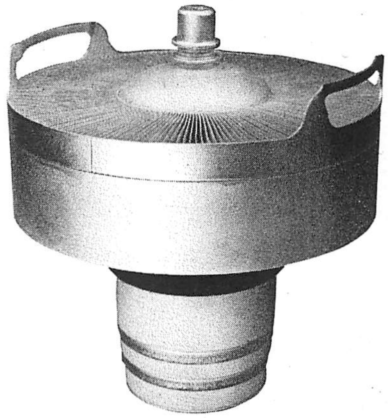
TECHNICAL DATA

4CX20,000B
RADIAL BEAM POWER TETRODE



The EIMAC 4CX20,000B is a ceramic/metal, forced-air cooled power tetrode. It is recommended for use as a Class C rf amplifier in AM broadcast service, for Class B push-pull audio amplifier or modulator service. Its high voltage hold-off capability makes it an excellent choice for pulse modulator service, for which ratings have been established.

The forced-air cooled anode is rated at 20 kilowatts dissipation capability and incorporates a highly efficient cooler of new design.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh	
Voltage	10.0 ± 0.5 V
Current, at 10.0 volts	140 A
Amplification Factor, Average (Grid to Screen)	6.7
Direct Interelectrode Capacitances (cathode grounded)[2]	
Cin	190 pF
Cout	23.5 pF
Cgp	1.5 pF
Direct Interelectrode Capacitances (grids grounded)[2]	
Cin	83 pF
Cout	24.5 pF
Cpk	0.2 pF
Maximum Frequency for Full Ratings (CW)	30 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. Varian EIMAC 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	9.84 In; 24.99 cm
Diameter	8.86 In; 22.50 cm
Net Weight (approximate)	14.0 Lbs; 6.35 kg
Operating Position	Axis Vertical, Base Up or Down
Cooling	Forced Air
Operating Temperature, Absolute Maximum, Ceramic/Metal Seals and Anode Core	250°C
Base	Special, Coaxial
Recommended Air-System Socket (dc, LF, HF Applications)	EIMAC SK-320
Recommended Air Chimney (for SK-320 Socket)	EIMAC SK-326
Recommended Air-System Socket (for VHF Applications)	EIMAC SK-360
Recommended Air Chimney (for SK-360 Socket)	EIMAC SK-326
Available Screen Grid Bypass Capacitor Kit for SK-360 (C = 8000 pF @ 5000 DCWV)	EIMAC SK-355
Available Anode Contact Connector	EIMAC ACC-3

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	12,500	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	20.0	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION (frequencies to 30 MHz)

Plate Voltage	7.5	9.0	kVdc
Screen Voltage	750	900	Vdc
Grid Voltage	-200	-250	Vdc
Plate Current	3.68	4.01	Adc
Screen Current *	208	222	mAdc
Grid Current *	91	88	mAdc
Peak rf Grid Voltage *	265	300	v
Calculated Driving Power	24.1	26.4	W
Plate Dissipation *	5.84	7.93	kW
Plate Output Power *	21.8	28.2	kW
Load Impedance	1062	1136	Ohms

* Approximate value

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VA4649

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CPI Communications & Power Industries
Eimac division
301 Industrial Way
San Carlos, CA 94070-2582
formerly a division of varian associates, inc.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER
GRID DRIVEN Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC GRID VOLTAGE	-1000	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	13.5	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION

Plate Voltage	7800	Vdc
Screen Voltage	750	Vdc
Grid Voltage	-300	Vdc
Peak af screen voltage (100% modulation)	750	v
Plate Current	4.6	Adc
Screen Current *	220	mAdc
Grid Current *	108	mAdc
Calculated Driving Power	35	W
Plate Impedance	845	Ohms
Plate Output Power	29	kW
Plate Dissipation	6880	W

* Approximate value

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR
GRID DRIVEN, Class AB1
(sinusoidal wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	12,500	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	6.0	AMPERES
PLATE DISSIPATION	20	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION (2 tubes)

