TECHNICAL DATA

9000

4CM300,000G HIGH POWER MULTIPHASE COOLED TETRODE

The EIMAC 4CM300,000G is a ceramic/metal, multiphase-cooled (water/vapor) power tetrode designed for high-power broadcast service. Pyrolytic graphite grids are used to provide high dissipation capability in combination with low secondary emission characteristics.

The 4CM300,000G has a thoriated-tungsten mesh filament mounted on water-cooled supports. The maximum anode dissipation rating is 300 kilowatts steady state.

Large-diameter coaxial terminals are used for the screen grid, control grid and filament connections.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten Mesh	
Voltage	15.0 ± 0.75 V
Current @ 15.0 volts (nominal)	480 A
Frequency of Maximum Ratings (CW)[3]	50 MHz
Amplification Factor, Average, Grid to Screen	4.5
Direct Interelectrode Capacitances (grounded cathode)[2]	
Cin	750 pF
Cout	79 pF
Cgp	5.6 pF
Direct Interelectrode Capacitances (grounded grid)[2]	
Cin	284 pF
Cout	83 pF
Cpk	0.9 pF

1. Characteristics and operating values are based on tests and calculations. 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 shown are nominal measured in accordance with Electronic Industries Association Standard RS-191.
3. The tube is projected to have excellent rf characteristics up to 150 MHz.

MECHANICAL

Net Weight	121 lb; 55 kg
Operating Position	Vertical, Base Down
Cooling	Water and Forced Air
Maximum Overall Dimensions:	
Length	22.5 in; 57.1 cm
Diameter	13.3 in; 33.8 cm
Maximum Operating Temperature, Envelope and Ceramic/Metal Seals	200°C
Base	Special Coaxial
Recommended Socket	EIMAC SK-2450

390850(Effective April 1985)
VA4816

Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN

Class AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20.0	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC PLATE CURRENT	50	AMPERES
PLATE DISSIPATION	300	KILOWATTTS
SCREEN DISSIPATION	6.0	KILOWATTS
GRID DISSIPATION	2.0	KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)
CLASS AB1, Single Sideband Peak Envelope Conditions

Plate Voltage	18.0	kVdc
Screen Voltage	2000	Vdc
Grid Voltage **	-460	Vdc
Zero Signal Plate Current	3.0	Adc
Single Tone Plate Current	30.5	Adc
Single Tone Screen Current *	1.4	Adc
Peak rf Grid Voltage *	460	v
Plate Dissipation *	145	kW
Plate Load Resistance	340	Ohms
Plate Power Output *	400	kW

* Approximate value. ** Adjust for specified value of zero-signal plate current.

RADIO FREQUENCY POWER AMPLIFIER OR
OSCILLATOR Class C Telegraphy or FM
(Key-down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20.0	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC PLATE CURRENT	50	AMPERES
PLATE DISSIPATION	300	KILOWATTS
SCREEN DISSIPATION	6.0	KILOWATTS
GRID DISSIPATION	2.0	KILOWATTS

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	18.0	18.0	kVdc
Screen Voltage	1000	1500	Vdc
Grid Voltage	-800	-900	Vdc
Plate Current	44	45	Adc
Screen Current *	4.7	3.5	Adc
Grid Current *	5.5	1.7	Adc
Calculated Driving Power	5.7	1.8	kW
Plate Dissipation *	140	154	kW
Plate Load Resistance	205	202	Ohms
Plate Power Output *	650	650	kW

* Approximate value.

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

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	13.0	KILOVOLTS
DC SCREEN VOLTAGE	1.5	KILOVOLTS
DC PLATE CURRENT	39	AMPERES
PLATE DISSIPATION #	195	KILOWATTS
SCREEN DISSIPATION	6.0	KILOWATT
GRID DISSIPATION	2.0	KILOWATTS

* Approximate value
\# 300 kW at 100% sine-wave modulation

TYPICAL OPERATION (Frequencies to 30 MHz)

Plate Voltage	11.0	kVdc
Screen Voltage	1000	Vdc
Grid Voltage	-450	Vdc
Plate Current	35	Adc
Screen Current *	1.75	Adc
Grid Current *	2.25	Adc
Peak Screen Voltage (100% modulation)	2000	v
Calculated Driving Power	1440	W
Plate Dissipation *	85	kW
Plate Load Resistance	155	Ohms
Plate Power Output *	300	kW

AUDIO FREQUENCY POWER AMPLIFIER OR
MODULATOR Class AB

ABSOLUTE MAXIMUM RATINGS (per tube):

DC PLATE VOLTAGE	20.0	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC PLATE CURRENT	50	AMPERES
PLATE DISSIPATION	300	KILOWATTS
SCREEN DISSIPATION	6.0	KILOWATTS
GRID DISSIPATION	2.0	KILOWATTS

\# Per tube.
* Approximate value.
** Adjust for stated zero-sig. plate current.

