



TECHNICAL DATA

HIGH-MU VHF TRIODE YC-156A

The Eimac YC-156A is a rugged ceramic/metal high-mu power triode designed for pulsed rf applications. Utilizing beam-forming cathode and control grid geometry, this tube provides the gain of a tetrode with circuit advantages and simplified design of a triode. The attributes of high gain, low grid interception and outstanding intermodulation performance make this tube well suited for application such as MRI and pulsed linear amplifier service.

The YC-156A is suitable for replacing the YC-156 in applications of pulsed rf amplifier service. This tube has a maximum anode voltage of 6500 volts and a peak anode current rating of 67 amperes. The anode is forced-air cooled for 5000 watts of dissipation. The YC-156A does not require a socket.

GENERAL CHARACTERISTICS¹

ELECTRICAL

Cathode: Oxide Coated, Unipotential	
Heater Voltage.....	15.0 ± 0.75 V
Current @ 15.0 volts	15.0 A
Minimum Warm-up Time.....	6 Min
(before application of rf drive and high voltage)	
Amplification Factor (approx)	200
Direct Interelectrode Capacitance (grounded grid) ²	
Cin.....	92.5 pF
Cout.....	36.2 pF
Cpk.....	0.35 pF
Frequency of Maximum Rating.....	150 MHz
(in Pulsed RF Service)	

MECHANICAL

Overall Dimensions:	
Length.....	8.25 in; 20.96 mm
Diameter.....	4.94 in; 12.55 mm
Net Weight.....	9.5 lb; 4.3 kg
Operating Position.....	Vertical, Base Up or Down
Maximum Operating Temperature:	
Ceramic/Metal Seals.....	250°C
Anode Core.....	250°C
Cooling.....	Forced Air
Base.....	Designed for Direct Chassis Mounting
Socket.....	None Required
Recommended Air Chimney.....	SK-306
Available Anode Connector Clip.....	Eimac ACC-3

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.





YC-156A

**PULSED RADIO FREQUENCY POWER AMPLIFIER
CATHODE DRIVEN - Class AB**

**TYPICAL OPERATION (to 30 MHz)
(Measured Data)**

ABSOLUTE MAXIMUM RATINGS:

DC Anode Voltage.....	6.5	Kilovolts
Peak Anode Current #	67	Amperes
DC Anode Current.....	3.75	Amperes
Anode Dissipation.....	5.0	Kilowatts
DC Grid Current.....	+0.1	Ampere
Instantaneous Grid/Cathode Voltage	560	Volts
Grid Dissipation.....	25	Watts

Anode Voltage.....	5.5	6.0	kVdc
Zero-Signal Anode Current.....	0.5	0.75	A
Pulse Anode Current #.....	3.9	5.25	A
Cathode Bias.....	+33	+30	Vdc
Pulse Grid Current * #.....	30	40	mA
Peak Driving Power *.....	425	750	W
Pulse Power Output # ¶.....	14	20	kW
Power Gain.....	15	14.2	dB
Cathode Input Impedance.....	23	19	Ω
Resonant Load Impedance.....	1100	600	Ω
Intermodulation Distortion ¹ :			
3 rd Order Products.....	-33	-30	dB
5 th Order Products.....	-38	-35	dB

* Approximate values.
Average during the pulse
¶ Power delivered to the load

NOTE: ¹To prevent excessive anode dissipation the tube must be cut off between pulses; a bias switching scheme should be employed to accomplish this. IMD is that of a similar product in CW service.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified anode current at the specified bias and anode 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

	<u>Min.</u>	<u>Max.</u>	
Cathode Warm-up Time.....	6	---	Minutes
Interelectrode Capacitance (Grounded Grid Connection) ¹			
Cin.....	88.0	100.0	pF
Cout.....	28.0	42.0	pF
Cpk.....	---	0.50	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

MECHANICAL

MOUNTING & SOCKETING - The YC-156A should be operated vertically, base up or down, and should be protected from severe shock and vibration. The tube is designed to be bolted directly to the chassis (by the grid flange) in equipment designed for dc and rf grounded grid circuit configuration. The mounting may be insulated for other circuitry. A flange with four threaded inserts is provided for a low-inductance cathode connection. A similar provision is made for the heater connection.

