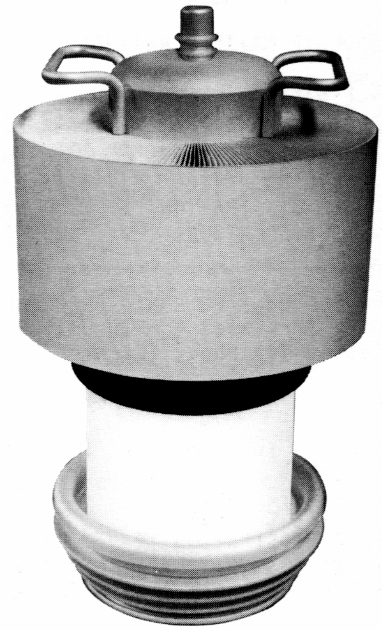
TECHNICAL DATA

4CX35,000D HF POWER TETRODE



The EIMAC 4CX35,000D is a ceramic/metal forced-air cooled power tetrode intended for use at the 50 to 150 kW output power level. It is recommended for use as a Class-C rf amplifier, a Class-AB rf linear amplifier, or a Class-AB push-pull audio amplifier or modulator. It is also useful as a plate and screen modulated Class-C rf amplifier.

The tube utilizes a rugged thoriated tungsten mesh cathode. It is interchangeable with the 8349/4CX35,000C and provides improved performance in many applications.

The forced-air cooled anode is rated at 35 kW maximum dissipation.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	10.0 ± 0.5	V
Current, at 10.0 volts	275	A
Amplification Factor (average)	4.5	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	445	pF
Cout	51	pF
Cgp	2.3	pF
Direct Interelectrode Capacitance (grounded grid)[2]		
Cin	195	pF
Cout	55	pF
Cpk	0.5	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	17.34 In; 44.04 cm
Diameter	9.75 In; 24.77 cm
Net Weight	50 lb; 22.7 kg
Operating	Vertical, base up or down
Maximum Operating Temperature, Anode Core or Ceramic/Metal Seals	250°C
Cooling	Forced Air
Base	Special, graduated rings
Recommended Air-System Socket	EIMAC SK-1500A or SK-1510A
Available Screen Grid Bypass Capacitor Components	2300 pF - EIMAC P/N 149089
	1100 PF - EIMAC P/N 149090
Required Set of Insulator Bushings	EIMAC P/N 149088
Available Anode Connector Clip	EIMAC ACC-3

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN
Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20 KILOVOLTS
DC SCREEN VOLTAGE	2.5 KILOVOLTS
DC GRID VOLTAGE	-2.0 KILOVOLTS
DC PLATE CURRENT	15 AMPERES
PLATE DISSIPATION	35 KILOWATTS
SCREEN DISSIPATION	1750 WATTS
GRID DISSIPATION	500 WATTS

* Approximate; will vary tube to tube.
# Adjust to specified zero-signal dc plate current.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	10.00	15.0	kVdc
Screen Voltage	1500	1500	Vdc
Grid Voltage #	-350	-400	Vdc
Zero-Signal Plate Current	2.0	0.91	Adc
Single-Tone Plate Current	8.7	7.9	Adc
Single-Tone Screen Current *	0.23	0.16	Adc
Peak rf Grid Driving Voltage *	287	335	v
Peak Driving Power *	0	0	w
Plate Dissipation *	30	33	kW
Plate Output Power *	56.5	85	kW
Resonant Load Impedance	593	1019	Ohms

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Varian EIMAC / 301 Industrial Way / San Carlos, CA 94070 / U.S.A.

RADIO FREQUENCY POWER AMPLIFIER

Class C Telegraphy or FM
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20 KILOVOLTS
DC SCREEN VOLTAGE	2.5 KILOVOLTS
DC GRID VOLTAGE	-2.0 KILOVOLTS
DC PLATE CURRENT	15 AMPERES
PLATE DISSIPATION	35 KILOWATTS
SCREEN DISSIPATION	1750 WATTS
GRID DISSIPATION	500 WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	10.0	15.0	19.0	kVdc
Screen Voltage	750	750	750	Vdc
Grid Voltage	-425	-480	-550	Vdc
Plate Current	7.1	6.6	8.7	Adc
Screen Current *	0.35	0.39	0.25	Adc
Grid Current *	0.17	0.14	0.30	Adc
Peak rf Grid Driving Voltage *	528	570	690	v
Calculated Driving Power *	88	77	197	W
Plate Dissipation *	14.7	15	25	kW
Plate Output Power *	56.6	85	140	kW

* Approximate; will vary tube to tube.

