



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

Filament:	Thoriated Tungsten	Min.	Nom.	Max.	
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 appropriate formula below:

$$L_o = \frac{R_{eff}}{18.8f} \begin{cases} \text{for full-wave} \\ \text{single wave} \\ \text{power supplies} \end{cases}$$

$$L_o = \frac{R_{eff}}{75f} \begin{cases} \text{for half-wave} \\ \text{three-phase} \\ \text{power supplies} \end{cases}$$

$$L_o = \frac{R_{eff}}{660f} \begin{cases} \text{for full-wave} \\ \text{three-phase} \\ \text{power supplies} \end{cases}$$

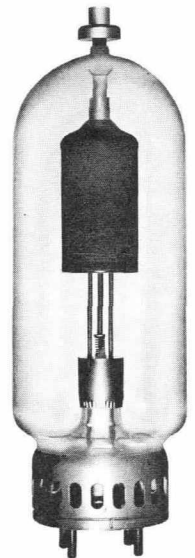
where: L_o = "critical" value of input inductance (henries)

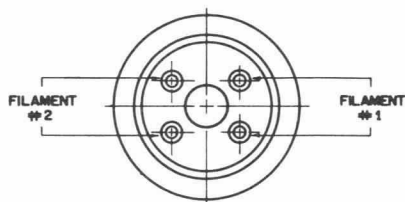
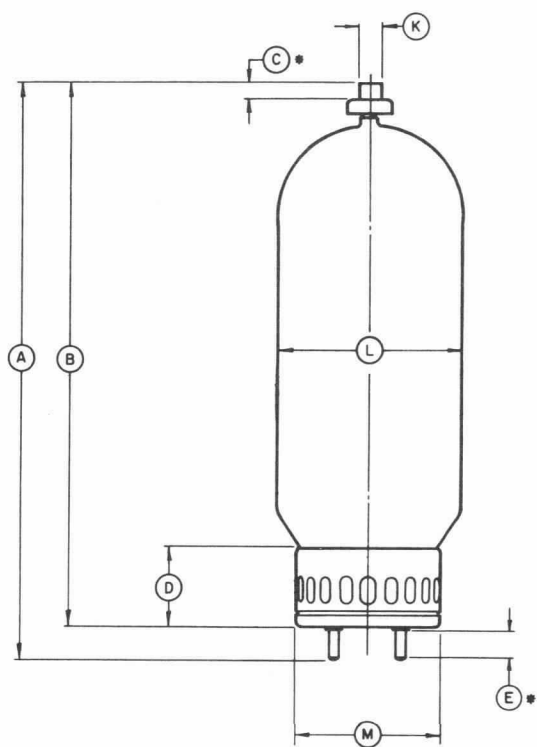
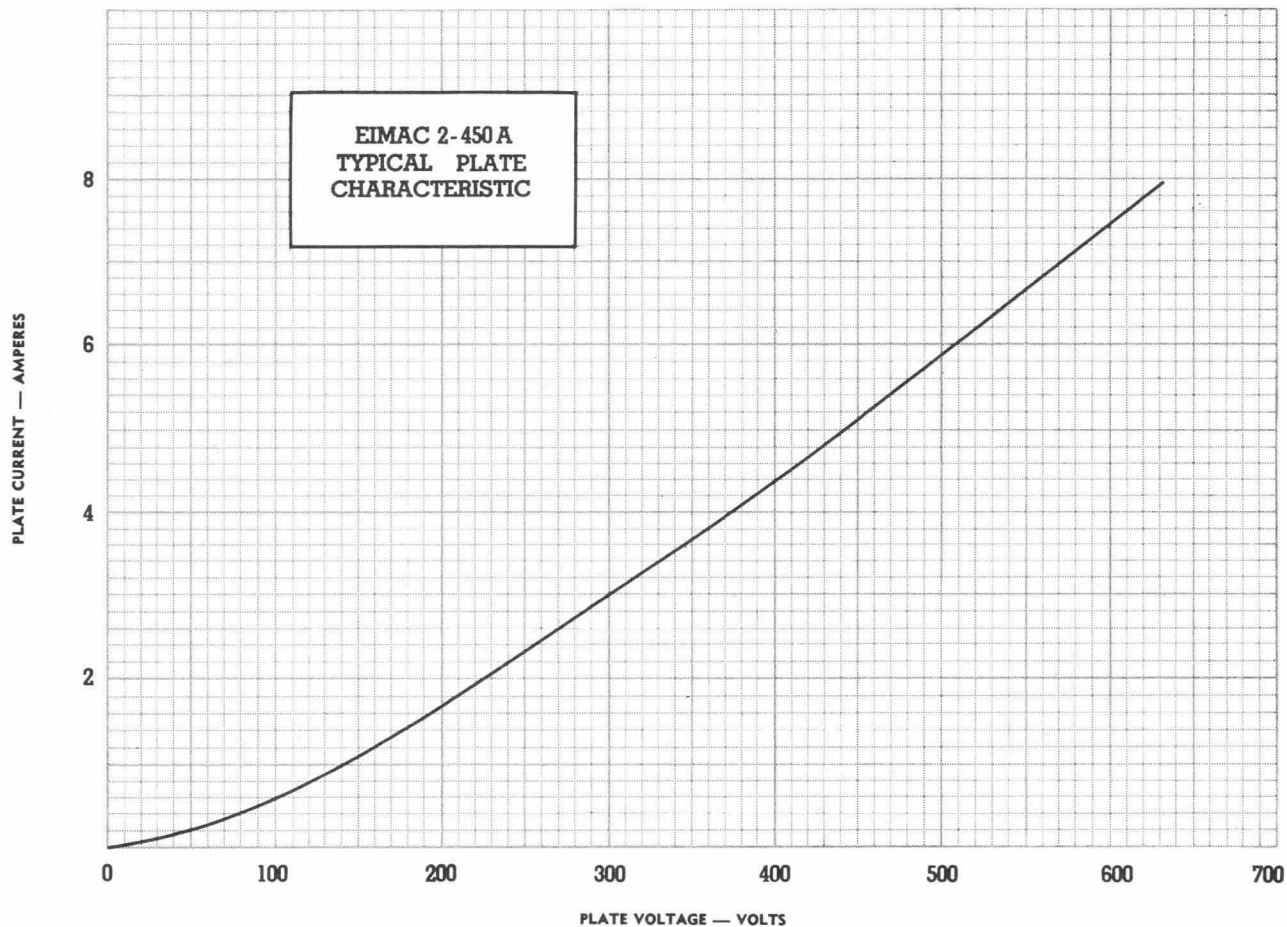
f = supply-line frequency (cycles per second)

