1500 W HIGH MU POWER TRIODE

3CX1500A7/8877

The Eimac 3CX1500A7/8877 is a rugged ceramic and metal power triode designed for use as a cathode driven Class AB2 or Class B amplifier in audio or rf applications including the VHF band, or as a cathode driven anode modulated Class C rf amplifier. As a linear amplifier, high power gain may be obtained with excellent intermodulation distortion characteristics.

Low grid interception and high amplification factor combine to make the 3CX1500A7/8877 drive power requirements exceptionally low for a tube of this power capacity.

CHARACTERISTICS[1]

ELECTRICAL:

Cathode: Oxide Coated, Unipotential
- Heater Voltage ..... 5.0 ± 0.25 V
- Heater Current at 5.0 Volts ..... 10.5 A
- Minimum Warm-up Time ..... 3 Min.

Transconductance (Average):
- I_b = 1.0 Adc ..... 55,000 µmhos
- Amplification Factor (Average) 200

Direct Interelectrode Capacitances (grounded grid)[2]
- Cin ..... 38.5 pF
- Cout ..... 10.0 pF
- Cpk ..... 0.1 pF
- Ck-htr ..... 9.7 pF

Direct Interelectrode Capacitances (grounded cathode)[2]
- Cin ..... 38.5 pF
- Cout ..... 0.1 pF
- Cgp ..... 10.0 pF

Frequency of Maximum Ratings ..... 250 MHz

MECHANICAL:

Overall Dimensions:
- Height ..... 4.02 in: 102.16 mm
- Diameter ..... 3.83 in; 85.85 mm

Net Weight ..... 25 oz; 708.8 gm

Operating Position ..... Any

Maximum Operating Temperature:
- Ceramic/Metal Seals & Anode Core ..... 250° C

Cooling ..... Forced Air

Base ..... Special, 7-pin

Recommended Air System Socket:
- Grounded Grid SK-2210
- Grounded Cathode SK-2200

Recommended Air Chimney (teflon) SK-2216

[1] Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. CPI MPP Eimac Operation 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.

RANGE VALUES FOR EQUIPMENT DESIGN			
	Min.	Max.	
Heater: Current @ 5.0 Volts	9.5	11.5	Amperes
Cathode Warm-up Time	3	---	Minutes
Interelectrode Capacitances [1] (grounded grid circui)			
Cin	36.0	41.0	pF
Cout	9.2	11.2	pF
Cpk	---	0.2	pF

[1] Capacitance values are for a cold tube as measured in a shielded fixture in accordance with Electronic Industries Assocation Standard RS-191.

RADIO FREQUENCY LINEAR AMPLIFIER
CATHODE DRIVEN Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC ANODE VOLTAGE.....	4000 V
DC ANODE CURRENT	1.0 A
ANODE DISSIPATION	1500 W
GRID DISSIPATION	20 W
CATHODE-TO-HEATER VOLTAGE...	250 Vdc

[1] Positive cathode bias provided by zener diode.
[2] The intermodulation distortion products are referenced against one tone of a two-equal-tone signal.
[3] Approximate values.

TYPICAL OPERATION - Frequencies to 30 MHz
Peak Envelope or Modulation Crest Conditions

ANODE VOLTAGE	2700	3500	Vdc
CATHODE VOLTAGE[1]	+8.2	+8.2	Vdc
ZERO-SIGNAL ANODE CURRENT[3].....	92	182	mAdc
SINGLE-TONE ANODE CURRENT.....	740	1000	mAdc
TWO-TONE ANODE CURRENT.....	480	675	mAdc
SINGLE-TONE GRID CURRENT[3].....	40	74	mAdc
TWO-TONE GRID CURRENT[3]	16	25	mAdc
PEAK RF CATHODE VOLTAGE[3].....	68	81	V
PEAK DRIVING POWER[3]	40	64	W
DRIVING IMPEDANCE	58	51	Ω
SINGLE-TONE USEFUL OUTPUT POWER[3] ...	1085	2075	W
RESONANT LOAD IMPEDANCE	1820	2000	Ω
INTERMODULATION DISTORTION[2]:			
3rd ORDER PRODUCTS	-40	-38	dB
5th ORDER PRODUCTS	-41	-41	dB

