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.

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 w ll 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 $\pm$ 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 $\pm$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.

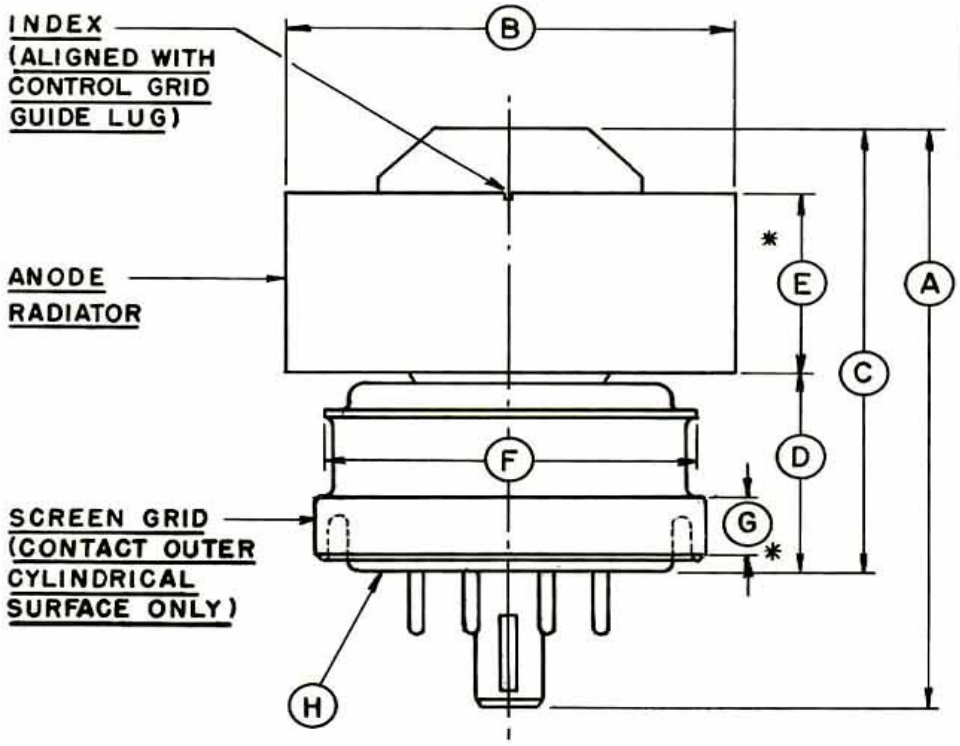
Multiple Operation—To obtain maximum power with minimum distortion from tubes operated in multiple it is desirable to adjust individual screen or grid-bias voltages so the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual d-c plate currents 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

