HIGH-MU WATER-COOLED POWER TRIODE 3CW5000H7

The EIMAC 3CW5000H7 is a ceramic/metal, water-cooled, high-mu triode for use as an amplifier, oscillator, or in voltage regulator applications. The maximum rated anode dissipation is 5000 watts.

The anode water jacket includes a mounting flange, and no socket is required since the grid terminates in another flange and the filament connection is made through flexible leads on the base.

Operation with zero grid bias in many applications offers circuit simplicity by eliminating the bias supply. Grounded-grid operation is attractive since a power gain of over 20 times can be obtained.

CHARACTERISTICS[1]

ELECTRICAL		
Filament: Thoriated Tungsten		
Voltage	7.5	V
Current at 7.5 Volts	50.5	A
Amplification Factor (average)	160	
Direct Interelectrode Capacitances (grounded filament)[2]		
Cin	38.0	pF
Cout	0.6	pF
Cgp	24.0	pF
Direct Interelectrode Capacitances (grounded grid)[2]		
Cin	38.0	pF
Cout	24.0	pF
Cpk	0.6	pF
Frequency of Maximum Ratings	30	MHz

MECHANICAL:	
Overall Dimensions:	
Length (including filament leads)	18.62 in; 47.29 cm
Diameter (anode mounting flange)	5.42 in; 13.77 cm
Weight (approx.)	7.5 lbs. 3.4 kg
Operating Position	Vertical, Base Up or Down
Maximum Operating Temperature:	
Ceramic/Metal Seals & Envelope	250° C
Filament Lead/Tube Base Junctions	150° C
Cooling	Water and Forced Air
Base	Special with Flying Leads

[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 MPP Eimac Operation 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 @7.5 Volts	**48.0**	**53.0**	**A**
Interelectrode Capacitances [1] (grounded filament connection)			
Cin	**30.0**	**45.0**	**pF**
Cout	**---**	**1.0**	**pF**
Cgp	**20.0**	**28.0**	**pF**
Interelectrode Capacitances [1] (grounded grid connection)			
Cin	**30.0**	**45.0**	**pF**
Cout	**20.0**	**28.0**	**pF**
Cpk	**---**	**1.0**	**pF**
Zero Bias Plate Current (E_b = 5000 volts)	**0.36**	**0.52**	**A**
Cut-off Bias (E_b = 5000 volts, I_b = 1.0 mAdc)	**---**	**-45.0**	**V**

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

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.

For information on this and other CPI products, visit our website at: **www.cpii.com**, or contact: CPI MPP, Eimac Operation, 607 Hansen Way, Palo Alto, CA 94303

TELEPHONE: (800) 414-8823. **FAX:** (650) 847-3795 | **EMAIL:** powergrid@cpii.com

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HIGH-MU WATER-COOLED POWER TRIODE 3CW5000H7

RADIO FREQUENCY LINEAR AMPLIFIER
CATHODE DRIVEN Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC ANODE VOLTAGE	5000	Volts
DC ANODE CURRENT	2.5	Amperes
ANODE DISSIPATION	5000	Watts
GRID DISSIPATION	225	Watts

[1] Bias voltage may be required. [2] Approximate value.

TYPICAL OPERATION (frequencies to 30 MHz:
Class AB_2, Peak Envelope or Modulation, Crest Conditions

ANODE VOLTAGE	4800	4800	4900	kVdc
ZERO-SIGNAL ANODE CURRENT[1]	0.35	0.35	0.36	Adc
SINGLE-TONE ANODE CURRENT	1.68	2.00	2.25	Adc
SINGLE-TONE GRID CURRENT[2]	0.46	0.60	0.65	Adc
DRIVING POWER[2]	293	410	535	W
ANODE DISSIPATION	2275	2775	2775	W
SINGLE-TONE ANODE OUTPUT POWER	6000	7266	8250	W
RESONANT LOAD IMPEDANCE	1720	1425	1308	Ω
DRIVING IMPEDANCE	50.0	46.3	49.2	Ω

RADIO FREQUENCY LINEAR AMPLIFIER
CATHODE DRIVEN Class AB_2

ABSOLUTE MAXIMUM RATINGS:

DC ANODE VOLTAGE	5000	Volts
DC ANODE CURRENT	2.5	Amperes
ANODE DISSIPATION	5000	Watts
GRID DISSIPATION	225	Watts

[1] Bias voltage may be required. [2] Approximate value.

TYPICAL OPERATION (Frequencies to 30 MHz)
Class AB_2, Grid Driven, Carrier Conditions

ANODE VOLTAGE	4000	4900	Vdc
ZERO SIGNAL ANODE CURRENT[1]	0.25	0.36	Adc
DC ANODE CURRENT	0.74	1.23	Adc
DC GRID CURRENT[1]	0.13	0.17	Adc
PEAK RF GRID VOLTAGE[2]	85.0	125	v
DRIVING POWER[2]	11.5	21.2	W
ANODE DISSIPATION	1830	3840	W
CARRIER PLATE OUTPUT POWER	1130	2200	W
RESONANT LOAD IMPEDANCE	1750	1100	Ω
PEAK RF ANODE VOLTAGE	2000	2200	v

RADIO FREQUENCY POWER AMPLIFIER

Class C Telegraphy or FM, Cathode Driven, (Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC ANODE VOLTAGE	5000	Volts
DC ANODE CURRENT	2.5	Amperes
ANODE DISSIPATION	5000	Watts
GRID DISSIPATION	225	Watts

[1] Approximate value. [2] Output circuit and filter loss of 10% assumed.

TYPICAL OPERATION (Frequencies to 30 MHz)

ANODE VOLTAGE	4900	kVdc
GRID VOLTAGE	-50	Vdc
ANODE CURRENT	2.16	Adc
GRID CURRENT[1]	0.61	Adc
PEAK RF CATHODE VOLTAGE[1]	300	v
CALCULATED DRIVING POWER[1]	691	W
ANODE DISSIPATION	2315	W
USEFUL OUTPUT POWER[2]	7500	W

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_2 , Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (Per tube)**:**

DC ANODE VOLTAGE	5000	V
DC ANODE CURRENT	2.5	A
ANODE DISSIPATION	5000	W
GRID DISSIPATION	225	Watts

[1] Approximate value. [3] Bias Voltage may be required.

[2] Per Tube

TYPICAL OPERATION (Two Tubes)

ANODE VOLTAGE	4000	4900	Vdc
ZERO-SIGNAL ANODE CURRENT[1,3]	0.50	0.72	Adc
MAX. SIGNAL ANODE CURRENT	3.58	4.72	Adc
MAX. SIGNAL GRID CURRENT[1]	0.58	1.10	Adc
PEAK AF GRID VOLTAGE[2]	190	250	v
DRIVING POWER[1]	115	276	W
MAX. SIGNAL ANODE DISSIPATION	3820	6618	kW
ANODE OUTPUT POWER	10.5	16.4	kW
LOAD RESISTANCE (anode to anode)	2720	2352	Ω

VOLTAGE REGULATOR SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC ANODE VOLTAGE	10,000	Vdc
DC ANODE CURRENT	4.0	Adc
PULSED PLATE CURRENT	10.0	a
ANODE DISSIPATION (See note)	5000	W
GRID DISSIPATION (See note)	225	W

NOTE: The equipment designer or user must assure that rated dissipation values are not exceeded. In continuous operation (Class A) element dissipation is simply the product of voltage and current at the operating conditions. In pulsed operation the element dissipation is basically the product of voltage, current and duty factor, though pulse shape and circuit conditions may effect actual dissipation values.

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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 anode current at the specified bias and anode 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 current. The grid current which results when the desired anode current is obtained is incidental and varies 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 grid voltage is applied.

APPLICATION

MECHANICAL

HANDLING – This product contains a thoriated-tungsten 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. The tube should be placed on a soft mat when it is out of the carton and the tube must be handled carefully to avoid any sharp blows which may cause broken filaments. Ceramic surfaces should be kept clean at all times therefore one should avoid touching ceramic parts when handling tubes and if necessary they may be cleaned with alcohol.

MOUNTING – The tube must be operated vertically, base down or up at the convenience of the circuit 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 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. When the tube is mounted in the normal position with the anode down the water must flow in the direction marked on the anode radiator. If the tube is mounted with the anode up, cooling water must flow in the opposite direction. This will prevent the formation of an air bubble in the anode cooler body which could result in an overheated anode.

COOLING - With an anode dissipation of 5000 watts and with an incoming water temperature of 50°C maximum, 7.7 gpm of cooling water must be supplied to the anode cooling jacket. Outlet water temperature from the cooling jacket should never exceed 70°C, and water pressure on the jacket should not exceed 60 psi. The pressure drop across the anode cooling jacket itself, with a water flow of 7.7 gpm, will be approximately 6 psi. The grid-terminal contact surface and adjacent ceramic must be cooled by forced air, with quantity, velocity and direction adjusted to limit the maximum seal temperature to less than 250°C.

The filament leads of the 3CW5000H7 are attached to the tube with soft solder and care must therefore be taken to supply sufficient forced-air cooling to this area of the tube to maintain temperatures below 150°C to avoid melting or loosening of these leads.

Additional air should be directed around the envelope and grid-flange area to assure adequate cooling of these seal areas and the envelope.

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 about 50 KΩ/cm^3, and preferably above 250 KΩ/cm^3. A relative water resistance check can be made continuously by measuring the leakage current which will bypass a short section of insulating hose column if metal nipples or fittings are used as electrodes.

Both air and water flow must be supplied before or simultaneously with the application of electrode voltages, including the filament, and may be removed simultaneously with them. Where long life and consistent performance are factors, cooling in excess of minimum requirements is normally beneficial.

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. These ratings are limiting values outside which 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.

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FILAMENT OPERATION - The filament voltage, as measured at the filament terminals, should be 7.5 volts, with maximum allowable variations due to the line fluctuations of from 7.12 to 7.87 volts.

INTERLOCKS - An interlock device should be provided to insure that cooling air flow is established before application of electrical power, including the heater. The circuit should be so arranged that rf drive cannot be applied in the absence of normal anode voltage.

INPUT CIRCUIT - When operated as a grounded-grid rf amplifier, the use of a matching network in the cathode circuit is recommended. For best results with a single-ended amplifier, and depending on the application, it is suggested the cathode tuned circuit operate with a "Q" of 5 or more.

RF 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, and the published OSHA (Occupational Safety and Health Administration) or other local recommendations to limit prolonged exposure of rf radiation should be followed. It is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many Eimac power tubes, such as this, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power and its associated circuitry - the more power involved the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier itself.

HIGH FREQUENCY OPERATION - the 3CW5000H7 is usable to 110 MHz, with a anode voltage reduction to 4000 volts, if the rf connections to the filament contacts are properly made directly at the base of the tube.

FAULT PROTECTION - In addition to normal cooling interlocks and anode and grid over-current interlocks, it is good practice to protect the tube from internal damage which could result from potential arcing at high anode voltage. In all cases some protective resistance, at least 10 Ohms, should be used in series with the tube's anode to absorb power supply stored energy in case an arc should occur. An electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, may be required. The test 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 AGW copper wire. The wire will remain intact if protection is adequate. Eimac application Bulletin #17, FAULT PROTECTION, contains considerable detail and is available upon request.

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 the 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 in a special shielded fixture. 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 mounting which represents approximate final layout if capacitance values are highly significant in the design.

HIGH VOLTAGE - The 3CW5000H7 operates 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.

HOT SURFACES - Air-cooled surfaces 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.

SPECIAL APPLICATIONS - If it is desired to operate this tube under conditions widely different from those given here, contact the Application Engineering Dept., CPI MPP Eimac Operation for information and recommendations.

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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 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.

Please review the detailed Operating Hazards Sheet enclosed with each tube, or request a copy from CPI Microwave Power Products, Eimac Operation.

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.

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

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.

MATERIALS 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).

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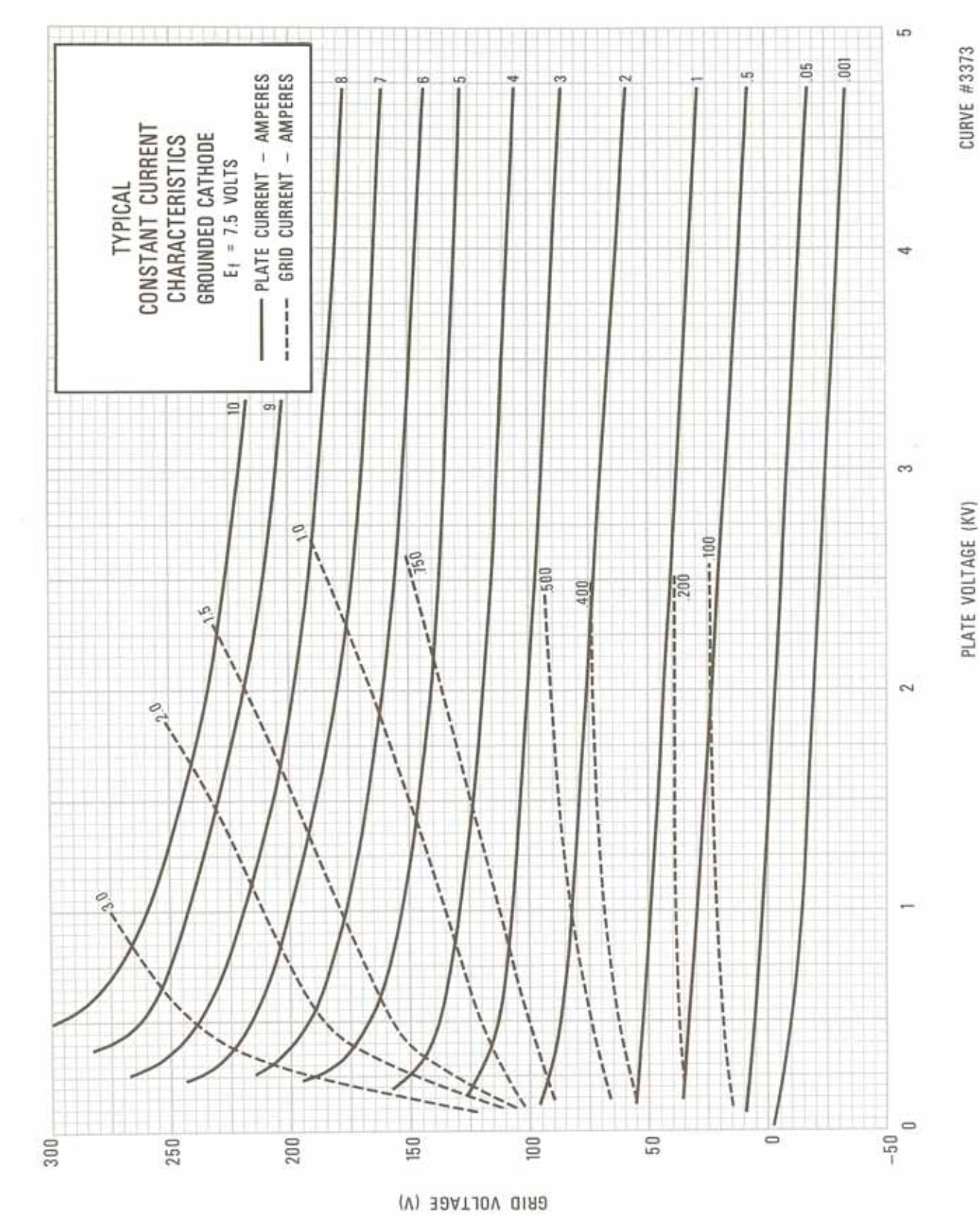

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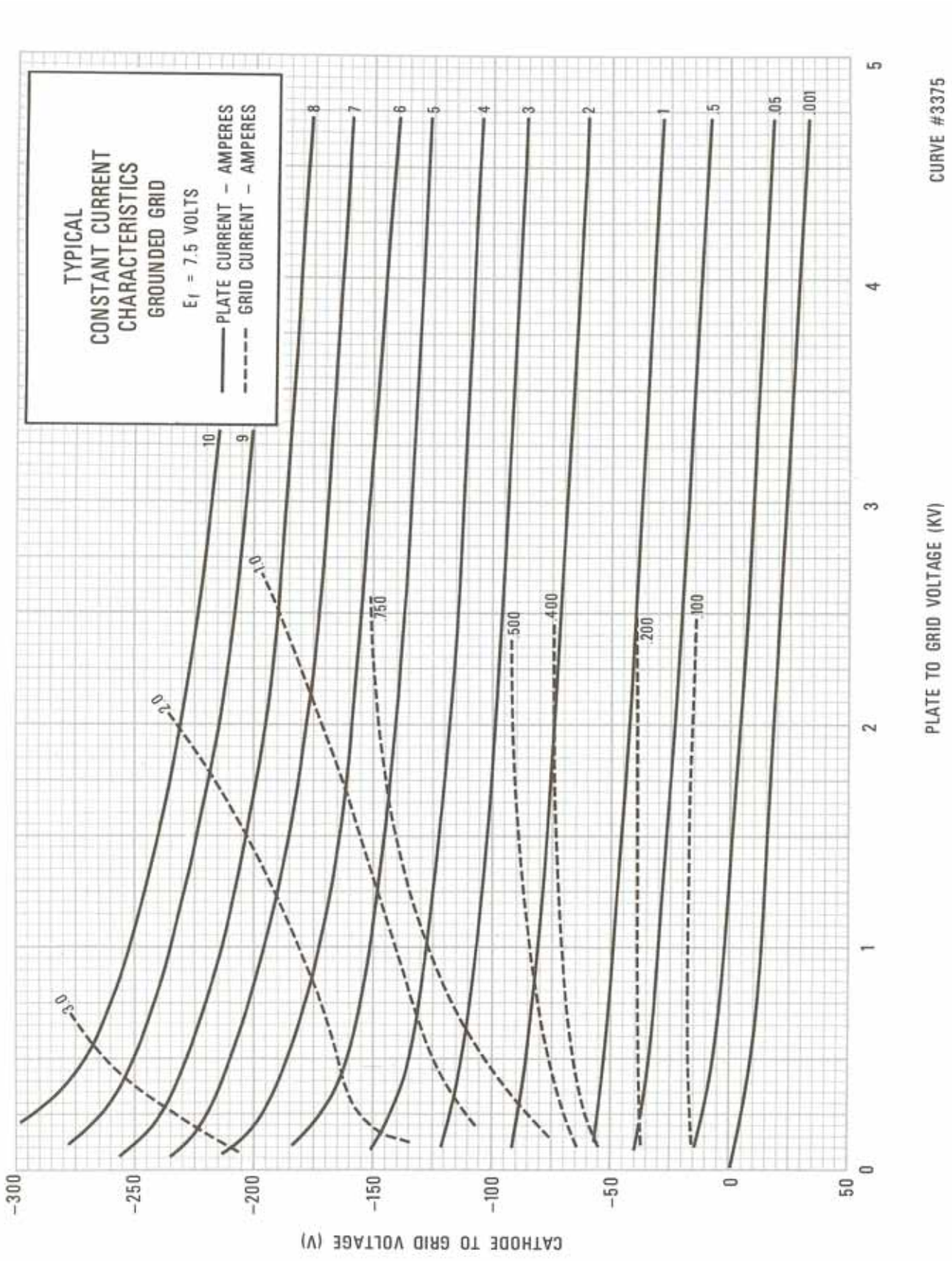