Plate Voltage	7800	7800	7800	Vdc
Screen Voltage	500	750	1500	Vdc
Grid Voltage #	-70	-125	-250	Vdc
Zero Signal Plate Current	0.75	0.75	1.0	Adc
Max.Signal Plate Current	3.4	5.2	9.2	Adc
Max.Signal Screen Current *	90	220	600	mAdc
Peak Grid Voltage *	65	115	200	v
Max.Signal Plate Diss. ##	6.0	7.0	13.5	kW
Plate Output Power	14.5	26.0	44.0	kW
Load Impedance p/p	6300	3500	1600	Ohms

* Approximate value # Adjust for specified zero-signal plate current ## Per tube

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PULSE MODULATOR OR REGULATOR SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	35	KILOVOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC GRID VOLTAGE	-1500	VOLTS
PEAK CATHODE CURRENT	80	AMPERES
PLATE DISSIPATION	20	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS
MAXIMUM PULSE LENGTH	100	MILLISEC

Note: Operation at altitudes significantly above sea level may require the use of a protective atmosphere or a reduction in the plate voltage and screen voltage maximum values shown.

CAUTION: X-RADIATION HAZARD - See detailed X-RADIATION HAZARD application note.

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in ouput power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

APPLICATION

MECHANICAL

MOUNTING - The 4CX20,000B must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the designer.

SOCKET & CHIMNEY - The EIMAC air-system socket SK-320 and air chimney SK-326 are designed for use with the 4CX20,000B in dc or LF/HF applications. For VHF applications the SK-360 air-system socket is recommended. The use of the recommended air flow through an air-system socket will provide effective cooling of the base, with air then guided to the anode cooling fins by the chimney.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250 Deg.C, and sufficient forced-air cooling must be used in all applications to keep the temperature of the anode (at the base of the cooling fins) and the temperature of the ceramic/metal seals comfortably below this rated maximum.

It is considered good engineering practice to design for a maximum anode core temperature of 225°C and temperature-sensitive paints are available for checking base and seal temperatures before any design is finalized. EIMAC Application Bulletin #20 titled "TEMPERATURE MEASUREMENTS WITH EIMAC TUBES" is available on request.

It is also good practice to allow for variables such as dirty air filters, rf seal heating, and the fact that the anode cooling fins may not be clean if the tube has been in service for some length of time. Special attention is required in cooling the center of the stem (base), by means of special directors or some other provision. An air interlock system should be incorporated in the design to automatically remove all voltages from the tube in case of even partial failure of the tube cooling air.

Minimum air flow requirements for a maximum anode temperature of 225°C for various altitudes and dissipation levels are listed. The pressure drop values are approximate and are for the tube in a SK-320 socket. Pressure drop in a typical installation will be higher because of system loss.

Pressure drop will be higher if the SK-360 socket is used unless additional air passages are provided around the mounted socket.

Inlet Air Temperature = 25°C

	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
Sea Level	12.5	257	0.6
	15.0	367	1.0
	17.5	498	1.5
	20.0	652	2.4
5000 Feet	12.5	311	0.6
	15.0	444	1.1
	17.5	603	1.7
	20.0	789	2.7
10,000 Feet	12.5	377	0.7
	15.0	537	1.2
	17.5	730	1.9
	20.0	955	3.0

Inlet Air Temperature = 35°C

	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
Sea Level	12.5	299	0.7
	15.0	426	1.2
	17.5	579	1.9
	20.0	758	2.9
5000 Feet	12.5	362	0.7
	15.0	516	1.3
	17.5	701	2.1
	20.0	917	3.3
10,000 Feet	12.5	438	0.8
	15.0	625	1.4
	17.5	848	2.4
	20.0	1111	3.8

Inlet Air Temperature = 50°C

	Plate Diss. kW	Flow Rate CFM	Press. Drop In.Water
Sea Level	12.5	379	0.9
	15.0	540	1.6
	17.5	733	2.6
	20.0	960	4.1
5000 Feet	12.5	459	1.0
	15.0	654	1.8
	17.5	888	3.0
	20.0	1162	4.7
10,000 Feet	12.5	555	1.1
	15.0	791	2.0
	17.5	1075	3.4
	20.0	1407	5.4

When long life and consistent performance are factors cooling in excess of minimum requirements is normally beneficial.

