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	$\mu\mu f$
Input	23.8		32.4	$\mu\mu f$
Output	6.8		9.4	$\mu\mu f$
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

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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.

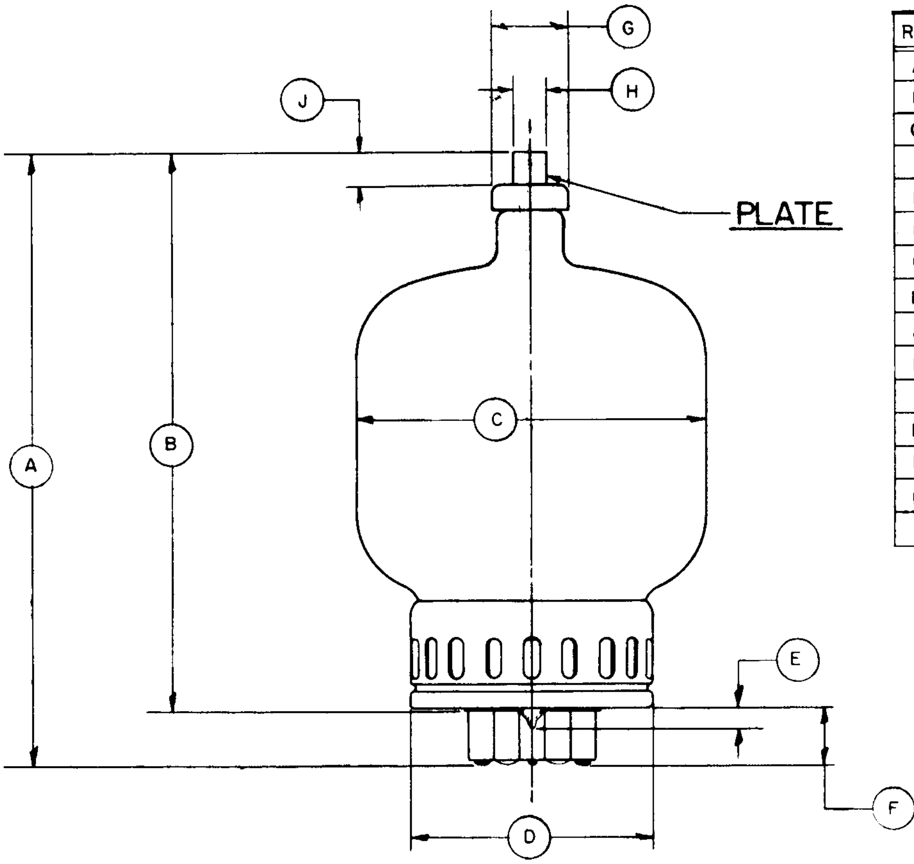
Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

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.

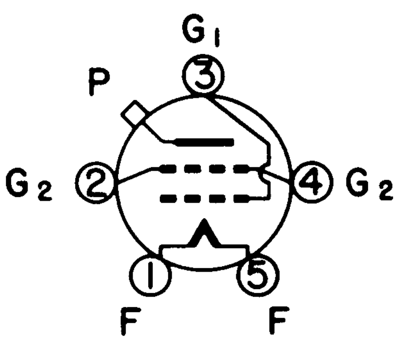
At frequencies above 30 megahertz the feedback is principally due to screen-lead-inductance effects. Feedback is eliminated by using series capacitance in the screen leads between the screen and ground. A variable capacitor of from 25 to 50 $\mu\mu$fds will provide sufficient capacitance to neutralize 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.

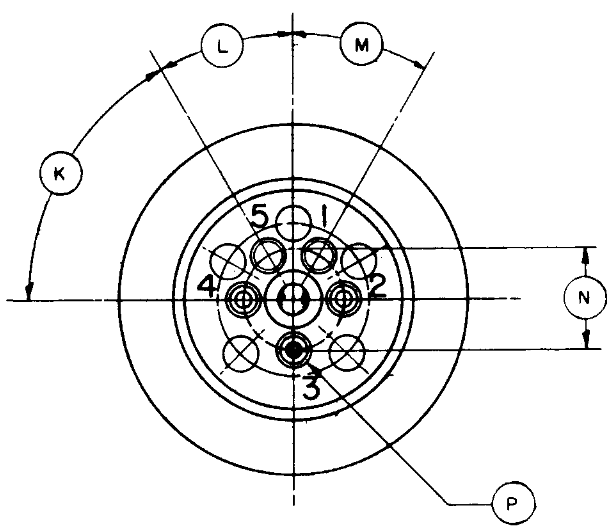
In general, plate, grid, filament, and screen-bypass or screen-neutralizing capacitors should be returned to rf ground through the shortest possible leads.

