RAYTHEON

1 WATT CW ARGON ION LASER MODEL LG12

I. Laser Head

A. Total Power Output (4545Å to 5145Å) ..... 1 watt CW

B. Output Wavelengths Available: ..... 4545Å, 4579Å, 4658Å, 4727Å, 4765Å, 4880Å, 4915Å, 5017Å, 5145Å simultaneously

C. Principal Wavelengths: ..... 4880Å Power Output Min. 350 mW
5145Å Power Output Min. 350 mW

D. Wave Front: (1) ..A diffraction-limited, uniphase, coherent, spherical wavefront with single transverse mode.

E. Beam Diameter: ..... 2 mm at exit aperture

F. Beam Divergence: Less than 25 seconds of arc with collimating telescope

G. Cavity Mode Configuration: ..... Large Radius mirror

H. Dimensions: ..... 45" long x 14" wide x 10" high

I. Weight: ..... Less than 100 lbs.

II. Power Supply

A. Power Input: .. 208/230 volt, 3 phase, 60 cycle AC, 30 amps maximum

B. Dimensions: ..... 48" high x 22" deep x 32" wide

C. Weight: ..... 600 lbs.

III. Water Cooling: ..... Filtered Tap Water, Flow Rate 2 gpm, at 60 psi

IV. Argon Laser Warranty

A. All mechanical, electrical, optical parts and assemblies excluding discharge tube unconditionally warranted to be free from defects in workmanship and material for the first six months following delivery.

B. The discharge tube shall be warranted to operate at the specified output power for the first 4000 ampere hours input of customer operation.

NOTE: Argon tube refill service available.

Printed in U. S. A.

RAYTHEON

MICROWAVE AND
POWER TUBE DIVISION

information bulletin

50 WATT CW M-BWO WITH
HALF OCTAVE TUNING

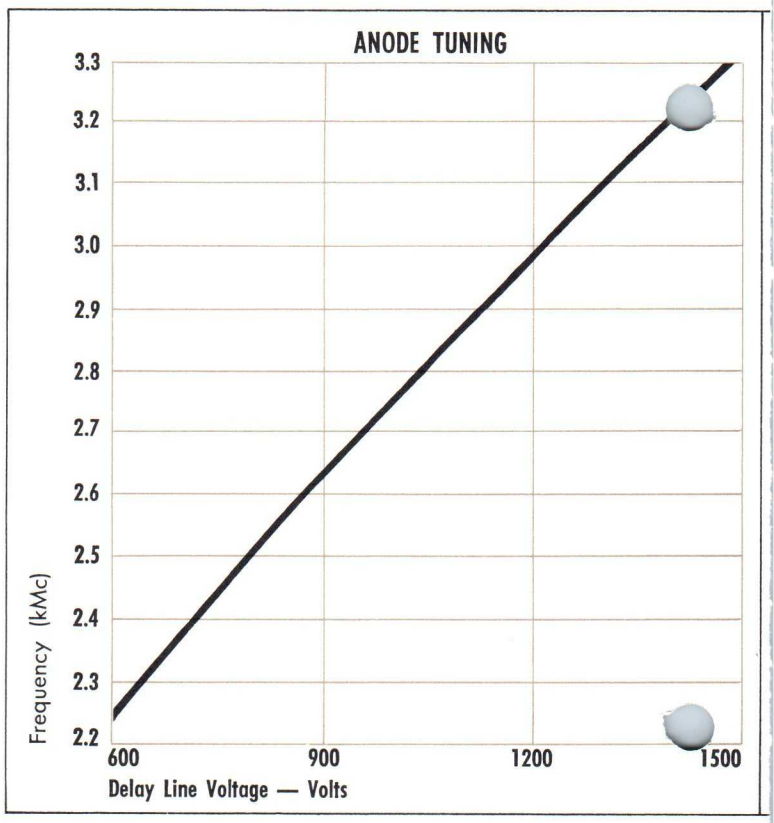
New M—BWO is smallest ever made

The QKA995 is the smallest M-BWO ever made. Measuring less than 4 inches in diameter and weighing 3½ pounds, this tube compares favorably in size with any voltage-tunable oscillator.

The QKA995 requires only conduction cooling, and is easily mounted by means of three lugs on the tube perimeter.

HALF-OCTAVE TUNING
No other voltage-tunable oscillator in the 50 watt power range approaches the wide tuning range of the QKA995. With anode tuning, the QKA995 has a 2200-3200 Mc range, with sole tuning, a 2700-3200 Mc range. These ranges are obtained with a voltage variation of only 750 volts for the anode or 350 volts for the sole.

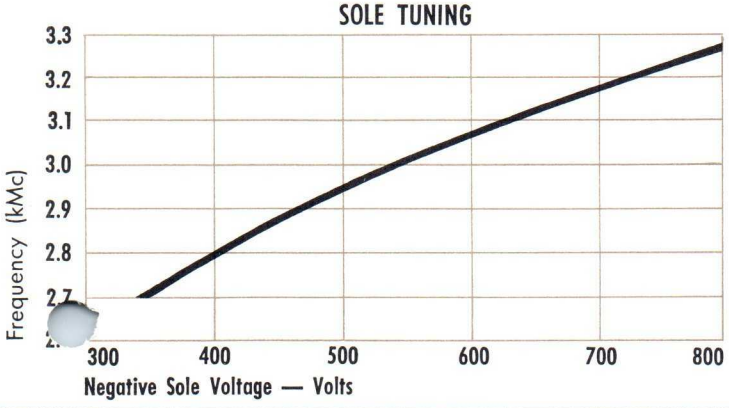
EFFICIENT
Efficiency is on the order of 40%, much higher than comparable low power tubes, including other voltage-tunable oscillators. Low weight and high efficiency gives the QKA995 higher watts/pound than any other voltage-tunable oscillator.

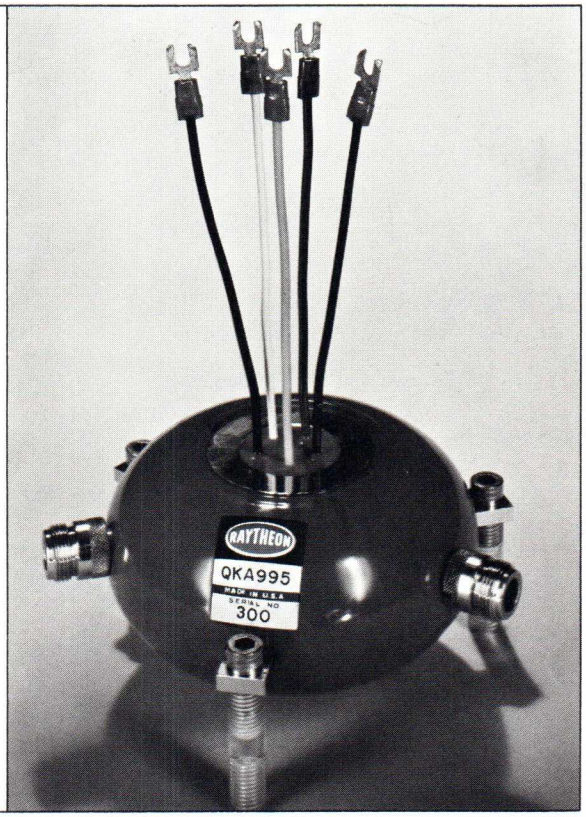


VERSATILE
Power needs for amplitude or frequency modulating and normal tuning are minimal, reducing modulator and power supply size, an important offering in portable and aerospace equipment. Modulation is achieved without spurious effects, and is under the complete control of the user.

RUGGED
The extremely rugged QKA995 was designed for use in nosecones and pods. It is of metal and ceramic construction and is very similar to Raytheon's higher power M-BWO's which have laboratory and field-proven reliability.

	SOLE TUNING	ANODE TUNING
Anode voltage	1200 V	600-1400 V
Anode current	115 mA	115 mA
Sole voltage	350-750 V	500 V
Sole current	0-7 mA	0-3 mA
Accelerator voltage	600 V	600 V
Frequency	2700-3200 Mc	2200-3200 Mc
Power	50 W	30-60 W
Weight	3½ lb	
Cooling	Conduction	





MASS MANUFACTURABLE

Basic design and assembly techniques have been patterned after Raytheon's high power line of tubes. This affords the QKA995 the same low-cost mass production capability as these high power tubes, many of which have been produced in very large volume.

APPLICATIONS

The QKA995 will fill a gap in microwave tubes wherever a rugged, high power voltage-tunable oscillator is needed. Equipment designers will find a new frontier opened in signal source, ECM, and communications equipment.

○ Pictured above

The QKA995 can also be made without internal attenuation and with a second output to permit frequency locking, adding another facet of versatility to its use.

For further information, you are invited to contact your nearest Raytheon office.

RAYTHEON REGIONAL OFFICES

NEW ENGLAND AREA AND UPPER NEW YORK STATE
Spencer Laboratory, Wayside Avenue, Burlington, Massachusetts, BRowning 2-9600

NEW YORK AREA
210 Sylvan Avenue, Englewood Cliffs, New Jersey, LOwell 7-4911 (New York City), WIsconsin 7-6400

WEST COAST AREA
225 North Van Ness, Hawthorne, California, PLymouth 7-3151

WASHINGTON
The Solar Building, Suite 601, 1000 Sixteenth Street, N.W., Washington 6, D. C., MEtropolitan 8-5205

SOUTH ATLANTIC AREA
100 Roesler Road, Glen Burnie, Maryland, SOuthfield 1-0450

MID-WEST AREA
9501 Grand Avenue, Franklin Park, Illinois, NAtional 5-4000

DAYTON
333 W. First Street, Room 455, Dayton 2, Ohio, BAldwin 3-8128

RAYTHEON CANADA LTD.
400 Phillips Street, Waterloo, Ontario, SHerwood 5-6831

IN EUROPE
Raytheon-Elsi AG, Alpenstrasse 1, Zug, Switzerland

IN OTHER AREAS OF THE WORLD
Raytheon Company, International Sales and Service, Lexington 73, Massachusetts

RAYTHEON

HIGH RESOLUTION CATHODE RAY TUBE

5CKP-

The 5CKP– is a 5 inch, high resolution, magnetic focus, magnetic deflection cathode-ray tube designed primarily for use in flying spot scanners. The 5CKP– has a spot size less than 0.001 inch and can therefore attain a resolution of approximately 4000 TV lines across the useful screen diameter. The tube is designed with an aluminized screen and uses an optical quality flat face-plate to minimize distortion.

GENERAL DATA

Phosphor	P11	P16	P24
Fluorescence	Blue	Violet + Near U-V	Green
Phosphorescence	Blue	Violet + Near U-V	Green
Persistence	Short	Extremely Short	Short
Focusing Method			Magnetic
Deflecting Method			Magnetic

ELECTRICAL DATA

HEATER CHARACTERISTICS:

Heater Voltage	6.3 volts
Heater Current	6 amps
Peak Heater-Cathode Voltage (Note 1)	
Heater Negative with Respect to Cathode	180 volts
Heater Positive with Respect to Cathode	180 volts

DIRECT INTERELECTRODE CAPACITANCE:

Grid 1 to all other electrodes	9 pf
Cathode to all other electrodes	2 pf

ABSOLUTE MAXIMUM RATINGS:

Collector Voltage	22,000 volts
Grid 2 Voltage	1500 volts
Grid 1 Voltage:	
Negative Bias Value	180 volts
Positive Bias Value	–2 volts
Positive Peak Value	0 volts

CHARACTERISTICS AND TYPICAL OPERATION:

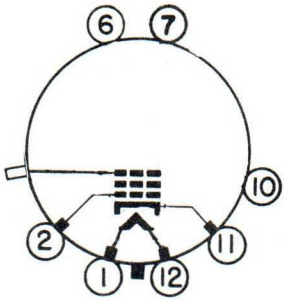
Collector Voltage	22,000 volts
Grid 2 Voltage	1,000 volts
Grid 1 Cutoff Voltage (Note 2)	–35 to –110 volts
Line Width (Note 3)	.001 inch max.

MAXIMUM CIRCUIT VALUES:

Grid 1 Circuit Resistance	1.5 meg. max.

MECHANICAL DATA

Base	JEDEC B7-51
Basing	12AM
Min. Screen Diameter	4.25"
Mounting Position	Any
Faceplate	Ground
Polished Flat;	
Thickness = 0.245 ± .005"	



BOTTOM VIEW

TERMINAL CONNECTIONS

Pin 1	Heater
Pin 2	Grid 1
Pin 7	Grid 2
Pin 11	Cathode
Pin 12	Heater
Cap	Grid 4 (Collector)

NOTES:

1. Cathode should be returned to one side or to the mid-tap of the heater transformer winding.

2. Visual extinction of an undeflected focused spot.

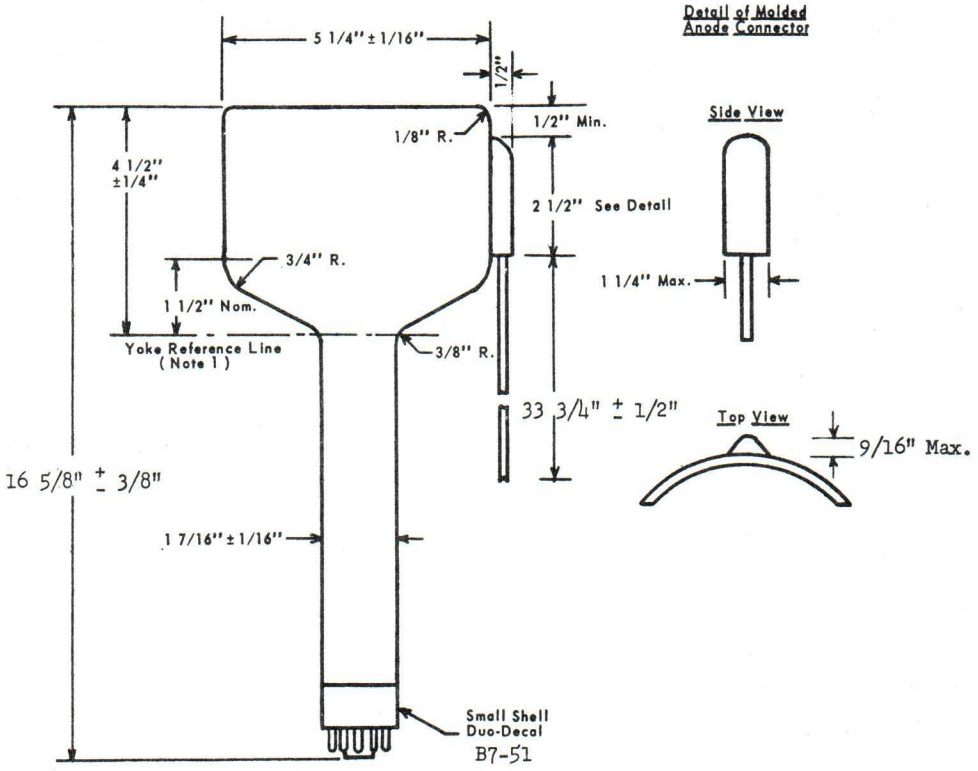
3. For optimum and uniform focus over the entire useful screen, it is recommended that dynamic focus be used. The wave shape of the dynamic focus voltage will depend on the type of scan used.

   Line Width is measured by the shrinking raster method in the center of the screen area and at a peak current of 25 uA. Scan rate is 30 usec./inch. The line width remains essentially constant over a wide range of brightness and current.

OPERATIONAL NOTES:

1. Specified data is attainable only when tube and coil assembly is shielded from external magnetic fields.
2. A high voltage insulting sleeve should be placed between focus and deflection coils and the tube neck to prevent corona heating of the glass.

3. Provide adequate X-ray shielding when tube is operated at anode voltages above 16,000 VDC.

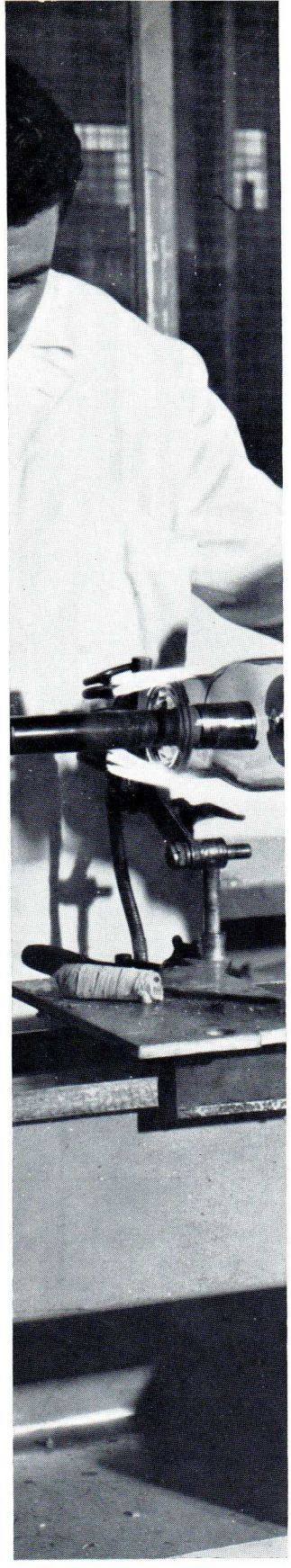


Note 1: Yoke Reference Line is the plane where a 1.500" + 0.003", –0.000" I.D. Ring Gauge will stop.
Note 2: Molded Anode Connector alignment with vacant pin position No. 3 has angular tolerance of = 10° measured about the tube axis.

5 DIVISIONS

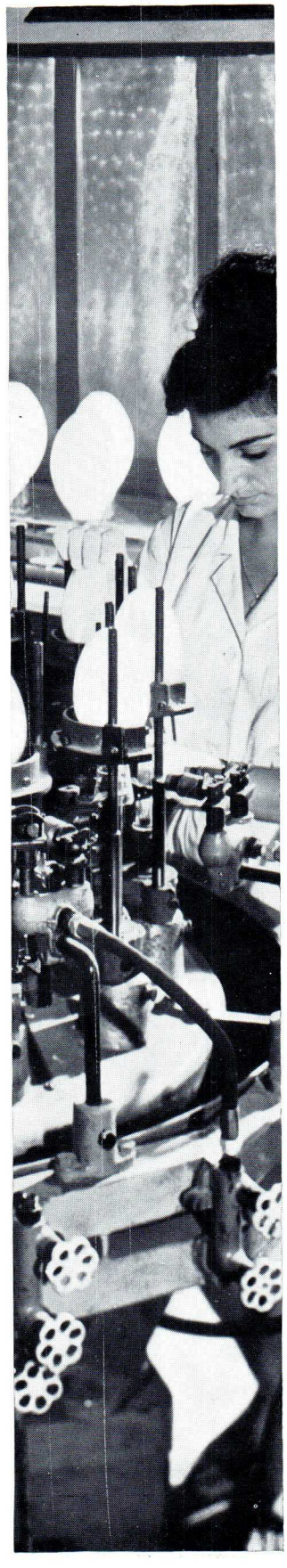
5 Divisions for the production of electronic components

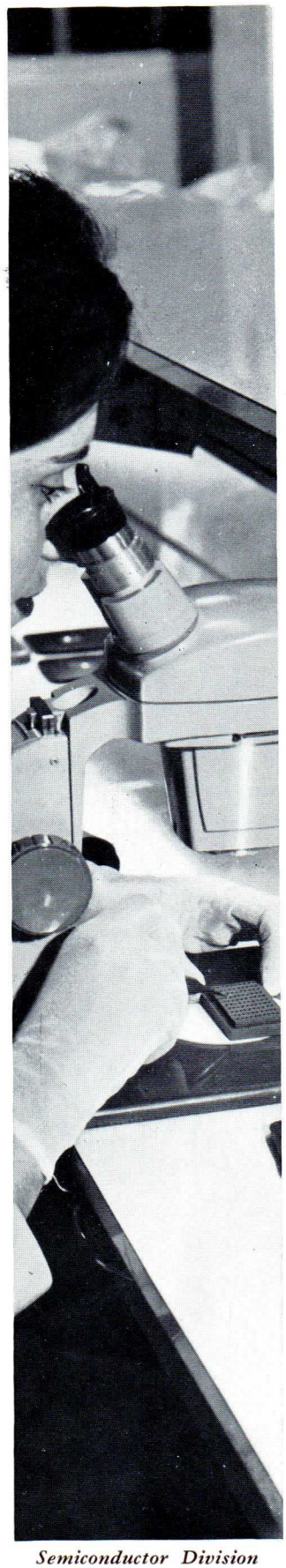
Microwave Tubes Division



X Ray Tubes Division

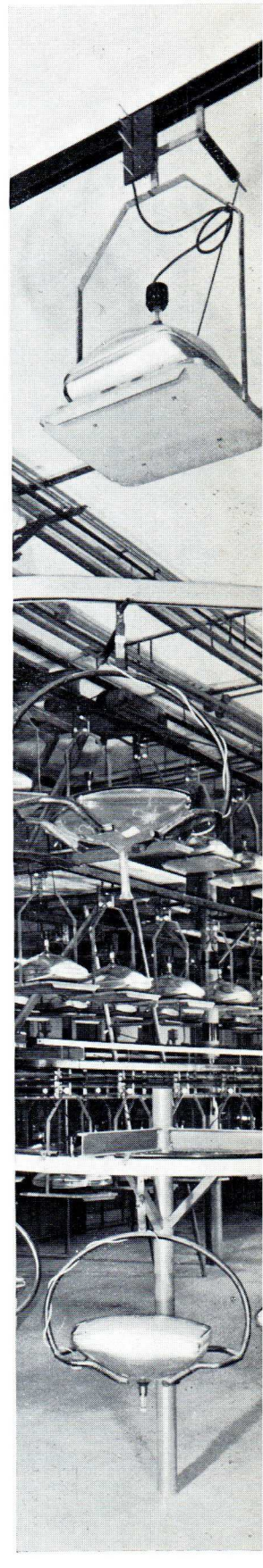
Lamps and Surge Arresters Division





Semiconductor Division

Cathode Ray Tubes Division



RAYTHEON

RAYTHEON-ELSI S.P.A.

PALERMO - ITALY

microwave tubes

The Microwave Tubes Division manufactures magnetrons, klystrons and stabilotrons for civilian and military use. This includes both mass production of low cost tubes and highly sophisticated production of the most technically advanced microwave tubes. A representative sample of its mass production is the QK707A. This tube, specifically designed for microwave heating, especially in radaranges, today is being sold in the United States in quantities of several thousands per year. Raytheon's entire production of radaranges, marketed all over the United States, presently uses Raytheon-Elsi made magnetrons as energy generators. The sophisticated production of the Microwave Tubes Division includes stabilotrons for high power radars, magnetrons for doppler effect radars and klystrons at a very low noise level for the most modern military systems.
The products of the Microwave Tubes Division are made with the knowhow and designs of Raytheon Company, the world's largest manufacturers of microwave tubes, who have contributed advanced technology through the extensive R & D programs of their renowned Spencer Laboratory.

Medium and high power pulsed magnetrons for radar applications.

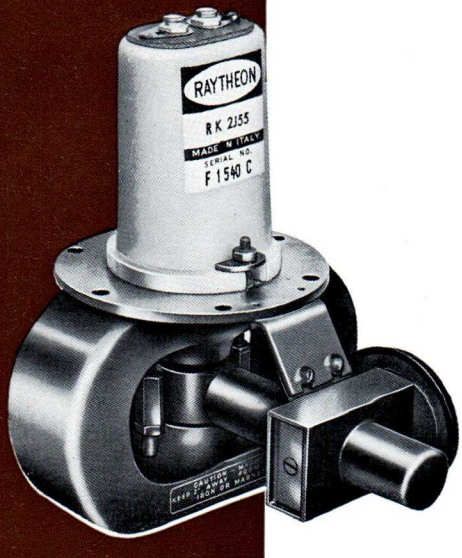
Tube type	Frequency	Minimum power output	
5J26	1220 ÷ 1350	400 Kw Kp	Tunable - separate magnet
2J42	9345 ± 30	7 Kw pK	Low cost, high reliability, integral magnet, fixed frequency, air cooled.
6027	9345 ± 30	18 Kw pK	
2J55	9345 ± 30	40 Kw pK	
2J70/A	3050 ± 25	20 Kw pK	
ES 105	3050 ± 25	50 Kw pK	

Continuous wave heating magnetrons for medical applications.

RK5609	2450 ± 25	80 Watt	Integral magnet, air cooled

Continuous wave heating magnetrons for industrial applications.

QK 390	2450 ± 25	800 Watt	Integral magnet, air cooled
QK 707A	2450 ± 25	800 Watt* 1600 Watt**	Electro-magnet, water cooled. * Single wave supply ** Double wave supply



Reflex klystrons for continuous wave operation.

RK 2K28	3315 - 3680	80 mWatt	External cavity
RK 6043	2950 - 3275	25 mWatt	Integral cavity

Reflex klystrons for pulsed operation.

RK 2K28/A	3315 - 3680	95 mWatt	External cavity

Pulsed stabilotron for high power radar.

QK 630	1270 - 1350	550 Kw pK	

x-ray tubes

The X-Ray Tubes Division of RAYTHEON-ELSI manufactures a complete range of rotating target tube units and inserts for every requirement of the most diagnostics and roengten therapy:

- **Rotating target tube units and inserts for diagnostics.**
- **Stationary target tube units and inserts for diagnostics, surface and endocavity therapy.**
- **Insert tubes for intensive therapy.**
- **High voltage rectifying valves.**

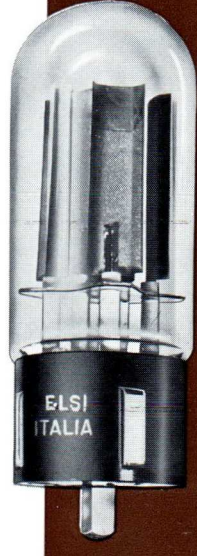
Nowadays a demanding radiologist expects an X-ray picture:

- **to present excellent resolution of detail and sufficient contrast;**
- **to be made with the lowest possible dosage of radiation;**
- **to be good for several reproductions in rapid succession.**

The high voltage ultrafine focal spot rotating target tube inserts made by RAYTHEON-ELSI with extremely high precision and the use of the most advanced fabrication and control techniques meet all these requirements.
The fine focal spot of the RAYTHEON-ELSI tubes (minimum 0.3 mm) reduces geometric shading to negligible values. The high voltages tolerated by the tubes enable shorter exposure time, and that cuts down kinetic shading.
As the use of high voltage reduces radiation absorption by patients, RAYTHEON-ELSI produces rotating target tube inserts with operating voltages up to 150 KV.
The high heat storage capacity of the tubes makes them ideally suitable for the most difficult techniques such as serialography, angiography and roengtencinematography.
Here are some X-Ray shockproof units made by RAYTHEON-ELSI:

Type	Focal Spots mm.	Max. Volt. kV.
Arodix 60/100	0.8 — 1.8	100
Arodix 75/125	0.3 — 1.5	125
Arodix-S 90/125	0.3 — 2	125
Arodix 100/150	0.3 — 2	150

lamps and surge arresters



The Lamps and Surge Arresters Division manufactures:

— **Mercury vapour lamps;**

— **Multiple self-piloting surge arresters;**

They are two products belonging to the same family (discharge tubes), but they differ substantially in their applications and in the manufacturing processes.
The mercury vapour lamps are widely used for lighting roads, squares, stadiums, industrial establishments, etc.
Available types include:

80 W, 125 W, 250 W, 400 W, 700 W, 1000 W.

Each model is made in three different types according to the kind of light desired:

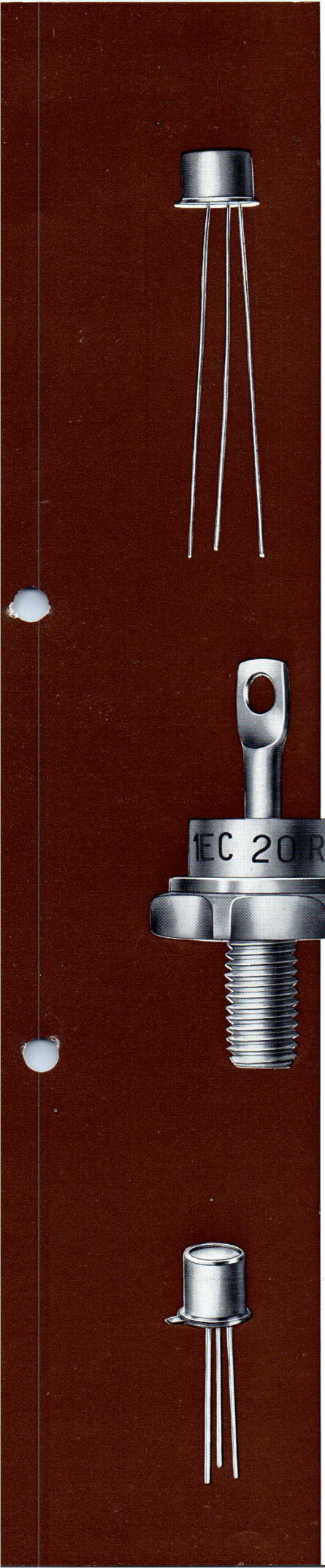
HE - Clear glass bulb and ice-blue light

HEL - Fluorescent bulb and silver-white light

HELL - Fluorescent bulb and gold-white light

The multiple self-piloting surge arresters are inert gas discharge tubes. They serve to « pilot to earth » overvoltages induced on telecommunication lines by high-voltage overhead lines with neuter terminal to earth or by atmospheric phenomena. Basic characteristic is that the starting of the discharge is simultaneous for the four wires of a quad as the discharge of the first electrode pilots the discharge of the remaining ones and the piloting time is shorter than one μs.
These arresters predominantly are used on telephone lines to protect terminal equipments against overvoltages and overcurrents and personnel against acoustic shock. They are also used to protect railway remote control lines against abnormal excitation of relays.

Types	Starting time with 1/50 wave	Max. charge on ground electrode	Residual voltage for 8 A total current discharge	Residual voltage for nominal current discharge	Actual starting voltage at 50 Hz
SCA 40	1 s	40 A per 2 sec.	15 V	6 V	150 ± 15% V
SCA 80A	1 s	80 A per 5 sec.	15 V	6 V	200 ± 15% V 250 ± 15% V
SCA 120A	1 s	120 A per 5 sec.	15 V	6 V	300 ± 15% V



semiconductors

The Semiconductors Division specializes in the manufacture of devices for the industrial and professional fields, where quality and reliability are essential.
Current production consists of:

— **Germanium transistors** for application as low and medium speed switches, audio and RF amplifiers;

— **Silicon low and high voltage rectifiers** up to 150 Kv with controlled bulk breakdown for application in transmitters, modulators, X-Ray equipment, etc.;

— **Germanium phototriodes** for special applications as discriminators, radiation detectors, etc.

The Division also has a large production of transistors and rectifiers for radio and TV sets and other entertainment applications.
The development programs of the Division provide for a complete range of high power rectifiers to meet the most varied industrial requirements. The Division is also engaged in the development of solid state devices for use in microwave applications and the extension of the range of photodevices for special applications and radiation detection.
The Research Laboratory of the Division is equipped to investigate specific components at customer request.
Careful product selection, perfect efficiency of equipment, especially quality control and measuring equipment, meticulous planning of production cycles and methodical analysis of life and quality factors make it possible to meet the severe quality requirements of the industrial market.

Germanium transistors for industrial use.

Switching transistors PNP Alloy	2N404 - 2N404A - 2N395 - 2N396 - 2N397 - 2N1303 - 2N1305 - 2N1307 - 2N1309 - 2N659 - 2N660 - 2N661 - 2N662 - etc.
Nixie driver PNP Alloy	2N398 - 2N398A

Low and medium power rectifiers.

Type	Rectified current	PIV
1 EA	750 mA	100 ÷ 1200 V
1 EB	3.5 A	100 ÷ 1200 V
1 EC	25 A	100 ÷ 700 V

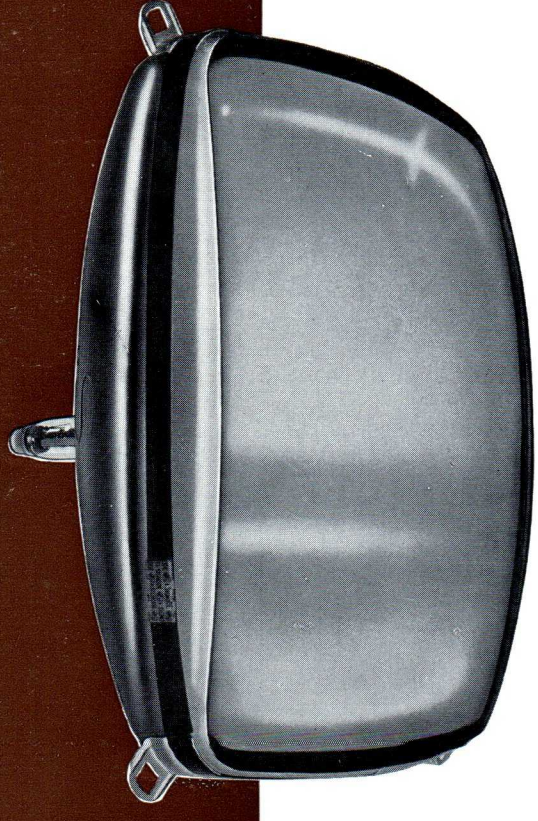
Silicon rectifier stacks for very high voltage.

Types	Rectified current	PIV
ES	200 mA	from 4 to 150 Kv

Germanium photodiscriminator.

Type	Wave length of max. sensitivity	Discriminator steepness	Photosensitivity	Max. freq. response
REP-1iD	1.5 μ	$10^{-4}\ \frac{\text{Volt}}{\mu}$	$2{,}8 \times 10^{-5}\ \frac{\text{mA}}{\text{Lux}}$	40 Mc/s

cathode ray tubes



The Cathode Ray Tubes Division has one of the most modern plants in Europe for the manufacture of black and white cathode ray tubes for television.
To this Division goes the merit of developing, right from the start, the laminated or twin panel tubes, which have become so popular with all TV set manufacturers and the public at large.
Many years of experience, modern facilities and the high degree of specialization acquired have enabled RAYTHEON-ELSI to play a top role in the European market.
Sensitive as it always is to the most advanced techniques, the Cathode Ray Tubes Division has recently signed an agreement with " Owens Illinois " for the manufacture of anti-implosive cathode ray tubes with a kimcode type metal belt protection.
The range of types that RAYTHEON-ELSI can offer today is unquestionably the widest and most technically advanced in Europe.
The current types of normal production and sale are:

Types	Single Panel	Twin Panel	Velvetone	Kimcode	
16″	x			x	
19″	x	x		x	
23″	x	x	x	x	

All picture tubes made are of the short neck type with unipotential gun and 6.3 V 300 mA heater, which make them especially suitable for mounting with filaments in series.
The growing interest of all TV set manufacturers in Europe and other Continents prove that the quality of the tubes manufactured by the Cathode Ray Tubes Division can meet the most varied requirements of the market.

RAYTHEON

In addition to the products made by its five Divisions, RAYTHEON-ELSI handles the distribution in Europe of a large range of electronic components made in the United States by its parent company RAYTHEON COMPANY of Lexington, Mass.

Microwave tubes
Magnetrons
Klystrons
Amplitrons
Backward wave oscillators
Travelling wave tubes

Industrial & military tubes
Miniature and subminiature tubes
Low power tubes
Gas tubes
Decade counter tubes
Radiation detector and counter tubes

Industrial cathode ray tubes

Storage tubes

Receiving tubes

Printer tubes

Lasers

Infra-Red detectors

Electromechanical components
Control Knobs
Connectors
Selective networks
Raysistors
Piezoelectric accelerometers
Magnetostriction filters
Magnetostriction delay lines
Noise source

Magnetic components
Transformers
Magnetic amplifiers
Choke coils
L-C Filter and delay lines
Deflection coils

Ferrites
Isolators
Circulators
Attenuators
Modulators
Switches

Circuit modules

Please send us technical data on the following products:

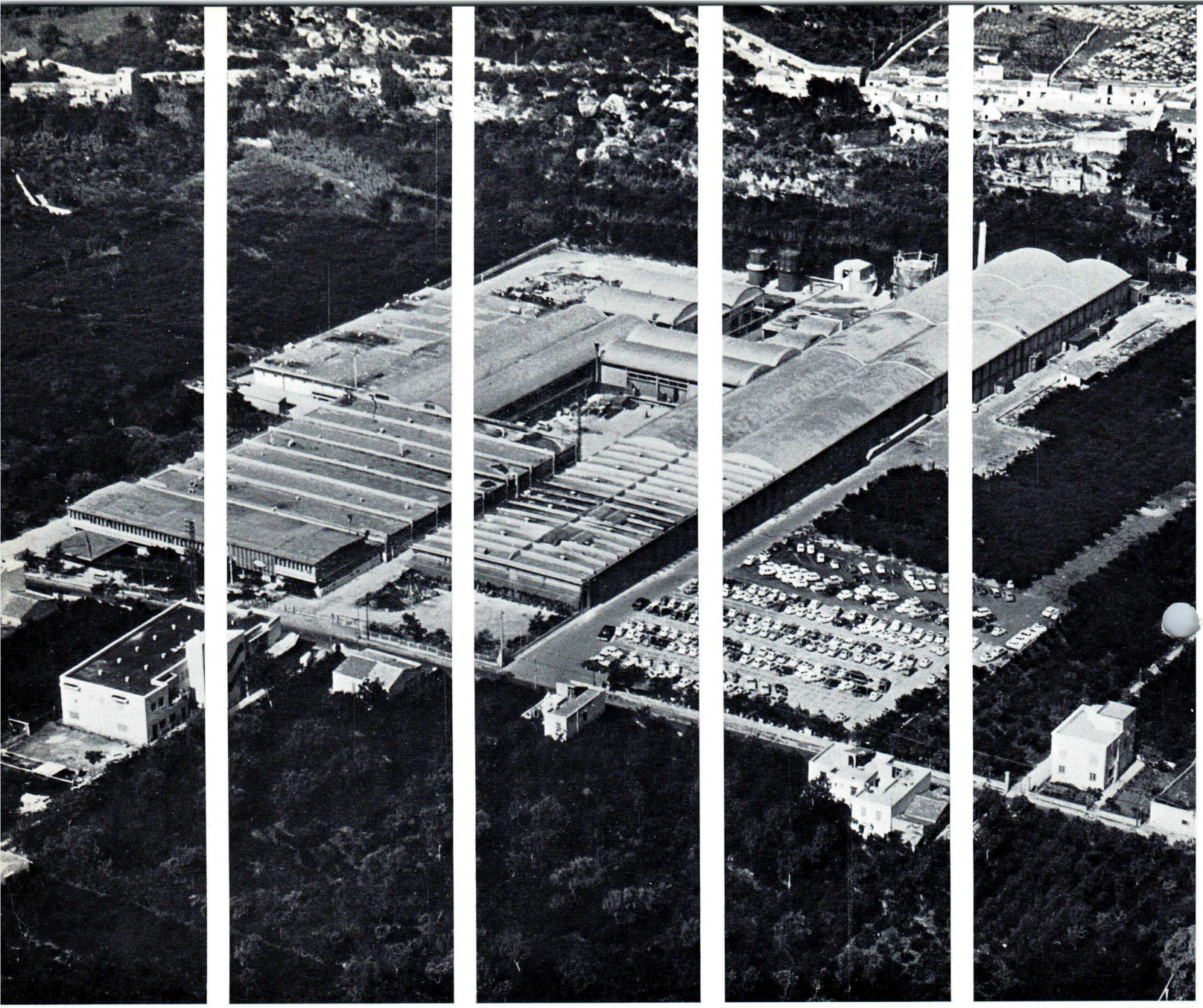
- ☐ Microwave Tubes
- ☐ Cathode Ray Tubes
- ☐ X-Ray Tubes
- ☐ .....
- ☐ Mercury Vapour Lamps and Surge Arresters
- ☐ .....
- ☐ Semiconductors
- ☐ .....

Name .....

Company .....

Address .....

For additional information please mail attached card



AERIAL VIEW OF PALERMO FACTORY

INFORMATION BULLETIN

NO. 1-66

A Versatile Line of Millimeter Klystrons

RAYTHEON

MICROWAVE AND POWER TUBE DIVISION

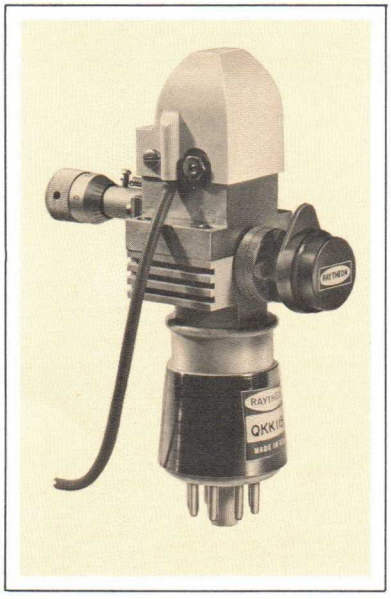
A Versatile Line of Millimeter Klystrons Having: • Long Life • High Power • Outstanding Reliability

FEATURES OF RAYTHEON MILLIMETER REFLEX KLYSTRONS:

- **Single mode operation provides full frequency coverage.**
- **Conservatively rated.**
- **Excellent frequency stability between periods of tube operation.**
- **Fixed focus-electrode voltage results in excellent frequency stability.**
- **1 year/500 hour warranty life for entire line.**
- **Uniform tube characteristics during life.**
- **Typical temperature coefficients of 10^{-5} to 10^{-6}.**
- **Calibrated micrometer frequency tuner on all tubes.**

Raytheon millimeter klystrons feature single mode operation, excellent frequency stability, and low operating voltages. Single mode operation provides full frequency coverage with simplified tracking of the reflector voltage, and eliminates the restrictions and inconvenience of changing reflector modes. Fixed voltage operation of the focus electrode results in excellent frequency stability throughout the specified frequency range. Compatible voltages for the entire line permit operation from a single power supply.

These versatile tubes are available at any desired frequency from 50 GHz to 101 GHz, trimmable ±1.0 GHz. Standard 10 GHz tuning ranges are also available, as shown in the adjacent table. Higher power output levels and lower thermal coefficient values can be supplied on special order.



AVERAGE POWER VS. FREQUENCY

QKK1148			
Frequency GHz	50	53.5	57
Power (mW) Avg.	40	150	200
QKK1149			
Frequency GHz	56	60.5	65
Power (mW) Avg.	40	120	100
QKK1150			
Frequency GHz	64	69	74
Power (mW) Avg.	50	110	100
QKK1151			
Frequency GHz	73	78	83
Power (mW) Avg.	50	100	70
QKK1152			
Frequency GHz	82	87	92
Power (mW) Avg.	60	100	60
QKK1153			
Frequency GHz	91	96	101
Power (mW) Avg.	30	50	30

Note

For maximum power output these tubes should be matched to the load. This can be done by incorporating an E-H tuner between the klystron and associated waveguide components.

These tubes will operate at up to ten times rated minimum power over a portion of their specified frequency-band.

The output impedance of the reflector voltage supply must not exceed 100 K ohms under any conditions.

An O-ring is incorporated in the short waveguide output section. This permits the klystron to be safely immersed in a liquid cooling bath for optimum frequency stability.

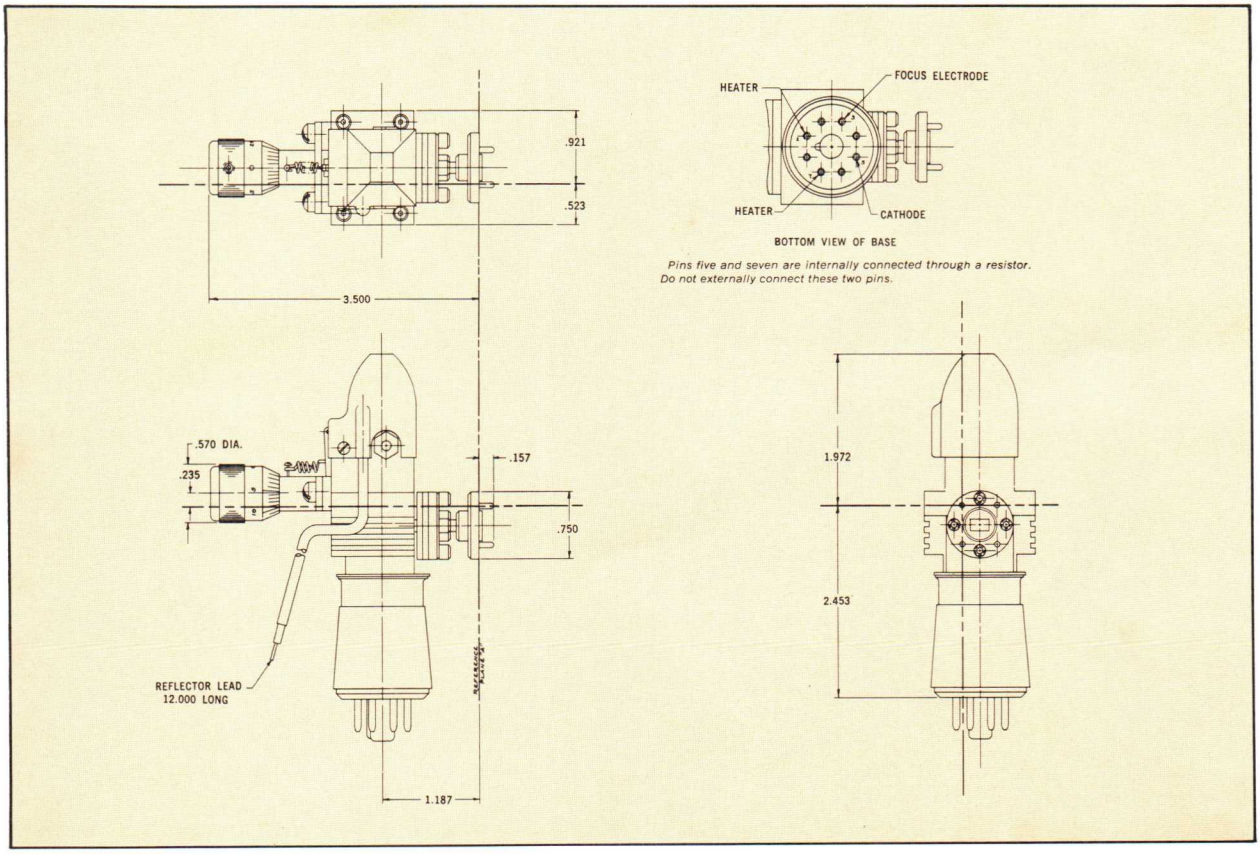
Raytheon Company
Microwave and Power Tube Division
Microwave Tube Operation
Waltham, Massachusetts 02154

OPERATING CHARACTERISTICS — STANDARD TUNING RANGES*

Tube Type Number	Tentative Specification QKK-1148	QKK-1149	QKK-1150	QKK-1151	QKK-1152	QKK-1153
Tunable Frequency Range (GHz)	50-57	56-65	64-74	73-83	82-92	91-101
Resonator Voltage (V) Max.	1800	1800	1800	1800	1900	1900
Resonator Voltage (V) Typical	1400	1400	1400	1400	1700	1700
Resonator Current (mA) Max.	50	50	50	60	60	60
Resonator Current (mA) Typical	40	40	40	40	40	55
Reflector Voltage (V) Range	–40 to –600	–40 to –600	–40 to –600	–40 to –600	–40 to –600	–40 to –600
Reflector Voltage (V) Typical	–150 to –400	–150 to –400	–180 to –300	–100 to –300	–100 to –300	–150 to –350
Focus Electrode Voltage (V) Range	–20 to –300	–20 to –300	–20 to –300	–20 to –300	–20 to –300	–20 to –300
Focus Electrode Voltage Fixed (V) Typical	–120	–120	–120	–120	–120	–120
Electronic Tuning Range (Mc) Minimum	55	60	70	80	90	100
Power Output (mW) Minimum	25	25	25	25	25	10
Tube Warranty (Hours)	500	500	500	500	500	500
Filament Voltage	6.3	6.3	6.3	6.3	6.3	6.3
Filament Current (Amps)	2.0	2.0	2.0	2.0	2.0	2.0
Output Waveguide	RG-98/U	RG-98/U	RG-98/U	RG-99/U	RG-99/U	RG-99/U
Output Flanges (Mates with)	UG-385/U	UG-385/U	UG-385/U	UG-387/U	UG-387/U	UG-387/U

**±1.0 GHz trimmable tubes also supplied within any of the frequency ranges specified above.*
Tubes operating at higher power output levels available on special order.

