TECHNICAL DATA

8961
3CX400U7

HIGH-MU UHF TRANSMITTING TRIODE

The EIMAC 3CX400U7 is designed for use up to 1000 MHz as a CW, pulse or linear amplifier, particularly in the 806 to 970 MHz portion of the spectrum allocated to land mobile, paging and Amateur radio services.

The 3CX400U7 is a ceramic/metal high-mu triode designed with beam-forming cathode and control grid geometry, having an external anode rating of 400 watts of dissipation with forced-air cooling.

The combination of an amplification factor of over 200 and minimum control grid current interception provides high power gain in cathode-driven (grounded grid) amplfiers. Coaxial terminals and continuous cone-shaped conductors for the grid and cathode allow the lowest possible inductance between these tube elements and the cavity. The heater terminals are separate from the cathode.

Over 200 watts of useful CW rf power at 900 MHz may be obtained with better than 33% efficiency and more than 10 dB of gain. Cavity assemblies are available from Varian EIMAC for operation in the range from 850 MHz to 970 MHz. Tube terminal collets are also available.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide-coated, Unipotential		
Heater Voltage, Nominal (see derating data for UHF use)	6.3 ± 0.3	V
Heater Current, at 6.3 volts	3.3	A
Cathode-Heater Potential, Maximum	± 150	V
Transconductance, Average (Ib = 250 mAdc)	29,000	umhos
Amplification Factor, Average	240	
Direct Interelectrode Capacitances (grid grounded)[2]		
Cin	17.5	pF
Cout	5.5	pF
Cpk	0.03	pF
Ck-htr	6.0	pF
Frequency of Maximum Rating:		
CW	1000	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. 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

Net Weight (approximate)	5.5 Oz; 155 gms

357600 (Effective 20 Sept 82 - replaces 1 Aug 1979) Printed in U.S.A.
VA4562

Maximum Overall Dimensions:	
Length	2.51 In; 63.75 mm
Diameter	2.08 In; 52.83 mm
Maximum Operating Temperature:	
Ceramic/Metal Seals and Anode Core	250 °C
Cooling	Forced Air
Base	Special Coaxial

Recommended Contact Collets:

Tube Element	EIMAC Part No.
Inner Heater	008290
Outer Heater	008291
Cathode	008292
Grid	882931
Anode	154418

Cavity Assemblies Available from Varian EIMAC:

Frequency 850 to 870 MHz; Nominal Useful Power Output = 225 Watts	CV-2800
Frequency 875 to 935 MHz; Nominal Useful Power Output = 225 Watts (FM/CW) 320 Watts (SSB #)	CV-2805
Frequency 910 to 970 MHz; Nominal Useful Power Output = 190 Watts	CV-2810

Maximum duty = 50% is assumed.

RADIO FREQUENCY POWER AMPLIFIER
CLASS C CW, FM OR SSB SERVICE

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	2200	VOLTS
DC GRID BIAS VOLTAGE	-100	VOLTS
DC PLATE CURRENT	0.400	AMPERES
PLATE DISSIPATION	400	WATTS
GRID DISSIPATION	5	WATTS

* Will vary with installation or tube.
** PEP values for SSB.
# Maximum duty = 50% is assumed.
Delivered to the load.

TYPICAL OPERATION - Cathode Driven
Measured Data in EIMAC CV-2805 Cavity

	FM/CW	SSB #	
Heater Voltage (warmup or standby)	6.3	6.3	Vac
Heater Voltage (during operation)	4.8	6.3	Vac
Heater Current (at 6.3 volts) *	3.3	3.3	Aac
Plate Voltage	1500	2000	Vdc
Cathode Bias Voltage *	+12.0	+12.0	Vdc
Plate Current **	400	400	mAdc
Grid Current *	-10	-10	mAdc
Driving Power *,**	20	20	W
Useful Power Output ##	230	320	W
Power Gain *	10.6	12.0	dB
Bandwidth * (3 dB points)	6.5	6.5	MHz

