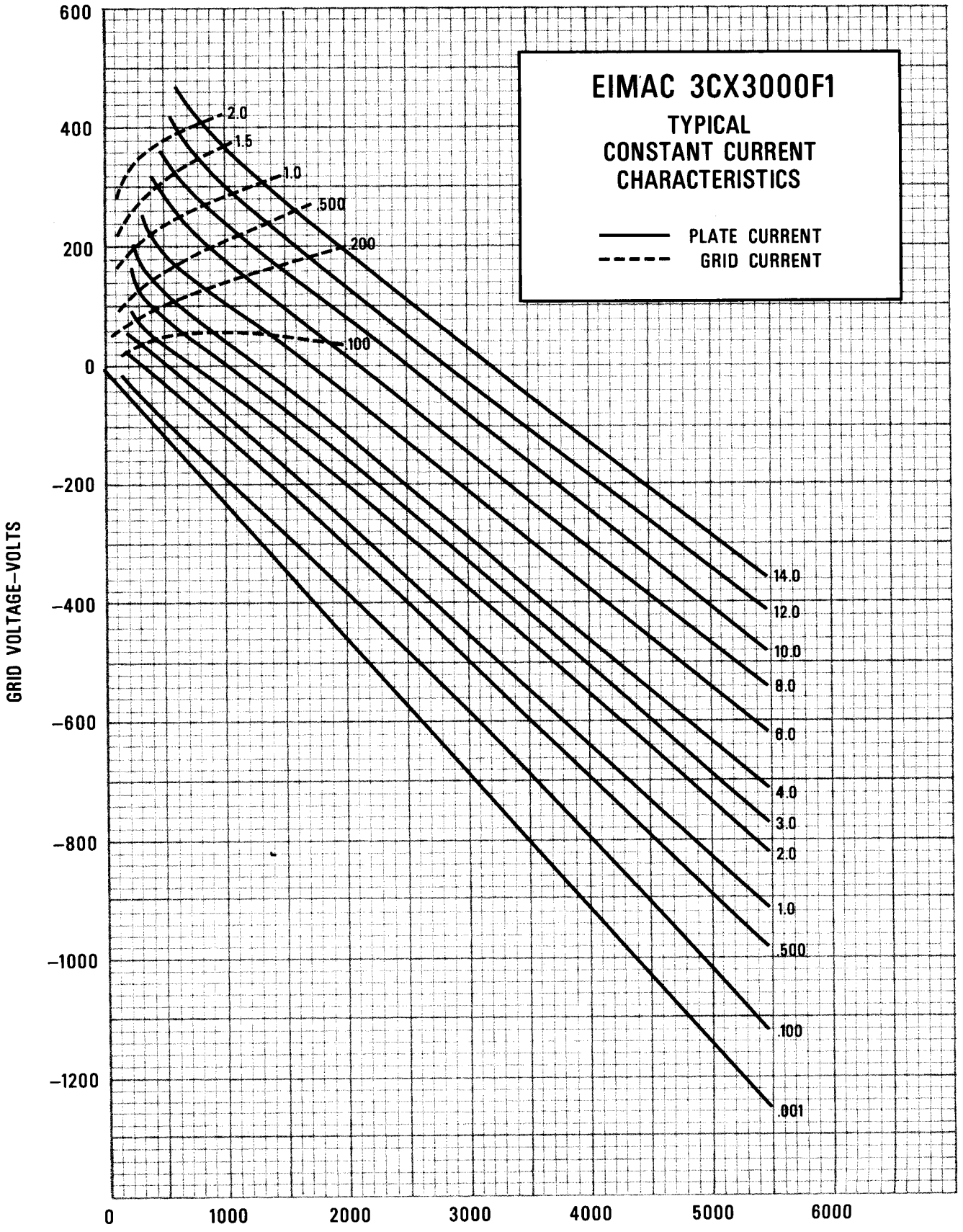
Grid Operation: The grid dissipation rating of the 3CX3000F1 is 50 watts. This is the product of the peak positive grid voltage and average dc grid current. When tubes are used in parallel in amplifier or modulator service, provision should be made for individual adjustment of bias voltage, in order to match the tubes.

Special Applications: If it is desired to operate the tube under conditions widely different from those given here, write to Eimac Division of Varian Assoc., 301 Industrial Way, San Carlos, California, for information and recommendations.



DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	4 3/32	4 5/32	
B	25/32	27/32	
C		3 5/8	
D	6.375	6.625	
E	.859	.890	
F	.812	.937	
G	11/16	13/16	
H	7.000	7.500	
K	3/8	7/16	
L	1	1 1/8	
M	7.000	7.500	
N	1 3/8	1 5/8	
P	7.937	8.437	
Q	3 7/8	4 1/4	
R	2 15/16	3 1/16	
S	1 3/16	1 11/16	
T	8	9	
U	8.937	9.437	
V	.194	.200	
W	.385	.395	


EIMAC 3CX3000F1
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
2.0
1.5
1.0
.500
.200
.100
14.0
12.0
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.500
.100
.001
600
400
200
0
-200
-400
-600
-800
-1000
-1200
0
1000
2000
3000
4000
5000
6000
GRID VOLTAGE-VOLTS
PLATE VOLTAGE-VOLTS
CURVE 3452

8240
3CW5000A1
8241
3CW5000F1

LOW-MU
WATER-COOLED
TRIODES

The EIMAC 8240/3CW5000A1 and 8241/3CW5000F1 are low-mu water-cooled power triodes intended for use as audio amplifiers or modulators. Their maximum rated plate dissipation is 5000 watts. The two types are identical except for the addition of flexible leads for the grid and filament terminals on the 8241/3CW5000F1.

Two of these tubes, in Class AB_1 audio service, will deliver more than 10 kilowatts maximum-signal plate output power at 6000 plate volts without drawing grid current.

These two types are electrically identical to the air-cooled EIMAC 8238/3CX3000A1 except for the plate dissipation rating.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten
- Voltage . . . . . 7.5 ± 0.37 V
- Current, at 7.5 volts
  - 8240/3CW5000A1 . . . . . 51.5 A
  - 8241/3CW5000F1 . . . . . 50.5 A

Transconductance (Average)
- I_b = 1.0 Adc, E_b = 3000 Vdc . 11,000 μmhos

Amplification Factor (Average) 4.9

1. Characterisitcs and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Div. of Varian should be consulted before using this information for final equipment design.

MECHANICAL

Maximum Overall Dimensions:
- Length (excluding leads on 8241/3CW5000F1) . . . . . 12.625 in; 321 mm
- Diameter . . . . . 3.255 in;86.2 mm

Net Weight (Approximate) . . . . . 3.5 lbs; 1.6 kg

Operating Position . . . . . Axis vertical, base down or up

Maximum Operating Temperature:
- Ceramic/Metal Seals or Envelope . . . . . 250°C

Cooling:
- Seals and Envelope . . . . . Forced Air
- Plate . . . . . Water

Base . . . . . See Outline Drawings

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AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_1, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	6000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	50	WATTS

1. Approximate value; adjust to give stated zero-signal plate current.
2. Per tube.

TYPICAL OPERATION (Class AB_1, Sinusoidal Wave, Two Tubes)

Plate Voltage	4000	5000	6000	Vdc
Grid Voltage[1]	-860	-1080	-1300	Vdc
Zero-Signal Plate Current	500	400	335	mAdc
Max. Signal Plate Current	3.00	2.80	2.65	Adc
Peak af Grid Voltage[2]	760	995	1250	v
Peak Driving Power	0	0	0	w
Max. Signal Plate Input Power	12,000	14,000	16,000	W
Max. Signal Plate Dissipation[2]	3000	3000	3000	W
Max. Signal Plate Output Power	6000	8000	10,000	W
Load Resistance (plate to plate)	2160	3320	4560	Ω

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the grid voltage to obtain the specified plate current at the specified bias, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 7.5 volts (8240/3CW5000A1)	49.0	54.0	A
(8241/3CW5000F1)	48.0	53.0	A
Amplification Factor	4.3	5.6	

APPLICATION

MECHANICAL

MOUNTING - The 3CW5000A1 and 3CW5000F1 must be mounted vertically, base down or up at the convenience of the circuit designer. The filament connections to the 3CW5000A1 should be made through spring collets. These are available from EIMAC with the following part numbers: 149575 Inner line collet; 149576 Outer line collet Reasonable care should be taken that these collets do not impart undue strain to the terminals or the base of the tube.

COOLING - With an anode dissipation of 5000 watts and with an incoming water temperature of 50°C maximum, 7.7 gpm of cooling water must be supplied to the anode cooling jacket. Outlet water temperature from the cooling jacket should never exceed 70°C, and water pressure on the jacket should not exceed 60 psi. The pressure drop across the anode cooling jacket itself, with a water flow of 7.7 gpm, will be approximately 6 psi.

The grid-terminal contact surface and adjacent ceramic must be cooled by forced air, with quantity, velocity, and direction adjusted to limit the maximum seal temperature to less than 250°C.

The filament stem structure also requires forced-air cooling. A minimum of 6 cfm should be directed into the space between the inner and outer filament contacting surfaces.

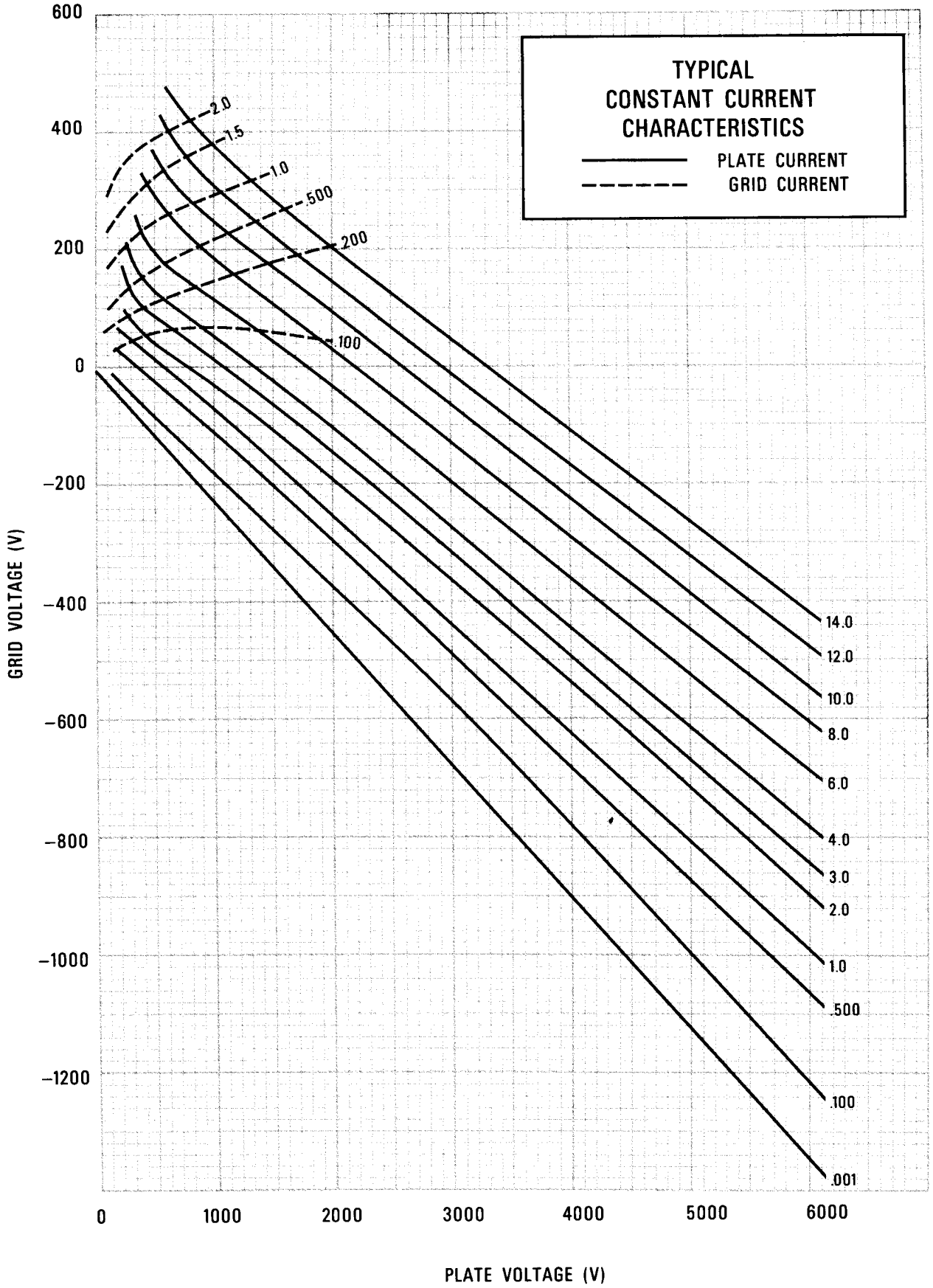
Both air and water flow must be supplied before or simultaneously with the application of electrode voltages, including the filament, and may be removed simultaneously with them. Where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial.

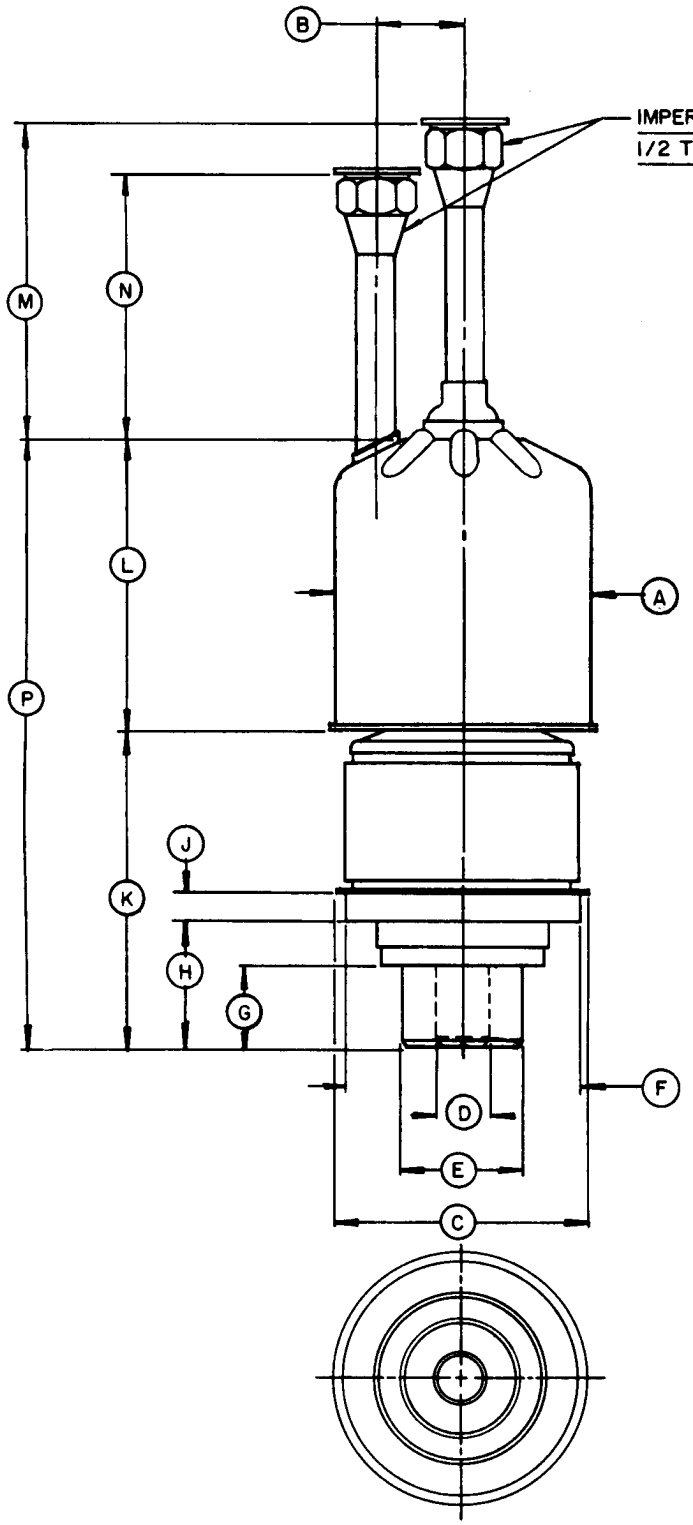
ELECTRICAL

FILAMENT OPERATION - The filament voltage, as measured at the filament terminals, should be 7.5 volts, with maximum allowable variations due to line fluctuations of from 7.12 to 7.87 volts.

HIGH VOLTAGE - The 3CW5000A1 and 3CW-5000F1 operate at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-voltage condensers when access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

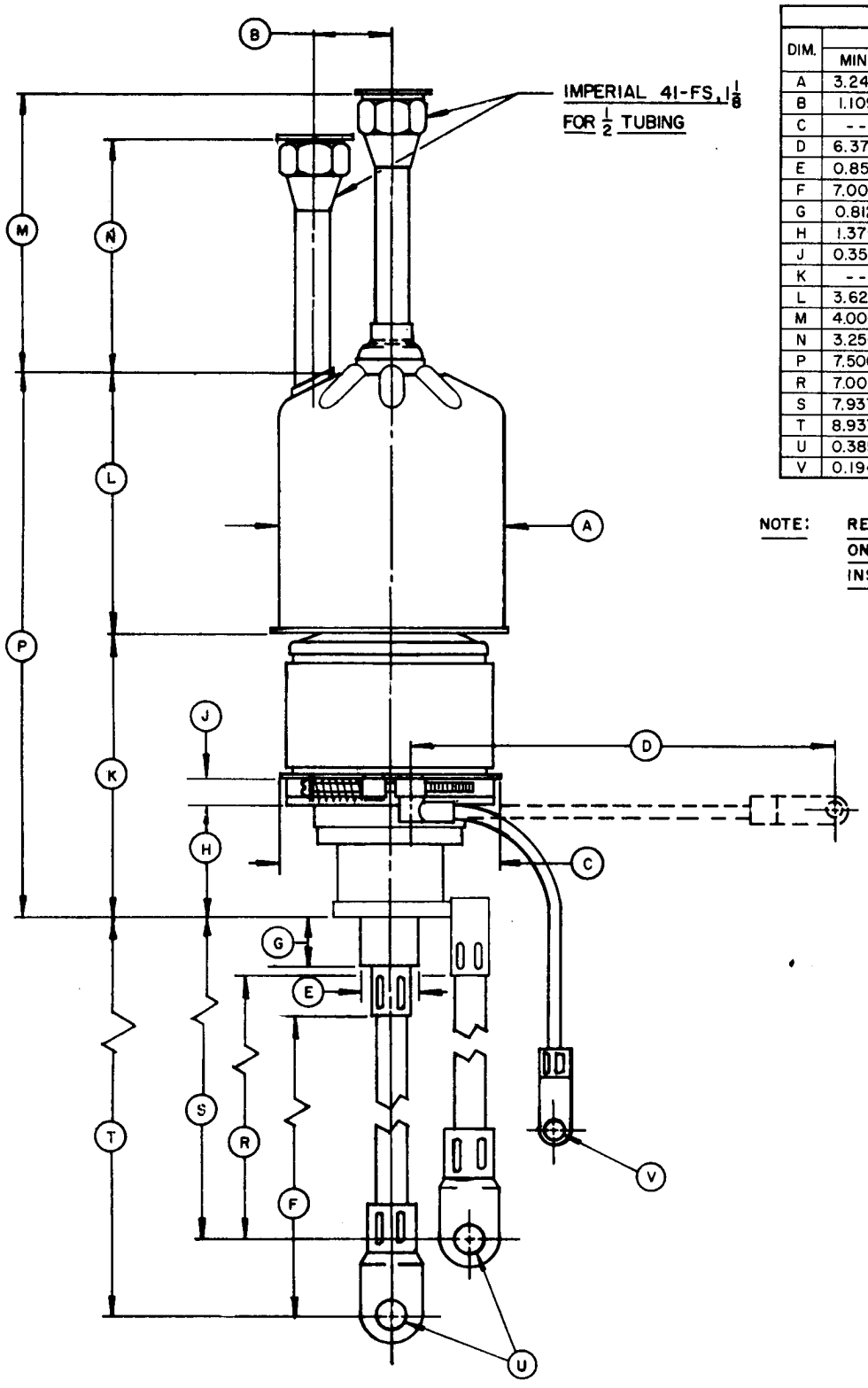
SPECIAL APPLICATIONS - If it is desired to operate these tubes under conditions widely different from those given here write to the Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, CA. 94070, for information and recommendations.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT
GRID CURRENT
600
400
200
0
-200
-400
-600
-800
-1000
-1200
GRID VOLTAGE (V)
0
1000
2000
3000
4000
5000
6000
PLATE VOLTAGE (V)
2.0
1.5
1.0
.500
.200
.100
14.0
12.0
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.500
.100
.001



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.245	3.255	--	82.42	82.68	--
B	1.109	1.141	--	28.17	28.98	--
C	--	3.625	--	--	92.08	--
D	0.615	0.635	--	15.62	16.13	--
E	1.490	1.510	--	37.85	38.35	--
F	2.990	3.010	--	75.95	76.45	--
G	0.812	0.938	--	20.62	23.83	--
H	1.375	1.625	--	34.93	41.28	--
J	0.359	0.422	--	9.12	10.72	--
K	--	--	3.599	--	--	91.41
L	3.625	3.875	--	92.08	98.43	--
M	4.000	4.500	--	101.60	114.30	--
N	3.250	3.750	--	82.55	95.25	--
P	7.500	8.125	--	190.50	206.38	--

NOTE: REF. DIMS ARE FOR INFO ONLY AND NOT REQ. FOR INSPECTION PURPOSES.



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.245	3.255	--	82.42	82.68	--
B	1.109	1.141	--	28.17	28.98	--
C	--	3.625	--	--	92.08	--
D	6.375	6.625	--	161.93	168.28	--
E	0.859	0.890	--	21.82	22.61	--
F	7.000	7.500	--	177.80	190.50	--
G	0.812	0.938	--	20.62	23.83	--
H	1.375	1.625	--	34.93	41.28	--
J	0.359	0.422	--	9.12	10.72	--
K	--	--	3.599	--	--	91.41
L	3.625	3.875	--	92.08	98.43	--
M	4.000	4.500	--	101.60	114.30	--
N	3.250	3.750	--	82.55	95.25	--
P	7.500	8.125	--	190.50	206.38	--
R	7.000	7.500	--	177.80	190.50	--
S	7.937	8.437	--	201.60	214.30	--
T	8.937	9.437	--	226.99	239.70	--
U	0.385	0.395	--	9.78	10.03	--
V	0.194	0.200	--	4.93	5.08	--

NOTE: REF. DIMS ARE FOR INFO ONLY AND NOT REQ. FOR INSPECTION PURPOSES.

TECHNICAL DATA

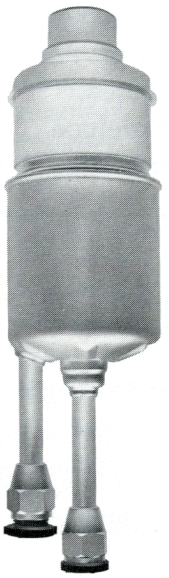
8242
3CW5000A3
8243
3CW5000F3

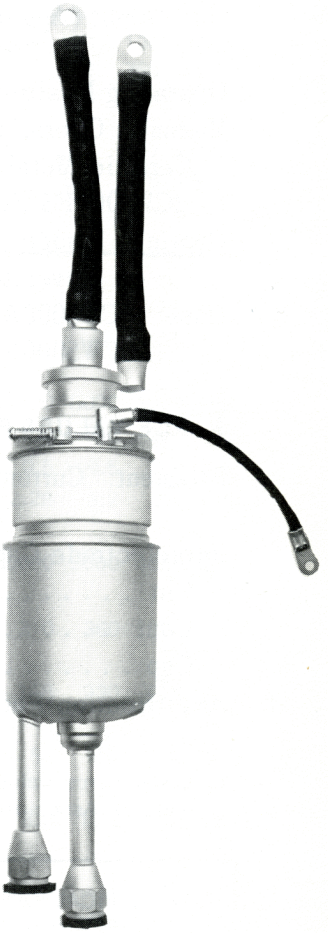
MEDIUM-MU
WATER-COOLED
POWER TRIODES

The EIMAC 8242/3CW5000A3 and 8243/3CW5000F3 are medium-mu water-cooled power triodes intended for use in amplifier, oscillator, or modulator service. Their maximum rated anode dissipation is 5000 watts. The two types are identical except for the addition of flexible leads for the grid and filament terminals of the 8243/3CW5000F3.

These tubes are water-cooled versions of the air-cooled 8161/3CX2500A3 and 8251/3CX2500F3.

The water-cooled tubes are recommended for industrial applications or installations where reserve anode dissipation is required.





GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten		
Voltage	7.5	V
Current @ 7.5 V (3CW5000A3)	51.5	A
(3CW5000F3)	50.5	A
Amplification Factor (Average)	22	
Transconductance (Average)	20,000	μmhos
(E_b = 3000 Vdc; I_b = 830 mAdc)		
Direct Interelectrode Capacitances (Cathode grounded)[2]		
Cin	35	pF
Cout	0.9	pF
Cgp	20	pF
Frequency of Maximum Ratings (CW)		
3CW5000A3 F1	75	MHz
F2	110	MHz
3CW5000F3 F1	30	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture, in accordance with Electronic Industries Association Standard RS-191.

(Revised 1-11-74) © 1962, 1964, 1967, 1974 by Varian

Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:	
Length (excluding leads on 3CW5000F3)	12.56 In; 31.9 Cm
Diameter	3.63 In; 9.22 Cm
Net Weight (Approximate) 3CW5000A3	4.8 lb; 2.2 kg
3CW5000F3	5.5 lb; 2.5 kg
Operating Position (both types)	Axis Vertical, Base Down or Up
Maximum Operating Temperatures:	
Ceramic/Metal Seals or Envelope	250°C
3CW5000F3 Filament Lead/Tube Base junctions	150°C
Cooling: Anode	Water or Equivalent Liquid
Envelope, Seals, Base Areas	Forced Air
Base: 3CW5000A3	Special Coaxial
3CW5000F3	Special with Flying Leads

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current @ 7.5 volts (3CW5000A3)	49.0	54.0	A
(3CW5000F3)	48.0	53.0	A
Interelectrode Capacitance (Grounded cathode) [1]			
Cin	29.2	40.2	pF
Cout	0.60	1.20	pF
Cgp	16.8	23.2	pF
Amplification Factor	19	26	

1. Capacitance values are for a cold tube as measured in a special shielded fixture, in accordance with Electronic Industries Association standard RS-191.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid current. The grid current which results when the desired plate current is obtained is incidental and varies from tube to tube. This current variation causes no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy or FM-Grid Driven

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE (up to F1)	6000	VOLTS
DC PLATE VOLTAGE (F1 to F2)	4000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	150	WATTS

1. Approximate value.
2. Approximate; useful power delivered to the load will be lower because of circuit losses.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	4000	5000	6000	Vdc
Plate Current	2.5	2.5	2.1	Adc
Grid Voltage	-300	-450	-500	Vdc
Grid Current [1]	245	265	180	mAdc
Peak rf Grid Voltage [1]	580	750	765	v
Driving Power [1]	142	197	136	W
Grid Dissipation [1]	68	78	46	W
Plate Power Input	10	12.5	12.5	kW
Plate Dissipation	2.5	2.5	2.5	kW
Plate Power Output [2]	7.5	10	10	kW

PLATE MODULATED RADIO FREQUENCY AMPLIFIER
Class C Telephony - Carrier Conditions

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE (up to F1)	5000	VOLTS
DC PLATE VOLTAGE (F1 to F2)	3500	VOLTS
DC PLATE CURRENT	2.0	AMPERES
PLATE DISSIPATION	3350	WATTS
GRID DISSIPATION	150	WATTS

1. Approximate value.
2. Approximate; useful power delivered to the load will be lower because of circuit losses.

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	4000	4500	5000	Vdc
Plate Current	1.67	1.55	1.45	Adc
Total Bias Voltage	-450	-500	-550	Vdc
Fixed Bias Voltage	-230	-325	-410	Vdc
Grid Resistor	1500	1500	1400	Ω
Grid Current	150	120	100	mAdc
Peak rf Grid Voltage[1]	680	720	760	v
Driving Power [1]	102	86	76	W
Grid Dissipation [1]	35	26	21	W
Plate Dissipation [1]	1.67	1.67	1.67	kW
Plate Power Output [2]	5.0	5.3	5.6	kW

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	6000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	150	WATTS

1. Approx. Adjust for specified zero-signal plate current.
2. Approximate.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	4000	5000	5000	6000	Vdc
Grid Voltage [1]	-145	-190	-190	-240	Vdc
Zero Signal Plate Current	0.6	0.5	0.5	0.4	Adc
Max. Signal Plate Current	2.70	2.26	3.2	3.0	Adc
Effective Load, plate-to-plate	3300	5000	3600	4650	Ω
Peak af Grid Voltage (per tube) [2]	285	310	360	390	v
Max. Signal Peak Driving Power [2]	134	118	230	225	W
Max. Signal Nom. Driving Power [2]	67	59	115	113	W
Max. Signal Plate Output Power [2]	7.4	8.0	11.0	13.0	kW

APPLICATION

MECHANICAL

MOUNTING - The 3CW5000A3 and 3CW5000F3 must be mounted vertically, base down or up at the convenience of the circuit designer. The filament connections to the 3CW5000A3 should be made through spring collets. These are available from EIMAC with the following part numbers:

149575 Inner line collet;
149576 Outer line collet

Reasonable care should be taken that these collets do not impart undue strain to the terminals or the base of the tube.

COOLING - With an anode dissipation of 5000 watts and with an incoming water temperature of 50°C maximum, 7.7 gpm of cooling water must be supplied to the anode cooling jacket. Outlet water temperature from the cooling jacket should never exceed 70°C, and water pressure on the jacket should not exceed 60 psi. The pressure drop across the anode cooling jacket itself, with a water flow of 7.7 gpm, will be approximately 6 psi. The grid-terminal contact surface and adjacent ceramic must be cooled by forced air, with quantity, velocity, and

direction adjusted to limit the maximum seal temperature to less than 250°C.

The filament stem structure also requires forced-air cooling. A minimum of 6 cfm should be directed into the space between the inner and outer filament contacting surfaces.

Both air and water flow must be supplied before or simultaneously with the application of electrode voltages, including the filament, and may be removed simultaneously with them. Where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial.

ELECTRICAL

FILAMENT OPERATION - The filament voltage, as measured at the filament terminals, should be 7.5 volts, with maximum allowable variations due to line fluctuations of from 7.12 to 7.87 volts.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

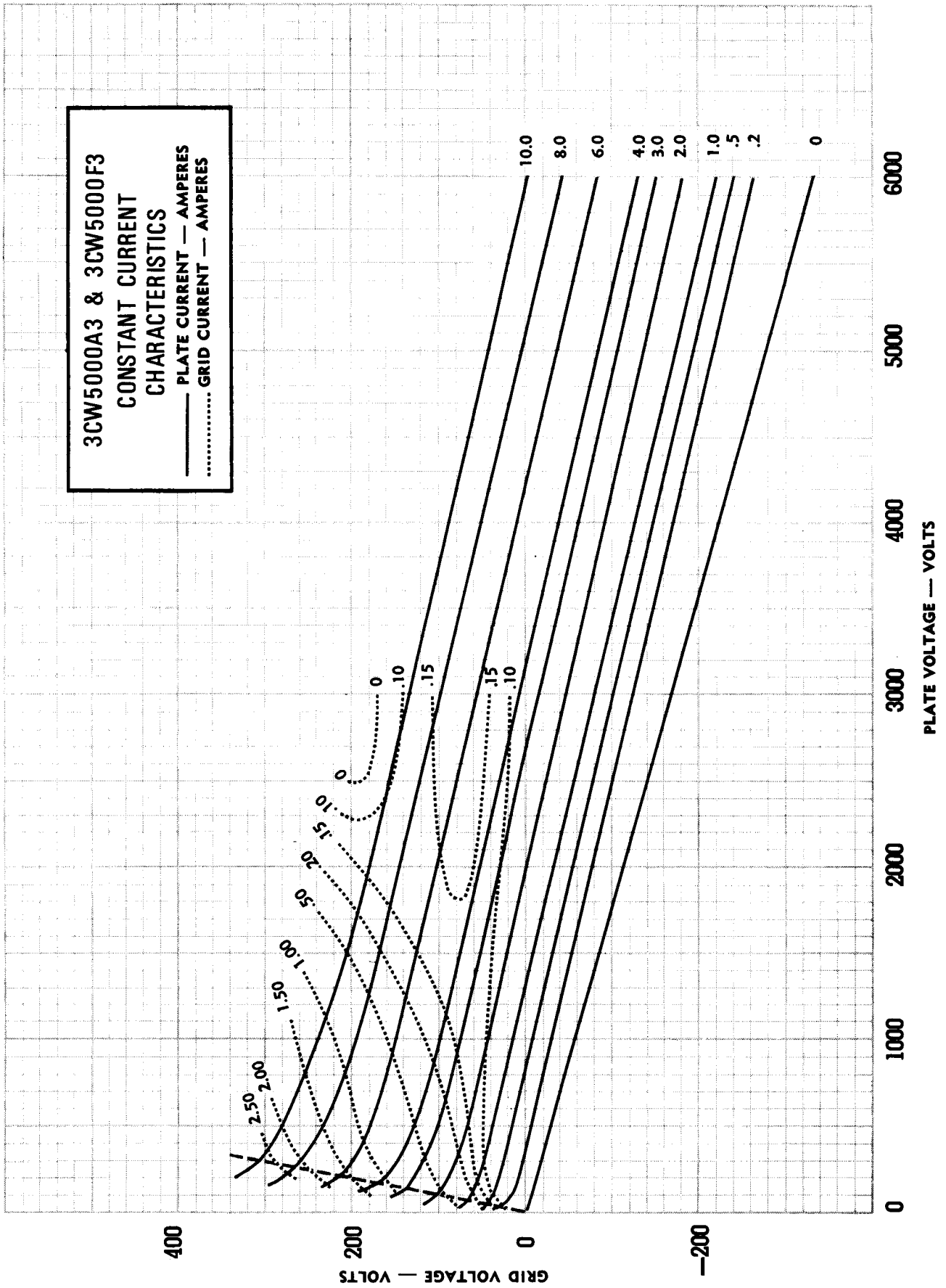
Many EIMAC power tubes, such as these, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry--the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

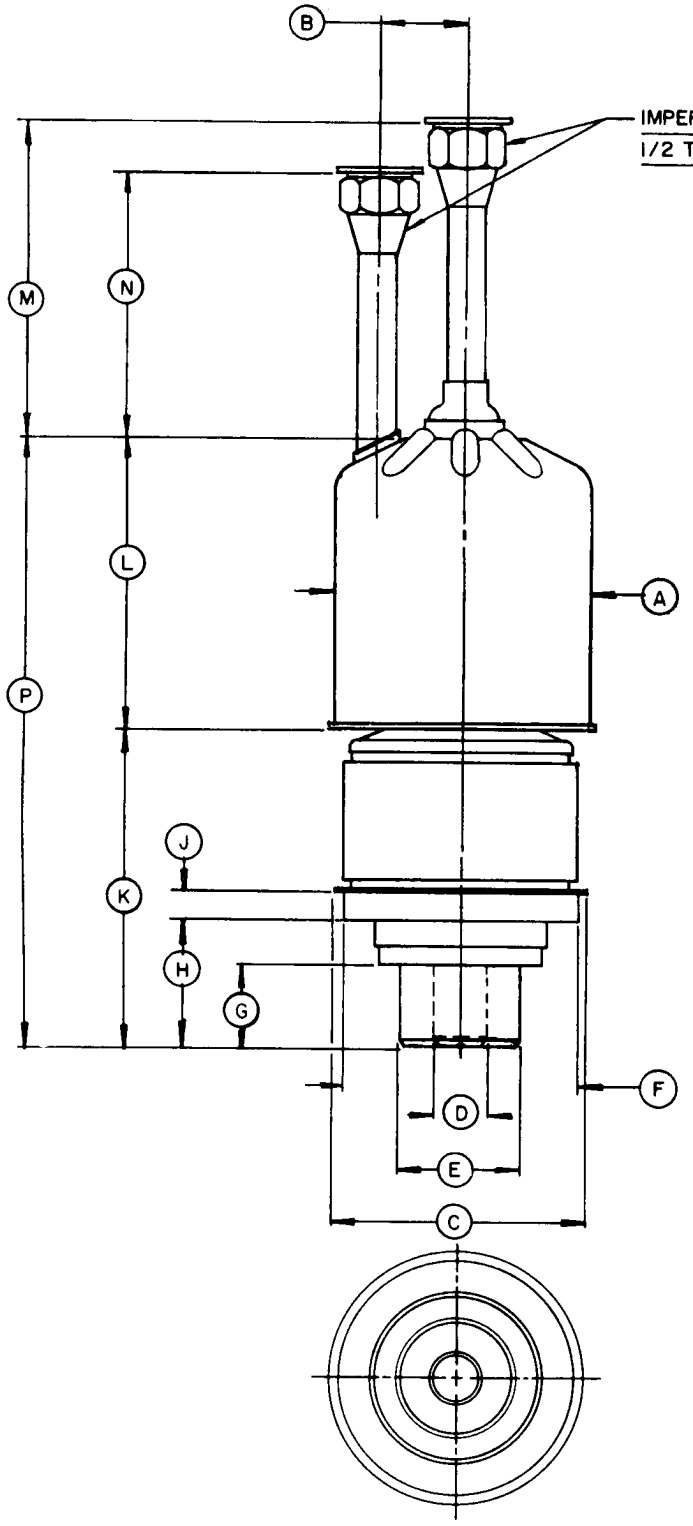
HIGH VOLTAGE - Normal operating voltages used with these tubes are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

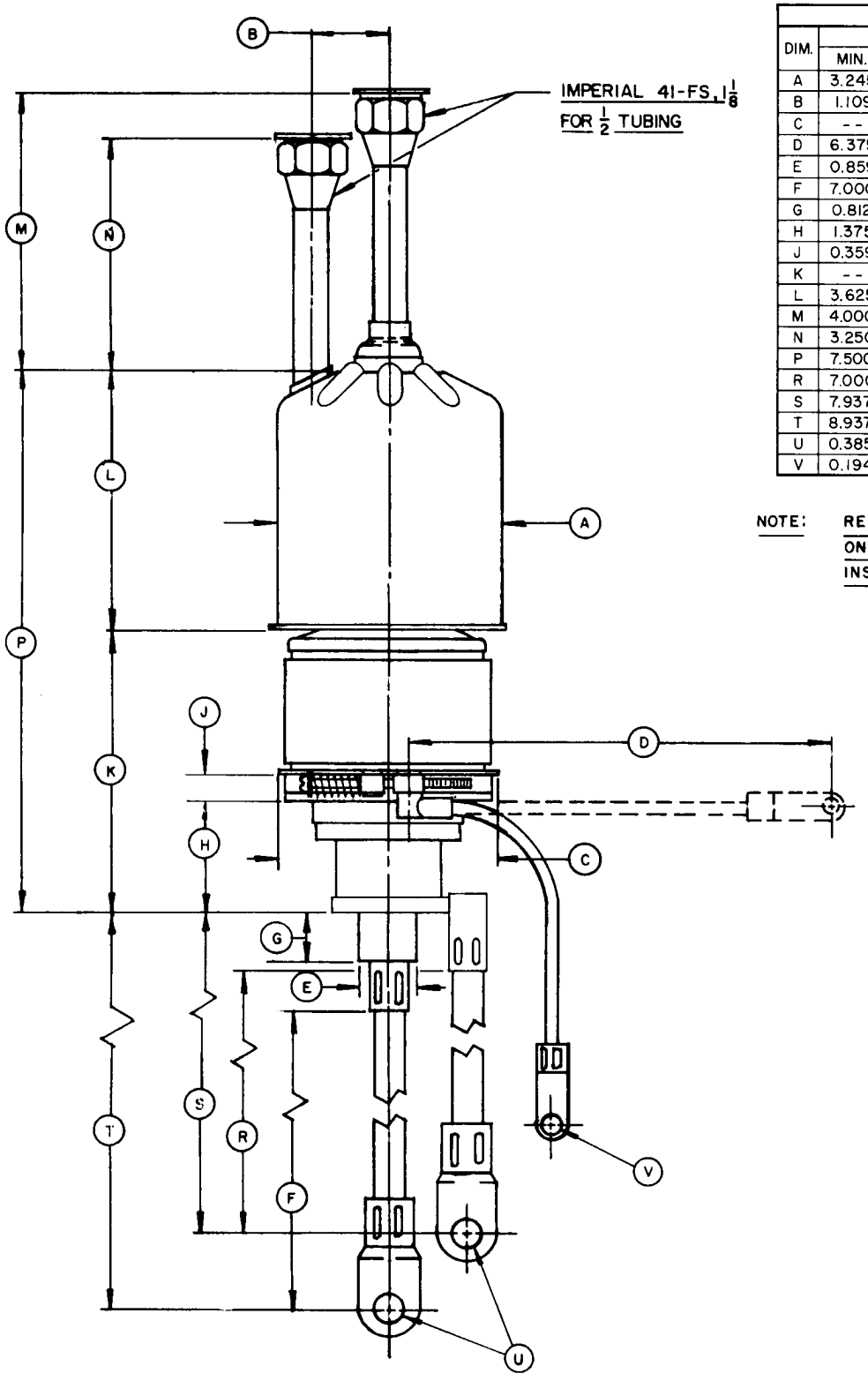
SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.


3CW5000A3 & 3CW5000F3
CONSTANT CURRENT
CHARACTERISTICS
PLATE CURRENT — AMPERES
GRID CURRENT — AMPERES
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.5
.2
0
.10
.15
.15
.10
0
.10
.15
.20
.50
1.00
1.50
2.00
2.50
400
200
0
—200
GRID VOLTAGE — VOLTS
0
1000
2000
3000
4000
5000
6000
PLATE VOLTAGE — VOLTS



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.245	3.255	--	82.42	82.68	--
B	1.109	1.141	--	28.17	28.98	--
C	--	3.625	--	--	92.08	--
D	0.615	0.635	--	15.62	16.13	--
E	1.490	1.510	--	37.85	38.35	--
F	2.990	3.010	--	75.95	76.45	--
G	0.812	0.938	--	20.62	23.83	--
H	1.375	1.625	--	34.93	41.28	--
J	0.359	0.422	--	9.12	10.72	--
K	--	--	3.599	--	--	91.41
L	3.625	3.875	--	92.08	98.43	--
M	4.000	4.500	--	101.60	114.30	--
N	3.250	3.750	--	82.55	95.25	--
P	7.500	8.125	--	190.50	206.38	--

NOTE: REF. DIMS ARE FOR INFO ONLY AND NOT REQ. FOR INSPECTION PURPOSES.



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.245	3.255	--	82.42	82.68	--
B	1.109	1.141	--	28.17	28.98	--
C	--	3.625	--	--	92.08	--
D	6.375	6.625	--	161.93	168.28	--
E	0.859	0.890	--	21.82	22.61	--
F	7.000	7.500	--	177.80	190.50	--
G	0.812	0.938	--	20.62	23.83	--
H	1.375	1.625	--	34.93	41.28	--
J	0.359	0.422	--	9.12	10.72	--
K	--	--	3.599	--	--	91.41
L	3.625	3.875	--	92.08	98.43	--
M	4.000	4.500	--	101.60	114.30	--
N	3.250	3.750	--	82.55	95.25	--
P	7.500	8.125	--	190.50	206.38	--
R	7.000	7.500	--	177.80	190.50	--
S	7.937	8.437	--	201.60	214.30	--
T	8.937	9.437	--	226.99	239.70	--
U	0.385	0.395	--	9.78	10.03	--
V	0.194	0.200	--	4.93	5.08	--

NOTE: REF. DIMS ARE FOR INFO ONLY AND NOT REQ. FOR INSPECTION PURPOSES.

TECHNICAL DATA

9000
4CM300,000G
HIGH POWER
MULTIPHASE
COOLED TETRODE



The EIMAC 4CM300,000G is a ceramic/metal, multiphase-cooled (water/vapor) power tetrode designed for high-power broadcast service. Pyrolytic graphite grids are used to provide high dissipation capability in combination with low secondary emission characteristics.

The 4CM300,000G has a thoriated-tungsten mesh filament mounted on water-cooled supports. The maximum anode dissipation rating is 300 kilowatts steady state.

Large-diameter coaxial terminals are used for the screen grid, control grid and filament connections.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten Mesh	
Voltage	15.0 ± 0.75 V
Current @ 15.0 volts (nominal)	480 A
Frequency of Maximum Ratings (CW)[3]	50 MHz
Amplification Factor, Average, Grid to Screen	4.5
Direct Interelectrode Capacitances (grounded cathode)[2]	
Cin	750 pF
Cout	79 pF
Cgp	5.6 pF
Direct Interelectrode Capacitances (grounded grid)[2]	
Cin	284 pF
Cout	83 pF
Cpk	0.9 pF

1. Characteristics and operating values are based on tests and calculations. These figures may change without notice as the result of additional data or product refinement. VARIAN EIMAC should be consulted before using this information for final equipment design.
2. Capacitance values shown are nominal measured in accordance with Electronic Industries Association Standard RS-191.
3. The tube is projected to have excellent rf characteristics up to 150 MHz.

MECHANICAL

Net Weight	121 lb; 55 kg
Operating Position	Vertical, Base Down
Cooling	Water and Forced Air
Maximum Overall Dimensions:	
Length	22.5 in; 57.1 cm
Diameter	13.3 in; 33.8 cm
Maximum Operating Temperature, Envelope and Ceramic/Metal Seals	200°C
Base	Special Coaxial
Recommended Socket	EIMAC SK-2450

390850(Effective April 1985)
VA4816

Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20.0	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC PLATE CURRENT	50	AMPERES
PLATE DISSIPATION	300	KILOWATTTS
SCREEN DISSIPATION	6.0	KILOWATTS
GRID DISSIPATION	2.0	KILOWATTS

* Approximate value. ** Adjust for specified value of zero-signal plate current.

TYPICAL OPERATION (Frequencies to 30 MHz)
CLASS AB1, Single Sideband Peak Envelope Conditions

Plate Voltage	18.0	kVdc
Screen Voltage	2000	Vdc
Grid Voltage **	-460	Vdc
Zero Signal Plate Current	3.0	Adc
Single Tone Plate Current	30.5	Adc
Single Tone Screen Current *	1.4	Adc
Peak rf Grid Voltage *	460	v
Plate Dissipation *	145	kW
Plate Load Resistance	340	Ohms
Plate Power Output *	400	kW

RADIO FREQUENCY POWER AMPLIFIER OR
OSCILLATOR Class C Telegraphy or FM
(Key-down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20.0	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC PLATE CURRENT	50	AMPERES
PLATE DISSIPATION	300	KILOWATTS
SCREEN DISSIPATION	6.0	KILOWATTS
GRID DISSIPATION	2.0	KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	18.0	18.0	kVdc
Screen Voltage	1000	1500	Vdc
Grid Voltage	-800	-900	Vdc
Plate Current	44	45	Adc
Screen Current *	4.7	3.5	Adc
Grid Current *	5.5	1.7	Adc
Calculated Driving Power	5.7	1.8	kW
Plate Dissipation *	140	154	kW
Plate Load Resistance	205	202	Ohms
Plate Power Output *	650	650	kW

* Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER
AMPLIFIER Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	13.0	KILOVOLTS
DC SCREEN VOLTAGE	1.5	KILOVOLTS
DC PLATE CURRENT	39	AMPERES
PLATE DISSIPATION #	195	KILOWATTS
SCREEN DISSIPATION	6.0	KILOWATT
GRID DISSIPATION	2.0	KILOWATTS

* Approximate value
# 300 kW at 100% sine-wave modulation

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	11.0	kVdc
Screen Voltage	1000	Vdc
Grid Voltage	-450	Vdc
Plate Current	35	Adc
Screen Current *	1.75	Adc
Grid Current *	2.25	Adc
Peak Screen Voltage (100% modulation)	2000	v
Calculated Driving Power	1440	W
Plate Dissipation *	85	kW
Plate Load Resistance	155	Ohms
Plate Power Output *	300	kW

AUDIO FREQUENCY POWER AMPLIFIER OR
MODULATOR Class AB

ABSOLUTE MAXIMUM RATINGS (per tube):

DC PLATE VOLTAGE	20.0	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC PLATE CURRENT	50	AMPERES
PLATE DISSIPATION	300	KILOWATTS
SCREEN DISSIPATION	6.0	KILOWATTS
GRID DISSIPATION	2.0	KILOWATTS

TYPICAL OPERATION (Two Tubes - Sinusoidal wave)

Plate Voltage	11.8	8.0	kVdc
Screen Voltage	1500	2000	Vdc
Grid Voltage **	-420	-460	Vdc
Zero-Signal Plate Current	6.0	6.0	Adc
Max.Signal Plate Current	53	29	Adc
Max.Signal Screen Current *	1.0	1.0	Adc
Peak Audio Freq.Grid Voltage * #	400	455	v
Max.Signal Plate Dissipation * #	106	148	kW
Plate/Plate Load Resistance	440	680	Ohms
Plate Power Output *	420	760	kW

\# Per tube.
* Approximate value.
** Adjust for stated zero-sig. plate current.

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. Following this procedure, there will be little variation in ouput power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

APPLICATION

MECHANICAL

MOUNTING - The 4CM300,000G must be mounted vertically, base down. The full weight of the tube should rest on the screen-grid contact flange at the base of the tube, and all lifting of the tube should be done with the lifting eye which is attached to the top of the anode cooling jacket.

ANODE COOLING - The anode is cooled by circulating water through the structure. Water/vapor cooling provides efficient anode heat removal and allows extra capacity for temporary overloads.

Tube life can be seriously compromised by water condition. With contaminated water deposits will form on the inside of the water jacket, causing localized anode heating and eventual tube failure. To minimize electrolysis and power loss, water resistivity at 25°C should always be one megohm per cubic centimeter or higher. Water resistivity can be continuously monitored in the reservoir by readily available instruments.

Minimum water flow requirements for the anode are shown in the table for an outlet water temperature not to exceed 100°C and inlet water temperature at 60°C. System pressure should not exceed 100 psi.

Anode Dissipation (kW)	Water Flow (gpm)	Approx.Jacket Press. Drop (psi)
Fil.Only	1	1
100	15	7.5
200	25	15
300	29	17

Cooling water must be well filtered, with effectiveness the equivalent of a 100-mesh screen, to eliminate any solid material and avoid the possibility of blockage of cooling passages, as this would immediately affect cooling efficiency and could produce localized anode overheating and failure of the tube.

EIMAC Application Bulletin #16, WATER PURITY REQUIREMENTS IN LIQUID COOLING SYSTEMS, is available on request, and contains considerable detail on purity requirements and maintenance systems.

BASE COOLING - The tube base requires air cooling with a minimum of 100 cfm of air at 50°C maximum at sea level, directed through the SK-2450 series socket toward the base seal areas. It should be noted that temperatures of the ceramic/metal seals and the lower envelope areas are the controlling and final limiting factor and that the maximum allowable temperature is 200°C. In addition, the socket contact finger temperature should not exceed 150°C. Temperature-sensitive paint is available for use in checking temperatures in these areas before equipment design and air cooling arrangements are finalized.

EIMAC Application Bulletin #20 titled TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES contains considerable information and is available on request.

ALL COOLING MUST BE APPLIED BEFORE OR SIMULTANEOUSLY WITH THE APPLICATION OF ELECTRODE VOLTAGES, INCLUDING THE FILAMENT, AND SHOULD NORMALLY BE MAINTAINED FOR SEVERAL MINUTES AFTER ALL VOLTAGES ARE REMOVED TO ALLOW FOR TUBE COOLDOWN.

ELECTRICAL

FILAMENT OPERATION - Filament turn-on and turn-off should be programmed. Filament voltage should be smoothly increased from zero to the operating level over a period of two minutes. A motor-driven continuously variable autotransformer (such as a VARIAC® or a POWERSTAT®) is suggested. Inrush current must never be allowed to exceed twice normal operating current. Normal turnoff procedure should be a smooth decrease from the operating voltage to zero over a period of two minutes.

At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). For operation The voltage should then be increased several tenths of a volt above the value where performance degradation was noted. The operating point should be rechecked after 24 hours. Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence caused by normal line voltage variations.

Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. Periodically throughout the life of the tube the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best tube life. EIMAC Application Bulletin #18, titled "EXTENDING TRANSMITTER TUBE LIFE", contains detailed information and is available on request.

Where hum is an important system consideration it is permissible to operate the filament with dc rather than ac power.

Care should be exercised to keep any rf power out of the filament of the tube, as this can cause excessive operating temperatures. Proper bypassing of the filament must be used to assure monopotential operation. It should be ascertained that no resonance exists in the filament circuit which could be excited during operation.

This tube is designed for commercial service, with no more than one normal off/on filament cycle per day. If additional cycling is anticipated it is recommended the user contact Application Engineering at Varian EIMAC for additional information.

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed these ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of the rating by a safety factor so that the absolute values will never be

exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

PLATE OPERATION - The 300 KW plate dissipation maximum rating may be exceeded for very brief periods during setup or tuning. When used as a plate-modulated rf amplifier, dissipation under carrier conditions is limited to 195 kilowatts.

GRID OPERATION - The maximum grid dissipation is 2000 watts and protective measures should be taken to insure that this rating is not exceeded. Grid dissipation is approximately equal to the product of dc grid current and peak positive grid voltage. A protective spark gap device should be connected between the control grid and the cathode to guard against excessive voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 6000 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. Suitable protective circuitry must be provided to remove screen power in case of a fault condition. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

PULSE OPERATION - The thermal time constants of the internal tube elements vary from a few milliseconds in the case of the grids to about 200 milliseconds for the anode. In many applications the meaning of duty as applied to a pulse chain is lost because the interpulse period is very long. For pulse lengths greater than 10 milliseconds, where the interpulse period is more than 10 times the pulse duration, the element dissipations and required cooling are governed by the watt-seconds during the pulse. Provided the watt-seconds are less than the listed maximum dissipation rating and sufficient cooling is supplied, tube life will be protected. EIMAC has determined that a minimum flow of 2 gpm (7.6 lpm) is required.

FAULT PROTECTION - In addition to the normal plate over-current interlock and coolant interlock, the tube must be protected from internal damage caused by any arc which may occur. A protective resistance should always be connected in series with the grid and anode to help absorb power supply stored energy if an arc should occur. An electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, is recommended. The protection criteria for each supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-inch length of #30 AWG copper wire. The wire will remain intact if criteria is met.

As noted under GRID OPERATION and SCREEN OPERATION a protective spark gap should be connected from the control grid to ground and from the screen grid to ground. EIMAC Application Bulletin #17 titled FAULT PROTECTION contains considerable detail and is available on request.

LOAD VSWR - The load VSWR should be monitored and the detected signal used to operate the interlock system to remove plate voltage within 20 milliseconds after a fault occurs. In the case of high stored energy in the load system, care must be taken to avoid excessive return energy from damaging the tube and associated circuit components.

X-RADIATION HAZARD - High-vacuum tubes operating at voltages higher than 15 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential X-ray source. Only limited shielding is afforded by the tube envelope. Moreover, the X-radiation level may increase significantly with tube aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by the high voltage. X-ray shielding may be required on all sides of tubes operating at these voltages to provide adequate protection throughout the life of the tube. Periodic checks on the X-ray level should be made, and the tube should never be operated without required shielding in place. If there is any question as to the need for or the adequacy of shielding, an expert in this field should be contacted to perform an equipment X-ray survey.

In cases where shielding has been found to be required operation of the equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

INTERELECTRODE RF TUNING CHARACTERISTICS - Typical interelectrode tuning characteristics may be obtained by contacting Varian EIMAC Power Grid Tube Application Engineering.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis from the tube terminals and associated wiring. To control actual capacitance values within the tube, as the key component involved, the industry and Military

Services use a standard test procedure described in Electronic Industries Association Standard RS-191. The test is performed on a cold tube which is mounted in a shielded fixture.

Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown in the technical data are taken in accordance with Standard RS-191 but with no special shielding.

The equipment designer is cautioned to make allowance for the capacitance values, including tube-to-tube variation and strays, which will exist in any normal application. Measurements should be taken with mounting which represent approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn: Product Manager High Power Tubes, 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

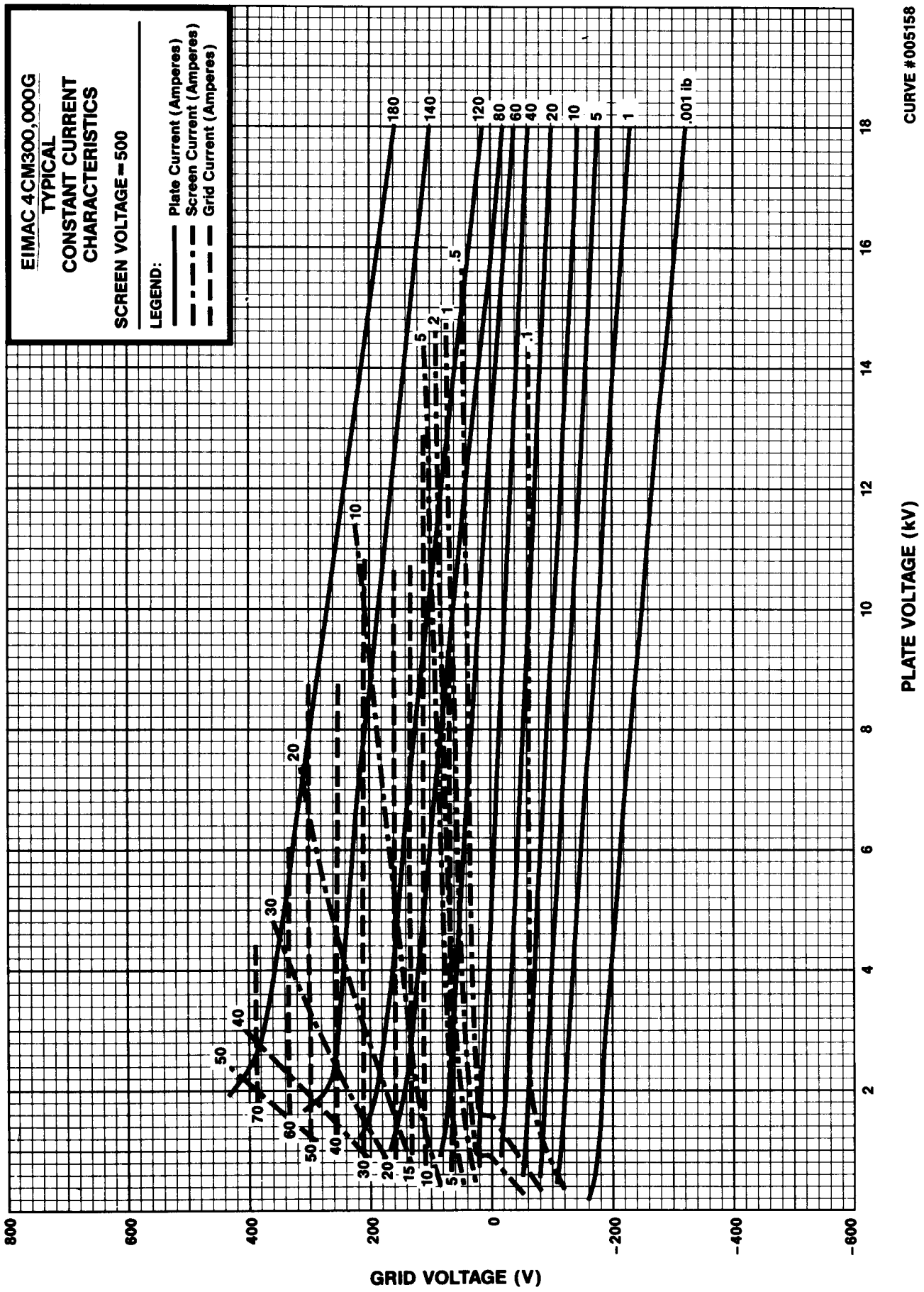
c. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

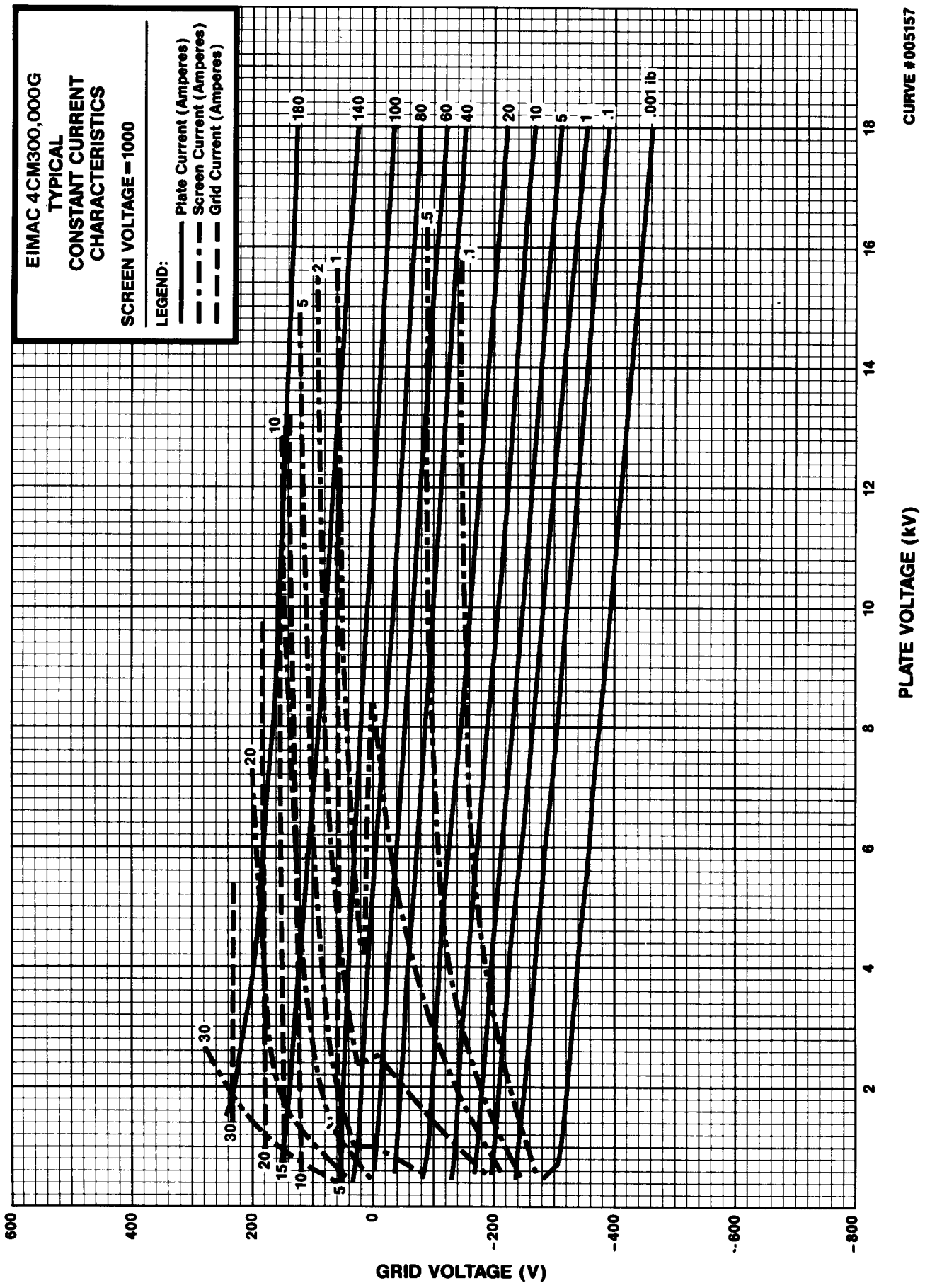
d. HOT WATER - Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

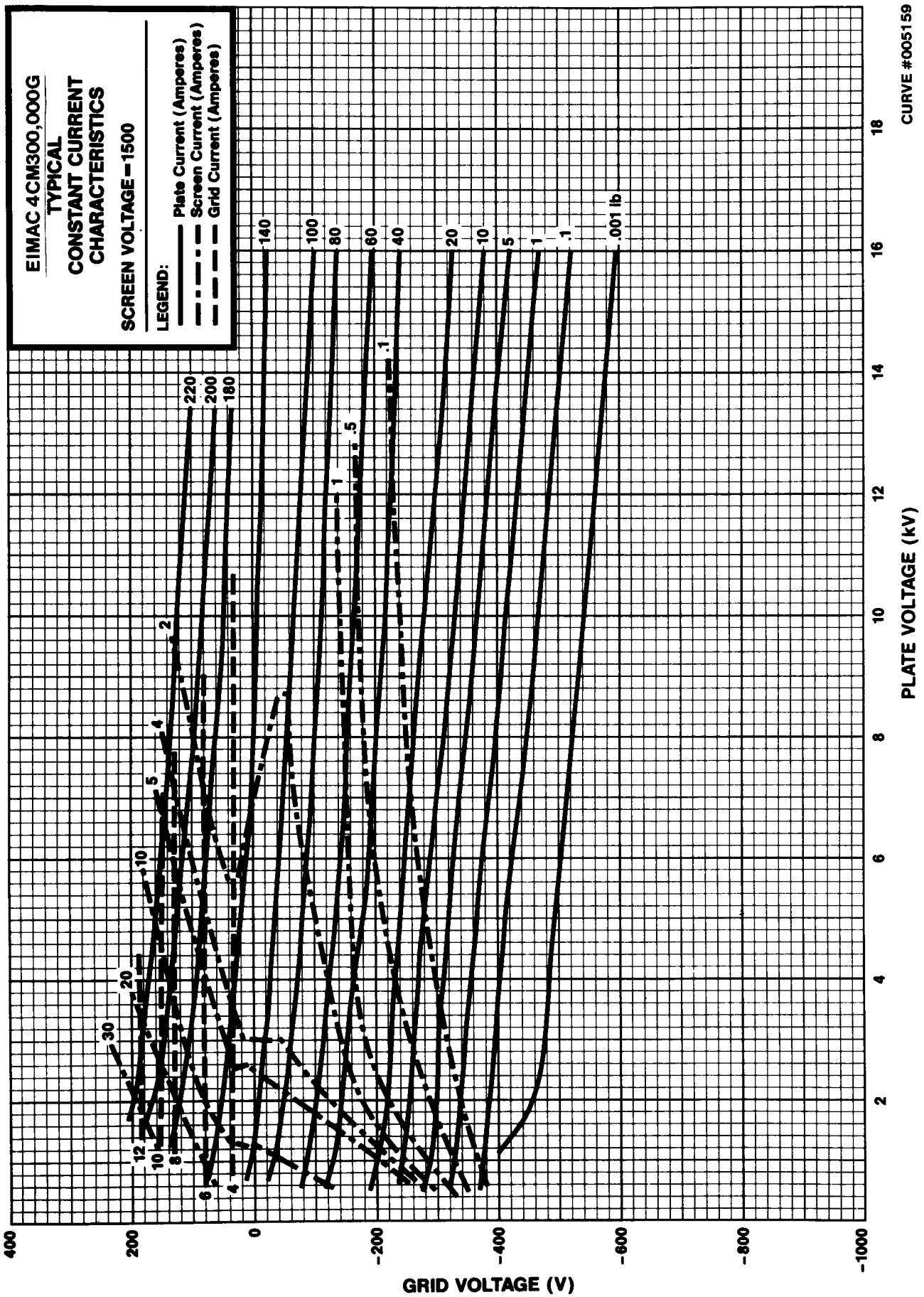
e. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

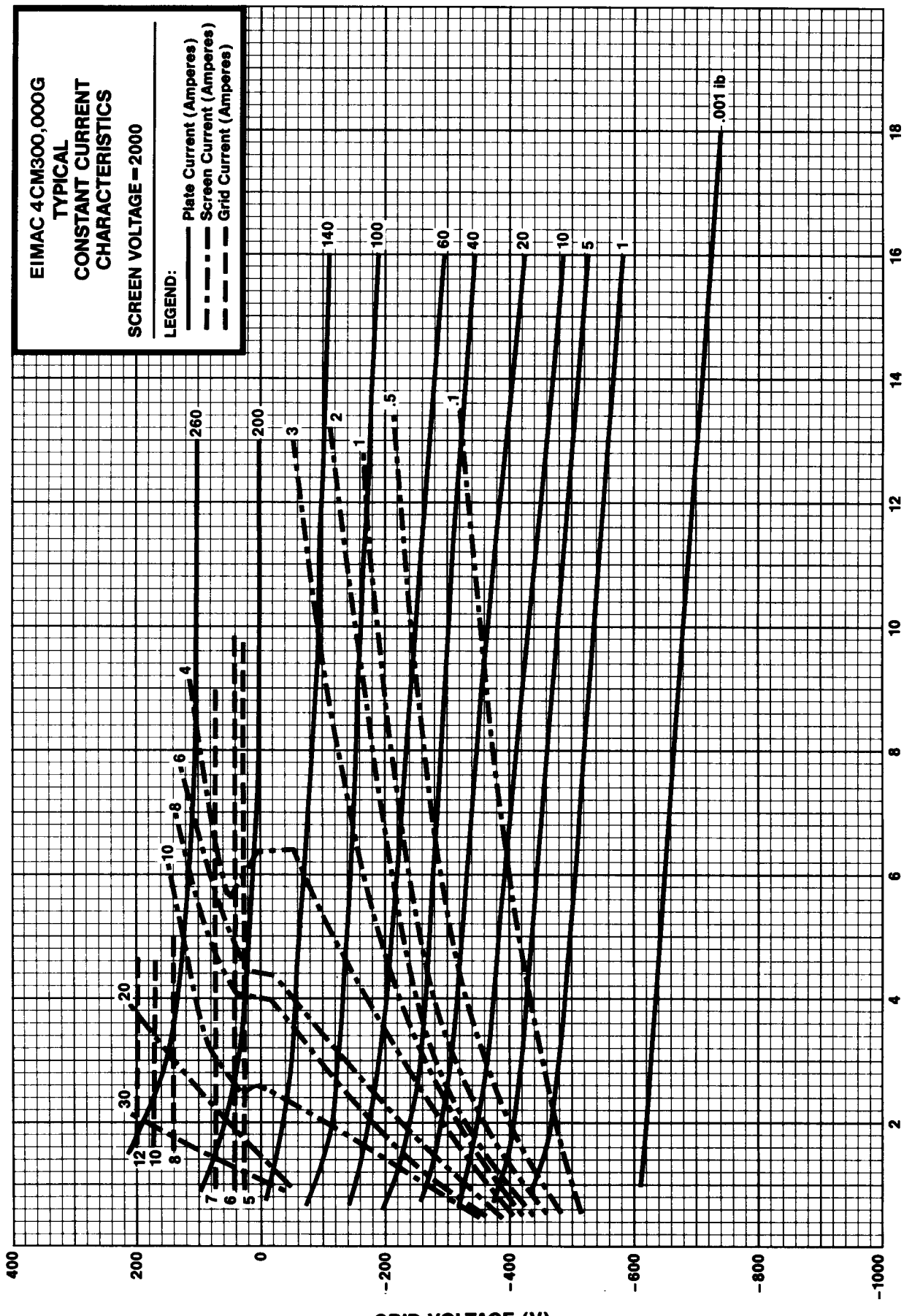
f. X-RAY RADIATION - High-voltage tubes can produce dangerous and possibly fatal X-rays and comprehensive shielding may be required. If shielding is provided, equipment should never be operated without all such shielding in place.

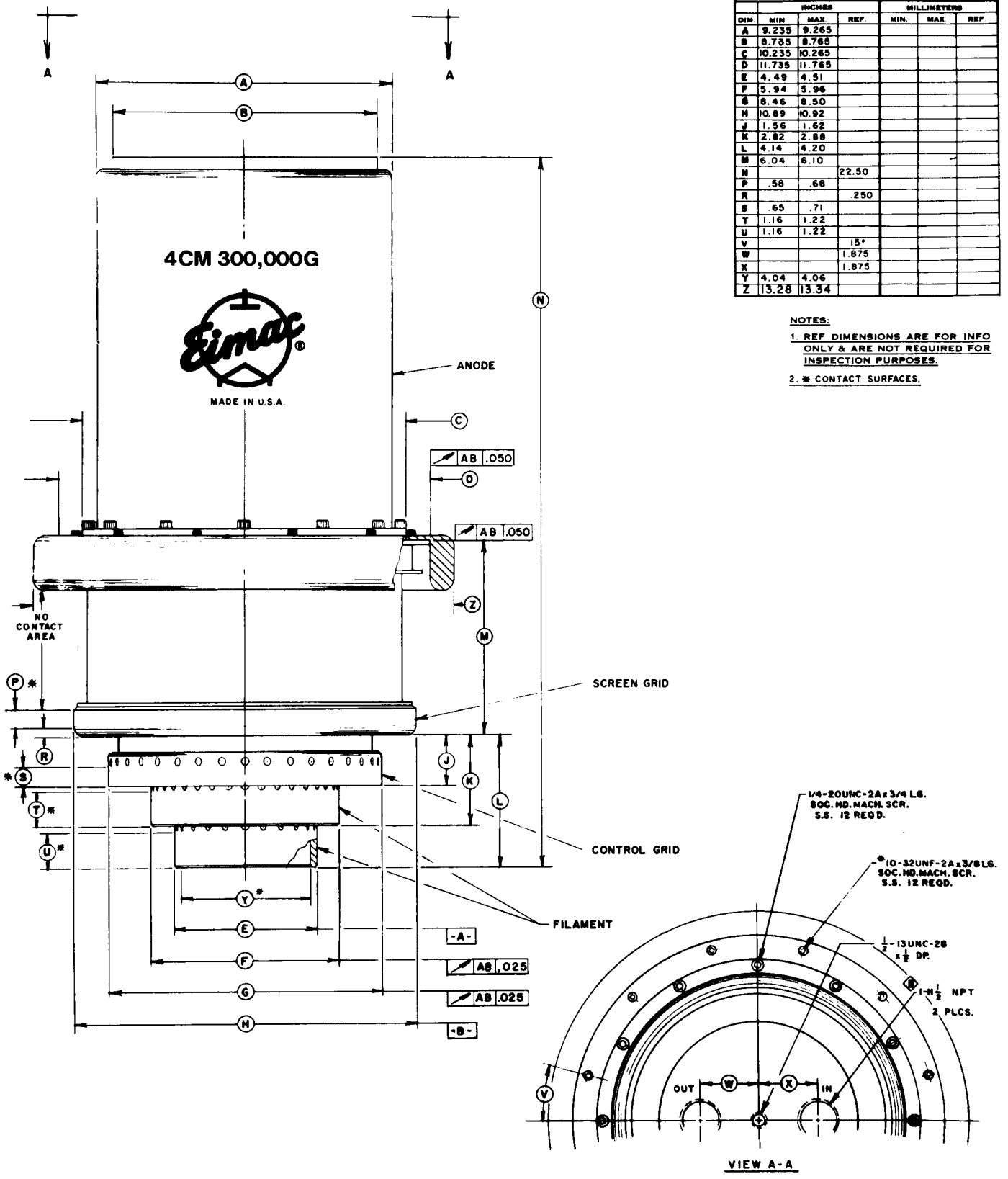
Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.


EIMAC 4CM300,000G
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500
LEGEND:
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
180
140
120
80
60
40
20
10
5
1
.5
.1
.001 lb
50
40
30
20
15
10
5
70
60
50
40
30
20
10
800
600
400
200
0
-200
-400
-600
2
4
6
8
10
12
14
16
18
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #005158


EIMAC 4CM300,000G
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE=1000
LEGEND:
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
180
140
100
80
60
40
20
10
5
2
1
.5
.1
.001 ib
30
20
15
10
5
600
400
200
0
-200
-400
-600
-800
2
4
6
8
10
12
14
16
18
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #005157


EIMAC 4CM300,000G
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE=1500
LEGEND:
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
140
100
80
60
40
20
10
5
1
.1
.001 lb
220
200
180
2
4
5
10
20
30
12
10
8
6
4
.5
1
.1
400
200
0
-200
-400
-600
-800
-1000
2
4
6
8
10
12
14
16
18
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #005159


EIMAC 4CM300,000G
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 2000
LEGEND:
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
.001 ib
PLATE VOLTAGE (kV)
GRID VOLTAGE (V)
CURVE # 005160



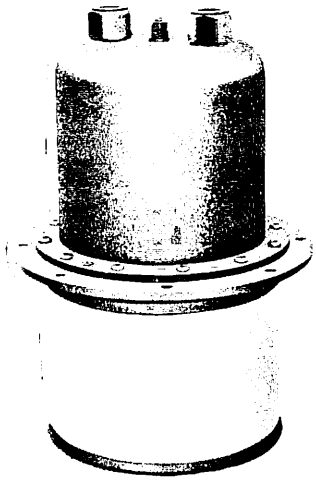
DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	9.235	9.265				
B	8.735	8.765				
C	10.235	10.265				
D	11.735	11.765				
E	4.49	4.51				
F	5.94	5.96				
G	8.46	8.50				
H	10.89	10.92				
J	1.56	1.62				
K	2.82	2.88				
L	4.14	4.20				
M	6.04	6.10				
N			22.50			
P	.58	.68				
R			.250			
S	.65	.71				
T	1.16	1.22				
U	1.16	1.22				
V			15°			
W			1.875			
X			1.875			
Y	4.04	4.06				
Z	13.28	13.34				

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACES.

TECHNICAL DATA

9013/Y-676A



The Y-676A is intended for use in pulse modulator or pulse regulator service. It is rated for 75 kV holdoff in a protective atmosphere, with 150 amperes peak cathode current rating during conduction for short pulses. Anode dissipation is 100 kW.

CHARACTERISTICS

Plate Dissipation (Max.) ..... 100,000 Watts
Screen Dissipation (Max.) ..... 1,750 Watts
Grid Dissipation (Max) ..... 500 Watts
Frequency for Max. Ratings (CW) ..... 110 MHz
Cooling ..... Water and Forced Air
Filament ..... Thoriated Tungsten Mesh
  Voltage ..... 15.5 volts
  Current ..... 215 amperes
Capacitances (Grounded Cathode Connection)
  Input ..... 430 pF
  Output ..... 60.0 pF
  Feed-through ..... 1.5 pF
Amplification Factor (g_1-g_2) 4.5
Base ..... Special Coaxial
Recommended Air System Socket ..... SK-2011 A
Maximum Seal & Anode Core Temperature ..... 250°C
Maximum Length ..... 15.97 in; 40.56 cm
Maximum Diameter ..... 9.53 in; 24.2 cm
Weight (approximate) ..... 50.0 lb; 22.7 kg
Operating Position ..... Vertical, base up or down

Class of Operation	Type of Service	MAXIMUM RATINGS: Plate Voltage (volts)	MAXIMUM RATINGS: Plate Current (amps)	TYPICAL OPERATION: Plate Voltage (volts)	TYPICAL OPERATION: Screen Voltage (volts)	TYPICAL OPERATION: Plate Current (amps)	TYPICAL OPERATION: Drive Power (watts)	TYPICAL OPERATION: Output Power (kW)
—	Pulse Modulator	75,000	150	60,000*	1,000	60†	—	3,420‡

*Anode voltage during conduction = 3000V.
†Peak cathode current.
‡Peak power to the load.

F1 = 100 MHz

ABSOLUTE MAXIMUM RATINGS: (See Note 1)

Parameter:	Ef	Eb	Ec2	Ec1	Ib	ib	Pg1	Pg2	Pp	Du	Seals & Env Temp	Cooling	Altitude
Units:	Vac	kVdc	kVdc	kVdc	Adc	a	W	W	kW	---	°C	---	Ft.
	Note 2	Note 5										Note 3	Note 4
Grid Pulsed rf Amplifier :	15.5 ± 5%	35	2.5	-1.5	---	50	500	1750	150	---	250	---	Note 5
Pulsed Mod. or Regulator :	15.5 ± 2%	75	2.5	-1.5	---	150	500	1750	150.	0.1	250	---	Note 5
TEST COND :	15.5	---	1.5	Adj.	---	---	---	---	---	---	---	Note 6	---

Communications & Power Industries
Eimac division
301 Industrial Way
San Carlos, CA 94070
(650) 592-1221

APPLICATION

MECHANICAL

MOUNTING - The 9013/Y676A must be mounted with its major axis vertical. The tube base may be up or down, at the discretion of the designer.

SOCKETING - The EIMAC SK-2011A, or equivalent, is recommended to assure good contact and allow for forced-air cooling of the tube base.

COOLING - Anode cooling is accomplished by circulating water through the water jacket. Insufficient water flow will cause anode temperature to rise to levels which will shorten tube life. Also, if the coolant lines become clogged, enough steam pressure may be generated to rupture the water jacket and destroy the tube.

High velocity water flow is required to maintain high thermal efficiency. Cooling water must be well filtered (with effectiveness the equivalent of a 100-mesh screen) to eliminate any solid materials, to avoid the possibility of blockage of any cooling passages, as this would immediately affect cooling efficiency and could produce localized anode overheating and failure of the tube.

Tube life can be seriously compromised by the cooling water condition. If it becomes contaminated, deposits will form on the inside of the water jacket, causing localized anode heating and eventual tube failure. To insure minimum electrolysis and power loss, the water resistance at 25 °C should always be one megohm per cubic centimeter or higher. The relative water resistance can be continuously monitored in the reservoir by readily available instruments.

EIMAC Application Bulletin #16, WATER PURITY REQUIREMENTS IN LIQUID COOLING SYSTEMS, is available on request, and contains considerable detail on purity requirements and maintenance systems.

The table lists the minimum cooling water requirements at various dissipation levels with a maximum inlet water temperature of 50°C. The pressure drop values shown should be considered approximate and system pressure should be limited to 80 psi.

Anode Diss. (kW)	Water Flow (gpm)	Press. Drop (psi)
20	5.0	2.8
40	9.0	5.8
60	12.5	9.3
80	16.5	14.2
100	20.0	19.2
125	23.5	27.5
150	26.0	36.0

Auxiliary forced-air cooling of the tube base is required to maintain filament and grid seal temperatures at safe operation levels. An air flow of approximately 100 cfm at 50°C maximum at sea level should be directed through the EIMAC SK-2011A series socket, toward the filament and grid seal areas.

Both anode and base cooling should be applied before or simultaneously with the application of electrode voltages, including the tube filament. Cooling should normally continue for about three minutes after removal of electrode voltages to allow the tube to cool down properly.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - The values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply voltage variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

FILAMENT OPERATION - During turn-on the filament inrush current should be limited to 450 amperes. At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The filament voltage should then be increased a few tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked after 24 hours. Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations.

Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. Periodically throughout the life of the tube the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best tube life.

GRID OPERATION - The maximum control grid dissipation is 500 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. A protective spark-gap device should be connected between control grid and cathode to guard against excessive voltage.

Under some operating conditions the control grid may exhibit a negative resistance characteristic. This may occur when, with high screen voltage, increasing the drive voltage decreases the grid current. As a result, large values of instantaneous negative grid current can be produced, causing the amplifier to become regenerative. Because this may happen, the driver stage must be designed to tolerate this condition. One technique is to swamp the driver so that the change in load, due to secondary grid emission, is a small percentage of the total driver load.

SCREEN OPERATION - The maximum screen grid dissipation is 1750 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

The tube may exhibit reverse screen current to a greater or lessser degree depending on operating conditions. The screen power supply should be designed with this characteristic in mind, so that the correct operating voltage will be maintained on the screen under all conditions. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. A current path from the screen to cathode must be provided by a bleeder resistor. A series regulated power supply can be used only when an adequate bleeder resistor is provided.

PLATE DISSIPATION - The rated plate dissipation of 150 kilowatts, attainable with water cooling, provides a margin of safety in most applications. This rating may be exceeded briefly during tuning. When the tube is used as a plate-modulated rf amplifier plate dissipation under carrier conditions should be limited to 100 kilowatts.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and coolant interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each tube anode, to help absorb power

supply stored energy if an internal arc should occur. An electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, is recommended. The protection criteria for each electrode supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-inch length of #30 AWG copper wire. The wire will remain intact if the criteria is met.

EIMAC Application Bulletin #17 titled FAULT PROTECTION contains considerable detail, and is available on request.

X-RADIATION HAZARD - High-vacuum tubes operating at voltages higher than 15 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential X-ray source. Only limited shielding is afforded by the tube envelope. Moreover, the X-radiation level may increase significantly with tube aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by the high voltage. X-ray shielding may be required on all sides of tubes operating at these voltages to provide adequate protection throughout the life of the tube. Periodic checks on the X-ray level should be made, and the tube should never be operated without required shielding in place. If there is any question as to the need for or the adequacy of shielding, an expert in this field should be contacted to perform an equipment X-ray survey.

In cases where shielding has been found to be required operation of high voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. Testing is performed on a cold tube. The capacitance values shown in the technical data are taken with no special shielding.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in the appliction. Measurements should be taken with the mounting which represents approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn: Applications Engineering; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE - Normal operating voltages can be deadly.

b. RF RADIATION - Exposure to strong rf fields should be avoided, even at low and medium frequencies. CARDIAC PACEMAKERS MAY BE EFFECTED.

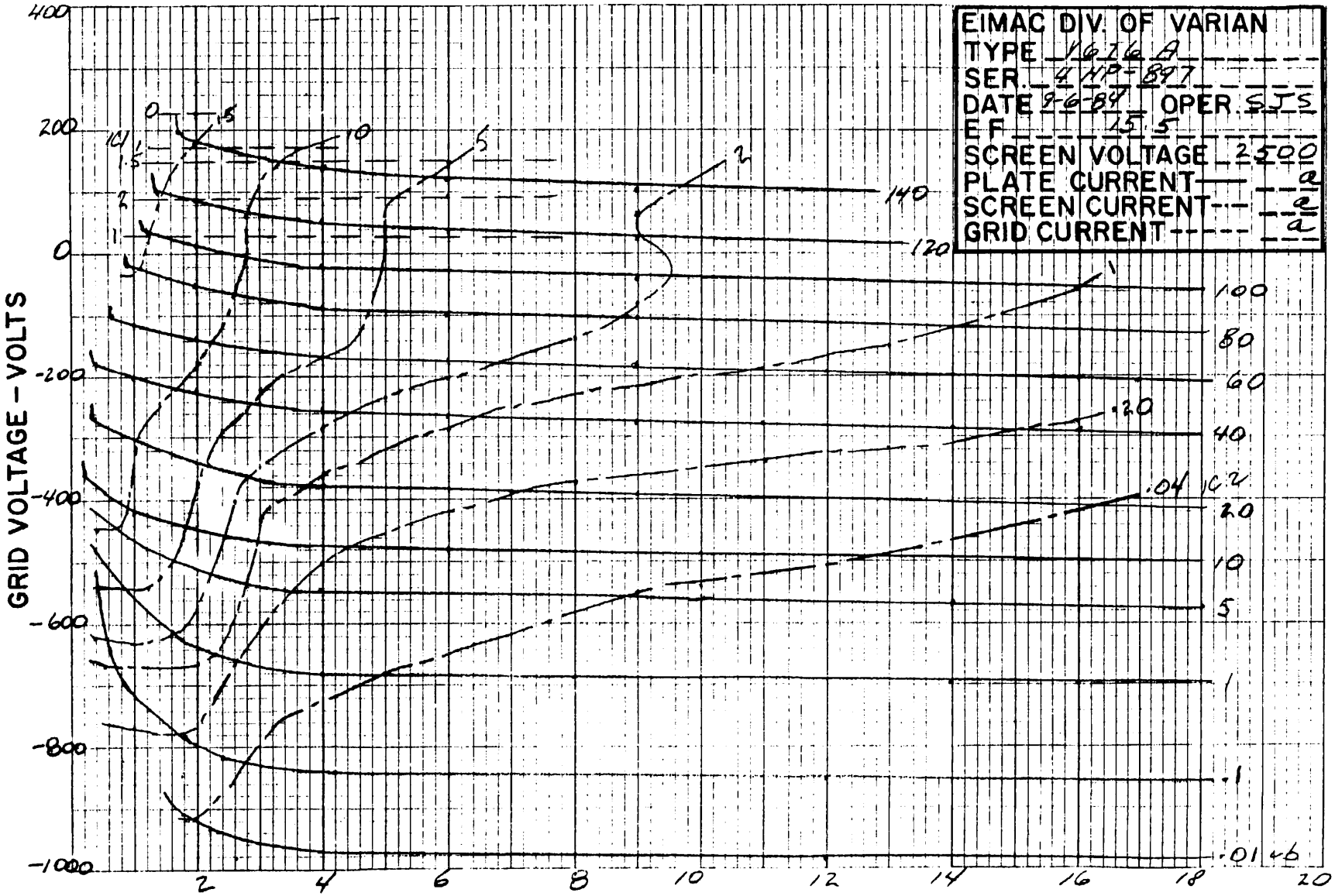
c. X-RAY RADIATION - High voltage tubes can produce dangerous and possibly fatal X-Rays.

d. HOT WATER - Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

f. HOT SURFACES - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred Degrees C and cause serious burns if touched for several minutes after all power is removed.

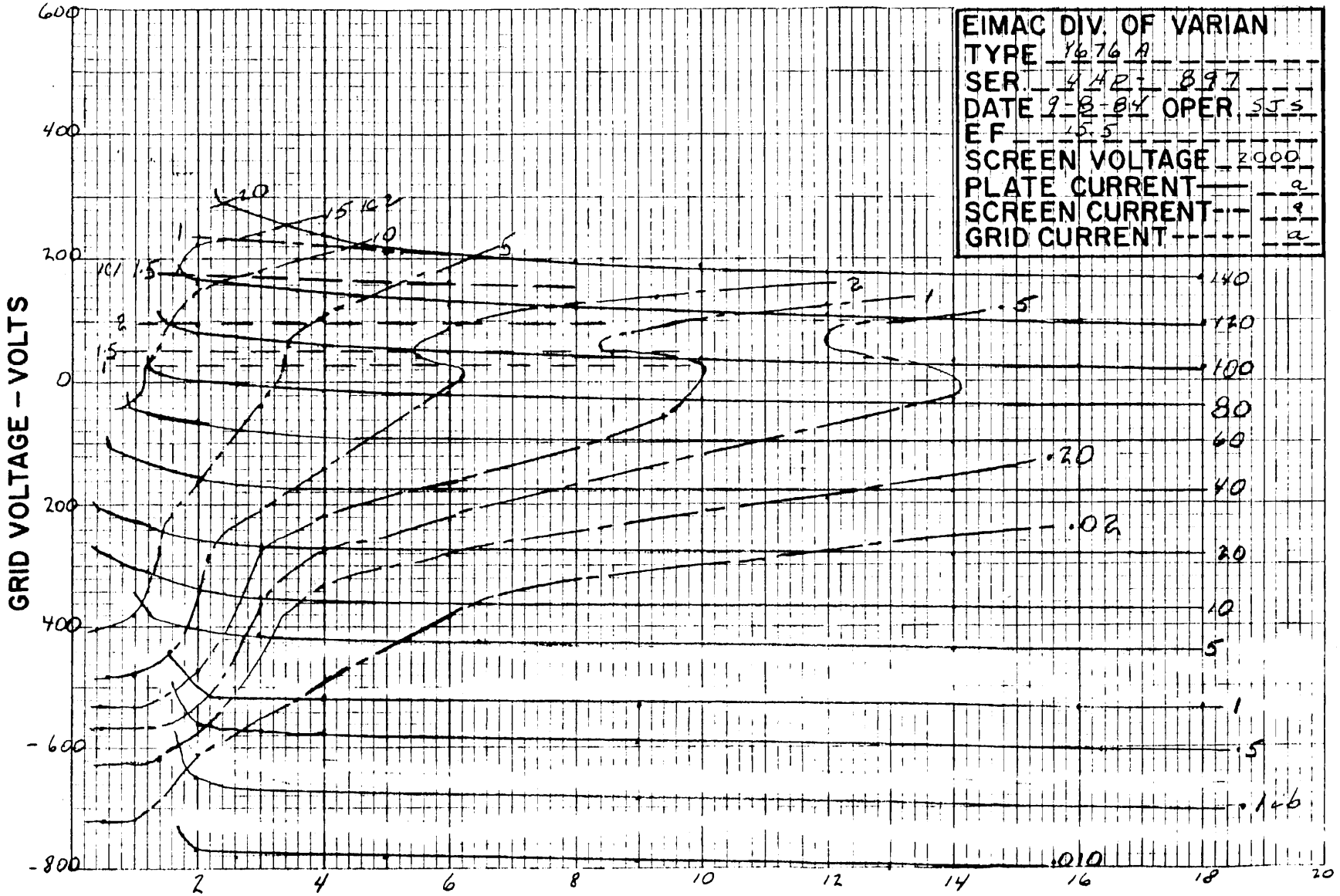
Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Tube Division, 301 Industrial Way, San Carlos CA 94070.

GROUNDED CATHODE
CONSTANT CURRENT CHARACTERISTICS



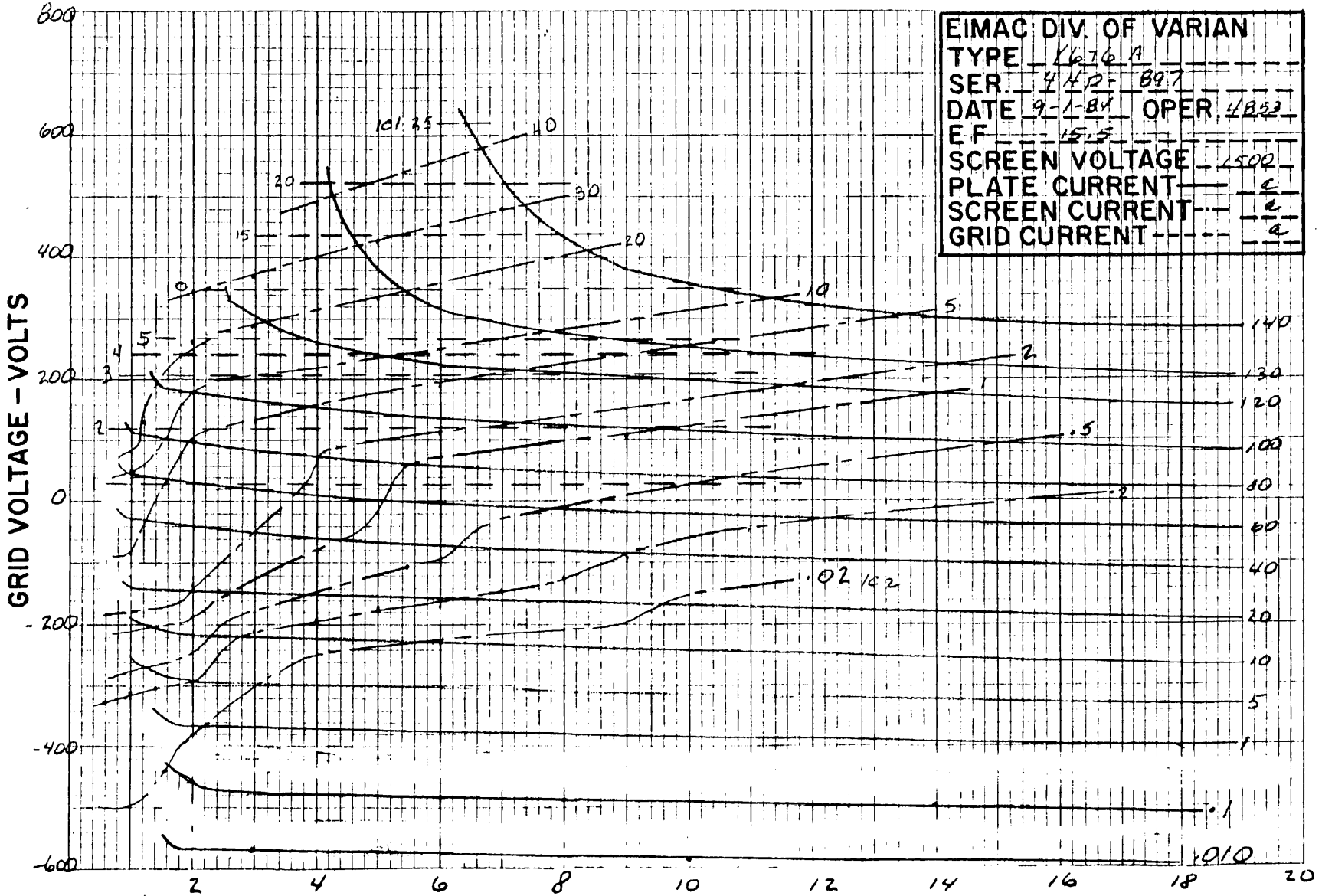
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GROUNDED CATHODE
CONSTANT CURRENT CHARACTERISTICS



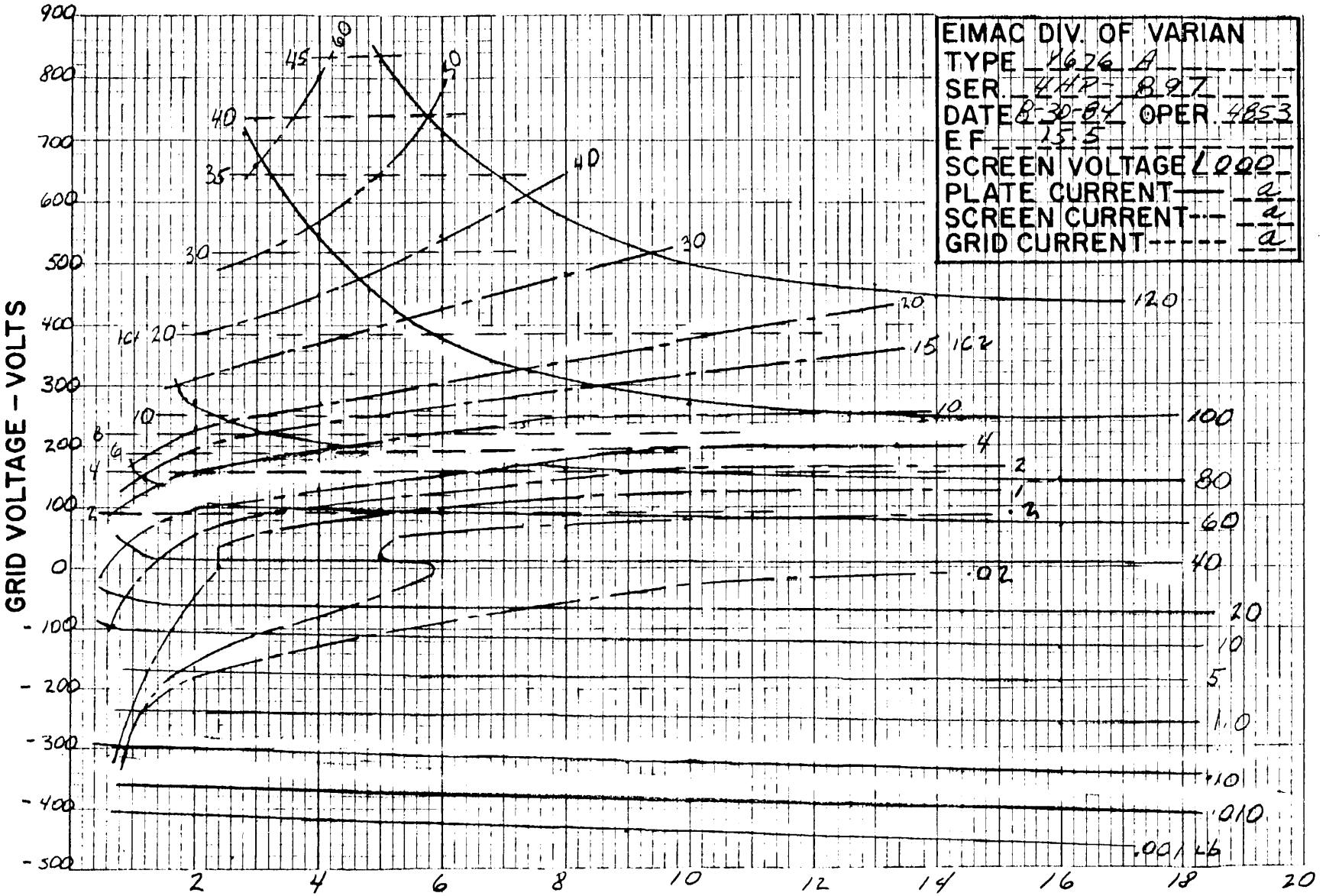
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GROUNDED CATHODE
CONSTANT CURRENT CHARACTERISTICS



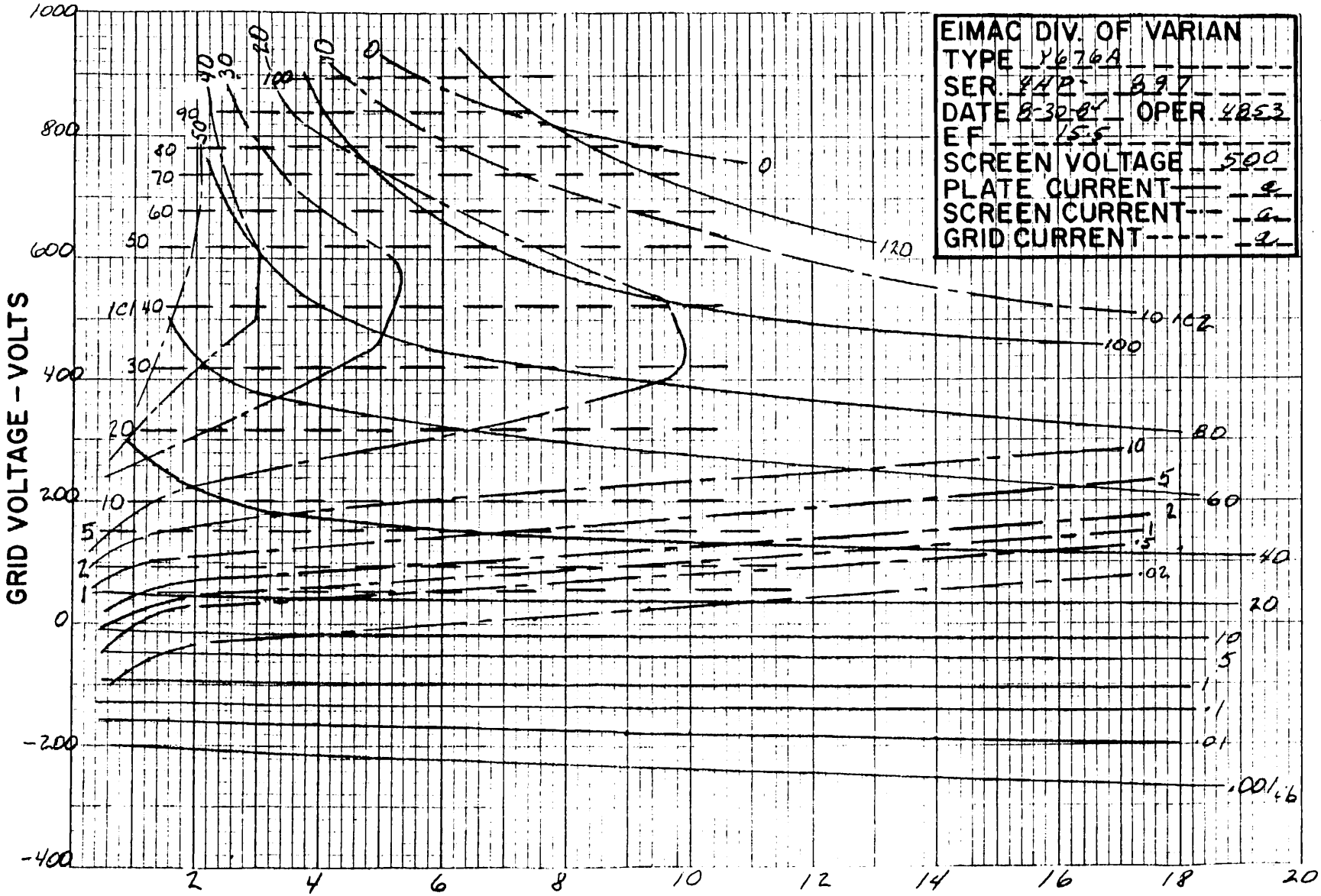
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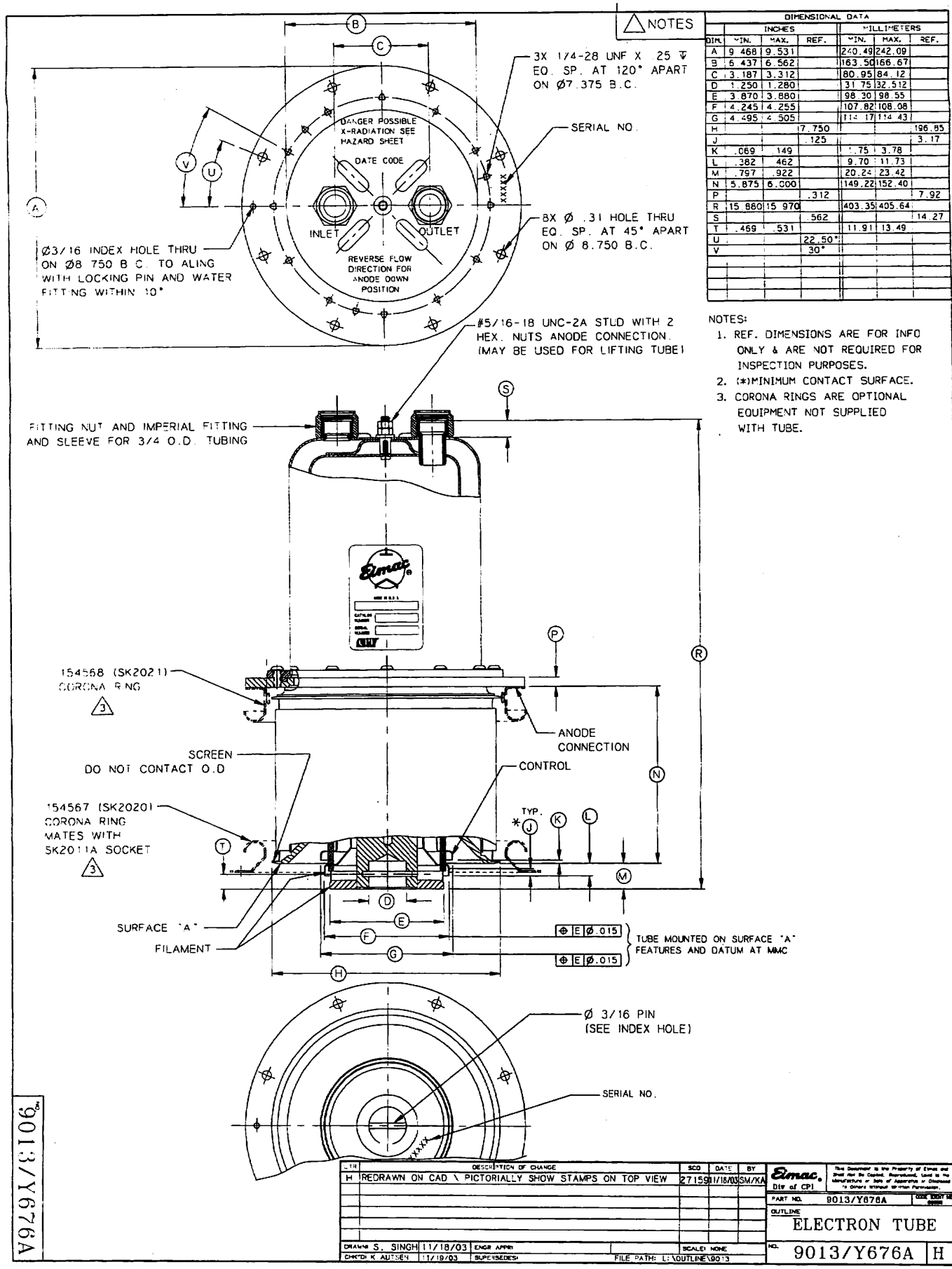
GROUNDED CATHODE
CONSTANT CURRENT CHARACTERISTICS



005345

GROUNDED CATHODE
CONSTANT CURRENT CHARACTERISTICS





DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	9.468	9.531		240.49	242.09	
B	6.437	6.562		163.50	166.67	
C	3.187	3.312		80.95	84.12	
D	1.250	1.280		31.75	32.512	
E	3.870	3.880		98.30	98.55	
F	4.245	4.255		107.82	108.08	
G	4.495	4.505		114.17	114.43	
H			7.750			196.85
J			.125			3.17
K	.069	.149		1.75	3.78	
L	.382	.462		9.70	11.73	
M	.797	.922		20.24	23.42	
N	5.875	6.000		149.22	152.40	
P			.312			7.92
R	15.880	15.970		403.35	405.64	
S			.562			14.27
T	.469	.531		11.91	13.49	
U			22.50°			
V			30°			

NOTES:
1. REF. DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (*)MINIMUM CONTACT SURFACE.
3. CORONA RINGS ARE OPTIONAL EQUIPMENT NOT SUPPLIED WITH TUBE.

LTR	DESCRIPTION OF CHANGE	ECO	DATE	BY
H	REDRAWN ON CAD \ PICTORIALLY SHOW STAMPS ON TOP VIEW	271591	11/18/03	SM/KA

DRAWN S. SINGH 11/18/03 | ENGR APPR | SCALE: NONE
CHK'D K. AUTSEN 11/19/03 | SUPERSEDES: | FILE PATH: L:\OUTLINE\9013

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PART NO. 9013/Y676A | CODE IDENT NO. 00656
OUTLINE ELECTRON TUBE
NO. 9013/Y676A | H

9013/Y676A

ADVANCE PRODUCT ANNOUNCEMENT

9019
YC130
VHF
RADIAL BEAM
POWER
TETRODE



The EIMAC 9019/YC130 is a ceramic/metal VHF power tetrode. It is rated for full power input to 110 MHz and is recommended for use as a Class C power amplifier or plate modulated amplifier.

Air-system sockets and matching air chimneys are available from EIMAC. A connector clip is available for making the dc connection to the anode.

GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh		
Voltage	7.5 ± 0.37	V
Current, at 7.5 volts	160	A
Amplification Factor (average), Grid to Screen	4.5	
Direct Interelectrode Capacitance (cathode grounded) [2]		
Cin	160	pF
Cout	26.5	pF
Cgp	1.5	pF
Direct Interelectrode Capacitance (grids grounded) [2]		
Cin	67	pF
Cout	27.5	pF
Cpk	0.2	pF
Maximum Frequency for Full Ratings (CW)	110	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.
2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	9.375 In; 23.81 cm
Diameter	7.580 In; 19.25 cm
Net Weight	12.8 Lb; 5.8 kg
Operating Position	Axis Vertical, Base Up or Down
Maximum Operating Temperature, Ceramic/Metal Seals or Envelope	250°C
Cooling	Forced Air
Base	Special Concentric
Recommended Air-System Socket: For LF or HF Service	EIMAC SK-300A
For VHF Service	EIMAC SK-360
Recommended Air-System Chimney: For Either the SK-300A or SK-360 Socket	EIMAC SK-316
Recommended Screen Grid Bypass Capacitor Kit for the SK-360 Socket	EIMAC SK-355
Available Anode Connector Clip	EIMAC ACC-3

RADIO FREQUENCY POWER AMPLIFIER
Class C FM
(Key-down conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000 VOLTS
DC SCREEN VOLTAGE	2000 VOLTS
DC GRID VOLTAGE	-750 VOLTS
DC PLATE CURRENT	5.0 AMPERES
PLATE DISSIPATION	18 KILOWATTS
SCREEN DISSIPATION	450 WATTS
GRID DISSIPATION	200 WATTS

TYPICAL OPERATION (Frequencies to 110 MHz)

DC Plate Voltage	7.5	10.0	kVdc
DC Screen Voltage	750	750	Vdc
DC Grid Voltage	-510	-550	Vdc
DC Plate Current	4.65	4.55	Adc
DC Screen Current *	0.59	0.54	Adc
DC Grid Current *	0.30	0.27	Adc
Peak rf Grid Voltage *	730	790	v
Calculated Driving Power	220	220	W
Plate Dissipation	8.1	9.0	kW
Plate Output Power	26.7	36.5	kW

* Approximate value; will vary with circuit and tube

395035(Effective March 1986)
VA4889

Printed in U.S.A.

9019/YC130

PLATE MODULATED RF POWER AMPLIFIER
Grid Driven
Class C Telephony - Carrier Conditions

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8000 VOLTS
DC SCREEN VOLTAGE	2000 VOLTS
DC GRID VOLTAGE	-750 VOLTS
DC PLATE CURRENT	4.0 AMPERES
PLATE DISSIPATION #	12 KILOWATTS
SCREEN DISSIPATION ##	450 WATTS
GRID DISSIPATION ##	200 WATTS

\# Corresponds to 18 kW at 100% sine-wave modulation.

TYPICAL OPERATION

DC Plate Voltage	6.0	8.0	kVdc
DC Screen Voltage	750	750	Vdc
Peak AF Screen Voltage (100% Mod)	740	710	v
DC Grid Bias Voltage	-600	-640	Vdc
DC Plate Current	3.75	3.65	Adc
DC Screen Current *	0.45	0.43	Adc
DC Grid Current *	0.18	0.18	Adc
Peak rf Grid Voltage *	800	840	v
Grid Driving Power (calculated) *	150	150	W
Plate Dissipation *	5.1	5.8	kW
Plate Output Power *	17.4	23.5	kW

* Approximate value.
\## Average, with or without modulation.

AUDIO FREQUENCY AMPLIFIER OR MODULATOR
Grid Driven, Class AB1, Sinusoidal Wave

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10.0 KILOVOLTS
DC SCREEN VOLTAGE	2000 VOLTS
DC PLATE CURRENT	6.0 AMPERES
PLATE DISSIPATION	18.0 KILOWATTS
SCREEN DISSIPATION	450 WATTS
GRID DISSIPATION	200 WATTS

* Approximate value. # Per tube.
\## Adjust for specified zero-signal plate current.