$$R_{eff} = \frac{\text{Load voltage (volts)}}{\text{Load current (amps)}}$$

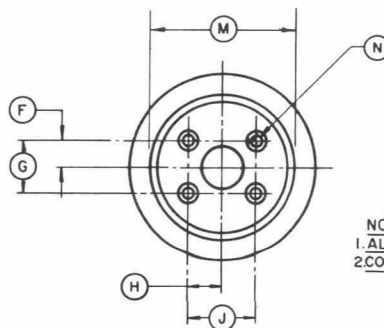
THESE SPECIFICATIONS ARE BASED ON DATA APPLICABLE AT PRINTING DATE. SINCE EIMAC HAS A POLICY OF CONTINUING PRODUCT IMPROVEMENT, SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

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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 (#).

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APPLICATION (Continued)

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 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 10.0 volts. Variations must be kept within the range from 9.5 to 10.5 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, putting 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 2-2000A reaches operating temperature in a fraction of a second after application of voltage. Plate voltage may be applied simultaneously with filament voltage.

Plate Operation—The plate of the 2-2000A operates at dull red color at the maximum plate dissipation rating of 1200 watts. The maximum peak-inverse-voltage rating of 75,000 volts should not be exceeded at any time.

Performance—The accompanying table shows some maximum performance capabilities of the 2-2000A when used as a power-supply rectifier.

Circuit Type	2-2000A MAXIMUM-PERFORMANCE CAPABILITIES				
	A-C Input Voltage (volts rms)	Capacitor-Input Filter D-C Output Voltage (volts)	Choke-Input Filter D-C Output Current (amperes)	Capacitor-Input Filter D-C Output Voltage (volts)	Choke-Input Filter D-C Output Current (amperes)
Single-Phase, Half-Wave	26,500	31,500	0.600		
Single-Phase, Full-Wave	26,500 ¹	31,500	1.20	23,800	1.50
Single-Phase, Bridge	53,000	63,000	1.20	47,600	1.50

¹One-half the transformer secondary voltage.