RADIO FREQUENCY LINEAR AMPLIFIER
CATHODE DRIVEN Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC ANODE VOLTAGE.....	4000 V
DC ANODE CURRENT	1.0 A
ANODE DISSIPATION	1500 W
GRID DISSIPATION	20 W
CATHODE-TO-HEATER VOLTAGE...	250 Vdc

[1] Positive cathode bias provided by zener diode.
[2] Approximate values.

TYPICAL OPERATION (200 MHz)

ANODE VOLTAGE.....	2500 Vdc
CATHODE VOLTAGE[1]	+8.2 Vdc
ANODE CURRENT	1000 mAdc
GRID CURRENT[2]	10 mAdc
USEFUL OUTPUT POWER[2]	1520 W
DRIVING POWER[2].....	57 W
POWER GAIN[2].....	14 dB

RADIO FREQUENCY POWER AMPLIFIER
Class B Telegraphy or FM
(Continuous Operating Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC ANODE VOLTAGE.....	4000 V
DC ANODE CURRENT	1.0 A
ANODE DISSIPATION	1500 W
GRID DISSIPATION	20 W
CATHODE-TO-HEATER VOLTAGE...	250 Vdc

[1] For measured case, idling anode current was set for 10 mAdc.
[2] Approximate values.
[3] Approximate, delivered to the load.
[4] For the measured case, may vary from tube to tube.

TYPICAL OPERATION - 88 - 108 MHz)
Measured Values Class B, Cathode Driven

ANODE VOLTAGE	2000	2500	3000	4000	Vdc
CATHODE VOLTAGE[1,2]	+9	+12	+15	+20	Vdc
ANODE CURRENT.....	1.0	1.0	1.0	1.0	Adc
GRID CURRENT[2].....	60	58	42	25	mAdc
DRIVING POWER[2]	64	54	65	78	W
USEFUL OUTPUT POWER[3]	1330	1670	1960	2600	W
EFFICIENCY[4].....	66.7	66.7	66.5	65.2	%
POWER GAIN[4]	13.2	14.2	14.8	15.3	dB

RADIO FREQUENCY POWER AMPLIFIER
Class C, Cathode Driven
Plate Modulated

ABSOLUTE MAXIMUM RATINGS:

DC ANODE VOLTAGE.....	3200 V
DC ANODE CURRENT	0.8 A
ANODE DISSIPATION	1000 W
GRID DISSIPATION	20 W
CATHODE-TO-HEATER VOLTAGE...	250 Vdc

[1] Bias may be obtained from a fixed supply of 15.8 volts in series with a 9.5 ohm resistor. The resistor and supply
[2] Approximate.
[3] Approximate, and driver must be modulated approximately 83%.

TYPICAL OPERATION (Frequencies to 30 MHz Carrier Conditions)

ANODE VOLTAGE.....	2400 Vdc
CATHODE VOLTAGE[1]	+22 Vdc
ANODE CURRENT	600 mAdc
GRID CURRENT[2]	45 mAdc
ANODE LOAD RESISTANCE	2000 Ω
DRIVING POWER[3].....	41 W
ANODE OUTPUT POWER	1000 W
POWER GAIN.....	14 dB

TYPICAL OPERATION

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 anode current at the specified bias and anode 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 current. The grid current which results when the desired anode current is obtained is incidental and varies 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 rf grid voltage is applied.

MECHANICAL

MOUNTING – The 3CX1500A7/8877 may be mounted in any position.