TYPICAL OPERATION (two tubes)

DC Plate Voltage	7.5	10.0	kVdc
DC Screen Voltage	1500	1500	Vdc
DC Grid Voltage ##	-350	-370	Vdc
Zero-Signal Plate Current	1.0	1.0	Adc
Maximum Signal Plate Current	8.8	8.5	Adc
Maximum Signal Screen Current *	0.34	0.30	Adc
Peak AF Grid Voltage * #	330	340	v
Driving Power *	0	0	W
Load Resistance Plate-to-Plate	1730	2520	Ohms
Maximum Signal Plate Dissipation * #	12.2	14.0	kW
Plate Output Power *	41.6	57.0	kW

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Filament: Current at 7.5 volts	148	168	A
Interelectrode Capacitance (grounded filament connection) [1]			
Cin	154	167	pF
Cout	24	29	pF
Cgp	---	2.0	pF

1 Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The tube must be mounted vertically, base up or down at the designer's convenience, and should be protected from vibration and shock.

STORAGE - If a tube is to be stored as a spare it should be kept in its original shipping carton, with the original packing material, to minimize the possibility of handling damage.

Before storage a new tube should be operated in the equipment for 100 to 200 hours to establish it has not been damaged and operates properly (See FILAMENT OPERATION for recommendations on initial value of filament voltage during this operation period). If the tube is still in storage 6 months later it again should be operated in the equipment for 100 to 200 hours to make sure there has been no degradation. If operation is satisfactory the tube can again be stored with great assurance of being a known-good spare.

SOCKETING - An air-system socket should be used in all applications to assure cooling of the tube base seals. The EIMAC SK-300A is recommended for audio or LF/HF rf operation; the SK-360 is recommended for VHF operation. The SK-360 incorporates low-inductance filament bypassing in the form of three 5000 pF copper-clad Kapton®capacitors. A screen grid bypass capacitor kit (the SK-355) is also available for the SK-360 socket, and includes eight 1000 pF 5000 DCWV capacitors (EIMAC P/N 050706), 16 mounting clips (EIMAC P/N 242859), and an assembly drawing (EIMAC P/N 243135) which shows how the parts are attached to the socket.

COOLING - The tube requires forced-air cooling in all applications. An air-system socket is recommended, with a matching air chimney. Normally the tube socket is mounted in a pressurized compartment so the cooling air passes through the socket and is then guided to the anode cooling fins by an air chimney. A chimney is available from EIMAC, the SK-316, for use with the SK-300A socket at frequencies below 30 MHz and with the SK-360 at VHF. If all cooling air is not passed around the base of the tube and through the socket, then arrangements must be made to assure adequate cooling of the tube base and the socket contacts themselves.

In this regard it should be noted the contact fingers used in the four contact collet assemblies (inner and outer filament, control grid and screen grid) are made of beryllium copper. If operated above 150°C for any appreciable length of time this material will lose its temper (or springy characteristic) and then will no longer make good contact to the base rings of the tube. This can lead to arcing which, in an extreme case, can burn through the metal of the tube base ring and the tube's vacuum integrity is then destroyed.

Thus adequate movement of cooling air around the base of the tube accomplishes a double purpose in keeping the tube base and the socket contact fingers at a safe operating temperature.

Though the maximum temperature rating for seals and the anode core is 250°C, it is considered good engineering practice to allow some safety factor and the table shown is for sea level with cooling air at 50°C and maximum tube anode temperature of 225 °C. Such a safety factor makes some allowance for variables such as dirty air filters, dirty tube anode cooling fins which will effect cooling efficiency, duct losses, etc. The figures shown are for the tube in an air-system socket with an air chimney in place, with air passing in a base-to-anode direction. Pressure drop values shown are approximate and are for the tube/socket/chimney combination.

Plate Diss. (Watts)	Air Flow (cfm)	Press.Drop Inches Water
7,500	230	0.7
12,500	490	2.7
15,000	645	4.6
18,000	970	8.2

At altitudes significantly above sea level flow rate must be increased for equivalent cooling. At 5000 feet both the flow rate and the pressure drop should be increased by a factor of 1.20, while at 10,000 feet both flow rate and pressure drop must be increased by 1.46.

Anode and base cooling should be applied before or simultaneously with filament voltage turnon and should normally continue for a brief period after shutdown to allow the tube to cool down properly.

IMPACT AND VIBRATION - The 9019/YC130 has a thoriated tungsten mesh filament and is intended for regular commercial service. Any tube with a thoriated tungsten filament should be protected from undue shock and vibration and if not installed in equipment should always be stored in its protective packing material in its shipping container.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

FILAMENT OPERATION - With a new tube, or one which has been in storage for some period of time, operation with filament voltage only applied for a period of 30 to 60 minutes is recommended before full operation begins. This allows the active getter material mounted within the filament structure to absorb any residual gas molecules which have accumulated during storage. Once normal operation has been established a minimum filament warmup time of four to five seconds is normally sufficient.

At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The voltage should then be increased a few tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked after 24 hours.

Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations.

Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. Periodically throughout the life of the tube the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best tube life.

EIMAC Application Bulletin #18 titled "EXTENDING TRANSMITTER TUBE LIFE" contains valuable information and is available on request.

GRID OPERATION - Maximum control grid dissipation is 200 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. A protective spark-gap device should be connected between control grid and cathode to guard against excessive voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 450 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

PLATE DISSIPATION - The rated maximum plate dissipation of the tube is 18 kilowatts, which may be safely sustained with adequate air cooling. When the tube is used as a plate-modulated rf amplifier the dissipation under carrier conditions should be limited to 12 kilowatts.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and cooling air interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each tube anode, to help absorb power supply stored energy if an internal arc should occur. An electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, is recommended. The protection criteria for each electrode supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-inch length of #30 AWG copper wire. The wire will remain intact if protection is adequate.

EIMAC Application Bulletin #17 titled FAULT PROTECTION contains considerable detail and is available from EIMAC on request.

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of a specially constructed test fixture which shields all external tube leads or contacts from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. The capacitance values shown in the technical data are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in the appliction. Measurements should be taken with the mounting which represents approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn: Product Manager; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - Personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

c. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

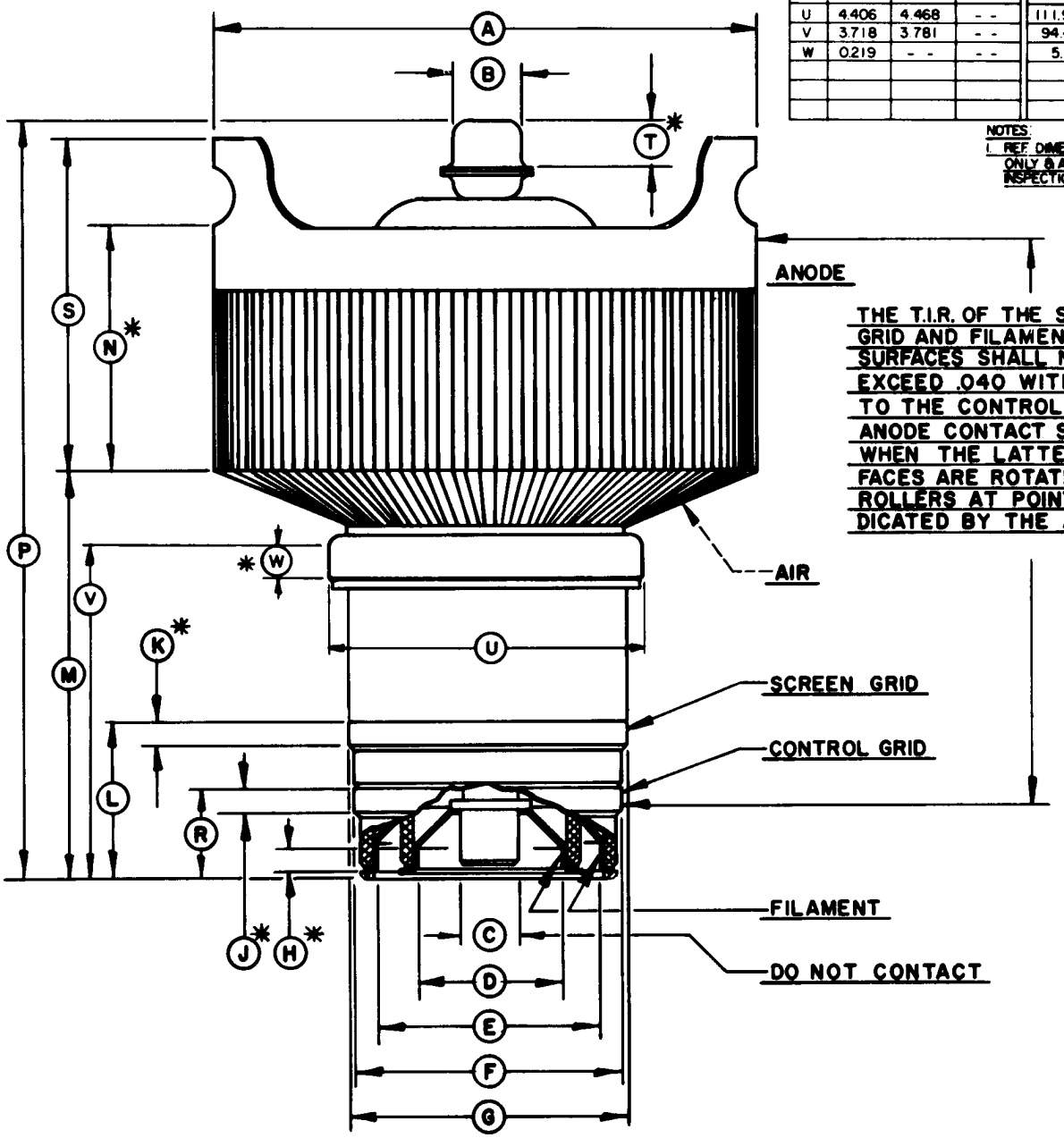
d. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.

DIMENSIONAL DATA

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	7.460	7.580	- -	189.48	192.53	- -
B	0.855	0.895	- -	21.72	22.73	- -
C	0.720	0.760	- -	18.29	19.30	- -
D	1.896	1.936	- -	46.63	49.17	- -
E	3.133	3.173	- -	79.58	80.59	- -
F	3.792	3.832	- -	96.32	97.33	- -
G	3.980	4.020	- -	101.09	102.11	- -
H	0.188	- -	- -	4.78	- -	- -
J	0.188	- -	- -	4.78	- -	- -
K	0.188	- -	- -	4.78	- -	- -
L	1.764	1.826	- -	44.81	46.38	- -
M	4.659	4.783	- -	118.34	121.49	- -
N	2.412	2.788	- -	61.26	70.82	- -
P	9.000	9.375	- -	228.60	238.13	- -
R	0.986	1.050	- -	25.04	26.67	- -
S	3.560	3.684	- -	90.42	93.57	- -
T	0.375	- -	- -	9.53	- -	- -
U	4.406	4.468	- -	111.91	113.49	- -
V	3.718	3.781	- -	94.44	96.04	- -
W	0.219	- -	- -	5.56	- -	- -

NOTES:
1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



THE T.I.R. OF THE SCREEN GRID AND FILAMENT CONTACT SURFACES SHALL NOT EXCEED .040 WITH RESPECT TO THE CONTROL GRID AND ANODE CONTACT SURFACE WHEN THE LATTER SURFACES ARE ROTATED ON ROLLERS AT POINTS INDICATED BY THE ARROWS

* CONTACT SURFACE

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

4-1000A

RADIAL-BEAM POWER TETRODE
•
MODULATOR OSCILLATOR AMPLIFIER

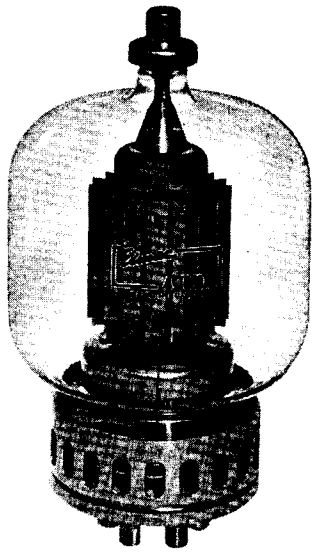
The Eimac 4-1000A is a radial beam tetrode with a maximum plate dissipation rating of 1000 watts. Intended for use as an amplifier, oscillator, or modulator, the 4-1000A is capable of efficient operation well into the vhf range.

In FM broadcast service on 110 Mc., two 4-1000A tetrodes will deliver a useful power output over 5000 watts.

Operating under class AB_2 modulator conditions with less than 10 watts of peak driving power, two of these tubes will deliver 3900 watts of output power.

With zero watts driving power in class AB_1, a pair of 4-1000A tetrodes will deliver 3800 watts of power output.

Cooling of the tube is accomplished by radiation from the plate and by circulation of forced-air through the base and around the envelope. Cooling can be simplified through the use of the Eimac SK-500 Air-System Socket.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Thoriated tungsten	
Voltage	7.5 volts
Current	21 amperes
Grid-Screen Amplification Factor (Average)	7
Direct Interelectrode Capacitances (Average)	
Grid-Plate (without shielding, base grounded)	0.24 $\mu\mu$fd
Input	27.2 $\mu\mu$fd
Output	7.6 $\mu\mu$fd
Transconductance (i_b=300 ma., E_b=2500 v., E_{c2}=500 v.)	10,000 μmhos
Highest Frequency for Maximum Ratings	110 Mc

MECHANICAL

Base	5-pin metal shell (see dwg.)
Basing	See drawing
Recommended Socket	Eimac SK-500 Air-System Socket
Mounting position	Vertical, base down or up
Cooling	Radiation and forced air
Recommended Heat Dissipating Connector:	
Plate	Eimac HR-8
Maximum Over-all Dimensions:	
Length	9.63 inches
Diameter	5.25 inches
Net Weight (tube only)	1.5 pounds
Shipping Weight	12 pounds

If an Air-System Socket is used, mounted on a 1/4" deck, the over-all dimensions of the system including chimney and HR-8 cooler are

Length	11.75 inches
Diameter	7.5 inches

Note: Typical operation data are based on conditions of adjusting the r-f grid drive to a specified plate current, maintaining fixed conditions of grid bias and screen voltage. It will be found that if this procedure is followed there will be little variation in power output between tubes even though there may be some variation in grid and screen currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy or FM Telephony

MAXIMUM RATINGS (Key-down conditions, per tube to 110 Mc.)

D-C PLATE VOLTAGE	6000 MAX. VOLTS
D-C SCREEN VOLTAGE	1000 MAX. VOLTS
D-C GRID VOLTAGE	—500 MAX. VOLTS
D-C PLATE CURRENT	700 MAX. MA
PLATE DISSIPATION	1000 MAX. WATTS
SCREEN DISSIPATION	75 MAX. WATTS
GRID DISSIPATION	25 MAX. WATTS

TYPICAL OPERATION (Frequencies below 110 Mc., one tube)

D-C Plate Voltage	3000	4000	5000	6000	volts
D-C Screen Voltage	500	500	500	500	volts
D-C Grid Voltage	—150	—150	—200	—200	volts
D-C Plate Current	700	700	700	700	ma
D-C Screen Current	146	137	147	140	ma
D-C Grid Current	38	39	45	42	ma
Screen Dissipation	73	69	73	70	watts
Grid Dissipation	5	6	7	6	watts
Peak R-F Grid Input Voltage (approx.)	290	290	355	350	volts
Driving Power (approx.)*	11	12	16	15	watts
Plate Power Input	2100	2800	3500	4200	watts
Plate Dissipation	670	700	690	800	watts
Plate Power Output	1430	2100	2810	3400	watts

*Apparent driving power requirements increase above 30 Mc. At 110 Mc. the driver should be capable of supplying 200 watts per tube to take care of feed-through, circuit losses, and radiation.

TYPICAL OPERATION (110 Mc., two tubes, push-pull)

D-C Plate Voltage	4000	5000	6000	volts
D-C Screen Voltage	450	500	500	volts
D-C Grid Voltage	—150	—160	—180	volts
D-C Plate Current	1.15	1.25	1.25	amps
D-C Screen Current	280	240	250	ma
D-C Grid Current	80	80	100	ma
Screen Dissipation (per tube)	63	60	63	watts
Driving Power (approx.)	350	400	400	watts
Plate Power Input	4600	6250	7500	watts
Plate Dissipation (per tube)	650	850	900	watts
Useful Power Output	3000	4200	5200	watts

These 110 Mc. typical performance figures were obtained by direct measurement in operating equipment. The output power is useful power measured in a load circuit. The driving power is that taken by the tube and a practical resonant circuit. In many cases with further refinement and improved techinques, better performance might be obtained.

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▶ Indicates changes from sheet dated 6-2-52.

PLATE MODULATED RADIO FREQUENCY AMPLIFIER
Class-C Telephony—Carrier Conditions

MAXIMUM RATINGS (Per tube to 110 Mc.)

D-C PLATE VOLTAGE	5000	MAX. VOLTS*
D-C SCREEN VOLTAGE	1000	MAX. VOLTS
D-C GRID VOLTAGE	—500	MAX. VOLTS
D-C PLATE CURRENT	600	MAX. MA.
PLATE DISSIPATION	670	MAX. WATTS
SCREEN DISSIPATION	75	MAX. WATTS
GRID DISSIPATION	25	MAX. WATTS

*5500 Max. volts below 30 Mc.

TYPICAL OPERATION (Frequencies below 110 Mc., one tube)

D-C Plate Voltage	3000	4000	5000	5500*	volts
D-C Screen Voltage	500	500	500	500	volts
D-C Grid Voltage	—200	—200	—200	—200	volts
D-C Plate Current	600	600	600	600	ma
D-C Screen Current	145	132	130	105	ma
D-C Grid Current	36	33	33	28	ma
Screen Dissipation	72	66	65	52	watts
Grid Dissipation	5	4	4	3	watts
Peak A. F. Screen Voltage (100% modulation)	250	250	250	250	volts
Peak R-F Grid Input Voltage	340	335	335	325	volts
Driving Power**	12	11	11	9	watts
Plate Power Input	1800	2400	3000	3300	watts
Plate Dissipation	410	490	560	670	watts
Plate Power Output	1390	1910	2440	2630	watts

*5500 volt operation may be used only below 30 Mc.
**Apparent driving power requirements increase above 30 Mc. At 110 Mc. the driver should be capable of supplying 200 watts per tube to take care of feed-through, circuit losses, and radiation.

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR
Class AB

MAXIMUM RATINGS (PER TUBE)

D-C PLATE VOLTAGE	6000	MAX. VOLTS
D-C SCREEN VOLTAGE	1000	MAX. VOLTS
MAX-SIGNAL D-C PLATE CURRENT	700	MAX. MA
PLATE DISSIPATION	1000	MAX. WATTS
SCREEN DISSIPATION	75	MAX. WATTS

TYPICAL OPERATION
Class AB_1 (Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	4000	5000	6000	volts
D-C Screen Voltage	1000	1000	1000	volts
D-C Grid Voltage (approx.)*	—115	—125	—135	volts
Zero-Signal D-C Plate Current	300	240	200	ma
Max-Signal D-C Plate Current	1.05	1.00	.95	amp
Zero-Signal D-C Screen Current	0	0	0	ma
Max-Signal D-C Screen Current	60	60	64	ma
Effective Load, Plate-to-Plate	7000	10,000	14,000	ohms
Peak A-F Grid Input Voltage (per tube)	115	125	135	volts
Driving Power	0	0	0	watts
Max-Signal Plate Dissipation (per tube)	930	950	930	watts
Max-Signal Plate Power Output	2340	3100	3840	watts

*Adjust to give stated zero-signal plate current. The D-C resistance in series with the control grid of each tube should not exceed 250,000 ohms.

TYPICAL OPERATION
Class AB_2 (Sinusoidal wave, two tubes unless otherwise specified)

D-C Plate Voltage	4000	5000	6000	volts
D-C Screen Voltage	500	500	500	volts
D-C Grid Voltage (approx.)*	—60	—70	—75	volts
Zero-Signal D-C Plate Current	300	200	150	ma
Max-Signal D-C Plate Current	1.20	1.10	.95	amp
Zero-Signal D-C Screen Current	0	0	0	ma
Max-Signal D-C Screen Current	95	90	65	ma
Effective Load, Plate-to-Plate	7000	11,000	15,000	ohms
Peak A-F Grid Input Voltage (per tube)	140	145	130	volts
Max-Signal Peak Driving Power	11.0	11.0	9.4	watts
Max-Signal Nominal Driving Power (approx.)	5.5	5.5	4.7	watts
Max-Signal Plate Dissipation (per tube)	900	850	900	watts
Max-Signal Plate Power Output	3000	3800	3900	watts

*Adjust to give stated zero-signal plate current.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.

Pulse Service—For information on Pulse Service Ratings, "Application Bulletin No. 3, Pulse Service Notes", will be furnished free on request.

APPLICATION

MECHANICAL

Mounting—The 4-1000A must be mounted vertically. The base may be down or up. The recommended socket for this tube is the SK-500 Air-System Socket.

Cooling—Adequate forced-air cooling must be provided to maintain the base seal temperatures below 150°C., and the plate seal temperature below 200°C. Cooling is simplified by the use of the Eimac SK-500 Air System Socket, and its SK-506 Air Chimney, which control the flow of air around the tube.

When the Eimac SK-500 Air-System Socket is used, the following flow rates apply to sea level operation, with an ambient temperature of 25°C., for the operating conditions described:

At 110 mc., with maximum rated plate dissipation, an air flow rate of 45 CFM is required. The corresponding pressure drop across the socket is 1.2 inches of water column.

At frequencies below 30 megacycles, an air flow rate of 30 CFM provides adequate cooling. The corresponding pressure drop across the socket is 0.5 inches of water column.

In the event that an Air-System Socket and Air Chimney are not used, air must be circulated through the base of the tube, over the envelope surface and the plate seal in sufficient quantities to maintain the temperatures below the maximum ratings. Seal temperature ratings may require that cooling air be supplied to the tube if the filament is maintained at operating temperature during standby periods.

In any questionable situation, the only criterion for correct cooling practice is temperature. A convenient method for measuring tube temperatures is the use of a temperature-sensitive paint, which melts at certain designated temperatures. One such product is made by the Tempil Corp., 11 W. 25th St., New York 10, N. Y.

ELECTRICAL

Filament Voltage—For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated voltage of 7.5 volts. Variations in filament voltage must be kept within the range from 7.13 to 7.87 volts.

Bias Voltage—The D-C bias voltage for the 4-1000A should not exceed 500 volts. With grid-leak bias, suitable means must be provided to prevent excessive plate- or screen dissipation in the event of loss of excitation. The grid-resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In the case of operation above 50 Mc., it is advisable to keep the bias voltage as low as possible. (See "Operation.")

Screen Voltage—The D-C screen voltage for the 4-1000A should not exceed 1000 volts. The screen voltages shown under "Typical Operation" are representative voltages for the type of operation involved.

Plate Voltage—The plate-supply voltage for the 4-1000A should not exceed 6000 volts in CW and audio applications. In plate-modulated telephony service above 30 Mc., the D-C plate-supply voltage should not exceed 5000 volts; however, below 30 Mc., 5500-volt operation may be used.

Grid Dissipation—Grid dissipation for the 4-1000A should not be allowed to exceed 25 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{cmp} I_c$$

where: P_g = Grid dissipation,
e_{cmp} = Peak postive grid to cathode voltage, and
I_c = D-c grid current.

e_{cmp} may be measured by means of a suitable peak volt-meter connected between filament and grid. (For suitable peak v.t.v.m. circuits, see for instance, "Vacuum Tube Ratings", Eimac News, January 1945. This article is available in reprint form on request.)

Screen Dissipation—The power dissipated by the screen of the 4-1000A must not exceed 75 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 75 watts in event of circuit failure.

Plate Dissipation—Under normal operating conditions, the plate dissipation of the 4-1000A should not be allowed to exceed 1000 watts.

In plate modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 670 watts. The plate dissipation will rise to 1000 watts under 100% sinusoidal modulation.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

OPERATION

CLASS-C R-F AMPLIFIER

Neutralization—If reasonable precautions are taken to prevent coupling between input and output circuits, the 4-1000A may be operated up to the 10 Mc. region without neutralization. In the region between 10 Mc. and 30 Mc., the conventional type of cross-neutralizing may be used with push-pull circuits. In single-ended circuits ordinary neutralization systems may be used which provide 180° out of phase voltage to the grid. A simple and effective method of neutralizing single-ended tetrode circuits is described by Warren B. Bruene in "How to Neutralize Your Single-Ended Tetrode Final", in the August, 1950, issue of CQ magazine.

At frequencies above 30 Mc. the feedback is principally due to screen-lead-inductance effects. Feedback is eliminated by using series capacitance in the screen leads between the screen and ground. A variable capacitor of from 25 to 50 uufds will provide sufficient capacitance to neutralize each tube in the region of 100 Mc. When using this method, the two screen terminals on the socket should be strapped together by the shortest possible lead. The lead from the mid-point of this screen strap to the variable capacitor and from the variable capacitor to ground should be made with as low inductance as possible.

In general, plate, grid, filament and screen bypass or screen neutralizing capacitors should be returned to r-f ground through the shortest possible leads.

In order to take full advantage of the high power gain obtainable with the 4-1000A, care should be taken to prevent feedback from the output to input circuits. A conventional method of obtaining the necessary shielding beween the grid and plate circuits is to use a suitable metal chassis with the grid circuit mounted below the deck and the plate circuit mounted above the deck. Power supply leads entering the amplifier should be bypassed to ground and properly shielded to avoid feedback coupling in these leads. The output circuit and antenna feeders should be arranged so as to preclude any possibility of feedback into other circuits.

VHF Circuits—A typical linear tank circuit for use with the 4-1000A in the 110 Mc. region consists of a "quarter wavelength" plate tank and a "half wavelength" grid tank circuit. Precautions must be observed in the placement of components to avoid the possibility of accidentally creating higher frequency tank circuits than the desired one. This could occur if a tuning capacitor were placed in a position on the line where it would create a resonant circuit at or near a harmonic frequency. A properly neutralized amplifier at the fundamental frequency would appear regenerative at higher parasitic frequencies and instability or oscillation would result.

Any capacitance tuning in the plate line should be kept to a small value, acting as a trimmer for the shorting-bar tuning. Such a variable capacitor should be positioned on the plate line as close as possible to the plate leads. The tuning capacitor on the "half wave" grid line should be positioned at the extreme end of the line away from the tube.

In many cases where parasitic oscillation or regenerative harmonic amplification occurs, it is not evident until grid excitation at the fundamental frequency is applied. If the amplifier tunes in a normal manner and the efficiency appears normal for the frequency of operation, it may be assumed that the amplifier is free of parasitic oscillation and harmonic regeneration.

VHF Operation—Above 50 Mc., electron transit time factors in the tube become important, increasing in degree as the frequency is increased. When the grid swings highly negative in potential, electrons, "trapped" enroute by the rapidly changing r-f voltage, can be deflected from their normal paths. If excessively large r-f plate voltages exist due to light plate loading, these electrons are rejected at high velocity to bombard tube parts normally outside the electron stream. This effect occurs when an amplifier goes into parasitic oscillation, as there is practically no loading in the plate circuit and the excitation is almost always extremely high. Bombardment can cause premature tube failure by a focusing of stray electrons on metal parts or the glass envelope of a tube. Such concentration of a stray electron stream will usually overheat the material at the point of focus, with the probability of gas evolvement that can lead to loss of filament emission or destruction of the tube. Where glass is the overheated material, a small hole or "suck-in" can occur, opening the tube to atmosphere. Dependent upon the degree of bombardment, tube failures can occur in a matter of minutes, or after a few thousand hours of life. Either way, the full life potential is not realized.

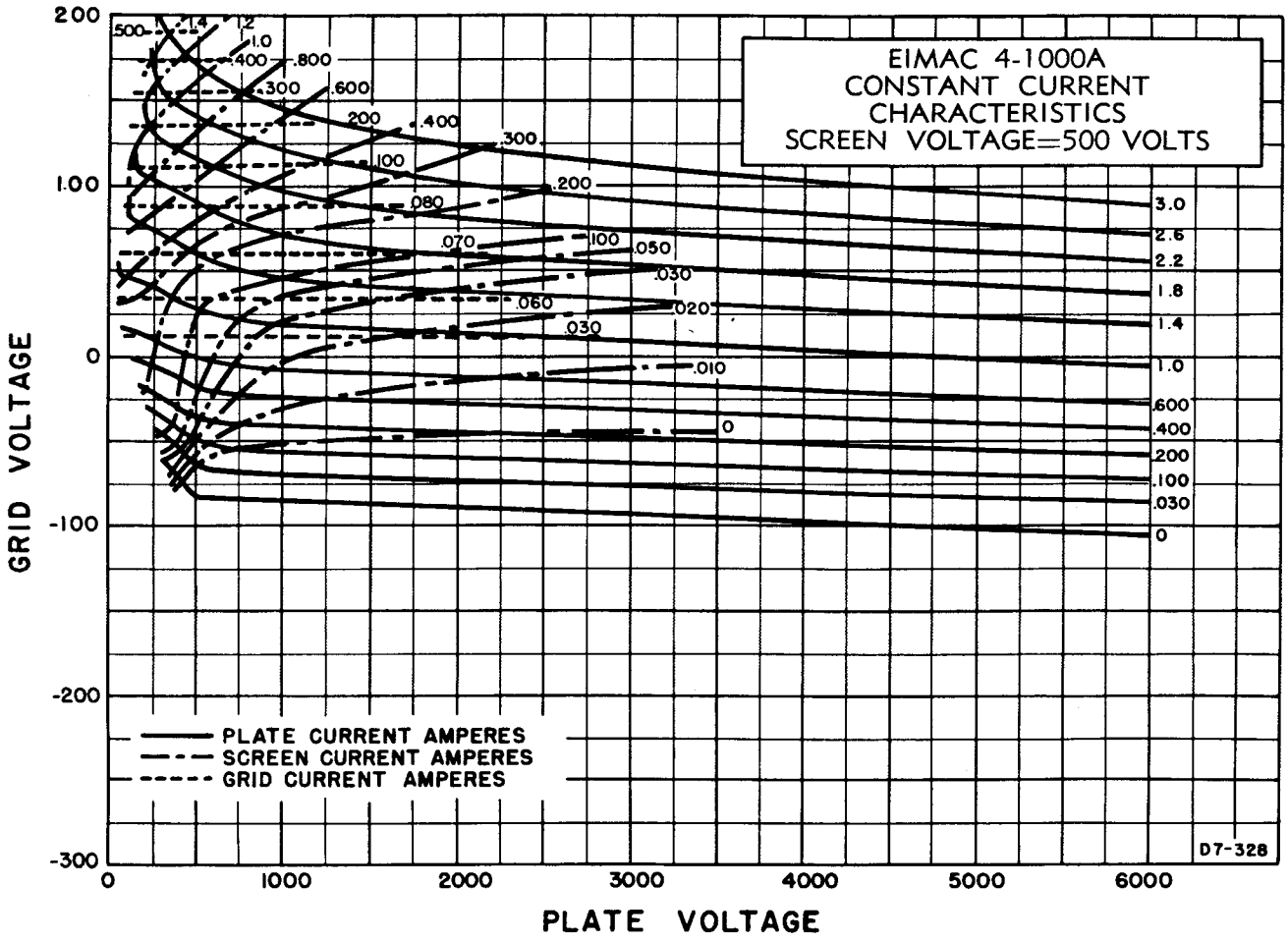
In order to minimize stray bombardment, the following rules should be followed in vhf operation of straight through amplifiers.

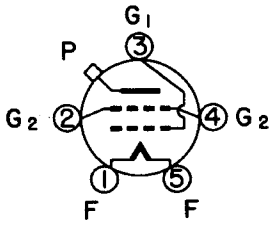
1. Use a minimum amount of bias (not over 1.5 to 2.0 times cut-off).

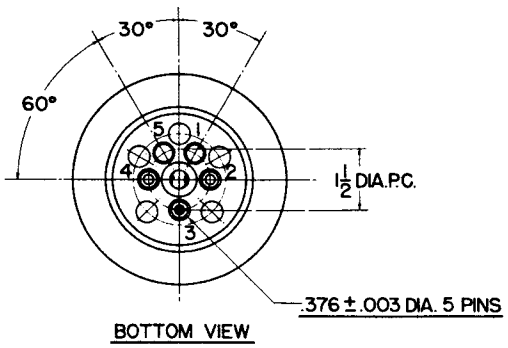
2. Use only enough drive to obtain satisfactory operation and good plate efficiency.

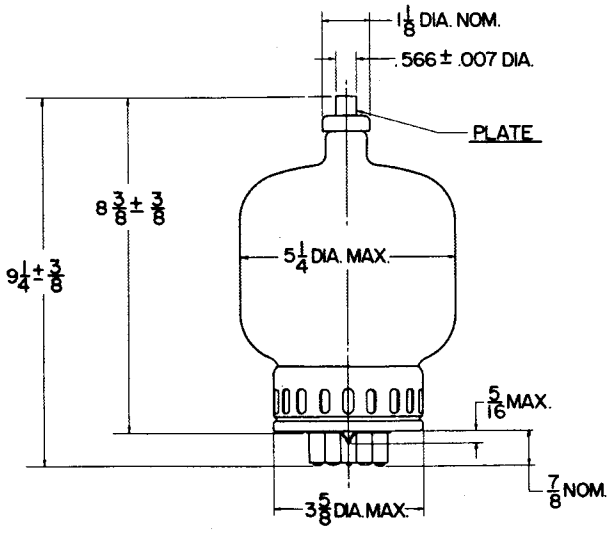
3. Use fairly heavy plate loading. Low plate voltage and high plate current is better than high plate voltage and low plate current. Avoid operating the stage unloaded or lightly loaded. If conditions are such that the stage must be operated lightly-loaded, then the driving power should be reduced proportionately. Install under-current protection, especially where unloaded operation can occur due to antenna failures or transmission line icing.

4. Operate the screen grid at a reasonably high voltage, still keeping within screen dissipation ratings.









Printed in U.S.A. 13309

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM15LS

INDUSTRIAL MAGNETRON

25 kW
915 Mc.



The Eimac EM15LS is a rugged power magnetron designed specifically for industrial processing. It is designed to operate in the industrial and scientific frequency allocation of 915 ±15 Mc. A power output of 25 kW can be obtained into a matched load at an efficiency of approximately 80%. Long operating life in severe industrial environment is assured through use of a directly heated pure tungsten spiral cathode. Further, ruggedness is assured through exclusive use of metal-ceramic construction. Every effort has been made in the design of this tube to keep water cooling pressure and purity requirements down to minimize cooling cost. The magnetic field is provided by an electromagnet which is an integral part of waveguide coupler Type H-195. This coupler mates with 9¾" x 4⅞" waveguide.

The magnetron may be operated with a fixed magnetic field or with the electromagnet connected in series with the anode. The latter mode of operation greatly reduces the variation in output power due to supply voltage changes.

Anode voltage for the EM15LS is normally supplied from a full wave three-phase rectifier with or without filter choke. The degree of filtering in any particular application is dictated by the permissible amplitude and frequency modulation of the rf output power. These are mainly determined by the anode current ripple.

CHARACTERISTICS

ELECTRICAL

Filament:	
Heating Time	10 seconds
Starting Voltage (±5%)	13 volts ac
Starting Current	115 amperes ac
Maximum Inrush Current	250 amperes
Cold Resistance	0.03 ohms
Output Power	25 kilowatts
Frequency	915 ±15 Mc

MECHANICAL

Maximum Dimensions:		
Length	17 inches	
Diameter	7 inches	
Weight	25 pounds	
Output Coupling (rf)	(See outline drawing)	
Mounting Position Preferred	Vertical	
Cooling: Water and Forced Air	*Flow Rate*	*Pressure Drop*
Anode	3 gpm	30 psi
Electromagnet	0.25 gpm	30 psi
Output Window	20 cfm	2" H_2O
Stem	5 cfm	2" H_2O

POWER SUPPLY REQUIREMENTS

Electromagnet Voltage, dc	50 volts
Electromagnet Current, dc	4 amperes
Filament Voltage, ac	14 volts
Filament Current, ac	120 amperes

(Effective 5-1-65) Copyright 1965 by Eitel-McCullough, Inc.

MAXIMUM RATINGS

Anode Voltage (dc)	14 kilovolts
Anode Current (dc)	3 Amperes
Anode Dissipation	15 Kilowatts
Load VSWR	2.5:1
Seal Temperature	175°C
Water Outlet Temperature	70°C

TYPICAL OPERATION

Frequency	915	915	megacycles
Output Power	20	25	kilowatts
Anode Voltage	11.5	12.5	kilovolts dc
Anode Current	2.1	2.4	amperes dc
Efficiency	83	83	percent
Filament Voltage	11	10.8	volts ac
Filament Current	106	103	amperes ac
VSWR	3:1*	2.5:1*	
Electromagnet Current	3.3	3.6	amperes dc

*Efficiency with mismatched load depends upon phase angle of the load. Efficiencies listed can be obtained with matched load or at selected phase angles.

NOTES

1. COOLING

Both air and water cooling must be applied before anode voltage is applied.

2. FILAMENT ADJUSTMENTS

Before the anode voltage is applied, the filament current must be set for 115 amperes and held there for 10 seconds. When the magnetron begins operating, the heater current should be reduced immediately to compensate for back bombardment. The filament current given above is for a matched rf load. Maximum life of this magnetron will be obtained if the filament voltage is decreased during operation until the filament resistance V_f/I_f is the same as that when the magnetron is not oscillating; i.e., V_{fo}/I_{fo}. When the rf load is reasonably constant in magnitude and phase, filament voltage and current can be reduced a fixed amount using manual switch control. However, when the variation of the load mis-match and phase is considerable, more accurate compensation should be provided by automatic control.

3. POWER SUPPLY

The short circuit characteristics of the anode supply must be such that the peak anode current is limited to 25 amperes in case of an arc in the magnetron. If the leakage reactance of the transformer, plus the resistance of the rectifiers, transformer and filter choke do not provide this degree of current limiting, a series resistor is recommended in the anode supply to achieve the additional current limiting required.

4. OPERATION WITH SERIES FIELD

With the coil of the electromagnet connected in series with the anode as shown in Fig. 4, the magnetron threshold voltage V_T (approx. equal to the anode voltage at zero anode current, see Fig. 3) becomes proportional to the anode current and curve of V_a against I_a for steady currents, and is obtained as given in Fig. 5. The slope of this characteristic, which depends upon the number of turns in the coil, is much greater than that with fixed field (compare with Fig. 3), and

hence the power changes with supply voltage variations are correspondingly reduced. This is one advantage of the series field mode of operation.

Operating points to the left of the line can be reached by supplying a biasing current through the coil. Assuming an initial biasing current, the behavior is then as follows: as the anode voltage, and hence current, rises from zero, the increasing voltage drop across the magnet coil causes a decrease in the biasing current, and a V_aI_a characteristic of reduced slope* is obtained. Beyond the branch point shown in Fig. 5, the biasing current is zero and full series field behavior is obtained. The characteristic is raised or lowered in accordance with the biasing current and threshold voltage V_T, and with a fixed supply voltage this enables the power output to be controlled in an economical way by varying the magnet current. Since the slope of the characteristic depends upon the magnet coil resistance, there is a slight drift of the operating point as the coil warms up. This can be minimized by making R_b large compared with R_m or by using a bias supply which behaves as a constant current source.

With series field, anode voltage cannot be applied instantaneously without biasing field current, because a transient voltage approximately equal to the anode supply voltage is developed across the magnet coil. A recommended method of starting is therefore to increase the biasing current to raise V_T above the no load voltage of the anode supply, switch on the anode voltage, and then reduce the biasing current until the required operating point is reached.

With series field, the stability against load mismatch remains the same as that with fixed field, but the variation in anode impedance V_a/I_a, with phase of load VSWR is reduced by a self-regulating action. This leads to a power variation (see Fig. 2 for example) which is mainly determined by efficiency changes.

Precautions should be taken to prevent excessive load reflection as stipulated in the maximum ratings, since operation in unwanted modes is always possible with series field, following a cessation of oscillation in the proper mode.

5. INSTALLATION

The EM15LS is constructed from metal and ceramic. Reasonable care should be taken to protect the tube from excessive shocks when handling and after installation. The mounting position is with axis vertical, either up or down.

Connection between the magnetron and the H-195 is made by a copper washer retained on a flange on the tube at the base of the dome window. The tube must be seated squarely in the electromagnet, and the retaining screws tightened up uniformly to ensure proper contact at the washer. A new washer should be used each time the magnetron is inserted. A new washer is supplied with each new tube purchased.

The magnetron dome window is forced-cooled by air ducted over the dome by a flanged insulating cylinder. To obtain proper cooling it is necessary to ensure a uniform gap between the cylinder and dome.

The cathode terminals must be securely clamped to make proper contact and avoid overheating. Cooling is by forced air through a duct attached to the small cathode terminal. The terminal temperature should not exceed 175°C.

*In proportion to $\frac{R_b}{R_b+R_m}$, where R_b is the effective internal impedance of the biasing supply, and R_m the magnet resistance.

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

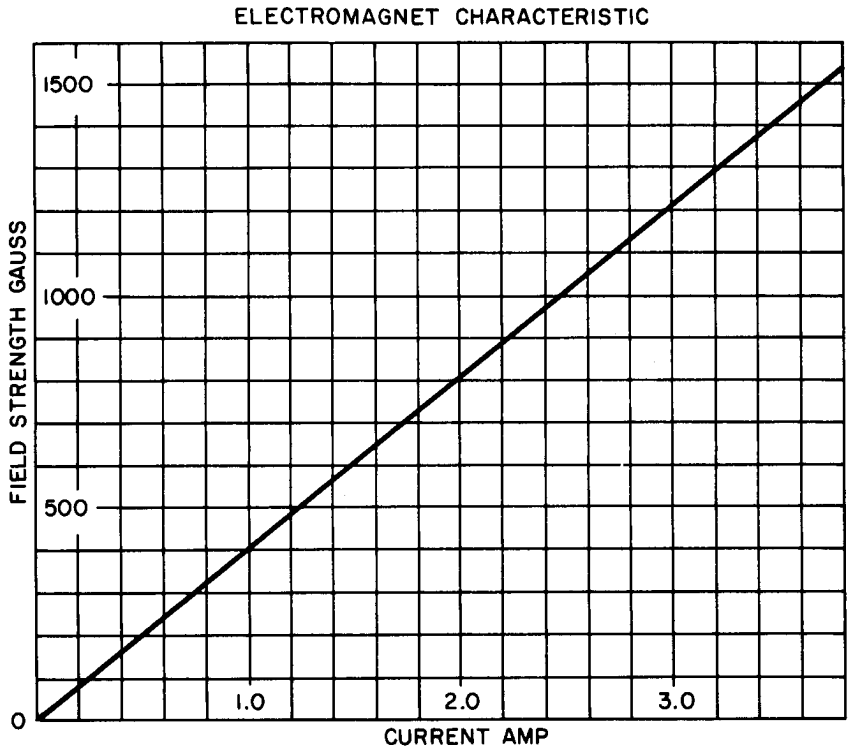
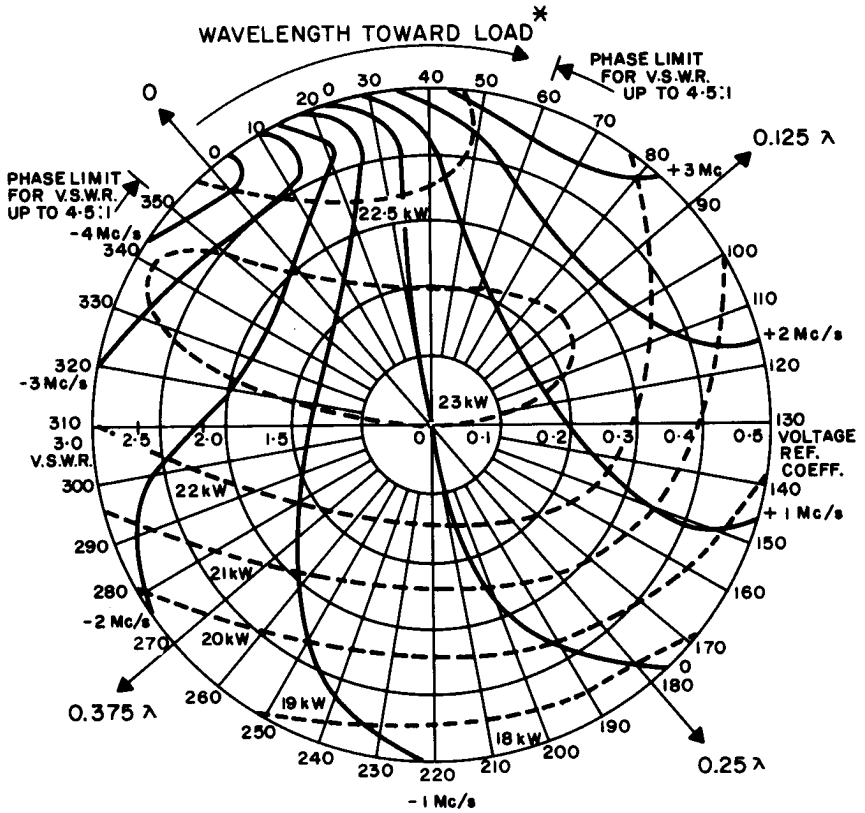


fig. 1



TYPICAL RIEKE DIAGRAM

fig. 2

Va = 12.5 kv
Ia = 2.4 a
f = 915 Mc

* ZERO WAVELENGTH IS AT FLANGE OF LAUNCHER AND INDICATES VOLTAGE MINIMUM AT THE FLANGE.

PERFORMANCE CHART

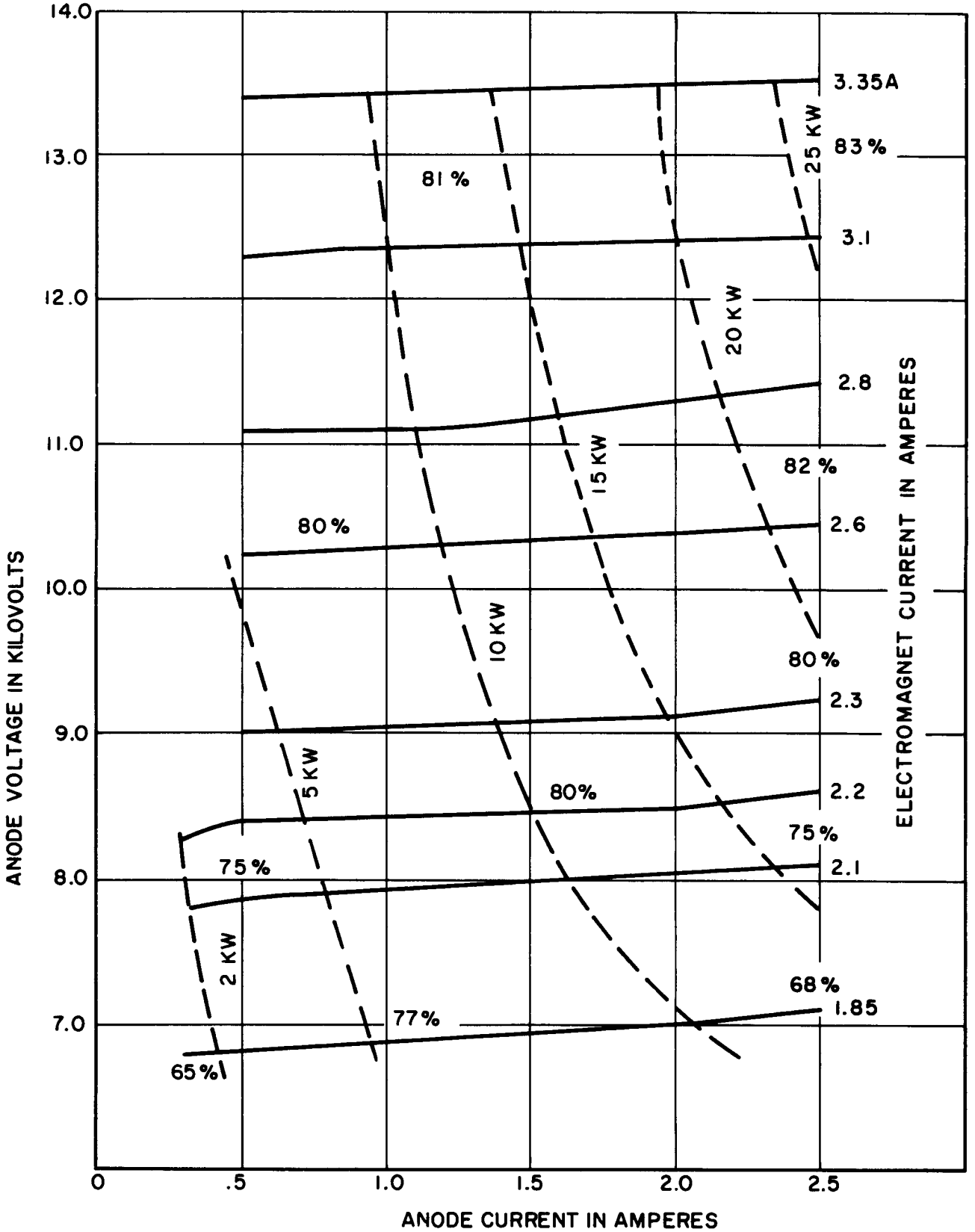
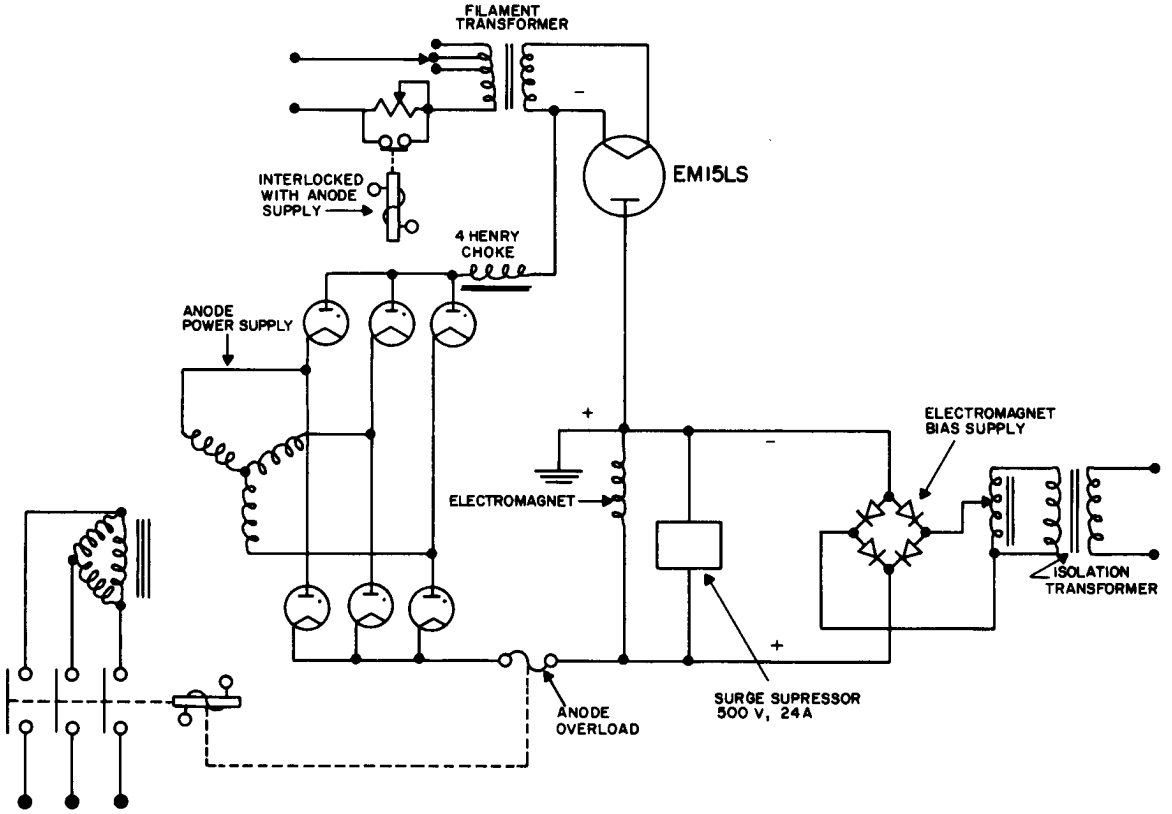


fig. 3



ELEMENTARY CIRCUIT FOR OPERATION WITH SERIES FIELD

fig. 4

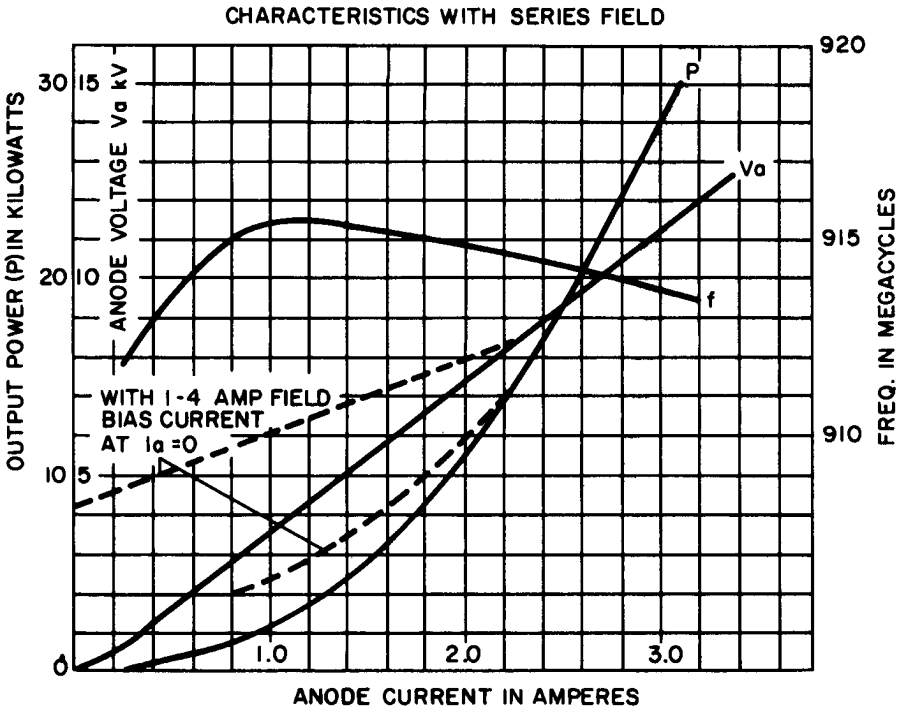
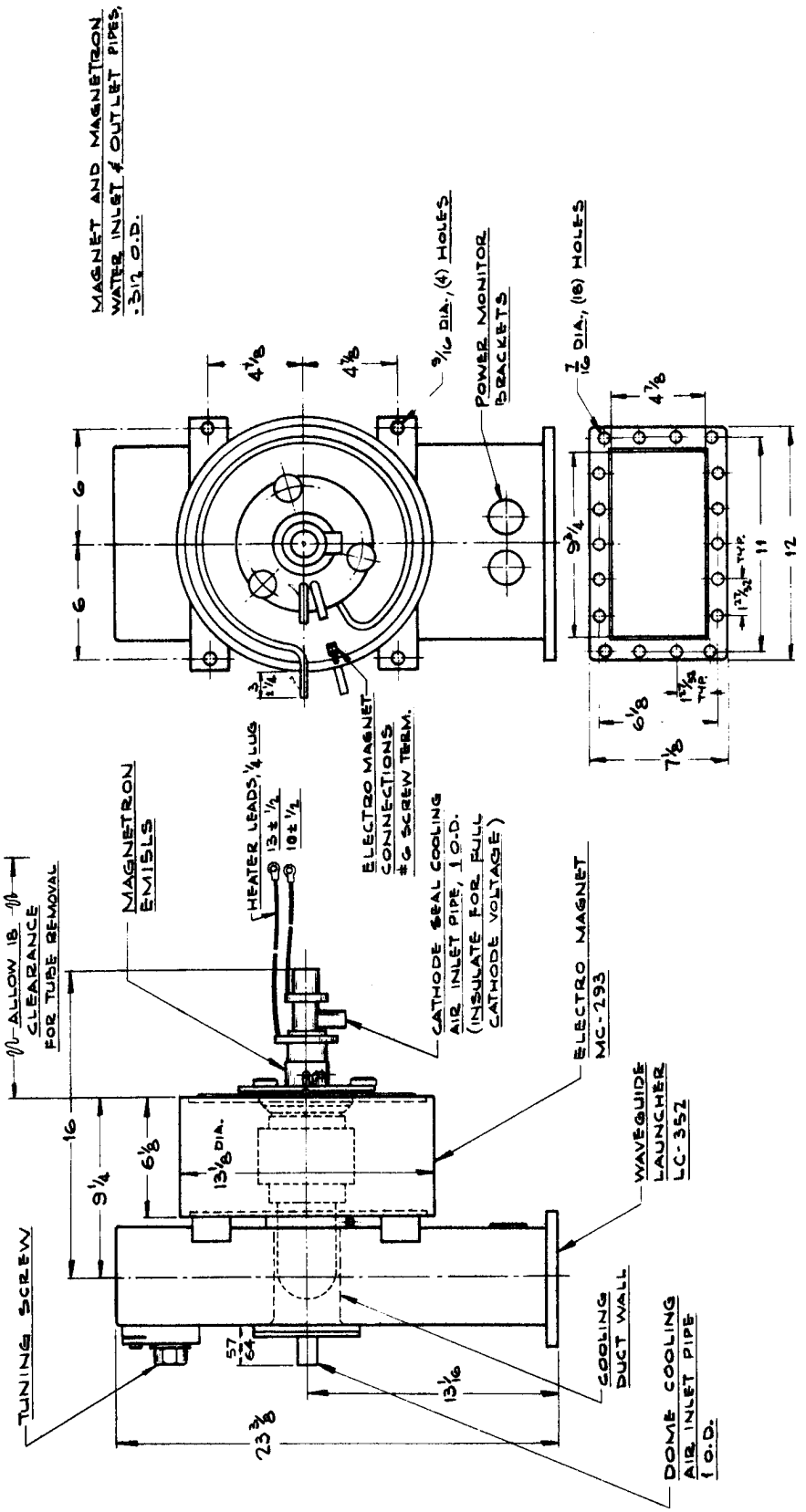
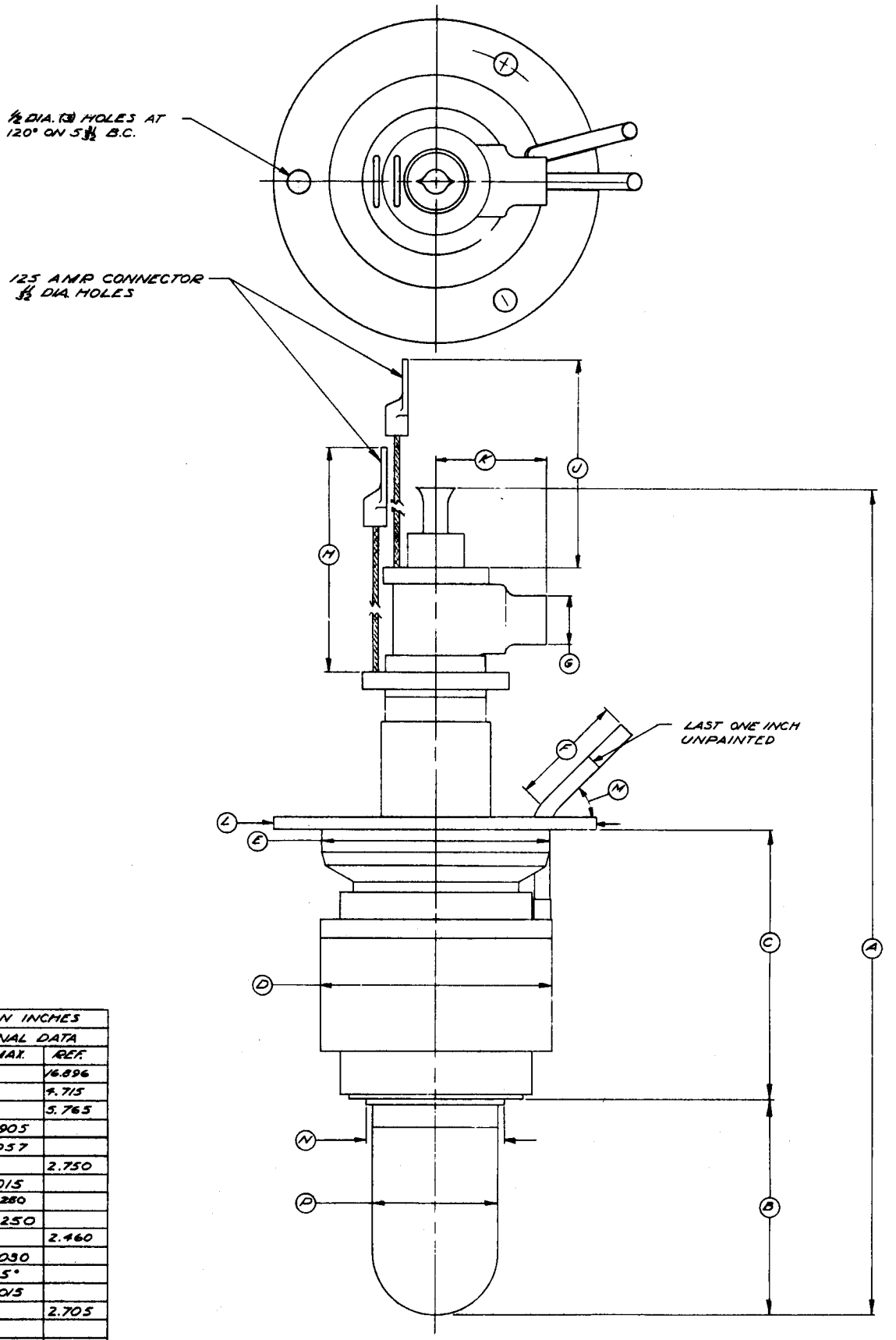


fig. 5

EM-15LS MAGNETRON AND H-195 WAVEGUIDE COUPLER





DIMINSIONS IN INCHES			
DIMINSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A			16.896
B			9.715
C			5.765
D	4.855	4.905	
E	4.917	4.957	
F			2.750
G	.985	1.015	
H	10.500	11.280	
J	12.500	13.250	
K			2.460
L	6.970	7.030	
M	25°	45°	
N	2.985	3.015	
P			2.705

EM15LS MAGNETRON

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM 108

TRAVELING WAVE TUBE



The EM108 is an octave bandwidth pulse PPM focused TWT capable of delivering 1.0 kw of power from 2.0–4.0 Gc. This tube is of metal-ceramic construction designed for operation in severe environments. This tube contains a grid for modulating purposes.

ELECTRICAL SPECIFICATIONS

Absolute Ratings	**Maximum**
Filament Voltage	7.0 Volts
Cathode Voltage	−8000 vdc
Peak Cathode Current	2.0 adc
Pulse Grid Voltage	+400 to −150 vdc
Duty Cycle	2%

Operating and Performance Data	
Filament Voltage	6.3 Volts
Filament Current	3.0 Amperes
Cathode Voltage	−7500 Vdc
Peak Cathode Current	1.3 Adc
Grid Voltage (Beam off)	−90 Vdc
Grid Voltage (Beam on)	+200 Vdc
Duty Cycle	2%
Frequency Range	2.0–4.0 Gc
Small Signal Gain—Minimum	36 db
Peak Saturated Power Out—Minimum	1.0 kw
Saturated Gain—Minimum	30 db
Grid Capacitance (to all other elements)	15 picofds.

ENVIRONMENTAL SPECIFICATIONS

Complies with MIL-5400 Class II Equipment

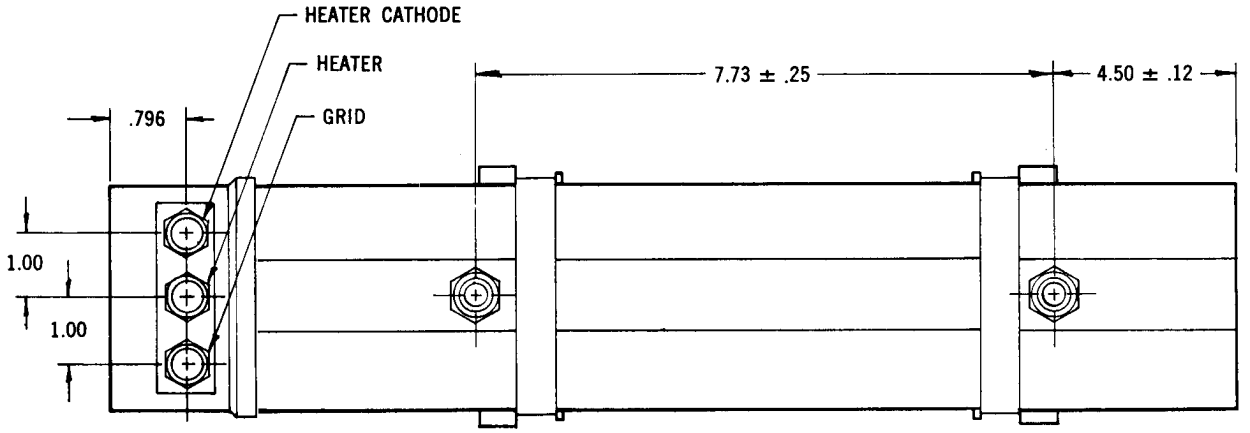
Temperature	−65° C to +125° C

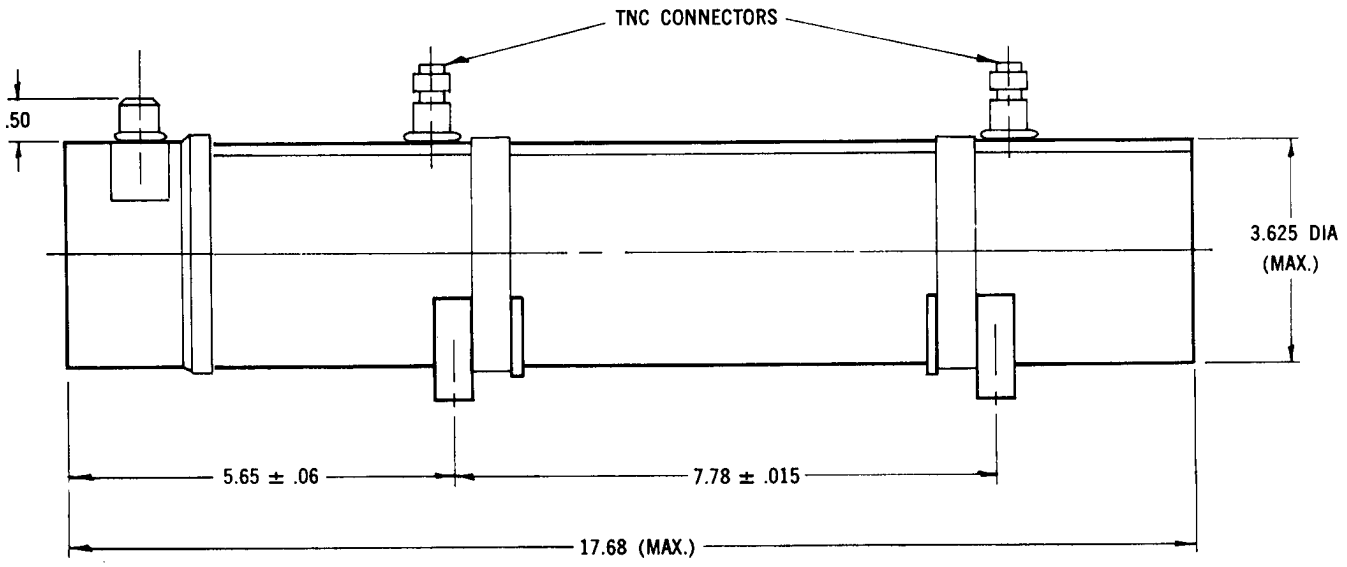
MECHANICAL SPECIFICATIONS

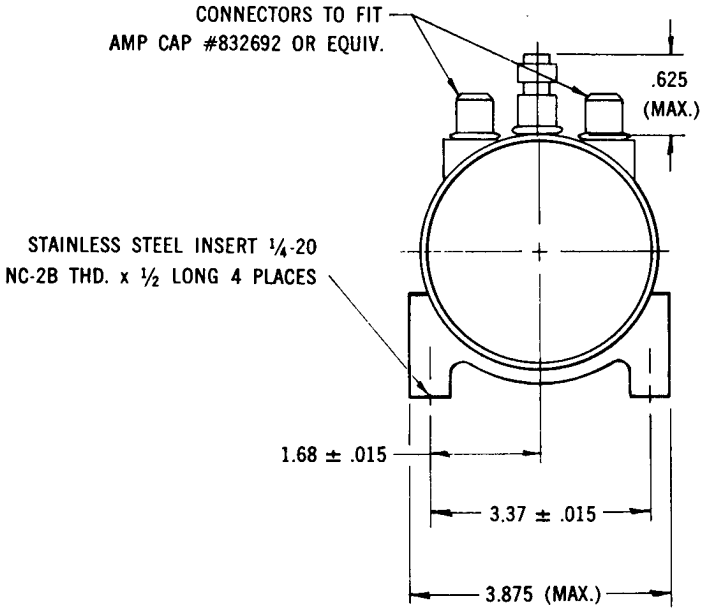
Operating Position	Any
Input Coupling, rf	TNC
Output Coupling, rf	TNC
Focusing	PPM
Cooling	75 CFM forced air
Dimensions	See outline drawing
Weight	9 lbs.
Supply Connections	Cathode—yellow Filament—brown Grid—green

NOTE: Electrode Voltages are with respect to cathode; tube shell at ground potential.

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HEATER CATHODE
HEATER
GRID
.796
7.73 ± .25
4.50 ± .12
1.00
1.00

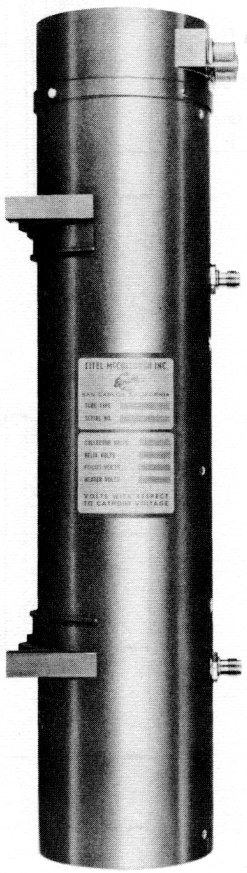

TNC CONNECTORS
.50
3.625 DIA
(MAX.)
5.65 ± .06
7.78 ± .015
17.68 (MAX.)


CONNECTORS TO FIT
AMP CAP #832692 OR EQUIV.
.625
(MAX.)
STAINLESS STEEL INSERT ¼-20
NC-2B THD. x ½ LONG 4 PLACES
1.68 ± .015
3.37 ± .015
3.875 (MAX.)

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM 113

TRAVELING WAVE TUBE



The EM113 delivers 1 kw of pulse power from 2.0–4.0 Gc. It is of metal-ceramic construction and is suitable for airborne and missile applications. The focusing is accomplished by periodic permanent magnet and compensated for operation over the temperature range −65° C to +125° C.

ELECTRICAL SPECIFICATIONS

Absolute Ratings	Maximum
Filament Voltage	7.0 Volts
Pulse Cathode Voltage	−8000 vdc
Peak Cathode Current	2.0 adc
Duty Cycle	2%

Operating and Performance Data	
Filament Voltage	6.3 Volts
Filament Current	3.0 Amperes
Cathode Voltage	−7500 Vdc
Peak Cathode Current	1.3 adc
Duty Cycle	2%
Frequency Range	2.0–4.0 Gc
Small Signal Gain—Minimum	36 db
Peak Saturated Power Out—Minimum	1.0 kw
Saturated Gain—Minimum	30 db

ENVIRONMENTAL SPECIFICATIONS

Complies with MIL-5400 Class II Equipment

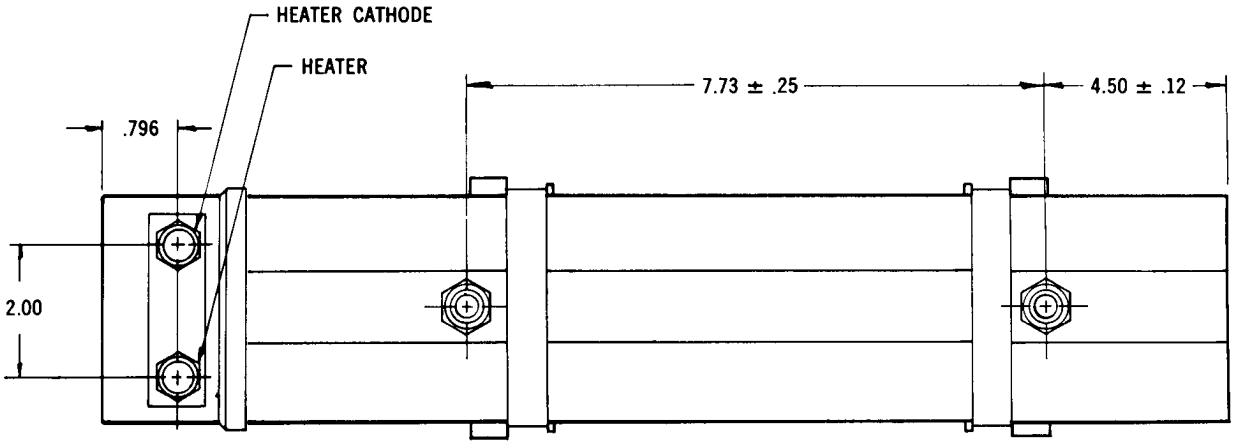
Temperature	−65° C to +125° C

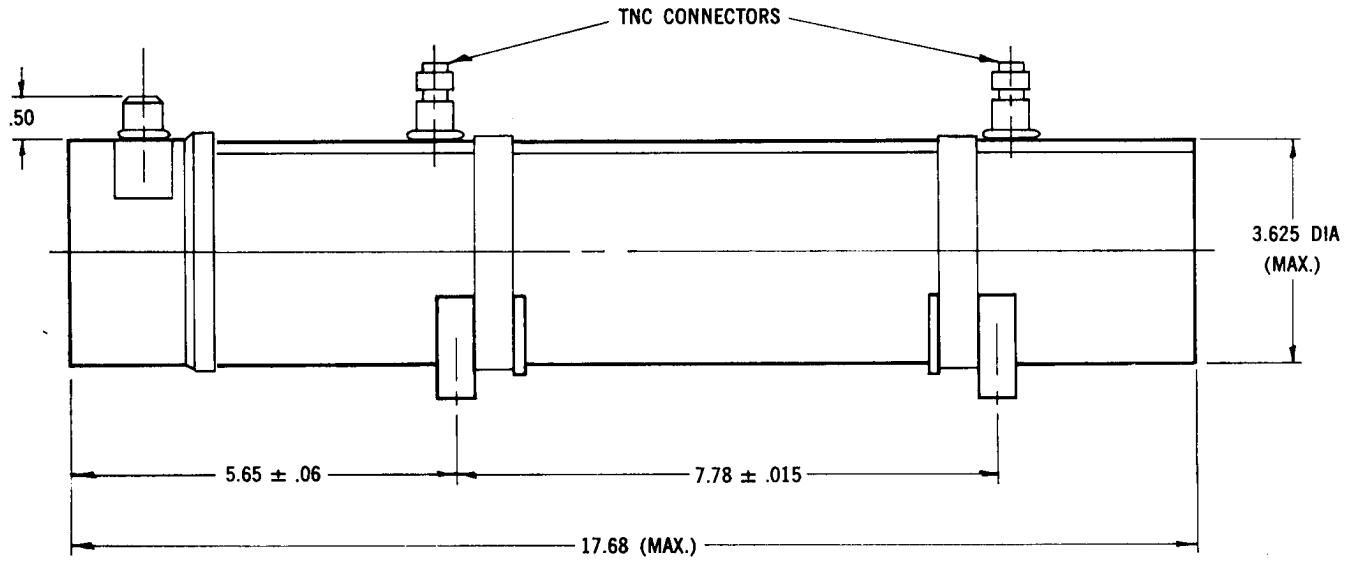
MECHANICAL SPECIFICATIONS

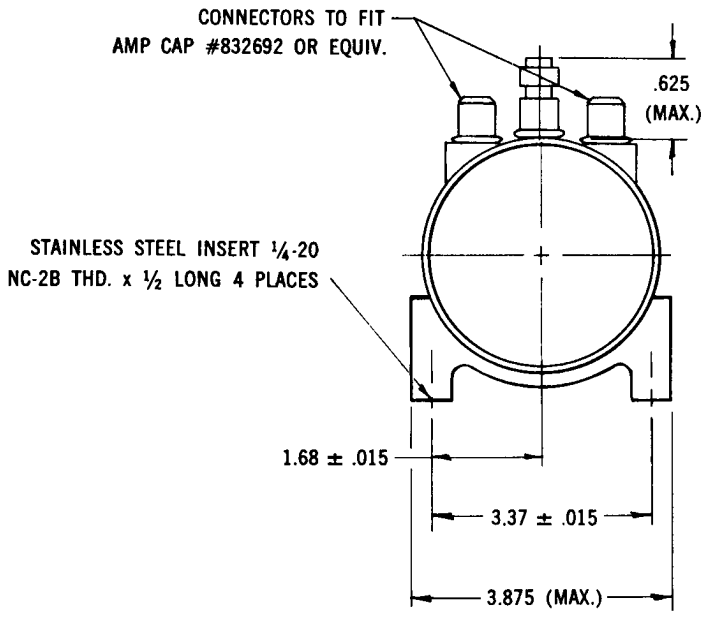
Operating Position	Any
Input Coupling, rf	TNC
Output Coupling, rf	TNC
Focusing	PPM
Cooling	75 CFM forced air
Dimensions	See outline drawing
Weight	9 lbs.
Supply Connections	Cathode—yellow Filament—brown Grid—green

NOTE: Electrode Voltages are with respect to cathode; tube shell at ground potential.

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HEATER CATHODE
HEATER
.796
7.73 ± .25
4.50 ± .12
2.00

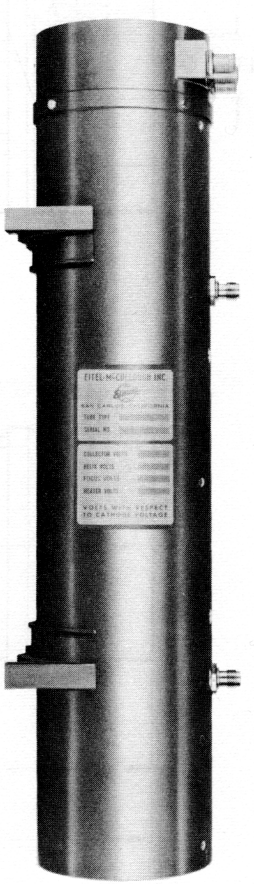

TNC CONNECTORS
.50
3.625 DIA
(MAX.)
5.65 ± .06
7.78 ± .015
17.68 (MAX.)


CONNECTORS TO FIT
AMP CAP #832692 OR EQUIV.
.625
(MAX.)
STAINLESS STEEL INSERT ¼-20
NC-2B THD. x ½ LONG 4 PLACES
1.68 ± .015
3.37 ± .015
3.875 (MAX.)

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM 114

TRAVELING WAVE TUBE



The EM114 is a grid modulated pulse TWT covering the frequency range of 2.8–3.5 Gc with a peak power output of 2.0 kw. This tube is designed for use in airborne and missile environments.

ELECTRICAL SPECIFICATIONS

Absolute Ratings	Maximum
Filament Voltage	7.0 Volts
Cathode Voltage	−8000 vdc
Peak Cathode Current	2.0 adc
Grid Voltage	+400 to −150 vdc
Duty Cycle	2%

Operating and Performance Data	
Filament Voltage	6.3 Volts
Filament Current	3.0 Amperes
Cathode Voltage	−7800 Vdc
Peak Cathode Current	1.5 adc
Grid Voltage (Beam on)	200 Vdc
Grid Voltage (Beam off)	−90 Vdc
Duty Cycle	2%
Frequency Range	2.8–3.5 Gc
Small Signal Gain—Minimum	36 db
Saturated Power Out—Minimum	2.0 kw
Saturated Gain—Minimum	30 db
Grid Capacitance (to all other elements)	15 picofds.

ENVIRONMENTAL SPECIFICATIONS

Complies with MIL-5400 Class II Equipment

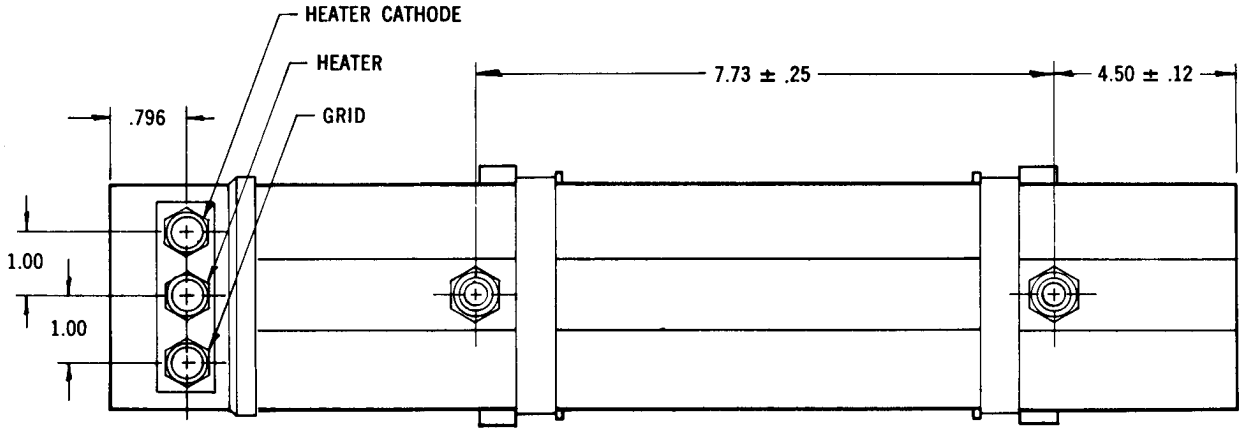
Temperature	−65° C to +125° C

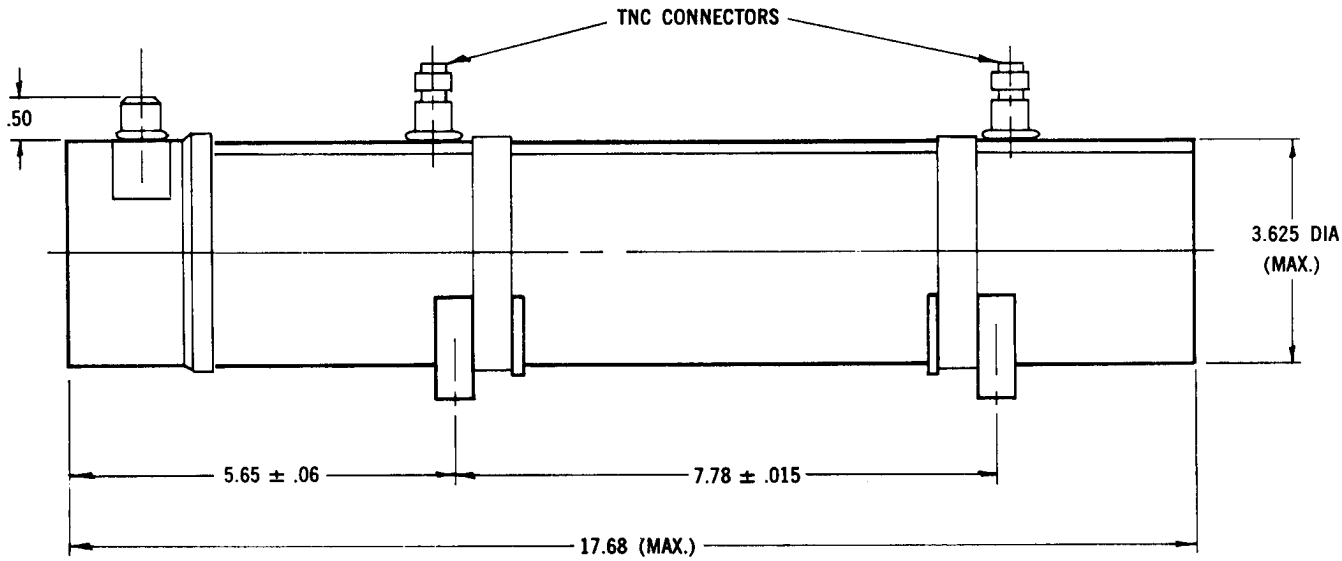
MECHANICAL SPECIFICATIONS

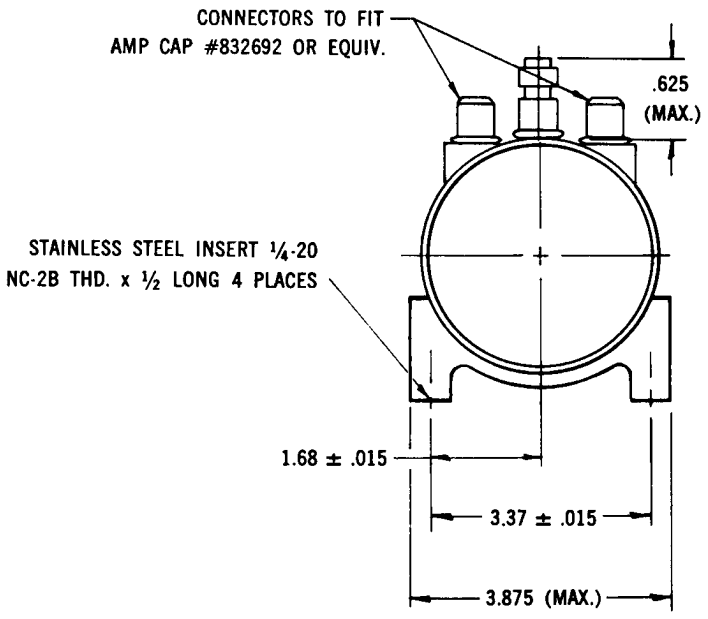
Operating Position	Any
Input Coupling, rf	TNC
Output Coupling, rf	TNC
Focusing	PPM
Cooling	75 CFM forced air
Dimensions	See outline drawing
Weight	9 lbs.
Supply Connections	Cathode—yellow Filament—brown Grid—green

NOTE: Electrode Voltages are with respect to cathode; tube shell at ground potential.

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HEATER CATHODE
HEATER
GRID
.796
7.73 ± .25
4.50 ± .12
1.00
1.00

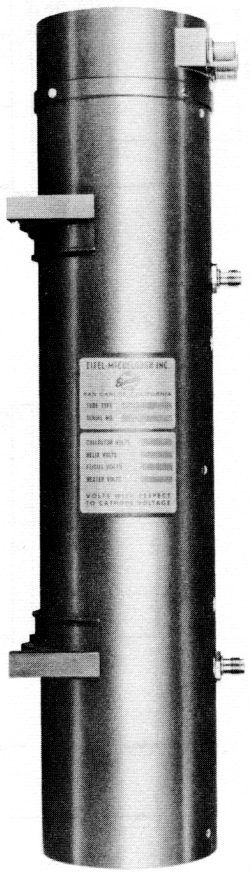

TNC CONNECTORS
.50
3.625 DIA
(MAX.)
5.65 ± .06
7.78 ± .015
17.68 (MAX.)


CONNECTORS TO FIT
AMP CAP #832692 OR EQUIV.
.625
(MAX.)
STAINLESS STEEL INSERT ¼-20
NC-2B THD. x ½ LONG 4 PLACES
1.68 ± .015
3.37 ± .015
3.875 (MAX.)

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM 116

TRAVELING WAVE TUBE



The EM116 is a 2% duty cycle TWT providing 1.6 kw of power over the frequency range of 2.9–3.1 Gc. This tube is PPM focused and of metal-ceramic construction for use in stringent environments.

ELECTRICAL SPECIFICATIONS

Absolute Ratings	Maximum
Filament Voltage	7.0 Volts
Pulse Cathode Voltage	−8000 vdc
Peak Cathode Current	2.0 adc
Duty Cycle	2%

Operating and Performance Data	
Filament Voltage	6.3 Volts
Filament Current	3.0 Amperes
Cathode Voltage	−7500 Vdc
Peak Cathode Current	1.3 adc
Duty Cycle	2%
Frequency Range	2.9–3.1 Gc
Small Signal Gain—Minimum	36 db
Saturated Power Out—Minimum	1.6 kw
Saturated Gain—Minimum	30 db

ENVIRONMENTAL SPECIFICATIONS

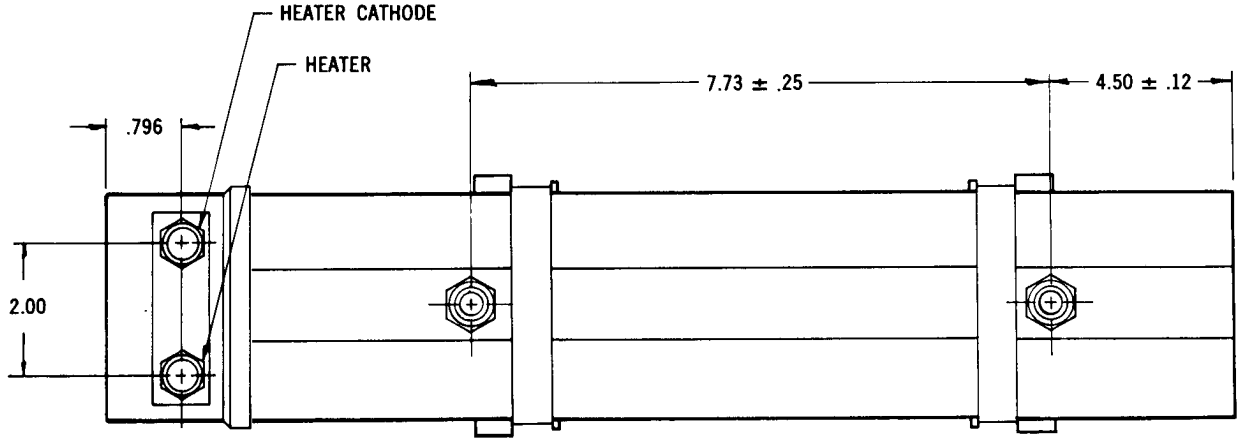
Complies with MIL-5400 Class II Equipment	
Temperature	−65° C to +125° C

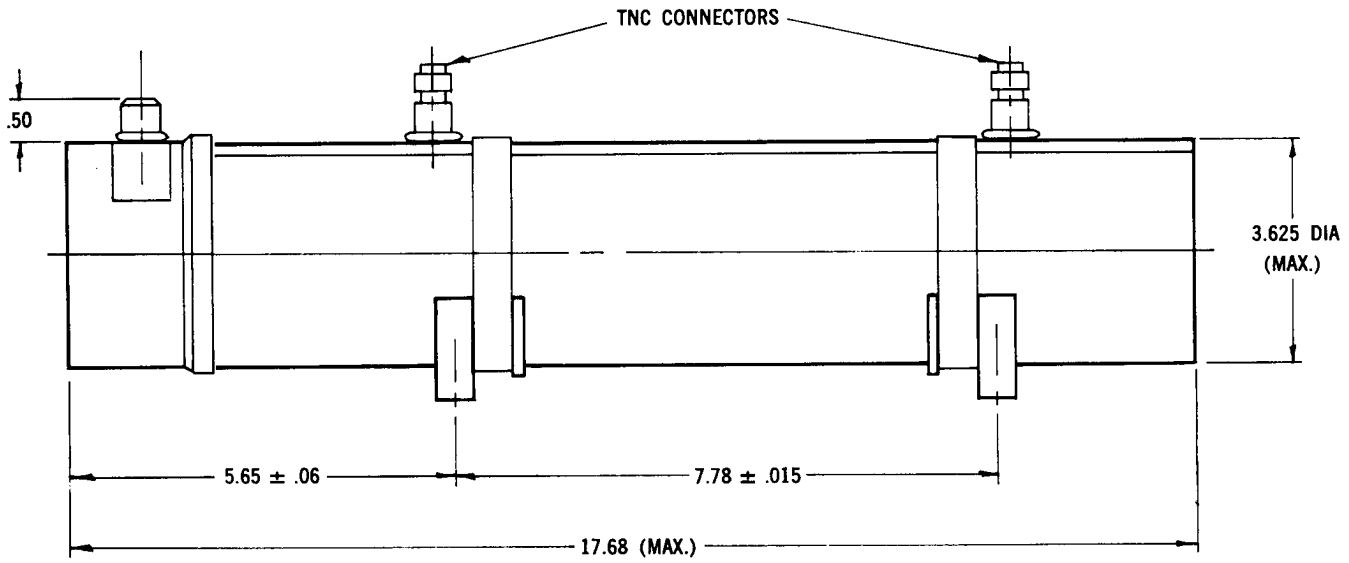
MECHANICAL SPECIFICATIONS

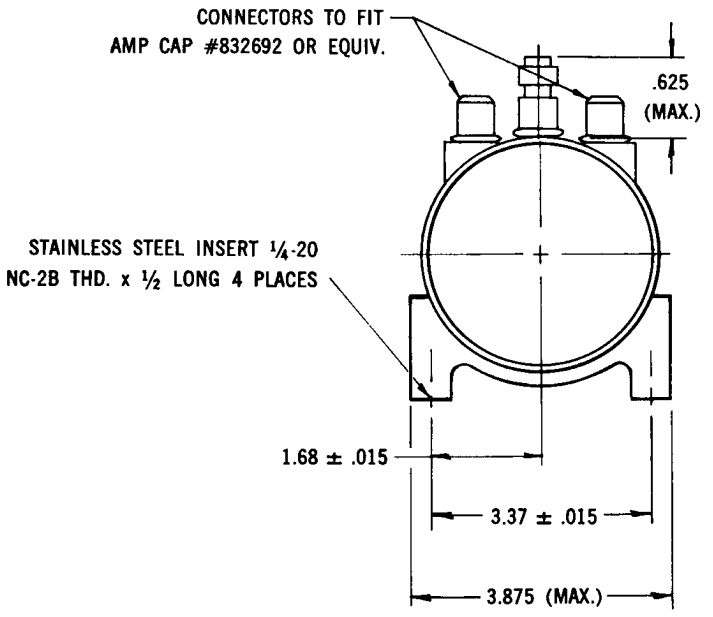
Operating Position	Any
Input Coupling, rf	TNC
Output Coupling, rf	TNC
Focusing	PPM
Cooling	75 CFM forced air
Dimensions	See outline drawing
Weight	9 lbs.
Supply Connections	Cathode—yellow Filament—brown Grid—green

NOTE: Electrode Voltages are with respect to cathode; tube shell at ground potential.

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HEATER CATHODE
HEATER
.796
7.73 ± .25
4.50 ± .12
2.00


TNC CONNECTORS
.50
3.625 DIA
(MAX.)
5.65 ± .06
7.78 ± .015
17.68 (MAX.)


CONNECTORS TO FIT
AMP CAP #832692 OR EQUIV.
.625
(MAX.)
STAINLESS STEEL INSERT 1/4-20
NC-2B THD. x 1/2 LONG 4 PLACES
1.68 ± .015
3.37 ± .015
3.875 (MAX.)

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM 118

TRAVELING WAVE TUBE

The EM118 is a medium-power grid pulse TWT suitable for operation in extreme environments. Rated power output of 500 watts is obtained over the frequency range of 2.7–2.9 Gc.



ELECTRICAL SPECIFICATIONS

Absolute Ratings	Maximum
Filament Voltage	7.0 Volts
Cathode Voltage	−5000 Vdc
Peak Cathode Current	1.0 adc
Pulse Grid Voltage	+400, to −150 vdc
Duty Cycle	2%

Operating and Performance Data	
Filament Voltage	6.3 Volts
Filament Current	3.0 Amperes
Cathode Voltage	−4700 Vdc
Peak Cathode Current	0.8 adc
Pulse Grid Voltage (Beam on)	+200 Vdc
Pulse Grid Voltage (Beam off)	−90 Vdc
Duty Cycle	2%
Frequency Range	2.7–2.9 Gc
Small Signal Gain—Minimum	46 db
Peak Saturated Power Out—Minimum	500 w
Saturated Gain—Minimum	40 db
Grid Capacitance (to all other elements)	15 picofds.

ENVIRONMENTAL SPECIFICATIONS

Complies with MIL-5400 Class II Equipment

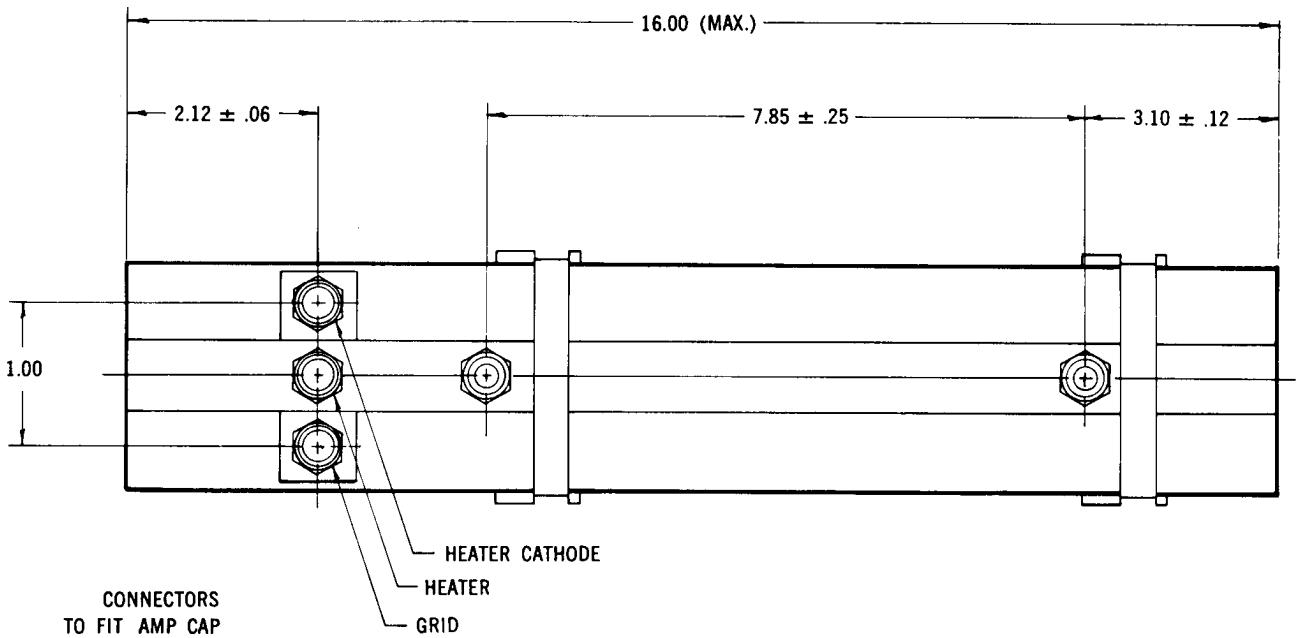
Temperature	−65° C to +125° C

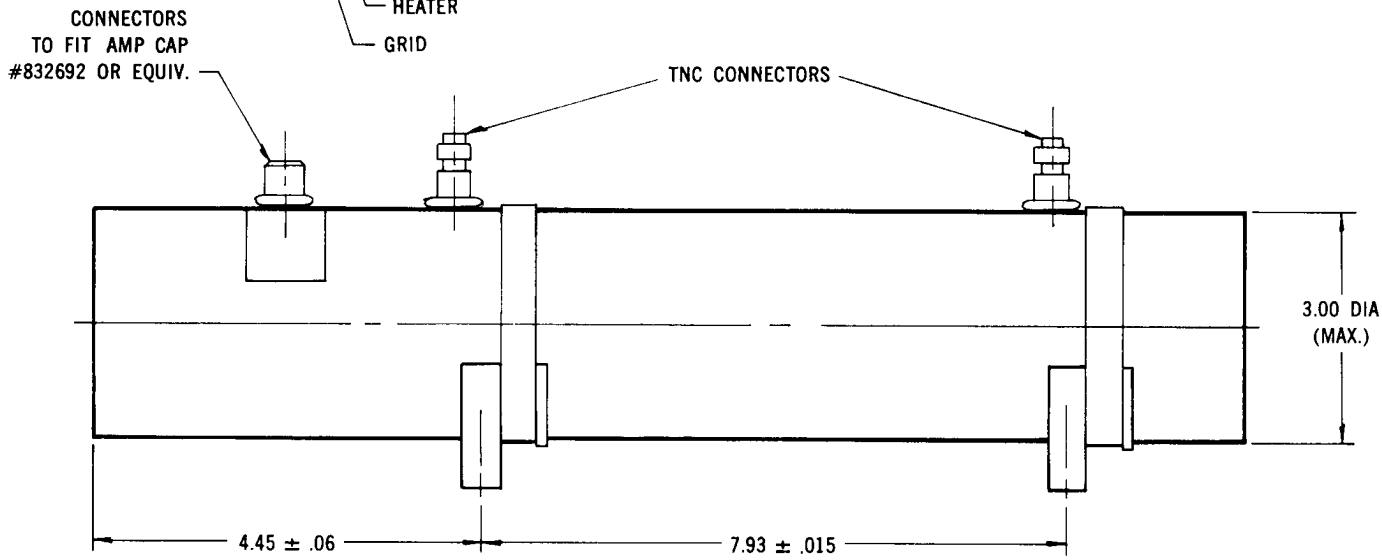
MECHANICAL SPECIFICATIONS

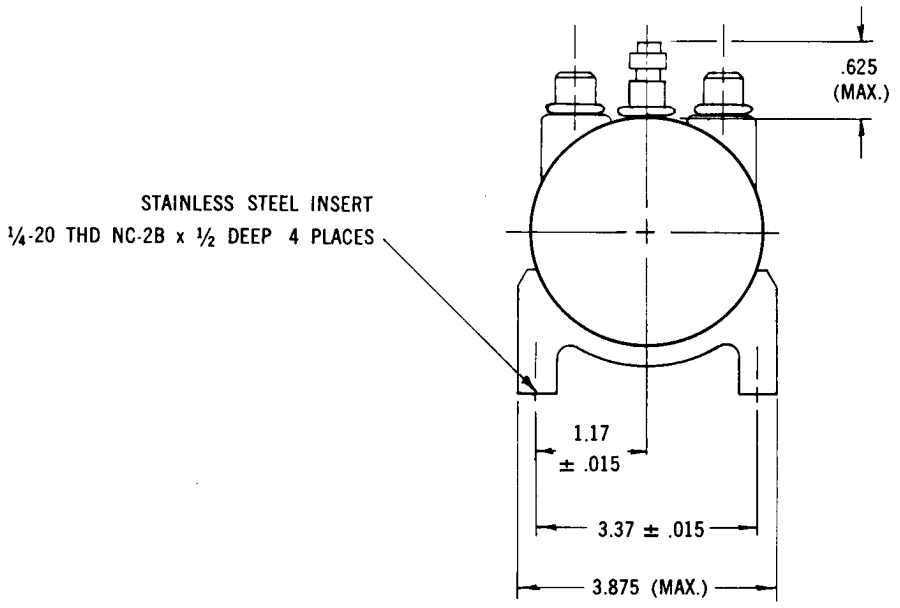
Operating Position	Any
Input Coupling, rf	TNC
Output Coupling, rf	TNC
Focusing	PPM
Cooling	75 CFM forced air
Dimensions	See outline drawing
Weight	9 lbs.
Supply Connections	Cathode—yellow Filament—brown Grid—green

NOTE: Electrode Voltages are with respect to cathode; tube shell at ground potential.

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16.00 (MAX.)
2.12 ± .06
7.85 ± .25
3.10 ± .12
1.00
HEATER CATHODE
HEATER
GRID


CONNECTORS
TO FIT AMP CAP
#832692 OR EQUIV.
TNC CONNECTORS
3.00 DIA
(MAX.)
4.45 ± .06
7.93 ± .015


.625
(MAX.)
STAINLESS STEEL INSERT
¼-20 THD NC-2B x ½ DEEP 4 PLACES
1.17
± .015
3.37 ± .015
3.875 (MAX.)

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

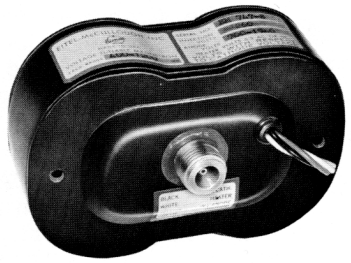
EM-747

Voltage Tunable Magnetron

Frequency 400—1200 Mc

Minimum Output Power 50 mW Min.

TYPICAL PERFORMANCE



L-BAND OSCILLATOR

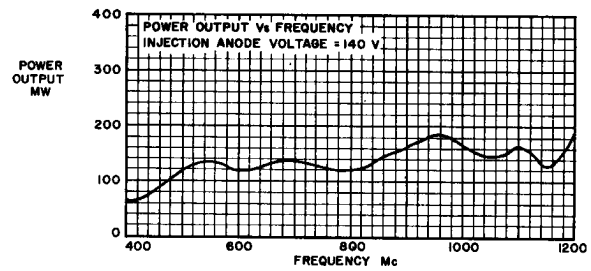
ELECTRICAL

Frequency Range	0.4-1.2 kMc
Anode Voltage	660-1980 V
Cathode Current	2-8 mA
Typical Output Power	75-250 mW
Anode FM Sensitivity	.65 Mc/V
Injection Anode Voltage	200 V
Injection Anode Current	0 mA
Heater Voltage (AC or DC)	6.3 V
Heater Current (AC or DC)	0.8 A
Load Impedance	50 ohms
Service	cw

*MAXIMUM RATINGS

Anode Voltage	2000 V
Cathode Current	20 mA
Injection Anode Voltage	500 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.

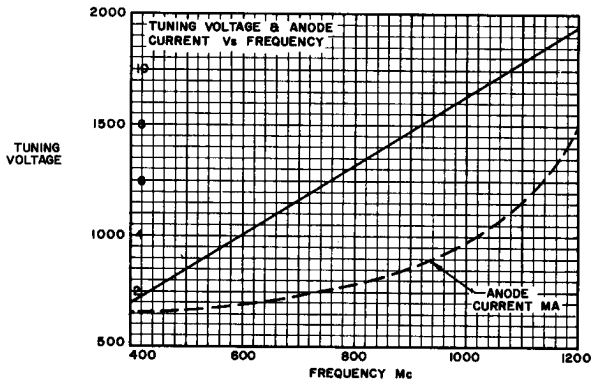


MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type N Jack
Weight	3.0 Pounds

ENVIRONMENTAL

Vibration	10G-(to 2kc)
Shock	100G-(11ms)
Altitude	70,000 ft.



OUTLINE DIMENSIONS

Height	3 inches
Width	1.6 inches
Length	4.5 inches

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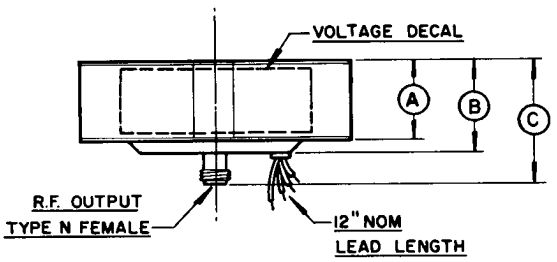
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

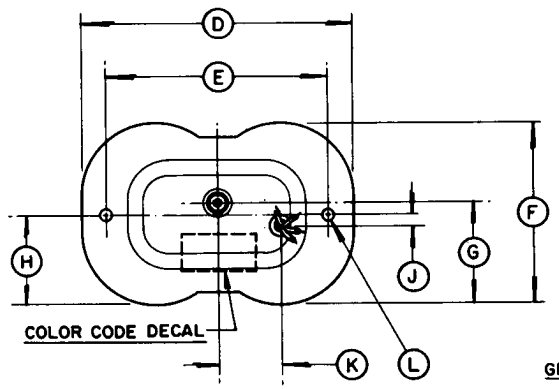
2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the EM-747 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the EM-747 package is typically .02% of the operating frequency per degree Centrigrade. Thus, for an operating frequency of 1000 megacycles, the temperature/frequency coefficient is typically 200 kilocycles per degree Centrigrade. A positive change in temperature will always produce a positive change in frequency. On special order, temperature compensation of .008% of the operating frequency per degree Centigrade can be provided.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			2.312
D		4.515	
E	3.640	3.671	
F		3.031	
G			1.656
H			1.500
J			.375
K			1.062
L			.187 D.



CONNECTIONS
GROUND - GREEN
HEATER – WHITE
HEATER CATHODE – BLACK
INJECTION ANODE – YELLOW

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

EM-779

TRAVELING WAVE TUBE
5.0 to 11.0 Gc.
1 Watt Minimum
30 db Gain



TENTATIVE DATA FOR EIMAC EM-779 TRAVELING WAVE TUBE

The Eimac EM-779 is a ruggedized, ceramic and metal, periodic permanent magnet focused, power-amplifier traveling wave tube. It is capable of delivering a minimum CW output power of one watt throughout the frequency range of 5.0 to 11.0 Gigacycles with a nominal small signal gain of 30 decibels. The EM-779 is designed to operate under severe environmental extremes of shock, vibration, temperature and altitude such as encountered in airborne applications.

