HIGH VOLTAGE TETRODE Y-546

Communications & Power Industries Tetrode

The Y-546 is a ceramic/metal forced-air cooled high voltage power tetrode intended for use in pulse modulator or regulator service. It is rated for 75 kVdc holdoff with a 100 ampere peak cathode current rating.

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

FEATURES[1]

Filament: Thoriated Tungsten		
Voltage	10.0± 0.5	V
Current at 10.0 Volts	295	A
Amplification Factor, Average,	4.5	
Direct Interelectrode Capacitances (grounded cathode)[2]		
Cin	440	pF
Cout	55	pF
Cgp	2.3	pF
Direct Interelectrode Capacitances (grounded grid)[2]		
Cin	175	pF
Cout	55	pF
Cpk	0.5	pF
Maximum Overall Dimensions:		
Length	17.34 in; 44.04 cm	
Diameter	9.75 in; 24.77 cm	
Net Weight	50 lbs. 22.7 kg	
Operating Position	Vertical, Base Up or Down	
Maximum Operating Temperature:		
Ceramic/Metal Seals, Anode Core	250° C	
Cooling	Forced Air	
Base	Special, Graduated Rings	
Recommended Air-System Socket	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	

[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 Eimac Division 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.	
Filament Current @ 10.0 Volts	**280.0**	**310.0**	**A**
Interelectrode Capacitances (grounded cathode connection)[2]:			
Cin	**410**	**470**	**pF**
Cout	**46**	**56**	**pF**
Cgp	**1.5**	**3.2**	**pF**
Interelectrode Capacitances (grounded grid connection)[2]:			
Cin	**155**	**195**	**pF**
Cout	**50**	**60**	**pF**
Cpk	**---**	**0.6**	**pF**

The values listed above represent specified limits for the product and are subject to change. The data should be used for basic information only. Formal, controlled specifications may be obtained from CPI for use in equipment design.

PULSE MODULATOR OR REGULATOR

ABSOLUTE MAXIMUM RATINGS:

DC ANODE VOLTAGE	60	kV
DC SCREEN VOLTAGE	2.5	kV
DC GRID VOLTAGE	-2.0	kV
DC ANODE CURRENT	15	A
PEAK CATHODE CURRENT	100	A
ANODE DISSIPATION#	35	kW
SCREEN DISSIPATION	1750	W
GRID DISSIPATION	500	W

See ANODE DISSIPATION Application Note

TYPICAL OPERATION:

ANODE SUPPLY VOLTAGE	50	kVdc
PLATE VOLTAGE DURING CONDUCTION	3.0	kVdc
SCREEN VOLTAGE	1500	Vdc
GRID VOLTAGE	-900	Vdc
ANODE CURRENT DURING PULSE	35	A
SCREEN CURRENT DURING PULSE*	1.0	A
GRID CURRENT DURING PULSE*	0	A
PEAK POWER TO THE LOAD	1640	kw
PEAK ANODE DISSIPATION#	105	kw

* Approximate
Note: See PULSE OPERATION Application Note

NOTE: TYPICAL OPERATION data are obtained by actual measurement or by calculation from published characteristic curves. To obtain the anode current shown at the specified bias, screen and anode voltages, adjustment of 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 anode 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

HANDLING - The Y-546 contains a thoriated-tungsten mesh filament and should be protected from shock and vibration. It is recommended that the tube be removed from equipment that is being shipped to prevent damage that may occur in transit. It is recommended that a thick rubber mat or similar material be used to absorb any undue shock that may occur if the tube is to be placed temporarily on a hard surface

MOUNTING - The Y-546 must be operated with its primary axis vertical. The base of the tube may be up or down at the option of the equipment designer.

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 an other 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.

SOCKET - The Eimac air-system sockets SK-1500A and SK1510A have been designed especially for the concentric base terminals of the Y-546. The SK-1510A includes a tube seating and locking device. Special screen bypass capacitor dielectrics are available. The Eimac part numbers are shown on Page 1.

COOLING - The maximum temperature rating for the external surfaces of the Y-546 is 250°C. Sufficient forced-air flow must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic-metal seals below 250°C.

Approximate 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).

Base to Anode Airflow
Anode Cooler Only

	SEA LEVEL		10,000 FEET	
Anode Dissipation (Watts)	Air Flow (CFM)	Pressure Drop (In. of Water)	Air Flow (CFM)	Pressure Drop (In. of Water)
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 applications must be capable of supplying 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.

The well in the center of the base plate of the tube is a critical area which requires cooling to maintain envelope temperatures less than 250°C. For most applications, one to two 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. Our 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 all power is removed to allow for tube cool down.

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. 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.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly. 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 650 amperes. 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 an Applications Engineer at CPI Eimac for additional information.

With a new tube, or one that has been in storage for some period of time, operation with filament voltage only applied for a period of 30 to 60 minutes is recommended before full operation begins. This allows the active getter mounted within the filament structure to absorb any residual gas molecules, which have accumulated during storage.