SOCKETING - The grid of the 3CX1500A7/8877 terminates in the cylindrical grid ring about the base of the tube. This may be contacted by multiple clips or flexible finger stock. Connections to the heater and cathode are made via the 7-pin base. The Eimac SK-2210 socket is recommended for all rf amplifier applications.

STORAGE – If a tube is to be stored as a spare it should be kept in its original shipping carton, with the original packing material, to minimize the possibility of handling damage. Before storage a new tube should be operated in the equipment for 100 to 200 hours to establish that it has not been damaged and operates properly. If the tube is still in storage 6 months later it should be operated in the equipment for 100 to 200 hours to make sure there has been no degradation. If operation is satisfactory the tube can again be stored with great assurance of being a known-good spare.

COOLING - The maximum temperature limit for external tube surfaces and the anode core is 250°C. Tube life is prolonged if these areas are maintained at lower temperatures. For full 1500 watts anode dissipation 35.0 cfm of air is required at a back pressure of 0.41" H_2O hold tube temperature below 225°C with 50°C ambient temperature at sea level. At frequencies higher than 30 MHz, or at high altitudes, the air quantity must be increased. The data shown is based on airflow in the base-to-anode direction.

	SEA LEVEL		10,000 FEET	
Anode Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (In. of Water)	Air Flow (CFM)	Pressure Drop (In. of Water)
500	7.5	0.10	11.0	0.15
1000	22.5	0.20	32.5	0.29
1500	35.0	0.41	51.0	0.60

NOTES:
1. Tube mounted in SK-2200 Socket with SK-2216 Chimney.
2. An allowance of 25 watts has been made for grid dissipation and 50 watts for filament power.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. It dœs not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

HEATER OPERATION – The heater power supply should be isolated from ground (ie.; no center tap on the secondary of a transformer if used). The rated heater voltage for the 3CX1500A7/8877 of 5.0 volts, as measured at the socket, should be maintained at this value to obtain optimum performance and maximum tube life. In no case should the voltage be allowed to deviate from 5.0 volts by more than plus or minus five percent (5%). This tube is designed for normal commercial service, where one heater on/off cycle is anticipated per day. Contact Eimac Application Engineering if more daily on/off cycles are expected.

CATHODE WARM-UP/COOL-DOWN TIME - It is recommended that heater voltage be applied for a minimum of three minutes before anode voltage and drive voltage are applied, to allow for proper conditioning of the cathode surface. It is also recommended that after all voltages are removed from the tube that air cooling be allowed to run for several minutes to allow for proper cooldown.

INPUT CIRCUIT - When the 3CX1500A7/8877 is operated as a cathode driven rf amplifier, the use of a resonant circuit in the cathode is recommended. For best results with a single ended amplifier, it is suggested that the cathode tank circuit operate with a "Q" of 5 or more.

ZERO-BIAS OPERATION - Operation at zero-bias is not recommended with anode potentials over 3000 volts, since anode dissipation may be exceeded. Higher anode voltage may be used with proper protective bias.

FAULT PROTECTION - All power tubes operate at voltages which can cause severe damage in the event of an internal arc, especially in those cases where large amounts of stored energy or follow-on current are involved. Some means of protection is advised in all cases, and it is recommended that a series resistor be used in the anode circuit (20 to 50 ohms) to limit peak current and provide a means of dissipating the energy in the event of a tube or circuit arc. For an oxide-cathode tube such as the 3CX1500A7/8877, a maximum of 4 joules total energy should be permitted to be dumped into an internal arc. Amounts in excess of this may permanently damage the cathode or the grid structure. Additional information is found Eimac's Application Bulletin #17 titled "FAULT PROTECTION," available on request.

RF RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 300 MHz most of the energy will pass completely through the human body with little attenuation or heating affect. Public health agencies are concerned with the hazard, and the published OSHA (Occupational Safety and Health Administration) or other local recommendations to limit prolonged exposure of rf radiation should be followed. It is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

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 in a special shielded fixture.

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 mounting which represents approximate final layout if capacitance values are highly significant in the design.