Air flow must be applied before or simultaneously with the application of power, including the tube filament, and should normally be maintained for a short period of time after all power is removed to allow for tube cooldown.

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 the 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 does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

FILAMENT OPERATION - During turn-on the filament inrush current should be limited to 300 amperes. At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should then be gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The filament voltage should then be increased a few tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked after 24 hours.

Filament voltage should be closely regulated (plus or minus two percent or better) when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by line voltage variations.

Filament voltage should be measured at the tube base or socket, using an rms-responding meter of known accuracy. Periodically throughout the life of the tube the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best tube life.

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings for the 4CX20,000B must be respected to avoid damage to the tube. An exception is the plate dissipation which may be permitted to rise above the rated maximum during brief periods (10 seconds maximum) such as may occur during tuning an rf amplifier.

In pulse modulator or regulator service average anode dissipation may be calculated as the product of pulse anode current, pulse tube-voltage drop during conduction, and the duty factor. The actual dissipation may often exceed the calculated value if pulse rise and fall times are appreciable compared to pulse duration. This occurs because long rise and fall times slow down plate voltage swing and allow plate current flow for a longer period in the high tube-voltage-drop region.

GRID OPERATION - The maximum control grid dissipation is 200 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. A protective spark-gap device should be connected between the control grid and the cathode to guard against excessive voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 450 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. Energy limiting circuitry (which will activate if there is a fault condition) and spark gap over-voltage protection are recommended as good engineering practice.

The tube may exhibit reversed (negative) screen current under some operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may be encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, to assure that net screen supply current is always positive. This is absolutely essential if a series electronic regulator is employed.

FAULT PROTECTION - In addition to the normal overcurrent interlocks and coolant interlock, the tube must be protected from damage caused by an internal arc which may occur at high plate voltage. A protective resistance should always be connected in series with the tube anode, to help absorb power supply stored energy if an internal arc should occur. An electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, may be required. The test for each electrode supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-inch length of #30 AWG copper wire. The wire will remain intact if the the protection is adequate.

EIMAC Application Bulletin #17 titled FAULT PROTECTION contains considerable detail, and is available on request.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment 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 primary circuits of the power supply 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.

X-RADIATION HAZARD - High-vacuum tubes operating at voltages higher than 15 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents in pulse modulator or regulator service, is a potential X-ray source. Limited shielding is afforded by the tube envelope. Moreover, the X-radiation level may increase significantly with tube aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by high voltage. X-ray shielding may be required on all sides of tubes operating at these voltages to provide adequate protection throughout the life of the tube. Periodic checks on the X-ray level should be made, and the tube should never be operated without required shielding in place. If there is any question as to the need for or the adequacy of shielding, an expert in this field should be contacted to perform an equipment X-ray survey.
Where shielding has been found to be required operation of high voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

RADIO-FREQUENCY 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 even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

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 Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of a specially constructed test fixture which shields all external tube leads or contacts 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. The capacitance values shown in the technical data 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 the appliction. Measurements should be taken with the mounting which represents approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn: Product Manager; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

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 OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH 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:

a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

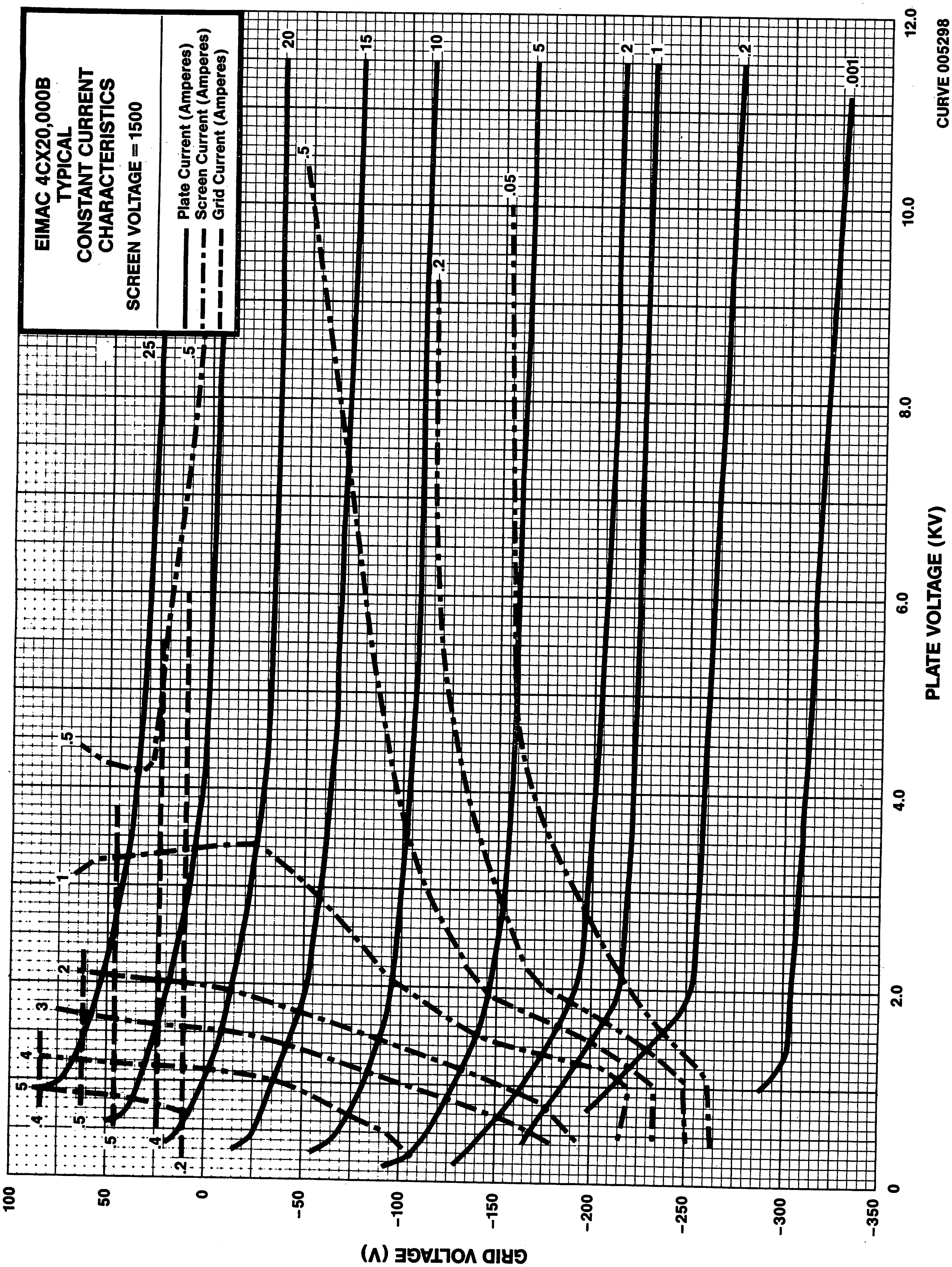
b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

c. X-RAY RADIATION - High-voltage pulse modulator tubes are a potential source of dangerous X-Ray radiation and shielding may be required on all sides of the tube. A survey may be required by an expert in this field.

