TECHNICAL DATA

INDUSTRIAL MEDIUM-MU POWER TRIODES 3CX2500A3/8161 3CX2500F3/8251 3CX2500H3

The Eimac 3CX2500 family of medium-Mu triodes are widely used in broadcast and industrial heating applications. The -A3 version has a coaxial base, the -F3 has flexible leads on all terminals and the –H3 has flexible filament leads and a flange for the grid terminal which may be used for mounting.

GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	7.5 ± 0.37	V
Current @ 7.0 volts	51.5	A
Direct Interelectrode Capacitances (grounded cathode)[2]		
Cin	35	pF
Cout	0.9	pF
Cgp	20	pF
Amplification Factor (average)	22	
Frequency of Maximum Rating:		
3CX2500A3	110	MHz
3CX2500F3/H3	75	MHz

MECHANICAL

Overall Dimensions:	
Length (3CX2500A3)	9.0 in; 227 mm
(3CX2500F3/H3)	15.44 in; 468 mm
Diameter (3CX2500A3/F3)	4.15 in; 105 mm
(3CX2500H3)	4.25 in; 108 mm
Weight (approx.)	7 lb; 2.9 kg
Operating Position	Vertical, base up or down
Maximum Operating Temperatures:	
Ceramic/Metal Seals & Envelope	250°C
Filament leads at Tube Base	150°C
Cooling	Forced Air

[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 Eimac Division 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.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C

ABSOLUTE MAXIMUM RATINGS:

Plate Voltage	6.0	Kilovolts
Plate Current	2.5	Amperes
Grid Voltage	-1.0	Kilovolt
Grid Current, DC	0.4	Ampere
Plate Dissipation	4.0	Kilowatts
Grid Dissipation	150	Watts

TYPICAL OPERATION BELOW 30 MHz:

Plate Voltage	4.0	5.0	6.0	kVdc
Plate Current	2.5	2.5	2.08	Adc
Grid Voltage	-300	-450	-500	Vdc
Grid Current*	245	265	180	mAdc
Peak Grid Voltage*	580	750	765	V
Driving Power*	142	197	136	W
Plate Input Power	10	12.5	12.5	kW
Plate Dissipation	2.5	2.5	2.5	kW
Plate Output Power*	7.5	10	10	kW

*Approximate Values

PLATE-MODULATED RADIO-FREQUENCY AMPLIFIER

Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATIINGS:

Plate Voltage	5.5	Kilovolts
Plate Current	2.0	Amperes
Grid Voltage	-1.0	Kilovolt
Plate Dissipation	2.67	Kilowatts
Grid Dissipation	150	Watts

TYPICAL OPERATION BELOW 30 MHz:

Plate Voltage	4.0	4.5	5.0	kVdc
Plate Current	1.67	1.47	1.25	Adc
Grid Voltage	-450	-500	-550	Vdc
Grid Current*	180	140	150	mAdc
Peak rf Grid Voltage*	685	715	760	V
Driving Power*	125	100	115	W
Grid Dissipation*	43	30	32	W
Plate Input Power	6.67	6.61	6.25	kW
Plate Dissipation	1.67	1.32	0.95	kW
Plate Output Power	5.0	5.3	5.3	kW

*Approximate Values

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR

Class AB or B

ABSOLUTE MAXIMUM RATINGS:

Plate Voltage	6.0	Kilovolts
Plate Current	2.5	Amperes
Grid Voltage	-1.0	Kilovolt
Plate Dissipation	4.0	Kilovolts
Grid Dissipation	150	Watts

TYPICAL OPERATION (Sinusoidal Wave) Two tubes in push-pull

Plate Voltage	4.0	5.0	6.0	kVdc
Grid Voltage*[1]	-150	-190	-240	Vdc
Resting Plate Current	0.6	0.5	0.4	Adc
Max Signal Plate Current	4.0	3.2	3.0	Adc
Plate Load Resistance	2.2	3.6	4.65	kOhms
Peak AF grid Voltage	340	360	390	v
Maximum Drive Power*	170	115	113	W
Maximum Output Power	11	11	13	kW