Maximum D-C Current Ratings—Plate dissipation rather than peak current usually limits the d-c current which the 2-2000A 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 2-2000A is 750 milliamperes when the load incorporates a choke-input filter with the "critical" value (or larger) of input inductance (L_i in Fig. 1):

$$L_o = \frac{R_{eff}}{18.8f} \text{ for full-wave single-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{75f} \text{ for half-wave three-phase rectifiers,}$$

$$L_o = \frac{R_{eff}}{660f} \text{ for full-wave three-phase rectifiers,}$$

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 2-2000A is particularly suitable for power-supply applications demanding high voltage at low cur-

rent. Under these conditions capacitor-input filter circuits become desirable. The maximum d-c current rating of the 2-2000A 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 2-2000A, which may be taken as 400 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 2-2000A is 75,000 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 2-2000A 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 2-2000A is 1500 milliamperes.

The plate characteristic curve for the 2-2000A serves as a guide to special applications. The maximum plate dissipation rating of 1200 watts, the maximum peak-inverse-voltage rating of 75,000 volts, and the maximum peak plate current of 12 amperes must not be exceeded.

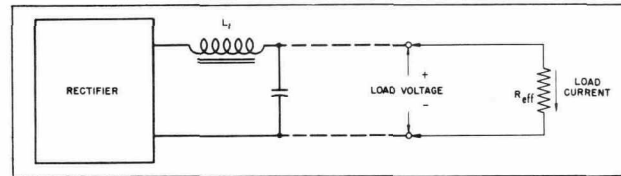
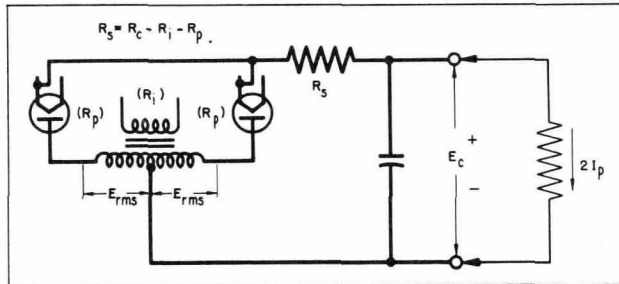
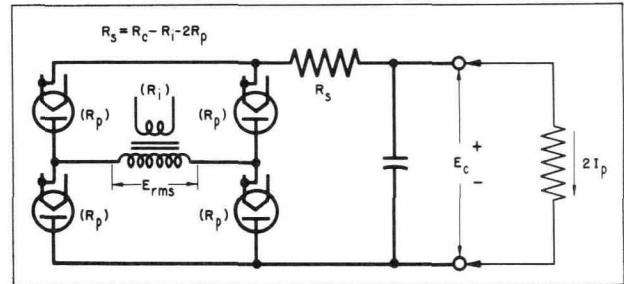


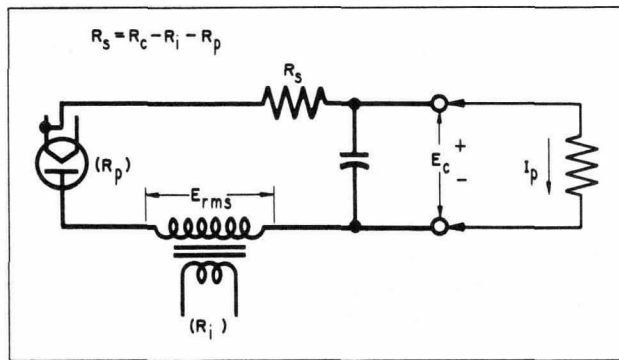
Fig. 1. Rectifier with Choke-Input Filter