Many Eimac power tubes such as this are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power and its associated circuitry - the more power involved the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier itself.

HIGH VOLTAGE - The 3CX1500A7/8877 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 capacitors 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.

HOT SURFACES - Air-cooled surfaces and other parts of tubes can reach temperatures of several hundred degrees C and cause serious burns if touched for several minutes after all power is removed.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, contact the Application Engineering Dept., CPI MPP Eimac Operation for information and recommendations.

OPERATING HAZARDS

Proper use and safe operating practices with respect to power tubes are the responsibility of equipment manufacturers and users of such tubes. All persons who work with and are exposed to power tubes, or equipment that utilizes such tubes, must take precautions to protect themselves against possible serious bodily injury. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel.

Please review the detailed Operating Hazards Sheet enclosed with each tube, or request a copy from CPI Microwave Power Products, Eimac Operation.

HIGH VOLTAGE – Normal operating voltages can be deadly. Remember the HIGH VOLTAGE CAN KILL.

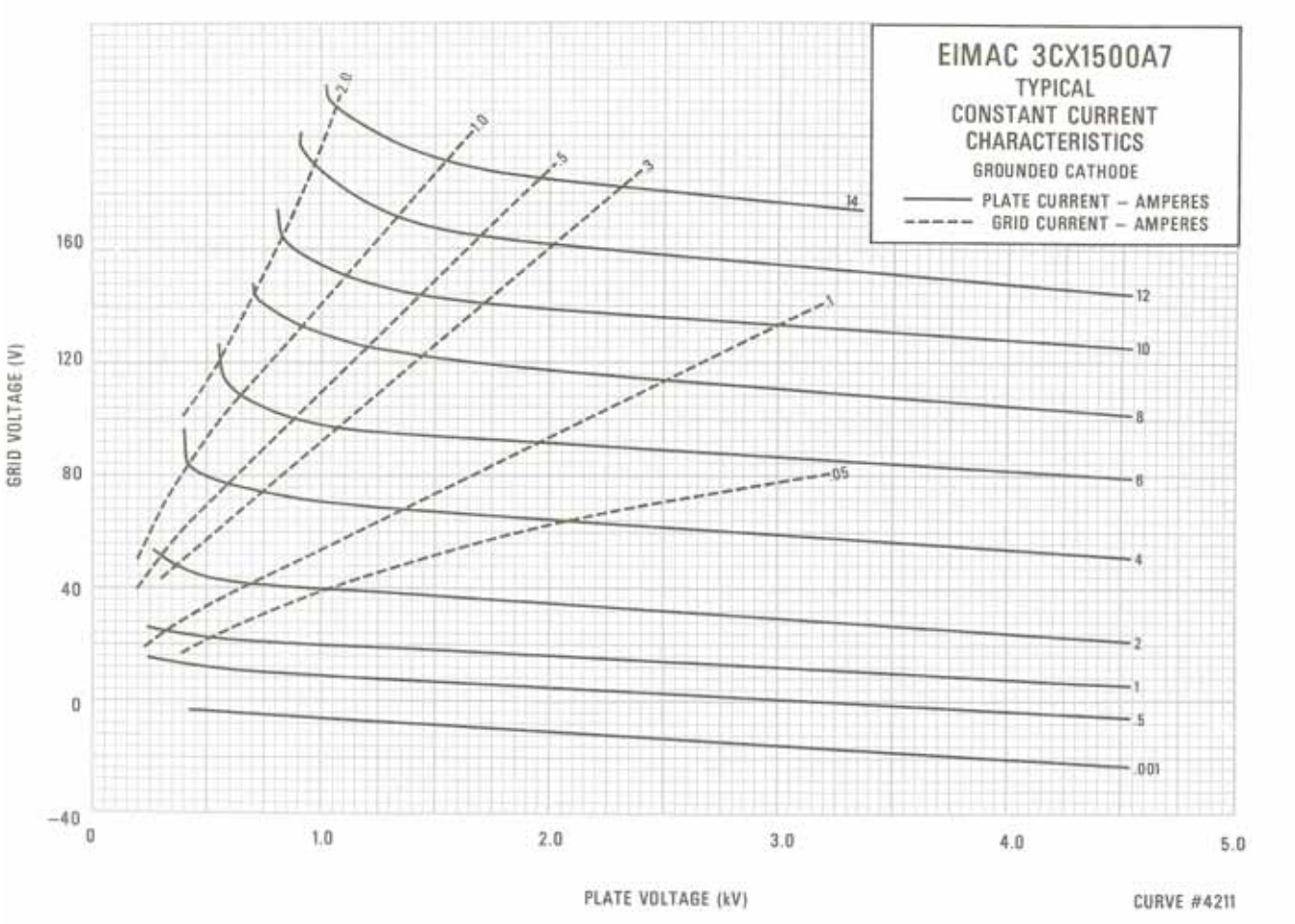
LOW-VOLTAGE HIGH-CURRENT CIRCUITS - Personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