TYPICAL OPERATION (Two Tubes - Sinusoidal wave)

Plate Voltage	11.8	8.0	kVdc
Screen Voltage	1500	2000	Vdc
Grid Voltage **	-420	-460	Vdc
Zero-Signal Plate Current	6.0	6.0	Adc
Max.Signal Plate Current	53	29	Adc
Max.Signal Screen Current *	1.0	1.0	Adc
Peak Audio Freq.Grid Voltage * #	400	455	v
Max.Signal Plate Dissipation * #	106	148	kW
Plate/Plate Load Resistance	440	680	Ohms
Plate Power Output *	420	760	kW

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. Following this procedure, 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 4CM300,000G must be mounted vertically, base down. The full weight of the tube should rest on the screen-grid contact flange at the base of the tube, and all lifting of the tube should be done with the lifting eye which is attached to the top of the anode cooling jacket.

ANODE COOLING - The anode is cooled by circulating water through the structure. Water/vapor cooling provides efficient anode heat removal and allows extra capacity for temporary overloads.

Tube life can be seriously compromised by water condition. With contaminated water deposits will form on the inside of the water jacket, causing localized anode heating and eventual tube failure. To minimize electrolysis and power loss, water resistivity at 25°C should always be one megohm per cubic centimeter or higher. Water resistivity can be continuously monitored in the reservoir by readily available instruments.

Minimum water flow requirements for the anode are shown in the table for an outlet water temperature not to exceed 100°C and inlet water temperature at 60°C. System pressure should not exceed 100 psi.

Anode Dissipation (kW)	Water Flow (gpm)	Approx.Jacket Press. Drop (psi)
Fil.Only	1	1
100	15	7.5
200	25	15
300	29	17

Cooling water must be well filtered, with effectiveness the equivalent of a 100-mesh screen, to eliminate any solid material and avoid the possibility of blockage of cooling passages, as this would immediately affect cooling efficiency and could produce localized anode overheating and failure of the tube.

EIMAC Application Bulletin #16, WATER PURITY REQUIREMENTS IN LIQUID COOLING SYSTEMS, is available on request, and contains considerable detail on purity requirements and maintenance systems.

BASE COOLING - The tube base requires air cooling with a minimum of 100 cfm of air at 50°C maximum at sea level, directed through the SK-2450 series socket toward the base seal areas. It should be noted that temperatures of the ceramic/metal seals and the lower envelope areas are the controlling and final limiting factor and that the maximum allowable temperature is 200°C. In addition, the socket contact finger temperature should not exceed 150°C. Temperature-sensitive paint is available for use in checking temperatures in these areas before equipment design and air cooling arrangements are finalized.

EIMAC Application Bulletin #20 titled TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES contains considerable information and is available on request.

ALL COOLING MUST BE APPLIED BEFORE OR SIMULTANEOUSLY WITH THE APPLICATION OF ELECTRODE VOLTAGES, INCLUDING THE FILAMENT, AND SHOULD NORMALLY BE MAINTAINED FOR SEVERAL MINUTES AFTER ALL VOLTAGES ARE REMOVED TO ALLOW FOR TUBE COOLDOWN.

ELECTRICAL

FILAMENT OPERATION - Filament turn-on and turn-off should be programmed. Filament voltage should be smoothly increased from zero to the operating level over a period of two minutes. A motor-driven continuously variable autotransformer (such as a VARIAC® or a POWERSTAT®) is suggested. Inrush current must never be allowed to exceed twice normal operating current. Normal turnoff procedure should be a smooth decrease from the operating voltage to zero over a period of two minutes.

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 gradually be reduced until there is a slight degradation in performance (such as power output or distortion). For operation The voltage should then be increased several tenths of a volt above the value where performance degradation was noted. The operating point should be rechecked after 24 hours. Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence caused 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. EIMAC Application Bulletin #18, titled "EXTENDING TRANSMITTER TUBE LIFE", contains detailed information and is available on request.

