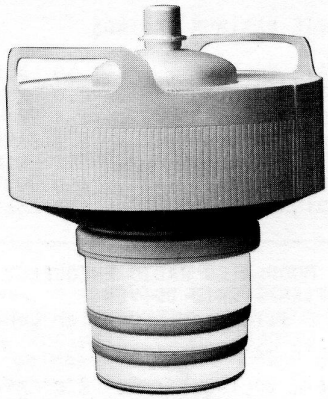
TECHNICAL DATA

4CX15,000R VHF RADIAL BEAM POWER TETRODE

The EIMAC 4CX15,000R is a ceramic/metal power tetrode intended for use in audio or radio frequency applications. It is directly interchangeable with the 4CX15,000A but incorporates a more rugged construction, including a sturdy mesh cathode, giving a low incidence of ac hum modulation. Low rf losses in this structure permit operation at full ratings up to 110 MHz, and at reduced ratings up to 225 MHz.

The 4CX15,000R is also recommended for radio-frequency linear power amplifier service, and for VHF TV linear amplifier service.



GENERAL CHARACTERISTICS [1]

ELECTRICAL

Filament: Thoriated Tungsten Mesh		
Voltage	6.3 ± 0.3	V
Current @ 6.3 volts	160	A
Amplification Factor, average		
Grid to Screen	4.5	
Direct Interelectrode Capacitance (cathode grounded) [2]		
Cin	160	pF
Cout	24.5	pF
Cgp	1.5	pF
Direct Interelectrode Capacitance (grid and screen grounded) [2]		
Cin	67.0	pF
Cout	25.5	pF
Cpk	0.2	pF
Maximum Frequency for Full Ratings (CW)	110	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

Maximum Overall Dimensions:	
Length	9.37 In; 23.81 cm
Diameter	7.58 In; 19.25 cm
Net Weight (approximate)	12.8 Lb; 5.8 kg
Operating Position	Axis Vertical, base up or down
Cooling	Forced Air
Operating Temperature Maximum, Ceramic/Metal Seals and Anode Core	250°C
Base	Special, Concentric
Recommended Air-System Sockets:	
LF or HF Applications	EIMAC SK-300A
VHF applications	EIMAC SK-360
Recommended Air Chimney, for use with SK-300A socket only	EIMAC SK-316
Available Screen Grid Bypass Capacitor Kit for SK-360 (8000 pF @ DCWV = 5000)	EIMAC SK-355
Available Anode Connector Clip	EIMAC ACC-3

RADIO FREQUENCY LINEAR AMPLIFIER
GRID DRIVEN, Class AB1

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	10	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-1.5	KILOVOLTS
DC PLATE CURRENT	6.0	AMPERES
PLATE DISSIPATION	15	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION
Peak Envelope or Modulation Crest Conditions

Plate Voltage	7.5	10.0	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage #	-350	-370	Vdc
Zero-signal Plate Current	1.0	1.0	Adc
Single-tone Plate Current	4.0	4.25	Adc
Single-tone Screen Current *	170	150	mAdc
Peak rf Grid Voltage *	330	340	v
Plate Dissipation *	12.2	14.0	kW
Single-tone Plate Output Power *	20.8	28.5	kW
Resonant Load Impedance	865	1260	Ohms

* Approximate value.
\# Adjust for specified zero-signal plate current.

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RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM
(Key-down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	10	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-1.5	KILOVOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	15	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION

Plate Voltage	7.5	10.0	kVdc
Screen Voltage	750	750	Vdc
Grid Voltage	-510	-550	Vdc
Plate Current	4.65	4.55	Adc
Screen Current *	590	540	mAdc
Grid Current *	300	270	mAdc
Peak rf Grid Voltage *	730	790	v
Calculated Driving Power	220	220	W
Plate Dissipation *	8.1	9.0	kW
Plate Output Power *	26.7	36.5	kW

* Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER - GRID DRIVEN
Class C Telephony - Carrier Conditions

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	8.0	KILOVOLTS
DC SCREEN VOLTAGE	1.5	KILOVOLTS
DC GRID VOLTAGE	-1.5	KILOVOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	10.0	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

* Approximate value.