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.

COOLING - Forced-air cooling must be provided to maintain the anode core and seal temperatures at a safe temperature. Data shown are for cooling air at 25°C, 35°C and 50°C, summarizing minimum requirements to limit tube temperatures to 225°C. The pressure drop figures are approximate.


INLET AIR TEMPERATURE = 25°C

Plate Dissipation (kW)	SEA LEVEL		5,000 FEET		10,000 FEET	
	Air Flow (CFM)	Pressure Drop (In. H ₂ O)	Air Flow (CFM)	Pressure Drop (In. H ₂ O)	Air Flow (CFM)	Pressure Drop (In. H ₂ O)
2,000	30	0.1	35	0.1	45	0.1
3,000	65	0.3	75	0.3	95	0.4
4,000	115	0.8	140	0.9	165	1.0
5,000	210	2.2	220	2.0	265	2.3

INLET AIR TEMPERATURE = 35°C

Plate Dissipation (kW)	SEA LEVEL		5,000 FEET		10,000 FEET	
	Air Flow (CFM)	Pressure Drop (In. H ₂ O)	Air Flow (CFM)	Pressure Drop (In. H ₂ O)	Air Flow (CFM)	Pressure Drop (In. H ₂ O)
2,000	35	0.1	40	0.1	50	0.1
3,000	75	0.3	90	0.4	105	0.4
4,000	130	0.9	160	1.1	190	1.3
5,000	180	1.7	255	2.5	305	3.0

INLET AIR TEMPERATURE = 50°C

Plate Dissipation (kW)	SEA LEVEL		5,000 FEET		10,000 FEET	
	Air Flow (CFM)	Pressure Drop (In. H ₂ O)	Air Flow (CFM)	Pressure Drop (In. H ₂ O)	Air Flow (CFM)	Pressure Drop (In. H ₂ O)
2,000	40	0.1	50	0.1	60	0.2
3,000	90	0.5	110	0.5	135	0.6
4,000	165	1.3	200	1.6	240	1.8
5,000	260	3.1	315	3.7	385	4.3

It is considered good engineering practice to design for a maximum anode core temperature of 225°C, and temperature-sensitive paints are available for checking base and seal temperatures before any design is finalized. It is also considered good practice to allow for variables such 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 length of time. Eimac Application Bulletin #20 titled TEMPERATURE MEASUREMENTS WITH EIMAC TUBES discusses this subject and is available on request.

Forced air cooling of the base is also required, with air directed past the seal areas. An air interlock system should be used to automatically remove all voltages from the tube in case of even partial failure of the tube cooling air. Airflow must be applied before or simultaneously with the application of power, including the tube heater, and

should normally be maintained for several minutes after power is removed for tube cool-down.

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 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 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.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly. 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 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

HEATER/CATHODE OPERATION - Rated heater voltage for the YC-156A is 15.0 volts AC or DC, as measured at the base of the tube, and short-term variations should be limited to ±0.75 volt for good life and consistent performance.

Pulse current capability of the YC-156A is dependent on cathode temperature, which in turn is dependent on heater voltage. For most consistent performance in pulsed rf service regulation of the heater voltage to limit variation to plus/minus one percent is recommended. Heater voltage should be measured with a known accurate RMS-responding meter.

This tube is designed for normal commercial service, where one heater on/off cycle is anticipated per day. Contact Eimac Application Engineering if more daily on/off cycles are expected.

CATHODE WARMUP/COOLDOWN TIME - It is recommended that heater voltage be applied for a minimum of 6 minutes before anode voltage and drive voltage are applied, to allow for proper conditioning of the



cathode surface. It is also recommended that after all voltages are removed from the tube that air cooling be allowed to run for several minutes to allow for proper cool down.

INPUT CIRCUIT - When this tube is operated as grounded-grid rf amplifier, the use of a resonant tank in the cathode circuit is recommended in order to obtain greatest linearity and power output. For best results with a single-ended amplifier, it is suggested that the cathode tank circuit operate at a "Q" of three or more.

GRID OPERATION - The maximum rated dc grid bias voltage for the tube is -250 volts and the maximum grid dissipation is 25 watts. The maximum instantaneous grid/cathode voltage must not exceed 425 volts, and average grid current should never exceed 100 mA dc.