Where hum is an important system consideration it is permissible to operate the filament with dc rather than ac power.

Care should be exercised to keep any rf power out of the filament of the tube, as this can cause excessive operating temperatures. Proper bypassing of the filament must be used to assure monopotential operation. It should be ascertained that no resonance exists in the filament circuit which could be excited during operation.

This tube is designed for commercial service, with no more than one normal off/on filament cycle per day. If additional cycling is anticipated it is recommended the user contact Application Engineering at Varian EIMAC for additional information.

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 these ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of the 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.

PLATE OPERATION - The 300 KW plate dissipation maximum rating may be exceeded for very brief periods during setup or tuning. When used as a plate-modulated rf amplifier, dissipation under carrier conditions is limited to 195 kilowatts.

GRID OPERATION - The maximum grid dissipation is 2000 watts and protective measures should be taken to insure that this rating is not exceeded. Grid dissipation is approximately equal to the product of dc grid current and 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 6000 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. Suitable protective circuitry must be provided to remove screen power in case of a fault condition. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

PULSE OPERATION - The thermal time constants of the internal tube elements vary from a few milliseconds in the case of the grids to about 200 milliseconds for the anode. In many applications the meaning of duty as applied to a pulse chain is lost because the interpulse period is very long. For pulse lengths greater than 10 milliseconds, where the interpulse period is more than 10 times the pulse duration, the element dissipations and required cooling are governed by the watt-seconds during the pulse. Provided the watt-seconds are less than the listed maximum dissipation rating and sufficient cooling is supplied, tube life will be protected. EIMAC has determined that a minimum flow of 2 gpm (7.6 lpm) is required.

FAULT PROTECTION - In addition to the normal plate over-current interlock and coolant interlock, the tube must be protected from internal damage caused by any arc which may occur. A protective resistance should always be connected in series with the grid and anode to help absorb power supply stored energy if an 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 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 criteria is met.

As noted under GRID OPERATION and SCREEN OPERATION a protective spark gap should be connected from the control grid to ground and from the screen grid to ground. EIMAC Application Bulletin #17 titled FAULT PROTECTION contains considerable detail and is available on request.

LOAD VSWR - The load VSWR should be monitored and the detected signal used to operate the interlock system to remove plate voltage within 20 milliseconds after a fault occurs. In the case of high stored energy in the load system, care must be taken to avoid excessive return energy from damaging the tube and associated circuit components.

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 the 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.

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.

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 RF TUNING CHARACTERISTICS - Typical interelectrode tuning characteristics may be obtained by contacting Varian EIMAC Power Grid Tube Application Engineering.

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 from the tube terminals and associated wiring. To control actual capacitance values within the tube, as the key component involved, the industry and Military

Services use a standard test procedure described in Electronic Industries Association Standard RS-191. The test is performed on a cold tube which is mounted in a shielded fixture.

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 but with no special shielding.

The equipment designer is cautioned to make allowance for the capacitance values, including tube-to-tube variation and strays, which will exist in any normal application. Measurements should be taken with mounting which represent 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 High Power Tubes, 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.