The use of temperature compensated permanent magnets allows the EM-779 to be operated over a wide temperature range without degradation of performance. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Saturated Output Power	1 watt
Frequency Range	5.0 to 11.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3000 VOLTS
D-C FOCUS ELECTRODE VOLTAGE*:	
NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	25 MILLIAMPERES

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TYPICAL OPERATING CHARACTERISTICS

Frequency	5.0 to 11.0 gigacycles
Minimum Output Power	1.0 watts
Small Signal Gain	30 decibels
D-C Beam Voltage*	2950 volts
D-C Cathode Current	23 milliamperes
D-C Focus Electrode Voltage*	−30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-779 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-779 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

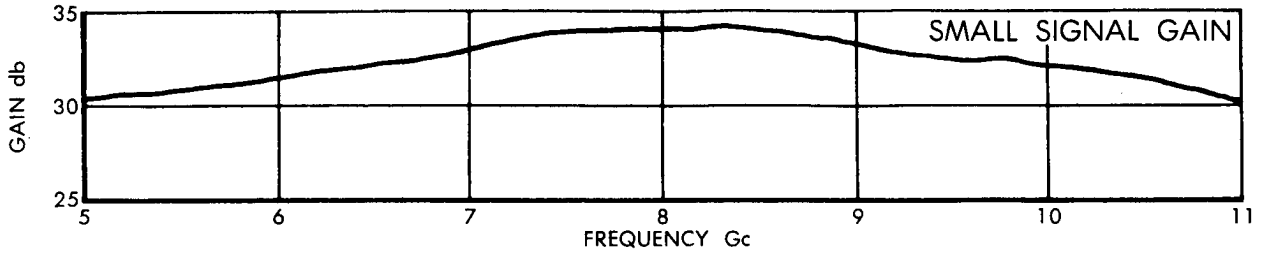
Temperature: −54°C to + 85°C

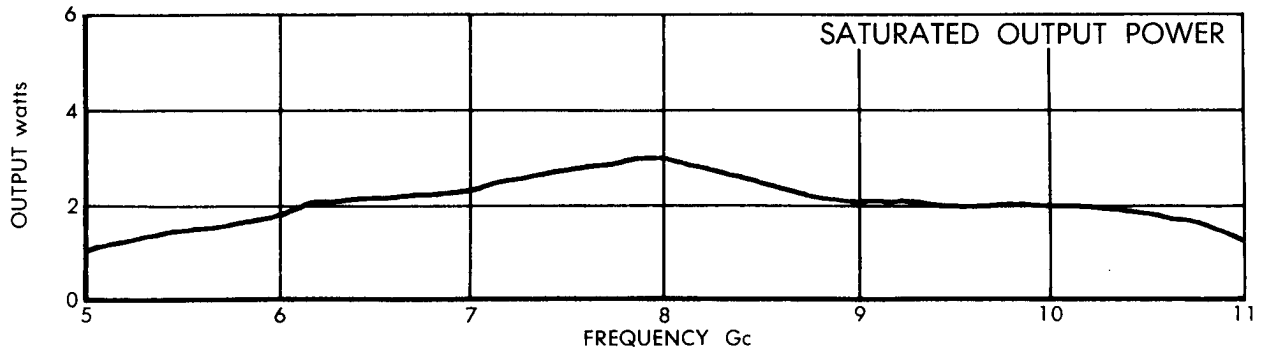
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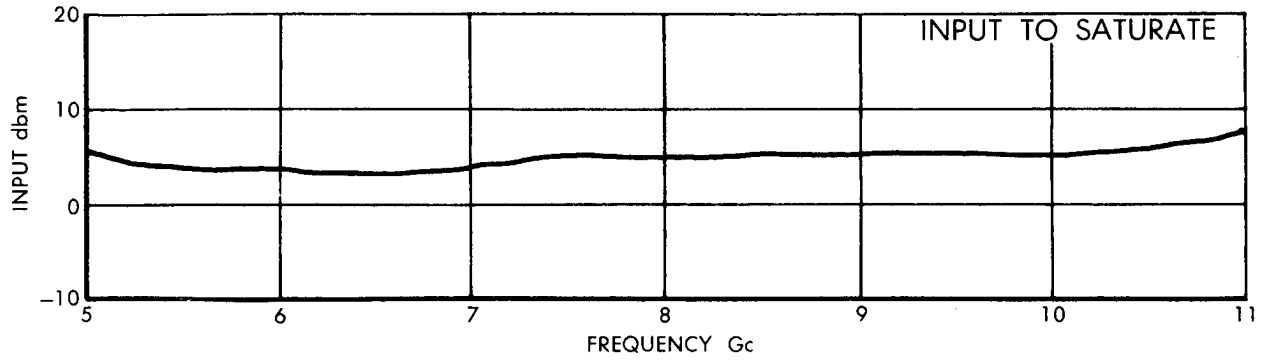
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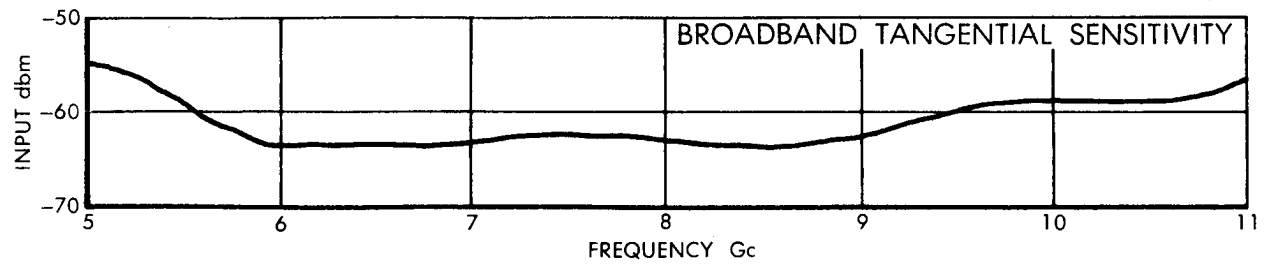
EM-779 TYPICAL OPERATING CHARACTERISTICS

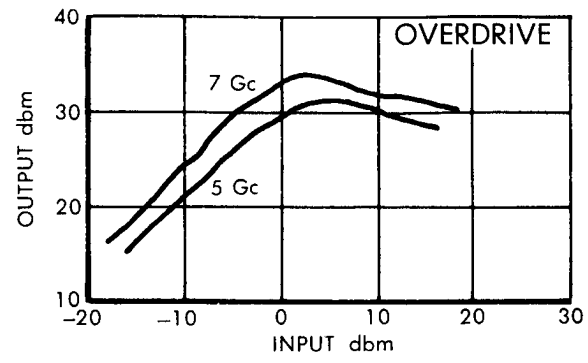
ANODE VOLTAGE	2950 Vdc	FOCUS VOLTAGE	−30 Vdc
CATHODE CURRENT	23 mAdc	FILAMENT VOLTAGE	6.3 Vac

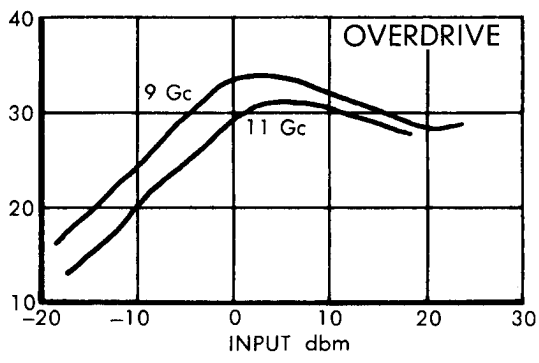








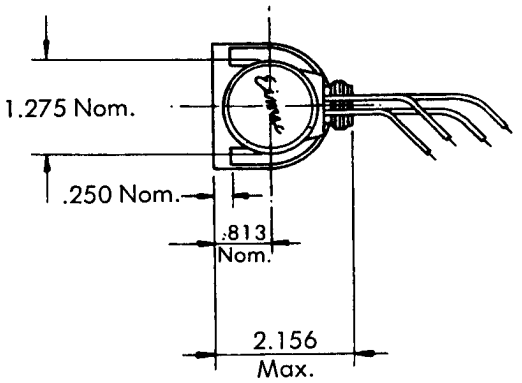


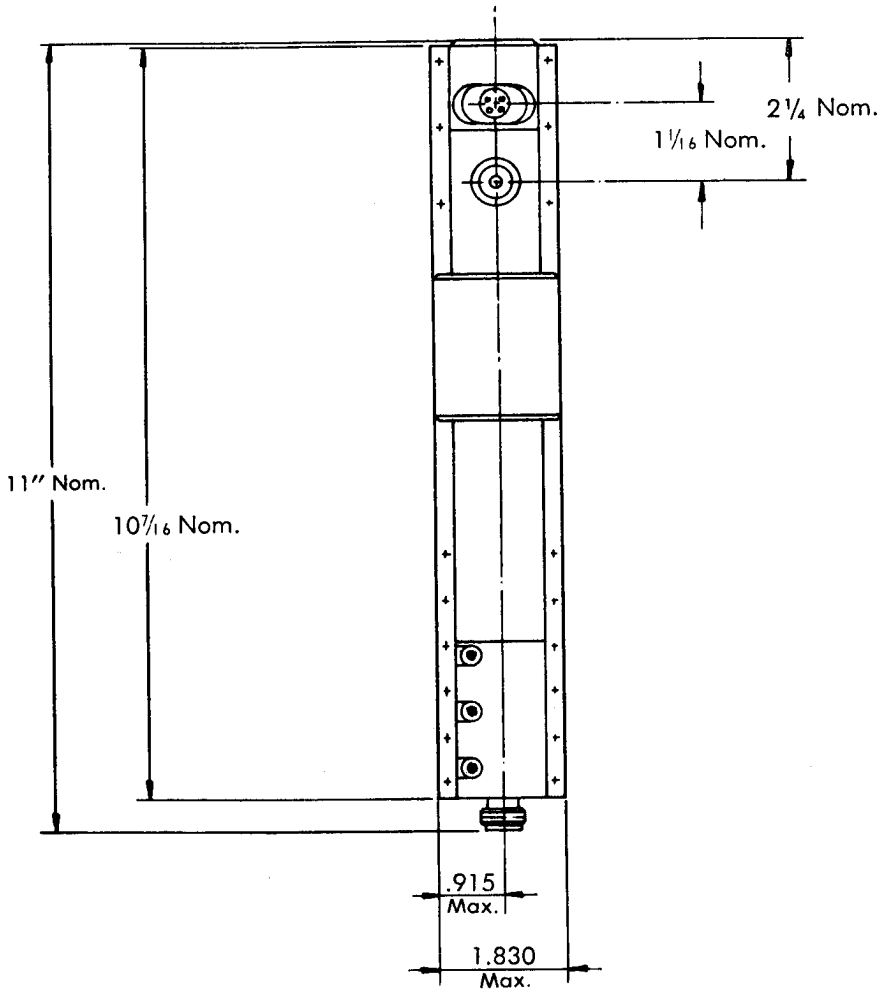


EM-779

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

EM-1011

TRAVELING WAVE TUBE
4.0 to 8.0 Gc.
1 Watt Min.
30 db Gain



TENTATIVE DATA FOR EIMAC EM-1011 TRAVELING WAVE TUBE

The Eimac EM-1011 is an intermediate-power traveling wave tube amplifier designed to operate in the 4.0 to 8.0 Gc frequency range. The EM-1011 will provide a minimum saturated power output of 1 watt over this frequency range with a nominal small signal gain of 30 db.

The EM-1011 features rugged ceramic and metal construction and focusing is provided by built-in periodic permanent magnets. These magnets are fully temperature compensated to allow operation from –55°C to + 85°C. No additional cooling is required at these temperatures due to the integral heat sink/mounting flange supplied with the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Saturated Output Power	1 watt
Frequency Range	4.0 to 8.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	2600 VOLTS
D-C FOCUS ELECTRODE VOLTAGE*:	
NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	30 MILLIAMPERES

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TYPICAL OPERATING CHARACTERISTICS

Frequency	4.0 to 8.0 gigacycles
Minimum Output Power	1.0 watt
Small Signal Gain	30 decibels
D-C Beam Voltage*	2550 volts
D-C Cathode Current	28 milliamperes
D-C Focus Electrode Voltage*	−30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1011 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1011 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

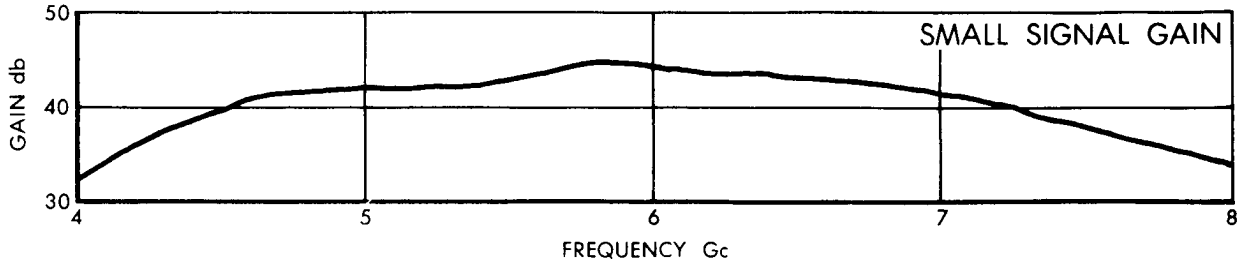
Temperature: −54°C to + 85°C

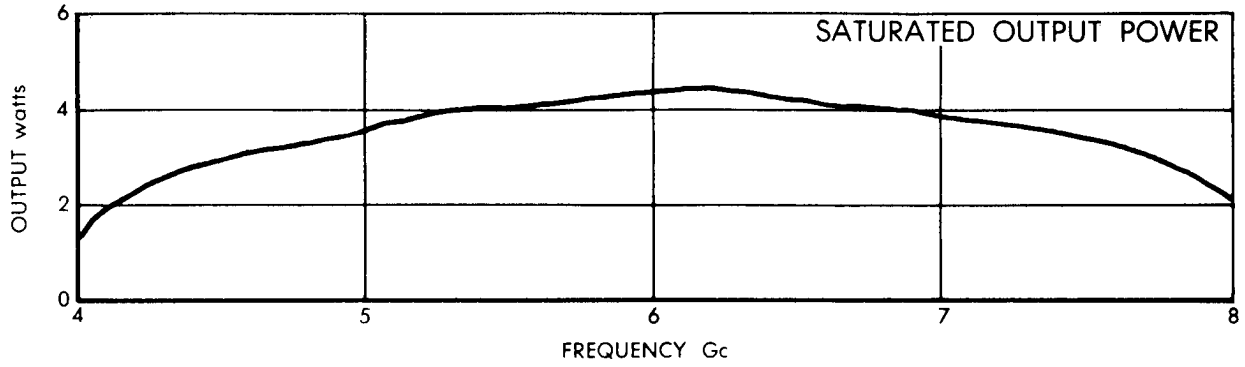
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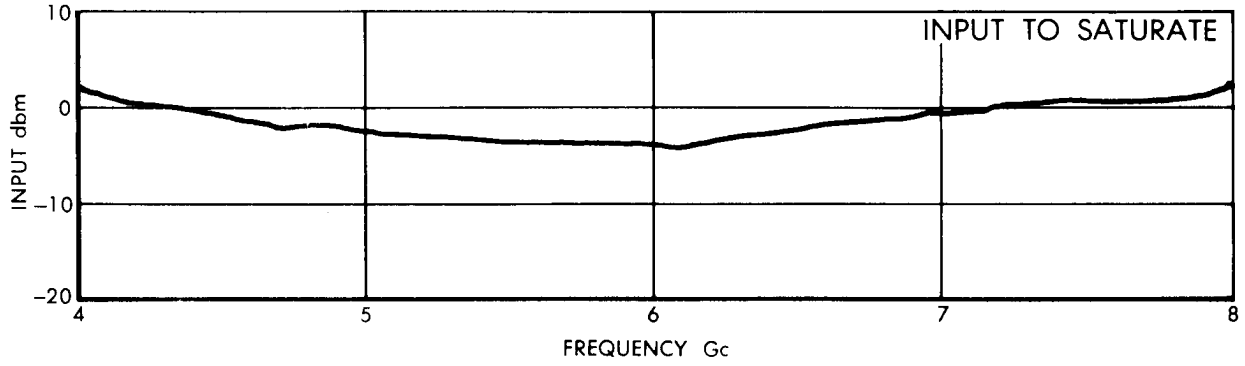
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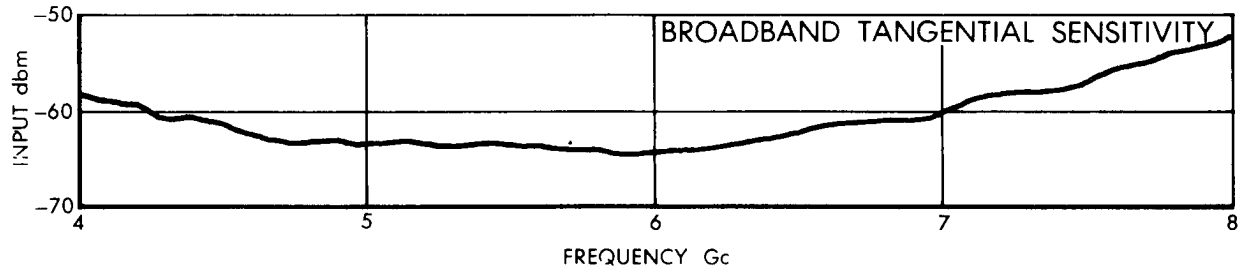
EM-1011 TYPICAL OPERATING CHARACTERISTICS

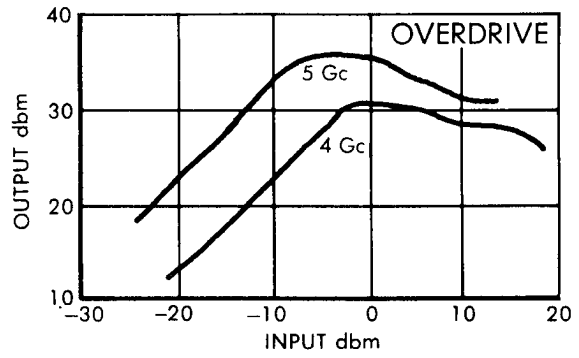
ANODE VOLTAGE	2550 Vdc	FOCUS VOLTAGE	−30 Vdc
CATHODE CURRENT	28 mAdc	FILAMENT VOLTAGE	6.3 Vac

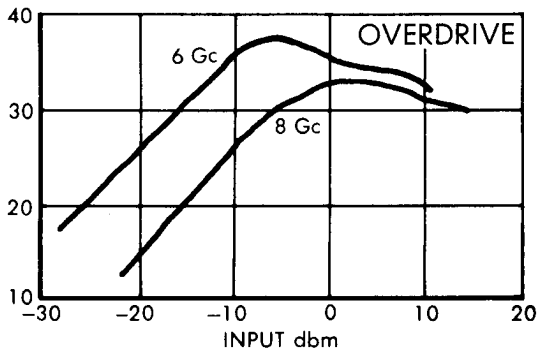








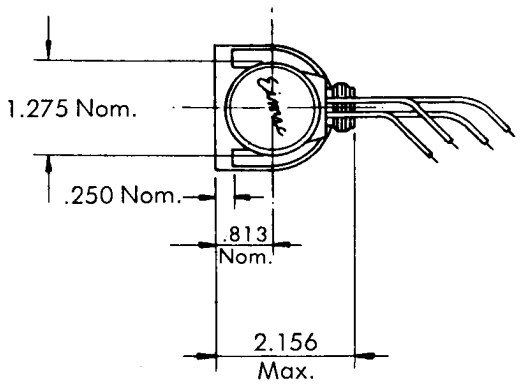


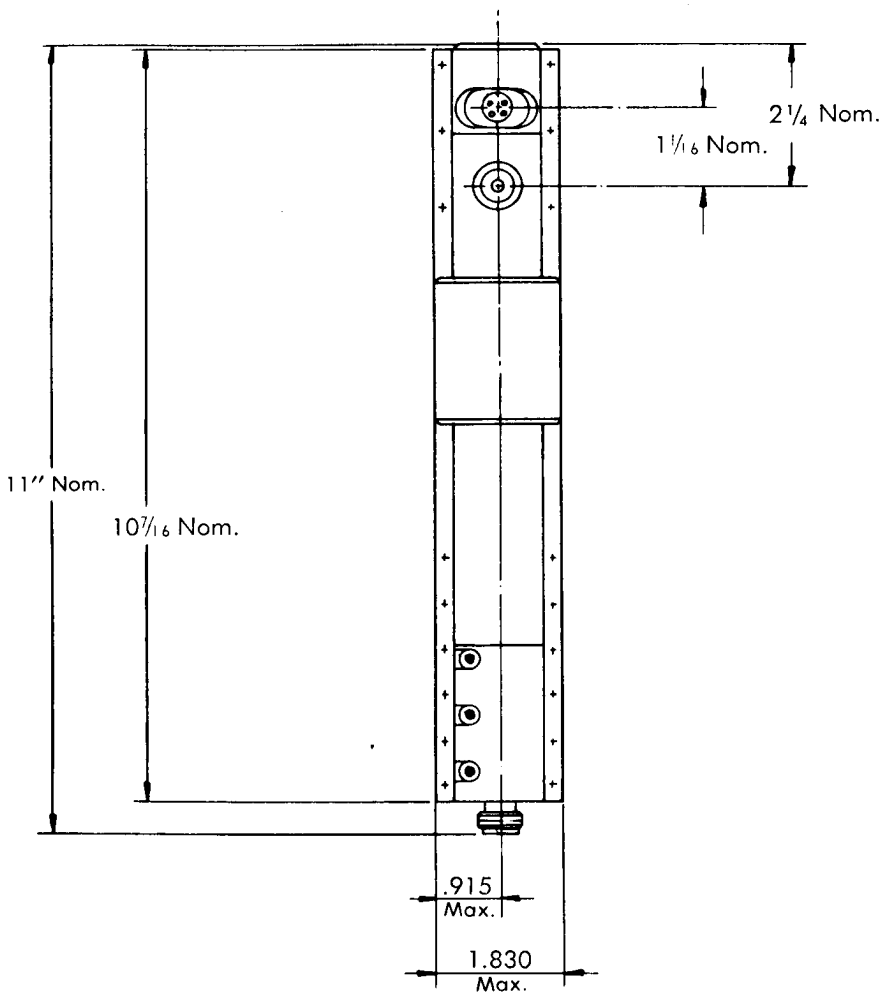


EM-1011

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

EM-1016

TRAVELING WAVE TUBE
4.0 to 8.0 Gc.
3 Watts Min.
30 db Gain



TENTATIVE DATA FOR EIMAC EM-1016 TRAVELING WAVE TUBE

The Eimac EM-1016 is an intermediate-power traveling wave tube amplifier designed to operate in the 4.0 to 8.0 Gc frequency range. The EM-1016 will provide a minimum saturated power output of 3 watts over this frequency range with a nominal small signal gain of 30 db.

The EM-1016 features rugged ceramic and metal construction and focusing is provided by built-in periodic permanent magnets. These magnets are fully temperature compensated to allow operation from –55°C to + 85°C. No additional cooling is required at these temperatures due to the integral heat sink/mounting flange supplied with the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	3 watts
Frequency Range	4.0 to 8.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	2600 VOLTS
D-C FOCUS ELECTRODE VOLTAGE:*	
NEGATIVE WITH RESPECT TO CATHODE	50 VOLTS
D-C CATHODE CURRENT	40 MILLIAMPERES

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TYPICAL OPERATING CHARACTERISTICS

Frequency	4.0 to 8.0 gigacycles
Minimum Output Power	3.0 watts
Small Signal Gain	30 decibels
D-C Beam Voltage*	2550 volts
D-C Cathode Current	35 milliamperes
D-C Focus Electrode Voltage*	−40 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1016 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1016 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

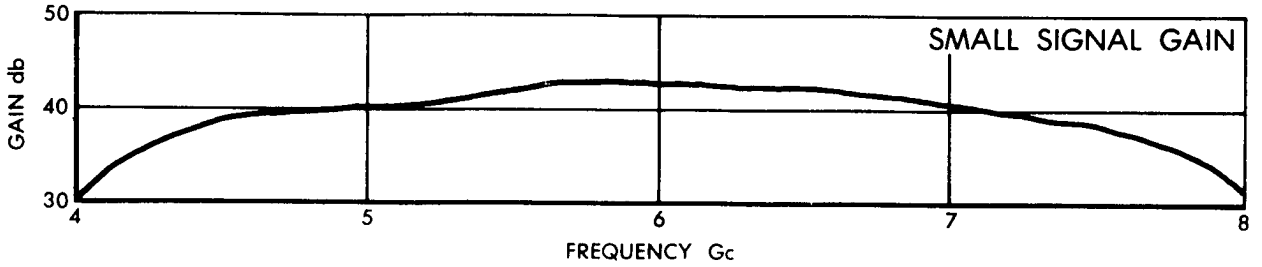
Temperature: −54°C to + 85°C

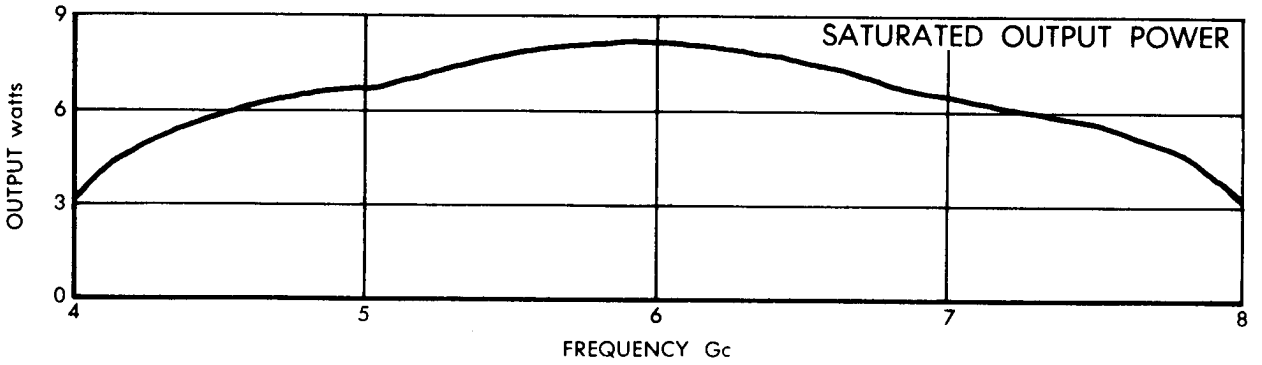
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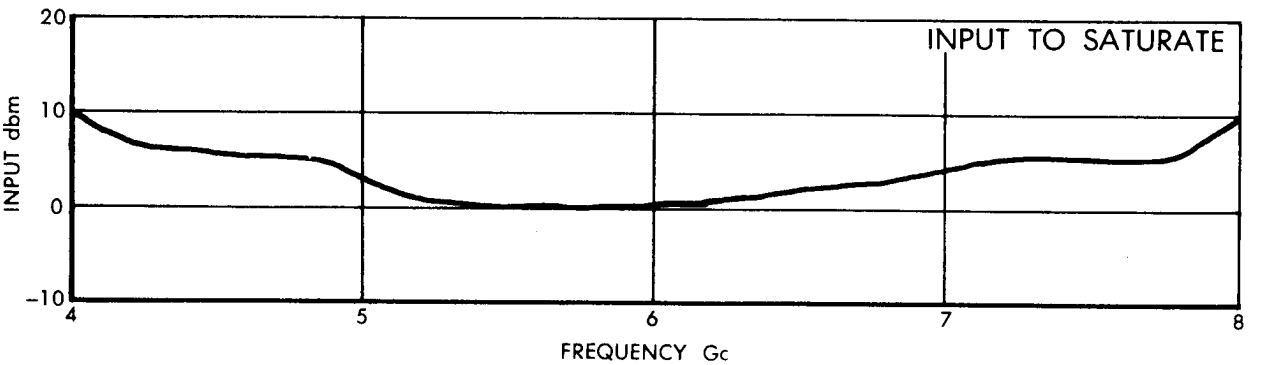
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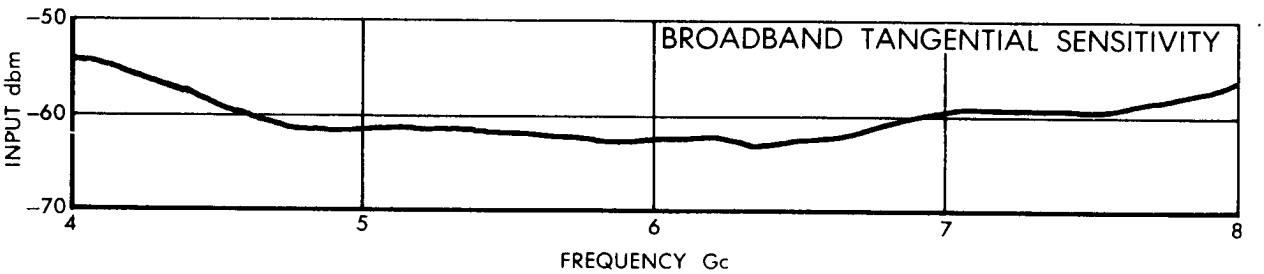
EM-1016 TYPICAL OPERATING CHARACTERISTICS

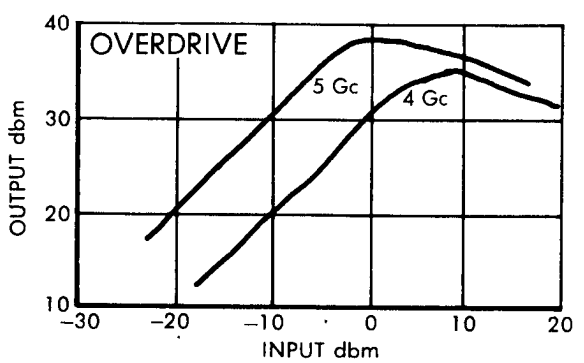
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CATHODE CURRENT 35 mAdc
FOCUS VOLTAGE −40 Vdc
FILAMENT VOLTAGE 6.3 V

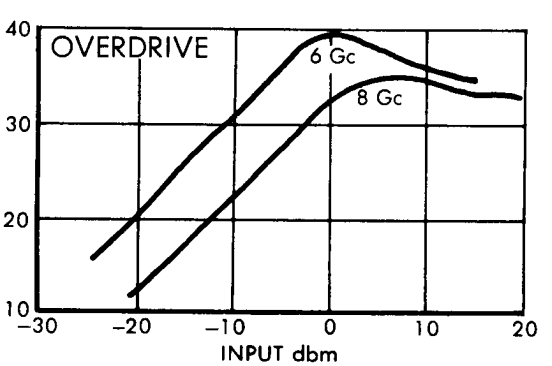








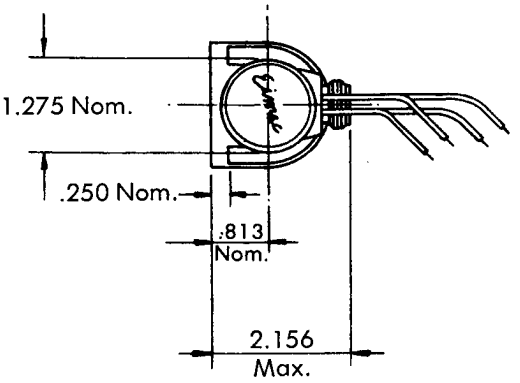


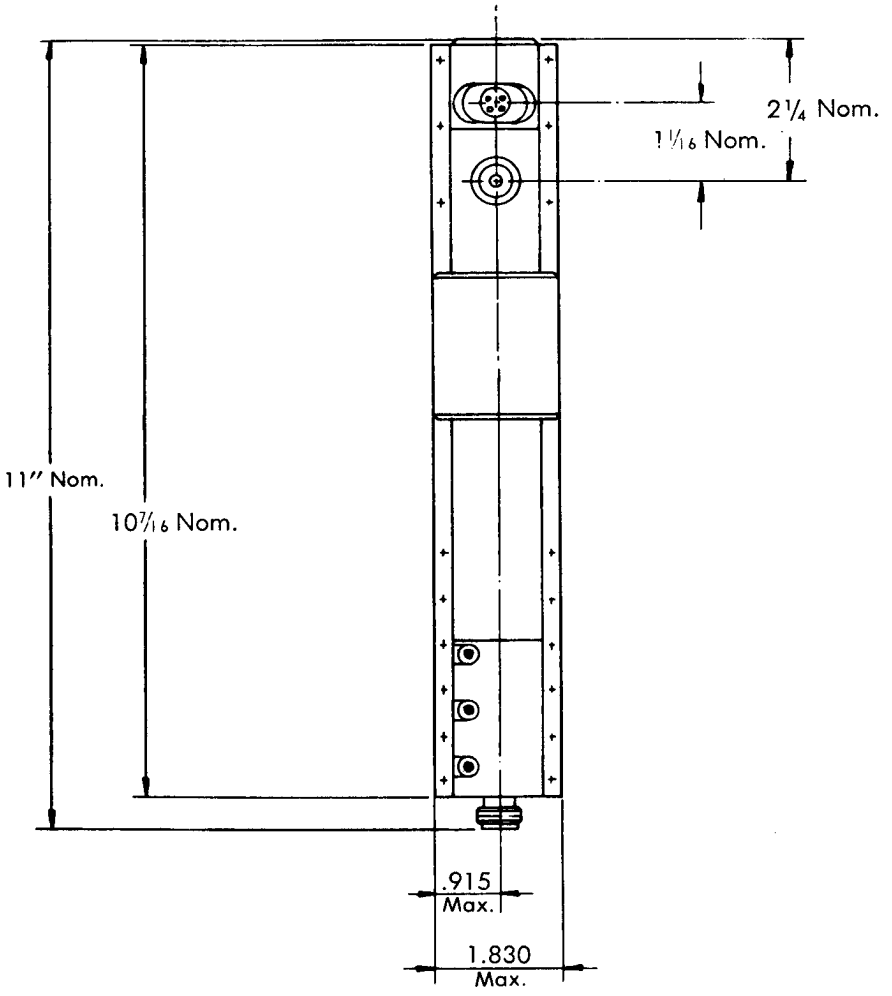


EM-1016

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

EM-1025

TRAVELING WAVE TUBE

4.0 to 12.0 Gc.

1 Watt Min.

40 db Gain



TENTATIVE DATA FOR EIMAC EM-1025 TRAVELING WAVE TUBE

The Eimac EM-1025 now offers performance over a frequency range that previously required **two or more** tubes to duplicate, providing 1 watt saturated power output from 4.0 to 12.0 gigacycles with 40 db gain! This tube is focused by light weight, periodic permanent magnets and utilizes proven ceramic and metal construction to insure reliable operation over a wide range of environments. The integral heat sink/mounting flange allows operation to + 85°C without additional cooling.

APPLICATIONS:

Wide bandwidth, high power output and high gain make the EM-1025 ideally suited for signal generators, power amplifier units or any application where these characteristics are required. In addition, the tube can be adapted to frequency-multiplier applications.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	−50 dbm
Minimum Saturated Output Power	1 watt
Frequency Range	4.0 to 12.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

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MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3000 VOLTS
D-C FOCUS ELECTRODE VOLTAGE:* NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	25 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	4.0 to 12.0 gigacycles
Minimum Output Power	1.0 watt
Small Signal Gain	40 decibels
D-C Beam Voltage*	2900 volts
D-C Cathode Current	23 milliamperes
D-C Focus Electrode Voltage*	−30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1025 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1025 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

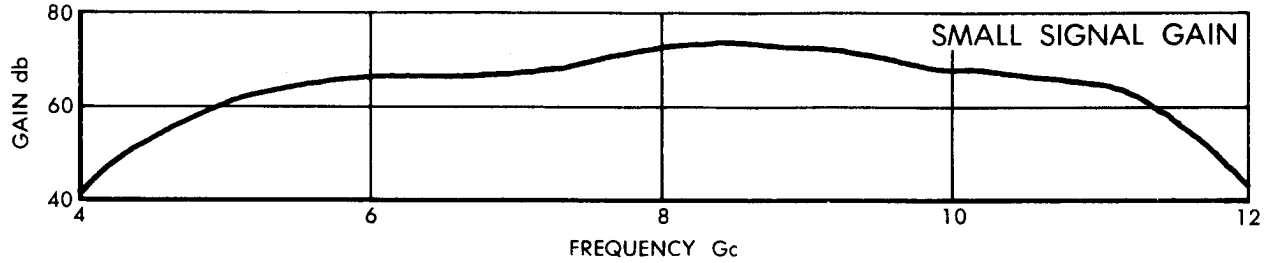
Temperature: −54°C to + 85°C

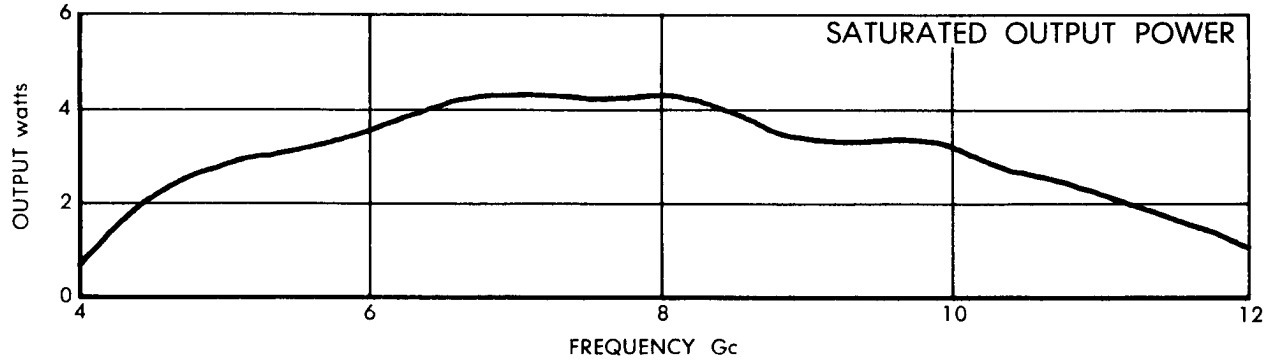
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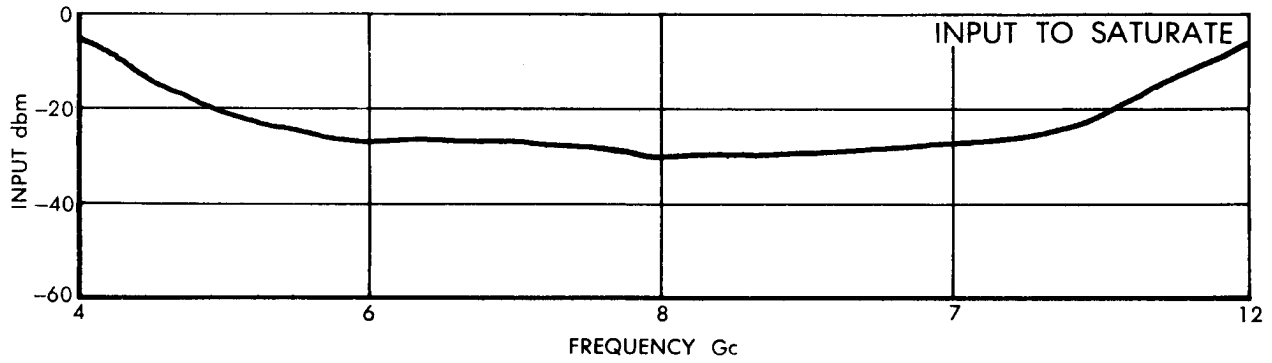
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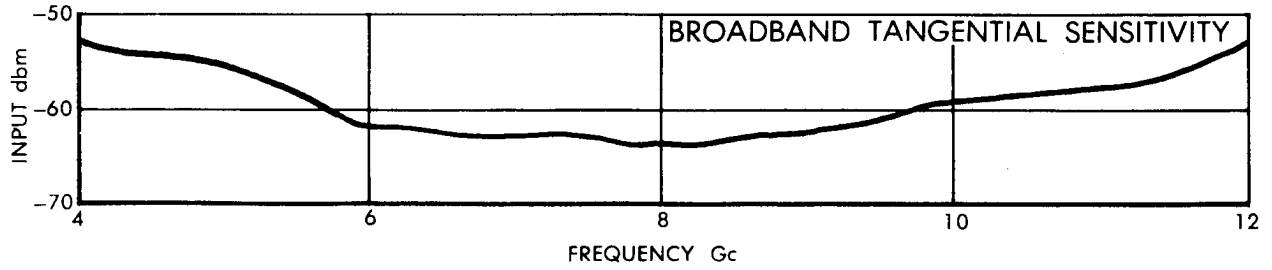
EM-1025 TYPICAL OPERATING CHARACTERISTICS

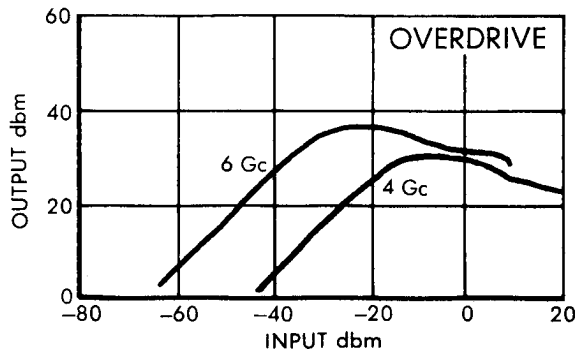
ANODE VOLTAGE 2900 Vdc
CATHODE CURRENT 23 mAdc
FOCUS VOLTAGE −30 Vdc
FILAMENT VOLTAGE 6.3 V

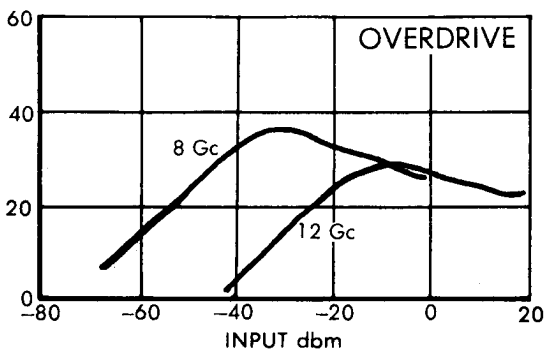








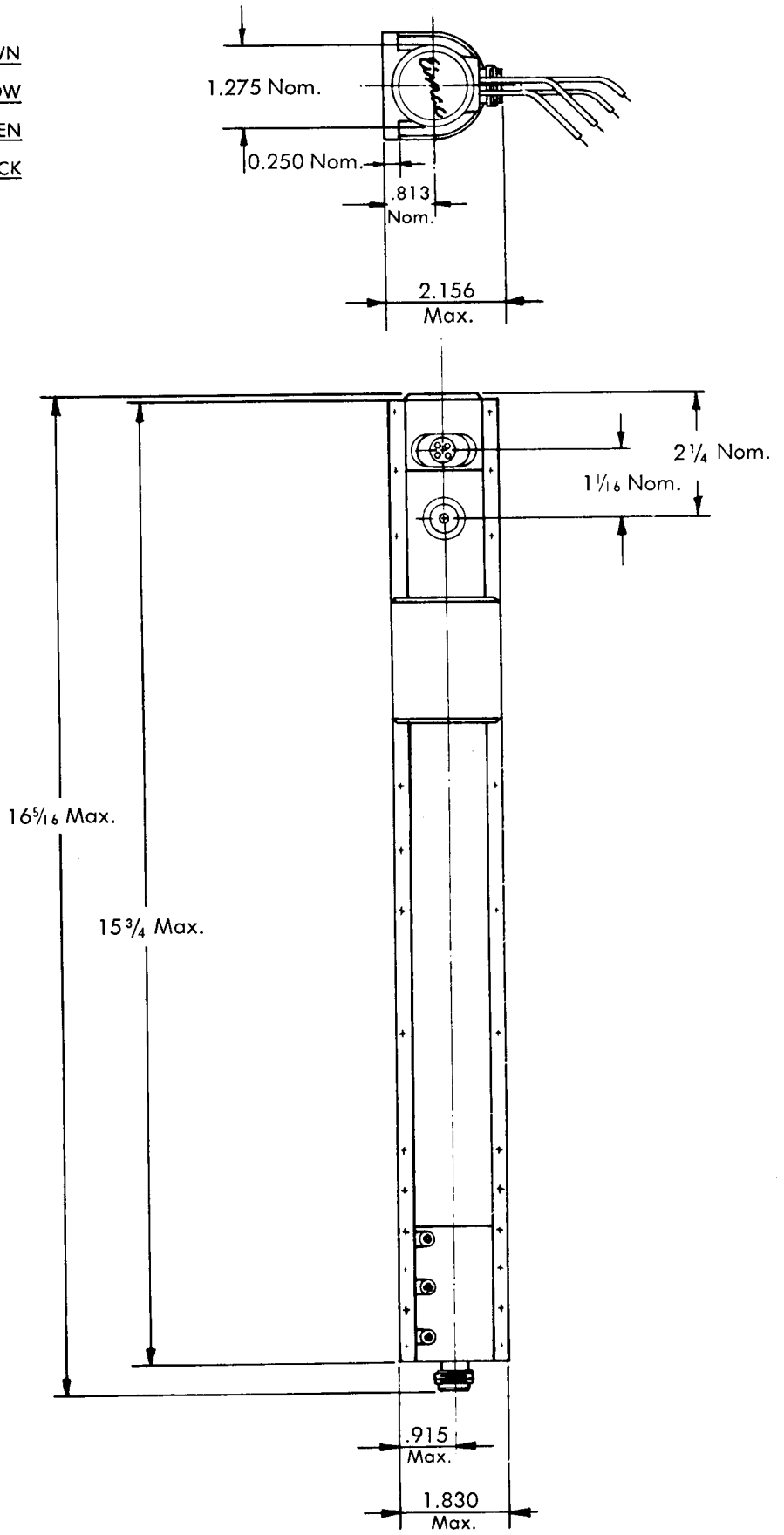




EM-1025

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK

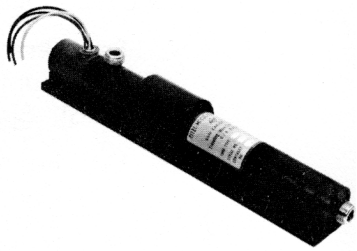


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

EM-1031

TRAVELING WAVE TUBE
7.0 to 11.0 Gc.
5 Watts Min.
30 db Gain



TENTATIVE DATA FOR EIMAC EM-1031 TRAVELING WAVE TUBE

The Eimac EM-1031 is a very rugged, light weight power-amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperature. The EM-1031 utilizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of 5 watts CW over the frequency range of 7.0 to 11.0 Gc with a nominal small signal gain of 30 db.

The integral heat sink/mounting flange allows operation to ambient temperatures of + 85°C without additional cooling. Flexible leads provide electrical connections to the tube. The integral heat sink/mounting flange permits this high temperature operation without additional cooling required for most applications.

APPLICATIONS:

Wide bandwidth, high power output and high gain make the EM-1031 ideally suited for radar augmentation or ECM applications in high performance aircraft or missile systems.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	5 watts
Frequency Range	7.0 to 11.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

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MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3400 VOLTS
D-C FOCUS ELECTRODE VOLTAGE:*	
NEGATIVE WITH RESPECT TO CATHODE	40 VOLTS
D-C CATHODE CURRENT	40 MILLIAMPERES

TYPICAL OPERATING CHARACTERISTICS

Frequency	7.0 to 11.0 gigacycles
Minimum Output Power	5.0 watts
Small Signal Gain	30 decibels
D-C Beam Voltage*	3350 volts
D-C Cathode Current	34 milliamperes
D-C Focus Electrode Voltage*	−30 volts
D-C Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1031 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

The EM-1031 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

Temperature: −54°C to + 85°C

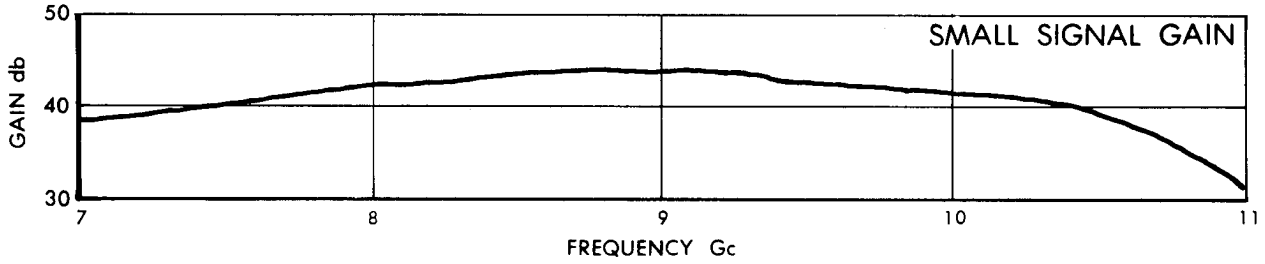
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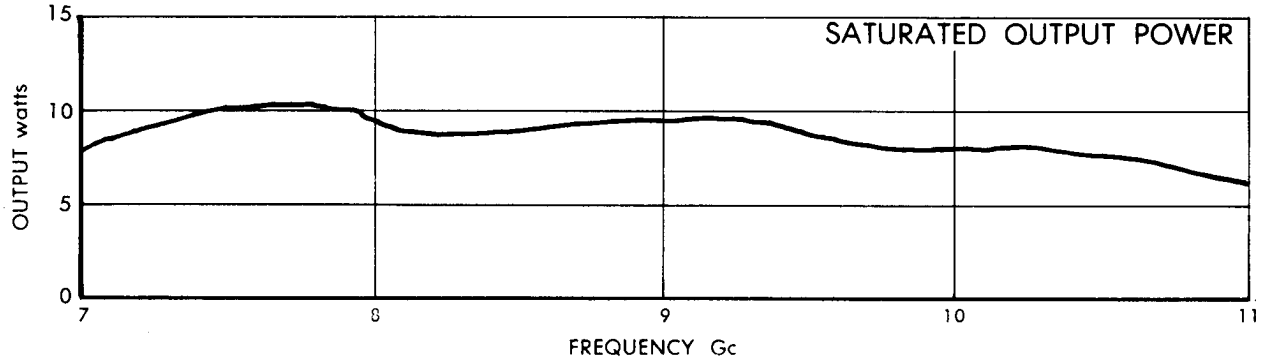
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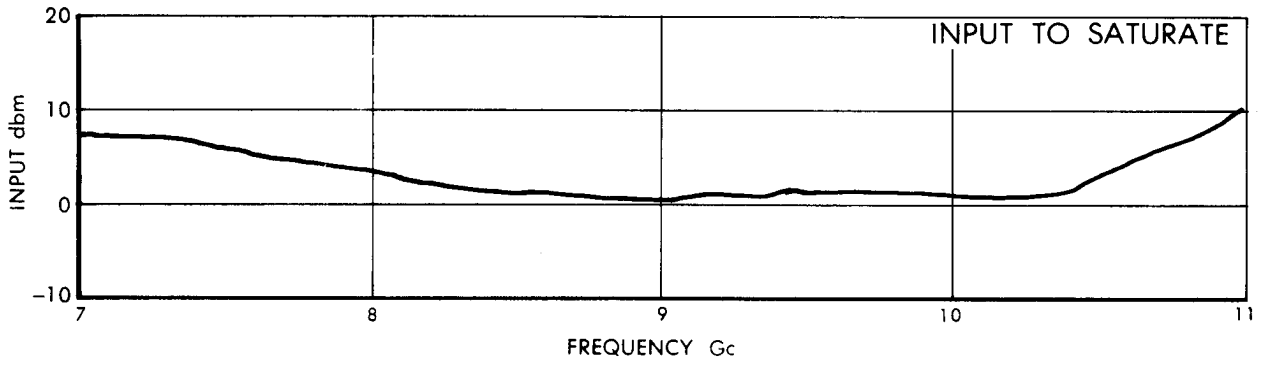
EM-1031 TYPICAL OPERATING CHARACTERISTICS

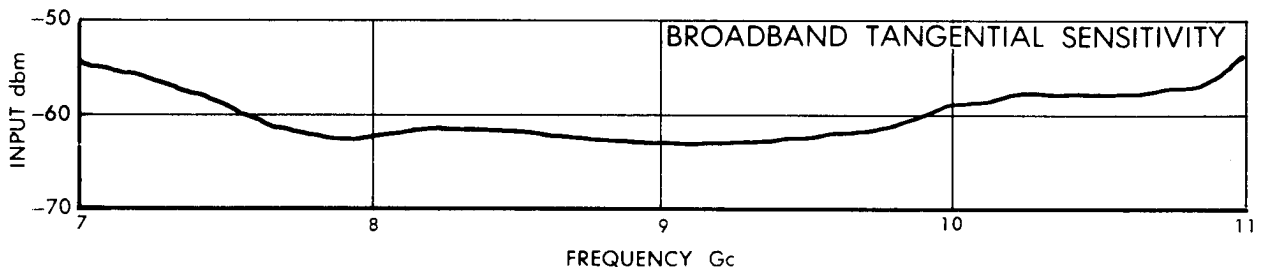
ANODE VOLTAGE 3350 Vdc
CATHODE CURRENT 34 mAdc

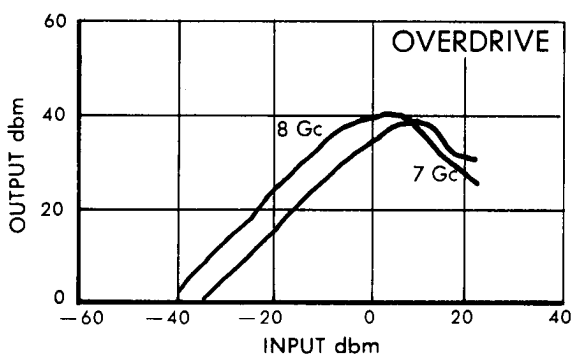
FOCUS VOLTAGE −30 Vdc
FILAMENT VOLTAGE 6.3 V

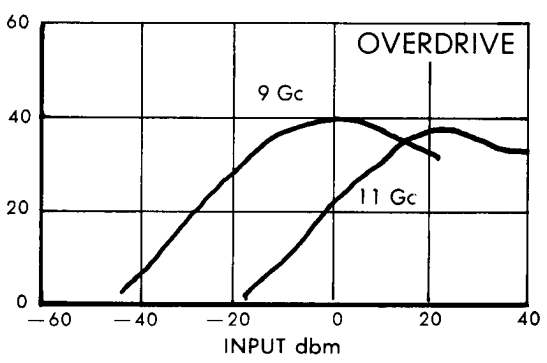








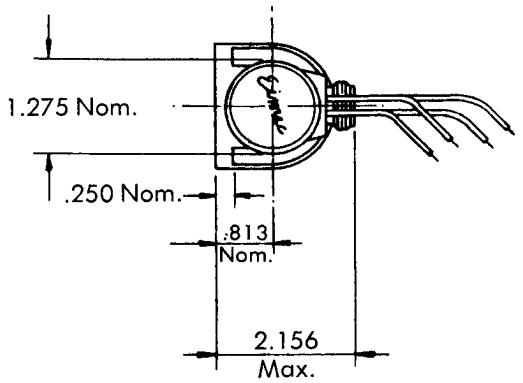


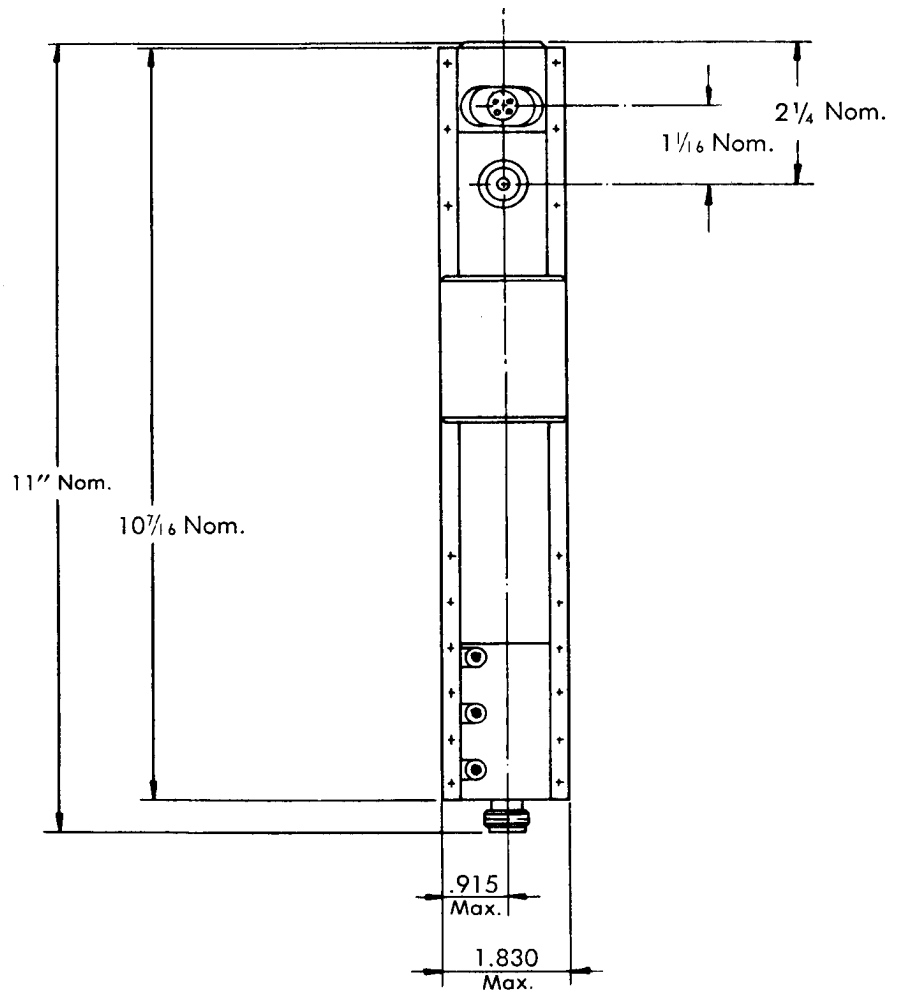


EM-1031

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





EIMAC
A Division of Varian Associates
SAN CARLOS, CALIFORNIA

Tentative Data

EM1046

TRAVELING WAVE TUBE

8.0 to 12.0 GHz
1 Watt Min.
30 db Gain

TENTATIVE DATA FOR EIMAC EM1046 TRAVELING WAVE TUBE



The EIMAC EM1046 is a ruggedized, ceramic and metal, periodic permanent magnet focused, power-amplifier traveling wave tube. It is capable of delivering a minimum CW output power of 1 watt throughout the frequency range of 8.0 to 12.0 gigahertz with a nominal small signal gain of 30 decibels. The EM1046 is designed to operate under severe environmental extremes of shock, vibration, temperature and altitude such as encountered in airborne applications.

The use of temperature compensated permanent magnets allows the EM1046 to be operated over a wide temperature range without degradation of performance. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	—50 dbm
Minimum Saturated Output Power	1 watt
Frequency Range	8.0 to 12.0 gigahertz
Input and Output Impedence	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

DC Beam Voltage*	3000 volts
DC Focus Electrode Voltage*:	
Negative with respect to Cathode	40 volts
DC Cathode Current	25 milliamperes

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TYPICAL OPERATING CHARACTERISTICS

Frequency	8.0 to 12.0 gigahertz
Minimum Output Power	1.0 watt
Small Signal Gain	30 decibels
DC Beam Voltage*	2950 volts
DC Cathode Current	23 milliamperes
DC Focus Electrode Voltage*	—30 volts
DC Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM1046 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ±5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ±1 per cent to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ±2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, Calif.

ENVIRONMENTAL

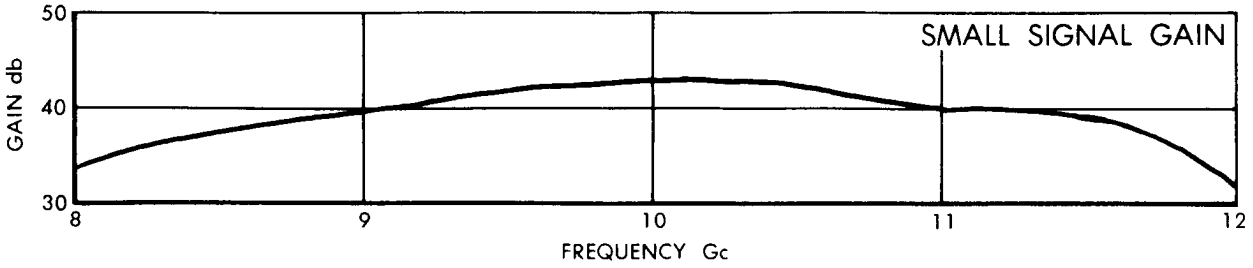
The EM1046 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

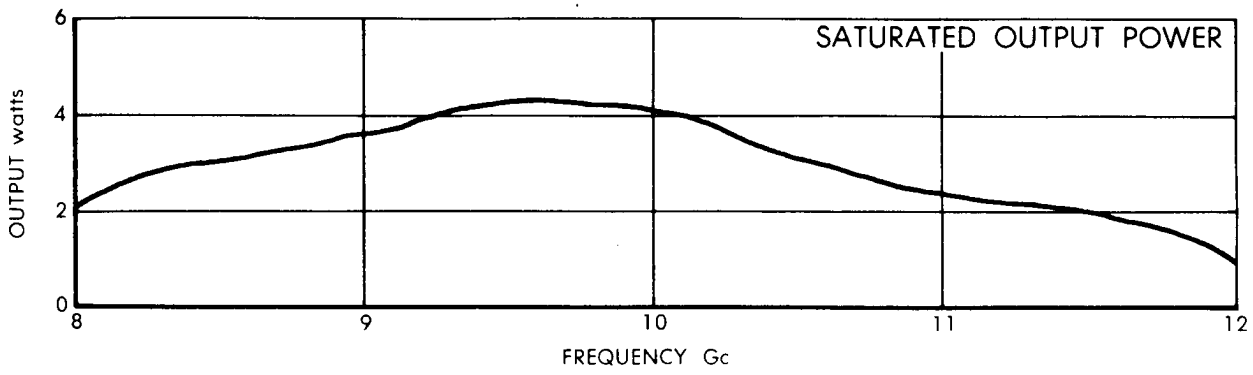
Vibration	10 g to 2000 Hz (Curve A of Proc. XII, MIL-E-5272C)
Shock	25 g, 11 ±1 ms
Acceleration	Sustained, 25 g's
Temperature	—54°C to +85°C
Altitude	70,000 ft.

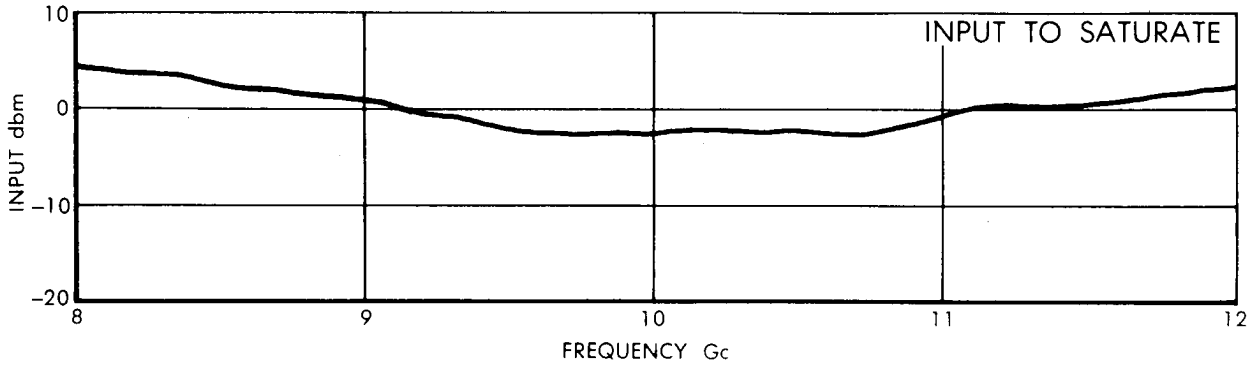
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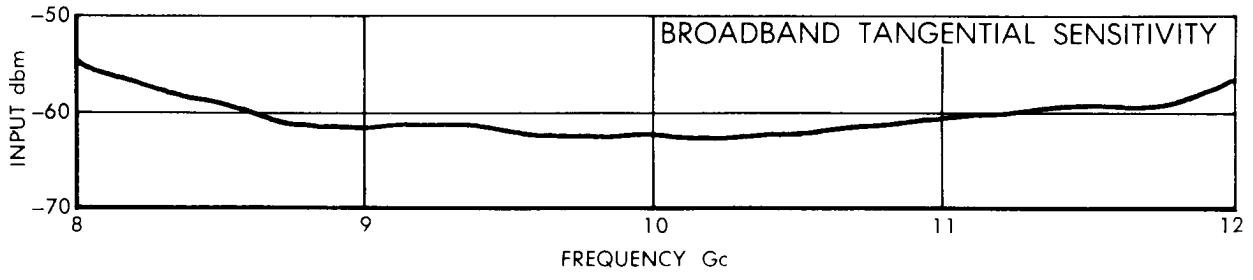
EM-1046 TYPICAL OPERATING CHARACTERISTICS

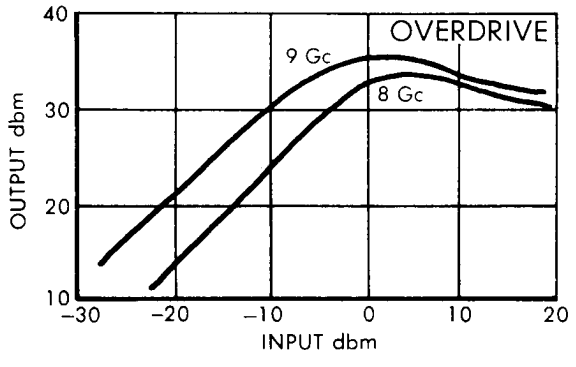
ANODE VOLTAGE	2950 Vdc	FOCUS VOLTAGE	−30 Vdc
CATHODE CURENT	23 mAdc	FILAMENT VOLTAGE	6.3 Vac

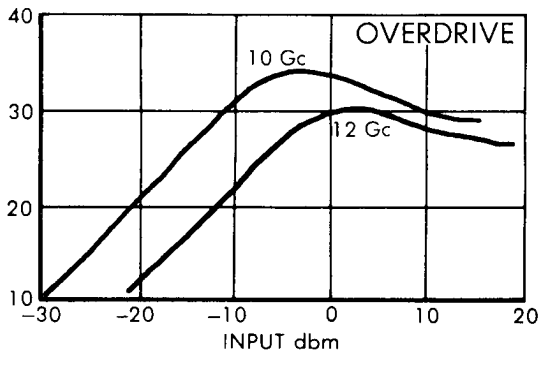








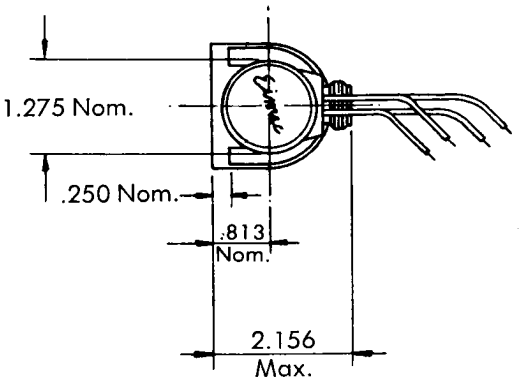


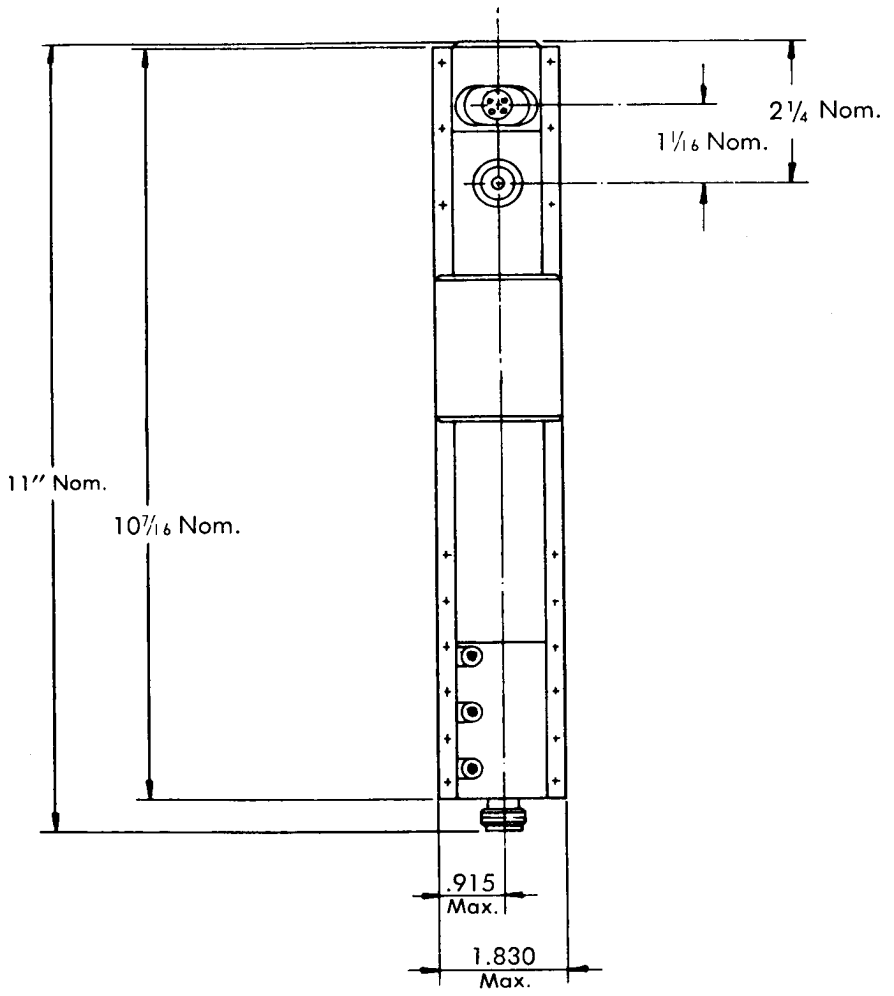


EM-1046

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

EM-1050

TRAVELING WAVE TUBE

8.0 to 12.0 Gc.

3 Watts Min.

60 db Gain



TENTATIVE DATA FOR EIMAC EM-1050 TRAVELING WAVE TUBE

The Eimac EM-1050 is an intermediate-power traveling wave tube amplifier designed to operate in the 8.0 to 12.0 Gc frequency range. The EM-1050 will provide a minimum saturated power output of 3 watts over this frequency range with a nominal small signal gain of 60 db.

The EM-1050 features rugged ceramic and metal construction and focusing is provided by built-in periodic permanent magnets. These magnets are fully temperature compensated to allow operation from –55 to + 85°C. No additional cooling is required at these temperatures due to the integral heat sink/mounting flange supplied with the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	–50 dbm
Minimum Saturated Output Power	3 watts
Frequency Range	8.0 to 12.0 gigacycles
Input and Output Impedance	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	4.5 Pounds

MAXIMUM RATINGS

D-C BEAM VOLTAGE*	3500 VOLTS
D-C FOCUS ELECTRODE VOLTAGE* NEGATIVE WITH RESPECT TO CATHODE	50 VOLTS
D-C CATHODE CURRENT	30 MILLIAMPERES

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TYPICAL OPERATING CHARACTERISTICS

Frequency	8.0 to 12.0	gigacycles
Minimum Output Power	3.0	watts
Small Signal Gain	60	decibels
D-C Beam Voltage*	3300	volts
D-C Cathode Current	28	milliamperes
D-C Focus Electrode Voltage*	−40	volts
D-C Focus Electrode Current	0	milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM-1050 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ± 5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ± 1% to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ± 2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California.

ENVIRONMENTAL

The EM-1050 conforms generally with MIL-E-5272C, "Environmental Testing, Areonautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

Vibration: 10 g to 2000 cps (Curve A of Proc. XII, MIL-E-5272C)

Shock: 25 g, 11 ± 1 ms

Acceleration: Sustained, 25 g's

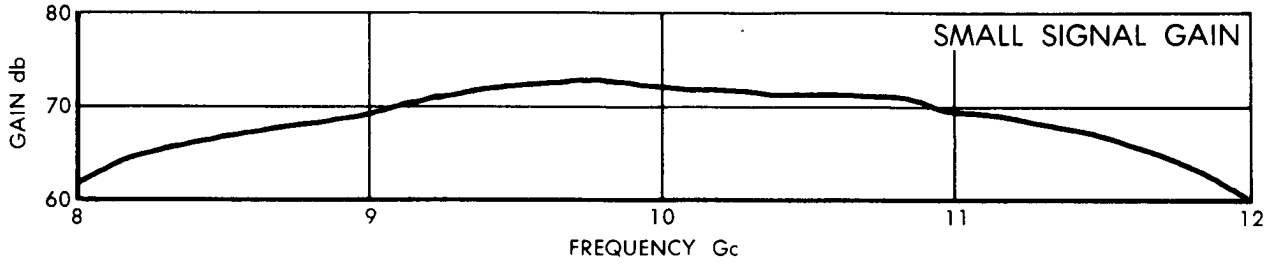
Temperature: −54°C to + 85°C

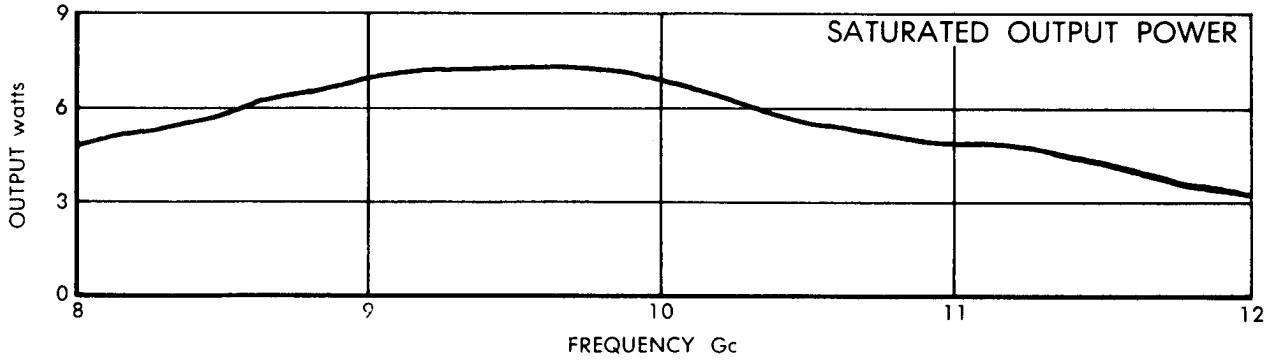
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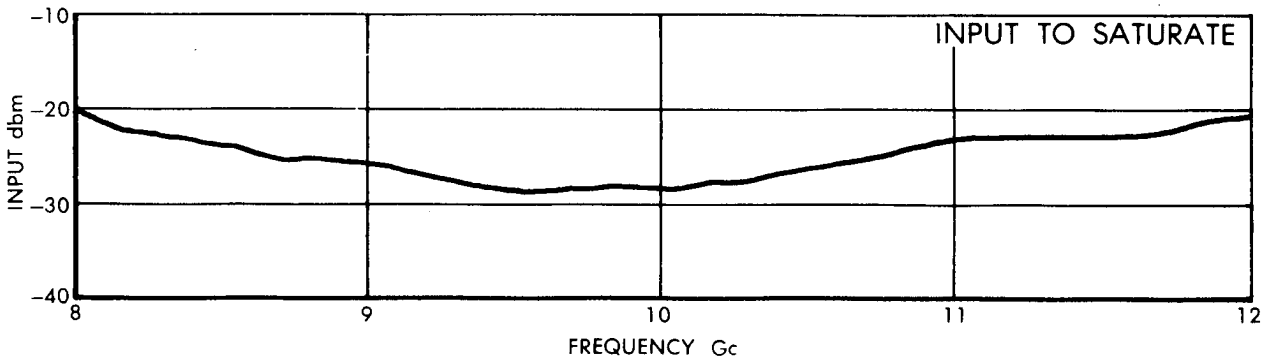
NOTE: This data should not be used for final equipment design.

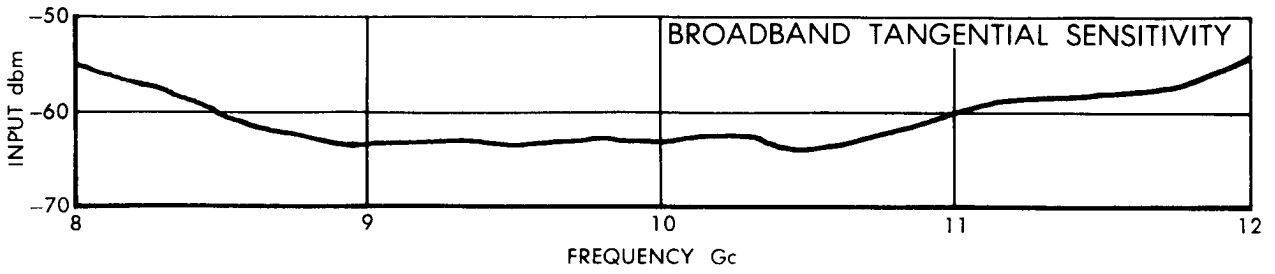
EM-1050 TYPICAL OPERATING CHARACTERISTICS

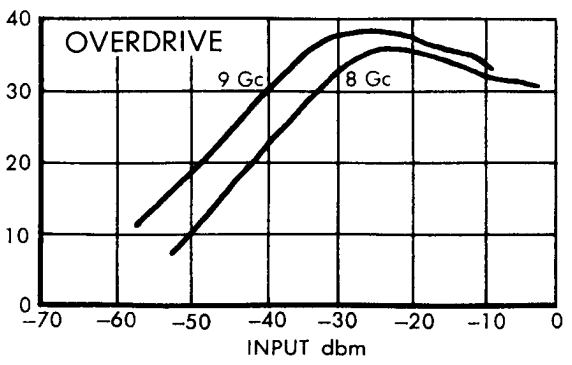
ANODE VOLTAGE 3300 Vdc
CATHODE CURRENT 28 mAdc
FOCUS VOLTAGE −40 Vdc
FILAMENT VOLTAGE 6.3 Vac

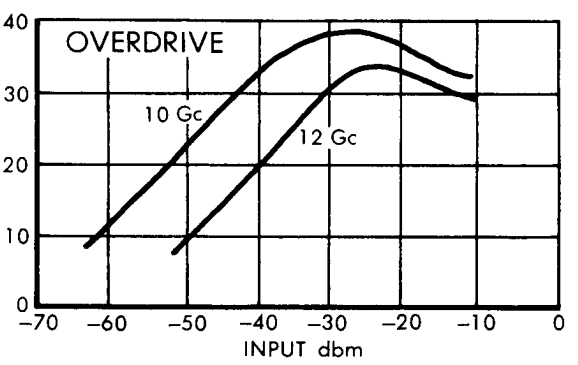








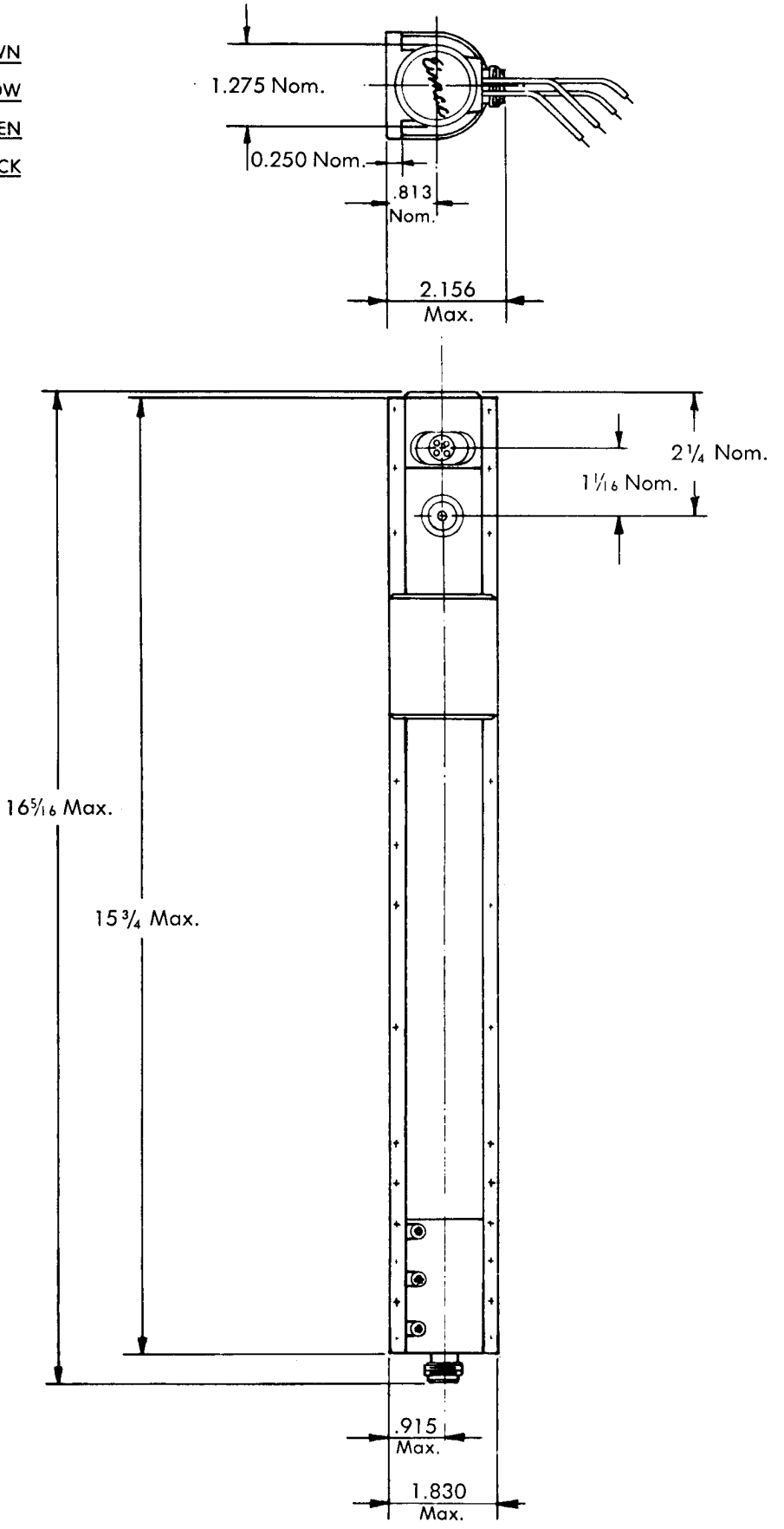




EM-1050

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK



EIMAC
A Division of Varian Associates
SAN CARLOS, CALIFORNIA

Tentative Data

EM1051

TRAVELING WAVE TUBE

8.0 to 12.0 GHz
3 Watts Min.
30 db Gain

TENTATIVE DATA FOR EIMAC EM1051 TRAVELING WAVE TUBE



The EIMAC EM1051 is a very rugged, light weight power-amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperature. The EM1051 utilizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of 3 watts CW over the frequency range of 8.0 to 12.0 GHz with a nominal small signal gain of 30 db.

The integral heat sink/mounting flange allows operation to ambient temperatures of +85°C without additional cooling. Flexible leads provide electrical connections to the tube.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	60 seconds
Heater: Voltage	6.3 volts
Current	0.6 amperes
Noise Figure	25 to 34 decibels
Minimum Tangential Sensitivity (Broadband)	—50 dbm
Minimum Saturated Output Power	3 watts
Frequency Range	8.0 to 12.0 gigahertz
Input and Output Impedence	50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Passive Heat Sink
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	2.5 Pounds

MAXIMUM RATINGS

DC Beam Voltage*	3500 volts
DC Focus Electrode Voltage*:	
Negative with respect to Cathode	50 volts
DC Cathode Current	30 milliamperes

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Printed in U.S.A.

TYPICAL OPERATING CHARACTERISTICS

Frequency	8.0 to 12.0 gigahertz
Minimum Output Power	3.0 watts
Small Signal Gain	30 decibels
DC Beam Voltage*	3300 volts
DC Cathode Current	28 milliamperes
DC Focus Electrode Voltage*	—40 volts
DC Focus Electrode Current	0 milliamperes

*All voltages referred to cathode.

APPLICATION

Cooling: The EM1051 is designed to be heat sink cooled by means of the mounting available and integral with the tube and PPM structure. Under environmental conditions normally encountered in military equipments, additional cooling will not be required.

Cathode: The heater voltage should be maintained within ±5 per cent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

Helix: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials. The cathode potential should be maintained within ±1 per cent to insure proper operation.

Focus Electrode: The focus electrode power supply must be regulated within ±2 per cent to minimize variations in performance.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, Calif.

ENVIRONMENTAL

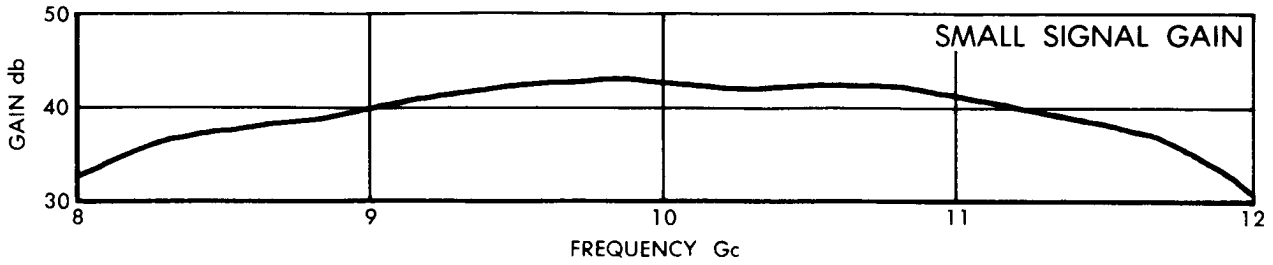
The EM1051 conforms generally with MIL-E-5272C, "Environmental Testing, Aeronautical and Associated Equipment, General Specification for," and MIL-E-5400, "Electronic Equipment, Aircraft, General Specification for," Class II.

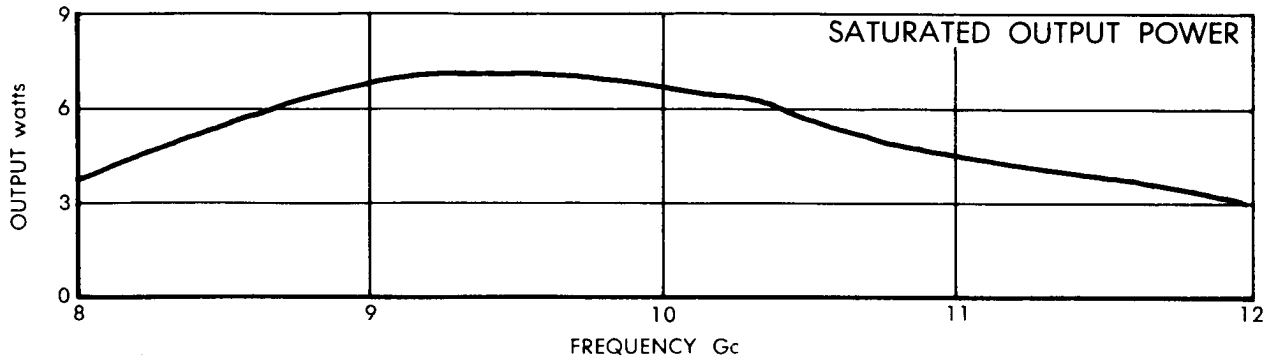
Vibration	10 g to 2000 Hz (Curve A of Proc. XII, MIL-E-5272C)
Shock	25 g, 11 ±1 ms
Acceleration	Sustained, 25 g's
Temperature	—54°C to +85°C
Altitude	70,000 ft.

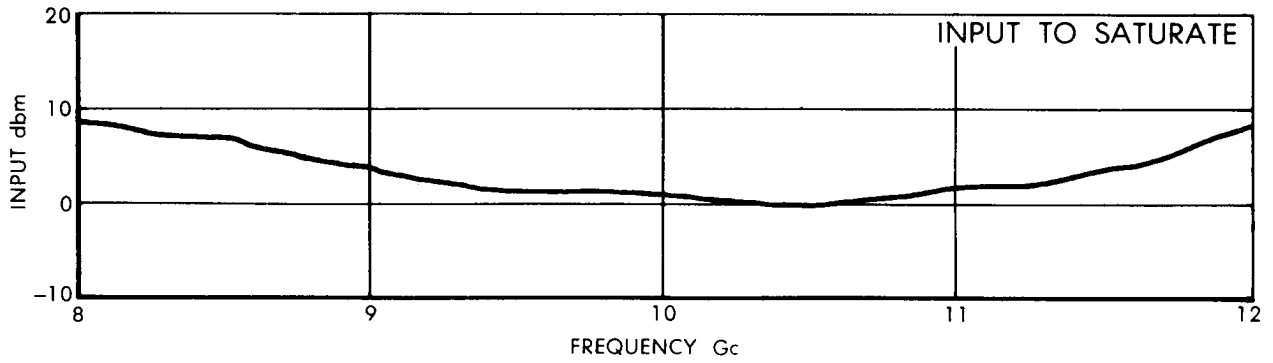
Note: This data should not be used for final equipment design.

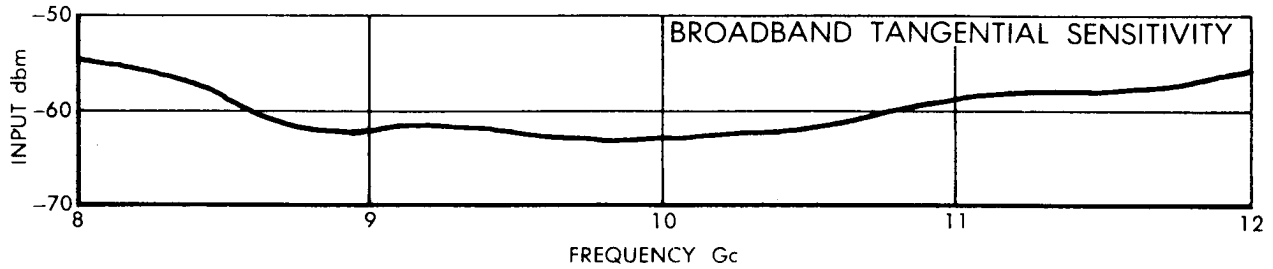
EM-1051 TYPICAL OPERATING CHARACTERISTICS

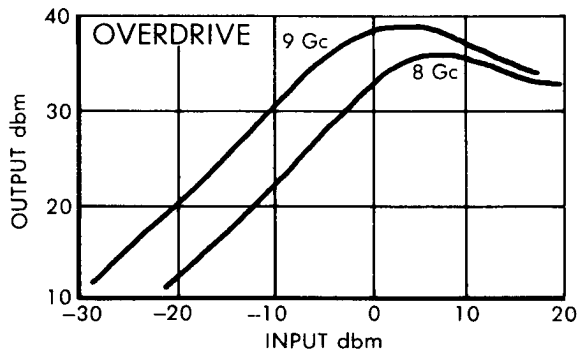
ANODE VOLTAGE 3300 Vdc
CATHODE CURRENT 28 mAdc
FOCUS VOLTAGE −40 Vdc
FILAMENT VOLTAGE 6.3 Vac

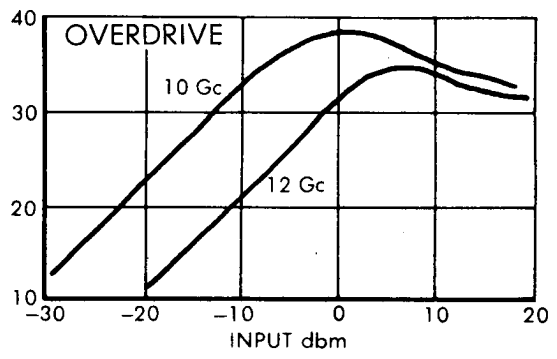








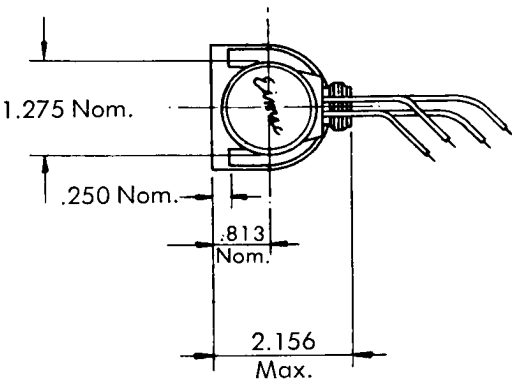


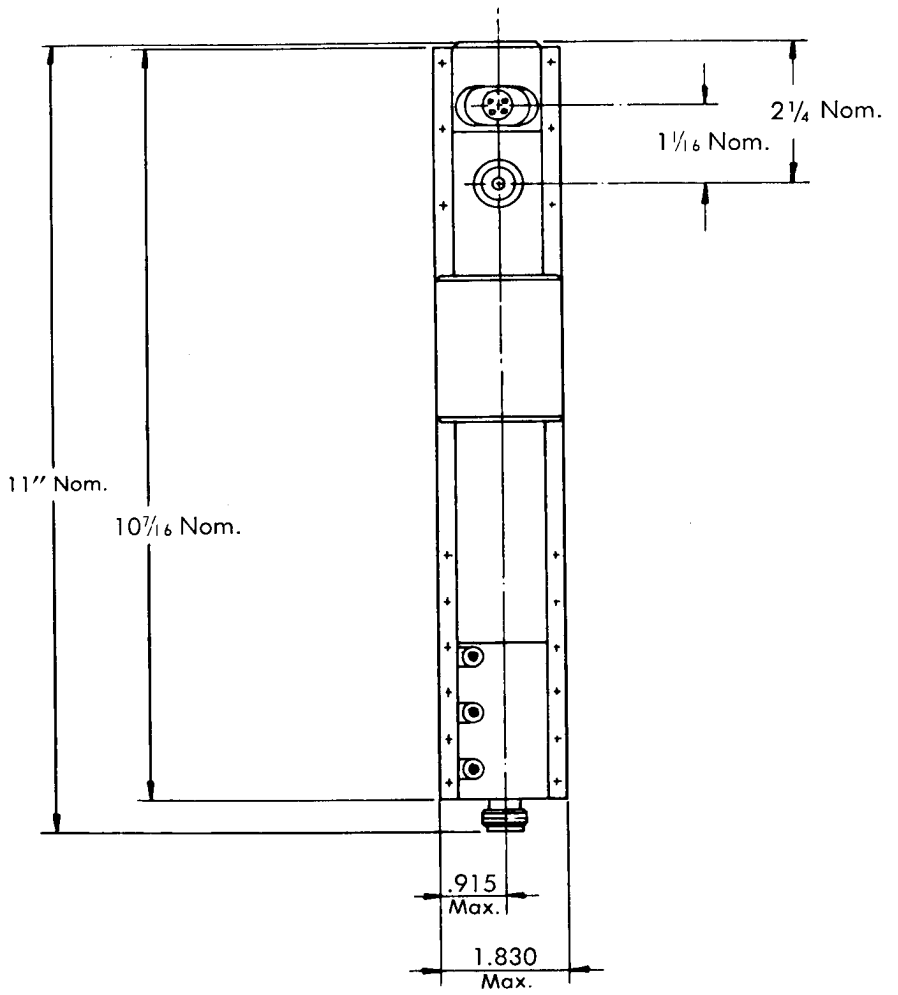


EM-1051

CONNECTIONS

1. HEATER —BROWN
2. CATHODE HEATER—YELLOW
3. FOCUS ELECTRODE —GREEN
4. BODY GROUND —BLACK





EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

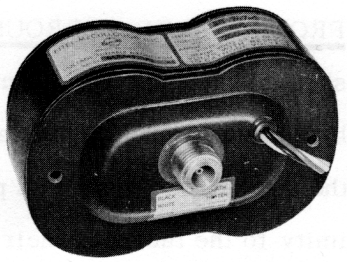
EM-1080

VOLTAGE TUNABLE MAGNETRON

FREQUENCY
1.2-2.2 kMc

MINIMUM OUTPUT POWER
100 mW

TYPICAL PERFORMANCE



S-BAND OSCILLATOR

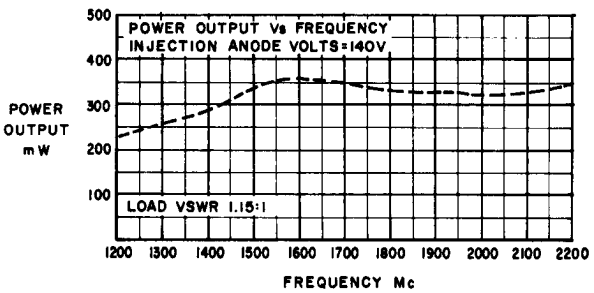
ELECTRICAL

Frequency Range	1.2-2.2 kMc
Anode Voltage	800-1400 V
Cathode Current	2-15 mA
Typical Output Power	140-300 mW
Anode FM Sensitivity	1.68 Mc/V
Injection Anode Voltage	200 V
Injection Anode Current	0.1 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw

*MAXIMUM RATINGS

Anode Voltage	1500 V
Cathode Current	25 mA
Injection Anode Voltage	+700 V
Injection Anode Current	1 mA

* Damage to the tube may occur if maximum ratings are exceeded.

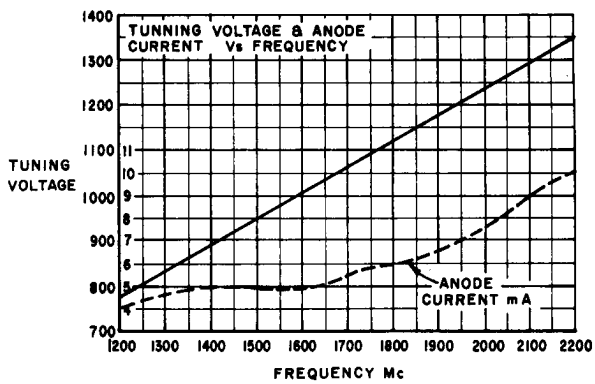


MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type N Jack
Weight	3.5 Pounds

ENVIRONMENTAL

Vibration	10G-(to 2kc)
Shock	100G-(11ms)
Altitude	70,000 ft.



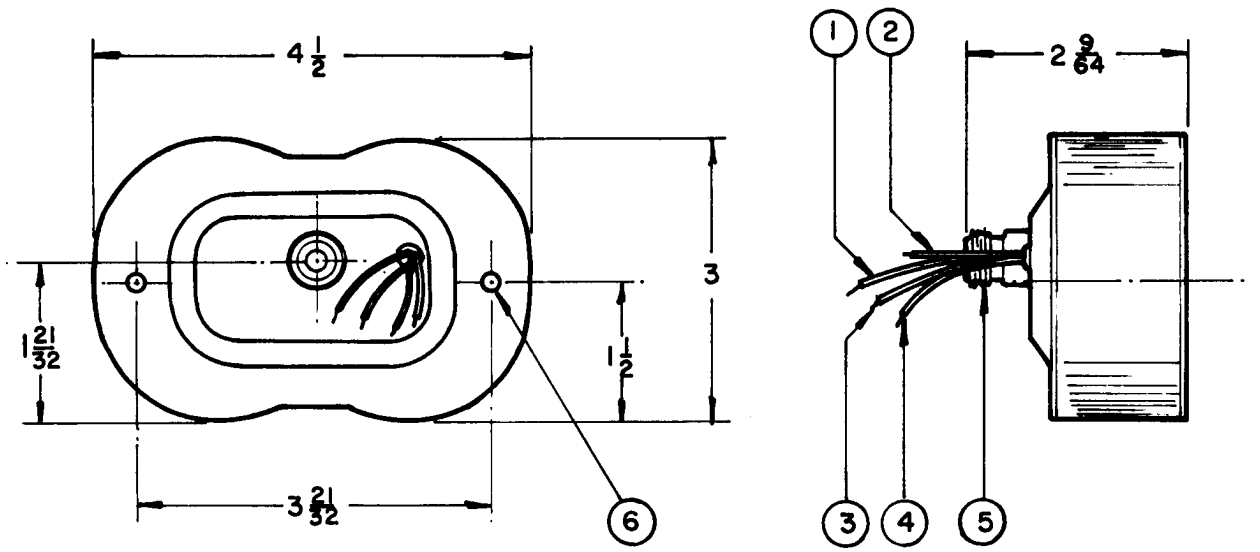
OUTLINE DIMENSIONS

Height	3 inches
Width	2.1 inches
Length	4.5 inches

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APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.
2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.
3. TEMPERATURE STABILITY: The permanent magnet for the X-1080 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1080 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1500 megacycles, the temperature/frequency coefficient is typically 300 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.
4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



6	3/16 DIA. MOUNTING HOLES (2) REQ'D
5	FEMALE TYPE "N" CONNECTOR
4	GROUND LEAD (GREEN)
3	HEATER LEAD (WHITE)
2	HEATER CATHODE LEAD (BLACK)
1	INJECTION ANODE LEAD (YELLOW)

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM-1086

L-BAND PACKAGED VOLTAGE TUNABLE MAGNETRON



The Eimac EM-1086 is a ruggedized, ceramic and metal packaged voltage-tunable magnetron capable of delivering a minimum output power of 15 watts into a 50 ohm termination over the frequency range of 940-1060 megacycles.

Eimac's three terminal VTM circuit has been used in this tube to give a more uniform output circuit with the added advantage of one-third more heat dissipating area extending out of the VTM envelope.

The electron injection design incorporated in this magnetron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduced output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The linear tuning characteristics of this magnetron simplifies programming the frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators.

The EM-1086 Circuit Assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, EMA	
	Warm-up Time	30 seconds
Heater:	Voltage (AC or DC)	6.3 volts
	Current	1.0 ampere
Minimum Output Power		15 watts
Frequency Range		940 to 1060 megacycles

MECHANICAL

Operating Position	any
Cooling	see note
Electrical Connections	flexible leads
RF Output Coupling	TNC male (6" flexible Rf connector)
Net Weight, including magnet and circuit	3.5 pounds
Shipping Weight	10 pounds
Maximum Overall Dimensions (Magnet and Circuit):	
Height	3 inches
Width	1.575 inches
Length	4.556 inches

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MAXIMUM RATINGS

Anode Voltage*	2500 volts
Cathode Current	35 milliamperes
Injection Anode Voltage*	750 volts
Injection Anode Current	1 milliampere

TYPICAL OPERATION (EM-1086 Circuit Assembly, Load VSWR=1.15:1)

Frequency Range	940-1060	megacycles
Anode Voltage* (Note 1)	1840-2075	volts
Cathode Current	21 - 25	milliamperes
Typical Power Output	16 - 16	watts
Anode FM Sensitivity	.50	Mc/volt
Injection Anode Voltage	500	volts
Injection Anode Current	.02	milliamperes
Heater Voltage (AC)	6.3	volts
Heater Current (AC)	0.8	amperes

*All voltages referred to the cathode.

Note 1. The operating frequency is determined by the Anode Voltage.

APPLICATION

Cooling: To insure normal operation over prolonged periods, sufficient cooling is required so that the EM-1086 magnet temperature does not exceed 70°C.

Anode: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential with the cathode and injection anode at appropriate negative potentials.

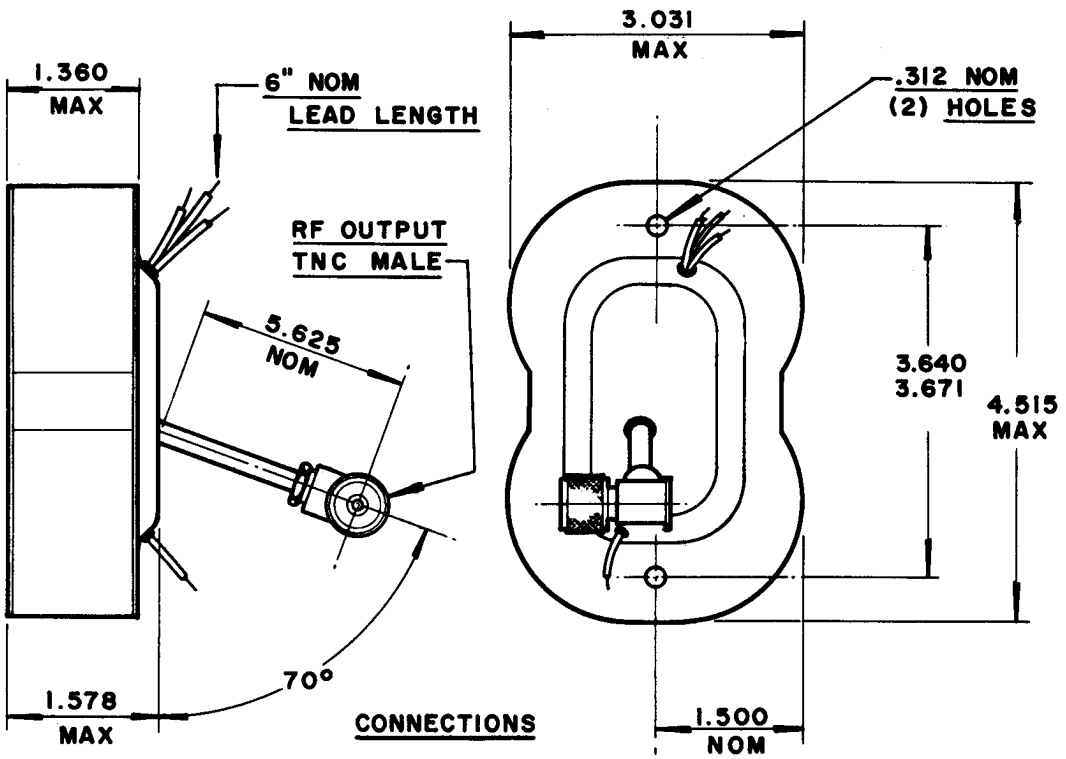
Cathode: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the EM-1086 heater in most applications as a result of the advanced counterwound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

Proximity of Ferrous Materials: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

Temperature Stability: The permanent magnet for the EM-1086 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the EM-1086 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1,000 megacycles, the temperature/frequency coefficient is typically 200 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451.
Cable: EIMAC.



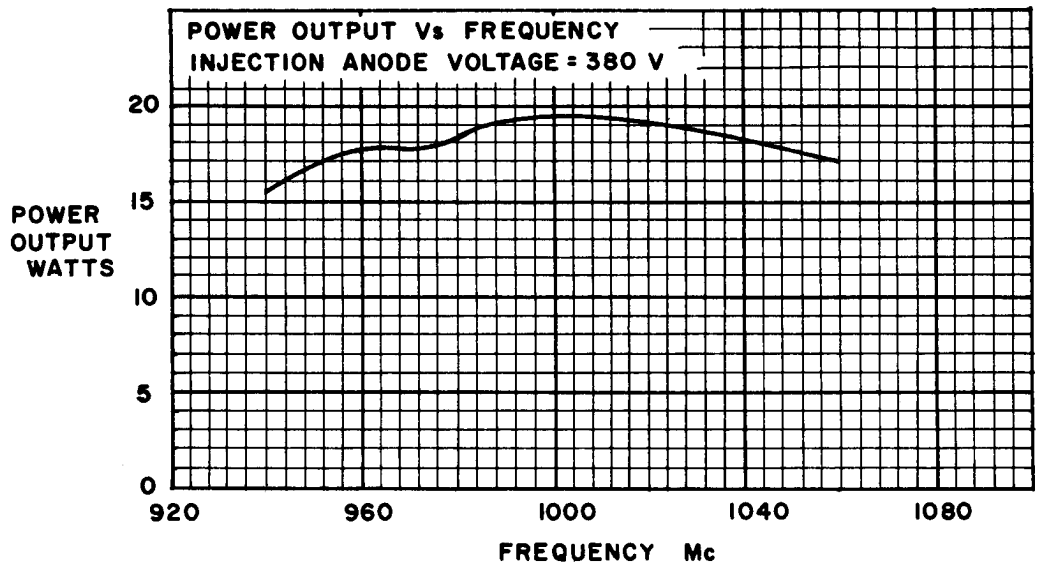
CONNECTIONS

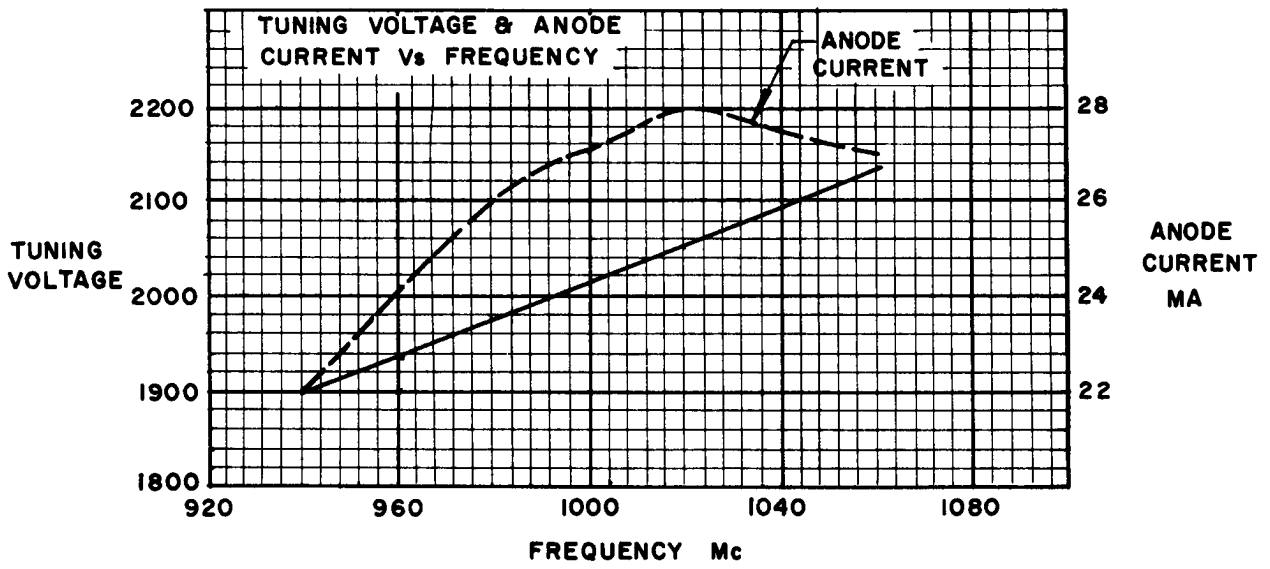
GROUND – BLACK

HEATER – BLUE

HEATER CATHODE – RED

INJECTION ANODE – WHITE


POWER OUTPUT Vs FREQUENCY
INJECTION ANODE VOLTAGE = 380 V
POWER OUTPUT WATTS
20
15
10
5
0
920
960
1000
1040
1080
FREQUENCY Mc


TUNING VOLTAGE & ANODE CURRENT Vs FREQUENCY
ANODE CURRENT
TUNING VOLTAGE
2200
2100
2000
1900
1800
28
26
24
22
ANODE CURRENT MA
920
960
1000
1040
1080
FREQUENCY Mc

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

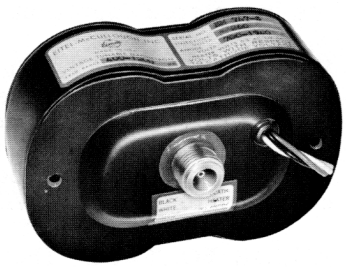
EM-1093

VOLTAGE TUNABLE MAGNETRON

FREQUENCY 2.475 - 2.725

MINIMUM OUTPUT POWER 1.75 W

TYPICAL PERFORMANCE



S-BAND OSCILLATOR

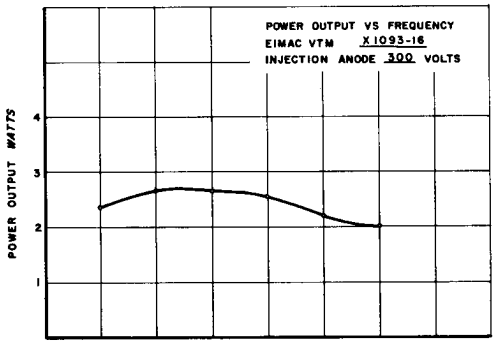
ELECTRICAL

Frequency Range	2475-2725 Mc
Anode Voltage	1100-1200 V
Cathode Current	12-20 mA
Typical Output Power	2-3 W
Anode FM Sensitivity	2.5 Mc/volt
Injection Anode Voltage	300 V
Injection Anode Current	0.0 mA
Heater Voltage (AC) (DC)	6.3 V
Heater Current (AC) (DC)	.65 A
Load Impedance	50 ohms
Service	cw

*MAXIMUM RATINGS

Anode Voltage	1500 V
Cathode Current	25 mA
Injection Anode Voltage	400 V
Injection Anode Current	0.5 mA

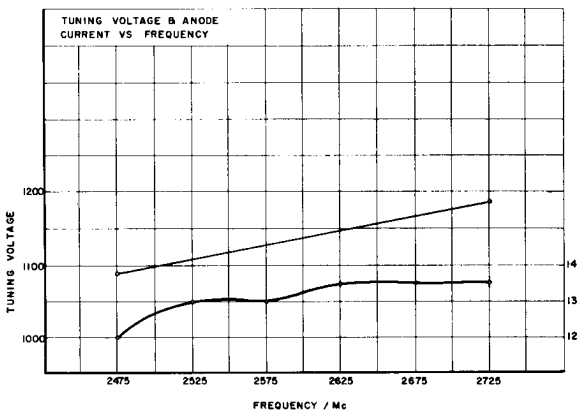
*Damage to the tube may occur if maximum ratings are exceeded.



FREQUENCY MC	2475	2525	2575	2625	2675	2725
ANODE VOLTAGE	1080	1100	1120	1140	1160	1180
ANODE CURRENT MA	12.0	13.0	13.0	13.5	13.5	13.5

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type N Jack
Weight	3.5 Pounds



ENVIRONMENTAL

Vibration	10 G-(to 2kc)
Shock	100 G-(11 ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3 inches
Width	2.1 inches
Length	4.5 inches

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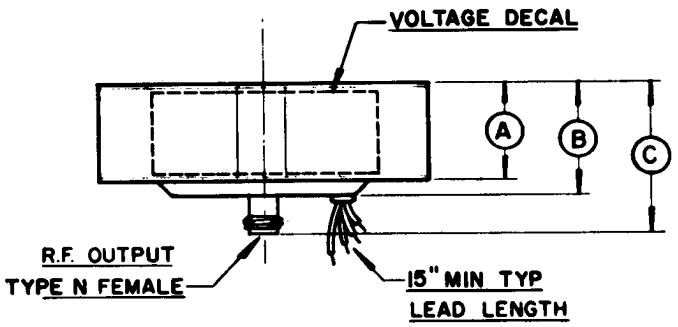
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70°C.

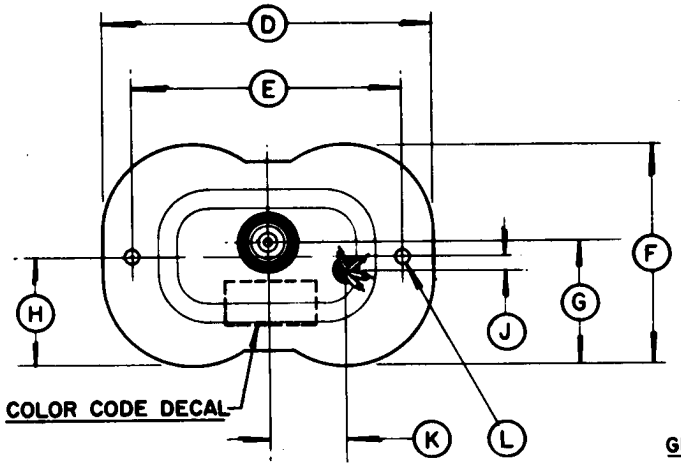
2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the EM-1093 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the EM-1093 package is typically .008% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 2600 megacycles, the temperature/frequency coefficient is typically 520 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			2.172
D		4.600	
E	3.640	3.671	
F		3.100	3.000
G			1.656
H			1.500
J			.375
K			1.000
L			.187 D.



CONNECTIONS

GROUND - GREEN

HEATER - WHITE

HEATER CATHODE - BLACK

INJECTION ANODE - YELLOW

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

EM-1114

X-BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency Setting	13.90 Gc
Mechanically Trimmable	±20 Mc
Power Output	200 mW
Electronic Tuning Range (3 db bandwidth)	25 Mc min
Resonator Voltage	400 Vdc
Cathode Current	40 mA
Repeller Voltage	−280 Vdc
Modulation Sensitivity	0.8 Mc/v max
Heater Voltage	6.3 V(ac or dc)±5%
Heater Current	1.3 A max
Mode	3-3/4
VSWR of Load	1.10:1
Temperature Coefficient	−150 Kc/°C
Warm-up Time	30 seconds
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator Voltage	500 Vdc
Cathode Current	55 mA
Repeller Voltage (negative with respect to the cathode)	(-50 to -500) Vdc

Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Electrical Connections	Flexible Lead
RF Output Coupling	RG-91/U waveguide
Cooling Required	Conduction
Net Weight	6 ounces
Shipping Weight (approximate)	4 pounds

ENVIRONMENTAL PERFORMANCE

Temperature Range (Max Ambient)	150° C
Altitude	100,000 ft. max
Vibration	10 G, (20-2000 cps)
Shock	40 G, (11 ms)

OUTLINE DIMENSIONS

Height	1.40 inches
Width	1.50 inches
Length	2.10 inches

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APPLICATION NOTES

COOLING: At sea level this tube will not require forced air cooling when operated at less than 20 watts resonator dissipation and an ambient temperature of less than 150° C. The waveguide flange connection will normally provide the required heat - sink for conduction cooling. If the tube is operated at a resonator dissipation of greater than 20 watts or if an insulator is used between the tube and waveguide for DC isolation, forced air cooling will be required to maintain the body temperature below the maximum rating of 175° Centigrade.

