Eimac®

EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

4X250B

RADIAL-BEAM POWER TETRODE

The 4X250B is a compact, forced-air cooled, external-anode radial-beam tetrode with a maximum plate dissipation rating of 250 watts. The 4X250B is capable of producing 390 watts of output power at frequencies up to 175 megacycles, and at the maximum rated frequency of 500 megacycles a minimum of 225 watts may be obtained.

The 4X250B has low driving-power requirements and is capable of producing up to 70 watts of output power with a plate supply of 500 volts, making it an excellent choice for mobile applications.

GENERAL CHARACTERISTICS

ELECTRICAL

	Min.	Nom.	Max.	
Cathode: Oxide-Coated, Unipotential				
Heating Time	30	60		seconds
Cathode-to-heater Potential			±150	volts
Heater: Voltage 4X250B		6.0		volts
Current 4X250B	2.3		2.9	amperes
Amplification Factor (Grid-to-Screen)	4.4		6.0	
Transconductance (I_b = 200 ma)		12,000		umhos
Direct Interelectrode Capacitances, Grounded Cathode:				
Input	14.2		17.2	uuf
Output	4.0		5.0	uuf
Feedback			0.06	uuf
Direct Interelectrode Capacitances, Grounded Grid and Screen:				
Input		13.0		uuf
Output	4.0		5.0	uuf
Feedback		0.01		uuf
Frequency for Maximum Ratings			500	mc

MECHANICAL

Base	Special 9-pin
Maximum Operating Temperatures:	
Glass-to-Metal Seals	175° C
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 POWER AMPLIFIER OR OSCILLATOR

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

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				500Mc	
D-C Plate Voltage	500	1000	1500	2000	2000	volts
D-C Screen Voltage	250	250	250	250	300	volts
D-C Grid Voltage	—90	—90	—90	—90	—90	volts
D-C Plate Current	250	250	250	250	250	ma
D-C Screen Current*	45	38	21	19	10**	ma
D-C Grid Current*	35	31	28	26	25**	ma
Peak R-F 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.

▶ Indicates change from sheet dated 8-18-58

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class-C Telephony (Carrier conditions)

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 175 Mc)

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*	31	22	20	ma
D-C Grid Current*	15	14	14	ma
Peak R-F 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.

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	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 (Frequencies up to 175 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

Class-AB_1 (Single-Sideband Suppressed-Carrier Operation)

MAXIMUM RATINGS

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 (Frequencies up to 175 Mc, peak-envelope conditions except where 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	100	100	100	ma
Peak R-F Grid Voltage*	50	50	50	volts
D-C Plate Current	250	250	250	ma
D-C Screen Current*	10	8	5	ma
Plate Input Power	250	375	500	watts
Plate Output Power	120	215	300	watts
Two-Tone Average D-C Plate Current	190	190	190	ma
Two-Tone Average D-C Screen Current*	2	—1	—2	ma

*Approximate values.

[1]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 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 4X250B 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.

The tube will fit in a standard Loktal socket, but use of the Loktal socket is *not* recommended. The use of a Locktal socket in the usual way does not provide for cooling the base of the tube.

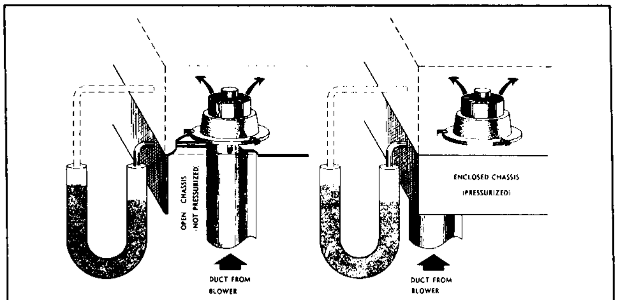
▶ **Cooling**—Sufficient cooling must be provided for the anode, base seals and body seals to maintain operating temperatures below the rated maximum values:

Ceramic-to-Metal Seals	250°C
Glass-to-Metal Seals	175°C
Anode Core	250°C

Air requirements to maintain seal temperatures at 175°C in 50°C ambient air are tabulated below. These requirements apply when the Eimac SK-600 or SK-610 socket is 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	3.8	0.28	5.5	0.40
250	5.6	0.53	8.1	0.77

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.