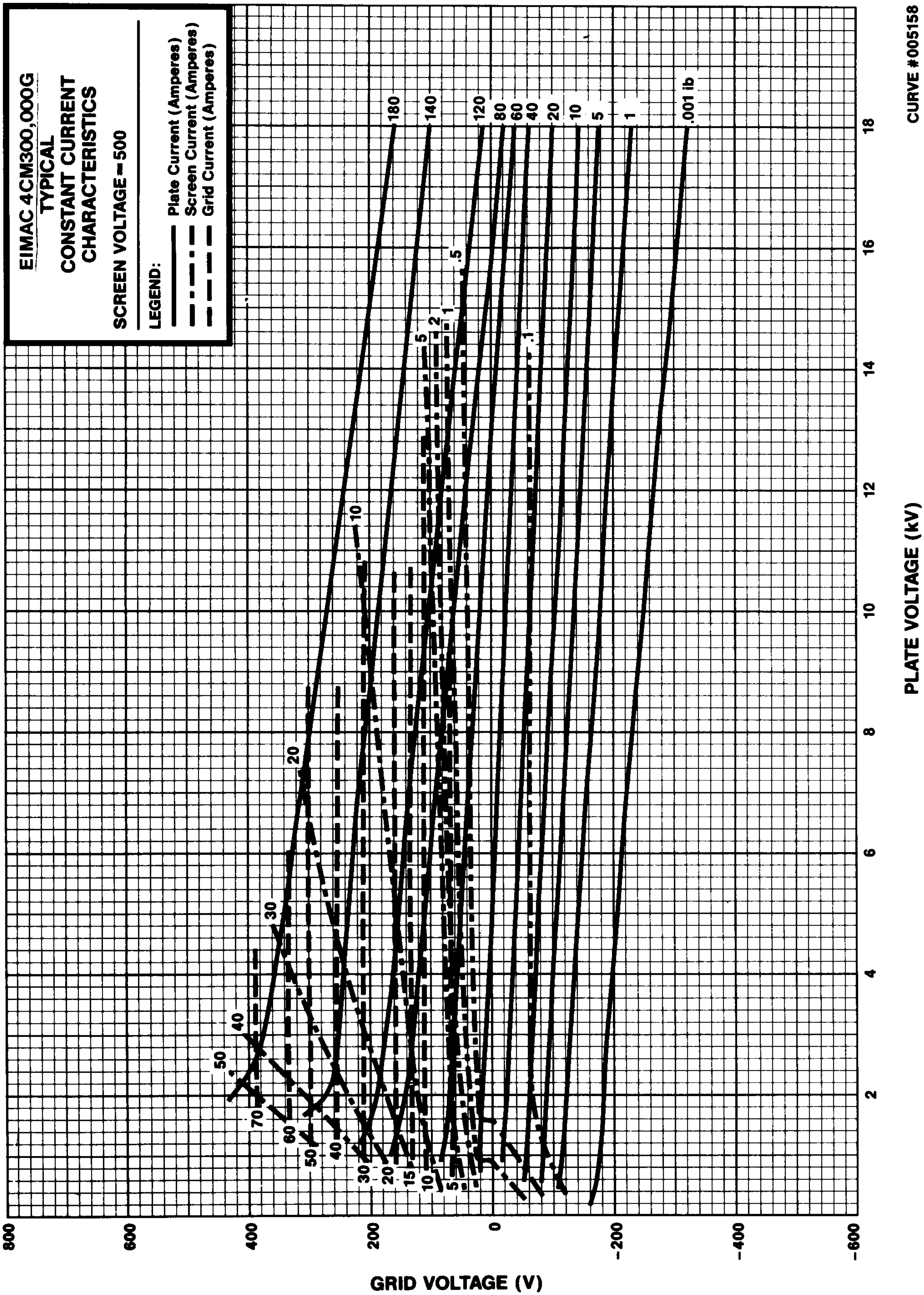
c. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.

