4CW100,000D

TECHNICAL DATA

LIQUID COOLED
POWER TETRODE

The EIMAC 4CW100,000D is a ceramic/metal, liquid-cooled power tetrode intended for use at the 100 to 200 kilowatt output power level. It is recommended for use as a Class-C rf amplifier or oscillator, a Class-AB, rf linear amplifier or a Class-AB, push-pull af amplifier or modulator. The 4CW100,000D is also useful as a plate and screen modulated Class-C rf amplifier, and in pulse modulator-regulator service.

The liquid-cooled anode is rated at 100 kilowatts maximum plate dissipation.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	10.0	V
Current	295	A
Amplification Factor (Grid-Screen)(average)	4.5	
Interelectrode Capacitances, Grounded Cathode: [2]		
Cin	440	pF
Cout	55	pF
Cgp	2.4	pF
Interelectrode Capacitances, Grounded Grid: [2]		
Cin	175	pF
Cout	57	pF
Cpk	0.5	pF
Frequency for Maximum Ratings	30	MHz

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. EIMAC Division of Varian 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

Base	Special, graduated rings
Maximum Seal Temperature	250°C
Maximum Envelope Temperature	250°C
Recommended Socket	EIMAC SK-1500 Series
Operating Position	Vertical, base up or down

Printed in U.S.A.

Maximum Dimensions:

Height	18.0 In.; 457.2 mm
Diameter	8.0 In.; 203.2 mm
Cooling	Liquid and forced air
Net Weight (Approximate)	60 lbs; 27.3 kg
Shipping Weight (Approximate)	85 lbs; 38.6 kg

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR Class-C Telegraphy or FM

(Key-down conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Calculated low frequency drive power.

TYPICAL OPERATION (Frequencies below 30 MHz)

Plate Voltage	15.0	17.0	19.0	kVdc
Screen Voltage	750	750	750	Vdc
Grid Voltage	-700	-700	-700	Vdc
Plate Current	9.0	9.8	10.6	Adc
Screen Current	1.6	1.67	1.83	Adc
Grid Current	0.8	1.0	1.12	Adc
Peak RF Grid Voltage	1000	1020	1040	v
Driving Power 1.	790	1020	1165	W
Plate Dissipation	24.0	30.0	35	kW
Plate Output Power	110	137.5	165	kW
Resonant Load Impedance	825	845	980	Ω

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER-GRID DRIVEN

Class-C Telephony

(Carrier conditions except where noted)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	17,500	VOLTS
DC SCREEN VOLTAGE	2000	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION[1]	66,500	WATTS
SCREEN DISSIPATION[4]	1750	WATTS
GRID DISSIPATION[4]	500	WATTS

1. Corresponds to 100,000 watts at 100% sine wave modulation.
2. Approximate value, depends on degree of driver modulation.

TYPICAL OPERATION (Frequencies below 30 MHz)

Plate Voltage	14	16	kVdc
Screen Voltage	750	750	Vdc
Peak AF Screen Voltage (For 100% modulation)[2]	750	750	v
Grid Voltage	-700	-700	Vdc
Plate Current	9.1	12.0	Adc
Screen Current	2.0	1.75	Adc
Grid Current	1.0	1.20	Adc
Peak RF Grid Voltage	1000	1050	v
Grid Driving Power[3]	1000	1260	W
Plate Dissipation	20.4	54.0	kW
Plate Output Power	107	138.5	kW
Resonant Load Impedance	790	620	Ω

3. Calculated low frequency drive power.
4. Average, with or without modulation.

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB

ABSOLUTE MAXIMUM RATINGS (per tube):

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Per Tube.
2. Approximate value.