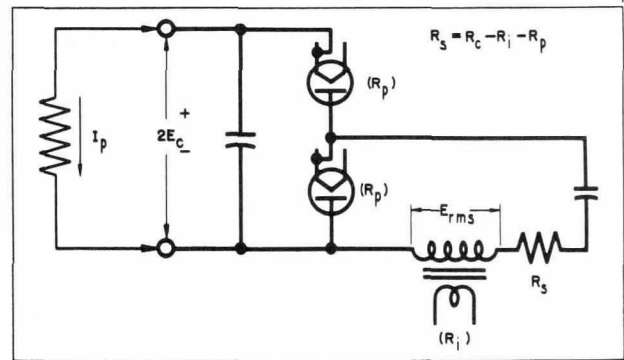
a. Full-Wave Center-Tapped Rectifier



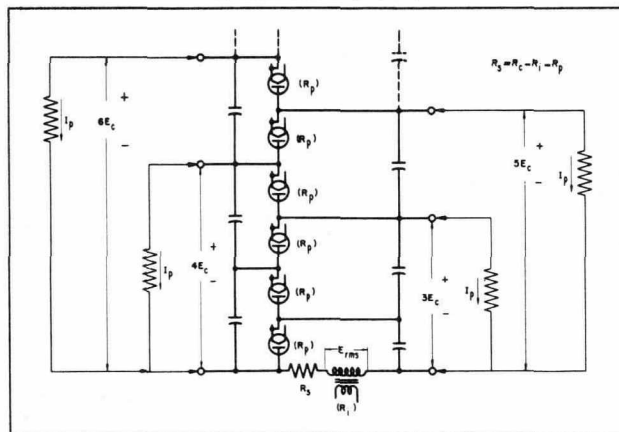
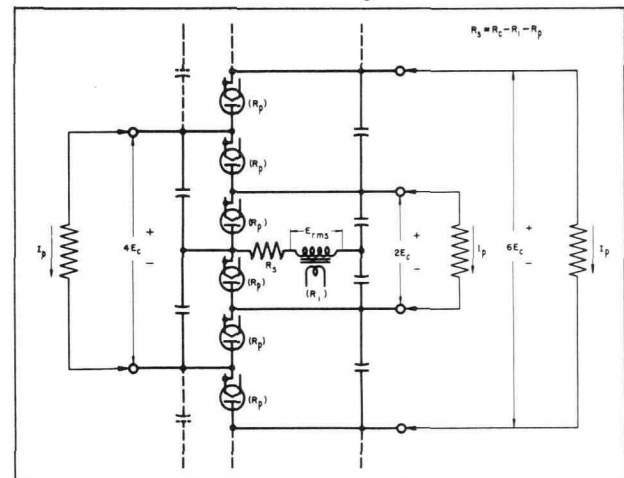
b. Full-Wave Bridge Rectifier



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 2-2000A Maximum D-C Current Ratings for R-C Filter Applications						
D-C Plate Current (I_p)	550	600	650	700	750	milliamperes per tube
Total Charging-Circuit Resistance (R_c)	1.1	2.1	3.8	7.0	13	percent of Effective Load Resistance per Tube (E_c/I_p)
A-C Supply Voltage (E_{rms})	0.80	0.84	0.90	1.00	1.16	times Filter-Input D-C Voltage (E_c)
Peak Inverse Voltage ($1/2$ these values for circuit b.)	2.3	2.4	2.6	2.8	3.3	times Filter-Input D-C Voltage (E_c)

Fig. 2 Eimac 2-2000A basic R-C Circuits (for any one of the indicated loads)

 R_i = Equivalent resistance of voltage source

 R_p = 400 ohms (200 ohms for two tubes in parallel)