OUTLINE DRAWING QKK1148 TO QKK1153



RAYTHEON REGIONAL OFFICES

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104 Roesler Rd., Glen Burnie, Md. 21061. Tel. 301-761-0450

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333 W. First St., Dayton, Ohio 45401. Tel. 513-223-8128

MID-WEST AREA
3158 Des Plaines Ave., Des Plaines, Ill. 60018. Tel. 312-296-6677

DALLAS AREA
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Raytheon Company, International Sales and Services, Lexington, Mass. 02173. Tel. 617-862-6600

RAYTHEON

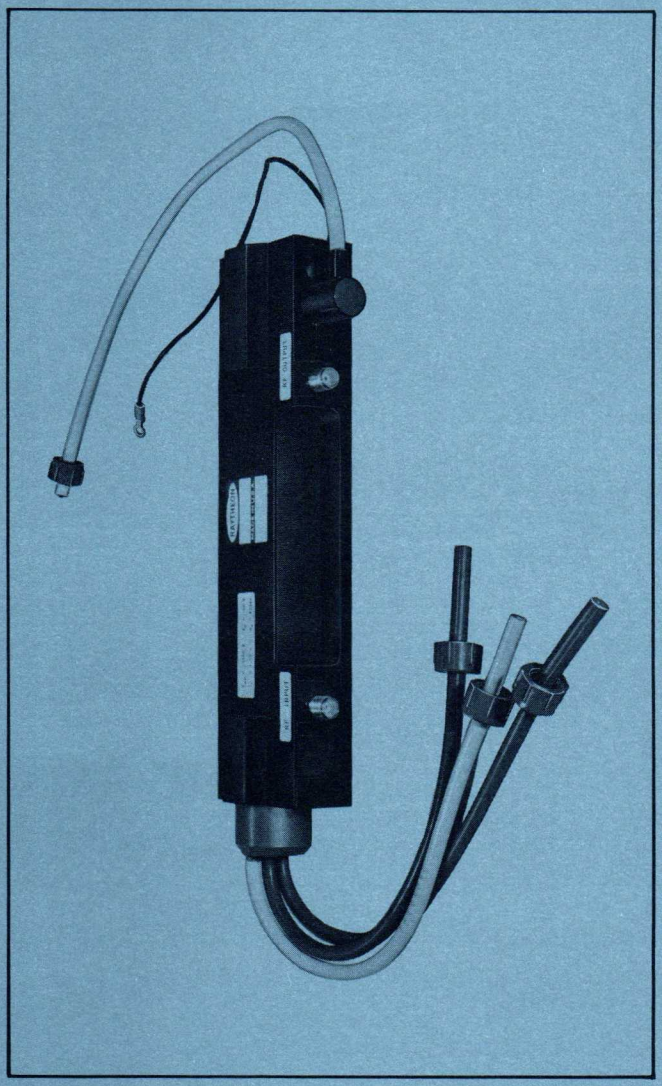
RAYTHEON COMPANY

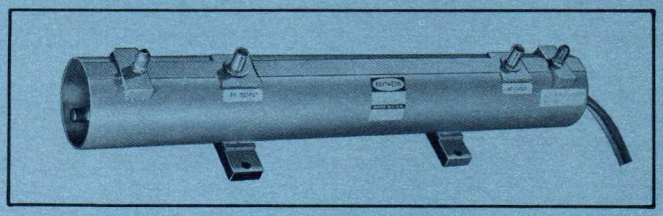
MICROWAVE AND POWER TUBE DIVISION

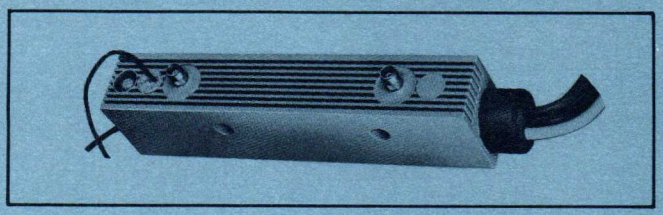
Printed in U. S. A. 3-66

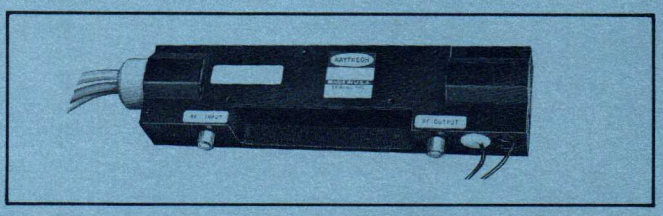
INFORMATION BULLETIN

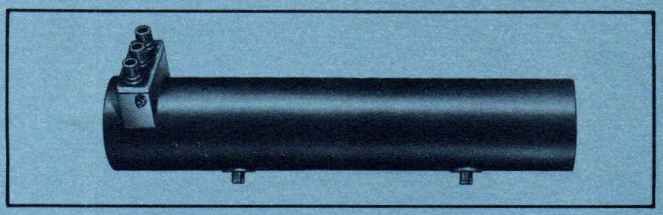
No. 2-65











Broadband Medium Power Pulsed TWT's

RAYTHEON

MICROWAVE AND POWER TUBE DIVISION

Broadband Medium Power Pulsed TWT's

- **Minimum power capability of 1 KW peak pulse.**
- **PPM focused for smallest size and weight.**
- **Rugged ceramic-metal construction.**
- **Meet MIL-E-5400 specifications.**

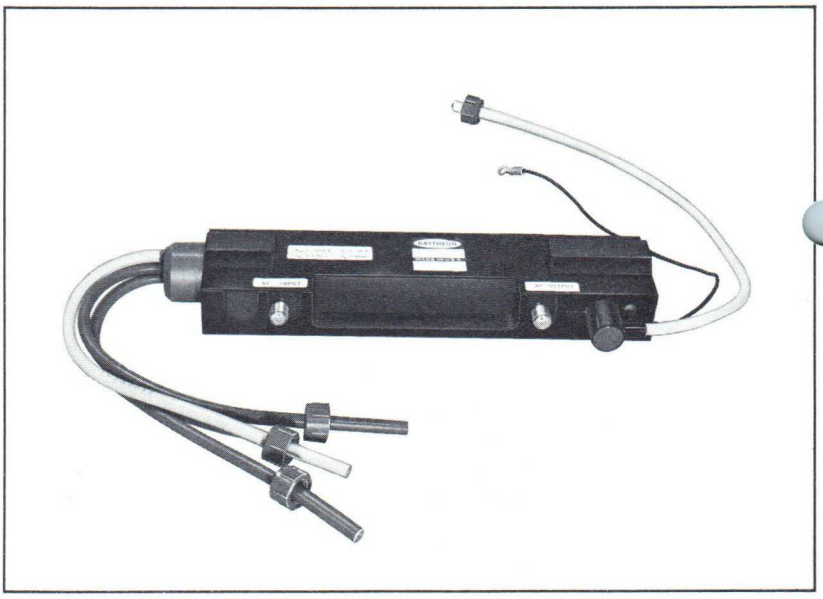
Raytheon announces a new family of state-of-the-art traveling wave tubes that combine broad bandwidth with high duty cycle and minimum power capability of 1 KW peak pulse.

These TWT's are PPM (periodic permanent magnet) focused, resulting in the smallest size and lowest weight tubes available for this service. PPM focusing also eliminates the need for external mounts and substantially reduces problems of magnetic field interference. Rugged ceramic-metal construction guarantees highly reliable operation meeting MIL-E-5400 Specifications.

Standard configurations and electrical characteristics for these tubes are given in this bulletin. Special configurations and characteristics are available to meet specific requirements. For further information and technical assistance, please contact your nearest Raytheon sales office.

Raytheon Company
Microwave and Power Tube Division
Microwave Tube Operation
Waltham, Massachusetts 02154

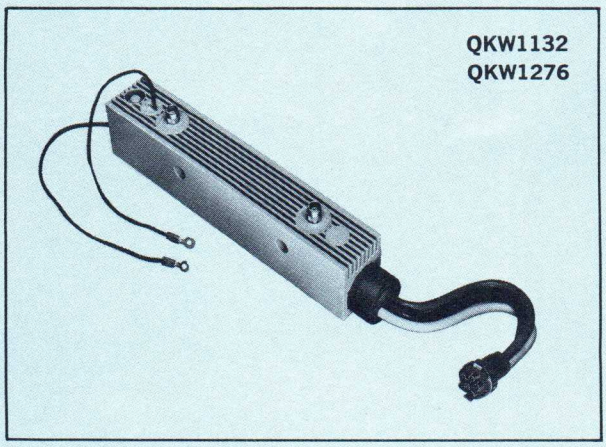
New QKW1366 covers C and X-Bands in a single tube.

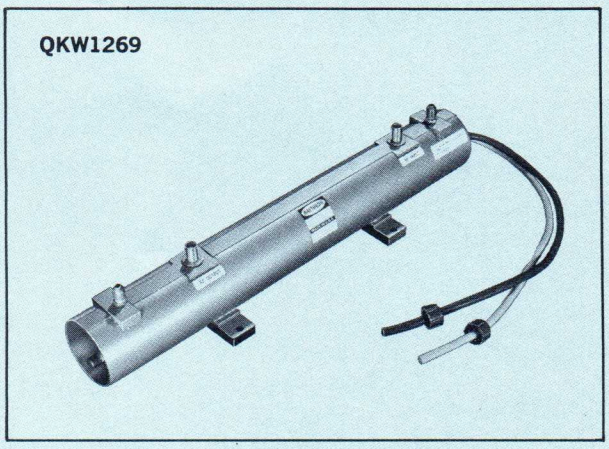


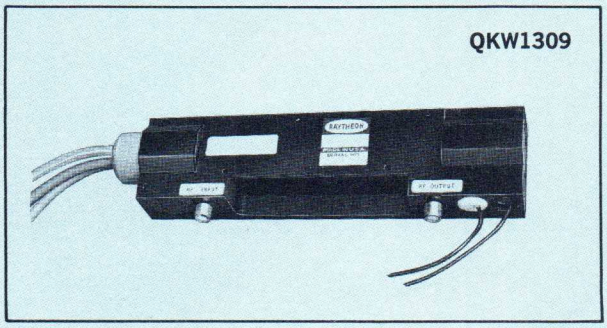
QKW1366 PERFORMANCE CHARACTERISTICS

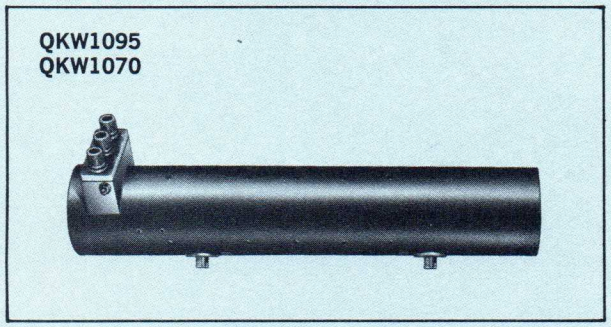
Freq. Range (Gc)	5.0-12.0
Pk. Power Output (min) (KW)	1.0
Gain at Rated Po (db)	34-40
Duty Cycle (%)	2
Heater Voltage (V)	6.
Heater Current (A)	3.0-4.0
Anode Helix Collector Voltage† (KV)	9.5-11.0
Pk. Cathode Current (A)	2.0
Helix Current (A)	0.4
Grid Bias† (V)	−90
Grid Pulse† (V)	160-270
Grid Current (A)	0.4
Depressed Collector Voltage (KV)	4.0
Mounting Position	Any
RF Connectors	TNC
DC Connectors	Flying Leads AMP HA/HO3 Wire
Cooling	Conduction
Weight (lbs.)	4.25
Size — Height (in.)	1.75
Width (in.)	2.5
Length (in.)	11.25

†*with respect to cathode*









PERFORMANCE CHARACTERISTICS

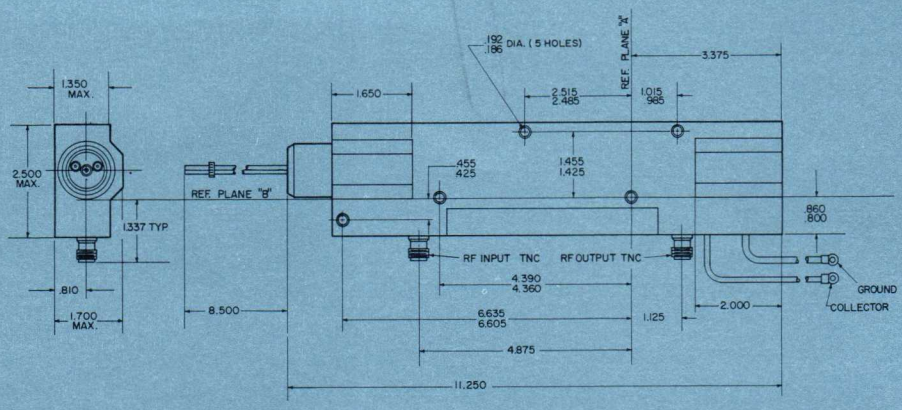
Tube Type	QKW1070	QKW1269	QKW1095*	QKW1132	QKW1309	QKW1276
Freq. Range (Gc)	2.0-4.0	2.9-3.1	4.5-8.0	7.0-11.0	7.0-11.0	8.5-9.6
Pk. Power Output (min) (KW)	1.0	2.5	1.0	1.0	1.0	1.5
Gain at Rated Po (db)	33-36	33-36	30-36	34-40	34-40	34-40
Duty Cycle (%)	2	3	1.5	1	2	2
Heater Voltage (V)	6.3	6.3	6.3	6.3	6.3	6.3
Heater Current (A)	3.75	3.0-5.0	5.0	2.5-4.5	3.0-4.0	2.5-4.5
Anode Helix Collector Voltage† (KV)	8.5-9.5	8.5-9.5	9.5-10.7	9.5-11.0	9.5-11.0	9.5-11.0
Pk. Cathode Current (A)	2.0	2.0	1.75	2.0	2.0	2.0
Helix Current (A)	.4	.4	.4	.4	.4	.4
Grid Bias† (V)	None	None	−90	−90	−90	−90
Grid Pulse† (V)	None	None	350	160-270	160-270	100-270
Grid Current (A)	None	None	.4	.4	.4	.4
Cooling	Forced Air	Liquid	Forced Air	Cond.	Cond.	Forced Air
Weight (lbs.)	11.0	8.0	10	4¾	4.5	4.5

All Tubes: *RF Connectors: TNC; DC Connectors: Flying Leads (AMP HA/HO3 Wire; Mounting Position: Any; See Outline Drawings on Back Cover for Dimensions.*

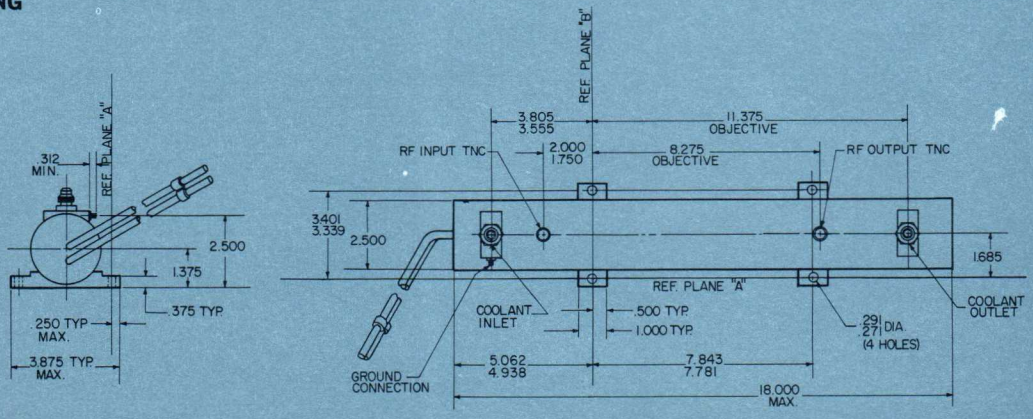
**QKW1095A TWT available with frequency range 4.0-8.0 Gc, duty cycle 2.0%, otherwise same characteristics as QKW1095.*

†with respect to cathode.

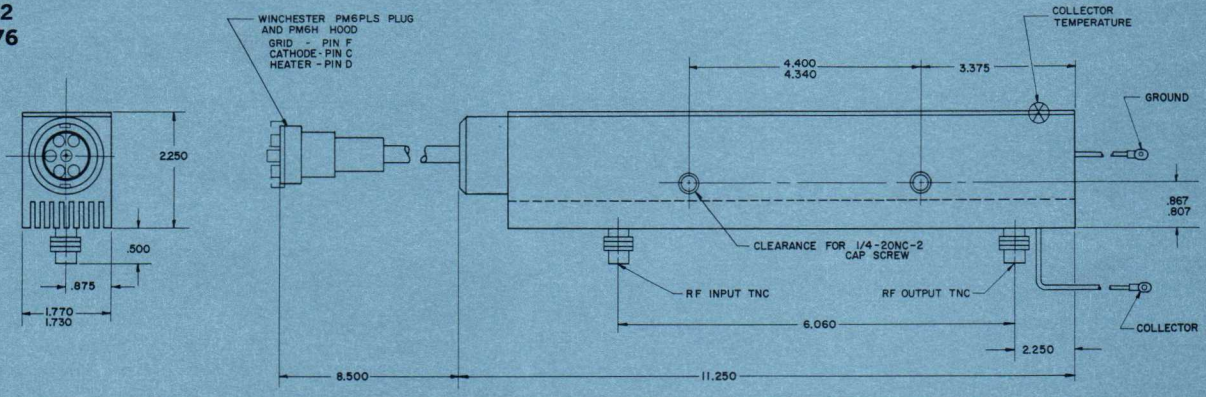
OUTLINE DRAWING
QKW1309



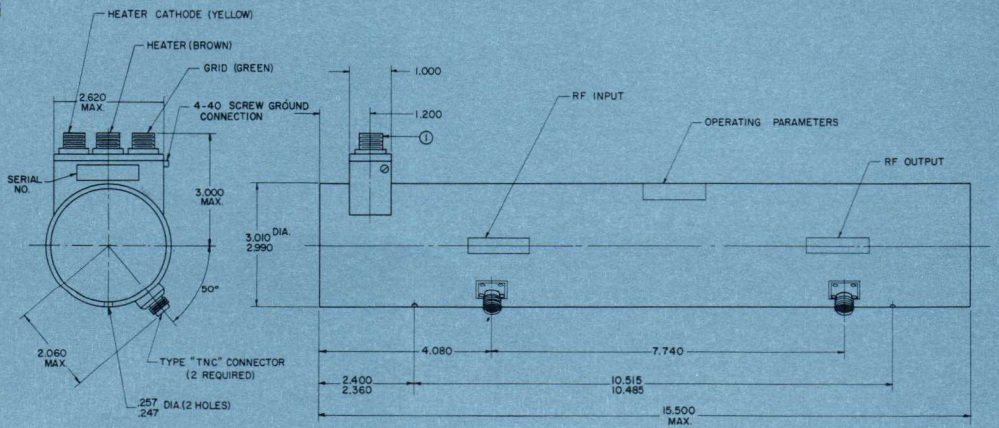
OUTLINE DRAWING
QKW1269



OUTLINE DRAWING
QKW1132
QKW1276



OUTLINE DRAWING
QKW1095
QKW1070



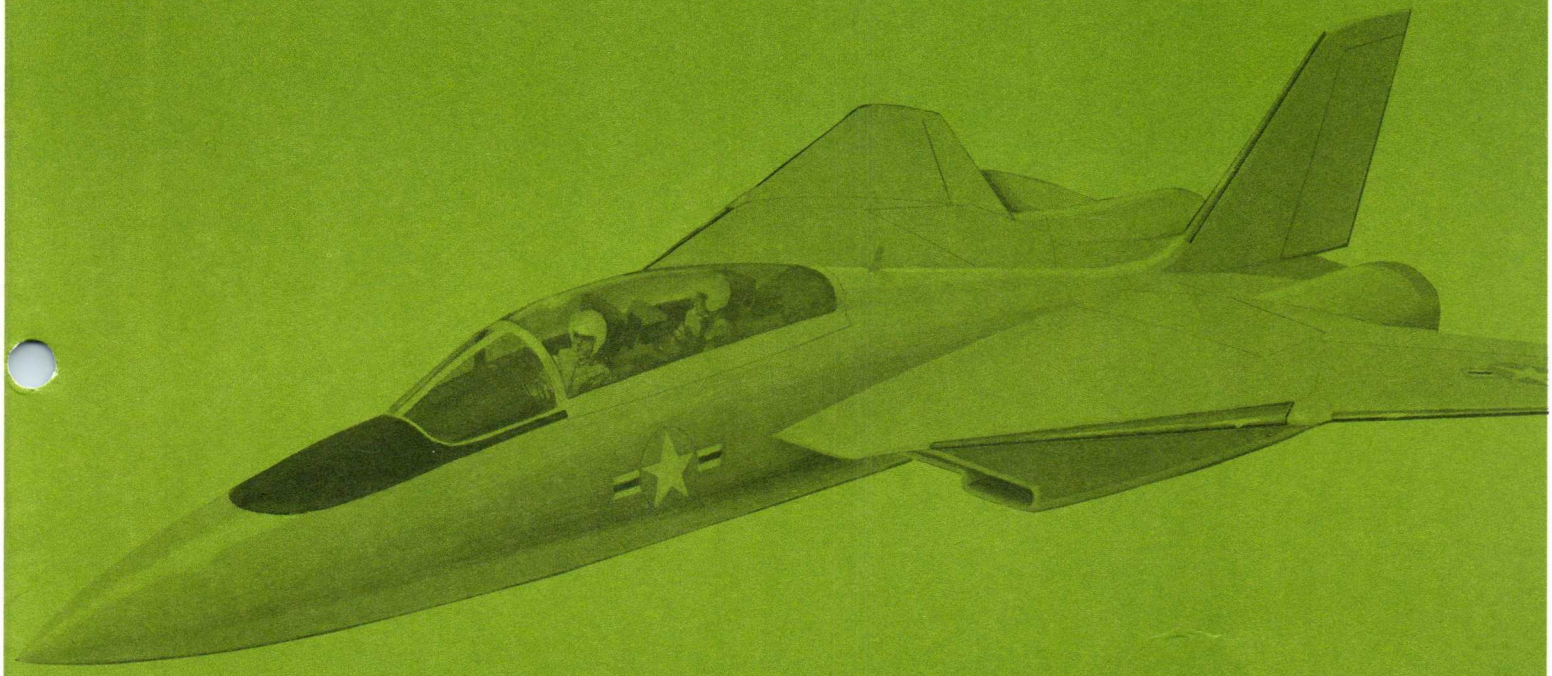
NOTES:
1. CONNECTORS TO MATE WITH AMP #834254 (3 REQUIRED)
2. WEIGHT 10 LBS. MAXIMUM

Printed in U. S. A. 4-65

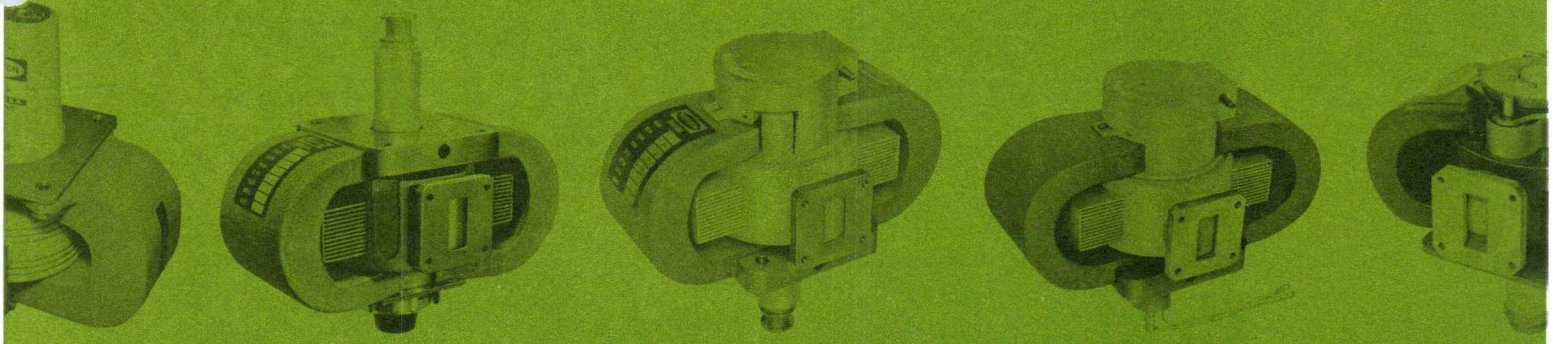
INFORMATION BULLETIN

NO. 1-69

High Performance Magnetrons For Advanced Radars



A CATALOG OF X-BAND COAXIAL MAGNETRONS



RAYTHEON

MICROWAVE AND POWER TUBE DIVISION

X-Band Coaxial Magnetrons

- **70 and 200 kW Power Levels**
- **Servo Tuning Available**

DESIGN PRINCIPLES

The unique feature of coaxial magnetrons is a built-in stabilizing cavity that basically improves frequency stability and increases tube efficiency. Several important secondary effects, such as better rf output spectrum and longer life, are inherent in this design approach. The cross-sectional view, figure 1, shows how the anode vane structure is coupled through slots in the supporting back wall to the surrounding (or coaxial) stabilizing cavity, and then through a slot in the outer wall of that cavity to the external waveguide load. By proper location of the vane coupling slots, the efficient "pi mode" rf pattern in the anode vanes excites the desired TE_{011} cavity mode.

The arrangement provides mode stability without any anode straps, one of the causes of low Q's and low efficiency in conventional magnetrons at frequencies of X-band and higher. The unloaded Q is typically 5000 for an X-band coaxial magnetron compared to only 1000 for a conventional design. The overall tube efficiency may be raised from 35% up to 45%.

Longer life and better reliability result from the use of more vanes than are possible in conventional tubes. At high frequencies, where dimensions of the anode resonant cavities are small, these additional vanes mean larger anode and cathode areas, and thus a more conservative tube design.

Tuning is accomplished by moving one end plate of the stabilizing cavity to change its height. This is made possible by the fact that there are no currents at the cavity corners in the TE_{011} mode. Various tuner drive mechanisms can be furnished, ranging from a hand knob or mechanical gear train to high speed voice-coil units for frequency agile systems. Wide or narrow band tuning from a closed-loop servo voltage input is obtainable, offering the system designer the utmost in versatility for present and future radar needs.

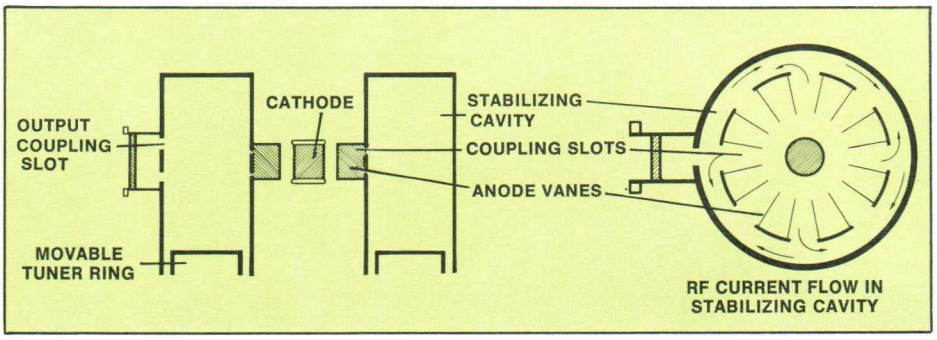


Figure 1.

PERFORMANCE

FREQUENCY STABILITY

Pushing is the change in operating frequency which results from a change in the anode current of the tube. It is caused by the presence of the electron stream at the vane tips of the anode resonant cavities. This effect is greatly reduced in coaxial magnetrons, because the main element determining the frequency is the high Q cavity, not the low Q vane system. Pushing figures are typically 1/5 to 1/10 of the values for conventional type magnetrons. Figure 2 shows plots of frequency vs. anode current for a conventional and a coaxial magnetron. Figure 3 displays the resulting spectrum when pulses of alternating amplitude are applied. It is clear that minor anode current variations can cause poor spectra, interpulse frequency jitter, and intrapulse FM unless the pushing figure is low. Pushing for coaxial magnetrons at X-band is below 100 KHz/ampere.

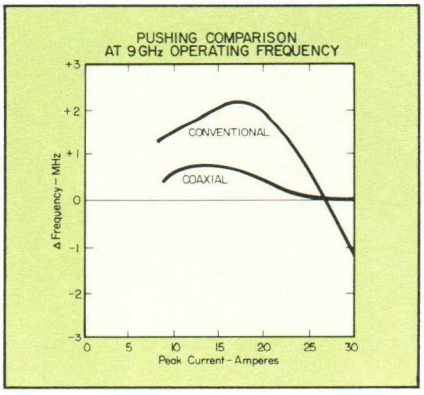


Figure 2. Plot of Frequency Pushing

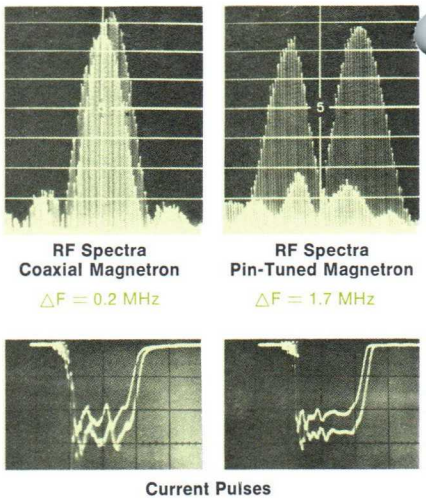


Figure 3. Spectrum Shift from Anode Current Pushing (pulses of alternating amplitude applied)

Pulling is the frequency change caused by variations in the external load on the magnetron. It is usually specified as the frequency excursion observed when a 1.5 VSWR load is moved through all phase positions. This corresponds to varying reflections from nearby targets or from moving elements in the waveguide system of the radar. Coaxial magnetrons have typical pulling figures of 4 MHz at X-band, or about 1/3 the value common to older type tubes.

Spectrum Quality of coaxial magnetrons is generally better than that of other tubes. Since it is closely related to the AM and FM occurring in the rf pulse envelope, the rf spectrum is improved by the low frequency pushing of the coaxial design. The spectrum bandwidth is easily less than 2.0/pulsewidth, and side lobes are at least 9 db below the main lobe. Stability ex-

pressed as a percent of missing pulses, due to either arcing or moding, is less than 0.25% for any load phase position. Figure 4 compares spectra of conventional and coaxial magnetrons with a poor pulse shape intentionally applied. For the system designer, greater freedom of pulse shape is a welcome relief.

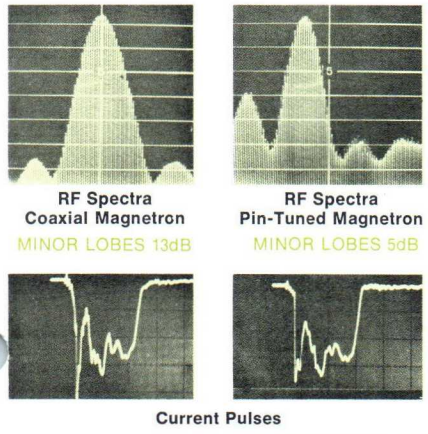


Figure 4. Spectrum Quality Comparison

LIFE

Coaxial magnetron life is longer than that obtained with older X-band tubes, because the cathode emitting surface and anode vane tip area are much greater. With more anode vanes and larger cathode size, the emission density and vane tip power dissipation are significantly lower, and the effects are seen directly in less arc damage and in better life. Typical operation of over 2000 hours is not uncommon. This means less system down time, higher reliability, and lower replacement costs.

EFFICIENCY

The low circuit losses and high rf energy storage of the coaxial magnetron permit greater efficiency to be achieved than in conventional tubes. At both X and Ku band it is now possible to offer more than 40% efficiency from magnetrons. This can be a significant advantage in new systems, allowing smaller power supplies and cooling systems to be used. For many tube replacement applications, however, the power supplies already exist and have fixed operating points. Also, the antenna or transmission line may not be able to handle increased rf power. Therefore, the coaxial magnetron may have to be specially decoupled to meet existing system limitations. The result is that the specifications do not always reflect the full capability inherent in the tube.

JITTER

One area in which special precautions are necessary with coaxial magnetrons is that of starting characteristics. Because of the time required for oscillation build-up in the high Q pi-mode, excessively fast pulse rise times may lead to misfiring and cause interference from other mode frequencies. A practical limit to the voltage rise time is 150 kV/μsec. It is good practice for a satisfactory interface between X-band coaxial tubes and the pulse modulator to keep this down to 110 kV/μsec when possible. Under these conditions, the tubes will start smoothly on each pulse, and starting time jitter can be kept to less than 10 nanoseconds rms.

Pulse-to-pulse frequency jitter on Raytheon X-band coaxial magnetrons is nominally about 50 KHz. Amplitude jitter is less than 0.25 db.

Raytheon manufactures high power magnetrons of both the conventional and the coaxial varieties, and thus can guide users to the best design for each application.

TEMPERATURE

The tubes described in this bulletin will operate properly in ambient air environments from −50° to +100°C. The principal consideration is that sufficient air be blown over the tube to prevent the anode from getting hotter than 150°C. As the temperature varies, the size of the coaxial cavity and the position of the tuning plate in the cavity change so that the output frequency shifts. Usually the shift is in a negative sense, and the thermal factor is typically −0.25 MHz/°C. Where system requirements are critical the thermal factor can be reduced to a value of 0.1 MHz/°C by choice of materials with expansion coefficients such that the tuner plate moves in the coaxial cavity to compensate for other dimensional changes of the anode or cavity.

At a fixed thermal environment there is an additional cause of thermal shift in frequency. This is snap-on shift, measured from the time pulse voltage is first applied to the tube to the point when the tube temperature stabilizes. For the coaxial magnetrons listed, the typical starting shift is about 5 MHz. Values of starting frequency shift vary from 3 MHz to 10 MHz, with the direction of shift changing randomly from tube to tube. When it is desirable to have low thermal starting shift, tubes can be selected to be certain their shift is below the required minimum.

VIBRATION AND SHOCK

Raytheon coaxial magnetrons have been ruggedized to withstand the vibration and shock encountered in aircraft. The shock test is 30 g at 11 milliseconds. Vibration testing over the 5 to 500 Hz range is conducted at a level of 5 to 10 g depending on the specified requirements. During vibration the frequency output of the tube is monitored to ensure that peak-to-peak frequency modulation is maintained within specified limits, usually less than 2 MHz.

GENERAL OPERATION

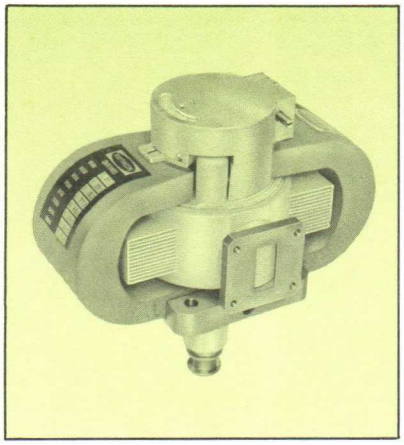
Heater power is reduced, once oscillation has started, until the sum of the thermal input to the cathode from the heater and from electron back bombardment is sufficient to maintain the cathode at its proper operating temperature for long life. The amount of reduction is dependent on the pulse width and the duty cycle at which the tube is operated. Correct values for heater input can be supplied when the pulse conditions are specified.

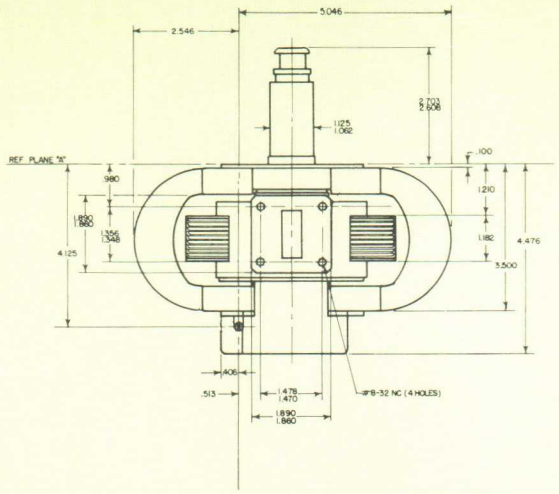
Pressurization is generally applied to the output waveguide and input high voltage area in the radar system, so that typical atmospheric conditions are maintained when high altitude is reached. The range to be maintained is 12 to 45 psia. Although the output windows are designed for "unpressurized" operation, experience has shown that at the 200 kW level, breakdown frequently occurs at discontinuities in X-band waveguide. Therefore, a waveguide pressurization of at least 20 psia is recommended for best system reliability at the 200 kW level.

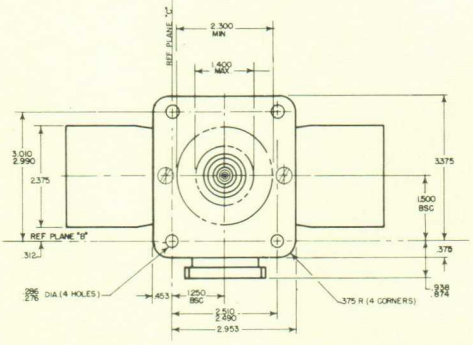
Special tube usage is sometimes permissible outside of the performance guidelines listed here. The data in this booklet is intended to aid in the selection of components which best suit the needs of a particular radar system, and to appraise system engineers of tube capabilities for future design planning. If the tubes described herein do not meet your particular requirements, it is advisable to contact a Raytheon representative to determine whether the desired operating conditions are possible with an existing tube, or whether a modest development can be carried out to meet your needs.

QKH1495

The QKH1495 is a pulsed coaxial magnetron, air cooled, with an integral magnet. It is mechanically tunable over the range 8.5 to 9.6 GHz by means of a worm-gear drive, which can be motor driven. The QKH1495 delivers a minimum peak power output of 200 kW.



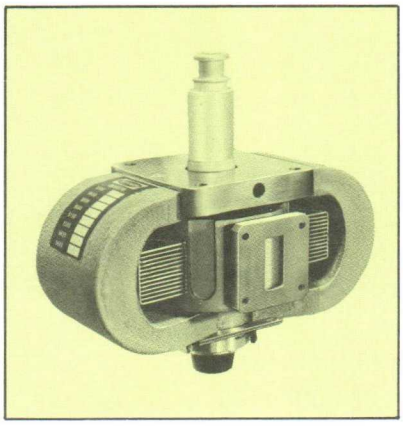


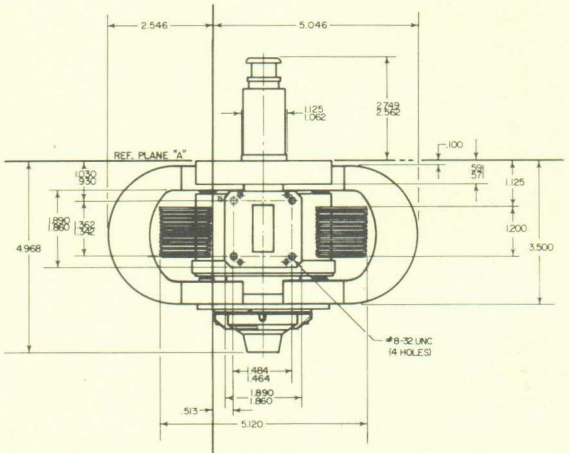


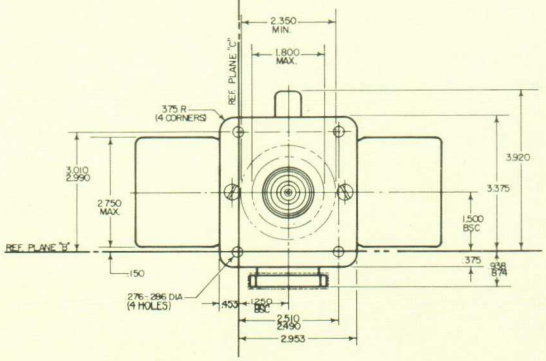
Frequency ..... 8.5 to 9.6 GHz mechanically tunable
Peak Power Output ..... 200 kW min
Pulse Width ..... 0.2 to 3.0 μsec
Duty Cycle ..... up to .001
Pulse Voltage ..... 22 kV
Peak Current ..... 27.5 A
Preheat Voltage ..... 13.75 V
Preheat Current ..... 3.1 A
Weight ..... 14 lbs
Output UG-52A/U
Input ..... Jettron Products 90-000 series
Replacement for 7111/7008 family tubes

QKH1578/8855

The QKH1578 is a pulsed coaxial magnetron, tunable over the frequency range 8.5 to 9.6 GHz by a hand knob with calibrated dial. The tube is rated at a peak power output of 200 kW minimum, is air cooled, and has an integral magnet. It is a popular replacement for tubes of the 7111/7008 family, offering better spectrum and longer life.



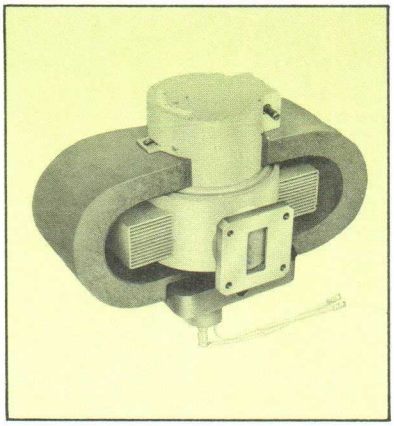


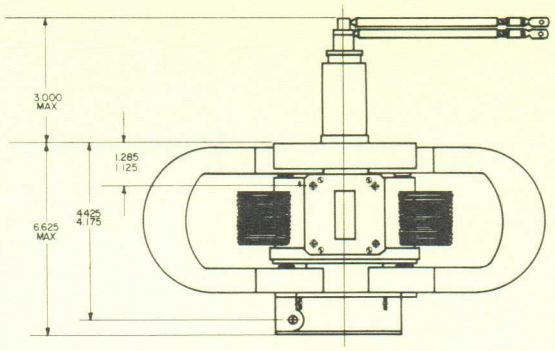


Frequency ..... 8.5 to 9.6 GHz mechanically tunable
Peak Power Output ..... 200 kW min
Pulse Width ..... 0.2 to 3.0 μsec
Duty Cycle ..... up to .001
Pulse Voltage ..... 22 kV
Peak Current ..... 27.5 A
Preheat Voltage ..... 13.75 V
Preheat Current ..... 3.1 A
Weight ..... 14 lbs
Output UG-52A/U
Input ..... Jettron Products 90-000 series
Replacement for 7111/7008 family tubes

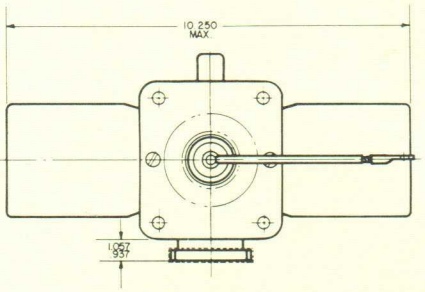
QKH1512/USAF304

The QKH1512/304 is a pulsed coaxial magnetron intended as a modern replacement for the widely used X-band RK6249 tube. It delivers a minimum peak power output of 250 kW, and is mechanically tunable across the frequency range 8.5 to 9.6 GHz with a worm-gear drive, capable of being motor driven. The tube includes an integral magnet and is air cooled.



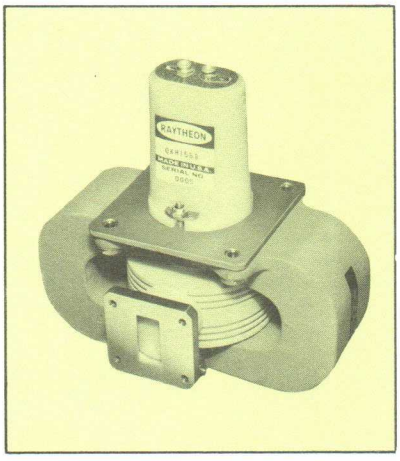


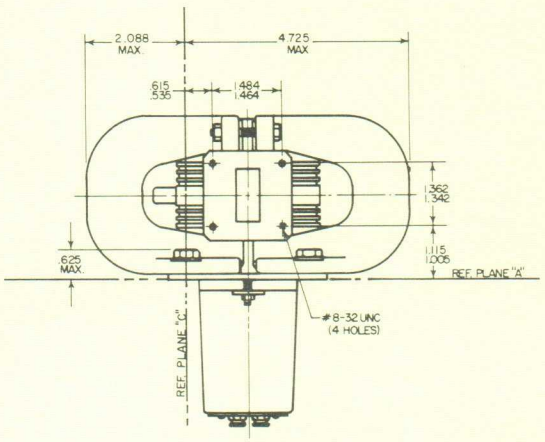
Frequency	**8.5 to 9.6 GHz mechanically tunable**
Peak Power Output	**250 kW min**
Pulse Width	**0.2 to 3.0 μsec**
Duty Cycle	**up to .001**
Pulse Voltage	**27 kV**
Peak Current	**30 A**
Preheat Voltage	**9.0 V**
Preheat Current	**14.0 A**
Weight	**19 lbs**
Output	**UG-52/AU**
Input	**Flying Leads**
Replacement for RK6249	



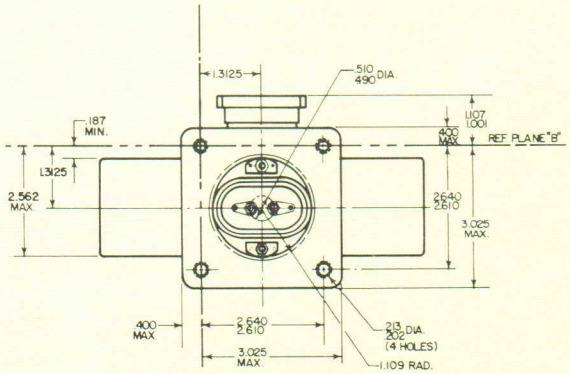
QKH1553

The QKH1553 is a fixed frequency, pulsed coaxial magnetron, designed for operation at 9245 MHz. It can also be furnished at any desired frequency between 9.0 and 9.6 GHz. The minimum peak power output rating is 75 kW. Tube is cooled by air and by conduction through the mounting surfaces, and contains an integral magnet.



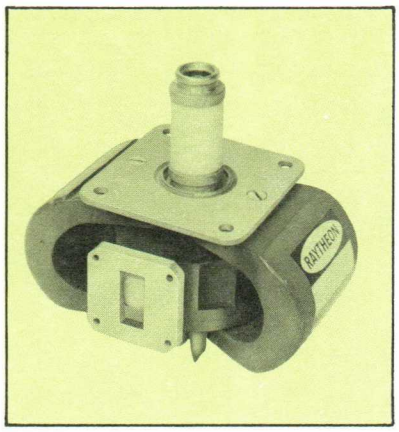


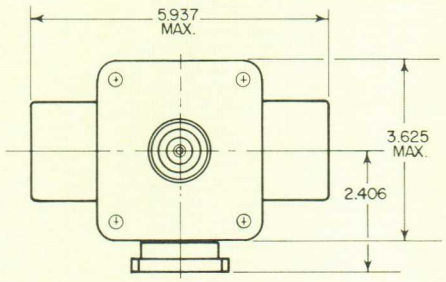
Frequency	**9245 MHz**
Peak Power Output	**75 kW min**
Pulse Width	**0.2 to 3.0 μsec**
Duty Cycle	**up to .001**
Pulse Voltage	**15 kV**
Peak Current	**13.5 A**
Preheat Voltage	**6.3 V**
Preheat Current	**2.9 A**
Weight	**7.5 lbs**
Output	**UG-52A/U**
Input	**Jettron Products 90-000 series**

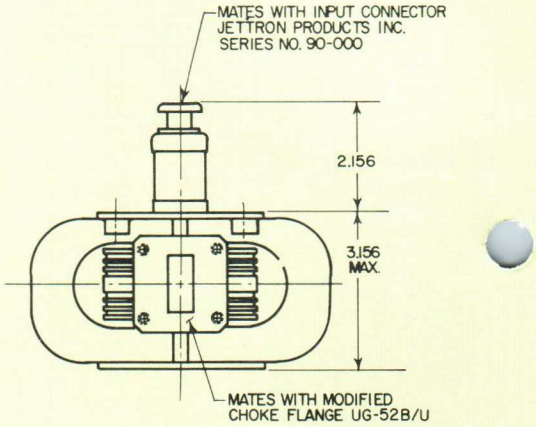


QKH1592

The QKH1592 is a pulsed coaxial magnetron, air cooled, with an integral magnet. It is a fixed frequency tube which is usually built to operate at 9.375 GHz. However, it can be delivered to oscillate at any frequency from 9.0 to 9.6 GHz. The minimum peak power output rating is 70 kW, suitable as a replacement for the 4J52 magnetron.





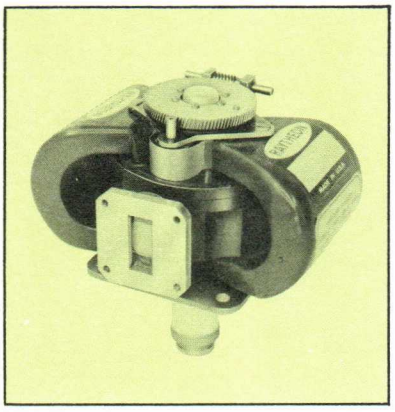


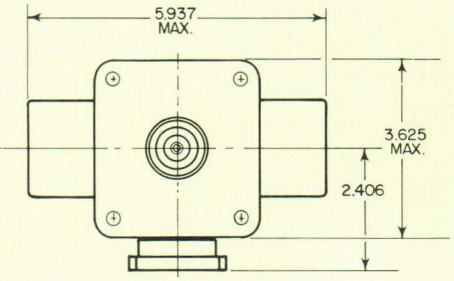
Frequency	**9375 ± 30 MHz**
Peak Power Output	**70 kW min**
Pulse Width	**0.2 to 3.0 μsec**
Duty Cycle	**up to .001**
Pulse Voltage	**15 kV**
Peak Current	**15 A**
Preheat Voltage	**12.6 V**
Preheat Current	**2.2 A**
Weight	**6.2 lbs**
Output	**UG-52A/U**
Input	**Jettron Products 90-000 series**

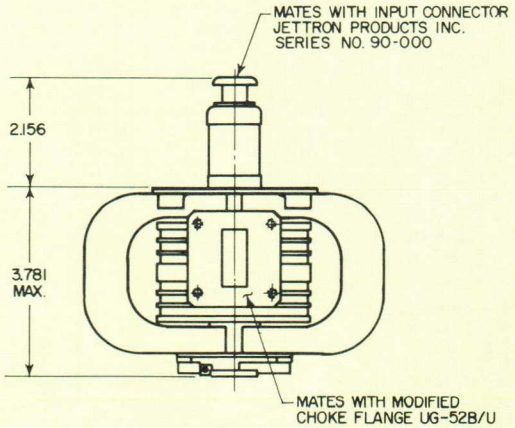
Replacement for 4J52

QKH1505

The QKH1505 is a 65 kw pulsed coaxial magnetron, mechanically tunable over the frequency range 8.5 to 9.6 GHz. It is air cooled, has an integral magnet and is designed to provide improved performance in systems using the conventional type 6543 magnetron.







Frequency	**8.5 to 9.6 GHz mechanically tunable**
Peak Power Output	**65 kW min**
Pulse Width	**0.2 to 5.0 μsec**
Duty Cycle	**up to .001**
Pulse Voltage	**15 kV**
Peak Current	**15 A**
Preheat Voltage	**12.6 V**
Preheat Current	**2.2 A**
Weight	**6.5 lbs**
Output	**UG-52A/U**
Input	**Jettron Products 90-000 series**

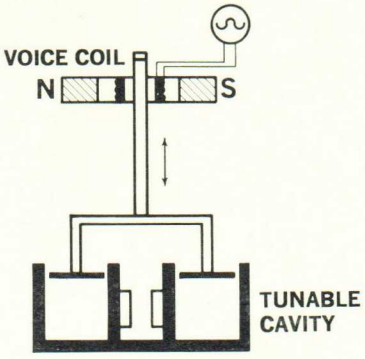
Replacement for 6543.