RANGE VALUES FOR EQUIPMENT DESIGN	Min.	Max.	
Heater Current, at 6.3 volts	3.0	3.6	Aac
Cathode Warmup Time, at 6.3 volts	60	---	Sec
Interelectrode Capacitance (grounded grid)[1]			
Cin	16.6	18.4	pF
Cout	5.0	6.0	pF
Cpk	---	0.04	pF

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

TYPICAL OPERATION values are obtained by measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias and plate 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 current. The grid current which occurs when the desired plate current is obtained is incidental and may vary from tube to tube. This current variation causes no performance degradation providing the circuit maintains the correct voltage in the presence of the current variation.

APPLICATION

MECHANICAL

MOUNTING & SOCKETING - Part numbers of available EIMAC collets are listed on page 2. These collets may be soft-soldered to the appropriate UHF line or cavity elements. The collets provide low-inductance connections between tube and circuitry and also serve to draw off a portion of the heat released during normal operation.

When collets are assembled in a cavity configuration, the tube should be inserted with care, making sure it is well aligned with the various collets before pressure is applied to force it into place. When the tube is removed for any reason it should be pulled straight out with a slow but steady pressure in order to avoid sudden release which might result in uneven tube movement and consequent damage to the contact collets.

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.

FORCED-AIR COOLING - For operation at full power input, and assuming full power output, the anode dissipation of the 3CX400U7 tube will approach 400 watts. A minimum of 11.5 cfm of clean filtered air must pass through the tube cooling fins to maintain tube temperatures within ratings. Air flow must be in the base-to-anode direction. The pressure drop across the tube only with a flow of 11.5 cfm, will be approximately 0.20 inch of water.

The cooling data above is based on an incoming cooling air temperature of 50°C maximum at sea level and a maximum tube temperature of 225°C.

Clean filtered air should be used. With air flowing in the base-to-anode direction, and if the base contacting arrangement does not restrict flow around the base seals, additional base cooling provisions may not be required, but the designer is cautioned to verify this before a circuit design is finalized, by means of temperature sensitive paints which are available for this purpose, or other equivalent means.

Depending on the circuit or cavity design, allowances must also be made for other losses in the air system, in order to always assure sufficient air flow for tube cooling. The designer is also cautioned that it is not good practice to operate at, or very close to, the absolute maximum temperature ratings for the metal/ceramic seals. Where long life and consistent performance are factors, cooling in excess of the minimum requirements is normally beneficial.

INTERLOCKING PROTECTION - Protective interlocking should be provided so that if forced-air cooling fails for any reason, or falls below the minimum allowable, all voltages will be removed from the tube, including rf drive and the heater supply. Conversely, it should not be possible to apply any voltages to the tube, including its heater, unless an adequate supply of forced air is flowing through the cavity.

ELECTRICAL

GENERAL OPERATION - For efficient operation at most power levels, bias voltage is required. A convenient means of obtaining bias voltage is with a cathode resistor, which may be a fixed value, or a wire-would variable if a simple power-output control is desirable. For linear amplifier service, zener diode(s) should be used.

For monitoring of operating conditions, and especially during tuning of a cavity, grid and plate current meters should be used. For grid current, a plus and minus 25 mAdc zero-center meter is desirable. The plate current meter should be 500 mAdc full scale. The dc connection is most easily made to the center cap of the anode, and it is recommended that a 10 to 25 ohm, 50 watt current limiting resistor be used in the B+ line to help protect the tube in case of a fault condition. See FAULT PROTECTION.

If the tube is used with an EIMAC cavity assembly, technical data, which includes detailed tuning instructions, is available on request.

HEATER VOLTAGE - The recommended nominal heater voltage of 6.3 volts should be applied for a minimum of 60 seconds before operation commences. After operation has started (in full-power FM or key-down CW service) the voltage should be reduced to (approximately) 4.8 volts to prevent cathode overheating due to rf transit-time effects in the tube. This reduction in heater voltage should preferably be made automatically with the application of the rf drive voltage to the cavity. The optimum value for the reduced heater voltage is dependent on a number of factors, but predominantly the power level of operation, and where long life and consistent performance are factors, operation at Ef = 4.8 volts is normally desirable.