TYPICAL OPERATION

Plate Voltage	6.0	8.0	kVdc
Screen Voltage	750	750	Vdc
Grid Voltage	-600	-640	Vdc
Plate Current	3.75	3.65	Adc
Screen Current *	450	430	mAdc
Grid Current *	180	180	mAdc
Peak audio freq.screen voltage * for 100% modulation	740	710	v
Peak rf Grid Voltage	800	840	v
Calculated Driving Power	150	150	W
Plate Dissipation *	5.1	5.8	kW
Plate Output Power *	17.4	23.5	kW

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR - GRID DRIVEN
Class AB1 (sinusoidal wave)

ABSOLUTE MAXIMUM RATINGS (per tube)

DC PLATE VOLTAGE	10	KILOVOLTS
DC SCREEN VOLTAGE	2.0	KILOVOLTS
DC GRID VOLTAGE	-1.5	KILOVOLTS
DC PLATE CURRENT	6.0	AMPERES
PLATE DISSIPATION	15	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

* Approximate value.

TYPICAL OPERATION (Two tubes)

Plate Voltage	7.5	10.0	kVdc
Screen Voltage	1.5	1.5	kVdc
Grid Voltage #	-350	-370	Vdc
Zero-signal Plate Current ##	1.0	1.0	Adc
Maximum-signal Plate Current	8.8	8.5	Adc
Maximum-signal Screen Current *	340	300	mAdc
Peak Audio Freq.Grid Voltage *	330	340	v
Maximum-Signal Plate Dissipation ##	12.2	14.0	kW
Plate Output Power *	41.6	57.0	kW
Load Resistance (plate to plate)	1730	2520	Ohms

\# Adjust for specified zero-signal plate current.
Per Tube.

TELEVISION LINEAR AMPLIFIER
Cathode Driven

ABSOLUTE MAXIMUM RATINGS

110 MHz to 225 MHz

DC PLATE VOLTAGE	6.5	KILOVOLTS
DC SCREEN VOLTAGE	1.5	KILOVOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	15	KILOWATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

* Approximate value.

TYPICAL OPERATION, Composite Signal Black Level Unless Otherwise Stated

Plate Voltage	5.0	6.0	kVdc
Screen Voltage	500	700	Vdc
Grid Voltage *	-160	-180	Vdc
Plate Current (zero signal)	500	650	mAdc
Plate Current	2.8	3.33	Adc
Grid Current *	75	35	mAdc
Screen Current *	60	40	mAdc
Peak Cathode Voltage (peak synch).	310	345	v
Cathode Driving Power (peak synch)	975	1350	w
Plate Output Power (peak synch)	11.0	16.5	kw
Plate Load Resistance	600	600	Ohms

TYPICAL OPERATION values are obtained by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid 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 and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

RANGE VALUES FOR EQUIPMENT DESIGN	MIN.	MAX.	
Heater Current, at 6.3 volts	152	168	A
Interelectrode Capacitances, cathode grounded [1]			
Cin	154.0	167.0	pF
Cout	22.0	27.0	pF
Cgp	---	2.0	pF
Interelectrode Capacitances, grid & screen grounded [1]			
Cin	62.0	72.0	pF
Cout	23.0	28.0	pF
Cpk	---	0.3	pF

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

APPLICATION

MECHANICAL

MOUNTING - The 4CX15,000R must be operated with its axis vertical. The base of the tube may be up or down at the option of the circuit designer.

SOCKETS - The EIMAC air-system sockets SK-300A and SK-360 are designed especially for the concentric base terminals of the 4CX15,000R. The SK-300A is recommended for use through 30 MHz, while the SK-360 is recommended for applications in the VHF range. The use of recommended airflow rates though through the socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the base of the tube, through an air chimney, and into the anode cooling fins. The SK-360 incorporates low-inductance filament bypassing in the form of 3 5000 pF copper-clad Kapton® capacitors. A screen grid bypass. capacitor kit (the SK-355) is also available for the SK-360 socket, and includes 8 1000 pF 5000 DCWV capacitors (EIMAC P/N 050706), 16 mounting clips (EIMAC P/N 242859), and an assembly drawing.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic/metal seals below 250°C. Airflow requirements to maintain tube temperatures at 225°C with incoming cooling air at 50°C are shown for operation below 30 MHz. The data is for sea level with the tube mounted in an SK-300A socket with an SK-316 air chimney, and the pressure drop values should be considered approximate. At 5000 feet both air flow and pressure drop must be increased by a factor of 1.2; at 10,000 feet the factor is 1.46.