At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communications 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. The 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 when voltage is to be reduced below nominal in this manner, to avoid any possible adverse influence by normal line voltage variations. Periodically throughout the life of the tube the procedure outlined above for voltage reduction should be repeated with voltage reset as required, to assure best tube life. Filament voltage should be measured at the tube base or socket with a known-accurate rms-responding meter.

EIMAC Application Bulletin #18 titled "Extending Transmitter Tube Life" contains valuable information and is available on request,

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 rated 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. Anode voltage 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.

ANODE DISSIPATION - The anode is nominally rated for 35 kilowatts of dissipation capability. 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.

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. For pulse lengths in excess of these thermal time constants, dissipations should be considered as CW values.

In many applications the meaning of duty as applied to a pulse chain is lost because the inter-pulse period is very long. For pulse lengths greater than 10 milliseconds, where the inter-pulse 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.

FAULT PROTECTION - In addition to the normal anode overcurrent interlock, screen current interlock, and cooling air flow interlock, the tube must be protected from internal damage caused by an internal anode arc which may occur at high voltages. A protective resistance of approx. 5 to 10 Ohms, 500 Watts should always be connected in series with the tube anode to absorb power supply stored energy if an internal arc should occur. If power supply stored energy is high 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 section of #30 AWG copper wire. The wire will remain intact if protection is adequate. EIMAC's Application Bulletin #17 titled "Fault Protection" contains considerable detail and is available on request.

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 effect. 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.

X-RAY RADIATION HAZARD – High vacuum tubes operating at voltages higher than about 15 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. The Y-546, operating at its rated voltages and currents, is a potential X-ray hazard, with only limited

shielding afforded by the tube envelope. Moreover, the X-ray radiation level can increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are affected by the high voltage. X-ray shielding must be provided on all sides of tubes operating at these voltages to provide adequate protection throughout the tube's life. Periodic checks on the X-ray level should be made and the tube should never be operated without adequate shielding in place. Lead glass, which attenuates X-rays, is available for viewing windows. If there is any doubt as to the requirement for or the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment. Operation of high-voltage equipment with interlock switches "cheated" and cabinet doors open in order to better able to locate an equipment malfunction can result in serious X-ray exposure.

INTERELECTRODE CAPACITANCE - The actual internal electrode 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 tubes, 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 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. 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 the socket and 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 CPI MPP, Eimac Operation, Applications Engineering, 811 Hansen Way, Palo Alto, CA 94304 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 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.

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

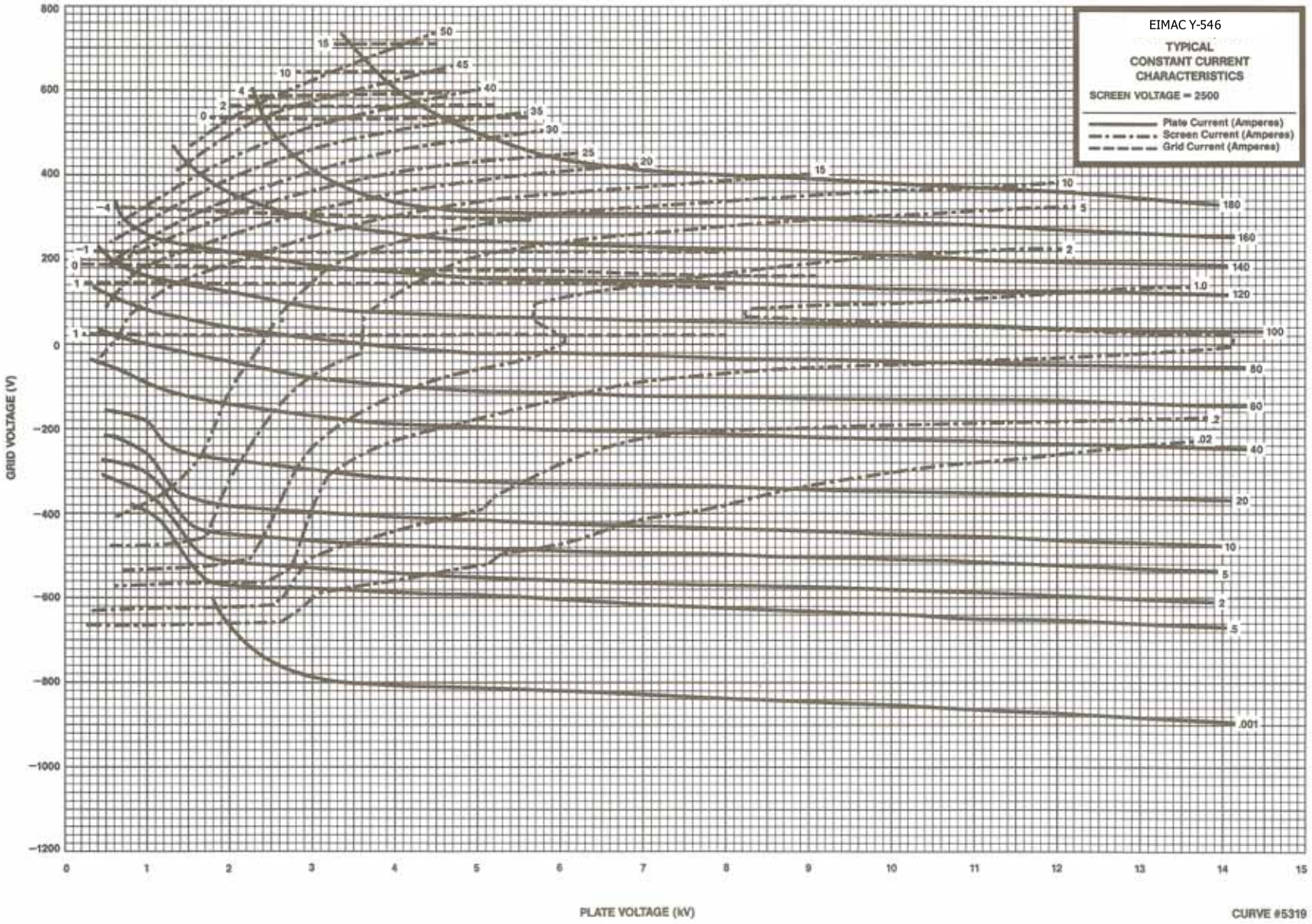
LOW-VOLTAGE HIGH-CURRENT CIRCUITS - Personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