In low duty factor applications such as CW telegraphy and voice SSB, heater voltage should be maintained at 6.3 volts.

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.

GRID OPERATION - The maximum control grid dissipation is 5 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. Care should be taken to prevent over-dissipation, as this could cause vaporization of the grid-coating material and resultant poisoning of emission from the tube's oxide cathode.

The use of a zero-center grid current meter (for tuning and monitoring) is recommended since normal grid current can be negative, as shown under TYPICAL OPERATION. This negative current does not indicate any circuit or tube malfunction and is the result of tube characteristics and transit-time effects at the frequency of operation.

UHF OPERATION - Operation in the UHF range should be conducted with heavy plate loading and the lowest driving power consistent with satisfactory performance. It is often preferable to operate at a sacrifice in efficiency to obtain increased tube life.

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 be used in the anode circuit to limit peak current and help dissipate the energy in the event of a tube or circuit arc. A resistance of 10 to 25 ohms in the positive plate power supply lead will help protect the tube in the event of an internal arc.

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.**

RADIO-FREQUENCY RADIATION - Avoid exposure to strong rf fields, especially at frequencies above 300 MHz, where energy absorption by the human body is significant. The human eye is particularly sensitive. Prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter (Occupational Safety & Health

Administration (OSHA) standard). It is generally accepted that exposure to "high levels" of rf radiation can result in severe bodily injury, including blindness. **CARDIAC PACEMEAKERS MAY BE AFFECTED.**

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 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. The capacitance values shown in the manufacturer's technical data 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 appliction. Measurements should be taken with the mounting which represent 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: Applications Engineering; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

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.

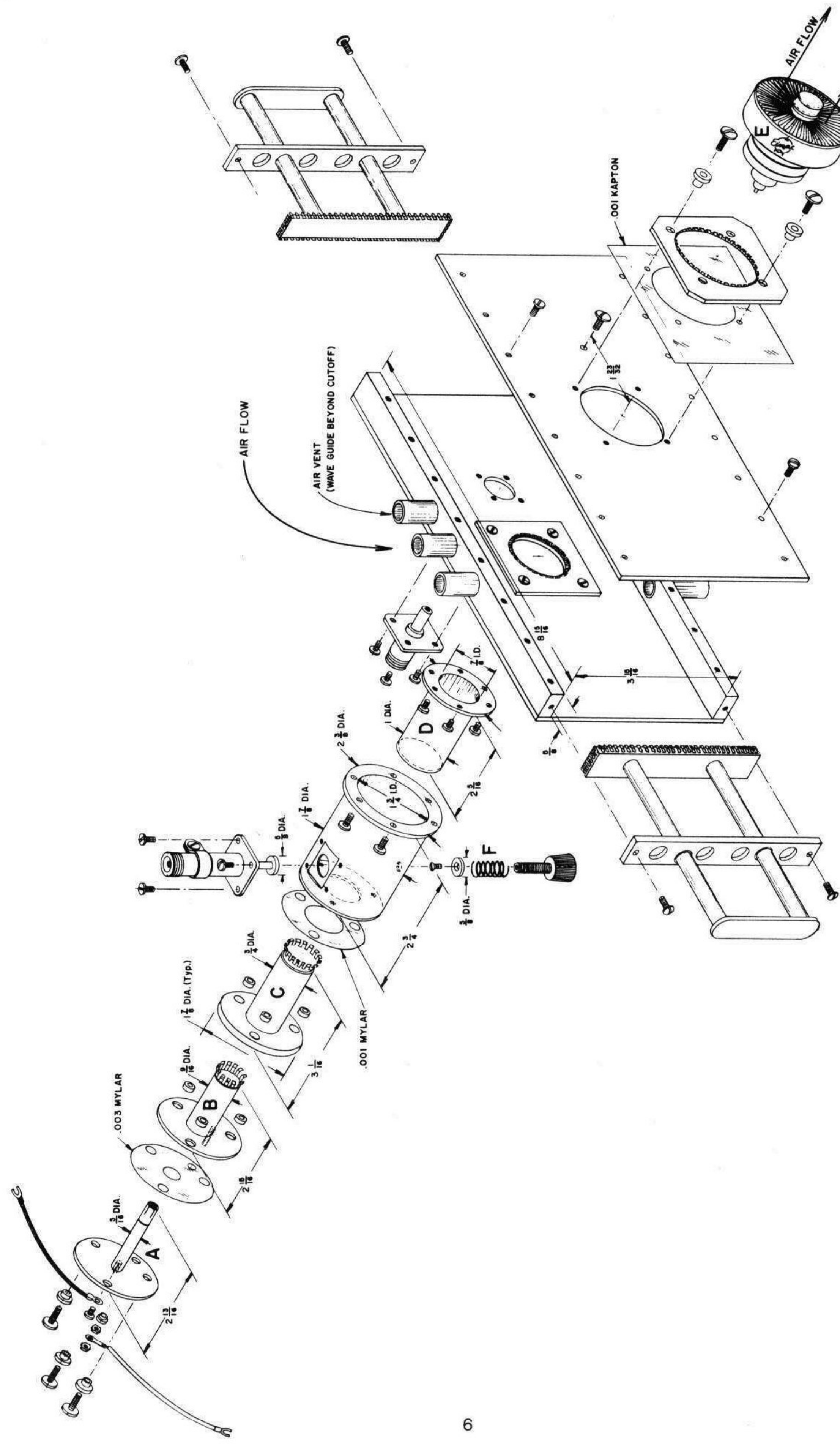
The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