TYPICAL OPERATION (Two Tubes) Class-AB1

Plate Voltage	15	18	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage	-360	-380	Vdc
Max-Signal Plate Current	18.8	20.0	Adc
Zero-Signal Plate Current	6.0	6.0	Adc
Max-Signal Screen Current[2]	0.690	0.700	Adc
Peak AF Driving Voltage[1]	350	380	v
Driving Power	0	0	W
Load Resistance, Plate-to-Plate	1800	2080	Ω
Max-Signal Plate Dissipation[1]	47.3	56.8	kW
Max-Signal Plate Output Power	187.4	246.4	kW

RADIO-FREQUENCY LINEAR AMPLIFIER
Class-AB

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	20,000	VOLTS
DC SCREEN VOLTAGE	2500	VOLTS
DC PLATE CURRENT	15.0	AMPERES
PLATE DISSIPATION	100,000	WATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

1. Approximate value.

TYPICAL OPERATION, Peak-Envelope or Modulation-Crest Conditions, (Frequencies below 30 MHz)
Class-AB

Plate Voltage	15	18	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage	-360	-380	Vdc
Max-Signal Plate Current	9.4	10.0	Adc
Zero-Signal Plate Current	3.0	3.0	Adc
Max-Signal Screen Current[1]	0.345	0.350	Adc
Peak RF Grid Voltage	350	380	v
Driving Power	0	0	W
Plate Dissipation	47.3	56.8	kW
Plate Output Power	93.7	123.2	kW
Resonant Load Impedance	900	1040	Ω

PULSE MODULATOR SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	40	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
PEAK CATHODE CURRENT	200	AMPERES
PLATE DISSIPATION(average)	100	KILOWATTS
SCREEN DISSIPATION (average)	1750	WATTS
GRID DISSIPATION (average)	500	WATTS

1. Approximate value.
Note: The power dissipated during rise and fall time is considered negligible.

TYPICAL OPERATION

Plate Voltage	38	kVdc
Pulse Plate Current	112	a
Screen Voltage	1.5	kVdc
Pulse Screen Current [1]	18.0	a
Grid Voltage	-1.2	kVdc
Pulse Grid Current[1]	10.0	a
Pulse Positive Grid Voltage	480	v
Duty	5	%
Pulse Output Voltage	32	kv
Pulse Input Power	4.25	Mw
Pulse Output Power	3.58	Mw
Pulse Cathode Current	140	a

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater: Current at 10.0 volts	280	310	A
Interelectrode Capacitances (grounded cathode connection)[2]			
Cin	410	470	pF
Cout	50	60	pF
Cgp	1.5	3.2	pF

2. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CW100,000D must be operated with its axis vertical. The base of the tube may be up or down at the convenience of the circuit designer.

SOCKET - The EIMAC sockets, type SK-1500 and SK-1510 are recommended for use with the 4CW100,000D.

COOLING - Anode cooling is accomplished by circulating water through the integral anode water jacket. The table below lists minimum cooling water requirements at various dissipation levels.

Plate Dissipation * (kilowatts)	Water Flow (GPM)	Pressure Drop (PSI)
50	10	10
75	15	25
100	20	40

* Since the power dissipated by the filament represents about 3000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 2250 watts, allowance has been made in preparing this tabulation for an additional 5250 watts dissipation.

The cooling table above assumes a water temperature rise of 20°C. Under no circumstances should the outlet water temperature exceed 70°C. Inlet water pressure should not exceed 80 PSI.

A major factor effecting long life of water cooled tubes is the condition of the cooling water. If the cooling water is ionized, deposits of copper oxide will form on the internal parts of the water jacket and can cause localized heating of the anode and eventual failure of the tube.

A simple method of determining the condition of the water is to measure the resistance across a known volume. The resistance of the water should be maintained above 50 K ohms/cm3, and preferably above 250 K ohms/cm3. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of the insulating hose column if metal nipples or fittings are used as electrodes.

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 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 for this purpose.

ELECTRICAL

FILAMENT OPERATION - The peak emission at rated filament voltage of the EIMAC 4CW100,000D is normally many times the peak emission required for communication service. A small decrease in filament temperature due to reduction of filament voltage can increase the life of the 4CW100,000D by a substantial percentage. It is good practice to determine the nominal filament voltage for a particular application that will not affect the operation of the equipment. This is done by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage is reduced on the 4CW100,000D. At some point in filament voltage there will be noticeable reduction in plate current, or power output, or an increase in distortion. Operation may be at a filament voltage slightly higher than that point at which performance appeared to deteriorate. This voltage should be measured at the socket with a 1% meter and periodically checked to maintain proper operation.