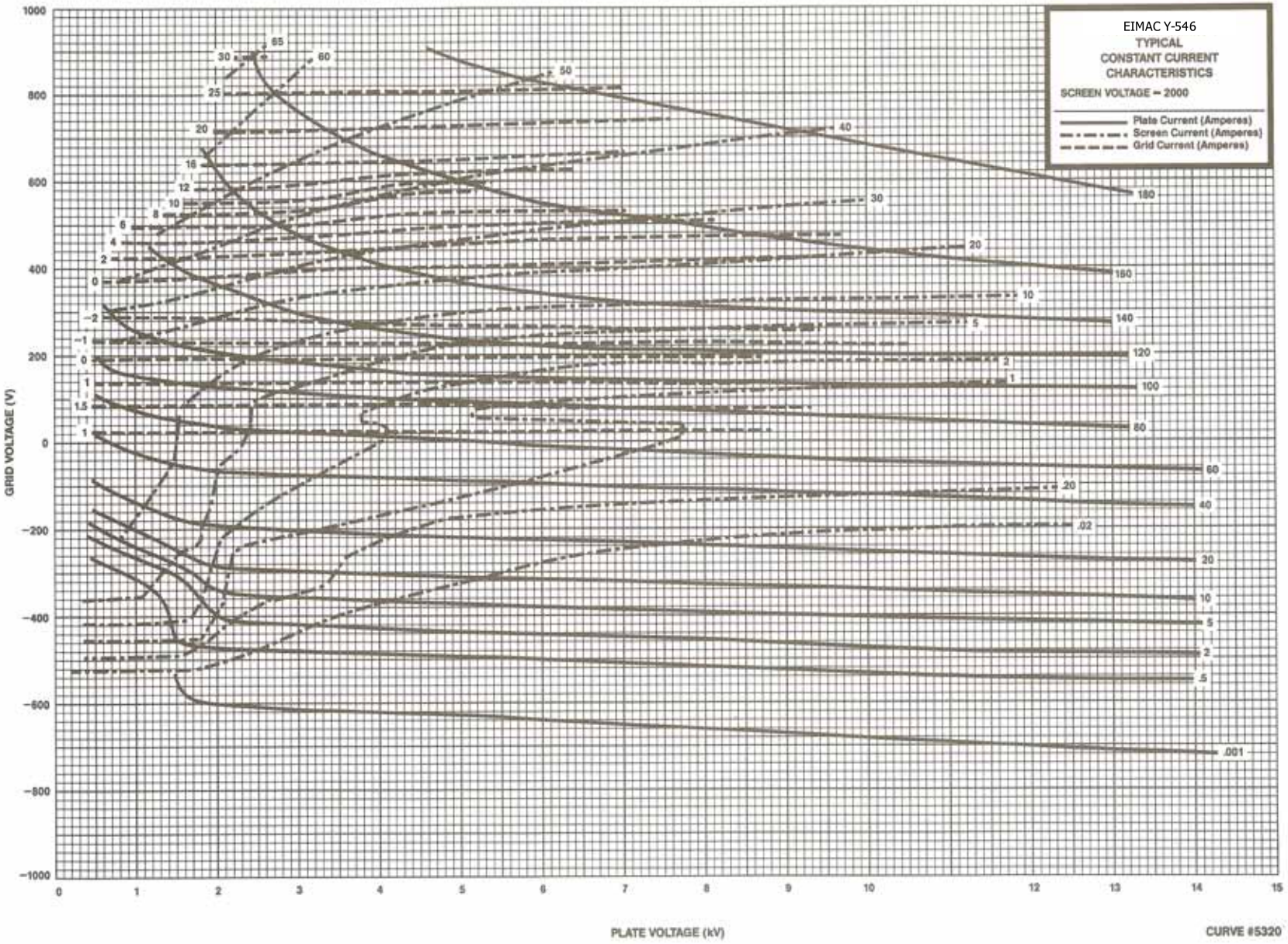
RF RADIATION – Exposure to strong rf fields should be avoided, even at relatively low frequencies. CARDIAC PACEMAKERS MAY BE AFFECTED.

