

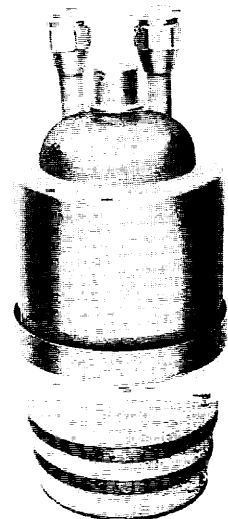


# TECHNICAL DATA

## 4CW10,000B WATER-COOLED POWER TETRODE

The EIMAC 4CW10,000B is a compact, high-power, ceramic/metal, liquid and forced-air cooled tetrode. It incorporates a special anode cooling jacket and a rugged thoriated-tungsten mesh filament to achieve very low noise modulation of the tube electron stream. The tube is rated for 12 kW anode dissipation. The tube may be entirely water cooled by use of the Y632D socket.

The 4CW10,000B is rated for full input up to 110 MHz and is recommended for use as a radio-frequency linear amplifier.



### GENERAL CHARACTERISTICS <sup>1</sup>

#### ELECTRICAL

Filament: Thoriated-Tungsten Mesh

Voltage . . . . .	7.5 ± 0.37 V
Current, at 7.5 volts . . . . .	75 A
Amplification Factor (average), Grid to Screen . . . . .	4.5

Direct Interelectrode Capacitance (grounded filament) <sup>2</sup>

C <sub>in</sub> . . . . .	120 pF
C <sub>out</sub> . . . . .	20.5 pF
C <sub>gp</sub> . . . . .	0.7 pF

Direct Interelectrode Capacitance (grounded grid) <sup>2</sup>

C <sub>in</sub> . . . . .	56 pF
C <sub>out</sub> . . . . .	21.5 pF
C <sub>pk</sub> . . . . .	0.1 pF

Frequency of Maximum Rating:

CW . . . . .	110 MHz
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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. Varian EIMAC 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

Maximum Overall Dimensions:

Length . . . . .	9.05 In; 22.99 cm
Diameter . . . . .	4.33 In; 11.0 cm
Net Weight . . . . .	8.6 Lb; 3.9 kg
Operating Position . . . . .	Vertical, Base Up or Down

Maximum Operating Temperature:

Ceramic/Metal Seals or Envelope . . . . .	250°C
Cooling . . . . .	Water & Forced Air*
Base . . . . .	Special Concentric

Recommended Air-System Socket:

For LF or HF Service . . . . .	EIMAC SK-300A
For VHF Service . . . . .	EIMAC SK-360
Recommended Water-Cooled Socket, for LF or HF Service - *(no forced air required)	EIMAC Y632D
Recommended Screen Grid Bypass Capacitor Kit for the SK-360 Socket . . . . .	EIMAC SK-355

392110 (Effective 15 July 83; replaces 19 May 1983)  
VA4648

Printed in U.S.A.

RADIO FREQUENCY LINEAR AMPLIFIER  
 GRID DRIVEN  
 Class AB1

TYPICAL OPERATION (Frequencies to 100 MHz)  
 Class AB1, Grid Driven, Peak Envelope or Modulation  
 Crest Conditions

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE . . . . .	7500 VOLTS
DC SCREEN VOLTAGE . . . . .	1600 VOLTS
DC PLATE CURRENT . . . . .	4.0 AMPERES
PLATE DISSIPATION . . . . .	12 KILOWATTS
SCREEN DISSIPATION . . . . .	250 WATTS
GRID DISSIPATION . . . . .	75 WATTS

- \* Approximate value.
- \*\* Delivered to the load.
- # Adjust to specified zero-signal dc plate current.

Plate Voltage . . . . .	7500	Vdc
Screen Voltage . . . . .	1600	Vdc
Grid Voltage # . . . . .	-400	Vdc
Zero-Signal Plate Current . . . . .	0.30	Adc
Single-Tone Plate Current . . . . .	2.20	Adc
Single-Tone Screen Current * . . . . .	0.30	Adc
Peak rf Grid Voltage * . . . . .	400	v
Single-Tone Plate Dissipation . . . . .	8500	W
Useful Output Power (PEP) ** . . . . .	10	kW
Load Impedance . . . . .	1650	Ohms
Intermodulation Distortion ##:		
3rd Order Products . . . . .	-35	dB
5th Order Products . . . . .	-40	dB

## Referenced against 1 tone of a 2 equal-tone signal.

TYPICAL OPERATION values are obtained 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. 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 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.

RANGE VALUES FOR EQUIPMENT DESIGN

	<u>Min.</u>	<u>Max.</u>	
Filament: Current at 7.5 volts . . . . .	70	80	A
Interelectrode Capacitance (grounded filament connection)			
Cin . . . . .	113	127	pF
Cout . . . . .	18	23	pF
Cgp . . . . .	---	1.0	pF
Interelectrode Capacitance (grounded grid connection)			
Cin . . . . .	51	61	pF
Cout . . . . .	19	24	pF
Cpk . . . . .	---	0.16	pF

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



## A P P L I C A T I O N

### MECHANICAL

**MOUNTING** - The tube must be mounted vertically, base up or down at the convenience of the circuit designer.

**SOCKETING** - An air-system or water-cooled socket should be used in all applications to allow cooling of the tube base seals. The EIMAC SK-300A is recommended for audio or LF/HF rf operation, while the SK-360 is recommended for VHF operation. The SK-360 incorporates low-inductance filament bypassing in the form of three 5000 pF copper-clad Kapton™ capacitors. A screen grid bypass capacitor kit (the SK-355) is also available for the SK-360 socket, and includes eight 1000 pF 5000 DCWV capacitors (EIMAC P/N 050706), sixteen mounting clips (EIMAC P/N 242859), and an assembly drawing (EIMAC P/N 243135) which shows how the parts are attached to the socket. If the water-cooled socket Y632D is used no forced-air cooling is required on the base of the tube.

**COOLING** - Anode cooling is accomplished by circulating water through the jacket. Insufficient water flow will cause the anode temperature to rise to levels which will shorten tube life.

For an anode dissipation of 10 kW a water flow of 3.8 gpm is required. This value is for a 20°C rise and an outlet water temperature maximum of 60°C. At this flow rate the approximate pressure drop across the cooler will be 3.8 psi. System pressure should not exceed 50 psi.

If the coolant lines become clogged for any reason enough steam pressure may be generated to rupture the water jacket and destroy the tube. Cooling water must be well filtered (with effectiveness the equivalent of a 100-mesh screen) to eliminate any solid materials, to avoid the possibility of blockage of any cooling passages, as this would immediately effect cooling efficiency and could produce localized anode overheating and failure of the tube.

Tube life can be seriously compromised by the cooling water condition. If it becomes contaminated, deposits will form on the inside of the water jacket, causing localized anode heating and eventual tube failure. To insure minimum electrolysis and power loss, the water resistance at 25 °C should always be one megohm per cubic centimeter or higher. The relative water resistance can

be continuously monitored in the reservoir by readily available instruments.

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.

Cooling of the tube base is required to maintain the filament and grid seal temperatures at safe operating levels. An air flow of approximately 30 cfm at 50°C maximum at sea level must be directed through the EIMAC air-system socket, toward the filament and grid seal areas, unless the Y632D water cooled socket is used. Seal temperature is the final criteria of effective cooling, and temperature-sensitive paints are available to the equipment designer for testing before equipment design is finalized.

Both anode and base cooling should be applied before or simultaneously with the application of electrode voltages, including the tube filament. Cooling should normally continue for a brief period after removal of electrode voltages to allow the tube to cool down properly.

### ELECTRICAL

**ABSOLUTE MAXIMUM RATINGS** - The 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 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 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, 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.

**FILAMENT OPERATION** - 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 a slight degradation in performance is noticed (such as power output or distortion). The filament 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 adverse influence 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.

**GRID OPERATION** - The maximum control grid dissipation is 75 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 control grid and the cathode to guard against excessive voltage.

**SCREEN OPERATION** - The maximum screen grid dissipation is 250 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. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

**PLATE DISSIPATION** - The rated maximum plate dissipation of the tube is 12 kilowatts, which may be safely sustained with adequate water cooling. When the tube is used as a plate-modulated rf amplifier, the dissipation under carrier conditions should be limited to 6.5 kilowatts.

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

EIMAC 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 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 CAPACITANCE** - The actual internal interelectrode 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 tube, 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 a specially constructed test fixture which shields all external tube leads or contacts 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. The capacitance values shown in the technical data 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 the application. Measurements should be taken with the mounting which represents

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; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

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#### 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:

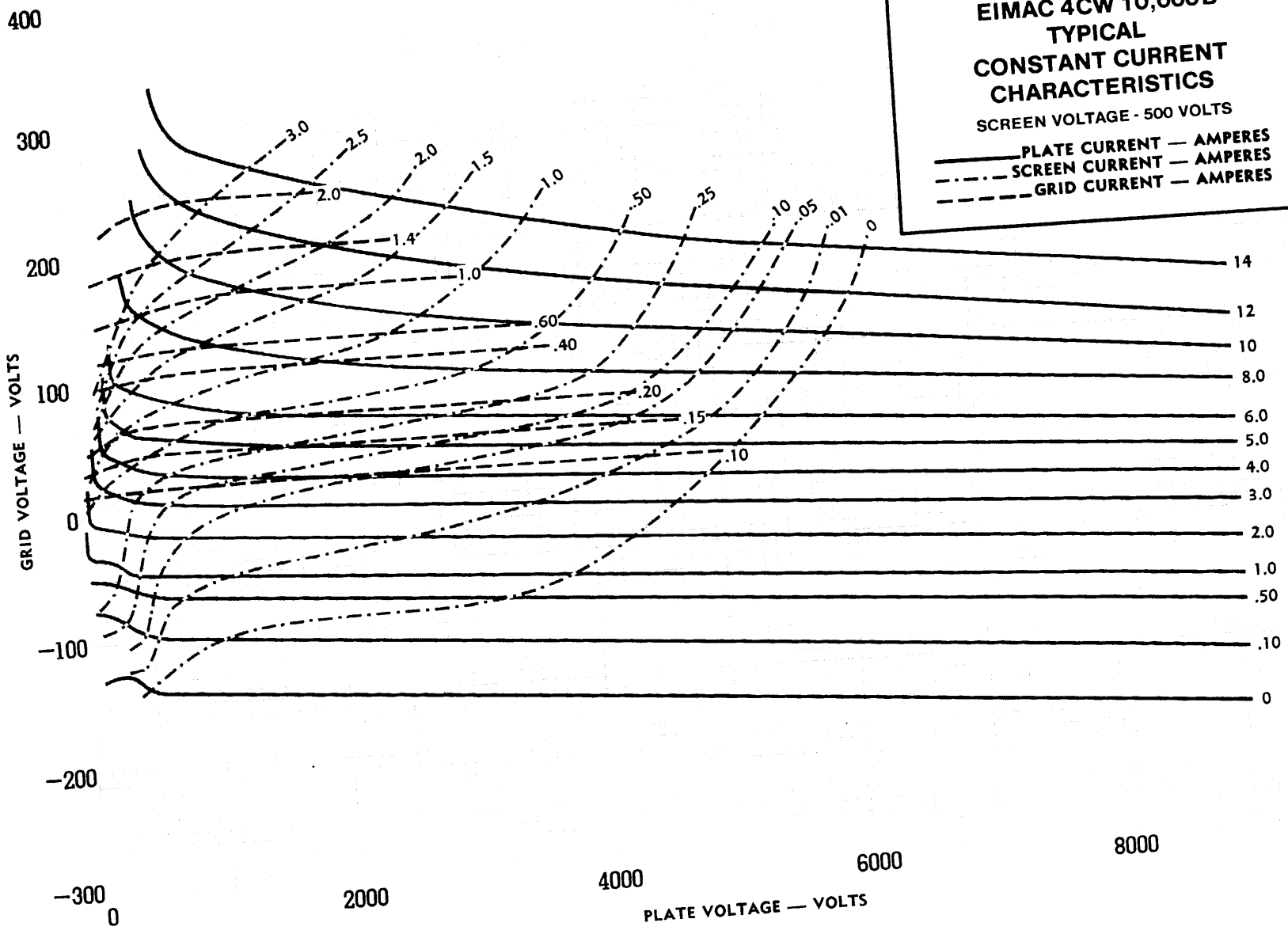
- a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.
- b. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE EFFECTED.
- c. HOT WATER - Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.
- d. HOT SURFACES - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred Degrees C and cause serious burns if touched for several minutes after all power is removed.

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

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**EIMAC 4CW 10,000B  
TYPICAL  
CONSTANT CURRENT  
CHARACTERISTICS**  
SCREEN VOLTAGE - 500 VOLTS

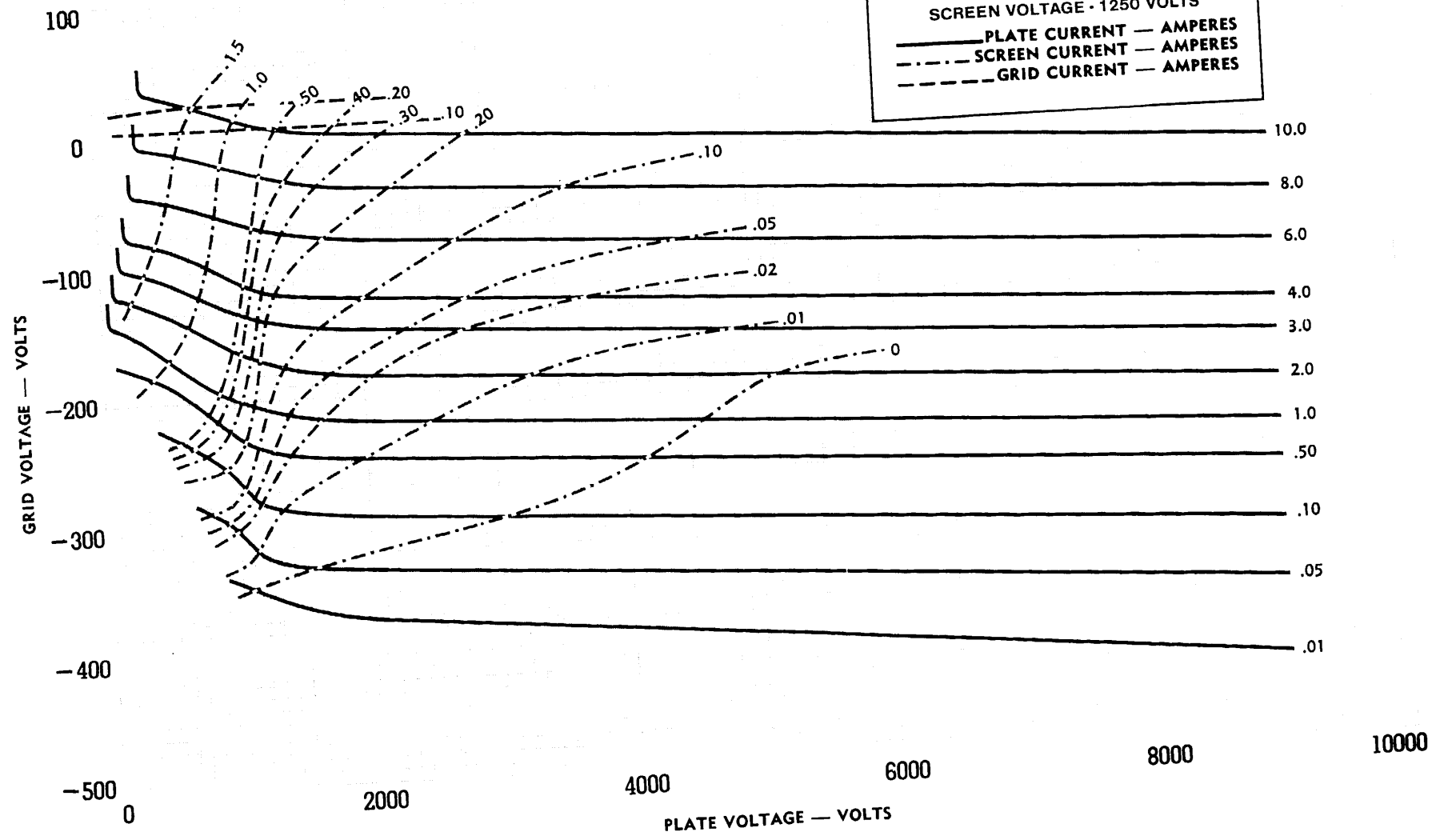
- PLATE CURRENT — AMPERES
- - - SCREEN CURRENT — AMPERES
- · - · - GRID CURRENT — AMPERES



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**EIMAC 4CW10,000B**  
**TYPICAL**  
**CONSTANT CURRENT**  
**CHARACTERISTICS**  
 SCREEN VOLTAGE - 1250 VOLTS

— PLATE CURRENT — AMPERES  
 - - - SCREEN CURRENT — AMPERES  
 - - - GRID CURRENT — AMPERES



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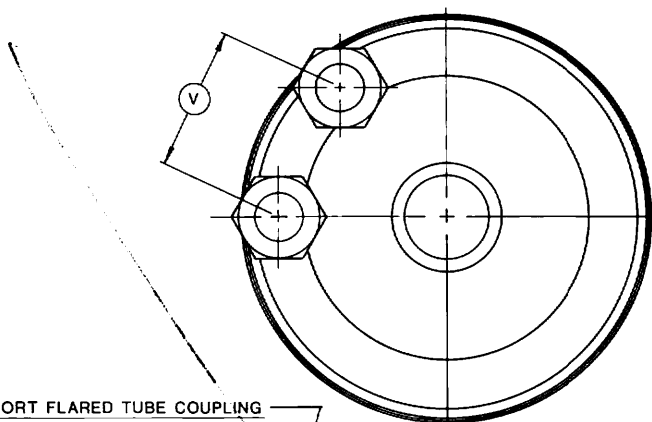
4CW10,000B  
 EIMAC

CURVE 4223

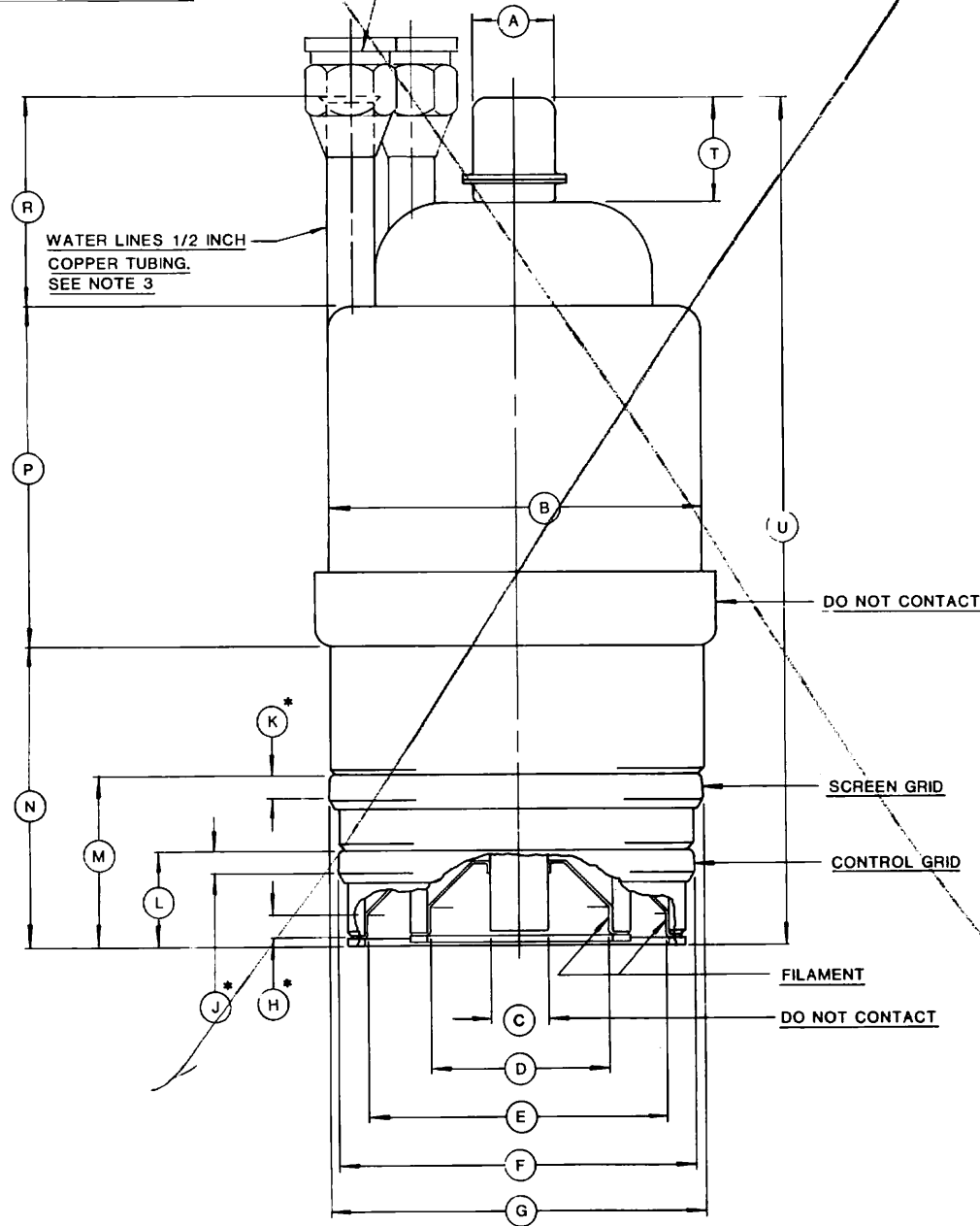


4CW10,000B

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN	MAX	REF	MIN	MAX	REF
A	.860	.890		21.844	22.608	
B	2.870	3.125		72.898	79.375	
C	.800	.780		15.240	19.804	
D	1.898	1.938		48.158	49.174	
E	3.133	3.173		79.678	80.694	
F	3.792	3.832		96.317	97.333	
G	3.980	4.020		101.09	102.11	
H	.188			4.719		
J	.188			4.719		
K	.188			4.719		
L	.988	1.050		25.044	26.670	
M	1.764	1.826		44.805	46.380	
N	3.028	3.278		76.911	83.261	
P	3.454	3.704		87.731	94.082	
R	1.837	2.187		46.200	55.650	
T	1.011	1.135		25.680	28.829	
U	8.717	9.117		221.41	231.67	
V	1.375	1.625		34.925	41.275	



1/2 INCH SHORT FLARED TUBE COUPLING  
 NUT, 3/4-16 UNF-2B THD.  
 ( MS 39166-7 OR EQUIV. )



NOTES:

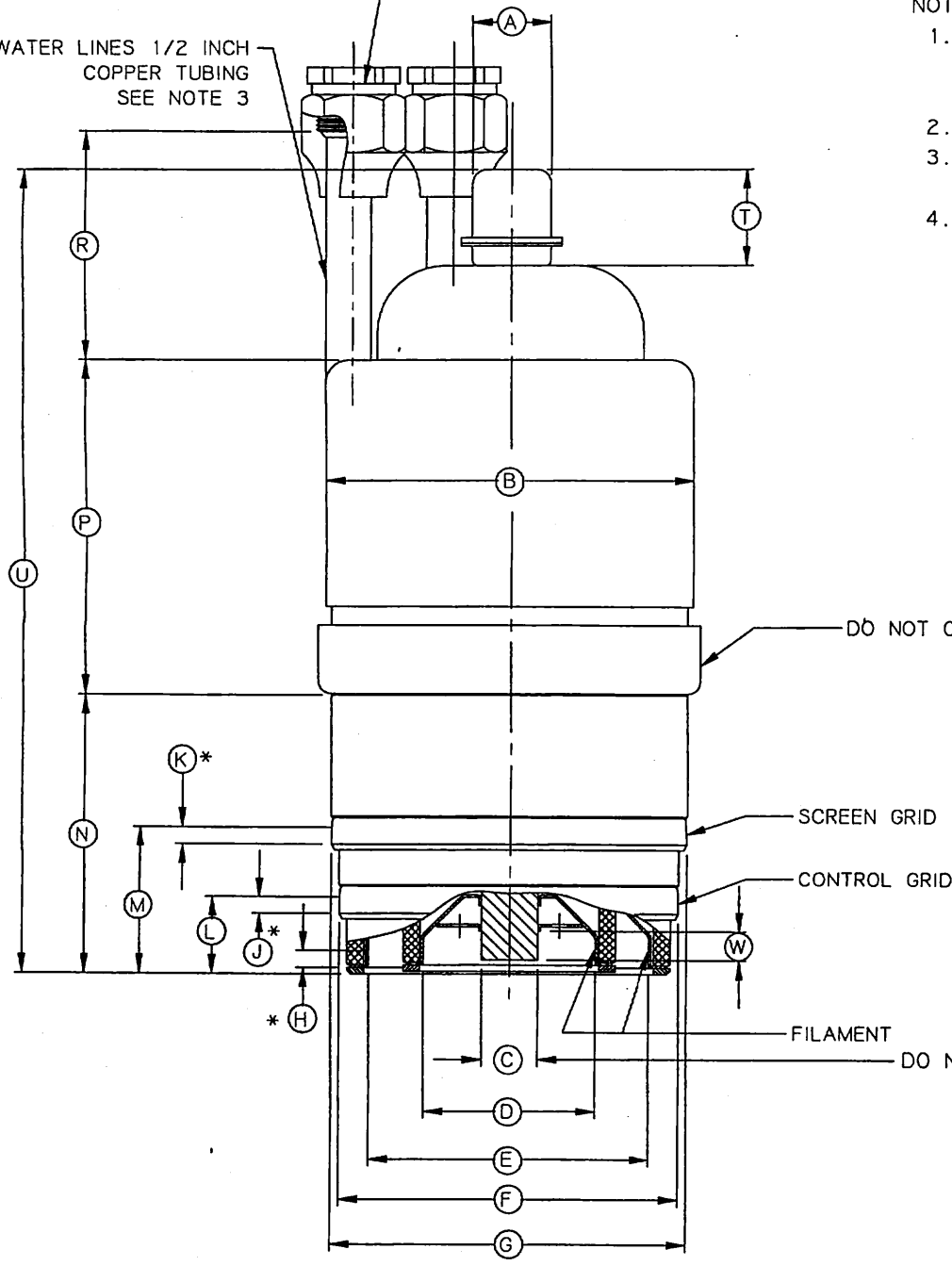
- 1 REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
- 2 (\*) CONTACT SURFACE
- 3 EITHER FITTING CAN BE USED AS INLET OR OUTLET

△ NOTES

DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	.860	.890		21.84	22.61	
B	4.050	4.110		102.87	104.39	
C	.615	.625		15.62	15.87	
D	1.898	1.936		48.16	49.17	
E	3.133	3.173		79.58	80.59	
F	3.792	3.832		96.32	97.33	
G	3.980	4.020		101.08	102.11	
H	.188			4.72		
J	.188			4.72		
K	.188			4.72		
L	.986	1.050		25.04	26.67	
M	1.764	1.826		44.80	46.38	
N	3.028	3.278		76.91	83.26	
P	3.600	3.850		91.44	97.79	
R	2.387	2.637		60.83	66.98	
T	1.011	1.135		25.66	28.83	
U	8.717	9.117		221.4	231.57	
V	1.975	2.205		50.16	56.01	
W	.275			6.98		

1/2 INCH SHORT FLARED TUBE COUPLING NUT, 3/4-16 UNF-2B THREADS (MS 39166-7 OR EQUIV.)


WATER LINES 1/2 INCH COPPER TUBING SEE NOTE 3



NOTES:

1. REF. DIMS. ARE FOR INFO. ONLY AND ARE NOT FOR INSPECTION PURPOSES.
2. (\*) CONTACT SURFACE.
3. LABEL RED INK ON TOP OF COOLER AS SHOWN.
4. DIM. "W" IS MIN. STRAIGHT SURFACE.

4CW10,000B

LTR	DESCRIPTION OF CHANGE	SCO	DATE	BY
K	REDRAWN ON CAD		26 10 04/06/01	SM/KA
<p>  <small>This document is the property of Eimac and shall not be copied, reproduced, used in the manufacture of parts or apparatus or disclosed to others without written permission.</small> </p>				
PART NO.		4CW10,000B		
OUTLINE				
ELECTRON DEVICE				
DRAWN S. SINGH 04/06/01 ENGR APPR		SCALE: NONE		NO.
CHK'D K. ALTSEN 04/09/01 SUPERSEDES		FILE PATH: L:\OUTLINE\4CW10,000B		4CW10,000B K