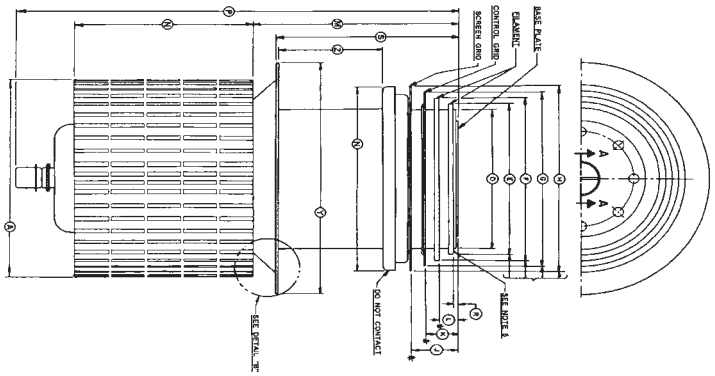

PL8351/ 4CV100,000C

Vapor Cooled Power Tetrode

The Penta Labs PL8351/4CV100,000C is a vapor-cooled ceramic-metal power tetrode specially designed to provide a power output of between 100 to 200 kilowatts. It is recommended for use as a Class C RF amplifier or oscillator. a Class AB push-pull AF amplifier or a Class AB linear amplifier or modulator.

The maximum dissipation of the vapor-cooled anode of this tube is 100 kilowatts when mounted in the Penta Labs PL-BR-300 series boiler.

ELECTRICAL CHARACTERISTICS[1]

Filament: Thoriated Tungsten		
Voltage	10	v
Current	300	A
Amplification Factor (Grid-Screen) (average)	4.5	
Interelectrode Capacitances, (grounded cathode)[1]		
Input	440	pF
Output	55	pF
Feedback	3.2	pF
Interelectrode Capacitances, (grounded grid)[2]		
Input	175	pF
Output	57	pF
Feedback	0.4	pF
Frequency for Maximum Ratings	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. Penta Labs should be consulted before using this information for final equipment design.

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

(Revised 04/10/93)

P E N T A L A B O R A T O R I E S

21113 SUPERIOR STREET * CHATSWORTH * CALIFORNIA 91311

(800) 421-4219 * (818) 882-3872 * FAX: (818) 882-3968

MECHANICAL CHARACTERISTICS

Base	Special, Graduated rings
Maximum Seal Temperature	250°C
Maximum Anode Flange Temperature	130°C
Recommended Socket	Penta Labs SK-1500 Series
Recommended Boiler	Penta Labs BR-300 Series
Operating Position	Vertical, Base up
Maximum Dimensions:	
Height	17.240 In; 43.79 cm
Diameter	10.070 In: 25.28 cm
Cooling	Liquid to vapor and forced air
Net Weight (approximate)	68 lb: 30.9 kg
Shipping Weight (approximate)	88 lb: 40.0 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	2,500 Volts
DC Plate Current	15.0 Amperes
Plate Dissipation	100,000 Watts
Screen Dissipation	1,750 Watts
Grid Dissipation	500 Watts

TYPICAL OPERATION (Frequencies below 30 MHz)

DC plate Voltage	15	17.5	kVdc
DC Screen Voltage	1.5	1.5	kVdc
DC Grid Voltage	-1020	-1050	Vdc
DC Plate Current	11.8	11.8	Adc
DC Screen Current	1.0	1.0	Adc
DC Grid Current	100	100	mAdc
Peak rf Grid Voltage	1220	1250	v
Driving Power[1]	120	125	W
Plate Dissipation	38	38.5	kW
Plate Output Power	139	168	kW
Resonant Load Impedance	600	710	Ω

1. Approximate volume.

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	2,000 Volts
DC Plate Current	15.0 Amperes

Plate Dissipation[1]	66,500 Watts
Screen Dissipation[4]	1,750 Watts
Grid Dissipation[4]	500 Watts

TYPICAL OPERATION (Frequencies below 30 MHz)

DC Plate Voltage	14	16	kVdc
DC Screen Voltage	750	750	v
Peak AF Screen Voltage (for 100% modulation)[2]	750	750	v
DC Grid Voltage	-700	-700	Vdc
DC Plate Current	9.1	12.0	Adc
DC Screen Current	2.0	1.75	Adc
DC 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

1. Corresponds to 100,000 watts of 100% sine wave modulation.
2. Approximate volume.
3. Calculated Low frequency drive power.
4. Average with or without modulation.

