TECHNICAL DATA

4CW800B
4CW800F

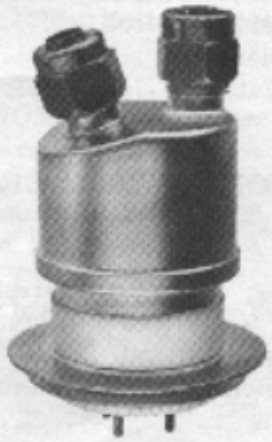
RADIAL BEAM POWER TETRODES

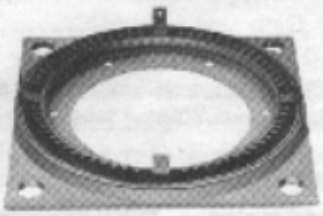
The EIMAC 4CW800B and 4CW800F are ceramic/metal, liquid cooled radial-beam tetrodes designed for use in distributed amplifiers and VHF/UHF power amplifiers.

The mechanical and electrical features of these tubes are compatible with distributed amplifier circuit requirements, i.e., low lead inductance, low input and output capacitance and small size.

Ruggedized construction consisting of a unitized electrode structure and direct mounting to the chassis, combine to make the 4CW800B and 4CW800F suitable for environments of severe shock and vibration.

The maximum rated plate dissipation is 800 watts for both types.





8K-880 By-pass Capacitor Unit

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide Coated, Unipotential

Heater: 4CW800B

Voltage	6.0 V
Current	4.4 A

Heater: 4CW800F

Voltage	26.5 V
Current	1.1 A

Transconductance: (I_b = 600 mAdc)	40,000 μmhos
Input Conductance: (I_b = 600 mAdc) (F = 30 MHz)	0.1×10^{-3} mhos
Frequency for Maximum Ratings	800 MHz
Direct Interelectrode Capacitance: (Grounded Cathode)[2]	
Cin	45 pF
Cout	5.8 pF
Cgp	0.15 pF

1. Characteristics and operating values are based upon peformance 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.

MECHANICAL

Base	Special
Operating Position	Any
Maximum Operating Temperatures	
Ceramic-to-Metal Seals	150°C
Cooling	Liquid
Cooling Jacket Nuts: 2 required, EIMAC P/N 122088	Not Supplied With Tube

3999 (Revised 12-15-79)

Printed in U.S.A.

Varian / EIMAC Division / 301 Industrial Way / San Carlos / California 94070
Telephone: (415) 592-1221 Twx: 910 376-4893

Sleeves for Jacket Nuts: 2 required, EIMAC P/N 122089 ..... Not Supplied With Tube
Nickel-Plated Brass 2-56 nut, EIMAC P/N 051710 ..... Not Supplied With Tube
(for connection to heater & grid base studs)
Screen Grid Bypass Capacitor & Mounting Plate, not supplied ..... EIMAC SK-680
C = 5000 pF (nominal), DCWV = 500
Maximum Over-all Dimensions:
Length ..... 3.00 In; 76.20 mm
Diameter ..... 2.03 In; 51.56 mm
Net Weight ..... 7 oz; 198 gm

RANGE VALUES FOR EQUIPMENT DESIGN

	Min	Max	
Heater: 4CW800B - Current at 6.0 volts	4.0	4.7	A
4CW800F - Current at 26.5 volts	0.85	1.25	A
Cathode Warmup Time - both types	180	—	sec.
Interelectrode Capacitances (grounded cathode circuit)[1]			
Cin	42.0	48.0	pF
Cout	5.3	6.3	pF
Cgp	—	0.20	pF

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

BROADBAND RF LINEAR AMPLIFIER
Class AB, Grid Driven

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000	VOLTS
DC SCREEN VOLTAGE	500	VOLTS
DC PLATE CURRENT	0.6	AMPERE
PLATE DISSIPATION	800	WATTS
SCREEN DISSIPATION	15	WATTS
GRID DISSIPATION	3	WATTS