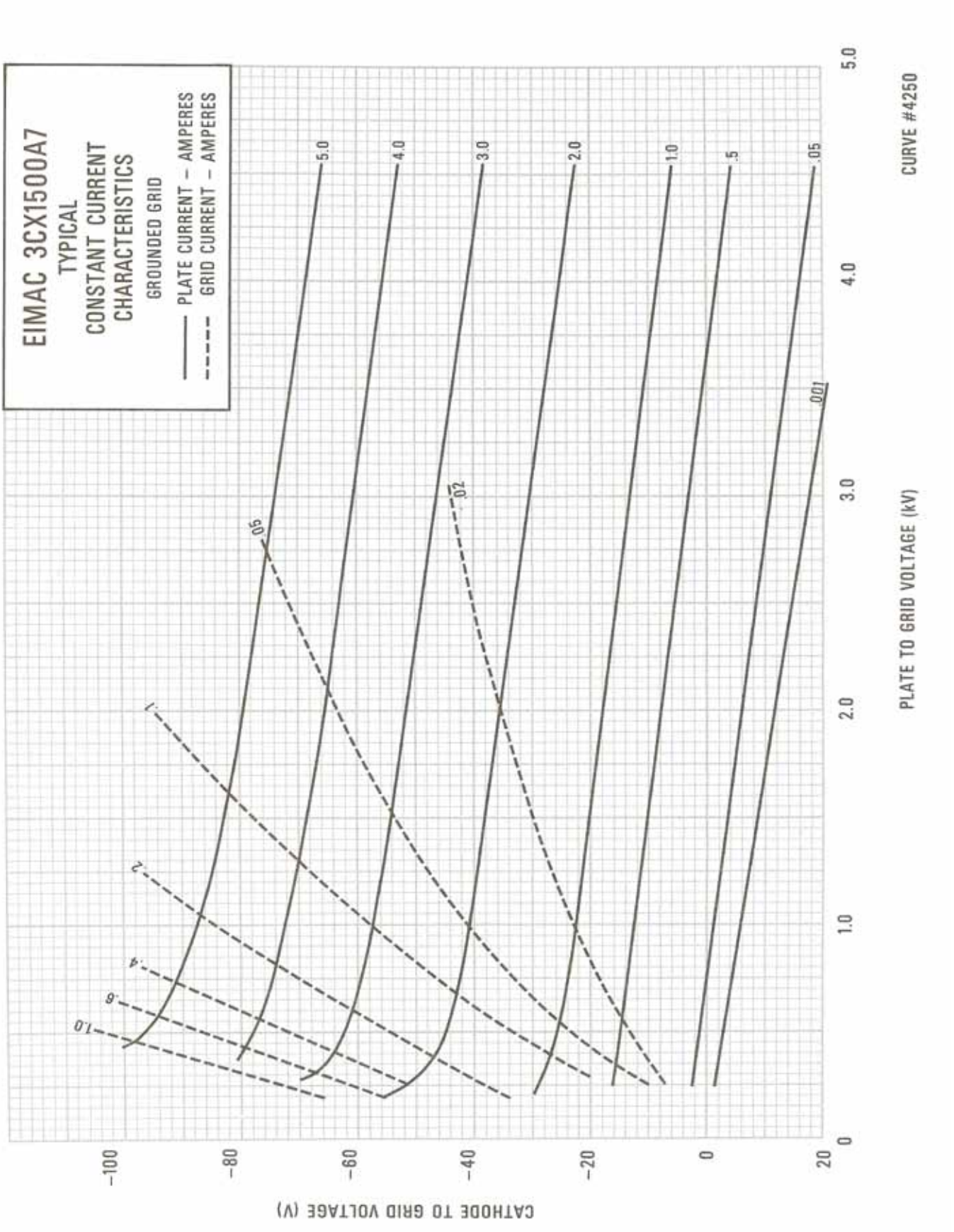
RF RADIATION – Exposure to strong rf fields should be avoided, even at relatively low frequencies. CARDIAC PACEMAKERS MAY BE AFFECTED.