AUDIO FREQUENCY AMPLIFIER OR MODULATOR
Class AB1

ABSOLUTE MAXIMUM RATINGS:

DC Plate Voltage	20,000 Volts
DC Screen Voltage	2,500 Volts
DC Plate Current	15.0 Amperes
Plate Dissipation	100,000 Watts
Screen Dissipation	1,750 Watts
Grid Dissipation	500 Watts

TYPICAL OPERATION (Two Tubes)

DC Plate Voltage	15	18	kVdc
DC Screen Voltage	1.5	1.5	kVdc
DC 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

1. Per Tube
2. Approximate volume

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER - Cathode Driven
Class C Telephony (Carrier conditions except where noted)

ABSOLUTE MAXIMUM RATINGS:

DC Plate Voltage	17,500 Volts
DC Screen Voltage	2,000 Volts
DC Plate Current	15.0 Amperes
Plate Dissipation	66,500 Watts
Screen Dissipation[2]	1,750 Watts
Grid Dissipation[2]	500 Watts

TYPICAL OPERATION (Frequencies below 30 MHz)

DC Plate Voltage	12	15	kVdc
DC Screen Voltage	560	900	Vdc
DC Grid Voltage	-440	-600	Vdc
DC Plate Current	12.4	11.6	Adc
DC Screen Current	1.32	0.72	Adc
DC Grid Current	0.20	0.10	Adc
Peak RF Cathode Voltage	655	720	v
Cathode Driving Power	8.1	8.1	kW
Cathode Driving Impedance	27	32	Ω
Plate Dissipation	49.2	47.0	kW
Plate Output Power	112.7	141.0	kW
Resonant Load Impedance	480	650	Ω

1. Voltages given are referenced to ground.
2. Average, with or without modulation

RADIO FREQUENCY LINEAR AMPLIFIER
Class AB1

ABSOLUTE MAXIMUM RATINGS:

DC Plate Voltage	20,000 Volts
DC Screen Voltage	2,500 Volts
DC Plate Current	15.0 Amperes
Plate Dissipation	100,000 Watts
Screen Dissipation	1,750 Watts
Grid Dissipation	500 Watts

TYPICAL OPERATION (Frequencies below 30 MHz)
Peak Envelope or Modulation Crest Condition

DC Plate Voltage	15	18	kVdc
DC Screen Voltage	1.5	1.5	kVdc
DC 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

1. Approximate value.

NOTE: TYPICAL OPERATION data are obtained by calculation from published characteristic curves. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when the tubes are changed. even though there may be some variations in grid and screen currents. 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. 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 driving voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current @ 10.0 volts	280	310	A
Direct Inter electrode Capacitance (grounded cathode)[1]			
Cin	410	470	pF
Cout	50	60	pF
Cgp	1.5	3.2	pF
Direct Inter electrode Capacitance (grounded grid)[1]			
Cin	155	195	pF
Cout	52	62	pF
Cpk	---	0.60	pF
Control Grid Voltage (Ec1) for conditions: Eb = 6.5 +0.5 kVdc.	-220	-350	Vdc
Ec2 = 1500 Vdc: adjust Ec1 for Ib = 5.0 Adc			
Control Grid Voltage (Ec1) for conditions: Eb = 15 kVdc:	---	-650	Vdc
Ec2 = 1500 Vdc: adjust Ec1 for Ib = 10 mAdc			

1. 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 4CV100,000C must be mounted vertically, anode down, in a Penta Labs PI-BR-300 series boiler. Care Must be exercised to insure that the axis of the tube/boiler combination is vertical and the water in the boiler is at the correct level. The anode flange on the tube must seat securely against the "O" ring, forming a vapor-tight seal between tube and boiler.

SOCKETING - The Penta Labs SK-1500 series socket is available for use with the 4CV100,000C. Filament, control grid and screen grid connections are made to this socket. Spring finger contacts on the socket are used to make connections to the concentric rings on the tube bases.

COOLING - Cooling is accomplished by immersing the anode of the 4CV100,000C. in a "Boiler" containing distilled water. Energy dissipated by the anode. causes the water to boil at the anode surfaces, be converted into steam and be carried away to an external condenser. The condensate is then returned to the boiler, completing the cycle.