*Approximate Values
[1]Adjust to give resting (zero signal) plate current

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage (feedback) 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.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament Current @ 7.5 Volts	49	54	A
Interelectrode Capacitances[1] (grounded cathode)			
Cin	29.2	42.2	pF
Cout	0.6	1.6	pF
Cgp	16.8	23.2	pF
Grid bias voltage at a plate voltage of 3.0 kV for plate current = 0.83 A	-67	-100	Vdc

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

APPLICATION

MOUNTING & SOCKETING – These tubes must be operated with the axis vertical. The base of the tube(s) may be up or down at the option of the equipment designer. These products contain thoriated-tungsten filaments and should be protected from shock and vibration.

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.

COOLING - The maximum temperature rating for the plate core and the ceramic/metal seals of these tubes is 250°C, and sufficient forced-air cooling must be provided to assure operation at safe tube temperatures. Tube life is usually prolonged if cooling in excess of the absolute minimum requirements is provided.

The filament leads of the 3CX2500F3 and 3CX2500H3 are attached using soft solder, therefore care must be taken to supply sufficient cooling to this area of the tube to maintain temperatures below 150°C to avoid melting the solder or loosening of the leads.

The table on page 4 shows minimum airflow rates for two values of plate dissipation with 40°C air flow in two directions, to maintain temperature of the plate cooler below 225°C at sea level and 5000 feet ASL. This data applies to operation below 30 MHz. If the tube is used above this frequency additional cooling may be required because of increased rf losses that occur at VHF.

At an altitude of 10,000 feet greatly increased airflow is required; in this case both the airflow and pressure drop values for sea level must be increased by the following factor: x 1.46. Additional cooling of the tube base may be required especially if the plate cooling air is not directed past the base first; the preferred configuration is air flow in the base-to-plate direction, although cooling air supplied in the alternate direction is permissible if of the proper flowrate.

Cooling air should be filtered to remove particles of foreign matter that may become embedded in the plate cooling fins and impair cooling efficiency. The main ceramic vacuum envelope in the 3CX2500H3 is glazed to allow easy cleaning in the event any particulate matter collects on this surface; this procedure should be performed regularly in industrial applications where dust or particles are generated in the environment.

The designer is cautioned that the cooling recommendations shown are absolute values for inlet air and temperature rise conditions shown with no safety factor: it is considered good engineering practice to allow additional air flow for conservatism and to make allowance for variables such as dirty air filters, dirty plate cooling fins, pressure losses in air ducting, etc.

Base-to-Plate Air Flow				
Plate Dissipation (Watts)	SEA LEVEL		5,000 FEET	
	Air Flow (CFM)	Pressure Drop (In. of Water)	Air Flow (CFM)	Pressure Drop (In. of Water)
2500	36	0.60	43	0.72
4000	67	1.20	80	1.45
Plate-to-Base Air Flow				
2500	42	0.70	50	0.84
4000	84	1.70	101	2.00

Temperature-sensitive paints are available which will allow a check of temperatures before any design is finalized. EIMAC Application Bulletin AB-20, TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES, covers this subject in detail and is available on request.

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.

FILAMENT OPERATION - With a new tube, or one which has been in storage for some period of time, operation with filament voltage only applied for a period of 30 to 60 minutes is recommended before full operation begins. This allows the active getter material mounted within the filament structure to absorb any residual gas molecules which have accumulated during storage. Once normal operation has been established a minimum filament warm-up time of five seconds is normally sufficient before commencing operation at full power.

Eimac Application Bulletin #18, EXTENDING TRANSMITTER TUBE LIFE, gives information on the effect of filament voltage on life expectancy.

Filament voltage should be measured at the tube base, using a known-accurate (preferably plus or minus one percent) rms-responding meter. Variation in filament voltage should be limited to no more than +/- five percent for consistent tube performance.