Types of Tuners

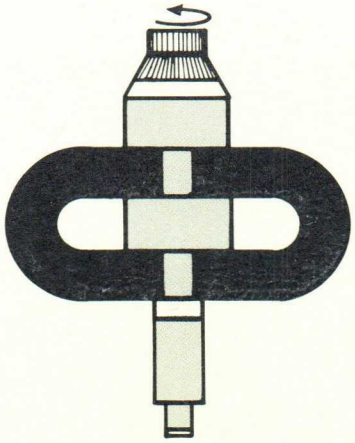
Frequency tuning of coaxial magnetrons is accomplished by moving one end plate of the stabilizing cavity (see Figure 1). The mechanism for moving the end plate can be any one of several types. The Raytheon tubes listed in this catalog have tuner drives which were designed to meet specific requirements. It is possible to modify them, or adapt other tuner drives to these tubes to meet customers' needs. A brief guide to the more common types of tuners is provided here as an aid to design planning.

Voice-Coil Actuated Tuners are recommended by Raytheon as offering the best all-around combination of versatility, accuracy, life, and reliability. Here the tuner shaft is moved by a servo-controlled, electro-magnetic coil, similar to that in a loudspeaker. The input voltage amplitude, waveshape and frequency determine the tuning curve of the magnetron. Thus, the output frequency can be truly voltage-controlled.

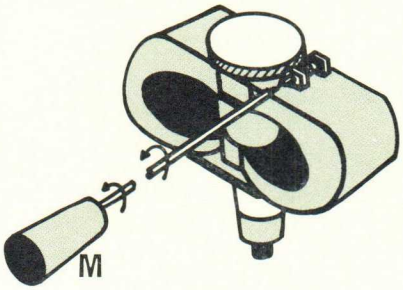
The same tuner can be used to cover the full frequency range of the magnetron, or any part of that range. Waveshapes can be triangular, sinusoidal, trapezoidal, etc. Power consumption is low, resistance to vibration is excellent (within 4 MHz at 5g) because of a corrective feedback loop, and frequency readout accuracy is also good (within 2 MHz). There are no fluid seal or mechanical wear problems, as in earlier types of tuners, to reduce reliability. Wide-band tuning at speeds of 50 cps or narrow-band tuning (30 MHz) at speeds up to 200 cps are possible. Raytheon therefore recommends this as being the most versatile and reliable tuner for frequency agile magnetrons.



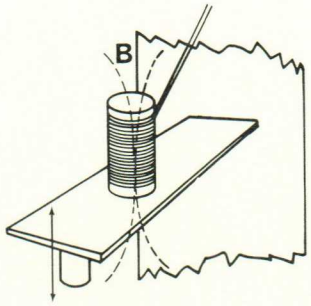
Hand Tuners are often provided on tubes, such as the QKH1495, permitting the operating frequency to be set to any desired point in the range by simply turning a hand knob. This rotates a screw, which moves the tuning plate up or down in the stabilizing cavity. A calibrated dial on the knob furnishes a frequency reference. These tuners are not intended for high-speed or remote-controlled use, but are the simplest, most reliable, and least expensive of any type.



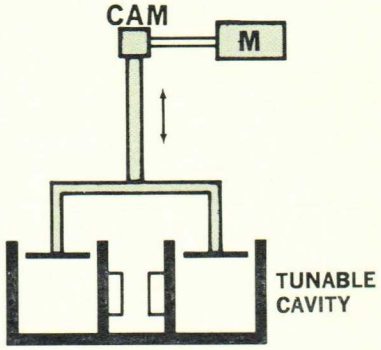
Gear Train and Drive Shaft. A worm-gear arrangement is attached to the main drive screw of some tubes, like the QKH1578/8855, to give finer control on the frequency setting. This also permits a motor drive to be connected to the tuner for remote servo control. The gear-driven tuners are an inexpensive, fool-proof means of readjusting tube frequency from a distant location.



Reed-Mounted Tuners have been used successfully for fast tuning over narrow ranges (80 MHz at 300 cps) in certain miniature magnetrons, where tuning elements are very small. A coil is mounted on the reed, located in a magnetic field and driven by externally applied voltages. When applied to coaxial magnetrons, the typical tuning ranges have been narrow (20 MHz at 600 cps rate). In comparison to other rapid tuners, the size and drive power are low with this system, but the available tuning range is short, the tuning curve shape is quite restricted, and the tuner is sensitive to certain vibration frequencies. For fast tuning of coaxial magnetrons, Raytheon prefers the voice-coil method described previously.



Motor-Driven Cams were first applied to Raytheon magnetrons 20 years ago to obtain rapid frequency changes. In recent years, this scheme has been adapted to coaxial magnetrons. Sometimes two motors are used to achieve both narrow and wide-range tuning. The size, power consumption, wear life, and frequency readout accuracy (for L.O. tracking) can present problems with this type of tuner, although improvements are possible. Again the versatility of the voice-coil tuner is preferable.



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MICROWAVE AND POWER TUBE DIVISION

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RAYTHEON

CATHODE RAY TUBES AND DISPLAY DEVICES

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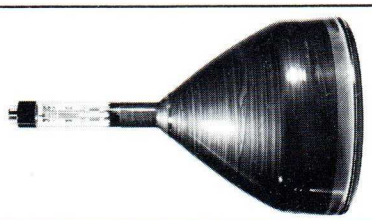
RAYTHEON

CATHODE RAY TUBES

All standard tubes — All popular phosphors

RADAR EQUIPMENT CATHODE RAY TUBES
(Magnetic Deflection)



TYPE	FACE PLATE	TYPE OF FOCUS	TYPICAL ANODE VOLTAGE	NOMINAL CUTOFF VOLTS	NOTES
5AHP	Round	Electro.	7,000	50	
7ABP	Round	Electro.	7,000	65	
10KP	Round	Mag.	9,000	50	
12ABP	Round	Electro.	10,000	50	High resolution, good depth of focus.
12DP	Round	Mag.	7,000	50	
16ADP	Round	Mag.	12,000	45	Metal envelope.
CK1352P	16″ Round	Electro.	12,000	55	Metal envelope, high resolution, good depth of focus.
CK1355P	7″ Round	Electro.	7,500	47	Special high altitude anode connector, close mechanical tolerances on bulb outline.

OSCILLOSCOPE CATHODE RAY TUBES
(Electrostatic Focus and Deflection)

TYPE	FACE PLATE	TYPICAL POST ACCEL. VOLTAGE	NOMINAL CUTOFF VOLTS	DEFLECTION SENSITIVITY V dc/inch		TYPICAL ANODE VOLTAGE
				D1-D2	D3-D4	
3ADP	Round	4,000	70	150	65	2,000
3UP	Rect.	—	82	275	264	2,000
5ADP	Round	3,000	45	45	34	1,500
7AEP	Round	4,000	60	91	75	2,000

FLYING SPOT SCANNER CATHODE RAY TUBES
Optically flat face plates, high light intensity output, useful for photographic applications. (Magnetic Deflection Types Listed.)

TYPE	FACE PLATE	TYPE OF FOCUS	TYPICAL ANODE VOLTAGE	NOMINAL CUTOFF VOLTS	NOTES
5AKP	Round	Mag.	30,000	110	Triode gun
5CEP	Round	Electro.	20,000	55	High resolution — .0015″ spot size at 10μA.
5WP	Round	Electro.	27,000	70	
5ZP	Round	Electro.	27,000	70	

Custom modifications and special versions

SPECIAL DISPLAY DEVICES

TYPE	FACE PLATE	TYPE OF FOCUS	TYPICAL ANODE VOLTAGE	NOMINAL CUTOFF VOLTS
7BUP	7″ Round	Electro.	7,500	53
CK1379	10″ Round	Electro.	10,000	50
CK1395P	24″ Rect.	Electro.	14,000	45
CK1409	—	Electro.	2KV	30
CK1413	5″	Mag.	40,000	50
CK1414	2″	Electro.	1,200	40

NOTES

Special high altitude anode connector, high resolution, close mechanical tolerances on bulb outline, magnetic deflection.

Two optically-ground rear windows for projecting a superimposed pattern on screen, and photographing composite display.

Combination magnetic and electrostatic deflection for alphanumeric displays. Also available in many other bulb sizes.

10 segment radial resolution type for fast beam switching. Electrical output.

High brightness projection cathode ray tube.

Monoscope with alphanumeric characters. Electrical output.

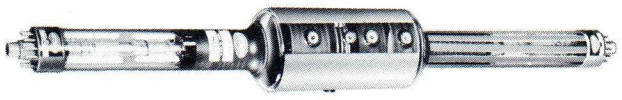
HIGH RESOLUTION CATHODE RAY TUBES

The following types are examples of Raytheon's capability to manufacture high resolution cathode ray tubes. (Magnetic Deflection Types Listed.)

TYPE	FACE PLATE	TYPE OF FOCUS	TYPICAL ANODE VOLTAGE	NOMINAL CUTOFF VOLTS	NOTES
5CEP	Round	Electro.	20,000	55	
10AKP	Round	Mag.	8,000	50	
CK1352P	16″ Round	Electro.	12,000	55	Metal envelope, 0.008″ spot size
CK1381P	16″ Round	Electro.	14,000	50	Glass envelope, used in FAA RBDE-5.

RECORDING STORAGE TUBES AND ASSOCIATED COMPONENTS

Following are representative types. Versions highlighting resolution or characteristics are available.



Raytheon Recording Storage Tubes are electronic input, electronic output cathode ray storage devices. Electronic storage is accomplished by electron charge of a dielectric material. These tubes feature fast writing, long storage, fast erase and immediate readout capabilities. Because of the high resolution characteristics of these tubes, high quality detailed information can be stored. Miniature tubes in development.

TYPE	CATHODE RAY CONSTRUCTION	TYPICAL ANODE VOLTAGE	NOMINAL CUTOFF VOLTS	STORAGE SCREEN OPERATING VOLTAGES	TYPICAL RESOLUTION (TV Lines)	NOTES
CK1500	Single Gun	3,500	50	10 to 500	1500	Sequential writing and reading.
CK7571/ QK685	Single Gun Mag. Deflection	3,500	30	10 to 500	1200	Sequential writing and reading.
CK7702	Dual Gun Mag. Deflection	3,500		10 to 500	1400	Capable of simultaneous write, read and gradual erasure (for electrostatic dynamic focus).
CK1383	Dual Gun Mag. Deflection	4,500		10 to 500	1400	Capable of simultaneous write, read and gradual erasure (for magnetic dynamic focus).
CK1519	Dual Gun	3,500	50	10 to 500	1400	Miniature version of CK1383.
CK1521	Single Gun Mag. Deflection	3,500	50	10 to 300	2200	Ultra-high resolution. Very fast erase capability.
CK1535	Dual Gun	2,500		10 to 600	1200	Narrow neck, high efficiency, magnetic sweep.
CK1537	Single Gun	2,500		10 to 500	1200	Narrow neck, high efficiency, magnetic sweep.

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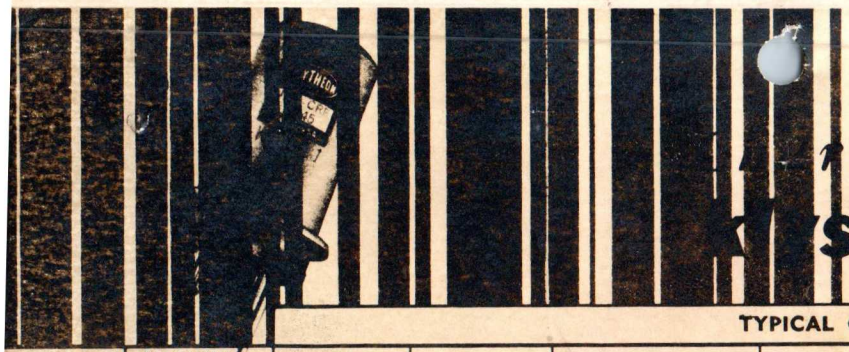

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RAYTHEON

TYPICAL OPERATION

TUBE TYPE	MAXIMUM FREQUENCY RANGE (kMc)	FREQUENCY (kMc)	WAVELENGTH (cm)	POWER OUTPUT (mw) Average	POWER OUTPUT (mw) Minimum	REFLECTOR POTENTIAL (D.C. Volts)	RESONATOR POTENTIAL (D.C. Volts)	CONTROL GRID POTENTIAL (D.C. Volts)	ELECTRONIC TUNING ΔE.REF. between ½ power pts. (Mc)	HEATER CURRENT AT 6.3V (amps)	TYPE OF CAVITY	TYPE OF TUNING	TYPE OF OUTPUT COUPLING	TYPE OF BASE	TUBE TYPE
RK5837	.55-2.3	1.5	20.0	160	50	—235	325	10	.....	0.675	External	Mechanical Inductive	Coaxial Cable	Pee Wee 4 Pin	RK5837
	1.1-3.0	2.2	13.6	60	20	—215	300								
	1.5-3.8	3.0	10.0	40	15		325								
RK6BM6	.550-2.3	.8-2.2	3.75	...	...	—30 to —60	325	0	.....	0.625					RK6BM6
			13.0	125	50	—250 to —330									
	1.1-3.0	1.15-2.75	26.0	40	10	—20 to —60	300								
			10.9	60	20	—275 to —355									
RK6BM6A	1.5-3.8	.....	.....	...	...	.....	325								RK6BM6A
		Same Characteristics as RK6BM6 — Pulsed Version													
RK5777	.6-2.35	.95-2.35	31.6-12.17	160	100	—50 to —625	400	0 to 5	8 min.	0.985				Std. Min. 7 Pn. Btn. Sl.	RK5777
RK6133	1.5-3.75	3.458-3.592	8.67-8.35	140	95	—182 to —277	300	300	20 min.	0.650				Intermediate Octal 4 Pin	RK6133
RK2K28	1.8-4.0	3315-3680	9.06-8.16	100	80	—145 to —300	300	300	20 min.	0.660					RK2K28
RK5981	1.245-1.46	1.245-1.46	24.1-20.5	100	40	—30 to —220	225	.....	2.5 min.	0.455	Self Contained	Mechanical Capacitive		Phenolic Wafer 8 Pin	RK5981
RK5778	1.8-4.62	2.14-4.62	14.0-6.52	150	100	—50 to —460	300	—5 to 5	8 min.	0.985	External			Intermediate Octal 5 Pin	RK5778
RK6BL6	1.6-4.0	2.5	12.0	121	...	—236	300	0	.....	0.675		Mechanical Inductive		Pee Wee 4 Pin	RK6BL6
	2.0-4.5	2.11-2.17	14.2-13.8	45	25	—30 to —60									
		4.225-4.355	7.1-6.89	72	25	—250 to —330									
	3.6-5.5	.....	.....	...	...	.....									
RK5836	1.6-4.0	2.5	12.0	121	...	—236	300	10	.....	0.675					RK5836
	2.0-4.5	2.11-2.17	14.2-13.8	45	25	—25 to —55			6 min.						
		4.255-4.355	7.1-6.89	72	25	—240 to —320			6 min.						
	3.6-5.5	.....	.....	...	...	.....			.....						
RK5721	2.0-12.0	2.5-4.5	12.0-6.67	150	50	—80 to —400	1000	4 to 18	.....	0.580				Special Sml. Mica Filled Bakelite 4 Pin	RK5721
		4.29-8.34	6.98-3.60	125	100	—50 to —625	1000		12 min.						
		6.87-11.0	4.37-2.73	40	20	—120 to —450	1250		.....						
RK726B	2.883-3.173	3.0	10.4-9.45	150	110	—60 to —160	300	.....	25 min.	0.440	Self Contained	Mechanical Capacitive		Phenolic Wafer 8 Pin	RK726B
RK6236	3.8-7.6	4.29-7.5	6.98-4.01	125	90	—60 to —510	1000	4 to 18	10 min.	0.580	External	Mechanical Inductive		Special Sml. Mica Filled Bakelite 4 Pin	RK6236
RK726C	2.7-2.96	2.8	10.7	100	85	—75 to —135	300	.....	25 min.	0.440	Self Contained	Mechanical Capacitive		Phenolic Wafer 8 Pin	RK726C
RK6043	2.95-3.275	3.2	9.38	.175	150	—100 to —175	300	300	20 min.	0.650					RK6043
				50	25	—40 to —100	250	250	25 min.						
RK726A	3.173-3.400	3.173-3.4	9.45-8.8	140	100	—100 to —210	300	.....	25 min.	0.440					RK726A
RK2K29	3.4-3.96	3.56	8.43	106	85	—75 to —180	300	.....	28 min.	0.440					RK2K29
RK2K56	3.84-4.46	4.15	7.23	100	80	—85 to —150	300	.....	30 min.	0.440					RK2K56
QK381	4.1-4.45	4.3	6.98	4.5	3.0	—67 to —87	250	.....	30 min.	0.440					QK381
RK2K22	4.24-4.91	4.575	6.56	115	75	—120 to —180	300	.....	30 min.	0.440					RK2K22

RK2K48	4.0-11.0	4.3-4.45	6.98-6.74	...	5	−20 to −50	1250	.....	.....	0.575	External	Mechanical Inductive		Pee Wee 3 Pin	RK2K48
		6.9-7.2	4.35-4.17	...	5	−65 to −110									
				...	20	−175 to −235									
		10.55-10.85	2.84-2.77	...	20	−240 to −300									
RK6115A	5.1-5.9	5.5	5.46	100	70	−115 to −175	300	.....	30 min.	0.440	Self Contained	Mechanical Capacitive	Coaxial to Waveguide RG-49/U	Phenolic Wafer 8 Pin	RK6115A
QK412	5.1-5.9	5.5	5.46	100	70	−160 Approx.	300	.....	.....	0.440					QK412
RK6037	5.12-5.43	5.28	5.68	30	20	−80 to −160	300	0 to −200	40 min.	Kly.-.470 Tuner-.825		Thermal Capacitive	Coaxial to Waveguide RG-50/U		RK6037
QK754	5.925-6.425		5.07-4.68	1300	1000	−280 to −450	750	.....	40 ave.	0.675		Mechanical Capacitive			QK754
QK461	5.925-6.45	6.2	4.83	120	100	−75 to −175	300	.....	30 min.	0.440					QK461
RK7158	5.925-6.45	6.2	4.83	120	100	−195 to −275	300	.....	20 ave.	0.440					RK7158
QK549	5.850-6.350	6.1	4.83	120	90	−50 to −150	300	.....	15 ave.	0.440					QK549
	5.925-6.425	6.2				−150 to −310									
RK5976	6.2-7.425	6.75	4.45	110	85	−78 to −158	300	.....	32 min.	0.440					RK5976
RK2K26	6.25-7.06	6.66	4.51	100	80	−70 to −115	300	.....	32 min.	0.440					RK2K26
QK755	6.575-7.125	6.85	4.57-4.37	1300	1000	−200 to −450	750	.....	40 ave.	0.675					QK755
QK531	6.5-6.8	6.65	4.46	60	40	−50 to −150	300	.....	15 min.	0.440					QK531
	6.575-6.875	6.725		120	90	−165 to −275									
QK532	6.8-7.05	6.9	4.28	60	40	−50 to −150	300	.....	15 min.	0.440					QK532
	6.895-7.125	7.0		120	90	−150 to −310									
QK757	7.125-7.65	7.39	4.22-3.93	1300	1000	−200 to −450	750	.....	35 ave.	0.675					QK757
QK623	7.0-7.65	7.32	4.06	60	40	−50 to −150	300	.....	15 min.	0.440					QK623
	7.125-7.65	7.39		120	90	−187 to −380									
QK752	7.05-7.845	7.45	4.22-3.88	60	40	−70 to −200	300	.....	15 ave.	0.450			Coaxial to Waveguide RG-51/U		QK752
	7.125-7.77	7.5		120	90	−130 to −350									
QK758	7.125-7.75	7.44	4.22-3.88	1300	1000	−200 to −450	750	.....	35 ave.	0.675			Coaxial to Waveguide RG-50/U		QK758
RK6586	7.05-7.125	7.09	4.45	100	65	−125 to −200	300	.....	18 min.	0.440					RK6586
	7.125-8.125	7.625		140	80	−125 to −200									
QK645	7.125-8.5	7.8	4.22-3.53	200	120	−160 to −225	375	.....	18 min.	0.440					QK645
RK6390	6.87-10.75	6.87-9.2	4.37-3.26	80	45	−90 to −420	1250	2 to 16	6 min.	0.580	External	Mechanical Inductive	Coaxial Cable	Special Mica Filled Bakelite 4 Pin	RK6390
		9.2-11.0	3.26-2.73	80	45	−115 to −360									
QK753	7.75-8.4	8.1	3.88-3.58	115	90	−75 to −145	300	.....	25 ave.	0.450	Self Contained	Mechanical Capacitive	Waveguide RG-51/U	Phenolic Wafer 8 Pin	QK753
QK759	7.75-8.4	8.1	3.88-3.57	1300	1000	−200 to −450	750	.....	35 ave.	0.675					QK759
QK646	8.5-10.0	9.3	3.23	70	25	−85 to −225	300	.....	48 min.	1.20			Waveguide RG-52/U	Molded Rubber	QK646
RK6310	8.5-10.0	9.3	3.23	70	25	−85 to −225	300	.....	48 min.	1.20				Pee Wee 3 Pin	RK6310
RK6312	8.5-10.0	9.3	3.23	70	25	−85 to −225	300	.....	48 min.	1.20				Molded Rubber	RK6312
RK6316	8.5-10.0	9.3	3.23	70	25	−85 to −225	300	.....	48 min.	1.20					RK6316
RK2K25	8.5-9.66	9.37	3.21	32	20	−128 to −183	300	.....	55 ave.	0.440			Coaxial to Waveguide RG-49/U	Phenolic Wafer 8 Pin	RK2K25
				22	15	−75 to −120			64 ave.						
RK2K45	8.5-9.66	9.66	3.11	32	20	−95 to −145	300	−35 to +15	70 ave.	0.762		Thermal Capacitive			RK2K45
RK6116	8.5-9.66	8.5-9.66	3.53-3.11	32	20	−95 to −145	300	0 to −280	70 ave.	0.50					RK6116
RK6845	8.5-9.66	8.5-9.66	3.53-3.11	32	20	−95 to −145	300	0 to −280	70 ave.	0.50					RK6845
RK6940	8.5-9.66	8.5-9.66	3.53-3.11	32	20	−95 to −145	300	0 to −280	70 ave.	0.50					RK6940
QK414	9.66-10.25	10.0	2.99	20	15	−128 to −183	300	.....	50 min.	0.440		Mechanical Capacitive			QK414

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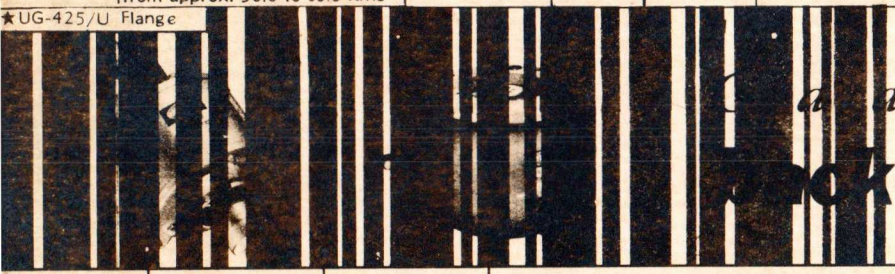
Detailed information necessary for specific applications may be obtained by contacting the Applications Engineering Department, Microwave and Power Tube Division. Where tubes are [illegible] to meet special application requirements, Raytheon invites inquiries and problem discussions. Special development services are available at all times by contacting the Sales [illegible] Microwave and Power Tube Division, Waltham, Ma[illegible]

INFORMATION ON CLASSIFIED TYPES IS AVAILABLE ON PROPER CLEARANCE FROM THE ARMED SERVICES

KLYSTRON OSCILLATORS

TUBE TYPE	MAXIMUM FREQUENCY RANGE (kmc)	TYPICAL OPERATION: FREQUENCY (kMc)	WAVELENGTH (cm)	POWER OUTPUT (mW) Average	POWER OUTPUT (mW) Minimu	REFLECTOR POTENTIAL (D.C. Volts)	RESONATOR POTENTIAL (D.C. Volts)	CONTROL GRID POTENTIAL (D.C. Volts)	ELECTRONIC TUNING ΔE.REF. between ½ power pts. (Mc)	HEATER CURRENT AT 6.3V (amps)	TYPE OF CAVITY	TYPE OF TUNING	TYPE OF OUTPUT COUPLING	TYPE OF BASE	TUBE TYPE
QK448	12.0-13.8	12.0-13.8	2.5-2.17	85	50	—75 to —275	300	.....	60 min.	[illegible]0	Self Contained	Mechanical Capacitive	Waveguide RG-91/U	Standard Intermediate Octal	QK448
QK510	12.0-13.8	12.0-13.8	2.5-2.17	85	50	—100 to —275	300	.....	60 min.	0.440					QK510
RK6178	15.75-16.25	15.75-16.25	1.95-1.84	25	20	—100 to —200	300	.....	75 min.	0.440					RK6178
RK6573	15.5-17.0	15.5-17.0	2.0-1.76	25	20	—60 to —210	300	.....	75 min.	0.440					RK6573
QK306	18.0-22.0	18.0-22.0	1.66-1.36	40	10	—80 to —220	1800	—20 to —100	40 ave.	0.580			Waveguide RG-53/U RG-66/U		QK306
★RK6253	18.0-22.0	18.0-22.0	1.66-1.36	40	10	—80 to —220	1800	—20 to —100	40 ave.	0.580					★RK6253
RK2K33	22.0-25.0	22.0-25.0	1.36-1.20	40	10	—80 to —220	1800	—20 to —100	40 ave.	0.580					RK2K33
★RK6254	22.0-25.0	22.0-25.0	1.36-1.20	40	10	—80 to —220	1800	—20 to —100	40 ave.	0.580					★RK6254
QK463 ★QK463A	24.5-27.5	24.5-27.5	1.22-1.09	40	10	—50 to —250	1800	—20 to —125	40 ave.	0.580					QK463 ★QK463A
QK289	.....	27.27-30.0	1.1-1.0	20	10	—50 to —200	2250	—20 to —250	45 ave.	0.580			Waveguide RG-96/U		QK289
QK290	.....	29.7-33.52	1.01-.895	20	10	—50 to —200	2250	—20 to —250	45 ave.	0.580					QK290
QK291	.....	33.52-36.25	.895-.826	18	5	—50 to —200	2250	—20 to —250	45 ave.	0.580					QK291
QK288	34.3-35.3	34.3-35.3	.875-.850	20	10	—110 to —210	2250	—50 to —180	50 min.	0.580					QK288
QK292	.....	35.1-39.7	.855-.755	10	8	—50 to —200	2500	—20 to —200	45 ave.	0.580					QK292
QK293	34.9-42.8	37.1-42.6	.810-.704	5	...	—50 to —200	2500	—20 to —200	To be specified	0.580			Waveguide RG-97/U		QK293
QK294	40.0-51.8	41.7-50.0 approx	.71-.60	5	...	—50 to —200	3000	—20 to —200		0.580					QK294
QK295	Two tubes necessary to cover from approx. 50.0 to 60.0 kMc		.60-.50	To be specified		—50 to —200	3000	—20 to —200		0.580			Waveguide RG-98/U		QK295

★UG-425/U Flange



characteristics of

backward wave oscillators

RAYTHEON

Type	Frequency Range Mcs	Delay Line Voltage Range V	GENERAL CHARACTERISTICS: Negative Control Grid V	Delay Line Current mA	Anode V	Anode mA	RF Power mW	Heater V	Heater A	ABSOLUTE MAXIMUM RATINGS: Delay Line V	Delay Line mA
QKB691	2000-4000	150-1500	0-100	15-45	100-250	0-20	70-1000	6.3	1.5	1600	45
QK528	3600-7200	150-1500	0-100	10-45	50-175	0-10	20-400	6.3	1.0	1600	45
QKB747	5200-5900	300-800	0-100	20-40	100-250	0-20	100-200	6.3	1.0	1600	45
RK7407	6700-11,400	20-300	0-250	15-35	100-200	0-20	20-300	6.3	1.3	1600	35

The values specified above must not be exceeded under any service condition. The ratings are limiting values above which the serviceability of any individual tube may be impaired. It does not necessarily follow that combinations of maximum ratings can be attained simultaneously.

The tubes listed are medium power, backward wave oscillators of the "O" type, designed for CW or pulsed operation over the bands indicated. A control grid normally at cathode potential for CW operation, facilitates low voltage pulsed or amplitude modulation. The control grid must never be operated positive with respect to the cathode.

Adequate clearance must be maintained between the tube magnet and ferromagnetic materials or other magnets to avoid deterioration of the tube's gauss level. In general, a 4" clearance between the tube and magnetic materials is sufficient. The tube should not be subjected to external magnetic fields in excess of 150 gauss.

The cooling-system capacity must be sufficient to maintain the delay-line temperature below 100°C and must be in operation before the application of the above voltages.

RAYTHEON

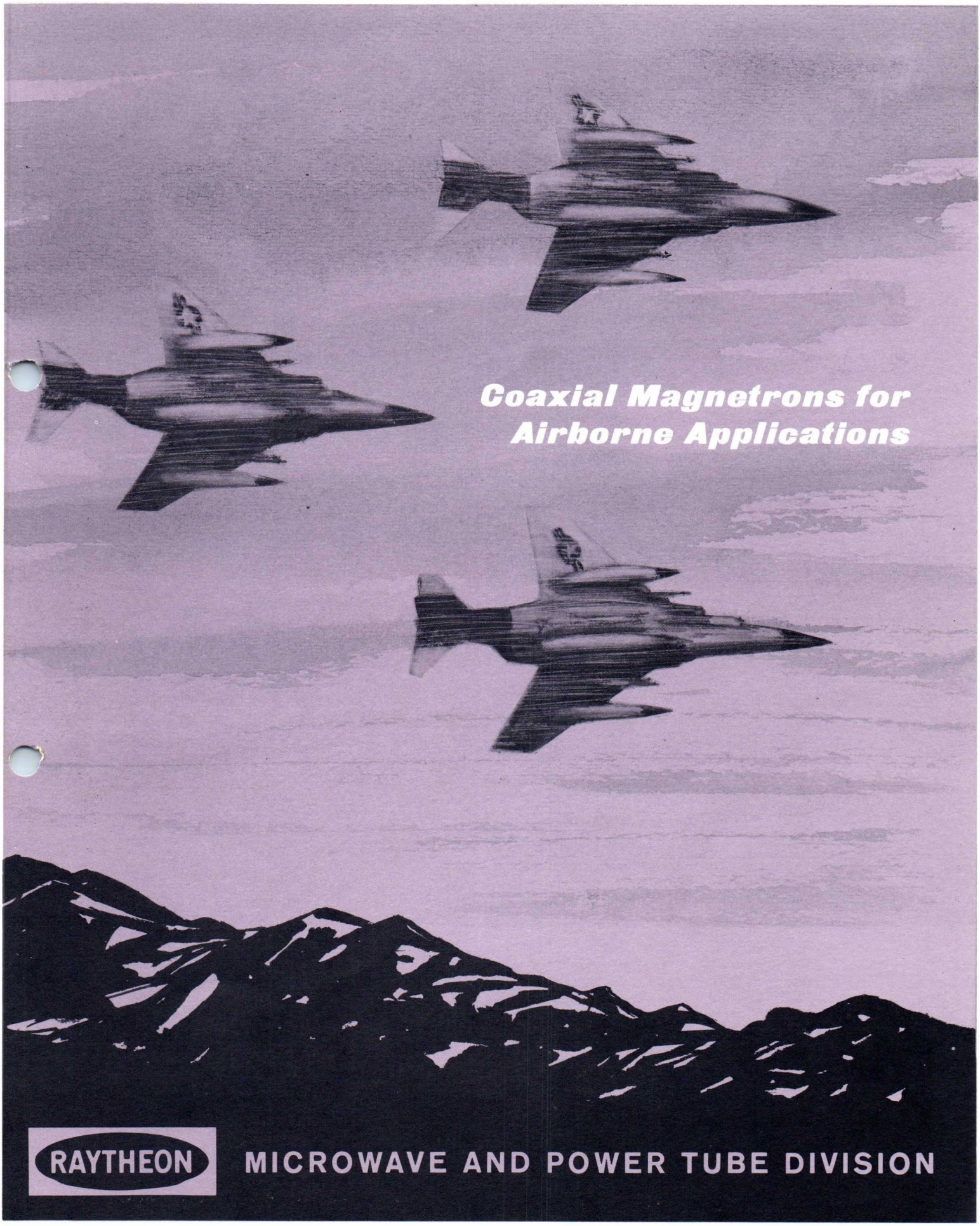
...acteristics ... magnetron oscillators

TYPE NUMBER	FREQUENCY	FREQUENCY BAND	CLASS	TYPICAL OPERATION: MIN. PEAK POWER (kw)	PEAK ANODE VOLT. (kv)	PEAK ANODE CURRENT Amps.	PULSE WIDTH usec.	DUTY CYCLE	HEATER VOLT. Volts	HEATER CURRENT Amps.	FIELD GAUSS	WEIGHT	COOLING	OUTPUT	ENVIRONMENT
RK7547	406-450		Tunable Pulsed	2000.0	55.0	97.3	6.0	.0018	6.5	55.0	Pkg.	220 lbs.	Liquid	3 1/8" Coaxial	Airc., Gnd.
QK508	420-450		Fixed F. Pulsed	2000.0	55.0	97.3	6.0	.0018	7.0	55.0	Pkg.	166 lbs.	Liquid	3 1/8" Coaxial	Airc., Gnd. Ship
RK5J26	1220-1350		Tunable Pulsed	400.00	28.0	46.0	4.0	.002	23.5	2.2	1400	20 lbs.	Air	3 1/8" Coaxial	Ship Ground
RK6517	1250-1350	L	"	1000.0	53.0	50.0	3.0	.0013	2.5	85.0	Pkg.	90 lbs.	Air	w/g	Ground
RK7528	1250-1350		"	2000.0	60.0	90.0	4.0	.0012	3.0	85.0	Pkg.	67 lbs.	Liquid	w/g	Ship Ground
RK7484	1250-1350		"	2000.0	60.0	90.0	3.0	.001	3.0	85.0	Pkg.	90 lbs.	Air	w/g	Ground
RK7484A	1250-1350		"	2000.0	60.0	90.0	3.0	.0012	3.0	85.0	Pkg.	90 lbs.	Air	w/g	Ground
QK665	1250-1285		Fixed F. Pulsed	5000.0	71.0	150.0	5.0	.0018	15.0	150.0	Pkg.	110 lbs.	Liquid	w/g	Ground
QK666	1320-1350		"	5000.0	71.0	150.0	5.0	.0018	15.0	150.0	Pkg.	110 lbs.	Liquid	w/g	Ground
RK2J34	2700-2740		"	240.0	20.0	30.0	1.0	.001	6.3	1.5	1900	2 lbs. 4 oz.	Air	Coaxial	Ground
RK4J35	2700-2740		"	800.0	28.0	70.0	1.0	.0005	16.0	3.1	2700	5 lbs.	Air	Coaxial	Ground Ship
RK7959	2700-2850		Tunable Pulsed	3500.0	61.5	115.0	2.0	.001	8.0	7.8	Pkg.	66 lbs.	Liquid	w/g	Ground
RK5586	2700-2900		"	800.0	29.5	70.0	1.0	.0005	16.0	3.1	2700	6 lbs. 4 oz.	Air	Coaxial	Airc., Ground
RK2J33	2740-2780		Fixed F. Pulsed	240.0	20.0	30.0	1.0	.001	6.3	1.5	1900	2 lbs. 4 oz.	Air	Coaxial	Ground
RK4J34	2740-2780		"	800.0	28.0	70.0	1.0	.0005	16.0	3.1	2700	5 lbs.	Air	Coaxial	Gnd., Ship
RK6410A	2750-2860		"	4500.0	71.0	130.0	2.0	.001	8.0	79.0	Pkg.	58 lbs.	Liquid	w/g	Ground
RK4J33	2780-2820		"	800.0	28.0	70.0	1.0	.0005	16.0	3.1	2700	5 lbs.	Air	Coaxial	Gnd., Ship
RK2J67	2795-2855		Tunable Pulsed	150.0	18.5	25.0	1.0	.001	6.3	1.5	1700	2 lbs. 8 oz.	Air	Coaxial	Ground
RK4J32	2820-2860		Fixed F. Pulsed	800.00	28.0	70.0	1.0	.0005	16.0	3.1	2700	5 lbs.	Air	Coaxial	Gnd., Ship
RK2J66	2845-2905	S	Tunable Pulsed	150.0	18.5	25.0	1.0	.001	6.3	1.5	1700	2 lbs. 8 oz.	Air	Coaxial	Ground
RK6406A	2850-2910		Fixed F. Pulsed	1750.0	52.0	85.0	2.0	.0006	8.8	79.0	Pkg.	40 lbs.	Liquid	w/g	Airc.
RK6518	2860-2900		Fixed F. Pulsed	1500.0	41.0	87.5	2.0	.0006	13.0	40.0	Pkg.	82 lbs.	Air	Coaxial	Ground
RK2J30	2860-2900		"	240.0	20.0	30.0	1.0	.001	6.3	1.5	1900	2 lbs. 4 oz.	Air	Coaxial	Ground
RK4J31	2860-2900		"	800.0	28.0	70.0	1.0	.0005	16.0	3.1	2700	5 lbs.	Air	Coaxial	Gnd., Ship
RK5657	2900-3100		Tunable Pulsed	800.0	30.0	70.0	1.0	.0005	16.0	3.1	2700	6 lbs. 4 oz.	Air	Coaxial	Gnd., Airc
RK2J71	3190-3210		Fixed F. Pulsed	6.0	5.0	5.0	1.0	.002	6.3	1.25	Pkg.	3 lbs. 12 oz.	Air	Coaxial	Airc.
RK4J41	3400-3450		"	700.0	28.0	70.0	1.0	.0005	16.0	3.1	2500	8 lbs. 7 oz.	Air	w/g	Ship
RK6695	3430-3570		Tunable Pulsed	650.0	31.0	60.0	1.0	.001	16.0	3.1	2600	6 lbs.	Liquid	Coaxial	Ship
RK6402	3430-3570		"	700.0	47.0	50.0	2.0	.0014	8.3	43.0	Pkg.	65 lbs.	Liquid	w/g	Ship
RK6403	3430-3570		"	2000.0	54.0	80.0	2.0	.0014	8.3	43.0	Pkg.	65 lbs.	Liquid	w/g	Ship
RK4J40	3450-3500		Fixed F. Pulsed	700.0	28.0	70.0	1.0	.0005	16.0	3.1	2500	8 lbs. 7 oz.	Air	w/g	Ship
RK4J39	3500-3550		"	700.0	28.0	70.0	1.0	.0005	16.0	3.1	2500	8 lbs. 7 oz.	Air	w/g	Ship

RK4J38	3550-3600	S (cont.)	"	700.0	28.0	70.0	1.0	0005	16.0	3.1	2500	"	Air	w/g	Ship
RK4J37	3600-3650		"	700.0	28.0	70.0	1.0	.0005	16.0	3.1	2500	"	Air	w/g	Ship
RK4J36	3650-3700		"	700.0	28.0	70.0	1.0	.0005	16.0	3.1	2500	"	Air	w/g	Ship
QK393	4300 ± 40		CW Fixed Frequency	1.0	0.3	0.03	. . .	. . . .	6.3	0.6	Pkg.	1 lb.	Convection	Coaxial	Airc.
RK6177	4309 ± 41		FM-CW	1.0	0.33	0.03	. . .	. . . .	6.3	0.6	Pkg.	1 lb.	Convection	Coaxial	Airc.
QK632	5250-5310		Fixed F. Pulsed	1000.0	35.5	60.0	1.0	.0001	5.0	19.0	Pkg.	50 lbs.	Air	w/g	Ground
RK7040	5380-5420		"	85.0	14.5	14.0	2.0	.001	6.3	1.65	Pkg.	7 lbs. 11 oz.	Air	w/g	Airc.
QK539	5450-5510		"	1000.0	35.5	60.0	2.5	.0001	5.0	19.0	Pkg.	50 lbs.	Air	w/g	Ground
QK735	5400-5900		Tunable Pulsed	0.4	2.1	1.5	0.25-1.0	.0003/ .002	5.0	1.0	Pkg.	8 oz.	Convection	TNC	Missile
RK7578	5400-5900		"	1.0	3.0	2.2	0.25-.75	.000025/ .002	5.0	1.6	Pkg.	14 oz.	Convection	TNC	Missile
QK737	5430-5570		"	0.225	1.6	1.1	0.3	.0003	5.0	1.0	Pkg.	8 oz.	Convection	TNC	Missile
RK7156	5450-5825		Tunable Pulsed	250.0	24.5	24.0	2.0	.001	5.0	5.0	Pkg.	35 lbs.	Air	w/g	Gnd., Airc.
RK6344	5450-5825		"	175.0	21.5	22.0	2.4	.001	11.0	11.0	Pkg.	25 lbs.	Air	w/g	Gnd., Ship
RK7417	5500-5600		Fixed F. Pulsed	9.0	7.5	4.0	0.2	.0003	6.3	1.6	Pkg.	8 lbs.	Air	w/g	Airc., Ship
RK2J51	8500-9600		Tunable Pulsed	35.0	14.0	14.0	1.0	.001	6.3	1.0	Pkg.	4 lbs. 14 oz.	Air	w/g	Airc., Gnd., Ship
RK2J51A	8500-9600		"	40.0	14.0	14.0	1.0	.0001	6.3	1.0	Pkg.	4 lbs. 14 oz.	Air	w/g	Gnd., Ship
RK7256	8500-9600		"	40.0	14.0	14.0	0.5	.001	6.3	1.0	Pkg.	5 lbs.	Air	w/g	Airc., Ground
RK6249A	8500-9600		"	200.0	28.0	25.0	2.5	.001	9.0	14.2	Pkg.	16 lbs.	Air	w/g	Airc.
RK6248	8700-8900		"	1.2	3.8	0.9	0.9	.045	6.3	5.0	Pkg.	6 lbs.	Air	w/g	Airc.
RK2J50	8750-8900		Fixed F. Pulsed	40.0	12.0	12.0	1.0	.001	6.3	1.0	5400	1 lb. 7 oz.	Air	w/g	Ship
RK6229	8900-9400		Tunable Pulsed	0.4	4.0	0.5	0.25	.0005	5.0	0.45	Pkg.	1 lb. 8 oz.	Convection	w/g	Missile
QK790	8900-9400	X	"	1.0	4.5	1.0	0.5	.001	5.0	0.45	Pkg.	1 lb. 8 oz.	Convection	w/g	Missile
RK2J49	9000-9160		Fixed F. Pulsed	40.0	12.0	12.0	1.0	.001	6.3	1.0	5400	1 lb. 7 oz.	Air	w/g	Ship
QK367	9015-9075		"	40.0	12.0	12.0	1.0	.001	6.3	1.0	Pkg.	31 lbs. 2 oz.	Air	w/g	Airc.
QK736	9130-9270		Tunable Pulsed	0.2	1.9	1.1	0.3	.0003	5.0	0.75	Pkg.	8 oz.	Convection	TNC	Missile
RK6967A	9205-9285		Fixed F. Pulsed	75.0	15.0	13.5	0.5	.001	6.3	2.9	Pkg.	7 lbs. 8 oz.	Air	w/g	Airc.
RK2J56A	9215-9275		"	40.0	12.0	12.0	1.0	.001	6.3	1.0	Pkg.	3 lbs. 2 oz.	Air	w/g	Airc., Gnd.
RK6002	9230-9404		"	225.0	27.5	30.0	5.0	.001	4.0	40.0	Pkg.	24 lbs.	Air	w/g	Airc., Gnd.
RK6959	9330-9420		Fixed F. Pulsed	428.0	34.0	38.0	3.2	.00105	6.0	30.0	Pkg.	45 lbs.	Air	w/g	Airc.
QK624	9340-9440		"	1000.0	40.5	68.7	2.5	.001	3.6	36.0	Pkg.	80 lbs.	Liquid	w/g	Airc.
RK2J55	9345-9405		Fixed F. Pulsed	40.0	12.0	12.0	1.0	.001	6.3	1.0	Pkg.	3 lbs. 2 oz.	Air	w/g	Gnd., Ship Airc.
RK2J42H	9345-9405		"	7.0	5.25	4.5	0.45	.00036	6.3	0.5	Pkg.	3 lbs. 4 oz.	Air	w/g	Airc.
RK2J42	9345-9405		"	7.0	5.5	4.5	2.0	.002	6.3	0.5	Pkg.	3 lbs. 4 oz.	Air	w/g	Gnd., Ship Airc.
RK730A	9345-9405		"	40.0	12.0	12.0	1.0	.001	6.3	1.0	5400	1 lb. 7 oz.	Air	w/g	Ground
RK725A	9345-9405		"	40.0	12.0	12.0	1.0	.001	6.3	1.0	5400	1 lb. 7 oz.	Air	w/g	Ship
RK7452	15,840-16,160		"	70.0	24.0	12.0	0.25	.00215	4.8	12.0	Pkg.	25 lbs.	Air	w/g	Ground
QK702	15,840-16,160	K	Tunable Pulsed	70.0	24.0	12.0	0.25	.00215	4.8	12.0	Pkg.	25 lbs.	Air	w/g	Ground
RK6841	16,410-16,625		Fixed F.	50.0	16.5	14.0	3.0	.0009	4.0	10.5	Pkg.	5 lbs. 12 oz.	Air	w/g	Airc., Ship

INFORMATION BULLETIN

NO. 2-66



Coaxial Magnetrons for Airborne Applications

RAYTHEON

MICROWAVE AND POWER TUBE DIVISION

Coaxial Magnetrons for Airborne Applications

FEATURES

- **Rugged Ceramic/metal construction**
- **Wide power range — 35 to 125 kilowatts**
- **Tunable and fixed frequency versions**
- **Light Weight**
- **Excellent starting stability, low jitter**
- **Being used in airborne systems meeting MIL-E-5400 specifications**

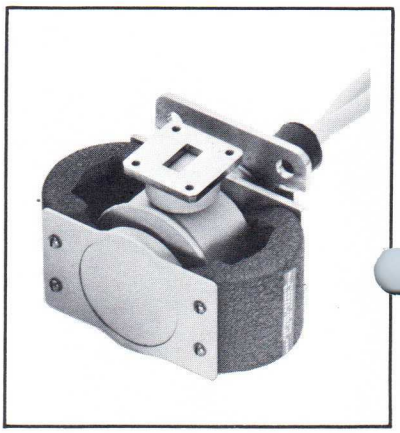
Raytheon coaxial magnetrons are lightweight, rugged tubes ideally suited for airborne radar applications which require high efficiency, improved frequency stability, and minimum size.

Coaxial magnetrons have an integral stabilizing cavity incorporated into the resonant structure of the tube. This design results in lower pushing and pulling figures, increased efficiency, and longer tube life than are obtainable with conventional magnetrons.

Raytheon coaxial magnetrons are available in both mechanically tunable and fixed frequency versions that meet the most rigorous airborne environmental conditions. The tubes exhibit very low starting jitter characteristics in operating systems.

In addition to the tubes shown here, a dither-tuned coaxial magnetron (QKH 1446) for target enhancement and ECCM applications is currently in development.

QKH1302. *Mechanically tunable 16.6 - 17.1 GHz. 35 kilowatt output.*



QKH1368. *Fixed frequency (17.2 GHz), 35 kilowatt output.*

QKH1325. *Fixed frequency (16.5 GHz), 65 kilowatt output.*

RK7208B. *Wide tuning range (15.5 - 17.5 GHz), high power (125 kw). Currently used in advanced systems in the field.*

For further information and technical assistance, please contact your nearest Raytheon sales office, listed on the back cover.