Filament starting current must be limited to a maximum of 900 amperes.

Voltage between filament and the base plates of the tube, and SK-1500 socket, must not exceed 100 volts.

CONTROL-GRID OPERATION - The 4CW-100,000D control grid is rated at 500 watts of dissipation. Grid dissipation is the approximate product of grid current and peak positive grid voltage.

SCREEN DISSIPATION - The power dissipated by the screen grid must not exceed 1750 watts.

Where no ac is applied to the screen, dissipation is the product of dc screen voltage and dc screen current. With screen modulation the dissipation is dependent on RMS screen voltage, and RMS screen current. Plate voltage, plate load or bias voltage must never be removed while filament and screen voltages are present since the screen dissipation rating will be exceeded. Suitable protective means must be provided to prevent any of these conditions.

PLATE DISSIPATION - The plate dissipation of 100 kilowatts attainable through water cooling provides a large margin of safety in most applications. The rating may be exceeded for brief periods during tuning. When the 4CW100,000D is used as a plate-modulated rf amplifier, plate dissipation under carrier conditions is limited to 66,500 watts.

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 condensers 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.

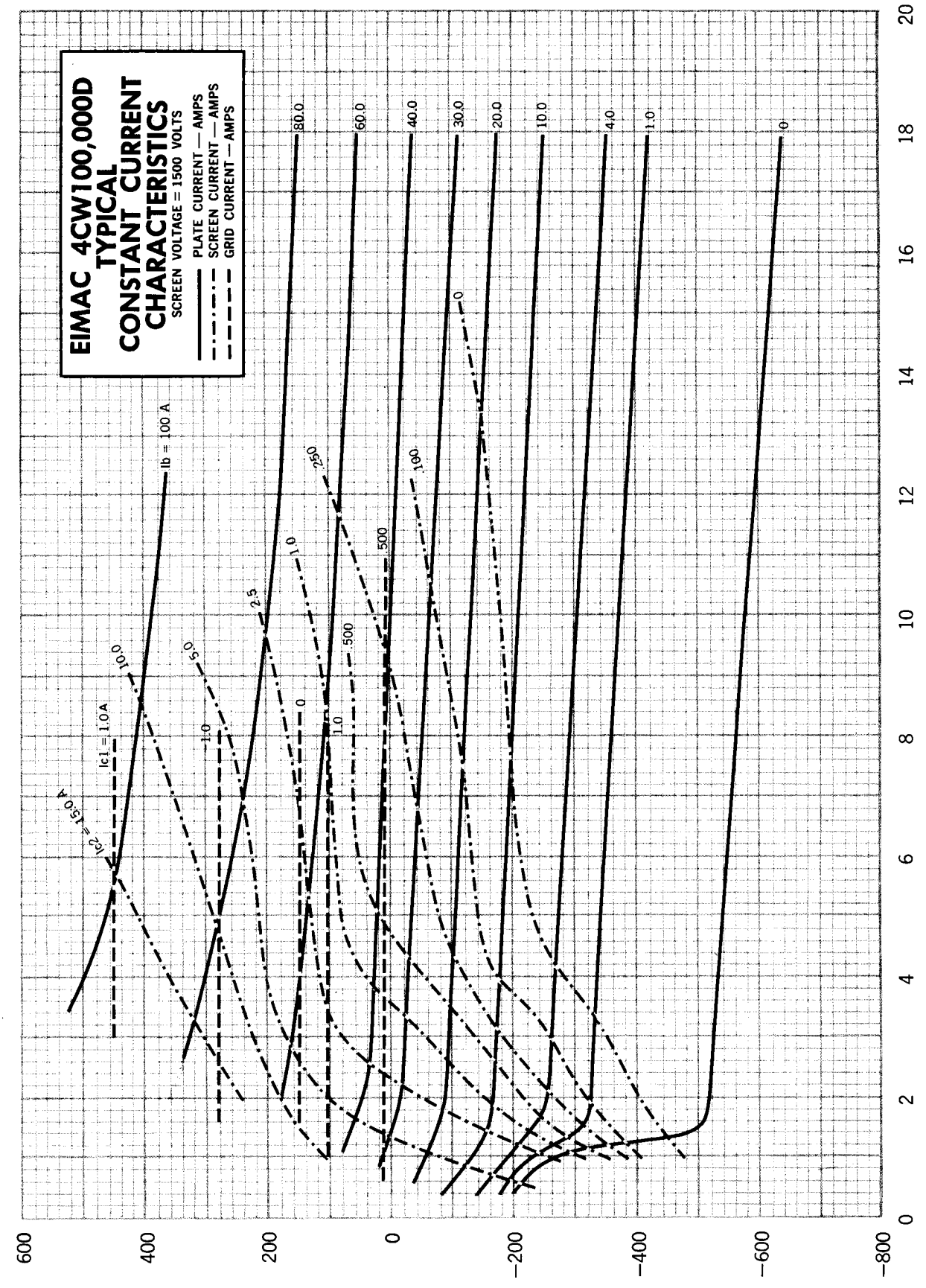
X-RADIATION - High-vacuum tubes operating at voltages higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential X-ray hazard. Only limited shielding is afforded by the tube envelope. 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 when voltages above 10 kilovolts are in use. 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 be better able to locate an equipment malfunction can result in serious X-ray exposure.

