TECHNICAL DATA

3CW5000A7
3CW5000F7

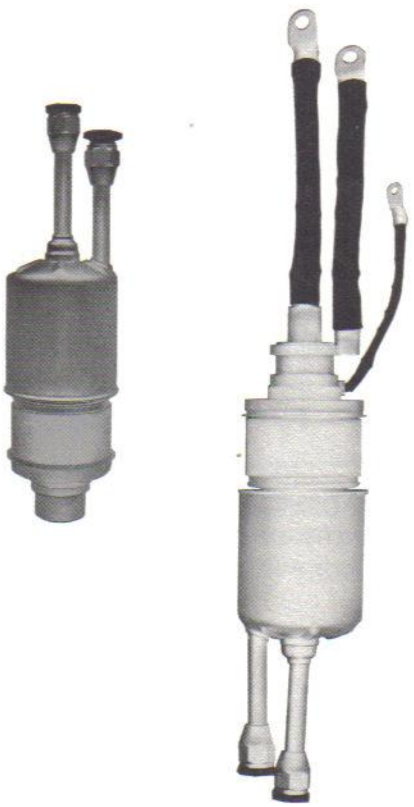
HIGH-MU WATER-COOLED POWER TRIODES

The EIMAC 3CW5000A7 and 3CW5000F7 are ceramic/metal, water-cooled, high-mu triodes for use as an amplifier, oscillator, or modulator, or in voltage regulator applications. Their maximum rated anode dissipation is 5000 watts.

These tubes are water-cooled versions of the air-cooled 3CX3000A7 and 3CX3000F7.

The 3CW5000A7 sockets coaxially and has a low-inductance cylindrical filament-stem structure which readily becomes part of a linear filament tank circuit for VHF operation. The 3CW5000F7 tube is identical except for the addition of flexible leads on the base for grid and filament connections, which can simplify socketing in low-frequency operations.

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.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated-tungsten	
Voltage	7.5 V
Current @ 7.5 V (3CW5000A7)	51.5 A
(3CW5000F7)	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

[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. 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.

Frequency of Maximum Rating: (3CW5000A7)	110 MHz
(3CW5000F7)	30 MHz

MECHANICAL

Maximum Overall Dimensions:	
Length (3CW5000A7)	12.625 in; 32.07 cm
(3CW5000F7, incl. fil. leads)	22.062 in; 56.04 cm
Diameter (both types)	3.625 in; 9.22 cm
Operating Position	Vertical, base up or down
Net Weight: (3CW5000A7) Approximate	4.8 lb; 2.2 kg
(3CW5000F7) Approximate	5.5 lb; 2.5 kg
Cooling	Water and Forced Air
Base (3CW5000A7)	Special Coaxial
(3CW5000F7)	Special with Flying Leads
Maximum Operating Temperature:	
Envelope and Ceramic/Metal Seals	250°C
Filament Lead/Tube Base Junctions (3CW5000F7)	150°C

RADIO FREQUENCY LINEAR AMPLIFIER CATHODE DRIVEN
Class AB 2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE 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

Plate Voltage	4800	4800	4900	Vdc
Zero-Signal Plate Current[1]	0.35	0.35	0.36	Adc
Single-Tone Plate 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
Plate Dissipation	2275	2775	2775	W
Single-Tone Plate 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 GRID DRIVEN
Class AB 2

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE 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

Plate Voltage	4000	4900	Vdc
Zero-Signal Plate Current[1]	0.25	0.36	Adc
DC Plate 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
Plate Dissipation	1830	3840	W
Carrier Plate Output Power	1130	2200	W
Resonant Load Impedance	1750	1100	Ω
Peak rf Plate Voltage	2000	2200	v

RADIO FREQUENCY POWER AMPLIFIER
Class C Telegraphy or FM, Cathode Driven
(Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	225	WATTS

TYPICAL OPERATION (Frequencies to 110 MHz for 3CW5000A7, to 30 MHz for 3CW5000F7)

Plate Voltage	4900	Vdc
Grid Voltage	-50	Vdc
Plate Current	2.16	Adc
Grid Current[1]	0.61	Adc
Peak rf Cathode Voltage[1]	300	v
Calculated Driving Power[1]	691	W
Plate Dissipation	2315	W
Useful Output Power[2]	7500	W