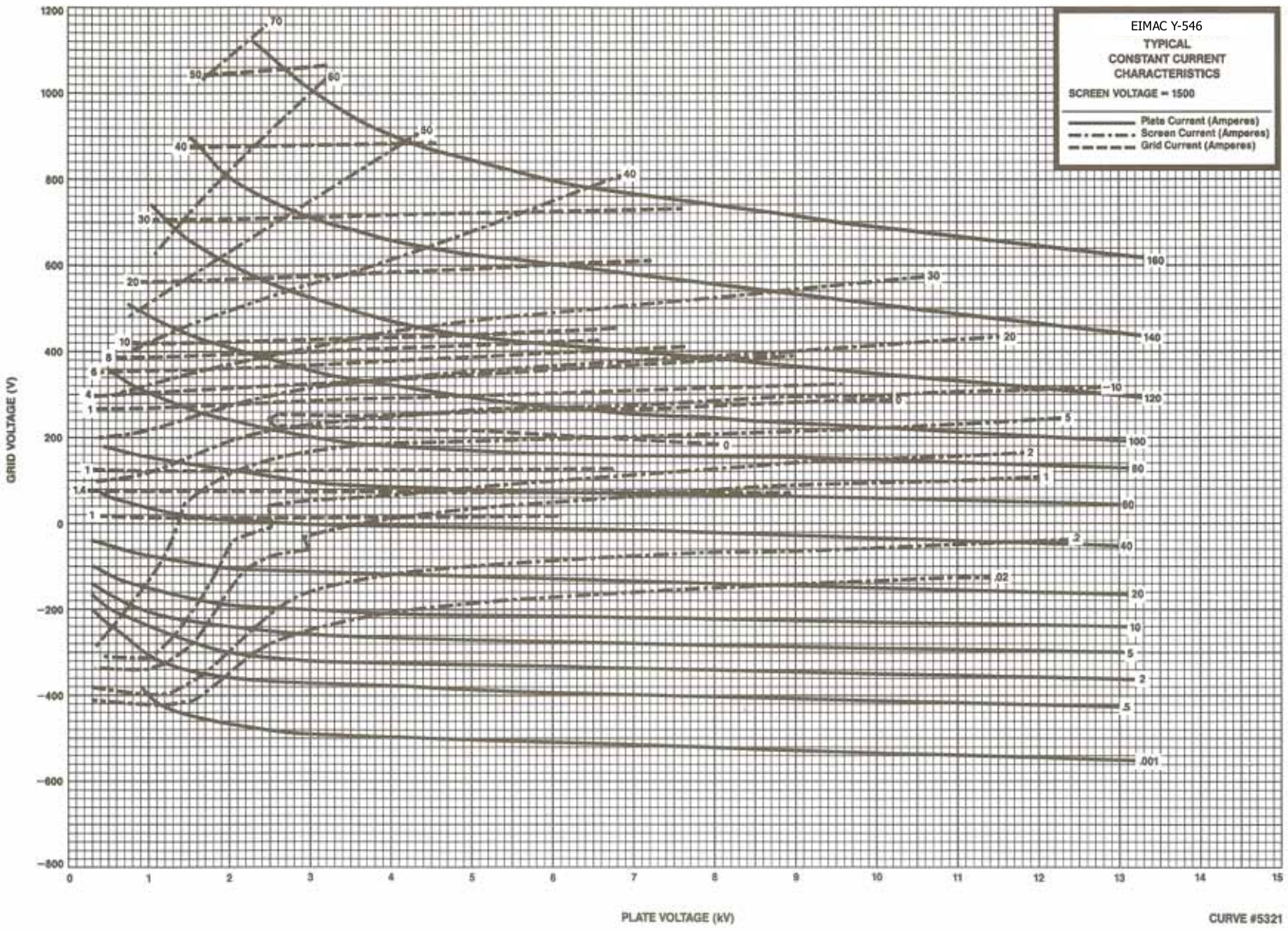
RF RADIATION – Exposure to strong rf fields should be avoided, even at relatively low frequencies. CARDIAC PACEMAKERS MAY BE AFFECTED.