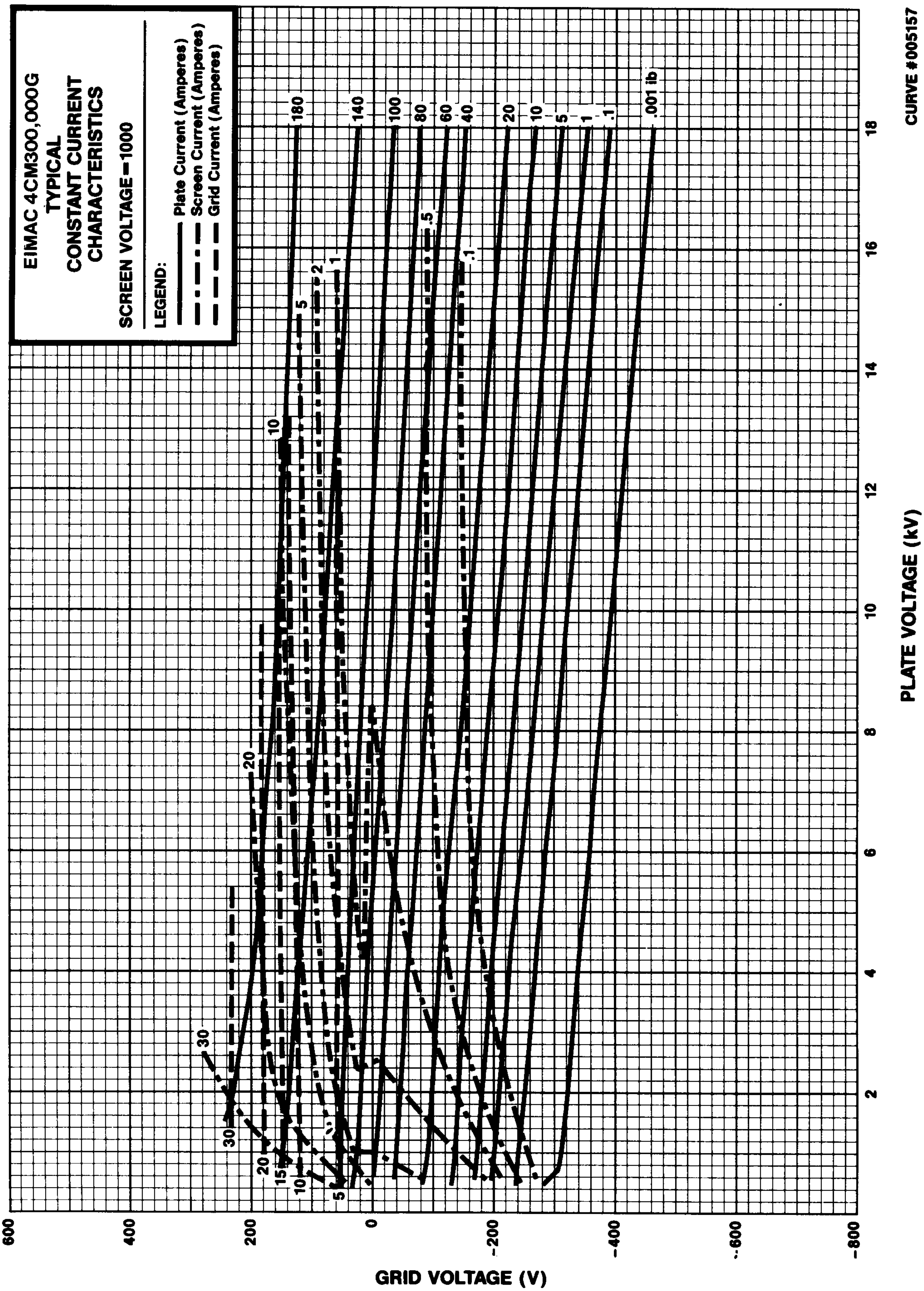
d. HOT WATER - Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