This boiling action maintains the anode surfaces at a fairly constant temperature near 100^{O} C. The vapor-cooled tube has good overload capabilities: excess dissipation for moderate periods only causes more water to boil.

Since the tube anode and boiler are usually at high potential to ground, water and steam connections to the boiler are made through insulating tubing.

High-purity water must be used to minimize power loss, corrosion of metal fittings, and loss of anode dissipation capability. Water resistivity must be maintained at 1 megohms/cm^{3} or better for long term operation.

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^{O} C. For most applications, 1 to 2 C.F.M. of air directed through the center of the socket is sufficient for this purpose.

ELECTRICAL

FILAMENT OPERATION - During turn-on inrush current should be limited to twice normal (nominal) current. At rated filament voltage, the peak emission of a 4CV100,000C is many times greater than the amount needed for communication service. Reducing the filament voltage decreases the filament temperature. A small decrease in filament temperature substantially increases filament life. The correct value of filament-voltage should be determined for the particular applications. First, gradually reduce the filament voltage to the point where there is a noticeable reduction in plate current or power output, or an increase in distortion. Then increase the voltage several tenths of a volt above the value where performance degradation occurred: this is the proper operating voltage. Filament voltage should always be measured at the tube base or socket using an rms responding meter. The above procedure should be performed periodically to assure optimum tube life.

GRID OPERATION - The maximum control-grid dissipation is 500 watts, determined approximately by the product of grid current and peak positive grid voltage.

Under some operating conditions, the control grid may exhibit a negative-resistance characteristic. This may occur when, with high screen-grid voltage, increasing the drive voltage decreases the grid current. As a result, large values of instantaneous negative grid current can be produced, causing the amplifier to become regenerative. Because this may happen, the driver stage must be designed to tolerate this condition. One technique is to swamp the driver so that the change in load, due to secondary grid emission, is a small percentage of the total driver load.

SCREEN OPERATION - The maximum screen-grid dissipation is 1750 watts. With no ac applied to the screen, dissipation is simply the product of dc screen voltage and 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 the screen dissipation rating will be exceeded. Suitable protective circuitry should be provided.