Plate Dissipation (kW)	Air Flow (cfm)	Pressure Drop In.Water
7.5	230	0.7
12.5	490	2.7
15.0	645	4.6

The blower selected in a given application must be capable of supplying the desired airflow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.
It is considered good practice to allow for such variables as dirty air filters, rf seal heating, and the fact that the anode cooling fins may not be clean if the tube has been in service for some time without cleaning. Temperature-sensitive paint is available for checking temperatures before any design is finalized. Air flow must be applied before or simultaneously with the application of electrode voltages, including the filament, and normally should be maintained for a short period of time after all power is removed.
An air interlock system should be incorporated in the design to automatically remove all voltages from the tube in case of even partial failure of cooling air.

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 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, load variation, or manufacturing variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

MESH FILAMENT - The 4CX15,000R thoriated-tungsten mesh filament is more rugged than a standard hairpin type filament, but the tube should still be protected from severe shock and vibration.

FILAMENT OPERATION - At rated (nominal) filament voltage the peak emission capability of the tube is many times that needed for communication service. A reduction in filament voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. Voltage should gradually be reduced until there is a slight degradation in performance (such as power output or distortion). The voltage should then be increased approximately two tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked after 24 hours. Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations.
Filament voltage should be measured at the tube base or socket, using an accurate rms-responding

meter. Periodically throughout the life of the tube the procedure outlined above for reduction of voltage should be repeated, with voltage reset as required, to assure best tube life.

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings must be respected to avoid damage to the tube. An exception is plate dissipation which may be permitted to rise above the rated maximum during brief tuning periods.

GRID OPERATION - The maximum control grid dissipation is 200 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. It is recommended that a protective spark-gap device should be connected between the control grid and the cathode to guard against excessive voltage.

SCREEN OPERATION - The maximum screen grid dissipation is 450 watts. With no ac applied to the screen grid, dissipation is simply the product of dc screen voltage and the dc screen current. With screen modulation, dissipation is dependent on rms screen voltage and rms screen current. Plate voltage, plate loading, or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

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.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and coolant interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with the tube anode, to help absorb power supply stored energy if an internal arc should occur. The protection criteria 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 AWG copper wire. The wire will remain intact if protection is adequate.

EIMAC Application Bulletin #17 titled FAULT PROTECTION contains considerable detail, and is available on request.

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 affect. Public health agencies are concerned with the hazard even at these frequencies. OSHA (Occupational Safety and Health Administration) recommends that prolonged exposure to rf radiation should be limited to 10 milliwatts per square centimeter.

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 a specially constructed test fixture which shields all external tube leads or contacts from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. The capacitance values shown in the technical data 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 the appliction. Measurements should be taken with the mounting which represents 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: Product Manager; 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:

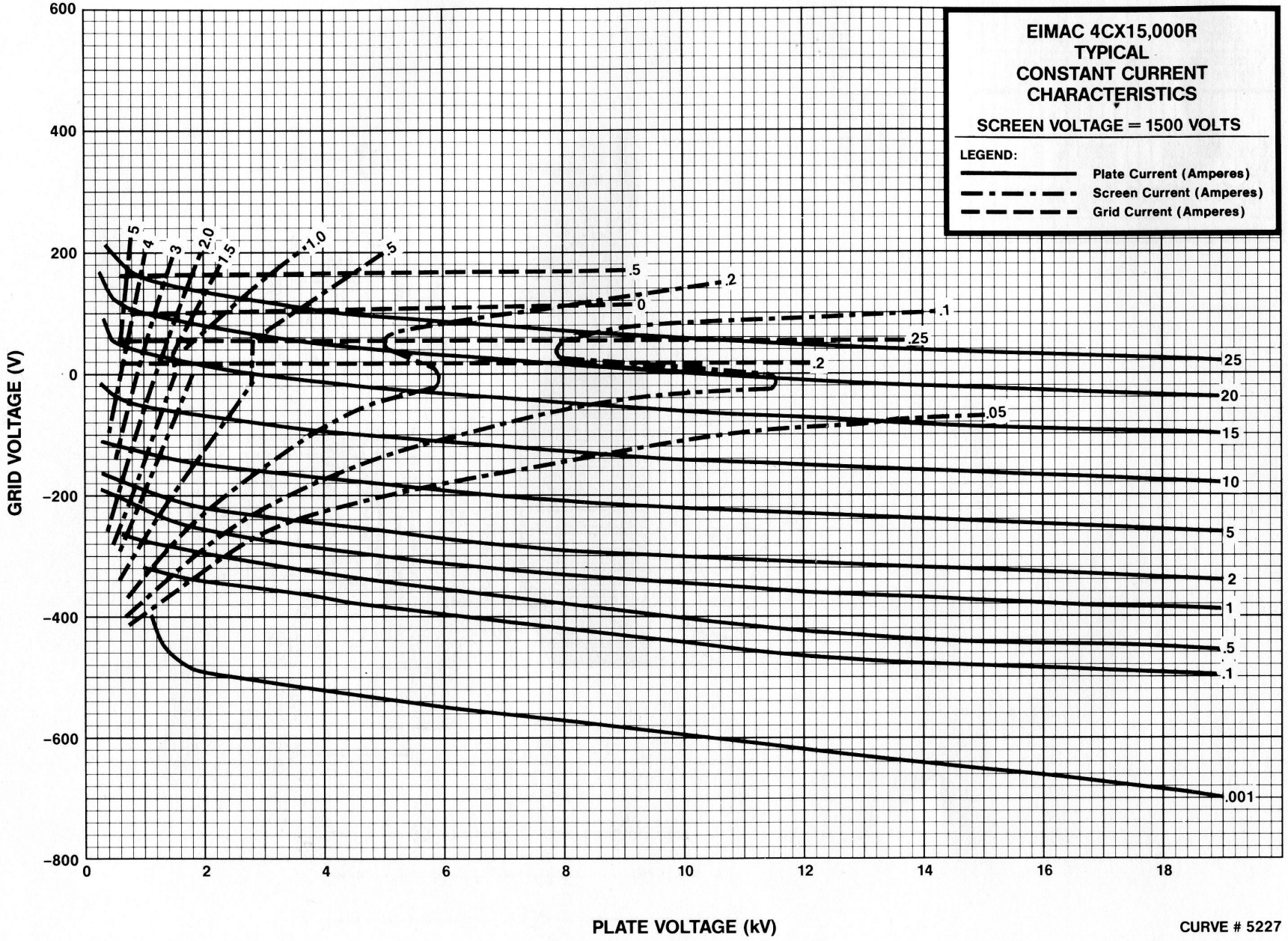
a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

b. 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.

c. 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.

d. 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: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.


EIMAC 4CX15,000R
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
LEGEND:
Plate Current (Amperes)
Screen Current (Amperes)
Grid Current (Amperes)
GRID VOLTAGE (V)
600
400
200
0
-200
-400
-600
-800
0
2
4
6
8
10
12
14
16
18
PLATE VOLTAGE (kV)
5
4
3
2.0
1.5
1.0
.5
.2
.1
.05
.001
25
20
15
10
5
2
1
.5
.1
CURVE # 5227

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM	MIN.	MAX	REF.	MIN.	MAX	REF
A	7.460	7.580		189.48	192.53	
B	.855	.895		21.72	22.73	
C	.600	.760		15.24	19.30	
D	1.896	1.936		48.16	49.17	
E	3.133	3.173		79.58	80.59	
F	3.792	3.832		96.32	97.33	
G	3.980	4.020		101.09	102.11	
H	.188			4.78		
J	.188			4.78		
K	.188			4.78		
M	4.550	4.783		115.57	121.49	
N	2.412	2.788		61.26	70.82	
P	9.000	9.375		228.60	238.13	
S	3.560	3.684		90.42	93.57	
T	.375			9.53		
U	4.406	4.468		111.91	113.49	
V	3.718	3.781		94.44	96.04	
W	.219			5.56		

NOTES:

1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. DIMENSIONS IN [ ] ARE MILLIMETERS.
3. * CONTACT SURFACE.
4. OPTIMUM FILAMENT & GRID CONNECTOR HEIGHTS FOR SOCKET DESIGN PURPOSES.