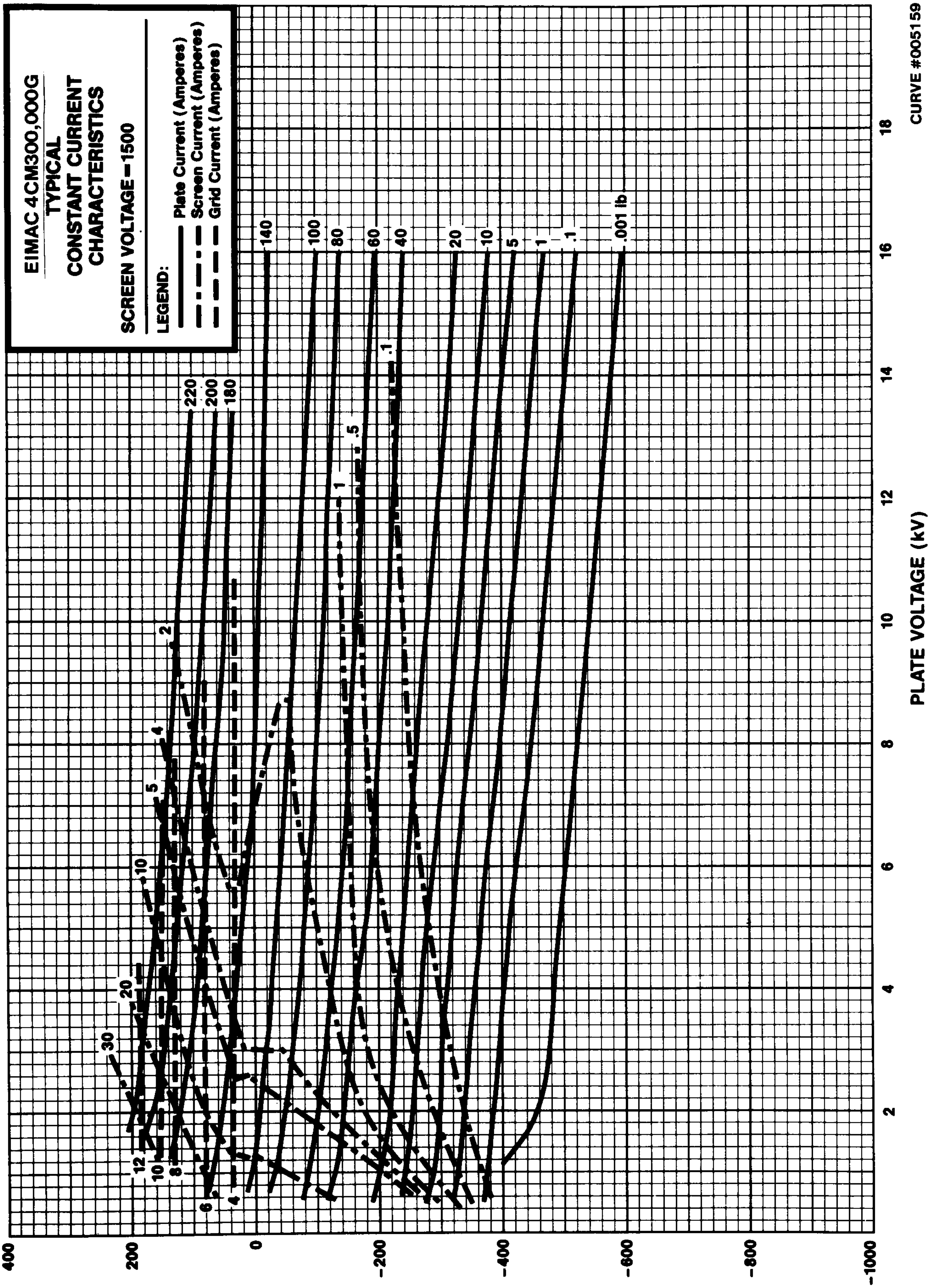
e. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

f. X-RAY RADIATION - High-voltage tubes can produce dangerous and possibly fatal X-rays and comprehensive shielding may be required. If shielding is provided, equipment should never be operated without all such shielding in place.

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 4CM300,000G
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500
LEGEND:
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
PLATE VOLTAGE (kV)
GRID VOLTAGE (V)
CURVE #005158


EIMAC 4CM300,000G
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE=1000
LEGEND:
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
PLATE VOLTAGE (kV)
GRID VOLTAGE (V)
CURVE #005157