Raytheon Company
Microwave and Power Tube Division
Microwave Tube Operation
Waltham, Massachusetts 02154

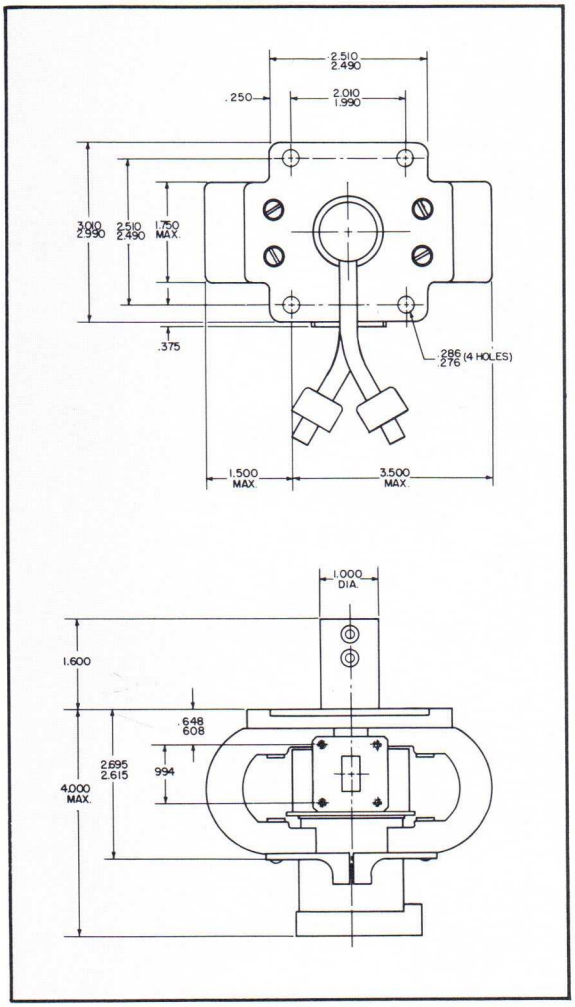
RAYTHEON

OPERATING CHARACTERISTICS

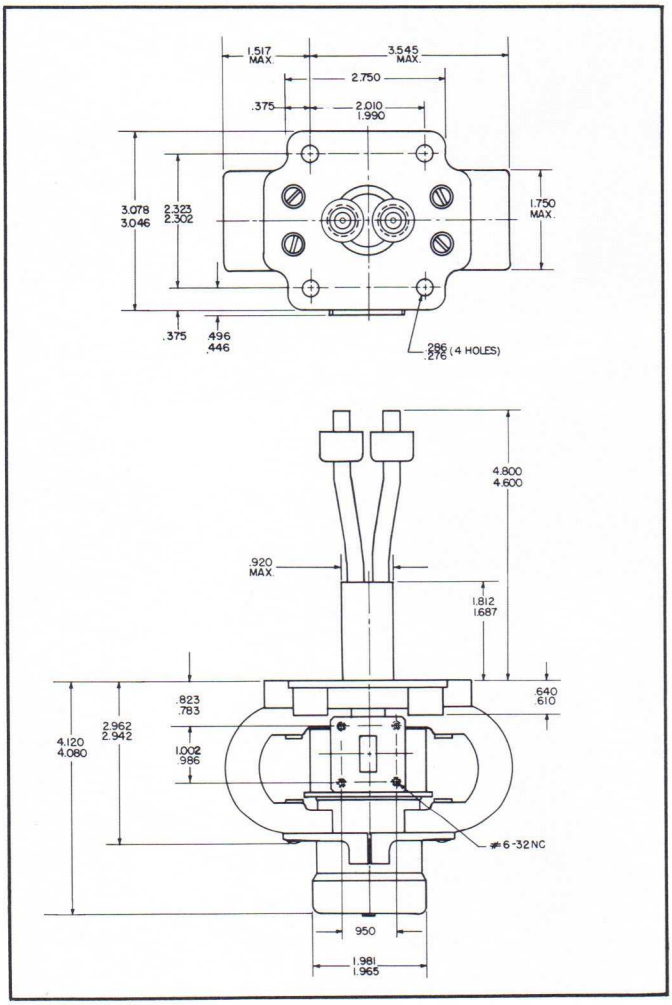
	RK7208B	QKH1302	QKH1325	QKH1368	QKH1446*
Frequency (GHz)	15.5-17.5 (mech. tunable)	16.6-17.1 (mech. tunable)	16.5 (fixed freq.)	17.2 (fixed freq.)	16.0-17.0 (mech. tunable) Dither range ±25 MHz
Peak Power Output (kw)	125	35	65	35	35
Pulse Width (usec)	0.25 & 3.0	0.2	0.2 & 1.0	0.2	0.2
Duty Cycle	.0007 & .001	.001	.00072	.001	.001
Anode Voltage (kv)	17.5	12	14	12	12
Peak Anode Current (a)	19	9.5	14	9.5	11
Efficiency (%)	41	37	38	37	33
Pulling (Mc)	8	10	8	10	10
Preheat Voltage (V)	12.6	12.6	12.6	12.6	12.6
Preheat Current (A)	3.2	1.9	1.75	1.9	1.9
Operate Heater Voltage (V)	7.1	7.6	6.5 & 9.0	7.6	7.6
Weight	14 lbs.	4 lbs., 2 oz.	4 lbs., 12 oz.	3 lbs., 10 oz.	—

**In development*

OUTLINE DRAWING — QKH1325



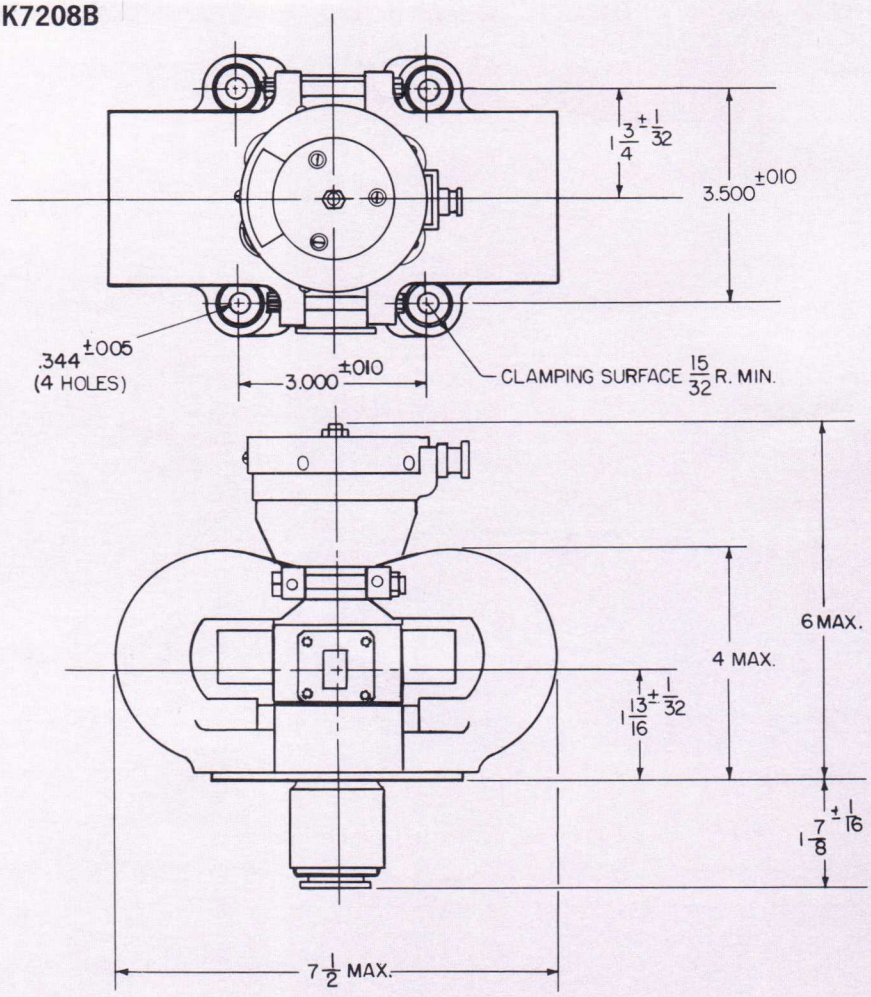
OUTLINE DRAWING — QKH1302 AND QKH1368*



SEE BACK COVER FOR OUTLINE DRAWING ON RK7208B.

**Same as QKH1302 except not tunable.*

OUTLINE DRAWING — RK7208B



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RAYTHEON

RAYTHEON COMPANY

MICROWAVE AND POWER TUBE DIVISION

Printed in U. S. A.

Sheppard

Dr. A.H. Pickering

Preliminary Data*

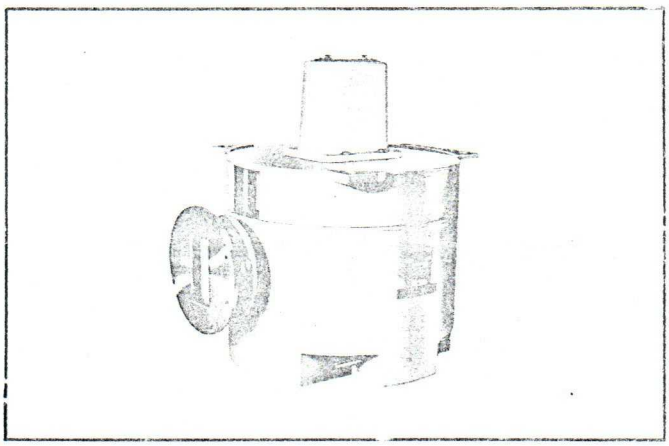
ISSUED 2/72

SC6

RAYTHEON

QKH 1667 COAXIAL MAGNETRON

The QKH1667 is a coaxial magnetron; pulse type, tunable over the 2700 to 2900 MHz frequency range. The QKH1667 delivers power outputs of 500 to 800 KW depending on input power levels. It has an integral light weight magnet and is air cooled. This tube has been designed primarily for airport surveillance work and is suited for systems having stringent RFI requirements.



ABSOLUTE RATINGS

Duty Factor	.0012
Current Pulse Width	2.4 μsec
Rate of rise of voltage	70 kv/μsec max.
VSWR	1.5:1
Pulse Voltage	32 kv (max.)
Peak Current	75 amps (max.)
Input Bushing Pressure	15-30 psia
Output Waveguide Pressure	15-30 psia
Anode (body) Temp.	125°C
Standby Filament Current	13 A
Frequency Range	2700-2900 MHz
Weight	50 lbs.
Overall Dimensions	10.31" x 13.53" x 12.93"

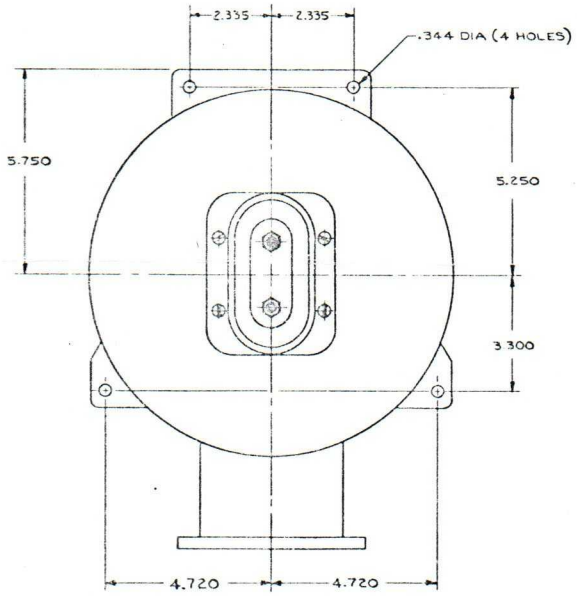
TYPICAL OPERATION

	(HIGH POWER)	(LOW POWER)
Duty Factor	.0011	.0010
Current Pulse Width	2.0 μsec	1.0 μsec
Pulse Voltage	28-32 kv	25-29 kv
Peak Current	65 amps	37.5 amps
Peak Power Output	800 kw	500 kw
Spectrum Characteristics		
Bandwidth	2/tpc	2/tpc
Minor Lobes	10 db	10 db
Pushing	20 kHz/amp	20 kHz/amp
Time Jitter	4 rms	4 rms
Frequency Jitter	3 kHz rms	3 kHz rms
Life	5000 hrs.	5000 hrs.

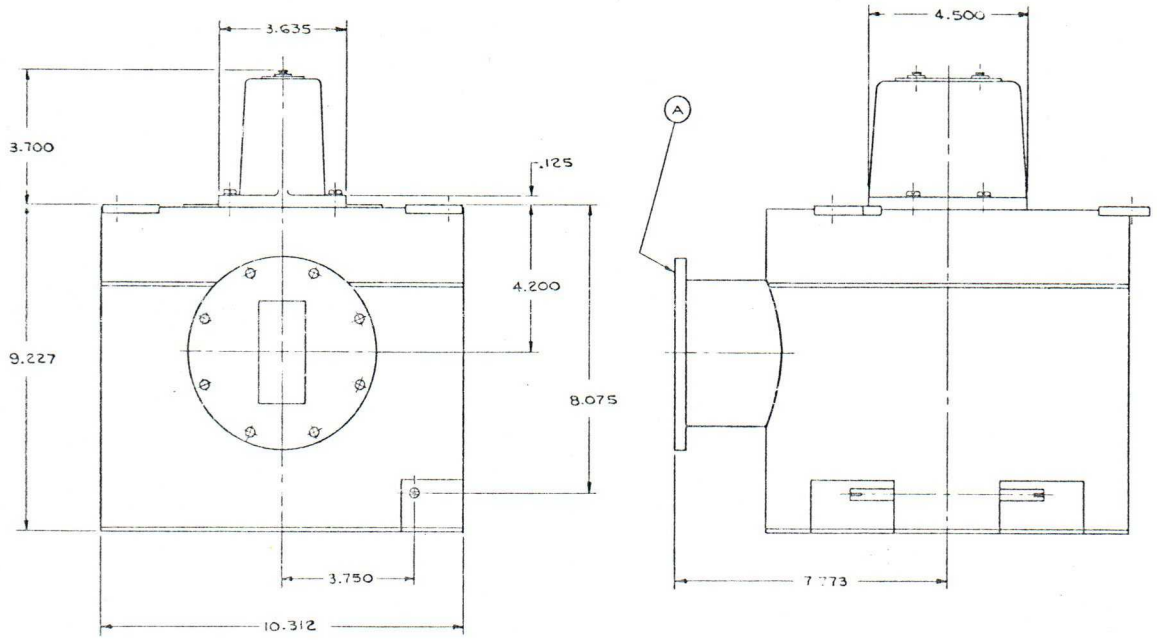
*The specifications for this device have not been finalized. For current information contact the nearest Microwave and Power Tube Regional Sales Representative.

Printed in U. S. A.

QKH1667 OUTLINE DRAWING



A - MATES WITH UG-54A/U



RAYTHEON

CATHODE RAY TUBE CK1395P-

The CK1395P– is a 24" rectangular cathode–ray tube which features magnetic major deflection and electrostatic minor deflection. The low–capacitance deflection design permits high speed character formation. Character positioning is accomplished magnetically. High resolution and high brightness are also major features of this tube type. The CK1395P– can be obtained with any of the JEDEC standard phosphors.

ELECTRICAL DATA

GENERAL CHARACTERISTICS:

Heater Voltage	6.3 volts
Heater Current at 6.3 Volts	.6 ± 10% amperes
Focusing Method	Electrostatic
Deflection Method	
Major: Deflection Angle Diagonal	90° Magnetic
Minor: Deflection	Electrostatic 2.5°

DIRECT INTERELECTRODE CAPACITANCES:

Cathode to All	6 pf
Grid No. 1 to All	9 pf
D1 to All	2.5 pf
D2 to All	2.5 pf
D3 to All	2.5 pf
D4 to All	2.5 pf

OPTICAL DATA

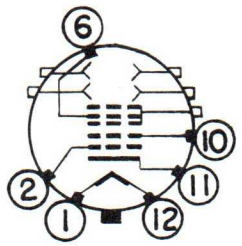
Screen	P31 Aluminized
Fluorescence	Green
Persistence	Medium
Face Plate (neutral gray) transmission	76%

MAXIMUM RATINGS: (Absolute Maximum Ratings)

Anode Voltage	18,000 Max. Volts
Focus Electrode	1,000 Max. Volts
Deflection Plate–to–Plate Voltage (MEAN = EA_2)	1,000 Max. Volts
Grid No. 2 Voltage	700 Max. Volts
Grid No. 1 Voltage	180 Max. Volts
Negative Bias Value	180 Max. Volts
Positive Bias Value	0 Max. Volts
Positive Peak Value	2 Max. Volts
EHK	± 180 Max. Volts
Grid No. 1 Circuit Resistance	1.5 Max. Megohms
Grid No. 2 Circuit Resistance	.1 Max. Megohm
Deflection Plate Circuit Resistance	5.0 Max. Megohms

MECHANICAL DATA

Overall Length	23" ± 1/4"
Bulb Number	J192A
Bulb Contact	Recessed
E. S. Deflection Contacts	Modified J1–22



BASING 12M
Base (6–63)

TERMINAL CONNECTIONS:

Pin 1	Heater
Pin 2	Grid #1
Pin 6	Focus Electrode
Pin 10	Grid #2
Pin 11	Cathode
Pin 12	Heater
Metal Cap	Anode

RAYTHEON CATHODE RAY TUBE CK1395P-

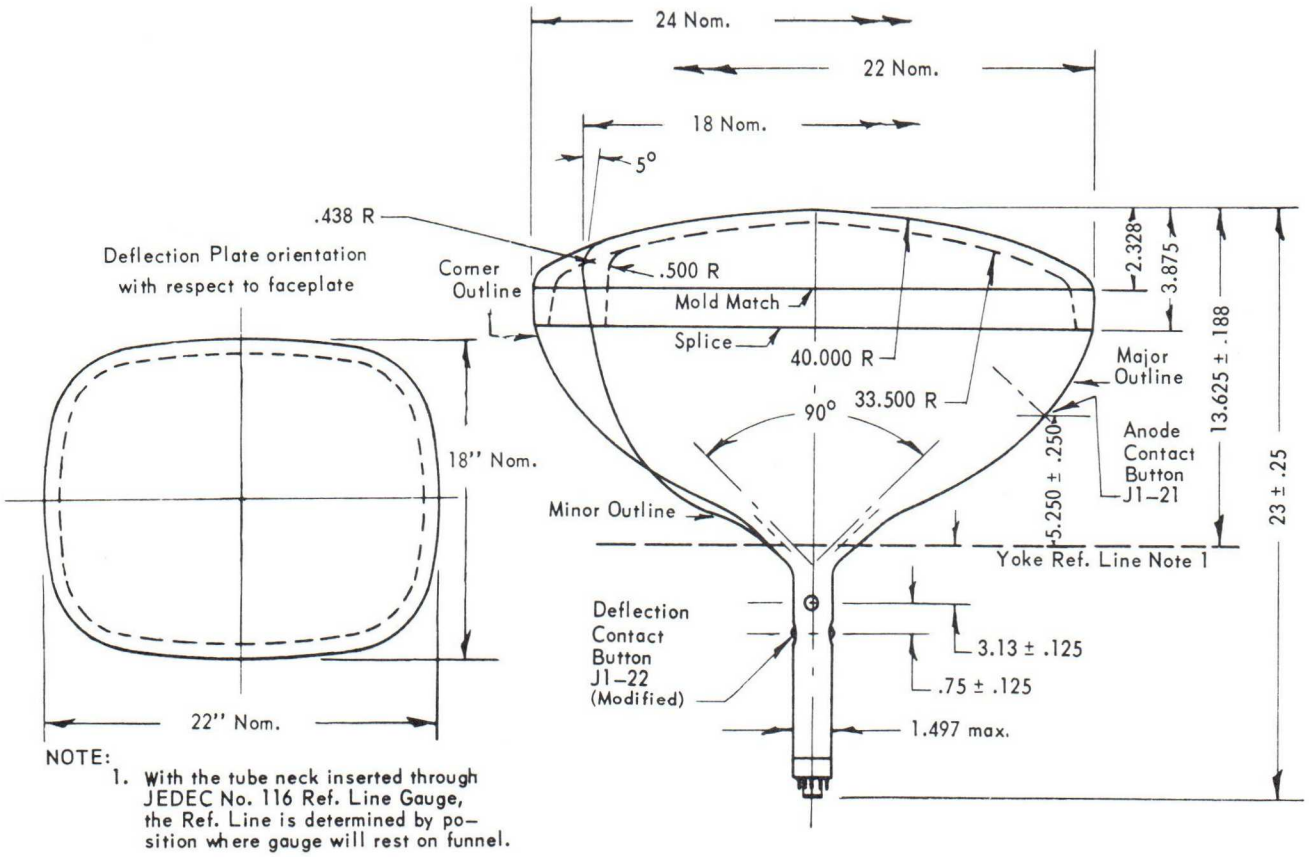
TYPICAL OPERATING CONDITIONS:

Anode Voltage	14,000 Volts
Focus Electrode Voltage	0 to 400 Volts
Grid No. 2 Voltage	400 Volts
Grid No. 1 Voltage (for cutoff)	–30 to –60 Volts
Grid drive for 125 μa I_k (nominal)	25 Volts
Light Output Note 1	50 FL
Dynamic Focus Voltage Required	Δ500 Volts
Resolution Note 1	.015"
Spot Position, Focused and Undeflected	.625" Radius of true center

ELECTROSTATIC DEFLECTION CHARACTERISTICS:

D1, D2 Deflection Factor	230 Volts Per Inch Max.
D3, D4 Deflection Factor	230 Volts Per Inch Max.
Deflection (ES) Orthagonality	
D1, D2 to D3, D4	± 1°
D1, D2 to Bulb Axes	± 3°
Maximum Useful Scan	
D1, D2	3/4"
D3, D4	3/4"

NOTE 1: Light output stated is at .5" per microsecond writing rate, refreshed 60 times per second. Line width stated is also under the same conditions. I_k = 125 μa approx.



NOTE:
1. With the tube neck inserted through JEDEC No. 116 Ref. Line Gauge, the Ref. Line is determined by position where gauge will rest on funnel.

RAYTHEON

CATHODE RAY TUBE CK1415P-

The CK1415P– is a 12–inch diagonal, rectangular face, electrostatic focus and magnetic deflection cathode–ray tube for monitor use in closed–circuit television, industrial and business equipment. A particular feature of this tube is a high–resolution electron gun which gives smaller spot size, improved spot shape, and greater resolution than heretofore available. Sharp focus is obtainable over the entire picture area. The fluorescent screen is aluminized to improve picture contrast and brightness. A 50% transmission faceplate is utilized to further enhance contrast in high ambient light locations.

ELECTRICAL DATA

Heater Voltage	6.3 Volts
Heater Current	0.6 ± 10% Amperes
Focusing Method	Electrostatic
Deflecting Method	Magnetic
Deflection Angle, approximate	70 Degrees
Direct Interelectrode Capacitances, approximate	
Cathode to all other electrodes	8.5 uuf
Grid No. 1 to all other electrodes	10.0 uuf

MAXIMUM RATINGS

Anode Voltage (See Note 1)	18,000 Max. Volts
Focus Electrode Voltage	800 Max. Volts
Grid No. 2 Voltage	800 Max. Volts
Grid No. 1 Voltage:	
Negative Bias Value	180 Max. Volts
Positive Bias Value	0 Max. Volts

OPTICAL DATA

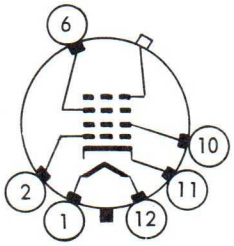
Screen	P31 Aluminized
Fluorescence	Green
Persistence	Medium

(This type is offered with any available phosphor desired)

MECHANICAL DATA

BASING. . . . . JEDEC 12L
MOUNTING POSITION . . . Any
OVERALL LENGTH 17" ±3/8" Inches Max.
BULB CONTACT Recessed Small Cavity Cap, JEDEC No. J1–21

BASING



BOTTOM VIEW

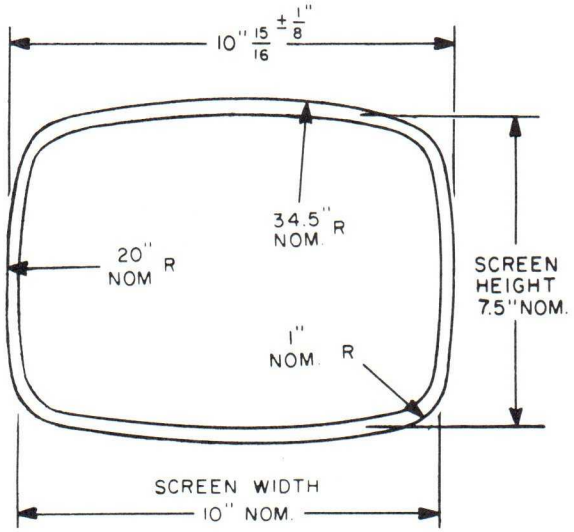
TERMINAL CONNECTIONS:

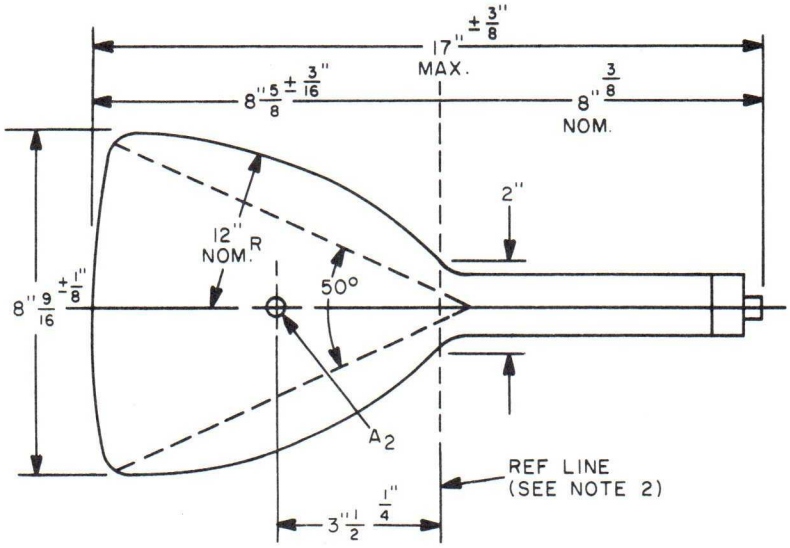
Pin 1 Heater
Pin 2 Grid #1
Pin 6 Focus
Pin 10 Grid #2
Pin 11 Cathode
Pin 12 Heater
Cap Anode

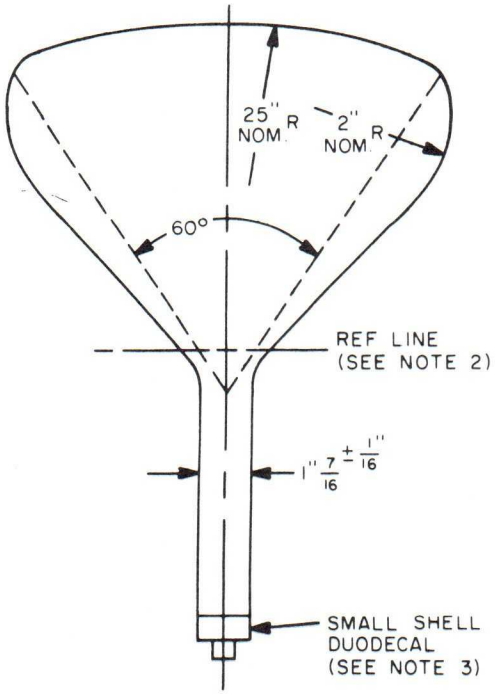
Printed in U.S.A.

TYPICAL OPERATING CONDITIONS

Anode Voltage	12,000 Volts
Focus Electrode Voltage	0 to +400 Volts
Grid No. 2 Voltage	400 Volts
Grid No. 1 Voltage (Cut–off)	–30 to –70 Volts
Line Width A (I_k = 150 ua)	0.015 Inches Max.







NOTE 1: Shielding of the tube for x–ray radiation may be required wherever the operating potential is in excess of 16 kilovolts.

NOTE 2: With tube neck inserted through flared end of reference line gauge (JETEC No. 110) and with tube seated in gauge, the reference line is determined by the inter–section of the plane CS of the gauge with the glass funnel. The I.D. of this gauge is 2".

NOTE 3: Socket for the base should not be rigidly mounted; it should have flexible leads and be allowed to move freely.

RAYTHEON

CATHODE RAY TUBE CK1419P-

The CK1419P– is a projection cathode ray tube that will yield high light output with excellent resolution and long life. It is intended for use in large display systems with television type format and raster scans. It can also be used for large Radar displays using scan conversion to television format.

The tube uses a removable heat exchanger to cool the phosphor screen surface during operation. This permits the screen to be energized to high light output levels and prolongs the life of the phosphor.

GENERAL DATA

Phosphor	31
Fluorescence	Blue–Green
Phosphorescence	Green
Persistence	Medium
Focusing Method	Magnetic
Deflecting Method	Magnetic
Deflection Angle (Approx.)	38° Maximum
Ion Trap Gun	See Note ▲

HEATER CHARACTERISTICS:

Heater Voltage	6.3 ± 10% volts
Heater Current	0.6 amps.
Peak Heater–Cathode Voltage: (Max.) ♦	
Heater Negative with Respect to Cathode	180 volts DC
Heater Positive with Respect to Cathode	180 volts DC

DIRECT INTERELECTRODE CAPACITANCES: (pf) (approx.)

Grid #1 to all other electrodes	6
Cathode to all other electrodes	5

DESIGN CENTER MAXIMUM RATINGS:

Anode Voltage	50,000 volts DC
Grid #2 Voltage	700 volts DC
Grid #1 Voltage:	
Negative–Bias Value	250 volts DC
Positive–Bias Value	0 volts DC
Positive–Peak Value	0 volts DC

CHARACTERISTICS AND TYPICAL OPERATION: (With Coolant System Operating)

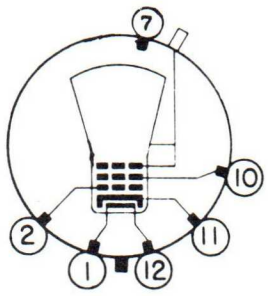
Anode Voltage	40,000 volts DC
Grid #2 Voltage	+600 volts DC
Grid #1 Voltage	–100 to 200
Resolution	600 TV lines ⊕
Light Output	38,000 Foot–lamberts

MECHANICAL DATA

BASE . . . . . Small Shell Duodecal 7–Pin

MOUNTING POSITION . . . Any

BASING



BOTTOM VIEW

TERMINAL CONNECTIONS

Pin 1 Heater
Pin 2 Grid #1
Pin 7 No Connection
Pin 10 Grid #2
Pin 11 Cathode
Pin 12 Heater
Cap Anode

CATHODE RAY TUBE CK1419P-

MAXIMUM CIRCUIT VALUES:

♦ Grid #1 Circuit Resistance . . . . . 1.5 max. megohms

Cathode should be returned to one side or to the mid–top of the heater transformer winding.

⊕ Spot cutoff (undeflected focused spot).
Anode Current – 500 μa

▲ An ion trap gun has been used to minimize phosphor and cathode damage from ions present in the tube. A magnetic or fixed permanent type may be used. It is necessary to use the trap magnet to produce a beam.

* 525 line raster, retrace blanked, 3'' x 4'', $1A_2$ will be no more than 500 μa to reach 20,000 FL at the face of the tube.

APPLICATION DATA

1. HEAT EXCHANGER DATA:
   Type – Esso univolt 30 or equivalent

   Flow Rate – 5 Gallons per minute minimum.

   It is recommended that a constant displacement type pump be used.

   Cooling capacity of system must be sufficient for 40 watts maximum heat dissipation at 70° F.

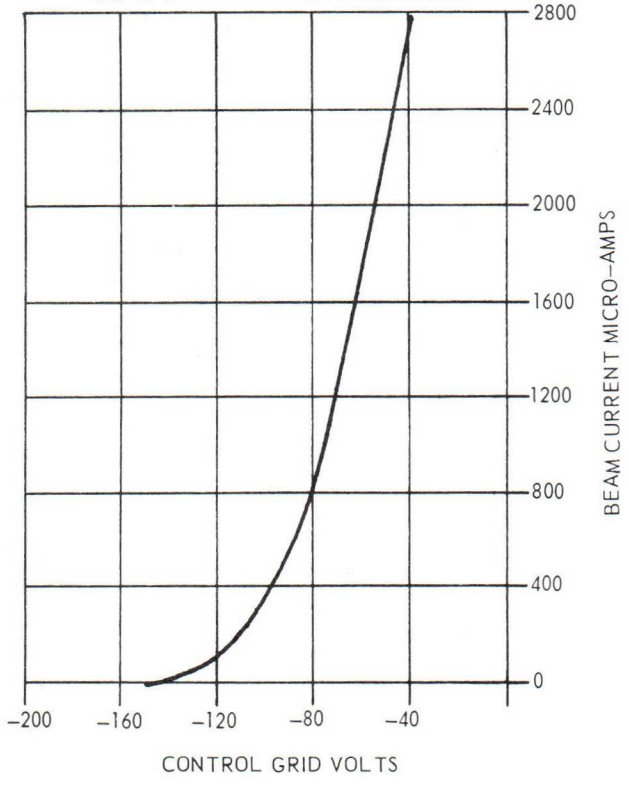
   If anode is operated above ground potential flexible insulating type tubing should be used. "Tygon" tubing made by U.S. Stoneware or equivalent is recommended.

2. CAUTION – OPERATION AT HIGH VOLTAGE
   presents potential X–ray and shock hazard.

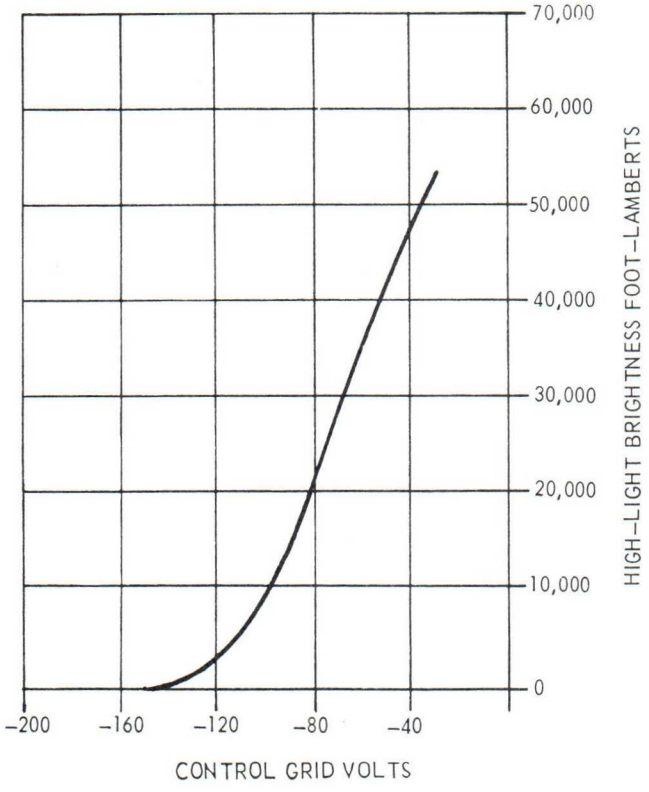
TYPICAL CHARACTERISTICS

PHOSPHOR TYPE –P31
Eh = 6.3V
Eanode = +40KV
Eg2 = +600 VDC

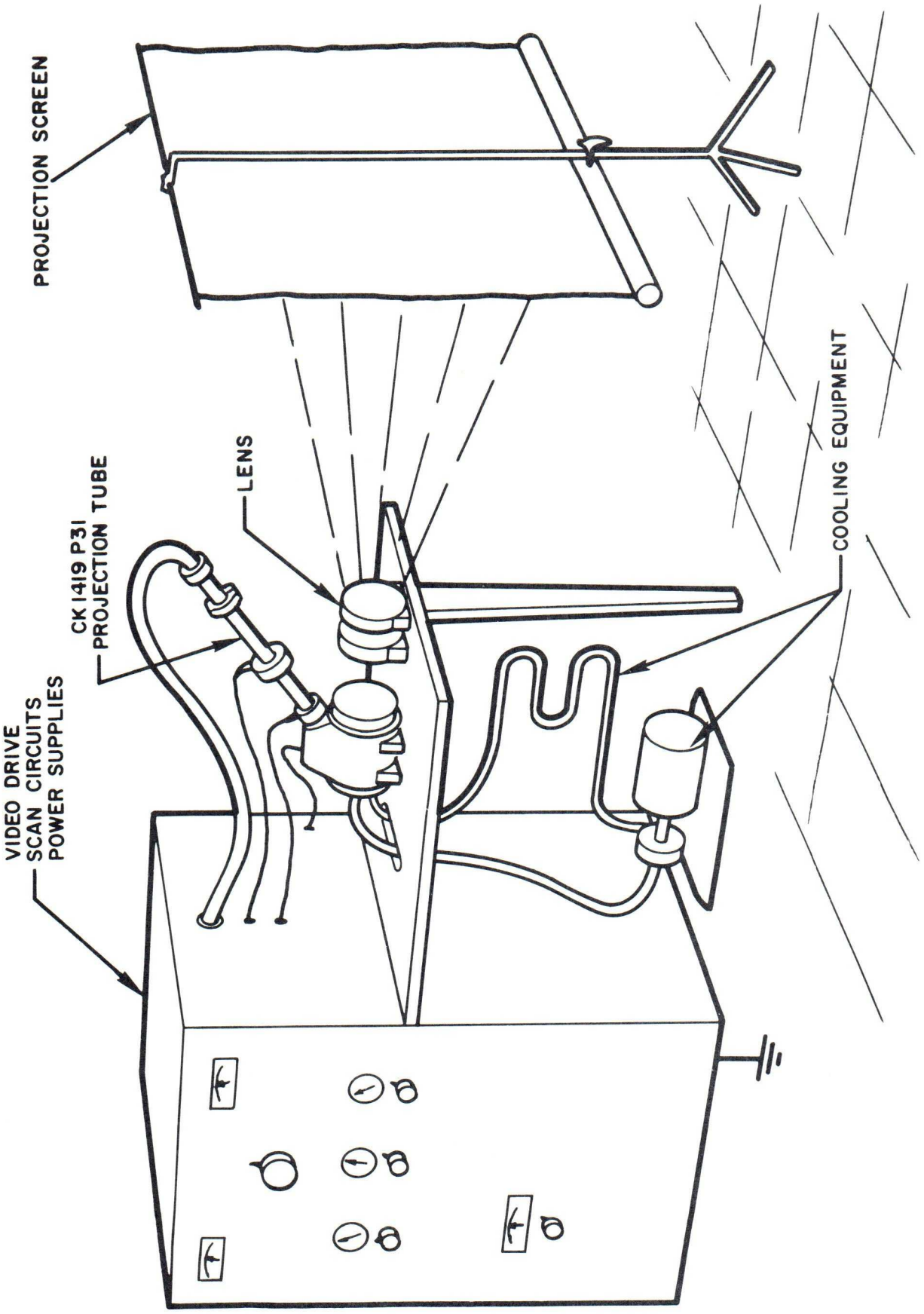
BEAM CURRENT VS GRID VOLTAGE



HIGH–LIGHT BRIGHTNESS VS GRID VOLTAGE



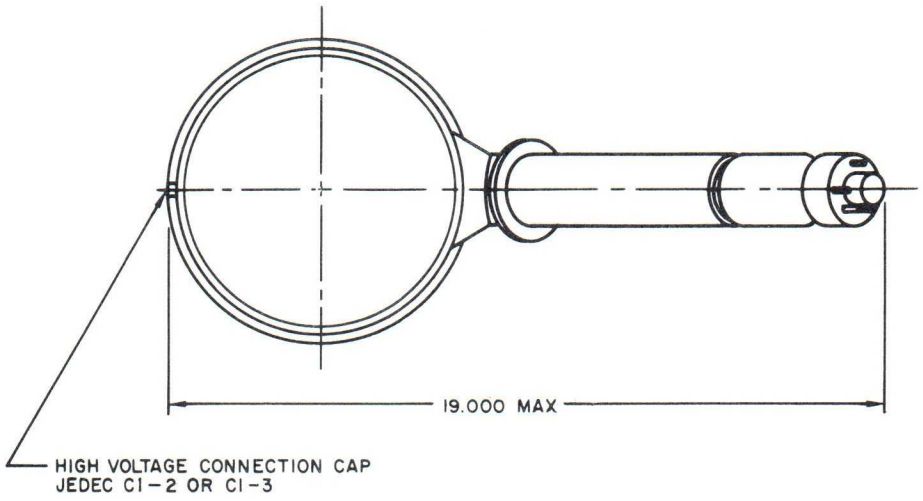
RAYTHEON

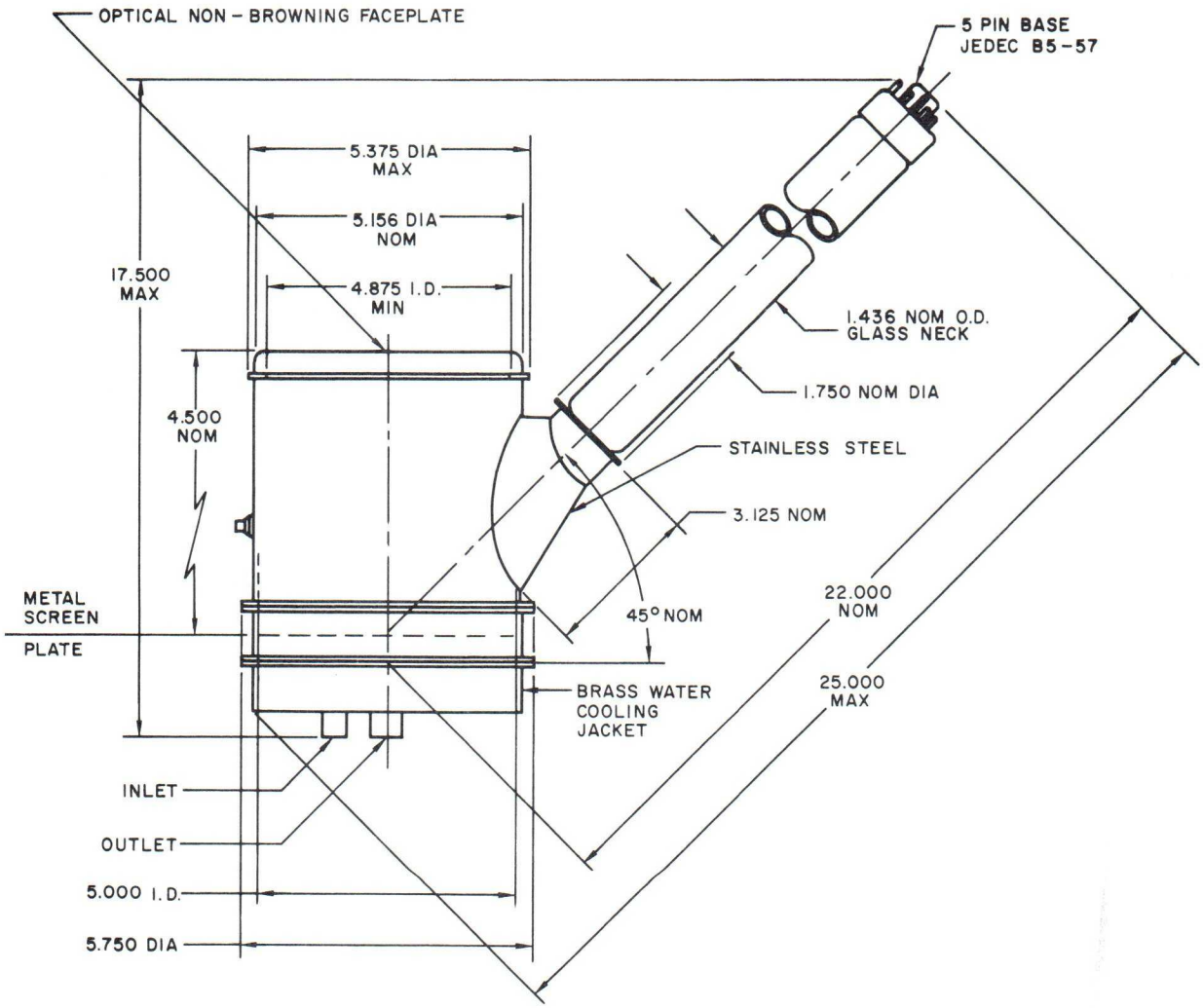


TYPICAL CK1419 P31 PROJECTION DISPLAY SYSTEM

RAYTHEON

CATHODE RAY TUBE CK1419P-





RAYTHEON

REAR-WINDOW CATHODE RAY TUBE

CK1437P14

The CK1437P14 is a 7" cathode-ray tube with an optically flat and clear rear port window. The tube therefore can be used for simultaneous direct viewing from the front and photo-recording from the rear in electronic display systems such as airborne reconnaissance mapping.

The rear window may also be used for projection of overlay information.

The tube has a magnetic shield bonded to the envelope and is ruggedized for use in severe military environments.

GENERAL DATA

Phosphor – Note 1	#14
Fluorescence	Blue
Phosphorescence	Orange
Persistence	Medium-long
Focusing Method	Electrostatic
Deflecting Method	Magnetic
Deflection Angle	*40°
Useful Screen Diameter	6-1/8" min

*Approximate – the center line axis of the tube neck is offset 3/8" from the center line of the tube

ELECTRICAL DATA

Heater Characteristics:

Heater Voltage	6.3±10% volts
Heater Current	0.6 amps.
Peak Heater-Cathode Voltage:	
Heater Negative with Respect to Cathode	180 volts DC
Heater Positive with Respect to Cathode	180 volts DC

Direct Interelectrode Capacitances (typical)

Grid #1 to all other electrodes	7 uufd
Cathode to all other electrodes	5 uufd

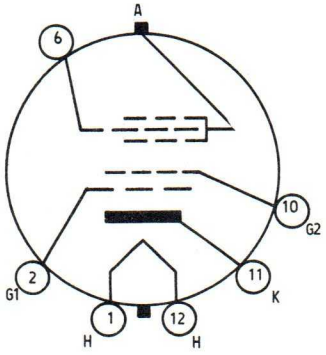
Design Center Maximum Ratings:

Anode Voltage – Note 2	12,000 volts DC
Grid #4 Voltage (Focusing Electrode)	–100 to +500 volts DC
Grid #2 Voltage	+500 volts DC
Grid #1 Voltage:	
Negative–Bias Value	180 volts DC
Positive–Bias Value	0 volts DC
Positive–Peak Value	0 volts

MECHANICAL DATA

Base . . . Small Shell Duodecal
Anode . High-Voltage Insulated Flying Lead

BASING



BOTTOM VIEW

TERMINAL CONNECTIONS

Pin 1 Heater
Pin 2 Grid #1
Pin 6 Focus Electrode
Pin 10 Grid #2
Pin 11 Cathode
Pin 12 Heater
Anode

ELECTRICAL DATA

Characteristics and Typical Operation:

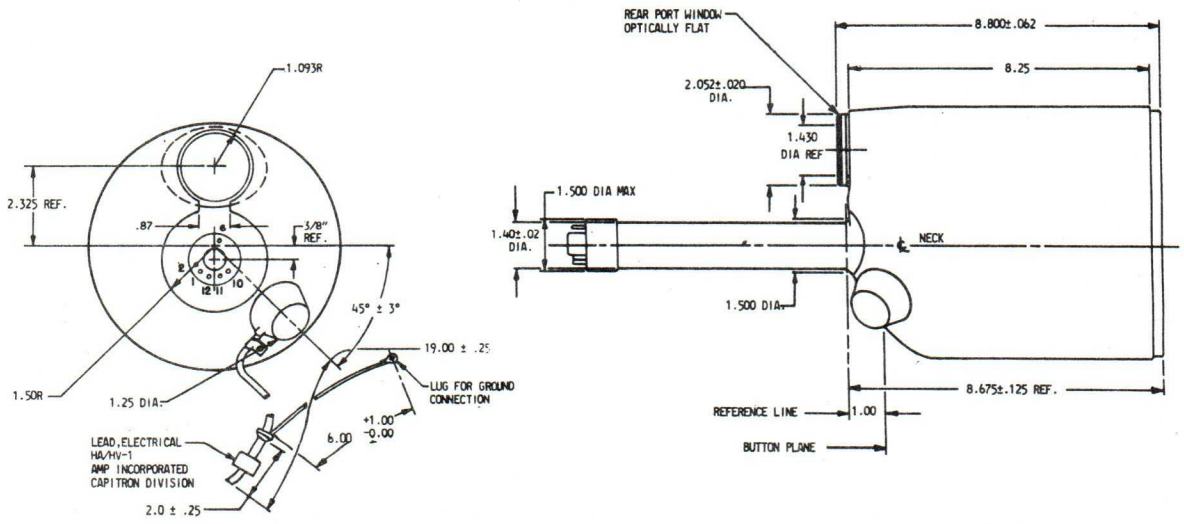
Anode Voltage – Notes 2 and 3	10,000 volts DC
Focusing Electrode – Note 4	0 to 200 volts
Focusing Electrode Current	–15 to +15 uAdc
Grid #2 Voltage	300 volts DC
Grid #1 Voltage - Note 5	–40 to –60 volts DC
Line Width – Note 6	0.010 inch max.
Spot Position (undeflected)	See Note 7

Maximum Circuit Values:

Grid #1 Circuit Resistance – Note 8	1.5 meg. max.

NOTES:

1. Available in all popular phosphors. However, the phosphor should be compatible with the photo-techniques.
2. The effective resistance of the anode supply should be adequate to limit the anode input power to 6 watts.
3. Brilliance and definition decrease with decreasing anode voltages. In general, anode voltage should not be less than 8,000 volts.
4. With Grid #1 voltage adjusted to produce a collector current of 50 uA, with the pattern adjusted for best overall focus. Measured with a 525-line interlaced and synchronized 5" x 5.6" raster pattern.
5. Visual extinction of the focused, undeflected spot.
6. Measured with a 525-line interlaced and synchronized pattern with interlaced line blanking. Pattern width adjusted to 5.6" and light output to 20 foot lamberts, measured before applying blanking. Line width is the merged raster height divided by the number of lines (262.5), measured in center of tube face.
7. The center of the focused, undeflected spot will fall within a 3/16" radius whose center is a point of intersection of the neck axis with the faceplate.
8. It is recommended that circuit resistance be as low as possible.



RAYTHEON

CATHODE RAY TUBE — CK1438P-

The CK1438P– is a 7–inch diagonal, rectangular face, electrostatic focus and magnetic deflection cathode–ray tube for monitor use in closed–circuit television, industrial and business equipment. A particular feature of this tube is a high–resolution electron gun which gives smaller spot size, improved spot shape, and greater resolution than heretofore available. Sharp focus is obtainable over the entire picture area. The fluorescent screen is aluminized to improve picture contrast and brightness. A clear faceplate is utilized to obtain high light output.

ELECTRICAL DATA

Heater Voltage	6.3 Volts
Heater Current	0.6 ± 10% Amperes
Focusing Method	Electrostatic
Deflecting Method	Magnetic
Deflection Angle, approximate (Diagonal)	70 Degrees
Direct Interelectrode Capacitance, approximate	
Cathode to all other electrodes	8.5 uuf
Grid No. 1 to all other electroded	10.0 uuf

MAXIMUM RATINGS

Anode Voltage	15,000 Max. Volts
Focus Electrode Voltage	800 Max. Volts
Grid No. 2 Voltage	600 Max. Volts
Grid No. 1 Voltage:	
Negative Bias Value	180 Max. Volts
Positive Bias Value	0 Max. Volts

OPTICAL DATA

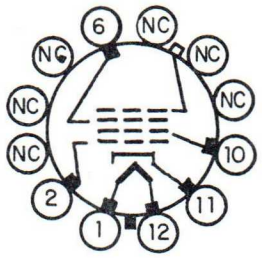
Screen	P31 Aluminized
Fluorescence	Green
Persistence	Medium

(This type is offered with any available phosphor desired)

MECHANICAL DATA

BASING. . . . . JEDEC 12L
MOUNTING POSITION . . . Any
OVERALL LENGTH 12.76 Inches Max.
BULB CONTACT Recessed Small Cavity Cap, JEDEC No. J1–21

BASING



BOTTOM VIEW

TERMINAL CONNCETIONS:

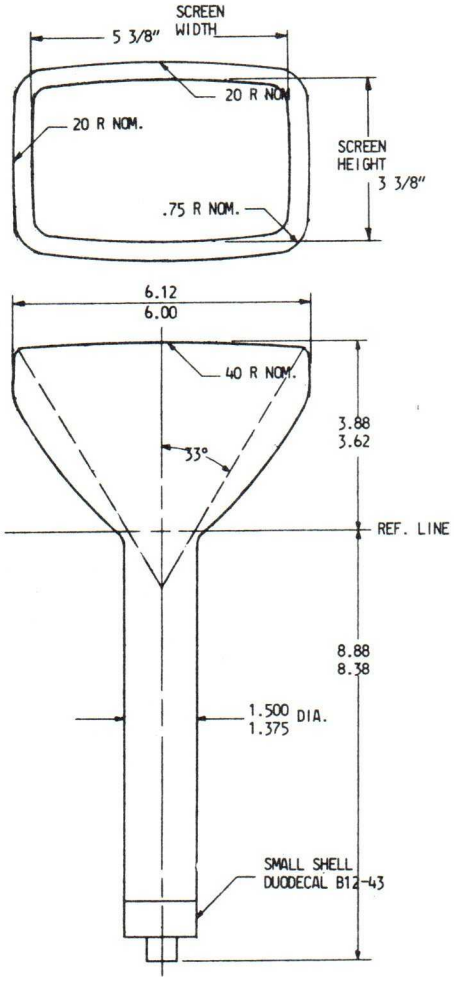
Pin 1 Heater
Pin 2 Grid #1
Pin 6 Focus
Pin 10 Grid #2
Pin 11 Cathode
Pin 12 Heater
Cap Anode

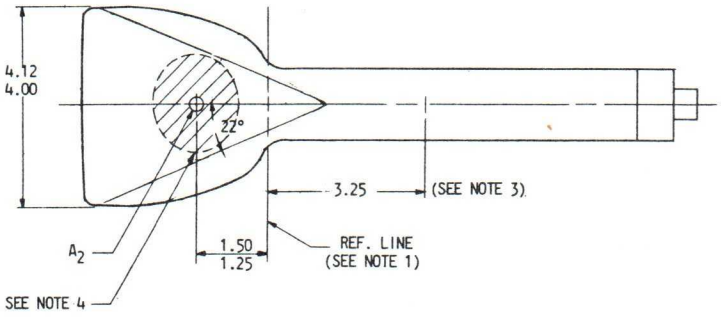
Printed in U.S.A.

