



TECHNICAL DATA

8560A

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 CHARACTERISTICS¹

ELECTRICAL

Cathode: Oxide Coated, Unipotential

Heater: Voltage 6.0 $\pm$ 0.3 V

Current, at 6.0 volts 2.6 A

Cathode-Heater Potential, Maximum $\pm$ 150 V

Amplification Factor (Average):

Grid-to-screen 5

Direct Interelectrode Capacitances (Grounded Cathode)²

C_{in} 16.5 pF

C_{out} 4.6 pF

C_{gp} 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 AB₁

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 AB₁, 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 AB₁

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 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	-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 Telephony 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 $250^{\circ}\text{C} - \frac{200\text{ W}}{1.9^{\circ}\text{C/W}} = 145^{\circ}\text{C}$

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)

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 BeO 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 $\pm 10\%$ will not damage the tube, but variations in performance must be expected. The heater voltage must be maintained within $\pm 5\%$ 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.

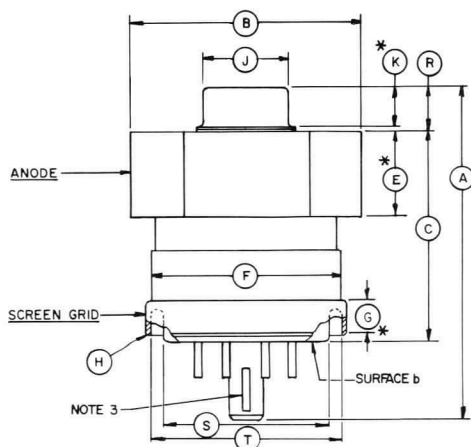
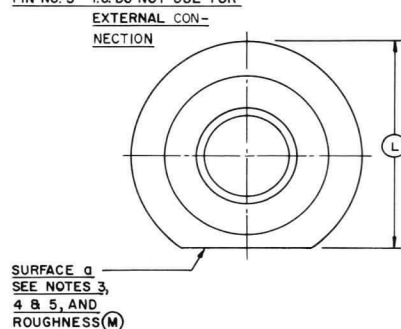
HIGH VOLTAGE - The 8560A operates at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits 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



DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	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:

- * CONTACT SURFACE.
- REF. DIMS. ARE FOR INF. ONLY AND ARE NOT REQD. FOR INSP. PURPOSES.
- SUR. a TO BE PERP. TO INDEX KEY LATERAL AXIS WITHIN (P) LIMITS AND ON SAME SIDE.
- SUR. a MUST BE FLAT WITHIN .001 & PERP. TO SUR. b WITHIN (N) LIMITS.
- SUR. a TO BE FREE OF ANY CODING & LABELING.