When exhaust air is restricted by a closed compartment (dotted lines), manometer return must be made to the compartment, not to free atmosphere.

METHODS OF MEASURING PRESSURE DIFFERENTIAL

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.

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. However, when shock and vibration are expected to exceed approximately 5g units, it is suggested that the Eimac 4CX300A be employed.

ELECTRICAL

Heater—The rated heater voltage for the 4X250B is 6.0 volts and this voltage 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.

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 the frequency, the plate current, and driving power being supplied to the tube. 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:

Freqency, Mc.	4X250B
300 and lower	6.0 volts
301 to 400	5.75 volts
401 to 500	5.50 volts

In no case should the heater of the 4X250B be operated at less than 5.4 volts.

Cathode Operation—The oxide-coated unipotential cathode must be protected against excessively high emission currents. The maximum rated d-c input current is 200 milliamperes for plate-modulated operation, and 250 milliamperes for all other types of operation except pulsed.

Higher cathode currents are permitted in pulsed operation and the maximum permissible pulse currents will depend entirely on the pulse lengths and the pulse repetition rates. The maximum rated pulse plate current of 6.0 amperes may be used only when the pulses do not exceed five microseconds in duration, and when the repetition rate does not exceed 1000 pulses per second. The curve of Fig. 2 shows the maximum permissible pulse currents and pulse durations for repetition rates of 1000 pps or less. For higher repetition rates the indicated pulse durations must be shortened by the factor 1000/n, where n is the number of pulses per second.

▶ Indicates change from sheet dated 1-3-58

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 maximum rated d-c 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 rated power. At operating frequencies above the 100-megacycle region, driving-power requirements for amplifiers increase noticeably until at 500 megacycles as much as 30 watts of driving power may have to be supplied. However, most of the driving power is absorbed in circuit losses other than the grid dissipation, so that the grid dissipation is only slightly increased. Satisfactory 500-megacycle operation of the tubes in a stable, "straight-through" amplifier is indicated by grid-current values below approximately 25 milliamperes.

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.

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 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.

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 a-c or r-f signal voltage applied to screen or cathode.

Protection for the screen can be provided by an over-current 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 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 this tube 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 separate small modulator tube will usually be more satisfactory. Screen-voltage modulation factors between 0.75 and 1.0 will result in 100% modulation of plate-modulated r-f amplifiers using the 4X250B

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.

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 collet 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.

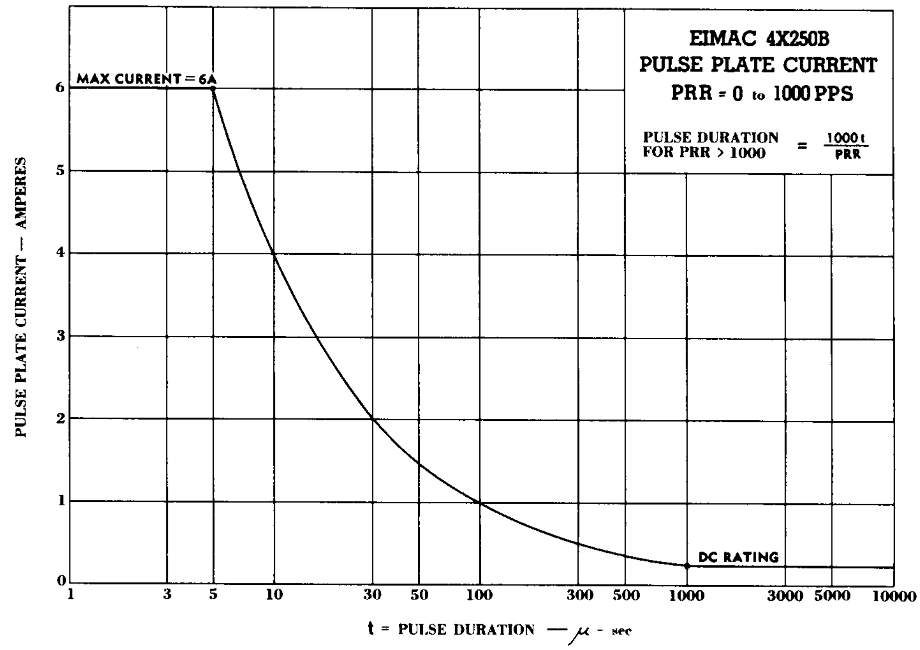
Where overload protection is provided, it should be capable of protecting the surviving tube/s in the event that one tube should fail.