LOAD FAULTS – In self- excited oscillators large load variations or faults can cause potentially dangerous changes in tube efficiency, which in turn can increase plate dissipation to a very high level. If this occurs tube damage can result even though plate current is near the normal operating value. The circuit designer is therefore cautioned to suitably proportion the circuit constants to minimize this effect, and to be sure cooling airflow is adequate to handle worst-case dissipation conditions. New system designs often incorporate a thermal detection device in the exhaust airflow to remove power from the tube in the case of fault conditions.

GRID OPERATION – The maximum no load grid current rating is 0.5 ampere dc. This value should not be exceeded except during tuning for very short periods, and over-current protection in the grid circuit should be provided. In industrial heating service with varying loads. grid current should be monitored continuously with a dc current meter. The maximum grid dissipation rating is 150 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 grid and the cathode to guard against excessive voltage.

FAULT PROTECTION - In addition to normal cooling interlocks and a plate over-current interlock, it is good practice to protect the tube from internal damage which could result from occasional arcing at high plate voltage. In all cases some protective resistance, at least 10 Ohms, should be used in series with the tube plate 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, however in the case of the 3CX2500F3 and 3CX2500H3 no special shielded fixture is used due to the length of the filament leads. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even with tubes made by different manufacturers. 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 3CX2500A3, 3CX2500F3 and 3CX2500H3 all operate 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.

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 effect. 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.

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 Eimac Division, San Carlos, Calif. 94070 U.S.A. for information and recommendations.

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.

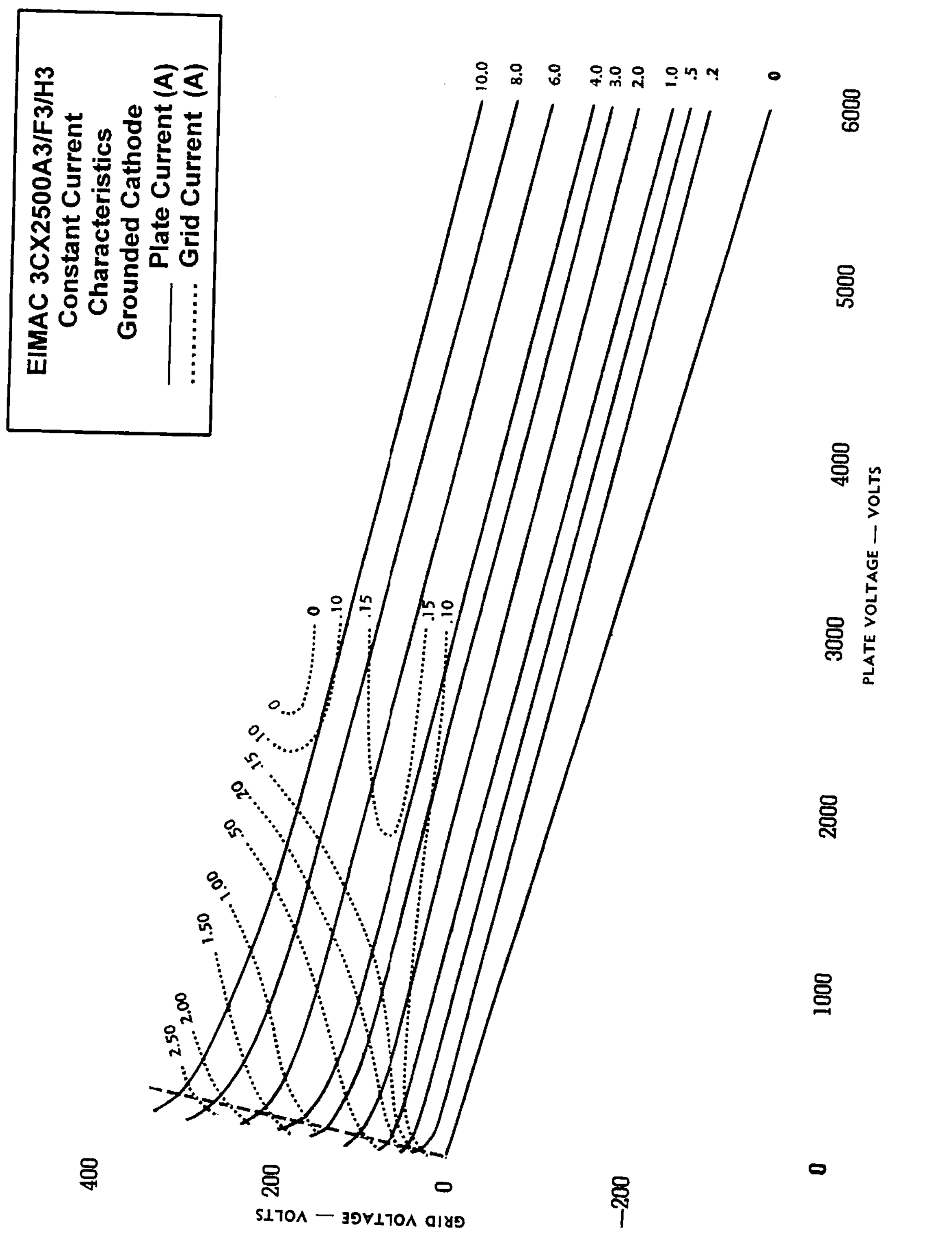
HIGH VOLTAGE – Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