PLATE MODULATED RADIO-FREQUENCY POWER AMPLIFIER - GRID DRIVEN

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17.5 KILOVOLTS
DC SCREEN VOLTAGE	2.0 KILOVOLTS
DC GRID VOLTAGE	-2.0 KILOVOLTS
DC PLATE CURRENT	15 AMPERES
PLATE DISSIPATION **	23 KILOWATTS
SCREEN DISSIPATION #	1750 WATTS
GRID DISSIPATION #	500 WATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	10	15	kVdc
Screen Voltage	750	750	Vdc
Grid Voltage	-520	-540	Vdc
Plate Current	7.1	6.9	Adc
Screen Current *	0.22	0.21	Adc
Grid Current *	0.18	0.19	Adc
Peak af Screen Voltage (100% modulation)##	540	530	v
Peak rf Grid Driving Voltage *	640	655	v
Calculated Driving Power *	130	120	W
Plate Dissipation *	10.6	13.6	kW
Plate Output Power *	60	90	kW
Resonant Load Impedance	705	1110	Ohms

* Approximate; will vary tube to tube.
** Corresponds to 35 kilowatts at 100% sine-wave modulation.
# Average, with or without modulation.
Approximate, depending on degree of driver modulation.

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20 KILOVOLTS
DC SCREEN VOLTAGE	2.5 KILOVOLTS
DC GRID VOLTAGE	-2.0 KILOVOLTS
DC PLATE CURRENT	15 AMPERES
PLATE DISSIPATION	35 KILOWATTS
SCREEN DISSIPATION	1750 WATTS
GRID DISSIPATION	500 WATTS

* Approximate; will vary tube to tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	10	15	kVdc
Screen Voltage	1500	1500	Vdc
Grid Voltage * #	-350	-410	Vdc
Zero-Signal Plate Current	4.0	1.8	Adc
Max.Signal Plate Current	17.4	15.8	Adc
Max.Signal Screen Current *	0.46	0.32	Adc
Peak af Grid Driving Voltage * ##	287	335	v
Max.Signal Plate Dissipation * ##	30.3	33	kW
Plate Output Power *	113	170	kW
Load Resistance (plate to plate)	1190	2040	Ohms

Adjust to give stated zero-signal plate current.
Per tube.

TYPICAL OPERATION values are obtained 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 output 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.

RANGE VALUES FOR EQUIPMENT DESIGN:

	MIN.	MAX.	
Filament Current, at 10.0 Volts	260	290	A
Interelectrode Capacitance (grounded cathode connection)[1]			
Cin	410	480	pF
Cout	46	56	pF
Cgp	1.5	3.2	pF
Interelectrode Capacitance (grounded grid connection)[1]			
Cin	185	215	pF
Cout	50	60	pF
Cpk	---	0.6	pF

1 Measured in a specially shielded fixture in accordance with EIA Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CX35,000D must be operated with its axis vertical, base up or down at the option of the equipment designer.

SOCKET - Air-system sockets SK-1500A and SK-1510A have been designed especially for the concentric base terminals of the 4CX35,000D. The SK-1510A includes a tube seating & locking device. Special screen bypass capacitor dielectrics are available and the EIMAC part numbers are shown on Page 1.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250°C. Sufficient forced-air cooling must be provided to maintain the anode at the base of the cooling fins, and the ceramic/metal seals, below 250°C.

Air flow requirements to maintain anode core temperature at 225°C with 40°C ambient cooling air are tabulated below (for operation below 30 MHz). This data is for flow in the base-to-anode direction; pressure drop figures are in inches of water, are for the anode cooler only, and are approximate.