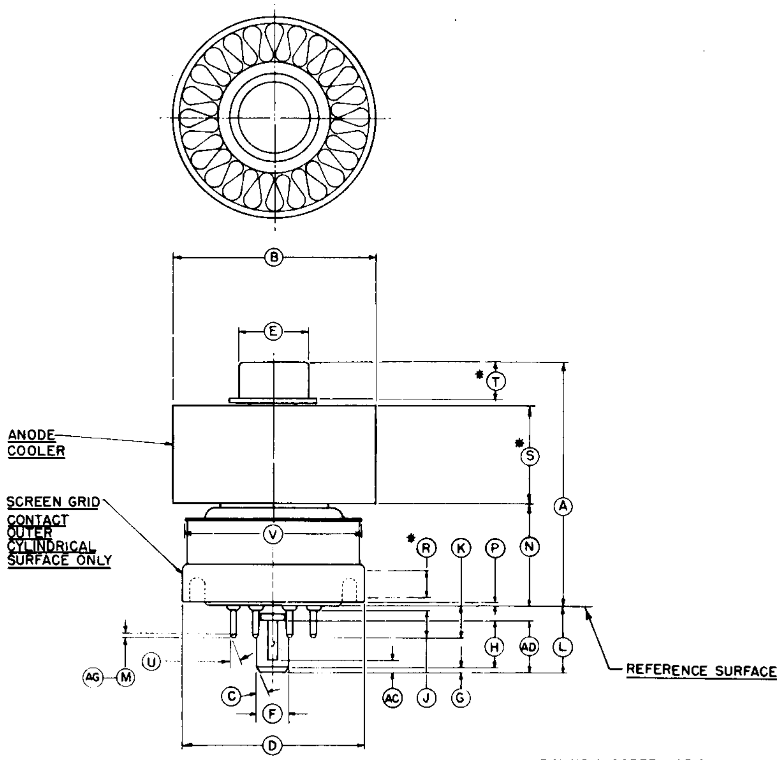
UHF Operation—The 4X250B is useful in the UHF region. UHF operation should be conducted with heavy plate loading, minimum bias and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

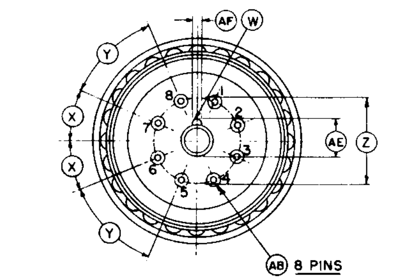
Some of the added circuit loss observed in UHF operation is in the base insulator of the tube. It is sometimes necessary to use more than the recommended minimum air-flow rates to maintain safe operating base temperatures at UHF.

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, Eitel-McCullough, Inc., San Carlos, California, for information and recommendations.