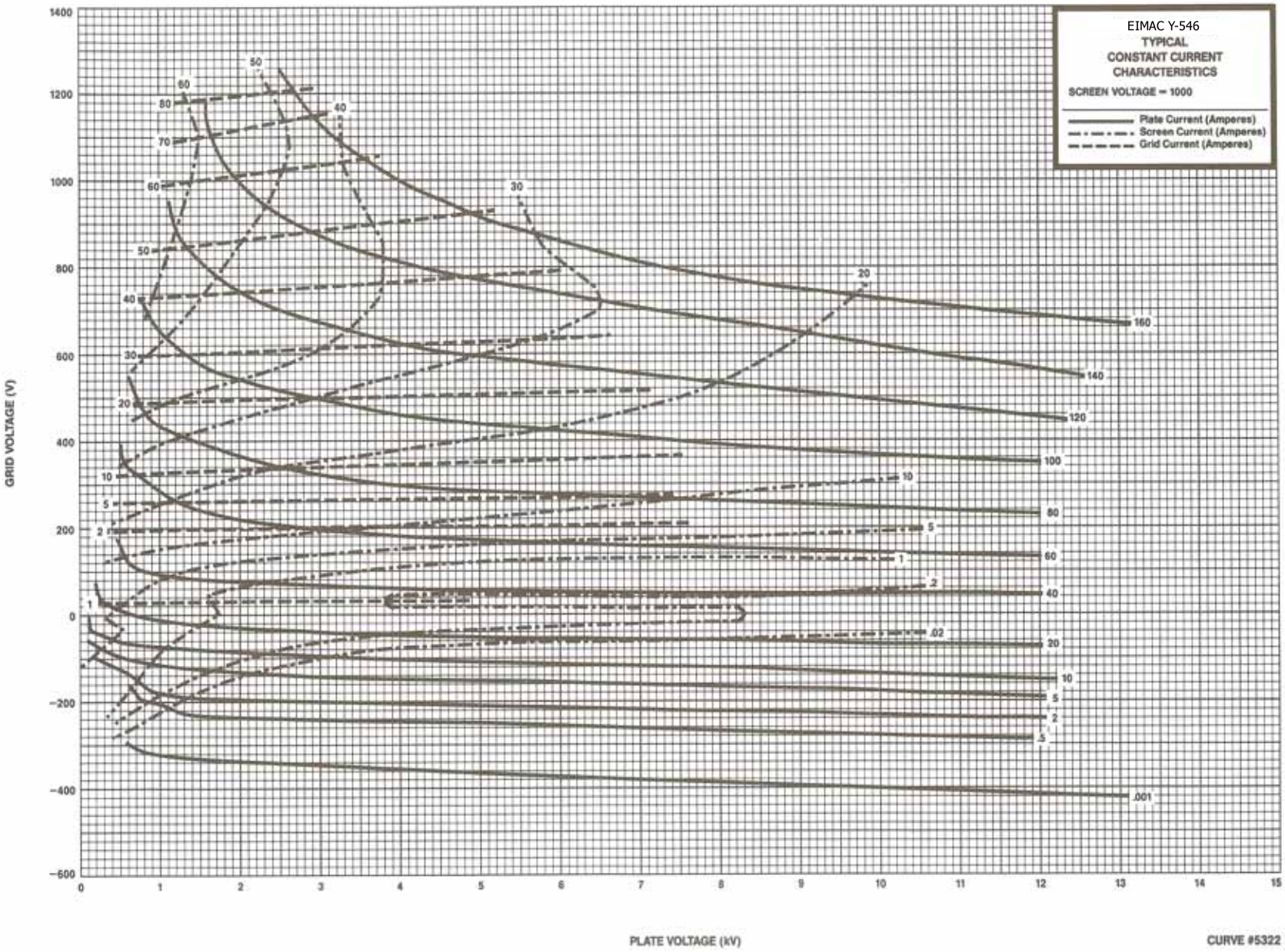
HOT SURFACES – Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