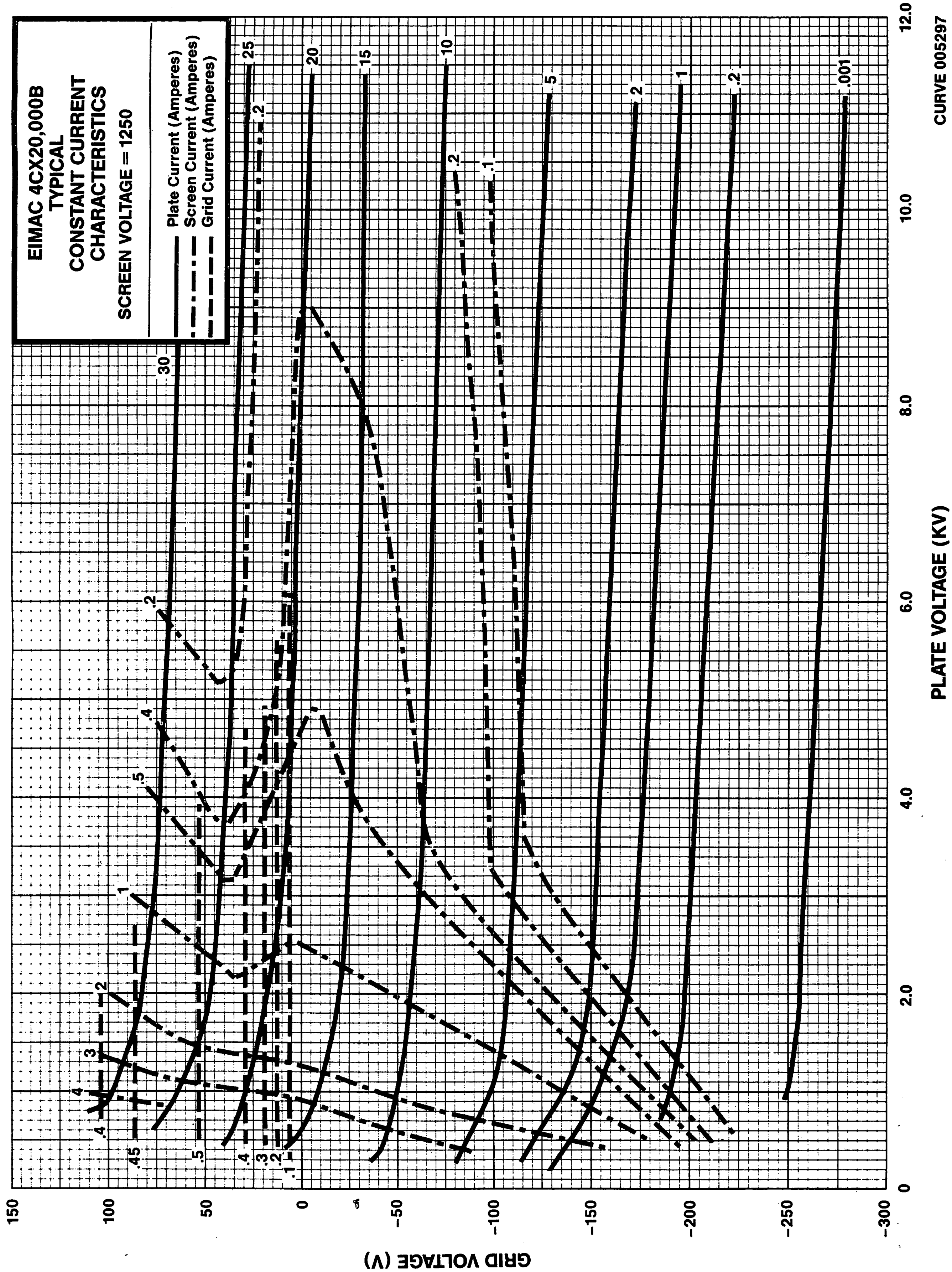
d. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. CARDIAC PACEMAKERS MAY BE EFFECTED.