In normal applications the grid dissipation will not approach the maximum rating. In applications where pulse duration exceeds 100mS or duty factor is high, the electrode dissipation ratings may prevent attaining peak anode current substantially over the dc rating.

Oxide cathode tubes may exhibit reverse grid current. Protective circuitry for detection of overload and fault conditions should be capable of accepting current flow in either direction. This type of circuitry is necessary to prevent excessive grid dissipation and resulting tube degradation which can occur if proper output (anode) tuning or loading is lost due to failure in the tuned circuit or failure in the load.

A protective spark gap such as the Siemens #B1-C145 connected between the cathode and grid will help protect the tube in the event of an internal arc. A maximum of four (4) joules total energy may be permitted to dissipate into a grid-cathode arc. Amounts in excess of this will permanently damage the cathode or grid structure. Additional information is given in Eimac Application Bulletin #17 titled FAULT PROTECTION, available on request.

CW OPERATION - Normal Class C operation is not permitted. Operation should be restricted to Class A, AB and B service. Operation in pulsed Class C is permissible only with low duty and short duration service.

New designs using tubes in pulse applications should include consideration of tube-to-tube performance variations which may effect equipment performance.

ANODE CURRENT - For pulsed service, a peak anode current (during the pulse) of up to 67 amperes is available. Peak current capability, pulse length, and duty factor are interrelated and the Pulse Derating Chart should be consulted. To use this chart, enter with pulse duration and

note the intersection with the desired pulse anode current. At this intersection read off values of maximum duty and/or pulse repetition rate.

The pulse derating chart is intended to allow selection of operating parameters which give a reasonable tube life. Operating under experimental combinations of maximum plate current and pulse duration which are outside the ranges of the chart may give useful results at low repetition rates, with a resulting tube life commensurate with that type of operation.

New designs using tubes in pulse applications should include consideration of tube-to-tube performance variations which may effect equipment performance.

ANODE OPERATION - The anode of the YC-156A is nominally rated for 5000 watts with forced-air cooling. In pulse service the average anode dissipation may be calculated as the product of pulse anode current, pulse tube-voltage drop during conduction, and the duty factor. Actual dissipation may often exceed the calculated value, if pulse rise and fall times are appreciable compared to pulse duration. This occurs because long rise and fall times allow anode current to flow for longer periods in the high tube-voltage drop region.

FAULT PROTECTION - All power tubes operate at voltages which can cause severe damage in the event of an arc, especially in cases where large amounts of power supply stored energy are involved. Some means of protection is advised in all cases, and it is imperative that a series resistor be used in the lead from the power supply to 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 ohms, with at least a 200W rating, in the positive anode power supply lead will help protect the tube in the event of an arc. A crowbar circuit which utilizes a high-speed switch tube is especially recommended for protection of the YC-156A in pulse service.

Energy dissipated in the event of an arc must be limited to no more than 4 joules to prevent damage to the tube and consequential degradation in performance. EIMAC Application Bulletin #17 titled FAULT PROTECTION discusses this subject and is available on request.

VHF OPERATION - Operation at VHF should be conducted with heavy anode loading and the lowest drive power consistent with satisfactory performance. It is preferable to operate at a sacrifice in efficiency to obtain increased tube life. VHF driving power will be greater than the typical values shown on page 2 because of higher circuit losses.

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.

RF 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 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 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 the **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. 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.**