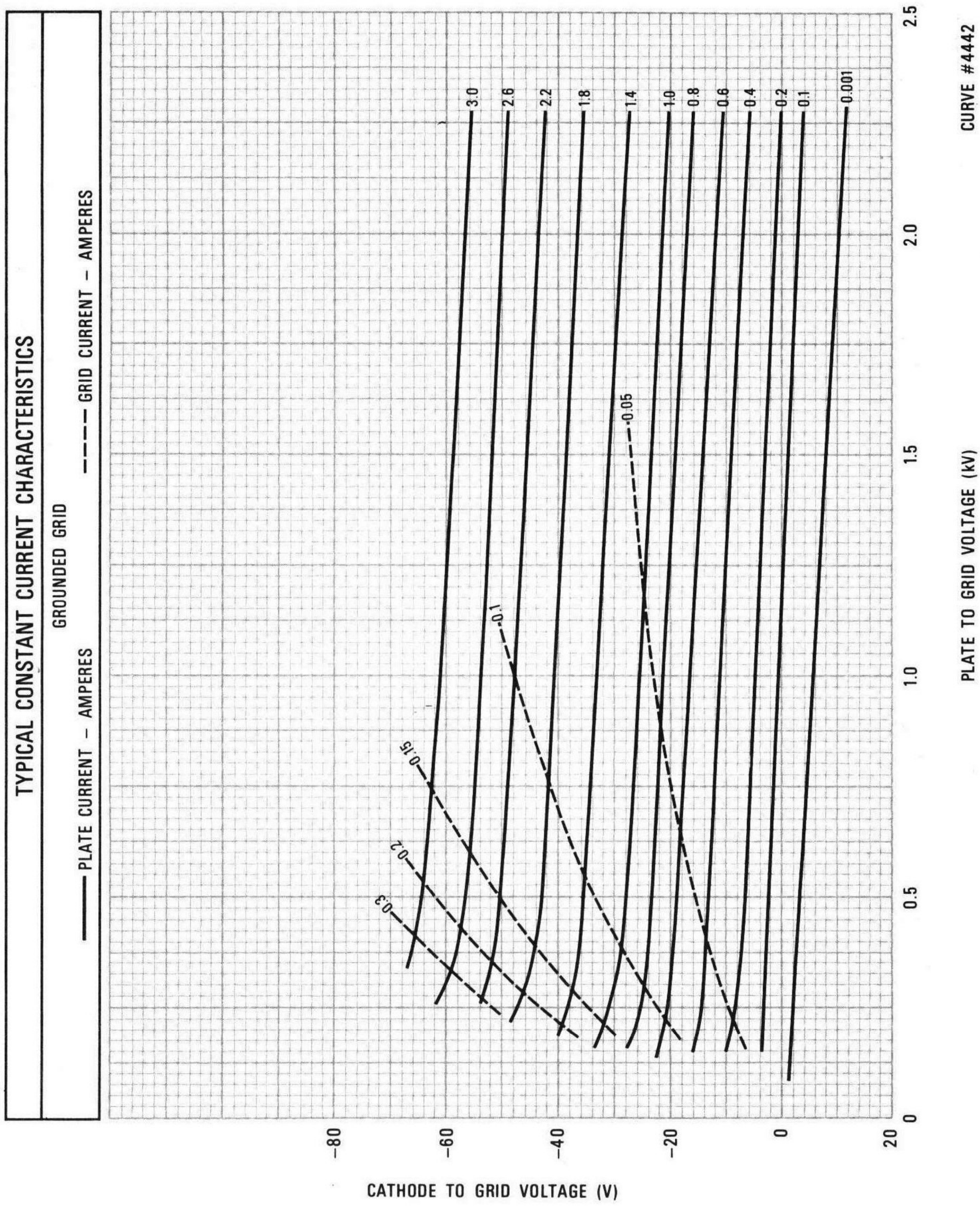
a. HIGH VOLTAGE - Normal operating voltages can be deadly.

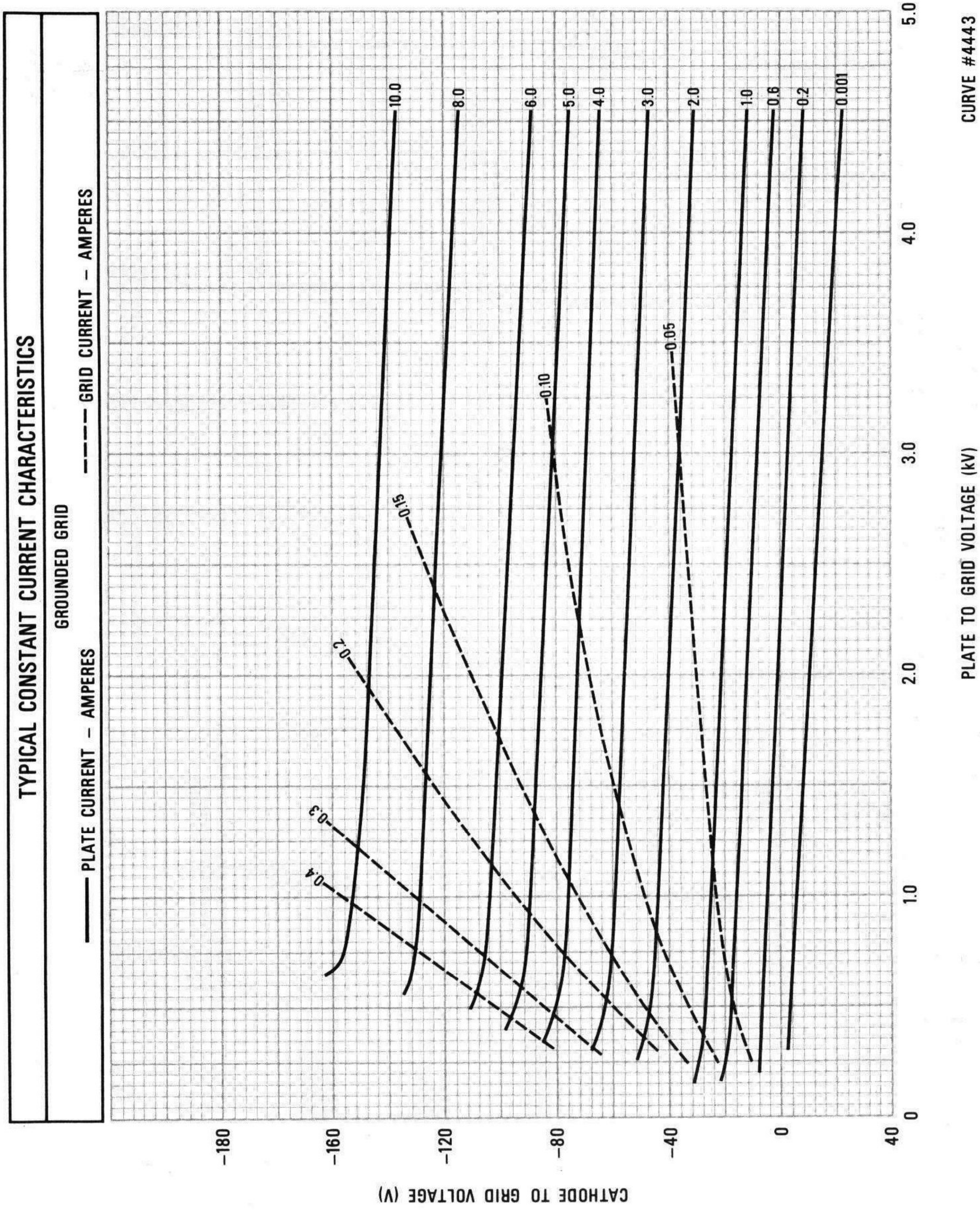
b. RF RADIATION - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. **CARDIAC PACEMAKERS MAY BE EFFECTED.**

c. HOT 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.


AIR FLOW
.001 KAPTON
AIR FLOW
AIR VENT
(WAVE GUIDE BEYOND CUTOFF)
E
D
F
C
B
A
.001 MYLAR
.003 MYLAR
1 DIA.
2 3/8 DIA.
1 7/8 DIA.
1 3/4 I.D.
7/8 I.D.
3/4 DIA.
1 7/8 DIA. (Typ.)
9/16 DIA.
3/16 DIA.
5/8 DIA.
8 15/16
3 15/16
1 23/32
2 3/4
3 1/16
2 15/16
2 13/16
2 5/16
5/8


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED GRID
PLATE CURRENT - AMPERES
GRID CURRENT - AMPERES
3.0
2.6
2.2
1.8
1.4
1.0
0.8
0.6
0.4
0.2
0.1
0.001
0.05
0.1
0.15
0.2
0.3
PLATE TO GRID VOLTAGE (kV)
0
0.5
1.0
1.5
2.0
2.5
CATHODE TO GRID VOLTAGE (V)
-80
-60
-40
-20
0
20
CURVE #4442


TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED GRID
PLATE CURRENT - AMPERES
GRID CURRENT - AMPERES
10.0
8.0
6.0
5.0
4.0
3.0
2.0
1.0
0.6
0.2
0.001
0.05
0.10
0.15
0.2
0.3
0.4
-180
-160
-120
-80
-40
0
40
CATHODE TO GRID VOLTAGE (V)
0
1.0
2.0
3.0
4.0
5.0
PLATE TO GRID VOLTAGE (kV)
CURVE #4443

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACE.
3. CONCENTRICITY MEASUREMENTS ARE TO BE PERFORMED WITH TUBE MOUNTED ON SURFACE Y.

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A			2.545			64.64
B	2.050	2.080		52.07	52.83	
C			1.910			48.51
D	.750	.810		19.05	20.57	
E	.710	.790		18.03	20.07	
F		1.406			35.71	
G	.187			4.75		
H	.200			5.08		
J	.559	.573		14.20	14.55	
K	.240			6.10		
L			.500			12.70
M			.150			3.81
N	.330			8.38		
P	.230			5.84		
R	1.417	1.433		35.99	36.40	
T	.091	.095		2.31	2.41	
U	.318	.325		8.08	8.26	
V	.588	.597		14.93	15.16	
W			.325			8.26
X	.025			.635