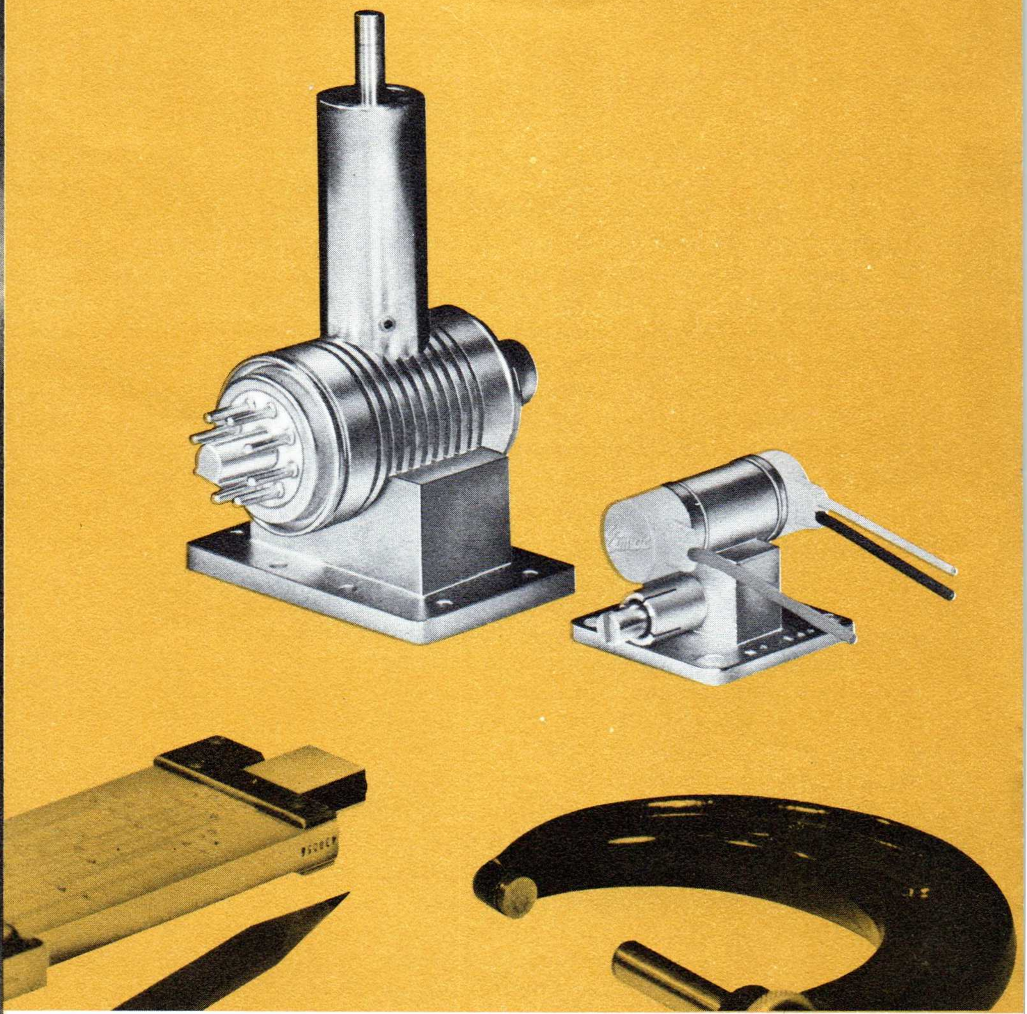
CERAMIC REFLEX KLYSTRONS



These new C- and X-Band Reflex Klystrons employ Eimac stacked-ceramic design for ruggedness, reliability and exceptional performance.

The simple advantages of the reflex klystron which originally prompted its use in microwave transmitters and receivers are still valid in up-to-date ground communications or air-borne radar systems. One demand of newer systems, however, is greater ruggedness manifested as greater basic frequency stability. This new line of reflex klystrons takes full advantage of Eimac-developed ceramic-metal design and achieves excellent frequency stability under conditions of shock, vibration and temperature extremes.