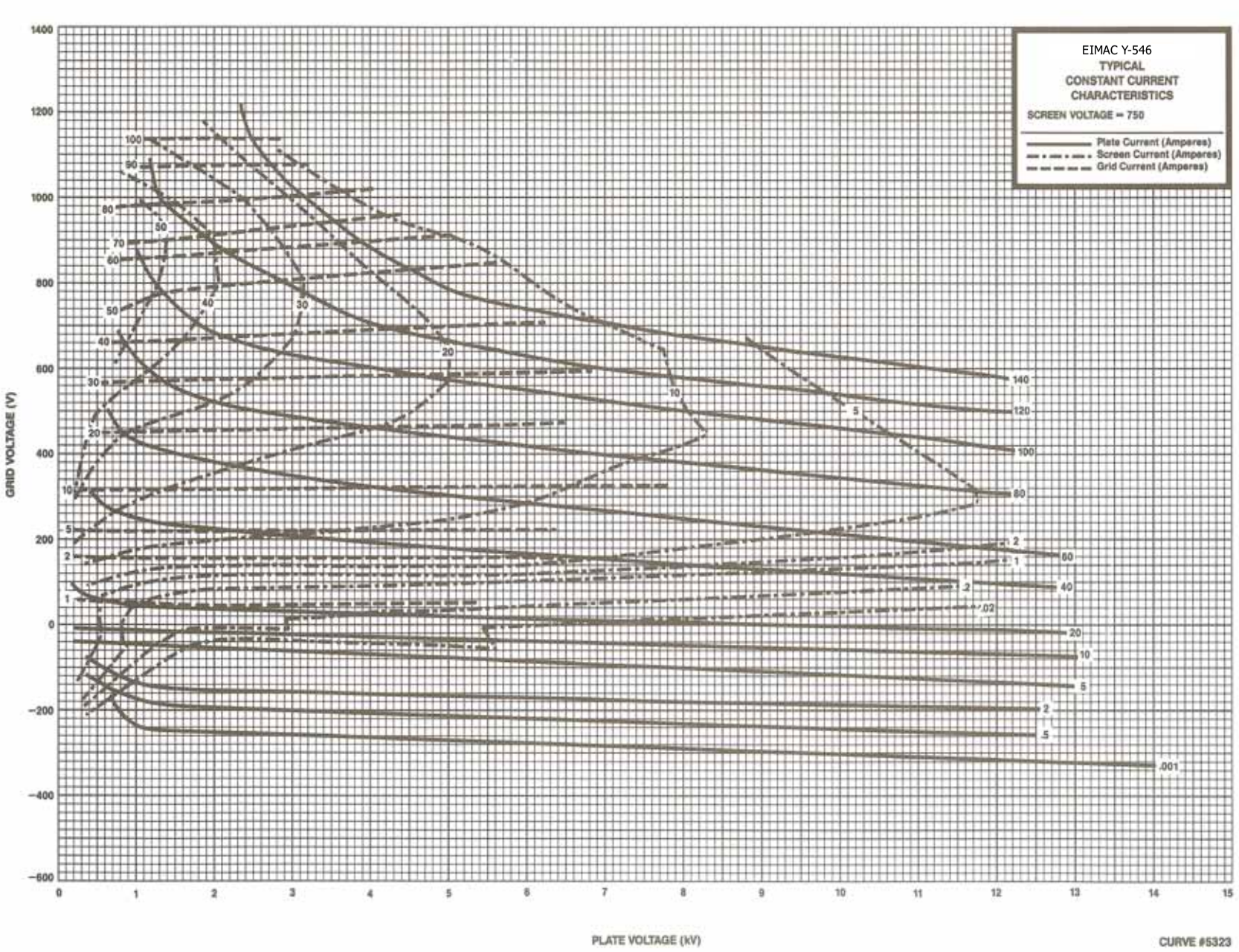
MATERIAL COMPLIANCE - This product and package conforms to the conditions and limitations specified in 49CFR 173.424 for radioactive material, excepted package-instruments or articles, UN2910. In addition, this product and package contains no beryllium oxide (BeO).