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

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB_2, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	5000	VOLTS
DC PLATE CURRENT	2.5	AMPERES
PLATE DISSIPATION	5000	WATTS
GRID DISSIPATION	225	WATTS

1. Approximate value.
2. Per tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	4000	4900	Vdc
Zero-Signal Plate Current[1,3]	0.50	0.72	Adc
Max. Signal Plate 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 Plate Dissipation	3820	6618	W
Plate Output Power	10.5	16.4	kW
Load Resistance (plate to plate)	2720	2352	Ω

3. Bias voltage may be required.

VOLTAGE REGULATOR SERVICE

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000	Vdc
DC PLATE CURRENT	4.0	Adc
PULSED PLATE CURRENT	10.0	a
PLATE DISSIPATION (See note)	5,000	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.

NOTE: TYPICAL OPERATION data are obtained by measurement or calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, 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 current. The grid current which results when the desired plate 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.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current @ 7.5 volts (3CW5000A7)	49.0	54.0	A
(3CW5000F7)	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.

APPLICATION

MECHANICAL

MOUNTING - The 3CW5000A7 and 3CW5000F7 must be mounted vertically, base down or up at the convenience of the circuit designer. The filament connections to the 3CW5000A7 should be made through spring collets. These are available from EIMAC with the following part numbers:

149575	Inner line collet
149576	Outer line collet

Reasonable care should be taken that these collets do not impart undue strain to the terminals or the base of the tube.

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 jacker 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 stem structure also requires forced-air cooling. A minimum of 6 cfm should be directed into the space between the inner and outer filament contacting surfaces.

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 KΩ/cm3, and preferably above 250 KΩ/cm3. 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

FILAMENT OPERATION - The filament voltage, as measured at the filament terminals, should be 7.5 volts, with maximum allowable variations due to line flucuations 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 plate 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.

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.

Many EIMAC power tubes, such as these, are specifically designer to generate or amplify radio frequency powerl There may be a relatively strong rf field in the general proximity of the power tube 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 unit itself.

FAULT PROTECTION - In addition to normal cooling airflow interlock and plate over-current interlock it is good practice to protect the tube from internal damage which could result from occasional plate arcing at high plate voltage.