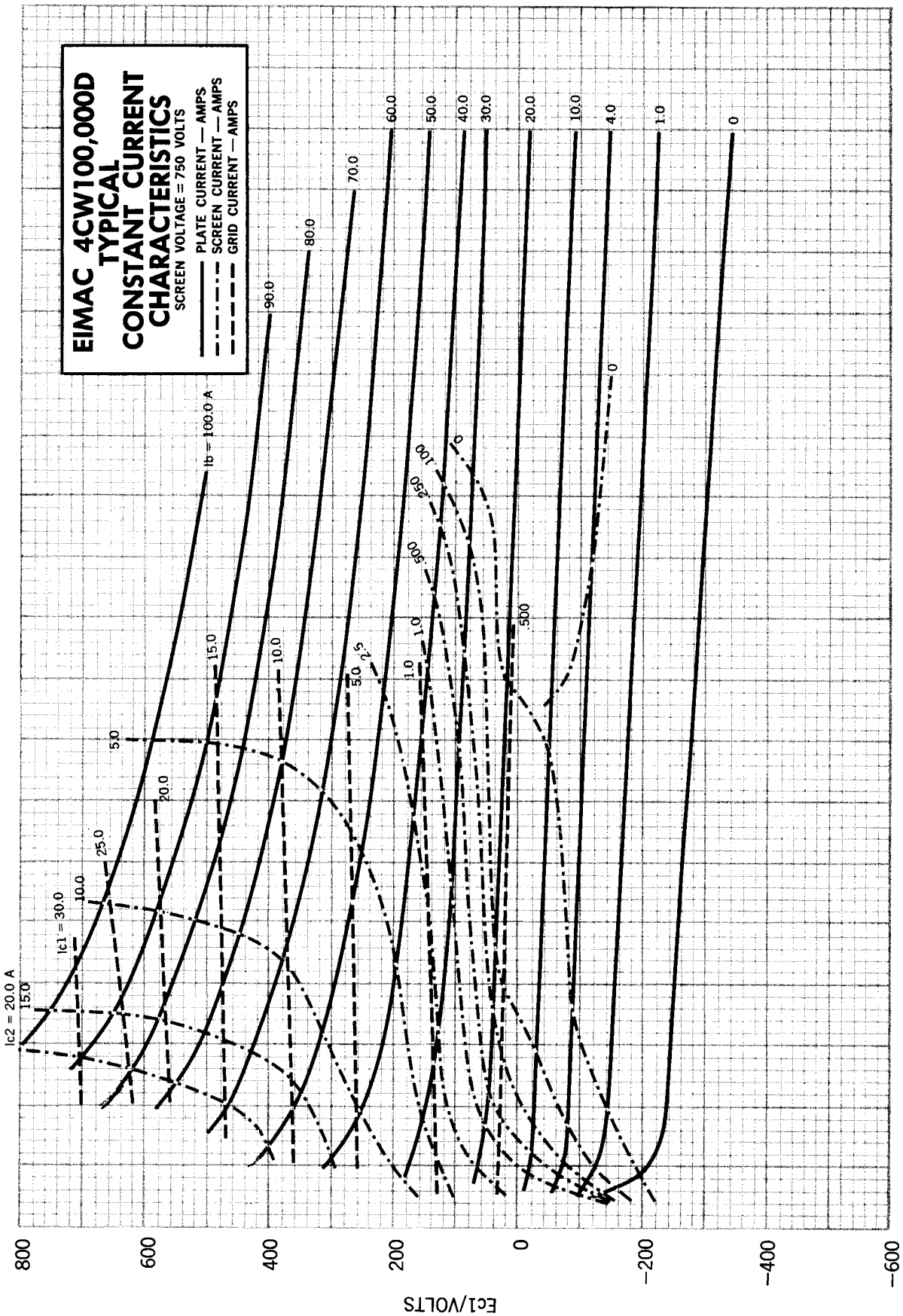
FAULT PROTECTION - In addition to normal plate overcurrent interlock, screen current interlock, and coolant flow interlock, it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high anode voltage.