RAYTHEON CATHODE RAY TUBE CK1438P-

TYPICAL OPERATING CONDITIONS

Anode Voltage	12,000 Volts
Focus Electrode Voltage	0 to +400 Volts
Grid No. 2 Voltage	400 Volts
Grid No. 1 Voltage (Cut-off)	−30 to −70 Volts
Line Width A (I_k = 150 ua)	0.012 Inches Max.





NOTES FOR CK1438
OUTLINE DRAWING

1. WITH TUBE NECK INSERTED THROUGH FLARED END OF REFERENCE LINE GAUGE (JEDEC #110) AND WITH TUBE SEATED IN GAUGE, THE REFERENCE LINE IS DETERMINED BY THE INTERSECTION OF THE PLANE C-C' OF THE GAUGE WITH THE GLASS FUNNEL.
2. SOCKET FOR THE BASE SHOULD NOT BE RIGIDLY MOUNTED; IT SHOULD HAVE FLEXIBLE LEADS AND BE ALLOWED TO MOVE FREELY.
3. MINIMUM DISTANCE TO ELECTRON GUN.
4. 2.25 / 1.75 DIAMETER ANTI-CORONA COATING WITH INDICATING DYE.

RAYTHEON

CATHODE RAY TUBE — CK1452P-

The CK1452P– is a 9–inch diagonal, rectangular face, electrostatic focus and magnetic deflection cathode–ray tube for monitor use in closed–circuit television, industrial and business equipment. A particular feature of this tube is a high–resolution electron gun which gives smaller spot size, improved spot shape, and greater resolution than heretofore available. Sharp focus is obtainable over the entire picture area. The flourescent screen is aluminized to improve picture contrast and brightness. A clear faceplate is utilized to permit high light output.

ELECTRICAL DATA

Heater Voltage	6.3 Volts
Heater Current	0.6 ± 10% Amperes
Focusing Method	Electrostatic
Deflecting Method	Magnetic
Deflection Angle, approximate (Diagonal)	70 Degrees
Direct Interelectrode Capacitances, approximate	
Cathode to all other electrodes	8.5 uuf
Grid No. 1 to all other electrodes	10.0 uuf

MAXIMUM RATINGS

Anode Voltage	15,000 Max. Volts
Focus Electrode Voltage	800 Max. Volts
Grid No. 2 Voltage	600 Max. Volts
Grid No. 1 Voltage:	
Negative Bias Value	180 Max. Volts
Positive Bias Value	0 Max. Volts

OPTICAL DATA

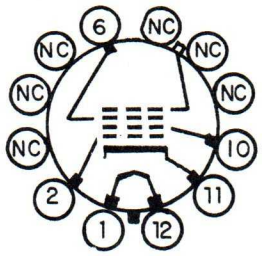
Screen	P31 Aluminized
Fluorescence	Green
Persistence	Medium

(This type is offered with any available phosphor desired)

MECHANICAL DATA

BASING. . . . . JEDEC 12L
MOUNTING POSITION . . . Any
OVERALL LENGTH 14.88 Inches Max.
BULB CONTACT Recessed Small Cavity Cap, JEDEC No. J1–21

BASING



BOTTOM VIEW

TERMINAL CONNECTIONS:

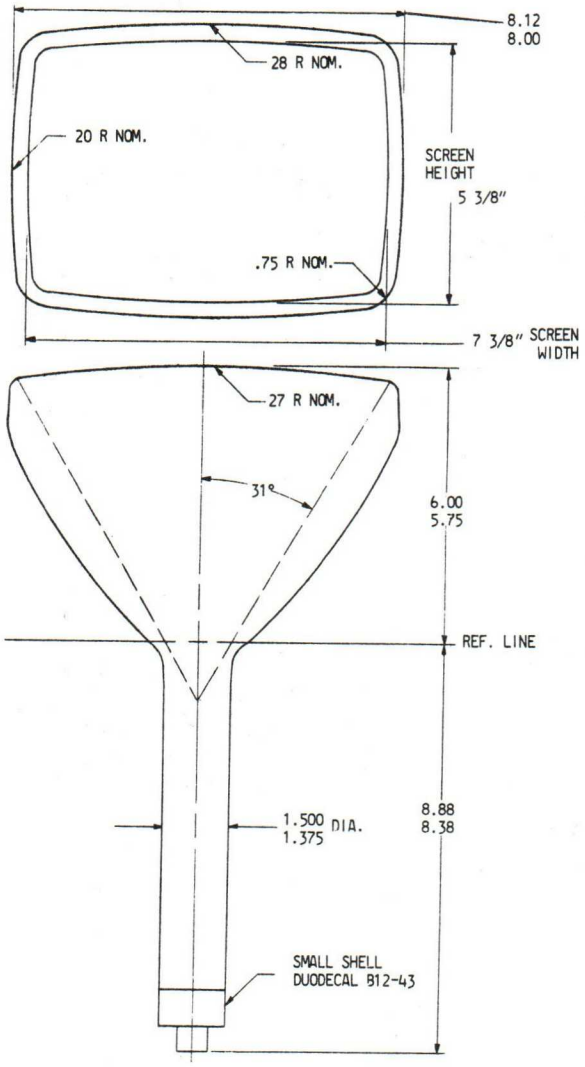
Pin 1 Heater
Pin 2 Grid #1
Pin 6 Focus
Pin 10 Grid #2
Pin 11 Cathode
Pin 12 Heater
Cap Anode

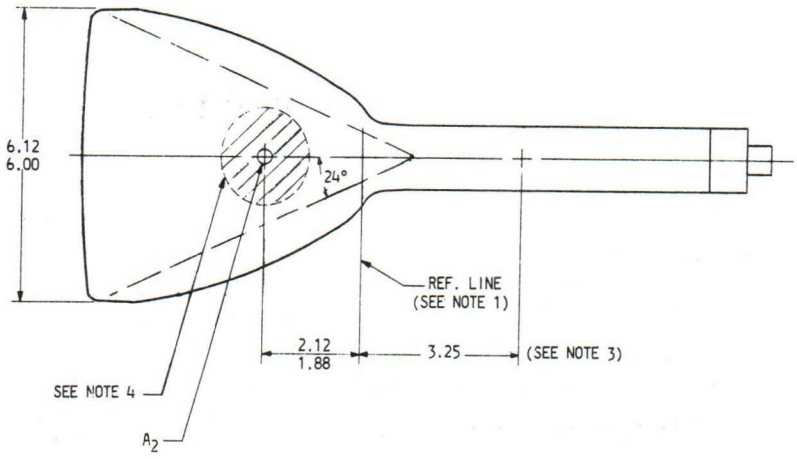
Printed in U.S.A.

RAYTHEON CATHODE RAY TUBE CK1452P-

TYPICAL OPERATING CONDITIONS

Anode Voltage	12,000 Volts
Focus Electrode Voltage	0 to +400 Volts
Grid No. 2 Voltage	400 Volts
Grid No. 1 Voltage (Cut–off)	−30 to −70 Volts
Line Width A (I_k = 150 ua)	0.012 Inches Max.





NOTES FOR CK1452
OUTLINE DRAWING

1. WITH TUBE NECK INSERTED THROUGH FLARED END OF REFERENCE LINE GAUGE (JEDEC #110) AND WITH TUBE SEATED IN GAUGE, THE REFERENCE LINE IS DETERMINED BY THE INTERSECTION OF THE PLANE C–C' OF THE GAUGE WITH THE GLASS FUNNEL.
2. SOCKET FOR THE BASE SHOULD NOT BE RIGIDLY MOUNTED; IT SHOULD HAVE FLEXIBLE LEADS AND BE ALLOWED TO MOVE FREELY.
3. MINIMUM DISTANCE TO ELECTRON GUN.
4. $\frac{2.25}{1.75}$ DIAMETER ANTI–CORONA COATING WITH INDICATING DYE.

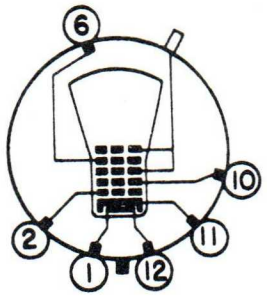
RAYTHEON

CATHODE RAY TUBE CK1478

The type CK1478 is a 10-inch electrostatic focus and magnetic deflection cathode-ray tube suitable for radar applications. A low-voltage electrostatic focus lens is employed, designed to operate at or near cathode potential to afford substantially automatic focus, independent of accelerator voltage variations. In addition the CK1478 employs a high-resolution electron gun and a special phosphor with a very long persistence characteristic.

MECHANICAL DATA

Base . . Small Shell Duodecal 6-Pin
Cap . . Recessed Small Cavity



BOTTOM VIEW

12M

Pin 1	Heater
Pin 2	Grid 1
Pin 6	Grid 4
Pin 10	Grid 2
Pin 11	Cathode
Pin 12	Heater
Cap	Grids 3 and 5

ELECTRICAL DATA

GENERAL CHARACTERISTICS:

Phosphor	Special
Fluorescence	Orange
Phosphorescence	Orange
Persistence	Very Long
Focusing Method	Electrostatic
Deflecting Method	Magnetic
Deflection Angle	50^{o}

HEATER CHARACTERISTICS:

Heater Voltage	6.3volts
Heater Current	0.6 ± 10%amps
Peak Heater-Cathode Voltage: ■	
Heater Negative with Respect to Cathode	
During warm-up period not to exceed 15 sec.	410volts DC
After equipment warm-up period	180volts DC
Heater Positive with Respect to Cathode	180volts DC

DIRECT INTERELECTRODE CAPACITANCES: (uufds.) (appro

Grid #1 to all other electrodes	6
Cathode to all other electrodes	5

DESIGN CENTER MAXIMUM RATINGS:

Collector Voltage	12,000volts DC
Grid #4 Voltage (Focusing Electrode)	-500 to + 1000volts DC
Grid #2 Voltage	700volts DC
Grid #1 Voltage:	
Negative-Bias Value	180volts DC
Positive-Bias Value * (See Operational Note)	0volts DC
Positive-Peak Value	0volts

ELECTRICAL DATA (Cont.)

CHARACTERISTICS AND TYPICAL OPERATION:

Collector Voltage ▲	10,000volts DC
Grid#4 Voltage (Focusing Electrode) ●	0 to 300volts DC
Grid#4 Current	-15 to +15
Grid#2 Voltage	300volts DC
Grid#1 Voltage ○	-28 to -72volts DC
Line Width ✪	.017inch max.
Spot Position (underflected) □	0.5inch

MAXIMUM CIRCUIT VALUES:

Grid#1 Circuit Resistance	1.5inch max.

NOTES:

* At or near this, the effective resistance of the collector supply should be adequate to limit the collector input power to 6 watts. The screen can be permanently damaged should the current density be permitted to rise too high. To prevent burning, minimum beam current densities should be employed,

▲ Collector, Grids#3 and#5 are connected internally and referred to as Collector. Brilliance and definition decrease with decreasing collector voltages. In general, collector voltage should not be less than 7,000 volts.

■ Cathode should be returned to one side or to the mid-tap of the heater transformer winding.

● With Grid # 1 voltage adjusted to produce a collector current of 20uA, with the pattern adjusted for best overall focus. Measured with a 525-line interlaced and synchronized 6 x 8 inch pattern, with interlaced line blanking (current measured before applying blanking.)

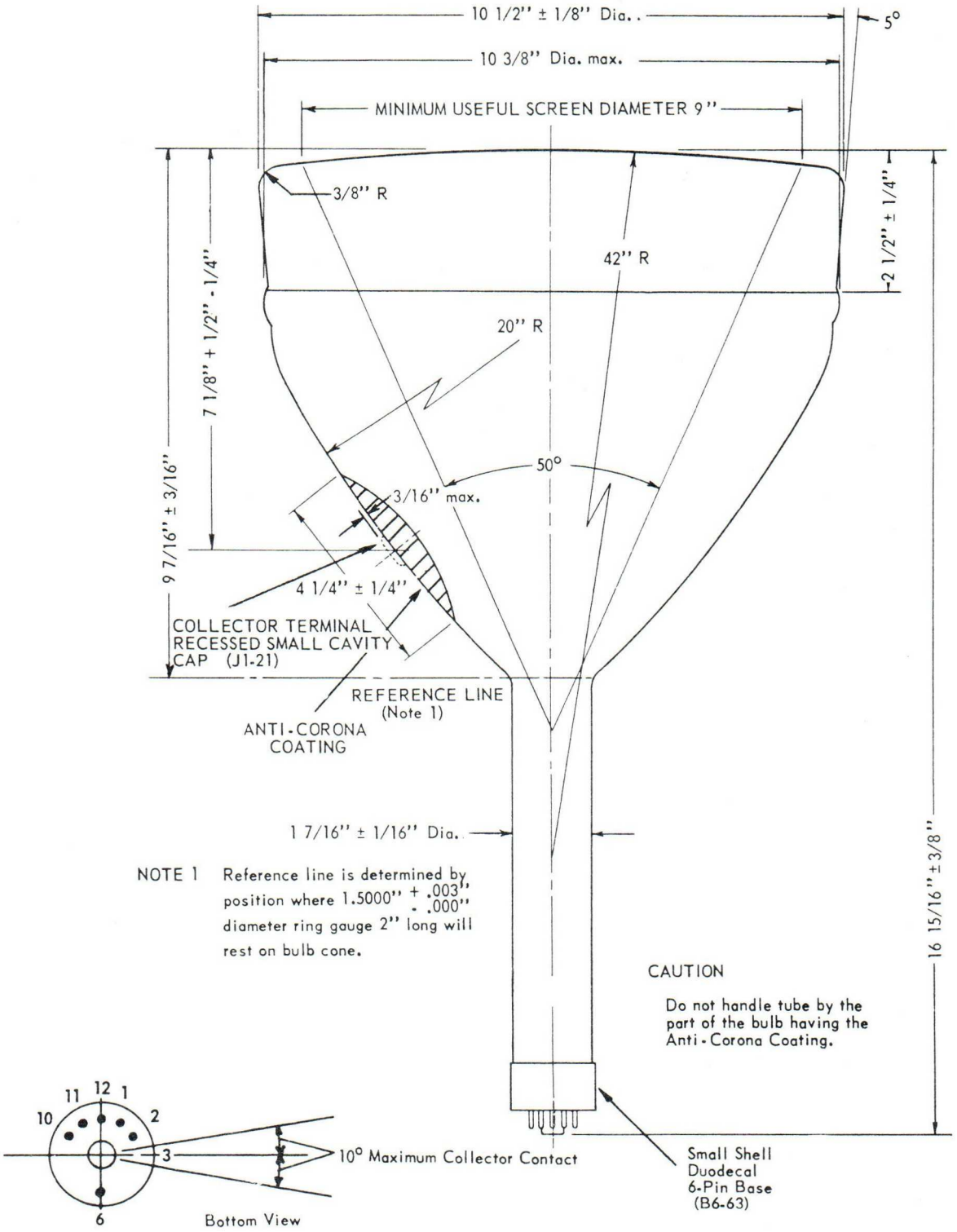
○ Visual extinction of focused 6 x 8 inch raster pattern.

✪ Measured with a 525-line interlaced and synchronized pattern with interlaced blanking. Pattern width adjusted to 90% of minmum useful screen diameter. Ib - 20uA, measured before applying blanking. Line width is the merged raster height divided by the number of lines (262.5) (measured in center of tube face.) To avoid damage to the screen, it is recommended that the screen current be not more than 50 uA when measuring line width. The line width under this condition will be .017 inch maximum (current measured before applying blanking.

□ The center of the undeflected, focused spot will fall within a circle of 1/2-inch radius concentric with the center of the tube face, with tube shielded.

OPERATIONAL NOTE:

Bombardment density should not exceed .004 watts/cm^2 under any condition.


10 1/2" ± 1/8" Dia..
5°
10 3/8" Dia. max.
MINIMUM USEFUL SCREEN DIAMETER 9"
3/8" R
42" R
2 1/2" ± 1/4"
20" R
7 1/8" + 1/2" - 1/4"
9 7/16" ± 3/16"
50°
3/16" max.
4 1/4" ± 1/4"
COLLECTOR TERMINAL
RECESSED SMALL CAVITY
CAP (J1-21)
REFERENCE LINE
(Note 1)
ANTI-CORONA
COATING
1 7/16" ± 1/16" Dia.
16 15/16" ± 3/8"
NOTE 1 Reference line is determined by position where 1.5000" + .003" - .000" diameter ring gauge 2" long will rest on bulb cone.
CAUTION
Do not handle tube by the part of the bulb having the Anti-Corona Coating.
12
1
2
3
6
10
11
10° Maximum Collector Contact
Bottom View
Small Shell
Duodecal
6-Pin Base
(B6-63)

RAYTHEON

DATARAY* CRT CK1406P-

The CK1406P– is a 17" rectangular cathode–ray tube which features magnetic major deflection and electrostatic minor deflection. The low–capacitance deflection design permits high speed character formation. Character positioning is accomplished magnetically. High resolution and high brightness are also major features of this tube type. The CK1406P– can be obtained with any of the JEDEC standard phosphors.

Major application of this type is in business and Military Displays where alpha-numeric messages are to be shown. The individual letters and numbers can be stroke-written by use of the electrostatic deflection "diddle" plates.

The tube has a bonded face plate, that makes it unnecessary to use safety glass in front of the display.

ELECTRICAL DATA

GENERAL CHARACTERISTICS:

Heater Voltage	6.3 volts
Heater Current at 6.3 Volts	.6 ± 10% amperes
Focusing Method	Electrostatic
Deflection Method	
Major Deflection Angle Diagonal	70° Magnetic
Minor Deflection	Electrostatic

DIRECT INTERELECTRODE CAPACITANCES:

Cathode to All	6 pf
Grid No. 1 to All	9 pf
D1 to All	2.5 pf
D2 to All	2.5 pf
D3 to All	2.5 pf
D4 to All	2.5 pf

OPTICAL DATA (Can be supplied with all popular phosphors)

Screen	P31 Aluminized
Fluorescence	Green
Persistence	Medium
Face Plate (neutral gray) transmission	60% Nom.

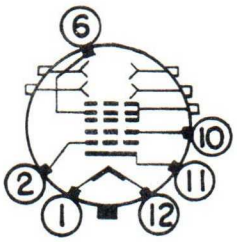
MAXIMUM RATINGS: (Absolute Maximum Ratings)

Anode Voltage	18,000 Max. Volts
Focus Electrode	1,500 Max. Volts
Deflection Plate–to–Plate Voltage (MEAN = EA_2)	1,000 Max. Volts
Grid No. 2 Voltage	770 Max. Volts
Grid No. 1 Voltage	
Negative Bias Value	150 Max. Volts
Positive Bias Value	0 Max. Volts
Positive Peak Value	1 Max. Volts
EHK	± 180 Max. Volts
Grid No. 1 Circuit Resistance	1.5 Max. Megohms
Deflection Plate Circuit Resistance	5.0 Max. Megohms

*Raytheon Company Trademark

MECHANICAL DATA

Overall Length	22.5 Max.
Bulb Number	J133B1
Bulb Contact	Recessed
E. S. Deflection Contacts	Modified J1–22



BASING 12M
Base (6–63)

TERMINAL CONNECTIONS:

Pin 1	Heater
Pin 2	Grid #1
Pin 6	Focus Electrode
Pin 10	Grid #2
Pin 11	Cathode
Pin 12	Heater
Side Button	Anode
Neck Buttons	Def. Plates

TYPICAL OPERATING CONDITIONS: (Voltages with respect to cathode)

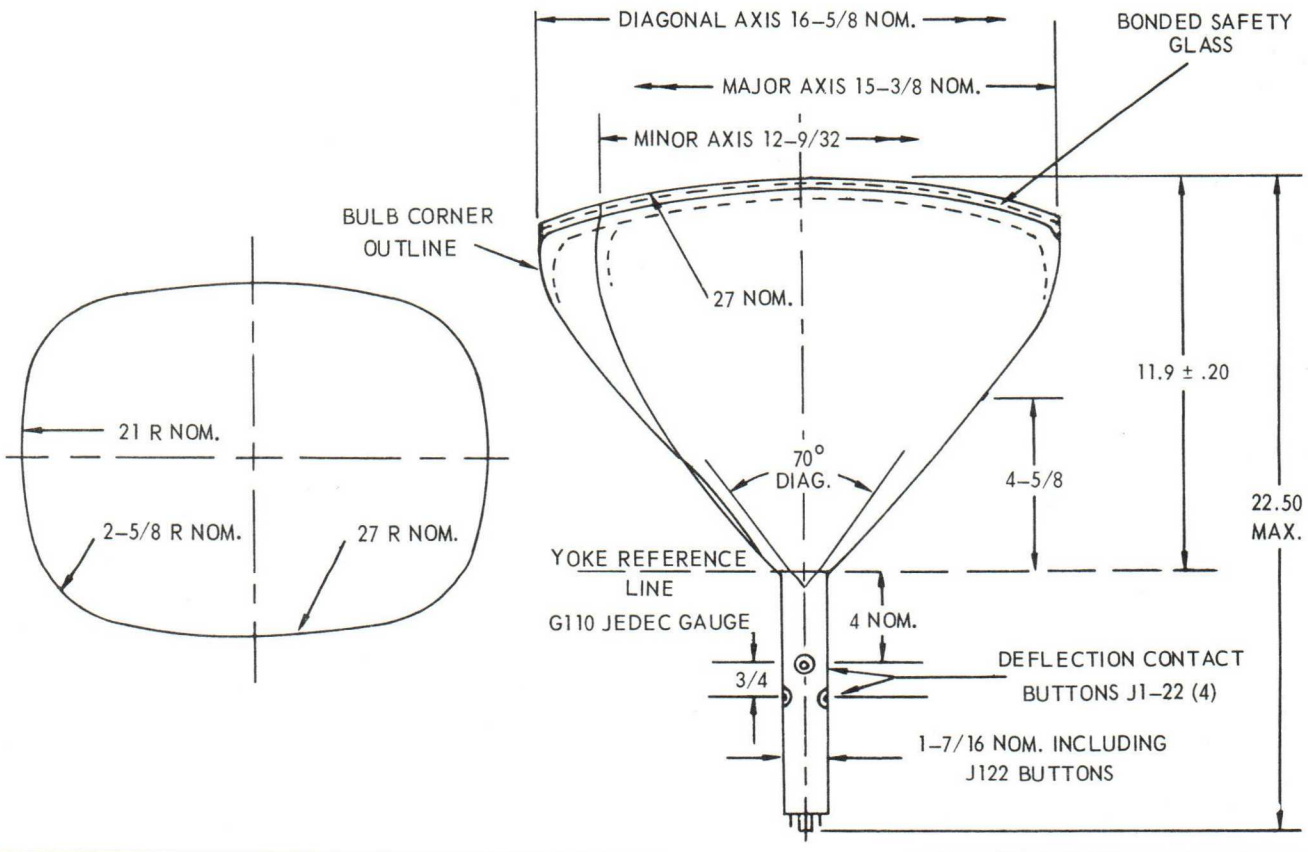
Anode Voltage	14,000 Volts
Focus Electrode Voltage	0 to 400 Volts
Grid No. 2 Voltage	400 Volts
Grid No. 1 Voltage (for cutoff)	−30 to −60 Volts
Light Output Note 1	50 FL
Dynamic Focus Voltage Required	Δ300 Volts
Resolution Note 1	.015"
Spot Position, Focused and Undeflected	.625" Radius of true center

ELECTROSTATIC DEFLECTION CHARACTERISTICS: Note 2

D1, D2 Deflection Factor	200 to 250 Volts Per Inch
D3, D4 Deflection Factor	180 to 230 Volts Per Inch
Deflection (ES) Orthagonality	
D1, D2 to D3, D4	± 1°
D1, D2 to Bulb Axes	± 3°
Maximum Useful Scan	
D1, D2	3/4"
D3, D4	3/4"

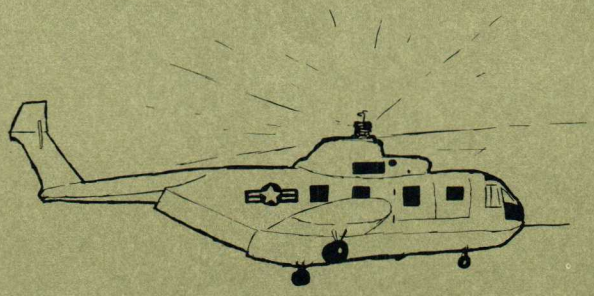
NOTE 1: Light output and line width are at .5" per microsecond writing rate, refreshed 60 times per second.

NOTE 2: Average value of voltage on deflection plates should be the same as anode to cathode voltage.

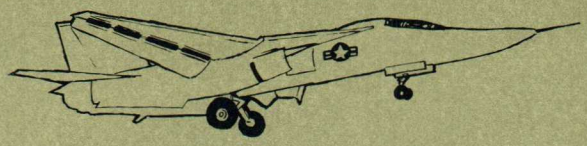


INFORMATION BULLETIN

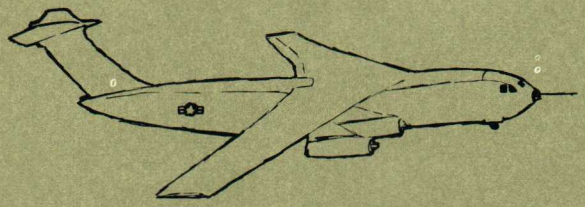
NO. 1-65



Efficient



Lightweight



Microwave Tubes

For Airborne, X-Band Radar

RAYTHEON

MICROWAVE AND POWER TUBE DIVISION

Raytheon CFA-TWT Chains Provide Outstanding Performance in Sophisticated X-Band Systems

- **Compact, lightweight tubes reduce system size and weight**
- **Broadband, long life performance with low operating voltages**
- **Complete capability under one roof assures compatibility**
- **Designed for rugged environments in all types of airborne radar, including:**

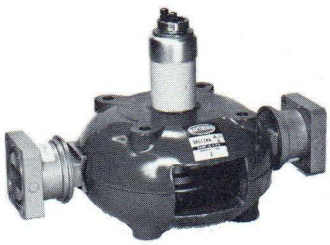
  Navigational
  Fire Control
  Terrain Avoidance
  Side Looker

Raytheon's new X-Band crossed field amplifiers and traveling wave tubes offer a combination of performance characteristics which make them ideally suited for sophisticated airborne radar applications. Operating in chains of two or more tubes, these CFA's and TWT's provide maximum output power and gain with minimum size and weight. For example, a chain which includes one TWT and two CFA's can produce over 70 db of gain at a tube weight of approximately 45 pounds with a typical efficiency of 50%. This is by far the lightest-weight, most efficient available means of obtaining a coherent 500 kw peak power source at X-Band.

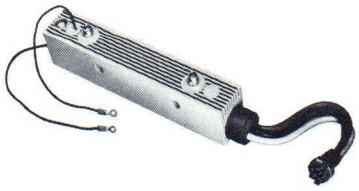
These tubes offer the further advantages of excellent phase characteristics, low operating voltages, simple modulator requirements, ruggedness, and reliability. The reliability of Raytheon CFA's has been extensively proven in actual field installations.

This bulletin contains brief performance specifications for three new crossed field amplifiers and a traveling wave tube driver. We will be happy to show you how these and similar tubes can be adapted to meet your exact X-Band airborne radar system requirements. For further information, and technical assistance, please contact your nearest Raytheon sales office, listed on the back cover.

Raytheon Company
Microwave and Power Tube Division
Microwave Tube Operation
Waltham, Massachusetts 02154



QKS1244 and QKS1350 Crossed Field Amplifiers 25 and 15 Kw peak power outputs, respectively



QKW1132 Traveling Wave Tube 1.5 Kw peak power output

QKS1243 Crossed Field Amplifier 500 Kw peak power output

Performance Characteristics of Raytheon X-Band Microwave Tubes

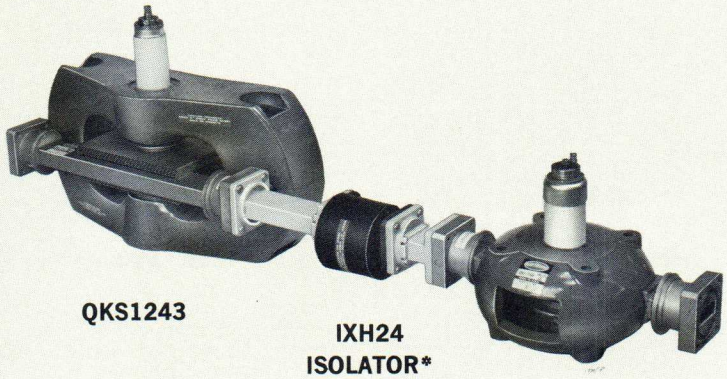
	QKS1244	QKS1243	QKS1350
Frequency	9.5-9.7Gc	9.5-9.7Gc	8.9-9.6Gc
Peak Power	25 kw	500 kw	15 kw
Duty Cycle	0.0028	0.0014	0.013
Voltage	16 kv	37 kv	14 kv
Current	4 A	26 A	2.5 A
RF Drive	1.0 kw	25 kw	1.5 kw
Heater	10 W @ 1.6V	None	10 W @ 1.6V
Cooling	Air	Air	Air
Weight	8.5 lbs.	35 lbs.	8.5 lbs.
Size	8.5" x 5¼" x 5¼"	12.5" x 5" x 8.5"	8.5" x 5¼" x 5¼"
Environment	MIL-E-5400	MIL-E-5400	MIL-E-5400
	Class I	Class I	Class I

Characteristics of the QKW1132 TWT

Frequency Gc.	Peak Power kw (min.)	Gain at Rated Power db	Duty Cycle	R.F. Connectors	D.C. Connectors	Cooling	Size (inches)	Weight (lbs) (max)
8.5-10	1.5	34-40	Up to 1%	TNC Female	Flying leads AMP HA/HO3 wire	Conduction-Convection	11¼ x 1¾ x 2¼	5.0

The QKW1132 is grid controlled, PPM focused.

Typical X-Band CFA Chain, utilizing QKS1244 and QKS1243



QKS1243

IXH24 ISOLATOR*

QKS1244

CHAIN DATA

Peak Power	500 kw
Gain	27 db
Phase sensitivity	1.5 degrees/1% BL
Phase linearity	+ or −4°
Amplitude variation	+ or −0.3

**The IXH24 ferrite isolator is a product of the Special Microwave Devices Operation of Raytheon's Microwave and Power Tube Division. This Operation supplies matching ferrite devices as part of Raytheon's overall capability in X-Band CFA-TWT chains.*

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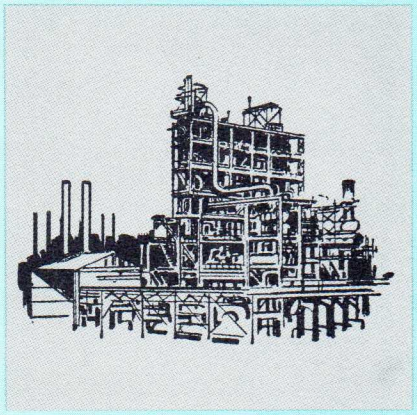
RAYTHEON

RAYTHEON COMPANY

MICROWAVE AND POWER TUBE DIVISION

Printed in U. S. A. 2-65

RAYTHEON INDUSTRIAL & MILITARY TUBES • CLASSIFICATION CHARTS



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This catalog covers the widest range of industrial, military and special purpose electron tubes available from one source.

It is designed as an aid to circuit designers, to facilitate rapid selection of tubes while displaying a broad range of types from which to choose. Included are diodes, twin diodes, triodes, twin (dual) triodes, multi-section types, thyratrons, decade counters, radiation counters, heptodes, trigger tubes, reference and regulator tubes, and a wide variety of pentodes (such as RF and IF amplifiers, oscillators, voltage and power amplifiers).

More extensive data can be obtained from five Raytheon Tube Characteristics Brochures each of which contains either power, gas-filled, miniature, cathode subminiature or filamentary subminiature tube information. Individual data sheets on each type are also available.

The data contained herein is compiled as a service to the field and is not intended to indicate type availability. Raytheon Company assumes no liability for information on applications derived from this book. Data supplied herein is believed to be accurate and reliable.

RAYTHEON

DIODES

HALF-WAVE RECTIFIERS, CLIPPER DIODES, AND DETECTORS

Class	Max. Peak Inverse Voltage	MAXIMUM DC OUTPUT CURRENT IN MILLIAMPERES																	Class
		20 Amps	10 Amps	1250	240	125	65 60	45-50	30	20	12	10	8	3	0.55	0.3	0.25 0.20	0.100	0.810	
S FILLED f-Wave Rectifiers ld cathode)	2800										CK1047 CK1013 5517 CK7996★ 6763 CK1058★ CK1058A★		CK1042★ 6659★	6174 CK1027						GAS FILLED Half-Wave Rectifiers (cold cathode)
	2000															CK1036★ 6436★				
S-FILLED f-Wave Rectifiers filamentary)	10,000			872A																GAS-FILLED Half-Wave Rectifiers (filamentary)
	7500					816														
THODE TYPE lf-Wave Rectifiers	1000	RX212																		CATHODE TYPE Half-Wave Rectifiers
	750	RX120A																		
	300		RX120A																	
	150	RX120																		
CUUM TYPE lf-Wave Rectifiers	25,000														8261★ϕ	CK1048★ϕ CK1059★ϕ				VACUUM TYPE Half-Wave Rectifiers
	20,000						3B24Wϕ 3B24WAϕ 3B24WBϕ		3B24Wϕ● 3B24WAϕ● 3B24WBϕ●											
	17,000						583 ⚡													
	16,000						3B29 4B31													
	15,000				583▲					3B26▲					CK579★ϕ					
	12,500																		CK1041★ϕ	
	10,000																5642★ϕ			
	3000-4000																5799★ϕ	5785★ϕ		
	930							7436★												
	850							5995★ CK626CX★												
	825												9006							
	460											5704★Ψ 5704WA★Ψ 7435★Ψ 6489★Ψ 5641★ 5647★Ψ CK606BX★Ψ								

★ Subminiature
ϕ Filament type
▲ Clipper Diode Rating
Ψ Detector
● Using one half filament
⚡ Rectifier Rating

RAYTHEON

DIODES

GAS-FILLED, COLD CATHODE VOLTAGE REGULATOR AND REFERENCE TUBES

Current Range in Milliamperes	OPERATING VOLTAGE (APPROX.) 75	85-87	90	95-100	105-108	130-132	150-155	700	900	1000	1200	2000	Current Range in Milliamperes
VOLTAGE REGULATORS													
5 to 40	OA3A				OC3A OC3W		OD3A OD3W						5 to 40
5 to 30	OC2		OB3A		OB2 OB2WA 6074 6627/OB2WA		OA2 OA2WA 6073 6626/OA2WA						5 to 30
5 to 25				CK1061★ 5644★ 5787★ 5787WA★ CK5787A			6542★ CK1069★ CK6542A★						5 to 25
0.065 to 0.300							CK1055★ 7099★						0.075 to 0.300
0.005 to 0.125								6437(CK1037)★	CK1038★		6438(CK1039)★ 6143★		0.005 to 0.125
0.005 to 0.055								5962		CK1022			0.005 to 0.055
0.002 to 0.050								5950★	5841★			6119★	0.002 to 0.050
VOLTAGE REFERENCE TUBES													
1.5 to 3.5		5651 5651WA 5783★ CK5783A★ 5783WA★ 6308★ CK1068★											1.5 to 3.5
1.0 to 2.5						6213★							1.0 to 2.5

★ Subminiature

RAYTHEON

TWIN DIODES

FULL WAVE RECTIFIERS

	Maximum Peak Inverse Voltage	MAXIMUM DC OUTPUT CURRENT, MILLIAMPERES (PER PLATE)														
		285	275	220	190	175	120	110	90	75-77	55	20	10	5	4.0-4.5	
GAS-FILLED Full-Wave Rectifiers	1800			CK1006ϕ			CK1007ϕ									**GAS-FILLED** Full-Wave Rectifiers
	1080															
	1000							0Z4A/1003♣	0Z4♣ 0Z4G♣							
	880					CK1024ϕ										
	450									CK1005ϕ						
VACUUM TYPE Full-Wave Rectifiers detectors and clipper diodes	2900				5R4WGA 5R4WGB											**VACUUM TYPE** Full-Wave Rectifiers detectors and clipper diodes
	1850		5R4WGA 5R4WGB													
	1375									6X4W 6X4WA	26Z5W[1]					
	1250									6203	6202					
	460												5896★▲ 5903★▲I 6052★▲ 6053★▲I		6110★	
	450											6184★				
	420														6AZ5★	
	360												5726◈▲ 5726/6AL5W◈▲ 5726/6AL5W/6097◈▲ 6887	5829★▲ 5829WA★▲		
	350												7055▲			
	300												6919#			
	275												6663/6AL5			

★ Subminiature
ϕ Filament type
♣ Cold-cathode type
▲ Detector
◈ Clipper
[1] Ef = 26.5V
Computer use

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TRIODES

UHF AND VHF OSCILLATORS AND AMPLIFIERS, CLASS A AMPLIFIERS, GROUNDED GRID AND VOLTAGE AMPLIFIERS

Amplification Factor (Mu)	CATHODE — HEATER TYPES HEATER VOLTAGE = 6.3V, UNLESS OTHERWISE NOTED HEATER CURRENT IN MILLIAMPERES									FILAMENT TYPES FILAMENT VOLTAGE = 1.25 VOLTS FILAMENT CURRENT IN MILLIAMPERES									Amplification Factor (Mu)
	4000	480 450	400	300	250	200	175	150	45	200	150	125 120	80	60	30	20	10	7.5	
1 to 2.5																5697◉★	CK587◉Σ 5802★ 5803★ 5886★Σ	5889★Σ	1 to 2.5
4		5987★							CK652★[1]	6029★									4
7-9																			7-9
10 to 19.5						6152★ 6R4/EC81	5975★ 6946★	6C4 6C4W 6C4WA 6K4★ 5977★	6055★[1]	6375★		5676★ 6050★ 6121★ 6286★		5677★			5828★		10 to 19.5
20 to 29	812A					5703★ 5703WA★ 5703WB★ 6026★ CK608CX★	6221★	9002 6AK4★ 5645★ 5718★ 5897★ 7437★ 6814★	5904★[1]		7246★		5971★		CK515BX◉★				20 to 29
30																	5801★		30
40 to 49		7576★		5842(417A)□ 5842WA□	7994★□														40 to 49
50 to 59			6J4 6J4WA			6533★ 6533WA★ 8096★ CK646★													50 to 59
60 to 69						6247★ 6247WA★ CK628CX★													60 to 69
70						5744★ 5744WA★ 5744WB★ CK619CX★	6222★	5637★ 5646★ 5719★ 5898★											70
80 to 89		6Q4/EC80																	80 to 89
160	811A																		160

★ Subminiature
□ Frame grid type
[1] Ef = 26.5V
◉ Ef = 0.625V

Σ Pentode used triode connected as Electrometer tube

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TWIN (DUAL) TRIODES

Amplification Factor (Mu)	HEATER CURRENT IN MILLIAMPERES (EF = 6.3V EXCEPT WHERE OTHERWISE NOTED)																		Amplification Factor (Mu)
	5000	2500	900	640	600	450	400	350 to 360	300	250	225	200	180	150-155	120	100	90	85	
1 to 3	6336A	6080 6080WA 6080WB																	1 to 3
9	6528																		9
11-19			5687 ♦ 5687WA ♦		6350 ♦			5814A ♦ 5814WA ♦ 5814WB ♦ 6386 6955 ♦	6189/12AU7WA ♦ 6680/12AU7 ♦						5967φ★			6321★	11-19
20-29			7044 ♦	7119/ E182CC ♦	6463 ♦		5920 E90CC 6832★		5844 5873★ 6111★ 6111WA★ 7079★ 5963 ♦ 6211 ♦								5798[1]★ 7760[1]★		20-29
30-39						6J6W 6J6WA 5964 6099 6101 6101/6J6WA 5635★		5670 5670WA 6947★	2C51 E88CC□ 6922□ 6BF7★ 6BF7W★ 6021★ 6021WA★ 6690★				7057 ♥			407A‡(WE)	7759★[1]		30-39
40-49						5965 ♦ 6414 ♦ 6829 ♦	E92CC 7062 ♦	6072A ♦											40-49
50 to 60									12AT7WA ♦ 12AT7WB ♦ 6201 ♦ 6679/12AT7 ♦ 6193★						5968φ★			6320★	50 to 60
70								5751 ♦ 5751WA ♦ 5755 ♦ 6948★	6112★ 6112WA★										70
100									12AX7WA ♦ 6681/12AX7 ♦ 7025 ♦					7058 ♥					100

♦ Ef = 6.3/12.6; If given is for Ef = 6.3
‡ Ef = 20/40; If given is for Ef = 20.0
□ Frame grid type
♥ Ef = 13.5V

★ Subminiature
1 Ef = 26.5V
φ Filament type, Ef = 1.25V

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PENTODES (MINIATURES AND SUBMINIATURES)

INDIRECTLY HEATED (CATHODE) TYPES WITH Ef = 6.3V, UNLESS OTHERWISE NOTED (¹♥)

MAX PLATE DISSIPATION (WATTS)

Trans-conductance	12.0-11.0	10.0-9.0	8.5-8.0	7.5	5.0-4.0	3.5-3.0	2.7-2.5	2.1-1.80	1.7-1.6	1.5-1.2	1.1-0.9	0.8-0.7	0.6-0.5	0.3-0.1	Trans-conductance
16500						6688A□	6688□ E180F/ 6688□								16500
13000 to 11000		6216	6677/ 6CL6	6197	6686/E81L				7995★ 5847(404A)						13000 to 11000
9000 to 6000					5639★ 5639WA★ 6AN5 6AN5WA 7761★¹	6485 6AH6WA		7056♥ E83F 6689							9000 to 6000
6000 to 5000						6AU6WB 6AU6WA 6136 5640★	6AG5WA 6186	CK631CX★ CK627CX★ 6245★	CK605CX★ 6AK5WB 5702★ 5654/6AK5W/ 6096 6028¹ 408A¹	5654/6AK5W 6AK5WA CK623CX★ 5702WA★ 7433★ 5702WB★	5840★ 7083★ 6540★ 7432★ 5901★ 5906★¹ 6205★ 6223★				6000 to 5000
5000 to 4000	6669/6AQ5 6005 6005/ 6AQ5W	7061♥			6224★ 7762★¹ 5902★ 5902WA★	6661/6BH6									5000 to 4000
4000 to 3000			5686			6945★		6AS6Θ	5784★Θ CK624CX★Θ	5725/ 6AS6WΘ 5784WB★Θ 6AS6WΘ 5784WA★Θ	6943★ 7434★ 5916★¹Θ 5636★Θ	5634★	5638★		4000 to 3000
3000 to 2000								6AJ5			7438★Θ	6BA5★		5905★¹ 5908★¹Θ 5908B★¹Θ	3000 to 2000
2000 to 1000						3B4φ 3B4WAφ							6788★ 6788A★ 9001Ψ		2000 to 1000

REMOTE AND SEMI-REMOTE CUT-OFF

4500 to 4000						6BA6W 5749/ 6BA6W 5749					6206★ 6872★ 6225★ 5899★ 5900★				4500 to 4000
4000 to 3000						6662/6BJ6					6049★ 6944★	5633★ 5797★¹		6056★¹ 5907★¹	4000 to 3000
3000 to 2000												6488A★			3000 to 2000
2000 to 1000								9003						26A6¹	2000 to 1000

★ Subminiature
Θ Mixer, Gated Amplifier
ψ Detector-Amplifier
□ Frame grid type
♥ Ef = 13.5V
¹ Ef = 26.5V

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DIRECTLY HEATED PENTODES (FILAMENTARY), SUBMINIATURE EXCEPT WHERE NOTED#

RF AMPLIFIERS, POWER AMPLIFIERS AND VOLTAGE AMPLIFIERS, FILAMENT VOLTAGE = 1.25V, EXCEPT WHERE OTHERWISE NOTED ◉

FILAMENT CURRENT IN MILLIAMPERES

POWER AMPLIFIERS

Power Output milliwatts	220	125	110	100	80	60	50	40	30	20	15	10	7.5	5	Power Output milliwatts
850			6373‡												850
600		CK578AX* 7626*													600
375		6526													375
220	6195÷¶														220
140		6397⌒÷													140
135				6999■											135
120		6147⌒÷	5851¶÷												120
65							5672, CK506AX								65
50				6051				1V5							50
35								1AG4							35
25							6092 CK506AX								25
10.5-11										6088					10.5-11
9.5									5854, CK503AX CK518AX	CK572AX					9.5
6									2E35, 2E36 CK502AX						6
3.5-3.75										CK526AX CK537AX	CK542DX				3.5-3.75
2.0-2.5									CK523AX CK524AX	CK525AX	CK539DX	6418, CK548DX CK547DX			2.0-2.5
1.5-1.9										CK529AX CK535AX CK531DX	CK532DX CK536AX	6519, CK546DX			1.5-1.9
1.0-1.4										CK528AX CK522AX	CK533AX CK541DX				1.0-1.4
0.5 to 0.75											CK527AX	CK544DX			0.5 to 0.75

RF AMPLIFIERS

Transconductance micromhos															Transconductance micromhos
3000					6612										3000
2000-2500				1AD4 5875											2000-2500
1300						5972									1300
900-1000							5678 1U4WA# 1T4WA#			6611					900-1000
725-750								1AH4 1W5		1AK4					725-750
475-500							2E31, 2E32			6932Θ					475-500
125-200										CK577CXΘ					125-200

VOLTAGE AMPLIFIER

Voltage Gain															Voltage Gain
35-39									CK501AX CK505AX◉	CK512AX◉ 6281◉					35-39
30-34							CK511AX								30-34
25-29											CK538DX◉ CK534AX◉	CK549DX◉, 6419◉	CK545DX◉		25-29
20-24											CK543DX◉			CK576DV◉	20-24

* 175 Mc
⌒ 250 Mc, Frequency doubler
÷ Ef = 1.25/2.5; If given is for Ef = 1.25V
■ Ef = 1.32/2.64; If given is for Ef = 1.32V

◉ Ef = 0.625V
Θ Mixer, Gated Amplifier
¶ 400 Mc, Frequency doubler
‡ Class C

Miniature

RF POWER TRIODES, TETRODES AND PENTODES (All ratings I.C.A.S. except where noted)

Type	Emitter	Heater		Bulb	Transconductance umho	Mu G-P or Mu G1-G2	Max. Freq. Full Rating Mc	Anode Max. Ratings	
		Voltage V	Current A					Voltage V	Diss Watts
TRIODES									
Series Regulators 6336A	Cath.	6.3	5.0	T16	13500	2.7	—	400	2x30
6528	Cath.	6.3	5.0	T16	37000	9.0	—	400	2x30
6080, 6080WA 6080WB	Cath.	6.3	2.5	T12	7000	2.0	—	250	2x13
RF-AF Amplifiers 811A	Fil.	6.3	4.0	ST19		160	30	1500	65
812A	Fil.	6.3	4.0	ST19		29	30	1500	65
BEAM POWER PENTODES AND POWER TETRODES									
2E24	Fil.	6.3	0.65	T9	3200	7.5	125	600	13.5
2E26	Cath.	6.3	0.80	T9	3500	6.5	125	750	13.5
8165/4-65A	Fil.	6.0	3.50	2.375" max. dia.	4000	6.0	150	3000	65.0◇#
8167/4CX300A	Cath.	6.0	2.7	1.64" max. dia.	12000	4.5	500	2500	300.0◇#
4D22	Cath.	12.6/25.2	1.6/0.8	2.31" max. dia.	—	10	60	600	50.0#
4D32	Cath.	6.3	3.75	2.31" max. dia.	—	10	60	600	50.0#
807	Cath.	6.3	0.90	ST16	6000	8.0	60	750	30.0
813	Fil.	10.0	5.00	T 20	3750	8.5	30	2500	125.0
814	Fil.	10.0	3.25	T 16	3300	—	30	1500	65.0
829B÷	Cath.	6.3/12.6	2.25/1.125	T 16	8500	9.0	200	750	40.0◇
832A÷	Cath.	6.3/12.6	1.6/0.8	— —	3500	6.5	200	750	20.0
837	Cath.	12.6	0.7	ST 16	3400	—	20	500	12.0#
1614	Cath.	6.3	0.9	MT-10A	6050	—	80	550	25.0
1625	Cath.	12.6	0.45	ST-16	6000	8.0	60	750	30.0
5656÷	Cath.	6.3	0.4	T6½	5800	—	400	250	2x3.5
5763	Cath.	6.0	0.75	T6½	7000	16	50	350	13.5
5894÷	Cath.	6.3/12.6	1.8/0.9	1.94" max. dia.		8.2	250	750	2x22.5
6146	Cath.	6.3	1.25	T-12	7000	4.5	60	750	25.0
6360÷	Cath.	6.3/12.6	0.82/0.41	T6½	3300	7.5	200	300	2x7
6417	Cath.	12.6	0.375	T6½	7000	16	50	350	13.5
6883	Cath.	12.6	0.625	T12	7000	4.5	60	750	25.0
6939÷	Cath.	6.3/12.6	0.6/0.3	T6½	10500	31.0	500	250	2x3.75
7377÷	Cath.	6.3/12.6	0.6/0.3	1.89" max. dia.	10500	28	1000	400	2x10

◇ Forced Air Cooling
CCS rating.
÷ Dual section type

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SUBMINIATURE ELECTROMETER PENTODES

TRIODE CONNECTED										PENTODE CONNECTED						
Type	Bulb	E_f V	I_f A	E_b V	E_{c1} V	I_b μA	μ	G_m μmhos	I_{c1} (max.) A	E_b V	E_{c2} V	E_{c1} V	I_b μA	I_{c2} μA	G_m μmhos	I_{c1} (nom.) A
5886	T2 x 3	1.25	0.010	10.0	–3	200	1.8	175	2.5×10^{-13}	8.5	4.5	–2	6.	3.6	14	1×10^{-14} (nom)
5889	T3	1.25	0.0075	10.5	–3	180	1.7	150	— — —	12.	4.5	–2	4.	4.	10	1×10^{-15}
CK587	T1½ x 2	0.625	0.010	22.5	–3	60	2.2	70	1×10^{-13}	8.	5.5	–2	6.	2.5	14	2×10^{-15}

MISCELLANEOUS TYPES

MULTI-SECTION TYPES

Type	Construction	Typical Application	Bulb	EF v	If A	Gm-pentode μmho	Gc μmho	Mu Triode
CATHODE TYPES								
26C6	Twin Diode Medium Mu Triode	Detector Amplifier	T 5½	26.5	0.07			16
6678/6U8	Med. Mu Triode Sharp co Pentode	Oscillator and Mixer	T 6½	6.3	0.45	8500		40
7059	Med. Mu Triode Sharp co Pentode	Mobile Equipment	T 6½	13.5	0.195	8500		40
7060	Med. Mu Triode Sharp co Pentode	Mobile Equipment	T 6½	13.5	0.220	7000		40
6487	Diode, RF Pentode	Detector Amplifier	T 3	6.3	0.200	2500		
FILAMENT TYPES								
1U5WA	Diode Pentode	AF Amplifier Detector	T 5½	1.25	0.050	650		
1AG5	Diode Pentode	Detector Amplifier	T2x3	1.25	.030	250		70
1AJ5	Diode Pentode	Detector Amplifier	T2x3	1.25	.040	425		80
1AK5	Diode Pentode	Detector Amplifier	T2x3	1.25	.020	280		60
1V6	Triode Pentode	Converter	T2x3	1.25	.040		200	
2G21, 2G22	Triode Heptode	Converter	T2x3	1.25	.050		60	

TRIGGER TUBES, MINIATURE T 5½

	TYPICAL Supply Voltage v	K to A Firing Voltage v	G to K Firing Voltage v	DC Plate Current mA
CK1066	3200	2400 to 2800	400 to 475	3 to 4
CK1067	3200	2000 to 2400	325 to 400	4 to 5

SPARK GAP TUBES

	Breakdown Voltage Vdc	Recommended Min. External Impedance Ohms
CK1030	1500 to 2000	5000
CK1031	3000 to 3500	10,000
CK1033	4200 to 4600	1000

MISCELLANEOUS

THYRATRONS

	Types	Bulb	Max. Peak Cathode Current Ma	Max. PIV Volts
TETRODES RELAY SERVICE	2D21	T 5½	500	1300
	2050	ST 12	1000	1300
	2050A	T 9	1000	1300
	2050W	T 9	1000	1300
	5696	T 5½	100	500
	5727/2D21W	T 5½	500	1300
LIGHT INDICATORS	SUBMINIATURE: TRIODE			
	7323	T 2	11	118
	7979 CK1050A	T 2	11	118
	TETRODE			
	CK1057 ♥	T 2	8	123
PULSE OR SWITCHING SERVICE	TETRODE			
	5643	T 3	100	500

♥ Cold Cathode

DECADE COUNTER TUBES

COLD CATHODE

Min. DC Supply Voltage (Vdc)	350	400
Anode Resistor (Meg.)	0.82	0.27
Nom. Tube Drop (V)	187	235
Max. Cath. Resistor (Ohm)	150K	50K
Min. Reset Pulse Width (μsec)	50	4
Min. Guide Bias (Vdc)	+35	+45
Min. Transfer Voltage (Vdc)	35	35
Anode Curent Min. & Max. (mA)	0.3 to 0.6	0.6 to 0.8
Supply Voltage (A to K) Min. (V)	350	400
Input Frequency (cps)	0 to 5000	0 to 100,000
	TYPES:	TYPES:
	GS10C/S	6909
	GC10/4B	6910
	Z303C	7155
	Z502S	8262
	6476	
	6476A	
	6802	
	6879	
	7978	

RADIATION COUNTER TUBES

MINIATURES, OPERATING VOLTAGE 900 Vdc.