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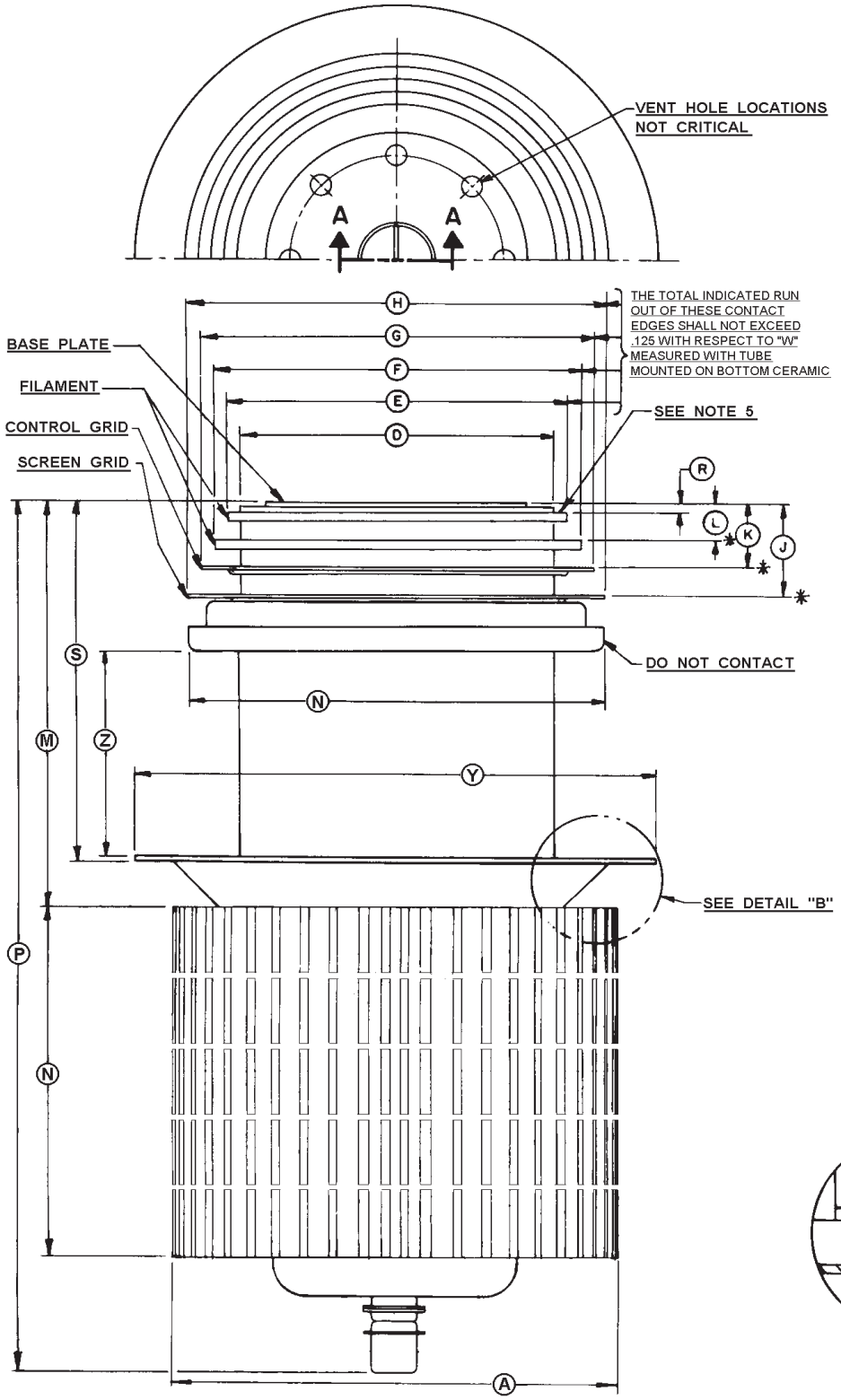
The 4CV100,000C may exhibit reverse screen current to a greater or lesser degree depending on operating conditions. The screen supply voltage must be maintained constant for any values of negative and positive screen current which may b encountered. Dangerously high plate current may flow if the screen power supply exhibits a rising voltage characteristic with negative screen current. Stabilization may be accomplished with a bleeder resistor connected from screen to cathode, or an electronic regulator circuit may b employed in the screen supply. A bleeder resistor must be used if a series electronic regulator is employed

FAULT PROTECTION - In addition to the normal plate-over current interlock, screen-current interlock, and coolant-flow interlock, it is good practice to protect the tube from internal damage caused by an internal plate are which may occur at high plate voltages.

A protective resistance of 5 to 25 ohms should always be connected in series with each tube anode, to absorb power-supply stored energy if a plate are should occur. An electronic crowbar, which will discharge power-supply capacitors in a few microseconds after the start of a plate arc, is recommended.

Properly spark gaps must be located between the screen grid and cathode and between the control grid and cathode to meet over-voltage protection criteria. A series resistance of 10 to 50 ohms is recommended in the screen and control grid power supply leads.

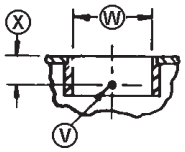


DIMENSIONS IN INCHES

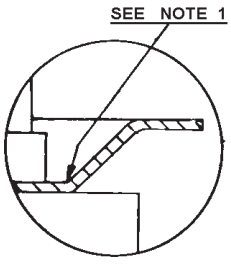
DIMENSIONAL DATA			
DIM	MIN.	MAX.	REF.
A	8.060	8.310	
B			
D			
	5.980	6.020	
E	6.510	6.560	
F	6.980	7.020	
G	7.480	7.520	
H	7.975	8.015	
J	1.750	1.800	
K	1.220	1.270	
L	.690	.740	
M	7.890	8.140	
N	6.375	6.625	
P	16.840	17.240	
R	.173	.215	
S	7.010	7.265	
T			
U	.187		
V		.135	
W	1.250	1.270	
X	.490	.530	
Y	9.900	10.070	
Z		---	3.850
AA			8.000

NOTE:

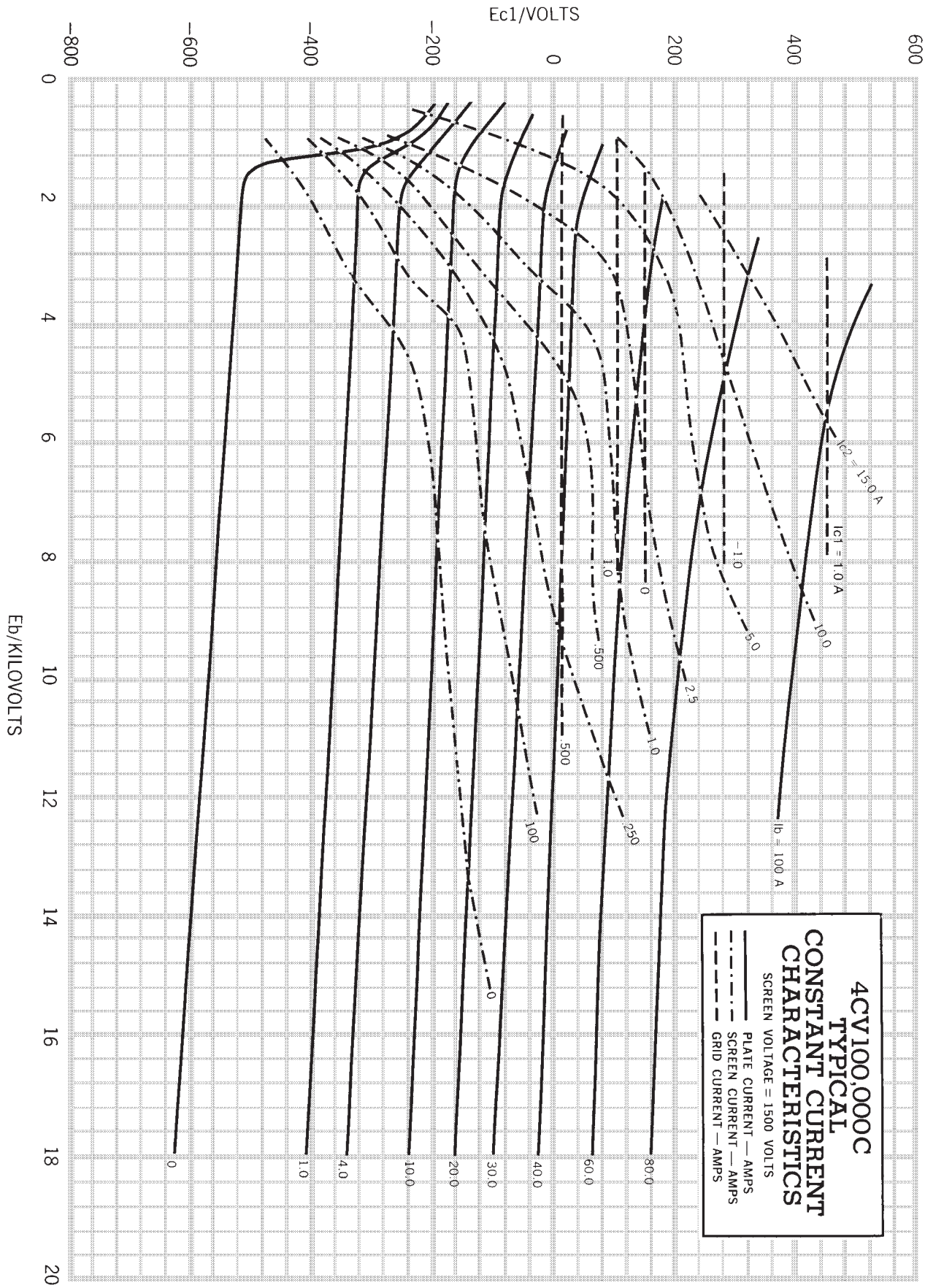
1. AREA FOR MEASURING ANODE FLANGE TEMPERATURE
2. "O"-RING P/M 124704N 9.1.D X 1/4 WALL SUPPLIED WITH TUBE
3. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
4. (*) CONTACT SURFACES: FROM PERIPHERY TOWARD Φ OF TUBE FOR "U" DIM., TO BE FLAT WITHIN .030
5. BOTTOM CONTACT SURFACE TO BE FLAT WITHIN .030.