EIMAC 4CM300,000G
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500
LEGEND:
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
PLATE VOLTAGE (kV)
GRID VOLTAGE (V)
CURVE #005159
400
200
0
-200
-400
-600
-800
-1000
2
4
6
8
10
12
14
16
18
140
100
80
60
40
20
10
5
1
.1
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220
200
180
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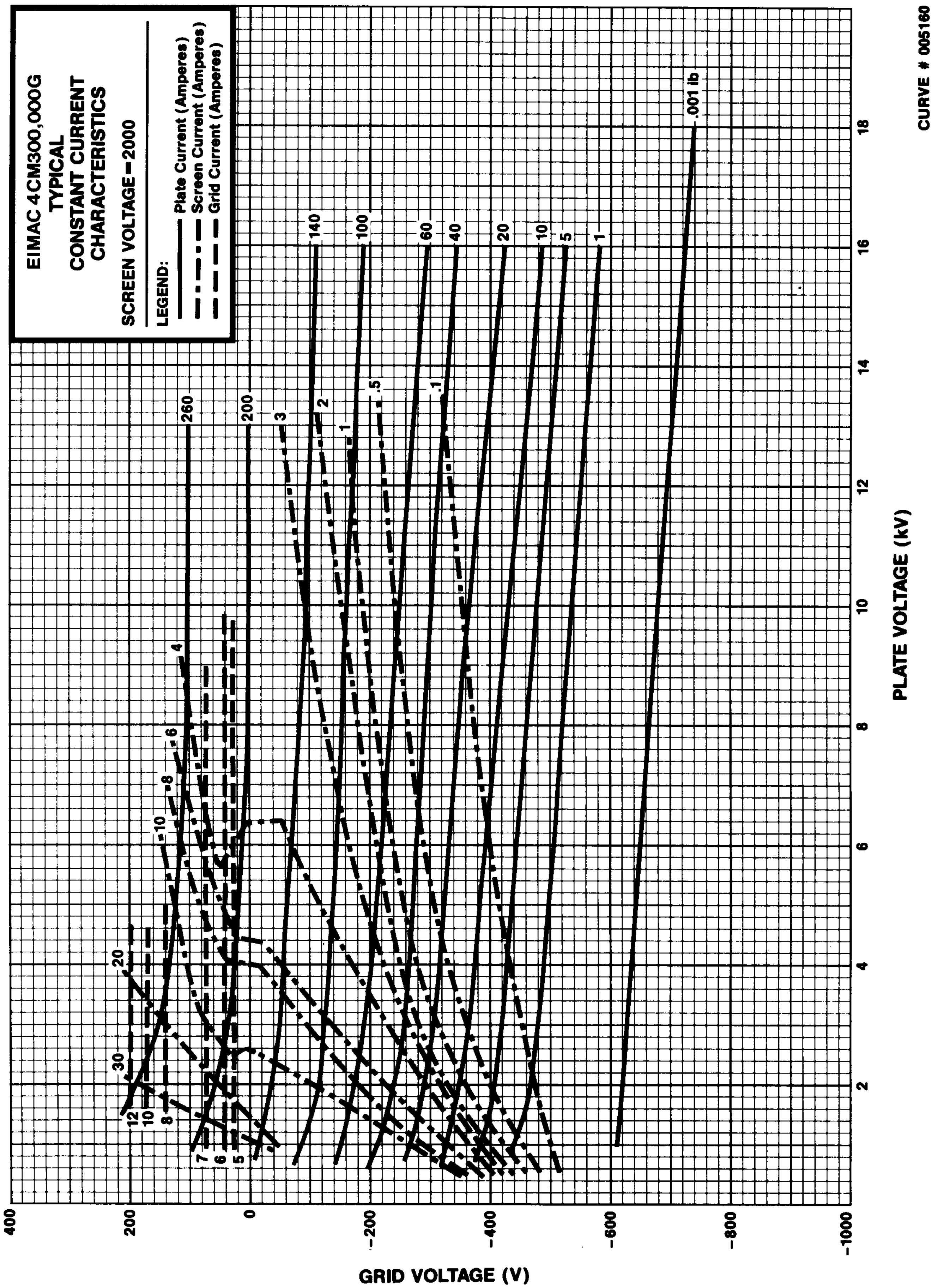
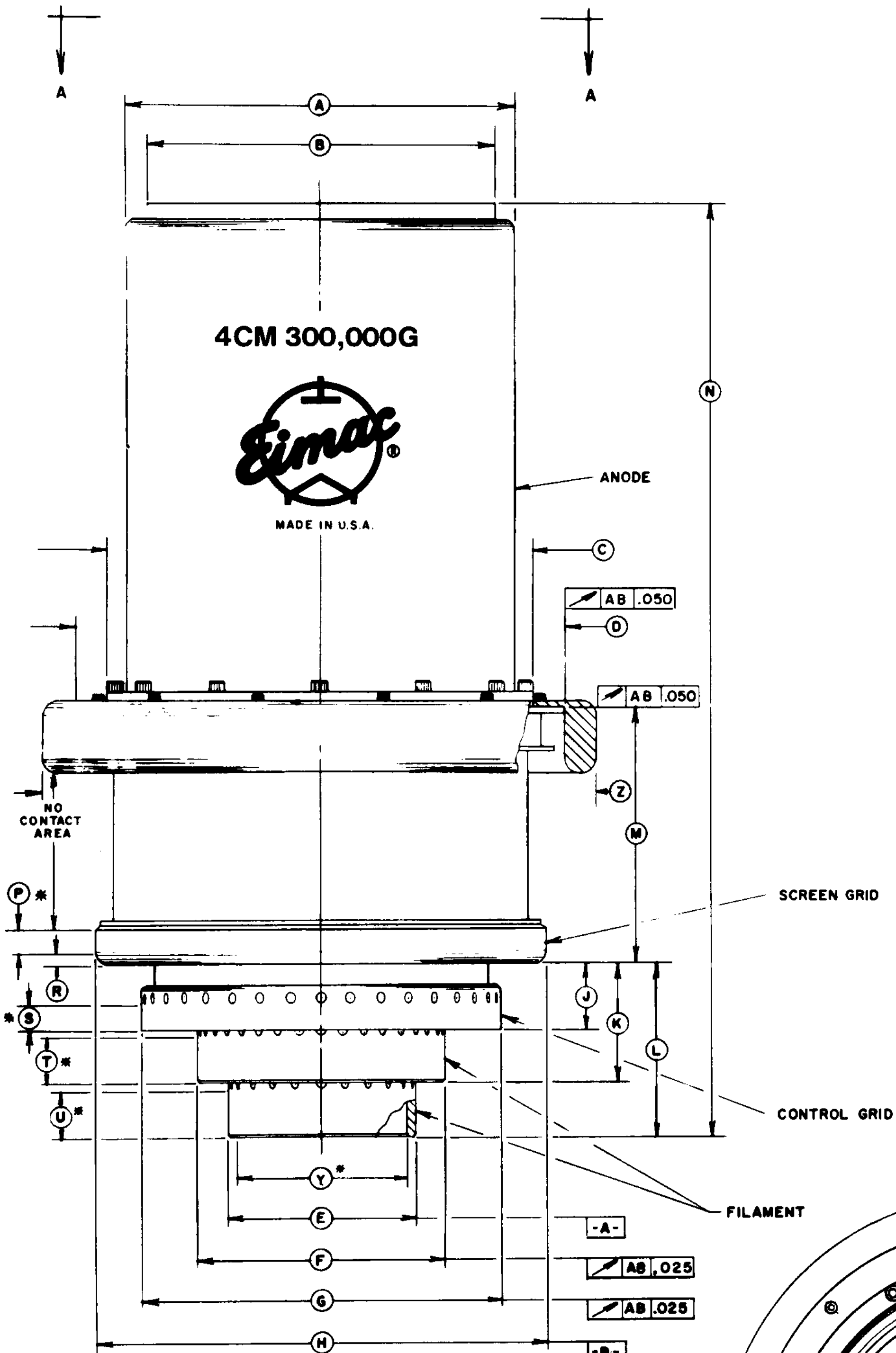
1
2
4
5
10
20
30
12
10
8
6
4