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.



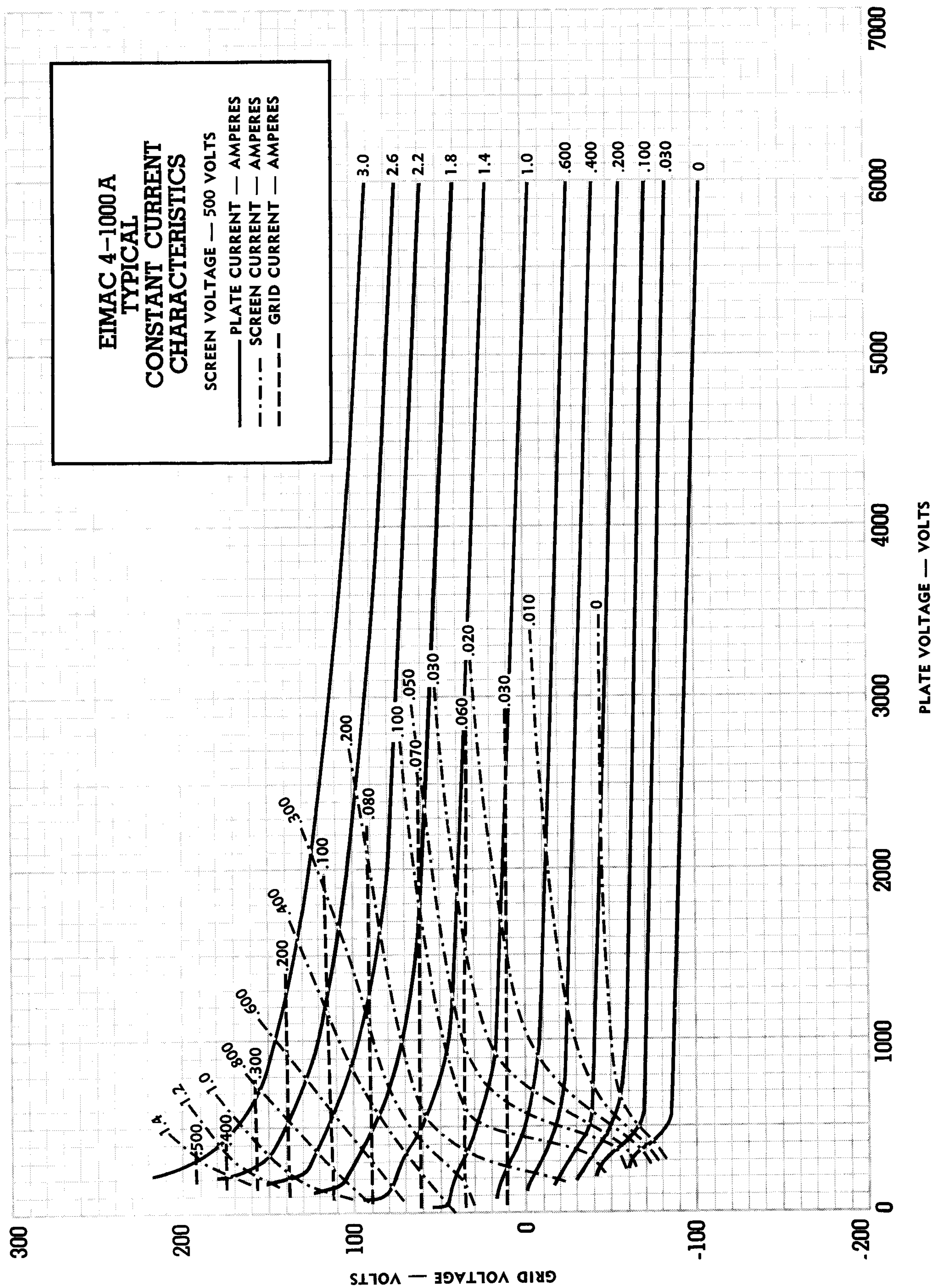
REF.	MIN.	NOM.	MAX.
A	8.875	9.250	9.625
B	8.000	8.375	8.750
C			5.250
D			3.625
E			.313
F	.825	.875	.925
G	1.110	1.125	1.140
H	.559	.566	.573
J	.484		
K		60°	
L		30°	
M		30°	
N	1.495	1.500	1.505
P	.371	.374	.377





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
PLATE VOLTAGE — VOLTS
GRID VOLTAGE — VOLTS
3.0
2.6
2.2
1.8
1.4
1.0
.600
.400
.200
.100
.030
0
0
1000
2000
3000
4000
5000
6000
7000
300
200
100
0
-100
-200