SECT. A–A



DETAIL B


4CV100,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ec1/VOLTS
Eb/KILOVOLTS
Ic2 = 15.0 A
Ic1 = 1.0 A
Ib = 100 A
600
400
200
0
−200
−400
−600
−800
0
2
4
6
8
10
12
14
16
18
20
10.0
5.0
2.5
1.0
.500
.250
.100
0
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40.0
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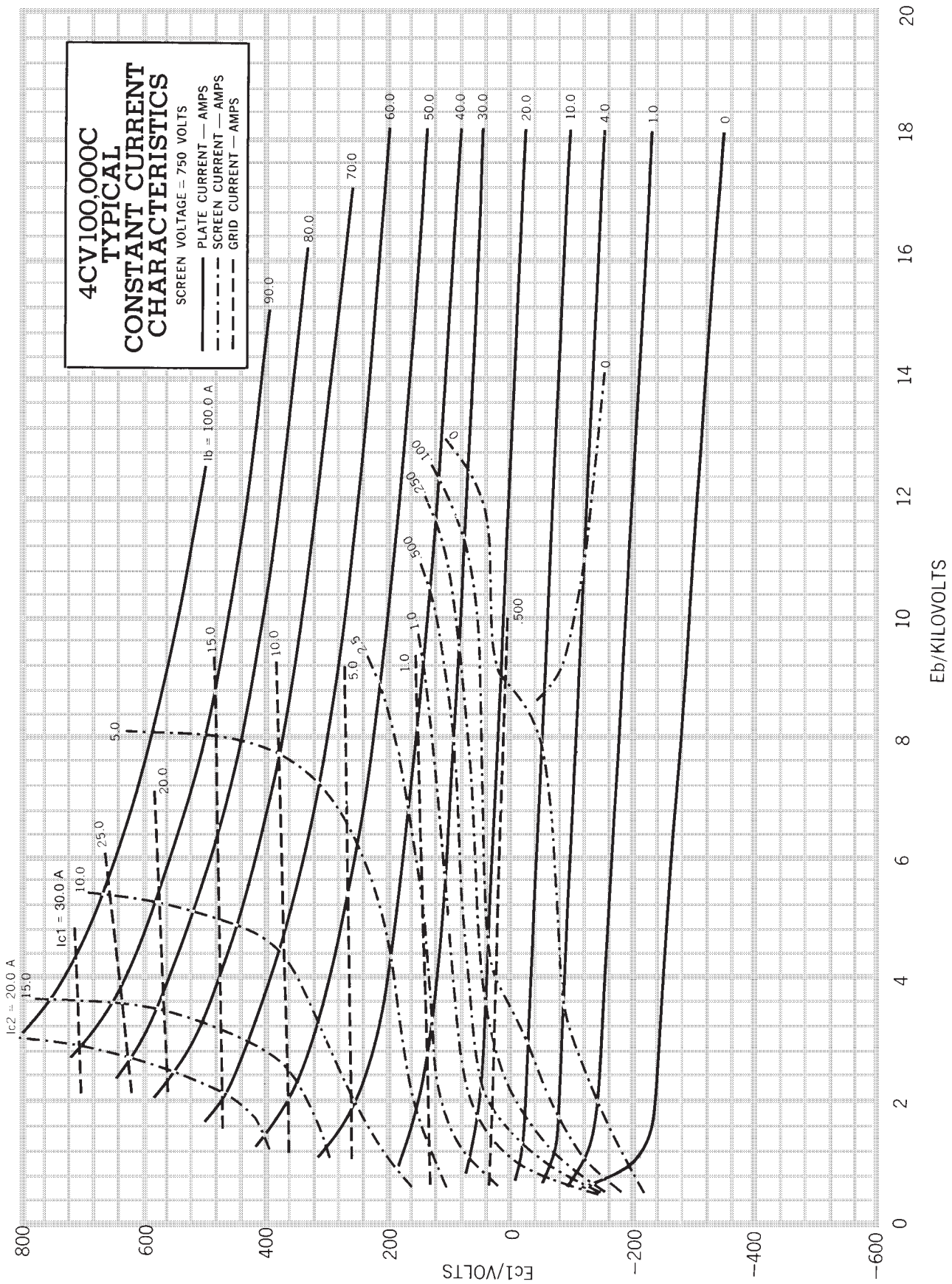
20.0
10.0
4.0
1.0
0


4CV100,000C
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT — AMPS
SCREEN CURRENT — AMPS
GRID CURRENT — AMPS
Ib = 100.0 A
Ic1 = 30.0 A
Ic2 = 20.0 A
Ec1/VOLTS
Eb/KILOVOLTS