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 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.

Please review the detailed Operating Hazards sheet enclosed with each tube, or request a copy from CPI, Eimac Division Application Engineering at 1-650-592-1221.

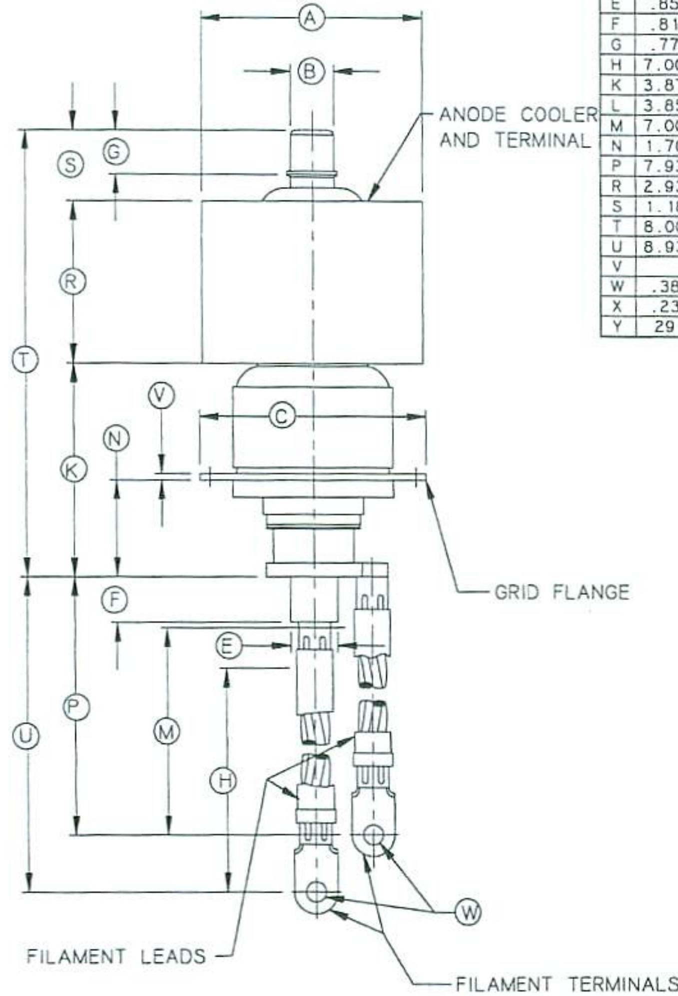

EIMAC 3CX2500A3/F3/H3
Constant Current
Characteristics
Grounded Cathode
——— Plate Current (A)
.... Grid Current (A)
10.0
8.0
6.0
4.0
3.0
2.0
1.0
.5
.2
0
2.50
2.00
1.50
1.00
.50
.20
.15
.10
0
PLATE VOLTAGE — VOLTS
0
1000
2000
3000
4000
5000
6000
GRID VOLTAGE — VOLTS
400
200
0
–200