In all cases some protective resistance, 5 ohms to 25 ohms, should be used in series with each tube anode to absorb power supply stored energy in case a plate arc should occur. If power supply stored energy exceeds 750 watt seconds, we strongly recommend use of some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a plate arc.

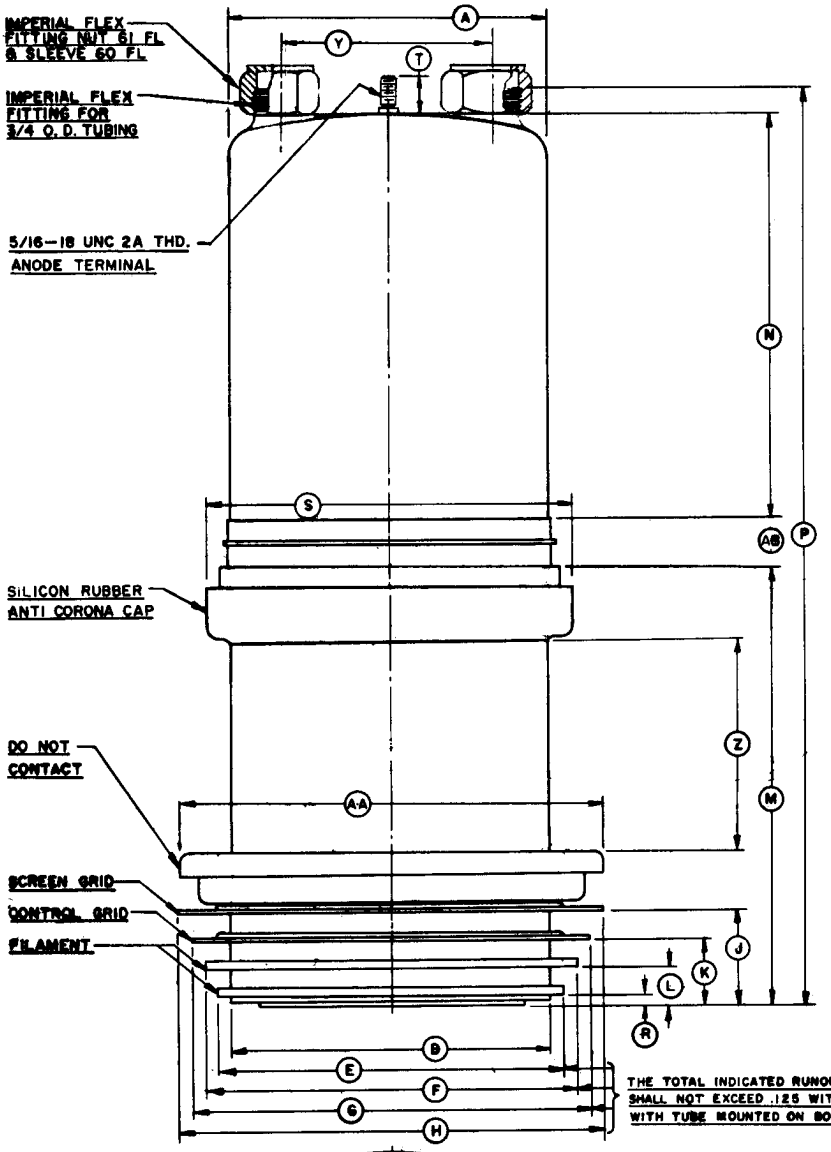
SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, write to Power Grid Tube Product Manager, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070 for information and recommendations.