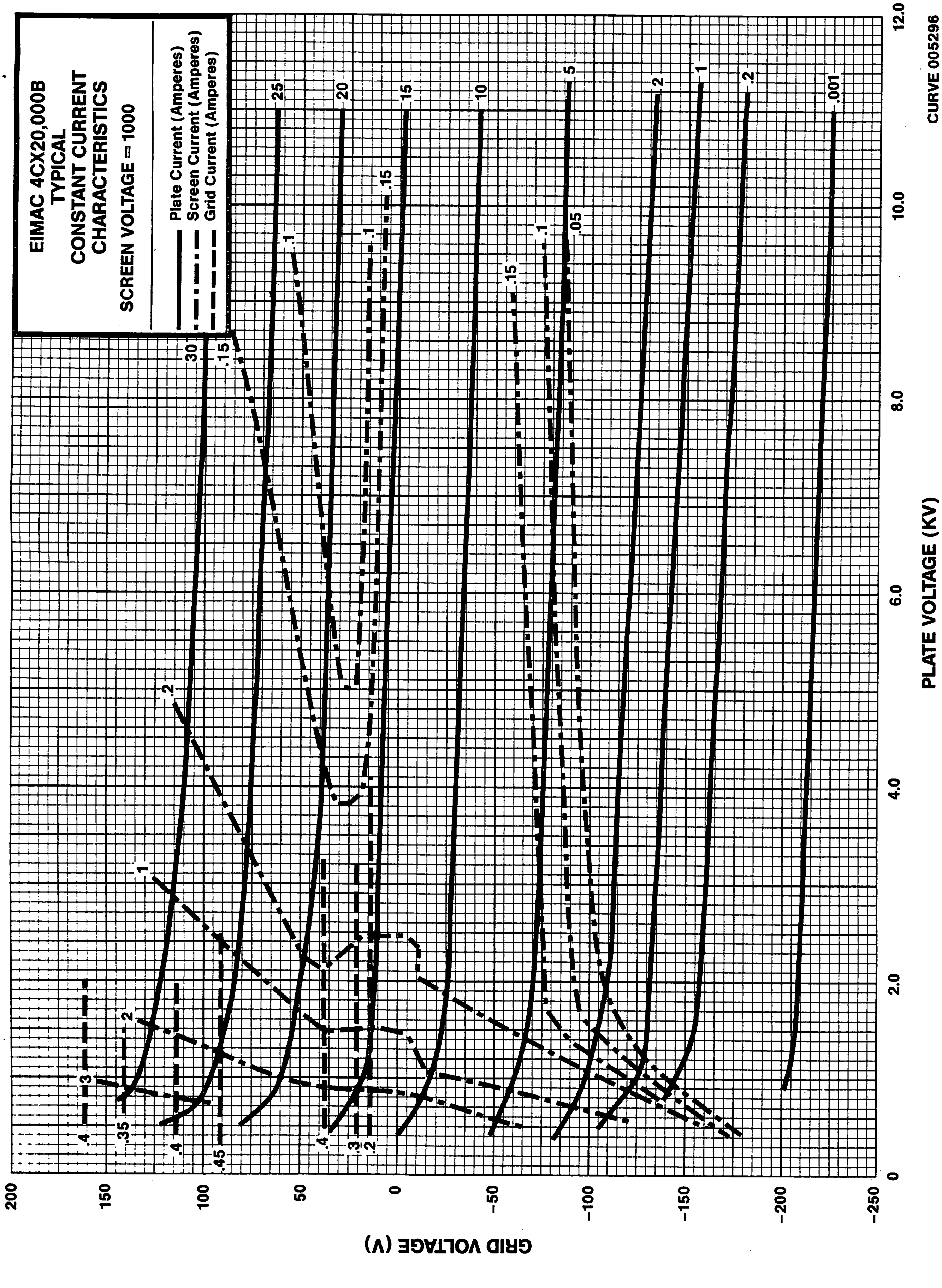
e. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.