	SEA LEVEL		10,000 FEET	
Plate Diss. (watts)	Air Flow (cfm)	Press. Drop	Air Flow (cfm)	Press. Drop
15,000	440	1.0	635	1.5
20,000	650	2.0	935	2.9
25,000	975	3.8	1400	5.5
30,000	1300	6.0	1870	8.6
35,000	1760	9.6	2535	13.8

The blower selected in any given application must be able to supply the desired air flow at a back pressure equal to the pressure drop shown above plus any drop(s) encountered in ducts and filters.

Separate cooling of the tube base is required and is accomplished by directing approximately 120 cfm of air horizontally through the socket from the side. It is preferable to direct this air through three equally spaced ducts. Temperature of spring contacts in the socket should not exceed 150°C to provide proper socket life.

The well in the center of the baseplate of the tube is a critical area which requires cooling to maintain envelope temperatures less than 250°C. For most applications, 1 to 2 cfm of air directed through the center of the socket is sufficient.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases. The designer is reminded that it is considered good engineering practice to allow some safety factor so the tube is not operated at the absolute maximum temperature rating. Temperature sensitive paints are available for testing before any equipment design is finalized, and Application Bulletin #20 titled TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES is available on request.

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 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 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. <u>It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously</u>.

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.

FILAMENT OPERATION - During turn-on the filament inrush current should be limited to 600 amperes.

At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in 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 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 in 24 hours. Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations.

Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. 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.

Where hum is an important system consideration it is permissible to operate the filaments with dc rather than ac power. Contact Varian EIMAC Application Engineering for special precautions when using a dc filament supply.

This tube is designed for commercial service, with only one off/on filament cycle per day. If additional cycling is anticipated it is recommended the user contact Application Engineering at EIMAC.

BASE PLATE VOLTAGE - Any difference in potential between the base plate and the tube filament must be limited to 100 volts (peak).

GRID OPERATION - The maximum control grid dissipation is 500 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 grid and the cathode to guard against excessive voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 1750 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. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

The screen current may reverse under certain conditions and produce negative indictions on the screen current meter. 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 the screen to cathode in the form of a bleeder resistor or a shunt regulator, connected between screen and cathode, may be required. A series regulated power supply can be used only when an adequate bleeder resistor is provided.

PLATE OPERATION - The rated maximum dissipation for the tube is 35,000 watts. When operated as a plate-modulated rf amplifier, under carrier conditions the maximum dissipation rating is 23,000 watts, which corresponds to 35,000 watts at 100% sine-wave modulation.

Operation with significant plate current under some conditions of high instantaneous anode voltage (such as regulator service or low power and low impedance "tuning" conditions) can, as a result of the screen and grid voltages chosen, lead to anode damage and subsequent failure. If operation under such conditions is necessary EIMAC Application Engineering should be contacted for assistance in selection of operating parameters.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and coolant interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each 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, is recommended. The protection criteria 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 protection is adequate.

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

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, is a potential X-ray source. Only 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 the 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.

In cases 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.

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 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 application. 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: Applications Engineering; 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. Always remember that HIGH VOLTAGE CAN KILL.