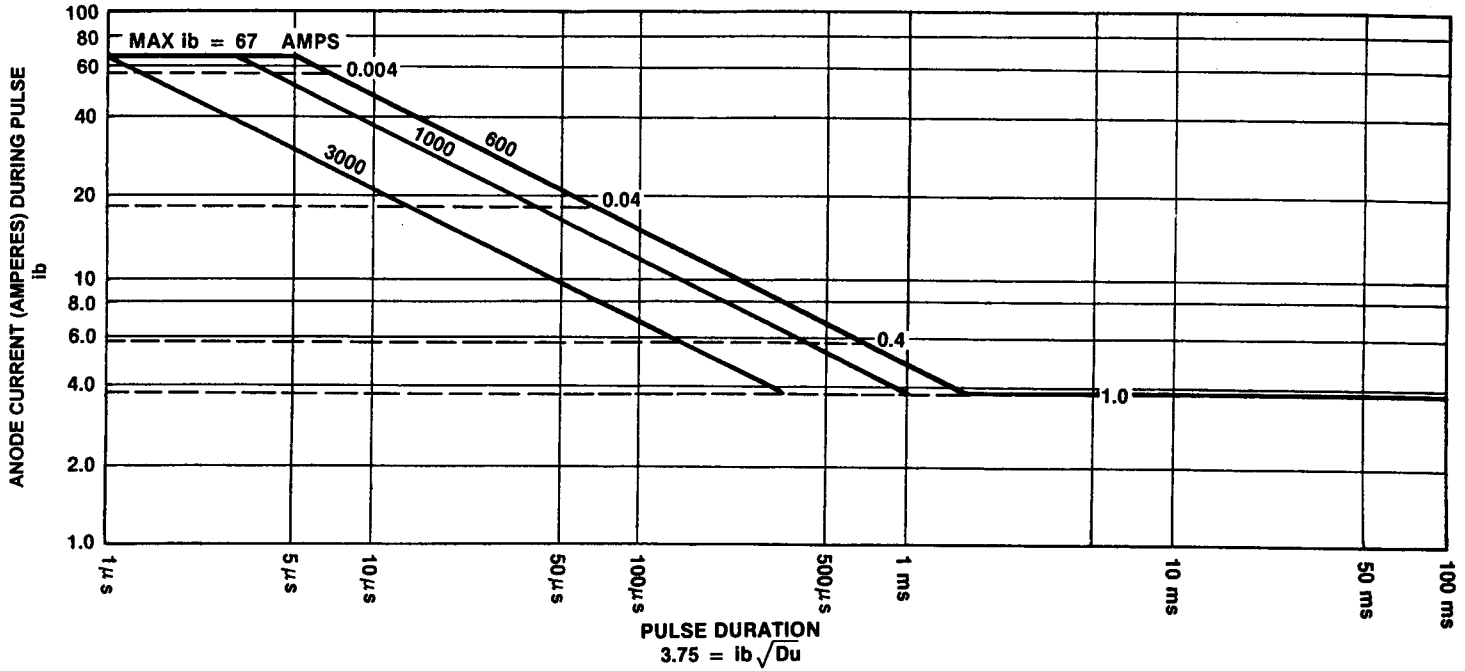
HOT SURFACES – Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

MATERIAL COMPLIANCE - This product and package conforms to the conditions and limitations specified in 49CFR 173.424 for radioactive material, excepted package-instruments or articles, UN2910. In addition, this product and package contains no beryllium oxide (BeO).