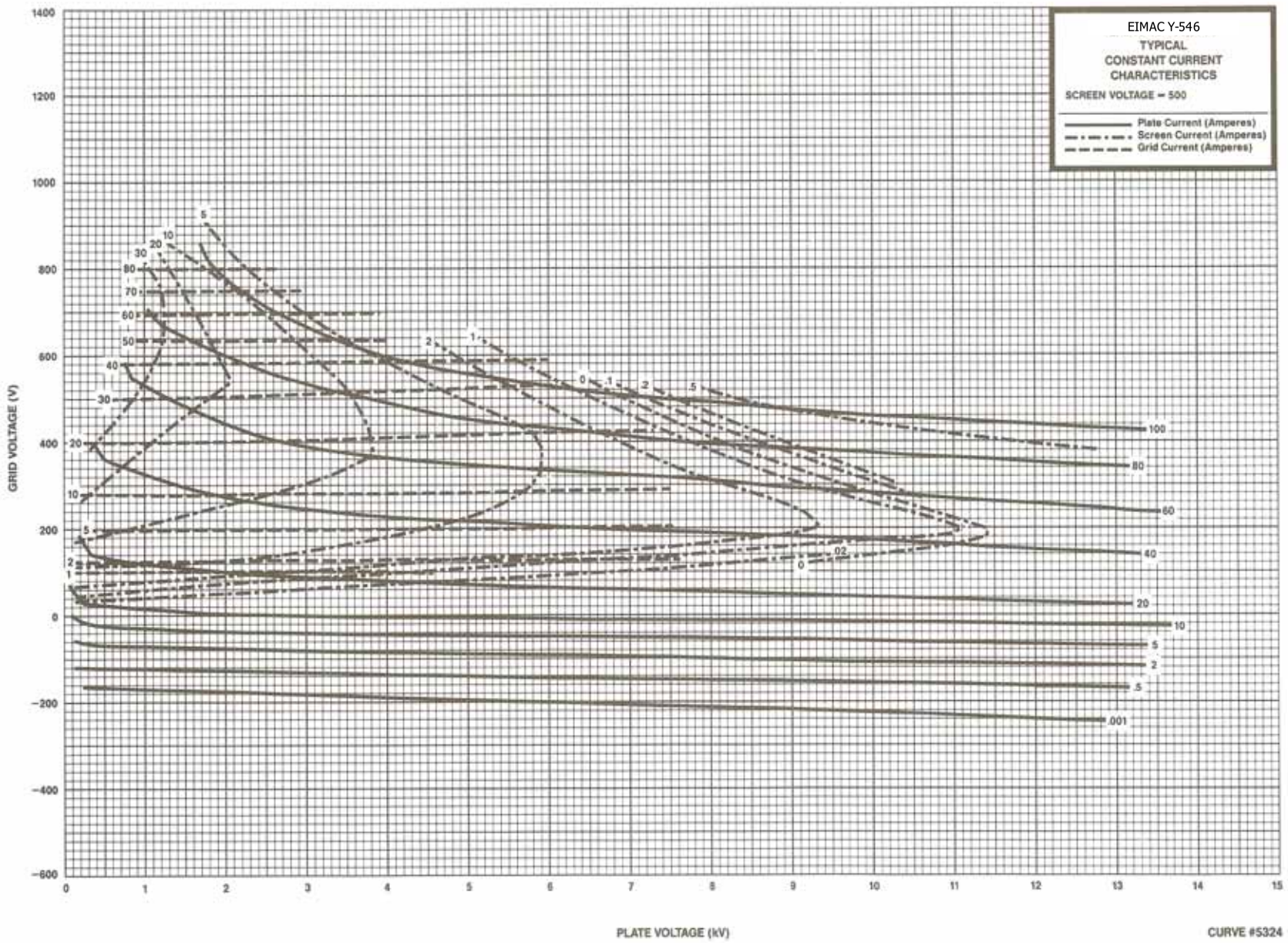

EIMAC Y-546
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 2500
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #5319

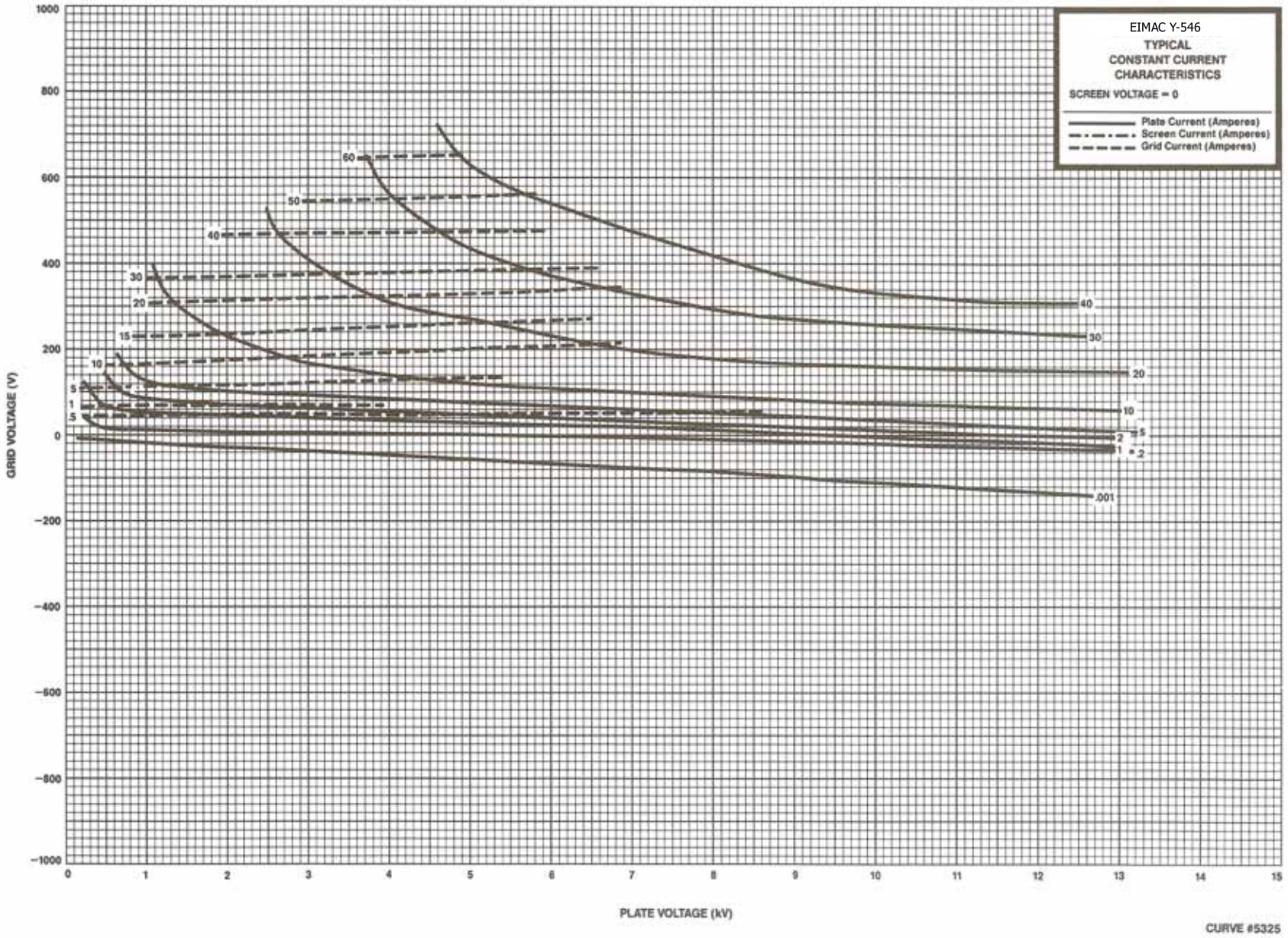

EIMAC Y-546
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 2000
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #5320