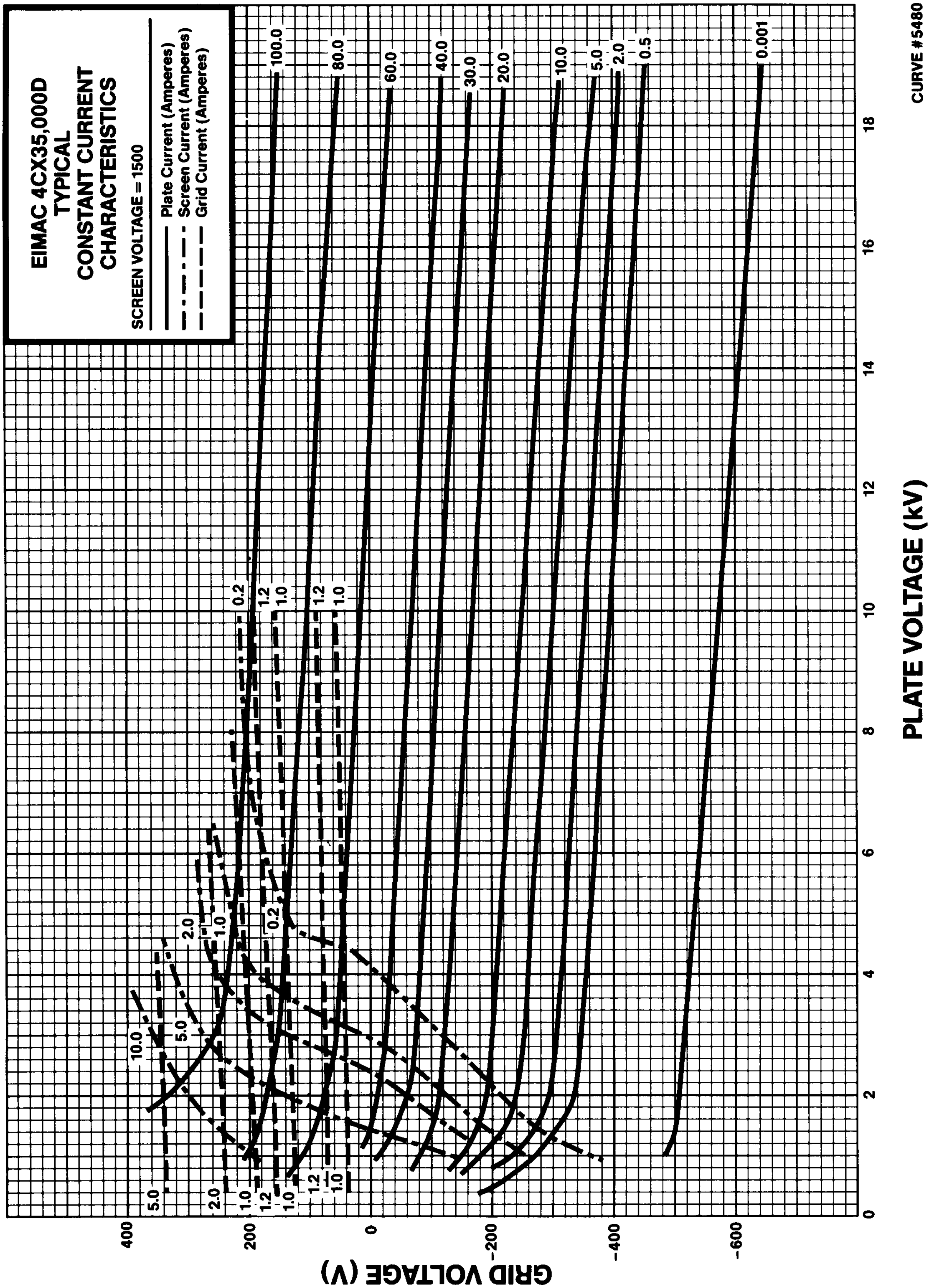
b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - Personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