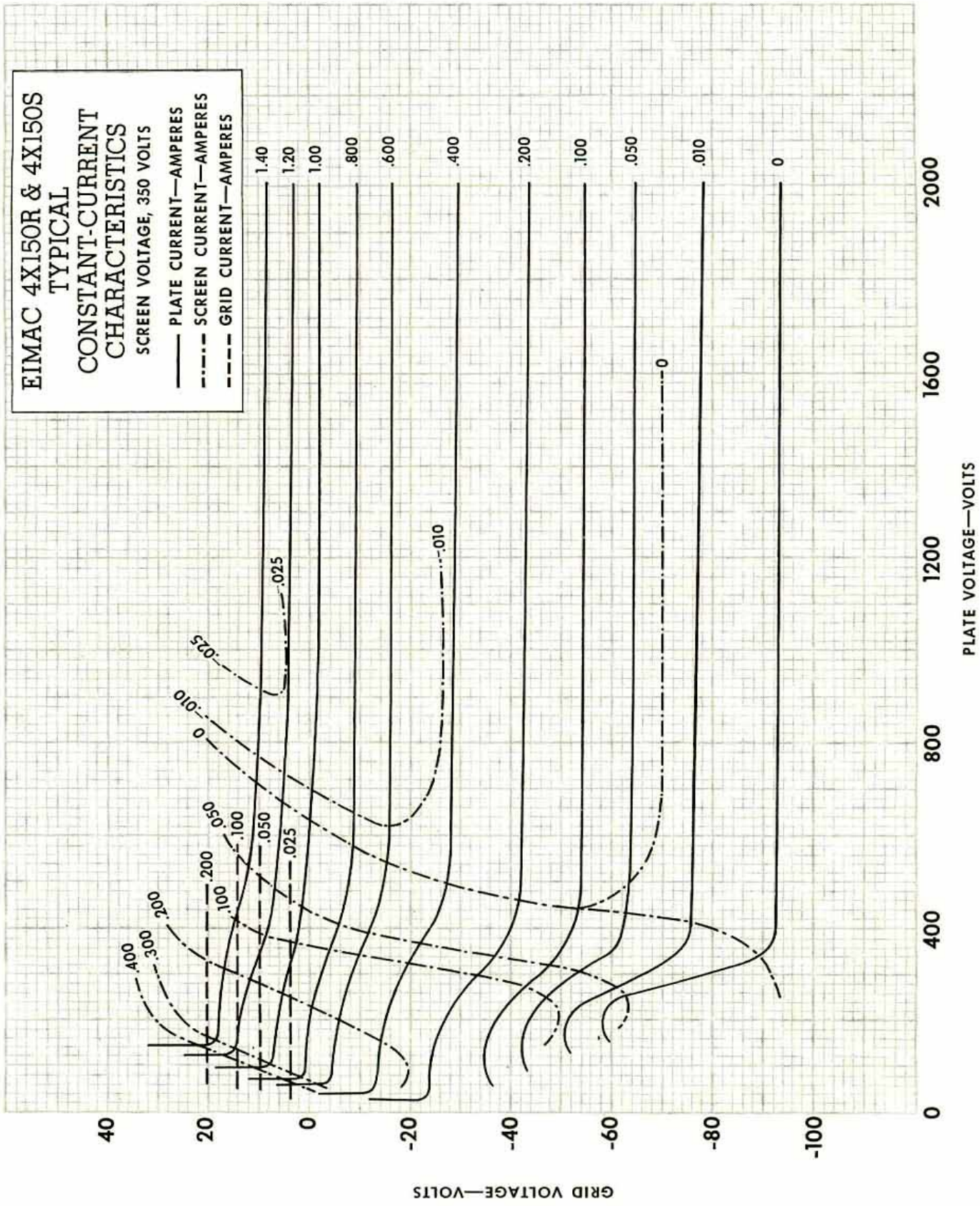
DIMENSIONS IN INCHES

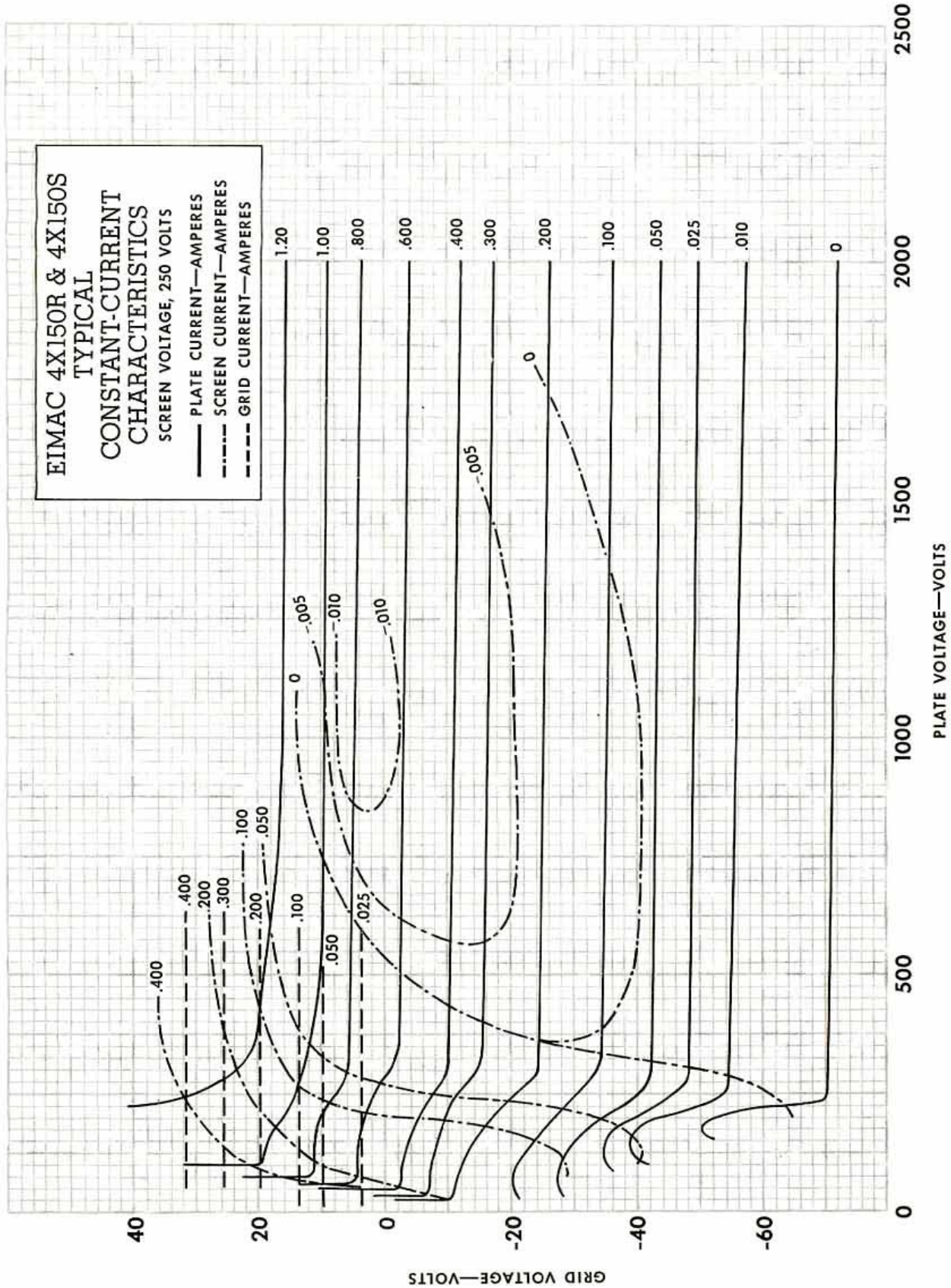
DIMENSIONAL DATA			
REF.	MIN.	MAX.	NOM.
A	2.224	2.414	
B	1.610	1.640	
C	1.710	1.860	
D	.750	.810	
E	.710	.790	
F		1.406	
G	.187		
H	BASE : B8-236 (JEDEC DESIGNATION)		



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
.200
.400
.300
.200
.100
.050
.025
.010
0
40
20
0
-20
-40
-60
-80
-100
GRID VOLTAGE—VOLTS
0
400
800
1200
1600
2000
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
.400
.200
.300
.200
.100
.050
.025
40
20
0
-20
-40
-60
GRID VOLTAGE—VOLTS
0
500
1000
1500
2000
2500
PLATE VOLTAGE—VOLTS