RESONATOR: The resonator of the EM-1114 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

CATHODE: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

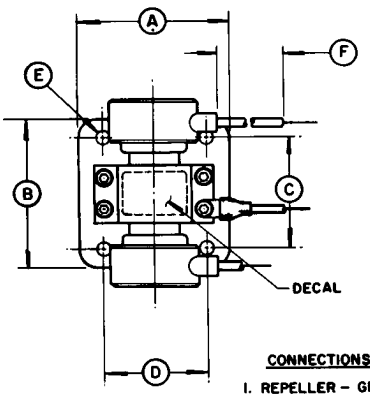
The heater and cathode of the EM-1114 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

MECHANICAL TRIMMING: The EM-1114 is fitted with a locking tuner that allows ±20 mc trimming. The center frequency is factory pre-set to your specification.

SHOCK AND VIBRATION: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20-2,000 cps) or shock of up to 40g (11 milliseconds duration).

With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 200 kilocycles.

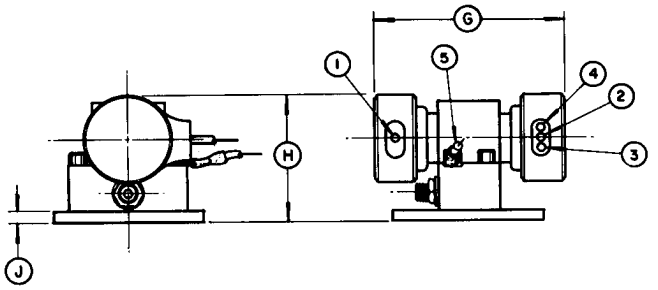
SPECIAL APPLICATIONS: For additional information regarding any specific application, write to Microwave Division, Eitel-McCullough, Inc., San Carlos, California, telephone Lytell 1-1451, Cable EIMAC.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.100	
H		1.400	
J			.125

CONNECTIONS

1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



EIMAC

A Division of Varian Associates

SAN CARLOS, CALIFORNIA

EM1300

MAGNETICALLY SHIELDED VOLTAGE TUNABLE MAGNETRON

250 - 500 Mc

100 mw

DESCRIPTION

The EM1300 Voltage Tunable Magnetron Oscillator delivers at least 100 mw over the frequency range of 250-500 mc. This miniature magnetically shielded oscillator is ideally suited for applications requiring compact lightweight packaging. Its unique magnetic circuit results in negligible external magnetic field and permits the tube to contact other ferromagnetic materials with no degradation in performance.



FEATURES

- Magnetically Shielded
- Light Weight
- Linear Voltage Tuning
- Small Size
- Rugged
- Flat Power Output

TYPICAL PERFORMANCE

ELECTRICAL

Frequency Range	250-500 Mc
Anode Voltage	920-1840 V
Cathode Current	0.5-2 mA
Typical Power Output	140 mw
Anode FM Sensitivity	0.3 Mc/V
Injection Anode Voltage	200 Volts
Injection Anode Current	0.0 mA
Heater Voltage (AC or DC)	6.3 Volts
Heater Current (AC or DC)	0.9 Amp
Load Impedance	50 Ohm
Load VSWR	1.1:1
Power Variation	±1 db

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flying Leads
RF Output Coupling	TNC Female
Weight	1.8 lbs.

MAXIMUM RATINGS*

Anode Voltage	2200 Volts
Cathode Current	10 mA
Injection Anode Voltage	500 Volts
Injection Anode Current	0.5 mA
Load VSWR	3:1

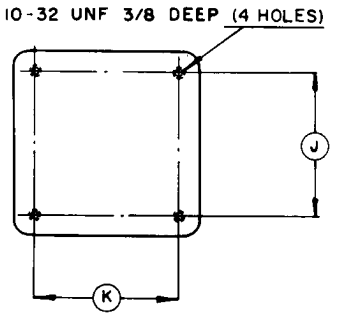
*Damage to the tube may occur if maximum ratings are exceeded.

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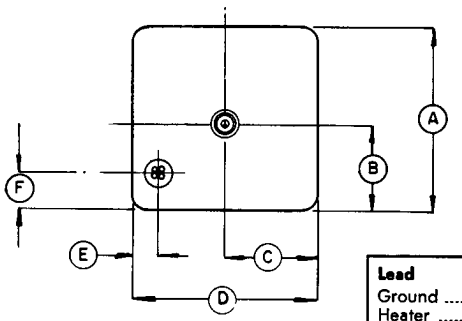
NOTES:

1. The operating frequency is a function of the anode voltage; therefore any voltage ripple on the anode supply appears as frequency modulation on the RF output.
2. The heater supply may be either alternating or direct current. If direct current is used, the heater connections *must* be connected to the negative terminal of the heater supply.
3. Cooling—To insure optimum tube performance, the magnet shell should be maintained below 70° C.
4. Temperature Stability — The permanent magnet of the shielded VTM has been temperature stabilized to minimize frequency changes caused by variations in the magnet temperature. The temperature/frequency coefficient for the shielded VTM is 0.008% of the operating frequency per degree centigrade. A positive change in temperature will always produce a positive change in frequency.

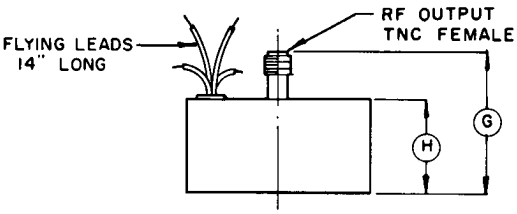


DIMENSIONS IN INCHES

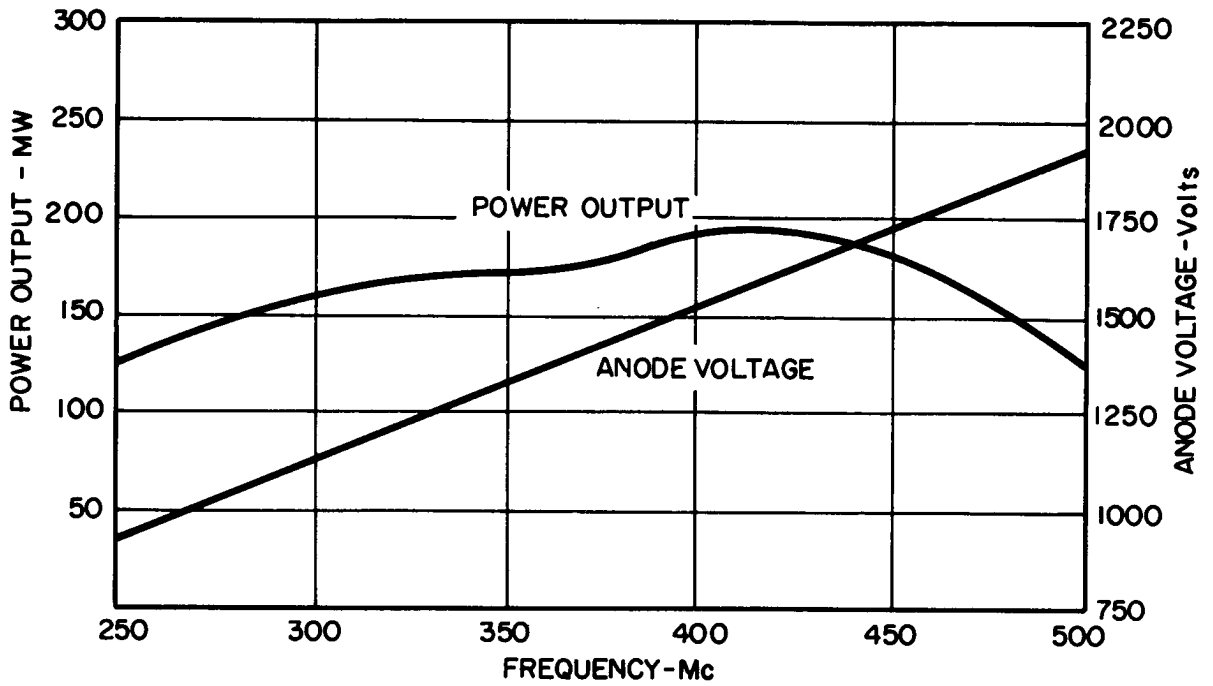
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		3.050	
B	1.200	1.800	
C	1.300	1.700	
D		3.050	
E	.300	.500	
F	.700	.900	
G		2.300	
H		1.525	
J	2.320	2.380	
K	2.320	2.380	



Lead	Color Code
Ground	Black
Heater	Blue
Heater Cathode	Red
Injection Anode	White



CHARACTERISTIC CURVES
Typical Performance Values



EIMAC

A Division of Varian Associates

SAN CARLOS, CALIFORNIA

EM1310

MAGNETICALLY SHIELDED VOLTAGE TUNABLE MAGNETRON

500 -1000 Mc

100 mw

DESCRIPTION

The EM1310 Voltage Tunable Magnetron Oscillator delivers at least 100 mw over the frequency range of 500-1000 Mc. This miniature magnetically shielded oscillator is ideally suited for applications requiring compact lightweight packaging. Its unique magnetic circuit results in negligible external magnetic field and permits the tube to contact other ferromagnetic materials with no degradation in performance.



FEATURES

- Magnetically Shielded
- Light Weight
- Linear Voltage Tuning
- Small Size
- Flat Power Output
- Rugged

TYPICAL PERFORMANCE

ELECTRICAL

Frequency Range	500-1000 Mc
Anode Voltage	920-1840 V
Cathode Current	0.5-2 mA
Typical Power Output	150 mw
Anode FM Sensitivity	0.55 Mc/V
Injection Anode Voltage	150 Volts
Injection Anode Current	0.0 mA
Heater Voltage (AC or DC)	6.3 Volts
Heater Current (AC or DC)	0.86 Amp
Load Impedance	50 Ohm
Load VSWR	1.1:1
Power Variation	±1 db

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flying Leads
RF Output Coupling	TNC Female
Weight	1.5 lbs. max.

MAXIMUM RATINGS*

Anode Voltage	2200 Volts
Cathode Current	10 mA
Injection Anode Voltage	500 Volts
Injection Anode Current	1 mA
Load VSWR	3:1

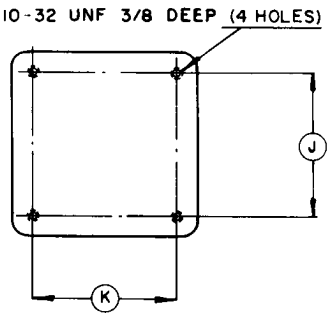
*Damage to the tube may occur if maximum ratings are exceeded.

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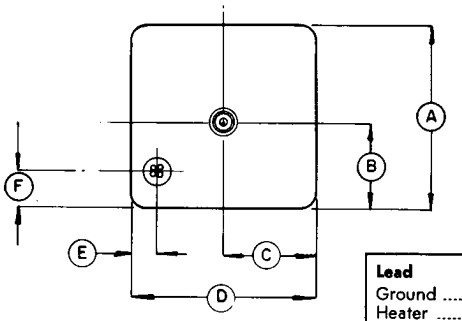
NOTES:

1. The operating frequency is a function of the anode voltage; therefore any voltage ripple on the anode supply appears as frequency modulation on the RF output.
2. The heater supply may be either alternating or direct current. If direct current is used, the heater connections *must* be connected to the negative terminal of the heater supply.
3. Cooling—To insure optimum tube performance, the magnet shell should be maintained below 70° C.
4. Temperature Stability — The permanent magnet of the shielded VTM has been temperature stabilized to minimize frequency changes caused by variations in the magnet temperature. The temperature/frequency coefficient for the shielded VTM is 0.008% of the operating frequency per degree centigrade. A positive change in temperature will always produce a positive change in frequency.

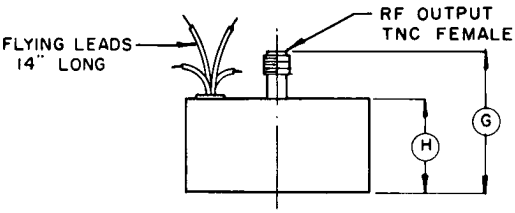


DIMENSIONS IN INCHES

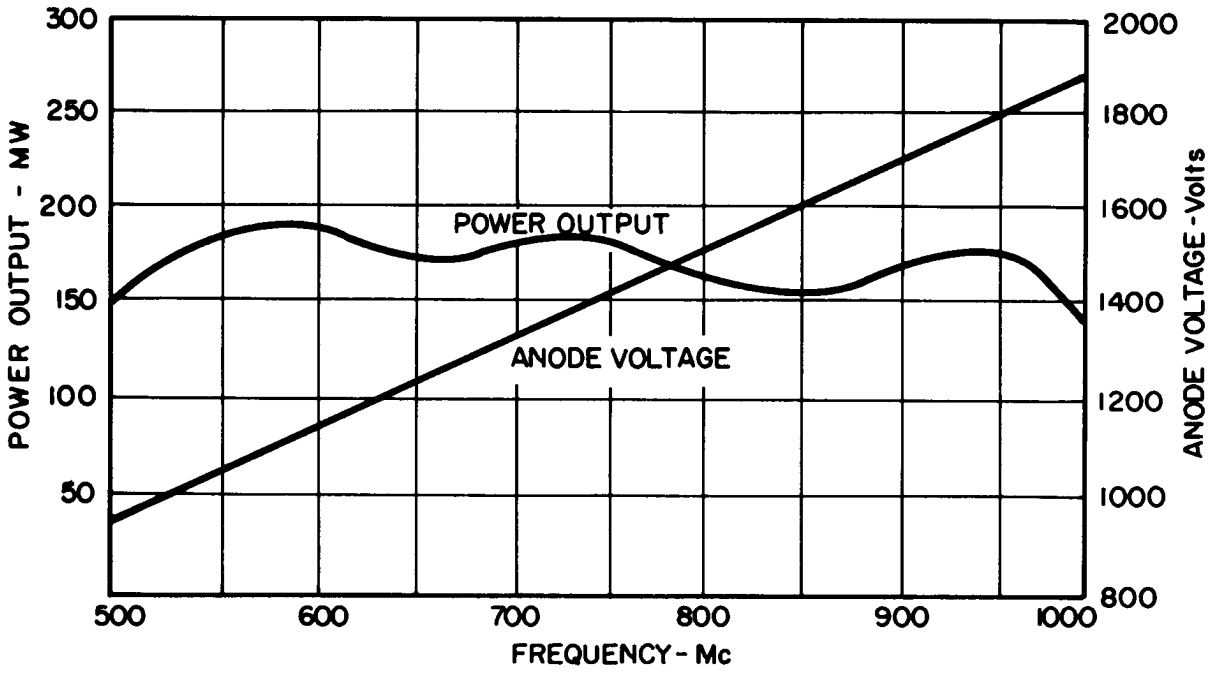
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		3.050	
B	1.200	1.800	
C	1.300	1.700	
D		3.050	
E	.300	.500	
F	.700	.900	
G		2.300	
H		1.525	
J	2.320	2.380	
K	2.320	2.380	



Lead	Color Code
Ground	Black
Heater	Blue
Heater Cathode	Red
Injection Anode	White



CHARACTERISTIC CURVES
Typical Performance Values



EIMAC

A Division of Varian Associates

SAN CARLOS, CALIFORNIA

EM1320

MAGNETICALLY SHIELDED VOLTAGE TUNABLE MAGNETRON

1000 - 2000 Mc

100 mw

DESCRIPTION

The EM1320 Voltage Tunable Magnetron Oscillator delivers at least 100 mw over the frequency range of 1000-2000 mc. This miniature magnetically shielded oscillator is ideally suited for applications requiring compact lightweight packaging. Its unique magnetic circuit results in negligible external magnetic field and permits the tube to contact other ferromagnetic materials with no degradation in performance.



FEATURES

- Magnetically Shielded
- Light Weight
- Linear Voltage Tuning
- Small Size
- Flat Power Output
- Rugged

TYPICAL PERFORMANCE

ELECTRICAL

Frequency Range	1000-2000 Mc
Anode Voltage	920-1840 V
Cathode Current	1-6 mA
Typical Power Output	200 mw
Anode FM Sensitivity	1 Mc/Volt
Injection Anode Voltage	200 Volts
Injection Anode Current	0.0 mA
Heater Voltage (AC or DC)	6.3 Volts
Heater Current (AC or DC)	0.9 Amp
Load Impedance	50 Ohm
Load VSWR	1.1:1
Power Variation	±1 db

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flying Leads
RF Output Coupling	TNC Female
Weight	1.5 lbs.

MAXIMUM RATINGS*

Anode Voltage	2200 Volts
Cathode Current	12 mA
Injection Anode Voltage	500 Volts
Injection Anode Current	1 mA
Load VSWR	3:1

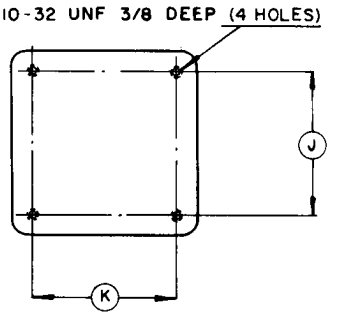
*Damage to the tube may occur if maximum ratings are exceeded.

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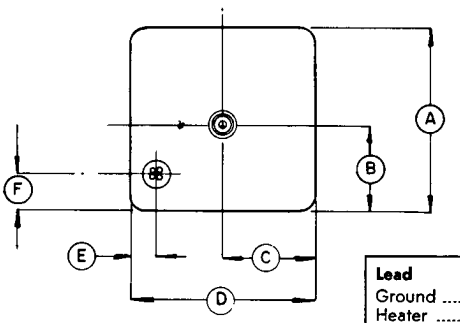
NOTES:

1. The operating frequency is a function of the anode voltage; therefore any voltage ripple on the anode supply appears as frequency modulation on the RF output.
2. The heater supply may be either alternating or direct current. If direct current is used, the heater connections *must* be connected to the negative terminal of the heater supply.
3. Cooling—To insure optimum tube performance, the magnet shell should be maintained below 70° C.
4. Temperature Stability — The permanent magnet of the shielded VTM has been temperature stabilized to minimize frequency changes caused by variations in the magnet temperature. The temperature/frequency coefficient for the shielded VTM is 0.008% of the operating frequency per degree centigrade. A positive change in temperature will always produce a positive change in frequency.

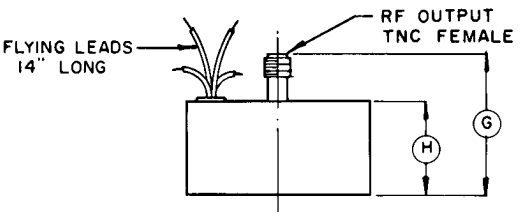


DIMENSIONS IN INCHES

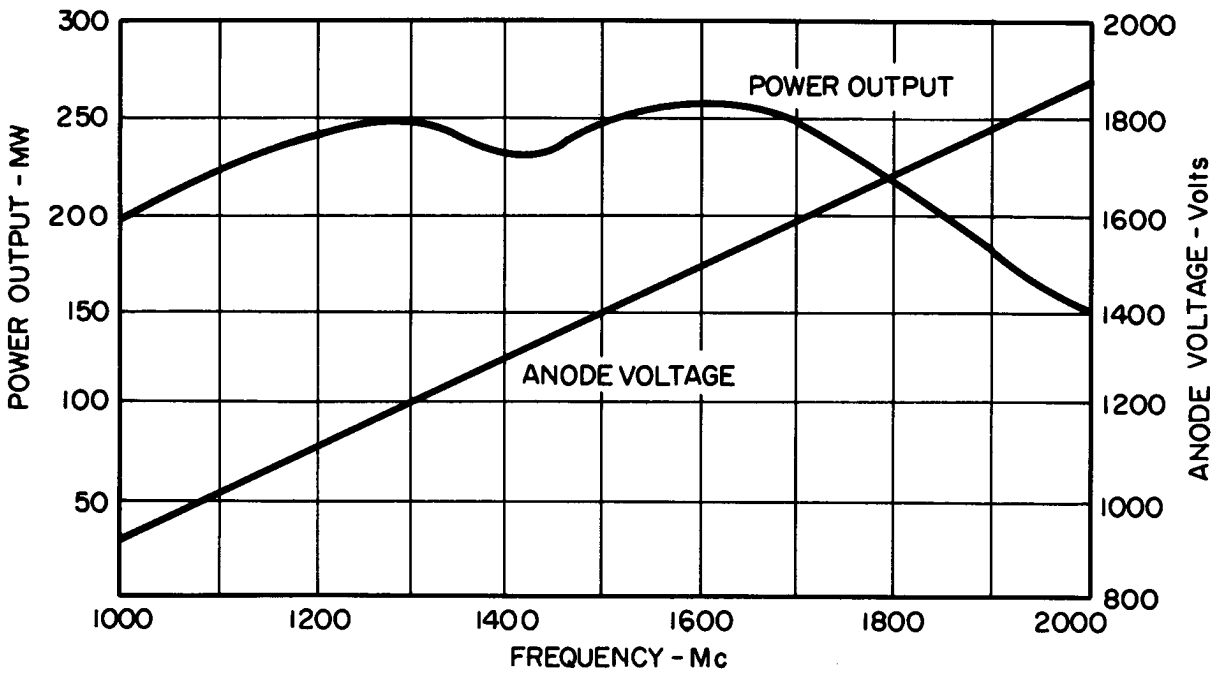
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		3.050	
B	1.200	1.800	
C	1.300	1.700	
D		3.050	
E	.300	.500	
F	.700	.900	
G		2.300	
H		1.525	
J	2.320	2.380	
K	2.320	2.380	



Lead	Color Code
Ground	Black
Heater	Blue
Heater Cathode	Red
Injection Anode	White



CHARACTERISTIC CURVES
Typical Performance Values



EIMAC

A Division of Varian Associates

SAN CARLOS, CALIFORNIA

EM1331

MAGNETICALLY SHIELDED VOLTAGE TUNABLE MAGNETRON

2200 - 2300 Mc

35 Watts

DESCRIPTION



The EM1331 Voltage Tunable Magnetron Oscillator delivers at least 35 watts over the frequency range of 2200-2300 Mc. This miniature magnetically shielded oscillator is ideally suited for applications requiring compact lightweight packaging. Its unique magnetic circuit results in negligible external magnetic field and permits the tube to contact other ferromagnetic materials with no degradation in performance.

FEATURES

- Magnetically Shielded
- Light Weight
- Linear Voltage Tuning
- Small Size
- Flat Power Output

TYPICAL PERFORMANCE

ELECTRICAL

Frequency Range	2200-2300 Mc
Anode Voltage	2060-2160 V
Cathode Current	41-44 mA
Typical Power Output	40-42 W
Anode FM Sensitivity	1 Mc/Volt
Injection Anode Voltage	500 Volts
Injection Anode Current	0.0 mA
Heater Voltage (AC or DC)	6.3 Volts
Heater Current (AC or DC)	1.0 Amp
Load Impedance	50 Ohm
Load VSWR	1.1:1
Power Variation	1 db

MECHANICAL

Operating Position	Any
Cooling	Forced Air
Electrical Connection	Flying Leads
RF Output Coupling	TNC Female
Weight	3.5 lbs. max.

MAXIMUM RATINGS*

Anode Voltage	2500 Volts
Cathode Current	60 mA
Injection Anode Voltage	750 Volts
Injection Anode Current	1 mA
Load VSWR	1.2:1

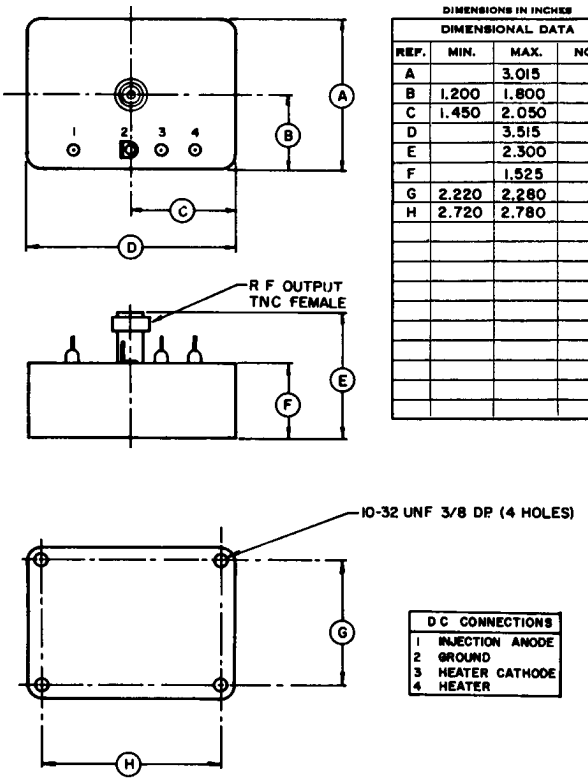
*Damage to the tube may occur if maximum ratings are exceeded.

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NOTES:

1. The operating frequency is a function of the anode voltage; therefore any voltage ripple on the anode supply appears as frequency modulation on the RF output.
2. The heater supply may be either alternating or direct current. If direct current is used, the heater connections *must* be connected to the negative terminal of the heater supply.
3. Cooling—To insure optimum tube performance, the magnet shell should be maintained below 70° C.
4. Temperature Stability — The permanent magnet of the shielded VTM has been temperature stabilized to minimize frequency changes caused by variations in the magnet temperature. The temperature/frequency coefficient for the shielded VTM is 0.008% of the operating frequency per degree centigrade. A positive change in temperature will always produce a positive change in frequency.



DIMENSIONS IN INCHES

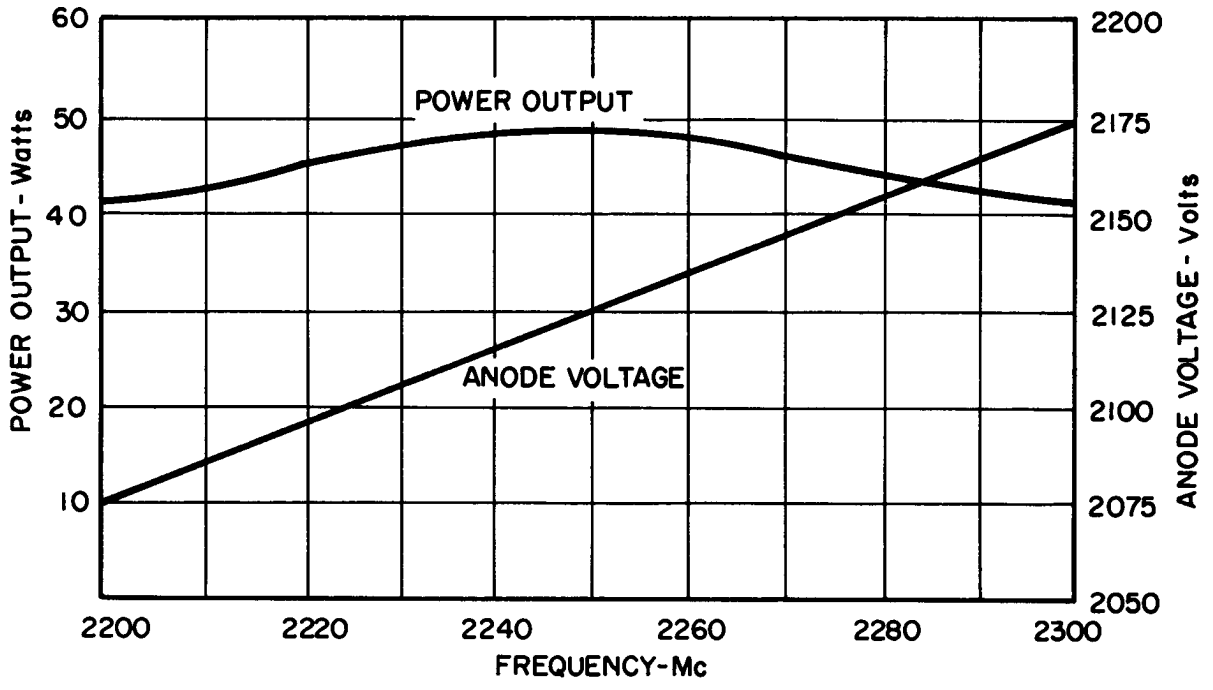
DIMENSIONAL DATA

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C	1.450	2.050	
D		3.515	
E		2.300	
F		1.525	
G	2.220	2.280	
H	2.720	2.780	

DC CONNECTIONS

1	INJECTION ANODE
2	GROUND
3	HEATER CATHODE
4	HEATER

CHARACTERISTIC CURVES
Typical Performance Values



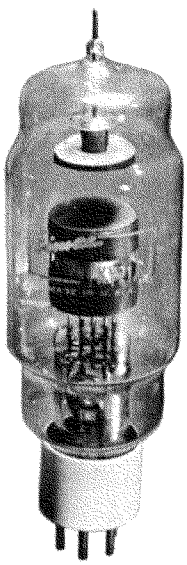
EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

KY21A

GRID-CONTROLLED MERCURY VAPOR RECTIFIER

The Eimac KY21A is a grid-controlled mercury vapor rectifier. A pair of KY21A's in a conventional single phase full wave circuit will supply a d-c power output of 5 kilowatts (3500 volts at 1.5 amperes) with a choke input filter.



GENERAL CHARACTERISTICS

ELECTRICAL	
Filament: Coated	
Voltage	2.5 volts
Current	10 amperes
Filament Heating Time (minimum)	30 seconds
Tube Voltage Drop (average)	15 volts
Ionization Time (approximately)	10 μseconds
Deionization Time (approximately)	1000 μseconds
MECHANICAL	
Base*	Medium, 5 Pin
Basing	See Outline Drawing
Maximum Overall Dimensions	
Length	8.0 inches
Diameter	2.25 inches
Net Weight	5 ounces
Shipping Weight	1 pound
MAXIMUM RATINGS (single tube)	
Peak Inverse Anode Voltage	11,000 max. volts
Peak Forward Anode Voltage	5,500 max. volts
Peak Anode Current	3 max. amperes
Average Anode Current	.75 max. amperes
Supply Frequency	150 max. C.P.S.
Temperature Limits, Condensed Mercury	20° to 60° Centigrade 65° to 140° Fahrenheit

*In order to carry the ten amperes of filament current the adjacent pins have been connected in parallel within the base. Similar connections should be made on the socket.

APPLICATION

MECHANICAL

Mounting—The KY21A must be mounted vertically, base down.

Cooling—Since the cooling of the KY21A is accomplished by radiation and convection, provision should be made for adequate air circulation around the tube. The temperature of the condensed mercury within the KY21A should be maintained at 40 degrees plus or minus 5 degrees Centigrade for best performance. To measure the condensed mercury temperature a thermocouple or small thermometer may be attached to the envelope in the area designated on the outline drawing, using a very small amount of putty.

ELECTRICAL

CAUTION SHOULD BE OBSERVED IN MEASURING THE FILAMENT VOLTAGE, AS THE FILAMENT CIRCUIT MAY BE AT A HIGH D-C POTENTIAL.

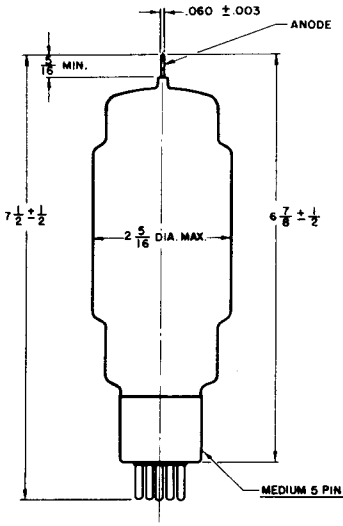
Filament Voltage—For maximum tube life the filament voltage, as measured directly at the filament pins, should be held at the rated value of 2.5 volts. Variations in filament voltage must be kept within the range of 2.4 to 2.6 volts. The filament of the KY21A should be allowed to reach operating temperature before the plate voltage is applied. Under normal conditions, a delay of approximately 30 seconds will be required. Under conditions where the tube is to be operated in extremely cold or extremely warm temperatures some external method of maintaining proper ambient temperature must be provided.

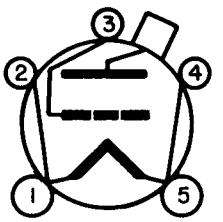
When a KY21A is first installed, the filament should be operated at rated voltage for approximately ten minutes with no plate voltage applied, in order that the mercury may be properly distributed. It will not be necessary to repeat this procedure unless the mercury is spattered on the filament and plate during subsequent handling.

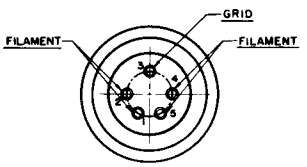
Shielding—Extreme care must be exercised in preventing r-f electromagnetic and electrostatic fields from entering the circuits incorporating the KY21A. Tube "hold-off" characteristics will be materially affected in the presence of r-f fields.

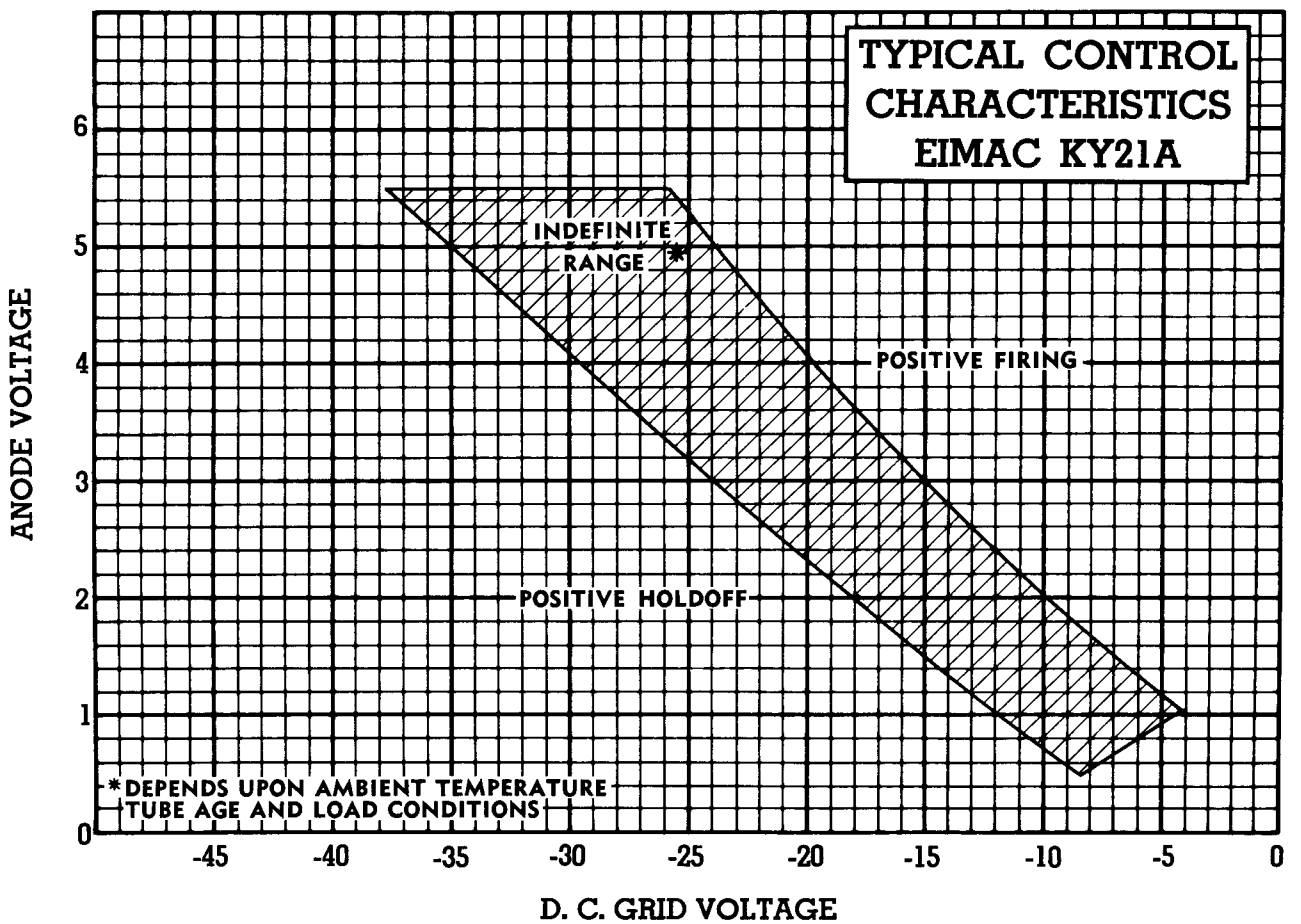
Grid Circuit—The KY21A is prevented from conducting by placing a negative potential on the grid. The relationship between negative grid control voltage and anode voltage is shown in the characteristic curve. The ratio of d-c plate voltage to control voltage varies from about 87:1 at 1000 volts to 130:1 at 3500 volts. The use of slightly higher than the minimum voltage for hold-off is recommended. It may be convenient to supply 100 to 150 volts of bias from a small pack. This grid voltage is satisfactory for all normal plate voltages. It will usually be advisable to protect the grid of the KY21A by means of a current limiting resistor of approximately 10,000 ohms.

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.060 ±.003
ANODE
5/16 MIN.
7 1/2 ± 1/2
2 5/16 DIA. MAX.
6 7/8 ± 1/2
MEDIUM 5 PIN BASE


3
2
4
1
5


GRID
FILAMENT
FILAMENT


TYPICAL CONTROL CHARACTERISTICS EIMAC KY21A
INDEFINITE RANGE
POSITIVE FIRING
POSITIVE HOLDOFF
*DEPENDS UPON AMBIENT TEMPERATURE TUBE AGE AND LOAD CONDITIONS
ANODE VOLTAGE
0
1
2
3
4
5
6
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
D. C. GRID VOLTAGE

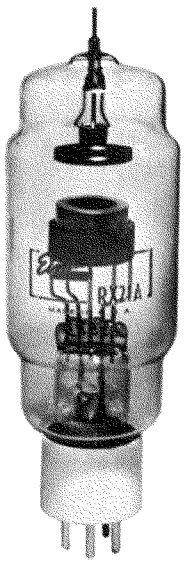
EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

RX21A

MERCURY VAPOR RECTIFIER

The Eimac RX21A is a half-wave mercury vapor rectifier incorporating features which enable it to withstand high peak inverse voltages and to conduct at relatively low applied voltages. The shielded ribbon filament, edgewise-wound, provides a large emmision reserve and long life.



GENERAL CHARACTERISTICS

ELECTRICAL

Filament: Coated	
Voltage	2.5 volts
Current	10 amperes
Tube Voltage Drop (approx.)	15 volts

MECHANICAL

Base[1]	Medium, 5-pin
Basing	See base connection diagram
Maximum Overall Dimensions:	
Length	8.0 inches
Diameter	2.25 inches
Net Weight	5 ounces
Shipping Weight	1 pound

MAXIMUM RATINGS (single tube)

PEAK INVERSE ANODE VOLTAGE[2]	11,000 MAX. VOLTS
PEAK ANODE CURRENT	3 MAX. AMPERES
AVERAGE ANODE CURRENT	.75 MAX. AMPERES
SUPPLY FREQUENCY	150 MAX. C. P. S.
CONDENSED-MERCURY TEMPERATURE RANGE[3]	20-60 °C

[1]In order to carry the ten amperes of filament current the adjacent pins have been connected in parallel within the base. Similar connections should be made in the socket.

[2]Temperatures in excess of 60° C limit the peak-inverse rating to 5,000 volts with a corresponding reduction in permissible RMS supply voltages to one-half those listed in the table.

[3]Operation at 40° plus or minus 5° C is recommended.

APPLICATION

MECHANICAL

MOUNTING—The RX21A must be mounted vertically, base down.

COOLING—Provisions should be made for adequate air circulation around the tube, because cooling is accomplished by convection. The temperature of the condensed-mercury in the RX21A should be kept within the ranges given under "MAXIMUM RATINGS". This temperature should be maintained at 40 degrees plus or minus 5 degrees C for most satisfactory operation of the tube. To measure the condensed-mercury temperature a thermocouple or small thermometer may be attached to the bulb in the area designated on the outline drawing, using a very small amount of putty. A condensed-mercury temperature lower than the recommended value raises the voltage at which the tube becomes conducting and tends to reduce the life of the filament. A temperature higher than recommended lowers the voltage at which the tube becomes conducting and tends to increase the life of the filament, but reduces the peak inverse voltage rating of the tube. When it is necessary to use a shield around the RX21A care must be taken to insure adequate ventilation and maintenance of normal condensed-mercury temperature.

ELECTRICAL

CAUTION SHOULD BE OBSERVED IN MEASURING THE FILAMENT VOLTAGE, AS THE FILAMENT CIRCUIT MAY BE AT A HIGH D-C POTENTIAL.

FILAMENT VOLTAGE—For maximum tube life, the filament voltage as measured directly at the filament pins, should be held at the rated value of 2.5 volts. Unavoidable variations in filament voltage must be kept within the range of 2.4 to 2.6 volts. A filament voltage less than the minimum recommended value may cause a high tube voltage drop, with consequent bombardment of the filament and eventual loss of emission. A filament voltage higher than the recommended maximum value will also decrease the life of the filament.

The plate-circuit return of each tube should preferably be connected to the center tap of the transformer winding supplying the filament voltage. This precaution is recommended to insure uniform starting voltage for each tube when several are used in a given circuit.

The filament of the RX21A should be allowed to reach operating temperature before the plate voltage is applied. Under normal conditions, a delay of approximately 30 seconds will be required. The delay time should be increased if there is any evidence of arc-back within the tube. In radio transmitter applications the filament should be kept at its rated voltage during "standby" periods to avoid delay due to warm-up. It is desirable to use a protective relay in the plate circuit to prevent the application of plate voltage before the filament has reached operating temperature. This relay should have a time delay adjustable up to a maximum of one minute.

When an RX21A is first installed, the filament should be operated at normal voltage for approximately ten minutes with no plate voltage applied, in order that the mercury may be properly distributed. It will not be necessary to repeat this procedure unless the mercury is spattered on the filament and plate during subsequent handling.

SHIELDING—Electromagnetic and electrostatic fields tend to cause the mercury vapor to break down, are detrimental to tube life and make proper operation difficult. Consequently, the RX21A should be isolated from such fields as exist around a transmitter or other similar equipment. When the tubes are located in the region of such fields, shielding with adequate ventilation should be used around the tubes. R-f filtering should also be employed when the tubes are affected by r-f voltages.

FILTERING—A "choke input" filter will allow the greatest usable d-c output current to the load. When using a section of filter between rectifier and load, to prevent exceeding the maximum peak current of 3 amperes, a suitable maximum value for the first capacitor should be determined. Determination of this capacitance should be made under conditions simulating those to be used in service.

The relationship of voltage input, inductance, and capacitance is one in which a higher operating voltage requires greater input inductance, and less following capacitance to keep the peak STARTING current from exceeding 3 amperes. This is for the usual case where the supply is controlled by an on-off switch.

Where the rectifier plate voltage is started by a control which gradually raises the voltage from zero or a small amount to the desired operating value, starting current need not ordinarily be considered, and the chaarcteristics of the filter may be based on preventing excessive peak current under normal operating conditions.

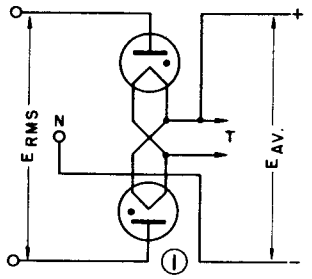
In the single phase cricuits (1 and 3), if the current drawn by the load is reduced or varies under operating conditions to values less than approximately 70% of the indicated maximum d-c load current, a swinging (input) choke will supply the necessary additional inductance to prevent the voltage from rising, and will afford proper filtering over a much greater current range.

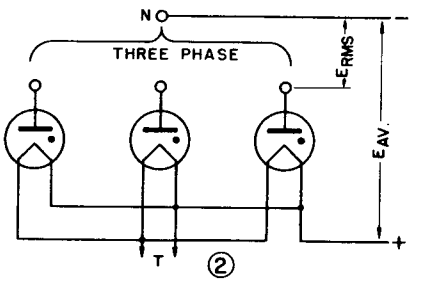
Where a larger value of inductance is desirable to obtain additional filtering, the subsequent capacitance may be proportionately increased to aid in still further filtering without excessive peak starting and operating current. Still lower ripple may of course be obtained by added sections of filter.

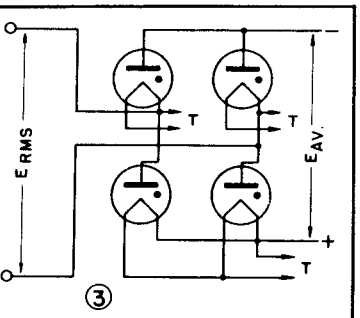
When "condenser input" filter is used, the peak current will be relatively high in respect to the usable load current, and the voltage across the capacitor may be as high as 1.4 times the nominal RMS voltage of the transformer.

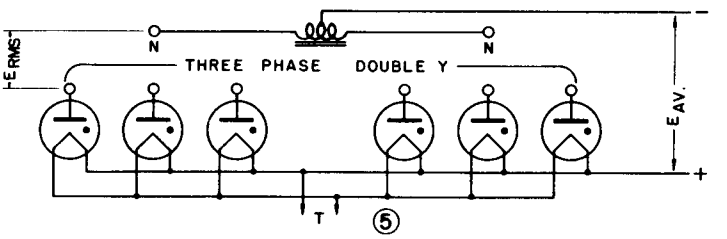
For parallel operation of RX21A rectifiers, suitable resistors or small inductors may be used in series with each plate lead to permit equal loading and starting characteristics. The inductors aid in reducing the peak current, and are more desirable due to their low d-c resistance. An approximate value for suitable resistors is 50 ohms, and for inductors, apprroximately one-third henry each.

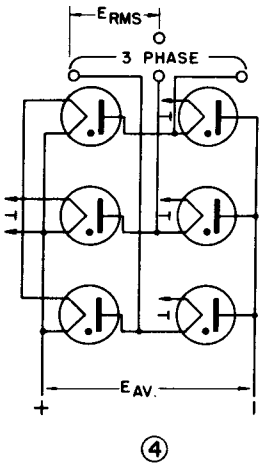
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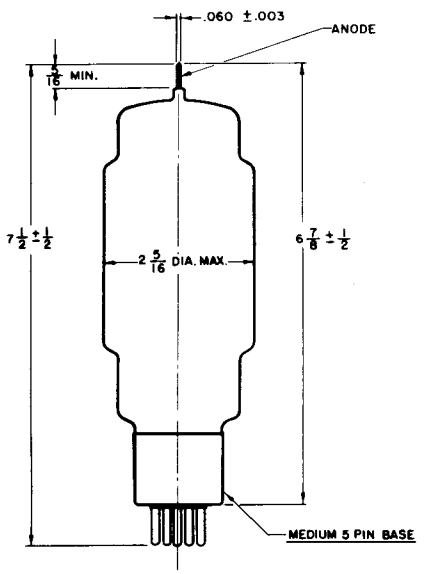


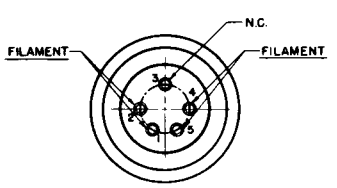


NUMBER	CIRCUIT	$E_{AVERAGE}$	$E_{INVERSE}$
①	SINGLE - PHASE FULL - WAVE 2 TUBES	0.318 E_{PEAK} 0.450 E_{RMS}	3.14 $E_{AVERAGE}$
②	THREE - PHASE HALF - WAVE	0.827 E_{PEAK} 1.170 E_{RMS}	2.09 $E_{AVERAGE}$
③	SINGLE - PHASE FULL - WAVE 4 TUBES	0.636 E_{PEAK} 0.900 E_{RMS}	1.57 $E_{AVERAGE}$
④	THREE - PHASE FULL - WAVE	1.65 E_{PEAK} 2.34 E_{RMS}	1.045 $E_{AVERAGE}$
⑤	THREE - PHASE DOUBLE - Y PARALLEL	0.827 E_{PEAK} 1.170 E_{RMS}	2.09 $E_{AVERAGE}$

CONDITIONS ASSUMED

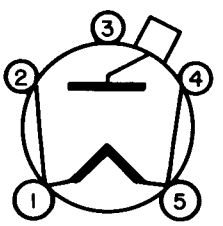
SINE WAVE SUPPLY, BALANCED PHASE VOLTAGES, ZERO TUBE DROP, PURE RESISTANCE LOAD, OR CHOKE INPUT FILTER.





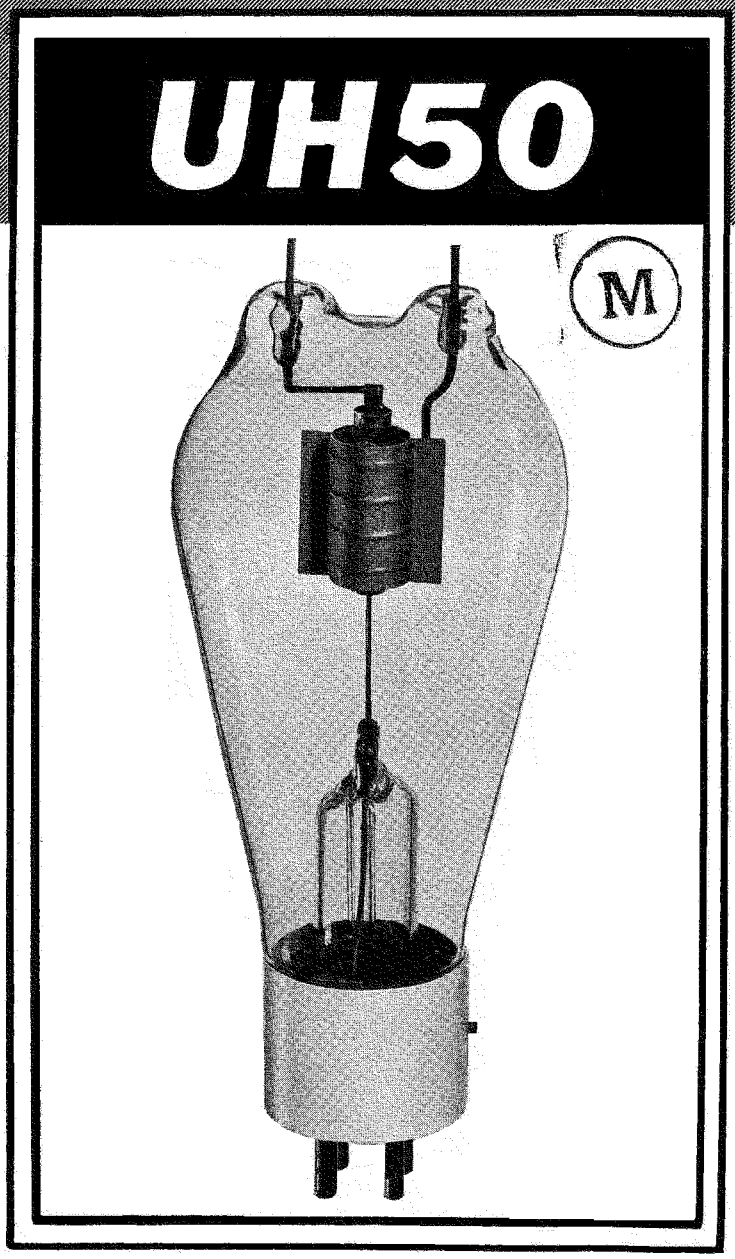
CIRCUIT	INPUT VOLTS* MAX. A-C (RMS)	APPROX. D-C OUTPUT VOLTS TO FILTER	MAX. D-C CURRENT OUTPUT (Amperes)
①	3890 per tube	3510	1.5
②	4490 per leg	5270	2.25
③	7780 total	7020	1.5
④	4490 per leg	10,520	2.25
⑤	4490 per leg	5270	4.5

*For use under the conditions of the 11,000 volt peak inverse rating. If the RX21A is to be used under frequency and/or temperature condition such that the peak inverse voltage is limited to 5500 volts, the a-c input voltage and d-c output voltage values in the table should be multiplied by a factor of 0.5 to give new values for the 5500 volt condition.



Eimac

UH50



THE DATA CONTAINED IN THIS BULLETIN IS APPLICABLE TO THE EIMAC UH50 TUBE ONLY

Radiation cooled, ultra high frequency triode embodying all of the superior constructional features common to Eimac tubes but specially designed to be directly interchangeable with certain conventional tubes on the market today.

Tantalum elements specially treated by the exclusive Eimac process, the new Eimac thoriated tungsten filament, elimination of the need for a "getter," and the long, severe exhaust give this tube vastly superior performance capabilities, yet in physical appearance it is almost identical to the conventional tube types. Like all Eimac tubes, UH50 is unconditionally guaranteed against tube failures resulting from gas released internally.

Characteristics

Filament Voltage	7.5 Volts
Filament Current	3.25 Amperes
Amplification Factor	10.6
Grid-Plate Capacity	2.6 mmfds.
Grid-Filament Capacity	2.2 mmfds.
Maximum Plate Voltage	1250 Volts
Maximum Plate Current	125 Milliamperes
Plate Dissipation	50 Watts

Tube must be operated vertically with ample ventilation provided. Seals must be cooled by Radiator Connectors.

Maximum Ratings

	Intermittent Service Telegraphy Class "B" Audio	Continuous Service Class "C" Telephony
Grid Current (milliamperes)	25	25
Plate Current (milliamperes)	125	125
Plate Dissipation (watts)	50	50
Plate Voltage	1250	1250

As frequency is increased circuit inefficiencies may necessitate a reduction of plate voltage or plate current so that maximum dissipation ratings are not exceeded.

Typical Operating Conditions for Class "C" Telephony

Plate Volts	750	1000	1250
Plate Current (milliamperes)	115	125	125
Grid Current (milliamperes)	20	20	20
Grid Bias (volts)	200	275	325
Power Output (watts)	60	95	115

Excitation power roughly 1/10 the input power.

Typical Operating Conditions for Class "C" Telegraphy

Plate Volts	1000	1250
Plate Current (milliamperes)	125	125
Grid Current (milliamperes)	20	20
Grid Bias (volts)	—200	—225
Power Output (watts)	94	115

Plate is designed to operate at a cherry-red color on its normal dissipation rating of 50 watts. A perceptible red color is noted at 25 watts. These temperatures are perfectly permissible and no damage will result from such operation. The advantages of using the anode color as a tuning indicator will be readily appreciated as you become familiar with the UH50.

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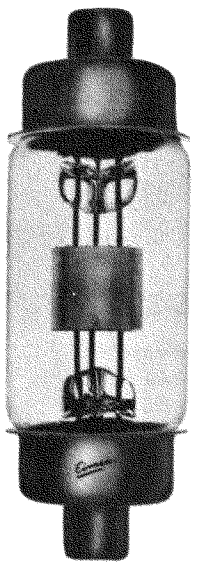
VACUUM CAPACITORS

VC50-32 VC50-20
VC25-32 VC25-20
VC12-32 VC12-20
VC6 - 32 VC6 - 20

Eimac vacuum capacitors are small, vacuum-dielectric units intended principally for use as all or part of the plate tank capacitance in radio-frequency amplifiers or oscillators. They are also frequently used as high-voltage coupling and by-pass capacitors at high frequencies and as high-voltage neutralizing capacitors, when used in conjunction with small high-voltage variable capacitors having a small capacitance range. The use of a vacuum as a dielectric permits the construction of a comparatively small, lightweight capacitor for a given voltage rating and capacitance. In addition, the effects of dust and atmospheric conditions on the capacitor are eliminated by sealing the plates within a glass envelope.

These capacitors are manufactured in two maximum peak voltage ratings, 32,000 and 20,000 volts, and in capacitances of 6, 12, 25 and 50 uufd. All types have a maximum current rating of 28 amperes. Each of the capacitors may be operated at its full maximum voltage rating at any frequency below that at which the rms current through the capacitor is 28 amperes. Above this frequency, the r-f voltage across the capacitor must be reduced as the frequency increases, to prevent the current from exceeding the maximum rating. The graphs below show the maximum peak r-f voltage which may be applied to each type of capacitor at frequencies between 100 kilocycles and 50 megacycles. Curves are also shown which indicate the rms current flowing through the capacitor under maximum r-f voltage conditions at any frequency between 100 kilocycles and 50 megacycles. Where both r-f and d-c voltages are applied to the capacitor, the sum of the peak r-f and d-c voltages must not exceed the peak voltage rating of the capacitor.

Eimac vacuum capacitors are provided with terminals which allow the use of standard 60-ampere fuse clips for mounting. These clips must be kept clean and must at all times make firm and positive contact with the capacitor terminals. Failure to maintain a low-resistance contact to the capacitor terminals may result in excessive heating and permanent damage to the capacitor seals.

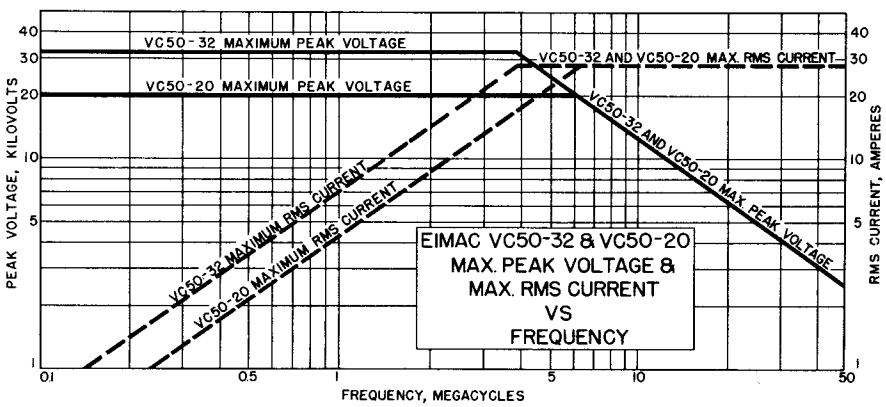


VC50-32

Capacitance* . . . . . 50 $\mu\mu$fd.
Max. Peak Voltage . . . . 32,000 volts
Max. RMS Current . . . . . 28 amps.

VC50-20

Capacitance* . . . . . 50 $\mu\mu$fd.
Max. Peak Voltage . . . . 20,000 volts
Max. RMS Current . . . . . 28 amps.

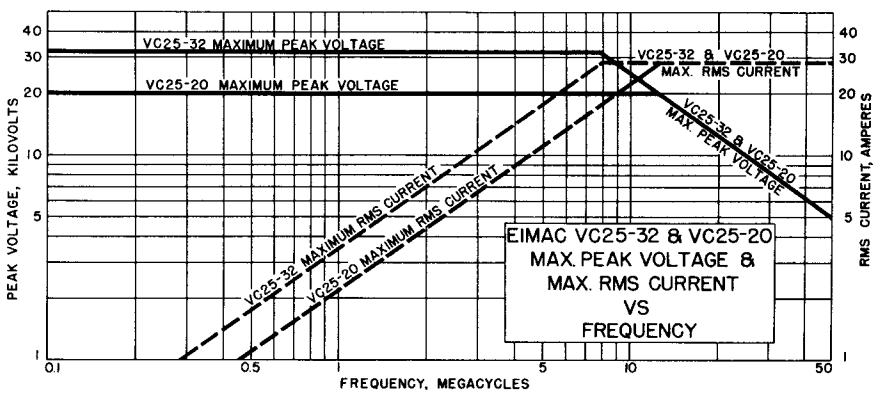


VC25-32

Capacitance* . . . . . 25 $\mu\mu$fd.
Max. Peak Voltage . . . . 32,000 volts
Max. RMS Current . . . . . 28 amps.

VC25-20

Capacitance* . . . . . 25 $\mu\mu$fd.
Max. Peak Voltage . . . . 20,000 volts
Max. RMS Current . . . . . 28 amps.



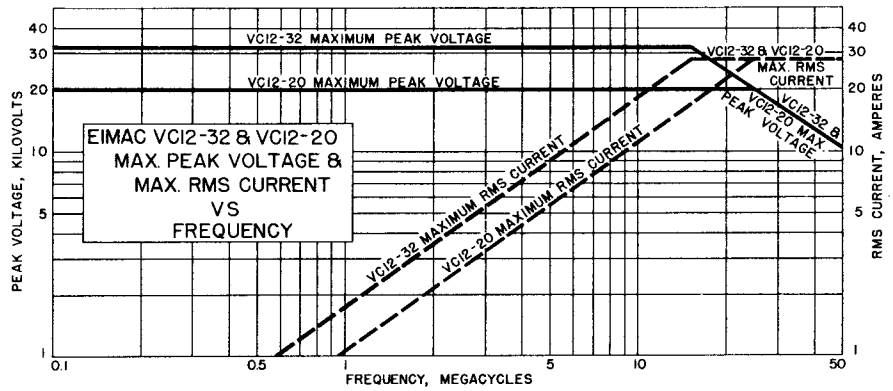
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VC12-32

Capacitance* . . . . . 12 $\mu\mu$fd.
Max. Peak Voltage . . . . 32,000 volts
Max. RMS Current . . . . . 28 amps.

VC12-20

Capacitance* . . . . . 12 $\mu\mu$fd.
Max. Peak Voltage . . . . 20,000 volts
Max. RMS Current . . . . . 28 amps.

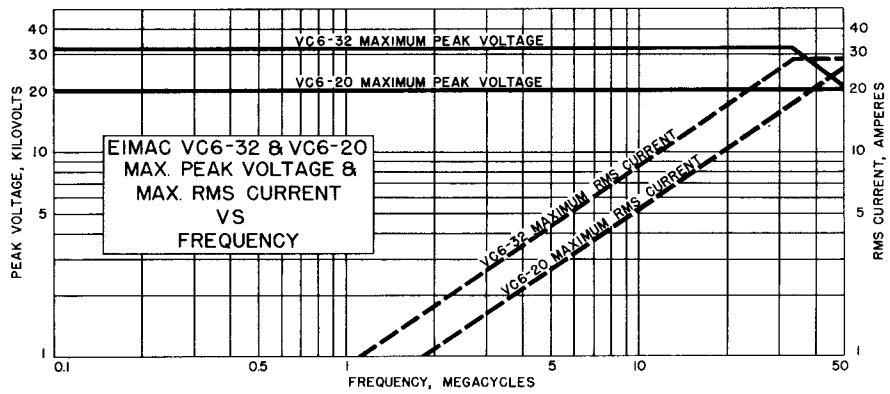


VC6-32

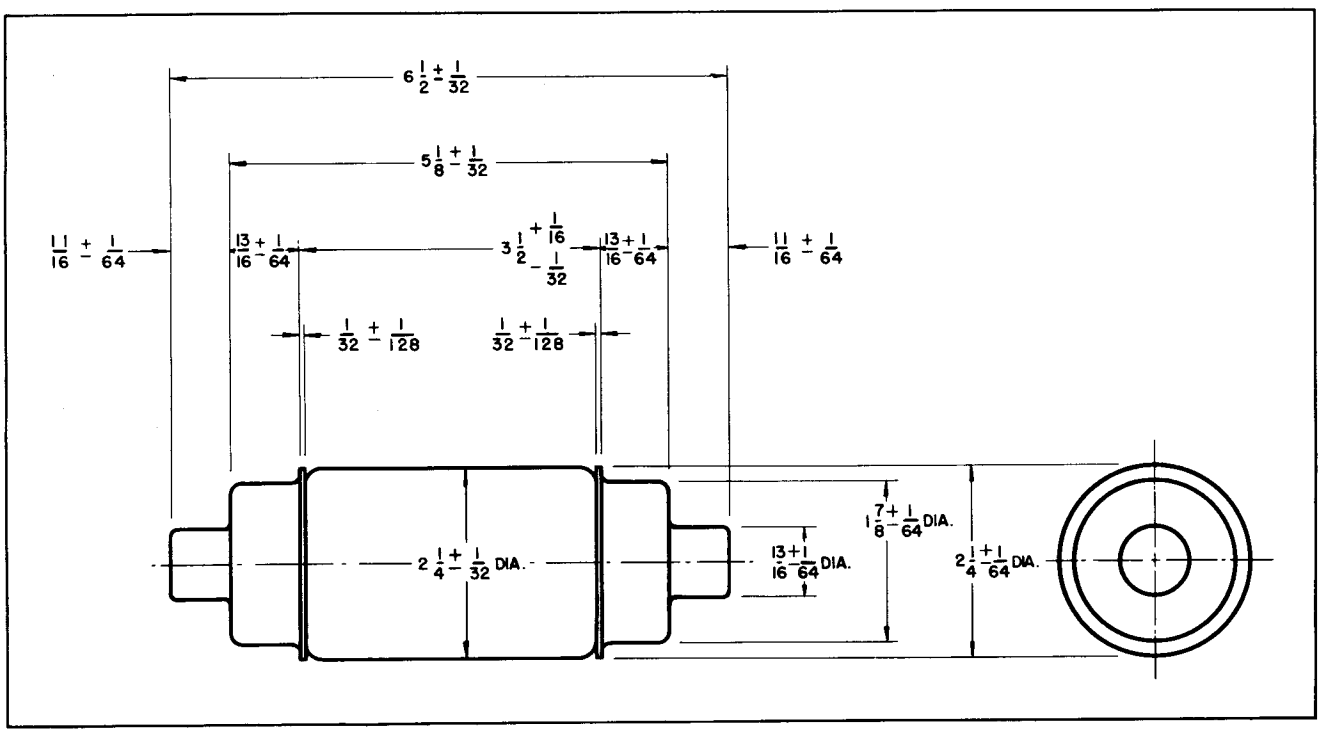
Capacitance* . . . . . 6 $\mu\mu$fd.
Max. Peak Voltage . . . . 32,000 volts
Max. RMS Current . . . . . 28 amps.

VC6-20

Capacitance* . . . . . 6 $\mu\mu$fd.
Max. Peak Voltage . . . . 20,000 volts
Max. RMS Current . . . . . 28 amps.



*Tolerances:
VC50-32, VC50-20 . . . . ± 1 $\mu\mu$fd.; VC25-32, VC25-20 . . . . ± 1 $\mu\mu$fd.; VC12-32, VC12-20 . . . . ± 1 $\mu\mu$fd.; VC6-32, VC6-20 . . . ± 0.5 $\mu\mu$fd.



Printed in U. S. A. 2-D6-22750

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

VARIABLE VACUUM CAPACITORS

TYPES VVC 60-20 VVC2-60-20 VVC4-60-20

GENERAL

Eimac variable vacuum capacitors are intended principally for use as plate tank capacitors in radio frequency amplifiers and oscillators. The use of vacuum for the dielectric permits close spacing of the electrodes giving concentrated capacitance at high voltage. The variable vacuum capacitors are compact, lightweight, and eliminate the effects of dust and atmospheric conditions.

The basic capacitor unit (VVC60-20) has an RF peak voltage rating of 20,000 volts and a maximum current rating of 40 amperes RMS. Ganged multiple unit capacitors are available using two units (VVC2-60-20) or four units (VVC4-60-20). These multiple unit capacitors include a single mounting plate, gear train, and single tuning shaft. One end of each unit capacitor mounts on the common plate and one end is free. Thus the multiple capacitor may be connected with the units in parallel, as two series capacitors for "split-stator" work, or as multiple capacitors with one terminal common.

The capacitors may be operated at the maximum voltage rating at any frequency provided the current rating is not exceeded. Above a particular frequency the maximum current rating becomes the limitation and voltage values less than the maximum must be used. Curves are given for each capacitor showing maximum allowable current (RMS) vs frequency.

MOUNTING

The VVC60-20 is provided with a mounting plate on one end, which also serves as an electrical connection. If the circuit is such that one side of the capacitor is grounded, the mounting plate can be fastened directly to the panel or chassis. Four eyelets are provided on the mounting plate that accommodate No. 8-32 screws. If the unit is to be ungrounded the mounting should be on insulators and the tuning shaft broken with an insulating coupling and the dial portion of the shaft grounded.

The other end of the capactor is provided with a large terminal that permits the use of a simple clamp or collet connector. This connector should be mounted flexibly to prevent undue mechanical strain being put on the capacitor seals. The connector must be kept clean and must at all times make a firm and positive contact with the capacitor terminal. Failure to maintain a low resistance contact to the capacitor terminal may result in excessive heating and permanent damage to the capacitor seals.

The multiple unit capacitor is designed so that it may be mounted readily on the chassis or from a panel. The mounting plate serves as one electrical connection and can be mounted directly at ground potential or insulated above ground. If the unit is ungrounded the tuning shaft should be broken with an insulating coupling and the dial portion of the shaft grounded.

The capacitors require normal circulation of air to keep the metal-to-glass seals below the maximum permissible temperature when carrying large values of current. In cases where the air flow is restricted or the ambient temperature is above room temperature a measurement of the seal temperature be made. Adequate cooling must be provided to keep the metal of the metal-to-glass seals below 150° centigrade.

The capacitance variation is linear with respect to shaft rotation, with the complete range being covered in seventeen revolutions of the shaft. Reference should be made to the tuning curve for each capacitor. A return to previously indexed settings is positive. The low-torque tuning mechanism provides easy hand operation of a dial directly on the shaft of either the single or multiple unit capacitors.

The variable vacuum capacitors have a low temperature coefficient resulting in a negligible change in capacitance due to variation in temperature. The actual coefficient values are given for each capacitor combination.

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VVC 60-20
VARIABLE VACUUM CAPACITOR

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA



The VVC60-20 is a single unit variable vacuum capacitor.

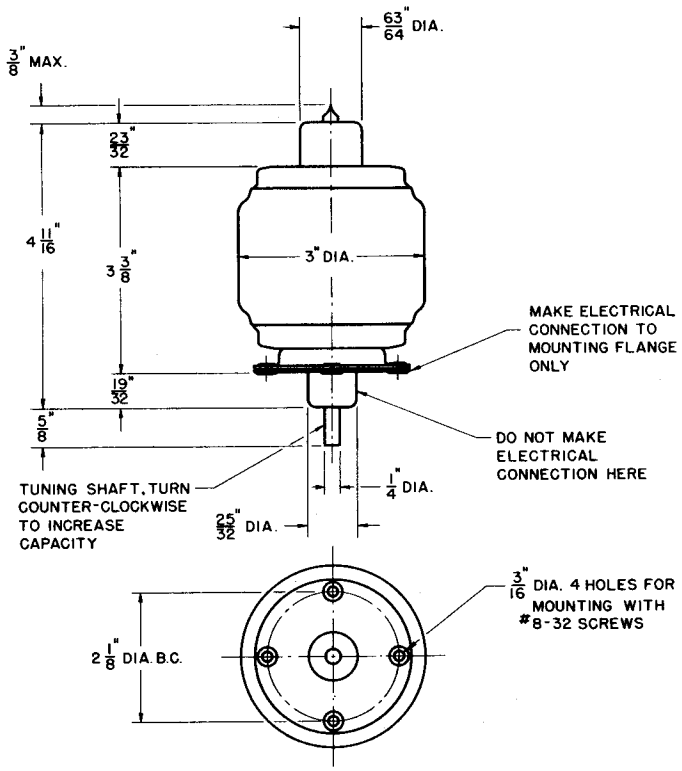
CHARACTERISTICS

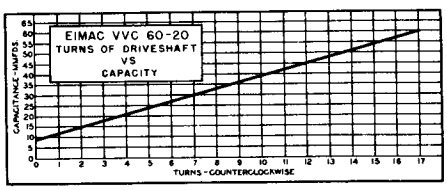
ELECTRICAL

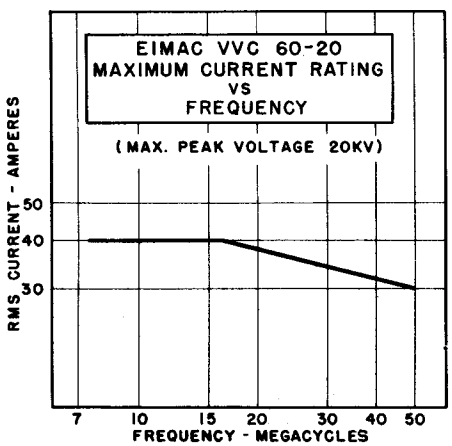
Capacitance	
Maximum	60 mmfd
Minimum	10 mmfd
Number of revolutions (See Curve)	17 turns
Maximum Peak R.F. Voltage	20 kilovolts
Maximum Current (RMS) (See derating curve vs frequency)	40 amperes
Temperature Coefficient	+.004 mmfd/°C

MECHANICAL

Mounting	See Outline Drawing
Cooling	Air Convection
Maximum Seal Temperature	150°C.
Maximum Overall Dimensions	
Length	5-11/16"
Diameter	3- 1/16"
Net Weight	1 lb. 6 oz.
Shipping Weight (average)	2 lb.





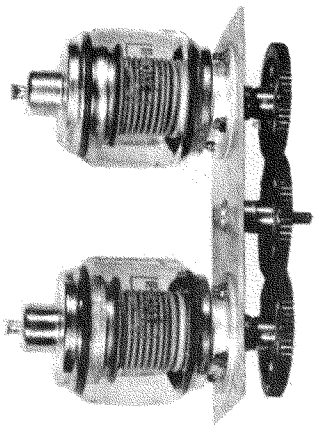


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VVC2-60-20
VARIABLE VACUUM CAPACITOR

The VVC2-60-20 is a dual unit variable vacuum capacitor consisting of two VVC60-20 units in a convenient gang-tuned mounting.



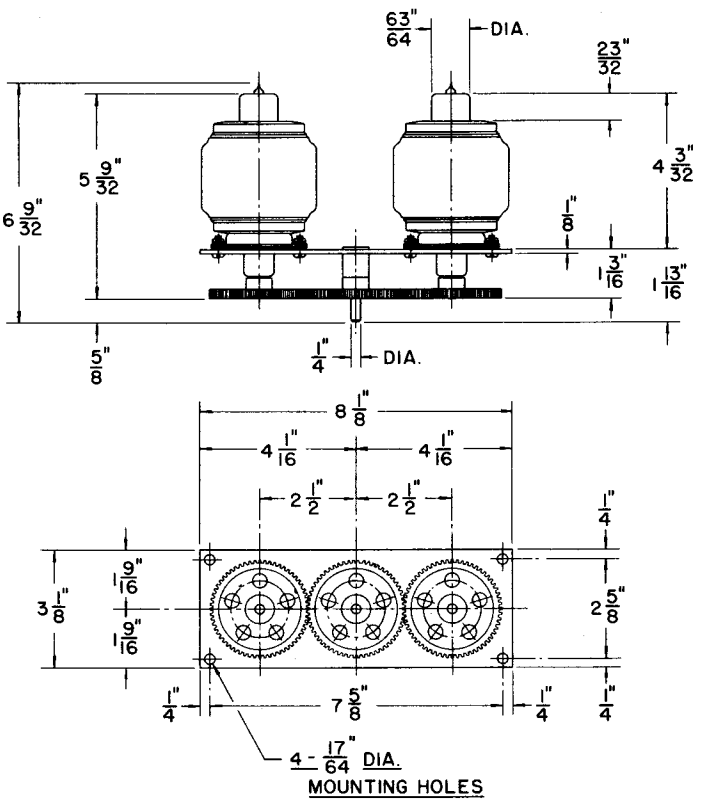
CHARACTERISTICS

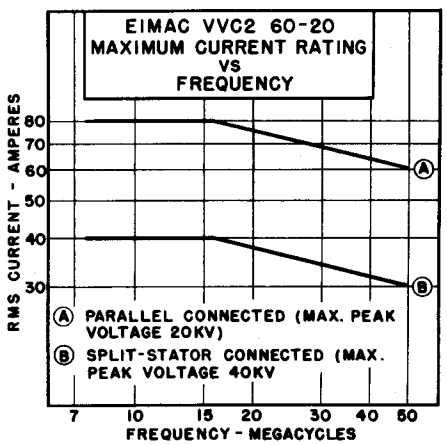
ELECTRICAL

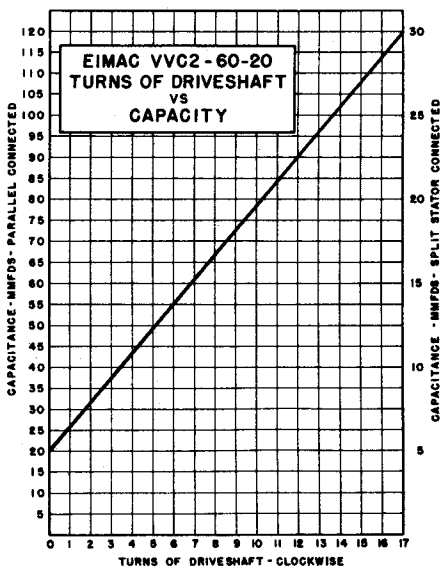
	Parallel	Split Stator	
Capacitance			
Maximum	120	30	mmfd
Minimum	20	5	mmfd
Number of revolutions (See Curves)	17	17	turns
Maximum Peak R.F. Voltage	20	40	kilovolts
Maximum Current (RMS) (See derating vs frequency)	80	40	amperes
Temperature Coefficient	+.008	+.002	mmfd/°C

MECHANICAL

Mounting	See Outline Drawing
Cooling	Air Convection
Maximum Seal Temperature	150° C
Maximum Overall Dimensions	
Depth	6-9/32"
Height	3-1/ 8"
Width	8-1/ 8"
Net Weight	4 lbs.
Shipping Weight (approx.)	8 lbs.



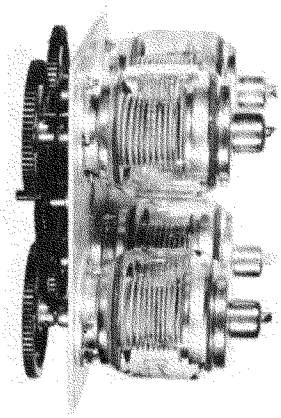




Effective 3-1-49

VVC4-60-20
VARIABLE VACUUM CAPACITOR

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA



The VVC4-60-20 is a four unit variable vacuum capacitor consisting of four VVC60-20 units in a convenient gang-tuned unit.

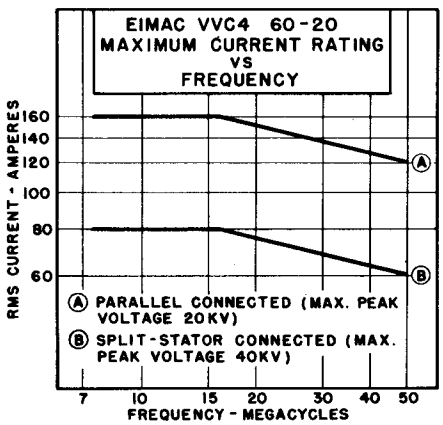
CHARACTERISTICS

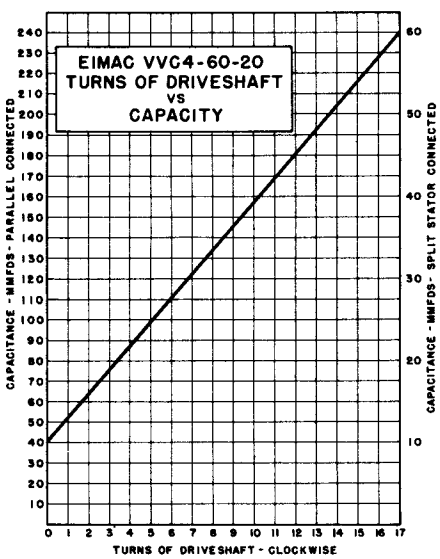
ELECTRICAL

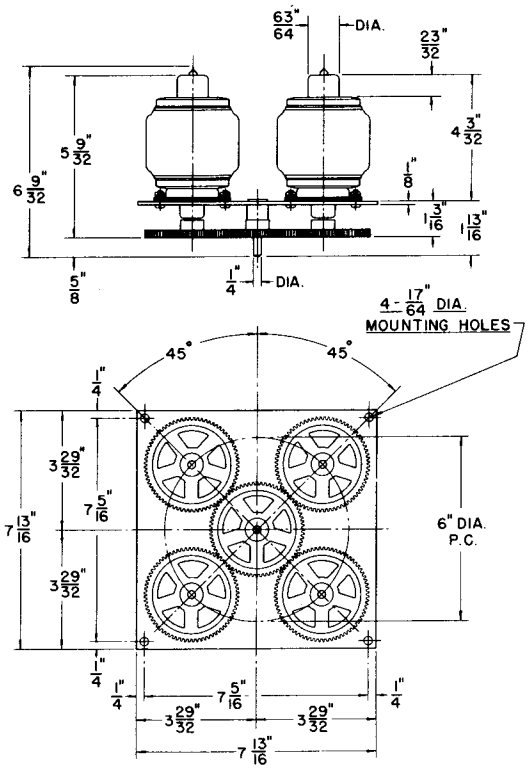
	Parallel	Split Stator	
Capacitance			
Maximum	240	60	mmfd
Minimum	40	10	mmfd
Number of revolutions (See Curves)	17	17	turns
Maximum Peak R.F. Voltage	20	40	kilovolts
Maximum Current (RMS) (See derating curve vs frequency)	160	80	amperes
Temperature Coefficient	+.016	+.004	mmfd/°C

MECHANICAL

Mounting	See Outline Drawing
Cooling	Air Convection
Maximum Seal Temperature	150°C
Mixiumum Overall Dimensions	
Depth	6- 9/32"
Height	7-13/16"
Width	7-13/16"
Net Weight	8 lbs.
Shipping Weight (approx.)	14 lbs.







Effective 3-1-49

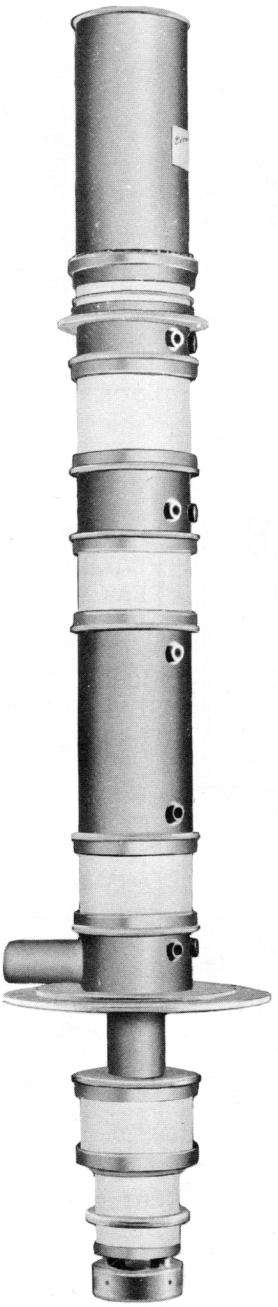
Printed in U.S.A. 2-A9-32150

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X626AC

PULSE-AMPLIFIER L-BAND KLYSTRON



The Eimac X626AC is a three-cavity, pulse-amplifier klystron designed for high-average-power pulse service at frequencies from 400 to 450 megacycles. This klystron will deliver a peak output power of 1.25 megawatts, at 75 kilowatts average power, with a narrow-band power gain of 30 decibels.

All tuning is accomplished outside the vacuum envelope by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design permits external cavity loading for wide-band applications. For spares or replacements, only the basic klystron, without cavities, need be purchased.

This klystron employs the Eimac Modulating Anode which provides a convenient means for pulse modulating the output power without changing the beam voltage. The electron-gun geometry is such that the required beam current is obtained with a peak modulating-anode voltage of only 52 kilovolts, at the rated beam voltage of 100 kilovolts.

Waveguide output coupling for the X626AC is achieved by means of an adjustable iris in the output cavity.

Eimac Klystron Amplifier Circuit Assembly H-123B has been designed for use with the X626AC to cover the specified frequency range. This assembly includes a supporting structure, magnetic focusing coils, tuning cavities, input load coupler, output waveguide transition, and a klystron socket.

CHARACTERISTICS

ELECTRICAL

Cathode:	EMA, Unipotential		
	Minimum Heating Time	10	minutes
Heater:	Voltage (±5%)	7.5	volts
	Current	90 to 100	amperes
	Maximum Starting Current	200	amperes
Getter:	Voltage	15.6	volts
	Current	36	amperes
Modulating Anode Capacitance (to all other electodes):			
	Dry	45	μμf
	In Typical Circuit (oil immersed)	125 to 150	μμf
Power Gain (Narrow Band)		30	decibels
Peak Output Power		1.25	megawatts
Average Output Power		75	kilowatts
Frequency Range (H-123B Circuit Assembly)		400 to 450	megacycles

MECHANICAL

Operating Position	Vertical, Cathode Down
R-F Input Coupling	1 5/8 inch, 50-ohm line
R-F Output Coupling	WR-2100 Waveguide
Weight (X626AC only)	590 pounds

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MECHANICAL cont.

Weight (H-123B Circuit Assembly)	1780	pounds
Maximum Dimensions (X626AC)		
Length	118	inches
Diameter	18	inches
Maximum Dimensions (X626AC and H-123B Circuit Assembly)		
Height	120	inches
Width	38	inches
Depth	38	inches

Cooling: Oil, Water and Forced Air
Electron Gun: Immersed in Oil

	Flow Rate	Pressure Drop
Penultimate and Output Cavities	250 cfm	3 inches H_2O
Four Drift-Tube Sections in Series	5 gpm	5.5 psi
Collector	50 gpm	26 psi

MAGNETIC COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil:	Voltage	0 to 60	volts
	Current	0 to 2	amperes
First Body Coil:	Voltage	0 to 100	volts
	Current	0 to 2	amperes
Each of Three Body Coils and Collector Coil:	Voltage	0 to 150	volts
	Current	0 to 6	amperes

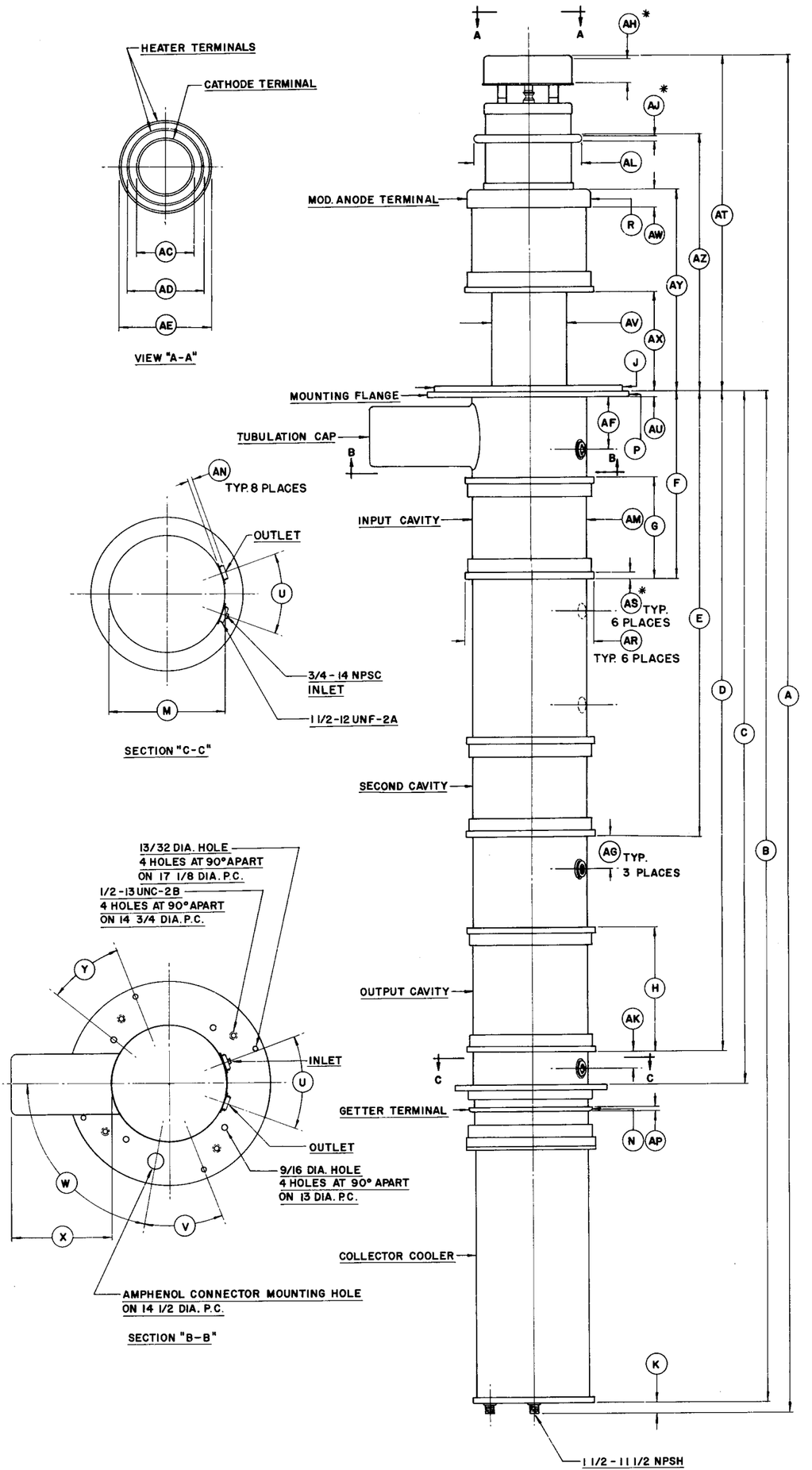
MAXIMUM RATINGS

D-C BEAM VOLTAGE	110	KILOVOLTS
PEAK BEAM CURRENT	36.5	AMPERES
PEAK MODULATING-ANODE VOLTAGE	66	KILOVOLTS
AVERAGE D-C BODY CURRENT	150	MILLIAMPERES
A-C GETTER CURRENT	50	AMPERES
COLLECTOR DISSIPATION	240	KILOWATTS
SEAL TEMPERATURES	175	DEGREES C
D-C FOCUS-ELECTRODE VOLTAGE	-500	VOLTS

TYPICAL OPERATION, NARROW-BAND, PULSE AMPLIFIER

Frequency	425	megacycles
D-C Beam Voltage	100	kilovolts
Peak Modulating-Anode Voltage	52	kilovolts
Peak Beam Current	32.5	amperes
Average D-C Body Current	130	milliamperes
Peak Output Power	1.25	megawatts
Average Output Power	75	kilowatts
Peak Drive Power	1.25	kilowatts
Power Gain	30	decibels
Peak Beam Power Efficiency	38.4	percent
Focus-Electrode Voltage	-50	volts
Pulse Width	2000	microseconds
Pulse Repetition Rate	30	pulses/second
Duty	0.06	
Electron-Gun Microperveance	2.6	
Beam Microperveance	0.98	
Magnetic-Coil Currents		
Prefocus Coil	1.4	amperes
First Body Coil	1.0	ampere
Second, Third & Fourth Body Coil and Collector Coil (each)	4.0	amperes

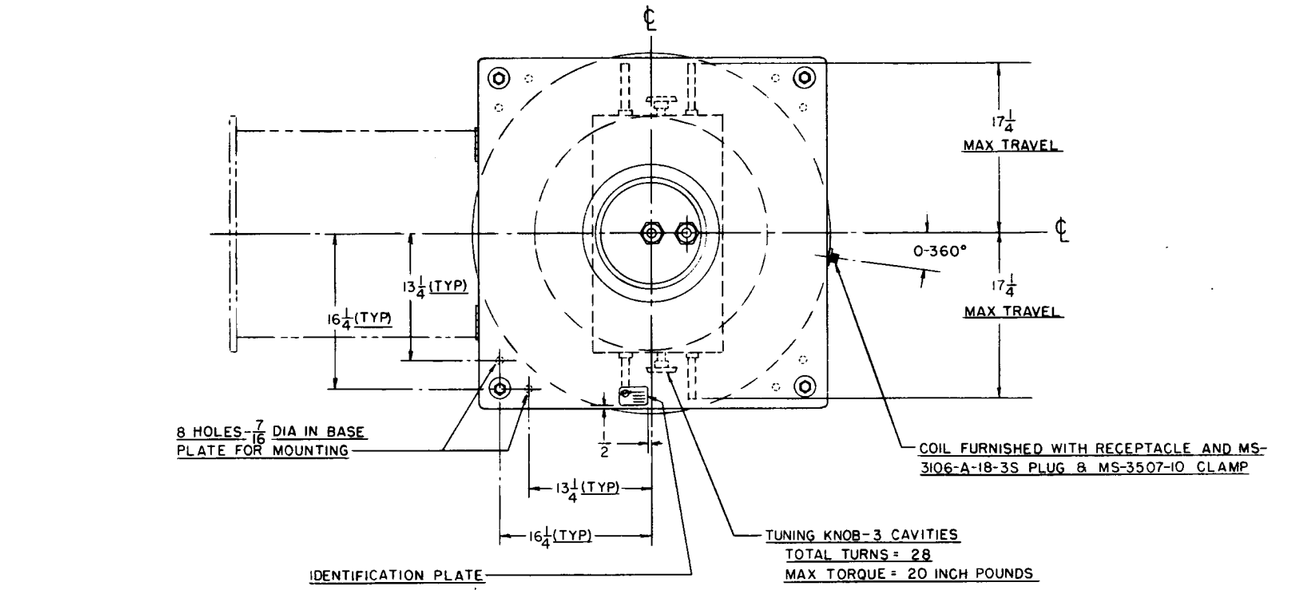
For additional information or information regarding a specific application write to Eitel-McCullough, Inc., San Carlos, California.

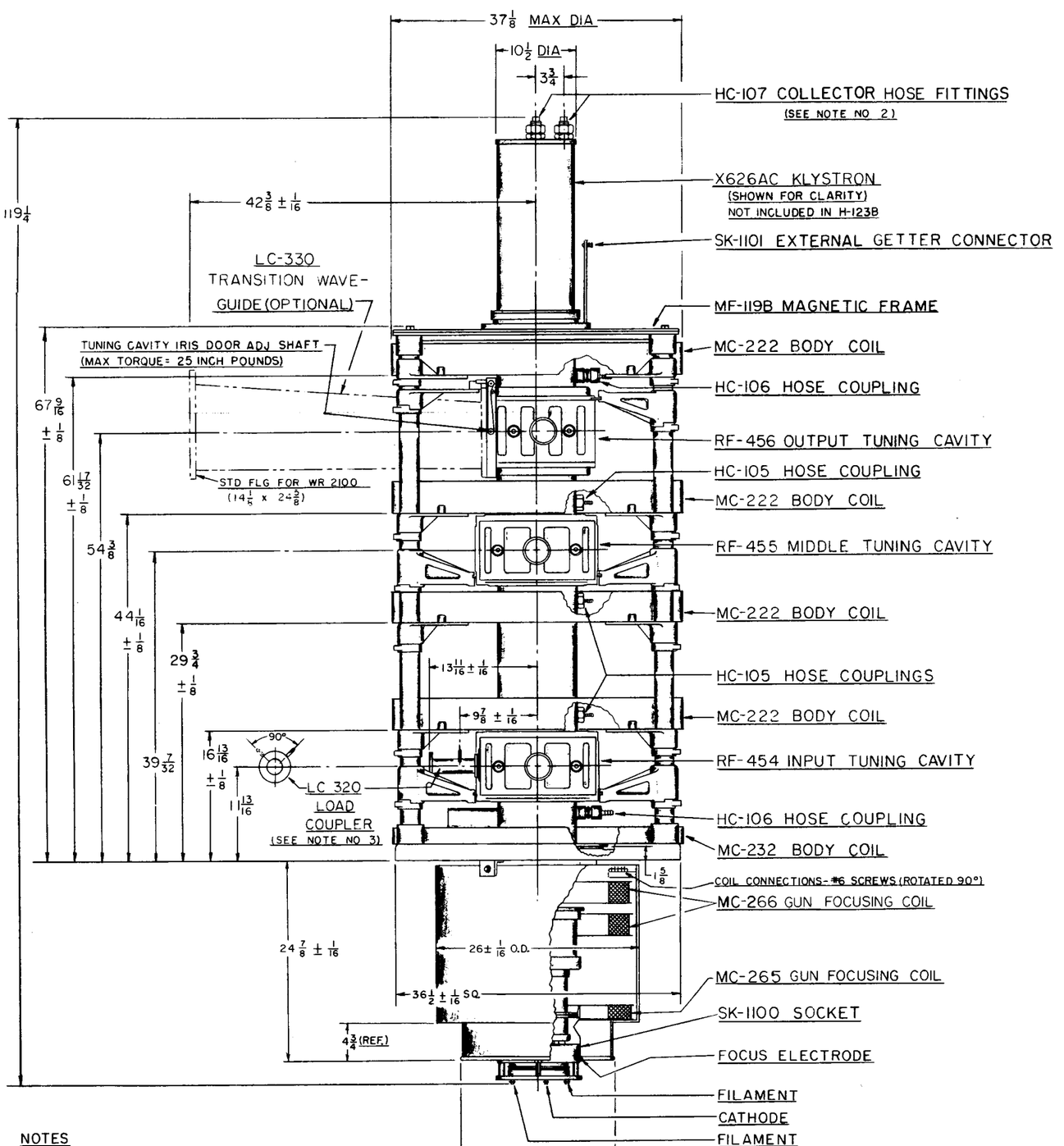


DIMENSIONAL DATA			
REF	NOM	MIN	MAX
A	117.5		
B	89.3		
C		60.78	61.20
D	58.0		
E	42.0		
F	14.6		
G		8.790	8.842
H		10.429	10.481
J		16.375	16.500
K		.600	
L	10.5		
M	10.0		
N	10.8		
P		17.875	18.030
R	10.9		
S	3.7		
T			
U	40°		
V	32°		
W	91.5°		
X	6.750		
Y	30°		
Z	4.0		
AA			
AB			
AC		33.970	4.090
AD		6.165	6.285
AE		7.910	8.030
AF	3.75		
AG	2.0		
AH		2.375	
AJ		.5	
AK		1.460	1.560
AL		9.281	9.343
AM	10.045		
AN		.375	
AP		.250	.500
AR		11.490	11.510
AS		.375	
AT		27.290	27.790
AU		.437	
AV	5.0		
AW			
AX	7.5		
AY	15.6		
AZ	20.7		

NOTES:
* 1. MIN. STRAIGHT SURFACE FOR CONTACT.
2. DIMENSIONS ARE INCHES.

X626AC KLYSTRON





NOTES

1. SOCKET TO BE SPRING MOUNTED IN KLYSTRON TANK TO MIN DIMENSION MIN SPRING COMPRESSION TO BE ¾ INCH
2. MATING PART (BY CUSTOMER) SNAP-TITE COUPLER HALF NO H24-2009-38
3. STD 1⅝ UHF COAX FLANGE ON LOAD COUPLER

PARTS NOT SHOWN

HT-105 EXTENSION WRENCH
HT-106 COUPLING WRENCH
HT-107 WATER FITTING WRENCH

H-123B KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X700

PULSE AMPLIFIER S-BAND KLYSTRON

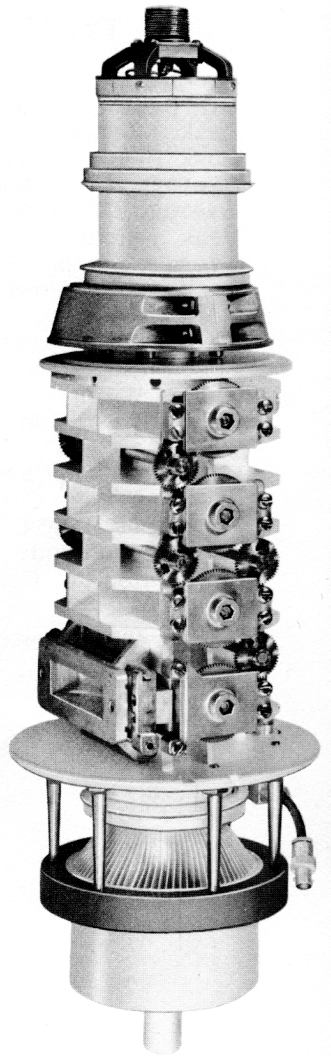
The Eimac X700 is a four cavity, magnetically focused, pulse amplifier klystron designed for use under severe environmental conditions. This klystron will deliver a peak output power of 20 kilowatts, at 1 kilowatt average power, at frequencies from 2400 to 2900 megacycles. Typical power gain is 40 decibels.

This klystron employs the Eimac Modulating Anode which provides an effective means of pulse modulating the output power without changing the beam voltage. The electron-gun geometry is such that the modulating anode voltage is only 50% as great as the beam voltage.

The resonant cavities of the X700 are an integral part of the klystron but are completed and tuned outside the vacuum envelope.

Waveguide output coupling for the X700 is achieved by means of an adjustable iris in the output cavity.

The associated magnetic circuitry for the X700 includes a supporting structure, focusing coils, extension tuning controls, and a waveguide transition.



CHARACTERISTICS

ELECTRICAL

Cathode:	Oxide Coated, Unipotential		
	Minimum Heating Time	5	minutes
Heater:	Voltage (±5%)	7.5	volts
	Current	5.5	amperes
	Maximum Starting Current	11	amperes
Typical Power Gain		40	decibels
Peak Output Power		20	kilowatts
Average Output Power		1.0	kilowatt
Frequency Range		2400 to 2900	megacycles

MECHANICAL

Operating Position		Vertical, Cathode up	
RF Input Coupling		50-ohm TNC	
RF Output Coupling		WR-284 Waveguide	
Weight (X700)		39	pounds
Weight (Circuit Assembly)		160	pounds
Maximum Dimensions (X700)			
	Length	24	inches
	Diameter	7	inches
Maxmum Dimensions (X700 and circuit assembly)			
	Length	24	inches
	Diameter	17	inches

Cooling: Forced Air	Flow Rate	Pressure Drop
Body	100 cfm	1.5 inches H_2O
Collector	100 cfm	1.5 inches H_2O

MAGNETIC-COIL POWER-SUPPLY REQUIREMENTS

Prefocus Coil: Voltage	0 to 40	volts
Current	0 to 2	amperes
Each of Two Body Coils:		
Voltage	0 to 40	volts
Current	0 to 10	amperes
Collector Coil: Voltage	0 to 50	volts
Current	0 to 5	amperes

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MAXIMUM RATINGS

DC BEAM VOLTAGE	28	KILOVOLTS
PEAK BEAM CURRENT	36.5	AMPERES
PEAK MODULATING-ANODE VOLTAGE	14	KILOVOLTS
AVERAGE DC BODY CURRENT	50	MILLIAMPERES
COLLECTOR DISSIPATION	2500	WATTS
DC FOCUS-ELECTRODE VOLTAGE	−500	VOLTS

TYPICAL OPERATION, NARROW-BAND, PULSE AMPLIFIER

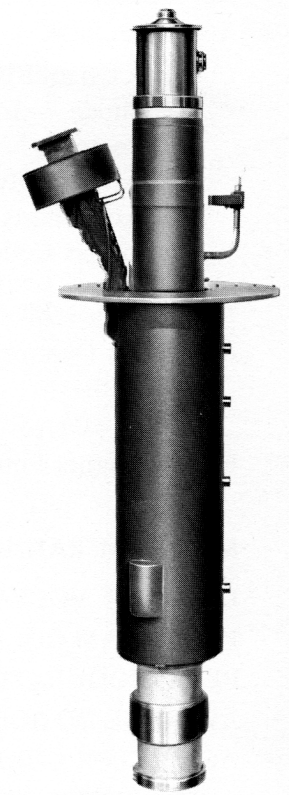
Frequency	2500	megacycles
DC Beam Voltage	21	kilovolts
Peak Modulating-Anode Voltage	10.5	kilovolts
Peak Beam Current	2.77	amperes
Average DC Beam Current	0.138	ampere
Average DC Body Current	25	milliamperes
Peak Output Power	21.5	kilowatts
Average Output Power	1.07	kilowatts
Peak Drive Power	2	watts
Power Gain	40.2	decibels
Peak Beam Power Efficiency	37	percent
Focus-Electrode Voltage	−100	volts
Pulse Width	50	microseconds
Pulse Repetition Rate	1000	pulses/second
Duty	0.05	
Magnetic Coil Currents:		
Prefocus Coil	1.2	amperes
First Body Coil	7.0	amperes
Second Body Coil	7.0	amperes
Collector Coil	3.2	amperes

For additional information or information regarding a specific application write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

X780

PULSE AMPLIFIER L-BAND KLYSTRON



The Eimac X780 is a pulse-amplifier klystron designed to operate at frequencies from 1235-1365 megacycles. This klystron will deliver a peak output power of 2.5 megawatts at 75 kilowatts average power, with a minimum saturated gain of 35 decibels. The small signal gain is in excess of 50 decibels.

Four integral cavities are used in the X780. The RF input and output coupling circuits are of the fixed broad-band type, optimized at maximum power. The output window is a thick beryllium oxide disc which will withstand severe abuse. The electron gun utilizes a confined flow configuration which results in a stable beam and non-critical focusing adjustments.

This klystron employs the Eimac Modulating Anode which provides a convenient means for pulse modulating the output power without changing the beam voltage. Also incorporated are two built-in vacuum pumps. One consists of an active titanium getter. The other is an ion pump which maintains a low vacuum pressure and provides for continuous monitoring of this pressure.

A focusing electromagnet and klystron supporting structure, Catalog Number H-145, has been designed for use with the X780.

CHARACTERISTICS

ELECTRICAL

Cathode: EMA, Unipotential		
Minimum Heating Time	10	minutes
Heater: Voltage (±5%)	7	volts
Current	90	amperes
Maximum Starting Current	180	amperes
Getter: Voltage (AC nominal)	4	volts
Current	20	amperes
Power Gain (minimum narrow band)	35	decibels
Peak Power Output	2.5	megawatts
Average Power Output	75	kilowatts
Frequency Range	1235-1365	megacycles
Phase: Beam Voltage Sensitivity	0.006	degree/volt
Ion Pump:		
Voltage DC	4000	volts
Current (0.1 megohm limiting resistor)	10	milliamperes
Beam Microperveance	1.5	
Electron Gun Microperveance	2.5	
Input VSWR (maximum)	1.5:1	

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MECHANICAL

Operating Position	Vertical, Cathode End Down	
RF Input Coupling	EIA standard RS 225, 7/8" rigid coaxial fitting	
RF Output Coupling	RG69/U Flange	
Approximate Weight (tube only)	400	pounds
Approximate Weight (H-145 Magnetic Circuit)	1500	pounds

Cooling: Oil and Water

	Flow Rate	*Pressure Drop*
Cathode — Immersed in Oil		
Collector	60 gpm	40 psi
Klystron Body	5 gpm	25 psi
Electromagnet	2 gpm	30 psi

Fittings: Collector — Hansen B12 HK
Body — Hansen B4-K26
Electromagnet — Hansen B4-H26

Maximum Overall Dimensions (Klystron & Electromagnet):

Length	71	inches
Diameter	24	inches
Electromagnet Power Supply Requirements	2.5	kilowatts

MAXIMUM RATINGS

DC BEAM VOLTAGE	120	kilovolts
PEAK BEAM CURRENT	62.5	amperes
PEAK MODULATING ANODE VOLTAGE	88	kilovolts
AVERAGE DC BODY CURRENT	150	milliamperes
AC GETTER CURRENT	45	amperes
COLLECTOR DISSIPATION	250	kilowatts
SEAL TEMPERATURES	175	degrees C
LOAD VSWR	1.5:1	

TYPICAL OPERATION, NARROW-BAND PULSE AMPLIFIER

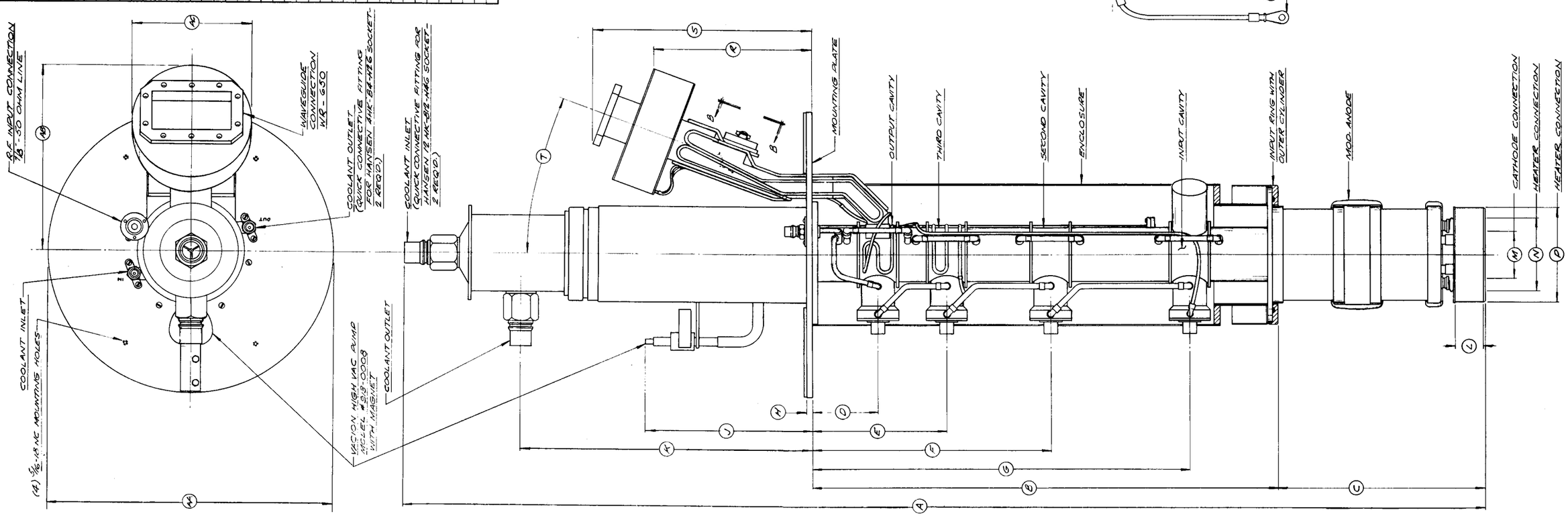
Frequency	1295	1295	megacycles
DC Beam Voltage	100	115	kilovolts
Peak Modulating-Anode Voltage	73.5	83.5	kilovolts
Peak Beam Current	41.8	58.6	amperes
Average DC Body Current	90	100	milliamperes
Peak Output Power	1.485	2.515	megawatts
Average Output Power	89	75.5	kilowatts
Peak Drive Power	0.475	0.790	kilowatts
Power Gain	35	35	decibels
Peak Beam Power Efficiency	35.6	36.8	percent
Pulse Width	2	1	millisecond
Pulse Repetition Rate	30	30	pulses/second
Duty	0.06	0.03	percent

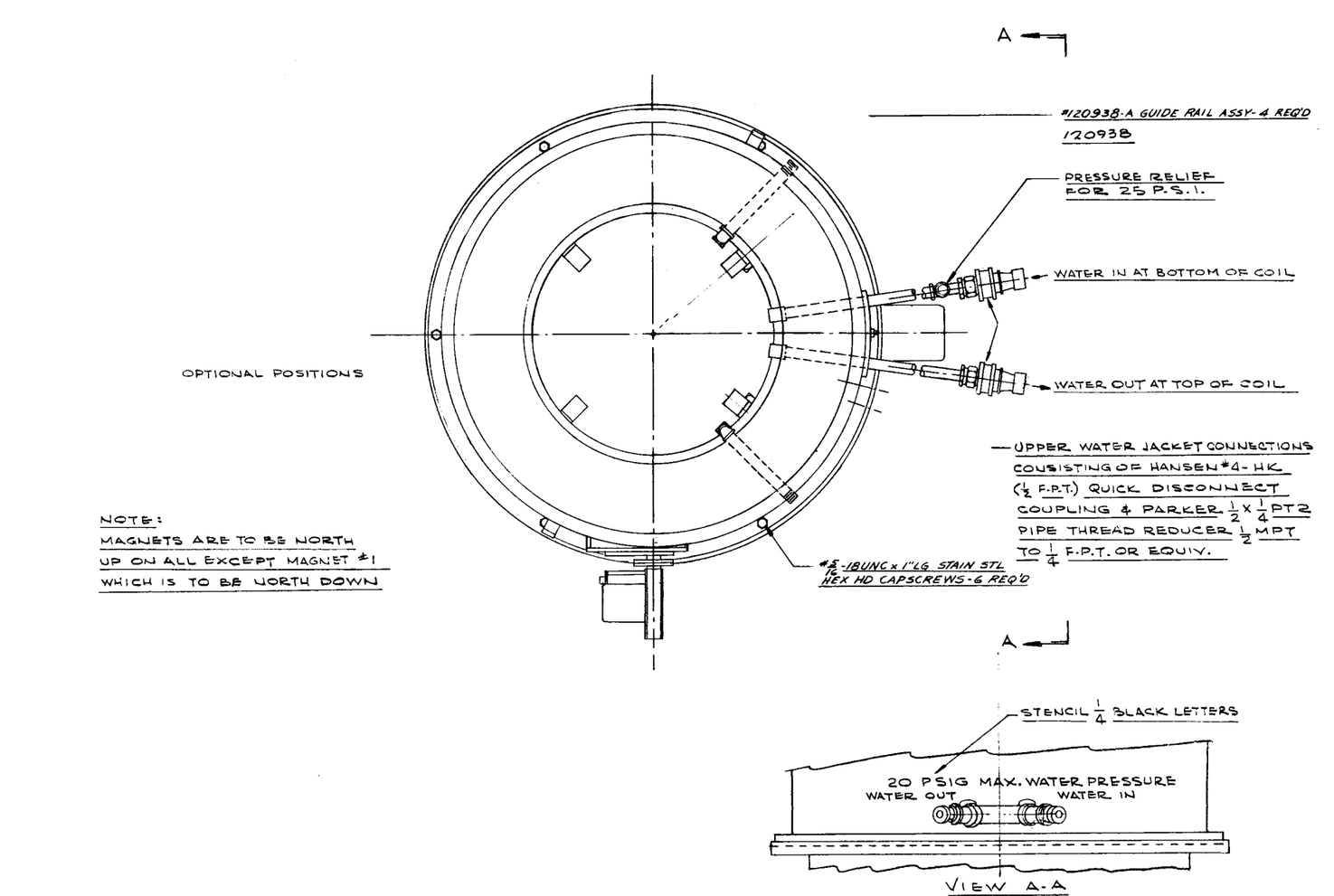
For additional information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.