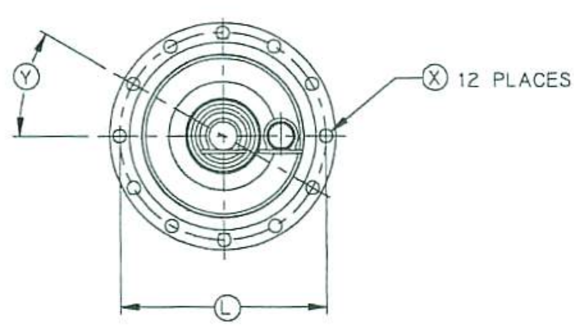
3CX2500H3

NOTE:

1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.093	4.156		103.96	105.56	
B	.781	.843		19.83	21.41	
C	4.230	4.255		107.44	108.07	
E	.859	.890		21.82	22.61	
F	.812	.937		20.62	23.80	
G	.775	.875		19.68	22.23	
H	7.000	7.500		177.80	190.50	
K	3.875	4.250		98.42	107.95	
L	3.855	3.885		97.92	98.68	
M	7.000	7.500		177.80	190.50	
N	1.703	1.953		43.26	49.61	
P	7.937	8.437		201.60	214.30	
R	2.937	3.062		74.60	77.77	
S	1.187	1.687		30.15	42.85	
T	8.000	9.000		203.20	228.60	
U	8.937	9.437		227.00	239.70	
V			.125			3.17
W	.385	.395		9.78	10.03	
X	.230	.265		5.84	6.73	
Y	29°	31°				