EIMAC 4CM300,000G
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 2000
LEGEND:
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
260
200
140
100
60
40
20
10
5
1
.001 ib
PLATE VOLTAGE (kV)
GRID VOLTAGE (V)
400
200
0
-200
-400
-600
-800
-1000
2
4
6
8
10
12
14
16
18
CURVE # 005160

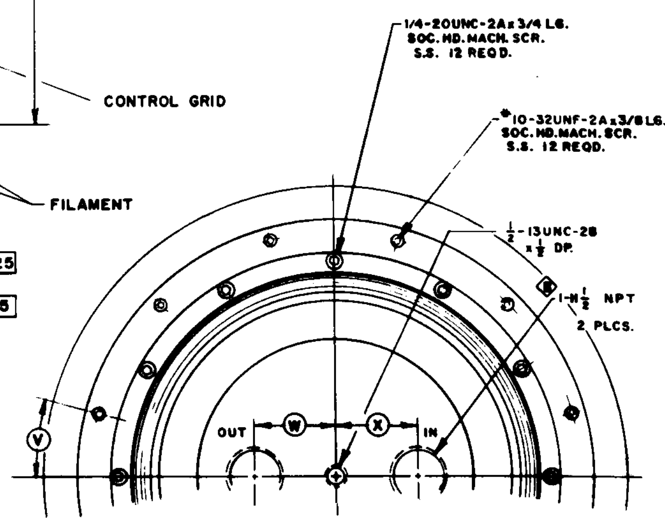
9000/4CM300,000G



DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	9.235	9.265				
B	8.735	8.765				
C	10.235	10.265				
D	11.735	11.765				
E	4.49	4.51				
F	5.94	5.96				
G	8.46	8.50				
H	10.89	10.92				
J	1.56	1.62				
K	2.82	2.88				
L	4.14	4.20				
M	6.04	6.10				
N			22.50			
P	.58	.68				
R			.250			
S	.65	.71				
T	1.16	1.22				
U	1.16	1.22				
V			15°			
W			1.875			
X			1.875			
Y	4.04	4.06				
Z	13.28	13.34				

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACES.



VIEW A-A