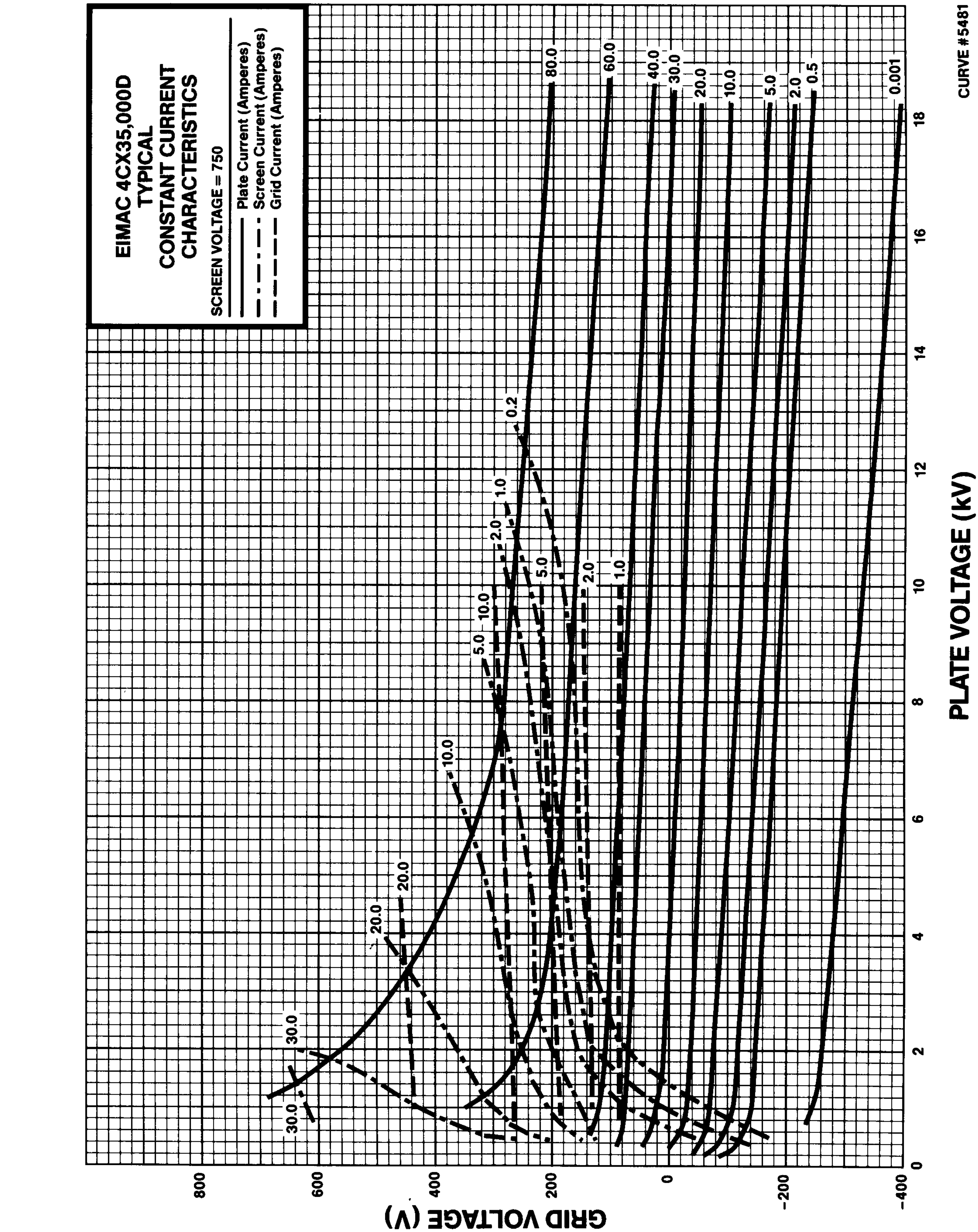
c. X-RAY RADIATION - High-voltage pulse modulator tubes are a potential source of dangerous X-Ray radiation and shielding may be required on all sides of the tube. A survey may be required by an expert in this field.