HOT WATER – Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

HOT SURFACES – Surfaces of tubes can reach temperatures of several hundred°C and cause serious burns if touched for several minutes after all power is removed.

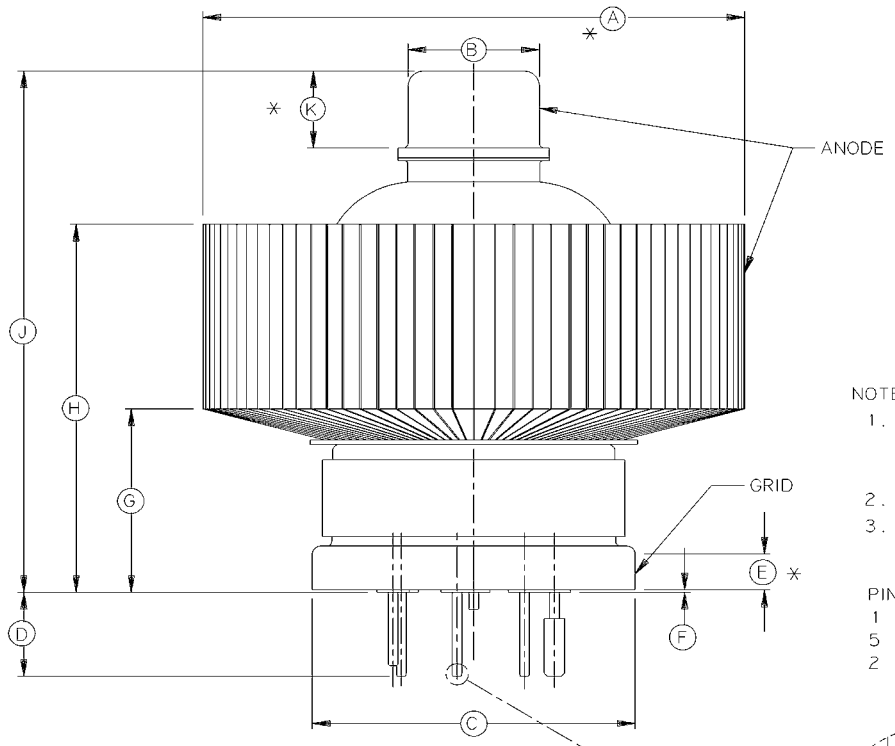
MATERIALS COMPLIANCE - This product and package conforms to the conditions and limitations specified in 49CFR 173.424 for radioactive material, excepted package-instruments or articles, UN2910. In addition, this product and package contains no beryllium oxide (BeO).