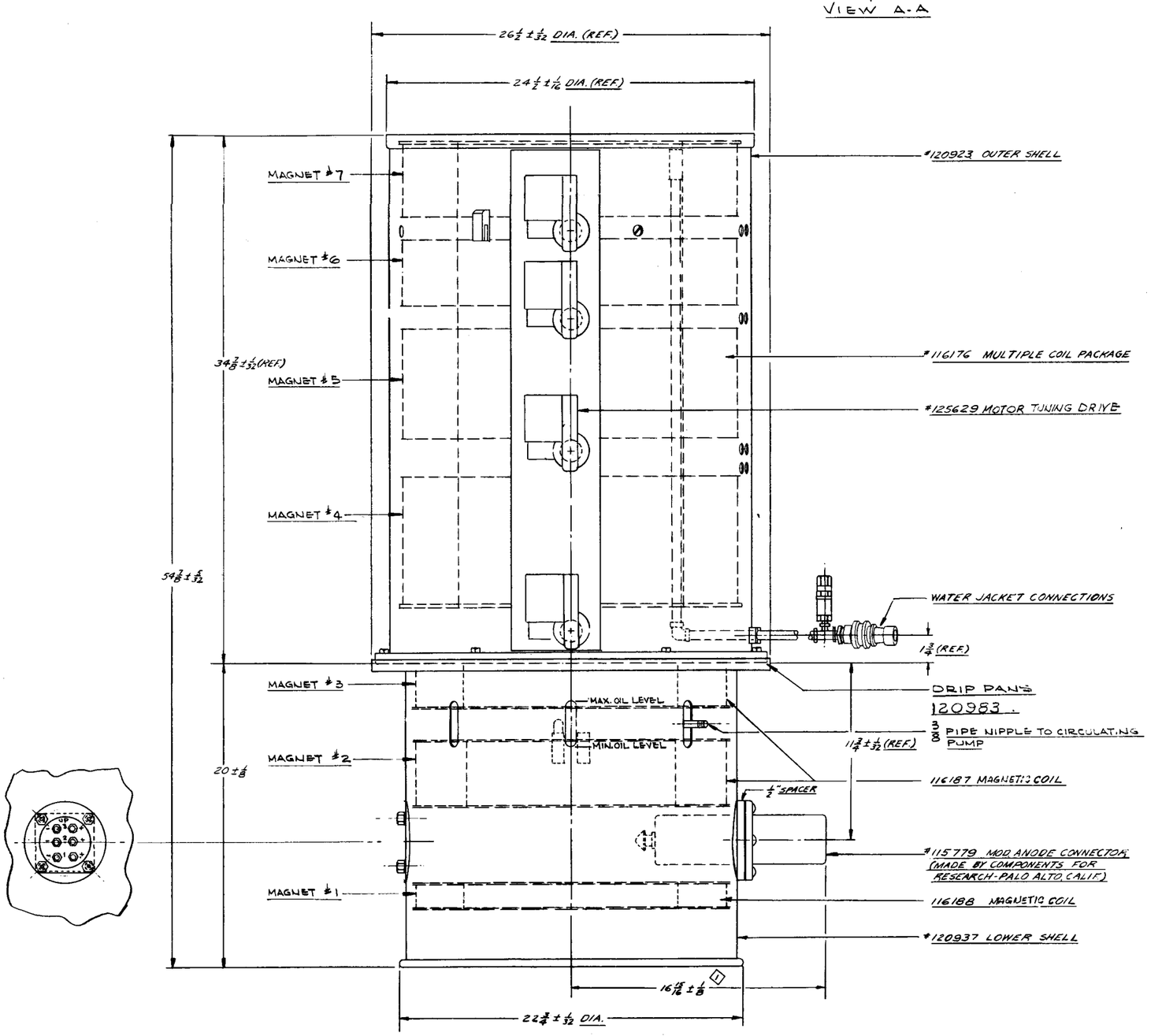
X780 Eimac

X780 KLYSTRON

DIMENSIONAL DATA			
REF.	NOM.	MIN.	MAX.
A	31.625		
B	40.250		
C	17.125		
D	6.000		
E	11.812		
F	20.562		
G	32.312		
H	.500		
J	12.625		
K	24.750		
L	2.375		
M	4.000		
N	6.250		
P	8.000		
R	12.500		
S	17.750		
T	20°		
AA	24.000		
AB	15.000		
AC	10.000		







H-145 KLYSTRON AMPLIFIER CIRCUIT ASSEMBLY

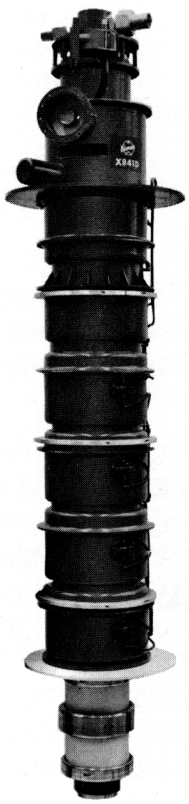
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

Tentative Data

X841D

PULSE AMPLIFIER

UHF KLYSTRON



The EIMAC X841D is a pulse amplifier klystron designed for broadband high average power pulse service at frequencies from 400-450 megacycles. This klystron will have a 5%, fixed-tuned band-width anywhere within this frequency range and will deliver a minimum peak output power of 2.5 megawatts, at 150 kilowatts average power, with a minimum power gain of 33 decibels.

Six integral cavities are used in the klystron. The output circuit mates to a 6⅛ inch transmission line.

This klystron employs the EIMAC Modulating Anode which provides a convenient means for pulse modulating the output power without changing the beam voltage. The electron-gun geometry is such that a typical switching voltage of 75 kilovolts is required for the modulating anode to provide the specified beam current, at the rated beam voltage of 115 kilovolts. The equivalent modulating anode impedance is approximately one megohm.

The tube incorporates a built-in ion pump and gauge which maintains a low gas pressure, and also provides a means for continuously monitoring this pressure.

Catalog Number H-150 has been assigned to the magnetic circuitry for this tube.

CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, oxide coated	
Minimum Heating Time	15 minutes
Heater: Voltage (maximum)	30 volts
Current (maximum)	35 amperes
Power Gain (minimum)	33 decibels
Peak Power Output	2.5 megawatts
Average Power Output	150 kilowatts
Phase shift as a function of beam voltage	0.006 degree/volt
Ion Pump: Voltage	3,000-4,000 volts dc
Current (0.1 megohm limiting resistor)	10 milliamperes
Beam Microperveance	1.6
Electron Gun Microperveance	3.0

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MECHANICAL

Operating Position	Vertical, Cathode End Down
Input Coupling (rf)	UG 22/U, Type N
Output Coupling (rf)	6⅛" Coax
Approximate Weight (tube only)	1,000 Pounds
Approximate Weight (H-150 Magnetic Circuit)	1,200 Pounds

Cooling: Oil and Water (Max Water Inlet Temp of 45°C)

	Flow Rate	*Pressure Drop*
Cathode — Immersed in Oil		
Collector	120 gpm	65 psi
Klystron Body	10 gpm	65 psi
Electromagnet	5 gpm	65 psi

Maximum Overall Dimensions (Klystron and Electromagnet):

Length	130 inches
Diameter	26 inches
Greatest Extending Radius	16-5/16 inches

ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Each of 3 supplies	75 volts at 10 amperes
Each of 2 supplies	150 volts at 10 amperes
Each of 3 supplies	300 volts at 10 amperes

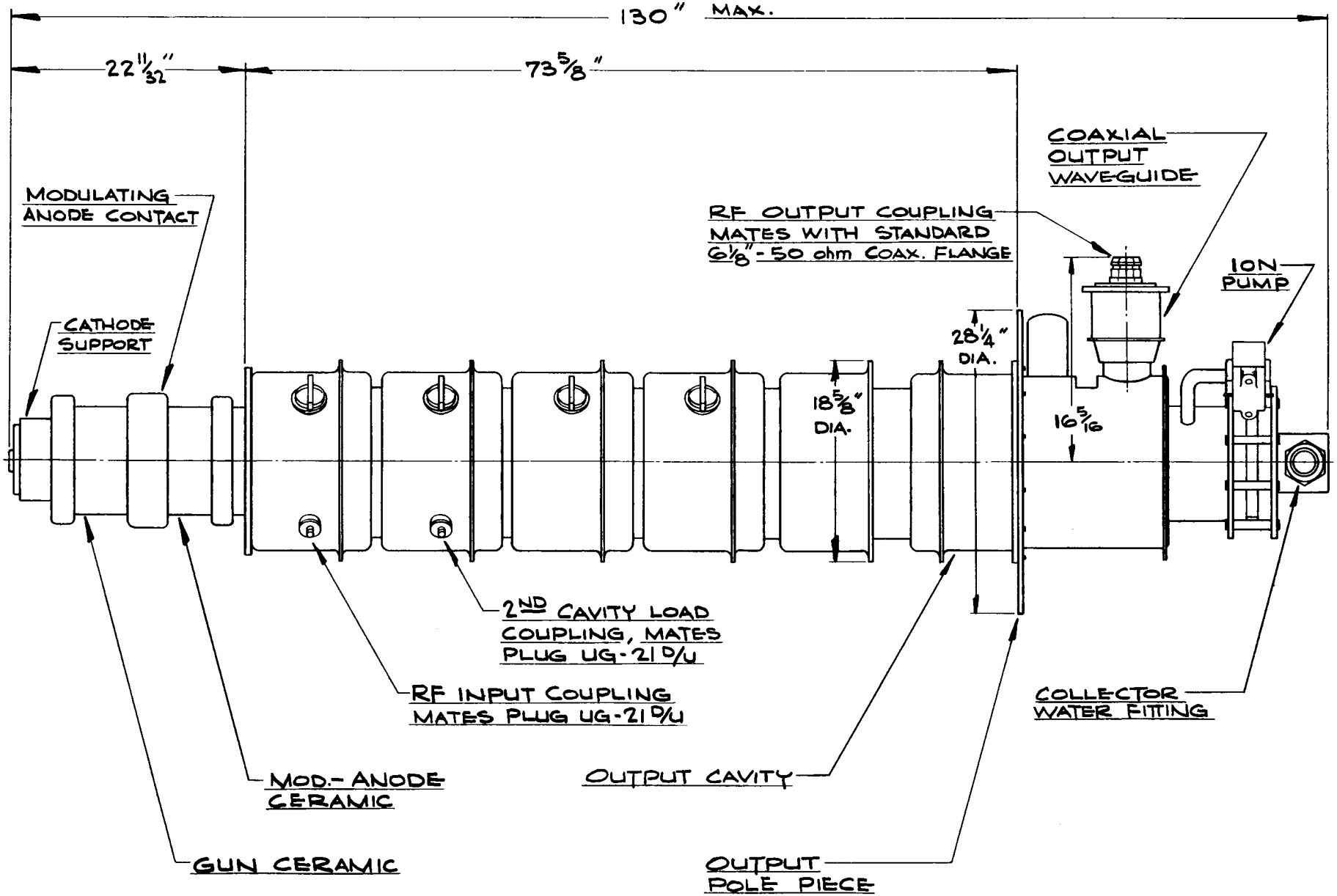
MAXIMUM RATINGS

BEAM VOLTAGE (dc)	115 Kilovolts
PEAK BEAM CURRENT	66 Amperes
PEAK MODULATING ANODE VOLTAGE	78 Kilovolts
AVERAGE MODULATING ANODE CURRENT	20 Milliamperes
AVERAGE BODY CURRENT	200 Milliamperes
PULSE WIDTH	2000 Microseconds
COLLECTOR DISSIPATION	450 Kilowatts
DUTY CYCLE	.06
SEAL TEMPERATURES	150 Degrees C
LOAD VSWR	1.5:1
INLET WATER PRESSURE	100 PSIG

TYPICAL OPERATION, BROAD-BAND PULSE AMPLIFIER

Center Frequency	425 Megacycles
Beam Voltage	112 Kilovolts dc
Peak Modulating-Anode Voltage	74 Kilovolts
Peak Beam Current	60 Amperes
Average Body Current	60 Milliamperes dc
Peak Output Power	2.5 Megawatts
Average Output Power	150 Kilowatts
Peak Drive Power	500 Watts
Power Gain	37 Decibels
Peak Beam Power Efficiency	40 Percent
Pulse Width	2000 Microseconds
Pulse Repetition Rate	30 Pulses per second
Duty	.06
Bandwidth (1 db)	25 Megacycles
Load VSWR	1.2:1

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.



X841D OUTLINE

X841D

Eimac

Eimac
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

OBJECTIVE DATA

X850 X-BAND 20 KW CW POWER AMPLIFIER KLYSTRON

The X850 is the most recent product of the Eimac High Power Microwave Tube Laboratory. It is the first of a series of Eimac X-band power klystrons which will ultimately include tubes at all commonly used power levels.

Four integral cavities are used in the X850. Each tube is pretuned at the laboratory to the frequency chosen by the user, within the 7.125 to 8.5 kMc band.

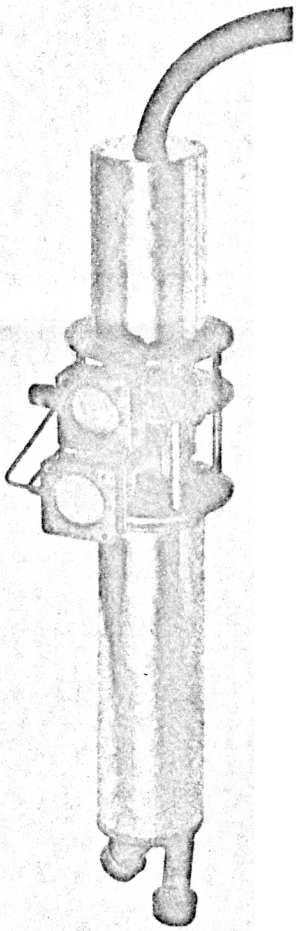
The X850 is intended especially for use in space age applications including missile and satellite tracking systems, radar astronomy, and space communications.

The electron gun of the X850 utilizes a convergent confined flow field which results in non-critical focusing adjustments and produces a stable, quiet beam. This electron gun is rugged in structure and completely enclosed in a metal shield with integral, shielded, connecting leads, to reduce the high-voltage hazard to a minimum.

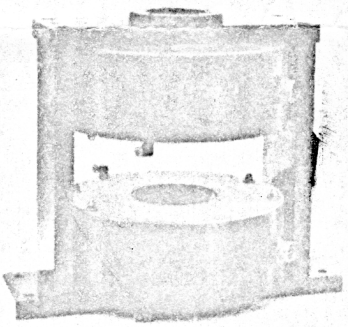
Fixed input and output couplings are used in the X850. The output window is a thick beryllium oxide disc. Unusual stability, for this power and frequency, is achieved through the use of improved body cooling.

The superior bandwidth of this klystron, 35 Mc minimum, and low beam voltage are due to high perveance design. Exceptionally high convergence of the electron gun, 50:1, means very low cathode emission density resulting in long life expectancy.

A focusing electromagnet and klystron supporting structure, Catalog Number H-160, has been designed for use with the X850. Only one power supply is required for the electromagnet.



X-850



H-160

CHARACTERISTICS

ELECTRICAL

Heater:	Voltage - - -	10	volts
	Current - - -	3.0	amperes
	Maximum Starting Current	6.0	amperes
Cathode:	Impregnated, Unipotential		
	Heating Time - -	5	minutes
Power Gain - - - -		43	decibels
Output Power - - - -		20	kilowatts
Frequency Range - - -		7.125 to 8.5	kilomegacycles

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WALMORE ELECTRONICS
LIMITED
11-15 BETTERTON STREET,
DRURY LANE, LONDON, W.C.2.,
TEMPLE BAR 0201-5

MECHANICAL (continued)

Operating Position		Any
RF Coupling:		
Input		WR-112 Waveguide
Output		WR-112 Waveguide
Dimensions:		
Klystron only	6x7x25	inches
H-160 Electromagnet:		
Length	17	inches
Width	18	inches
Depth	12	inches
Weight:		
Klystron only	20	lbs
H-160 Electromagnet	200	lbs

Cooling: Water and Forced Air

	Flow Rate	Pressure Drop
Cathode	5 cfm	free
Klystron Body and Electromagnet	2 gpm	100 psi
Klystron Collector	8.5 gpm	45 psi

ELECTROMAGNET POWER-SUPPLY REQUIREMENTS

Voltage	50	volts
Current	25	amperes

MAXIMUM RATINGS

DC BEAM VOLTAGE	22	KILOVOLTS
DC BEAM CURRENT	3.5	AMPERES
DC BODY CURRENT (with RF drive)	80	MILLIAMPERES
COLLECTOR DISSIPATION	70	KILOWATTS
INLET WATER PRESSURE	120	PSI

TYPICAL OPERATION

Frequency	7.6	kilomegacycles
Output Power	22	kilowatts
Driving Power	1	watt
Power Gain	43	decibels
DC Beam Voltage	20	kilovolts
DC Beam Current	3.1	amperes
Beam Power Efficiency	35.5	percent
DC Body Current	40	milliamperes
3 db bandwidth	35	megacycles

The Eimac EM778 Traveling Wave Tube in recommended as a driver for this klystron.

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., San Carlos, California.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X-1021 TWT

4.0-8.0 GC

40 db Gain



TENTATIVE DATA FOR EIMAC X-1021 TRAVELING WAVE TUBE

The Eimac X-1021 is a C-Band, ruggedized, light weight power amplifier traveling wave tube designed to operate under severe environmental extremes of shock, vibration, altitude and temperatures. The X-1021 utilizes ceramic and metal construction and is focused by a fully temperature-compensated periodic permanent magnet array. This tube will provide a minimum output power of 10 watts and 40 db gain over the frequency range of 4.0 to 8.0 Gc.

APPLICATIONS

The all ceramic-metal design coupled with a temperature compensated periodic permanent magnet array enables the X-1021 to perform under adverse environmental conditions while heat sink cooling provides an improved form factor for equipment design, making it an excellent choice for power amplification in augmentation or ECM systems in high performance aircraft, rocket or missile applications.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode.	Unipotential, dispenser type	
	Minimum Heating Time	120 seconds
Heater:	Voltage	6.3 volts
	Current	1.2 amperes
Noise Figure		35 decibels
Minimum Saturated Output Power		10 watts
Minimum Saturated Gain		40 db
Frequency Range		4.0 to 8.0 gigacycles
Input and Output Impedance		50 ohms nominal

MECHANICAL

Operating Position	Any
RF Input Coupling	Type N Female Coaxial Fitting
RF Output Coupling	Type N Female Coaxial Fitting
Focusing	Periodic Permanent Magnet
Cooling	Heat Sink and/or Forced Air
Maximum Overall Dimensions	See Outline Drawing
Net Weight (Including Magnets)	3.5 Pounds

Effective 1 August 1962

MAXIMUM RATINGS

D-C Beam Voltage*	2900 volts
D-C Focus Electrode Voltage*: Negative with respect to cathode	
(a) For CW Operation	40 volts
(b) For maximum current control	400 volts
D-C Cathode Current	90 milliamperes

TYPICAL OPERATING CHARACTERISTICS

Frequency	4.0 to 8.0 gigacycles
Minimum Output Power	10 watts
Minimum Saturated Gain	40 decibels
D-C Beam Voltage*	2850 volts
D-C Cathode Current	80 milliamperes
D-C Focus Electrode Voltage*	—30 volts
D-C Focus Electrode Current	1.0 milliamperes

*All voltages referred to cathode

APPLICATION

Cooling: The X-1021 is designed to be cooled by means of conduction to the mounting flange integral with the tube and PPM structure, or by forced air directed across the collector. Adequate cooling is determined when the envelope temperature is maintained below 250°F by thermocouple measurements at monitoring point indicated.

Cathode: The heater voltage should be maintained within ±5 percent of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

HELIX: The helix, collector and anode are internally connected to the tube body and are operated at the same potential. Therefore, it is often convenient to operate these elements at chassis potential, with the cathode and focus electrode at appropriate negative potentials.

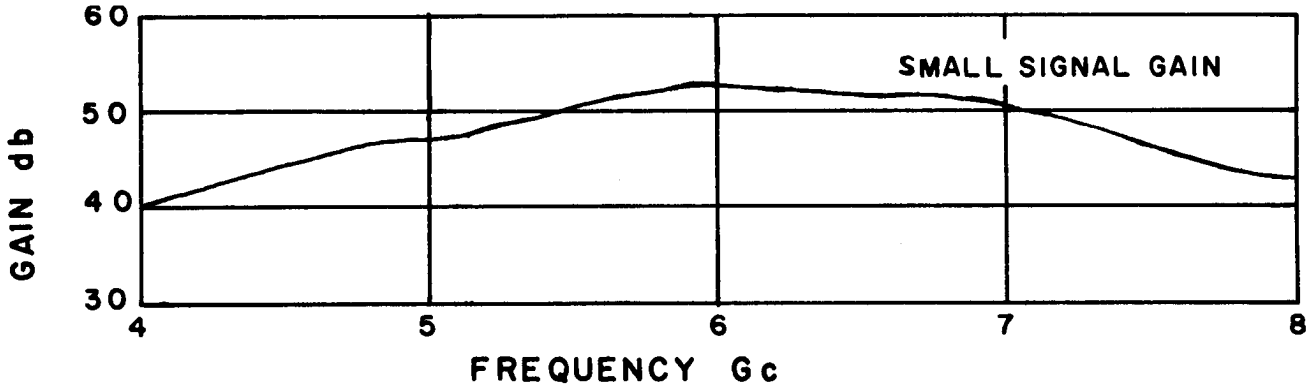
Focus Electrode: The focus electrode power supply must be regulated within ±2 percent to minimize variations in performance. This electrode may be used as a cathode current control electrode, within the limits of the maximum ratings listed above.

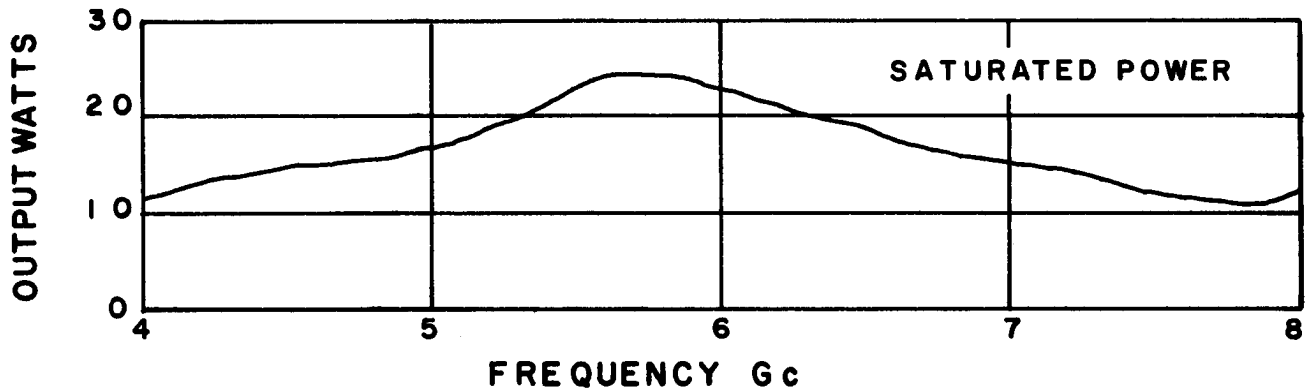
Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, Telephone LYtell 1-1451, Cable: EIMAC.

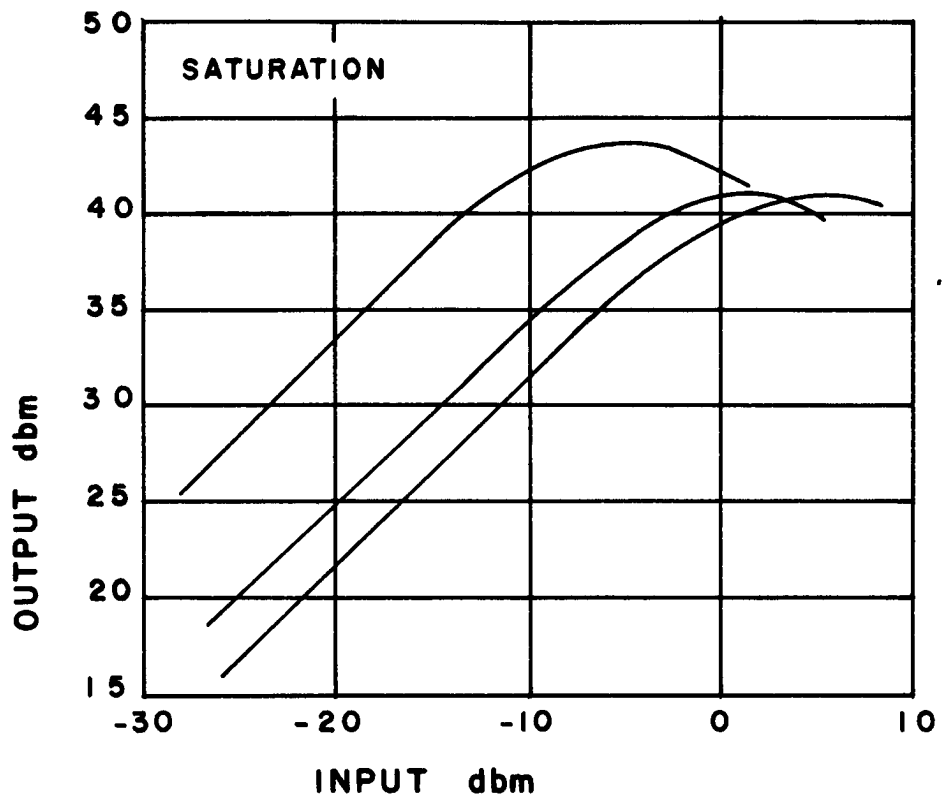
EM 1021 TYPICAL OPERATING CHARACTERISTICS

HELIX VOLTAGE 2850 Vdc FOCUS VOLTAGE -30 Vdc

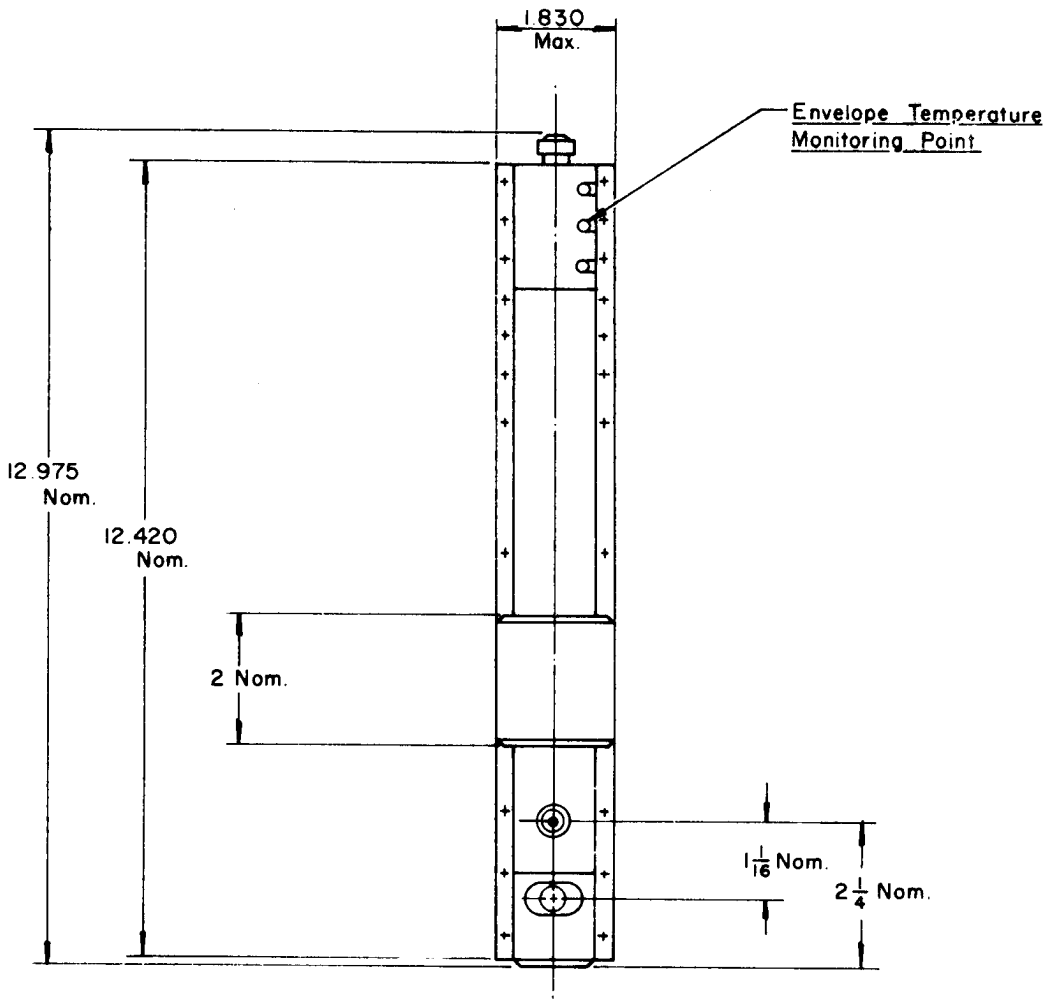
CATHODE CURRENT 80 mAdc FILAMENT 6.3V





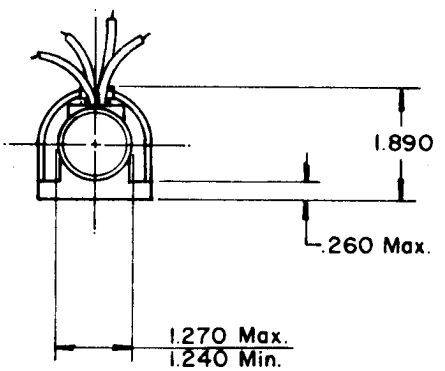


X1021



CONNECTIONS

1.	HEATER	-BROWN
2.	CATHODE HEATER	-YELLOW
3.	FOCUS ELECTRODE	-GREEN
4.	BODY GROUND	-BLACK



EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

X1059

TRAVELING WAVE TUBE
4.0-8.0 Gc
2 WATT MIN.
38 db SMALL SIGNAL GAIN

TENTATIVE DATA SHEET TRAVELING WAVE TUBE X1059

DESCRIPTION

The X1059 is a ruggedized, C-Band, octave bandwidth Travleing Wave Tube with metal-ceramic construction capable of operation under severe environments. Focusing is accomplished by a fully temperature compensated magnet array. This tube may be used in serrodyning applications.

ELECTRICAL SPECIFICATIONS:

Absolute Ratings	Maximum	Minimum
Filament Voltage	6.7	5.9 V
Filament Current	1.5	- A
Helix Current	7.0	- mAdc
Helix Voltage	+2600	- Vdc
Cathode Current	30.0	- mAdc
Control Grid Voltage	−150	0 Vdc
Anode Voltage	+200	0 Vdc
Anode Current	0.250	- mAdc
Duty Cycle	CW	
Beam Power Output	78	- W
Input Power, rf	20	- dbm
Power Reflected From Load	5	- W
Temperature, Body	+175	° C
Temperature, Collector	+175	° C
Ambient Temperature	+120	−54° C
Cathode Warm-Up	-	60 Seconds
Altitude	70,000	- ft

Operating and Performance Data	
Filament Voltage	6.3 V
Filament Current	0.9 A
Helix Voltage	+2500 Vdc
Cathode Current	30 mAdc
Control Grid Voltage	0 Vdc
Control Grid Current	0 mAdc
Anode Voltage	0 to 200 Vdc
Anode Current	0.250 mAdc
Serrodyne Voltage	105-115 Vdc
Duty Cycle	CW
Frequency Range	4.0-8.0 Gc
Small Signal Gain --Minimum	33 db
--Typical	38 db
Saturated Power Out--Minimum	2 W
--Typical	3 W
Output VSWR (Cold)	2.5:1
Input VSWR (Cold)	2.0:1
Input and Output Impedance	50 ohms

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ENVIRONMENTAL SPECIFICATIONS:

The X1059 conforms to MIL-E-5400

Vibration	10 g's to 2000 cps
Shock	15 g's (11 ± 1 msec)
Temperature	−54°C to + 120°C
Altitude	70,000 Ft.

MECHANICAL SPECIFICATIONS:

Operating Position	Any
Input Coupling, rf	Type TNC Coaxial Fitting
Output Coupling, rf	Type TNC Coaxial Fitting
Focusing	PPM
Cooling	Passive Heat Sink
Dimensions	See Outline Drawing
Weight	4 Pounds
H. V. Leads	#22 AWG Teflon Ins. Flying Leads

APPLICATION NOTES:

ALL VOLTAGES ARE WITH RESPECT TO CATHODE.

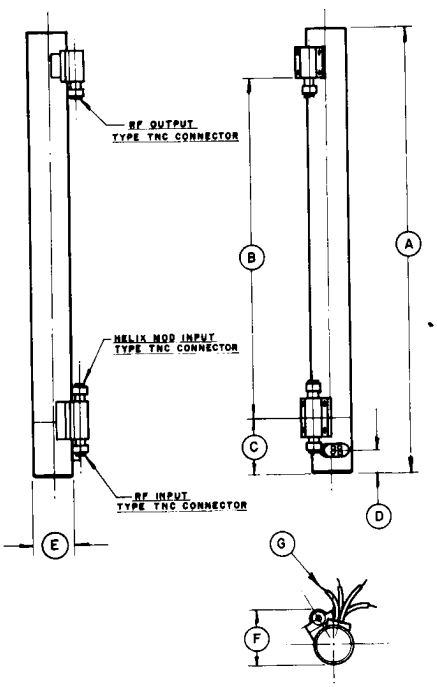
COOLING: The X1059 is designed to be heat sink cooled. Under environmental conditions normally encountered in military equipments, additional cooling is not required.

FILAMENT: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations of performance are to be minimized and best tube life obtained.

CONTROL GRID: The control grid is a high mu control electrode. Normal operation is obtained at zero volts, eliminating the need for an additional control power supply. However, in pulse applications the grid may be used to gate the tube on and off.

SERRODYNE: The helix is isolated from the tube body allowing serrodyne operation for frequency translation applications. The cathode voltage should be maintained within ±1% to insure rated performance.

THIS DATA SHOULD NOT BE USED FOR FINAL EQUIPMENT DESIGN.



DIMENSIONS IN INCHES

DIMENSIONAL DATA

REF.	MIN.	MAX.	NOM.
A	13.940	14.060	
B	10.625	10.875	
C	1.690	2.810	
D	.630	.870	
E	1.230	1.270	
F		1.700	
G	24"	26"	LEAD LENGTH

CONNECTIONS

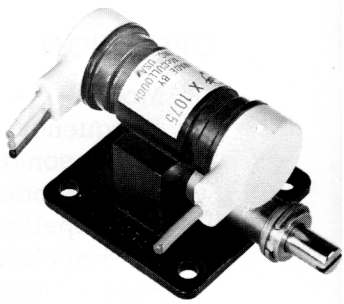
1. HEATER - BROWN
2. HEATER CATHODE - YELLOW
3. GRID - GREEN
4. ANODE - BLUE

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X-1075

X-BAND REFLEX KLYSTRON



The Eimac X-1075 is a ceramic and metal, conduction cooled reflex klystron designed for local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 30 milliwatts over the frequency range of 8500 to 9600 megacycles.

The stacked-ceramic construction results in an extremely rugged design and a low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

FEATURES: This tube features Eimac's new long-life tuner which renders excellent torque control under extreme environmental conditions over as many as 10,000 cycles.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up Time	30	seconds
Heater:	Voltage	6.3	volts
	Current	1.0	ampere
Typical Output Power (Load VSWR = 1.15:1)		30	milliwatts
Frequency Range		8500 to 9600	megacycles

MECHANICAL

Operating Position		Any
Mounting		UG-39/U Waveguide Flange
Cooling		Conduction
Electrical Connections		Flexible Leads
RF Output Coupling		RG-52/U Waveguide
Net Weight	4	Ounces
Shipping Weight (Approximate)	2	Pounds
Maximum Overall Dimensions:		
Height	1.40	Inches
Width	1.63	Inches
Length	2.28	Inches

ENVIRONMENTAL

Maximum Ambient Temperature	150°	C
Maximum Altitude	No Limit	
Maximum Non-Operating Shock (11 ms Duration)	40	g
Maximum Operating Shock (11 ms Duration)	40	g
Maximum Operating Vibration (20 to 2000 cps)	10	g

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MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	400 MAX.	VOLTS
DC CATHODE CURRENT	40 MAX.	MA
RESONATOR DISSIPATION	20 MAX.	WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0 MAX.	VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX.	VOLTS

OPERATION

	MIN.	AVE.	MAX.	UNIT
Mode	---	6-3/4	---	
Frequency	8.5	---	9.6	Gc.
DC Resonator Voltage	---	250	---	Volts
DC Cathode Current	20	---	30	ma
DC Repeller Voltage	---	65	---	Volts
DC Repeller Current	---	---	1	μamp
Power Output	20	30	50	mW
Electronic Tuning (3 db bandwidth)	---	35	---	mc
Modulation Sensitivity	---	---	2	mc
Peak-to-Peak FM Deviation (10g, 20 - 2000 cps)			250	kc
Residual FM	---	---	50	kc

*All voltages referred to cathode.

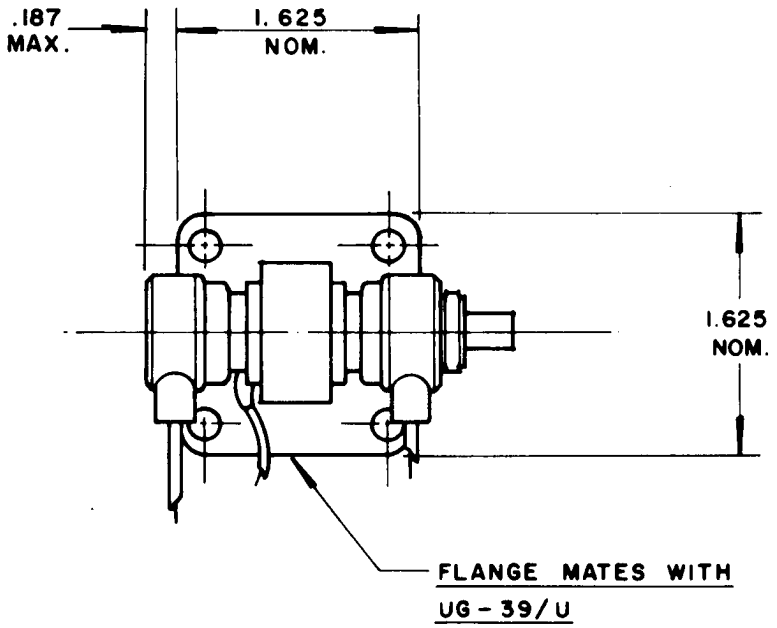
APPLICATION

Cooling: At sea level this tube will not require forced-air cooling when operated at its maximum rated dissipation with am ambient temperature less than 150° Centigrade. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced-air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 175° Centigrade. Maximum life will be obtained if the tube is maintained at 150° C or less.

Resonator: The resonator of the X-1075 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within $\pm$ 5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

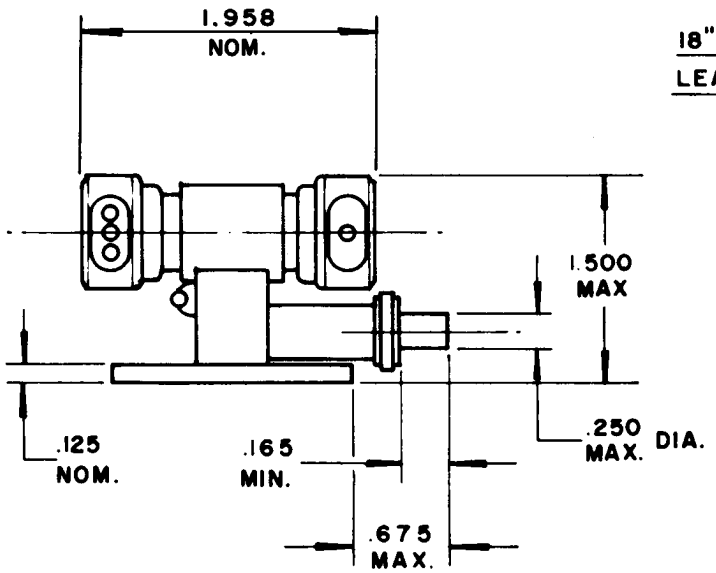
The heater and cathode of the X-1075 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

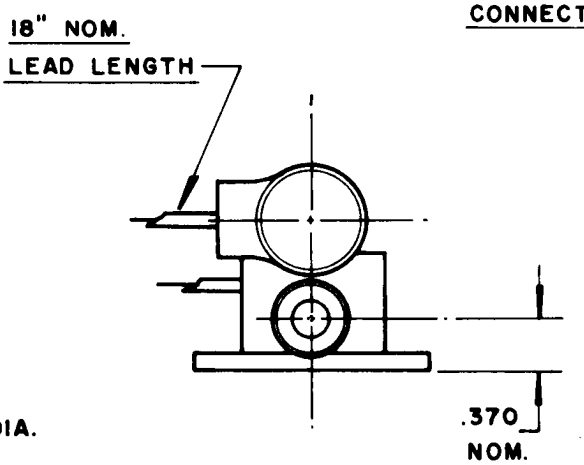


LEAD CONNECTIONS

	YELLOW	HEATER
*	GREEN	CATHODE
*	WHITE	HEATER
	GRAY	REFLECTOR
	BROWN	BODY

* INTERNALLY CONNECTED

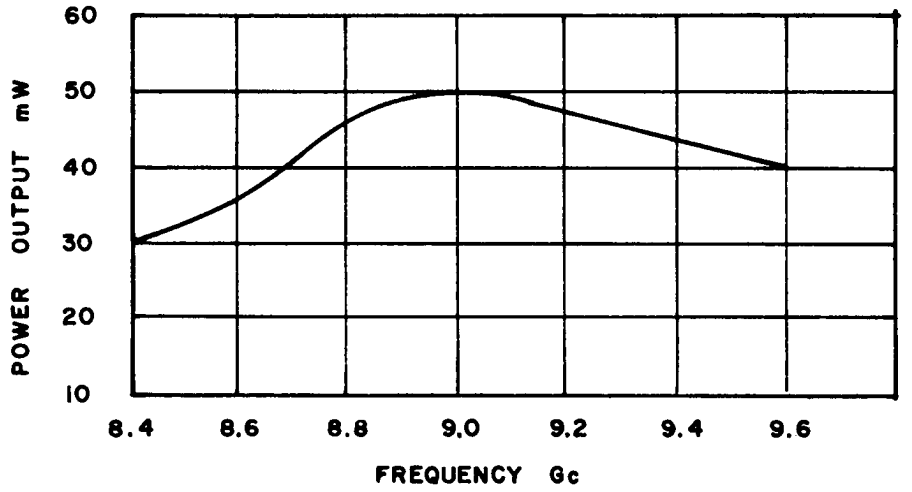


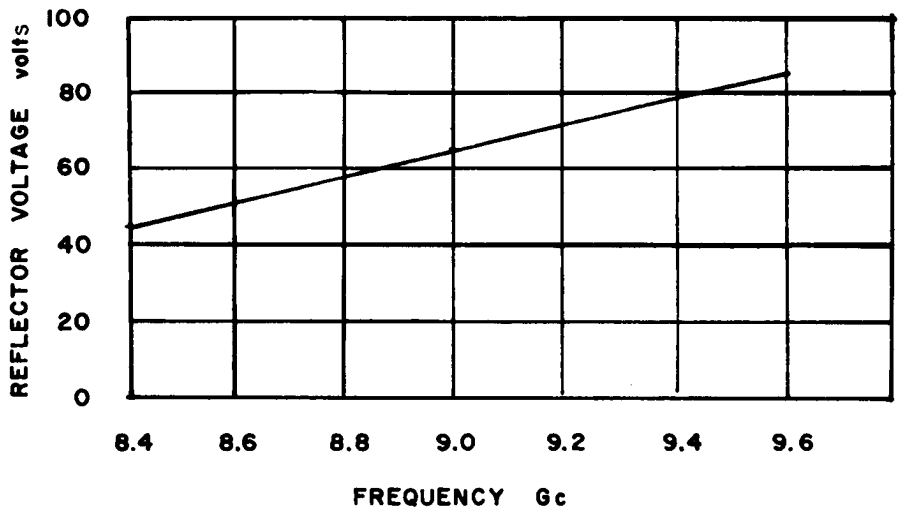


X 1075

X1075 OPERATING CHARACTERISTICS

Ers = 250 Vdc
Ik = 22 mA dc
$6\frac{3}{4}$ MODE



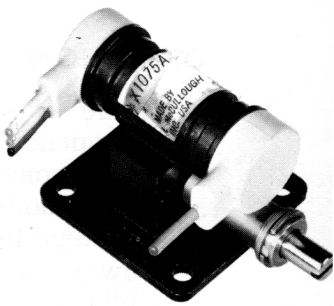


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X-1075A

X-BAND REFLEX KLYSTRON



The Eimac X-1075A is a ceramic and metal, conduction cooled reflex klystron designed for local oscillator service in applications encountering severe vibration, shock or temperature extremes. This tube will deliver a typical output power of 100 milliwatts over the frequency range of 8500 to 9600 megacycles.

The stacked-ceramic construction results in an extremely rugged design and a low sensitivity to vibration.

Leads to the tube are permanently attached and protected by molded silastic rubber caps which permit operation at any altitude without flashover.

FEATURES: This tube features Eimac's new long-life tuner which renders excellent torque control under extreme environmental conditions over as many as 10,000 cycles.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up Time	30	seconds
Heater:	Voltage	6.3	volts
	Current	1.0	ampere
Typical Output Power (Load VSWR = 1.15:1)		100	milliwatts
Frequency Range		8500 to 9600	megacycles

MECHANICAL

Operating Position		Any
Mounting		UG-39/U Waveguide Flange
Cooling		Conduction
Electrical Connections		Flexible Leads
RF Output Coupling		RG-52/U Waveguide
Net Weight	4	Ounces
Shipping Weight (Approximate)	2	Pounds
Maximum Overall Dimensions:		
Height	1.40	Inches
Width	1.63	Inches
Length	2.28	Inches

ENVIRONMENTAL

Maximum Ambient Temperature	150°	C
Maximum Altitude	No Limit	
Maximum Non-Operating Shock (11 ms Duration)	40	g
Maximum Operating Shock (11 ms Duration)	40	g
Maximum Operating Vibration (20 to 2000 cps)	10	g

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MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	500 MAX.	VOLTS
DC CATHODE CURRENT	50 MAX.	MA
RESONATOR DISSIPATION	25 MAX.	WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0 MAX.	VOLTS
NEGATIVE WITH RESPECT TO CATHODE	500 MAX.	VOLTS

OPERATION	MIN.	AVE.	MAX.	UNIT
Mode	---	5-3/4	---	
Frequency	8.5	---	9.6	Gc.
DC Resonator Voltage	---	400	---	Volts
DC Cathode Current	---	40	---	ma
DC Repeller Current	---	---	1	μamp
Power Output	100	130	200	mW
Electronic Tuning (3 db bandwidth)	---	30	---	mc
Modulation Sensitivity	---	---	2	Mc/Volt
Peak-to-Peak FM Deviation (10g, 20 - 2000 cps)			250	kc
Residual FM	---	---	50	kc

*All voltages referred to cathode.

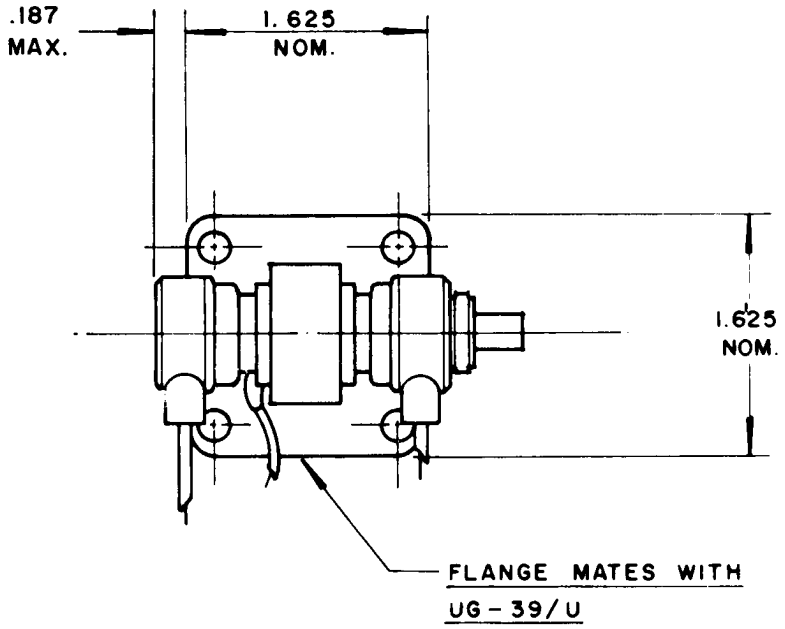
APPLICATION

Cooling: At sea level this tube will not require forced-air cooling when operated at its maximum rated dissipation with an ambient temperature less than 150° Centigrade. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced-air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 175° Centigrade. Maximum life will be obtained if the tube is maintained at 150° C or less.

Resonator: The resonator of the X-1075A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ± 5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

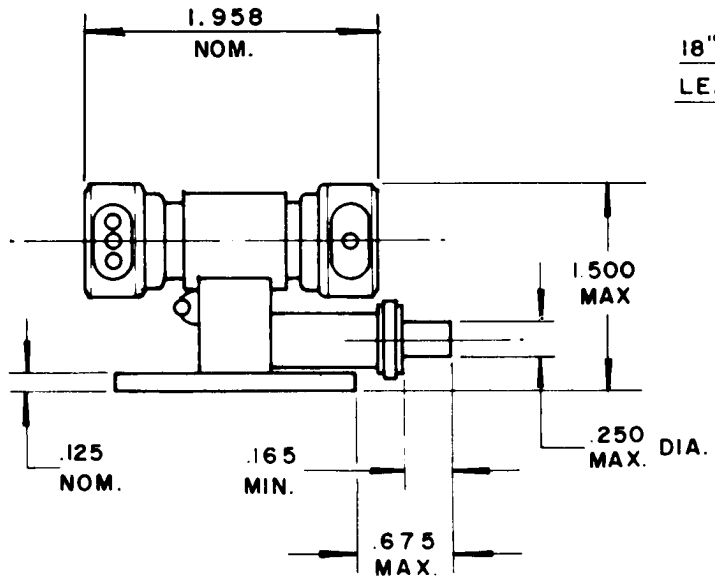
The heater and cathode of the X-1075A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

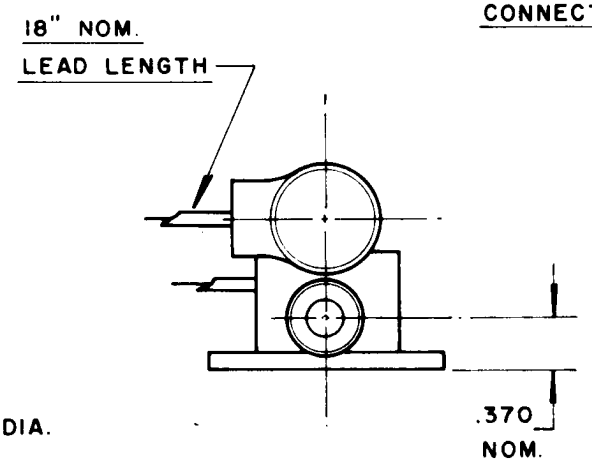


LEAD CONNECTIONS

	YELLOW	HEATER
*	GREEN	CATHODE
*	WHITE	HEATER
	GRAY	REFLECTOR
	BROWN	BODY

* INTERNALLY CONNECTED

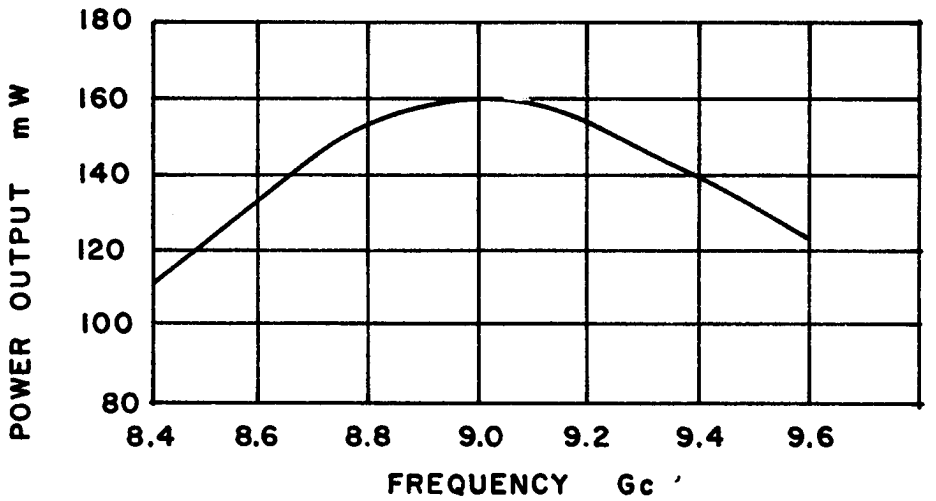


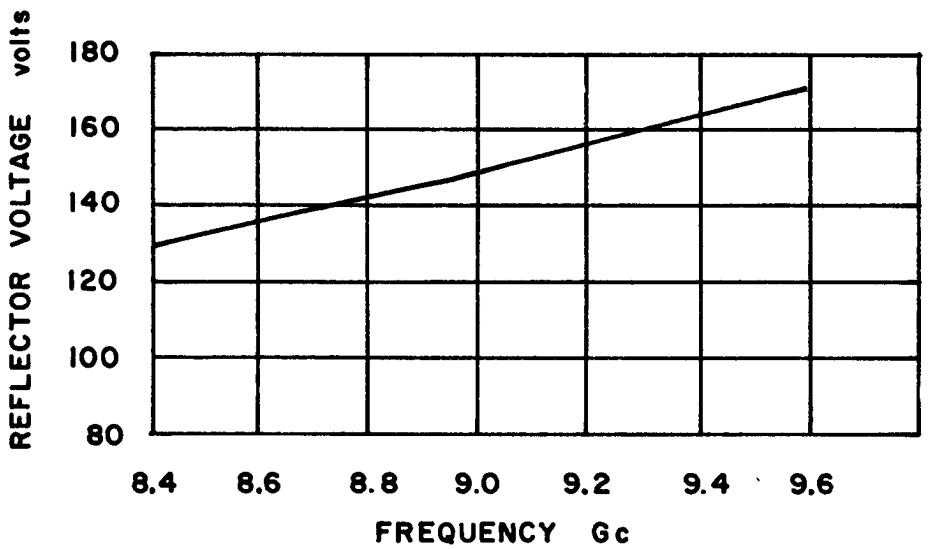


X 1075 A

X1075A OPERATING CHARACTERISTICS

Ers = 400 V dc
Ik = 40 mA dc
$5\frac{3}{4}$ MODE



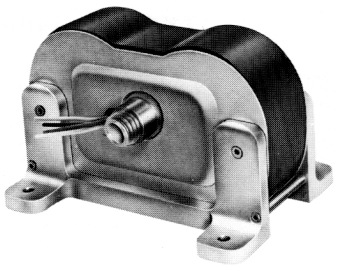


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X-1081

L-BAND PACKAGED VOLTAGE TUNABLE MAGNETRON



The Eimac X-1081 is a ruggedized, ceramic and metal, packaged voltage-tunable magnetron capable of delivering a minimum output power of 10 watts into a 50-ohm termination over the frequency range of 900-1200 megacycles.

Eimac's three terminal VTM circuit has been used in this tube to give a more uniform output circuit with the added advantage of one third more heat dissipating area extending out of the VTM envelope.

The electron injection design incorporated in this magnetron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduces output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The extremely linear tuning characteristing of this magnetron simplifies programming the frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators.

The X-1081 Circuit Assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, EMA		
	Warm-up time	30	seconds
Heater:	Voltage (AC or DC)	6.3	volts
	Current	1.0	ampere
Minimum Output Power		10	watts
Frequency Range		900 to 1200	megacycles

MECHANICAL

Operating Position	any
Cooling	forced air
Electrical Connections	flexible leads
RF Output Coupling	Type N, or TNC female
Net Weight, including magnet and circuit:	3.2 pounds
Shipping Weight	10 pounds
Maximum Overall Dimensions (Magnet and Circuit):	
Height	3 inches
Width	3-3/8 inches
Length	4-1/2 inches

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MAXIMUM RATINGS

Anode Voltage*	2400	volts
Cathode Current	30	milliamperes
Injection Anode Voltage*	800	volts
Injection Anode Current	1	milliampere

TYPICAL OPERATION (X-1081 Circuit Asssembly, Load VSWR = 1.15:1)

Frequency Range	900	1200	megacycles
Anode Voltage* (Note 1)	1800	2380	volts
Cathode Current	15	18	milliamperes
Typical Power Output	10	12	watts
Anode FM Sensitivity		.55	Mc/volt
Injection Anode Voltage		400	volts
Injection Anode Current		0.5	milliampere
Heater Voltage (AC)		6.3	volts
Heater Current (AC)		0.8	ampere

*All voltages referred to the cathode.
Note 1. The operating frequency is determined by the Anode Voltage.

APPLICATION

Cooling: To insure long life and best operation, sufficient cooling air is required to maintain the magnet temperature below 70° C.

Anode: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential, with the cathode and injection anode at appropriate negative potentials.

Cathode: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the X-1081 heater in most applications as a result of the advanced counter-wound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

Proximity of Ferrous Materials: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

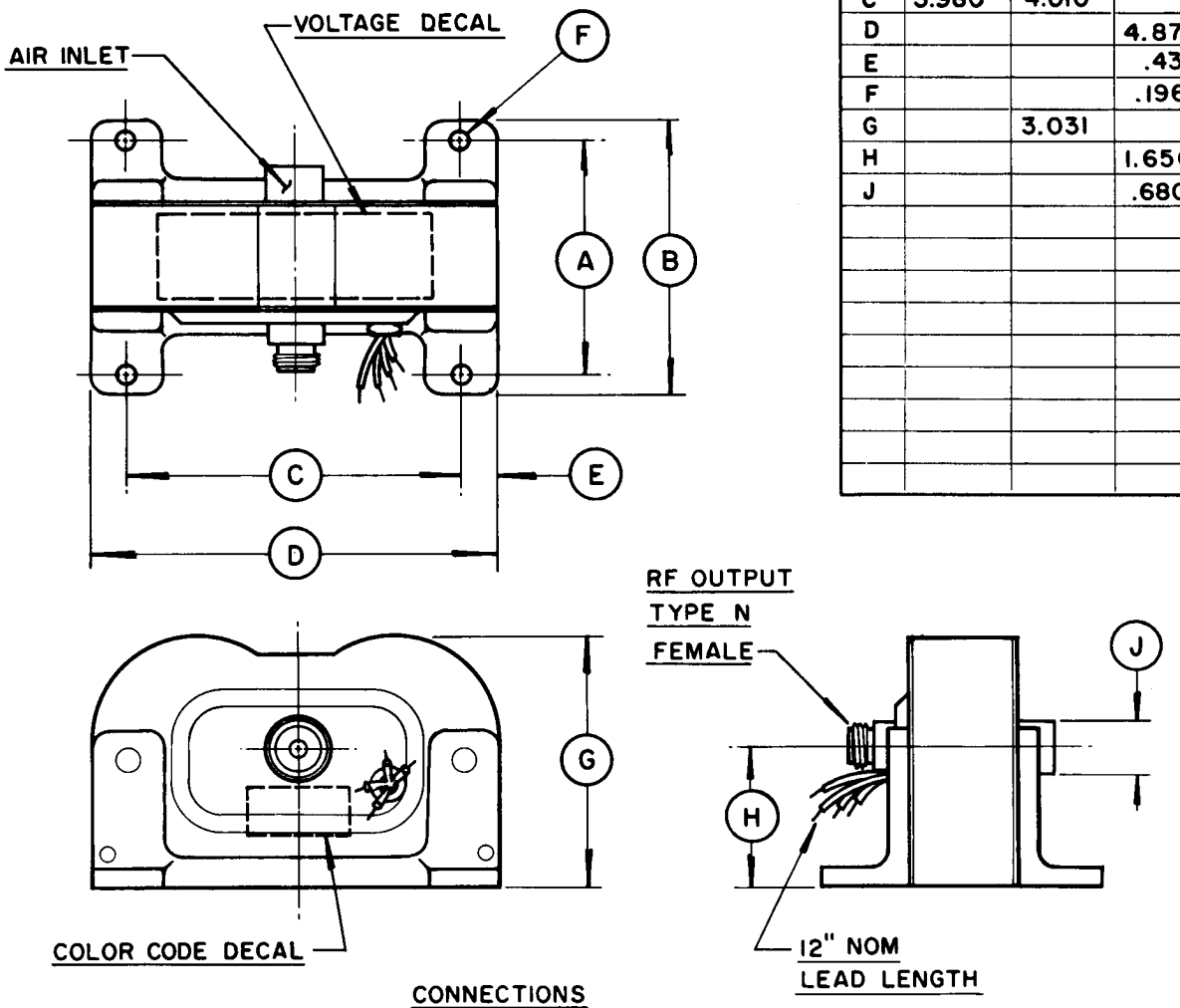
Temperature Stability: The permanent magnet for the X-1081 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1081 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1000 megacycles, the temperature/frequency coefficient is typically 200 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

Linearity: The voltage/magnetic-field/frequency relationship of a magnetron is theoretically linear and this linearity is observed in practical tube. The frequency versus tuning voltage curve for the X-1081 is a straight line with a positive slope and may be easily programmed for the desired frequency sweep. Tests of the fine grain linearity curve show a deviation from a straight line of approximately 3-5 parts per thousand over a 20 megacycle bandwidth.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451, Cable: EIMAC.

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			2.875
B			3.375
C	3.980	4.010	
D			4.875
E			.437
F			.196 D.
G		3.031	
H			1.656
J			.680 D.



CONNECTIONS

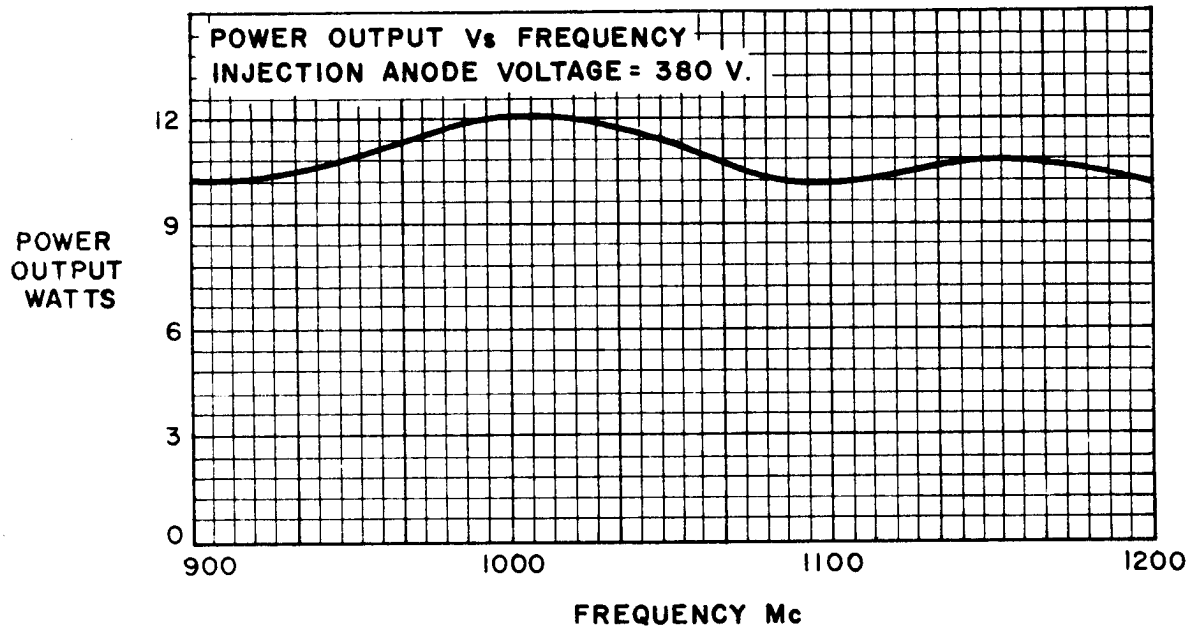
GROUND – GREEN

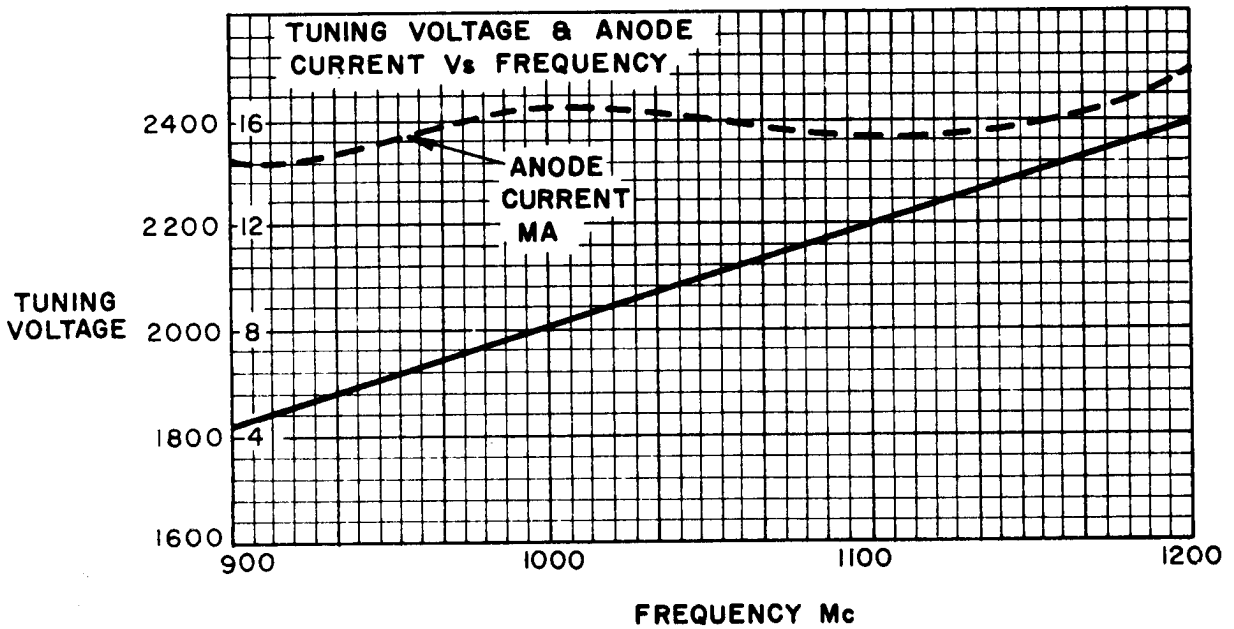
HEATER – WHITE

HEATER CATHODE – BLACK

INJECTION ANODE – YELLOW

X1081 VTM


POWER OUTPUT Vs FREQUENCY
INJECTION ANODE VOLTAGE = 380 V.
POWER OUTPUT WATTS
12
9
6
3
0
900
1000
1100
1200
FREQUENCY Mc


TUNING VOLTAGE & ANODE CURRENT Vs FREQUENCY
ANODE CURRENT MA
TUNING VOLTAGE
2400
2200
2000
1800
1600
16
12
8
4
900
1000
1100
1200
FREQUENCY Mc

Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

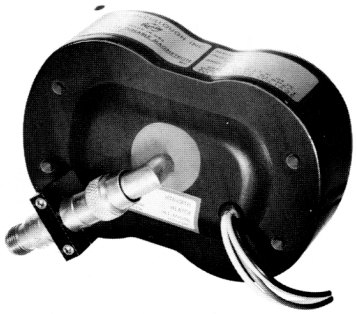
X-1083B

Low Noise Voltage Tunable Magnetron

Frequency 320 - 525 Mc

Minimum Power Output 32 mW

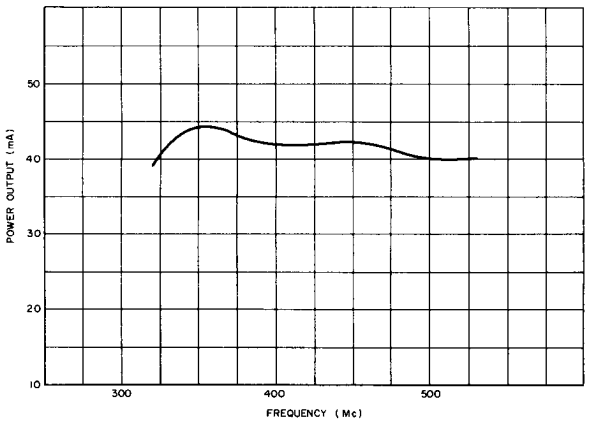
TYPICAL PERFORMANCE



P-BAND OSCILLATOR

ELECTRICAL

Frequency Range	320-525 Mc
Anode Voltage	1230-2000 V
Cathode Current	0.5-1.5 mA
Typical Output Power	30-50 mW
Anode FM Sensitivity	.26 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0.02 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw
Noise	−85 db (See Note 5)
VSWR (max)	2:1



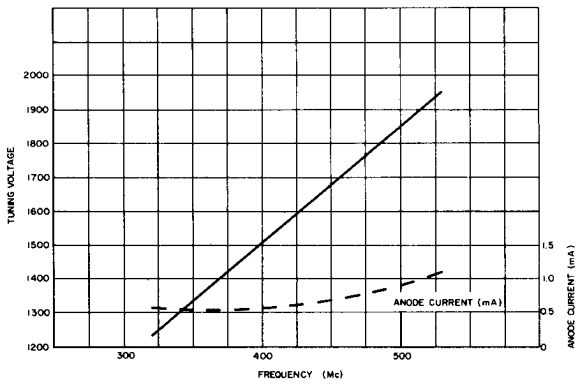
MAXIMUM RATINGS*

Anode Voltage	2300 V
Cathode Current	10 mA
Injection Anode Voltage	+300 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type TNC Jack (See Outline Drawing)
Weight	3.5 Pounds



ENVIRONMENTAL

Vibration	10G-(to 2kc)
Shock	100G-(11ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3.1 inches
Width	2.5 inches
Length	4.6 inches

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APPLICATION NOTES

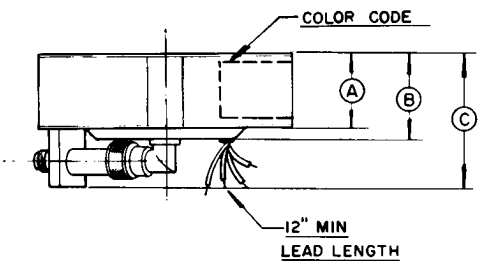
1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

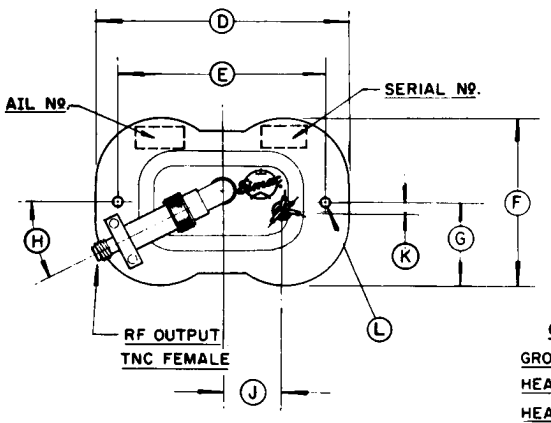
3. TEMPERATURE STABILITY: The permanent magnet for the X-1083-B has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficent for the X-1083-B package is typically .008% of the operating frequency per degree Centrigrade. Thus, for an operating frequency of 400 megacycles, the temperature/frequency coefficient is typically 32 kilocycles per degree Centrigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.

5. NOISE: 5 points as measured using a 60 Mc If, both sidebands and a 2 Mc bandpass (this measuring technique is one of many methods available. Other methods will be entertained.)



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			2.500
D		4.600	
E	3.640	3.671	
F		3.100	
G			1.500
H			27°
J			1.062
K			.375
L			.173 D.



CONNECTIONS

GROUND - GREEN

HEATER - WHITE

HEATER CATHODE - BLACK

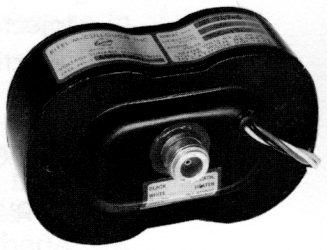
INJECTION ANODE - YELLOW

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X-1084

UHF PACKAGED VOLTAGE TUNABLE MAGNETRON



The Eimac X-1084 is a ruggedized, ceramic and metal packaged voltage-tunable magnetron capable of delivering a minimum output power of 30 milliwatts into a 50-ohm termination over the frequency range of 300 to 600 megacycles.

The electron injection design incorporated in this magnetron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduces output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The extremely linear tuning characteristic of this magnetron simplifies programming and frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators. In addition, the injection anode may be programmed to provide some leveling action on the output power during the frequency sweep.

The X-1084 circuit assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, EMA	
	Warm-up time	60 seconds
Heater:	Voltage (AC or DC)	6.3 volts
	Current	.8 ampere
Minimum Output Power		30 milliwatts
Frequency Range		300 to 600 megacycles

MECHANICAL

Operating Position	any
Cooling	conduction
Electrical Connections	flexible leads
RF Output Coupling	TNC Female
Net Weight, including magnet and circuit	3.2
Shipping Weight	10 lbs.
Maximum Overall Dimensions (Magnet and Circuit):	
Height	3 inches
Width	2 inches
Length	4½ inches

Effective 1 August 1962
Printed in U.S.A.

MAXIMUM RATINGS

Anode Voltage*	1800 volts
Cathode Current	10 milliamperes
Dissipation	18 watts
Injection Anode Voltage*	+500 volts
Injection Anode Current	.5 milliamperes

TYPICAL OPERATION (Load VSWR = 1.15:1)

Frequency Range	300	600 megacycles
Anode Voltage* (Note 1)	800	1550 volts
Cathode Current	1	3 milliamperes
Typical Power Output	50	200 milliwatts
Anode FM Sensitivity		.40 Mc/volt
Injection Anode Voltage		200 volts
Injection Anode Current		0.05 milliamperes
Heater Voltage (AC)		6.3 volts
Heater Current (AC)		0.8 amperes

*All voltages referred to the cathode.

Note 1. The operating frequency is determined by the Anode Voltage.

Anode: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential, with the cathode and the injection anode at appropriate negative potentials.

Cathode: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

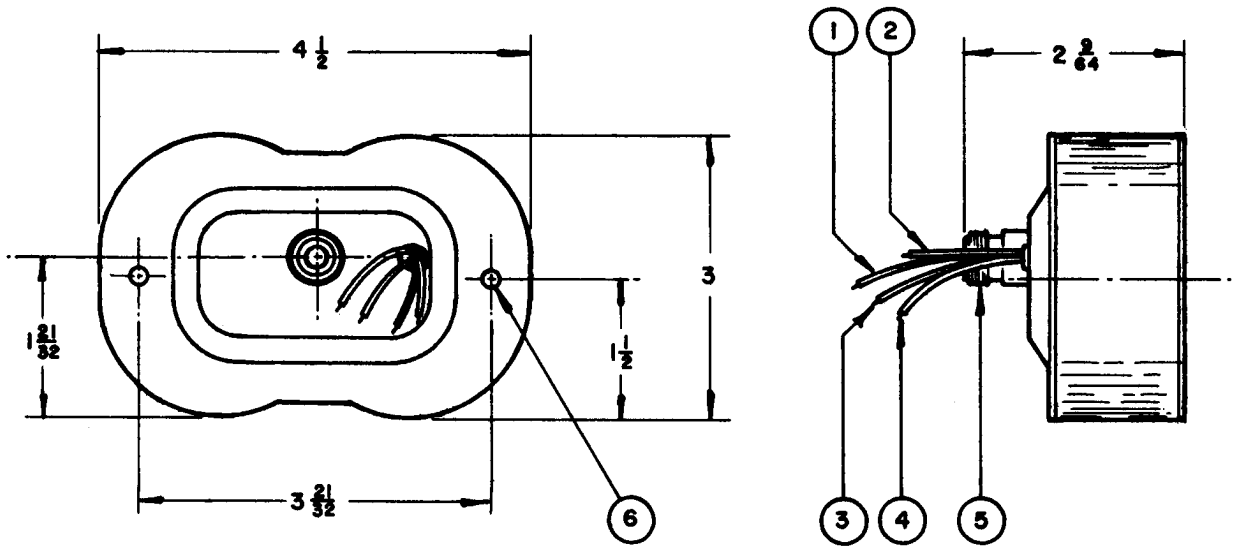
The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the X-1084 heater in most applications as a result of the advanced counter-wound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

Proximity of Ferrous Materials: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

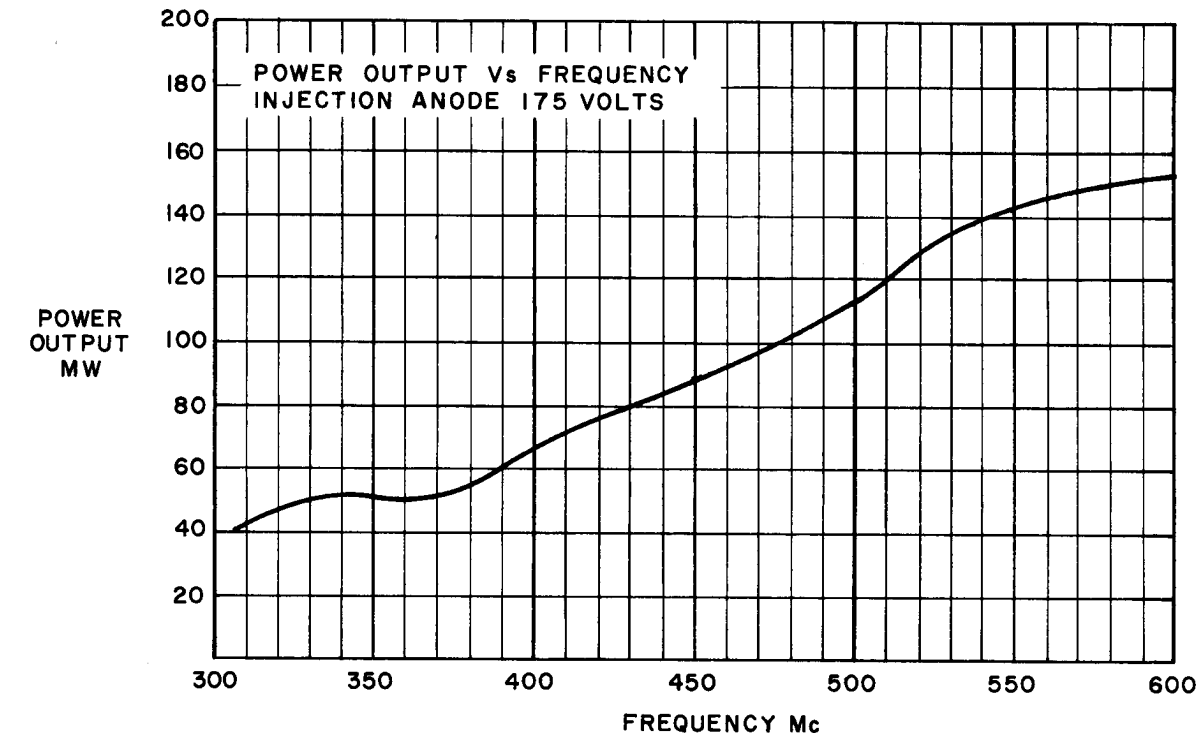
Temperature Stability: The permanent magnet for the X-1084 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1084 package is typically .008 of the operating frequency per degree Centigrade. Thus, for an operating frequency of 500 megacycles, the temperature/frequency coefficient is typically 40 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

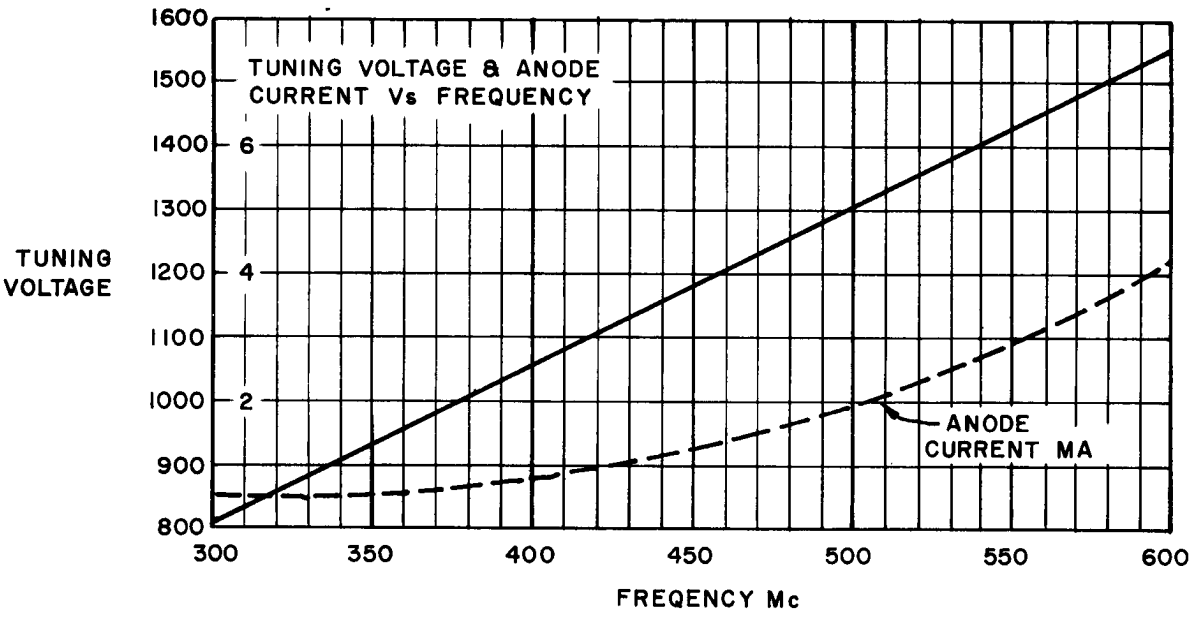
Linearity: The voltage/magnetic-field/frequency relationship of a magnetron is theoretically linear and this linearity is observed in practical tubes. The frequency versus tuning voltage curve for the X-1084 is a straight line with a positive slope and maye be easily programmed for the desired frequency sweep. Tests of the fine grain linearity curve show a deviation from a straight line of approximately 3-5 parts per thousand over a 20 megacycle bandwidth.

Special Applications: For any aditional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451, Cable: EIMAC.



6	3/16 DIA. MOUNTING HOLES (2) REQ'D
5	FEMALE TNC CONNECTOR
4	GROUND LEAD (GREEN)
3	HEATER LEAD (WHITE)
2	HEATER CATHODE LEAD (BLACK)
1	INJECTION ANODE LEAD (YELLOW)


POWER OUTPUT Vs FREQUENCY
INJECTION ANODE 175 VOLTS
POWER OUTPUT MW
200
180
160
140
120
100
80
60
40
20
300
350
400
450
500
550
600
FREQUENCY Mc


TUNING VOLTAGE & ANODE CURRENT Vs FREQUENCY
TUNING VOLTAGE
1600
1500
1400
1300
1200
1100
1000
900
800
6
4
2
ANODE CURRENT MA
300
350
400
450
500
550
600
FREQENCY Mc

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

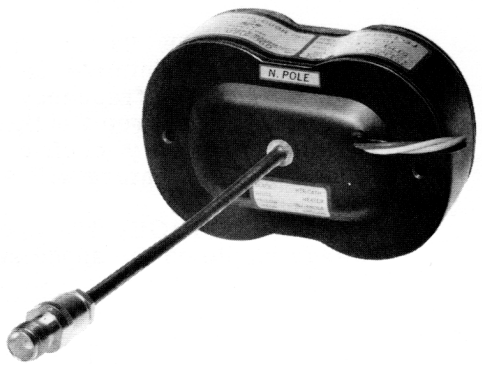
X-1087

VOLTAGE TUNABLE MAGNETRON

FREQUENCY 515-605 Mc

MINIMUM POWER OUTPUT 10 WATTS

TYPICAL PERFORMANCE



P-BAND OSCILLATOR

ELECTRICAL

Frequency Range	515	605	Mc
Anode Voltage	1480	1790	V
Cathode Current	13	15	mA
Typical Output Power		10	W
Anode FM Sensitivity		0.3	Mc/V
Injection Anode Voltage		500	V
Injection Anode Current		0.1	mA
Heater Voltage (AC)		6.3	V
Heater Current (AC)		0.8	A
Load Impedance		50	ohms
Service			cw

*MAXIMUM RATINGS

Anode Voltage	2500	V
Cathode Current	25	mA
Injection Anode Voltage	+700	V
Injection Anode Current	1	mA

*Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical	Flexible Leads
RF Output Coupling	Type TNC Female
Weight	3.5 Pounds

ENVIRONMENTAL

Vibration	10 G-(to 2 kc)
Shock	100 G-(11 ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3	inches
Width	2.1	inches
Length	4.5	inches

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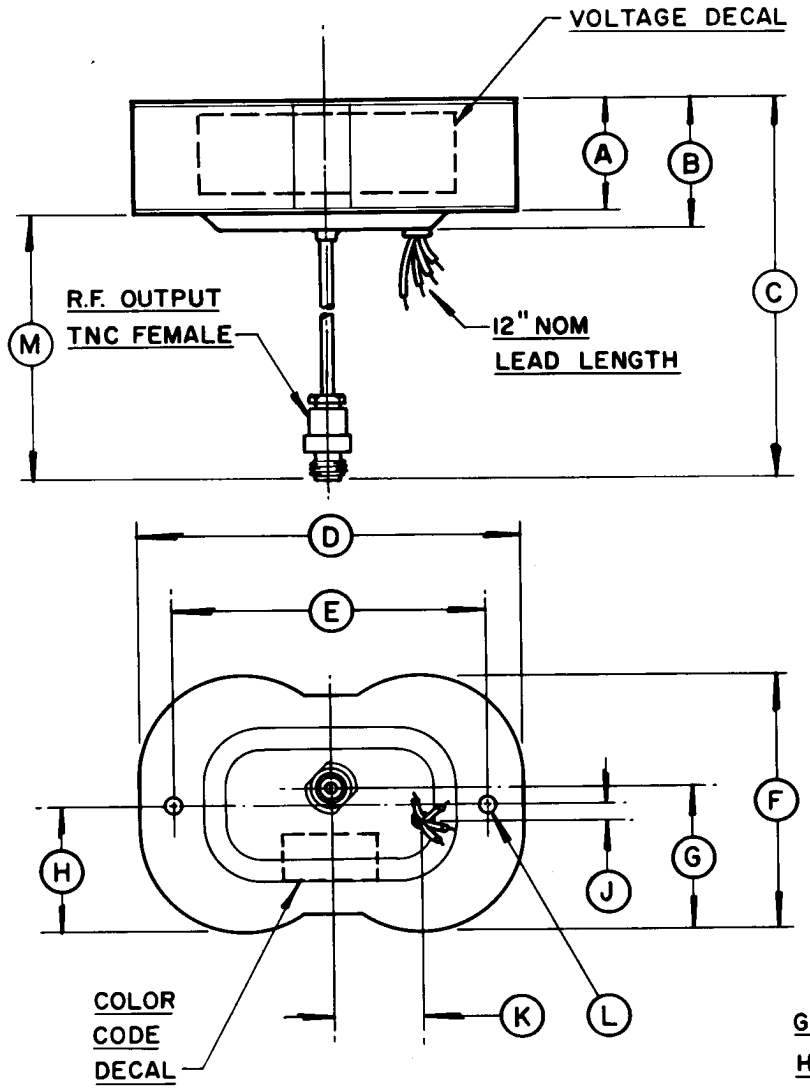
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the X-1087 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficent for the X-1087 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 600 megacycles, the temperature/frequency coefficient is typically 120 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			9.375
D		4.515	
E	3.640	3.671	
F		3.031	
G			1.656
H			1.500
J			.375
K			1.062
L			.187 D.
M			8"

CONNECTIONS

GROUND - GREEN

HEATER - WHITE

HEATER CATHODE - BLACK

INJECTION ANODE - YELLOW

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

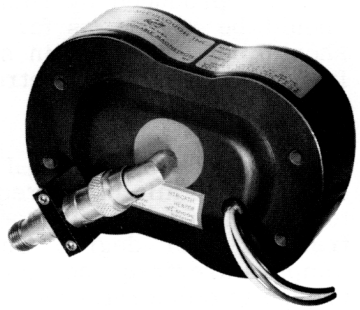
X-1088-B

Low Noise Voltage Tunable Magnetron

Frequency 520 - 925 Mc

Minimum Output Power 32 mW

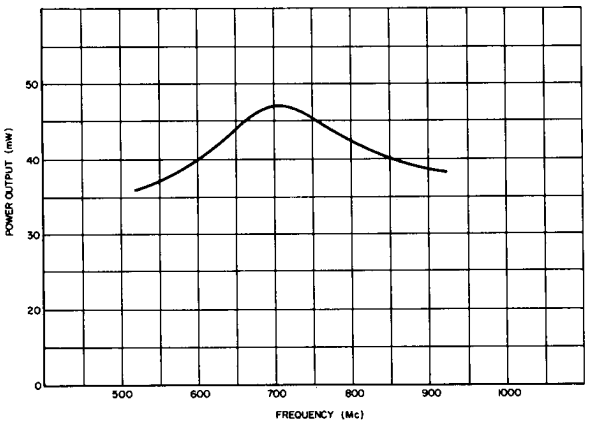
TYPICAL PERFORMANCE



P-BAND OSCILLATOR

ELECTRICAL

Frequency Range	520-925 Mc
Anode Voltage	1000-2000 V
Cathode Current	2-4 mA
Typical Output Power	30-50 mW
Anode FM Sensitivity	.55 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0.02 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw
Noise	−85 db (See Note 5)
VSWR (max)	2:1



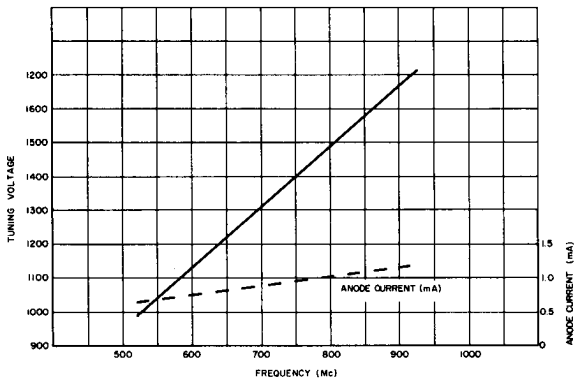
*MAXIMUM RATINGS

Anode Voltage	2300 V
Cathode Current	10 mA
Injection Anode Voltage	+300 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type TNC Jack (See Outline Drawing)
Weight	3.5 Pounds



ENVIRONMENTAL

Vibration	10G-(to 2 kc)
Shock	100G-(11 ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3.1 inches
Width	2.5 inches
Length	4.6 inches

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APPLICATION NOTES

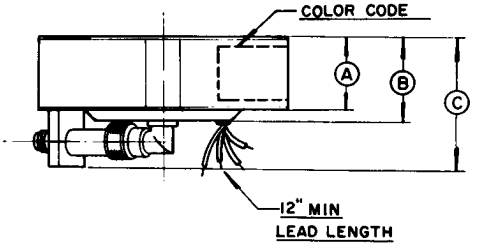
1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

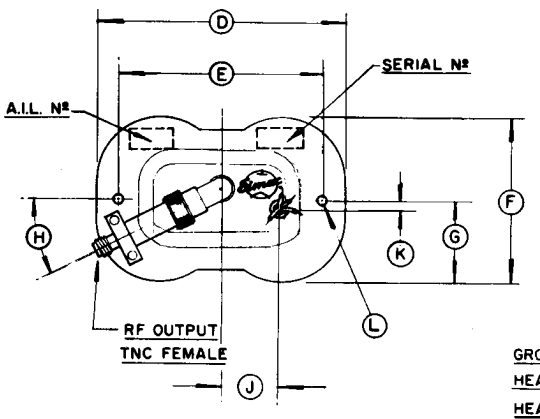
3. TEMPERATURE STABILITY: The permanent magnet for the X-1088-B has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1088-B package is typically .008% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 700 megacycles, the temperature/frequency coefficient is typically 56 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.

5. NOISE: 5 points as measured using a 60 Mc If, both sidebands and a 2 Mc bandpass (This measuring technique is one of many methods available. Other methods will be entertained.)



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			2.500
D		4.600	
E	3.640	3.671	
F		3.100	
G			1.500
H			27°
J			1.062
K			.375
L			.173 D.



CONNECTIONS

GROUND - GREEN

HEATER - WHITE

HEATER CATHODE - BLACK

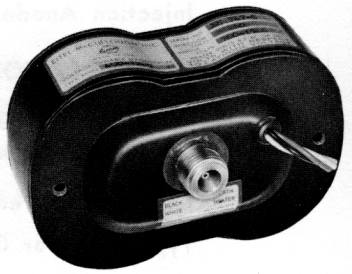
INJECTION ANODE - YELLOW

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

OBJECTIVE DATA

X-1091

S-BAND PACKAGED VOLTAGE TUNABLE MAGNETRON



The Eimac X-1091 is a ruggedized, ceramic and metal packaged voltage-tunable magnetron capable of delivering a minimum output power of 35 watts into a 50 ohm termination over the frequency range of 2.2 to 2.3 Kmc.

The electron injection design incorporated in this magentron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduces output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The extremely linear tuning characteristic of this magnetron simplifies programming the frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators.

The X-1091 Circuit Assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, Matrix		
	Warm-up Time	60 seconds
Heater:	Voltage (AC or DC)	6.3 volts
	Current	1.0 ampere
Minimum Output Power		35 watts
Frequency Range		2200 to 2300 megacycles

MECHANICAL

Operating Position	Any
Cooling	Forced Air
Electrical Connections	Flexible leads
RF Output Coupling	Type N or TNC Female
Net weight, including magnet and circuit	3.2 pounds
Shipping Weight	10 pounds
Maximum Overall Dimensions (Magnet and Circuit):	
Height	3 inches
Width	2 5/16 inches
Length	4 1/2 inches

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MAXIMUM RATINGS

Anode Voltage*	2500 volts
Cathode Current	60 milliamperes
Injection Anode Voltage*	600 volts
Injection Anode Current	1 milliampere

TYPICAL OPERATION (In X-1091 Circuit Assembly, Load VSWR=1.15:1)

Frequency Range	2200-2300	megacycles
Anode Voltage* (Note 1)	1800-1940	volts
Cathode Current	35 - 40	milliamperes
Typical Power Output	35 - 35	watts
Anode FM Sensitivity	1.4	Mc/volt
Injection Anode Voltage	300	volts
Injection Anode Current	0.5	milliampere
Heater Voltage (AC)	6.3	volts
Heater Current	0.8	amperes

*All voltages referred to the cathode.

Note 1. The operating frequency is determined by the anode voltage.

APPLICATION

Cooling: The X-1091 is designed to be cooled by forced air. To insure normal operation over long periods, sufficient cooling is required to maintain the magnet temperature below 70°C.

Anode: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential, with the cathode and injection anode at appropriate negative potentials.

Cathode: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the X-1091 heater in most applications as a result of the advanced counter-wound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

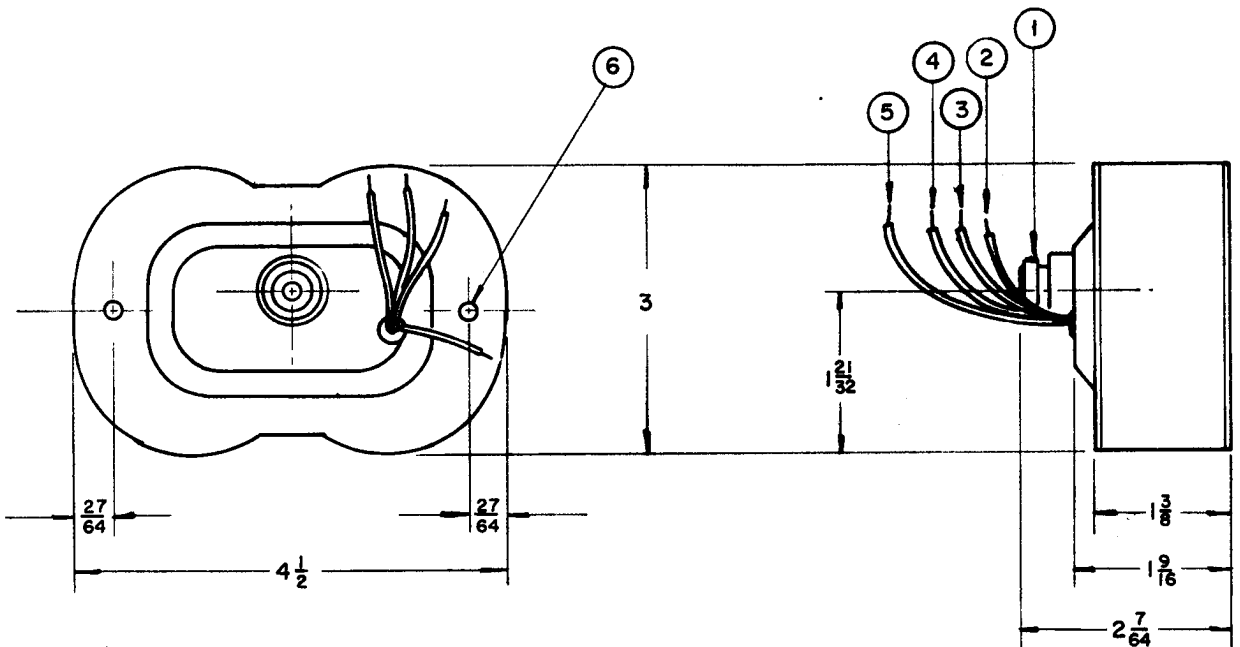
Proximity of Ferrous Materials: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

Temperature Stability: The permanent magnet for the X-1091 has been temperature stabilized to minimize

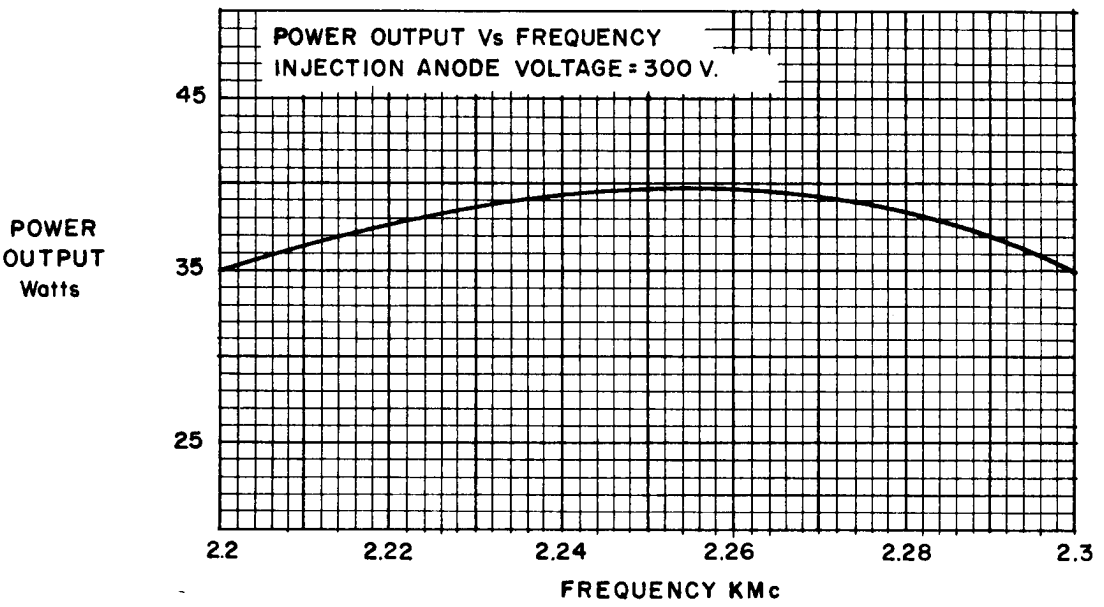
frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1091 package is typically .008% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 2250 megacycles, the temperature/frequency coefficient is typically 180 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

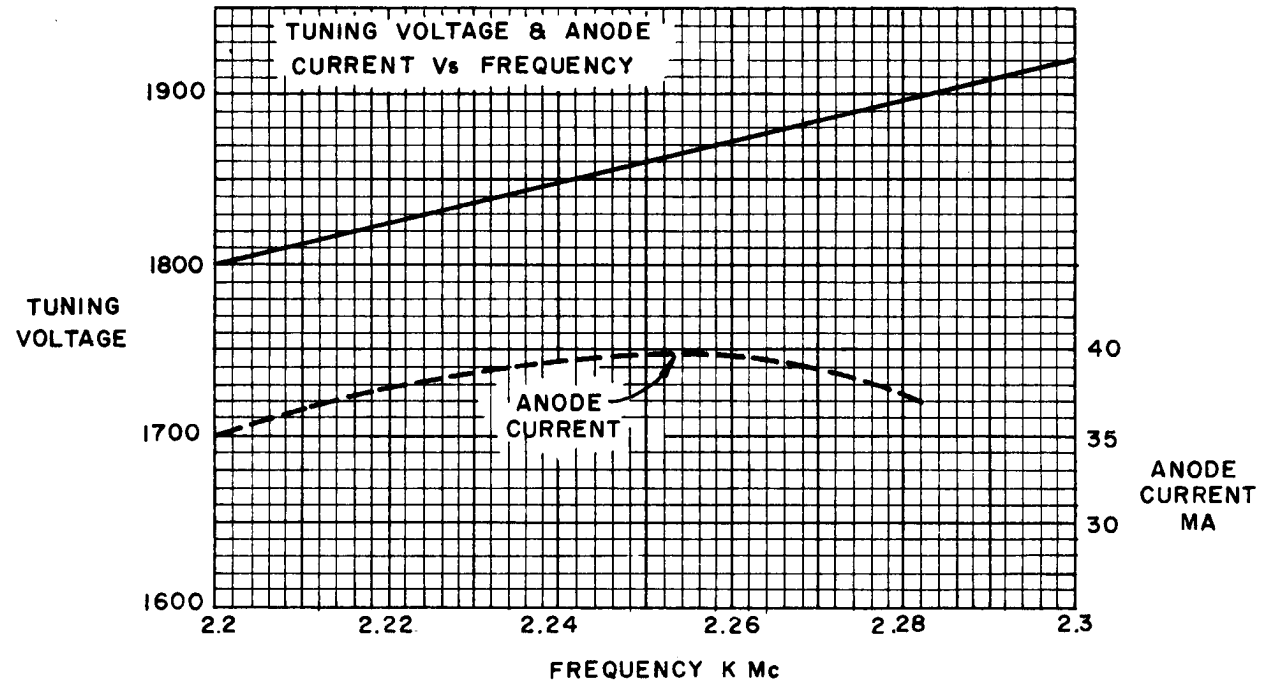
Linearity: The voltage/magnetic-field/frequency relationship of a magnetron is theoretically linear and this linearity is observed in practical tubes. The frequency versus tuning voltage curve for the X-1091 is a straight line with a positive slope and may be easily programmed for the desired frequency sweep. Tests of the fine grain linearity curve show a deviation from a straight line of approximately 3-5 parts per thousand over a 20 megacycle bandwidth.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451.
Cable: EIMAC.



6	3/16 DIA. MOUNTING HOLES
5	GROUND LEAD – Green
4	HEATER LEAD – White
3	INJECTION ANODE LEAD – Yellow
2	HEATER CATHODE LEAD – Brown
1	FEMALE TNC CONNECTOR


POWER OUTPUT Vs FREQUENCY
INJECTION ANODE VOLTAGE = 300 V.
POWER OUTPUT Watts
45
35
25
2.2
2.22
2.24
2.26
2.28
2.3
FREQUENCY KMc

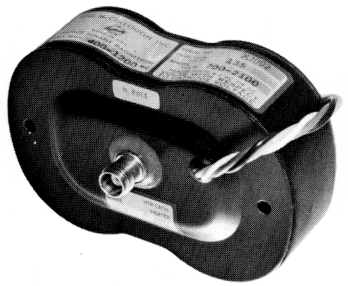

TUNING VOLTAGE & ANODE CURRENT Vs FREQUENCY
TUNING VOLTAGE
1900
1800
1700
1600
ANODE CURRENT
40
35
30
ANODE CURRENT MA
2.2
2.22
2.24
2.26
2.28
2.3
FREQUENCY K Mc

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

OBJECTIVE DATA

X-1092

L-BAND PACKAGED VOLTAGE TUNABLE MAGNETRON



The Eimac X-1092 is a ruggedized, ceramic and metal packaged voltage-tunable magnetron capable of delivering a minimum output power of 750 milliwatts into a 50-ohm termination over the frequency range of 800 to 1450 megacycles.

The electron injection design incorporated in this magnetron minimizes back-bombardment of the indirectly heated EMA cathode with resultant long life. This design also reduces output power variation across the tuning range by limiting the cathode current variation resulting from anode voltage changes.

The extremely linear tuning characteristic of this magnetron simplifies programming the frequency sweep, by eliminating the complicated compensating networks required by other voltage tunable oscillators.

The X-1092 Circuit Assembly has been designed for use with this tube to cover the specified frequency range and includes the permanent magnet and rf circuitry. Electrical connections to the tube are completed by means of flexible leads.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, EMA		
	Warm-up time	60	seconds
Heater:	Voltage (AC or DC)	6.3	volts
	Current	0.8	ampere
Minimum Output Power		750	milliwatts
Frequency Range		800 to 1450	megacycles

MECHANICAL

Operating Position		any
Cooling		forced air
Electrical Connections		flexible leads
RF Output Coupling		TNC female
Net Weight, including magnet and circuit		3.5 pounds
Shipping Weight		10 pounds
Maximum Overall Dimensions (Magnet and Circuit):		
	Height	3 inches
	Width	2 inches
	Length	4-1/2 inches

MAXIMUM RATINGS

Anode Voltage*	2500	volts
Cathode Current	25	milliamperes
Injection Anode Voltage*	+500	volts

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TYPICAL OPERATION (In X-1092 Circuit Assembly, Load VSWR = 1.15:1)

Frequency Range	800	1450	megacycles
Anode Voltage* (Note 1)	1175	2070	volts
Cathode Current	7	15	milliamperes
Typical Power Output	0.9	3	watts
Anode FM Sensitivity		.75	Mc/volt
Injection Anode Voltage*		200	volts
Injection Anode Current		.05	milliampere
Heater Voltage (AC)		6.3	volts
Heater Current (AC)		0.8	ampere

*All voltages referred to the cathode.

Note 1. The operating frequency is determined by the Anode Voltage.

APPLICATION

Anode: The operating frequency is determined by the anode voltage. The anode is mounted in direct electrical contact with the external circuit. Therefore, it is often convenient to operate the anode at chassis potential, with the cathode and injection anode at appropriate negative potentials.

Cathode: The cathode and one leg of the heater are internally connected. Therefore, the heater supply must be insulated for the maximum tuning voltage.

The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained. Either alternating or direct current may be used to energize the X-1092 heater in most applications as a result of the advanced counter-wound helical heater package. In applications where residual FM at the power supply frequency must be held to an absolute minimum, it is recommended that direct current be used for the heater.

Proximity of Ferrous Materials: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

Cooling: To insure long life and best operation, the magnet temperature should not exceed 70° C.

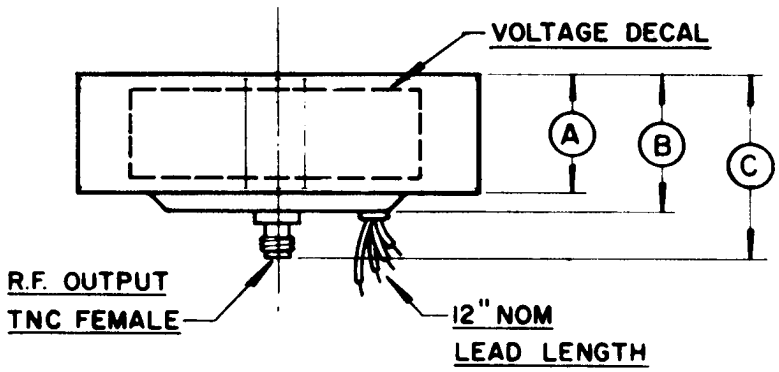
Temperature Stability: The permanent magnet for the X-1092 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1092 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1000 megacycles, the temperature/frequency coefficient is typically 200 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

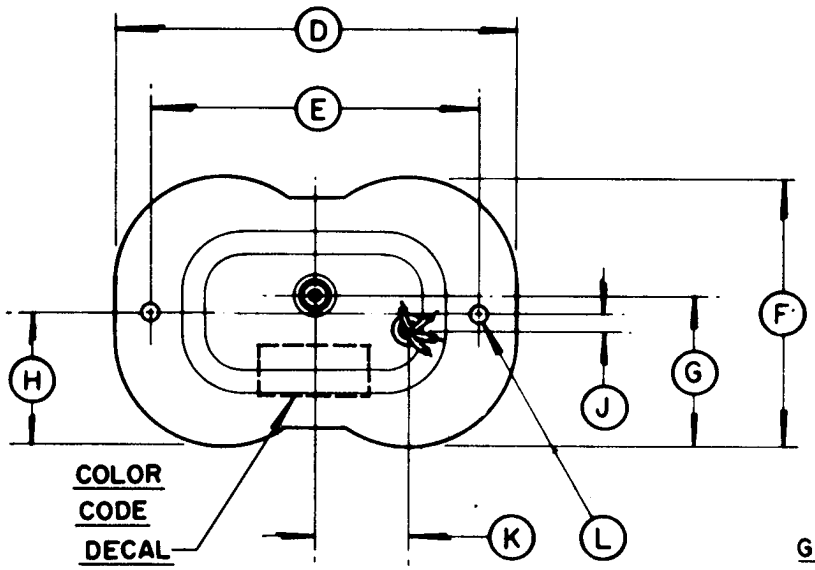
Linearity: The voltage/magnetic-field/frequency relationship of a magnetron is theoretically linear and this linearity is observed in practical tubes. The frequency versus tuning voltage curve for the X-1092 is a straight line with a positive slope and may be easily programmed for the desired frequency sweep.

Special Applications: For any additional information concerning this tube or its application, write to Microwave Product Manager, Eitel-McCullough, Inc., San Carlos, California, telephone LYtell 1-1451, Cable: EIMAC.

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			2.312
D		4.515	
E	3.640	3.671	
F		3.031	
G			1.656
H			1.500
J			.375
K			1.062
L			.187 D.