PLATE CURRENT--AMPERES

EIMAC 2-2000A PLATE CHARACTERISTIC

10

5

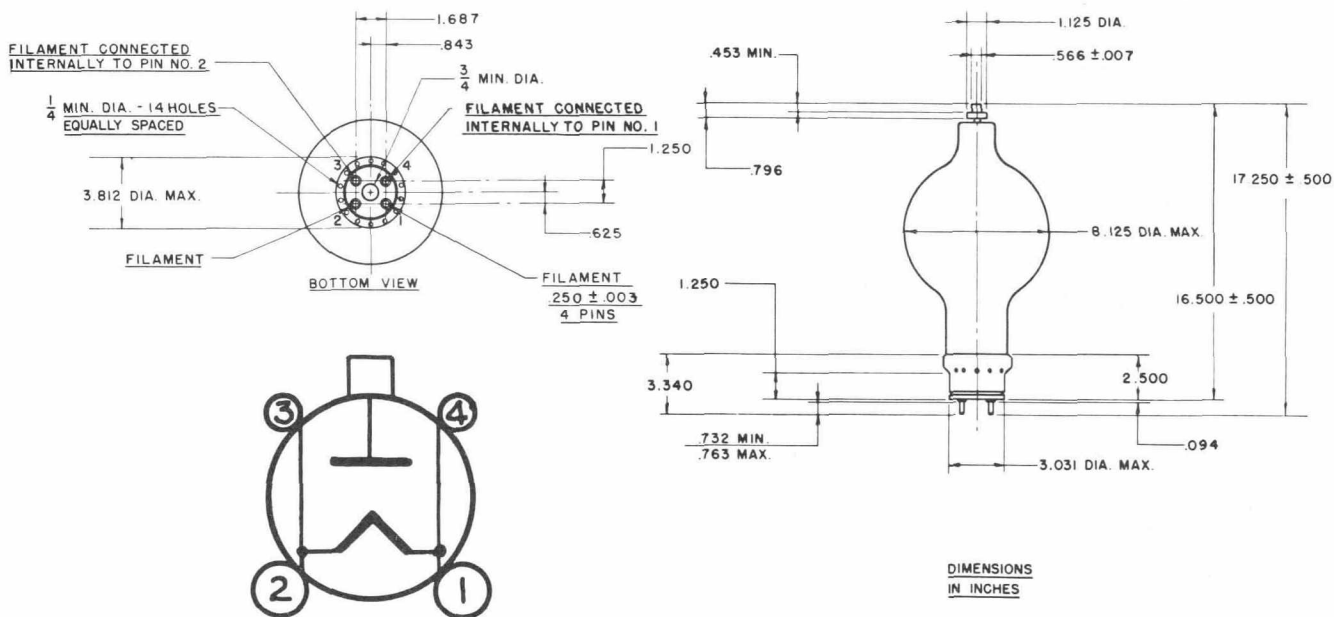
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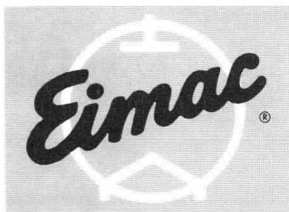
1000

2000

3000

PLATE VOLTAGE--VOLTS





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.