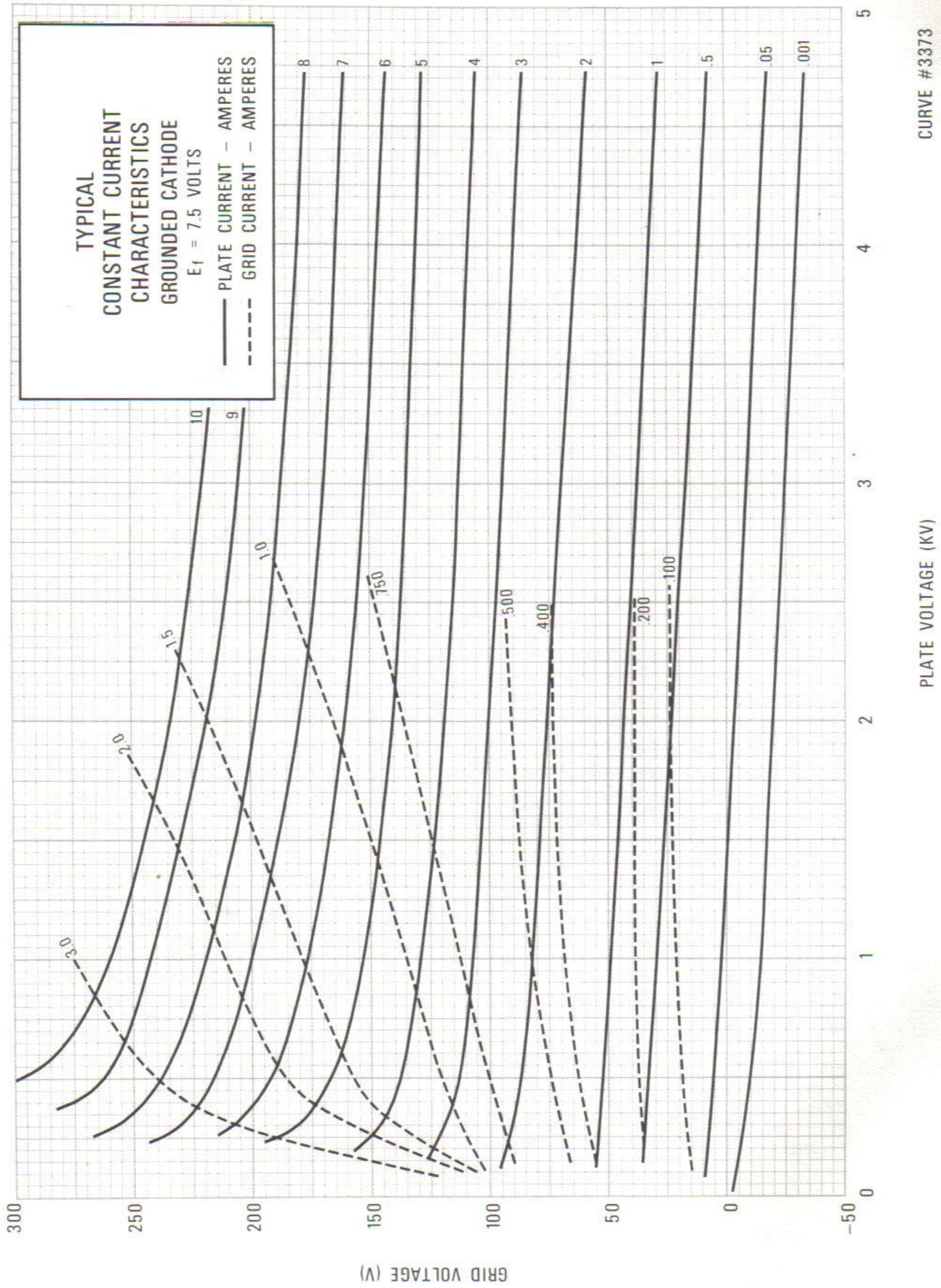
In all cases some protective resistance, at least 10 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a plate arc should occur.

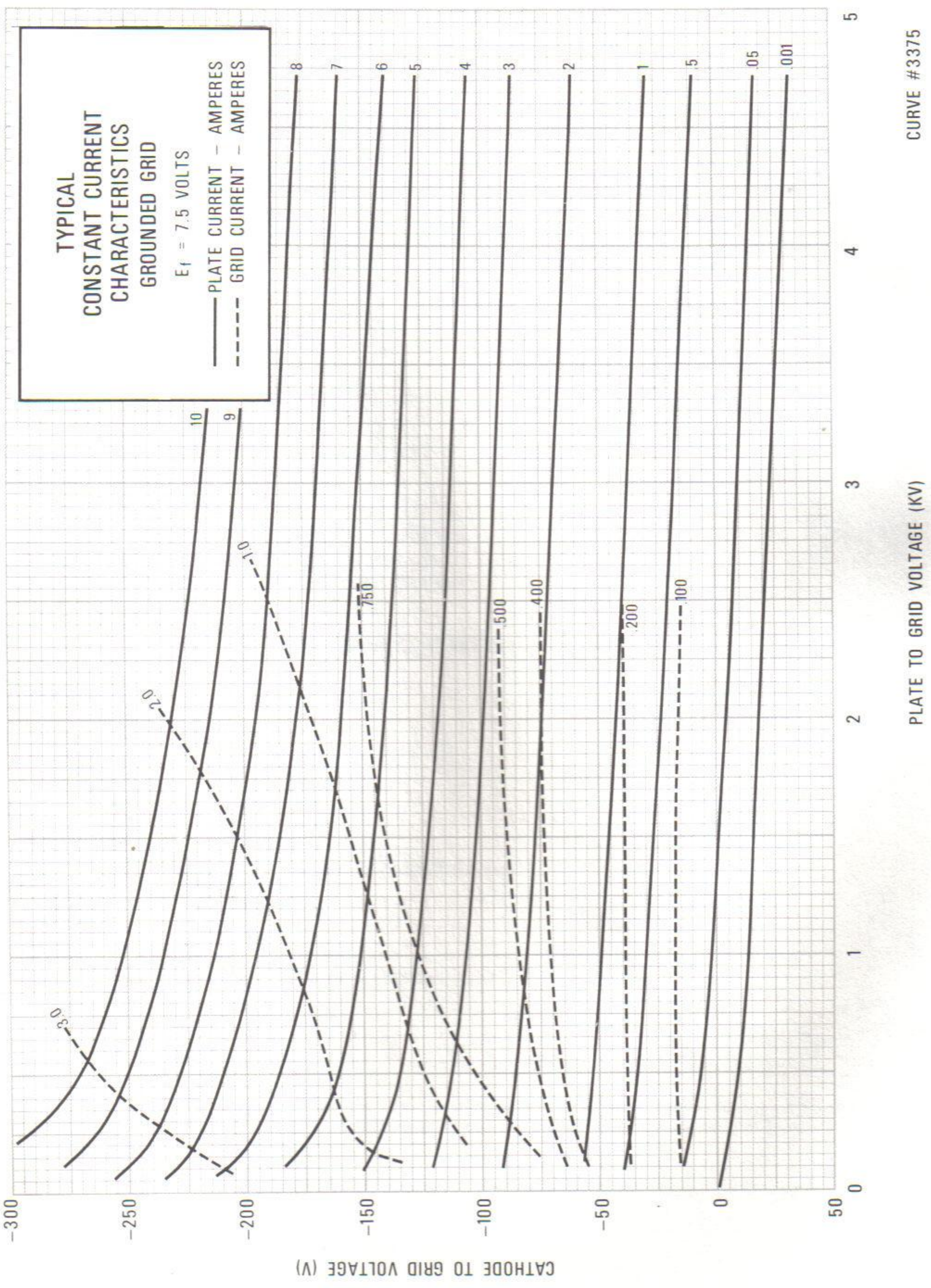
HIGH VOLTAGE - Normal operating voltages used with these tubes are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage 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.