1. Adjust for specified zero-signal plate current.
2. Approximate value.

TYPICAL OPERATION

Plate Voltage	1000	1500	2500	Vdc
Screen Voltage	275	275	275	Vdc
Grid Voltage[1]	-40	-40	-40	Vdc
Zero Signal Plate Current	100	100	100	mAdc
Plate Current	570	580	585	mAdc
Screen Current[2]	32	29	17	mAdc
Peak rf Grid Voltage[2]	44	43	42	v
Plate Output Power[2]	320	590	1000	W
Plate Dissipation[2]	250	280	460	W
rf Load Impedance	765	1225	2325	Ω

RADIO FREQUENCY POWER AMPLIFIER
Class B, Grid Driven

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	3000	VOLTS
DC SCREEN VOLTAGE	500	VOLTS
DC PLATE CURRENT	0.6	AMPERE
PLATE DISSIPATION	800	WATTS
SCREEN DISSIPATION	15	WATTS
GRID DISSIPATION	3	WATTS

1. Adjust for specified zero-signal plate current.
2. Approximate value.
3. Delivered to the load.

TYPICAL OPERATION	140-250 MHz Strip-line amp		432 MHz Cavity	865 MHz Cavity	
Plate Voltage	1650	1950	2500	2000	2000 Vdc
Screen Voltage	400	300	300	300	300 Vdc
Grid Voltage[1]	-75	-60	-60	-54	-60 Vdc
Zero Signal Plate Current	15	15	15	20	15 mAdc
Maximum Signal Plate Current	600	530	600	600	600 mAdc
Screen Current[2]	14	11	11	7	8 mAdc
Grid Current[2]	-6	-3	-8	+14	0 mAdc
Useful Power Output[3]	540	555	820	770	550 W
Bandwidth (3dB) of Amplifier	6	6	4.5	—	9 MHz
Power Gain[2]	—	—	—	15.3	10.4 dB

APPLICATION

MECHANICAL

MOUNTING - These tubes may be mounted in any position. No socket is required. The tube may be mounted directly on the SK-680 Screen Bypass Capacitor which in turn is mounted to the chassis with four 6-32 screws. The chassis thickness should be 0.062 inch to insure adequate space for connections to the base of the tube and care should be exercised to insure a flat mounting surface to minimize cathode lead inductance.

COOLING - Sufficient cooling must be provided for the anode and ceramic-to-metal seals to maintain operating temperatures below the rated maximum value of 150°C.

Anode cooling is accomplished by circulating liquid through the integral jacket.

Each of the two connectors on the cooling jacket contains an "O" ring as the tube is supplied (if replacement or spare "O" rings are required they should be ordered by EIMAC P/N 122090). The matching nuts and sleeves are not supplied with the tube and must be ordered separately (see MECHANICAL section, page 2). The tubing used with this nut/sleeve combination must be ¼-inch OD.

At ambient temperatures of 25°C or less, no base cooling is required.

At higher temperatures, base cooling may be required to maintain base temperatures below 150°C. This can be accomplished by mounting the tube to a cold plate cooled by the inlet liquid.

WATER COOLING - The tabulation below lists the minimum water flow requirements for 25°C inlet water temperature with a temperature rise of 15°C from inlet to outlet.

Plate Dissipation (Watts)	Water Flow (GPM)	Pressure Drop psi)
200	.050	.025
400	.100	.050
600	.156	.075
800	.202	.100

Water pressure should never exceed 200 psi psi and outlet temperature must be limited to 70°C.

In cases where there is any doubt regarding the adequacy of the supplied cooling, it should be borne in mind that operating temperature is the sole criterion of cooling effectiveness.

BASE CONNECTIONS - One heater and four control grid terminals are on the base of the tube. These are in the form of threaded (2-56UNC-2A) studs. Standard 2-56 nuts will fit these studs, but these are not supplied with the tube. The EIMAC part number for a nickel-plated brass 2-56 nut is 051710. When making connection to the studs care must be taken to not exceed 2.0 inch-pounds of torque to avoid damage to the ceramic/metal seals.

ELECTRICAL

HEATER - The rated heater voltage is 6.0 volts for the 4CW800B and 26.5 volts for the 4CW800F. The voltage, as measured at the tube base, should be maintained at this value to minimize variations in operation and to obtain maximum tube life. In no case should the voltage be allowed to exceed 5% above or below the rated value.

The cathode and one side of the heater are internally connected.