QUENCH GAS	ORGANIC	HALOGEN
Plateau Length (Vdc)	150	200 min.
Relative Plateau Slope per 100V (%)	3	20
Geiger Threshold Max. (Vdc)	850	800
Ambient Temp. Range (°C)	−40 to +55	−55 to +75
Life Counts	10^8	$> 10^{10}$
	TYPES: CK1020** CK1021**	TYPES: CK1026* CK1049**

*Radiation detected: Gamma
**Radiation detected: Beta, Gamma

HEPTODES T5½ MINIATURES

DUAL CONTROL AND CONVERTER USE

TYPES	EF V	IF A	Gc μmho	Gm μmho
Converters:				
IR5WA	1.25	0.05	235	
26D6	26.5	0.07	270	
5750/6BE6W	6.3	0.30	500	
Dual Control Amplifiers:				
1217	6.3	0.30		G1 2400,G3 1700
6687	6.3	0.27	450	
E91H	6.3	0.27	450	
5915	6.3	0.30		G1 2400,G3 1700,

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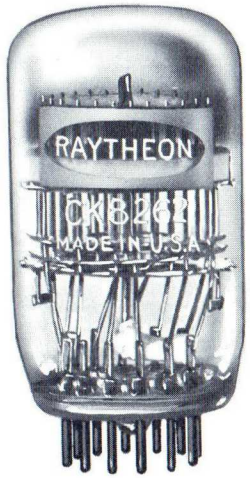
CK6763 Miniature gas half wave rectifier, PIV = 2800, average cathode current 12 mAdc

CK5727/2D21W Miniature thyratron, pulse modulator peak currents to 10a, ruggedized to withstand severe applications.

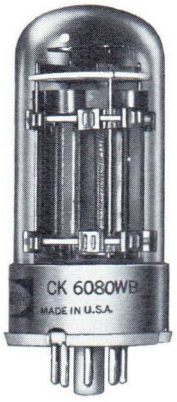
CK6939 Miniature frame grid twin power pentode transconductance = 10,500 umhos per section.



CK8262 T-9 decade counter, speed to 100 Kc, readout at all 10 cathodes

CK7978 T-9 decade counter, speed to 5 Kc, readout at all 10 cathodes

RAYTHEON

			
CK6080WB Series regulator, twin power triode, ruggedized for severe applications, max. cathode current 200 mAdc per section, plate dissipation 13 watts per section, design max.	5R4WGB Ruggedized full wave rectifier, supplies 840V at 165 mA or 730 Vdc at 275 mA	CK6146 48 watt transmitting tube at Ef = 6.3V; CK6883 is at Ef = 12.6V	CK6336A Series regulator, double triode, Pp = 30 watts per plate, Ib = 400 mAdc per plate
			
CK7996 Subminiature metal-ceramic gas half-wave rectifier, PIV = 2800V, Max. DC output current = 12 mAdc.	CK7994 Subminiature frame grid triode, transconductance = 18,000 umhos, noise factor = 2.5 db	CK7576 Subminiature telemetering tube, Pp = 3.5 watts at 235 Mc.	CK7995 Subminiature frame grid pentode, transconductance = 13,000 umhos, noise factor = 3.5 db

RAYTHEON

For three decades, Raytheon Company's Industrial Components Division has been vigorously engaged in the research, development and production of electron tubes.

In 1925 the nucleus of the present Industrial Components Division was formed with the development of the BH tube, the first gas-filled rectifier, which made ac-dc radio a reality. This development led to expansions into other receiving tube types and by 1930 Raytheon was a leading producer of electron tubes. Continued growth and diversification led to the development of many industrial types of receiving tubes, and the formation of the Industrial Tube Division. In 1959, to clearly illustrate the expansion of the division into other component areas, the division was renamed the Industrial Components Division.

Significant in the Division organization is the position of Quality Control. This group operates independently of manufacturing groups with the Quality Control manager reporting directly to the Division General Manager. Heavy emphasis has been placed on quality control in order to achieve the inherent reliability required to pioneer in the production of reliable tubes which must withstand a wide range of environmental stresses. It has therefore not been subjugated to an operational status within the divisional organization but elevated to its divisional importance as a direct overall function.

Reliability at Raytheon is the outgrowth of:

- sound design
- advanced manufacturing techniques
- engineering capability
- knowledge of customer applications
- stringent quality control
- continuous evaluation and improvement.

Finished tubes not only meet Raytheon's internal inspection requirements but also the applicable Military Specifications. For operating characteristics the tubes must meet an AQL as low as 0.4%, using Mil-Std-105B to determine sample sizes. Operating characteristics tests, visual and mechanical tests are supplemented by environmental and usage tests such as:

Shock Test	Low Pressure Voltage Breakdown Test
Vibration Test	Glass Strain Test
Heater Cycle Test	Normal Life Test
Stability Life Test	High Temperature Life Test
Survival Life Test	
Lead Fatigue Test	

To further improve reliability, Raytheon's Quality Control Department, using the latest statistical techniques, isolates causes of variation and stimulates product improvements. Active participation in industry and government-sponsored groups concerned with improving testing and inspection procedures is an important function of the Quality Control Department. Experiments are continuously underway which will not only guarantee the present high reliability of Raytheon products but also will foster improved reliability in the future.

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The Industrial Components Division maintains eleven sales offices and through Raytheon's Distributor Products Division, a network of over 200 franchised distributors throughout the United States. Each sales office is staffed to handle every detail of customer service in addition to providing sales engineering advice and assistance. Contact with any of these offices will bring complete product price and delivery information. A complete application engineering facility and staff at Division headquarters, working with industry's most advanced equipment, is also available, to assist in providing solutions to complex circuitry and design problems.

RAYTHEON

INDUSTRIAL COMPONENTS DIVISION

Newton 58, Massachusetts

SP-1087

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RAYTHEON

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International Sales and Services
Product Information Bulletin

MICROWAVE TUBES – MAGNETRONS

Prepared by
M. H. O'Connell

Raytheon Company is the world's largest manufacturer of magnetrons. No other company produces a more complete line, every tube is the outgrowth of an intensive research and development program. The scientific competence and engineering "knowhow' thus accumulated, are unmatched in the industry.

Of all microwave tubes, the magnetron offers the lowest cost–per–hour life, and because of its construction simplicity, is frequently the most rugged tube available. Its power–per–pound is the highest available among standard microwave tubes and its price is lower than for any other tube of equal power.

APPLICATIONS

Choice of a magnetron is indicated where a compact, low cost and simple and reliable system is sought. The magnetron affords the means of having a one tube system with the absolute minimum of connections and associated equipment.

The high power magnetrons are well suited for ground and airborne search radar, moving target indicator applications and general purpose radars. The medium power tubes are ideally suited for either ground, small boat shipboard or airborne search, weather radar, surveillance systems and general purpose radars.

The suitable applications for the individual types are suggested in the frequency groupings of tubes that follow.

RAYTHEON'S CAPABILITY

The following chart indicates Raytheon Magnetron capabilities in relation to power and frequency. Only the most active tubes are listed. Many other types, both classified and unclassified, are available for special applications and replacement use. For complete information contact Raytheon International Sales and Services, Lexington, Mass.

POWER	FREQUENCY BANDS					
PK Kw	UHF	L	S	C	X	K
1–100			S1	C	X1, X2	K
101–490		L1	S1	C	X1	
401–800			S2, S3		X2	
801–1000		L1	S2	C		
1001–2000	UHF	L1	S2			
2001–5000		L2	S2			

Raytheon's CW magnetrons are listed in a table on the last page.

C–BAND MAGNETRONS

Pulsed magnetrons for a wide variety of applications including ground based, small and large boat, and airborne search and weather radars. Require forced air cooling.

TUBE TYPE	FREQUENCY RANGE (Mcs)	POWER OUTPUT (Kw Typ.)	ANODE CURRENT (a)	ANODE VOLTAGE (kv)	PULSE WIDTH (usec)	DUTY CYCLE	OUTPUT	WEIGHT (Lbs.)	DIMENSIONS (Inches)
QKH632 (Fixed Frequency)	5250–5310	1000	60	35	2.5	.001	Waveguide	50	16.384
RK7040/QKH456 (Fixed Freq.)	5380–5420	85	14	14.5	2.0	.001	Waveguide	8.0	6.81
QKH639 (Fixed Frequency)	5450–5510	1000	60	35	1.0	.001	Waveguide	50	16.384
RK7460/QKH686 (Tunable)	5450–5825	250	25	24.5	0.5	.000342	Waveguide	35	13.625
RK7158/QKH662 (Tunable)	5450–5825	250	24	25	2.0	.001	Waveguide	35	17.375
RK6344/QKH235 (Tunable)	5450–5825	175	22	22	2.4	.00085	Waveguide	25	11.375
QKH124 (Tunable)	5665–5715	1000	65	35	1.0	.001	Waveguide	50	16.384

K and Ku–BAND MAGNETRONS

Integral magnet pulsed tubes for general purpose radar applications. Require forced air cooling.

TUBE TYPE	FREQUENCY RANGE (Mcs)	PEAK POWER OUTPUT (Kw Typ.)	PEAK ANODE CURRENT (a)	PEAK ANODE VOLTAGE (kv)	PULSE WIDTH (usec)	DUTY CYCLE	OUTPUT	WEIGHT (Oz.)	MAXIMUM DIMENSIONS (Inches)
RK7630/QKH702 (Tunable)	15,840–16,160	85	12	24	0.25	.00215	Waveguide	26	12.5
RK7452/QKH324 (Fixed Frequency)	15,840–16,160	85	12	24	0.25	.00215	Waveguide	25	12.5
RK6841 (Fixed Frequency)	16,400–16,600	50	14	16.5	1.0	.001	Waveguide	5.75	5.750
QKH124 (Fixed Frequency)*	23,800–24,200	30	10.5	13.75	.08	.00032	Waveguide	4	5.0

*Designed for missile environment – rugged, fast warm–up, long life.

L–BAND MAGNETRONS

1. Tunable high power air cooled tubes with excellent life and stability characteristics. Used in MTI, ground search, and height finder radars.

TUBE TYPE	FREQUENCY RANGE (Mcs)	POWER OUTPUT (Kw)	ANODE CURRENT (a)	ANODE VOLTAGE (kv)	PULSE WIDTH (usec)	DUTY CYCLE	OUTPUT	WEIGHT (Lbs.)	MAXIMUM DIMENSIONS (Inches)
5J26 (UNPACKAGED)	1220–1350	400	46	28	4.0	.001	Coaxial	20	12.5
RK7484A/QKH470A	1250–1350	2000	90	60	3.0	.001	Waveguide	90	22.325
RK7484/QKH470	1250–1350	2000	90	60	3.0	.001	Waveguide	90	22.325
RK6517/QKH358	1250–1350	1000	50	53	3.0	.0013	Waveguide	90	22.2

2. Liquid cooled high power tubes for MTI and approach radar systems requiring microwave power relatively free from frequency and time jitter. Electrically and mechanically interchangable.

TUBE TYPE	FREQUENCY RANGE (Mcs)	POWER OUTPUT (Mw)	ANODE CURRENT (a)	ANODE VOLTAGE (kv)	PULSE WIDTH (usec)	DUTY CYCLE	OUTPUT	WEIGHT (Lbs.)	MAXIMUM DIMENSIONS (Inches)
QKH665 (Fixed Frequency–Pulsed)	1250–1285	5.0	150	71.0	5.0	.0018	Waveguide	110	18.614
QKH942 (Hydraul. Tuned–Pulsed) (10 cps tuning rate)	1250–1350	5.0	150	71.0	5.0	.0018	Waveguide	140 (includes actuator)	30.0
QKH666 (Fixed Frequency–Pulsed)	1320–1350	5.0	150	71.0	5.0	.0018	Waveguide	110	18.614

S-BAND MAGNETRONS

1. Fixed frequency medium power air cooled tubes for general purpose radar systems including commercial ship-board navigation and search radar. All except 2J70A are unpackaged, operate at 1900 gauss.

TUBE TYPE	FREQUENCY RANGE (Mcs)	POWER OUTPUT (Kw)	ANODE CURRENT (a)	ANODE VOLTAGE (kv)	PULSE WIDTH (usec)	DUTY CYCLE	OUTPUT	WEIGHT (Lbs.)	MAXIMUM DIMENSIONS (Inches)
2J34	2700-2740	240	30	20	1.0	.001	Coaxial	2.25	6.25
2J33	2740-2780	240	30	20	1.0	.001	Coaxial	2.25	6.25
2J32	2780-2820	240	30	20	1.0	.001	Coaxial	2.25	6.25
2J31	2820-2860	240	30	20	1.0	.001	Coaxial	2.25	6.25
2J30	2860-2900	240	30	20	1.0	.001	Coaxial	2.25	6.25
2J70A	3025-3075	20	8.0	7.0	1.0	.001	Coaxial	3.75	7.25

2. Compact high power liquid cooled tubes for height finding radar and linear accelerator use. Offer high efficiency and outstanding reliability.

TUBE TYPE	FREQUENCY RANGE (Mcs)	POWER OUTPUT (Kw)	ANODE CURRENT (a)	ANODE VOLTAGE (kv)	PULSE WIDTH (usec)	DUTY CYCLE	OUTPUT	WEIGHT (Lbs.)	MAXIMUM DIMENSIONS (Inches)
RK7529/QKH327 (Tunable—Pulsed)	2700-2850	3500	115	62	2.0	.00072	Waveguide	66	21.375
RK6410A/QKH338A (Fixed Freq.—Pulsed)	2750-2860	4500	130	70	2.0	.001	Waveguide	58	21.375
QKH883 (Tunable—Pulsed)	2750-2860*	4500	130	70	2.0	.001	Waveguide	58	21.375
QKH898 (Tunable—Pulsed)	2846-2866*	4500	130	70	2.0	.001	Waveguide	58	21.375
RK6406A/QKH428A (Fixed Freq.—Pulsed)	2850-2910	1750	85	52	2.0	.0006	Waveguide	40	21.375
RK5795 (Tunable—Pulsed)	3100-3500	1000	45	45	1.3	.002	Waveguide	65	---
RK6402/QKH437 (Tunable—Pulsed)	3430-3570	700	50	47	2.0	.0014	Waveguide	65	19.750

*30 Mc anywhere in band

3. Reliable, low cost high power tubes. Operate at 2700 gauss with system located solenoid or permanent magnet. Air cooled.

TUBE TYPE	FREQUENCY RANGE (Mcs)	POWER OUTPUT (Kw Typ.)	ANODE CURRENT (a)	ANODE VOLTAGE (kv)	PULSE WIDTH (usec)	DUTY CYCLE	OUTPUT	WEIGHT (Lbs.)	MAXIMUM DIMENSIONS (Inches)	COOLING
RK5586 (Tunable)	2700-2900	800	70	29.5	1.0	.0005	Coaxial	6	10.0	Air
4J35 (Fixed Frequency)	2700-2740	800	70	28	1.0	.0005	Coaxial	5	10.5	Air
4J34 (Fixed Frequency)	2740-2780	800	70	28	1.0	.0005	Coaxial	5	10.5	Air
4J33 (Fixed Frequency)	2780-2820	800	70	28	1.0	.0005	Coaxial	5	10.5	Air
4J32 (Fixed Frequency)	2820-2860	800	70	28	1.0	.0005	Coaxial	5	10.5	Air
4J31 (Fixed Frequency)	2860-2900	800	70	28	1.0	.0005	Coaxial	5	10.5	Air
RK5657 (Tunable)	2900-3100	800	70	30	1.0	.0005	Coaxial	6	10.0	Air
RK6695/QKH253 (Tunable)	3430-3570	600	55	28	2.0	.001	Coaxial	6	10.0	Liquid

UHF MAGNETRONS

Stable high power long life tubes ideally suited to ground and airborne search radar and MTI applications. Tunable types may be rapidly motor or hand tuned.

TUBE TYPE	FREQUENCY RANGE (Mcs)	POWER OUTPUT (pk Kw)	ANODE CURRENT (a)	ANODE VOLTAGE (kv)	PULSE WIDTH (usec)	DUTY CYCLE	OUTPUT	WEIGHT (Lbs.)	MAXIMUM DIMENSIONS (Inches)
RK7547/QKH516 (Tunable—Pulsed)	406–450	2000	97.3	55.0	6.8	.002	Coaxial	220	22.625
QKH517B (Fixed Freq.—Pulsed)	535–545	2000	90.0	50.0	6.0	.0018	Coaxial	Less than QKH516	
QKH626 (Tunable—Pulsed)	570–630	2000	90.0	50.0	6.0	.0018	Coaxial	Less than QKH516	
QKH517A (Fixed Freq.—Pulsed)	600–610	2000	90.0	50.0	6.0	.0018	Coaxial	Less than QKH516	
QKH517 (Fixed Freq.—Pulsed)	670–680	2000	90.0	50.0	6.0	.0018	Coaxial	Less than QKH516	

X–BAND MAGNETRONS

1. Tunable pulsed tubes for ground, shipboard, and airborne search, surveillance, and weather radar.

TUBE TYPE	FREQUENCY RANGE (Mcs)	POWER OUTPUT (Kw Typ.)	ANODE CURRENT (a)	ANODE VOLTAGE (kv)	PULSE WIDTH (usec)	DUTY CYCLE	OUTPUT	COOLING	WEIGHT (Lbs.)	MAXIMUM DIMENSIONS (Inches)
RK6249B	8500–9600	200	25	28	2.5	.001	Waveguide	Air	16.25	10.25
2J51A	8500–9600	40	14	14	3.5	.001	Waveguide	Air	5.0	6.5
RK6248	8700–8900	1.1	.91	3.55	1.0	.045	Waveguide	Air	6.0	5.250
QKH1121	9175–9575	7.0	4.5	5.5	2.0	.002	Waveguide	Air	3.0	5.5

2. Fixed frequency pulsed tubes for radar applications.

RK6967	9205–9285	75	13.5	15.0	0.5	.001	Waveguide	Air	7.5	6.8
2J56	9210–9280	40	12	12	2.0	.001	Waveguide	Air	4.0	6.25
RK6959/QKH172	9330–9420	600 425	67 38	33	0.5 3.2	.0003 00105	Waveguide	Air	45	14.625
2J55	9345–9405	40	12	12	2.0	.001	Waveguide	Air	4.0	6.25
2J42	9345–9405	7.0	4.5	5.5	2.0	.002	Waveguide	Air	3.0	5.5
2J42H*	9345–9405	7.0	4.5	5.5	2.0	.002	Waveguide	Air	3.0	5.5
725A	9345–9405	40	12	12	2.5	.001	Waveguide	Air	1.5	6.0

*Designed for jet aircraft environments, operates to 60,000 ft. altitude without pressurization.

CW MAGNETRONS

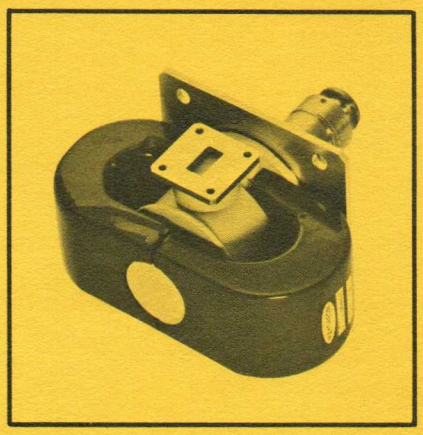
L– and S–band tubes primarily used as power sources in microwave signal generators. The RK6177 is electro–mechanically frequency modulated by a 300 cps vibrating reed mechanism for use in radar altimeters.

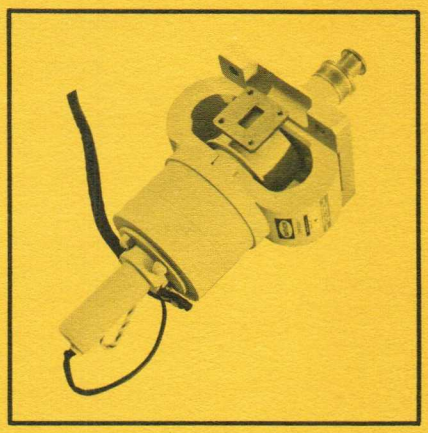
TUBE TYPE	FREQUENCY RANGE (Mcs)	POWER OUTPUT (W)	ANODE CURRENT (mA)	ANODE VOLTAGE (kv)	OUTPUT	WEIGHT (Lbs.)	MAXIMUM DIMENSIONS (Inches)
QKH959 (Tunable)	950–1525	190	225	2.9	Coaxial	24	12.0
QKH960 (Tunable)	2350–3600	190	225	2.9	Coaxial	24	12.0
4J62 (Tunable)	2675–3015	50	125	1.2	Coaxial	—	7.0
4J63 (Tunable)	2985–3385	50	125	1.2	Coaxial	—	7.0
4J64 (Tunable)	3305–3675	50	125	1.2	Coaxial	—	7.0
RK6177 (Fixed Frequency)	4268–4350	1.0	30	305	BNC	1.0	3.28

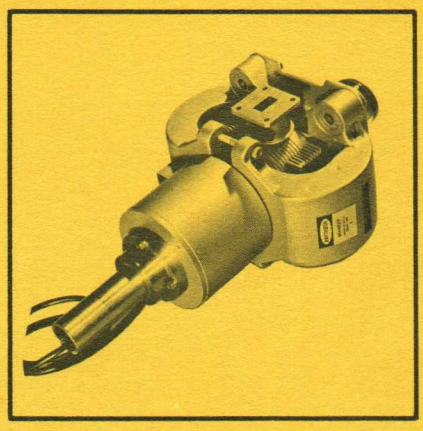
INFORMATION BULLETIN

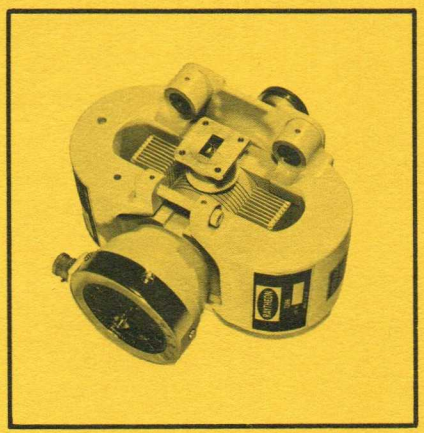
NO. 1-68

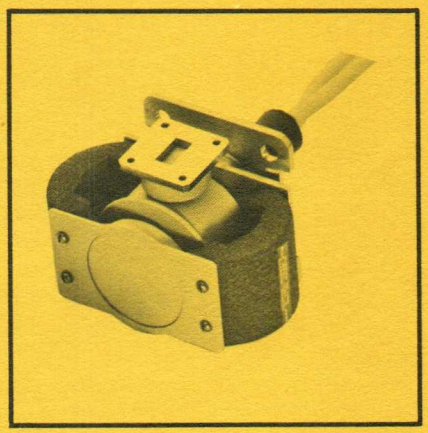
Ku-Band Coaxial Magnetrons











RAYTHEON

MICROWAVE AND POWER TUBE DIVISION

Ku-Band Coaxial Magnetrons

FEATURES

- **Rugged ceramic/metal construction**
- **Wide power range — 35 to 125 kilowatts**
- **Servo-tunable and fixed frequency versions**
- **Light weight, long life**
- **Excellent stability, spectrum and efficiency**
- **Being used in airborne systems meeting MIL-E-5400 specifications**

The information presented in this brochure indicates Raytheon Company's capability in coaxial cavity magnetrons operating in Ku-Band. Six magnetrons are described, ranging from the QKH1368 fixed frequency 35 kW tube to the sophisticated voice coil tuned 95 kW QKH1527.

The coaxial magnetron with its integral stabilizing cavity offers greater frequency stability than obtainable from the conventional magnetron. Frequency pulling and pushing are reduced to less than one third of their usual values and better rf output spectra are obtained. At high frequencies, where resonator dimensions are small, the coaxial cavity magnetron can employ more vanes. The resulting increased anode and cathode areas contribute significantly to life and reliability of Ku-band magnetrons.

The voice coil tuner provides closed loop servo-controlled voltage tuning of the magnetron. Random tuning or high cycling rates can be applied, adding ECCM and frequency agility features to the radar system.

The data and performance given here is of a general nature. It is intended to aid in the selection of components which may best suit the needs of a particular radar system and to appraise system engineers of tube capabilities for future design work.

If the tubes described herein do not meet your particular requirements, a modest development can usually be carried out to obtain the desired performance.

PERFORMANCE AND ENVIRONMENT

TEMPERATURE

The tubes described in this bulletin will operate properly in ambient air environments from −50° to +100°C. The principal consideration is that sufficient air be blown over the tube to prevent the anode from getting hotter than 150°C. As the temperature varies, the size of the coaxial cavity and the position of the tuning plate in the cavity change so that the output frequency shifts. Usually the shift is in a negative sense, and the thermal factor is typically −0.25 MHz/°C. Where system requirements are critical the thermal factor can be reduced to a value of 0.1 MHz/°C by choice of materials with expansion coefficients such that the tuner plate moves in the coaxial cavity to compensate for other dimensional changes of the anode or cavity.

At a fixed thermal environment there is an additional cause of thermal shift in frequency. This is snap on shift, measured from the time pulse voltage is first applied to the tube to the point when the tube temperature stabilizes. For the coaxial magnetrons listed the typical starting shift is about 5 MHz. Values of starting frequency shift vary from 3 MHz to 10 MHz, with the direction of shift changing randomly from tube to tube. When it is desirable to have low thermal starting shift, tubes can be measured to be certain their shift is below the required minimum. Usually this means a loss of yield in the production of the tube.

PRESSURIZATION

Generally the output waveguide and the input to the cathode stem are pressurized so that standard atmospheric conditions are maintainable when high altitude is reached. The permissible range of pressure to be kept in the input and output areas of the tubes is 12 to 45 psia.

VARIATION IN RF OUTPUT

The tubes will easily tolerate a mismatch of 1.5/1 VSWR in the output load. The pulling figure is typically 5 MHz as the phase of the mismatch is varied. Spectrum quality is maintained with a bandwidth of 2.0/pulse width and with side lobes 9.0 dB down from the main lobe. Stability expressed as a percent of missing pulses is less than 0.25% independent of the load mismatch position.

Pushing, the frequency shift that occurs when the anode current changes, is typically less than 100 kHz/ampere.

Pulse to pulse frequency jitter is nominally about 50 kHz, and amplitude jitter is less than 0.25 dB.

The Ku-band coaxial magnetrons will start smoothly on each pulse provided the rate of rise of voltage is slow enough to allow oscillation to build up in the high Q π mode. If it is too fast the tube will misfire and operate partly at some frequency other than the π mode — such as the slot mode. A practical limit to the voltage rise time is 150 kV/μsec. It is good practice for a satisfactory interface between the tube and pulse modulator to keep this down to 130 kV/μsec when possible. Starting time jitter then can be kept to less than 10 nanoseconds rms.

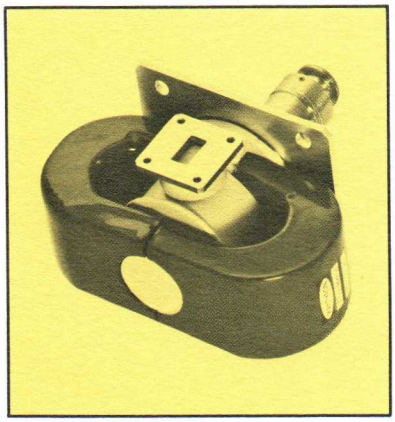
Heater power is reduced, once oscillation has started, until the sum of the thermal input to the cathode from the heater and from electron back bombardment is sufficient to maintain the cathode at its proper operating temperature. The reduction is dependent on the pulse width and the duty cycle at which the tube is operated. Correct values for the heater input can be supplied when the pulse conditions are specified.

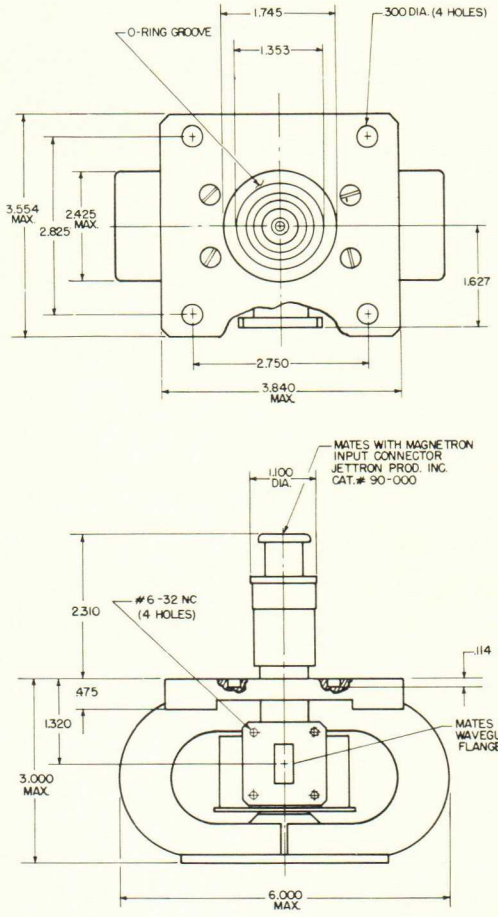
VIBRATION AND SHOCK

Raytheon coaxial magnetrons have been ruggedized to withstand vibration and shock conditions encountered in aircraft. The shock test is 30 g at 11 milliseconds. Vibration testing over the 5 to 500 Hz range is conducted at a level of 5 to 10 g depending on the specified requirements. During vibration the frequency output of the tube is monitored to ensure that peak-to-peak frequency modulation is maintained within 4 MHz.

QKH1325

The QKH1325 is a pulsed coaxial magnetron, air and conduction cooled, with an integral magnet. It is a fixed frequency tube which is usually built to operate at 16.5 GHz. However, it can be delivered to oscillate at any frequency between 16.2 and 17.1 GHz.

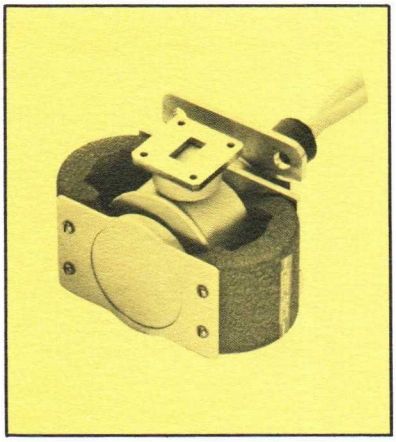


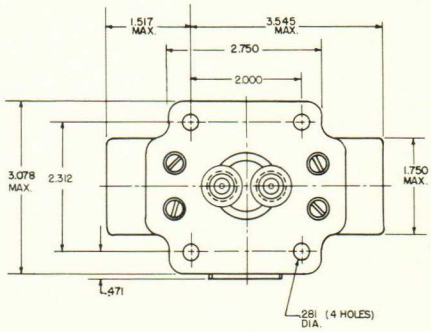


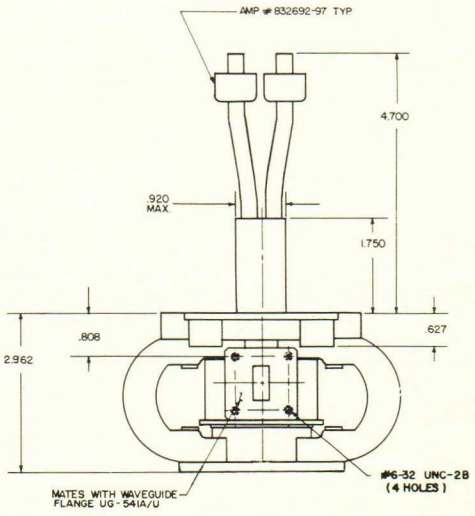
Frequency	**16.5 GHz**
Peak Power Output	**65 kW min**
Pulse Width	**0.2 to 2.0 μsec**
Duty Cycle	**up to .001**
Pulse Voltage	**16 kV**
Peak Current	**16 A**
Preheat Voltage	**12.6 V**
Preheat Current	**1.8 A**
Weight	**4 lb, 12 oz**
Output	**UG 541/U**
Input Connection	**Jettron Products 90-000 series**

QKH1368

The QKH1368 is a pulsed coaxial magnetron, air cooled, with an integral magnet delivering 35 kW minimum peak power output. The tube is fixed frequency and is normally built to operate at 17.2 GHz. It can also be delivered with an output frequency preset at any point in the range from 16.2 to 17.2 GHz.



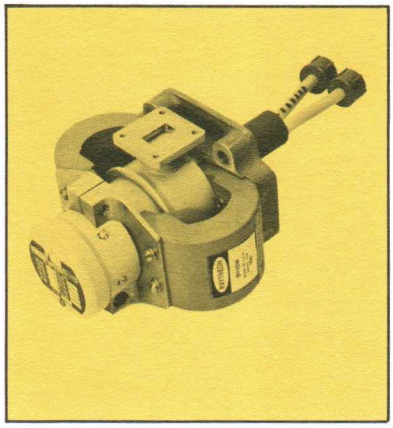




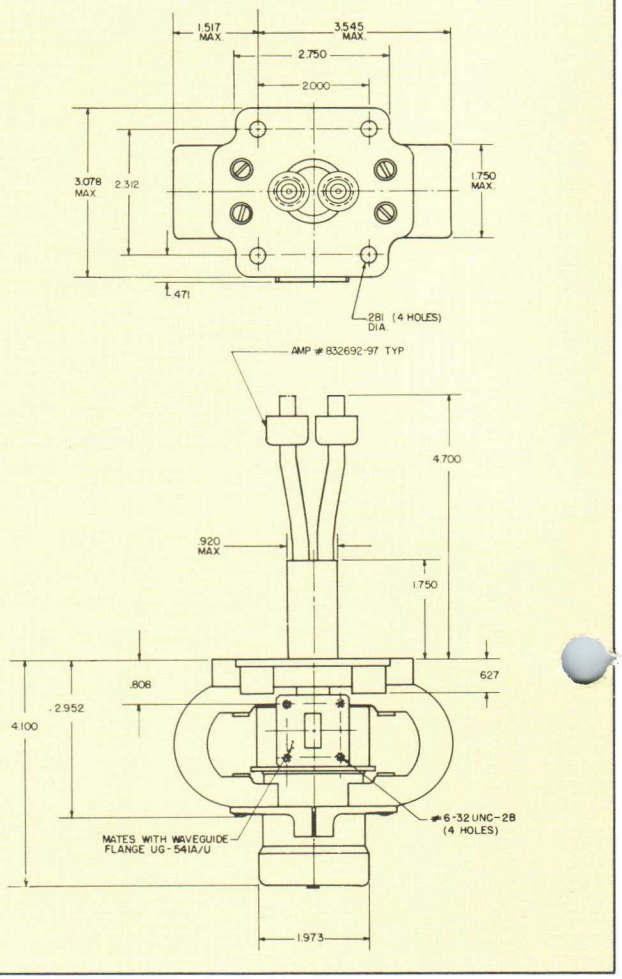
Frequency	**17.2 GHz**
Peak Power Output	**35 kW min**
Pulse Width	**0.2 to 2.0 μsec**
Duty Cycle	**up to .001**
Pulse Voltage	**12 kV**
Peak Current	**9.5 A**
Preheat Voltage	**12.6 V**
Preheat Current	**1.8 A**
Weight	**3 lb, 4 oz**
Output	**UG 541/U**
Input	**Flying Leads**

QKH1516

The QKH1516 is a pulsed coaxial magnetron, tunable over the range 16.6 to 17.1 GHz. It can also be built to be tunable over any 500 MHz portion of the band between 16.2 and 17.2 GHz. The QKH1516 has a minimum peak power output of 35 kW, is air cooled, and has an integral magnet.

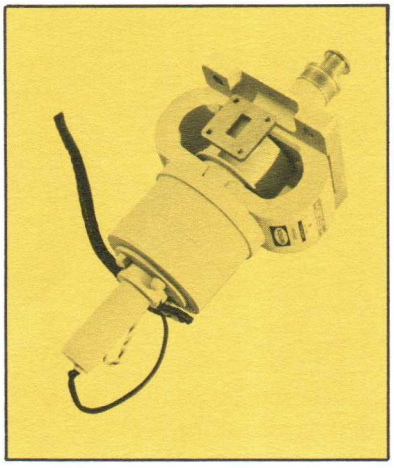


Frequency	**16.6 to 17.1 GHz (screw driver adjustable)**
Peak Power Output	**35 kW min**
Pulse Width	**0.2 to 2.0 μsec**
Duty Cycle	**up to .001**
Pulse Voltage	**12 kV**
Peak Current	**9.5 A**
Preheat Voltage	**12.6 V**
Preheat Current	**1.8 A**
Weight	**4 lb, 4 oz**
Output	**UG 541/U**
Input	**Flying Leads**

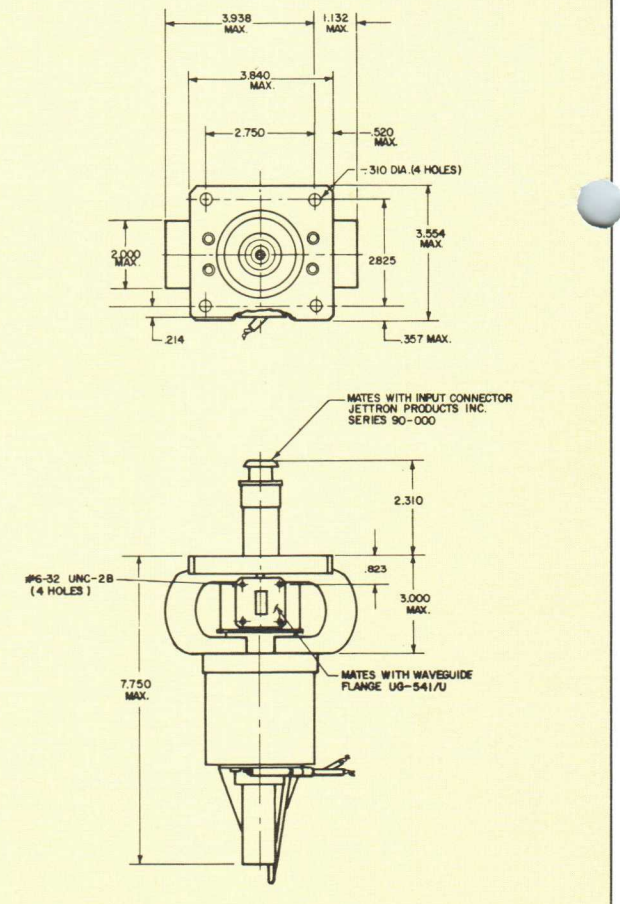


QKH1526

The QKH1526 is a pulsed coaxial magnetron tunable over any specified 600 MHz portion of the range between 16.1 and 16.9 GHz. It provides 65 kW minimum peak power output, is air cooled and has an integral magnet. The QKH1526 tuner is equipped with an electromagnetic actuator and sensing elements which give electrical analog outputs indicating the tuner shaft position and velocity. The tuner is driven from a servo amplifier which may be programmed in any desired manner from a voltage signal generator. (See section discussing servo tuning.)

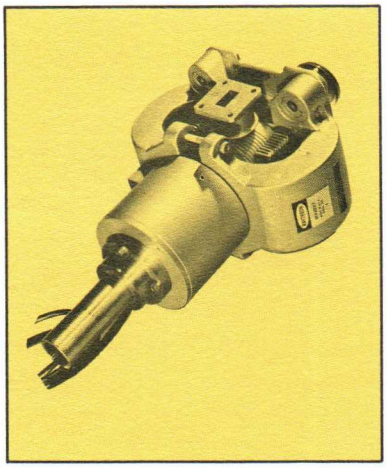


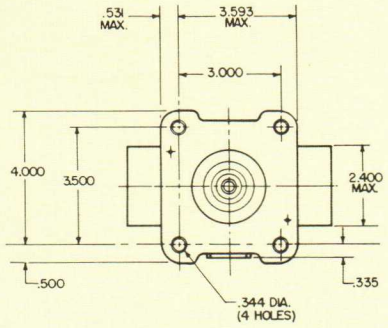
Frequency	**600 MHz servo tunability, centered according to customer needs, within the range 16.1 to 16.9 GHz**
Peak Power Output	**65 kW min**
Pulse Width	**0.2 to 2.0 μsec**
Duty Cycle	**up to .001**
Pulse Voltage	**14 kV**
Peak Current	**14 A**
Preheat Voltage	**12.6 V**
Preheat Current	**1.8 A**
Weight	**7 lb, 8 oz**
Output	**UG 541/U**
Input Connection	**Jettron Products, 90-000 series**

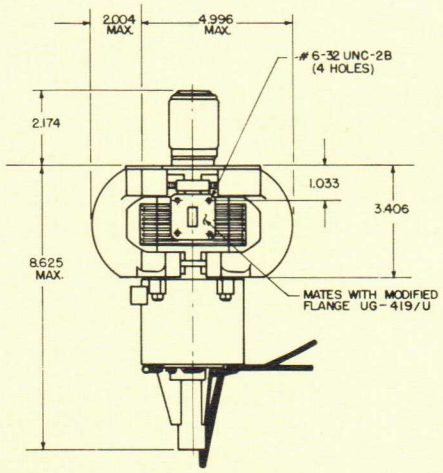


QKH1527

The QKH1527 is a pulsed coaxial magnetron tunable over any specified 600 MHz segment of the range between 15.5 and 17.5 GHz. It provides 95 kW minimum peak power output, is air cooled, and has an integral magnet. The QKH1527 tuner is equipped with an electromagnetic actuator and sensing elements which give electrical analog outputs indicating the tuner shaft position and velocity. The tuner is driven from a servo amplifier which may be programmed in any desired manner from a voltage signal generator (see section discussing Servo Tuning).



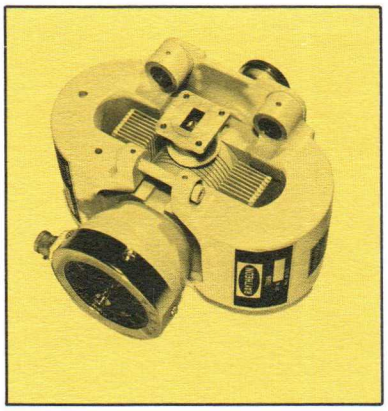


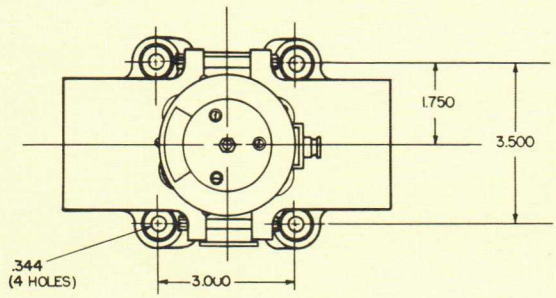


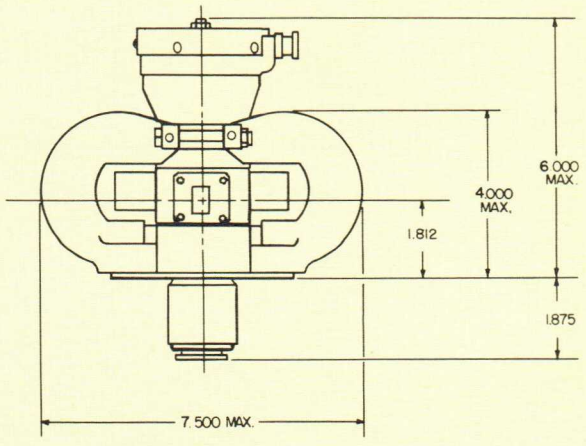
Frequency	**600 MHz servo tunability, centered according to customer needs, within the range 15.5 to 17.5 GHz**
Peak Power Output	**95 kW min**
Pulse Width	**0.2 to 2.0 μsec**
Duty Cycle	**up to .001**
Pulse Voltage	**16 kV**
Peak Current	**16 A**
Preheat Voltage	**12.6 V**
Preheat Current	**2.5 A**
Weight	**13 lb**
Output	**UG 541/U**
Input Connection	**McNally Bros. NES 48067 Grantsburg, Wisconsin**

RK7208B

The RK7208B is a pulsed coaxial magnetron mechanically tunable over the range 15.5 to 17.5 GHz. It gives 125 kW minimum peak power, is air cooled, and has an integral magnet.







Frequency	**15.5 to 17.5 GHz mechanically tunable**
Peak Power Output	**125 kW min**
Pulse Width	**0.2 to 3.0 μsec**
Duty Cycle	**up to .001**
Pulse Voltage	**17.5 kV**
Peak Current	**19 A**
Preheat Voltage	**12.6 V**
Preheat Current	**3.2 A**
Weight	**14 lb**
Output	**UG 541/U**
Input Connection	**McNally Bros. NES 48067 Grantsburg, Wisconsin**

Frequency-Agile Magnetrons For Modern Radar Requirements

SERVO TUNING

Both the QKH1526 and QKH1527 are made with servo tunable electromagnetic actuators. The tuner drive is similar in principle to the operation of the voice coil in a permanent magnet loud speaker. The tuning plate forming the end of the TE_{01} mode magnetron cavity is attached to a shaft which passes through a bellows assembly to the outside of the vacuum envelope. External to the tube, the shaft is held in a low friction bearing and is attached to a coil located in a magnetic field. As current is passed through the coil, the shaft and tuning plate are moved inward or outward depending on the direction of current flow.