EIMAC Y-546
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #5321


EIMAC Y-546
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1000
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #5322


EIMAC Y-546
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #5323

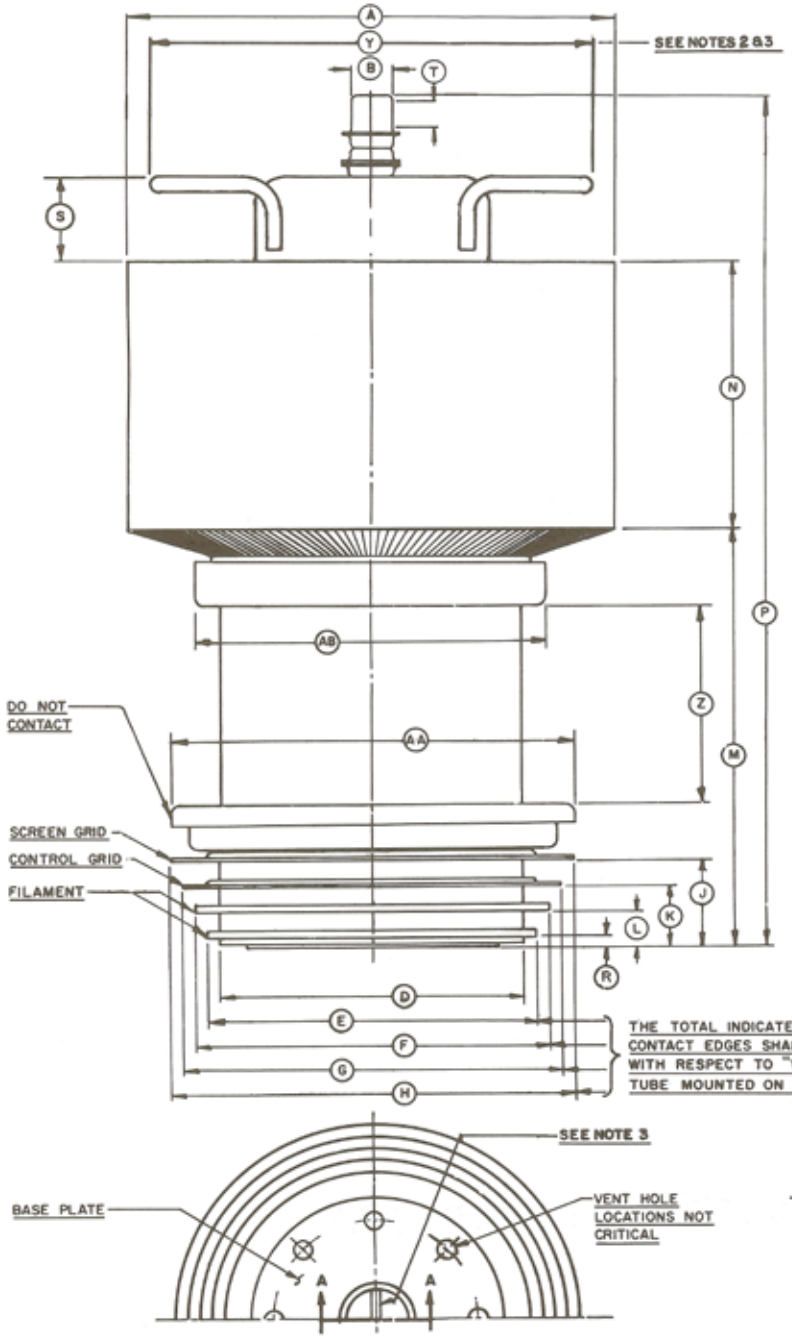

EIMAC Y-546
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 500
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
CURVE #5324


EIMAC Y-546
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 0
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
PLATE VOLTAGE (kV)
1000
800
600
400
200
0
−200
−400
−600
−800
−1000
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
60
50
40
30
20
15
10
5
1
.5
40
30
20
10
5
2
1
.2
.001

CURVE #5325

HIGH VOLTAGE TETRODE

Y-546



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.

With a history of producing high quality products, we can help you with your tetrode.
Contact us at MPPMarketing@cpii.com or call us at +1 650-846-2800. The data should be used for basic information only.
Formal, controlled specifications may be obtained from CPI for use in equipment design.

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For more detailed information, please refer to the corresponding CPI technical description if one has been published, or contact CPI. Specifications may change without notice as a result of additional data or product refinement. Please contact CPI before using this information for system design.