It is recommended that the heater voltage be applied for a period of not less than three minutes before current is drawn from the cathode. Tube operation will stabilize after a period of approximately five minutes from a cold start.

CONTROL-GRID OPERATION - The control-grid has a maximum dissipation of 3.0 watts and precautions should be observed to avoid exceeding this rating. The 3.0 watt rating is dependent on the base flange temperature not exceeding the rated 150°C maximum.

There are four threaded grid pins on the base of the tube. These pins can be used separately or in parallel to control the amount of grid lead inductance to suit the requirements of the circuit. The grid lead inductance for one pin is 2.4 nanohenries.

SCREEN GRID OPERATION - The maximum rated screen dissipation for the 4CW800B or 4CW800F is 15 watts.

Under certain operating conditions the screen current of a tetrode may reverse as indicated on the screen current meter. This condition is the result of secondary emission from the screen and is normal for a power tetrode. If the impedance of the screen power supply is high, negative screen current will cause the screen voltage to approach the anode voltage and the results will be a runaway condition which could lead to a catastrophic failure. This condition can be avoided if sufficient bleeder current is drawn from the screen supply by an appropriate bleeder or regulator tube. The recommended bleeder current for these tubes is 20 mA for each tube connected to a common screen power supply.

A low inductance screen bypass capacitor, EIMAC SK-680, is available for either tube. This capacitor is easily installed with six 0-80 screws. With the SK-680 capacitor installed, the screen self-resonant frequency of either tube is in excess of 900 MHz.

PLATE OPERATION - The maximum rated plate dissipation power for either tube is 800 watts. Except for brief periods during circuit adjustments, the maximum value should not be exceeded. Connection to the anode is accomplished by a clamp around the anode.

DISTRIBUTED AMPLIFIER SERVICE - The mechanical and electrical features of the 4CW800B and 4CW800F are compatible with distributed amplifier circuit requirements, combining the qualities of low lead inductance, low input and output capacitances, high transconductance, and small size. Connection is made to the control grid by means of four threaded studs. By using the correct number of connections, the designer has available a choice of several values of grid lead inductance. This feature is quite useful in design of VHF/UHF distributed amplifiers. In addition, rugged internal tube construction, consisting of a unitized electrode structure and a solid direct-chassis flange mount, are features which make these tubes suitable for environments exhibiting severe shock and vibration, such as encountered in mobile or airborne sevice.

A distributed amplifier is a wideband, cascade device, employing vacuum tubes placed along an artificial transmission line, the tube capacitances appearing as the shunt elements of the line. In a properly designed distributed amplifier, the driving impedance is virtually independent of the number of tubes. The amplifier may make use of the characteristics of the low pass, the band pass, or the high pass filter configuration.

The 4CW800B and 4CW800F are ideal tubes for distributed amplifier service, as anode heat may be readily disposed of by a compact, external cooling system. An amplifier using one of these types is an advantage in instantaneous bandwidth rf systems as it eliminates the need of complex and slow tuning and tracking equipment necessary for a tuned amplifier.

EIMAC APPLICATION BULLETIN NUMBER FOUTEEN - This 23-page booklet is available from EIMAC and contains additional information on the use of these tubes (or similar types of the same tube family), including some constructional details in strip-line amplifier circuitry in the 140-250 MHz range, distributed amplifier service, and cavity amplifier operation at 432 MHz and 864 MHz.

HIGH VOLTAGE - These tubes operate at voltages which can be deadly, and the equipment must be designed properly and operating precautions must be followed. Equipment must be designed 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 the primary circuits of the power supplies 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 30 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, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at

frequencies as low as the 13 and 27 MHz bands.

FAULT PROTECTION - All power tubes operate at voltages which can cause severe damage in the event of an internal arc, especially in those cases where large amounts of stored energy or follow-on current are involved.

Some means of protection is advised in all cases, and it is recommended that a series resistor of 25 to 50 ohms be used in the anode circuit to limit peak current and provide a means of dissipating the energy in the event of a tube or circuit arc. For an oxide-cathode type such as these tubes are a maximum of 4 joules total energy should be permitted to be dumped into an internal arc. Amounts in excess of this may permanently damage the cathode or the grid structure.