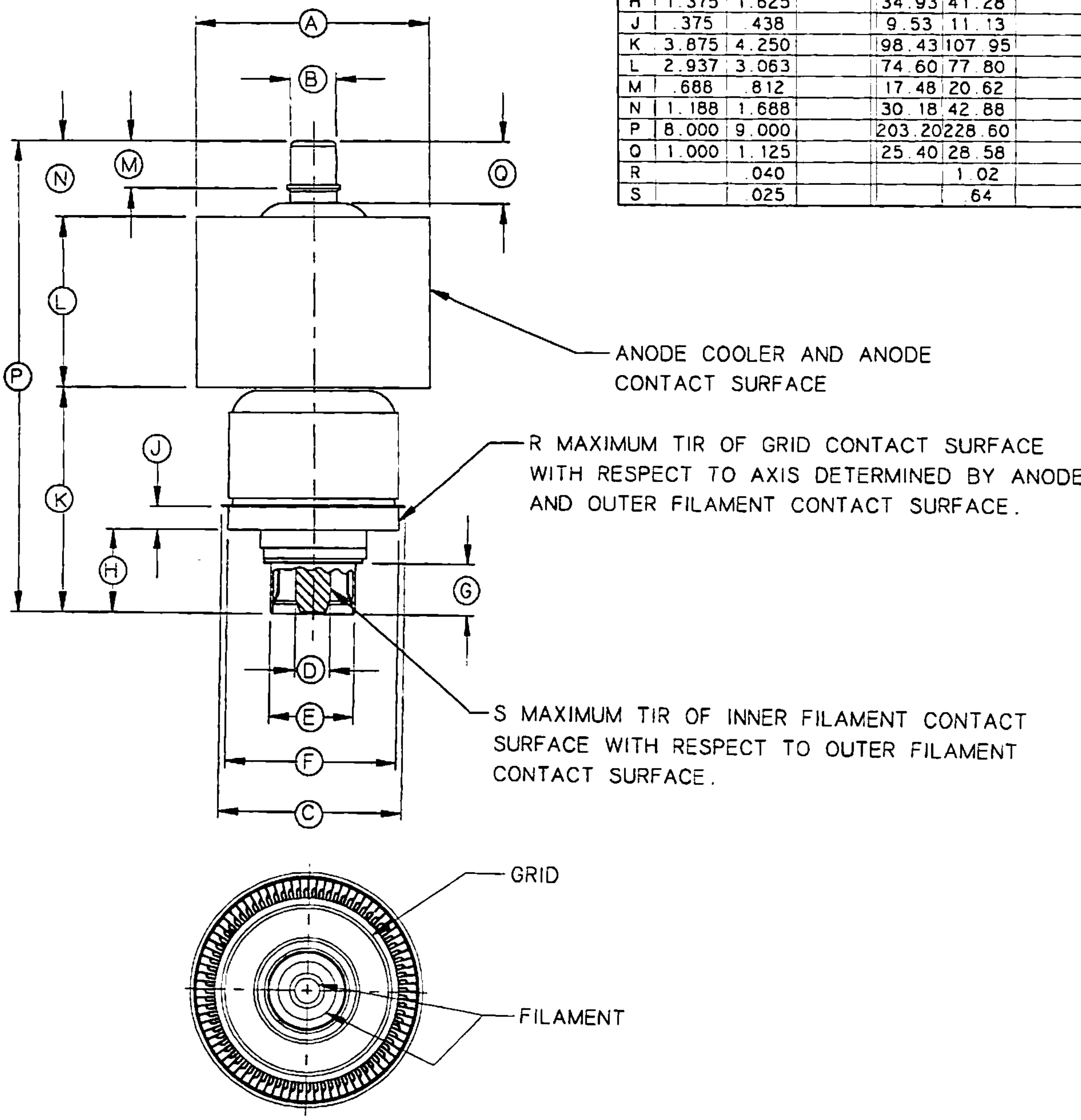
Communications & Power Industries
Eimac division
301 Industrial Road, San Carlos, CA 94070 • Tel: 650-592-1221 • Fax: 650-592-9988
11/02 Printed in USA.

3CX2500A3

NOTE:

1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.094	4.156		103.99	105.56	
B	.781	.844		19.84	21.44	
C		3.625			92.08	
D	.615	.635		15.62	16.13	
E	1.490	1.510		37.85	38.35	
F	2.990	3.010		75.95	76.45	
G	.812	.938		20.62	23.83	
H	1.375	1.625		34.93	41.28	
J	.375	.438		9.53	11.13	
K	3.875	4.250		98.43	107.95	
L	2.937	3.063		74.60	77.80	
M	.688	.812		17.48	20.62	
N	1.188	1.688		30.18	42.88	
P	8.000	9.000		203.20	228.60	
Q	1.000	1.125		25.40	28.58	
R		.040			1.02	
S		.025			.64	



3CX2500F3

NOTE:

1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.

DIMENSIONAL DATA

	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.093	4.156		103.96	105.56	
B	.781	.843		19.83	21.41	
C		3.625			92.07	
D	6.375	6.625		161.92	168.27	
E	.859	.890		21.82	22.61	
F	.812	.937		20.62	23.80	
G	.775	.875		19.68	22.23	
H	7.000	7.500		177.80	190.50	
K	.375	.437		9.52	11.10	
M	7.000	7.500		177.80	190.50	
N	1.375	1.625		34.92	41.27	
P	7.937	8.437		201.60	214.30	
Q	3.875	4.250		98.42	107.95	
R	2.937	3.062		74.60	77.77	
S	1.187	1.687		30.15	42.85	
T	8.000	9.000		203.20	228.60	
U	8.937	9.437		227.00	239.70	
V	.194	.200		4.93	5.08	
W	.385	.395		9.78	10.03