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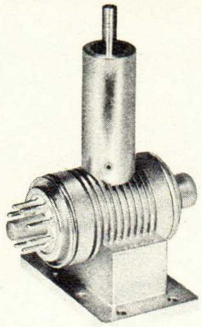
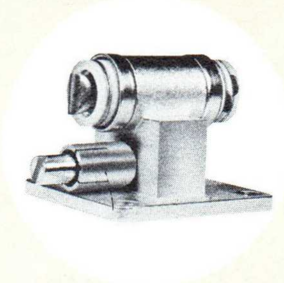
The World's Largest Manufacturer of Transmitting Tubes



1K125 series C-Band Reflex Klystron

EIMAC CERAMIC REFLEX KLYSTRONS

Two-Watt Reflex Klystrons for Transmitter Service



1K20 series X-Band Reflex Klystron (before encapsulation)

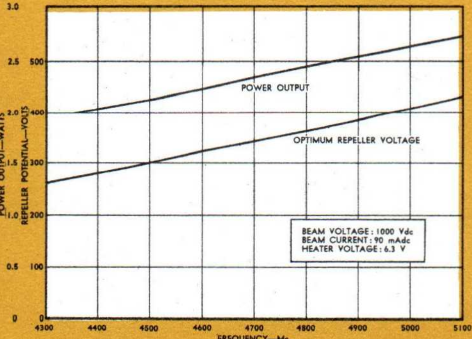
The 1K125CA and 1K125CB klystrons for transmitter service cover the frequency ranges of 3700 to 4400 megacycles and 4400 to 5000 megacycles. Among the advanced features of these new tubes are the ceramic vacuum seals for the RF output window and the repeller stem. The standard octal base is also ceramic. The waveguide output is matched so that the tube will deliver its rated power into a flat load over the entire tuning range without the necessity of additional matching devices or load couplers. Integral cooling fins are provided for adequate body cooling with an air flow of 20 CFM.

A desirable design goal for a klystron in this type of service is to cover a wide portion of the frequency spectrum with as few tubes as possible. Another desired feature is a tuning method that operates without changing the grid gap spacing. Such changes are always in the opposite direction to that required for optimum gap transit angle. In addition, the tuning rate is usually so great with gap tuning that reliable frequency resettability cannot be achieved. The tuning mechanism for the 1K125CA and 1K125CB klystrons consists of a low-loss ceramic plunger which is moved in or out of the cavity by means of a bellows. The plunger is non-contacting within the cavity but is supported by two bearing surfaces for smooth tuning control. Since the cavity gap need not be changed for tuning, the cavity walls are rigidly constructed and the entire tube can withstand vibration forces of 10G in any plane.

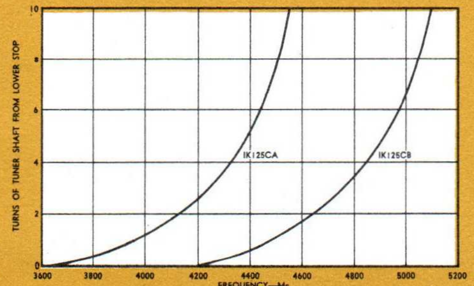
The electrical performance of a reflex klystron is dependent upon its beam optics which includes the design of the electron gun and repeller. Power output and efficiency, modulation linearity and electronic bandwidth, and residual FM noise are all affected by the electron beam design. An important part of the gun design for these tubes is its gridless accelerating anode. Because of the circuit advantage of operating the tube at a relatively low beam voltage, the resulting gun perveance ($I_0/V_0^{3/2}$) is high. If a gridded anode is used, a high perveance is easily attained. However, such a design has two serious disadvantages. The first is that the grid, no matter how well designed, will intercept some of the beam. The lost electrons subtract from the tube's efficiency and result in unwanted heating of the grid. Secondly, the accelerating grid and the first cavity grid, if separated by an appreciable drift space, constitute a trap for ions. This drift space, closed at each end by a gridded surface of positive potential, will trap ions in the beam until an unstable plasma of ions and electrons is formed. The result is excessive residual noise or self-modulation of the tube by plasma oscillation. If a gridless gun is used, as in the 1K125CA and 1K125CB klystrons, the ions are free to drain from the beam toward either the cathode or repeller electrode. A perveance of 3.0×10^{-6} was achieved in the gun for these tubes with a beam transmission of 90% through the anode and both cavity grids.

The repeller electrode was designed to reflect the electrons in the beam along paths of uniform transit time. These paths are such that a high percentage of the returning electrons strike the outer rim of the grid or just graze the outer diameter of the grid support post. Thus the grid heating in the gap is kept to a minimum and electronic hysteresis due to multiple transit electrons is reduced to a low value.

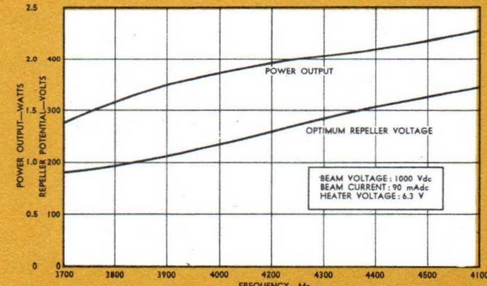
The 1K125CA and 1K125CB klystrons are intended to deliver 1.5 to 2.0 watts CW output power over their respective tuning ranges. In addition to the relatively high power output, these tubes exhibit excellent characteristics for use in FM communications systems.



1K125CB Reflex Klystron: Power Output and Repeller Voltage vs. Frequency.



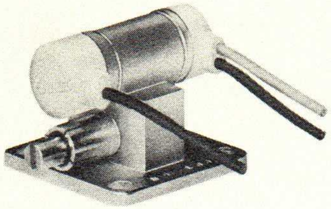
Frequency coverage of the 1K125CA and 1K125CB Reflex Klystrons related to tuning rate.



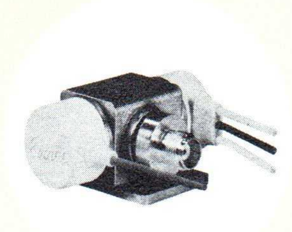
1K125CA Reflex Klystron: Power Output and Repeller Voltage vs. Frequency.

EIMAC CERAMIC REFLEX KLYSTRONS

Ruggedized Local Oscillator Klystrons



1K20 series X-Band Reflex Klystron (encapsulated)



X756 Fixed-tuned Reflex Klystron

The Eimac 1K20X and 1K20K series of X- and K-Band reflex klystrons are designed primarily for systems which are subjected to environments of high level vibration or shock and temperature extremes. This tube derives its ruggedness from two basic features. The first is the ceramic construction which enables the electrodes to be supported internally on a series of concentric cones. All parts, with the exception of the two heater leads, are brazed in place for added strength. The second feature is the resonant cavity design which consists of a fixed-tuned (and hence rugged) inner cavity closely coupled through a ceramic window to a secondary cavity outside the vacuum. Tuning over a minimum range of 700 megacycles per tube is accomplished by a capacitive slug.

Electrically the performance of the 1K20X and 1K20K tubes is not far different from that expected of reflex types used as local oscillators and the details need not be recited. Of interest however, is the unusual performance of the tube under vibration. The ability of a receiver klystron to stand up under vibration is measured by the amount of FM noise or peak-to-peak frequency deviation introduced into the tube's output by the applied vibration. A deviation of less than 1 megacycle at vibration levels of 10 to 15G usually puts a tube into the so-called ruggedized class. At a vibration level of 15 or 20G, which is the normal testing level for some of the most exacting specifications, the peak-to-peak deviation of these tubes is less than 50 kilocycles for any vibrating frequency in the range of 20 to 2000 cycles, with the force applied in any plane of the tube. The advantage of a low FM noise level such as this in the local oscillator of a receiver system is self evident.

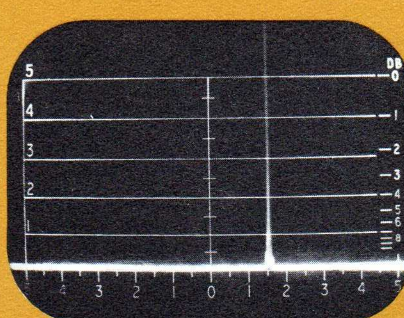
Because of their ceramic construction, these tubes are able to withstand temperature extremes or shocks not permissible with tubes sealed with glass or mica. This ruggedness and reliability is due partly to the greater strength of the ceramic and partly to the higher processing temperatures to which the ceramic tube may be subjected. These tubes may be operated without forced-air cooling at their rating of 20 watts input in an ambient temperature up to 100° C. Tube or seal temperatures can reach 250° C without impairment of operation.

X756 Fixed-Tuned Reflex Klystron

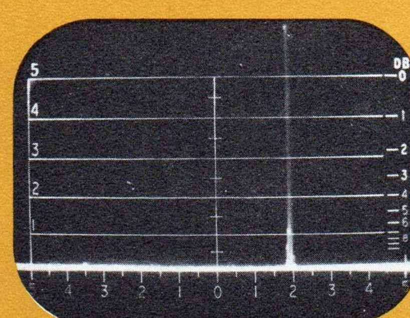
The latest addition to Eimac's line of ceramic-metal reflex klystrons is the integral-cavity, fixed-tuned X756. This tube is intended for use in altimeter applications and operates at a frequency of 4300 (±50) megacycles. Under typical electrical conditions with a beam potential of 500 volts d-c, a beam current of 35 mA and a repeller voltage of -150 volts d-c, the X756 achieves an output power of 300 milliwatts. Minimum output power at the 2¾ mode is one watt with a beam potential of 850 volts.