Additional information is found in EIMAC's Application Bulletin #17 titled FAULT PROTECTION", available on request.

INTERELECTORDE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications such as stray capacitance to the chassis, stray capacitance between tube terminals, and wiring effects. To control the acutal capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard SR-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. 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 mounting which represent approximate final layout if capacitance values are highly significant in the design.

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

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 power tubes involves one or more of 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.

b. *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 AFFECTED.

c. *X-RAY RADIATION* - High voltage tubes can produce dangerous and possibly fatal x-rays.

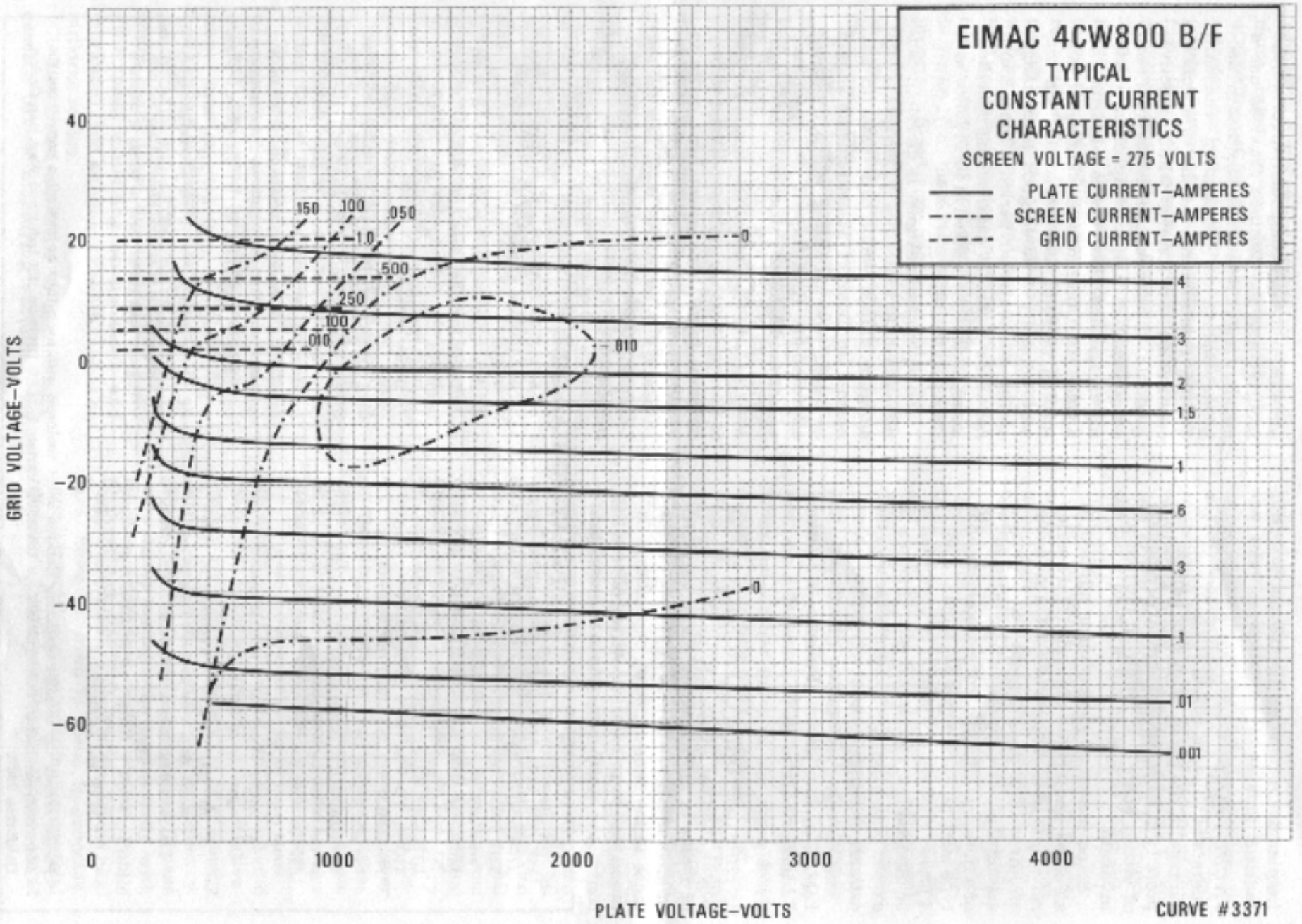
d. *BERYLLIUM OXIDE POISONING* - Dust or fumes from BeO ceramics used as thermal links with some conduction-cooled power tubes are highly toxic and can cause serious injury or death.

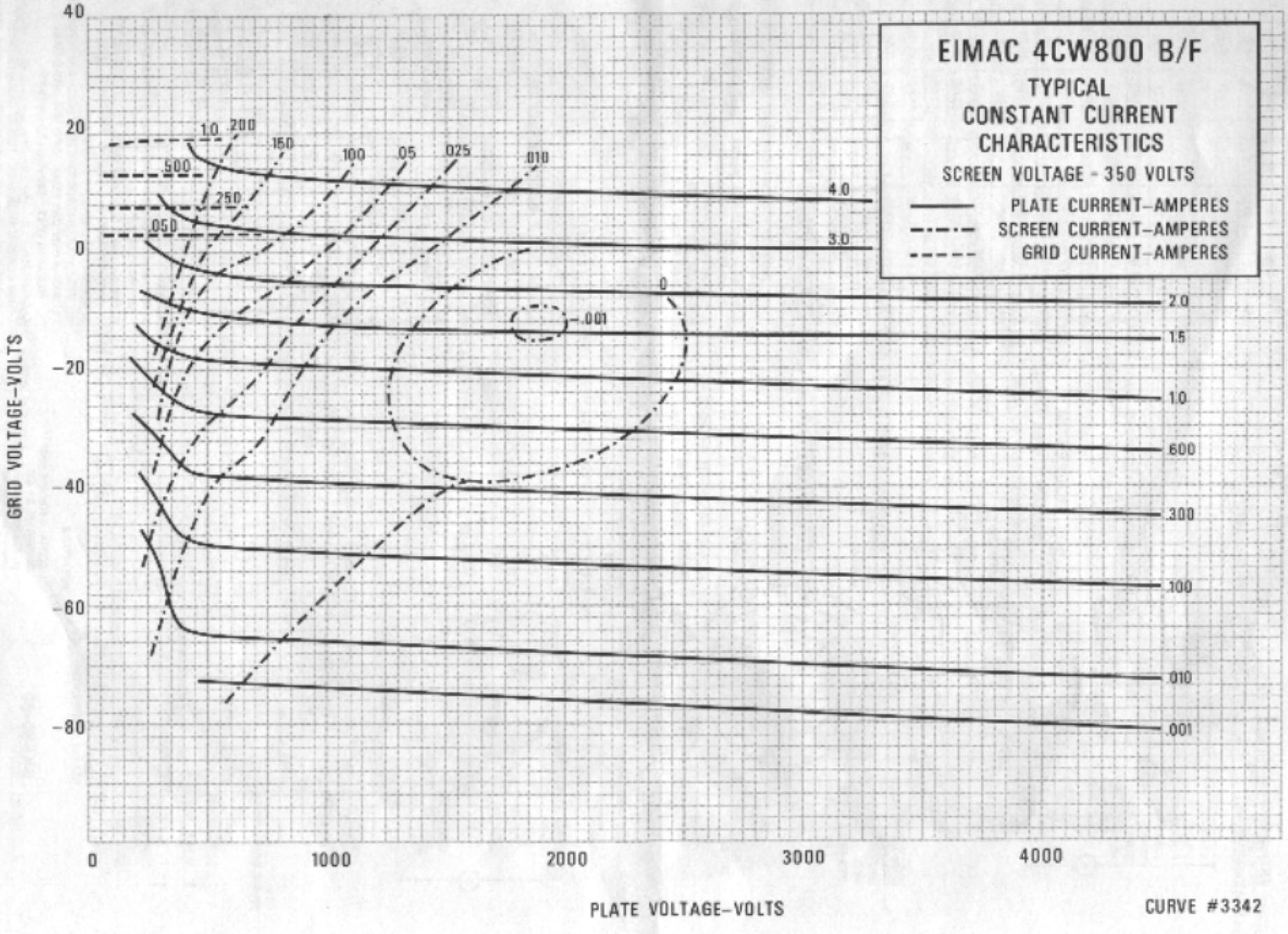
e. *GLASS EXPLOSION* - Many electron tubes have glass envelopes. Breaking the glass can cause an implosion, which will result in an explosive scattering of glass particles. Handle glass tubes carefully.

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

g. *HOT SURFACES* - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred degrees centigrade and cause serious burns if touched.

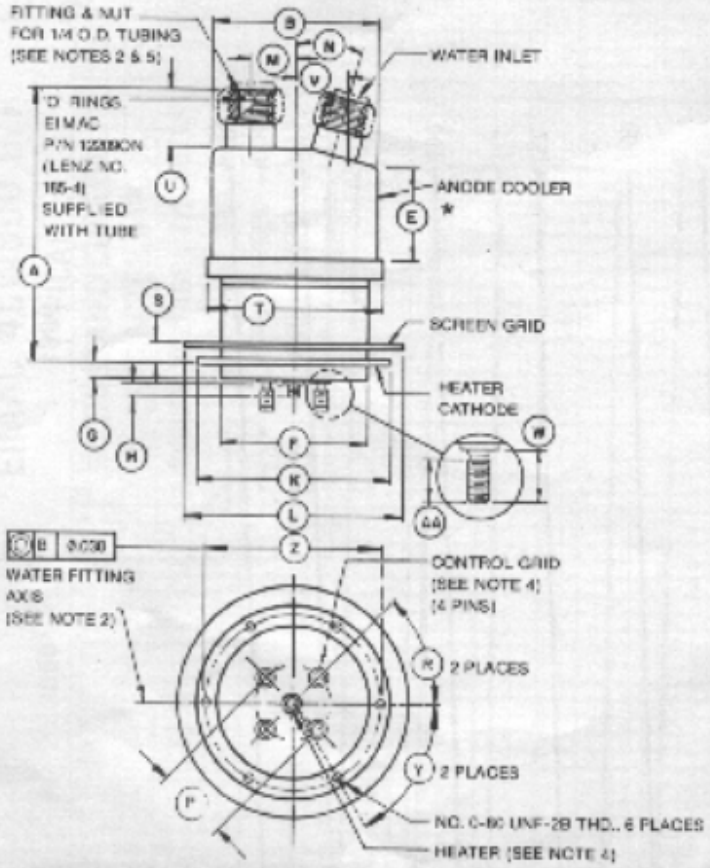
Please review the detailed operating hazards sheet enclosed with each tube or request a copy from the address shown below: Power Grid Tube Division, Varian, EIMAC Division, 301 Industrial Way, San Carlos, California 94070.


EIMAC 4CW800 B/F
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 275 VOLTS
PLATE CURRENT–AMPERES
SCREEN CURRENT–AMPERES
GRID CURRENT–AMPERES
GRID VOLTAGE–VOLTS
40
20
0
-20
-40
-60
0
1000
2000
3000
4000
PLATE VOLTAGE–VOLTS
CURVE #3371
150
100
050
1.0
500
250
100
010
010
0
0
4
3
2
1.5
1
6
3
1
.01
.001



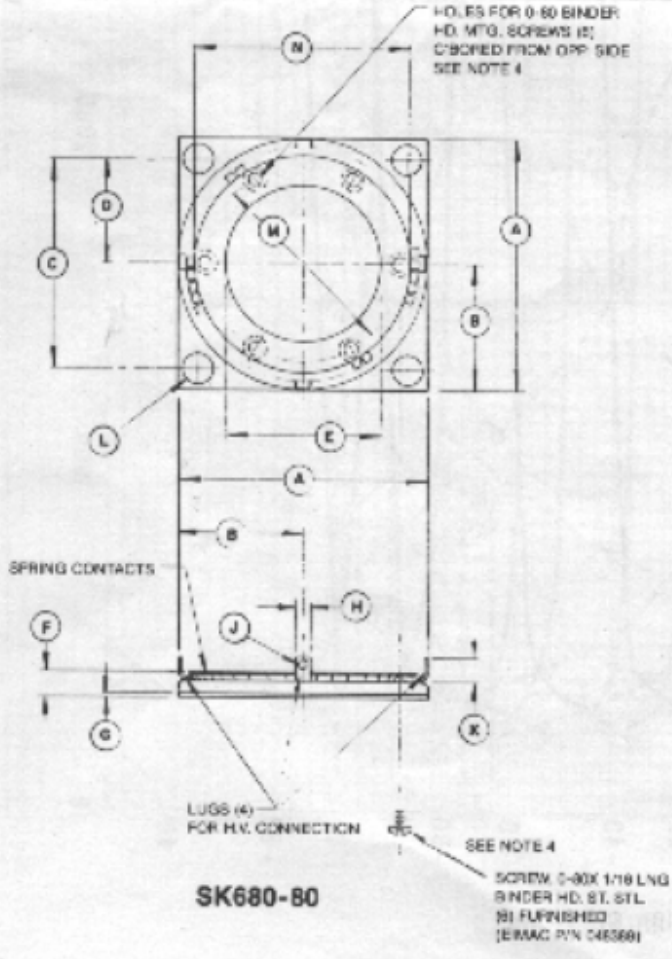
4CW800B/F

CURVE #3342



DIMENSIONAL DATA							
DIM.	INCHES				MILLIMETERS		
	MIN.	MAX.	REF.		MIN.	MAX.	REF.
A		2.515				63.88	
B	1.485	1.515			37.35	38.10	
E	0.065				16.35		
F	1.305	1.325			32.82	33.32	
G	0.130	0.155			3.27	3.90	
H	0.130	0.180			3.27	4.53	
K	1.710	1.750			43.01	44.01	
L	1.930	2.025			48.54	50.93	
M	0.435	0.475			10.94	11.95	
N	15°	25°			15°	25°	
P	0.550	0.600			13.97	15.24	
R	44°	46°			44°	46°	
S	0.180	0.220			4.53	5.53	
T	1.550	1.610			38.98	40.46	
U	0.400				10.06		
V	0.440	0.520			11.07	13.08	
W	0.250	0.300			6.29	7.54	
Y	59°	61°			59°	61°	
Z	1.606	1.629			40.84	41.35	
AA	.220				5.59		

NOTES:
1. REF. DIMS ARE FOR INFO ONLY AND ARE NOT REQ'D FOR INSP PURPOSES
2. WATER FITTINGS ARE DIAMETRICALLY OPPOSED & AXIS IS LOCATED BETWEEN AXES OF PINS
3. (*) CONTACT SURFACE.
4. 2-56 UNC-2A. THREAD
5. COOLER FITTING NUTS, EIMAC P/N 122088N & SLEEVES, EIMAC P/N 122089N ARE NOT SUPPLIED WITH TUBE (SOLD SEPARATELY)



SK680-80

DIMENSIONS IN INCHES							
DIMENSIONAL DATA							
DIM.	MIN.	MAX.	REF.		MILLIMETERS		
					MIN.	MAX.	REF.
A	2.235	2.265			56.77	57.53	
B	1.110	1.140			28.19	28.49	
C	1.860	1.890			47.24	48.01	
D	.923	.953			23.44	24.21	
E	1.370	1.385			34.80	35.18	
F	.175	.210			4.45	5.33	
G			.060				1.52
H			.125				3.18
J			.031DIA				.079
K			.188				4.78
L			.187				4.75
M	1.613	1.623			40.97	41.22	
N	1.716	1.730			43.59	43.94	

NOTES:
1. REF. DIMS. ARE FOR INFO. ONLY & ARE NOT REQ'D FOR INSPECTION PURPOSES.
2. INSULATING & BONDING MATL. TO WITHSTAND TEMPS -55° C TO +150°
3. OPERATING DATA:
   TEST VOLT.-1000 VDC MIN. (SEA LEVEL CAPACITANCE-5000 pf GMV OPR TEMP. -25° C MIN., 150° C MAX.
   WORKING VOLT. -600 VDC (TO 20000 FT.)
4. CAUTION:
   USE SCREWS FURNISHED FOR ATTACHING SK680 TO TUBES Y-431, 4CW800F. TUBE MUST BE SEATED EVENLY ON BASE PLATE BEFORE STARTING SCREWS.