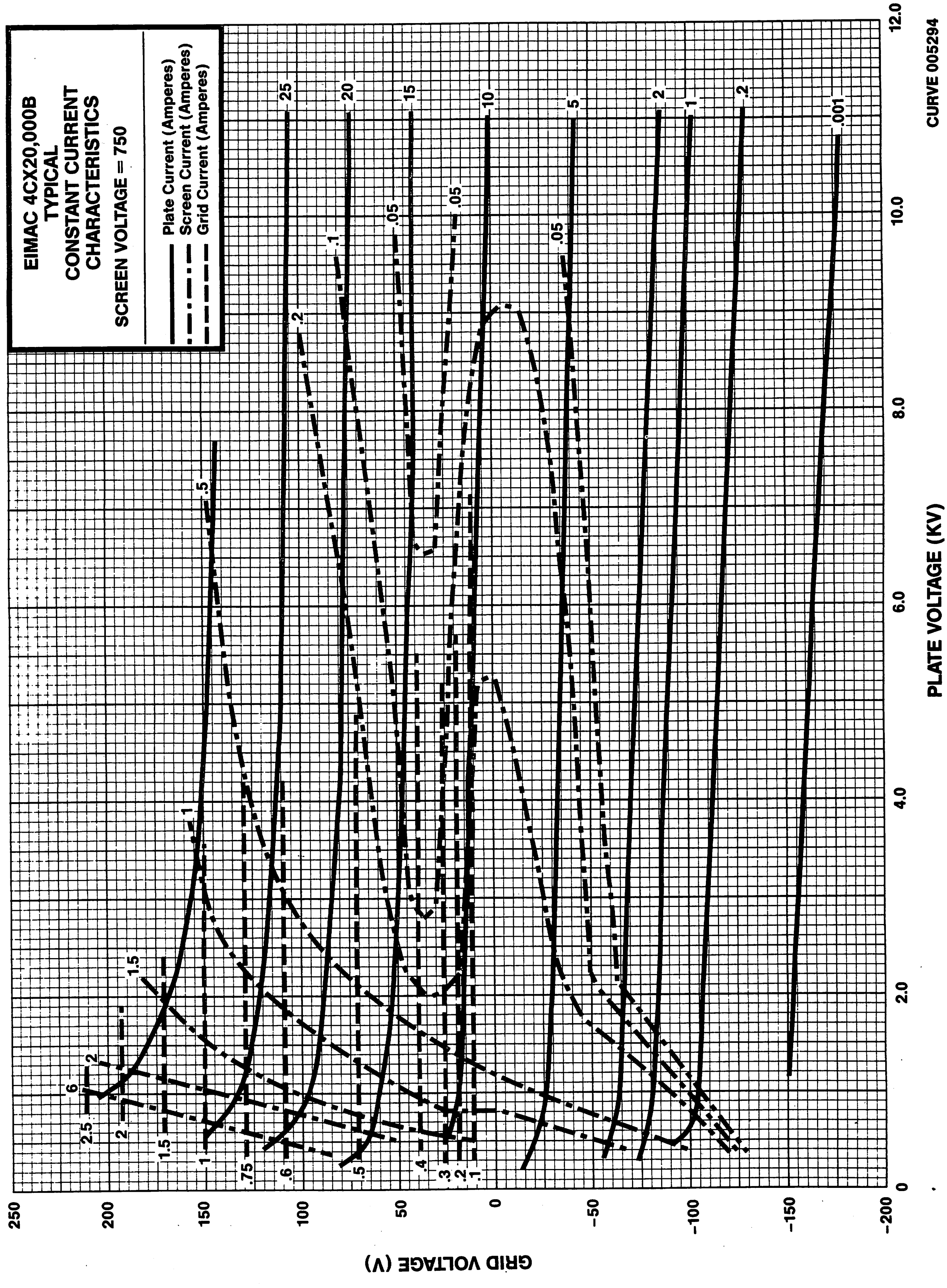


EIMAC 4CX20,000B
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
PLATE VOLTAGE (KV)
GRID VOLTAGE (V)
CURVE 005298


EIMAC 4CX20,000B
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1250
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
PLATE VOLTAGE (KV)
GRID VOLTAGE (V)
CURVE 005297



EIMAC 4CX20,000B
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1000
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (KV)
CURVE 005296
200
150
100
50
0
-50
-100
-150
-200
-250
0
2.0
4.0
6.0
8.0
10.0
12.0


EIMAC 4CX20,000B
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
PLATE VOLTAGE (KV)
GRID VOLTAGE (V)
CURVE 005294
0
2.0
4.0
6.0
8.0
10.0
12.0
250
200
150
100
50
0
-50
-100
-150
-200

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	8.730	8.860		221.74	225.04	
B	.855	.895		21.72	22.73	
C	4.593	4.656		116.66	118.26	
D	.600	.760		15.24	19.30	
E	1.896	1.936		48.16	49.17	
F	3.133	3.173		79.58	80.59	
G	3.792	3.832		96.32	97.33	
H	3.980	4.020		101.09	102.11	
J	.188			4.78		
K	.188			4.78		
L	.188			4.78		
M						
N						
P	4.843	4.906		123.01	124.61	
R	1.940	2.060		49.28	52.32	
S	9.465	9.840		240.41	249.94	
T	.500			12.70		
U	1.766	1.828		44.86	46.43	

NOTES
1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES
2. * CONTACT SURFACE.
3. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES