3CX400U7

TECHNICAL DATA

HIGH-MU UHF TRANSMITTING TRIODE

The EIMAC 3CX400U7 is designed for use above 200 MHz as a CW, pulse, or linear rf amplifier, particularly in the 806 to 950 MHz portion of the spectrum allocated to land mobile services.

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

The combination of an amplification factor of over 200 and minimum current interception by the control grid provides good power gain in cathode-driven (grounded grid) amplifiers. 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.

200 watts of useful CW rf power may be obtained with better than 33% efficiency, and better than 10 dB of gain. At frequencies near 900 MHz the amplifier circuit may be essentially a quarter-wave radial or rectangular resonator for the anode, and a three-quarter wave coaxial line section between ground and cathode. The amplifier is described in this data sheet. Terminal collets are available and are listed.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide-Coated, Unipotential	
Heater Voltage, Nominal (see derating table for UHF use)	6.3 ± 0.3 V
Heater Current, at 6.3 volts	3.0 A
Cathode-Heater Potential, Maximum	±150 V
Transconductance, average (I_b = 250 mAdc)	29,000 μmhos
Amplification Factor, average	240
Direct Interelectrode Capacitances (grid grounded)[2]	
Cin	18.4 pF
Cout	6.1 pF
Cpk	0.07 pF
Ck-htr	6.0 pF
Frequency of Maximum Rating:	
CW	1000 MHz

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. 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.

 Printed in U.S.A.

MECHANICAL

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

Maximum Overall Dimensions:	
Length	2.51 in; 63.75 mm
Diameter	2.08 in; 52.83 mm
Net Weight (approximate)	5.5 oz; 155 gms

RADIO FREQUENCY POWER AMPLIFIER CLASS C TELEGRAPHY OR FM

MAXIMUM RATINGS:

DC PLATE VOLTAGE	1500	VOLTS
DC GRID VOLTAGE	-100	VOLTS
DC PLATE CURRENT	0.400	AMPERE
PLATE DISSIPATION	400	WATTS
GRID DISSIPATION	5	WATTS

TYPICAL OPERATION, Cathode Driven, 850 MHz

Plate Voltage	1500	Vdc
Plate Current	400	mAdc
Grid Current	-5	mAdc
Measured Driving Power	13.0	W
Useful Output Power	225	W
Efficiency	37	%
Power Gain	12	dB

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater Current, at 6.3 volts	2.8	3.4	A
Cathode Warmup Time	60	---	Sec
Interelectrode Capacitances (grid grounded)[1]			
Cin	16.0	21.0	pF
Cout	5.0	7.0	pF
Cpk	---	0.1	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.

APPLICATION

MOUNTING & SOCKETING - Part numbers of available EIMAC collets are listed under MECHANICAL. 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 serve to draw off a portion of the heat released during normal operation.

HEATER-CATHODE OPERATION - The nominal heater voltage for the 3CX400U7 is 6.3 volts. For CW operation at frequencies above 300 MHz the heater voltage should be reduced as the cathode receives additional heat from rf charging currents and a transit-time effect. The following table gives approximate values of heater voltage recommended versus operating frequency for CW power levels at, or near, the typical operating conditions shown on Page 2. It is recommended that a mechanical relay, or other type of switching device, be provided so that near-nominal heater voltage will be provided during warmup and standby periods, and then dropped to the recommended level when rf drive is applied to the amplifier.

Frequency (MHz)	Heater Volts
300 or lower	6.3
300 to 400	6.1
400 to 500	5.7
500 to 600	5.3
600 to 700	4.9
700 to 800	4.5
800 to 900	4.0
900 to 1000	3.6

The heater voltage should be operated at nominal voltage of 6.3 volts for a minimum of 60 seconds before application of plate voltage or rf driving voltage.

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.

COOLING - Forced-air cooling of the tube is required, with 11.5 cfm of air directed through the anode cooler when operating at full rated (400 W) dissipation. The pressure drop across the anode cooler only at this flow rate is approximately 0.2 inch of water, and these figures are based on an incoming air temperature of 50°C and a maximum tube anode temperature of 225°, at sea level, and with air flowing in a base-to-anode direction. When air is flowing in this direction, and the base contacting arrangement does not restrict flow in and around the base seals, additional base cooling provisions may not be required, but the designer is cautioned to verify whether base cooling is adequate 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, allowance must also be made for other losses in the air system, in order to always assure sufficient 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 outlined is normally beneficial.

UHF CAVITY AMPLIFIER - Included in this data sheet is an exploded view of a typical cavity amplifier of simple construction requiring little precise machine work. The dimensions shown are for an amplifier to be operated near 900 MHz. The typical operating conditions for 850 MHz, shown on Page 2, were obtained with this cavity.

The output circuit is essentially a quarter-wave rectangular cavity forming the tuned circuit between anode and grid. Output coupling is magnetic. A loop is formed by a post *F* which terminates at one end in the center conductor of the coaxial fitting, and at the other end it is solidly in contact with the opposite plate (or wall) of the cavity.

The input circuit, while simple mechanically, is not as easily visualized as an electrical circuit. Starting with the small inner conductor *A*, this is a heater conductor and rf choke. The next tube, *B*, is the second heater conductor and rf choke. The third tube, *C*, is the cathode line which may be considered as a broadly tuned three-quarter wave line. The next diameter of tubing, *D*, is a sleeve tuned to an electrical three-quarter wave-length by an adjustable capacity probe, *E*. The sleeve is excited by the input capacity probe, *F*. Current flows on the inside as well as on the outside wall of the three-quarter wave sleeve, thereby coupling energy to the cathode line. Sleeve *D* is electrically three-quarter wavelength because there is approximately a loaded quarter wavelength within the vacuum tube itself, *E*.

Suitable cowling (not shown) should be provided to introduce cooling air through three short tubes on each side of the output cavity for anode cooling. The air then exhausts through the anode cooling fins of the 3CX400U7. The three short tubes on each side of the cavity are dimensioned to serve as waveguide-above-cutoff frequency filters in the air openings.

HIGH VOLTAGE - Normal operating voltages used with the 3CX400U7 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.

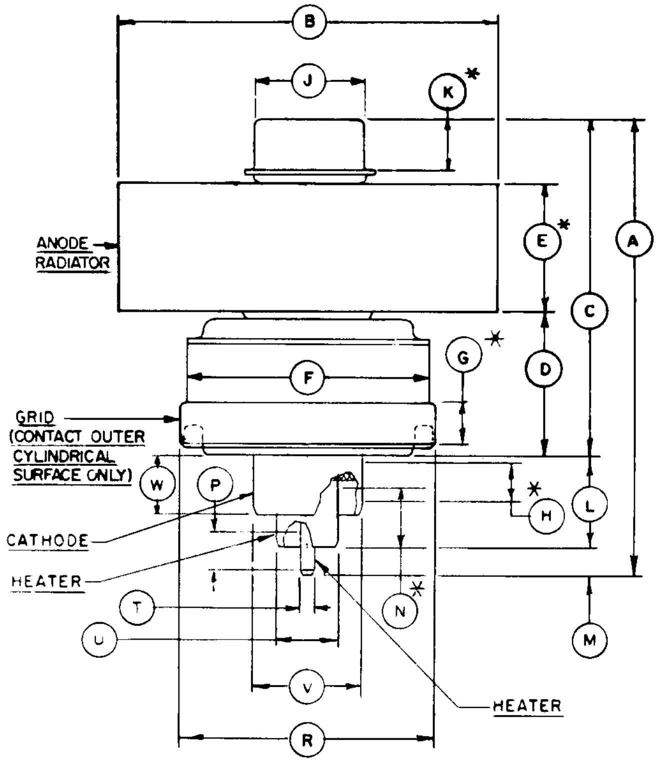
The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

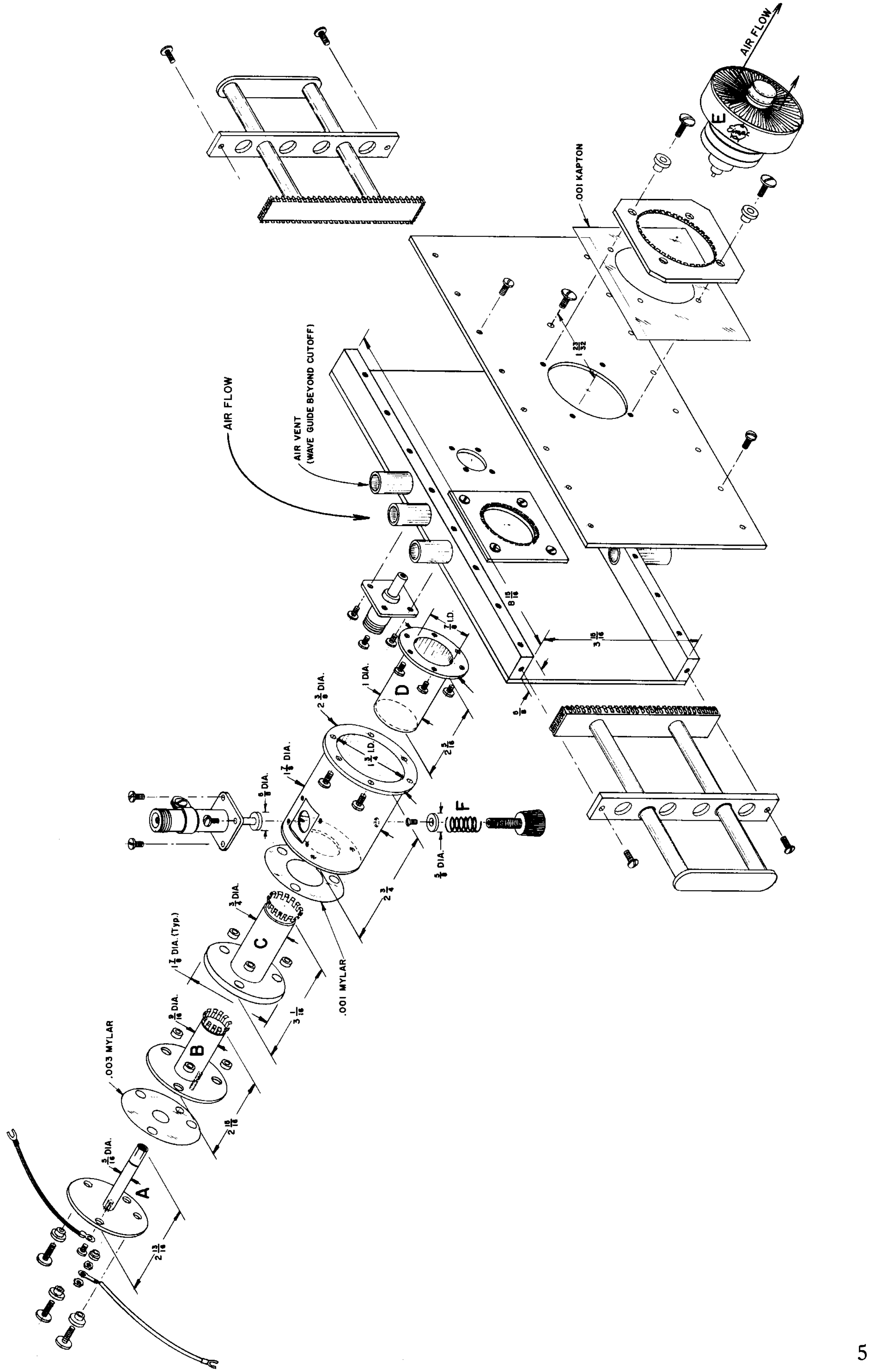
SPECIAL APPLICATIONS - If it is desired to operate these tubes under conditions widely different from those given here, write to Power Grid Tube Division, EIMAC Division of Varian, San Carlos, Calif. 94070 for information and recommendations.

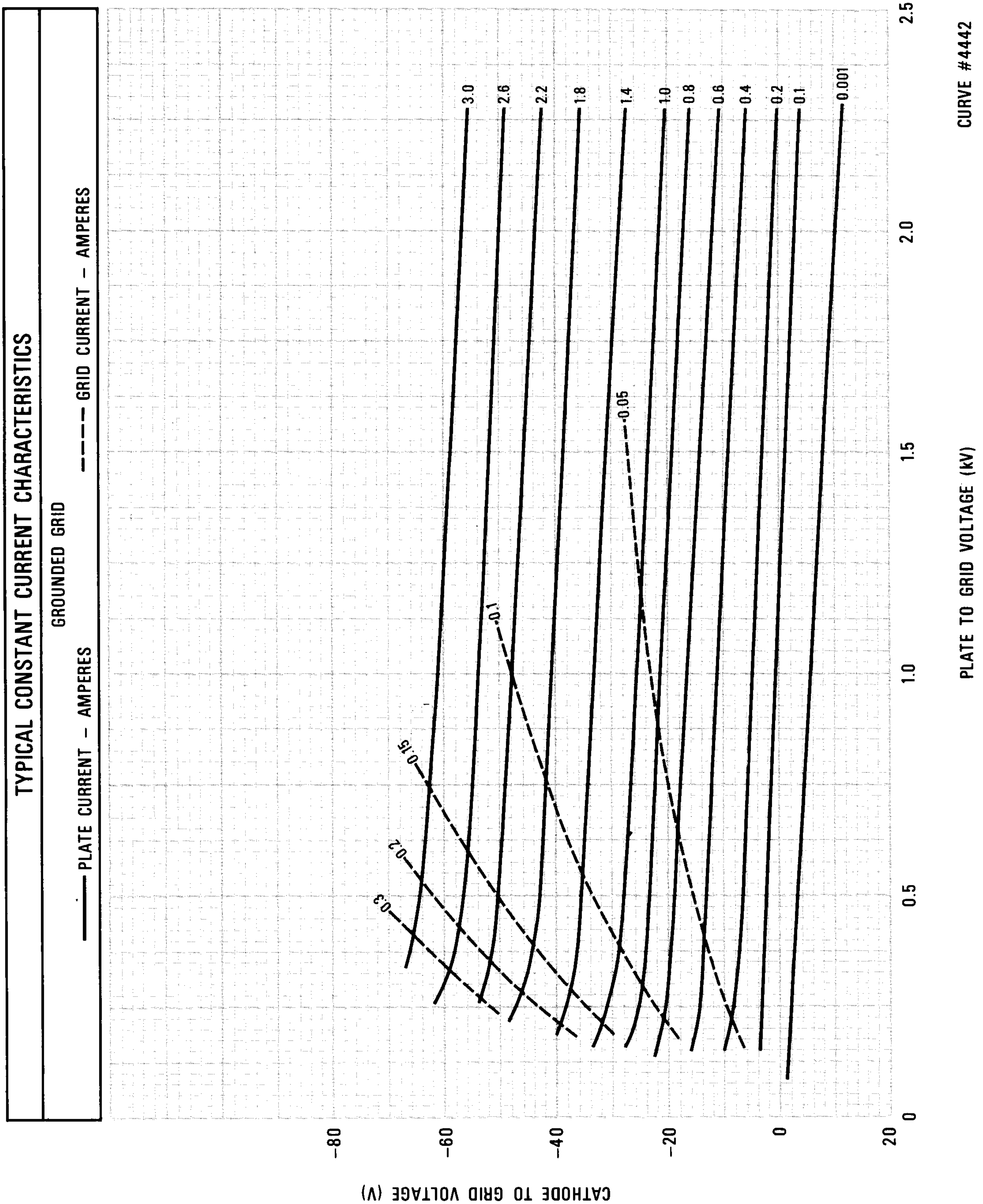
DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	- -	- -	2.510	- -	- -	63.75
B	2.050	2.080	- -	52.07	52.83	- -
C	1.810	1.910	- -	45.97	48.51	- -
D	0.750	0.810	- -	19.05	20.57	- -
E	0.710	0.790	- -	18.03	20.07	- -
F	- -	1.406	- -	- -	35.71	- -
G	0.187	- -	- -	4.75	- -	- -
H	0.200	- -	- -	5.08	- -	- -
J	0.559	0.573	- -	14.20	14.55	- -
K	0.240	- -	- -	6.10	- -	- -
L	- -	- -	0.500	- -	- -	12.70
M	- -	- -	0.150	- -	- -	3.81
N	0.330	- -	- -	8.38	- -	- -
P	0.230	- -	- -	5.84	- -	- -
R	1.417	1.433	- -	35.99	36.40	- -
T	0.091	0.095	- -	2.31	2.41	- -
U	0.318	0.325	- -	8.08	8.25	- -
V	0.588	0.597	- -	14.93	15.16	- -
W	- -	- -	0.325	- -	- -	8.25