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. 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.

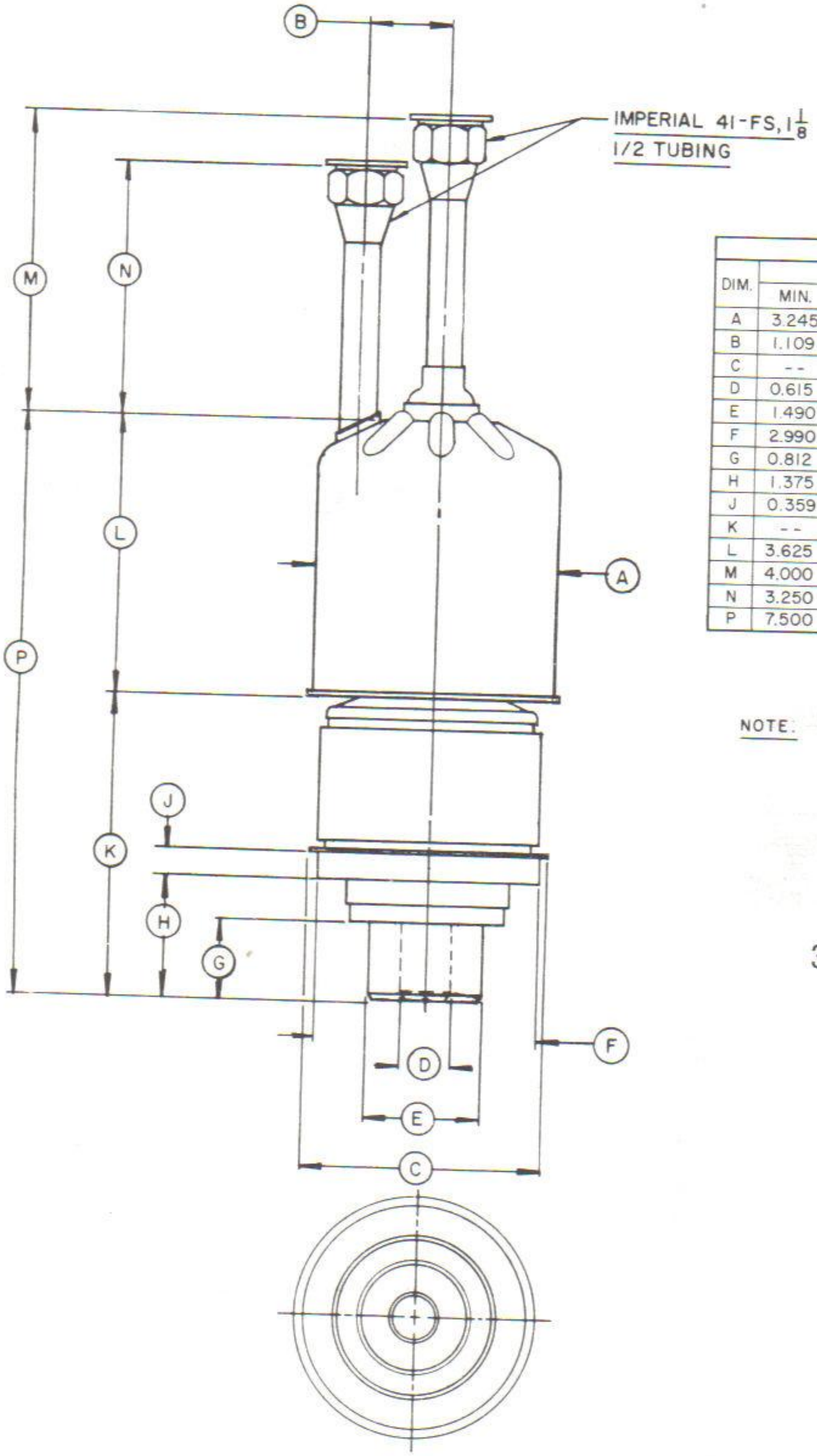
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