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

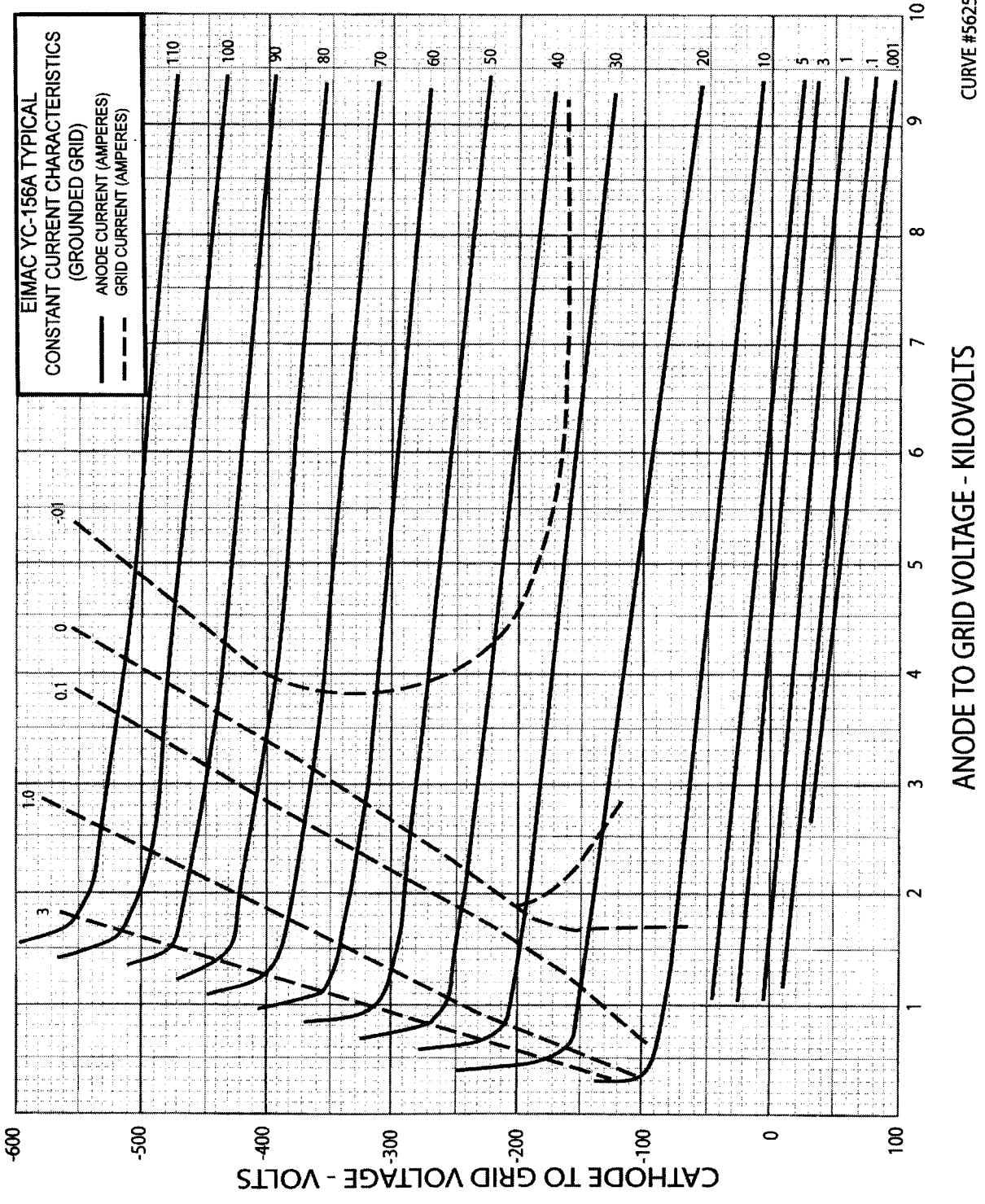


PULSE DERATING CHART



Solid lines represent constant repetition rates. Dashed lines represent constant duties. Do not extrapolate above or to the right of bold lines which set boundaries of maximum anode current and minimum repetition rate, respectively.

Refer to ANODE CURRENT section on page 4 for discussion of this chart.