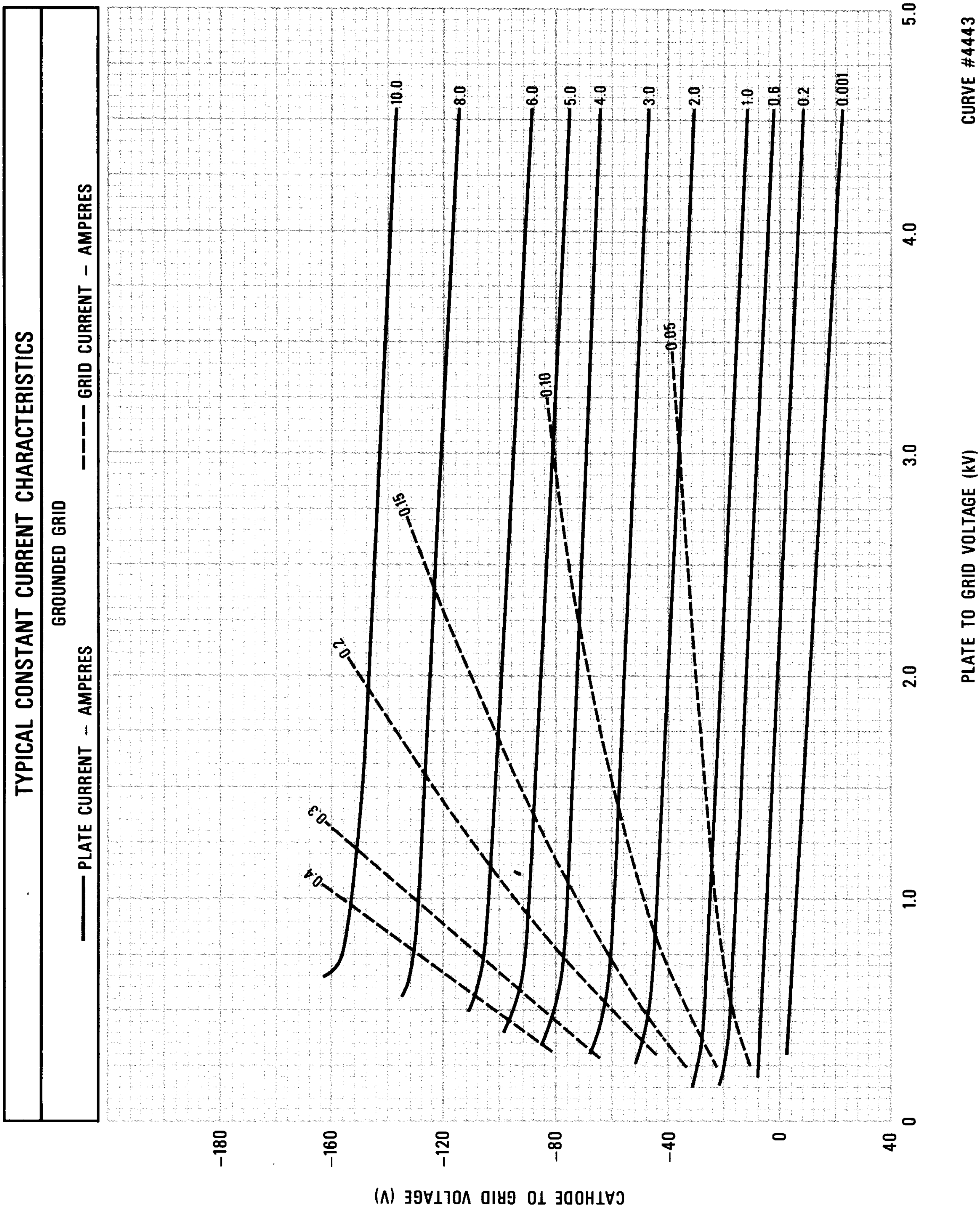
NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACE.




AIR FLOW
AIR VENT (WAVE GUIDE BEYOND CUTOFF)
AIR FLOW
.001 KAPTON
.001 MYLAR
.003 MYLAR
A
B
C
D
E
F


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
-80
-60
-40
-20
0
20
0
0.5
1.0
1.5
2.0
2.5
CATHODE TO GRID VOLTAGE (V)
PLATE TO GRID VOLTAGE (kV)
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
0.4
0.3
0.2
0.15
0.10
0.05
-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