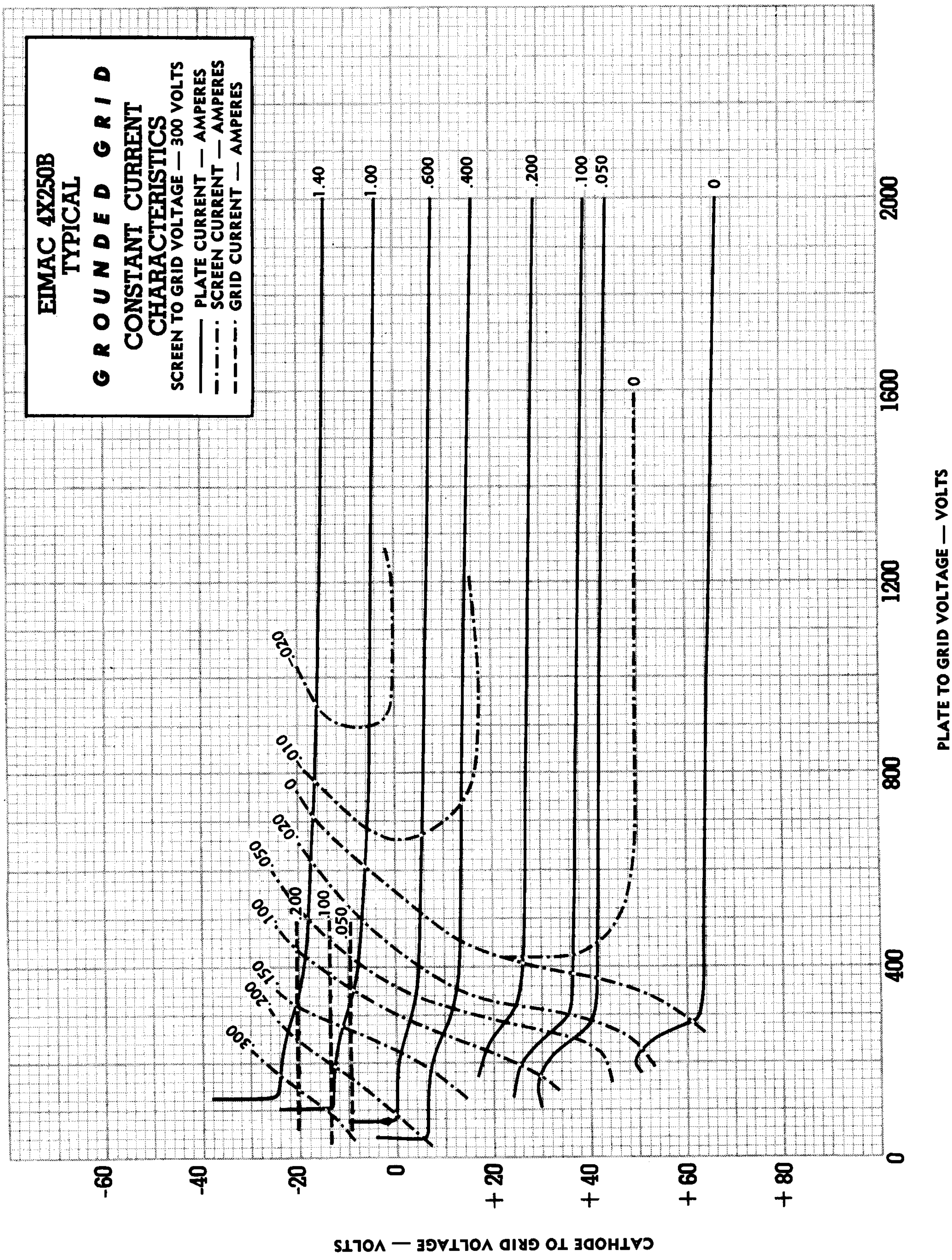


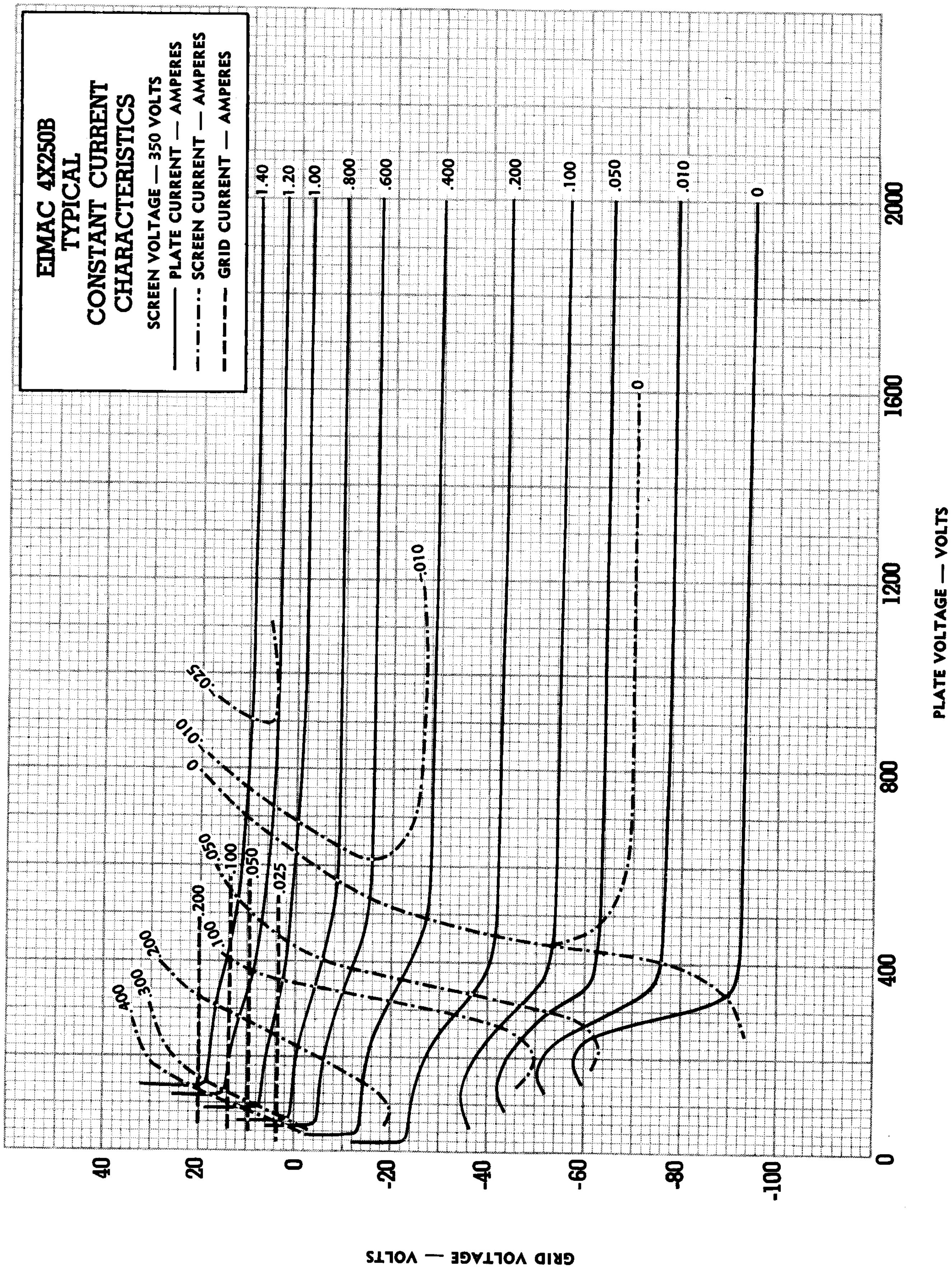




PIN NO. 1 - SCREEN GRID
PIN NO. 2 - CATHODE
PIN NO. 3 - HEATER
PIN NO. 4 - CATHODE
PIN NO. 5 - DO NOT USE FOR EXTERNAL CONN.
PIN NO. 6 - CATHODE
PIN NO. 7 - HEATER
PIN NO. 8 - CATHODE
CENTER PIN - CONTROL GRID
* CONTACT SURFACE

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	.005R.MIN.(ALTERNATE TO M&U)	


EIMAC 4X250B
TYPICAL
GROUNDED GRID
CONSTANT CURRENT
CHARACTERISTICS
SCREEN TO GRID VOLTAGE — 300 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
1.40
1.00
.600
.400
.200
.100
.050
0
.020
.010
0
.020
.050
.100
.150
.200
.300
.200
.100
.050
0
PLATE TO GRID VOLTAGE — VOLTS
0
400
800
1200
1600
2000
CATHODE TO GRID VOLTAGE — VOLTS
-60
-40
-20
0
+20
+40
+60
+80