The force acting along the axis of the tuning shaft is 2.0 lb/ampere. Working against this force is the spring constant of the bellows which is approximately 75 lb/inch. Atmospheric pressure, which normally exerts pressure against the magnetron tuner, is eliminated by the use of a double bellows system which presents equalizing pressure above and below a central tuner plate. The bellows used in the tuner are of the long-life welded plate construction. The weight of the moving parts of the tuner is 0.3 lb. Mechanical damping, which is estimated at 0.25 lb/in./sec, is negligible compared to the damping provided by the rate loop in the servo. The cold resistance of the coil is 3 ohms; the inductance is less than 500 microhenries.

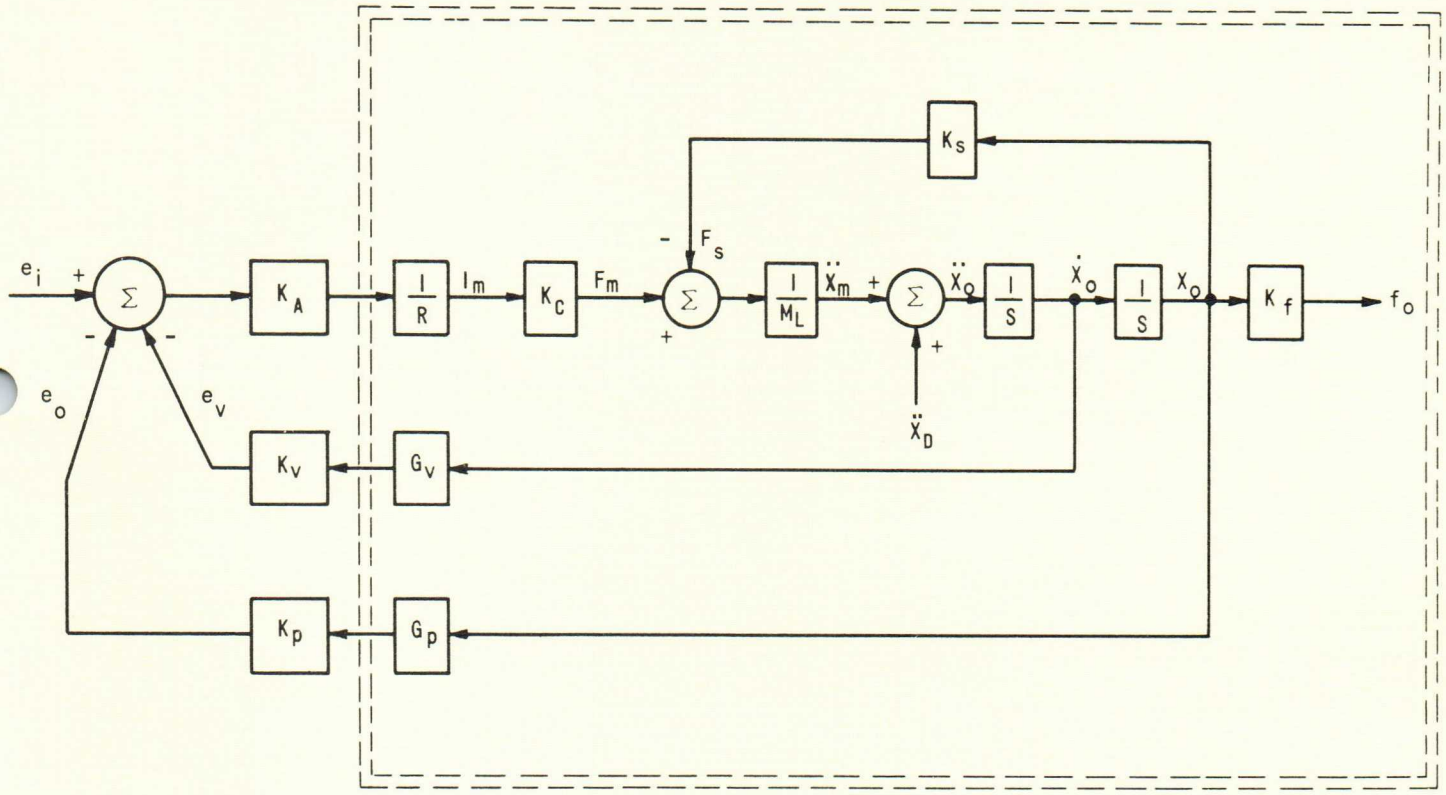
Connected to the tuning shaft is a two-element transducer probe containing a steel core and a magnet. In passing through fixed transducer windings, the magnet generates a voltage proportional to the velocity of the shaft; the steel core provides variable coupling between a primary and two oppositely wound secondaries of a transformer. The amplitude of the voltage across the secondaries is proportional to the shaft position. The transducer is positioned on the tube so that null output voltage occurs at the frequency range midband; the phase of the output is a measure of whether the tuner is above or below midband. A 20 kHz, 10 V rms signal is used for the input to the position transducer. The output sensitivity is 20 V rms/in. The tuning curve of both tubes has a slope of about 15,000 MHz/in. Thus the position transducer, which is used both for feedback to the servo control and for AFC provides an indication of the frequency with a sensitivity of roughly 1.33 mV rms/MHz. The velocity transducer has an output of 0.1 V/in./sec.

A block diagram for the servo tuned magnetron is given below. Twenty kHz modulation and demodulation circuits for the position transducer are not shown and back emf, inductance, and mechanical damping have been disregarded. The amplifiers in the velocity loop should have a gain of about 150 volts/volt; the position loop amplifiers 1500V/volt p-p. With the servo loop gains thus set it will be found that both reasonably fast response time and stable operation are accommodated.

To a first approximation the vibration transfer function of $X_o/\ddot{X}_d$ gives a theoretical ability of the servo to hold the tuner at a fixed point within about 2.0 MHz peak-to-peak deviation against a 5 g environmental acceleration input. Slightly more peak-to-peak shift, 4 MHz, is seen in practice due to lateral motion of the tuner plate in the cavity. In the absence of vibration, the output frequency is quite steady when a constant voltage command input is applied to the servo. Fidelity to various waveform inputs is adequate; e.g., the turn around time for the tuner to switch from motion in one direction to motion in the opposite direction on a triangular waveform is less than 1.0 millisecond.

The tuner can accommodate average I^2R losses of about 45 watts before coil temperature becomes excessive (greater than 220° C). At this power level the coil resistance moves up to 5 ohms, and the maximum average useful current is 3 amperes. Current requirements due to combinations of vibration environment, tuning agility rate, and tuner position should be examined to determine that the maximum current capacity is not exceeded. Tuning rates of 50 Hz across the entire band can be achieved. Faster rates over smaller segments can also be accommodated.

BLOCK DIAGRAM — SERVO TUNED MAGNETRON



ELEMENTS WITHIN DASHED LINES ARE INTEGRAL WITH TUBE

e_i – SIGNAL FROM COMMAND GENERATOR (VOLTS)

K_A – POWER AMPLIFIER (VOLTS/VOLT)

K_v – VELOCITY AMPLIFIER (VOLTS/VOLT)

K_p – POSITION AMPLIFIER (VOLTS/VOLT)

G_v – VELOCITY TRANSDUCER (VOLTS/IN/SEC)

G_p – POSITION TRANSDUCER (VOLTS/IN)

R – FORCE MOTOR RESISTANCE (OHMS)

M_L – MASS (lb/IN/SEC^2)

K_C – FORCE CONSTANT (lbs/AMP)

K_S – SPRING CONSTANT (lbs/IN)

S – LAPLACE OPERATOR (I/SEC)

$\ddot{X}$ – ACCELERATION (IN/SEC^2)

$\dot{X}$ – VELOCITY (IN/SEC)

X – POSITION (IN)

$\ddot{X}_D$ – ACCEL DISTURBANCE (IN/SEC^2)

K_f – TUNING SENSITIVITY (MHz/INCH)

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RAYTHEON

RAYTHEON COMPANY

MICROWAVE AND POWER TUBE DIVISION

PRINTED IN U. S. A.

Preliminary Data*

ISSUED 6/65

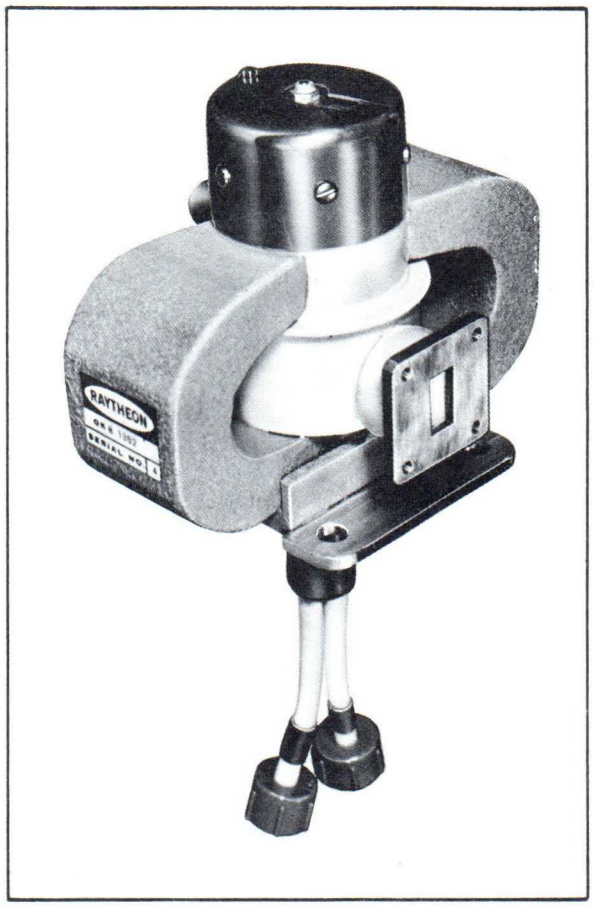
RAYTHEON

Ku-Band Coaxial Magnetrons

Raytheon coaxial magnetrons are the lightest weight, most rugged tubes of this type available. They are ideally suited for airborne radar applications which require high efficiency, improved frequency stability, and minimum size.

Coaxial magnetrons have an integral stabilizing cavity incorporated into the resonant structure of the tube. This design results in lower pushing and pulling figures, increased efficiency, and longer tube life than are obtainable with conventional magnetrons.

Raytheon coaxial magnetrons meet the most rigorous airborne environmental conditions. In operating systems, the tubes have exhibited very low starting jitter characteristics. The QKH1325 has the lowest input power requirements of any coaxial magnetron with similar output power.



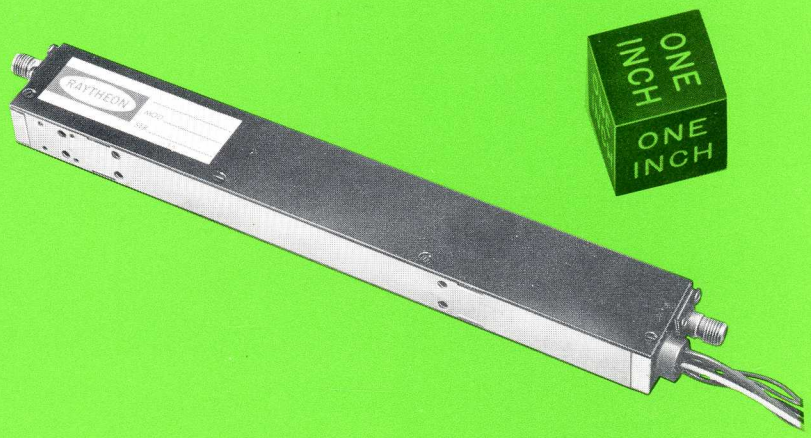
Standard Raytheon coaxial magnetrons are listed below. Other power levels and Ku-Band frequencies are available to meet specific requirements.

	QKH1302	QKH1325	QKH1368
Frequency (Gc)	16.6 - 17.1 (mech tunable)	16.5 (fixed freq)	17.2 (fixed freq)
Peak Power Output (kw)	35	65	35
Pulse Width (usec)	0.2	0.2 & 1.0	0.2
Duty Cycle	.001	.00072	.001
Anode Voltage (kv)	12	14	12
Peak Anode Current (a)	9.5	14	9.5
Weight	4 lbs, 2 oz	4 lbs, 12 oz	3 lbs, 10 oz

*The specifications for this device have not been finalized. For current information contact the nearest Microwave and Power Tube Regional Sales Representative.

Printed in U. S. A.

RAYTHEON LOW & MEDIUM POWER TWT'S



Raytheon now offers the complete RCA line of low and medium power TWT's, including loop tubes and miniaturized TWT's, to meet a wide variety of ECM and communications applications.

RAYTHEON

Low & Medium Power TWT's

As an addition to its long-established capabilities in higher power TWT's, Raytheon now offers the complete RCA line of low and medium power TWT's, including loop and miniaturized tubes. These TWT's are specifically designed to meet a wide variety of ECM and communications applications, and are backed by complete engineering and production facilities devoted exclusively to these tubes.

Miniaturized TWT's

The Raytheon line of miniaturized Traveling-Wave-Tubes (MINI-TWT's), incorporates samarium-cobalt magnets and features outstanding performance as well as small size and weight. Volumes are as low as 3 cubic inches and weights are as low as 7 ounces. Intended for airborne applications as amplifiers in EW systems, where size and weight are critical considerations, Raytheon MINI-TWT's provide 10 to 50 watts of RF power output in the frequency range of 2.5 to 18 GHz and have bandwidths greater than one octave.

The miniature tubes use depressed collector operation for improved overall DC-to-RF efficiency, and have a conduction-cooled heat sink. Specifically designed for side-by-side operation with minimum interaction between adjacent tubes, they are particularly suited for applications in phased-array systems. A typical tube has a cross-section only one-half inch in width and one inch in height, including the RF coupler housing.

Raytheon has made a major effort to obtain improved reliability, thermal stability, and tube-to-tube consistency in the MINI-TWT line. This includes the ability to obtain full DC-to-RF operation without noticeable power fade even at the 30-watt RF power output level. Such capability is achieved with only a modest cost increase (in production quantities) over standard traveling-wave tubes.

Loop Tubes

Traveling-wave tubes for loop-memory subsystems must provide RF storage capability while operating with the required passive delay components in the feedback loop. To accomplish this, it is necessary for the traveling-wave tube to meet the following prerequisites:

1. Produce small-signal gain contour which complements the delay line loss.
2. Maintain excess gain spread and gain contour with temperature variation over operating environment.
3. Provide storage operation over the memory period with ±5% variation in helix voltage and ±5% variation in collector voltage, over the normal range of temperature variation.
4. Meet the requirements mentioned above over a wide input pulse power range.
5. For the in-line loop, meet the specific system interface characteristics as an amplifier between the input and final traveling-wave tubes in the chain as well as RF storage.

Raytheon offers a wide variety of both "in-line" and "off-line" traveling-wave tubes that meet these requirements.

Major Application Areas

ECM Systems: Raytheon specializes in providing traveling-wave tubes for the low-level input amplifier stage, recirculating rf memory (loop) stage, and the driver stage of electronic counter measure systems. Raytheon medium-noise traveling-wave tubes meet the diverse and opposing requirements of low noise and wide dynamic range for the input amplifier stage of ECM systems. These tubes cover the L-Ku frequency band and have noise figures from approximately 12 to 20 dB. Where desirable, tubes can be prepackaged with delay lines, power dividers, and integral power supplies as complete subsystems.

Communications Systems: Recent developments in X and Ku common carrier and Community Antenna Distribution systems have led to the production of a family of 10- and 20-Watt communication TWT's. These tubes incorporate the latest design advances to assure long life and reliability at an economical price.

Subsystems: Raytheon can provide solid-state power supplies (designed to MIL-E-5400) integral with traveling-wave tubes or as separate units. The power supplies can be either of the field or depot repairable form, depending on the application. Controlling the interface between the traveling-wave tube and the power supply can reduce the total cost for the system and/or result in improved tube performance. Power alarm and monitoring circuits can be customized to your specific needs with quick reaction capability.

Typical Operating Characteristics of Loop Tubes

Performance Mode	Frequency Band	Storage Time	Power Level	SS Gain
In-Line	S	5 μsec approx.	∿1 - 4 W	35 dB
In-Line	C	5 μsec approx.	100 mW - ½ W	40 dB
In-Line	X	5 μsec approx.	100 mW - ½ W	40 dB
In-Line	X-Ku	5 μsec approx.	½ W	60 dB

Miniaturized Traveling-Wave Tubes

Raytheon Type Number	Replaces RCA Type	Frequency Range GHz	RF Output Saturated W	Gain Small Signal dB	Noise Figure dB	Heater Voltage V	Heater Current A	Collector Voltage V	Collector Current mA	Helix Voltage V	Helix Current mA	Anode Voltage V	Control Grid	Dimensions (Excludes Connectors) inches L	Dimensions (Excludes Connectors) inches W	Dimensions (Excludes Connectors) inches H	Weight Approx. lbs.	Application
QKW1930	A1485	2.6- 5.2	24	40	35	6.3	1.0	1200	120	2100	8.0	3800	Yes	10.0	0.75	1.0	1.0	P, E.
QKW1931	A1483	4.0- 8.0	10	40	35	6.3	1.3	2000	60	2100	6.0	2400	Yes	10.0	1.0	1.0	0.8	
QKW1932	A1464	5.0-10.0	5	35	30	6.3	1.25	2300	50	2200	4.0	2250	No	8.0	1.0	1.0	1.0	
QKW1934	A1481	5.2-10.4	26	40	35	6.3	0.6	1300	100	2500	8.0	3500	Yes	8.0	0.6	0.85	0.6	P, E.
QKW1935	A1487	7.0-17.0	10	50	35	6.3	0.4	1700	70	3000	5.0	2900	No	10.0	0.5	1.0	1.0	P, E.
QKW1936	A1465	8.0-16.0	10	30	30	6.3	1.25	2400	60	3800	1.0	2450	No	8.0	1.0	1.0	1.0	
QKW1937	A1484	8.0-18.0	10	45	35	6.3	0.35	1700	60	3300	6.0	2300	Yes	9.0	0.63	1.35	0.75	
QKW1938	A1478	8.0-18.0	16	40	—	6.3	0.4	2000	75	3000	8.0	2900	Yes	7.0	0.5	1.0	0.6	
QKW1939	A1486	10.4-18.0	20	40	35	6.3	0.5	1800	95	3000	8.0	3400	Yes	7.0	0.6	0.85	0.6	P, E.
QKW1940	A1480	11.0-18.0	20	40	—	6.3	0.3	1800	75	3200	8.0	2800	Yes	7.0	0.5	1.0	0.6	P, E.
QKW1941	A1497	4.6- 5.4	45	45	35	6.3	1.25	1600	110	2350	16.0	1150	Yes	11.87	0.95	0.98	1.0	E.

NOTES: 1. All tubes ceramic metal construction. 2. RF connectors, all tubes: SMA. 3. Tubes normally furnished with flying leads. 4. All tubes periodic-permanent-magnetic focusing.
P — Phased Array. E — ECM.

Medium-Power Traveling-Wave Tubes (10W and above)

Raytheon Number	Replaces RCA Type	Frequency Range GHz	RF Output (Saturated) W	Gain (Small Signal) dB	Noise Figure dB	Heater Voltage V	Heater Current A	Collector Voltage V	Collector Current mA	Helix Voltage V	Helix Current mA	Anode Voltage A	Control Grid	RF Connectors	Dimensions (Excludes Connectors) inches L	Dimensions (Excludes Connectors) inches W	Dimensions (Excludes Connectors) inches H	Weight Approx. lbs.
QKW1924	A1317	0.75- 1.0	20	30	23	6.3	1.3	1550	60	1650	0.5	1400	No	N	20.0	2.19	2.13	5.0
QKW1901	7642	1.7 - 2.3	18	28	—	6.3	1.3	2000	70	2250	0.7	1375	No	N	20.5	3.12	3.88	6.5
QKW1922	4054	1.7 - 2.7	17	29	—	6.3	1.3	2000	70	2250	0.1	1400	Yes	N	19.0	3.12	3.88	6.5
QKW1921	4079	10.7 -11.7	10	41	28	6.3	0.9	2400	45	3700	0.5	2250	No	WR-75	13.3	3.75	3.8	9.2

NOTES: 1. All tubes periodic-permanent-magnet focusing. 2. Tubes normally furnished with flying leads.

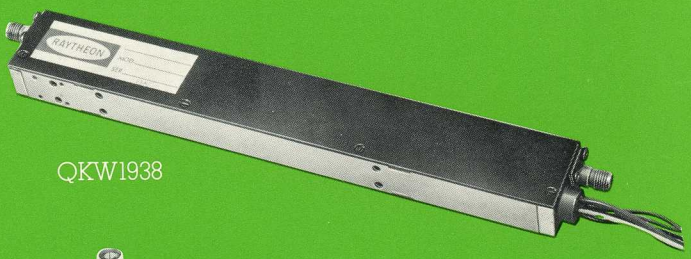
Low-Power Traveling-Wave Tubes (9.9 watts and less)

Raytheon Type Number	Replaces RCA Type	Frequency Range GHz	RF Output Saturated W	Gain (Small Signal) dB	Noise Figure dB	Heater Voltage V	Heater Current A	Collector Voltage V	Collector Current mA	Helix Voltage V	Helix Current mA	Anode Voltage V	Control Grid	RF Connector	Dimensions (Excludes Connectors) inches L	Dimensions (Excludes Connectors) inches W	Dimensions (Excludes Connectors) inches H	Weight Approx. lbs.	Application
QKW1903	A1381	2.0 - 3.85	0.02	35	—	6.3	0.7	550	4.0	400	1.0	200	Yes	SMA	12.3	1.56	1.56	2.0	
QKW1904	A1384	2.0 - 3.85	1.0	37	—	6.3	1.4	1200	34.0	1000	2.0	1100	No	SMA	13.0	1.69	1.31	3.0	L
QKW1923	A1310	2.0 - 6.0	3.0	40	30	6.3	1.3	900	45.0	1600	0.5	1300	No	TNC	15.4	1.87	2.0	3.0	
QKW1927	A1468*	2.5 - 8.5	2.0	38	28	6.3	1.0	1500	30.0	2100	2.0	1600	Yes	SMA	14.0	1.5	1.65	3.3	
QKW1926	A1358	3.0 - 8.0	2.0	35	30	6.3	1.3	900	45.0	2000	2.0	1000	No	TNC	15.2	1.87	2.0	3.0	
QKW1905	A1382*	3.85- 7.4	0.003	30	20	6.3	0.24	650	0.3	470	0.3	300	Yes	SMA	12.0	1.5	1.5	1.6	
QKW1906	A1385	3.85- 7.4	0.1	38	—	6.3	0.29	950	8.0	830	1.0	800	No	SMA	13.0	1.25	1.25	1.6	L
QKW1916	A1360*	4.0 - 8.0	0.01	35	15	6.3	0.24	720	1.0	670	0.1	300	No	TNC	12.0	1.5	1.6	2.0	
QKW1929	A1379	7.0 -11.0	0.03	30	—	6.3	0.24	1350	3.0	1200	2.8	350	Yes	½ RG-320	13.0	4.0	2.5	5.0	L
QKW1919	A1438*	7.0 -16.0	0.003	35	15	6.3	0.20	1150	0.5	1050	0.1	350	Yes	SMA	12.0	1.25	1.25	1.6	
QKW1907	A1383*	7.4 -12.0	0.005	33	20	6.3	0.24	1050	0.5	900	0.1	350	Yes	SMA	12.0	1.5	1.5	1.6	
QKW1908	A1386	7.4 -12.0	0.2	40	—	6.3	0.2	950	12.0	1800	0.5	1050	No	SMA	13.1	1.25	1.25	1.6	L
QKW1920	A1476*	8.0 -16.0	0.5	55	—	6.3	0.3	2300	11.0	2300	1.0	1000	Yes	SMA	14.0	1.0	1.0	1.6	L
QKW1918	A1360V2	4.0 - 8.0	0.01	35	15	6.3	0.24	720	1.0	670	0.1	300	No	TNC	12.0	1.25	1.6	2.0	
QKW1917	A1301V3	2.0 - 4.0	1.0	35	—	6.3	1.4	1200	34.0	1000	4.0	1050	No	SMA	13.0	1.6	1.31	3.0	L
QKW1915	A1301V4	2.0 - 4.0	1.0	35	—	6.3	1.4	1200	34.0	1000	4.0	1050	No	TNC	13.0	1.6	1.31	3.0	L

NOTES: 1. Types marked with asterisk (*) are ceramic-metal construction. 2. All tubes periodic-permanent-magnet focusing. 3. Tubes normally furnished with flying leads.
L — Loop.

In addition to the tubes listed herein, Raytheon is developing new types to supplement the existing former RCA line. Information on classified types to meet specific program requirements is also available upon receipt of proper security clearance and evidence of need to know.

Complete details of any of the Raytheon line of low and medium power TWT's may be obtained through your nearest Raytheon sales office, listed on the back page of this brochure.



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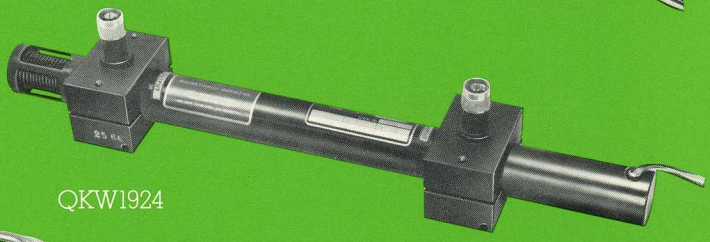

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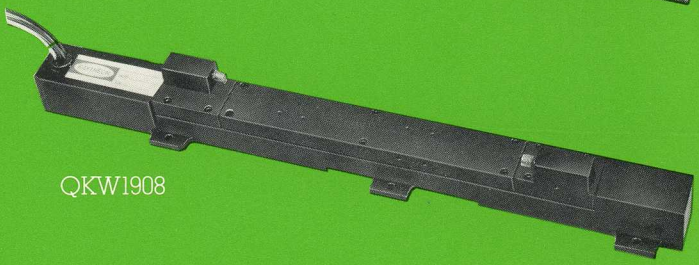

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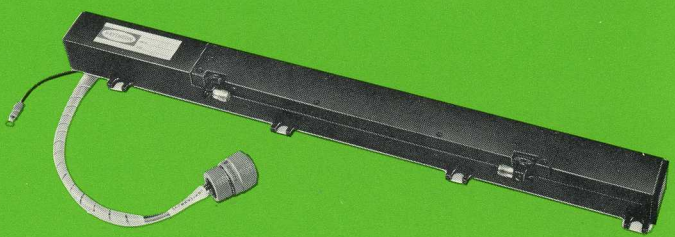

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Preliminary Data*

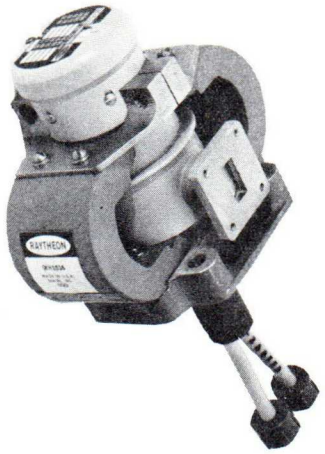
ISSUED 6/67

RAYTHEON

QKH 1516 MAGNETRON

GENERAL DESCRIPTION

The QKH1516 is a coaxial magnetron; pulse type, tunable over the 16.6 to 17.1 GHz frequency range. The QKH1516 delivers 40 kilowatts nominal peak power output, has an integral magnet, and is air cooled. It has been designed primarily for airborne radar applications requiring ruggedization.

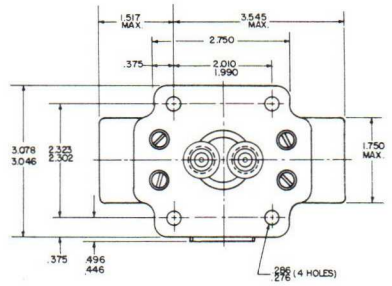


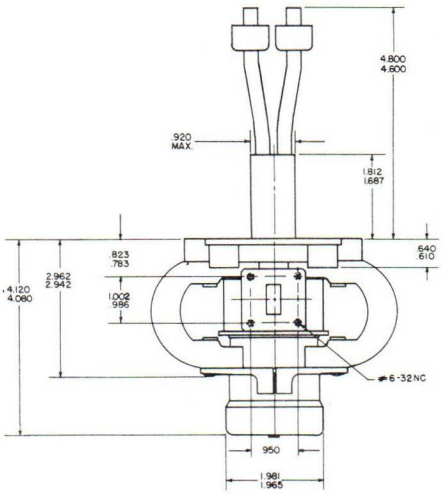
ABSOLUTE RATINGS

Duty Factor	.001
Current pulse width	0.1 to 1 us
Rate of rise of voltage	130 Kv/us
VSWR	1.5
Pulse voltage	14 KV
Peak current	11 a
Input bushing pressure	12 to 45 psia
Output waveguide pressure	12 to 45 psia
Anode (body) temperature	150 °C
Operating vibration	10g, 5 to 500 Hz

TYPICAL OPERATION

Duty factor	.001
Current pulse width	0.2 us
Rate of rise of voltage	120 Kv/us
VSWR	Isolator
Pulse voltage	11 to 13 KV
Peak current	9.5 a
Peak power output	40 Kw
Spectrum characteristics: Bandwidth (6 db)	6 MHz
Minor lobes	9 db
Missing pulse stability	less than 0.25%
Standby filament current (at 12.6 volts)	1.5 to 2 A
Operate filament voltage	8 v
Frequency (screwdriver adjustable)	16.6 to 17.1 GHz
Weight	4.5 pounds maximum





*The specifications for this device have not been finalized. For current information contact the nearest Microwave and Power Tube Regional Sales Representative.

Printed in U. S. A.

TENTATIVE SPECIFICATIONS FOR ELECTRON TUBE TYPE RK7460

Issued: December 20, 1960: Note 3

The provisions of MIL-E-1 apply to this specification. Note 21

Description: Magnetron, 5450 to 5825 megacycles, 250 kilowatts (minimum), mechanically tunable, pulsed type, air-cooled, integral magnet, unipotential cathode.

Dependent Absolute Ratings Note 2

Parameter:	Ib	ib	Pi	pi	Du	tp
Unit:	mAdc	a	W	kw		us
Maximum:	30	30	750	750	0.0012	2.5
Minimum:	—	—	—	—	—	—
						Note 5

Independent Absolute Ratings Note 1

Parameter:	Ef	epy	tk	VSWR	Pressure
Unit:	V	kv	sec	—	psia
Maximum:	5.5	28	—	1.5	—
Minimum:	—	—	180	—	10
	Note 4			Note 7	

Parameter:	Tuner Torque	Anode T	Bushing T	Output Pressurization
Unit:	in-oz	°C	°C	psia
Maximum:	200	120	270	35
Minimum:	—	—	—	12
		Note 8	Note 8	Note 9

STORAGE, HANDLING, AND INSTALLATION

Input Bushing:	Note 8	Output Coupling:	Note 21
Mounting Support:	Note 21	Input Connections:	Note 21
Cooling:	Note 13	Vibration, Shock:	Note 11
Mounting Position:	Any	Weight:	35 lbs. Approx.
		Magnet:	Note 10

RAYTHEON COMPANY
Microwave and Power Tube Division
Waltham 54, Massachusetts

Ref.	Test	Condition	Sym.	Min.	Max.	Unit
	GENERAL TESTS					
3.1	Qualification Approval	Required for JAN Marking				
4.9.2	Dimensions	Note 21				
3.7	Marking	Raytheon RK7460				
4.5	Holding Period	t = 168 hours				
	QUALIFICATIONS TESTS					
4.9.8	Salt Spray Corrosion	Omit				
4.9.19.2	High-Frequency Vibration	No Voltage				
---	Shock Test	Note 12; G = 15				
---	Anode-Cathode Capacity		C	10	17	uuf
4.9.14	Temperature Coefficient	Anode T: 50 to 120 °C F1, F3 Note 8, 15	ΔF/°C	---	-0.2	Mc
	MEASUREMENTS ACCEPTANCE TESTS - PART ONE - (PRODUCTION)					
4.9.7	Water-vaporproof Barrier	Required				
4.9.13	Pressurizing	30 psia min.				
4.10.8	Heater Current	Ef = 5.0 V tk = 180 sec. min.	If	4.5	5.4	A
4.16.3	Oscillation I					

Ref.	Test	Condition	Sym.	Min.	Max.	Unit
---	Standing Wave Ratio	VSWR = 1.1 max. except as specified herein				
4.16.3.2	Heater-Cathode Warmup Time	tk = 180 sec. max. at EF = 5.0 V; Note 4 Ef = 5.0 operate				
4.16.3.3	Pulse Characteristics	tp = 0.45 to 0.55 us Du = .000342; trv = 0.1 us (min.) to 0.7 us (max.); Note 14, 5, 6				
4.16.3.4	Average Anode Current	Ib = 8.6 mAdc				
4.10.7.3.2	Tunable Frequency		F	5450	5825	Mc
4.16.3.6	Power Output	F1: = 5450 Mc F2: = 5660 Mc F3: = 5825 Mc	Po	87	---	W
4.16.3.5	Pulse Voltage	F1	epy	23	26	kv
4.16.3.7	R.F. Bandwidth	F1, F2, F3 Note 16	BW	—	$\frac{2}{tpc}$	Mc
4.16.7.3	Starting Stability	F3; Note 20	MP	—	5.0	%
4.16.7.1	General (RF) Energy Stability	F1, F2, F3 VSWR = 1.5/1 Note 18	MP	—	0.25	%
4.16.5	Pulling Factor	F3, Note 17	ΔF	—	15	Mc
	MEASUREMENT ACCEPTANCE TEST - PART TWO - (DESIGN)					
4.9.19.1	Low Frequency Vibration	No Voltage				
	ACCEPTANCE LIFE TEST					
4.11	Life Test	Cathode Horizontal Group D, Note 19		72		Cylces

Ref.	Test	Condition	Sym.	Min.	Max.	Unit
4.11.4	Life Test End Points					
4.16.3.6	Power Output	F1, F2, F3	Po	69.0		W
4.16.3.5	Pulse Voltage	F1	epy	22	27	kv
4.16.3.7	R.F. Bandwidth	F1, F2, F3; Note 16	BW	—	2.5 tpc	Mc
4.[illegible]7.1	Stability	F1, F2, F3 VSWR = 1.5/1, Note 18	MP	—	0.5	%
	PACKAGING INFORMATION					
4.9.18.1.8	Carton Drop	Required				

1. The independent absolute ratings shall not be exceeded if the life specified herein is to be obtained. These independent absolute ratings are limiting values beyond which the serviceability of any individual tube may be impaired.

2. The dependent absolute ratings are interrelared, and it does not necessarily follow that combinations of ratings can be attained simultaneously. The provisions of 6.5 Specification MIL-E-1 shall apply in the selection of the operating point.

3. These tentative specifications are subject to revision. The tube manufacturer should be consulted with regard to details of application.

4. The maximum value specified herein is for a non-oscillating condition. Heater surge current shall not exceed 12 amperes.

5. The characteristics of the applied pulse shall be those which result in proper starting and oscillation. The rate of pulse voltage rise, the percentage of pulse voltage ripple, and the rate of pulse voltage fall shall be among the more important considerations. The manufacturer will be consulted with regard to specific applications where pulse characteristics differ from those used in this specification.

6. The pulse characteristics of Oscillation (1) shall be as follows: trv = 0.1 to 0.17 us, measured between 20 and 85 percent levels of the steepest tangent above the 50% level. No spike or ripple shall exceed ± 5% of the average peak value of voltage or current. The current pulse fall time shall not exceed 0.2 us (max.) as measured between 0 and 85 percent levels. Pulse shall be applied directly to plates of oscilloscope.

7. Frequency skipping or unstable operation may be encountered at some phase positions when the mismatch occurs at the end of a "long line".

8. The temperature shall be measured at the point shown on Drawing D-82221.

9. The gas used in pressurization shall provide insulating properties at least equal to that of clean, dry air at the pressure specified herein.

10. In handling and mounting the magnetron, care shall be taken to prevent demagnetization. Ferromagnetic materials shall not at any time be permitted to come closer than 8 inches from the magnet, except at the ends where the clearance may be 3 inches minimum. Energized magnets shall not at anytime be permitted to come closer than 12 inches from the tube magnet.

11. Care shall be used in the storage, installation, and handling of the tube to avoid imparting vibration or shock in excess of the values for which it is designed to withstand.

12. The magnetron shall be mounted on a test plate and dropped five times on each of three mutually perpendicular axes parallel to the reference planes shown on Drawing D-82221. The shock pulse shall have a duration of approximately 11 milliseconds as measured at the quarter amplitude points of the acceleration shock wave.

13. Cooling requirements, where the ambient temperature does not exceed 50°C, shall be as follows: In no case shall the temperature of the anode exceed 120°C.

Average Anode Power input watts	Air Flow c.f.m.	Back Pressure (Inches of H_2O)
0	2.5	0.06
100	7.5	.16
200	10.0	.28
300	15.0	.44
400	19.5	.63
500	24.0	.87
600	29.0	1.13

14. This test may be conducted only under one set of conditions within the limits for the oscillation specified herein.

15. Measurements of temperature and frequency shall be made after conditions of thermal equilibrium have been reached.

16. Stability shall not be measured under this test. The r.f. bandwidth shall be within the limits specified herein when a VSWR of 1.5/1.0 is introduced in the load at a distance of not greater than 0.5 meter from the magnetron coupling flange, the phase being adjusted for maximum bandwidth.

17. The pulling measurement shall be made in such a manner that thermal effects do not introduce appreciable errors.

18. Not more than the percentage of pulses specified herein shall result in r.f. output pulses, each having less than 70 percent of the energy content of a normal pulse. Missing pulses shall be counted within a range of plus or minus 1 percent of the test frequency during the last 3 minutes of a test interval not to exceed 6 minutes. Observations shall be made for the load phase position corresponding to maximum missing pulses.

19. The VSWR shall be 1.5/1.0. The interpretation of the value of the VSWR shall be as specified in paragraph 4.16.5 of Specification MIL-E-1. The standing wave introducer shall be cycled continuously through a line length approximately 1/2 wavelength long at an approximate rate of 4 cycles per hour. Application of operating voltages shall be in accordance with the following cycle:

a)	Cathode preheat	-3 minutes
b)	Pulse voltage	-7 hours
c)	Off	-57 minutes

The frequency shall be changed at the start of each running period and shall be cycled between 5450 mc., 5525 mc, 5675 mc, 5750 mc, and 5825 mc, spending one 7-hour period at each frequency.

20. Immediately after the non-operational holding period and after a 180 second heater warm-up time, the anode voltage as specified in Oscillation (1) shall be instantaneously applied and the magnetron missing pulse count shall not exceed 5% over the first minute of operation. A missing pulse is defined as an r.f. pulse whose average energy is 70% or less than that of a normal pulse.

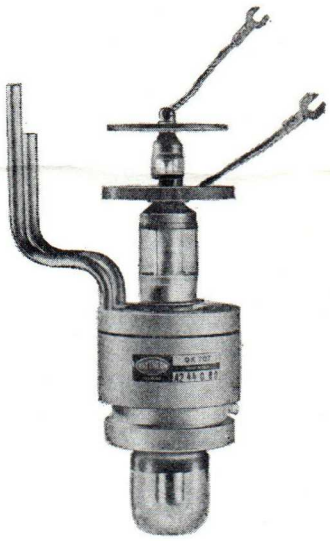
21. The following drawing forms a part of these specifications:

Electron Tube, Raytheon D-82221.

PRODUCT SPECIFICATIONS

QK 707

The QK707 is a fixed frequency microwave oscillator designed to operate on an a.c. anode supply in the 2425-2475 Mc region with an average power output of 1000 watts. It is water cooled, and requires an electromagnet. The tube is designed for coupling to a 2,15 × 3,75 inch waveguide, and has been especially designed for microwave heating and cooking applications.



Made in Italy under Raytheon - licence

GENERAL CHARACTERISTICS

ELECTRICAL

Heater

Heater Voltage	9,3 V
Heater Current	30,5 - 35,5 A
Preheat Time	3 minutes

Maximum Ratings

Heater Voltage	10.0 V
Peak Anode Voltage	6.3 kv
Peak Anode Current	1.4 amps
Average Anode Current	290 mAdc
Electromagnet Current	1000 mAdc (■)
Anode Temperature	100°C
Cathode Bushing Temperature	300°C
VSWR	4/1

A decreased life expectancy must be anticipated if the QK707 is operated at or near its maximum ratings for extended periods.

(■) This value is for the electromagnet that can be supplied with the magnetron.

Typical Operation

Heater Voltage	9.3 V ± 5 %
Peak Anode Voltage	6.3 kv
Average Anode Current	275 mAdc
Average Power Output at 275 mAdc	1000 W
VSWR	2/1
Frequency	2425-2475 Mc

MECHANICAL

Mounting	Cathode vertical
Net Weight	4 Lbs. (1.800 kg) approx.
Overall dimensions	See Outline Dwg.
Cooling	Water.
Output Coupling	As per drawing Fig. 5

DETAILED ELECTRICAL INFORMATION

HEATER

The cathode should be heated at Ef.= 9.3 V ± 5 % for at least 3 minutes prior to the application of anode high voltage.

Heater voltage is measured at the heater terminals of the filter box. Voltage measured at any other point may be significantly in error due to the drops occurring in the line, the R.F. filter and other components in the heater circuit. Fig. 1 is a plot of heater current as a function of heater voltage.

OPERATION

The QK707 is designed to operate at an a.c. power supply of 6,3 peak kvolt. Normal anode current for most operation is in the order of 275 milliemperers, although satisfactory operation anywhere between 225 and 290 milliamperes may be obtained.

The power output can be increased by supplying the magnetron with rectified current; further information may be obtained from Raytheon - Elsi Applications Engineering.

R. F. LOAD

The performance and life of the QK707 will depend to a large extent on the nature of the load it operates into. Mismatched loads causing VSWR's in excess of 4/1 affect tube life and performance adversely.

COOLING

The magnetron in cooled with water circulation which operates in closed cycle. The water flow is dependent on water temperature at the magnetron input, and flows at the rate of approx. 1 liter/ minute.

R. F. NOISE RADIATION

Some R.F. radiation from the cathode stem of all magnetrons is inherent in their design and is troublesome only insofar as conformity to different national radiation regulations is concerned. Incorporation of the filter shown in fig. 2 in the design of the equipment should avoid any difficulties. This filter is in production and is supplied as a package with the electromagnet.

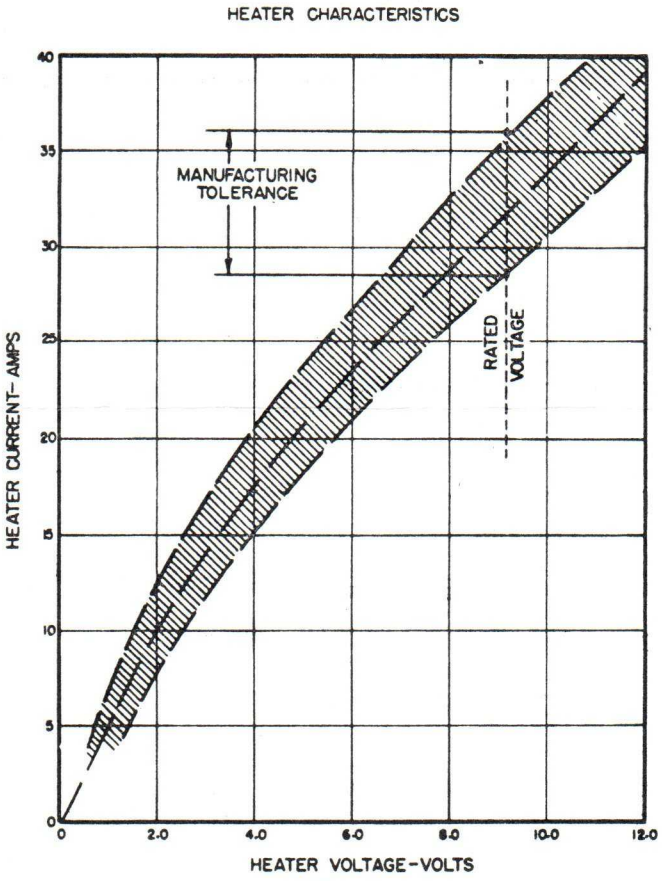


Fig. 1

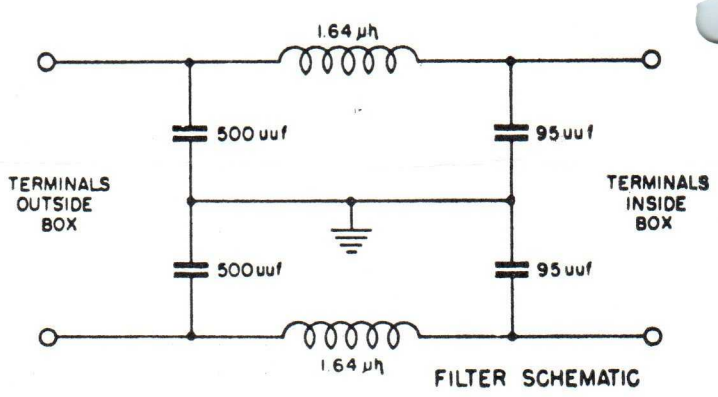
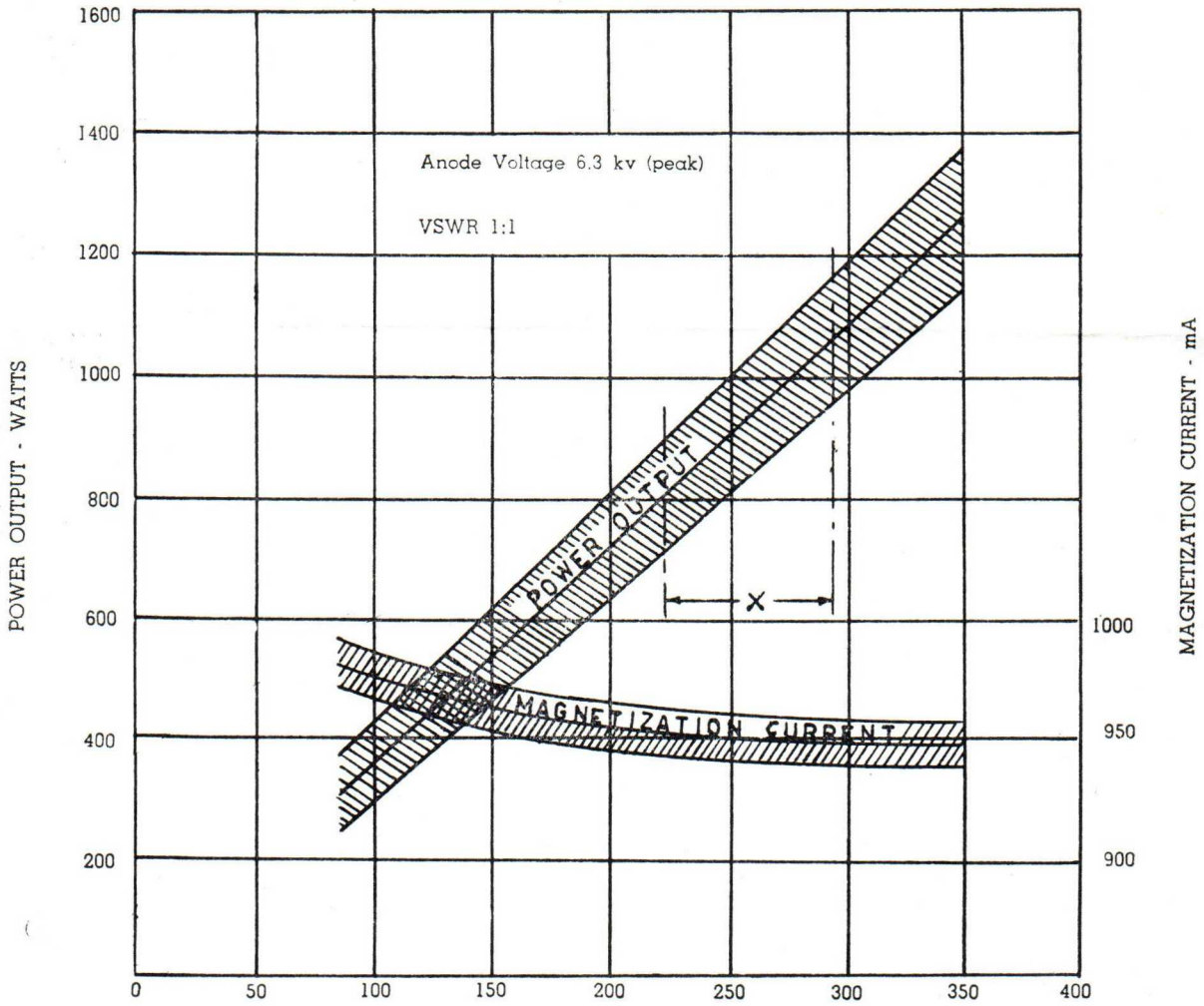


Figure 2

OPERATING CHARACTERISTICS

Figure 3 is a plot of average power output and magnetization current vs. average anode current.



(X) Recommended Operating Range

Figure 3

DETAILED MECHANICAL INFORMATION

The detailed mechanical dimensions for the QK707 are given in Figure 4. These dimension should be used in the mechanical layout of an equipment rather than those of a sample tube.

QK 707 ELECTRON TUBE OUTLINE DRAWING

NOTES:

1. Reference plane «A» is defined as a plane passing along the face of the mounting surface.
2. With this surface resting on a plane surface, the flatness for a distance of .500 (12,7) from the edge shall be such that a .005 (.12) thk. gage - .125 (3.17) wide shall not enter.
3. Water passages to be free of foreign matter.
4. These pipes are long and short as indicated.
5. All parts within this area must pass a gage having a 3.001 (76.2) inside dia.
6. These diameters shall simultaneously accept a gage having inside step dia's of 1.781 (44.12), 2.710 (68.83), and 3.125 (79.37) respectively.
7. Common cathode connection.
8. Heater connection.
9. This dia. is defined as a dia. passing through the center of ref. dia. Z and the center of the pin.
10. Shippin guard.
11. «Anode temperature» ⅛ (3.17) above antenna pole ring.
12. «Cathode terminal temperature» just above cathode bushing.
13. «Heater terminal temperature» on top of tube.
14. Connector to fit a #10 screw.
15. This surface to be parallel with ref. plane «A» within .050 (1.27).