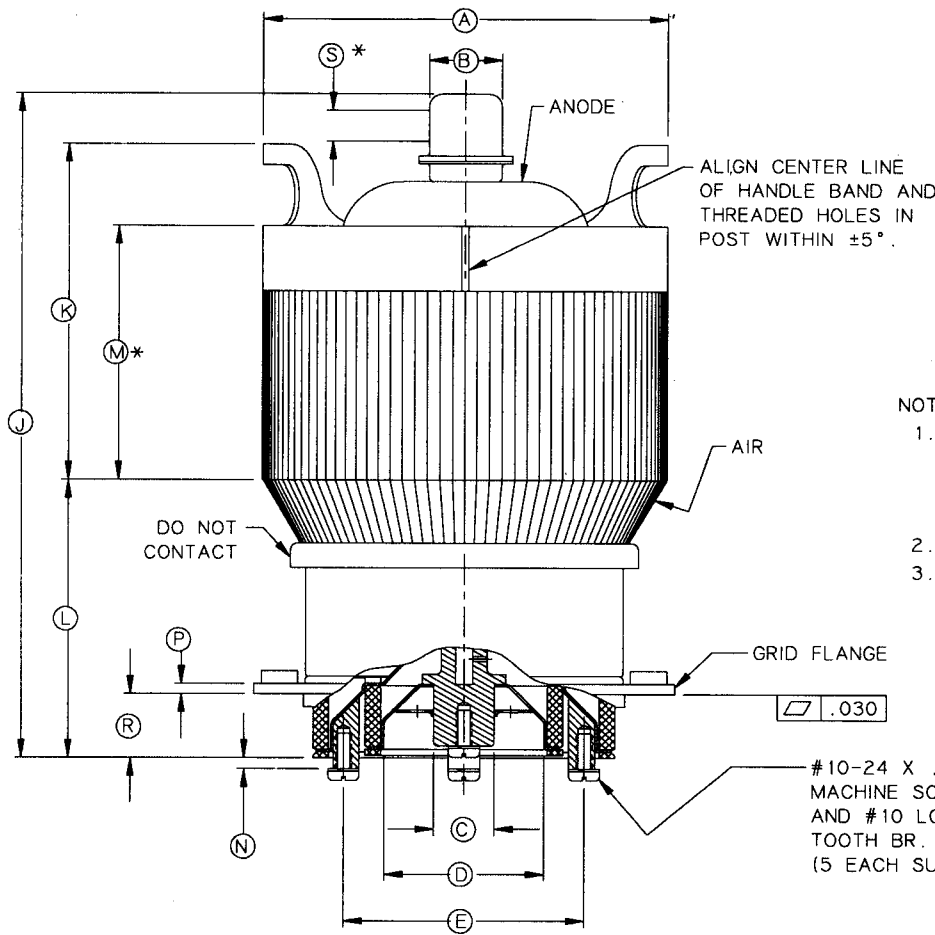
CURVE #5625

ANODE TO GRID VOLTAGE - KILOVOLTS

CATHODE TO GRID VOLTAGE - VOLTS



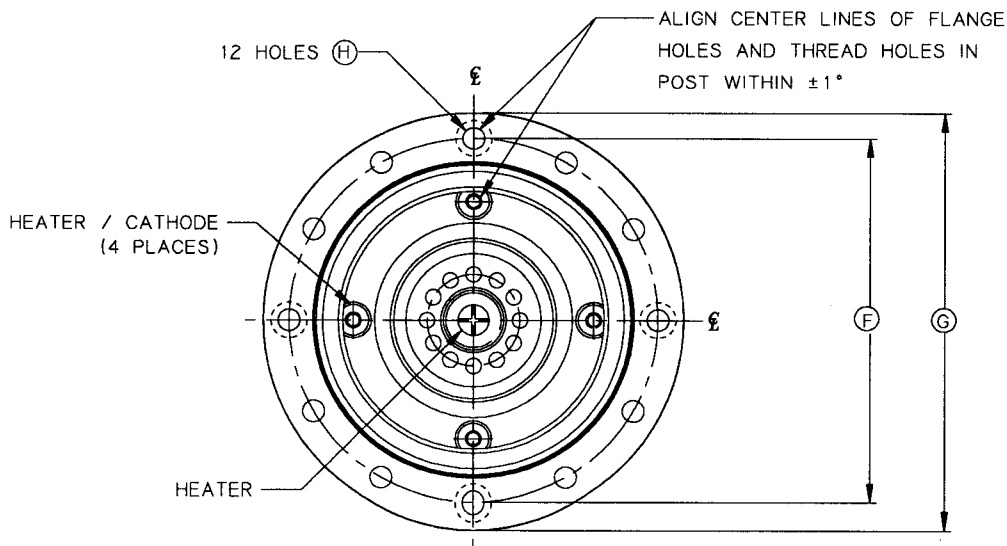
YC-156A



DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	4.812	4.938		122.22	125.43	
B	.855	.895		21.72	22.73	
C	.600	.760		15.24	19.30	
D	1.896	1.936		48.16	49.17	
E	2.895	2.935		73.53	74.55	
F	4.425	4.445		112.40	122.90	
G	5.030	5.090		127.76	129.29	
H			.265			6.73
J	8.017	8.267		203.63	209.98	
K	3.925	4.299		99.70	109.19	
L	3.223	3.597		81.86	91.36	
M	2.925	3.299		74.30	83.79	
N	.093	.156		2.36	3.96	
P			.125			3.18
R	.721	.845		18.31	21.46	
S	.375			9.53		

NOTES:

1. REF. DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. (*) CONTACT SURFACE
3. FLANGE, THREADED HOLES AND HANDLE BAND ALL TO BE ALIGNED WITHIN $\pm 5^\circ$.



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