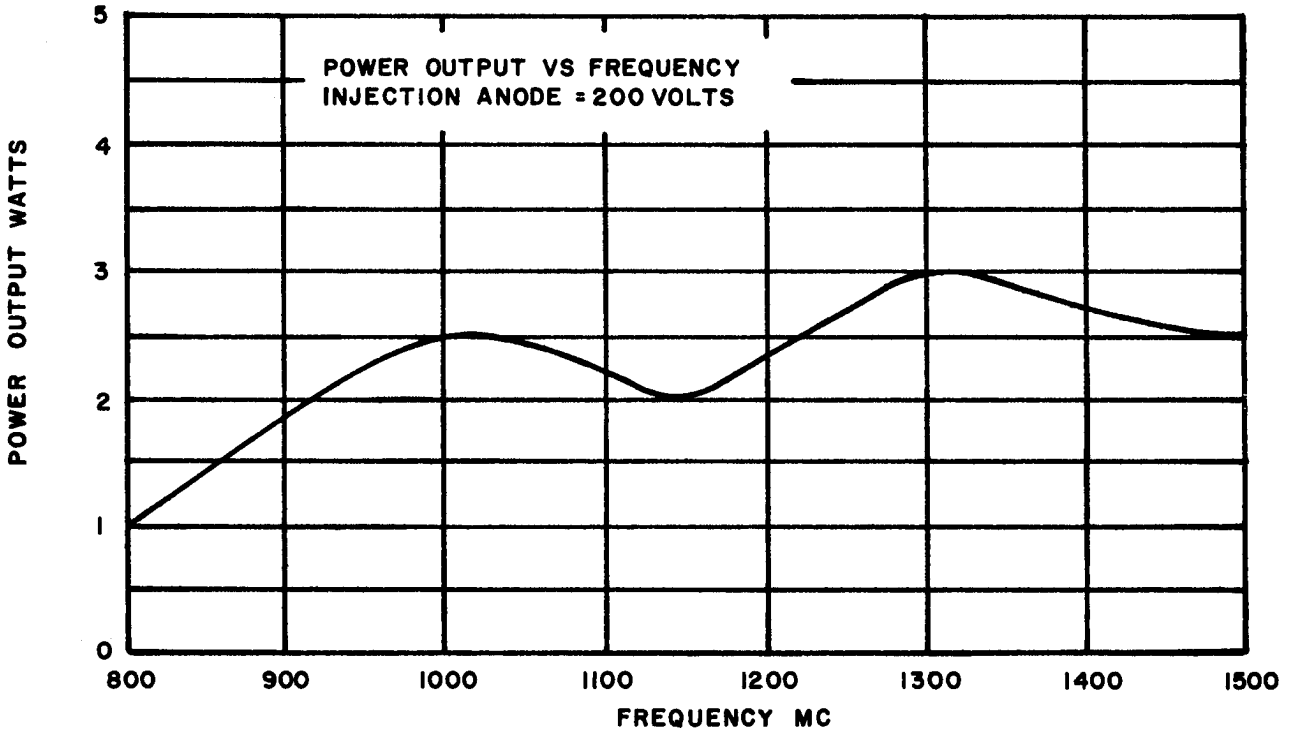
CONNECTIONS

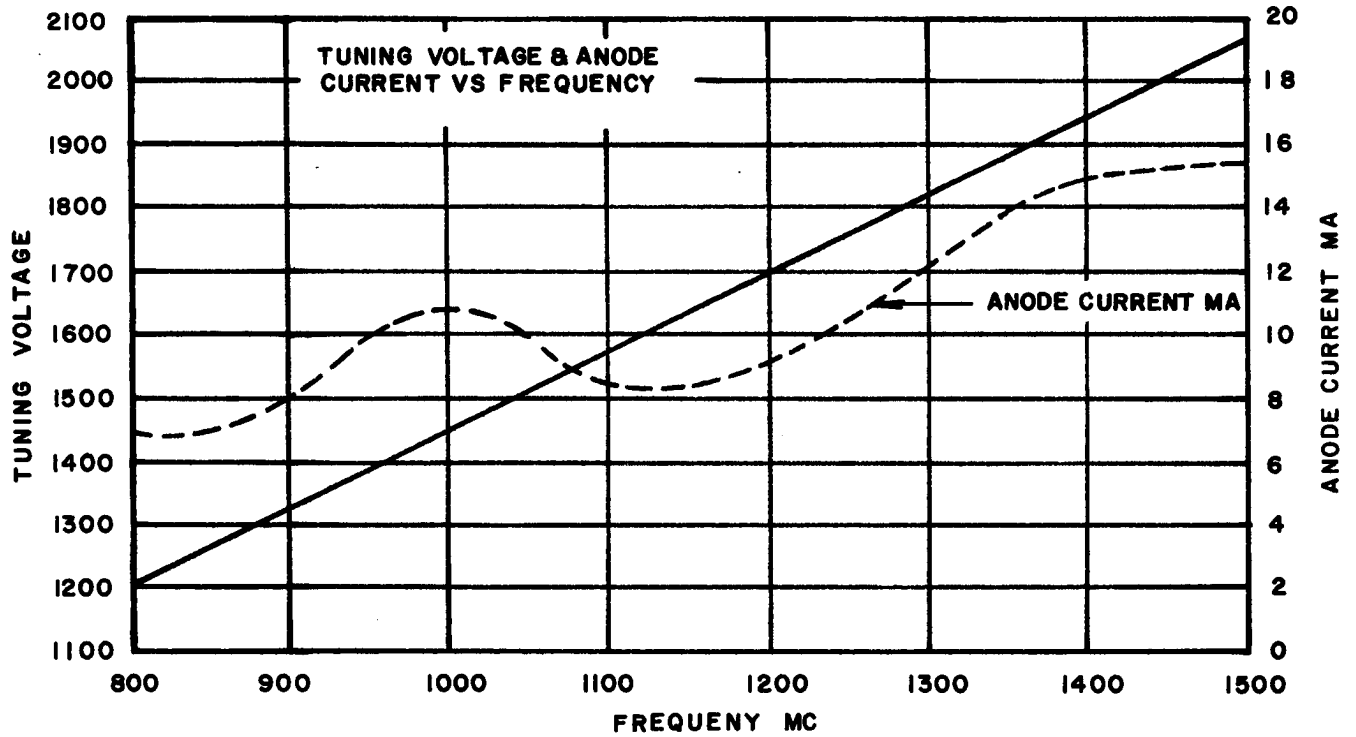
GROUND - GREEN

HEATER – WHITE

HEATER CATHODE – BLACK

INJECTION ANODE – YELLOW


POWER OUTPUT VS FREQUENCY
INJECTION ANODE = 200 VOLTS
POWER OUTPUT WATTS
0
1
2
3
4
5
800
900
1000
1100
1200
1300
1400
1500
FREQUENCY MC


TUNING VOLTAGE & ANODE
CURRENT VS FREQUENCY
TUNING VOLTAGE
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
ANODE CURRENT MA
20
18
16
14
12
10
8
6
4
2
0
800
900
1000
1100
1200
1300
1400
1500
FREQUENY MC

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

X-1094

Voltage Tunable Magnetron

Frequency 375 - 481 Mc

Minimum Output Power 50 mW

TYPICAL PERFORMANCE

ELECTRICAL

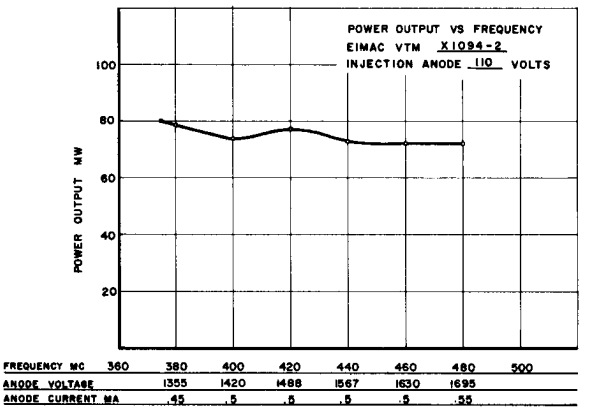
Frequency Range	375-480 Mc
Anode Voltage	1355-1700 V
Cathode Current	.45 to .55 mA
Typical Output Power	75 mW
Anode FM Sensitivity	.3 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0.0 mA
Heater Voltage (AC or DC)	6.3 V
Heater Current (AC or DC)	0.8 A
Load Impedance	50 ohms
Service	cw

P-BAND OSCILLATOR

*MAXIMUM RATINGS

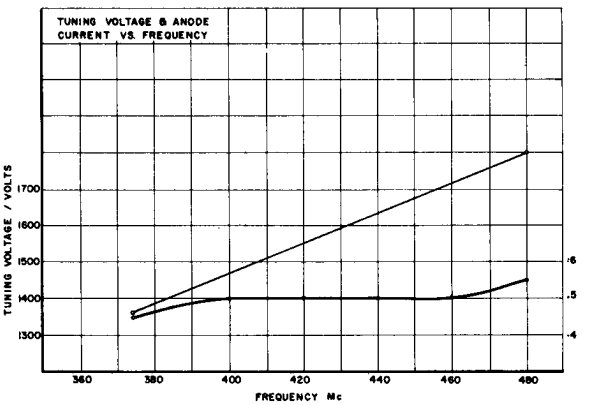
Anode Voltage	2000 V
Cathode Current	10 mA
Injection Anode Voltage	250 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.



MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type N Jack
Weight	3.5 Pounds



ENVIRONMENTAL

Vibration	10G-(to 2kc)
Shock	100G-(11ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3 inches
Width	2.1 inches
Length	4.5 inches

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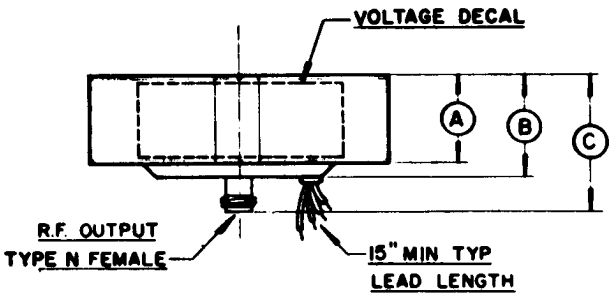
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

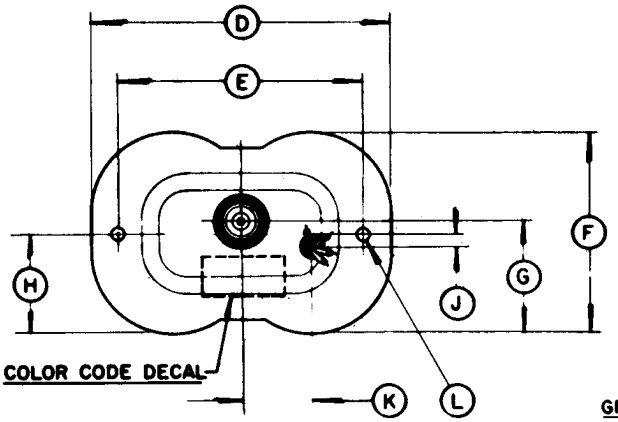
2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray megnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the X-1094 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1094 package is typically .008% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 400 megacycles, the temperature/frequency coefficient is typically 32 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF	MIN	MAX	NOM
A			1.375
B			1.562
C			2.172
D		4.600	
E	3.640	3.671	
F		3.100	3.000
G			1.656
H			1.500
J			.375
K			1.000
L			.187 D.



CONNECTIONS

GROUND - GREEN

HEATER - WHITE

HEATER CATHODE - BLACK

INJECTION ANODE - YELLOW

EIMAC

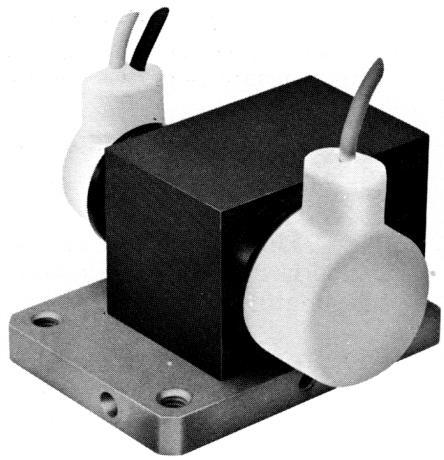
A Division of Varian Associates

SAN CARLOS, CALIFORNIA

X-1095

REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency Setting	factory preset at frequency between 5.9 & 6.7 Gc
Power Output	400 mW
Electronic Tuning Range (3 db bandwidth)	100 Mc
Resonator Voltage	600 Vdc
Cathode Current	45 mA
Repeller Voltage	—100 to —200 Vdc
Modulation Sensitivity	2.0 to 3.0 Mc/V
Heater Voltage	6.3 V (ac or dc)
Heater Current	0.7 A
Mode	4¾
VSWR of Load	1.2:1 max
Temperature Coefficient	±50 kc/°C
Warm-up Time	30 seconds

MAXIMUM RATINGS

Resonator Voltage	700 Vdc
Cathode Current	60 mA
Repeller Voltage (negative with respect to the cathode)	—50 to —500 Vdc

Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Electrical Connection	Flexible Leads
RF Output Coupling	See Outline Drawing
Cooling Required	Conduction
Net Weight	6 ounces
Shipping Weight (approximate)	4 Pounds

ENVIRONMENTAL PERFORMANCE

Temperature	—55°C to +125°C
Altitude	70,000 feet max
Vibration	10 G, 5 to 2000 cps
Shock	100 G, 11 ms

OUTLINE DIMENSIONS

Height	1.42 inches
Width	2.00 inches
Length	2.45 inches

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APPLICATION NOTES

NOTE: All voltages referred to the cathode.

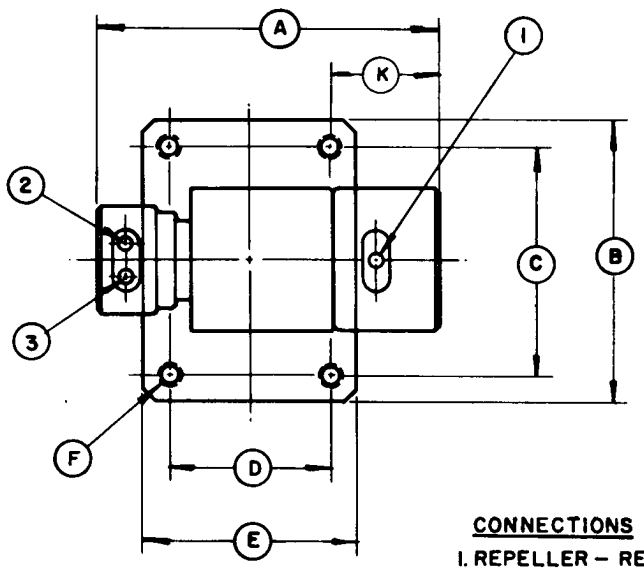
COOLING: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat-sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

RESONATOR: The resonator of the X1095 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

CATHODE: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1095 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

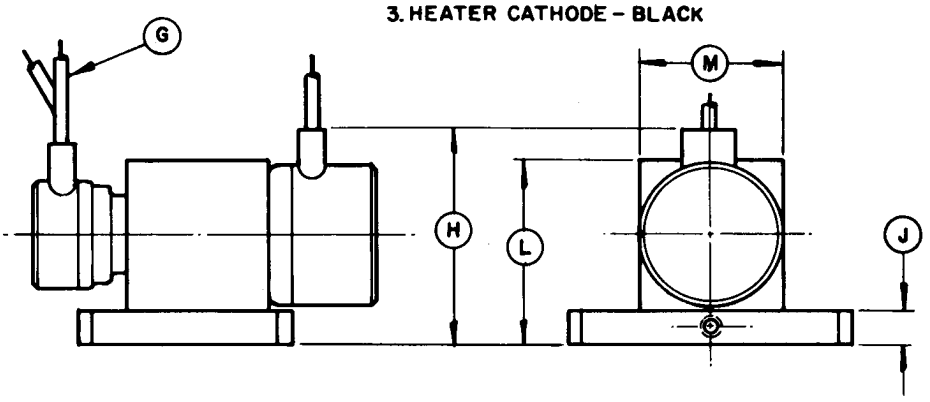
VSWR OF LOAD: To obtain the typical performance listed, the load VSWR should be less than 1.2:1.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		2.520	
B		2.015	
C	1.620	1.630	
D	1.120	1.130	
E		1.515	
F	#8-32 TAP		
G	12±1 TYP LEAD LENGTH		
H			1.500
J		.260	
K	.800	.880	
L		1.325	
M		1.015	

CONNECTIONS

1. REPELLER – RED
2. HEATER – WHITE
3. HEATER CATHODE – BLACK



EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

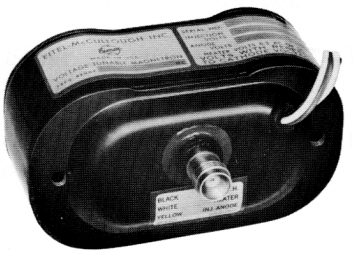
X1097

VOLTAGE TUNABLE MAGNETRON

FREQUENCY 600-1200 Mc

MINIMUM OUTPUT POWER 5 WATTS

TYPICAL PERFORMANCE



L-BAND OSCILLATOR

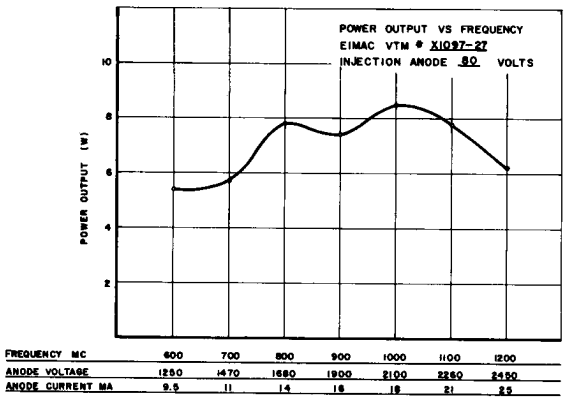
ELECTRICAL

Frequency Range	600-1200 Mc
Anode Voltage	1250-2450 V
Cathode Current	9-25 mA
Typical Output Power	5.5 watts
Anode FM Sensitivity	0.48 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw

*MAXIMUM RATINGS

Anode Voltage	3000 V
Cathode Current	35 mA
Injection Anode Voltage	+500 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.



FREQUENCY MC	600	700	800	900	1000	1100	1200
ANODE VOLTAGE	1250	1470	1680	1900	2100	2280	2450
ANODE CURRENT MA	9.5	11	14	16	19	21	25

MECHANICAL

Operating Position	Any
Cooling	Forced Air
Electrical Connection	Flexible Leads
RF Output Coupling	TNC Jack
Weight	1.5 Pounds

ENVIRONMENTAL

Vibration	10 G-(to 2kc)
Shock	100 G-(11 ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	2 inches
Width	1-1/4 inches
Length	3.5 inches

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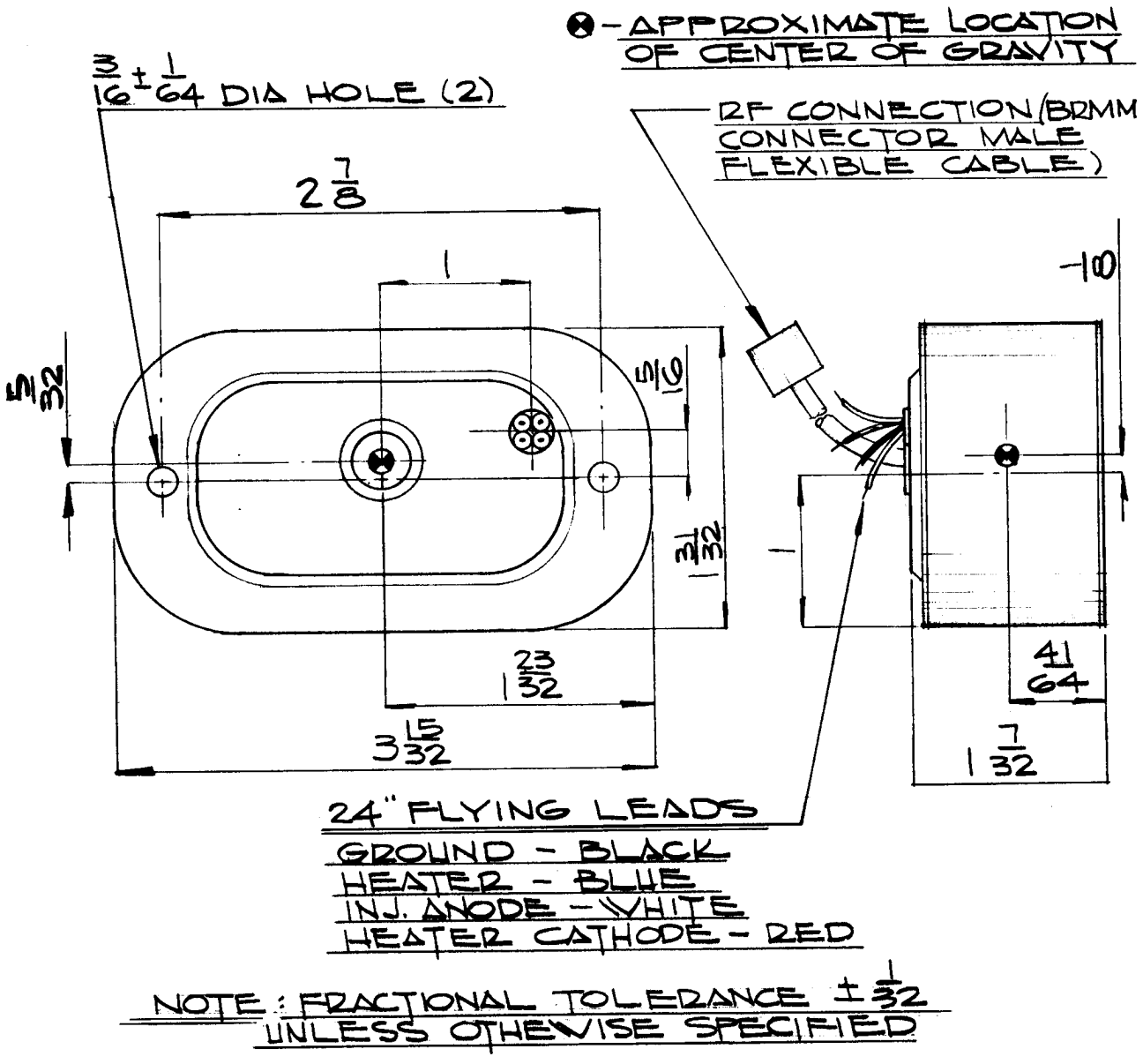
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. This tube was designed for operation in missile environments and can be operated for short periods of time without any cooling.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



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TENTATIVE DATA

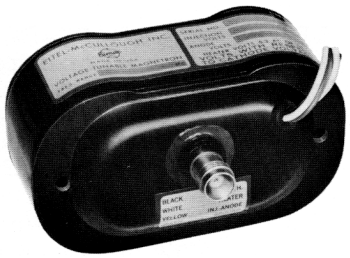
X-1098

VOLTAGE TUNABLE MAGNETRON

FREQUENCY
885-1460 Mc

MINIMUM OUTPUT POWER
32 mW

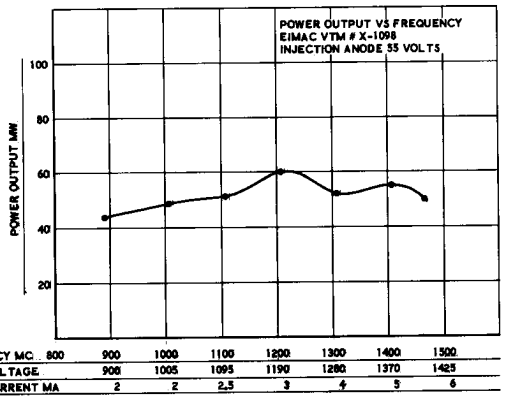
TYPICAL PERFORMANCE



LOW NOISE L-BAND OSCILLATOR

ELECTRICAL

Frequency Range	885-1460 kMc
Anode Voltage	900-1420 V
Cathode Current	2-6 mA
Typical Output Power	45-80 mW
Anode FM Sensitivity	1.1 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0.0 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw



FREQUENCY MC	800	900	1000	1100	1200	1300	1400	1500
ANODE VOLTAGE		900	1005	1095	1190	1280	1370	1425
ANODE CURRENT MA		2	2	2.5	3	4	5	6

*MAXIMUM RATINGS

Anode Voltage	1800 V
Cathode Current	20 mA
Injection Anode Voltage	300 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type N Jack
Weight	3.5 Pounds

ENVIRONMENTAL

Vibration	10 G-(to 2 kc)
Shock	100 G-(11 ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3 inches
Width	2.1 inches
Length	4.5 inches

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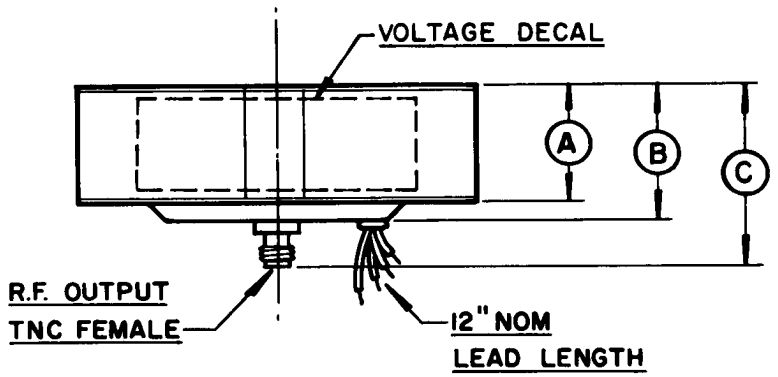
APPLICATION NOTES

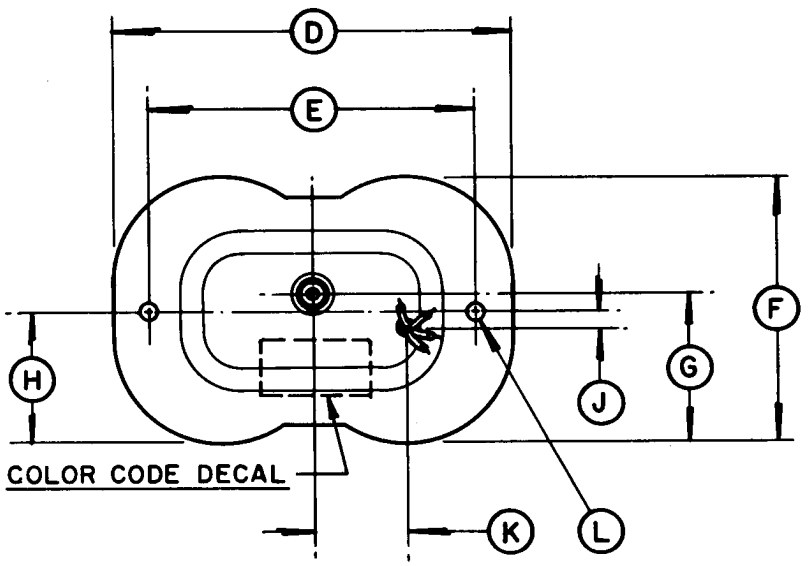
1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70°C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the X-1098 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1098 package is typically .006% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1450 megacycles, the temperature/frequency coefficient is typically 300 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.





DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			2.312
D		4.515	
E	3.640	3.671	
F		3.031	
G			1.656
H			1.500
J			.375
K			1.062
L			.187 D.

CONNECTIONS

GROUND - GREEN

HEATER – WHITE

HEATER CATHODE – BLACK

INJECTION ANODE – YELLOW

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

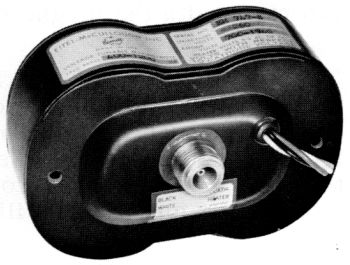
X-1099

VOLTAGE TUNABLE MAGNETRON

FREQUENCY 530 - 655 Mc

MINIMUM OUTPUT POWER 8 mW

TYPICAL PERFORMANCE



P-BAND OSCILLATOR

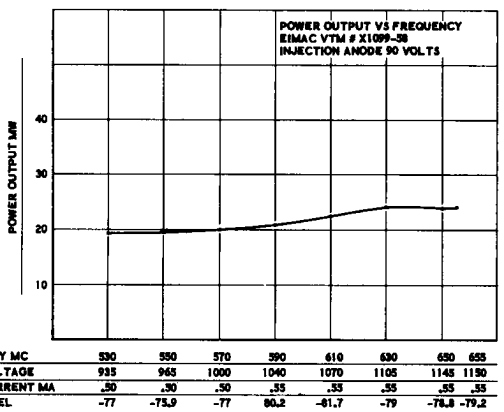
ELECTRICAL

Frequency Range	530-655 Mc
Anode Voltage	925-1150 V
Cathode Current	0.5 mA
Typical Output Power	20-25 mW
Anode FM Sensitivity	.55 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0.0 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw
AM Noise (See Note #5)	—75 db

*MAXIMUM RATINGS

Anode Voltage	1500 V
Cathode Current	10 mA
Injection Anode Voltage	500 V
Injection Anode Current	1 mA

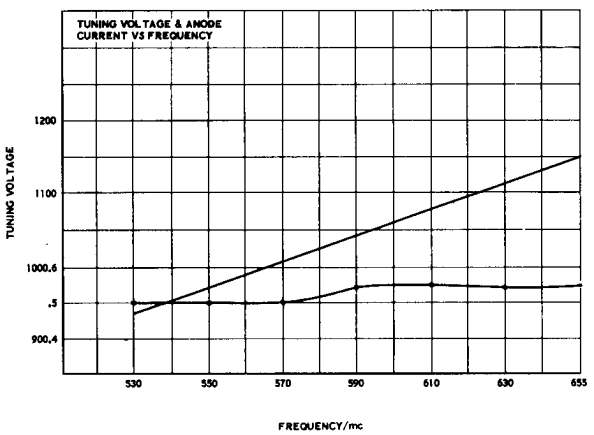
*Damage to the tube may occur if maximum ratings are exceeded.



FREQUENCY MC	530	550	570	590	610	630	650	655
ANODE VOLTAGE	935	965	1000	1040	1070	1105	1145	1150
ANODE CURRENT MA	.50	.30	.50	.35	.33	.55	.55	.55
NOISE LEVEL	-77	-75.9	-77	80.2	-81.7	-79	-78.8	-79.2

MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type N Jack
Weight	3.5 Pounds



ENVIRONMENTAL

Vibration	10G-(to 2kc)
Shock	100G-(11ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3 inches
Width	2.1 inches
Length	4.5 inches

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APPLICATION NOTES

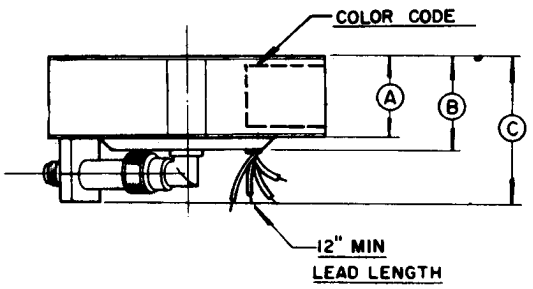
1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

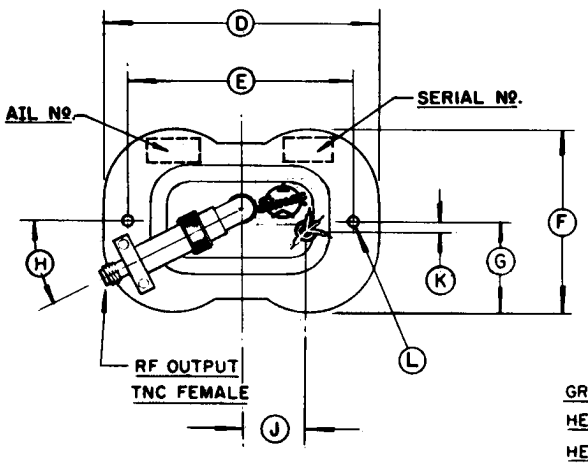
3. TEMPERATURE STABILITY: The permanent magnet for the X-1099 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1099 package is typically .008% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 600 megacycles, the temperature/frequency coefficient is typically 48 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.

5. AM NOISE: AM noise is defined as noise in db below the carrier using a 6 omc IF Strip with 2 Mc band pass and includes power in both side bands. Other measurement techniques can be utilized as the application requires.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN	MAX.	NOM.
A			1.375
B			1.562
C			2.500
D		4.600	
E	3.640	3.671	
F		3.100	
G			1.500
H			27°
J			1.062
K			.375
L			.173 D.



CONNECTIONS

GROUND - GREEN

HEATER - WHITE

HEATER CATHODE - BLACK

INJECTION ANODE - YELLOW

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

X-1111

TWO-CAVITY KLYSTRON

TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency Setting	13.3±.005 Gc
Power Output	2.0 W min
Electronic Tuning Range (3 db bandwidth)	10 Mc
Resonator Voltage	2150±75 Vdc
Cathode Curent	15-25 mA
Modulation Sensitivity	100 kc/V
Heater Voltage	6.3 V(ac or dc)±5%
Heater Current	0-70 A
VSWR of Load	1.2:1
Temperature Coefficient	±100 kc/°C
Warm-up Time	35 seconds
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator Voltage	2500 Vdc
Cathode Current	30 mA

Note: Damage to the tube may occur if the maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Electrical Connection	Flexible Leads
RF Output Coupling	RG—91/V waveguide flange
Cooling Required	Conduction
Net Weight	8 ounces
Shipping Weight (approximate)	4 Pounds

ENVIRONMENTAL PERFORMANCE

Temperature Range	−20 to +75° C
Altitude	100,000 feet max
Vibration	10 G, 20 to 2000 cps
Shock	60 G, 11 ms

OUTLINE DIMENSIONS

Height	.90 inches
Width	1.35 inches
Length	2.80 inches

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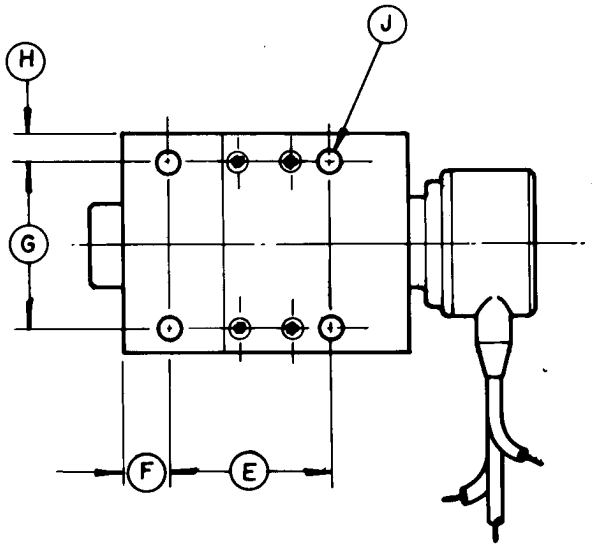
APPLICATION NOTES

1. NOTE: All voltages are referred to the cathode.

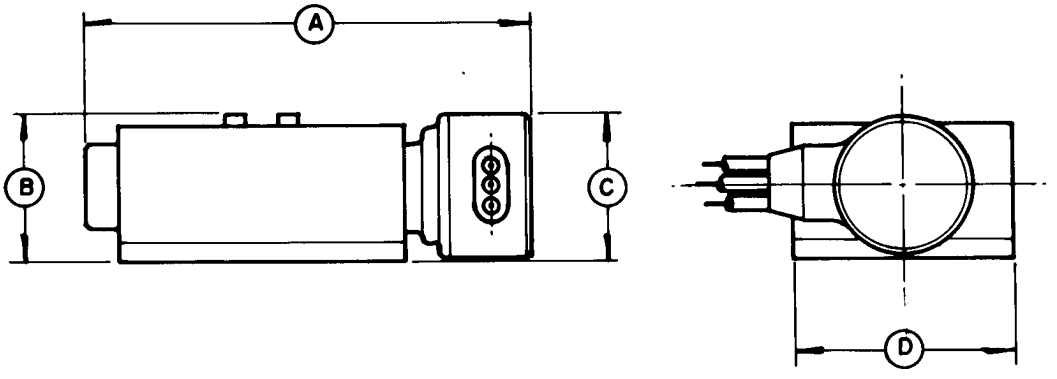
2. RESONATOR: The resonator of the X-1111 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

3. CATHODE: The heater voltage should be maintained with ± 5% of the rated value of 6.3 volts if variations in performance are to be mimimized and best tube life obtained.

   The heater and cathode of the X-1111 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A		2.660	
B			.920
C			.905
D		1.325	
E	.946	.966	
F			.250
G	.984	1.004	
H			.159
J	.144 D	.150 D	



EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

X-1113

TWO-CAVITY KLYSTRON

TENTATIVE DATA

ELECTRICAL PERFORMANCE

Frequency Setting	35 Gc
Power Output	2.0 W min
Electronic Tuning Range (3 db bandwidth)	40 Mc
Resonator Voltage	2500±150 Vdc
Cathode Current	25-40 mAdc
Modulation Sensitivity	100 Kc/V.
Heater Voltage	6.3 V(ac or dc)±5%
Heater Current	2.0 A
VSWR of Load	1.2:1
Warm-up Time	35 seconds
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator Voltage - - - - - - - - 3100 Vdc

Note: Damage to the tube may occur if the maximum rating is exceeded.

MECHANICAL

Operating Position	Any
Electrical Connection	Flexible Leads
RF Output Coupling	RG-96/V waveguide flange
Cooling Required	Blower or Conduction
Net Weight	17 ounces
Shipping Weight (approximate)	5 Pounds

ENVIRONMENTAL PERFORMANCE

Temperature	−20 to +75°C
Altitude	100, 000 feet max
Vibration	2 G, 20 to 2000 cps
Shock	15 G, 11 ms

OUTLINE DIMENSIONS

Height	2.0 inches
Width	1.9 inches
Length	3.5 inches

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APPLICATION NOTES

NOTE: All voltages are referred to the cathode.

1. RESONATOR: The resonator of the X-1113 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

2. CATHODE: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

   The heater and cathode of the X-1113 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

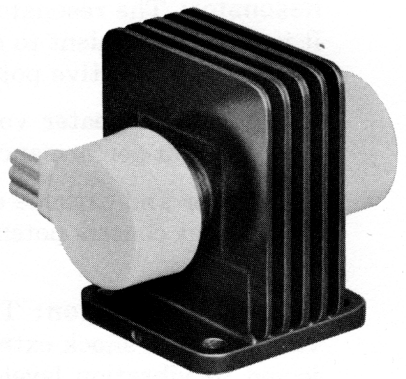
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1115

KU BAND REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	12.2 to 12.7 Gc
Mechanically tunable	500 Mc
Power output	1 W min.
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	750 Vdc
Cathode current	90 mA max.
Repeller voltage	−300 Vdc
Modulation sensitivity	1.5 Mc/V max.
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.3 A max.
Mode	3¾
VSWR of load	1.2:1 max.
Temperature coefficient	±100 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	900 Vdc
Cathode current	110 mA
Repeller voltage:	
Negative with respect to cathode	−50 to −1000 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction & convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.6 in.
Width	1.6 in.
Length	2.1 in.

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APPLICATION

NOTE: All voltages referred to cathode.

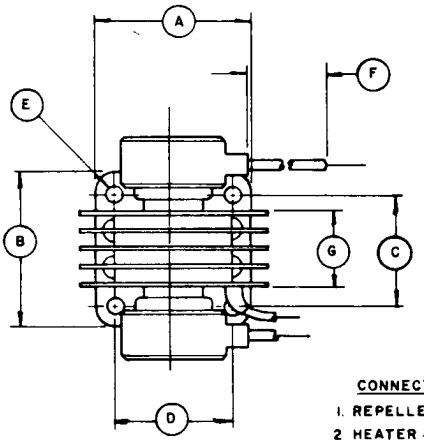
Cooling: The X1115 may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1115 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1115 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

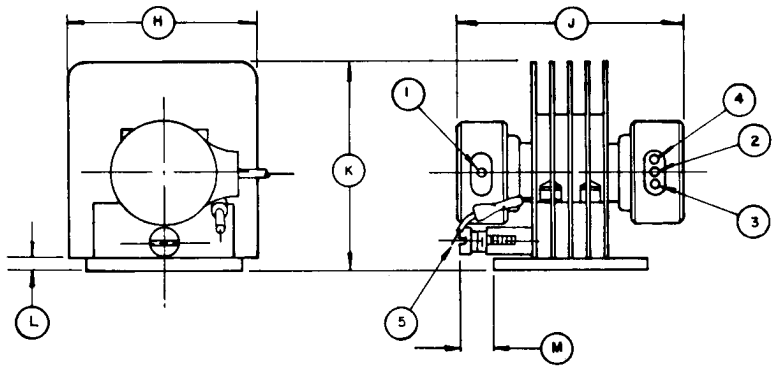
Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.



CONNECTIONS
1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D	148D.	
F	12±1 TYP. LEAD LENGTH		
G			.650
H			1.600
J		2.100	
K		1.600	
L			.125
M		.532	

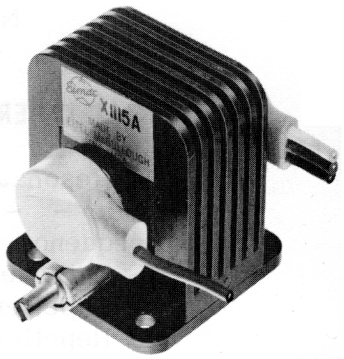


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1115A

REFLEX KLYSTRON



The Eimac X1115A is a ceramic and metal, conduction-cooled reflex klystron designed for transmitter/local oscillator service in 12.2 - 12.7 Gc. microwave relay equipments. This tube provides a minimum output power of 100 mW and is tunable across the entire 500 Mc. band. High power output and good power/frequency stability also make the X1115A a good choice for parametric amplifier pump applications.

The X1115A features low-noise gridless gun optics and is warranteed for 1000 hours life.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up time	30	seconds
Heater:	Voltage	6.3	volts
	Current	0.8	ampere
Typical Output Power (Load VSWR 1.15:1)		100	milliwatts
Frequency Range		12.200 to 12.700	megacycles

MECHANICAL

Operating Position		Any
Mounting		WR-75 Waveguide Flange
Cooling		Conduction
Electrical Connections		Flexible Leads
RF Output Coupling		WR-75 Waveguide
Net Weight	4	ounces
Shipping Weight (Approximate)	2	pounds
Maximum Overall Dimensions:		
Height	1.8	inches
Width	1.5	inches
Length	2.5	inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-operating Shock (11 ms duration)	40 g
Maximum Operating Shock* (11 ms duration)	40 g
Maximum Operating Vibration** (20 to 2000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 250 kilocycles.

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MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	500	MAX. VOLTS
DC CATHODE CURRENT	60	MAX. MA
RESONATOR DISSIPATION	30	MAX. WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	(25	MAX. VOLTS)
NEGATIVE WITH RESPECT TO CATHODE	(500	MAX. VOLTS)

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

DC Resonator Voltage*	400	volts
Mode		4-3/4
Frequency	12,450	megacycles
DC Cathode Current	40	milliamperes
DC Repeller Voltage*	-200	volts
DC Repeller Current	1	microampere
Power Output	150	milliwatts
Electronic Tuning (3 db bandwidth)	30	megacycles
Modulation Sensitivity ($E_r = \pm 3$ volts)	2.0	Mc/volt
Peak-to-peak FM Deviation (10 g, 20 - 2000 cps)	250	kilocycles
Residual FM	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

Resonator: The resonator of the X1115A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

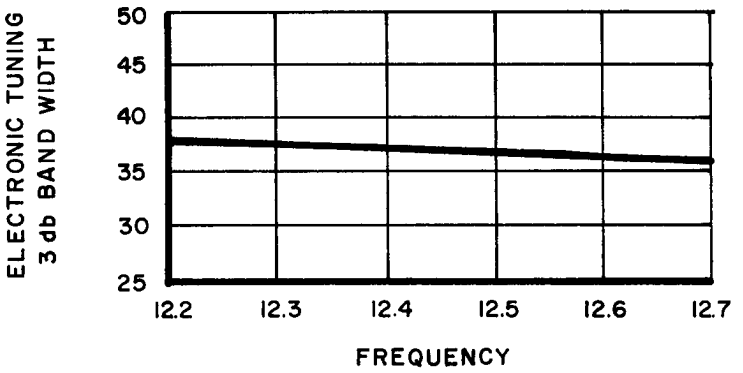
The heater and cathode of the X1115A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

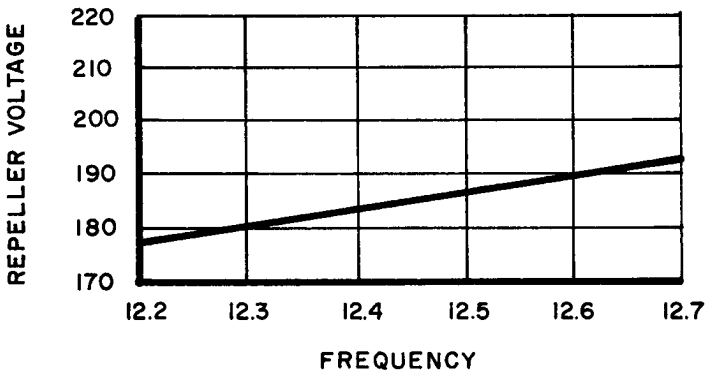
Mechanical Tuning: In the X1115A a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

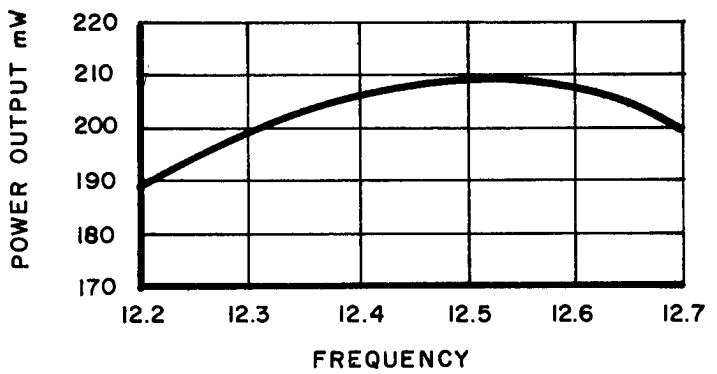
A clockwise rotation of the tuner will produce a decrease in frequency.

X1115A OPERATING CHARACTERISTICS

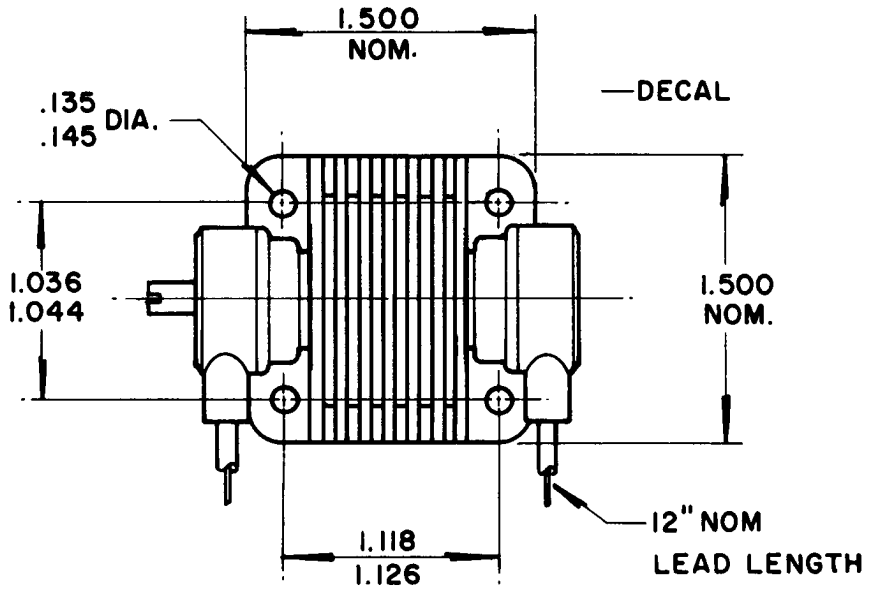
Ers = 400 V.
$5\frac{3}{4}$ MODE







X1115A



CONNECTIONS

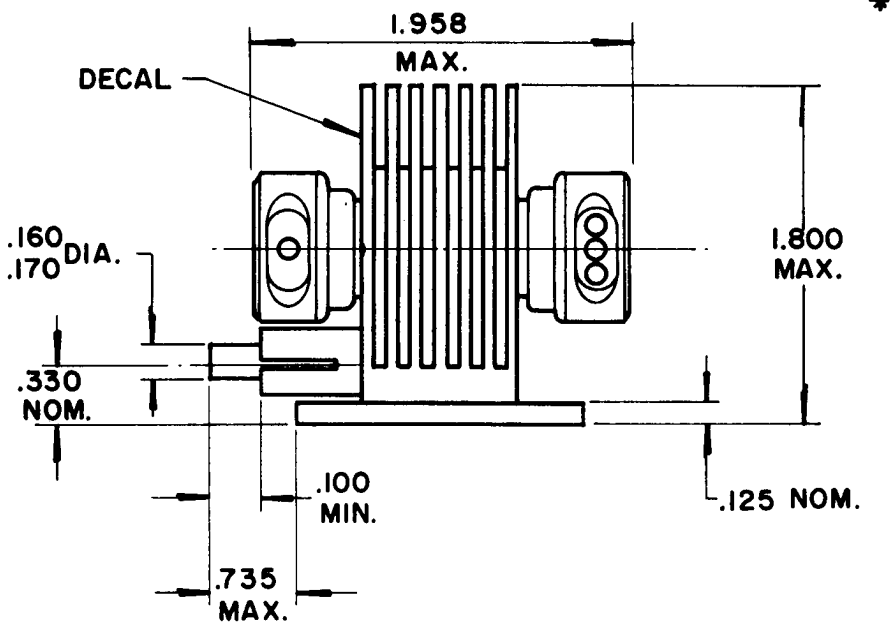
REPELLER - RED

HEATER - WHITE

* CATHODE - BLACK

* HEATER - BLACK

* INTERNALLY CONNECTED

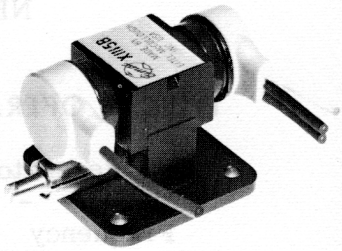


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1115B

REFLEX KLYSTRON



The Eimac X1115B is a ceramic and metal, conduction-cooled reflex klystron designed for local oscillator service in 12.2 - 12.7 Gc. microwave relay equipments. The tube provides a minimum power output of 30 mW and is tunable across the entire 500 Mc. band.

The X1115B features low-noise gridless gun construction, good power and frequency stability and is conservatively warranteed for 1000 hours life.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential, oxide coated		
	Warm-up time	30	seconds
Heater:	Voltage	6.3	volts
	Current	0.8	ampere
Typical Output Power (Load VSWR 1.15:1)		30	milliwatts
Frequency Range		12,200 to 12,700	megacycles

MECHANICAL

Operating Position		Any
Mounting		WR-75 Waveguide Flange
Cooling		Conduction
Electrical Connections		Flexible Leads
RF Output Coupling		WR-75 Waveguide
Net Weight	4	ounces
Shipping Weight (Approximate)	2	pounds
Maximum Overall Dimensions:		
Height	1.4	inches
Width	1.5	inches
Length	2.5	inches

ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	No limit
Maximum Non-operating Shock (11 ms duration)	40 g
Maximum Operating Shock* (11 ms duration)	40 g
Maximum Operating Vibration** (20 to 2000 cps)	10 g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 250 kilocycles.

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MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	425	MAX. VOLTS
DC CATHODE CURRENT	45	MAX. MA
RESONATOR DISSIPATION	20	MAX. WATTS
PEAK REPELLER VOLTAGE*		
POSITIVE WITH RESPECT TO CATHODE	0	MAX. VOLTS
NEGATIVE WITH RESPECT TO CATHODE	400	MAX. VOLTS

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

DC Resonator Voltage*	300	volts
Mode		6-3/4
Frequency	12,450	megacycles
DC Cathode Current	26	milliamperes
DC Repeller Voltage*	-130	volts
DC Repeller Current	1	microampere
Power Output	40	milliwatts
Electronic Tuning (3 db bandwidth)	35	megacycles
Modulation Sensitivity ($E_r = \pm 3$ volts)	2.5	Mc/volt
Peak-to-peak FM Deviation (10 g, 20 - 2000 cps)	250	kilocycles
Residual FM	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

Resonator: The resonator of the X1115B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

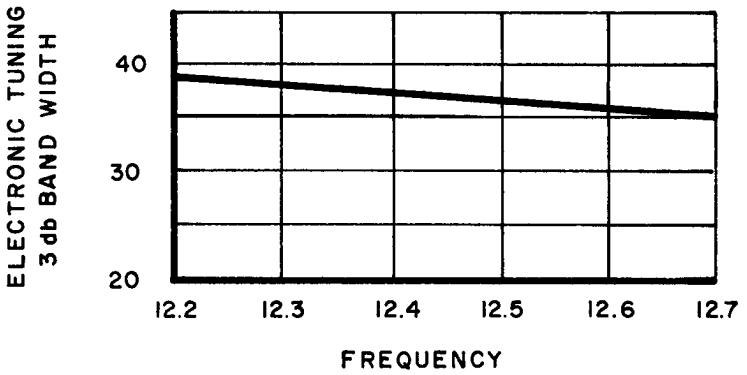
The heater and cathode of the X1115B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

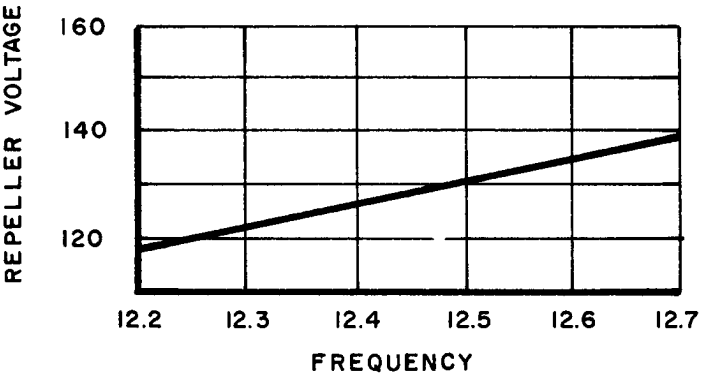
Mechanical Tuning: In the X1115B a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

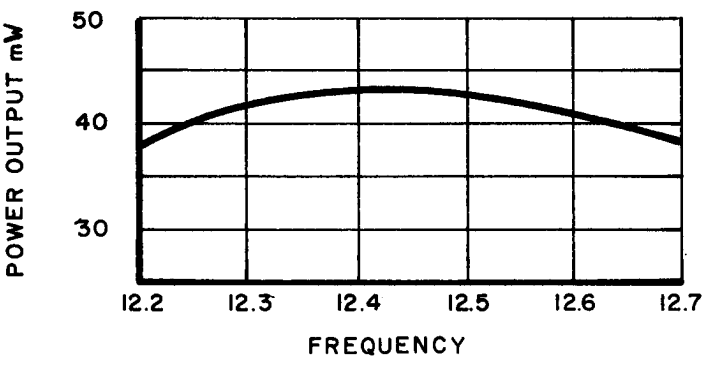
A clockwise rotation of the tuner will produce a decrease in frequency.

X1115B OPERATING CHARACTERISTICS

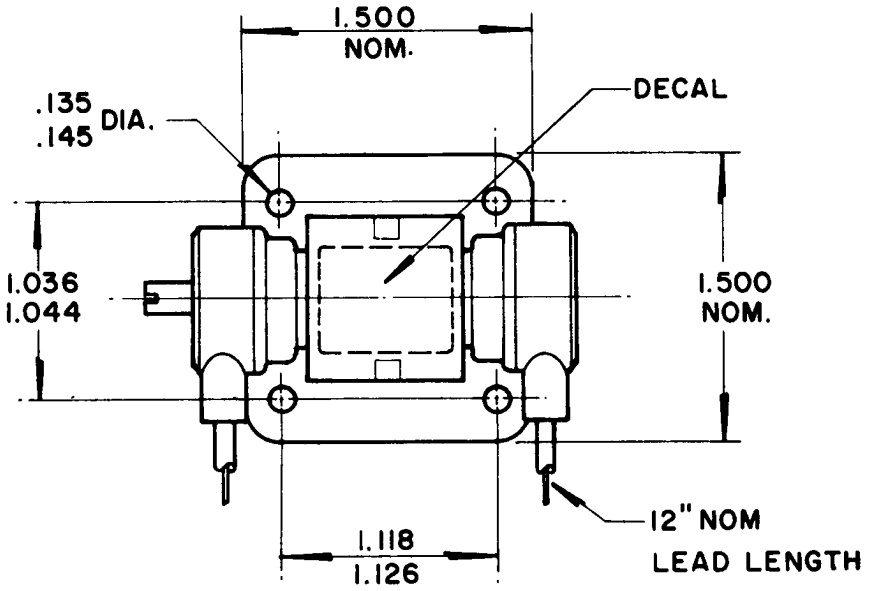
Ers = 300 V.
$6\frac{3}{4}$ MODE







X1115B



CONNECTIONS

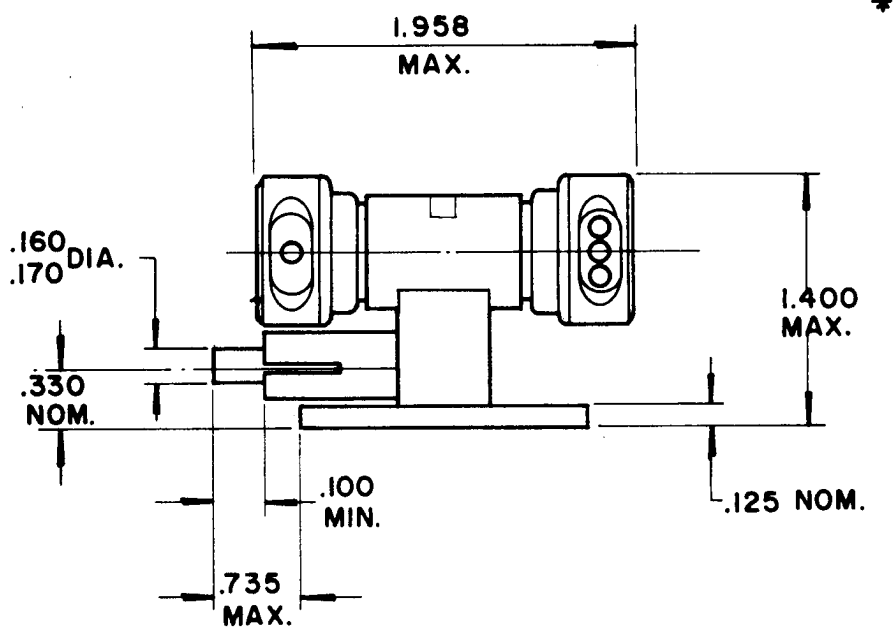
REPELLER - RED

HEATER - WHITE

* CATHODE - BLACK

* HEATER - BLACK

* INTERNALLY CONNECTED



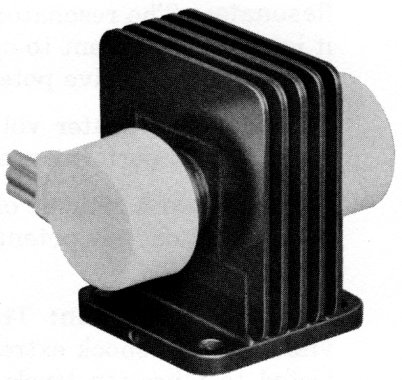
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1116

X BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	11.7 to 12.2 Gc
Mechanically tunable	500 Mc
Power output	1 W min.
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	750 Vdc
Cathode current	90 mA max.
Repeller voltage	−300 Vdc
Modulation sensitivity	1.5 Mc/V max.
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.3 A max.
Mode	3¾
VSWR of load	1.2:1 max.
Temperature coefficient	±100 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	900 Vdc
Cathode current	110 mA
Repeller voltage:	
Negative with respect to cathode	−50 to −1000 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction & convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.6 in.
Width	1.6 in.
Length	2.1 in.

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APPLICATION

NOTE: All voltages referred to cathode.

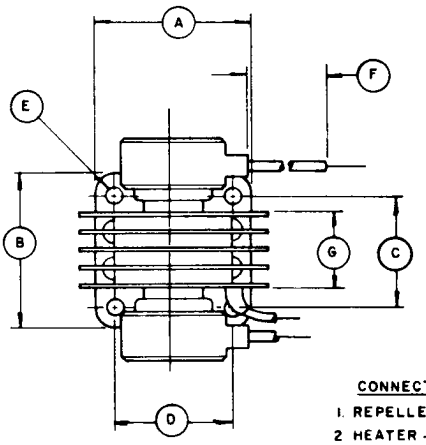
Cooling: The X1116 may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1116 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1116 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

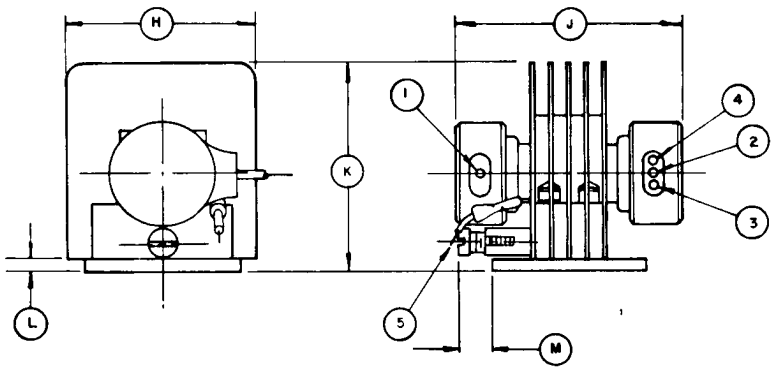
Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.



CONNECTIONS
1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D	.148D.	
F	12±1 TYP. LEAD LENGTH		
G			.650
H			1.600
J		2.100	
K		1.600	
L			.125
M		.532	

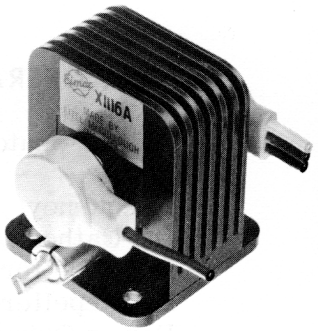


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1116A

REFLEX KLYSTRON



The Eimac X1116A is a ceramic and metal. conduction-cooled reflex klystron designed for transmitter/local oscillator service in 11.7 - 12.2 Gc. microwave relay equipments. This tube provides a minimum output power of 100 mW and is tunable across the entire 500 Mc. band. High power output and good power/frequency stability also make the X1116A a good choice for parametric amplifier pump applications.

The X1116A features low-noise gridless gun optics and is warranteed for 1000 hours life.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Unipotential. oxide coated		
	Warm-up time	30	seconds
Heater:	Voltage	6.3	volts
	Current	0.8	ampere
Typical Output Power (Load VSWR 1.15:1)		100	milliwatts
Frequency Range		11,700 to 12,200	megacycles

MECHANICAL

Operating Position	Any	
Mounting	WR-75 Waveguide Flange	
Cooling	Conduction	
Electrical Connections	Flexible Leads	
RF Output Coupling	WR-75 Waveguide	
Net Weight	4	ounces
Shipping Weight (Approximate)	2	pounds
Maximum Overall Dimensions:		
Height	1.8	inches
Width	1.5	inches
Length	2.5	inches

ENVIRONMENTAL

Maximum Ambient Temperature	150°	C
Maximum Altitude	No limit	
Maximum Non-operating Shock (11 ms duration)	40	g
Maximum Operating Shock* (11 ms duration)	40	g
Maximum Operating Vibration** (20 to 2000 cps)	10	g

*Based on a permanent frequency shift after drop of 2 megacycles.
**Based on a maximum peak-to-peak frequency deviation of 250 kilocycles.

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MAXIMUM RATINGS

DC RESONATOR VOLTAGE*	500	MAX. VOLTS
DC CATHODE CURRENT	60	MAX. MA
RESONATOR DISSIPATION	30	MAX. WATTS
PEAK REPELLER VOLTAGE*		
NEGATIVE WITH RESPECT TO CATHODE	(25	MAX. VOLTS)
	(500	MAX. VOLTS)

TYPICAL OPERATION (Load VSWR less than 1.15 to 1)

DC Resonator Voltage*	400	volts
Mode		4-3/4
Frequency	11.950	megacycles
DC Cathode Current	40	milliamperes
DC Repeller Voltage*	-200	volts
DC Repeller Current	1	microampere
Power Output	150	milliwatts
Electronic Tuning (3 db bandwidth)	30	megacycles
Modulation Sensitivity (E_r = ±3 volts)	2.0	Mc/volt
Peak-to-peak FM Deviation (10 g. 20 - 2000 cps)	250	kilocycles
Residual FM	50	kilocycles

*All voltages referred to cathode.

APPLICATION

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation. forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

Resonator: The resonator of the X1116A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential. with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

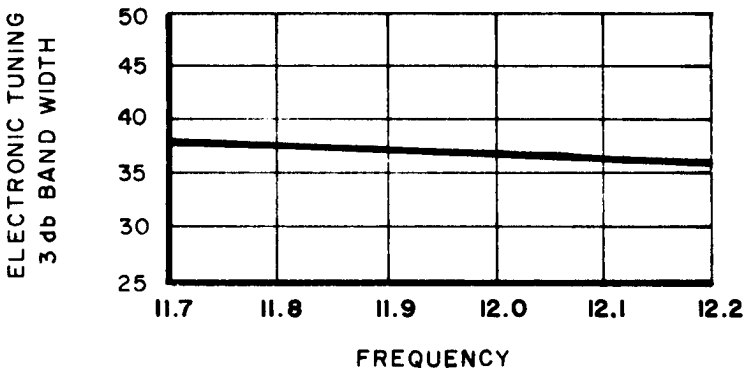
The heater and cathode of the X1116A are internally connected. When the resonator of this tube is operated at chassis potential. the heater transformer must be insulated for the cathode-to-resonator voltage.

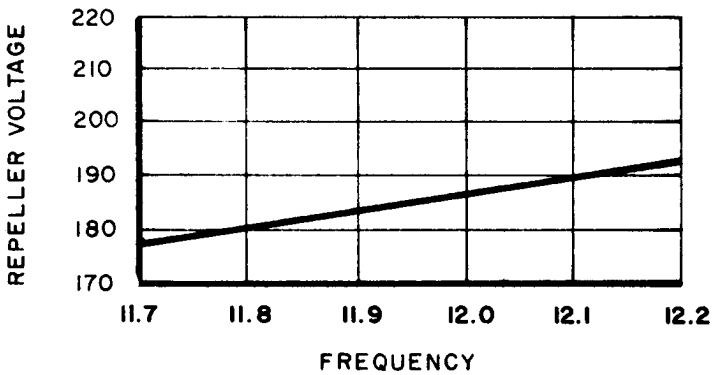
Mechanical Tuning: In the X1116A a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

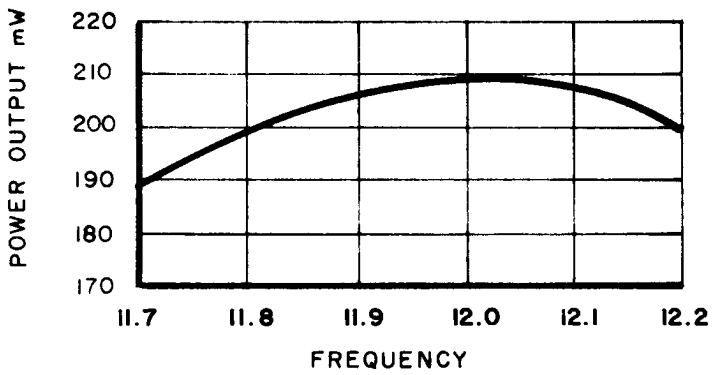
A clockwise rotation of the tuner will produce a decrease in frequency.

X1116A OPERATING CHARACTERISTICS

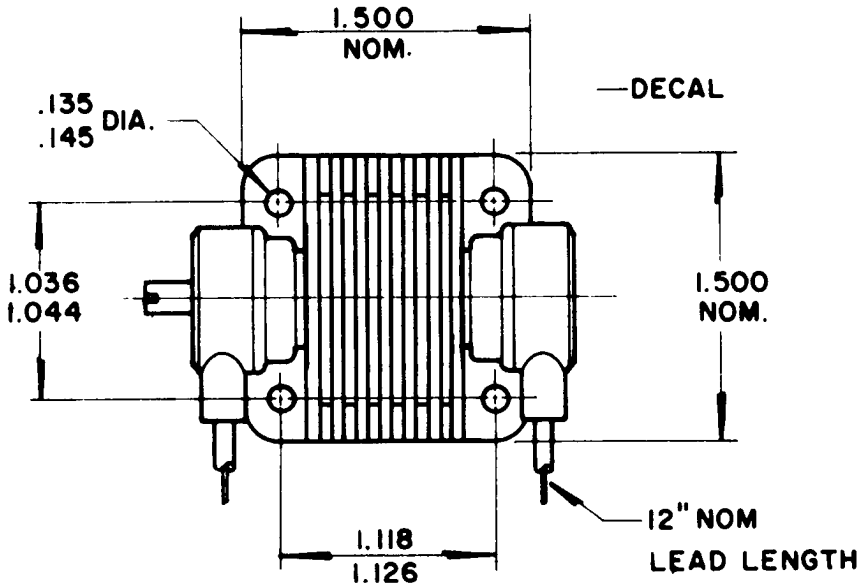
Ers = 400 V.
$5\frac{3}{4}$ MODE







X1116A



CONNECTIONS

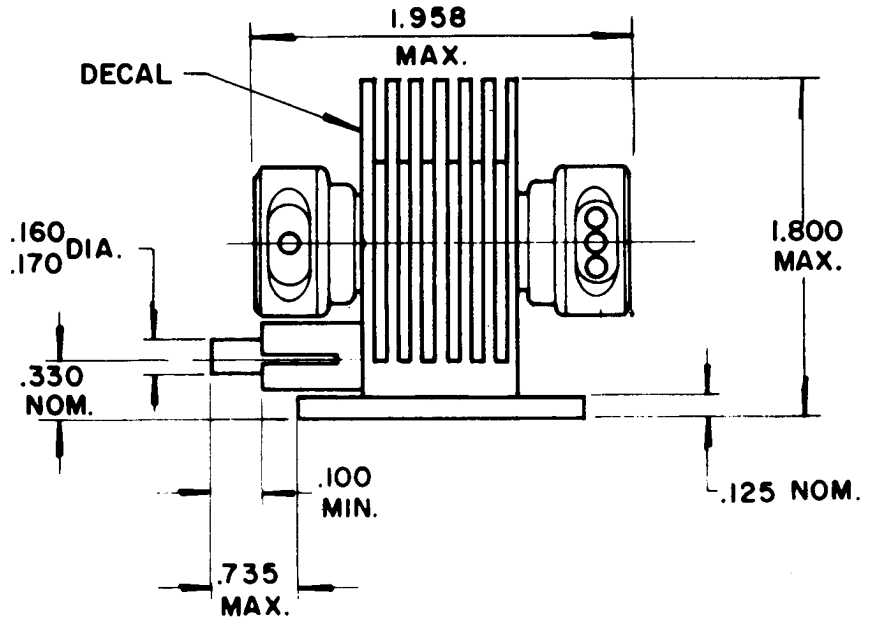
REPELLER - RED

HEATER - WHITE

* CATHODE - BLACK

* HEATER - BLACK

* INTERNALLY CONNECTED



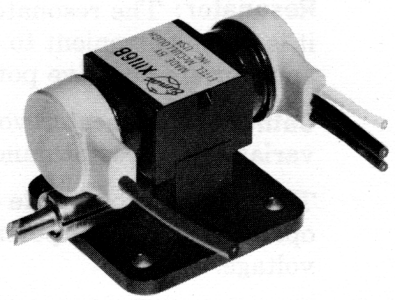
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1116B

X BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	11.7 to 12.2 Gc
Mechanically tunable	500 Mc
Power output	30 mW
Electronic tuning range (3 db bandwidth)	40 Mc
Resonator voltage	300 Vdc
Cathode current	25 mAdc
Repeller voltage	−100 Vdc
Modulation sensitivity	2.5 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.0 A max.
Mode	6¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	425 Vdc
Cathode current	45 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −400 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction or convection
Net weight	4½ oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.5 in.
Length	2.5 in.

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APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

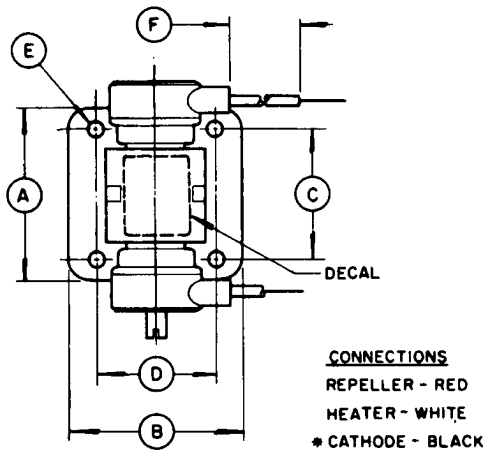
Resonator: The resonator of the X1116B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1116B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the X1116B a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

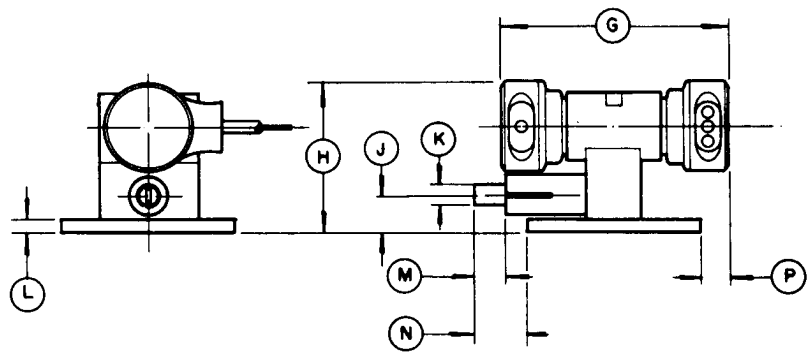
A clockwise rotation of the tuner will produce a decrease in frequency.



CONNECTIONS
REPELLER - RED
HEATER - WHITE
* CATHODE - BLACK
* HEATER - BLACK
*INTERNALLY CONNECTED

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		1.958	
H		1.400	
J			.330
K	.160	.170	
L			.125
M	.100		
N		.735	
P		.250	

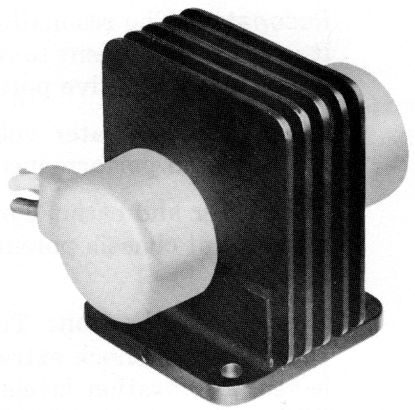


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1117

X BAND
REFLEX KLYSTRON



TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency range	11.2 to 11.7 Gc
Mechanically tunable	500 Mc
Power output	1 W min.
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	750 Vdc
Cathode current	90 mA max.
Repeller voltage	−300 Vdc
Modulation sensitivity	1.5 Mc/V max.
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.3 A max.
Mode	3¾
VSWR of load	1.2:1 max.
Temperature coefficient	±100 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	900 Vdc
Cathode current	110 mA
Repeller voltage:	
Negative with respect to cathode	−50 to −1000 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction & convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.6 in.
Width	1.6 in.
Length	2.1 in.

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APPLICATION

NOTE: All voltages referred to cathode.

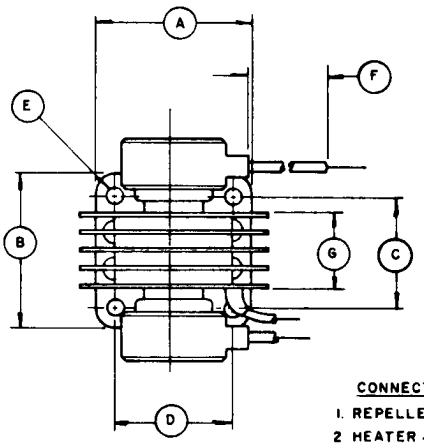
Cooling: The X1117 may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1117 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1117 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.

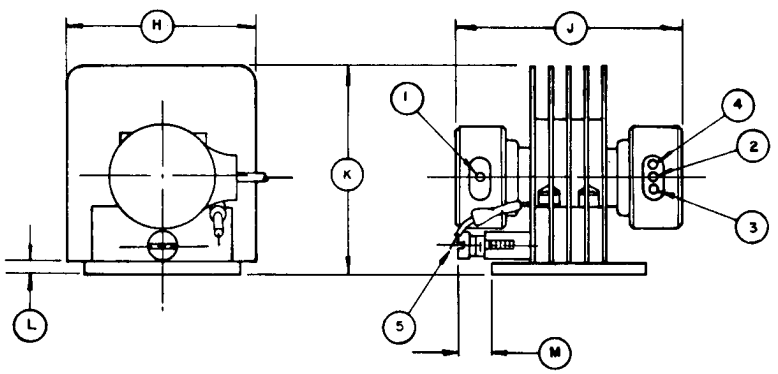


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D	.148D.	
F	12±1 TYP. LEAD LENGTH		
G			.650
H			1.600
J		2.100	
K		1.600	
L			.125
M		.532	

CONNECTIONS

1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



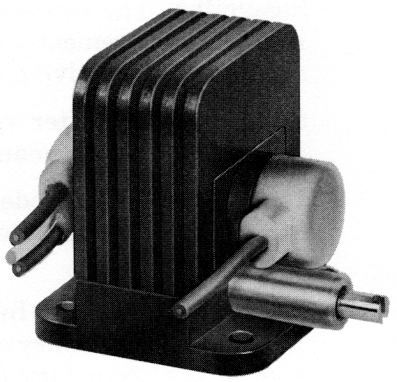
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1117A

X BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	11.2 to 11.7 Gc
Mechanically tunable	500 Mc
Power output	100 mW
Electronic tuning range (3 db bandwidth)	40 Mc
Resonator voltage	400 Vdc
Cathode current	40 mAdc
Repeller voltage	−150 Vdc
Modulation sensitivity	2.0 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.0 A max.
Mode	4¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	500 Vdc
Cathode current	60 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction or convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.8 in.
Width	1.5 in.
Length	2.5 in.

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APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

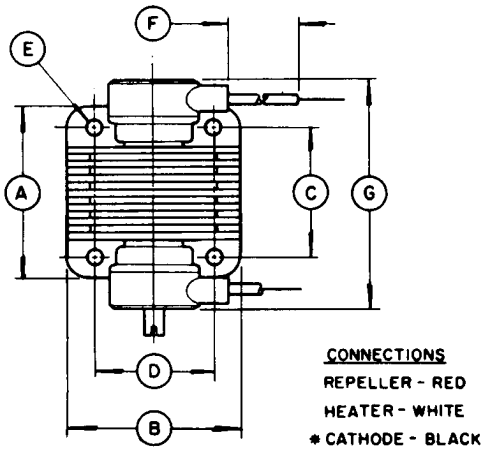
Resonator: The resonator of the X1117A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1117A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the X1117A a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

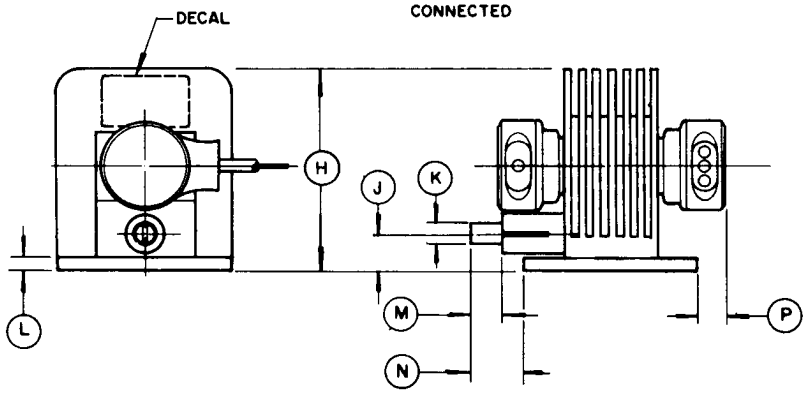
A clockwise rotation of the tuner will produce a decrease in frequency.



CONNECTIONS
REPELLER - RED
HEATER - WHITE
* CATHODE - BLACK
* HEATER - BLACK
*INTERNALLY CONNECTED

DIMENSIONS IN INCHES

DIMENSIONAL DATA *			
REF.	MIN.	MAX.	NOM.
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		1.958	
H		1.800	
J			.330
K	.160	.170	
L			.125
M	.100		
N		.735	
P		.250	



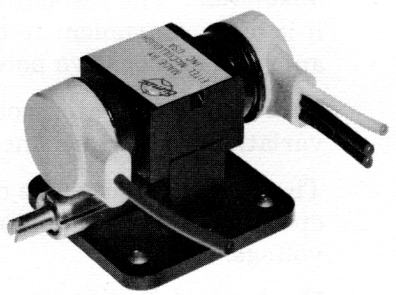
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1117B

X BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	11.2 to 11.7 Gc
Mechanically tunable	500 Mc
Power output	30 mW
Electronic tuning range (3 db bandwidth)	60 Mc
Resonator voltage	300 Vdc
Cathode current	25 mAdc
Repeller voltage	−100 Vdc
Modulation sensitivity	2.5 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.0 A max.
Mode	6¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	425 Vdc
Cathode current	45 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −400 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction or convection
Net weight	4½ oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.5 in.
Length	2.5 in.

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APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

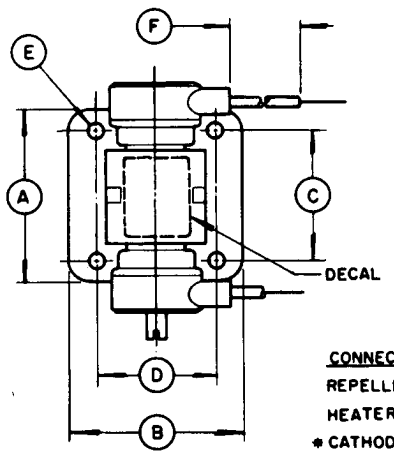
Resonator: The resonator of the X1117B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1117B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the X1117B a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

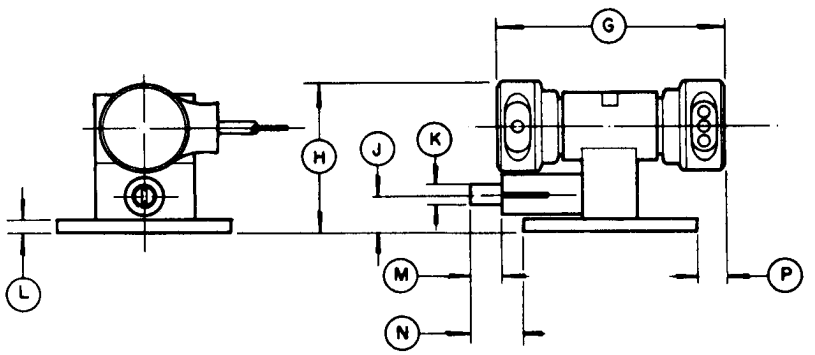


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		1.958	
H		1.400	
J			.330
K	.160	.170	
L			.125
M	.100		
N		.735	
P		.250	

CONNECTIONS
REPELLER - RED
HEATER - WHITE
* CATHODE - BLACK
* HEATER - BLACK

*INTERNALLY CONNECTED



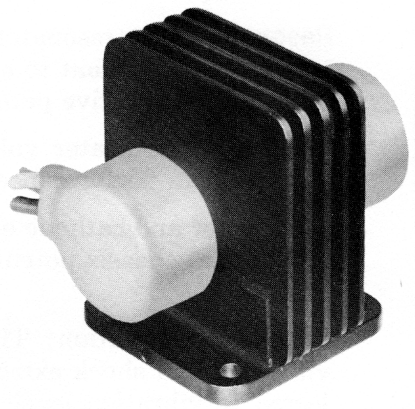
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1118

X BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	10.7 to 11.2 Gc
Mechanically tunable	500 Mc
Power output	1 W min.
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	750 Vdc
Cathode current	90 mA max.
Repeller voltage	−300 Vdc
Modulation sensitivity	1.5 Mc/V max.
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.3 A max.
Mode	3¾
VSWR of load	1.2:1 max.
Temperature coefficient	±100 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	900 Vdc
Cathode current	110 mA
Repeller voltage:	
Negative with respect to cathode	−50 to −1000 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction & convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.6 in.
Width	1.6 in.
Length	2.1 in.

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APPLICATION

NOTE: All voltages referred to cathode.

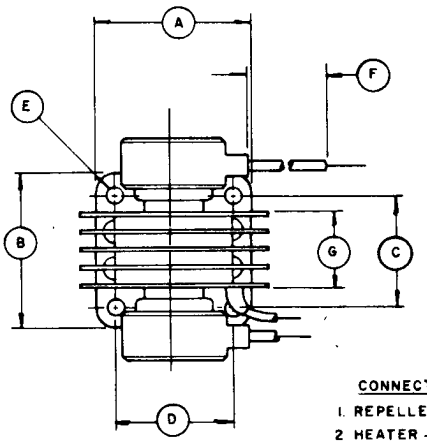
Cooling: The X1118 may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1118 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1118 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

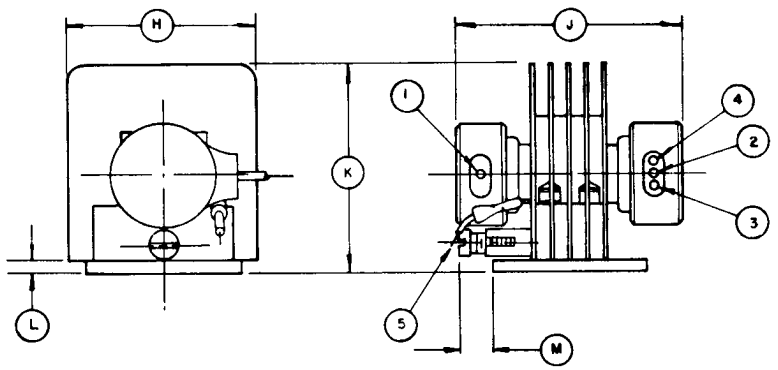
Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.



DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D	148D.	
F	12±1 TYP. LEAD LENGTH		
G			.650
H			1.600
J		2.100	
K		1.600	
L			.125
M		.532	

CONNECTIONS
1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



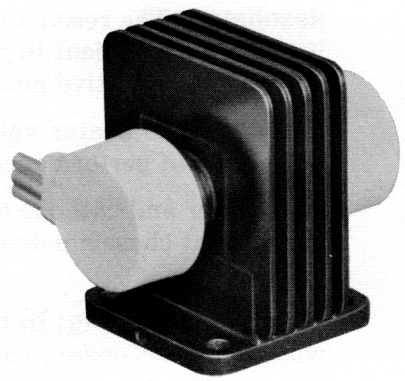
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1118A

X BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	10.7 to 11.2 Gc
Mechanically tunable	500 Mc
Power output	100 mW
Electronic tuning range (3 db bandwidth)	40 Mc
Resonator voltage	400 Vdc
Cathode current	40 mAdc
Repeller voltage	−150 Vdc
Modulation sensitivity	2.0 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.0 A max.
Mode	4¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	500 Vdc
Cathode current	60 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction or convection
Net weight	6 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps.
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.8 in.
Width	1.5 in.
Length	2.5 in.

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APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

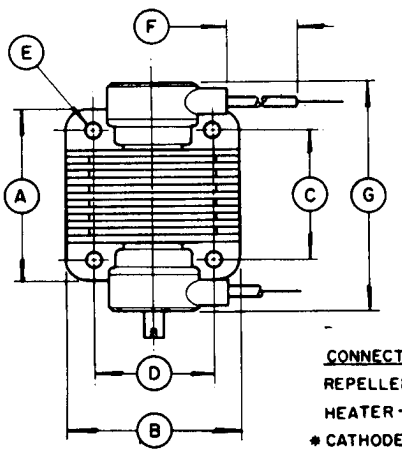
Resonator: The resonator of the X1118A is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1118A are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the X1118A a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

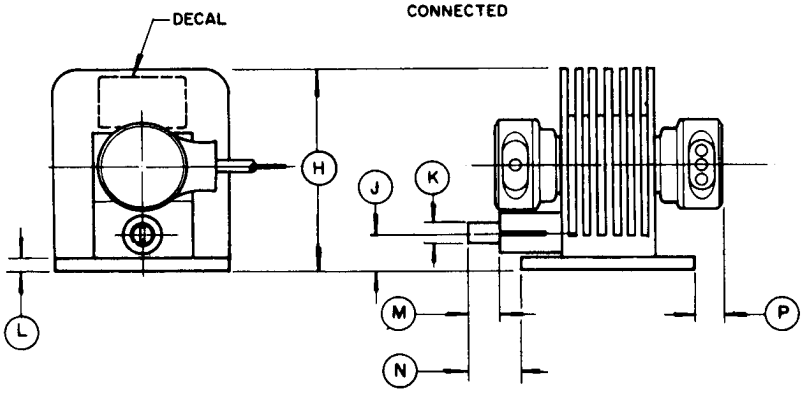
A clockwise rotation of the tuner will produce a decrease in frequency.



CONNECTIONS
REPELLER - RED
HEATER - WHITE
* CATHODE - BLACK
* HEATER - BLACK
*INTERNALLY CONNECTED

DIMENSIONS IN INCHES

DIMENSIONAL DATA *			
REF.	MIN.	MAX.	NOM.
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		1.958	
H		1.800	
J			.330
K	.160	.170	
L			.125
M	.100		
N		.735	
P		.250	



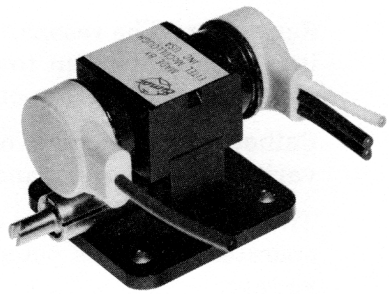
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1118B

X BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	10.7 to 11.2 Gc
Mechanically tunable	500 Mc
Power output	30 mW
Electronic tuning range (3 db bandwidth)	40 Mc min.
Resonator voltage	30 Vdc
Cathode current	25 mAdc
Repeller voltage	−100 Vdc
Modulation sensitivity	2.5 Mc/V
Heater voltage	6.3 V (ac or dc)±5%
Heater current	1.0 A max.
Mode	6¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	30 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	425 Vdc
Cathode current	45 mA
Repeller voltage:	
Negative with respect to cathode	−50 to −1000 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	WR-75 wave-guide flange
Cooling required	conduction & convection
Net weight	4½ oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40G, 11 mc

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.5 in.
Length	2.5 in.

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APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

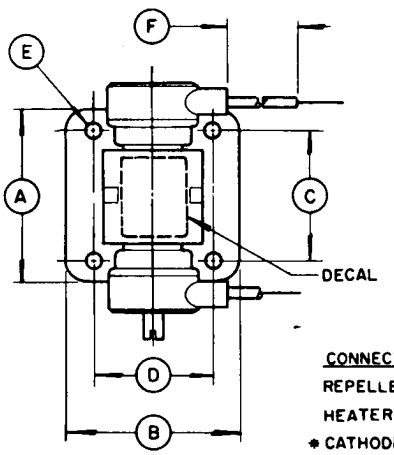
Resonator: The resonator of the X1118B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1118B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Mechanical Tuning: In the X1118B a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

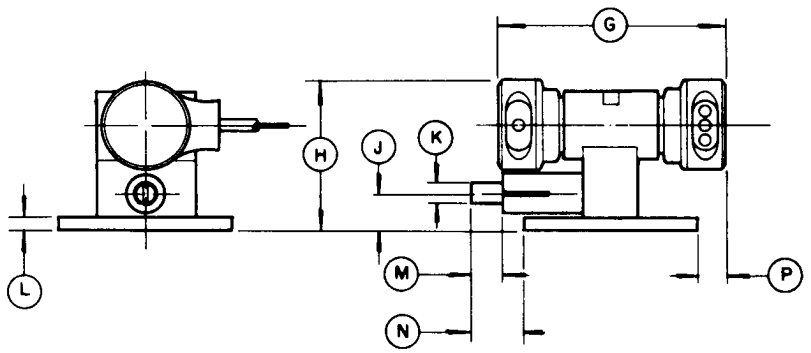
A clockwise rotation of the tuner will produce a decrease in frequency.



CONNECTIONS
REPELLER - RED
HEATER - WHITE
* CATHODE - BLACK
* HEATER - BLACK
*INTERNALLY CONNECTED

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.500
B			1.500
C	1.118	1.126	
D	1.036	1.044	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		1.958	
H		1.400	
J			.330
K	.160	.170	
L			.125
M	.100		
N		.735	
P		.250	

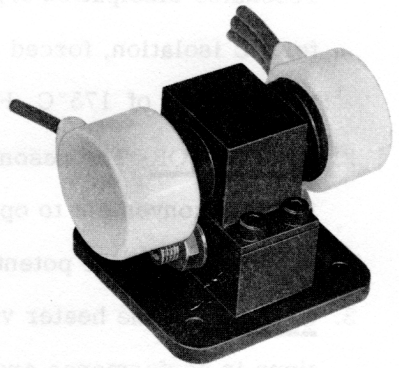


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

X-1120

REFLEX KLYSTRON
OPERATING-FREQUENCY
12.5 to 15Gc
TRIMMABLE ± 50 Mc
MINIMUM OUTPUT POWE
200 mW

TYPICAL PERFORMANCE



KU-BAND

ELECTRICAL

Frequency Range	12.5 to 15 Gc (preset)
Resonator Voltage[2]	400 V
Output Power	225 mW
Cathode Current	38 mAdc
Repeller Voltage	−300 v
3db Bandwidth	35 Mc
Modulation Sensitivity	0.7 Mc/V
Temperature Coefficient	±100 Kc/°C
Heater Voltage (AC)[3]	6.3 v
Heater Current (AC)	1.25 A
VSWR	1.2:1 max
Mode	3-3/4

MECHANICAL

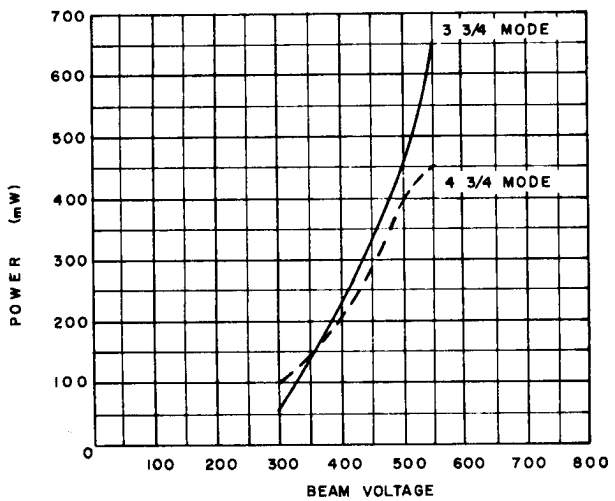
Operating Position	Any
Mounting	Waveguide Flange
RF Output Coupling	RG/91U Waveguide
Net Weight	6 ounces
Cooling[1]	(See note 1)

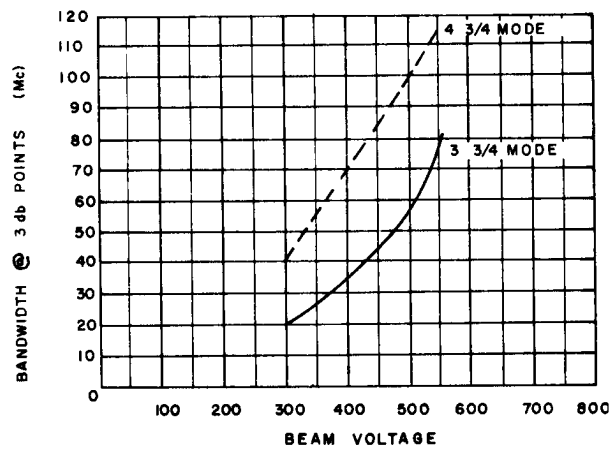
ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	NO LIMIT
Maximum Shock (11ms duration)[4]	40g
Maximum Operating Vibration[4] (20-2000cps)	10g

OUTLINE DIMENSIONS

Height	1.400 inches
Width	1.312 inches
Length	2.100 inches





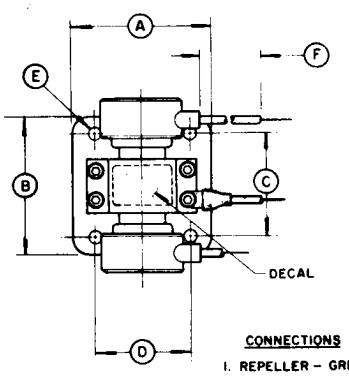
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APPLICATION NOTES

1. COOLING: At sea level this tube will not require forced air cooling when operated at less than 20 watts resonator dissipation and an ambient temperature of less than 150°C. The waveguide-flange connection will normally provide the required heat sink for conduction cooling. If the tube is operated at a resonator dissipation of greater than 20 watts or if an insulator is used between the tube and waveguide for DC isolation, forced air cooling will be required to maintain the body temperature below the maximum rating of 175°C. For maximum tube life, the operating temperature should be less than 100°C.
2. RESONATOR: The resonator of the X 1120 is integral with the body of the kylstron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.
3. CATHODE: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

   The heater and catholde of the X 1120 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.
4. SHOCK AND VIBRATION: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20 - 2000 cps) or shock of up to 40g (11 milliseconds duration).

   With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.



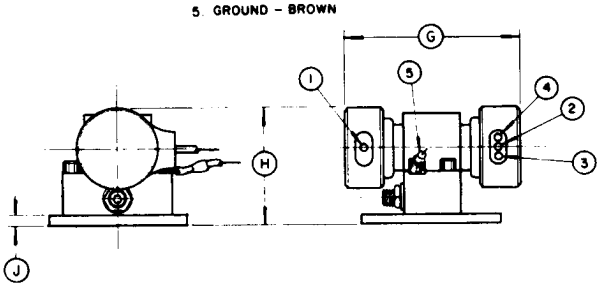
DIMENSIONS IN INCHES

DIMENSIONAL DATA

REF.	MIN.	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	.990	.998	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.100	
H		1.400	
J			.125

CONNECTIONS

1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN

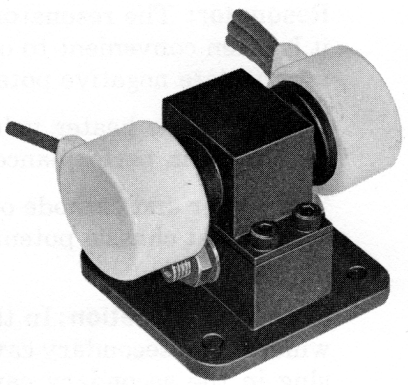


EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1123

KU BAND REFLEX KLYSTRON



TYPICAL PERFORMANCE

ELECTRICAL PERFORMANCE

Frequency setting	13.395 Gc
Mechanically trimmable	±50 Mc
Power output	20 mW
Electronic tuning range (3 db bandwidth)	30 Mc
Resonator voltage	300 Vdc
Cathode current	30 mAdc max.
Repeller voltage	−80 to −100 Vdc
Modulation sensitivity	3.0 Mc/V max.
Heater voltage	6.3 V (ac or dc)
Heater current	0.8 A max.
Mode	5¾
VSWR of load	1.2:1 max.
Temperature coefficient	0 to −200 Kc/°C
Warm-up time	20 sec
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	500 Vdc
Cathode current	55 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	RG-91/U waveguide flange
Cooling required	conduction
Net weight	5 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−55 to +125 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40G, 11 ms

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.3 in.
Length	2.1 in.

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APPLICATION

NOTE: All voltages referred to cathode.

Cooling: At sea level this tube will not require forced air cooling when operated at its maximum rated dissipation with an ambient temperature less than 125° Centigrade. The waveguide flange connection will normally provide the required heat sink for conduction cooling. If an insulator is used between the tube and waveguide for DC isolation, forced air cooling may be required to maintain the ceramic-to-metal seal temperatures below the maximum rating of 150° Centigrade.

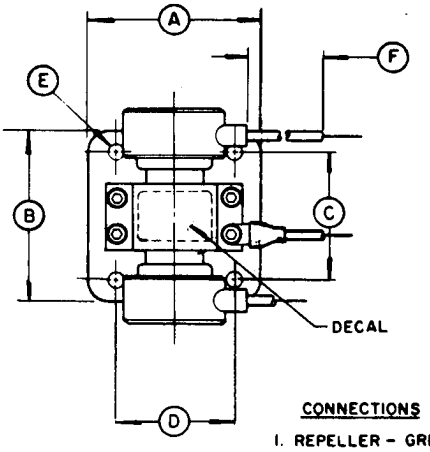
Resonator: The resonator of the X1123 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained within ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and the best tube life obtained.

The heater and cathode of the X1123 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Shock and Vibration: In the X1123 a fixed-tuned inner cavity is closely coupled through a ceramic window to a secondary cavity outside the vacuum. Mechanical tuning is accomplished by a capacitive slug in the secondary cavity with a tuning rate of approximately 150 megacycles per turn. This design allows repeated tuner cycling without damaging the vacuum seals. The maximum tuner torque is 40 inch-ounces.

A clockwise rotation of the tuner will produce a decrease in frequency.

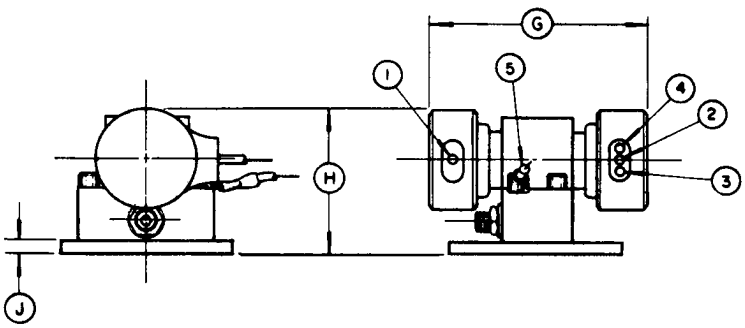


DIMENSIONS IN INCHES

	DIMENSIONAL DATA		
REF.	MIN.	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	.990	.998	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.100	
H		1.400	
J			.125

CONNECTIONS

1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



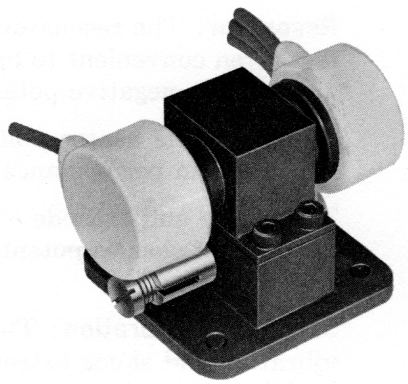
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1126

KU BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	16.0 to 17.0 Gc
Mechanically tunable	1000 Mc
Power output	20 mW
Electronic tuning range (3 db bandwidth)	50 Mc
Resonator voltage	300 Vdc
Cathode current	30 mAdc max.
Repeller voltage	−80 to −100 Vdc
Modulation sensitivity	5.0 Mc/V max.
Heater voltage 6.3 V [redacted]	(ac or dc) ±5%
Heater current	1.3 A max.
Mode	6¾
VSWR of load	1.2:1 max.
Temperature coefficient	±150 Kc/°C
Warm-up time	20 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	500 Vdc
Cathode current	55 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	RG-91/U wave-guide flange
Cooling required	conduction
Net weight	5 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−50 to +100 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40 G, 11 ms

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.3 in.
Length	2.1 in.

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APPLICATION

NOTE: All voltages referred to cathode.

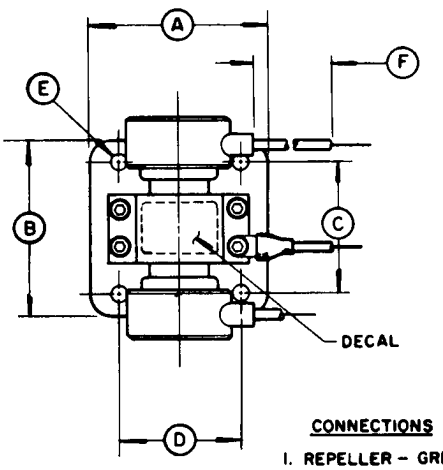
Cooling: The X1126 may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1126 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1126 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.

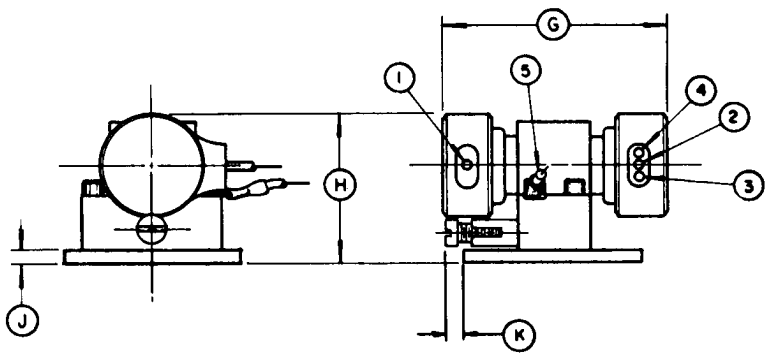


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	.990	.998	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.700	
H		1.400	
J			.125
K		.437	

CONNECTIONS

1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



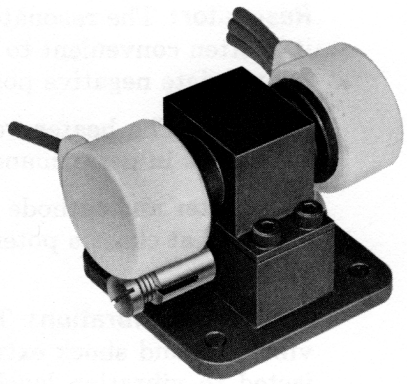
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

TENTATIVE DATA

X1126B

KU BAND
REFLEX KLYSTRON

TYPICAL PERFORMANCE



ELECTRICAL PERFORMANCE

Frequency range	16.5 to 17.2 Gc
Mechanically tunable	700 Mc
Power output	20 mW
Electronic tuning range (3 db bandwidth)	40 Mc
Resonator voltage	300 Vdc
Cathode current	30 mAdc max.
Repeller voltage	−40 to −150 Vdc
Modulation sensitivity	1.3 to 3.5 Mc/V
Heater voltage	6.3 V (ac or dc) ±5%
Heater current	1.3 A max.
Mode	5¾
VSWR of load	1.2:1 max.
Temperature coefficient	−200 to −400 Kc/°C
Warm-up time	20 sec.
[redacted]	[redacted]

MAXIMUM RATINGS

Resonator voltage	500 Vdc
Cathode current	55 mA
Repeller voltage:	
Negative with respect to cathode	−25 to −500 Vdc

NOTE: Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating position	any
Electrical connections	flexible leads
RF output coupling	RG-91/U wave-guide flange
Cooling required	conduction
Net weight	5 oz.
Shipping weight (approximate)	4 lbs.

ENVIRONMENTAL PERFORMANCE

Temperature range	−55 to +120 °C
Altitude	100,000 ft. max.
Vibration	10G, 20 to 2000 cps
Shock	40 G, 11 ms

OUTLINE DIMENSIONS

Height	1.4 in.
Width	1.3 in.
Length	2.1 in.

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APPLICATION

NOTE: All voltages referred to cathode.

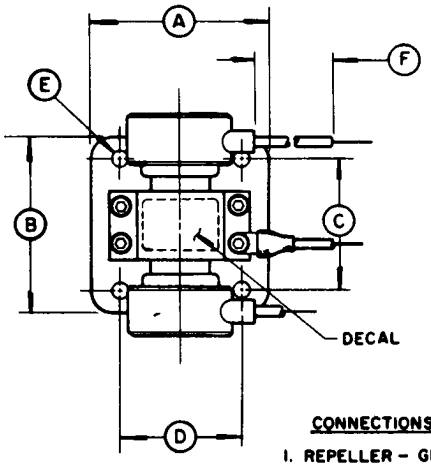
Cooling: The X1126B may be cooled by conduction if the connecting waveguide flange provides an adequate heat-sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade. Normal operating conditions will require convection cooling to maintain desired body temperatures.

Resonator: The resonator of the X1126B is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

Cathode: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

The heater and cathode of the X1126B are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

Shock and Vibration: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20–2000 cps) or shock of up to 40g (11 milliseconds duration.) With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.

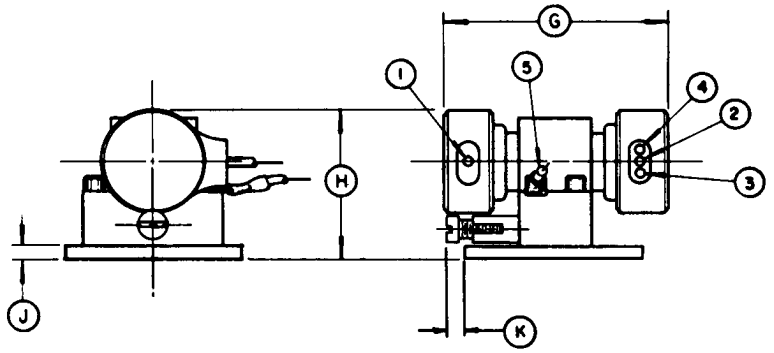


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	.990	.998	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.700	
H		1.400	
J			.125
K		.437	

CONNECTIONS

1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

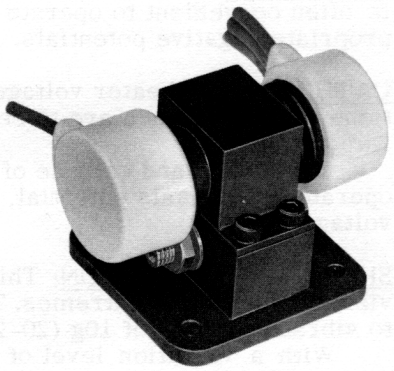
X-1130

REFLEX KLYSTRON

OPERATING FREQUENCY
15-18 Gc
TRIMMABLE ±50 Mc

MINIMUM OUTPUT POWER
200 mW

TYPICAL PERFORMANCE



KU-BAND

ELECTRICAL

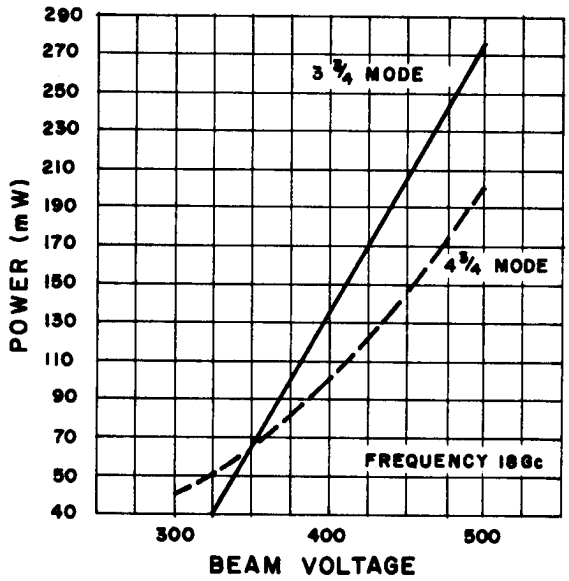
Frequency Range 15.0 to 18 Gc (preset)	
Resonator Voltage[2]	500 V
Output Power	250 mW
Cathode Current	52 mAdc
Repeller Voltage	-300 V
3db Bandwidth	35 Mc
Modulation Sensitivity	0.7 Mc/V
Temperature Coefficient	±150 Kc/°C
Heater Voltage (AC)[3]	6.3 V
Heater Current(AC)	1.25 A
VSWR	1.2:1 max
Mode	3-3/4

MECHANICAL

Operating Position	Any
Mounting	Waveguide Flange
RF Output Coupling	RG-91/U waveguide
Net Weight	6 ounces
Cooling[1]	(See note 1)

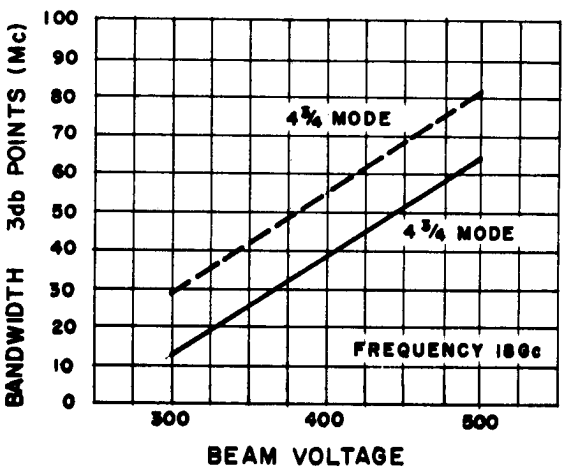
ENVIRONMENTAL

Maximum Ambient Temperature	150° C
Maximum Altitude	NO LIMIT
Maximum Shock (Hms duration)[4]	40 g
Maximu Operating Vibration (20-2000cps)[4]	10 g



OUTLINE DIMENSION

Height	1.40 inches
Width	1.312 inches
Length	2.100 inches



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APPLICATION NOTES

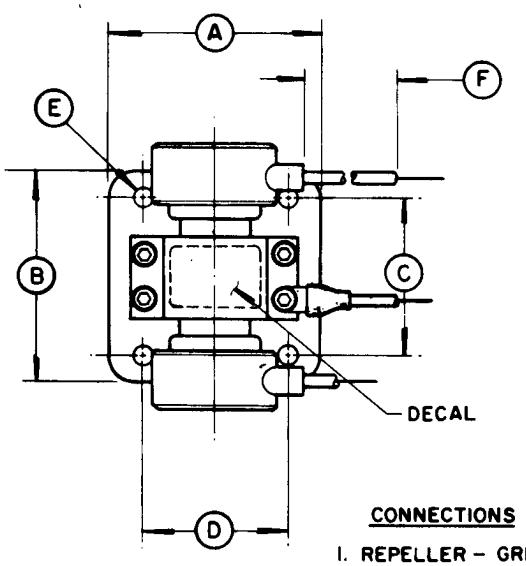
1. COOLING: The X 1130 may be cooled by conduction if the connecting waveguide flange provides an adequate heat sink to maintain the tube body temperature below the maximum rating of 150° Centigrade. At high ambient temperatures, forced air cooling may be required to operate within this rating. For maximum tube life, the tube body temperature should be less than 100° Centigrade.

2. RESONATOR: The resonator of the X 1130 is integral with the body of the klystron. For this reason it is often convenient to operate the resonator at chassis potential, with the repeller and cathode at appropriate negative potentials.

3. CATHODE: The heater voltage should be maintained with ±5% of the rated value of 6.3 volts if variations in performance are to be minimized and best tube life obtained.

   The heater and cathode of the X 1130 are internally connected. When the resonator of this tube is operated at chassis potential, the heater transformer must be insulated for the cathode-to-resonator voltage.

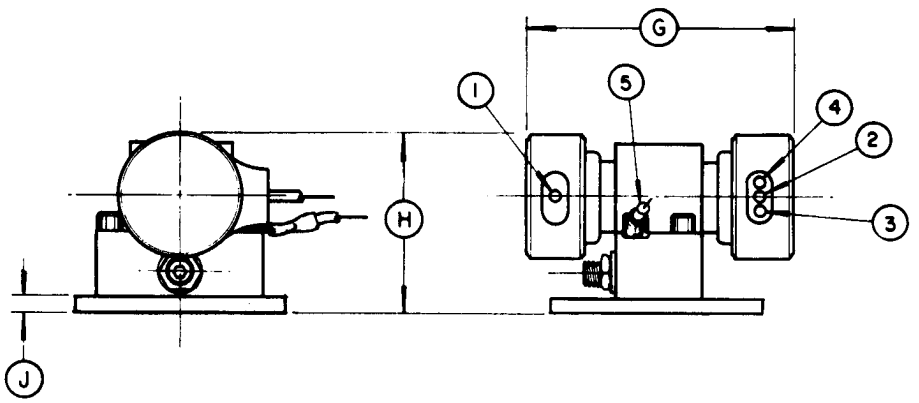
4. SHOCK AND VIBRATION: This klystron is specifically designed for use in applications encountering vibration and shock extremes. This tube is capable of delivering its rated power output when subjected to vibration levels of 10g (20-2000 cps) or shock of up to 40g (11 milliseconds duration).
   With a vibration level of 10g in any reference plane, the peak-to-peak FM deviation will be less than 100 kilocycles.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.312
B			1.312
C	.952	.960	
D	.990	.998	
E	.143 D.	.148 D.	
F	12±1 TYP LEAD LENGTH		
G		2.100	
H		1.400	
J			.125

CONNECTIONS

1. REPELLER - GREY
2. HEATER - YELLOW
3. CATHODE - GREEN
4. HEATER CATHODE - WHITE
5. GROUND - BROWN



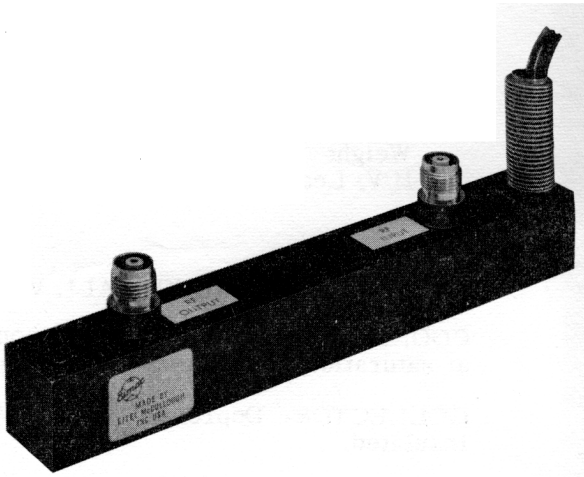
EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

X1131

TRAVELING WAVE TUBE
7.0 - 8.0 Gc
3.0 WATTS
36 db GAIN

TENTATIVE DATA SHEET TRAVELING WAVE TUBE X1131

The X1131 is a highly reliable light weight miniaturized Traveling Wave Tube Amplifier designed for long life in space applications. The tube is of metal-ceramic construction utilizing periodic permanent magnets as the focusing array. From 7.0 to 8.0 Gc, 2.5 Watts of rf power at 36 db gain is provided. Electronic efficiency with collector depression is typically 33%.