EIMAC 3CX1500A7
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
5.0
4.0
3.0
2.0
1.0
.5
.05
.001
.90
.20
1.0
.6
.4
.2
.1
CATHODE TO GRID VOLTAGE (V)
-100
-80
-60
-40
-20
0
20
0
1.0
2.0
3.0
4.0
5.0
PLATE TO GRID VOLTAGE (kV)
CURVE #4250

HIGH-MU POWER TRIODE

3CX1500A7/8877



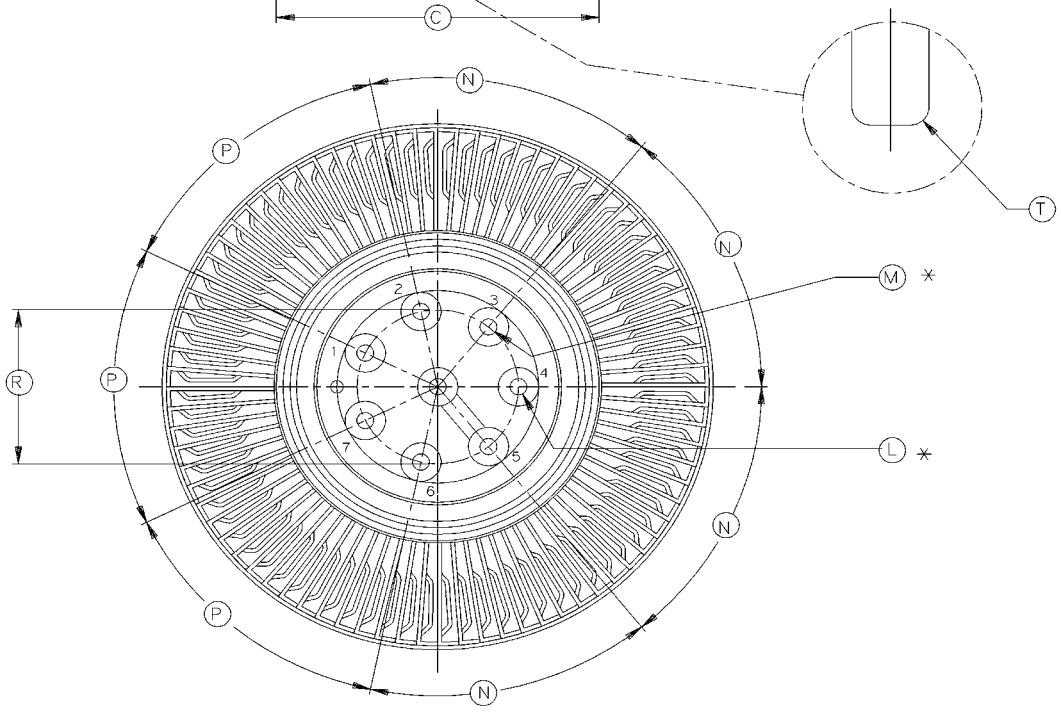
DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.335	3.365		84.71	85.47	
B	.810	.820		20.57	20.83	
C	1.985	2.015		50.42	51.18	
D	.438	.562		11.13	14.27	
E	.200			5.08		
F	.000	.040		.00	1.02	
G	1.100	1.225		27.94	31.12	
H	2.300	2.500		58.42	63.50	
J	3.250	3.420		82.55	86.87	
K	.470	.530		11.94	13.46	
L	.120	.127		3.05	3.23	
M	.056	.062		1.42	1.57	
N			51°			
P			52°			
R			1.000			25.40
T	.005 R			.13R		

NOTES:

1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACE.
3. DIMENSION "T" APPLIES TO ALL BUT CENTER PIN.

PIN CONNECTIONS:

1 - HEATER
5 - HEATER
2 - 3 - 4 - 6 - 7 CATHODE



Communications & Power Industries

Microwave Power Products Division
tel: +1 650-846-2800
email: MPPmarketing@cpii.com
web: www.cpii.com/mpp