EIMAC 4X250B
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 350 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
PLATE VOLTAGE — VOLTS
GRID VOLTAGE — VOLTS
0
400
800
1200
1600
2000
40
20
0
-20
-40
-60
-80
-100
1.40
1.20
1.00
.800
.600
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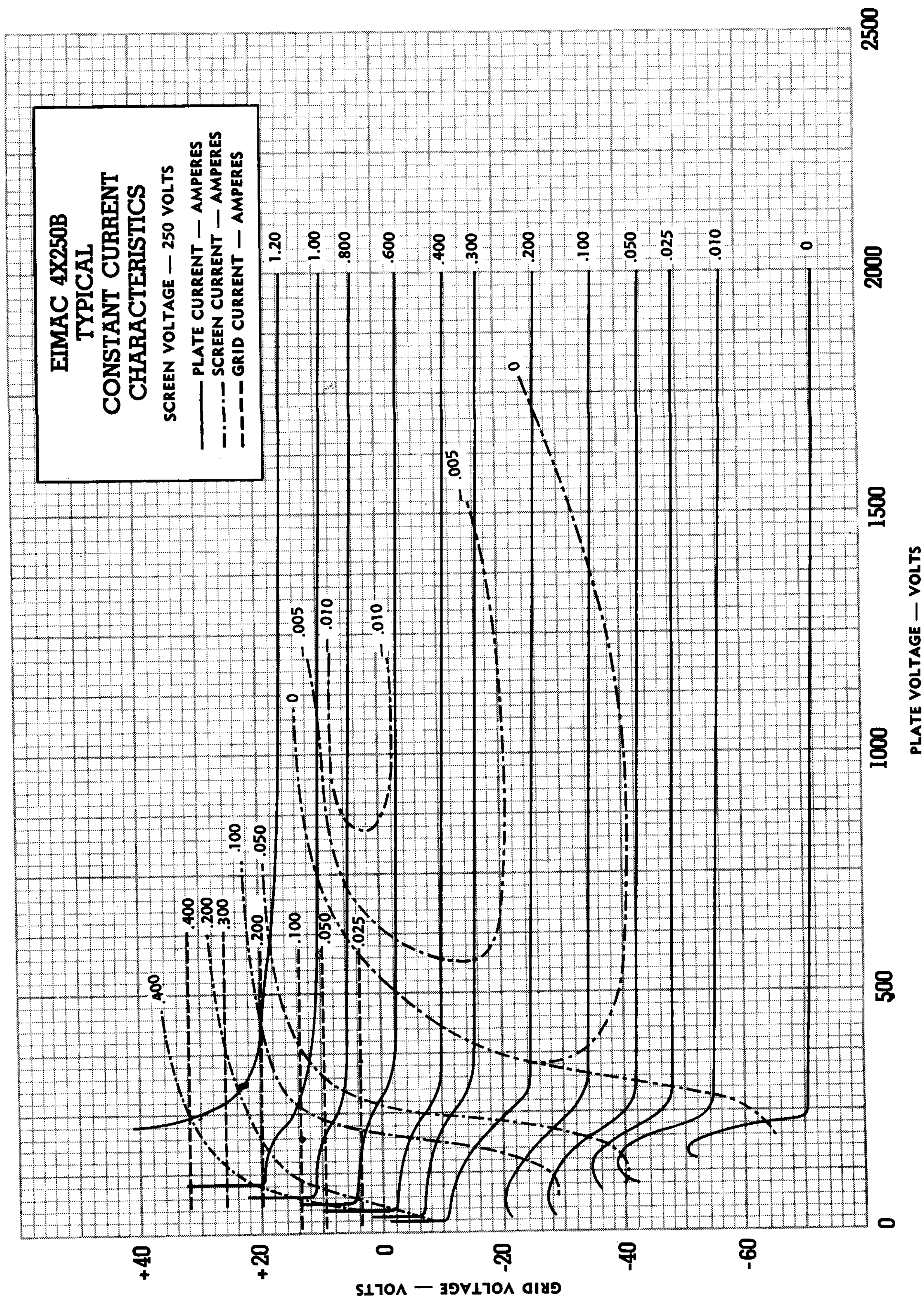
.010
0
.050
.100
.200
.300
.400
.025



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