ELECTRICAL SPECIFICATIONS:

Absolute Ratings	Maximum	Minimum
Filament Voltage	10	- volts
Filament Current	0.30	- Ampere
Helix Voltage	1600	1200 Vdc
Body and Helix Current	1.0	- mAdc
Collector Voltage	1600	550 Vdc
Collector Current	16	- mAdc
Focus Electrode Voltage	—100	- Vdc
Focus Electrode Current	1.0	- mAdc
Anode Voltage	1800	1650 Vdc
Anode Current	0.2	- mAdc
Duty Cycle	100	- %
Beam Power Input	25	- W
Input Power, rf	100	- mW
Power Reflected From Load	3.0	- W
Temperature, Body	+100	-60° C
Temperature, Collector	+200	-60° C
Ambient Temperature	+100	-50° C
Cathode Warm-Up	-	120 Seconds

Operating and Performance Data	
Filament Voltage	6.3 Volts
Filament Current	0.20 A
Helix Voltage	1450 Vdc
Body and Helix Current	0.50 mAdc
Collector Voltage	575 Vdc
Collector Current	14.5 mAdc
Focus Electrode Voltage	0 Vdc
Focus Electrode Current	0 mAdc
Anode Voltage	1550 Vdc
Anode Current	0.2 mAdc
Duty Cycle	100 %
Frequency Range	7.0-8.0 Gc
Small Signal Gain-Minimum	40 db
-Typical	43 db
Saturated Power Out-Minimum	2.5 W
-Typical	3.0 W
Saturated Gain-Minimum	36 db
-Typical	38 db
Output VSWR (Cold)	1.5:1
Input VSWR (Cold)	1.5:1
Input and Output Impedance	50 ohms
Noise Figure, Typical	28 db

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ENVIRONMENTAL SPECIFICATIONS:

Applicable military specifications: MIL-E- 5400
MIL-E- 5272

Vibration - - - - - -	20 g's at 5000 cps
Shock - - - - - - -	100 g's
Acceleration - - - - -	20 g's
Temperature - - - - -	−50° C to +100° C

Altitude--Any, when used in conjunction with hermetically sealed capsule

MECHANICAL SPECIFICATIONS:

Operating Position -	Any
Input Coupling, rf - -	TNC
Output Coupling, rf -	TNC
Focusing - - - - -	PPM, magnetically shielded
Cooling - - - - - -	Heat Sink conduction
Dimensions - - -	See outline drawing
Weight - - - - - -	9 ounces, encapsulated
H.V. Leads - - - -	Flying

APPLICATION NOTES

VOLTAGES REFERENCE: ALL VOLTAGES ARE WITH RESPECT TO CATHODE.

COOLING: Tube is cooled by conduction through base. With depressed collector and rf output at saturation, 6.0 watts are dissipated.

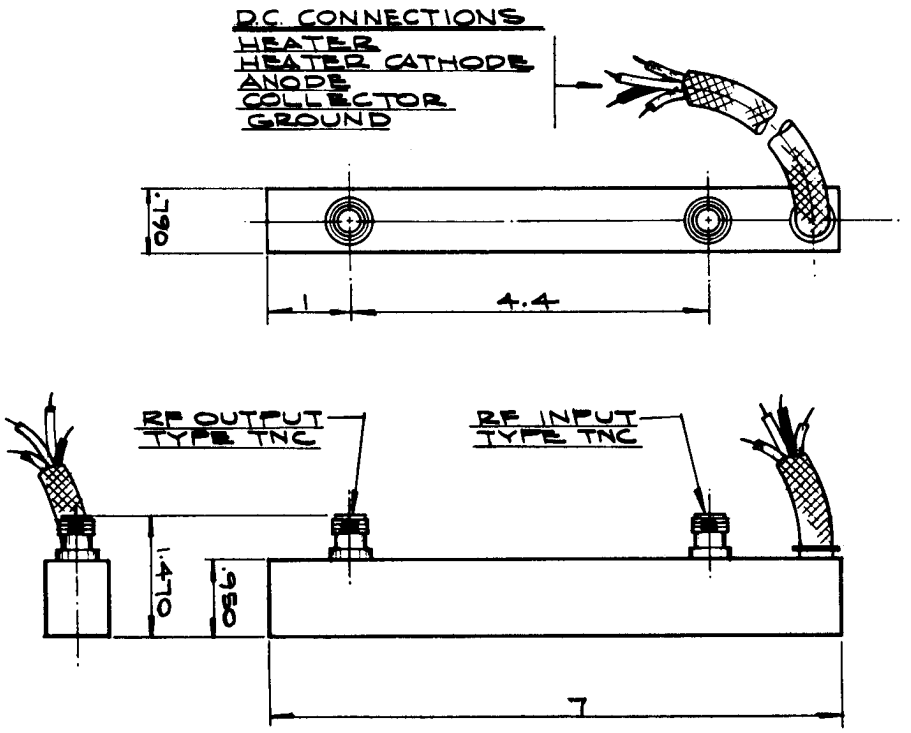
COLLECTOR: Depressed up to 65% for full rf output. Collector is completely encapsulated and insulated.

HELIX: Grounded. Can be supplied floating for modulation capability.

FOCUS ELECTRODE: Used to gate off the tube in certain applications.

MISSION: This is a high reliability tube with a design "wearout" of 100,000 hours. Reliability coupled with high efficiency and light weight makes this tube ideal for long mission space applications.

DATA SHOULD NOT BE USED FOR FINAL EQUIPMENT DESIGN



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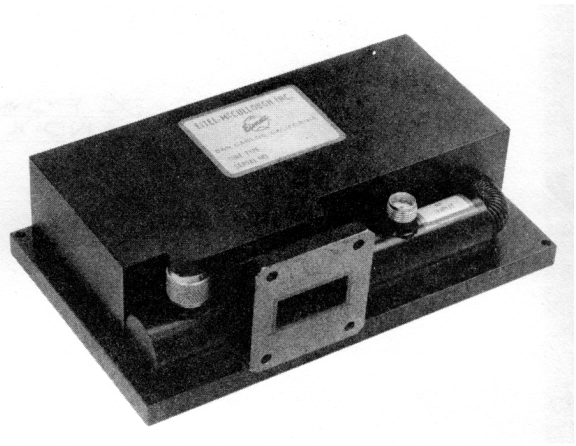
X1132

TRAVELING WAVE TUBE - POWER SUPPLY PACKAGE

7.0 - 8.0 Gc
3.0 WATTS
36 db GAIN

TENTATIVE DATA SHEET
TRAVELING WAVE TUBE AMPLIFIER POWER SUPPLY PACKAGE X1132

The X1132 is a long life, highly reliable amplifier package consisting of a PPM focused ceramic-metal TWT amplifier (X1131) and integral solid state power supply designed for space applications. Over the frequency range of 7.0 to 8.0 Gc, 2.5 Watts of rf power are produced at a saturated gain of 36 db.



ELECTRICAL SPECIFICATIONS:

Absolute Ratings	Maximum	Minimum
Power Supply Voltage	40	20 V
Power Supply Power	16	- W
Duty Cycle	100	- %
Input Power, rf	100	0 mw
Power Reflected From Load	3.0	- W
Temperature, Collector	+150	- 40° C
Ambient Temperature	+80	- 40° C
Altitude	Any	
Operating and Performance Data		
Power Supply Voltage	28	V
Power Supply Current	0.48	A
Duty Cycle	100	%
Frequency Range	7.0-8.0	Gc
Small Signal Gain-Minimum	40	db
-Typical	43	db
Saturated Power-Minimum	2.5	W
-Typical	3.0	W
Saturated Gain-Minimum	36	db
-Typical	38	db
Output VSWR (Cold)	1.5:1	
Input VSWR (Cold)	1.5:1	
Input and Output Impedance	50	ohms
Noise Figure-Maximum	30	db
-Typical	28	db

ENVIRONMENTAL SPECIFICATIONS:

Vibration	20 g's to 2000 cps
Shock	100 g's
Acceleration	20 g's, sustained
Temperature	−20° C to +50° C
Altitude	Any

MECHANICAL SPECIFICATIONS:

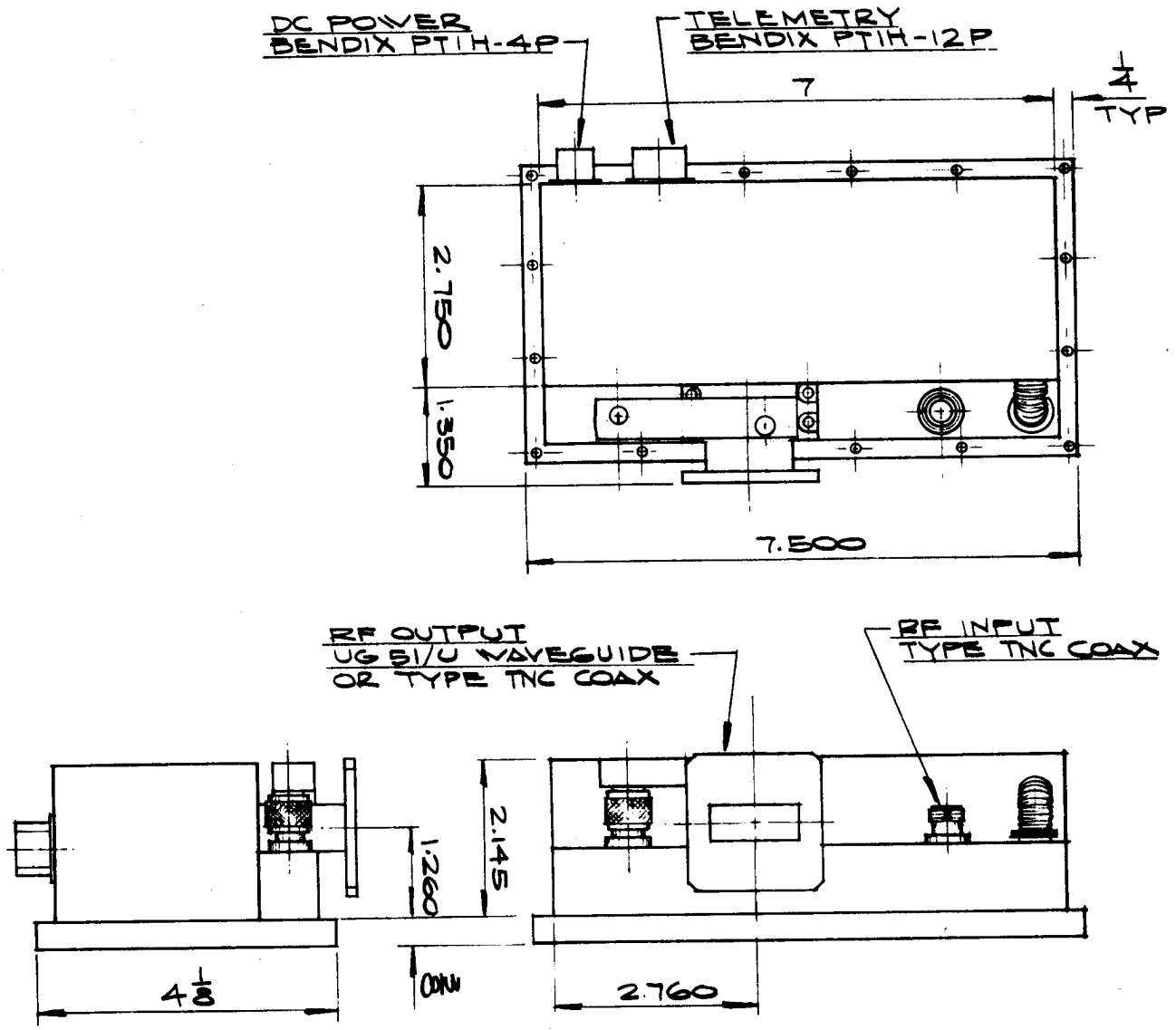
Operating Position	Any
Input Coupling, rf	TNC Coax Fitting
Output Coupling, rf	TNC Coax or UG 51/U Waveguide
Focusing	PPM, shielded
Cooling	Conduction through heat sink
Dimensions	See outline drawing
Weight	4.0 lbs
Power Supply Connections	Bendix PTIH - 3P

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APPLICATION NOTES:

1. Full rf performance will be obtained for input voltages between 24 and 30 volts dc.
2. Six telemetry outputs are available for monitoring of TWTA performance.
3. DC operation may be programmed by use of 20 V control signal (draws 10 mW).
4. Especially useful in long unattended mission applications, MTTFF 50,000 hours, rated.
5. Magnetic shield minimizes interference with sensitive components, permits dense packing. Two units may be mounted and operated as close as mechanical outline permits.

DATA SHOULD NOT BE USED FOR FINAL EQUIPMENT DESIGN



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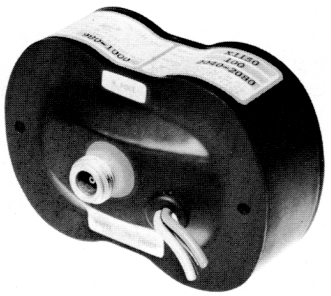
X-1150

VOLTAGE TUNABLE MAGNETRON

FREQUENCY 980 - Mc 1020

MINIMUM OUTPUT POWER 40 W

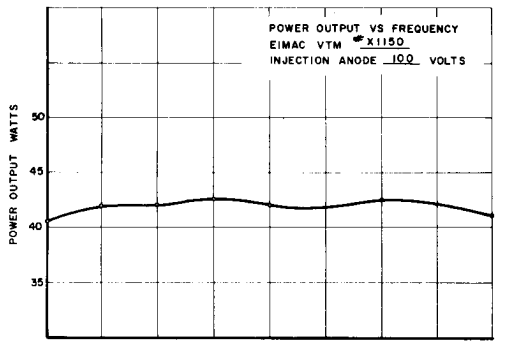
TYPICAL PERFORMANCE



L-BAND OSCILLATOR

ELECTRICAL

Frequency Range	980 Mc 1020
Anode Voltage	2040 V 2120
Cathode Current	45-50 mA
Typical Output Power	45 W
Anode FM Sensitivity	.45 Mc/V
Injection Anode Voltage	200 V
Injection Anode Current	0.0 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw



FREQUENCY MC	980	985	990	995	1000	1010	1020
ANODE VOLTAGE	2040	2047	2058	2064	2080	2100	2120
ANODE CURRENT MA	45	47	46	47	49	51	52

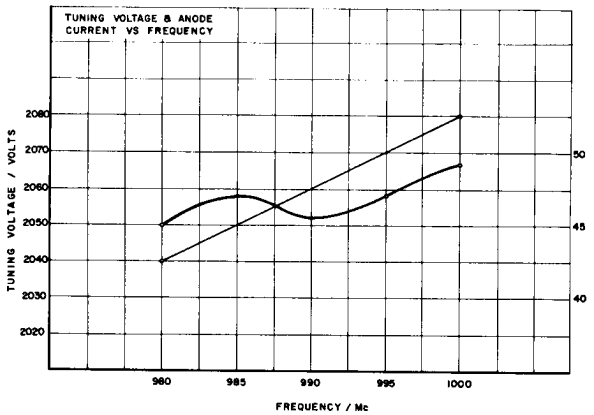
*MAXIMUM RATINGS

Anode Voltage	2500 V
Cathode Current	60 mA
Injection Anode Voltage	500 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.

MECHANICAL

Operating Position	Any
Cooling	Forced Air
Electrical Connection	Flexible Leads
RF Output Coupling	Type N Jack
Weight	3.5 Pounds



ENVIRONMENTAL

Vibration	10G (to 2kc)
Shock	100G (11ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	35 inches
Width	2.5 inches
Length	4.5 inches

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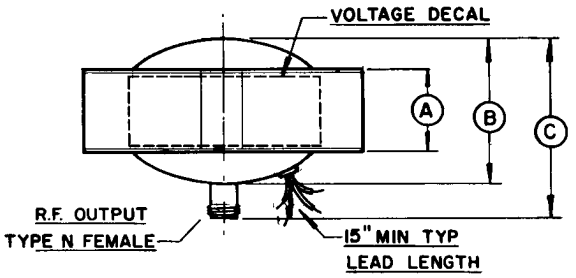
APPLICATION NOTES

1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70° C.

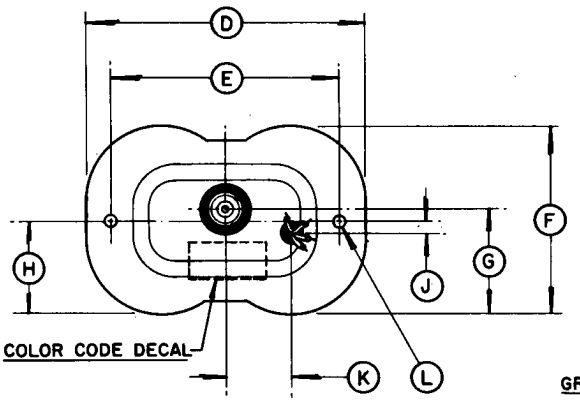
2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the X-1150 has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. The temperature/frequency coefficient for the X-1150 package is typically .02% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 1000 megacycles, the temperature/frequency coefficient is typically 200 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.



DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			1.375
B			2.300
C			2.910
D		4.600	
E	3.640	3.671	
F		3.100	3.000
G			1.656
H			1.500
J			.375
K			1.000
L			.187 D.



CONNECTIONS
GROUND - GREEN
HEATER - WHITE
HEATER CATHODE - BLACK
INJECTION ANODE - YELLOW

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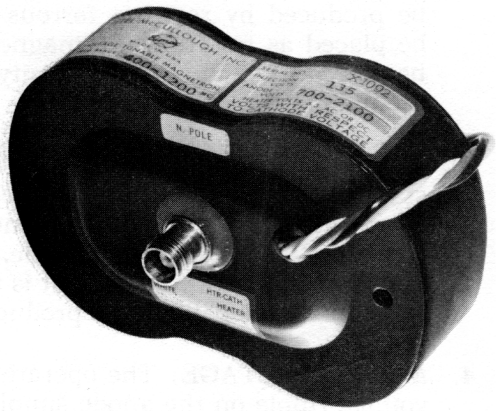
X-1153-C

LOW NOISE VOLTAGE TUNABLE MAGNETRON

Frequency 0.6 - 1.2 Gc

Minimum Output Power 20 mW

TYPICAL PERFORMANCE



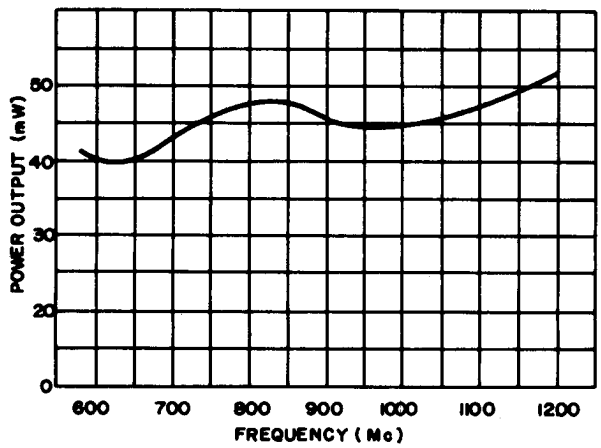
ELECTRICAL

Frequency Range	0.6-1.2 Gc
Anode Voltage	1000-2000 V
Cathode Current	2-4 mA
Typical Output Power	30-50 mW
Anode FM Sensitivity	.66 Mc/V
Injection Anode Voltage	100 V
Injection Anode Current	0.02 mA
Heater Voltage (AC)	6.3 V
Heater Current (AC)	0.8 A
Load Impedance	50 ohms
Service	cw
Noise	—85 db (See Note 5)
VSWR (max)	2:1

*MAXIMUM RATINGS

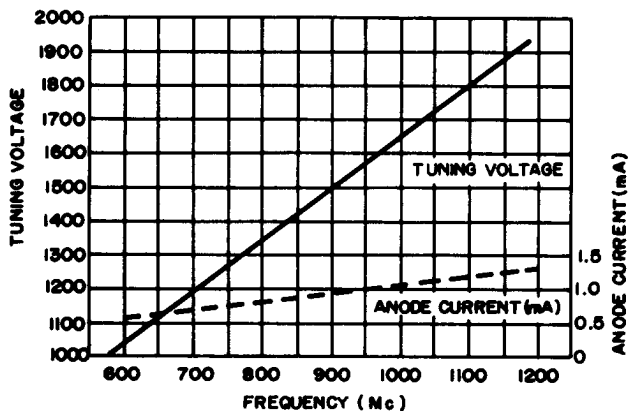
Anode Voltage	2300 V
Cathode	10 mA
Injection Anode Voltage	+300 V
Injection Anode Current	1 mA

*Damage to the tube may occur if maximum ratings are exceeded.



MECHANICAL

Operating Position	Any
Cooling	Conduction
Electrical Connection	Flexible Leads
RF Output Coupling	Type TNC Jack (See Outline Drawing)
Weight	3.5 Pounds



ENVIRONMENTAL

Vibration	10G-(to 2 kc)
Shock	100G-(11 ms)
Altitude	70,000 ft.

OUTLINE DIMENSIONS

Height	3.1 inches
Width	2.5 inches
Length	4.6 inches

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APPLICATION NOTES

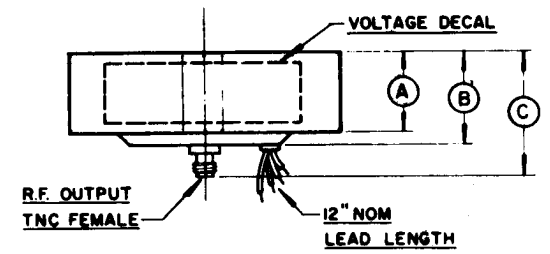
1. COOLING: To insure optimum tube performance the magnet temperature should be maintained below 70°C.

2. PROXIMITY OF FERROUS MATERIALS: To minimize variations in performance, ferrous materials should be kept at least 6 inches from the magnetron package. Modulation of the tube may be produced by rotating ferrous materials and such parts as fans, shafts and couplings should be placed as far from the magnetron package as possible. Transformers and chokes should not be placed in such close proximity to the tube that their stray magnetic fields will interfere with the magnetron operation.

3. TEMPERATURE STABILITY: The permanent magnet for the X-1153-C has been temperature stabilized to minimize frequency changes caused by variations in the ambient temperature. This temperature/frequency coefficient for the X-1153-C package is typically .008% of the operating frequency per degree Centigrade. Thus, for an operating frequency of 700 megacycles, the temperature/frequency coefficient is typically 56 kilocycles per degree Centigrade. A positive change in temperature will always produce a positive change in frequency.

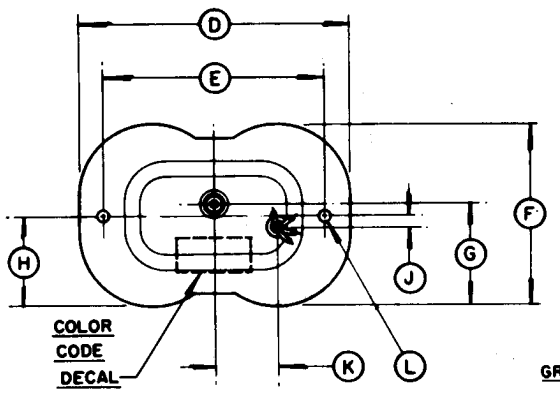
4. ANODE VOLTAGE: The operating frequency is a function of the anode voltage; therefore, any voltage ripple on the anode supply will appear as frequency modulation on the RF output signal.

5. NOISE: Noise power, in db below carrier, is measured using a 60 Mc I_f which has a bandpass of 2 Mc. Both sidebands are included in the measurement. (This measuring technique is one of many methods available. Other methods will be entertained.)



DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF	MIN.	MAX.	NOM.
A			1.375
B			1.562
C			2.312
D		4.515	
E	3.640	3.671	
F		3.031	
G			1.656
H			1.500
J			.375
K			1.062
L			.187 D.



CONNECTIONS

GROUND - GREEN

HEATER - WHITE

HEATER CATHODE - BLACK

INJECTION ANODE - YELLOW

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

PRELIMINARY DATA*

X2013-B

The Eimac X2013-B is a quick filament heating, metal-ceramic tetrode intended for use in portable and mobile transmitters. Power output 3 db down from normal is available within one second after the application of rated filament voltage. Tube operation in 100 milliseconds can be obtained utilizing a built-in control diode and a minimum amount of additional circuitry.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode:	Directly heated, oxide coated		
	Voltage	2.5	volts
	Current	8.0	amperes
	Absolute maximum filament voltage for fast warm-up (Note 1)	15	volts
	Heating time at rated filament voltage	1.0	second
	Heating time at 15 volts	0.1	second
Amplification Factor (grid-screen)		13	
Transconductance (I_b = 150 mA; E_c2 = 400 V; E_b = 800 V)		15,000	μmhos
Frequency for maximum ratings		250	mcs
Interelectrode capacitance (grounded cathode):			
	Input (maximum)	28.0	μμf
	Output (maximum)	6.0	μμf
	Feed-through (maximum)	0.07	μμf
Control Diode:			
	Maximum plate resistance (I_d = .010 A)	1,200	ohms

*This information applies to a laboratory tube design and is subject to change. No obligations are assumed as to future manufacture unless otherwise arranged.

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MECHANICAL

Base	9	Pin, special
Maximum operating temperatures:		
Anode core	250° C	
Ceramic-to-metal seals	250° C	
Socket		Eimac, X-4011
Operating position		Any

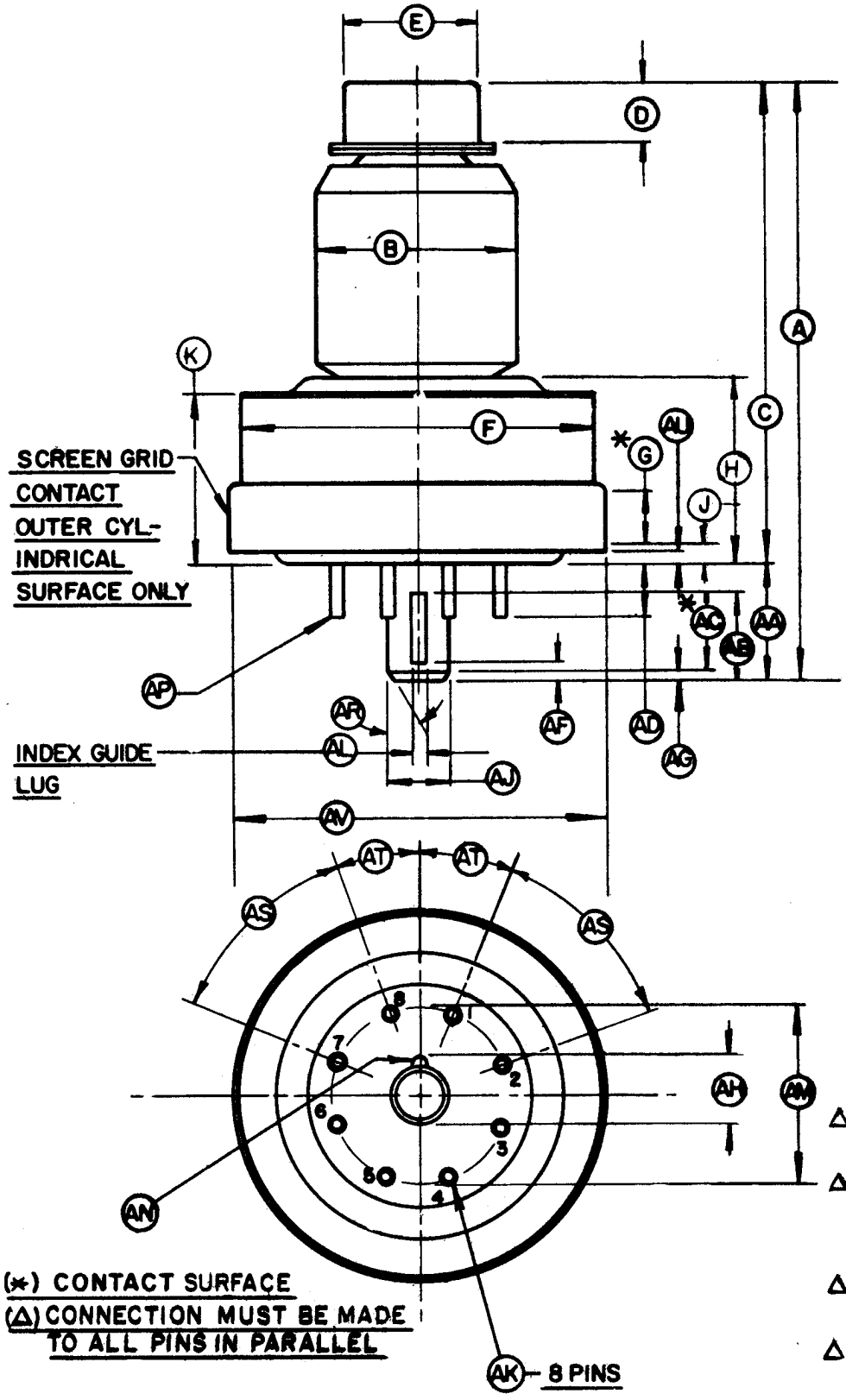
MAXIMUM RATINGS

DC Anode Voltage	2000	Max. volts
DC Screen Voltage	400	Max. volts
DC Grid Voltage	-250	Max. volts
DC Control Diode Voltage	±250	Max. volts
DC Anode Current	250	Max. mA
DC Control Diode Current	20	Max. mA
Anode Dissipation (radiation cooled)*	15	Max. watts
Screen Dissipation	8	Max. watts
Control Diode Anode Dissipation	0.5	Max. watts
Grid Current	2	Max. mA

*Also available with forced air cooled anode rated at 350 watts maximum dissipation.

Note 1: Extreme caution must be taken to insure that filament overvoltage is not applied beyond the time at which the cathode reaches operating temperature since the voltage used is sufficient to destroy the tube. Proper operation will be insured if overvoltage is removed when control diode anode current reaches 65% of its steady state operating value.

It is recommended that Application Engineering Department, Eitel-McCullough, Inc., San Carlos, California, be contacted for additional details and circuit approval prior to using the X2013-B in applications requiring the use of filament overvoltages.



(*) CONTACT SURFACE

(△) CONNECTION MUST BE MADE TO ALL PINS IN PARALLEL

DIMENSIONS IN INCHES			
DIMENSIONAL DATA			
REF	MIN	MAX	NOM
A	2.324	2.464	
B	.880	.894	
C	1.810	1.910	
D	.240	.280	
E	.559 DIA	.573 DIA	
F		1.406 DIA	
G	.187		
AA	.514	.554	
AB		.456	
AC	.360		
AD		.250	
AF	.068	.108	
AG			.031
AH	.298	.308	
AJ	.255 DIA	.265 DIA	
AK	.045 DIA	.053 DIA	
AL	.078	.086	
AM	.680 DIA	.694 DIA	
AN		.043 R	
AP	.005 R. MIN. OR		
	.035 X 22.5°		
AR			30°
AS	44.0	46.0	45°
AT	21.5	23.5	22.5°
AU	.020	.050	
AV	1.417 DIA	1.433 DIA	
H	.700	.760	
J	.050	.090	
K	.600	.660	

CONNECTIONS

PIN NO. 1: SCREEN GRID

△ PIN NO. 2: CATHODE-HEATER 1

PIN NO. 3: CONTROL GRID

△ PIN NO. 4: CATHODE-HEATER 1

PIN NO. 5: ANODE OF CONTROL DIODE

△ PIN NO. 6: CATHODE-HEATER 1

PIN NO. 7: CONTROL GRID

△ PIN NO. 8: CATHODE-HEATER 1

CENTER PIN: HEATER 2

OUTLINE

X2013

VARIAN associates

EIMAC DIVISION

QUICK HEAT TETRODE

NEW PRODUCT BULLETIN

X2099

OBJECTIVE DATA

The EIMAC X-2099 is a compact, quick heat tetrode designed for push-to-talk mobile and airborne applications. The tube warms up to 70% peak current or 50% RF power output in 250 milliseconds. The X-2099 can be driven by low-level solid state up to its rated plate dissipation of 500 watts. The tube is air cooled, ceramic-metal construction.

The data supplied in this sheet is for guidance only. Before establishing final design specifications contact Product Manager, Power Grid Division, EIMAC Division of Varian.



GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Oxide Coated, Uni-Potential

Heating Time, nominal (see curves)	250 ms

Heater:

Voltage, nominal (see curves)	2.5 V
Current, nominal (Inrush current approximately twice operating current)	10.5 A

Direct Interelectrode Capacitances, grounded cathode

Input	56.0 pF
Output	6.1 pF
Feedback	0.14 pF

Direct Interelectrode Capacitances, grounded grid

Input	33.0 pF
Output	6.2 pF
Feedback	0.02 pF

MECHANICAL

Base	Special 9-pin

Maximum Operating Temperatures:

Ceramic-to-Metal Seals	250°C
Anode Core	250°C

Nominal Dimensions:

Height	3.50 in.
Seated Height	3.00 in.
Diameter	2.65 in.

Cooling	Forced Air
Net Weight	8 ozs.

(Advance information for engineering purposes only)

OPERATING CHARACTERISTICS

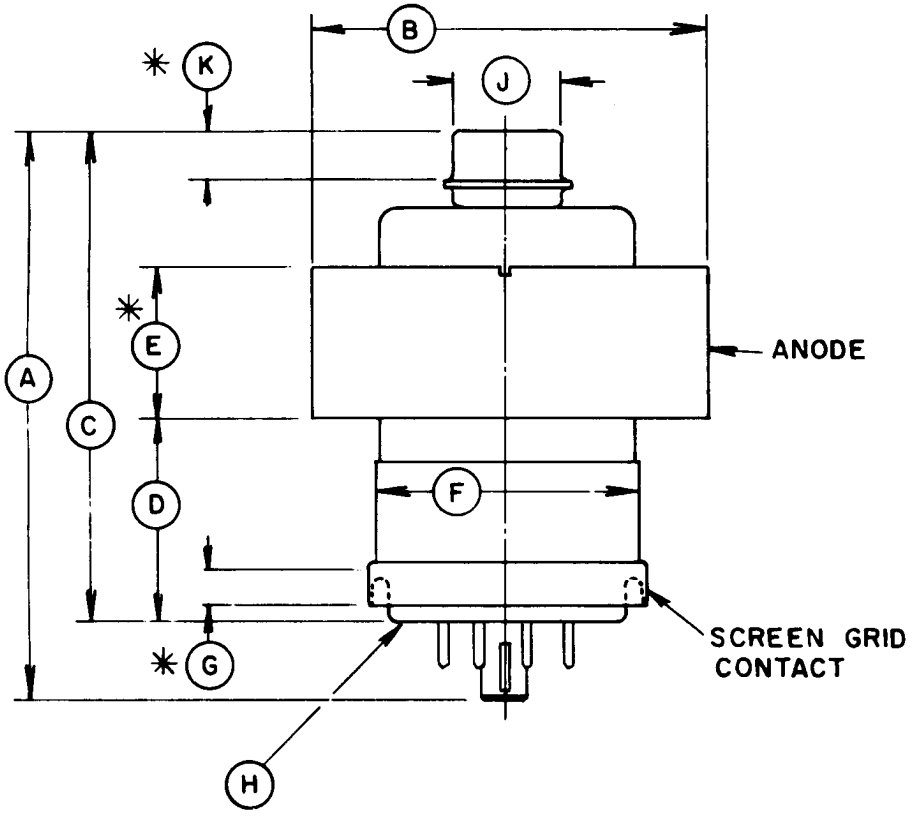
Class AB_1 Radio Frequency Linear Power Amplifier

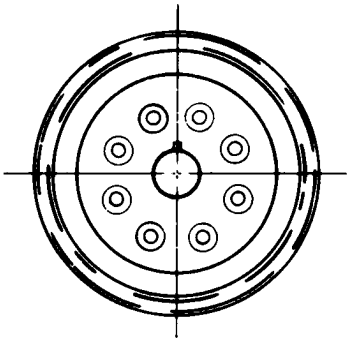
DC Plate Voltage	1600	2600 V
DC Screen Voltage	200	250 V
DC Grid Voltage	-24	-34 V
Zero Signal Plate Current	250	225 mA
Max Signal DC Plate Current	455	370 mA

OPERATING CHARACTERISTICS (cont.)

PEP or CW Plate Output Power	400	500 W
Third Order Intermodulation Distortion	-36	-38 dB
Fifth Order Intermodulation Distortion	-54	-46 dB
Filament Voltage	2.5	2.5 V
Filament Current	10.0	10.0 A
Warm up time to half power	250	250 ms

PINS 1,3,5,7 — CONTROL GRID
PINS 2,4,6,8 — HEATER CATHODE
CENTER PIN — HEATER

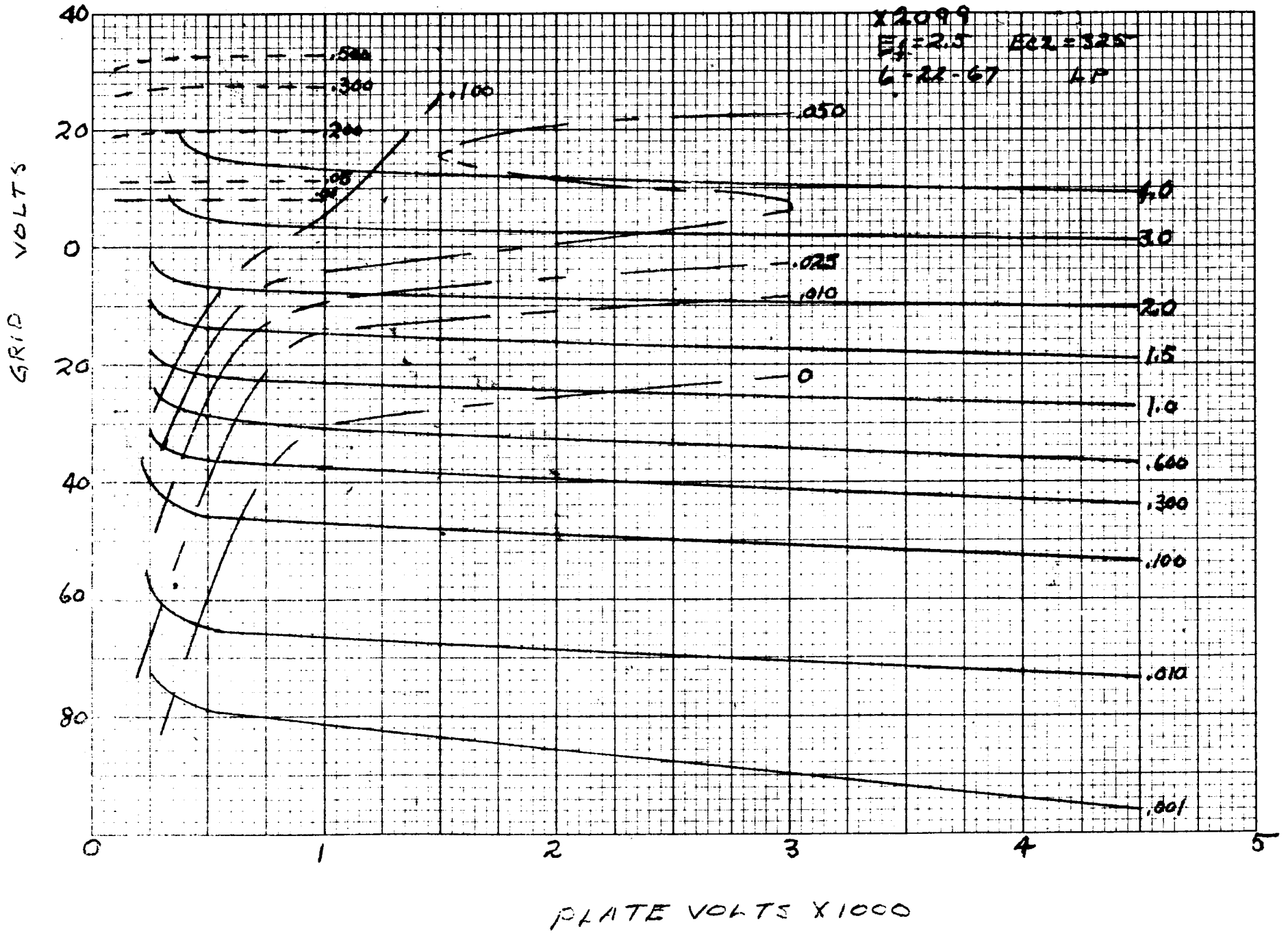


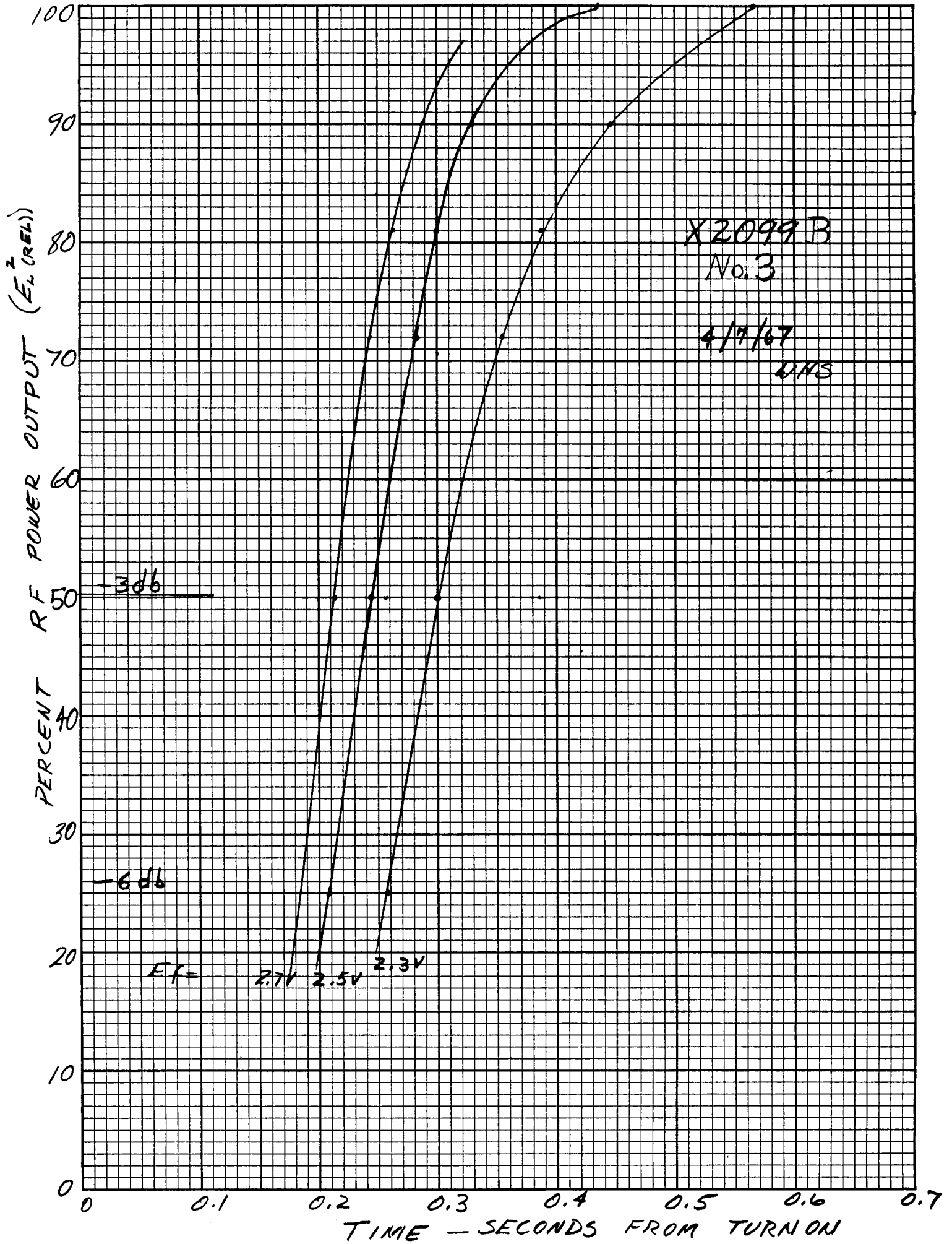


DIMENSIONS IN INCHES

DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A			3 1/2
B	2.050	2.080	
C			3
D	.910	1.030	
E	.710	.790	
F		1.406	
G	.187		
H	BASE: B8-236 (JEDEC DESIGNATION)		
J	.559	.573	
K	.240	.280	

NOTES:
1. (*) CONTACT SURFACE
2. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.


X4099
Ef=2.5 Ec2=325
6-22-67 4P
GRID VOLTS
PLATE VOLTS X1000
40
20
0
20
40
60
80
0
1
2
3
4
5
.500
.300
.200
.100
.050
.025
.010
0
4.0
3.0
2.0
1.5
1.0
.600
.300
.100
.010
.001


PERCENT RF POWER OUTPUT (E_L^2 (REL))
100
90
80
70
60
50
40
30
20
10
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
TIME — SECONDS FROM TURN ON
-3db
-6db
EF=
2.1V
2.5V
2.3V
X2099B
No. 3
4/17/67
2 MS

X-2159

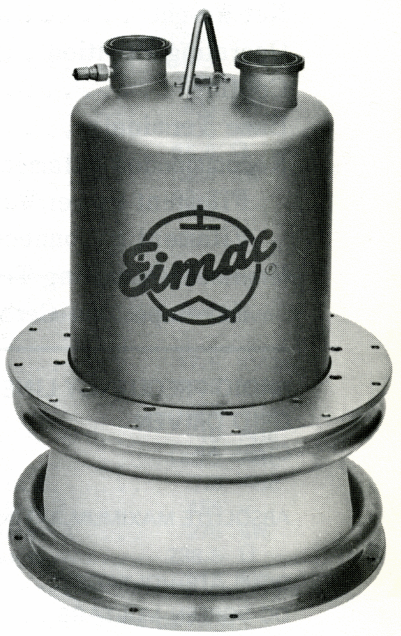
TECHNICAL DATA

WATER-COOLED
POWER TETRODE

The EIMAC X-2159 is a ceramic/metal, water-cooled power tetrode designed for very-high-powered medium-frequency or high-frequency broadcast service and very-low-frequency communication in the megawatt power range.

The X-2159 has a two-section thoriated-tungsten filament mounted on water-cooled supports. The two sections may be fed in quadrature to reduce hum contributed by an ac power source. The maximum anode dissipation rating is 1250 kilowatts steady state.

Large-diameter coaxial terminals are used for the control grid and the three rf filament terminals. Filament power and filament support cooling-water connections are made through three special couplings with knurled and threaded clamping rings.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten, two-section		
Voltage per section	18.5 ± 0.9	V
Current at 18.5 V per section	700	A
Amplification Factor (Average), Grid to Screen	4.5	
Direct Interelectrode Capacitance (grounded cathode)[2]:		
Cin	1650	pF
Cout	260	pF
Cgp	10	pF
Direct Interelectrode Capacitance (grounded grid)[2]:		
Cin	675	pF
Cout	260	pF
Cpk	1.0	pF

Frequency of Operation: for use above 30 MHz, contact:
Product Manager, Power Grid Division, EIMAC Div. of Varian.

1. The design of this tube is subject to change. The data supplied is for guidance only. Before establishing a final equipment design with this tube, contact: Product Manager, Power Grid Division, EIMAC Division of Varian.

2. Capacitance values shown are nominal, measured with no special shielding.

(Effective 7-1-73) © 1973 by Varian Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:	
Length	23.75 in; 60.32 cm
Diameter	17.03 in; 43.26 cm
Net Weight	175 lbs; 80 kg
Operating Position	Vertical, base down
Cooling	Water and Forced Air
Base Terminals	Special
Recommended Filament Connectors (not supplied with tube):	
Filament Power/Water Connector (3 required)	EIMAC X-2175
Filament rf Connector (1 required)	EIMAC X-2181
Maximum Operating Temperature:	
Envelope, and Ceramic/Metal Seals	200°C

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC PLATE CURRENT	125	AMPERES
PLATE DISSIPATION	1250	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB1, Peak Envelope Conditions

Plate Voltage	20.0	kVdc
Screen Voltage	1500	Vdc
Grid Voltage [1]	-380	Vdc
Zero Signal Plate Current	20.0	Adc
Single Tone Plate Current	86.5	Adc
Single Tone Screen Current [2]	3.8	Adc
Peak rf Grid Voltage [2]	380	v
Plate Dissipation	505	kW
Plate Load Resistance	132.2	Ω
Plate Power Output	1225	kW
Efficiency	70.8	%

1. Adjust to specified zero-signal plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class C Telegraphy or FM

(Key-down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC PLATE CURRENT	125	AMPERES
PLATE DISSIPATION	1250	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	21.5	kVdc
Screen Voltage	1000	Vdc
Grid Voltage	-700	Vdc
Plate Current	125	Adc
Screen Current [1]	12	Adc
Grid Current [1]	7.2	Adc
Calculated Driving Power	7.0	kW
Plate Dissipation [1]	530	kW
Screen Dissipation [1]	12	kW
Grid Dissipation [1]	1.9	kW
Plate Load Resistance	85.5	Ω
Plate Power Output	2158	kW
Efficiency	80.1	%

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER Class C Telephony

(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17.5	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC PLATE CURRENT	100	AMPERES
PLATE DISSIPATION	800	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	17.5	kVdc
Screen Voltage	1000	Vdc
Grid Voltage	-1000	Vdc
Plate Current	95.0	Adc
Screen Current [1]	8.0	Adc
Grid Current [1]	4.4	Adc
Pk. Screen Voltage (100% Mod)	1000	v
Pk. rf Grid Voltage	1280	v
Calculated Driving Power	6465	W
Plate Dissipation	279	kW
Screen Dissipation [1]	8.0	kW
Grid Dissipation [1]	2.05	kW
Plate Load Resistance	85.6	Ω
Plate Output Power	1384	kW
Efficiency	83.3	%

1. Approximate value.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB

ABSOLUTE MAXIMUM RATINGS (per tube):

DC PLATE VOLTAGE	22.5	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC PLATE CURRENT	125	AMPERES
PLATE DISSIPATION	1250	KILOWATTS
SCREEN DISSIPATION	15	KILOWATTS
GRID DISSIPATION	4.0	KILOWATTS

TYPICAL OPERATION Two Tubes - Sinusoidal Wave

Plate Voltage	17.5	kVdc
Screen Voltage	1500	Vdc
Grid Voltage [1]	-455	Vdc
Zero Signal Plate Current	10	Adc
Max. Signal Plate Current	146.2	Adc
Max. Signal Screen Current [2]	7.8	Adc
Pk. Audio Freq. Grid Voltage [3]	455	v
Max. Signal Plate Dissipation [3]	275	kW
Plate/Plate Load Resistance	238.5	Ω
Plate Output Power	2015	kW

1. Adjust for stated zero-signal plate current.
2. Approximate value.
3. Per Tube.

NOTE: TYPICAL OPERATION data are obtained by calculation from the published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen, and plate voltages is assumed. If this procedure is followed, there will be little variation in output power then the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current.

APPLICATION

MECHANICAL

MOUNTING - The X-2159 must be mounted vertically, base down. The full weight of the tube should rest on the main screen-grid contact flange at the base of the tube, and all lifting of the tube should be done with the lifting eye which is attached to the top of the anode cooling jacket.

COOLING - It is essential that high purity water be used for anode cooling to minimize power loss and corrosion of metal fittings. Good distilled or de-ionized water will have a resistance of 1 to 2 megohms per cm^3. Water should be discarded if resistivity falls to 50,000 ohms/cm^3. Since the anode is normally

at high potential to ground, water connections to the anode are made through insulating tubing. These insulating sections should be long enough so that column resistance is above 100,000 ohms per 1000 plate supply volts. The table shows minimum anode cooling water requirements for several plate dissipation levels.

Plate Dissipation (Kilowatts)	Water Flow (GPM)	Pressure Drop (PSI)
500	130	15
800	205	30
1000	250	45
1250	310	66

This data is based on an inlet water temperature of 40°C and an outlet temperature of 70°C. In no case should the outlet water temperature be allowed to exceed 70°C, and system pressure should be limited to 85 PSI maximum.

Water cooling is also required for the screen grid, with a minimum flow of 2.0 GPM, at an approximate pressure drop of 25 PSI. The tube outline drawing shows which of the two connections should be used for inlet water.

Water cooling of the filament supports is required. Each of the three water connections includes both an inlet and outlet line, with the proper section for the inlet water shown on the outline drawing. Minimum flow for the F1 and F3 connectors should be 2.0 GPM, with an approximate pressure drop of 10 PSI for each connector; minimum flow for the F2 connector should be 4.0 GPM, with an approximate pressure drop of 55 PSI.

Base water cooling requirements can sometimes be simplified if the screen grid and filament connectors F1 and F3 are all cooled in series, with suitable insulation between terminals.

In addition to the water-cooling requirements, cooling air should be directed against the lower envelope surface, in the area of the ceramic/metal seals, and particularly from below, up into the recesses involving the control grid and screen grid contact surfaces. Under normal circumstances, a general purpose blower capable of supplying a minimum of one hundred CFM (at zero head), properly directed, will provide adequate cooling in the recessed base area. Temperatures of the ceramic/metal seals and the lower envelope areas are the controlling and final limiting factor. Temperature-sensitive paints are available for use in checking temperatures in these areas before equipment design and air-cooling arrangements are finalized.

All base cooling, air and water, *must* be applied before power is applied to the filaments. For standby operation, with no direct anode dissipation, a minimum flow of 5 GPM of anode cooling water is still required to prevent anode overheating, in addition to base cooling.

In all cases, both air-flow and water-flow interlocks should be used to remove all power from the tube in case of a cooling failure. However, cooling normally should be maintained for a brief period after all power is removed to allow for tube cool-down.

ELECTRICAL

FILAMENT OPERATION - Special procedures must be used in the application and removal of filament power. Cooling water flow *must* be on and at the correct level before any voltage is applied. Then a voltage of (approximately) 4 volts should be applied (per section), and held for a minimum of 30 seconds. Voltage can then be gradually increased until the full operating filament voltage level is achieved, but at no time should surge current be allowed to exceed 1600 amperes per section. To remove filament power, the voltage should be reduced gradually to (approximately) 4 volts and held at this level for a minimum of 30 seconds before all voltage is removed.

The peak emission capability at the rated, or nominal, filament voltage is normally many times that required for communication service. A small decrease in filament temperature due to a reduction of filament voltage can increase tube life by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance, such as plate current, power output, or an increase in distortion, while filament voltage is reduced in small steps. At some value of filament voltage there will be a noticeable reduction in plate current or power output, or an increase in distortion. Operation should then be at a filament voltage slightly higher than the point at which performance degradation was

noted. The voltage should be measured at the tube base terminals with a 1% accuracy rms responding meter and periodically checked.

GRID OPERATION - The X-2159 grid is rated at 4000 watts of dissipation. Protective measures should be included in the circuitry to insure that this rating is not exceeded. Grid dissipation is the approximate product of dc grid current and peak positive grid voltage.

SCREEN OPERATION - Base cooling (air and water) must be on and at the correct level before tube operation is started. The power applied to the screen grid must not exceed 15 kilowatts. Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is the product of rms screen current and rms screen voltage.

Plate voltage, plate load, or grid bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective circuitry must be provided to remove screen power in case of such a fault condition. Tetrode tubes may exhibit reversed screen current to a greater or lesser degree depending on individual tube design and operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen currents that may be encountered. Dangerously high plate currents may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished by use of a shunt regulator circuit in the screen voltage supply, or other suitable techniques.

PLATE OPERATION - The maximum dissipation rating of the X-2159 is 1250 kilowatts with water cooling. When used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 800 kilowatts.

FAULT PROTECTION - In addition to the normal plate-overcurrent interlock, screen-current interlock, and coolant (both air and water) interlocks, it is good practice to protect the tube from internal damage caused by an internal plate arc which may occur at high plate voltages. An electronic crowbar, which will discharge power-supply capacitors in a few microseconds after the start of a plate arc, is recommended.

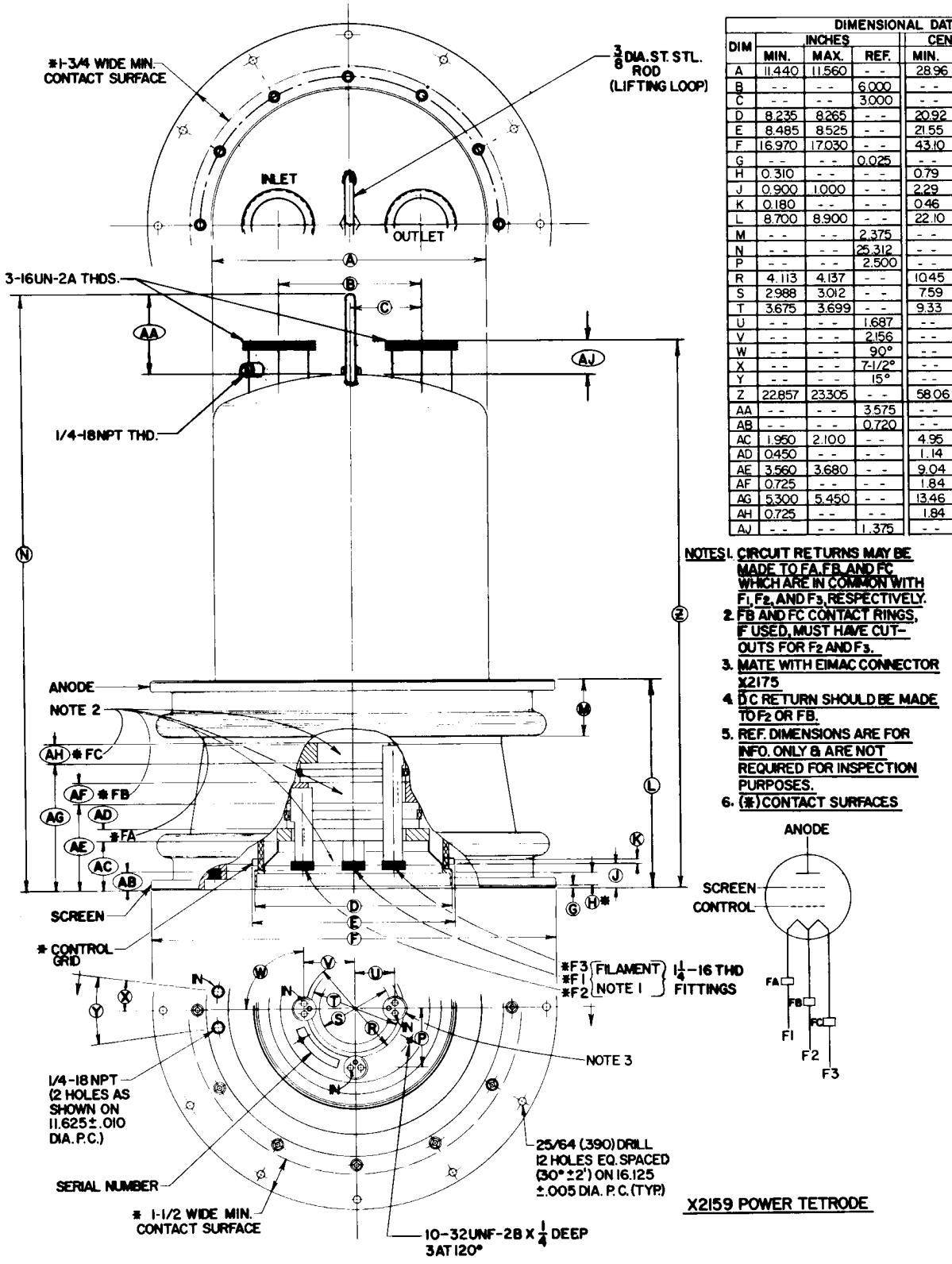
HIGH VOLTAGE - Normal operating voltages used with the X-2159 are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The X-2159, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made, and the tube should never be operated without adequate shielding in place when voltages above 10 kilovolts are in use. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

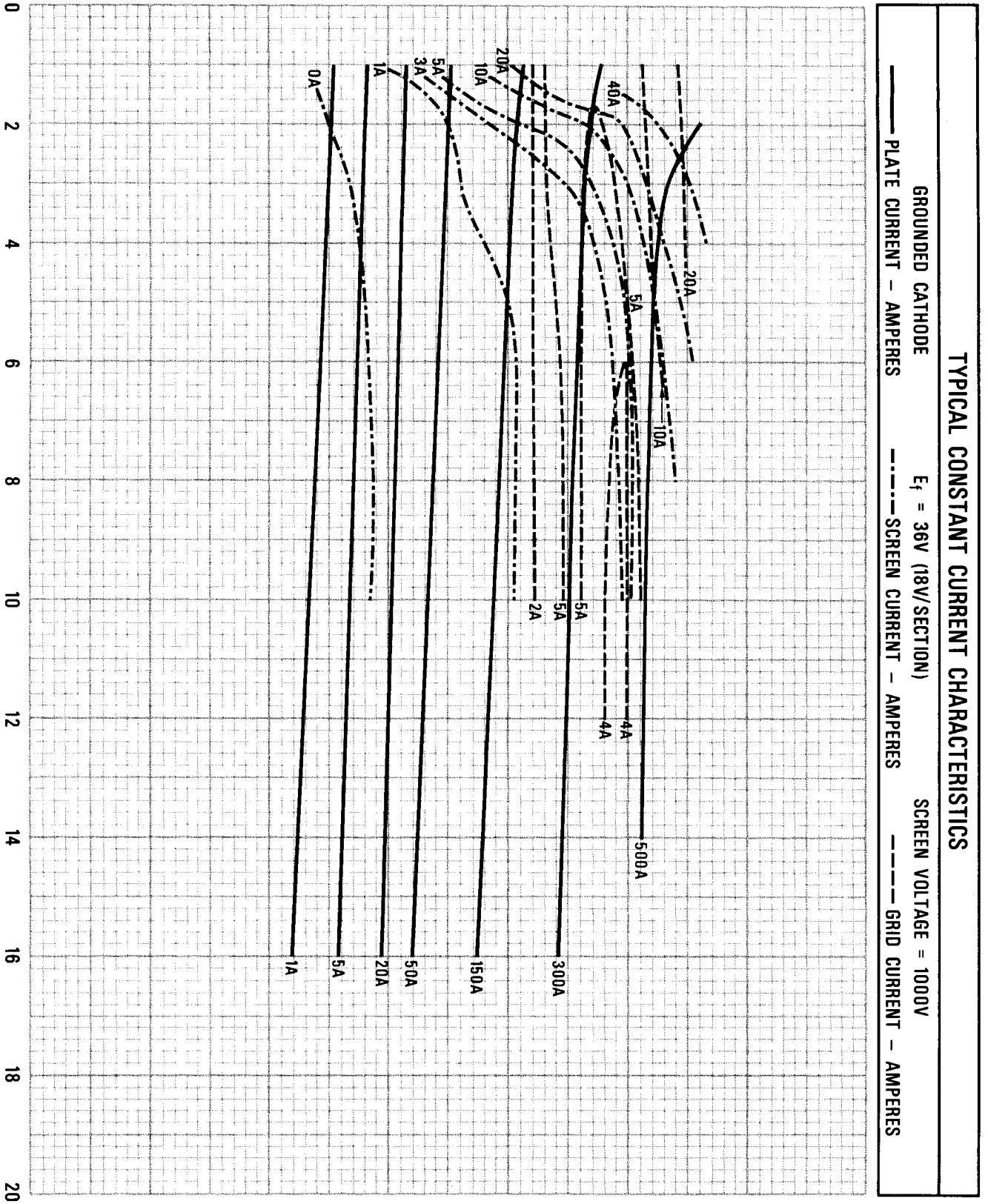
SPECIAL APPLICATION - Where it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, Ca. 94070, for information and recommendations.



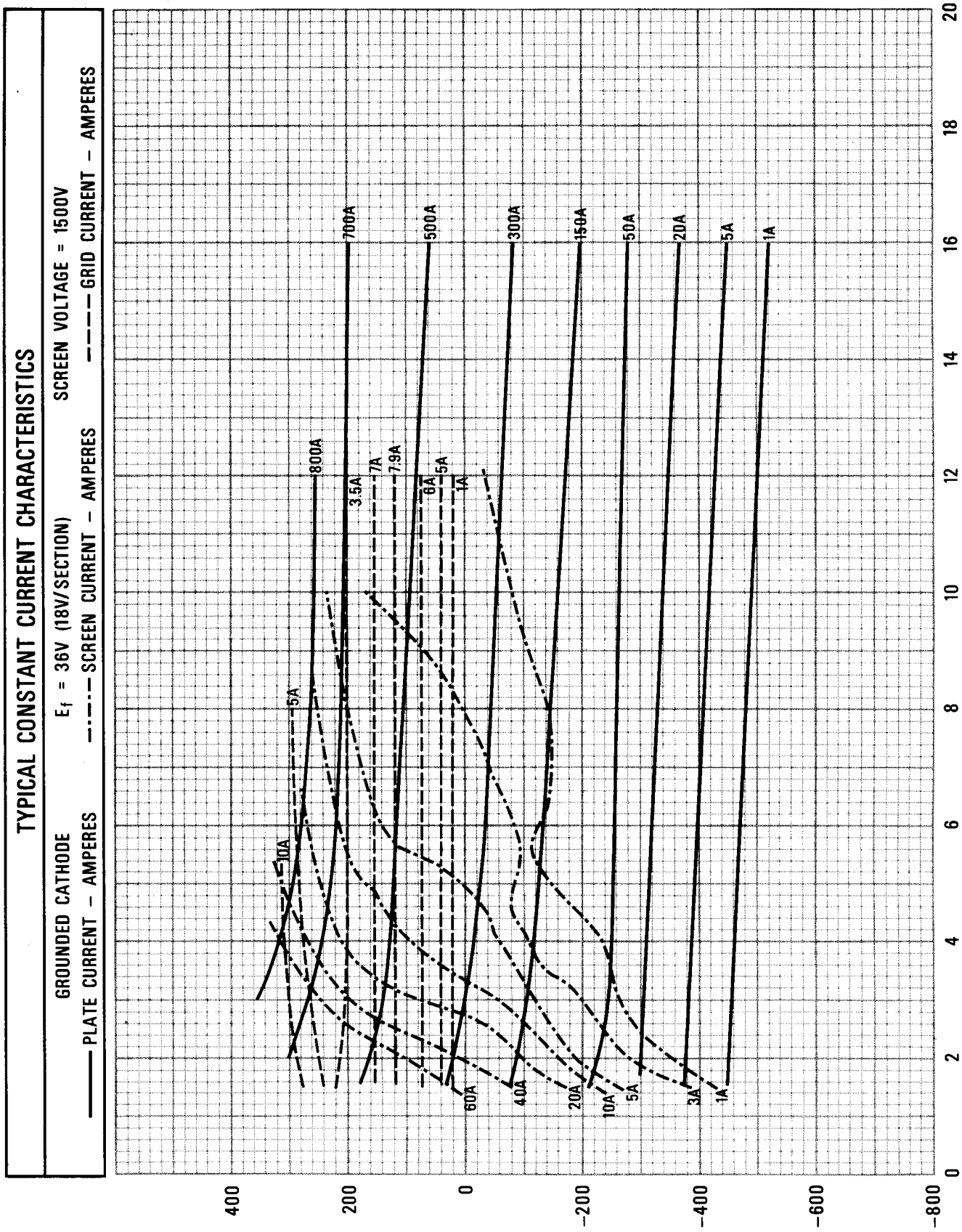
DIM	DIMENSIONAL DATA INCHES MIN.	MAX.	REF.	CENTIMETERS MIN.	MAX.	REF.
A	11.440	11.560	- -	28.96	29.36	- -
B	- -	- -	6.000	- -	- -	15.24
C	- -	- -	3.000	- -	- -	7.62
D	8.235	8.265	- -	20.92	20.99	- -
E	8.485	8.525	- -	21.55	21.65	- -
F	16.970	17.030	- -	43.10	43.26	- -
G	- -	- -	0.025	- -	- -	0.063
H	0.310	- -	- -	0.79	- -	- -
J	0.900	1.000	- -	2.29	2.54	- -
K	0.180	- -	- -	0.46	- -	- -
L	8.700	8.900	- -	22.10	- -	- -
M	- -	- -	2.375	- -	- -	6.03
N	- -	- -	25.312	- -	- -	64.30
P	- -	- -	2.500	- -	- -	6.35
R	4.113	4.137	- -	10.45	10.51	- -
S	2.988	3.012	- -	7.59	7.65	- -
T	3.675	3.699	- -	9.33	9.40	- -
U	- -	- -	1.687	- -	- -	4.28
V	- -	- -	2.156	- -	- -	5.48
W	- -	- -	90°	- -	- -	90°
X	- -	- -	7-1/2°	- -	- -	7-1/2°
Y	- -	- -	15°	- -	- -	15°
Z	22.857	23.305	- -	58.06	59.19	- -
AA	- -	- -	3.575	- -	- -	9.08
AB	- -	- -	0.720	- -	- -	1.83
AC	1.950	2.100	- -	4.95	5.33	- -
AD	0.450	- -	- -	1.14	- -	- -
AE	3.560	3.680	- -	9.04	9.35	- -
AF	0.725	- -	- -	1.84	- -	- -
AG	5.300	5.450	- -	13.46	13.84	- -
AH	0.725	- -	- -	1.84	- -	- -
AJ	- -	- -	1.375	- -	- -	3.49

NOTES:
1. CIRCUIT RETURNS MAY BE MADE TO FA, FB AND FC WHICH ARE IN COMMON WITH F1, F2, AND F3, RESPECTIVELY.
2. FB AND FC CONTACT RINGS, IF USED, MUST HAVE CUT-OUTS FOR F2 AND F3.
3. MATE WITH EIMAC CONNECTOR X2175
4. DC RETURN SHOULD BE MADE TO F2 OR FB.
5. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
6. (*) CONTACT SURFACES

X2159 POWER TETRODE


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
E_f = 36V (18V/SECTION)
SCREEN VOLTAGE = 1000V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
400
200
0
−200
−400
−600
−800
0
2
4
6
8
10
12
14
16
18
20
20A
10A
5A
40A
4A
500A
5A
4A
20A
10A
2A
5A
300A
5A
3A
150A
1A
50A
0A
20A
5A
1A

CURVE #4417


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
E_f = 36V (18V/SECTION)
SCREEN VOLTAGE = 1500V
——— PLATE CURRENT – AMPERES
–·–·– SCREEN CURRENT – AMPERES
– – – – GRID CURRENT – AMPERES
GRID VOLTAGE (V)
400
200
0
-200
-400
-600
-800
0
2
4
6
8
10
12
14
16
18
20
PLATE VOLTAGE (kV)
800A
700A
600A
500A
300A
150A
50A
20A
5A
1A
10A
5A
3.5A
7A
7.9A
6A
5A
1A
60A
40A
20A
10A
5A
3A
1A

CURVE #4432

EIMAC

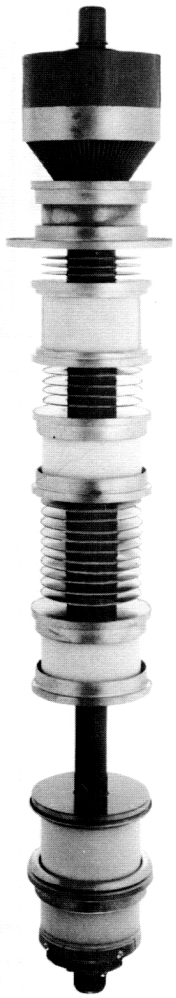
A Division of Varian Associates

SAN CARLOS, CALIFORNIA

X3002

PULSE AMPLIFIER

L-BAND KLYSTRON



The Eimac X3002 is a three-cavity, magnetically focused, pulse amplifier klystron. Designed for use at frequencies between 1235 and 1365 megacycles, this klystron will deliver a minimum peak output power of 4 kilowatts with a power gain of at least 23 decibels during long-pulse service.

Tuning for the X3002 is accomplished by means of external resonant cavities which enclose the cylindrical ceramic windows of the klystron. This design permits an unlimited number of tuning cycles without risk of damage to the vacuum seals.

Eimac Klystron Amplifier Circuit Assembly H-147 is provided for use with the X3002 to cover the frequency range of 1235 to 1365 megacycles. This assembly includes a klystron supporting structure, focusing coils, external cavities, and adjustable load couplers for the input and output cavities.

CHARACTERISTICS

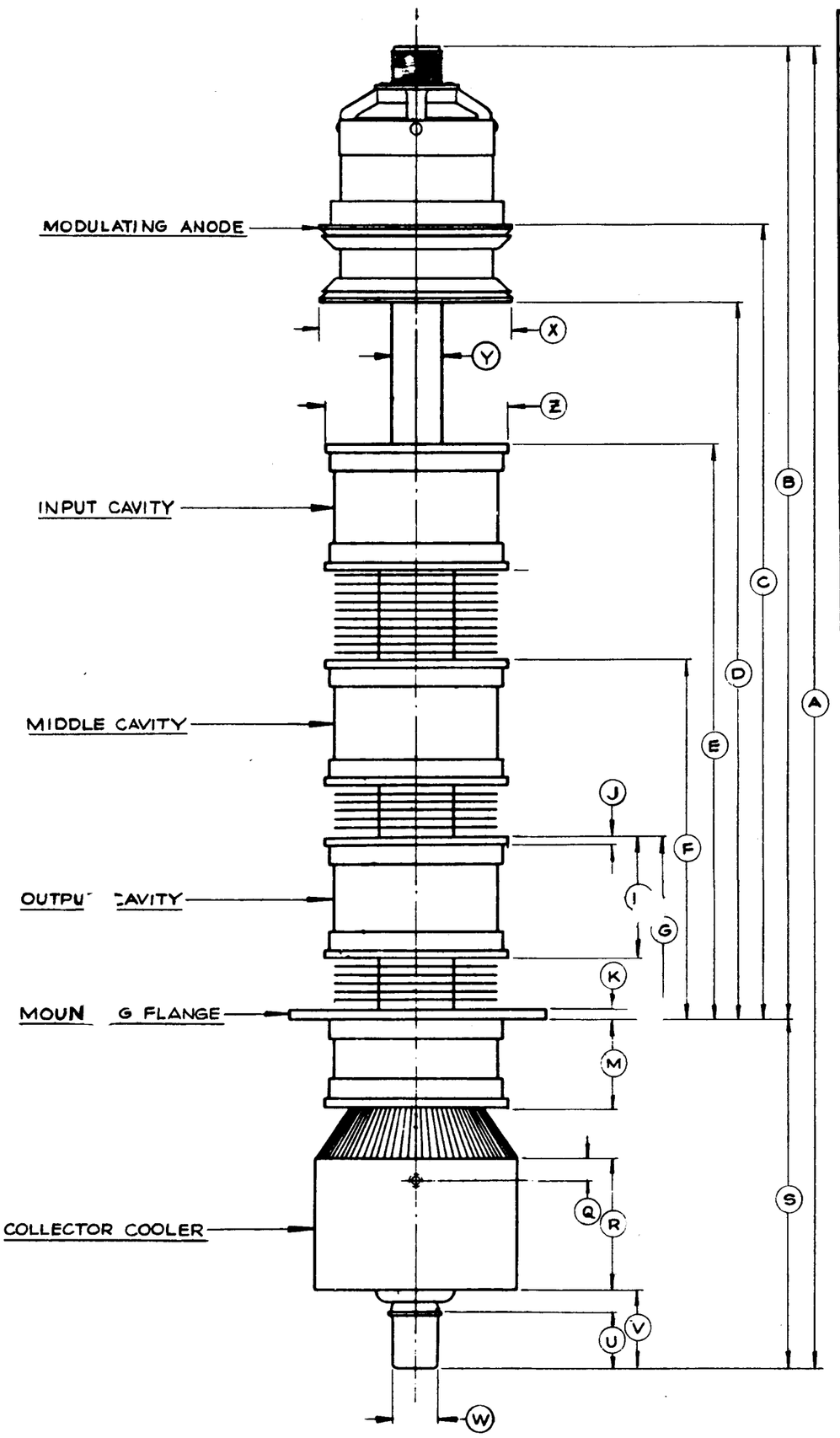
ELECTRICAL

Cathode: Unipotential		
Minimum Heating Time	5	minutes
Heater: Voltage (±5%)	7.5	volts
Current	5.5	amperes
Minimum Power Gain	23	decibels
Minimum Output Power	4	kilowatts
Frequency Range	1235 to 1365	megacycles
Phase Shift as a Function of Beam Voltage	0.0005	degrees/volt

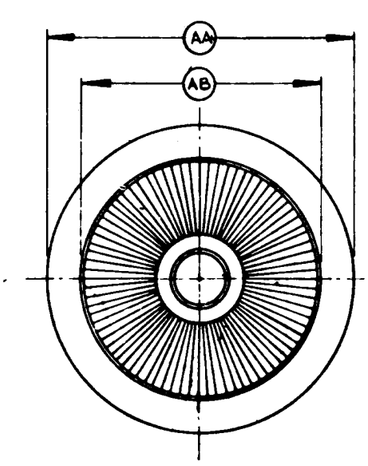
MECHANICAL

Operating Position	Vertical, cathode end up	
Coupling (rf): Input	Type "N", Coaxial Fitting	
Output	⅞ inch, 50-ohm coaxial	
Cooling: (20 degrees C inlet air at sea level)	*Flow Rate*	*Pressure Drop*
Body	100 cfm	1.5" H_2O
Collector	150 cfm	1.6" H_2O
X3002 Length	27	inches
X3002 Diameter	5.3	inches
X3002 Weight	23	pounds
H-147 Height	15	inches
H-147 Diameter	18	inches
H-147 Weight	155	pounds

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DIMENSION DATA			
REF.	NOM.	MIN.	MAX.
A	26.718		
B	19.750		
C	15.812		
D	14.312		
E	11.500		
F	7.250		
G	3.750		
H	2.500		
J	.250		
K	.250		
M	1.687		
Q	.437		
R	2.625		
S	6.968		
U	1.125		
V	1.812		
W	.875		
X	3.812		
Y	1.500		
Z	3.625		
AA	5.125		
AB	4.125		



X3002 OUTLINE DRAWING

FOCUS COIL POWER SUPPLY REQUIREMENTS

Body Coil	Variable to 200 volts, 3 amperes maximum
Prefocus Coil	Variable to 25 volts, 1.5 amperes maximum

TYPICAL OPERATION

Pulse Amplifier

Frequency	1300	1300	megacycles
Peak Output Power	5	3.2	kilowatts
Power Gain	23	23	decibels
Beam Voltage	13	10	kilovolts dc
Peak Beam Current	1.12	0.91	amperes
Peak Modulating Anode Voltage	5.0	4.0	kilovolts
Focus Electrode Voltage	—50	—50	volts
Pulse Length	2000	2000	microseconds
Duty	3	3	percent
Efficiency	35	40	percent

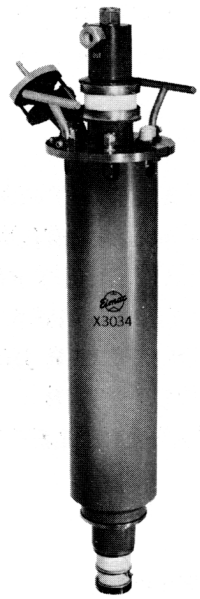
For additional information or information regarding a specific application, write to Eimac Division, Varian Associates, 301 Industrial Way, San Carlos, California

EIMAC
A Division of Varian Associates
SAN CARLOS, CALIFORNIA

Tentative Data

X3034

POWER AMPLIFIER S-BAND (1.1 KW CW) TWT



The Eimac X3034 is a power-amplifier TWT intended for use in broadband communications systems. It is designed to operate at frequencies from 1.7 to 2.1 gigacycles with a minimum output power of 1.1 kilowatts. The electron gun of this TWT has a confined flow configuration which makes focusing adjustments unnecessary and produces a stable beam. Excellent isolation between input and output is assured through the use of terminated severed circuits. This TWT incorporates the Eimac Modulating Anode which provides a versatile means for controlling the beam.

Eimac electromagnet assembly Type Number H-199 has been designed for use with the X3034.

CHARACTERISTICS

ELECTRICAL

Cathode: Impregnated, Unipotential	
Heating Time	5 Min
Heater: Voltage (±5%)	5.6 Vac or Vdc
Current (Nominal)	3.8 Aac or Adc
Power Gain (Saturated)	20 db
Power Gain (Small Signal)	25 db
Output Power	1.1 kW
Frequency Range	1.7-2.1 Gc
Maximum Power Variation in any 50 Mc band (Note 1)	1 db

MECHANICAL

Maximum Dimensions:	
Length	34⅝ inches
Width	7⅛ inches
Depth	7½ inches
Weight (Including Electromagnet)	160 pounds
Input Coupling (rf)	Type N Coaxial
Output Coupling (rf)	⅞" coaxial, EIA STD RS-225
Mounting Position	Any

Cooling: Forced Air and Water	*Flow Rate*	*Pressure Drop*
Cathode	20 cfm	free
Body	1 gpm	50 psi
Collector	5 gpm	10 psi
Electromagnet	1.5 gpm	40 psi

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ELECTROMAGNET POWER SUPPLY REQUIREMENTS

Upper Coil	Adjustable to 50 Vdc at 10 Adc
Lower Coil	Adjustable to 35 Vdc at 7 Adc

MAXIMUM RATINGS

BEAM VOLTAGE	13 kVdc
BEAM CURRENT	1 Adc
BEAM INPUT POWER	11 kW
BODY CURRENT	25 mAdc
COLLECTOR DISSIPATION	11 kW
LOAD VSWR	1.2:1
WATER INLET TEMPERATURE	50 °C

TYPICAL OPERATION

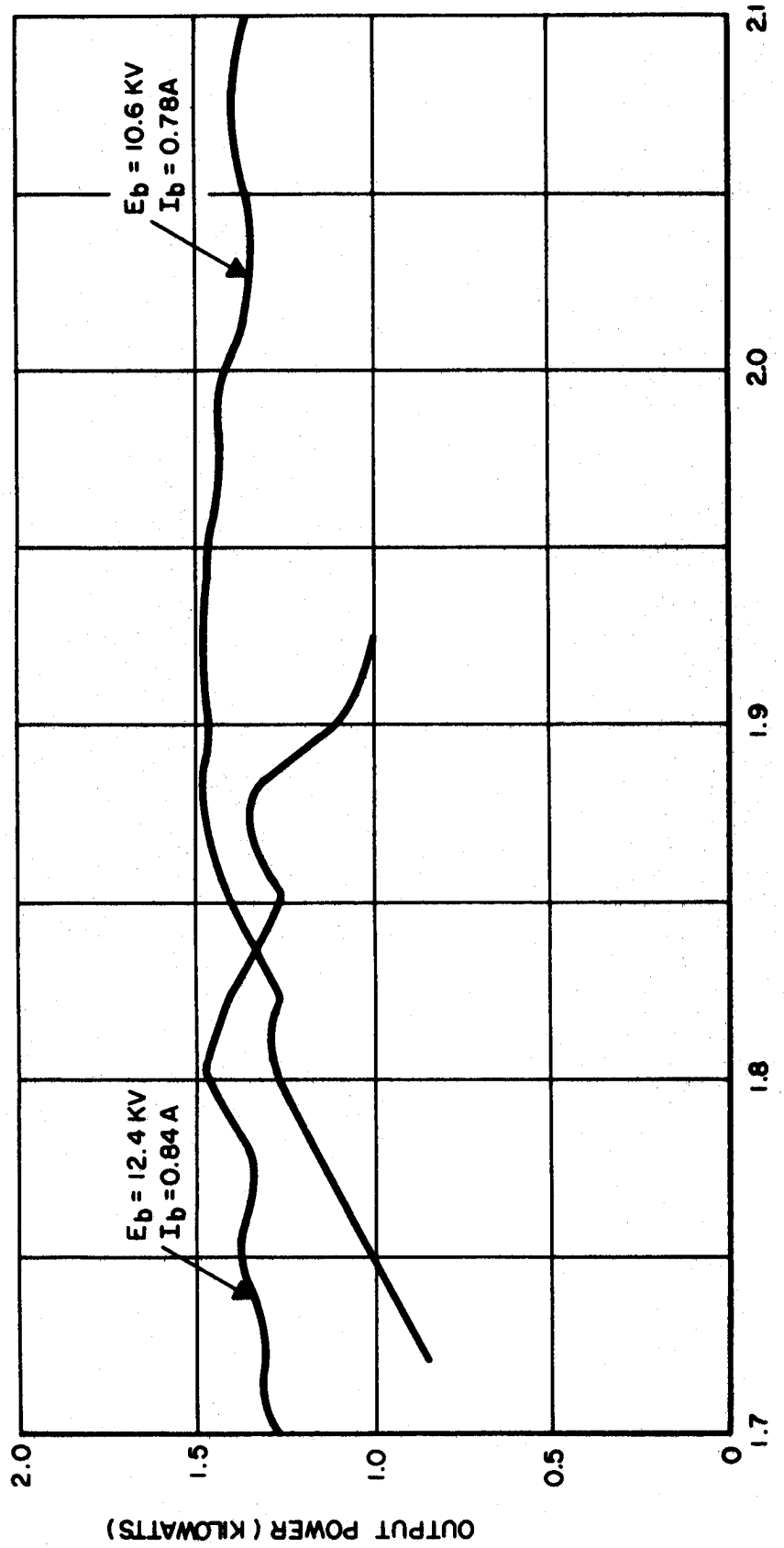
Frequency	1.7	1.8	1.9	2.0	2.1	Gc
Beam Voltage	12.4	12.4	10.6	10.6	10.6	kVdc
Beam Current	0.84	0.84	0.78	0.78	0.78	Adc
Mod Anode Voltage (with respect to cathode)	10.0	10.0	9.7	9.7	9.7	kVdc
Body Current	13	13	17	17	17	mAdc
Drive Power	10	10	10	10	10	W
Output Power	1.25	1.47	1.47	1.43	1.36	kW
Gain	20.9	21.6	21.6	21.5	21.3	db
Electromagnet Currents						
Upper Coil	9.5	9.5	9.5	9.5	9.5	Adc
Lower Coil	6	6	6	6	6	Adc

NOTE:

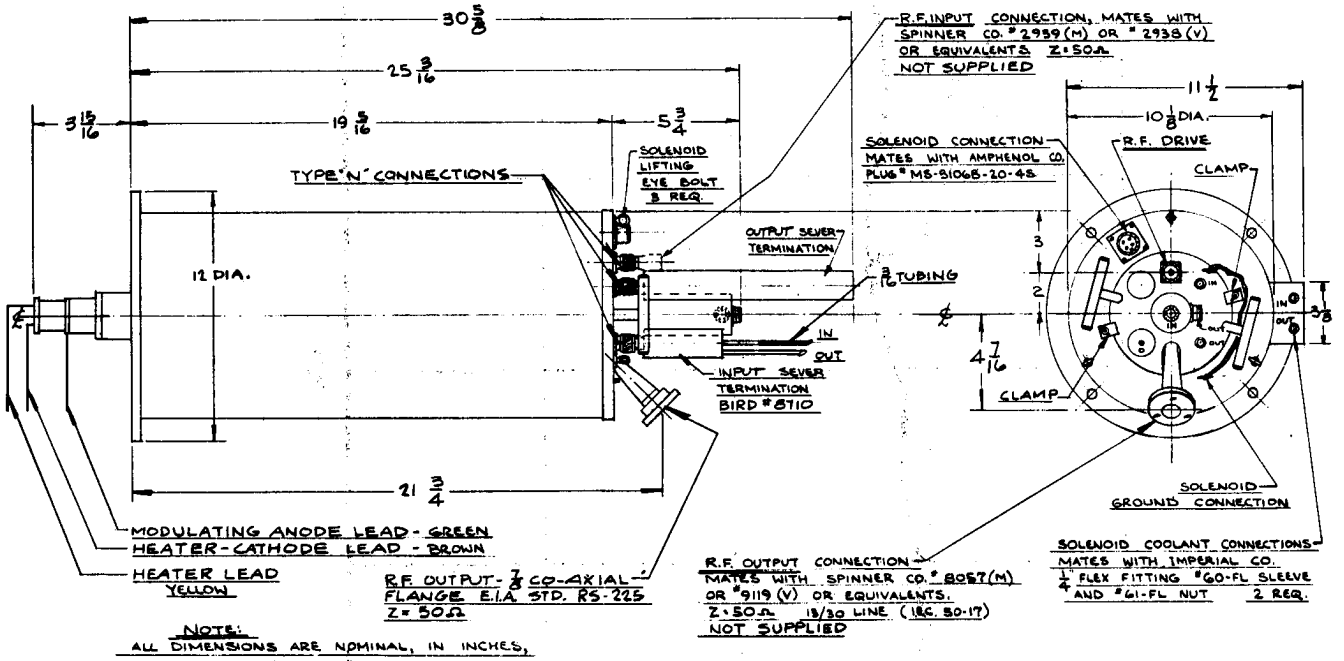
(1) Beam Voltage may be optimized for each 50 Mc segment.

(2) In the event of rapid change in VSWR such as caused by a transmission line arc, the rf drive must be removed in 20 milliseconds. It is recommended that an isolator be inserted in the output line between a re-active filter and the TWT.

(3) The nominal input and output impedances are designed to work into 50 ohm transmission lines.

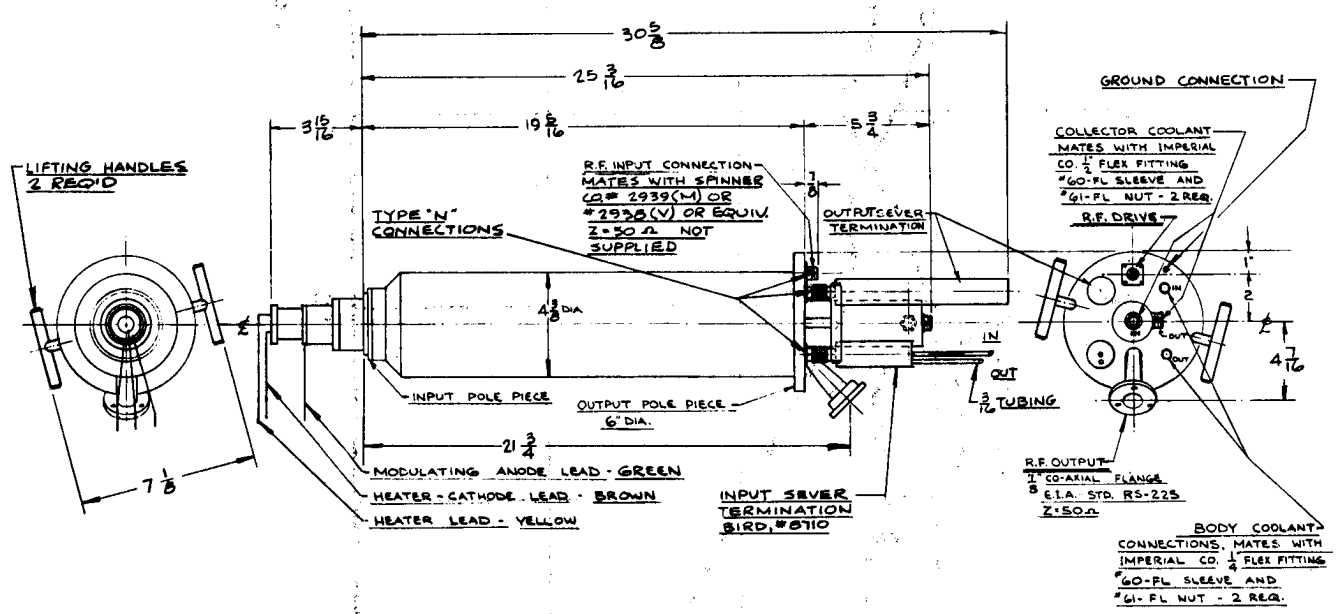

E_b = 10.6 KV
I_b = 0.78A
E_b = 12.4 KV
I_b = 0.84 A
OUTPUT POWER (KILOWATTS)
2.0
1.5
1.0
0.5
0
1.7
1.8
1.9
2.0
2.1
FREQUENCY (Gc)

X-3034



NOTE:
ALL DIMENSIONS ARE NOMINAL, IN INCHES.

X-3034 AND H-199



NOTE:
ALL DIMENSIONS ARE NOMINAL, IN INCHES.

X-3034 TWT

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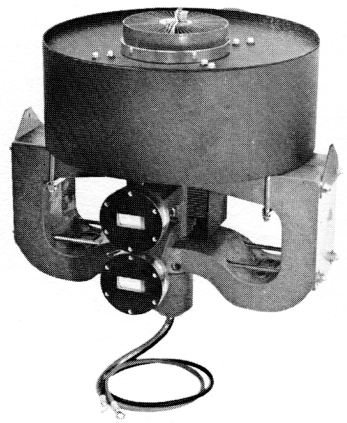
SAN CARLOS, CALIFORNIA

Tentative Data

X3054

2.5 KW
POWER AMPLIFIER
C-BAND KLYSTRON

The Eimac X3054 is a five-cavity, air-cooled power amplifier klystron tunable over the frequency range of 5.925 to 6.425 gigacycles. It will deliver a minimum CW output power of 2.5 kilowatts with a minimum power gain of 50 decibels and a minimum 1 db bandwidth of 20 megacycles.



The very high gain and efficiency of this klystron make it particularly attractive for transportable equipment.

A common air inlet is used for collector and body cooling. Improved collector cooling is achieved through use of an integral plenum chamber which encloses the collector.

This klystron is focused with a permanent magnet and an auxiliary low voltage collector coil.

Both input and output rf couplings of the X3054 are fixed. The only adjustments required are the tuning of the cavities.

CHARACTERISTICS

ELECTRICAL

Cathode: Impregnated, Unipotential		
Heating Time	5	minutes
Heater:		
Voltage (±5%)	5.75	volts
Current (nominal)	3.7	amperes
Power Gain	50	decibels
Output Power	2.5	kilowatts
Frequency Range	5.925-6.425	gigacycles

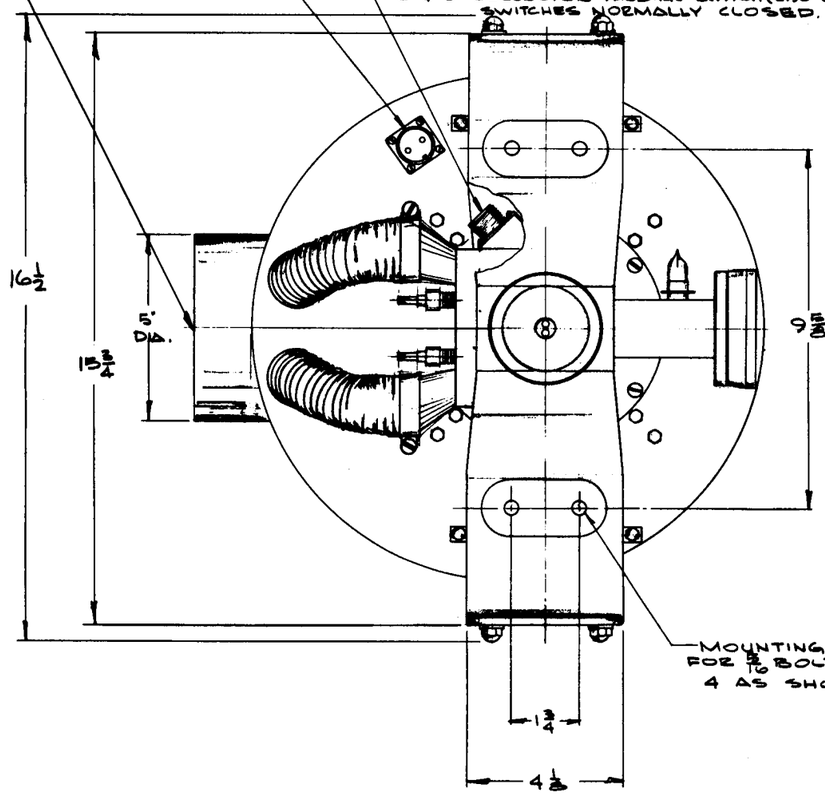
(Effective 7-15-65) Copyright 1965 by Varian Associates Printed in U.S.A.

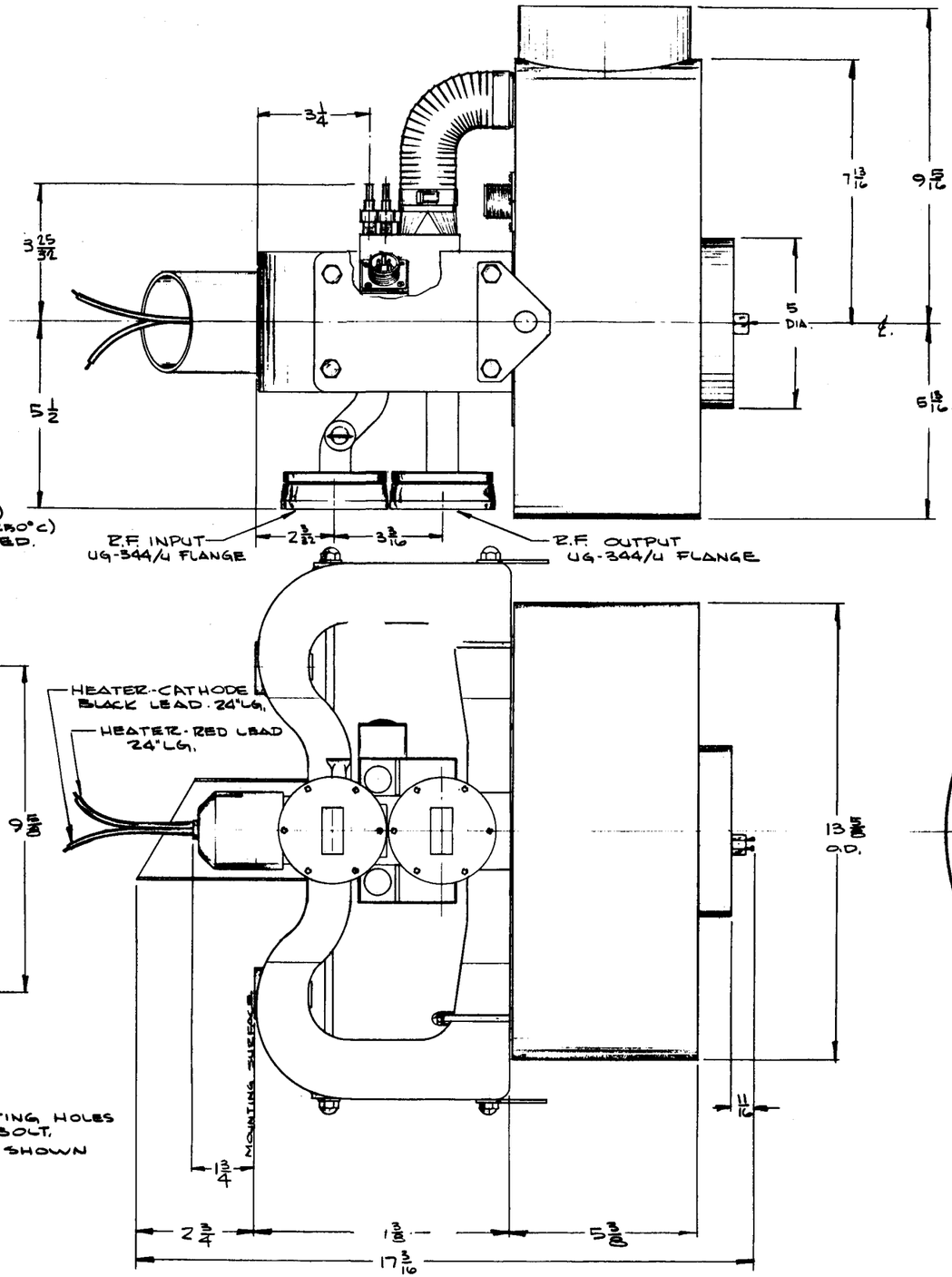
X3054

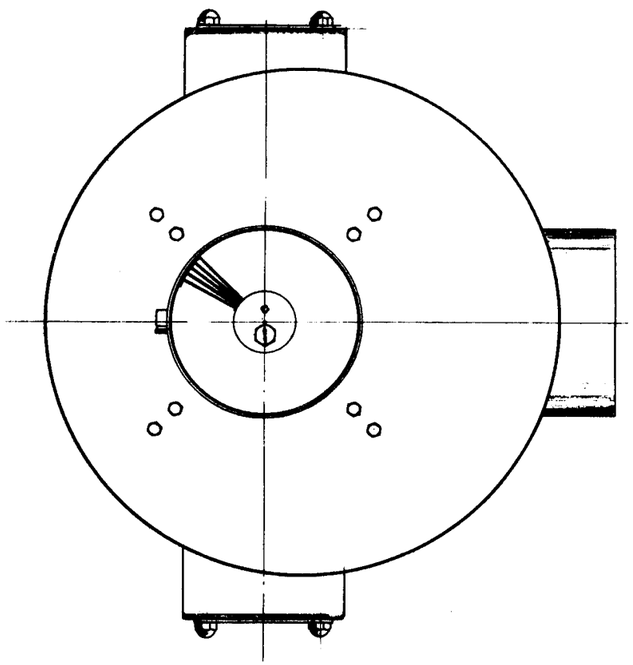
COLLECTOR COIL RECEPTACLE
BOX MOUNT RECEPTACLE
#MS3102A-16-11P.
MATES WITH -
PLUG # MS3106A-16-11S
& CABLE CLAMP AN3057-8
'A' = NEGATIVE
'B' = POSITIVE

THERMAL SWITCH RECEPTACLE
BOX MOUNT RECEPTACLE# MS3102A-14S-2P
MATES WITH-
PLUG # MS3106A-14S-2S
& CABLE CLAMP AN3057-6
"A" & "B" BODY THERMAL SWITCH (150°C)
"C" & "D" COLLECTOR THERMAL SWITCH (250°C)
SWITCHES NORMALLY CLOSED.

COOLING AIR INLET.







X3054 KLYSTRON

MECHANICAL

Maximum Dimensions		
Length	17½	inches
Width	16½	inches
Depth	15½	inches
Weight	120	pounds
Input Coupling (rf)	UG-344/U	flange
Output Coupling (rf)	UG-344/U	flange
Maximum Tuner Start Torque	30	in-oz
Maximum Tuner Stop Torque	100	in-oz
Mounting Position		any

Cooling: Forced Air (25°C at sea level)

	Flow Rate	*Pressure Drop*
Body and Collector	175 cfm	1.2 in. H_2O

Collector Coil Power Supply Requirements - - - - - - - - - 40 volts at 9 amperes

MAXIMUM RATINGS

BEAM VOLTAGE (dc)	8.5	kilovolts
BEAM CURRENT (dc)	0.85	ampere
BEAM INPUT POWER	6.5	kilowatts
BODY CURRENT WITH RF DRIVE (dc)	70	milliamperes
COLLECTOR DISSIPATION	6.5	kilowatts
LOAD VSWR	1.5:1	
TEMPERATURE OF BODY AND TUNER FINS	150°C	
TEMPERATURE OF COLLECTOR	250°C	

TYPICAL OPERATION — TUNED FOR BROADBAND OPERATION

Frequency	6175	megacycles
Output Power	2.7	kilowatts
Driving Power	8	milliwatts
Gain	56	decibels
Beam Voltage	8.2	kilovolts dc
Beam Current	0.74	ampere dc
Beam Power Efficiency	44	percent
1 db Bandwidth	24	megacycles
Body Current	40	milliamperes dc
Collector Coil Current	7	amperes dc

For additional information or information regarding a specific application, write to Eimac, a Division of Varian Associates, 301 Industrial Way, San Carlos, California

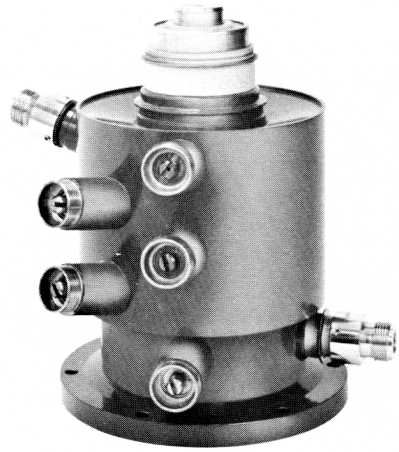
EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

Tentative Data

X3065

POWER AMPLIFIER
S-BAND KLYSTRON

The EIMAC X3065 is a conduction cooled, electrostatically focused, power-amplifier klystron designed to operate at frequencies from 2100 to 2110 megahertz. It will deliver a minimum output power of 200 watts with a minimum power gain of 40 decibels. The X3065 is intended for use in applications where light weight and compactness are essential.



FEATURES

- ELECTROSTATIC FOCUSING
- FIVE INTEGRAL CAVITIES
- LOW NOISE LEVEL
- FIXED INPUT AND OUTPUT COUPLING
- INSTANT FAULT RECYCLING

CHARACTERISTICS

ELECTRICAL

Frequency	2100-2110 MHz
Minimum Output Power	200 W
Minimum Power Gain	40 db
Cathode: Oxide, Unipotential	
Starting Time	1 minute
Heater: Voltage	7 Vac
Current	1.0 Aac
Maximum Starting Current	2 Aac

MECHANICAL

Operating Position	Any
Cavity Tuning Torque (maximum)	1 inch pounds
Cooling	By Conduction
Maximum Dimensions:	
Length	6.5 inches
Width	6.50 inches
Depth	5.5 inches
Input rf coupling	Connector TNC
Output rf coupling	Type N
Weight	5 pounds

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MAXIMUM RATINGS

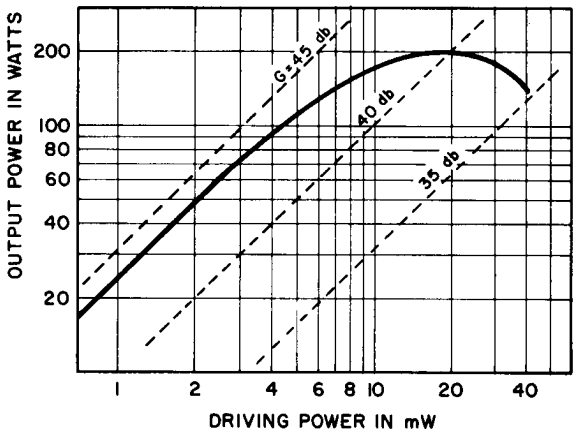
BEAM VOLTAGE	4.0 kVdc
BEAM CURRENT	180 mAdc
BEAM INPUT POWER	720 W
COLLECTOR DISSIPATION	720 W
CATHODE SEAL TEMPERATURE	150 °C
LOAD VSWR	2:1

TYPICAL OPERATION
A — Tuned For Maximum Efficiency

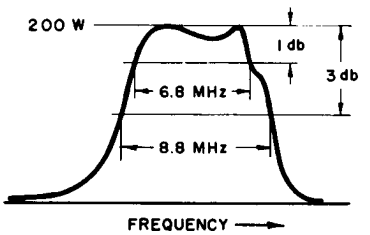
Frequency	2105	2105	MHz
DC Beam Voltage	2.2	3.5	kVdc
DC Beam Current	73	145	mAdc
Driving Power	5	20	mW
Output Power	50	200	W
Gain	40	40	db
Beam Power Efficiency (without collector depression)	31	39.5	%
Beam Power Efficiency (with collector depression)	39	42	%
3 db Bandwidth	2.0	2.2	MHz

TYPICAL OPERATION
B — Tuned For Bandwidth

Frequency	2105	MHz
DC Beam Voltage	3.6	kVdc
DC Beam Current	151	mAdc
Driving Power	400	mW
Output Power	196	W
Gain	27	db
Beam Power Efficiency	36	%
1 db Bandwidth	6.8	MHz
3 db Bandwidth	8.8	MHz

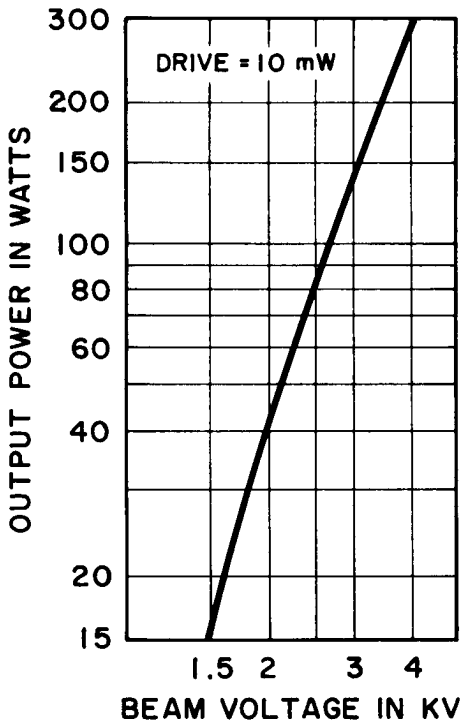


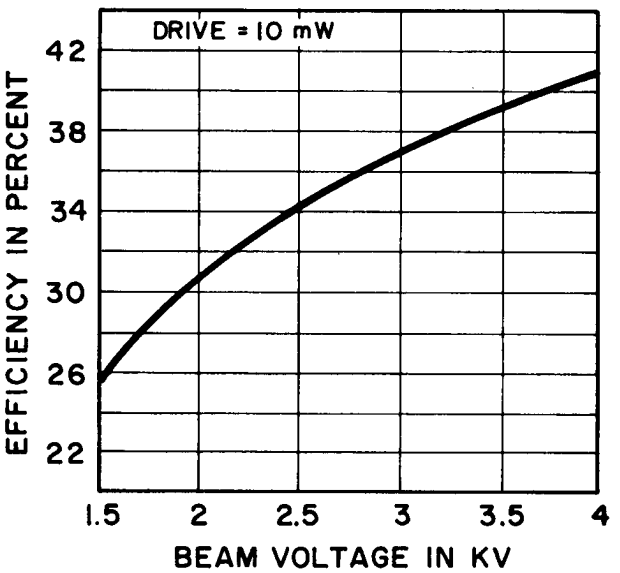
OUTPUT POWER vs DRIVING POWER AT 3.5 KV BEAM VOLTAGE.



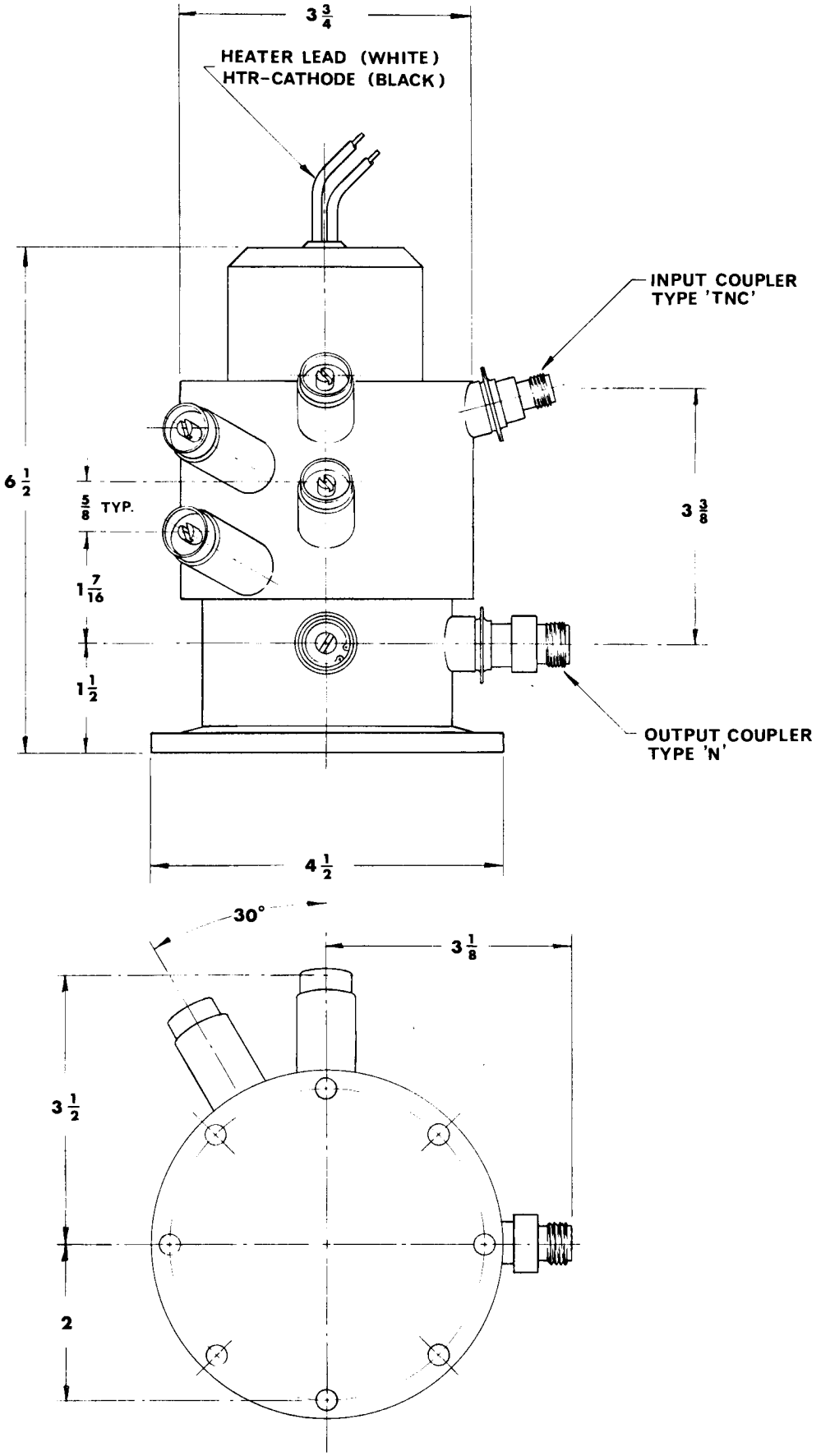
DRIVING POWER — 400 mW
OUTPUT POWER — 200 W
GAIN — 27 db
EFFICIENCY — 36 %
1 db BANDWIDTH — 6.8 MHz
3 db BANDWIDTH — 8.8 MHz

RF-OUTPUT POWER vs FREQUENCY. THE CAVITIES ARE TUNED FOR BANDWIDTH





BEAM POWER EFFICIENCY, WITHOUT COLLECTOR DEPRESSION, vs BEAM VOLTAGE.