The X756 also incorporates a gridless electron gun which assures low residual noise and clean electronic tuning. Eimac ceramic design and integral cavity construction give this reflex klystron the ability to withstand the shock, vibration and acceleration encountered in airborne service.

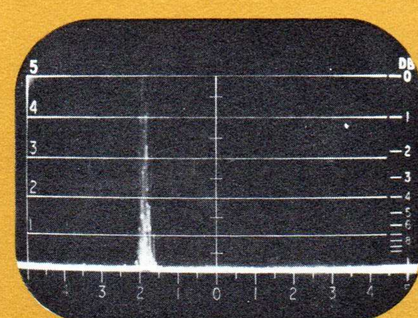
It is the purpose of this adaptation of Eimac ceramic techniques to small klystrons to help overcome a few of the hurdles of the microwave system designer and to make his product more reliable.



Spectrum analysis of 1K20KA being operated at 10.8 Kmc CW with no vibration applied to the tube. Each numbered division equals 100 kilocycles.



Spectrum analysis of 1K20KA being operated at 10.8 Kmc with a sinusoidal vibration of 40G at a rate of 50 cycles being applied axially to the tube. Peak-to-peak deviation is less than 50 kilocycles. Each numbered division equals 100 kilocycles.



Spectrum analysis of 1K20KA being operated at 10.8 Kmc with a sinusoidal vibration of 40G at a rate of 800 cycles being applied axially to the tube. Peak-to-peak deviation is 50 kilocycles or less. Each numbered division equals 100 kilocycles.

Preliminary Data

TYPICAL ELECTRICAL PERFORMANCE OF THE 1K125CA AND 1K125CB REFLEX KLYSTRONS

	1K125CA (4050mc)	1K125CB (4700mc)	
Beam Voltage	1000	1000	volts
Beam Current	90	90	ma
Heater Voltage	6.3	6.3	volts
Heater Current	1.1	1.1	amperes
Repeller Voltage	−250	−350	volts
Power Output (CW)	2.0	2.3	watts
Electronic Tuning ($P_o/2$)	50	40	mc
Repeller Modulation Sensitivity ($\Delta E_r = \pm 5$ volts)	500	400	kc/volt

	1K125CA (4050mc)	1K125CB (4700mc)	
Linearity at ± 2 Mc Deviation			
Level of Harmonics Below Fundamental:			
2nd Harmonic	−40	−40	db
All Other Harmonics	>−60	>−60	db
Residual FM Deviation (Noise)			
60 cycle	15	15	kc
Freq. Above 200 cps	<2	<2	kc
Carrier Shift	0	0	kc
Plasma Oscillation	None	None	......
Temperature Coefficient	75	50	kc/°C

1K20X AND 1K20K SERIES REFLEX KLYSTRONS

Klystron Type	Tuning Range
1K20XS	8,500 - 9,200 mc
1K20XK	9,200 - 10,000 mc
1K20XD	10,000 - 10,700 mc
1K20KA	10,700 - 11,500 mc

Maximum Ratings

Heater Voltage	6.3 ± 10%
Heater Current	1.0 amperes
Beam Voltage	350 volts
Beam Current	50 ma
Repeller Voltage	−500 volts
Altitude	Any
Seal Temperature	+250° C

Mechanical Characteristics

Cathode	Oxide, Unipotential
Output Connection	UG-39/U Waveguide Flange
Electrical Connections	Molded Silastic Caps with flexible leads
Mounting	Any position, by Waveguide Flange only
Tuning	Single Shaft; clockwise rotation decreases frequency
Cooling	Conduction; Maximum seal temperature +250° C

Typical Electrical Performance

Heater Voltage	6.3	volts
Heater Current	0.8	amperes
Beam Voltage	350	volts
Beam Current	45	ma
Reflector Voltage	−40 to	−200 volts
Power Output	75	mw
Electronic Tuning	30	mc
Peak-to-Peak FM Deviation 15 g, 20-2,000 cps	50	kc

TYPICAL ELECTRICAL PERFORMANCE OF THE X756 REFLEX KLYSTRON

Beam Voltage	850 volts
Beam Current	70 ma
Heater Voltage	6.3 volts
Heater Current	1.1 amperes
Frequency (Fixed-Tuned)	4300 ± 50 mc
Power Output	1 watt

Repeller Voltage	−350 volts
Electronic Tuning ($P_o/2$)	30 mc
Output Connection	TNC (Insulated)
Cooling	Heat Sink
Mounting	Heat Sink Flange

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