EIMAC 4CW100,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 100 A
Ic1 = 1.0 A
80.0
60.0
40.0
30.0
20.0
10.0
4.0
1.0
0
250
100
50
25
10
5.0
2.5
1.0
0.5
0
Eb/KILOVOLTS
Ec1/VOLTS
0
2
4
6
8
10
12
14
16
18
20
600
400
200
0
−200
−400
−600
−800

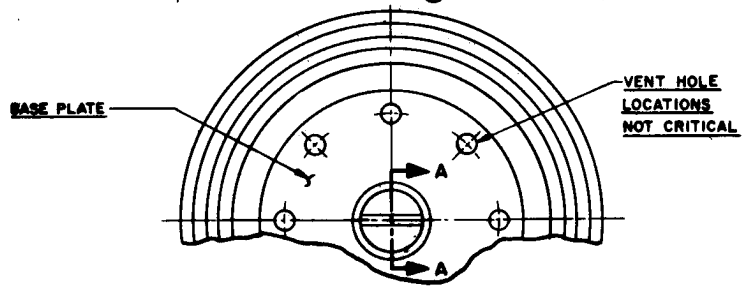
CURVE #2621

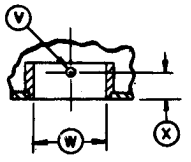

EIMAC 4CW100,000D
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 100.0 A
Ic2 = 20.0 A
Ic1 = 30.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
15.0
10.0
5.0
4.0
1.0
0
25.0
20.0
15.0
10.0
5.0
2.5
1.0
.500
.250
.100
0
Ec1/VOLTS
800
600
400
200
0
−200
−400
−600
0
2
4
6
8
10
12
14
16
18
20
Eb/KILOVOLTS

CURVE #2623



THE TOTAL INDICATED RUNOUT OF THESE CONTACT EDGES SHALL NOT EXCEED .125 WITH RESPECT TO "W" MEASURED WITH TUBE MOUNTED ON BOTTOM CERAMIC





SECTION A-A
ROTATED 180°

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	5.875	6.125	- -	149.2	155.6	- -
D	5.980	6.020	- -	151.9	152.9	- -
E	6.510	6.560	- -	165.3	166.6	- -
F	6.980	7.020	- -	177.3	178.3	- -
G	7.480	7.520	- -	190.0	191.0	- -
H	7.975	8.015	- -	202.6	203.6	- -
J	1.750	1.800	- -	44.4	45.7	- -
K	1.220	1.270	- -	31.0	32.3	- -
L	0.690	0.740	- -	17.5	18.8	- -
M	8.600	8.800	- -	218.4	223.5	- -
N	7.000	7.500	- -	177.8	190.5	- -
P	17.250	18.000	- -	438.1	457.2	- -
R	0.173	0.213	- -	4.39	5.41	- -
S	- -	- -	6.950	- -	- -	176.5
T	- -	- -	0.718	- -	- -	18.2
V	- -	0.135	- -	- -	3.43	- -
W	1.250	1.270	- -	31.7	32.2	- -
X	0.490	0.530	- -	12.4	13.5	- -
Y	3.940	4.060	- -	100.1	103.1	- -
Z	- -	- -	4.200	- -	- -	106.7
AA	- -	- -	8.000	- -	- -	203.2
AB	- -	- -	1.080	- -	- -	27.4

NOTES:
1. THE LATERAL AXES OF THE WATER FITTINGS & BASE LOCKING PIN ARE TO BE WITHIN 10°
2. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.