3 3/4
HEATER LEAD (WHITE)
HTR-CATHODE (BLACK)
INPUT COUPLER
TYPE 'TNC'
6 1/2
5/8 TYP.
1 7/16
1 1/2
3 3/8
OUTPUT COUPLER
TYPE 'N'
4 1/2
30°
3 1/8
3 1/2
2

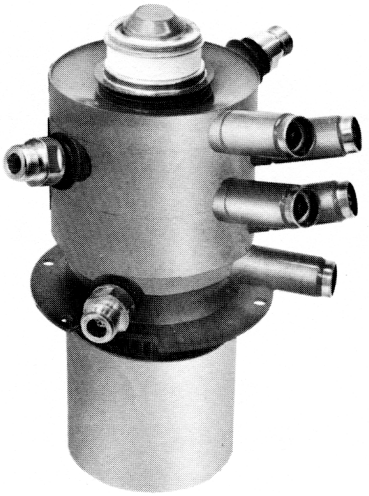
EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

Tentative Data

X3065A

POWER AMPLIFIER
S-BAND KLYSTRON

The EIMAC X3065A is an air cooled, electrostatically focused, power-amplifier klystron designed to operate at frequencies from 2100 to 2110 megahertz. It will deliver a minimum output power of 500 watts with a minimum power gain of 40 decibels. The X3065A is intended for use in applications where light weight and compactness are essential.



FEATURES

- ELECTROSTATIC FOCUSING
- FIVE INTEGRAL CAVITIES
- LOW NOISE LEVEL
- FIXED INPUT AND OUTPUT COUPLING
- INSTANT FAULT RECYCLING

CHARACTERISTICS

ELECTRICAL

Frequency	2100-2110 MHz
Minimum Output Power	500 W
Minimum Power Gain	30 db
Cathode: Oxide, Unipotential	
Starting Time	1 minute
Heater: Voltage	7 Vac
Current	1 Aac
Maximum Starting Current	2 Aac

MECHANICAL

Operating Position	Any
Cavity Tuning Torque (maximum)	1 inch pounds
Cooling	Forced Air (20°C at sea level)
Collector Flow	100 cfm
Collector Pressure Drop	1 inches H_2O
Maximum Dimensions:	
Length	9.0 inches
Width	6.5 inches
Depth	5.5 inches
Rf Input Coupling	Connector TNC
Rf Output Coupling	7/8 inch, 50-ohm line
Weight	5 pounds

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MAXIMUM RATINGS

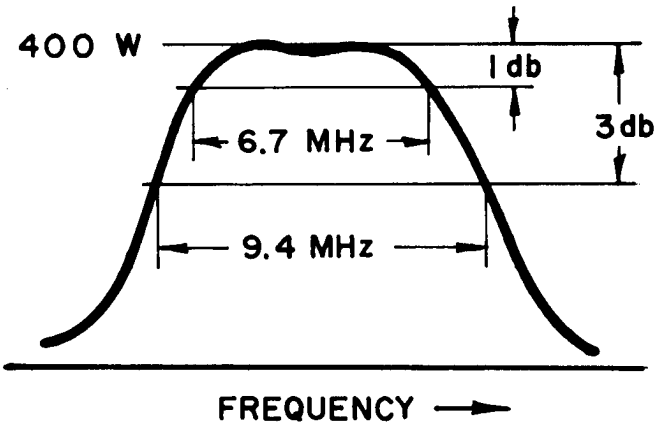
DC BEAM VOLTAGE	6.0 kVdc
DC BEAM CURRENT	0.325 mAdc
DC BEAM INPUT POWER	1.95 kW
COLLECTOR DISSIPATION	1.95 kW
CATHODE SEAL TEMPERATURE	150 °C
LOAD VSWR	2:1

TYPICAL OPERATION
A — Tuned For Maximum Output Power

Frequency	2105	2105	MHz
DC Beam Voltage	4.75	4.9	kVdc
DC Beam Current	230	250	Madc
Driving Power	500	50	mW
Output Power	500	500	W
Gain	30	40	db
Beam Power Efficiency	46	41	%
3 db Bandwidth	7.5	3.7	MHz

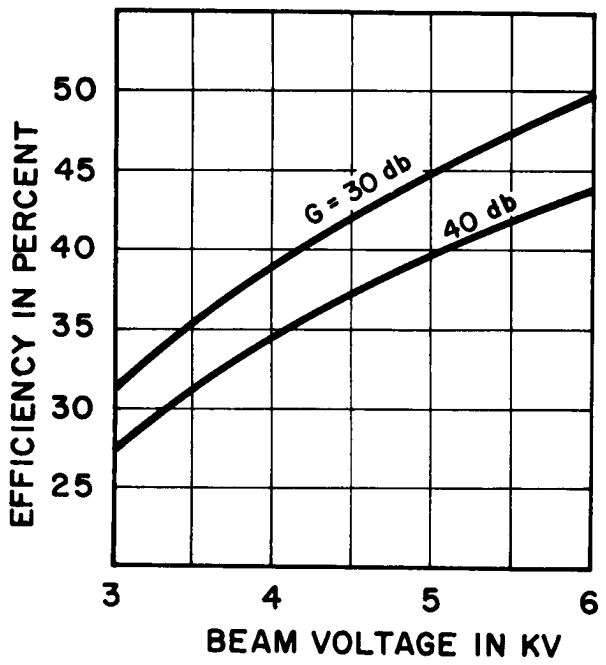
TYPICAL OPERATION
B — Tuned For Bandwidth

Frequency	2105	MHz
DC Beam Voltage	5.3	kVdc
DC Beam Current	270	mAdc
Driving Power	500	mW
Output Power	500	W
Gain	30	db
Beam Power Efficiency	35	%
1 db Bandwidth	6.7	MHz
3 db Bandwidth	9.4	MHz

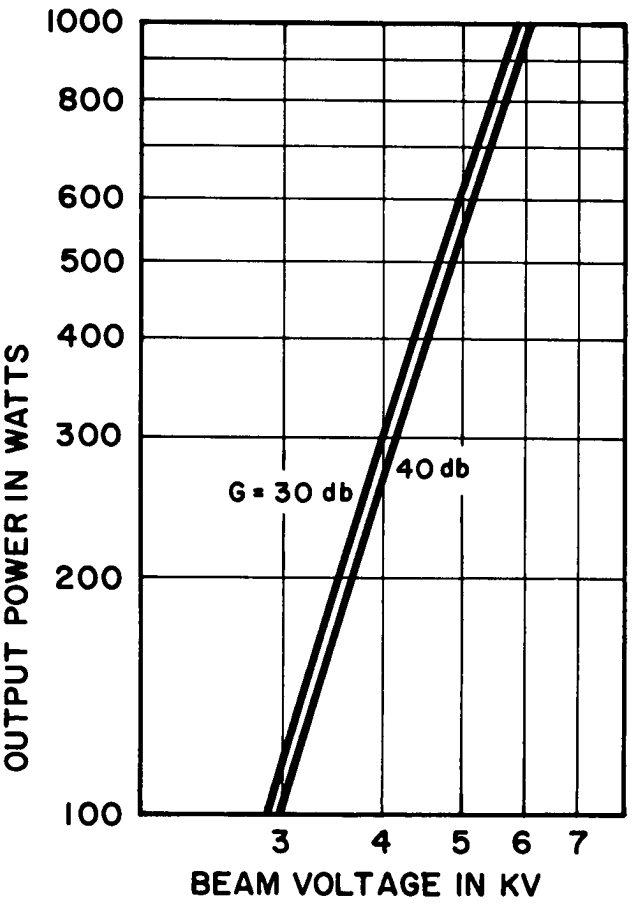


DRIVING POWER — 500 mW
OUTPUT POWER — 400 W
GAIN — 29 db
EFFICIENCY — 35 %
1 db BANDWIDTH — 6.7 MHz
3 db BANDWIDTH — 9.4 MHz

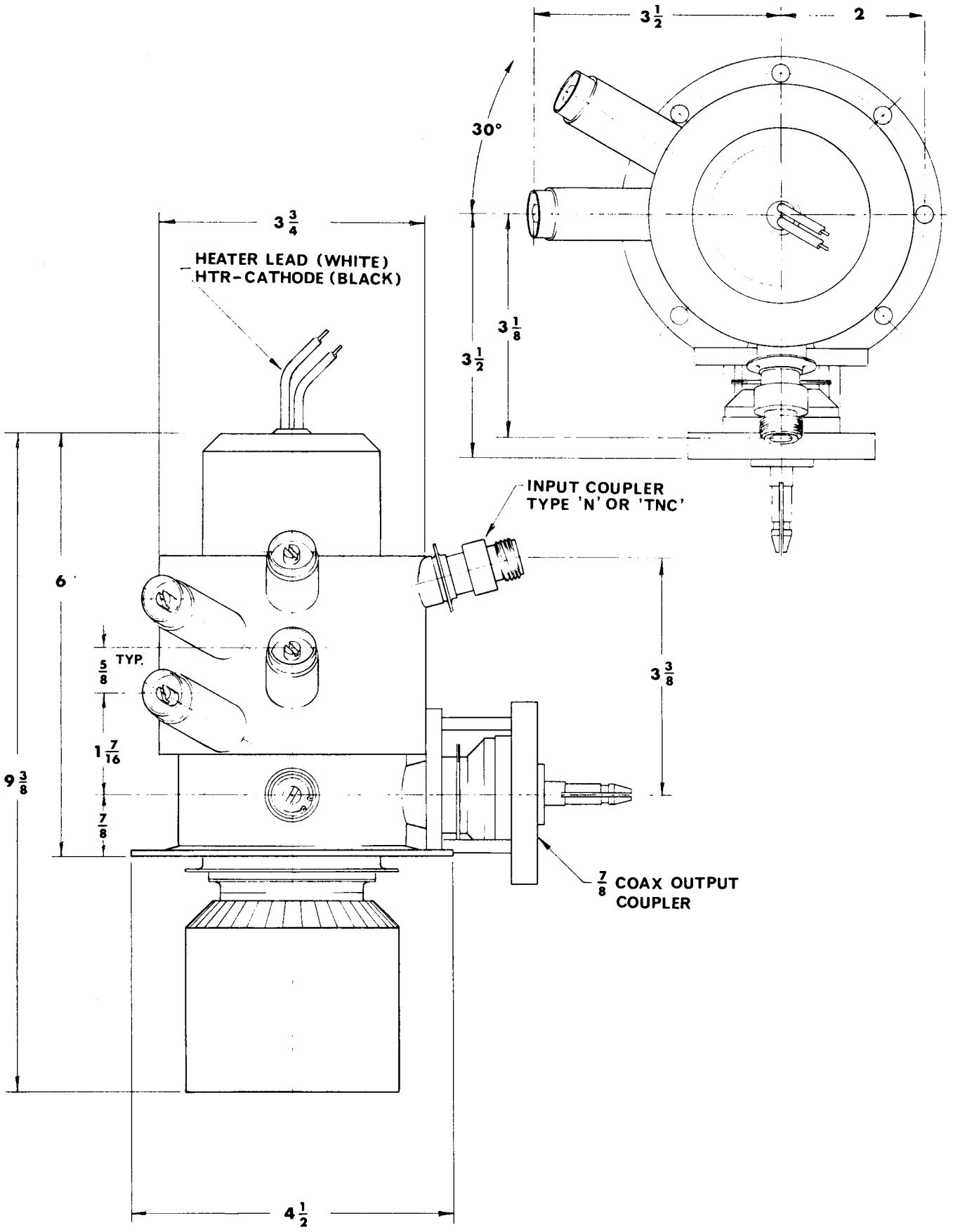
RF-OUTPUT POWER vs FREQUENCY. THE CAVITIES ARE TUNED FOR BANDWIDTH.

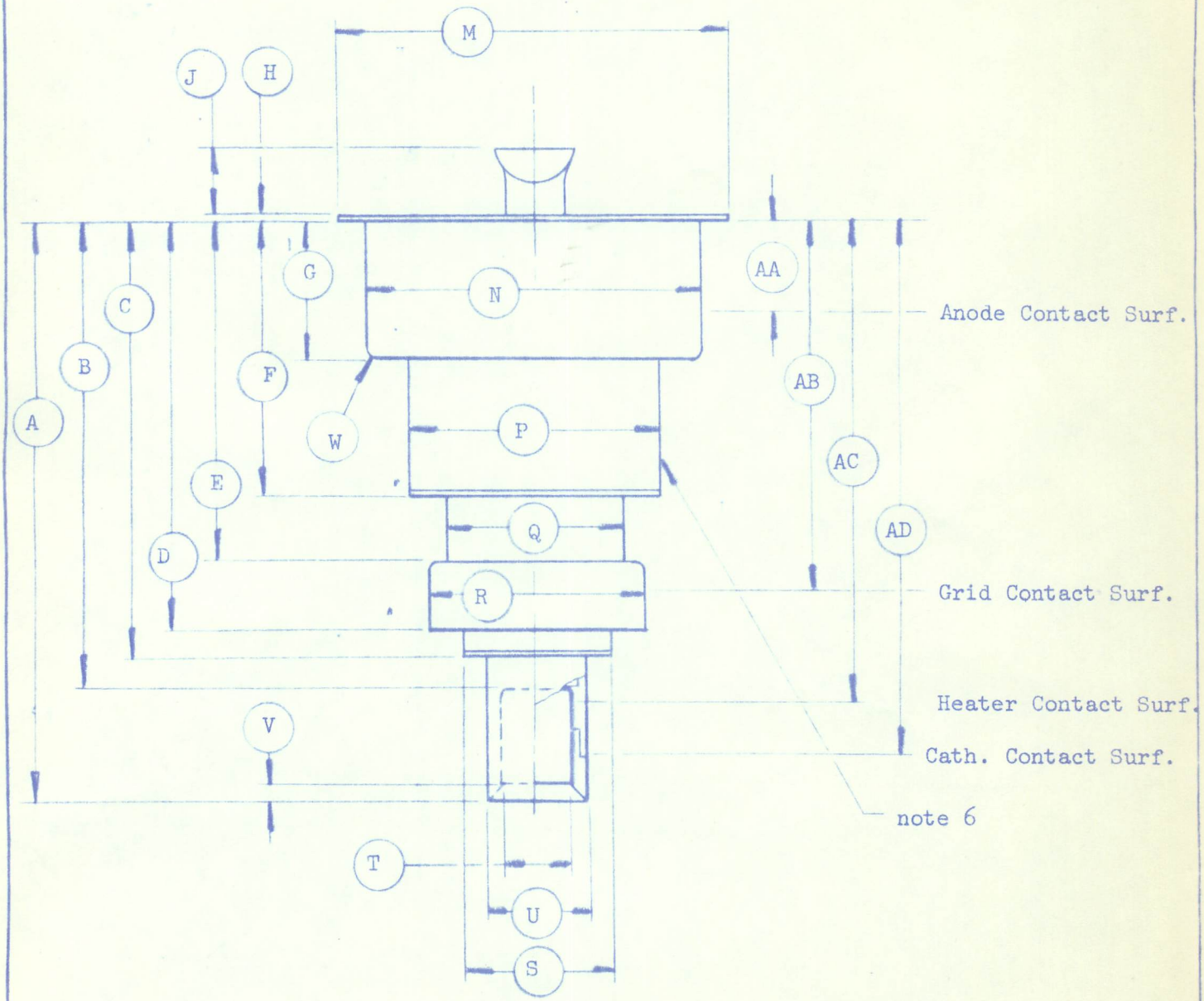


CAVITIES TUNED FOR MAXIMUM EFFICIENCY



CAVITIES TUNED FOR MAXIMUM EFFICIENCY


3 1/2
2
30°
3 3/4
HEATER LEAD (WHITE)
HTR-CATHODE (BLACK)
3 1/8
3 1/2
INPUT COUPLER
TYPE 'N' OR 'TNC'
6
5/8 TYP.
3 3/8
1 7/16
9 3/8
7/8
7/8 COAX OUTPUT
COUPLER
4 1/2



NO.	DESCRIPTION OF CHANGE	SCO	DATED	BY

DRAWN: BM 2-1-75 SCALE: NONE DIVISION: 4

CHK'D:

ENGR. APPR.:

SUPERSEDES

EIMAC Division of Varian
SALT LAKE CITY, UTAH

CODE IDENT NO. 08594

PART NO. Y466

ELECTRON TUBE

NO. Y466-60 CHANGE —

Electrode Contact Dims.

Dim. in mm Min.	Dim. in mm Max.	Dim	Dim. in Inches Min.	Dim. in Inches Max.
0.89	9.17	AA	.035	.361
30.10	32.14	AB	1.185	1.265
38.96	43.89	AC	1.534	1.728
37.47	46.10	AD	1.475	1.815

Notes.

1. Metric equivalents to the nearest .01mm are given for general info. only & are based on 1 inch =25.4mm
4. Eccentricity of contact sirfaces shall be gaged from center line of reference & shall be as follows:

Contact Surface	TIR Max.	Reference
Anode	.020	Cathode
Grid	.020	Cathode
Heater	.012	Cathode

5. Dias. N,R,T,U shall apply throughout entire lenght as defined by dims.AB,AC,AD,AB.
6. This surface shall not be used for clamping or locating.
7. Electrode Contact dims. are given for socket design purposes & are not intended for inspection purposes

Dimension Data

Dim. in mm Min.	Dim. in mm Max.	Dim	Dim. in Inches Min.	Dim. in Inches Max.
46.10	47.62	A	1.815	1.875
	38.96	B		1.534
	37.46	C		1.475
32.74	33.76	D	1.289	1.329
27.56	28.83	E	1.085	1.135
22.35	23.37	F	.880	.920
11.73	12.12	G	.462	.477
	1.02	H		.040
[redacted]			[redacted]	
	7.75	J		.305
[redacted]			[redacted]	
29.97	30.35	M	1.180	1.195
26.04	26.29	N	1.025	1.035
19.20	20.12	P	.752	.792
13.74	14.25	Q	.541	.561
16.64	16.89	R	.655	.665
•	13.84	S		.545
5.41	5.66	T	.213	.223
8.00	8.26	U	.315	.325
	2.54	W		.100
[redacted]			[redacted]	
	2.18	V		.086

NO.	DESCRIPTION OF CHANGE	SCO	DATED	BY

DRAWN: BM 2-1-75 SCALE: NONE DIVISION: 4

CHK'D:

ENGR. APPR.:

SUPERSEDES

EIMAC Division of Varian
SALT LAKE CITY, UTAH

CODE IDENT NO. 08594

PART NO. Y466

ELECTRON TUBE

NO. Y466-60 CHANGE —

Y503

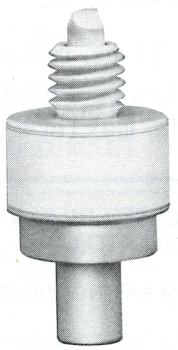
TECHNICAL DATA

HIGH-MU
PLANAR TRIODE

The EIMAC Y503 is a small frequency stable rugged planar triode which has been specially processed and tested to assure the high reliability demanded and required in airborne service. The tube is supplied without radiator for conduction and/or convection or heat sink cooling.

The tube may be used as an amplifier, oscillator, or frequency multiplier in grid or plate pulsed applications. In addition to the low interelectrode capacitances, high transconductance and Mu, the tube exhibits such special design features as a frequency-stable anode and an arc-resistant cathode to assure stable operation under adverse conditions and minimize catastrophic failure due to arcover if it should occur due to circuit malfunction.

The tube is usable from low frequency to 3 GHz.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	6.0 ± 0.3 V
Current, at 6.0 volts	1.00 A
Transconductance (Average):	
I_b = 70 mA	25 mmhos
Amplification Factor (Average):	80
Direct Interelectrode Capacitances (Grounded Cathode)[2]	
Cin	6.8 pF
Cout	0.04 pF
Cgp	2.50 pF
Cut-off Bias[3]	-30 V max.

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.
3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

MECHANICAL

Maximum Overall Dimensions:	
Length	1.810 in; 45.97 mm
Diameter	0.792 in; 20.12 mm

(Effective 5-1-75) © by Varian

Printed in U.S.A.

Net Weight	18 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Conduction, convection
Terminals	Coaxial, special

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axes 55 to 500 Hz	10 G
Altitude, max (in a suitably designed circuit)	50,000 ft.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE (grid pulsed)	2500 VOLTS
PEAK PULSE PLATE VOLTAGE (plate pulsed)	3500 VOLTS
DC GRID VOLTAGE	-150 VOLTS
INSTANTANEOUS PEAK GRID CATHODE VOLTAGE	
Grid negative to cathode	-700 VOLTS
Grid positive to cathode	250 VOLTS
PULSE PLATE CURRENT	3.0 AMPERES
PULSE GRID CURRENT	1.5 AMPERES
PLATE DISSIPATION (Average)	
Conduction & Convection	10 WATTS *
GRID DISSIPATION	2.0 WATTS
FREQUENCY	3.0 GIGAHERTZ
PULSE DURATION [1]	6 μsec
DUTY FACTOR [1]	.0033

TYPICAL OPERATION Grid Pulsed Oscillator, Representative Application

Plate Voltage	2000 Vdc
Grid Voltage	-75 Vdc
Heater Voltage	5.7 V
Peak Video Plate Current	1.3 a
Peak Video Grid Current	0.8 a
Useful Power Output (approx.)	750 w
Frequency	1.090 GHz
Pulse Duration	0.5 μs
Duty Factor	.001

1. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube and Device Field Office, or the Product Manager EIMAC Division of Varian, Salt Lake City, Utah.

* Plate dissipation of up to 100 Watts is permissable with adequate cooling.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.0 volts	0.90	1.05	A
Cathode Heating Time	60	---	sec.
Interelectrode Capacitances [1] (grounded cathode connection)			
Cin	6.00	7.50	pF
Cout	---	0.04	pF
Cgp	2.25	2.60	pF

1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

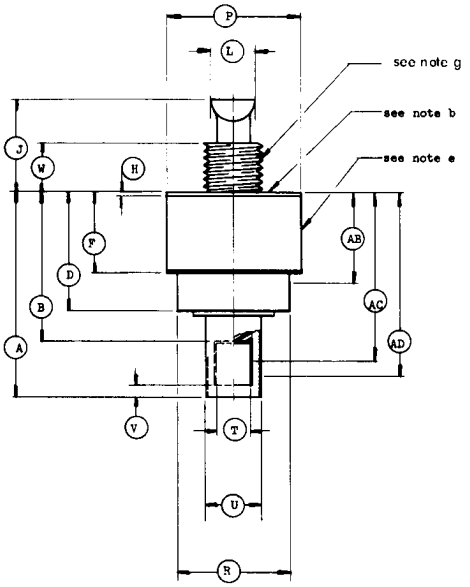
APPLICATION

For general application information please refer to the Planar Triode Operating Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube type. For unusual and special applications consult the nearest Varian Electron Tube Field Office, or Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

The cathode and grid terminals should not be altered such as by machining or filing, since final seal could be damaged. Maximum torque applied to the tube during installation should not exceed 15 inch pounds.

For optimum performance, the anode line should make good rf contact on the anode area.

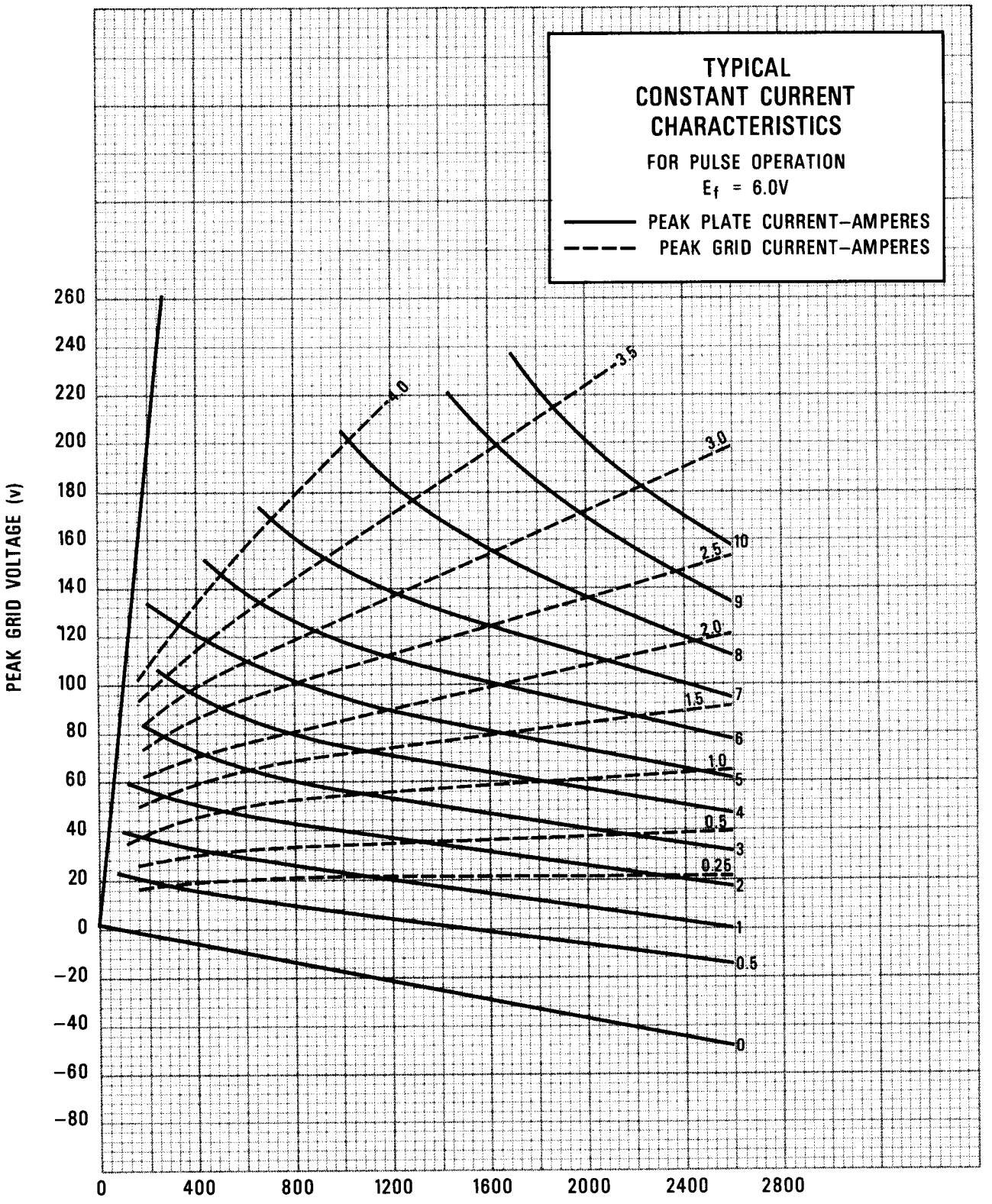
Soldered connections may be made to the anode stud, grid or cathode terminals, and heater contact where adequate heat sinking and good soldering practices are followed to minimize the heat applied to the tube and the thermal gradient across the metal to ceramic brazed areas.



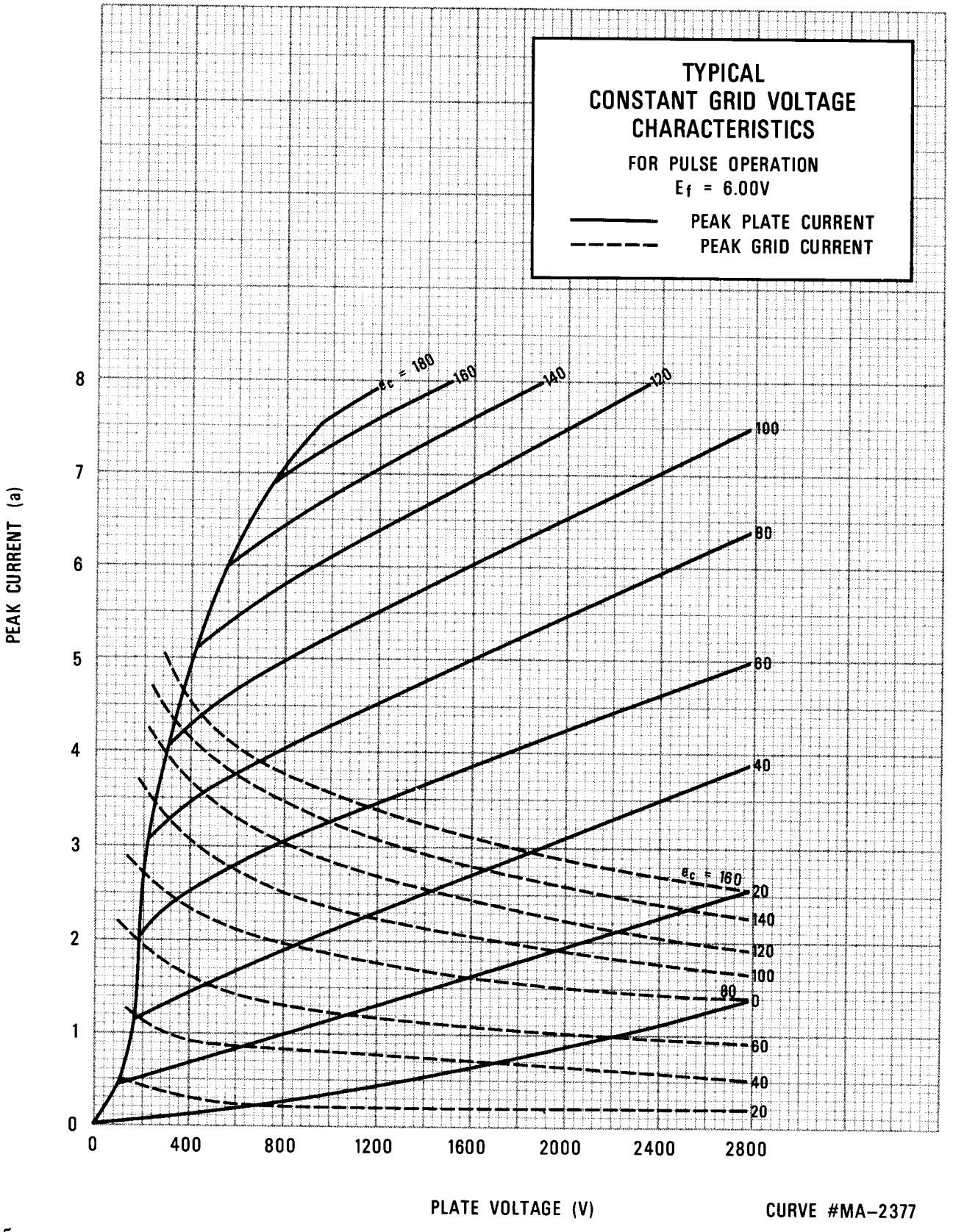
DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	1.125	1.210	- -	28.58	30.73	- -
B	- -	0.865	- -	- -	21.97	- -
D	0.782	0.822	- -	19.86	20.88	- -
F	- -	0.475	- -	- -	12.07	- -
H	- -	- -	0.030	- -	- -	0.762
I	0.345	0.375	- -	8.76	9.53	- -
J	- -	0.600	- -	- -	15.24	- -
L	- -	0.260	NOTE e	- -	6.60	NOTE e
P	0.752	0.792	NOTE e	19.10	20.12	NOTE e
R	0.655	0.665	NOTE d,b	16.64	16.89	NOTE d,b
T	0.213	0.223	NOTE d,b	5.41	5.66	NOTE d,b
U	0.315	0.325	NOTE d,b	8.00	8.26	NOTE d,b
V	- -	0.086	- -	- -	2.18	- -
ELECTRODE CONTACT AREA DIMENSIONS						
AB	0.695	0.775	NOTE b	17.65	19.68	NOTE b
AC	0.860	1.046	NOTE b	21.84	26.57	NOTE b
AD	0.800	1.090	NOTE b	20.32	27.69	NOTE b

NOTES:

a. Metric equivalents to the nearest .01mm are given for general information only & are based on 1 inch = 25.4 mm.
b. This surface shall be used to measure Anode shank temperature.
c. The total indicated runout of the Grid contact surface (DIMS AB & R) and Cathode contact surface (DIMS AC & U) will not exceed .020. This measurement is made with the gage (J-21685) screwed on the Anode thread so that the face of the gage makes full contact with the Anode contact surface. Runout is then measured by the O.D. of the gage as the reference surface. The total indicated runout of the Cathode contact surface using the Heater contact surface as the reference will not exceed .012.
d. Dias. R, T, U shall apply throughout entire contact area as defined by dims. AB, AC, AD.
e. This surface shall not be used for clamping or locating.
f. Electrode Contact Dims. are given for socket design & are not intended for inspection purposes.
g. Thread 3/8-16 UNC-2A.



CURVE #MA–2376



CURVE #MA-2377

Y-540

TECHNICAL DATA

PLANAR TRIODE



The Y-540 is a high voltage planar triode especially designed for switch or series regulator service,for general purpose as well as radar applications. Being essentially a UHF triode, the tube capacitances and inductances are small, which enhances operation in the nanosecond region. Other noteworthy features include an extended grid-anode insulator making 10 kV operation at sea level possible, and a matrix cathode of the arc-resistant, extended interface type. The tube exhibits the standard features of a planar triode, such as high transconductance, high mu, and high cathode current capability, coupled with great mechanical strength, permitting reliable operation at elevated temperatures.

The compact ceramic/metal construction and solder tabs provided on grid, cathode-heater, and heater terminals make this tube especially suited for ECM and other switch applications. The tube is small in size and light-weight. The cathode is an indirectly heated disc requiring minimal heater power. These are all factors of great importance in airborne applications.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential		
Heater: Voltage	6.3 ± 5%	V
Current, at 6.3 volts	1.3	A
Cathode Heating Time	60	Sec
Transconductance (Average):		
I_b = 100 mA	30	mmhos
Amplification Factor (Average):	145	
(Cut-off)[3]	110	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	9.5	pF
Cout	0.06	pF
Cgp	1.00	pF

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.

2. Capacitance values are for a cold tube as measured in a special shielded fixture (Eimac Dwg. #EC-043-919-0002). When the cathode is heated to the proper temperature the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

(Effective 4-1-74) © 1974 by Varian Printed in U.S.A.

MECHANICAL

Maximum Overall Dimensions:

Length	1.56 in; 39.62 mm
Diameter	0.785 in; 19.94 mm
Net Weight	0.56 oz; 16.0 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Conduction, Forced Air with appropriate heat sink adaptor or radiator (Rad. P/N 157254. H.S.P/N SK-3020)

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 6.3 volts	1.20	1.40	A
Cathode Warmup Time	60	---	sec.
Maximum Inrush Current	---	10.0	A
Interelectrode Capacitance[1] (grounded cathode connection)			
Cin	---	10.5	pF
Cout	---	0.06	pF
Cgp	---	1.65	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture (P/N EC-043-919-0002) in accordance with Electronic Industries Association Standard RS-191.

PULSE MODULATOR AND PULSE AMPLIFIER SERVICE

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10	KILOVOLTS
PEAK PLATE VOLTAGE	12	KILOVOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	150	VOLTS
PULSE CATHODE CURRENT	7.5	AMPERES
DC PLATE CURRENT	150	MILLAMPERES
DC GRID CURRENT	45	MILLAMPERES

AVERAGE PLATE DISSIPATION		
Conduction and Convection Cooling	10	WATTS
Forced Air Cooling[1]	150	WATTS
GRID DISSIPATION	1.5	WATTS
PULSE DURATION[2]	6.0	μs
CUT-OFF Mu	110	
DUTY[2]	.0033	

1. Only with Radiator #157271 attached with heat conducting grease such as Insulgrease S-641 (G.E.).
2. For applications using longer plus duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

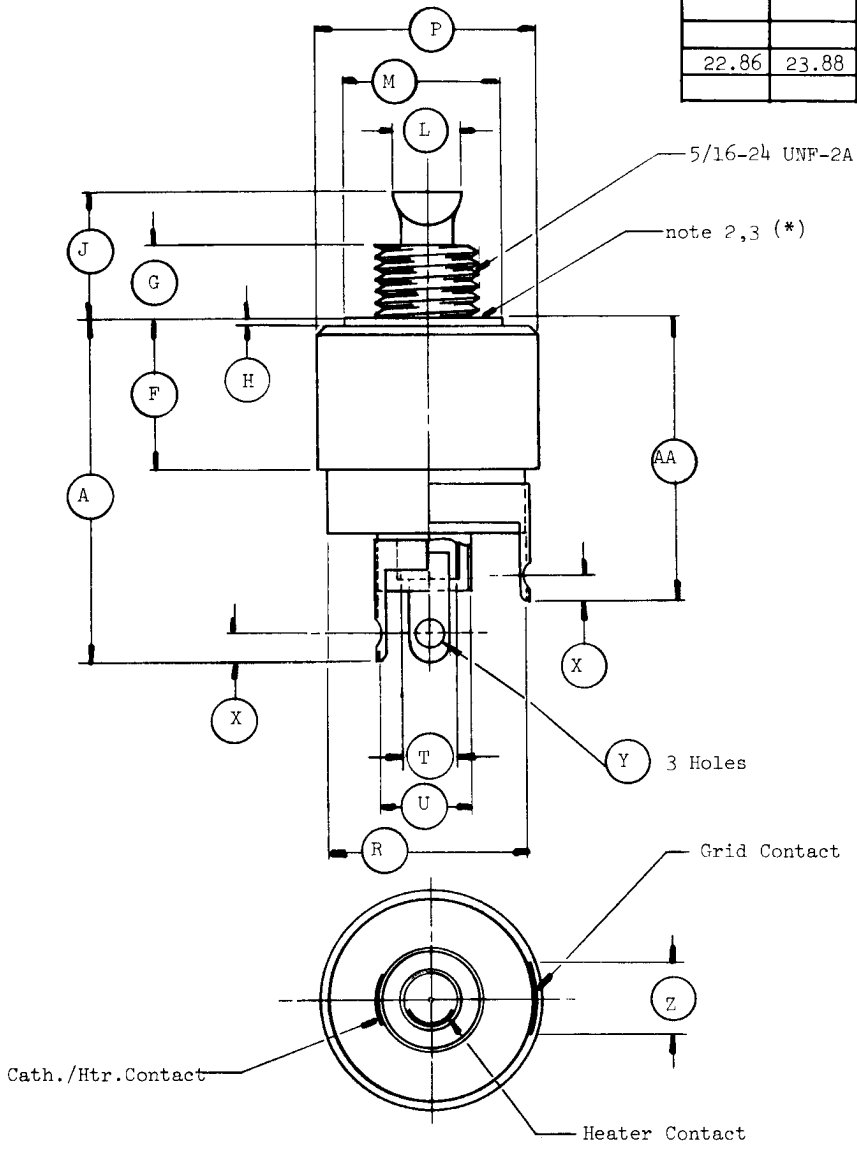
APPLICATION

For general application information please refer to the Planar Triode Operating Instruction Sheet. The operating instructions should be consulted prior to the designing of new requirements around the above tube type. For unusual and special applications consult the nearest Varian Electron Tube Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

NOTES:

1. Ref. dimensions are for information only & are not req'd for inspection purposes.
2. (*) contact surface
3. Anode flange is for electrical contact. Stud is for heat transfer.
4. Metric equivalents to the nearest mm. are for information only & are based on 1 inch= 25.4mm.

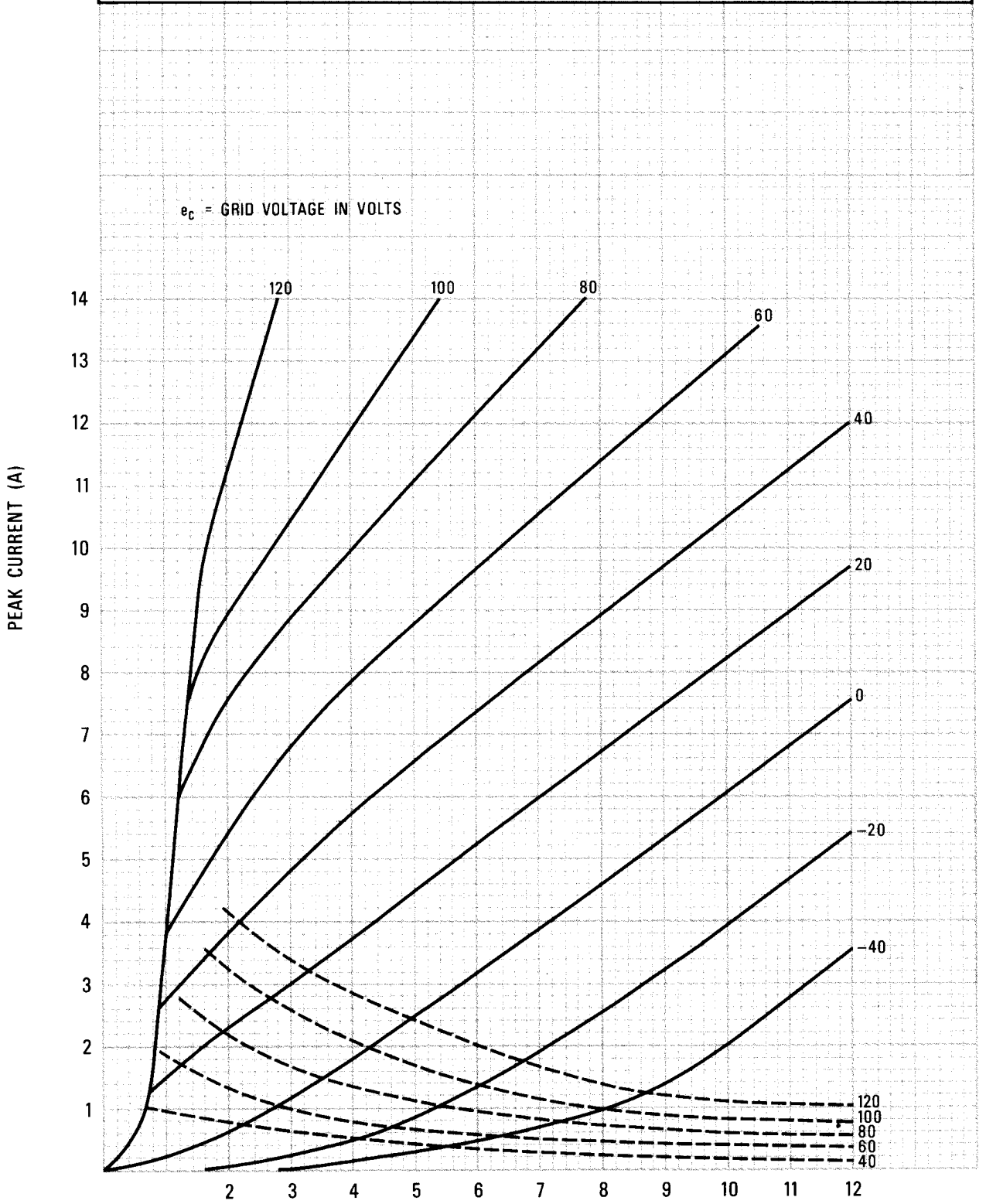
DIMENSIONS IN MILLIMETERS			DIM.	DIMENSIONS IN INCHES		
MIN.	MAX.	REF.		MIN.	MAX.	REF.
28.45	29.46		A	1.120	1.160	
	14.48		F		.570	
6.10	6.86		G	.240	.270	
	1.02		H		.040	
	10.16		J		.400	
	6.60		L		.260	
13.84	14.48		M	.545	.570	
19.69	19.94		P	.775	.785	
		16.76	R			.660
		5.54	T			.218
		8.13	U			.320
1.78	2.79		X	.070	.110	
		2.29	Y			.090
6.10	8.18		Z	.240	.322	(flat)
22.86	23.88		AA	.900	.940	



TYPICAL CONSTANT GRID VOLTAGE CHARACTERISTICS

FOR PULSE OPERATION E_f = 6.3V

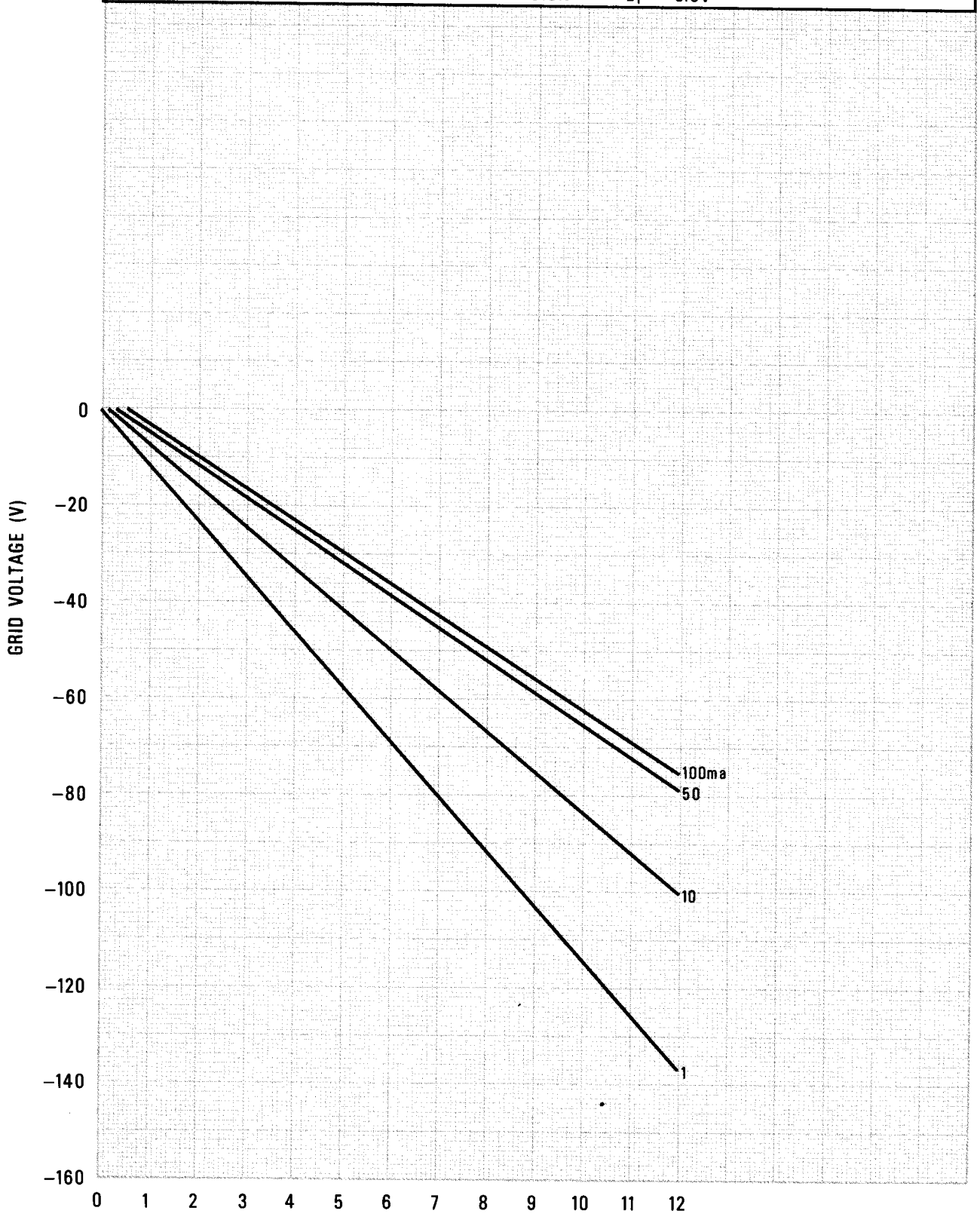
——— PEAK PLATE CURRENT – AMPERES – – – – PEAK GRID CURRENT – AMPERES



CURVE #MA–2664

TYPICAL CONSTANT PLATE CURRENT CHARACTERISTICS

NEGATIVE GRID REGION E_f = 6.3V

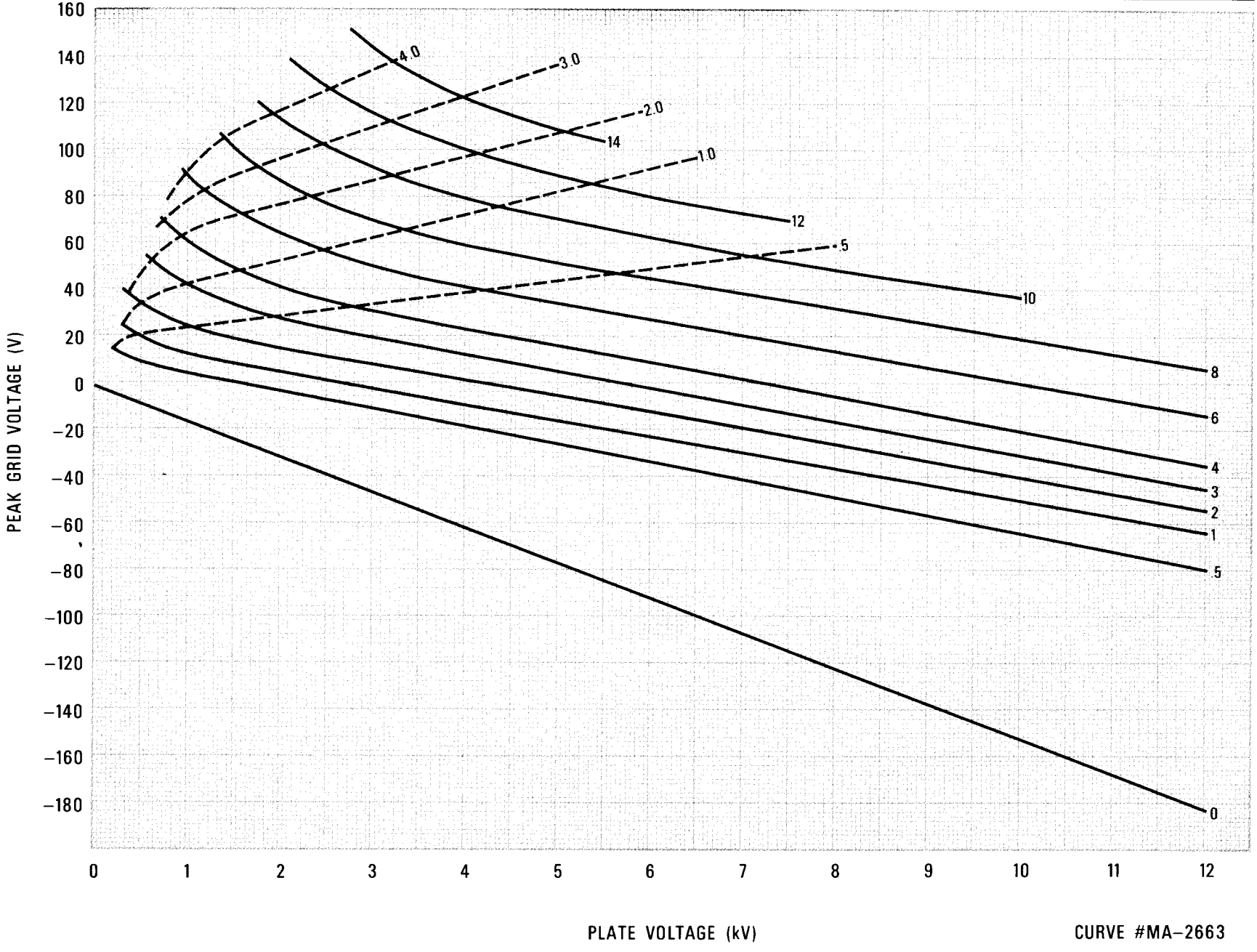


CURVE #MA-2397

TYPICAL CONSTANT CURRENT CHARACTERISTICS

FOR PULSE OPERATION E_f = 6.3V

PEAK PLATE CURRENT – AMPERES — — — — PEAK GRID CURRENT – AMPERES



CURVE #MA–2663

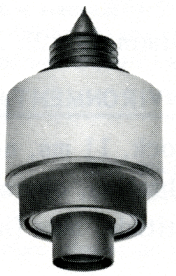
Y654

TECHNICAL DATA

PLANAR TRIODE
HIGH MU

The Y654 is a miniature ceramic/metal rugged planar triode for advanced airborne, ground, and space applications up to 3.0 GHz.

The Y654 may be used as an amplifier, oscillator, or frequency multiplier in the C-W mode, grid- or plate-pulsed mode, as well as a modulator or regulator tube. In addition to the low interelectrode capacitance, high transconductance and amplification factor the Y654 has an arc-resistant cathode to assure stable, reliable, and long-life operation under adverse conditions, and a specially supported grid structure.



The Y654 is supplied without radiator and may be conduction, convection, heat sink, or liquid cooled. Radiators for forced air cooling, as well as heat sink adaptors, permitting an anode dissipation up to 300 watts, can be furnished on separate order.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater: Voltage	6.3 ± 0.3 V
Current, at 6.3 volts	1.30 A
Transconductance (Average):	
(200 mA/cm^2)	50
Amplification Factor (Average)	135
Direct Interelectrode Capacitance (grounded cathode)[2]	
Cin	9.75 pF
Cout	0.065 pF max.
Cgp	1.05 pF
Cut-off Bias[3]	-20 V
Frequency of Maximum Rating:	
CW	2500 MHz
Plate or Grid-Pulsed	3000 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.
3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

MECHANICAL

Maximum Overall Dimensions:	
Length	1.370 in; 34.75 mm
Diameter	0.785 in; 19.94 mm

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Net Weight	0.56 oz; 16.0 gm
Operating Position	Any
Maximum Operating Temperature:	
Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Conduction, convection, forced air, or liquid
Terminals	Coaxial special

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axes 55 to 500 Hz	10 G
Altitude, max (in a suitably designed circuit)	70,000 ft.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater Current at 6.3 volts	1.20	1.40	A
Cathode Warmup Time	60	---	sec.
Interelectrode Capacitance[1] (grounded cathode connection)			
Cin	8.5	11.0	pF
Cout	---	0.065	pF
Cgp	0.90	1.20	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pf due to the thermal expansion of the cathode.

GRID PULSED OR PLATE PULSED AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE (grid pulsed)	8000	VOLTS
PEAK PULSE PLATE VOLTAGE (plate pulsed)	10,000	VOLTS
DC GRID VOLTAGE	-200	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	150	VOLTS
PULSE PLATE CURRENT	6.0	AMPERES
PULSE GRID CURRENT	2.5	AMPERES
AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	300	WATTS
GRID DISSIPATION (Average)	1.5	WATTS
FREQUENCY	3.0	GHz
PULSE DURATION[2]	6.0	μs
DUTY FACTOR[2]	.0033	

OPERATING CONDITIONS IN REPRESENTATIVE APPLICATION

GRID PULSED AMPLIFIER

Frequency	1.1	GHz
Heater Voltage	6.3	V
DC Plate Voltage	4000	Vdc
DC Grid Voltage	-80	Vdc
Peak Video Plate Current	1.8	a
Plate Efficiency	35	%
Pulse Drive Power (approx.)	200	w
Useful Power Output (approx.)	2500	w
Gain	11	db
Duty Factor	0.02	

1. Using one of the EIMAC radiators shown on the cooling curves.

2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

PULSE MODULATOR AND PULSE AMPLIFIER SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	10,000	VOLTS
PEAK PLATE VOLTAGE	12,000	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	100	VOLTS
PULSE CATHODE CURRENT	9.0	AMPERES
DC PLATE CURRENT	190	MILLIAMPERES

AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	300	WATTS
GRID DISSIPATION (Average)	1.5	WATTS
PULSE DURATION[2]	6.0	μs
CUT-OFF Mu	90	

1. Using one of the EIMAC radiators shown on the cooling curves.
2. For applications using longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube & Devices Field Office, or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

CW RF POWER AMPLIFIER OR OSCILLATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	7500	VOLTS
DC GRID VOLTAGE	-200	VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE		
Grid negative to cathode	-400	VOLTS
Grid positive to cathode	30	VOLTS
DC PLATE CURRENT	300	MILLIAMPERES
DC GRID CURRENT	45	MILLIAMPERES

AVERAGE PLATE DISSIPATION		
Forced Air Cooling[1]	300	WATTS
GRID DISSIPATION (Average)	1.5	WATTS

1. Using one of the EIMAC radiators shown on the cooling curves.

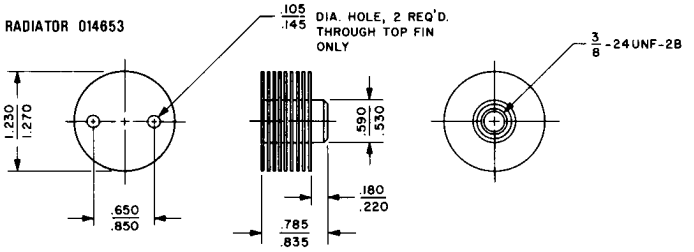
APPLICATION

COOLING - The Y654 can be cooled by conduction, convection, forced air, or liquid cooling. The tube is designed to permit high-temperature operation up to the limit indicated. However, if long life is the prime objective, tube terminal and seal temperatures should be kept well below 250°C. If forced air cooling is provided, auxiliary air flow, apart from the air flowing thru the radiator, should be provided to cool the tube envelope and other tube terminals. Some conduction cooling is always provided thru the contact terminals. However, these terminals usually exhibit poor heat transfer, often having a temperature gradient across them as high as 50°C. Cooling curves are given for four standard radiators which are suitable for use with the Y654. Special cooling designs are available upon request.

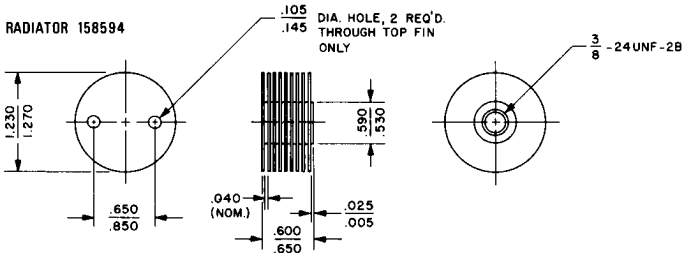
For unusual operating conditions contact the nearest Varian Electron Tube and Devices Field Office or the Product Manager, EIMAC Division of Varian, Salt Lake City, Utah.

For general operating information refer to EIMAC bulletin #15, "Operating Data for Planar Triodes."

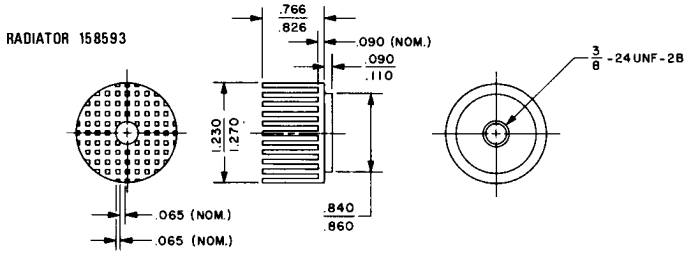
RADIATOR 014653



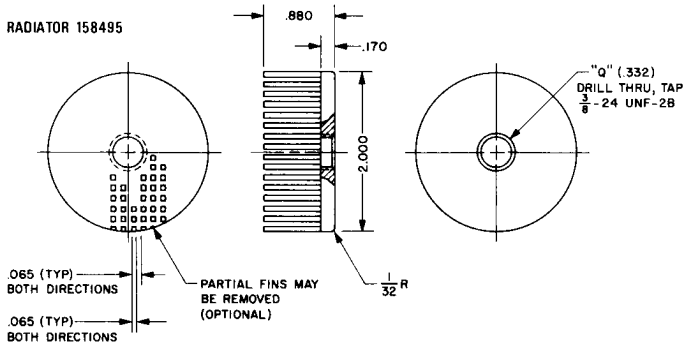
RADIATOR 158594



RADIATOR 158593



RADIATOR 158495



COMBINED CORRECTION FACTORS FOR INLET AIR TEMPERATURE AND ALTITUDE

(RELATIVE TO 25°C AND SEA LEVEL)

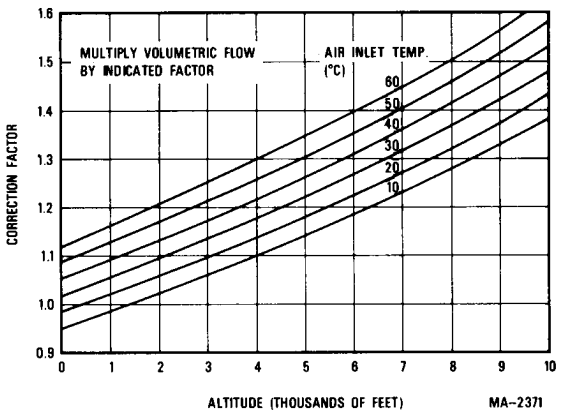
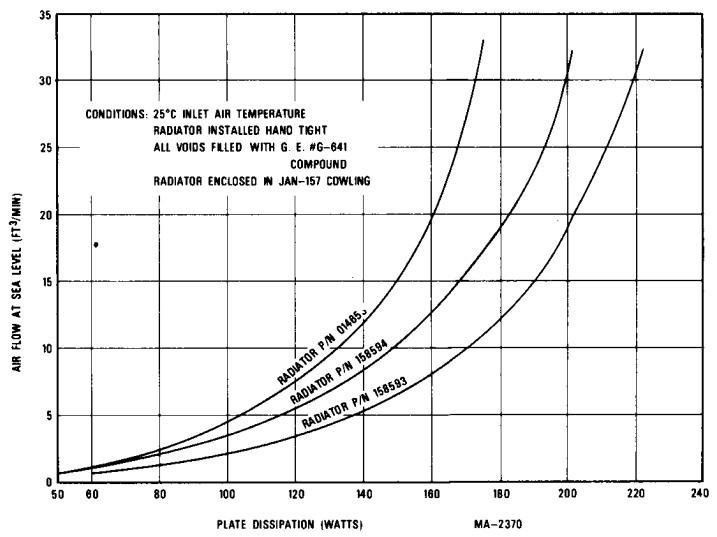
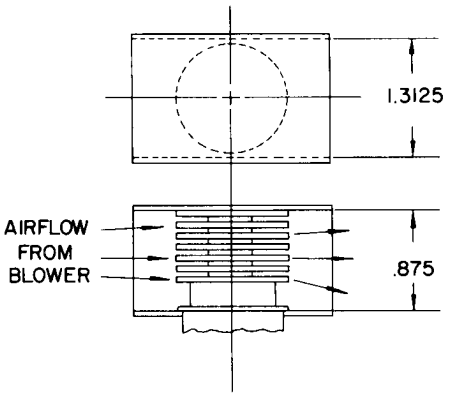


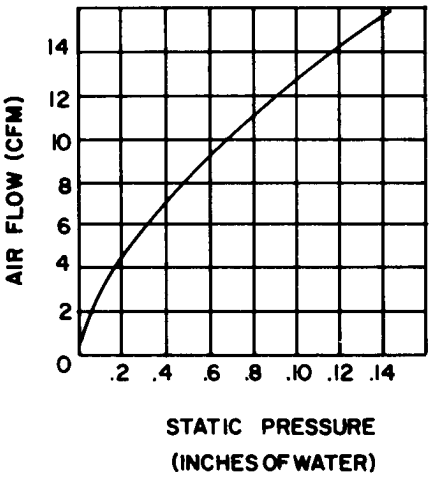
PLATE DISSIPATION VARIATION WITH COOLING AIR FLOW



AIRFLOW vs STATIC PRESSURE WITH STANDARD COWLING JAN-157



-STANDARD COWLING-
FOR 014653, 158594, 158593
RADIATORS



AIRFLOW COWLING FOR EIMAC "PIN" RADIATOR PART #158495

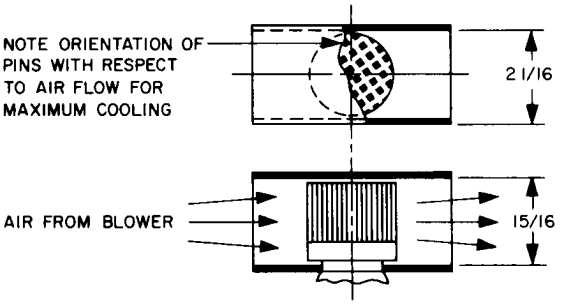
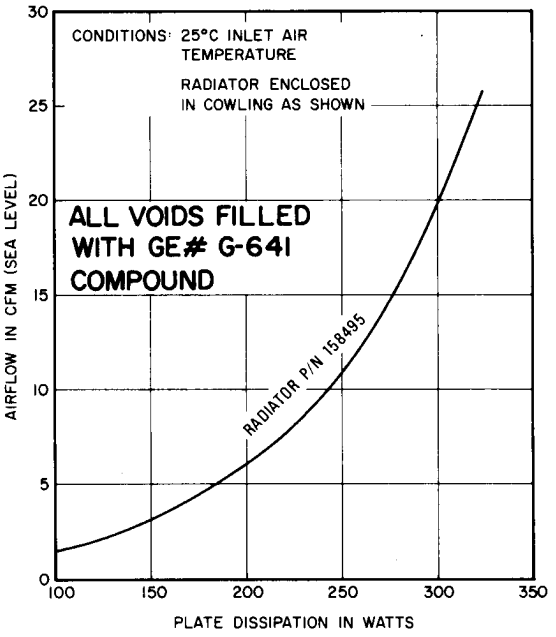
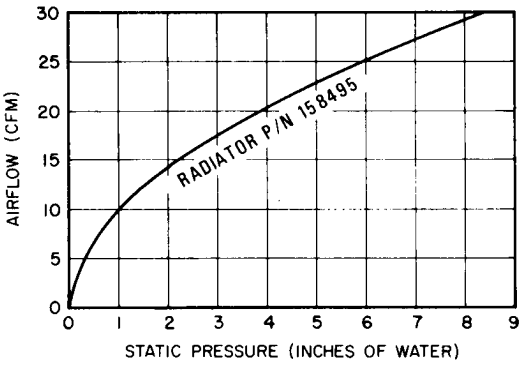


PLATE DISSIPATION VARIATION WITH COOLING AIRFLOW





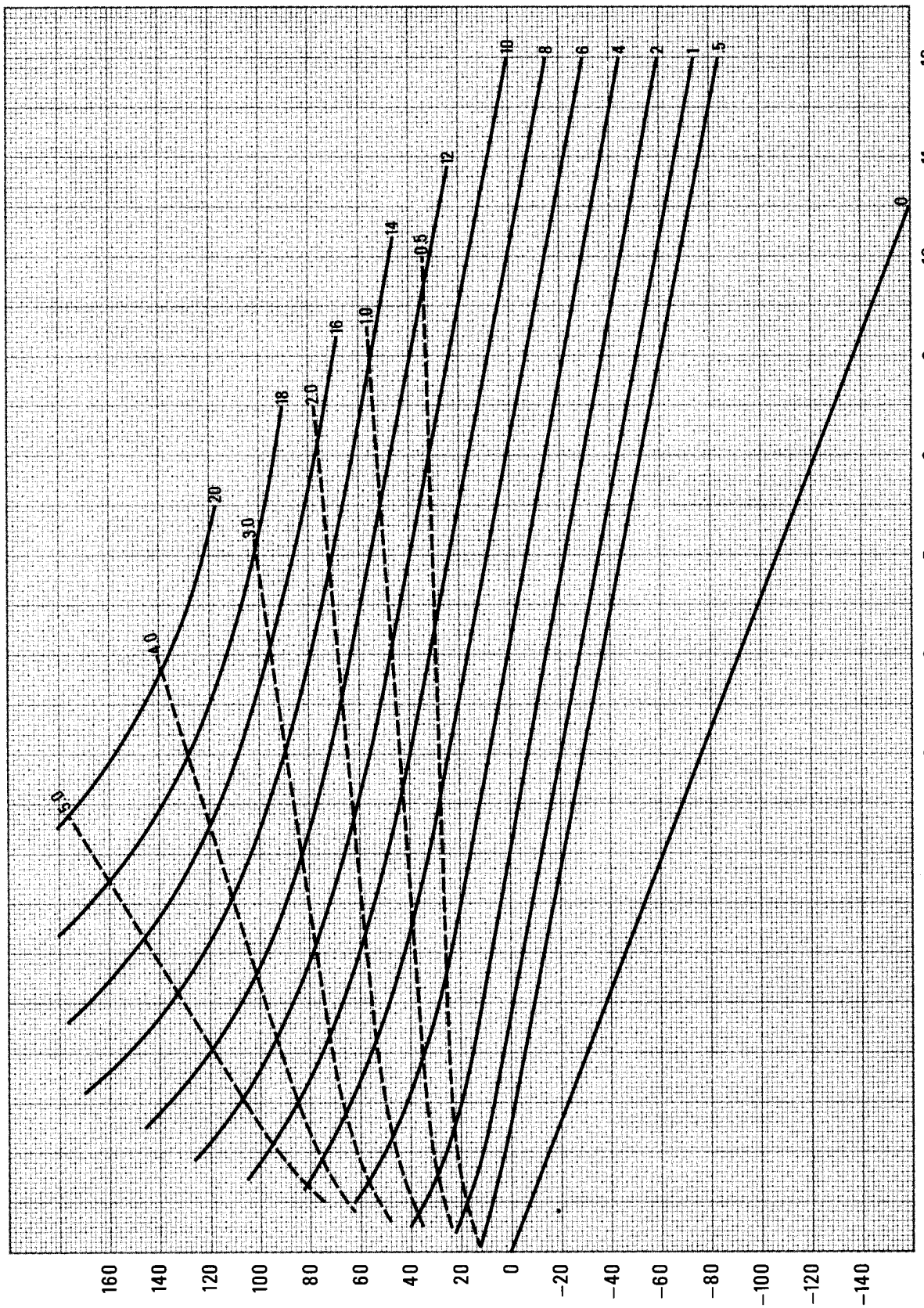
TYPICAL CONSTANT CURRENT CHARACTERISTICS

FOR PULSE OPERATION

E_f = 6.3V

——— PLATE CURRENT – AMPERES

– – – – GRID CURRENT – AMPERES

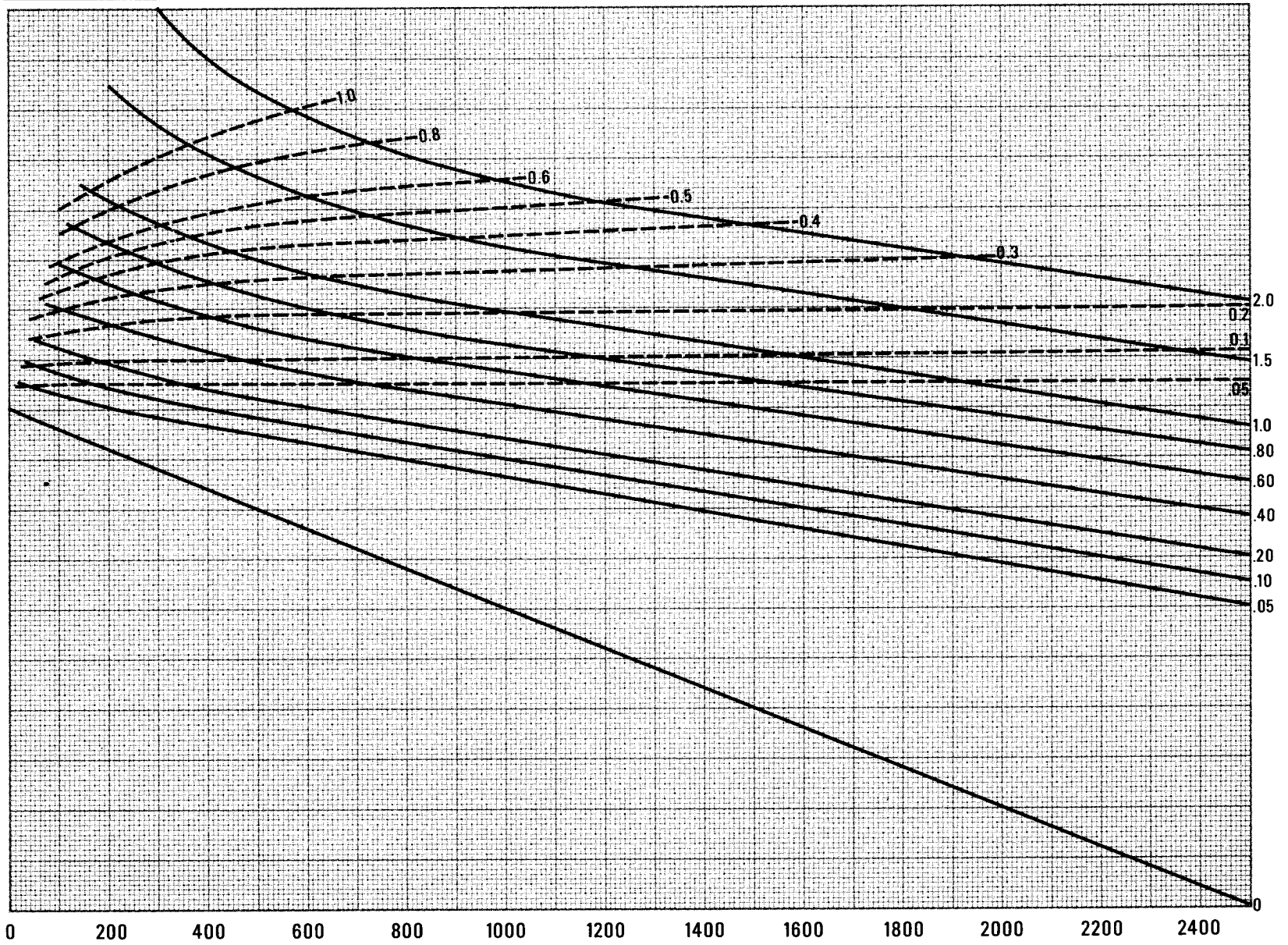


CURVE #MA–2467

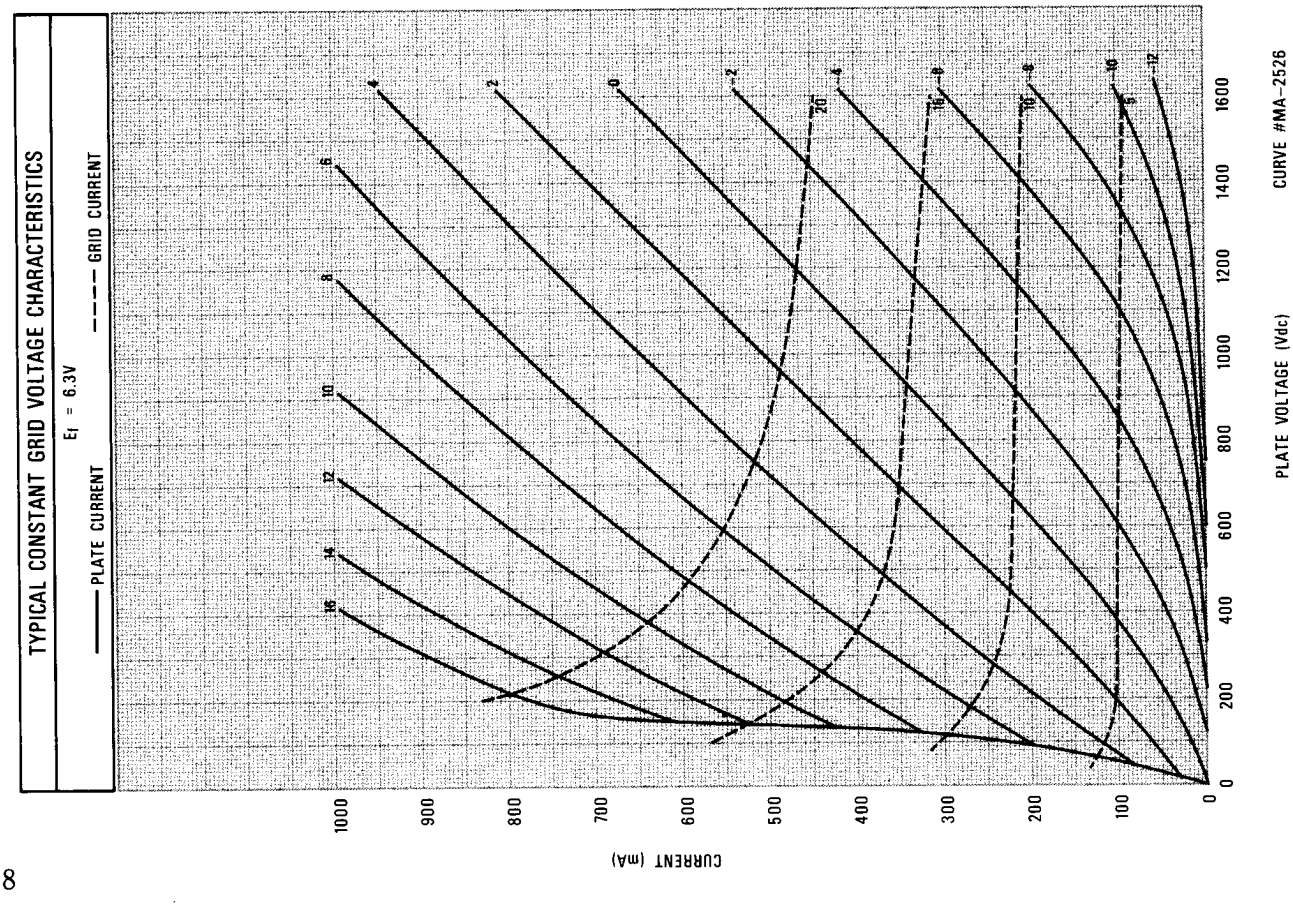
TYPICAL CONSTANT CURRENT CHARACTERISTICS

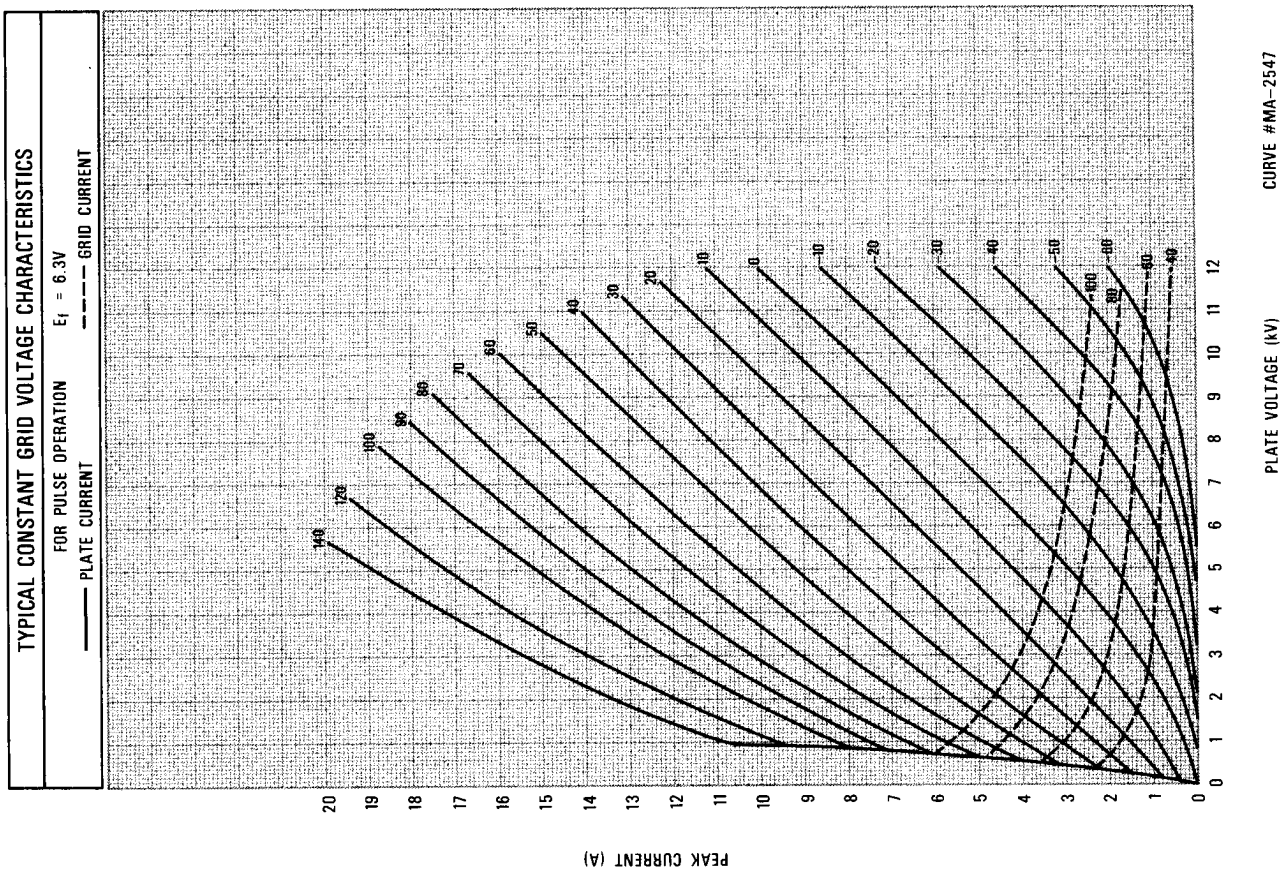
E_f = 6.3V

——— PLATE CURRENT – AMPERES - - - - GRID CURRENT – AMPERES



CURVE #MA–2527


TYPICAL CONSTANT GRID VOLTAGE CHARACTERISTICS
E_f = 6.3V
PLATE CURRENT
GRID CURRENT
CURRENT (mA)
PLATE VOLTAGE (Vdc)
CURVE #MA-2526


TYPICAL CONSTANT GRID VOLTAGE CHARACTERISTICS
FOR PULSE OPERATION
E_f = 6.3V
PLATE CURRENT
GRID CURRENT
PEAK CURRENT (A)
PLATE VOLTAGE (kV)
CURVE #MA-2547

TECHNICAL DATA

Y-834

TETRODE

THIS IS EIMAC'S EQUIV TO TM 3647

The EIMAC Y834 is a ceramic/metal, forced-air cooled, radial-beam tetrode with a rated maximum plate dissipation of 4.5 kW. It is especially designed for UHF LPTV, TV translator and linear amplifier operation requiring low intermodulation distortion up to 1000 MHz. IMD level is better than -52dB.



GENERAL CHARACTERISTICS

ELECTRICAL

Type of Cathode	Thoriated Tungsten
Heating	Direct
Filament Voltage[1]	6.0 ± 2% volts
Filament Current, approximately	34 amps
Peak Cathode Current	6 amps
Interelectrode Capacitances, approximately:	
Input (g2 tied to g1)	40 pF
Output (g2 tied to g1)	8.2 pF
Cathode/Anode	0.02 pF
Amplification Factor (g1 - g2 average)	7
Transconductance, average	40 mmhos

MECHANICAL

Mounting Position	Vertical
Anode Cooling	Forced Air
Minimum Airflow[2]	70 cfm
Corresponding Pressure Drop	0.8" H_2O
Maximum Inlet Air Temperature	45°C
Maximum Outlet Air Temperature	100°C
Maximum Temperature[3]	250°C
Net Weight	5 lbs/2.3Kg
Dimensions	See Drawing

[1]In the high frequency operation the cathode is subjected to considerable back bombardment which raises its temperature. After the circuit has been adjusted for proper tube operation, the filament voltage must be reduced to prevent overheating of the cathode with resulting short life.

[2]For 30°C inlet air temperature and 2 kW anode dissipation.

[3]At any point on the ceramic insulators. For maximum tube life, this temperature must not exceed 200°C. The cooling air flow must be established before application of any voltage and maintained for at least one minute after filament voltage has been removed.

20April84; Revised April 86

OPERATING CONDITIONS

MAXIMUM RATINGS (all potentials refer to cathode)

DC Anode Voltage	5 kV
DC Grid g2 Voltage	650 V
DC Grid g1 Voltage	-200 V
Peak Cathode Current	6 A
DC Anode Current	2 A
Anode Dissipation	4.5 kW
Grid g2 Dissipation	25 W
Grid g1 Dissipation	5 W
Frequency	1000 MHz

CLASS A — LINEAR AMPLIFIER FOR TELEVISION TRANSLATOR

Aural and Video Signals Simultaneously

TYPICAL OPERATION

Operating Frequency	474-850 MHz
Bandwidth	10 MHz
Filament Voltage	6 V
DC Anode Voltage	4 kV
DC Grid g2 Voltage	400 V
DC Anode Current (no signal)	0.4 A
Peak Video Power	1.1 kW
Anode Current (black level + audio)	0.8 A
Gain	15.0dB
Intermodulation Products	-54 dB (*)
Distance Between Audio and Video Carriers	4.5 MHz

(*) Under video level (3-tone test) typical; depending on the cavity/circuit used and adjustments made.

ABSOLUTE MAXIMUM RATINGS: Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which the serviceability of the tube may be impaired. In order not to exceed absolute ratings, the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply voltage variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

HIGH VOLTAGE: Normal operating voltages used with this tube are deadly. Equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that **HIGH VOLTAGE CAN KILL.**

INTERELECTRODE CAPACITANCE: The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between the tube terminals, and wiring effects. To control the actual capacitance values within the tube as the key component involved, the industry and military services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminate any capacitance reading to "ground." The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even if the tube is made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is, therefore, cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

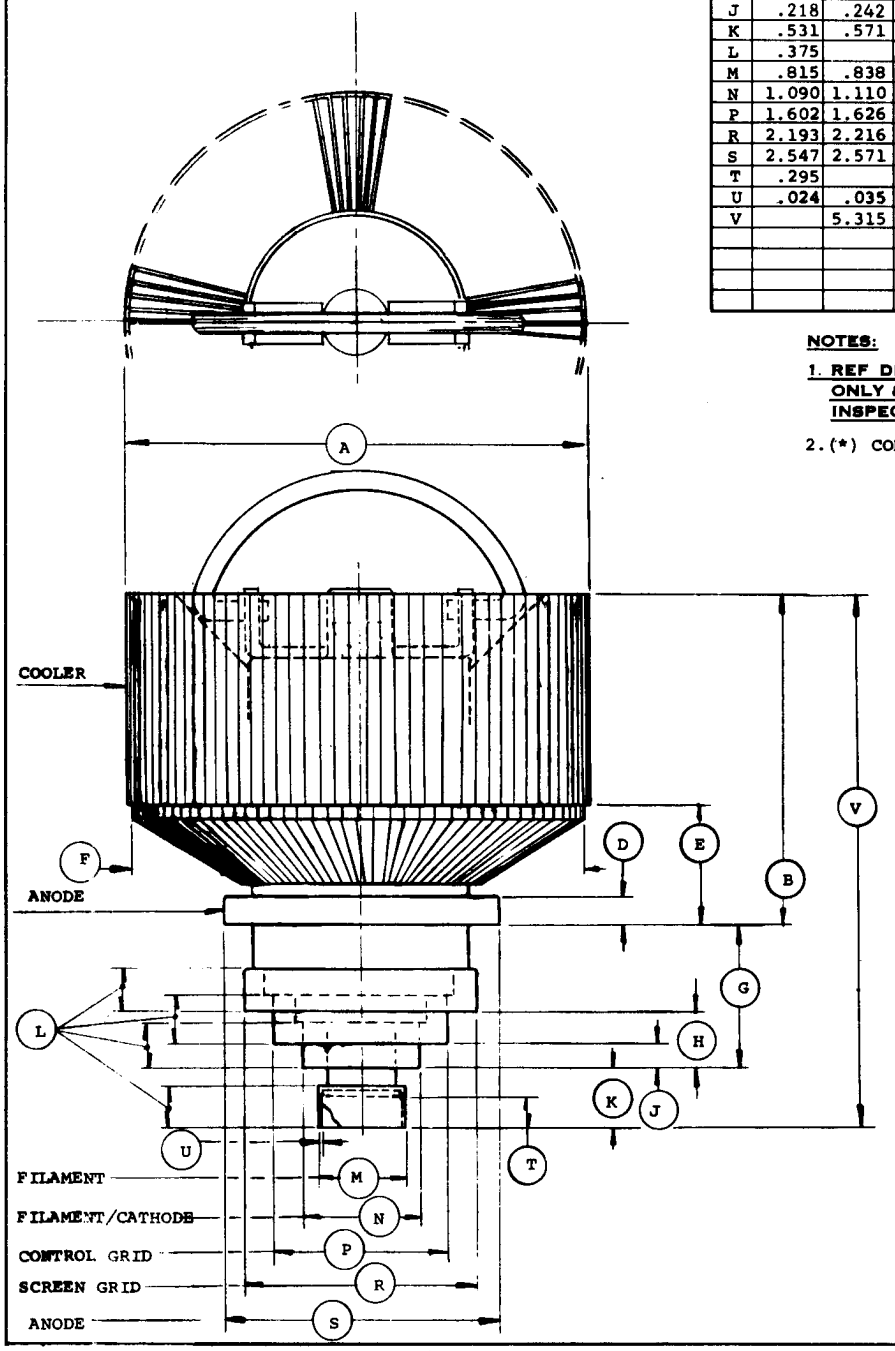
GRID OPERATION: Maximum control grid dissipation is 5 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage.

SCREEN GRID OPERATION: Maximum screen grid dissipation is 25 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.270	4.350		108.5	110.5	
B	3.150			80.0		
D	.260			6.5		
E	1.140	1.265		29.0	32.13	
F	4.110	4.230		104.5	107.5	
G	1.366	1.445		34.7	36.7	
H	.531	.590		13.5	15.0	
J	.218	.242		5.5	6.1	
K	.531	.571		13.5	14.5	
L	.375			9.5		
M	.815	.838		20.7	21.3	
N	1.090	1.110		27.7	28.3	
P	1.602	1.626		40.7	41.3	
R	2.193	2.216		55.7	56.3	
S	2.547	2.571		64.7	65.3	
T	.295			7.5		
U	.024	.035		.60	.90	
V		5.315			135.0	

NOTES:

1. **REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.**
2. (*) CONTACT DIMS.



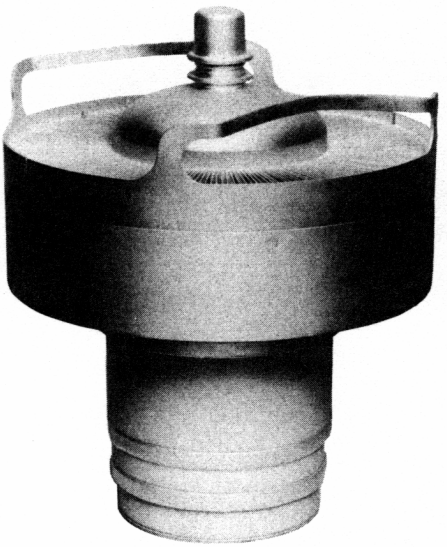
TECHNICAL DATA

Y863
VHF - TETRODE
TO REPLACE
8F76R
DATA INCLUDES
YC112
RETROFIT KIT

The EIMAC Y863 is a ceramic/metal VHF power tetrode intended for use as a retrofit for the 8F76R in VHF-TV amplifier service. A retrofit kit is available which allows use of the Y863 in NEC 10-15 kW visual TV cavities. No other changes are required. The Y863 features an electro-mechanical structure which provides high rf operating efficiency. Low losses in the structure permit operation at full ratings to 250 MHz in TV linear amplifier service.

Improved electron optics provide higher gain than the 8F76R, particularly in the high channels, easing exciter problems. Improved grid construction reduces tube-to-tube differences and contributes to extended life.

The anode is rated for 15 kilowatts dissipation with forced air cooling.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh		
Voltage	7.5 ± 0.4	V
Current, at 7.5 volts	120	A
Amplification Factor, average		
Grid to Screen	8.5	
Direct Interelectrode Capacitances (cath. grounded)[2]		
Cin	170	pF
Cout	16	pF
Cgp	0.5	pF
Direct Interelectrode Capacitances (grids grounded)[2]		
Cin	72.5	pF
Cout	17.5	pF
Cpk	0.08	pF
Maximum frequency for Full Ratings (TV)	250	MHz

1. Characteristics and operating values are based on performance tests. These figures may change without notice as a result of additional data or product refinement.
2. Capacitance values are for a cold tube, as measured with no special shielding, in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	9.3 In; 23.6 cm
Diameter	7.4 In; 18.8 cm
Net Weight (approximate)	14 Lbs; 6.4 kg
Operating Position	Axis Vertical, Base Up or Down
Cooling	Forced Air
Operating Temperature, Absolute Maximum	
Ceramic/Metal Seals and Anode Core	250°C
Base	Special, Coaxial
EIMAC Retrofit Kit, for Installation in NEC PCN-1200 VHF-TV Visual Cavity (See Page 2)	EIMAC YC112

Effective August 86
VA4928

Printed in U.S.A.



TECHNICAL DATA

HIGH-MU WATER COOLED POWER TRIODE YU-191A

The EIMAC YU-191A is a ceramic/metal, water cooled, high-mu triode intended for use as an amplifier, oscillator, or modulator, or in voltage regulator applications. Its maximum rated anode dissipation is 7000 watts.

Operation with zero grid bias in many applications offers circuit simplicity by eliminating the bias supply. Grounded grid operation is attractive since a power gain of over 20 times can be obtained.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	7.5 ± 0.37	V
Current @ 7.5 volts	51.5	A
Amplification Factor, Average	160	
Direct Interelectrode Capacitances (Grounded Filament)[2]		
Cin	38.0	pF
Cout	0.6	pF
Cgp	24.0	pF
Direct Interelectrode Capacitances (Grounded Grid)[2]		
Cin	38.0	pF
Cout	24.0	pF
Cpk	0.6	pF
Frequency of Maximum Ratings (CW)	110	MHz

MECHANICAL

Maximum Overall Dimensions:	
Length	10.4 in; 264 mm
Width	7.1 in; 180 mm
Net Weight	5.5 lb; 2.5 kg
Operating Position	Vertical, Base Up or Down
Maximum Operating Temperature:	
Envelope and Ceramic/Metal Seals	250°C
Cooling	Water
Base	Special Coaxial

[1] Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. CPI Eimac Division should be consulted before using this information for final equipment design.

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN

Class AB_2

MAXIMUM RATINGS:

DC PLATE VOLTAGE..... 5000 Volts
DC PLATE CURRENT. .....2.5 Amperes
PLATE DISSIPATION .....7000 Watts
GRID DISSIPATION . ..... 225 Watts

TYPICAL OPERATION:

Plate Voltage	4800	4800	4900	Vdc
Zero-Signal Plate Current[1]	0.35	0.35	0.36	Adc
Single -Tone Plate Current	1.68	2.00	2.25	Adc
Single-Tone Grid Current[2]	0.46	0.60	0.65	Adc
Driving Power[2]	293	410	535	Watts
Plate Dissipation	2275	2275	2275	Watts
Single-Tone Plate Output Power	6000	7266	8250	Watts
Resonant Load Impedance	1720	1425	1308	Ω
Driving Impedance	50.0	46.3	49.2	Ω

1. Bias voltage may be required.

2. Approximate value.

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_2

MAXIMUM RATINGS:

DC PLATE VOLTAGE..... 5000 Volts
DC PLATE CURRENT..... 2.5 Amperes
PLATE DISSIPATION ..... 7000 Watts
GRID DISSIPATION .....225 Watts

TYPICAL OPERATION

Plate Voltage	4000	4900	Vdc
Zero-Signal Plate Current[1]	0.25	0.36	Adc
DC Plate Current	0.74	1.23	Adc
DC Grid Current[1]	0.13	0.17	Adc
Peak RF Grid Voltage[2]	85.0	125	Volts
Driving Power[2]	11.5	21.2	Watts
Plate Dissipation	1830	3840	Watts
Carrier Plate Output Power	1130	2200	Watts
Resonant Load Impedance	1750	1100	Ω

1. Bias voltage may be required.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER CATHODE DRIVEN

Class C

MAXIMUM RATINGS:

DC PLATE VOLTAGE.....5000 Volts
DC PLATE CURRENT..... 2.5 Amperes
PLATE DISSIPATION ..... 7000 Watts
GRID DISSIPATION..... 225 Watts

TYPICAL OPERATION

Plate Voltage	4900	Vdc
Grid Voltage	-50	Vdc
Plate Current	2.16	Adc
Grid Current[1]	0.61	Adc
Peak RF Cathode Voltage[1]	300	Volts
Calculated Driving Power[1]	691	Watts
Plate Dissipation	2315	Watts
Useful Output Power[2]	7500	Watts

1. Approximate value.
2. Output circuit and filter loss of 10% assumed.

NOTE: The equipment designer and user must assure that rated dissipation values are not exceeded. In continuous opertion (Class A) element dissipation is simply the product of voltage and current at the operating conditions. In pulsed operation the element dissipation is basically the product of voltage, current, and duty factor, though pulse shape and circuit conditions may effect actual dissipation values.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min	Max	
Filament Current @ 7.5 volts…….....	48.0	54.0	A
Interelectrode Capacitances[1] (grounded filament connection)			
Cin	30.0	45.0	pF
Cout	---	1.0	pF
Cgp	20.0	28.0	pF
Interelectrode Capacitances[1] (grounded grid connection			
Cin	30.0	45.0	pF
Cout	20.0	28.0	pF
Cpk……	---	1.0	pF
Zero Bias Plate Current (Eb = 5000 Volts)……	0.36	0.52	A
Cut-off Bias (Eb = 5000 Volts, Ib = 1.0 mAdc……	---	-45.0	V

[1]Capacitance values are for a cold tube as mounted in a shielded fixture.

APPLICATION

MECHANICAL

MOUNTING – The YU-191A must be mounted vertically, base down or up at the convenience of the circuit designer.

COOLING - The cooling data indicates the minimum flow and pressure drop across the tube required for varous levels of anode dissipation. The cooling water outlet temperature should not exceed 70°C.

Anode Dissipation (kW)	Water Flow (gpm)	Pressure Drop (psi)
2	0.9	1.3
4	1.3	2.5
6	2.0	4.7
7	2.4	5.9

The filament stem structure also requires forced air cooling. A minimum of 6 cfm should be directed into the space between the inner and outer filament contacting surfaces.

A major factor effecting long life of water cooled tubes is the condition of the cooling water. High purity water must be used to minimize power loss, corrosion of metal fittings, and loss of anode dissipation capability. Water resistivity must be maintained at 1 megohm/cm (at 25°C) or better for long term operation. EIMAC Application Bulletin #16 should be consulted for details on maintenance of water quality standards and use of a water purification loop in the installation. Since the anode is normally at high potential to ground, water connections to the anode are made through insulating tubing, with long enough sections that column resistance is above 4 megohms per 1000 plate supply volts, or 10 megohms total, whichever is less.

Both air and water flow must be supplied before or simultaneously with the application of electrode voltages, including the filament, and may be removed simultaneously with them. Where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial.

ELECTRICAL

FILAMENT OPERATION – The filament voltage, as measured at the filament terminals, should be 7.5 volts, with maximum allowable variations due to the line fluctuations of from 7.12 to 7.87 volts.

INTERLOCKS – An interlock device should be provided to ensure that cooling water and air flow is established before application of electrical power, including the heater. The circuit should be so arranged that RF drive cannot be applied in the absence of normal plate voltage.

INPUT CIRCUIT – When operated as a ground grid RF amplifier, the use of a matching network in the cathode circuit is recommended. For best results with a single ended amplifier, and depending on the application, it is suggested the cathode tuned circuit operate with a "Q" of 5 or more.

RADIO FREQUENCY RADIATION – Avoid exposure to strong RF fields even at relatively low frequency. Absorption of RF energy by human tissue is dependent on frequency. Under 30 MHz most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as these, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong RF field in the general proximity of the power tube and its associated circuitry – the more power involved the stronger the RF field. Proper enclosure design and efficient coupling of RF energy to the load will minimize the RF field in the vicinity of the power amplifier unit itself.

FAULT PROTECTION – In addition to normal cooling flow interlock and plate over-current interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high plate voltage

In all cases some protective resistance, at least 10 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers. The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

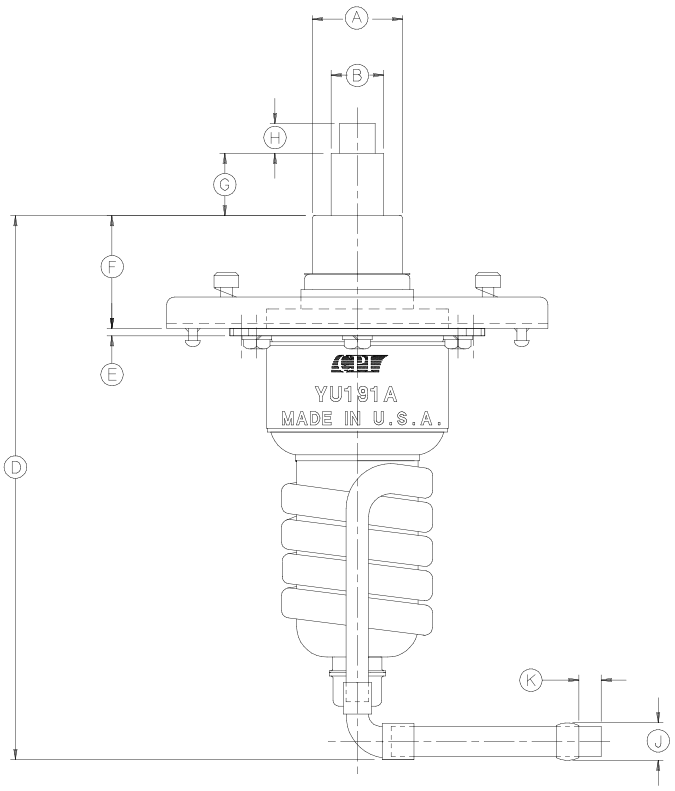
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

HOT SURFACES – When the tube is used in air and air cooled, external surfaces of the tube may reach temperatures up to 200°C and higher. In addition to the anode, the cathode insulator and cathode/heater surfaces may remain hot for an extended time after the tube is shut off. To prevent serious burns, take care to avoid any bodily contact with these surfaces both during, and for a reasonable cool down period after, tube operation.

HIGH VOLTAGE - The YU-191A operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high-voltage condensers whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

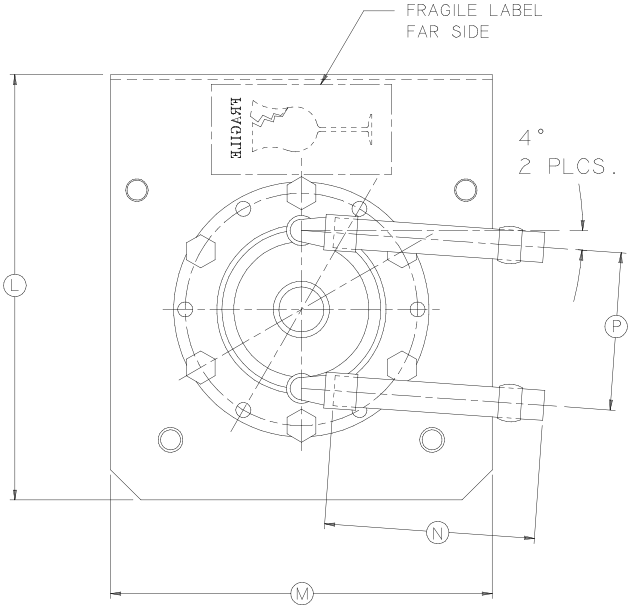
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to the Application Engineering Dept., CPI Eimac Division, San Carlos, Calif. 94070 for information and recommendations.

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	1.490	1.510		37.8	38.4	
B	.871	.881		22.1	22.4	
C						
D			8.985			228.22
E			.125			3.175
F	1.703	1.953		43.26	49.6	
G	.812	.938		20.62	23.82	
H	.480	.520		12.2	13.2	
J			.59			15.0
K			.38			9.65
L			7.08			179.83
M			6.35			161.29
N			3.500			88.90
P			2.625			66.68
R						
S						
T						
U						
V						
W						
X						
Y						
Z						



NOTES:

1. REF. DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.



YU191A

LTR	DESCRIPTION OF CHANGE	SCO	DATE	BY
A	DRAWN / ESTAB. IN ECO SYS.	25214	5/18/99	DB/KA

DRAWN: DB 5/18/99 ENGR APPR: I:/outline/yu191a SCALE: NONE
CHK'D: KA 5/24/99 SUPERSEDES: PRC-24366

Eimac Div of CPI

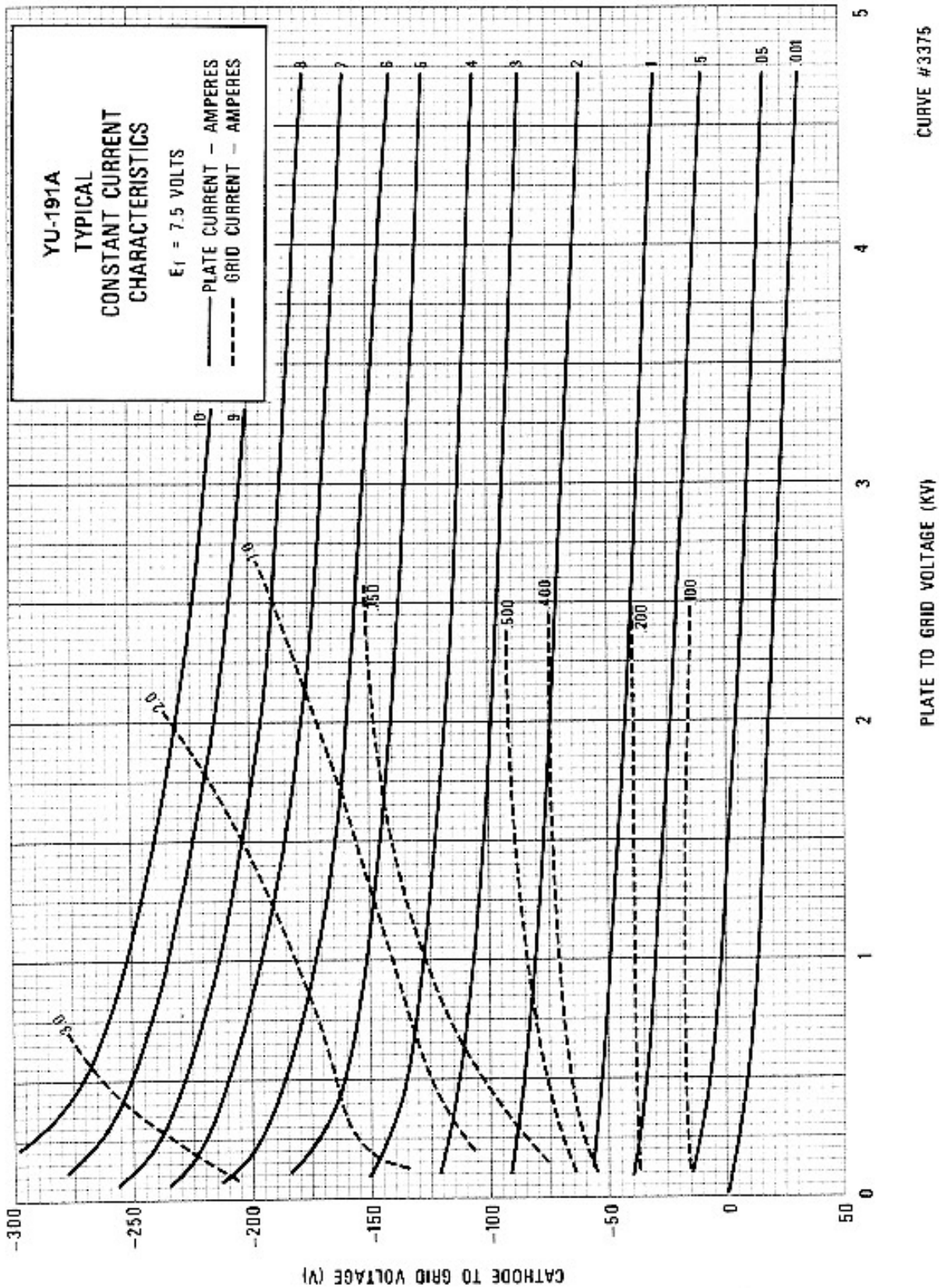
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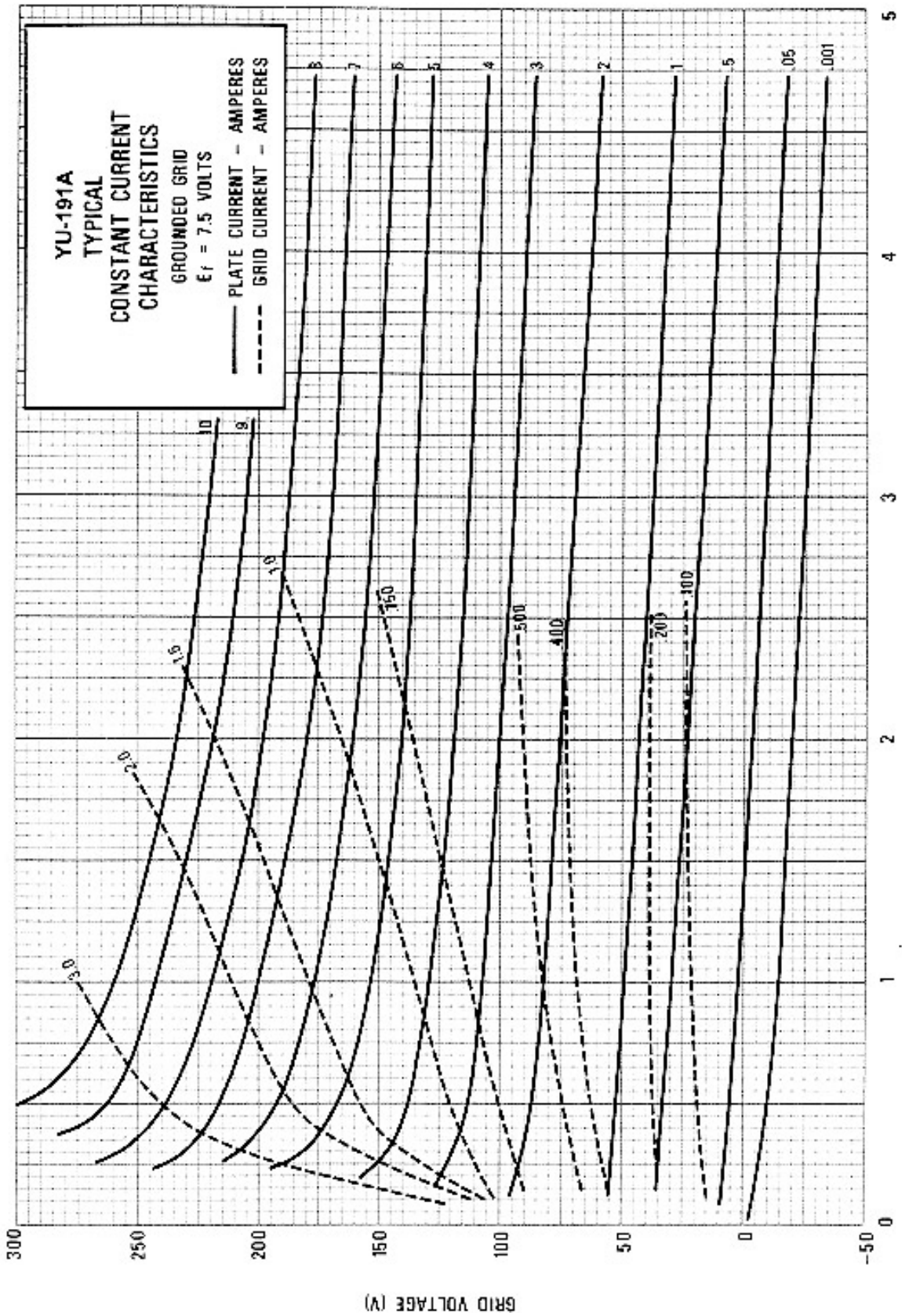
PART NO. CODE IDENT NO. 00383

OUTLINE

ELECTRON TUBE

NO. YU191A A


YU-191A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
Ef = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
CATHODE TO GRID VOLTAGE (V)
PLATE TO GRID VOLTAGE (KV)
CURVE #3375


YU-191A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
300
250
200
150
100
50
0
−50
0
1
2
3
4
5
10
9
8
7
6
5
4
3
2
1
.5
.05
.001
3.0
2.0
1.5
1.0
150
500
400
200
100