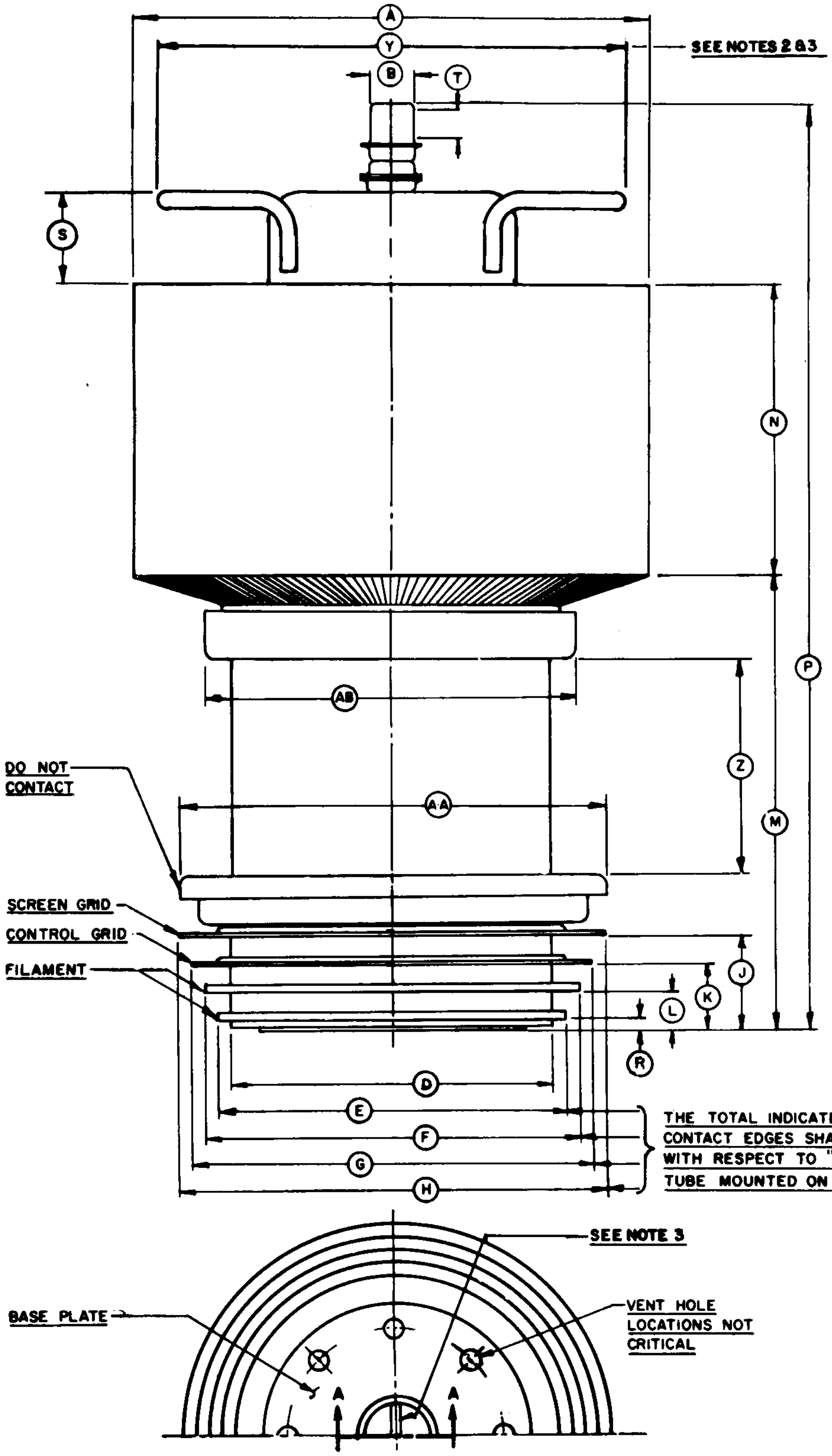
d. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

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 4CX35,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
100.0
80.0
60.0
40.0
30.0
20.0
10.0
5.0
2.0
0.5
0.001
PLATE VOLTAGE (kV)
GRID VOLTAGE (V)
CURVE #5480


EIMAC 4CX35,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
PLATE VOLTAGE (kV)
GRID VOLTAGE (V)
CURVE #5481



DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	9.500	9.750	241.30	247.65
B	0.860	0.890	21.84	22.60
D	5.980	6.020	151.89	152.91
E	6.510	6.560	165.35	166.62
F	6.980	7.020	177.29	178.31
G	7.480	7.520	189.99	191.01
H	7.975	8.015	202.57	203.58
J	1.750	1.800	44.45	45.72
K	1.220	1.270	30.99	32.26
L	0.690	0.740	17.53	18.80
M	8.442	8.692	214.43	220.78
N	5.375	5.625	136.52	142.88
P	17.070	17.340	433.58	440.44
R	0.173	0.213	4.40	5.41
S	1.750		44.45	
T	0.485	0.515	12.32	13.08
V	— —	0.135	— —	3.43
W	1.250	1.270	31.75	32.26
X	0.490	0.530	12.45	13.46
Y	— —	8.750	— —	222.25
Z	3.750		95.25	
AA	8.000		203.20	
AB	6.875		174.63	

NOTES:
1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. DIM. Y IS MAXIMUM DIA. ACROSS CORNERS
3. HANDLE LATERAL AXIS ORIENTATION WITH BASE LOCK PIN IS AS SHOWN.