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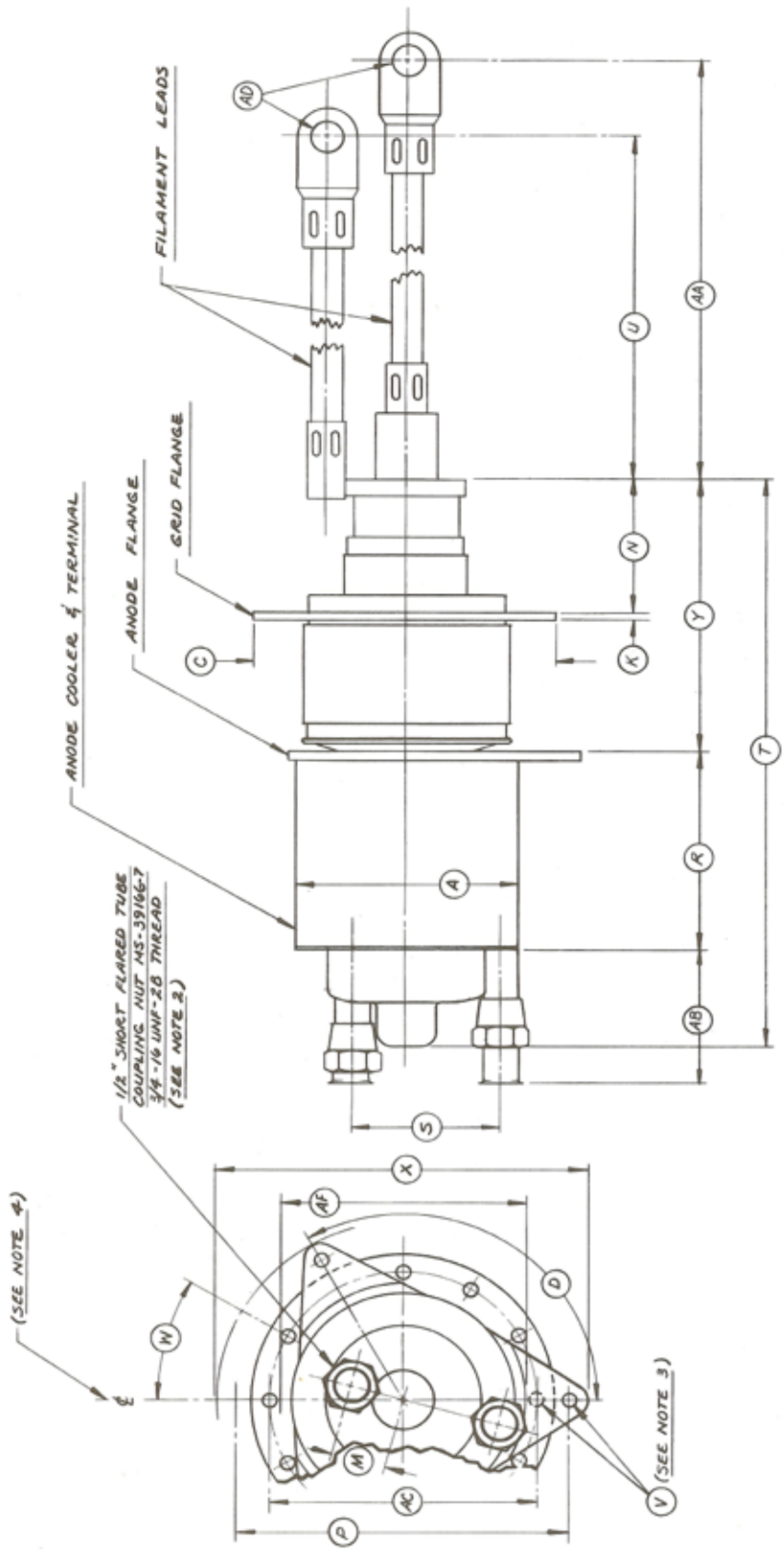
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.235	3.265		82.17	82.93	
C	4.230	4.250		107.44	107.95	
D	118°	122°		118°	122°	
K			.125			3.17
M			.800			20.32
N	1.703	1.953		43.26	49.61	
P	4.615	4.635		117.22	117.73	
R	2.625	2.875		66.67	73.02	
T	7.750	8.750		196.85	222.25	
U	7.937	8.437		201.60	214.30	
V			.250			6.35
W	29°	31°		29°	31°	
X	5.330	5.420		135.38	137.67	
Y	3.875	4.250		98.42	107.95	
AA	8.937	9.437		227.00	239.70	
AB			2.000			50.40
AC	3.855	3.885		97.92	98.68	
AD			.390			9.91
AF			3.625			92.07
S			2.155			54.74



NOTES:
1. REF. DIM. ARE FOR INFO ONLY & ARE NOT REQ'D FOR INSP. PURPOSES.
2. EITHER FITTING CAN BE USED AS INLET OR OUTLET.
3. 3 HOLES IN ANODE FLANGE, 12 HOLES IN GRID FLANGE.
4. MTG. FLANGE, FIL. LEADS & WATER FITTINGS ARE TO BE ORIENTED AS SHOWN.