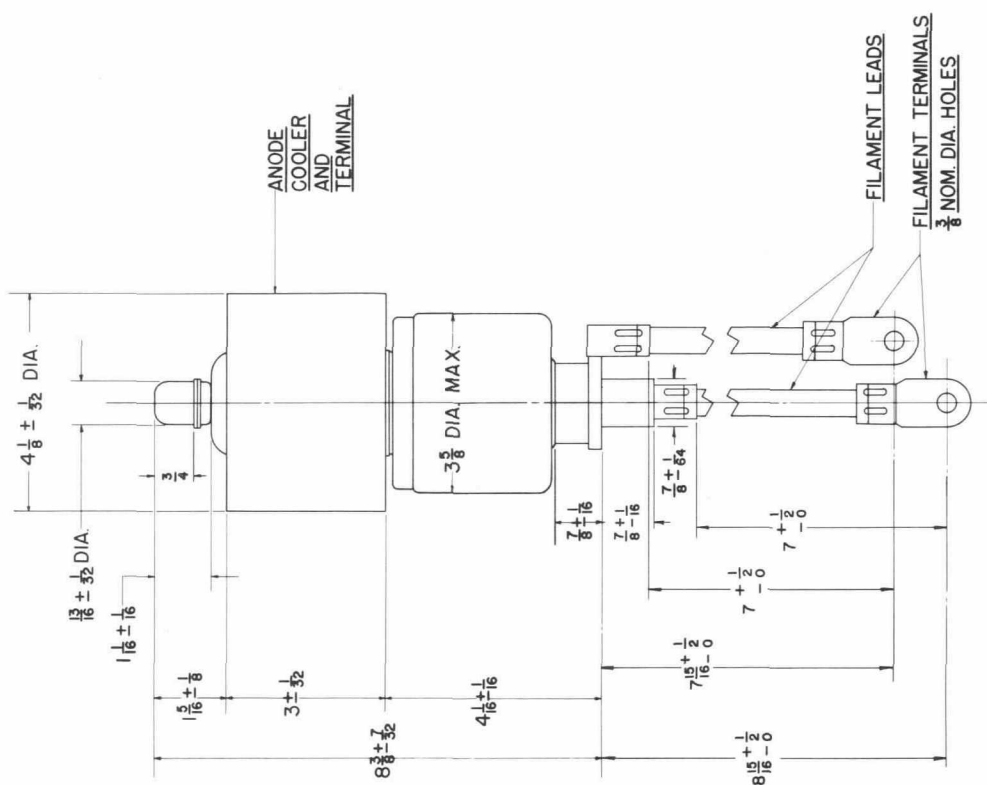
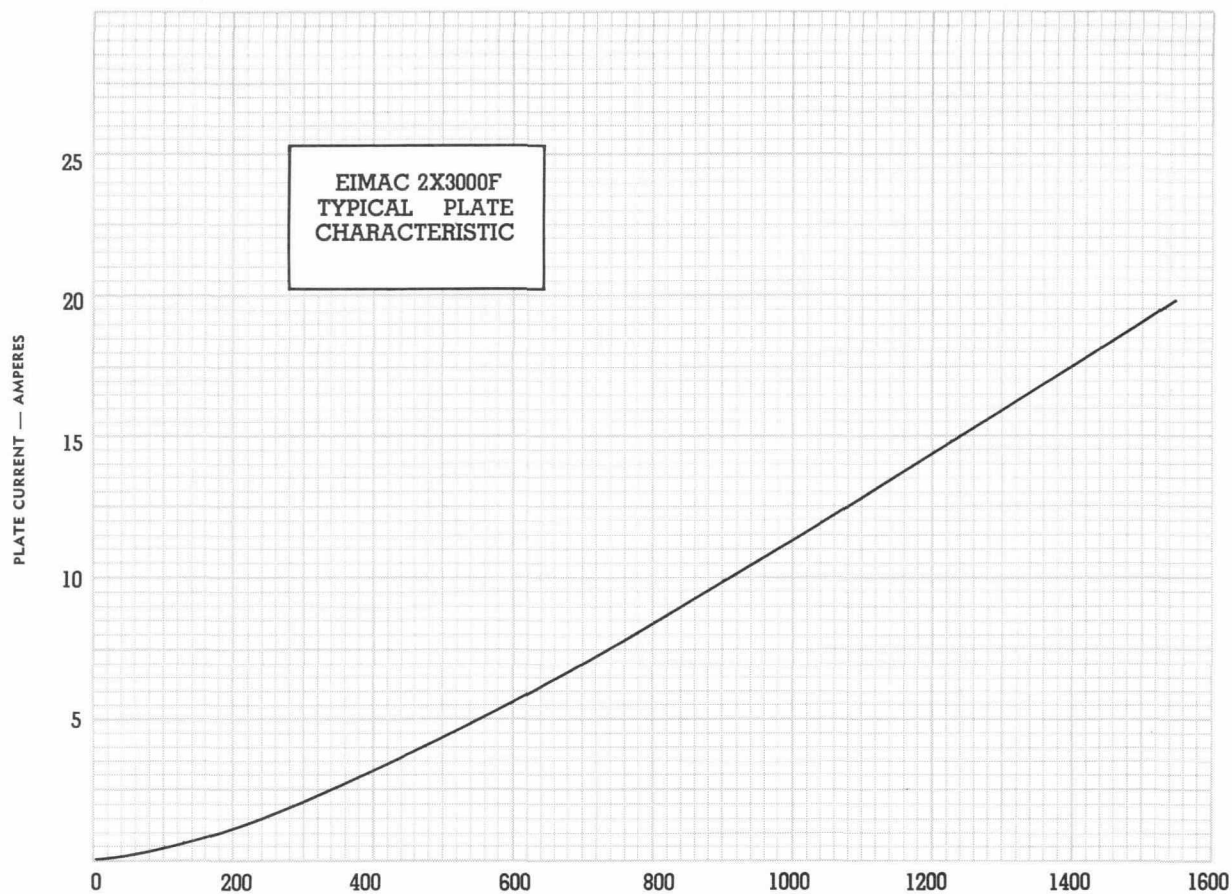
The table below lists minimum air-flow requirements to maintain tube temperatures below 175°C with air flowing in both the base-to-anode and anode-to-base directions. This tabulation presumes air at 40°C and sea level. A separate supply of approximately six cubic feet per minute, directed into the filament 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				
Plate Dissipation (Watts)	BASE-TO-ANODE FLOW		ANODE-TO-BASE FLOW	
	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.





ALL DIMENSIONS
IN INCHES

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