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


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED CATHODE
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
10
9
8
7
6
5
4
3
2
1
.5
.05
.001
3.0
2.0
1.5
1.0
.750
.500
.400
.200
.100
GRID VOLTAGE (V)
300
250
200
150
100
50
0
–50
PLATE VOLTAGE (KV)
0
1
2
3
4
5
CURVE #3373


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
GROUNDED GRID
E_f = 7.5 VOLTS
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
10
9
8
7
6
5
4
3
2
1
.5
.05
.001
3.0
2.0
1.0
.750
.500
.400
.200
.100
PLATE TO GRID VOLTAGE (KV)
0
1
2
3
4
5
CATHODE TO GRID VOLTAGE (V)
-300
-250
-200
-150
-100
-50
0
50

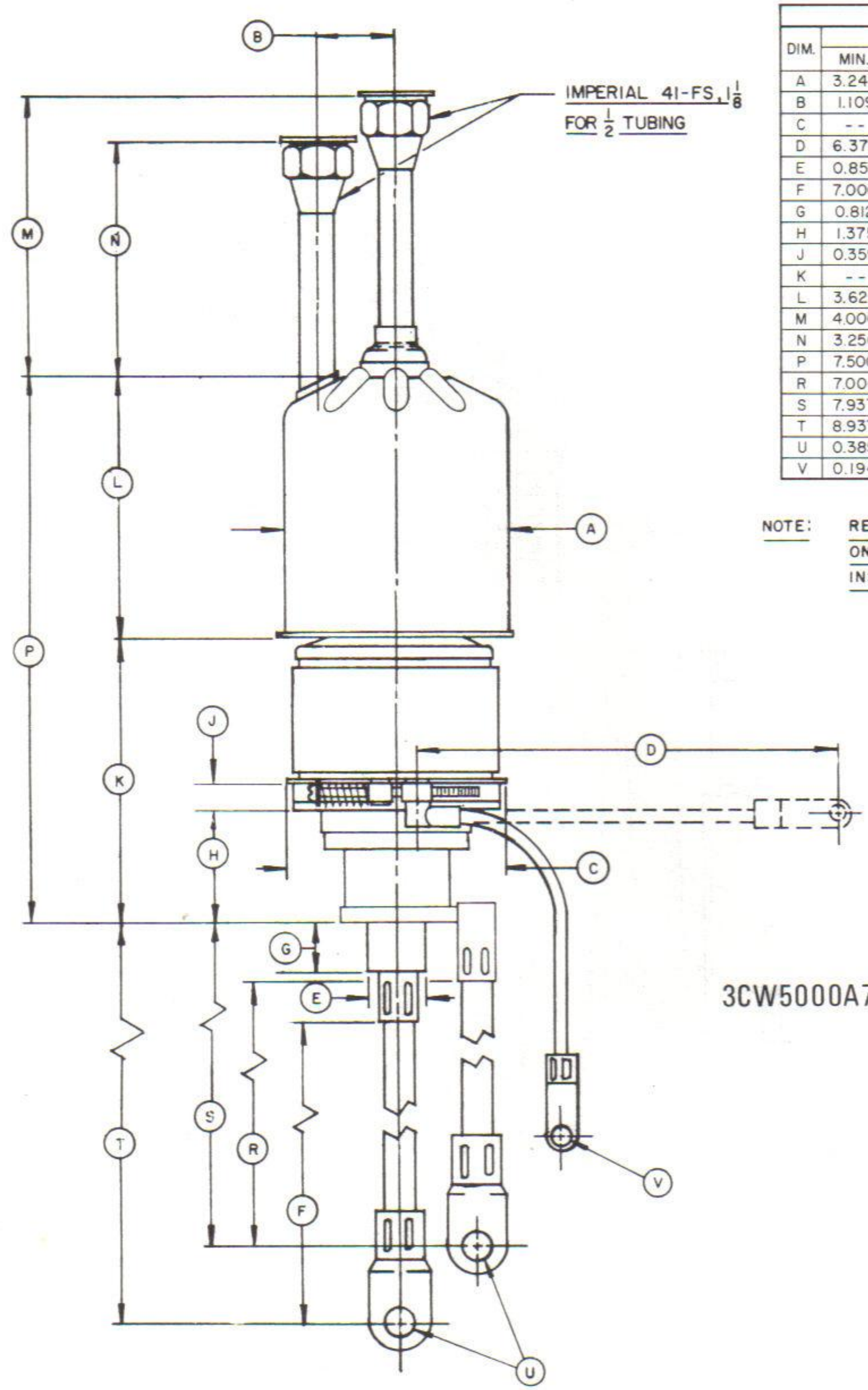
CURVE #3375



DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.245	3.255	--	82.42	82.68	--
B	1.109	1.141	--	28.17	28.98	--
C	--	3.625	--	--	92.08	--
D	0.615	0.635	--	15.62	16.13	--
E	1.490	1.510	--	37.85	38.35	--
F	2.990	3.010	--	75.95	76.45	--
G	0.812	0.938	--	20.62	23.83	--
H	1.375	1.625	--	34.93	41.28	--
J	0.359	0.422	--	9.12	10.72	--
K	--	--	3.599	--	--	91.41
L	3.625	3.875	--	92.08	98.43	--
M	4.000	4.500	--	101.60	114.30	--
N	3.250	3.750	--	82.55	95.25	--
P	7.500	8.125	--	190.50	206.38	--

NOTE: REF DIMS ARE FOR INFO ONLY AND NOT REQ. FOR INSPECTION PURPOSES.

3CW5000F7



3CW5000A7

DIMENSIONAL DATA						
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.245	3.255	- -	82.42	82.68	- -
B	1.109	1.141	- -	28.17	28.98	- -
C	- -	3.625	- -	- -	92.08	- -
D	6.375	6.625	- -	161.93	168.28	- -
E	0.859	0.890	- -	21.82	22.61	- -
F	7.000	7.500	- -	177.80	190.50	- -
G	0.812	0.938	- -	20.62	23.83	- -
H	1.375	1.625	- -	34.93	41.28	- -
J	0.359	0.422	- -	9.12	10.72	- -
K	- -	- -	3.599	- -	- -	91.41
L	3.625	3.875	- -	92.08	98.43	- -
M	4.000	4.500	- -	101.60	114.30	- -
N	3.250	3.750	- -	82.55	95.25	- -
P	7.500	8.125	- -	190.50	206.38	- -
R	7.000	7.500	- -	177.80	190.50	- -
S	7.937	8.437	- -	201.60	214.30	- -
T	8.937	9.437	- -	226.99	239.70	- -
U	0.385	0.395	- -	9.78	10.03	- -
V	0.194	0.200	- -	4.93	5.08	- -

NOTE: REF. DIMS ARE FOR INFO ONLY AND NOT REQ. FOR INSPECTION PURPOSES.