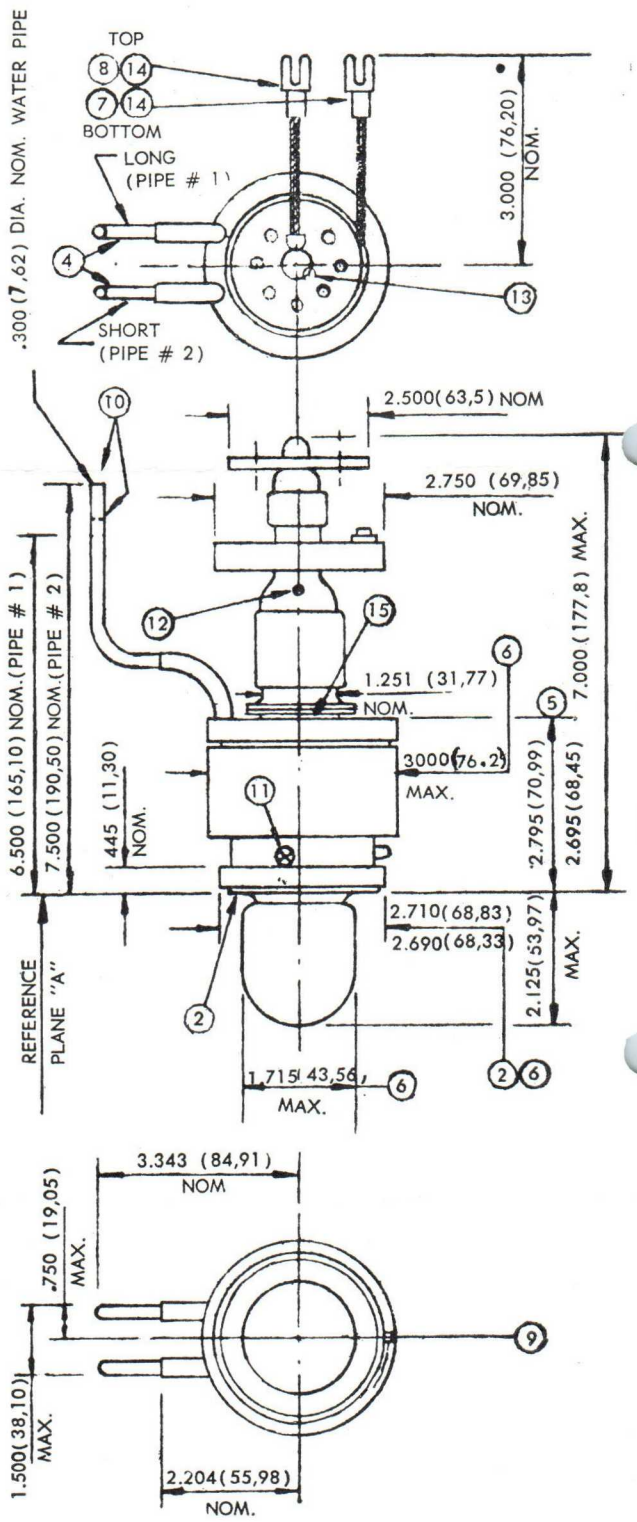


Figure 4

(Dimensions in ( ) expressed in mm.)

RAYTHEON

INSTALLATION AND HANDLING PRECAUTIONS

Although a magnetron lends the appearance of being structurally strong and capable of rough handling, its critically aligned parts; and glass components make it in reality quite fragile. Unnecessary jarring or rough handling may destroy, the alignment or crack the glass and make the tube unsorvicoable.

Parts of the cathode assembly exhibit considerable plasticity at normal operating temperatures and may be deformed if tube is handled while hot. It is recommended that the tube be allowed to cool ten minutes after the heater is turned off before handling. Failure to observe this precaution may result in permanent damage to.the tube.

MOUNTING

The tube mounting plate mates with the mounting flange on the waveguide coupling section as shown in Figure 5. The waveguide should be so oriented that the cathode bushing is vertical when the tube is mounted. Satisfactory performance for experimental purposes will be obtained using a standard JAN-RG-104/U waveguide 4.300 x 2.150 inches (109.22 x 54.61). Use of the standard waveguide requires the dimensions between the shorted end of the guide and the center of magnetron output dome be 3.460 at .003 inches (87.88 ± .007) rather than 3.721 — 3.736 inches used (94.51 — 94.90) with the Raytheon waveguide. See Figure 6.

COUPLING TO THE R.F. OUTPUT SYSTEM

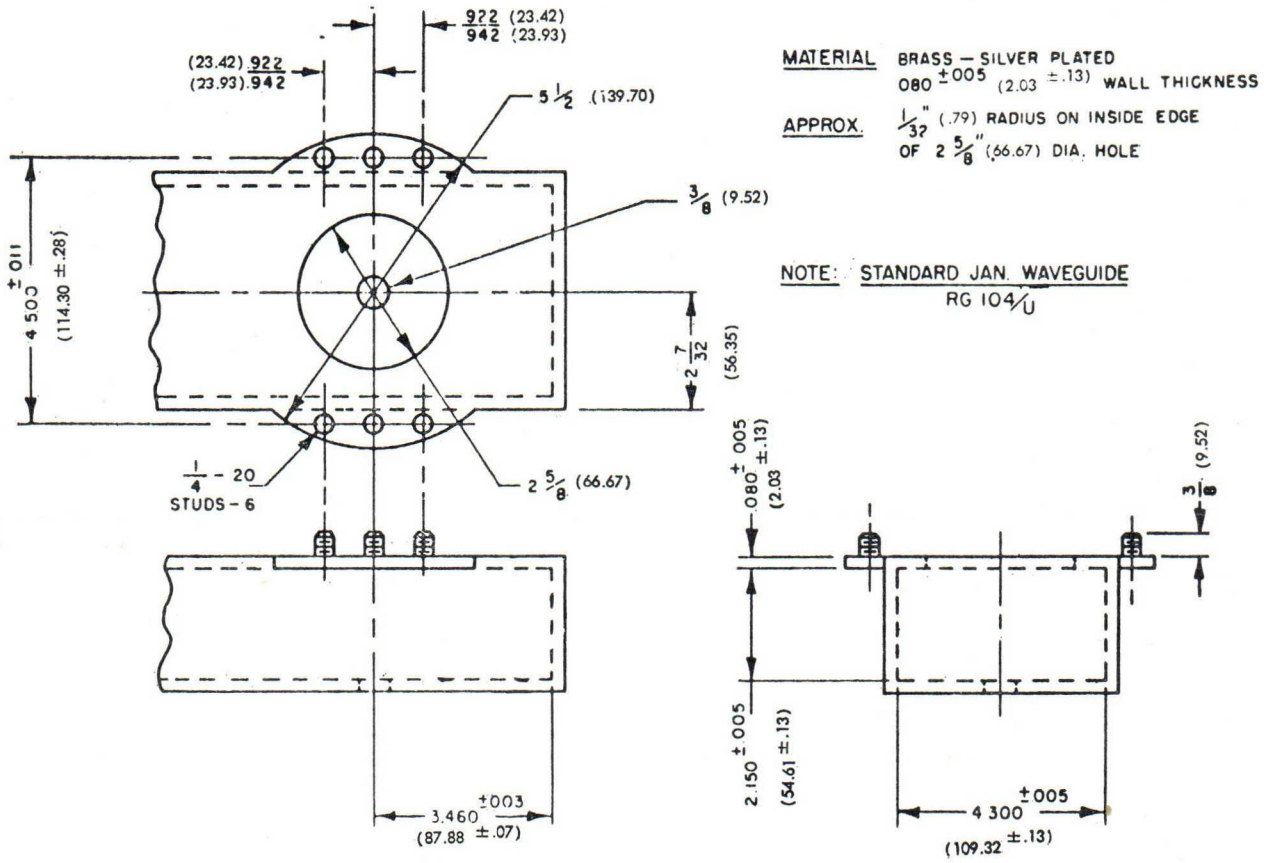


Figure 5

(Dimensions in ( ) expressed in mm.)

COUPLING TO THE R.F. OUTPUT SYSTEM

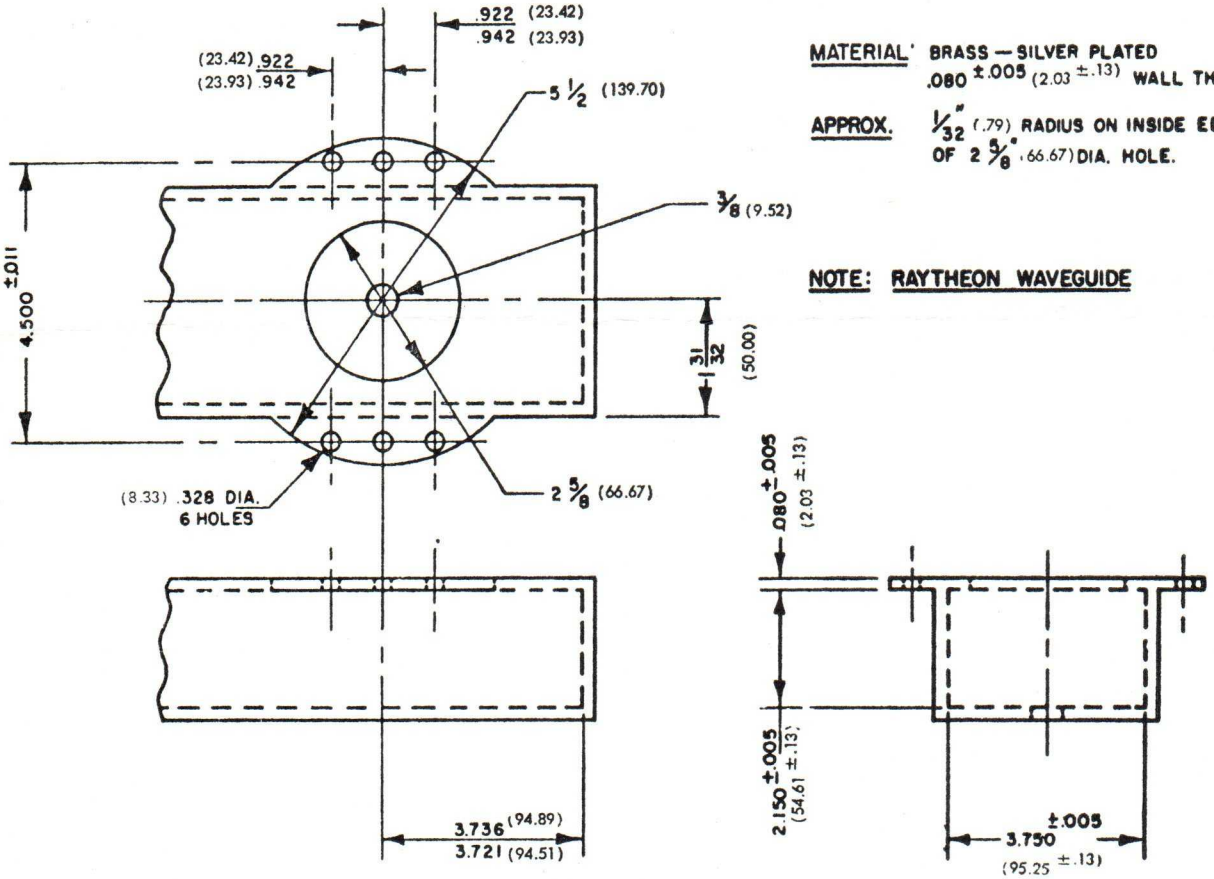


Figure 6.

(Dimensions in ( ) expressed in mm.)

ELECTRICAL CONNECTIONS

Electrical connections are made to the frame of the tube and to the terminal posts projecting from the filter box. Positive high voltage is grounded to the frame preferably at the mounting plate. The unmarked terminal post is connected to one side of the heater power supply, while the other terminal, marked with a "K", serves as a common connection for the remaining heater and cathode negative high voltage leads.

MIL-E-1/1002A(NAVY)
28 November 1958
SUPERSEDING
MIL-E-1/1002(NAVY)
9 December 1955

INDIVIDUAL MILITARY SPECIFICATION SHEET

ELECTRON TUBE, TYPE 2J42H

The requirements and tests of the latest issue of Specification MIL-E-1 shall apply, except as otherwise required herein.

Description: Magnetron, 7 peak kilowatts minimum, fixed frequency, 9345 to 9405 megacycles, pulse type, air-cooled, integral magnet.

Absolute ratings

Independent: Parameter:	Note 18 Ef	epy	tk	VSWR	Anode Temp.	Output Pressurization	Input Bushing Pressurization
Units:	V	kv	sec		°C.	p.s.i.a.	p.s.i.a.
Maximum:	7.0	6.0	---	1.5	120	45	45
Minimum:	--- Notes 1 and 2	---	120 Notes 1 and 2	--- Note 6	--- Note 7	0.97 Note 8	0.97 Note 8

Dependent: Parameter:	Note 17 ib	Pi	pi	Du	tp
Units:	a	W	kw		us
Maximum:	5.5	70	35	0.002	2.5
Minimum:	3.7	--	--	-----	Note 3

tpc us	rrv kv/us		tfv us
Min.	Min.	Max.	Max.
0.4	65	85	0.5
1	65	75	.5
2	65	75	.5

Cooling: Notes 7 and 16
Magnet Isolation: Note 9
Mounting position: Any
Cathode: Oxide coated, unipotential
Output coupling: Per figure 1, Note 6

Mounting Support: As shown on figure 1
Vibration: Note 10
Weight: Approx. 3 pounds
Input connections: As shown on figure 1

Ref.	Test	Conditions	Sym.	Limits Min.	Limits Max.	Units
3.1	Qualification approval:	Required; Note 22				
3.7	Marking:	Note 11				
4.5	Holding period:	t=168 hours				
4.19.18	Container drop:	Required, Note 21				
4.9.19.1	*Vibration:	No voltage				
4.9.19.2	**Vibration:	No voltage				
4.9.2	Dimensions:	Per figure 1				
4.10.8	Heater current:	Ef=6.3 V, tk=180 (min.)	If:	0.43	0.60	A
4.16.3	Oscillation(1):	VSWR=1.1 except where noted				
4.16.3.2	Heater cathode warm-up time:	Ef=6.3 V; Note 2 Ef=6.0 V for test				
4.16.3.3	Pulse characteristic:	tp=0.4 to 0.5 μs Du=0.00036; Notes 3 and 19; rrv=65 to 85 kv/μs, tfv=0.3 to 0.5 μs				
-------	Peak anode current:	ib=4.5 a				
4.16.3.5	Pulse voltage:		epy:	5.0	5.55	kv
4.16.3.6.2	Power output:	t=300 sec (max.)	Po:	2.5	4.0	W
4.10.7.3.1	Fixed frequency:	Anode temperature 40°C. ±10°C.	F:	9345	9405	Mc
4.16.3.7	R.F. bandwidth:	Notes 14 and 15	BW:	----	2.0 tpc	Mc
4.16.5	Pulling factor:		ΔF:	----	20	Mc
4.16.7	*Stability:	ib=4.5 a Notes 12 and 13	MP:	----	0.25	%
-------	*Low pressure operation:	Osc. (1); Note 4				
4.9.14	**Temperature coefficient:	Anode T=40°C. to 70°C.; Note 7	ΔF/°C:	----	0.25	Mc

Ref.	Test	Conditions	Sym.	Limits Min.	Limits Max.	Units
4.9.15	**Low temperature operation:	Notes 2, 12 and 13; Stability	MP:	----	0.25	%
-------	Cycled life test:	Group D; Note 20		250	----	Cycles
4.11.4	Life test end point:	Note 5				
	Power output:	Osc (1)	Po:	2.0	----	W
	Bandwidth:	Osc (1)	BW:	----	2.5 tpc	Mc
	Stability:	Osc (1); Notes 12 and 13	MP:	----	0.5	%
5.1	Preparation for delivery:	To be packaged in container size A in accordance with Specification MIL-E-75/1; Container drop test(i) in accordance with Specification MIL-E-75, Note 21				

Note 1: The maximum value specified herein is for nonoscillating conditions. Heater surge current shall not exceed 3 amperes.

Note 2: The cathode heater time shall be a minimum of 120 seconds at an ambient temperature greater than 0°C. and a minimum of 180 seconds at a temperature between 0° and -55°C. The heater voltage shall be reduced within 3 seconds after applying pulse voltage according to the following formula:

$$Ef = 6.3 (1 \text{ minus } 0.03 Ib) \text{ volts}$$

Where Ib = mAdc

Note 3: The rate of rise of voltage (rrv) shall be the slope of the steepest tangent to the leading edge of the magnetron voltage pulse above 80 percent amplitude. The fall time of the voltage pulse (tfv) shall be measured between 0 and 85 percent amplitude.

Note 4: The tube shall be operated in a chamber evacuated to simulate pressure conditions of 60,000 feet altitude (50 mm. Hg absolute). The VSWR shall be 1.3 minimum, varying through all phases. There shall be no evidence of arc-overs during this test.

Note 5: The tube shall pass all applicable production tests at the end of the life test specified herein, with the condition that the criteria for acceptance be modified in accordance with the life test end points specified herein.

Note 6: Frequency skipping or unstable operation may be encountered at some phase positions when the mismatch occurs at the end of a "long line".

Note 7: The temperature shall be measured at the point shown on figure 1.

Note 8: The gas used in pressurization shall provide properties at least equal to that of the clean dry air at the pressure specified herein.

Note 9: In handling and mounting the magnetron, care shall be exercised to prevent demagnetization. Ferromagnetic materials and energized magnets shall not be brought within 2 inches of the tube.

Note 10: Care shall be taken in the storage installation and handling of the tube to avoid imparting vibration or shock in excess of the values which it is designed to withstand.

Note 11: Tubes shall be marked "USN-2J42H".

Note 12: This test shall be performed into a 1.5/1 VSWR adjusted in phase to produce maximum instability.

Note 13: Stability shall be measured in terms of the average number of output pulses missing expressed as a percentage of the number of input pulses applied during the period of observation. Pulses shall be considered to be missing if, due to any cause, the r.f. energy is less than 70 percent of the normal energy level in the frequency range of 9345 to 9405 megacycles. The percentage of missing pulses (MP) shall not exceed the amount specified herein during the last 3 minutes of a test interval not exceeding 6 minutes. The stability test shall be started 60 seconds after high voltage is applied.

Note 14: The magnetron current shall be adjusted between 3.7a and 5.5a for widest spectrum.

Note 15: Stability shall not be measured under this test. The r.f. bandwidth shall be within the limits specified herein when a VSWR of 1.5/1.0 is introduced in the load at a maximum distance of 0.4 meter from the magnetron coupling flange, the phase adjusted to produce maximum spectrum degradation.

Note 16: The anode shall be cooled to the temperature specified herein by a suitable flow of air over the anode body.

Note 17: Caution: The dependent absolute rating limits are interrelated, and it does not necessarily follow that combinations of limits can be attained simultaneously. The provisions of paragraph 6.5 of Specification MIL-E-1 shall apply in the selection of the operating point.

Note 18: The independent absolute ratings shall not be exceeded. These independent absolute ratings are limiting values beyond which the serviceability of any individual tube may be impaired.

Note 19: This test shall be conducted under one set of conditions within the limits for the oscillation specified herein.

Note 20: The conditions for cycled life test shall be as follows:

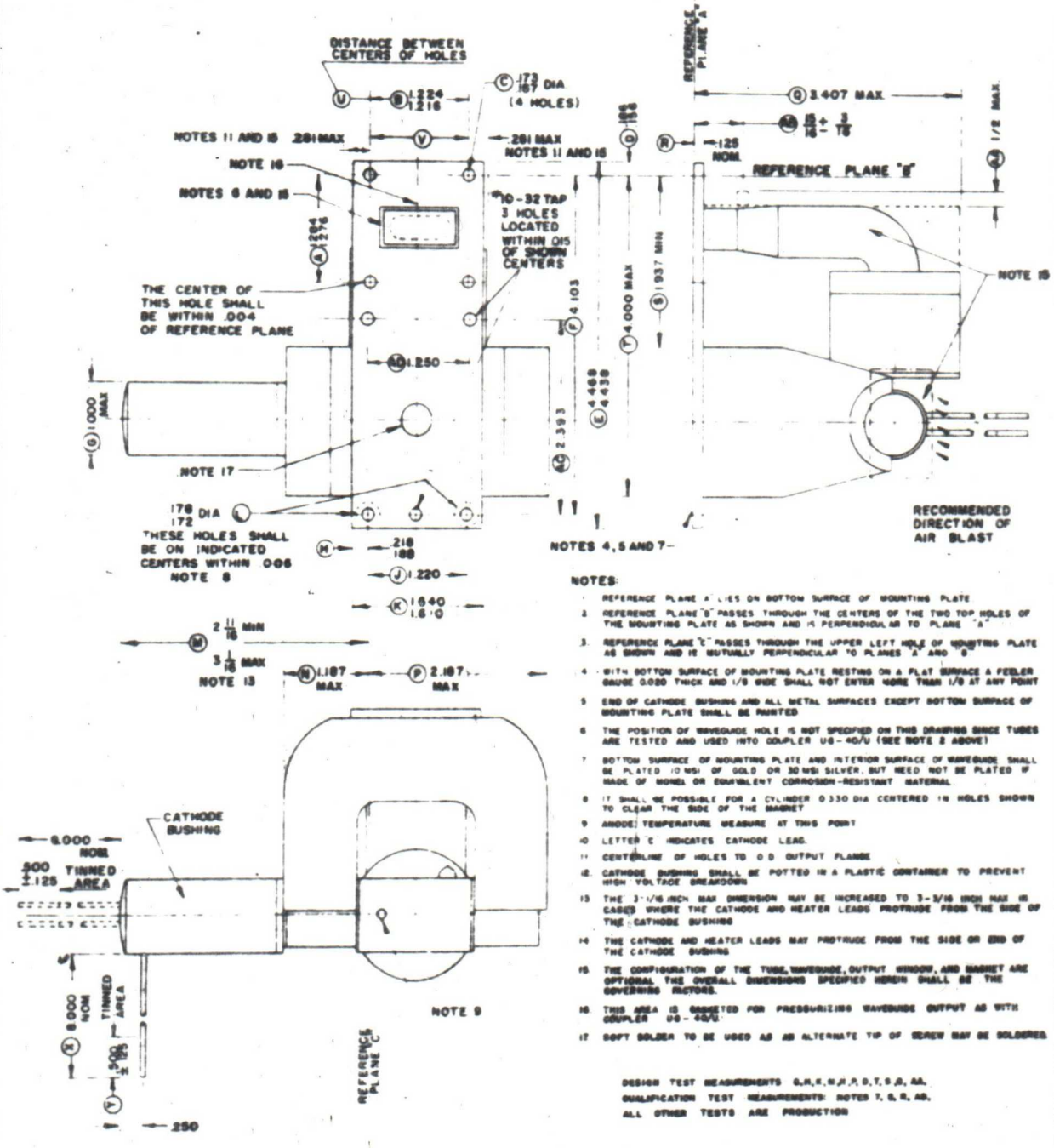
Condition	ib	Ef	Duration
Standby	0	6.3	2 minutes
Osc (1)	4, 5a	6.0	1 hour
Off	0	0	13 minutes

Note 21: Not required for qualification approval of the product.

Note 22: Qualification - With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in Qualified Products List QPL-1, whether or not such products have actually been so listed by that date.

The attention of suppliers is called to this requirement, and manufacturers are urge to arrange to have the products that they propose to offer to the Federal Government, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products covered by this specification may be obtained from the Chief of the Bureau of Ships, Department of the Navy, Washington 25, D. C.

Preparing activity:
Navy - Bureau of Ships
(Project 5960-0070N)



NOTES:

1. REFERENCE PLANE A LIES ON BOTTOM SURFACE OF MOUNTING PLATE
2. REFERENCE PLANE "B" PASSES THROUGH THE CENTERS OF THE TWO TOP HOLES OF THE MOUNTING PLATE AS SHOWN AND IS PERPENDICULAR TO PLANE "A"
3. REFERENCE PLANE "C" PASSES THROUGH THE UPPER LEFT HOLE OF MOUNTING PLATE AS SHOWN AND IS MUTUALLY PERPENDICULAR TO PLANES "A" AND "B"
4. WITH BOTTOM SURFACE OF MOUNTING PLATE RESTING ON A FLAT SURFACE A FEELER GAUGE 0.020 THICK AND 1/8 WIDE SHALL NOT ENTER MORE THAN 1/8 AT ANY POINT
5. END OF CATHODE BUSHING AND ALL METAL SURFACES EXCEPT BOTTOM SURFACE OF MOUNTING PLATE SHALL BE PAINTED
6. THE POSITION OF WAVEGUIDE HOLE IS NOT SPECIFIED ON THIS DRAWING SINCE TUBES ARE TESTED AND USED INTO COUPLER UG-40/U (SEE NOTE 2 ABOVE)
7. BOTTOM SURFACE OF MOUNTING PLATE AND INTERIOR SURFACE OF WAVEGUIDE SHALL BE PLATED 10 MSI OF GOLD OR 30 MSI SILVER, BUT NEED NOT BE PLATED IF MADE OF MONEL OR EQUIVALENT CORROSION-RESISTANT MATERIAL
8. IT SHALL BE POSSIBLE FOR A CYLINDER 0.330 DIA CENTERED IN HOLES SHOWN TO CLEAR THE SIDE OF THE MAGNET
9. ANODE TEMPERATURE MEASURE AT THIS POINT
10. LETTER "C" INDICATES CATHODE LEAD.
11. CENTERLINE OF HOLES TO O.D. OUTPUT FLANGE
12. CATHODE BUSHING SHALL BE POTTED IN A PLASTIC CONTAINER TO PREVENT HIGH VOLTAGE BREAKDOWN
13. THE 3-1/16 INCH MAX DIMENSION MAY BE INCREASED TO 3-3/16 INCH MAX IN CASES WHERE THE CATHODE AND HEATER LEADS PROTRUDE FROM THE SIDE OF THE CATHODE BUSHING
14. THE CATHODE AND HEATER LEADS MAY PROTRUDE FROM THE SIDE OR END OF THE CATHODE BUSHING
15. THE CONFIGURATION OF THE TUBE, WAVEGUIDE, OUTPUT WINDOW, AND MAGNET ARE OPTIONAL. THE OVERALL DIMENSIONS SPECIFIED HEREIN SHALL BE THE GOVERNING FACTORS.
16. THIS AREA IS SUBJECTED FOR PRESSURIZING WAVEGUIDE OUTPUT AS WITH COUPLER UG-40/U.
17. SOFT SOLDER TO BE USED AS AN ALTERNATE TIP OF SCREW MAY BE SOLDERED.

DESIGN TEST MEASUREMENTS G,H,K,M,N,P,Q,T,U,Z, AA.
QUALIFICATION TEST MEASUREMENTS: NOTES T, U, Z, AB.
ALL OTHER TESTS ARE PRODUCTION

Figure 1 - Dimensions, mounting support, output couplings and input connections of electron tube, type 2J42H.

RAYTHEON

MINIATURE DUAL GUN STORAGE TUBE

QV–286

DEVELOPMENTAL

The QV 286 is a high resolution dual gun electronic input and output storage tube. Its storage medium is a semiconductive target, and the tube operates on the "bombardment–induced–conductivity" principle.

The tube is capable of receiving and writing a signal in one scanning mode and generating a separate electronic output signal which may be read in another scanning mode and/or time base. The tube also incorporates an electrostatic erase electrode to permit fast complete erasure of the target. No dynamic focus or crosstalk cancellation is required.

The small size of this scan converter tube makes it particularly useful in scan conversion applications for Airborne and Space vehicles. The major application is scan conversion of radar PPI to television type presentation. The electrical output signal would be fed to a television type monitor and this would yield a bright video display with high resolution and automatic erasing characteristics.

The design of the tube results in a wide dynamic range of grey shades, fast writing speeds, and selective erasure of stored information, if this is desired.

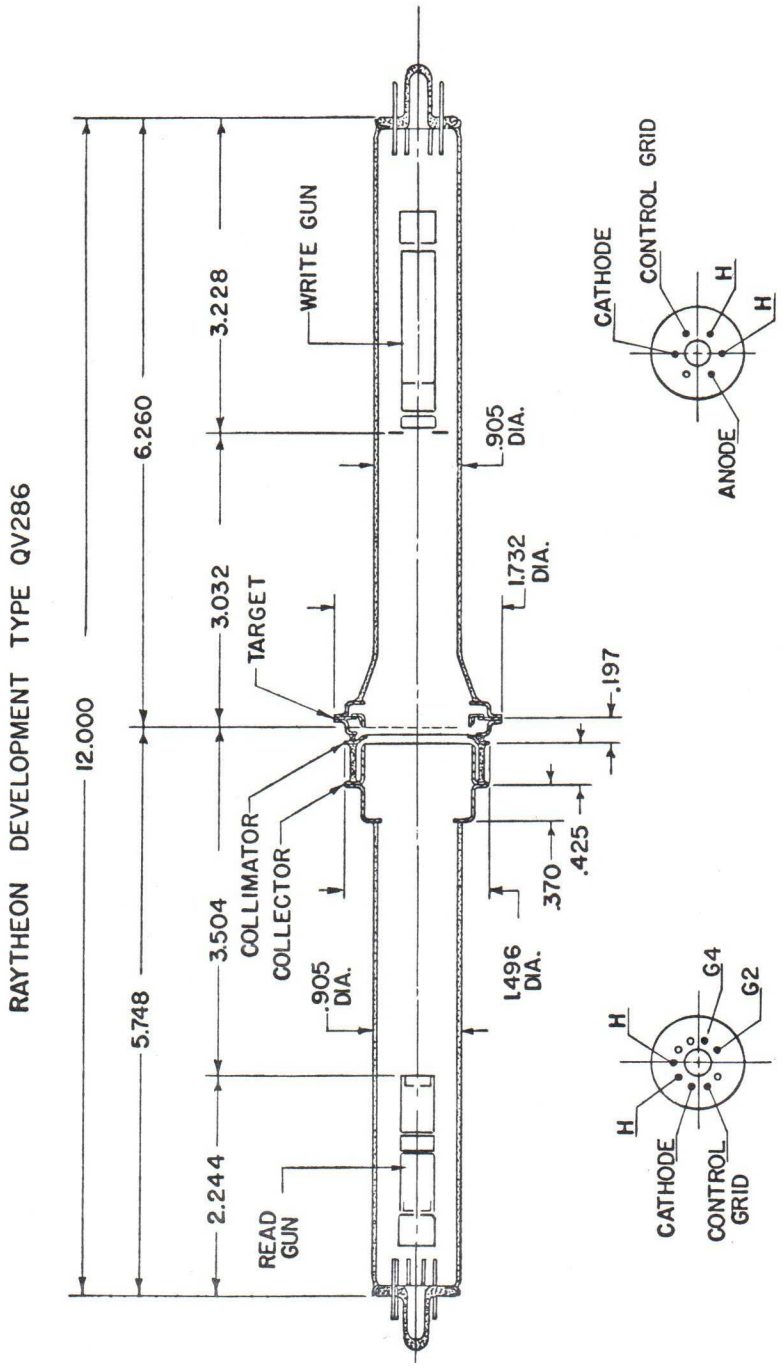
ELECTRICAL DATA

GENERAL CHARACTERISTICS:

Gun locations	Co–axial
Deflection (Both Guns)	Magnetic
Focusing (Read Gun)	Magnetic
Focusing (Write Gun)	Electrostatic or Magnetic
Resolution	125 range rings/dia. at 50% amplitude modulation or 600 television lines (for orthogonal write and read)
Grey levels	Comparable to TV presentation, 5 levels minimum
Signal/Noise	15:1 – 80:1, depending on storage time and bandwidth
Storage range	From 1/30 sec. to 2 min.
Operating position	Any, if vertically mounted, write gun should be up
Erase time	2 sec. maximum at max. storage setting
Signal currents	Output $\sim$ 2 μA
Output capacitance	8 $\mu\mu$f (approx)

ELECTRICAL CHARACTERISTICS:

Write Gun	
Cathode to anode & target voltage	–6000 to 8000 V
E_{G_1} (for I beam cut–off)	–70 to –110 V
Read Gun	
Cathode to anode voltage	–1100 to –1300 V
Control grid to cathode voltage	–100 to 0 V
Cathode current for 1 μA read beam	110 μA
Target Assembly	
Target to ground voltage	0
Collector to target voltage	–100 to +100 V
Useable target diameter	28 mm (1.1")



All data is the result of preliminary measurements and is subject to change or abandonment without prior notice.

RAYTHEON

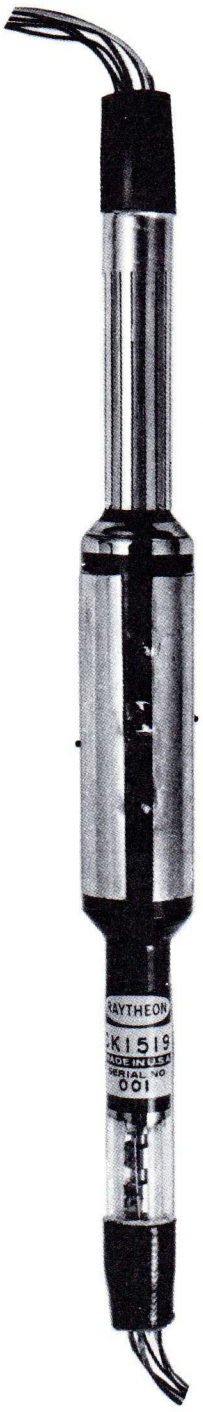
MINIATURE RECORDING STORAGE TUBE

CK1519

The CK1519 is a miniature dual–gun cathode–ray recording storage tube capable of simultaneous writing and reading. It is an electronic input–electronic output storage device which combines high output signal with high resolution. The major application is scan conversion in airborne equipment, such as sonar, infrared and radar to television type presentation. This type of system yields a bright video display, with high resolution and adjustable automatic erasing. Stored signals can be held for a long period, read several thousand times, or erased in a fraction of a second if desired. The storage capabilities permit additional coherence of target information under conditions of high noise levels.

Both the writing and reading guns use magnetic deflection and magnetic focus. For uniform resolution over the storage surface, dynamic focus correction is recommended.

The design of the tube results in a wide dynamic range of gray shades, fast writing speeds, and selective erasure of the stored information if desired. Erasure of stored information can be carried out by either the reading or writing gun.



ELECTRICAL DATA

GENERAL CHARACTERISTICS

Gun Locations	Co–axial
Gun Type (Both Guns)	Tetrode High Resolution
Deflection (Both Guns)	Magnetic
Max. Deflection Angle (Both Guns)	20°
Focusing	Magnetic
Mounting Position	Any
Resolution	
TV lines per diameter (See Note 1)	850 TV lines typical
Output Capacitance	
(Collector and Write Decelerator to all other elements)	5 pf (approx.)
Erasing Technique	By Switching or Automatic

MECHANICAL CHARACTERISTICS

Seated Length	16½" Nominal
Bulb Diameter	1.5" Maximum
Neck Diameters	0.875" Maximum
Storage Assembly Buttons	JEDEC Type J1–22

ELECTRICAL CHARACTERISTICS

RATINGS – ABSOLUTE MAXIMUM VALUES (See Note 2)

Heater Voltage	6.3 ± 5% Volts
Anode Voltage (Either Gun)	4500 Vdc
Grid Voltage Positive (Either Gun)	0 Vdc
Write Control Grid Voltage Negative	–150 Vdc
Read Control Grid Voltage	–275 Vdc
Write Grid #2 Voltage	500 Vdc
Read Grid #2 Voltage	650 Vdc
Inter Screen Voltage	1000 Vdc
(Between any pair)	
Grid Circuit Resistance	0.5 Meg.

ELECTRICAL CHARACTERISTICS

RATINGS – ABSOLUTE MAXIMUM VALUES (Cont'd.)

Heater Cathode Voltage

Heater to Cathode Voltage	±125 Vdc
Write Collimating Lens Voltage	800 Vdc
Read Collimating Lens Voltage	800 Vdc
Read Decelerator Voltage	800 Vdc
Write Decelerator Voltage	1000 Vdc

NOTE 1: Resolution Versus Anode Potential at 50% modulation measured in the center of the storage area.

850 TV lines min.	4000V (Anode) Max.
600 TV lines min.	2500V (Anode)

NOTE 2: Except for heater rating and interscreen voltages, all voltages shown above are referenced to the respective gun cathode.

TYPICAL OPERATING CHARACTERISTICS

Deflection drive must be applied to both guns whenever the tube is conducting to avoid damage to the storage assembly.

All Voltages except RF drive and read G1 with respect to write cathode.

WRITE GUN

Cathode Voltage	0 Vdc
G–1 Cut–off	–20 Vdc to –70 Vdc
G–2	450 Vdc
Anode	4000 Vdc
Collimating Lens (Vary for best scan shape and linearity)	±200 Vdc
Write Decelerator	700 Vdc
Collector	Variable – See Note 3.

READ GUN

Cathode Voltage	+400 Vdc
Cathode Current (nominal)	50 μA
G–1 Cut–off (with respect to Read K)	–100 Vdc to –250 Vdc
G–1 RF Drive (see Special Application Notes section on RF separation) (See Page 5)	30 Vrms
G–2	900 Vdc
Anode	4000 Vdc
Decelerator	+1150 Vdc
Collimating Lens (Vary for best shading)	+800 to 1100 Vdc
Storage Screen	405 Vdc
Output Signal (Peak Level at Collector)	3 μa

NOTE 3: Gradual automatic priming is controllable by varying the value of collector voltage from 900 Vdc (for slow priming) down to 400 Vdc (for fast priming.) Also see special application notes for further information.

PRINCIPLES OF OPERATION

When an electron beam strikes any material, secondary electrons are emitted. The quantity of secondary electrons emitted is a function of the velocity of the primary electron beam.

The secondary electron emitting surface in the Recording Storage Tube is a dielectric that has been deposited on a metal mesh or screen. Figure 1 illustrates this storage screen mesh.

Figure 2 shows the characteristic curve for secondary to primary emission ratio for the dielectric material used. Since the velocity of the electron beam will be proportional to the voltage on the dielectric material the ordinate of velocity in Figure 2 can be voltage. The crossover, called critical potential, where the secondary to primary ratio is unity occurs at approximately 50 volts.

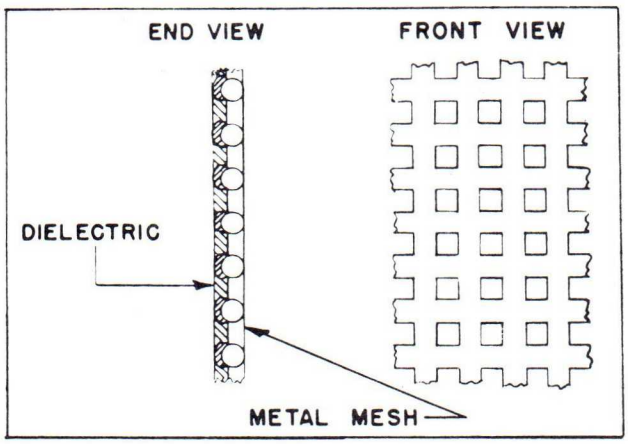


FIGURE 1
MAGNIFIED SECTION OF STORAGE SCREEN

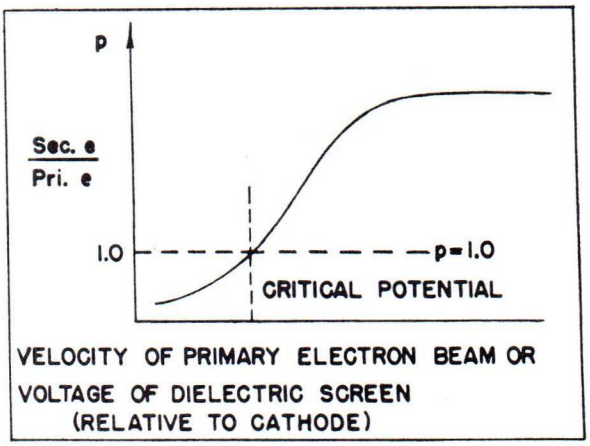


FIGURE 2
SECONDARY EMISSION CHARACTERISTIC OF RECORDING STORAGE TUBE DIELECTRIC

Using the secondary emission character shown by Figure 2, the dielectric screen surface can be discretely charged or discharged as a function of the potential on the metal screen and the position and magnitude of the primary electron beam.

The various modes of operation are described as follows:

PRIME – This is the basic form of erasure and prepares the storage screen for subsequent writing. It is accomplished by scanning the storage screen dielectric with an unmodulated beam. The storage screen mesh is operated at a voltage below critical potential and since the secondary to primary emission ratio is less than unity the dielectric surface can store electrons and become negatively charged to cathode gun potential. A total prime can be used if complete erasure of old patterns is desired or a partial prime can be used if it is desired to gradually decrease old signals in amplitude (e.g.: to generate target trails in radar). Selective priming of only part of the storage screen can be accomplished by only scanning the area where it is desired to erase previously stored information. Typical storage screen voltage for prime is +5 volts. Priming can be accomplished with either beam. When the writing beam is used for priming, the storage screen is switched to +5 volts above write cathode and the beam is turned on and scanned over the area to be primed.

When the read beam is used it is only necessary to switch the collector to a more negative potential than read cathode and read beam is then scanned over the area to be erased. Under these conditions, the read beam primes the dielectric surface by reflection from the collector after it has passed through the storage screen. The read beam electrons recharge the dielectric surface. Storage screen voltage should be separately adjustable between prime and read modes. Normally the prime voltage will be slightly lower than read voltage.

WRITE – "Writing" of the charge pattern is accomplished by modulation ot a scanning electron beam and operation at a storage screen voltage that yields a high secondary to primary emission ratio. This is any voltage above critical potential and is nominally 400 volts. Since during the prime mode the dielectric surface was negatively charged, the surface is discretely discharged towards the positive direction by the writing beam. As the modulated beam scans over the surface varying amounts of secondary electrons, depending on the instantaneous beam amplitude, are emitted at the surface and the stored pattern is established.

READ – Once a charge pattern has been written in, it can be read out by scanning the storage screen with an unmodulated beam. The storage screen is operated at 5 volts with respect to the reading gun cathode. Depending on the charged pattern the electron beam is therefore modulated as it passes through the storage screen to the collector element. By selecting the proper storage screen voltage the most negative areas of the dielectric (established by the prime mode) can completely cut off the electron beam from the collector and thus the "black" level is established. Various gray shades will appear in any areas where the dielectric is less negative.

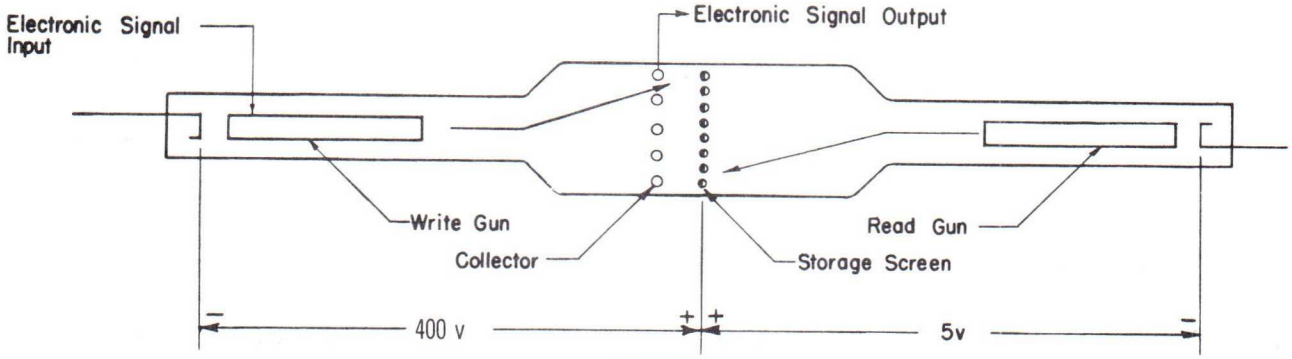


FIGURE 3
TWO GUN RECORDING STORAGE TUBE — SIMPLIFIED DRAWING

Simultaneous Write and Read modes are possible with the use of the two electron guns. This is desirable in most scan–conversion applications. Since two independent potentials can be maintained on the storage screen with respect to the two electron gun cathodes, the tube can be truly writing a charge pattern and reading it at the same time. (This is shown in Fig. 3.)

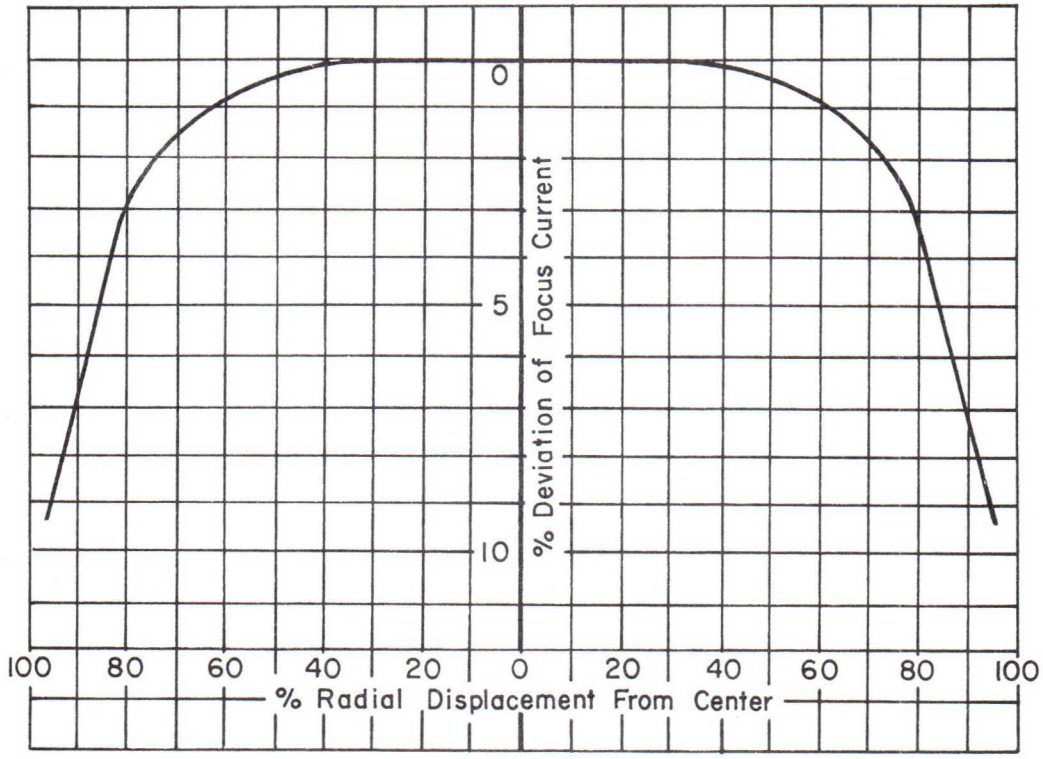


FIGURE 4
MAGNETIC DYNAMIC FOCUS CHARACTERISTIC

ERASE – Where total erasure is needed, it is frequently desirable to operate the tube in the positive erase mode. To accomplish this, the storage screen voltage is set at or above the value used for Write and the storage surface is scanned with an unmodulated electron–beam. This action discharges any stored pattern, bringing the whole storage surface to a uniform equilibrium potential. The tube must then be primed prior to subsequent writing. This can also be done with the read gun by operating the storage screen at +250 Vdc above read cathode. The collector must be negative by approximately 25 volts with respect to the read cathode. A prime cycle must follow.

SPECIAL APPLICATION NOTES: (See Figure 5)

RF SEPARATION – Since the collector intercepts the writing beam as well as the reading beam, a spurious output signal will result from the writing signal at the collector. This can be removed by cancellation techniques or by RF separation. RF separation is accomplished by modulating the read beam with insertion of an RF signal at the read gun control grid. As the RF read beam passes through the storage screen it is amplitude modulated by the stored charge pattern. This amplitude modulated signal then appears at the collector. The center frequency chosen is much higher than the highest write video frequencies and therefore a tuned circuit will reject the writing signal and accept only the read signal. This is amplified and typical amplitude–modulation detection re–establishes a read–out video signal with no writing signal. Typical RF center frequencies used are 30 mc and 50 mc. To adjust for proper RF drive, set read G1 bias for a read current of approximately 10 μadc with RF drive at zero. Increase RF drive until the read cathode current is approximately 50 μa.

VIDEO SEPARATION – A no–RF alternate method to the above is use of the secondary emission characteristic of the collector. This can be adjusted for a ratio of one–to–one by operating the write decelerator at approximately +20 Vdc above the collector. The writing signal is then cancelled automatically. Write decelerator to collector voltage should be variable between 0 volts and +30V for proper adjustment.

AUTOMATIC PRIME –(Controllable erasure while reading) – During simultaneous writing and reading the tube can be operated at conditions that will allow either short or long storage of the charge pattern. It can also be variable for storage time between the two limits. Thus, in PPI to TV scan–conversion, target trails can be generated and the length of these trails are controllable by adjusting the storage time. This gradual automatic prime is obtained by varying the value of collector voltage from a high voltage for long storage (slow Prime) to a low voltage for short storage (fast Prime). The priming is accomplished by some of the read beam electrons between the collector and storage–screen dielectric returning to the dielectric to recharge it negatively in the specific areas where the negative charge was reduced by the written–in pattern.

COLLIMATION – An electrostatic lens and deceleration screen are provided to collimate the beam as it arrives in the region of the storage screen. For optimum shading characteristics the reading and writing beams should arrive at the storage screen dielectric orthognally to it. The voltage on the lens should therefore be adjusted for the most uniform background shading.

SHIELDING – Since any extraneous fields will cause unwanted deflection, it is recommended that good magnetic and electrostatic shielding techniques be used in the design of the tube mount.

RESOLVING POWER – The resolution of the storage tube at the 50% modulation level is usually in excess of 800 TV lines across the diameter and is obtainable when the minimum current for writing a fully modulated signal is employed with max. limit of anode potential and the focus coils designed to minimize astigmatism. Resolution is also dependent on the orientation of the focus coil with respect to the gun, and the sharpness of focus across the storage screen. Therefore, for applications requiring optimum resolution, dynamic focusing is often needed. (Typical correction curves are shown in Figure 4.)

STORAGE ABILITY –The length of time a tube will retain the stored information is a function of the operating conditions and varies inversely as the reading current. When reading with a low beam current at standard television repetition rate and scan, several thousand consecutive readings can be made without any appreciable deterioration of the stored signal. The tube is capable of storing information for many hours without appreciable change or deterioration when not reading.

TYPICAL SCHEMATIC

Radar PPI to TV Scan Conversion, Simultaneous Write and Read with automatic prime (erasure) and RF separation.

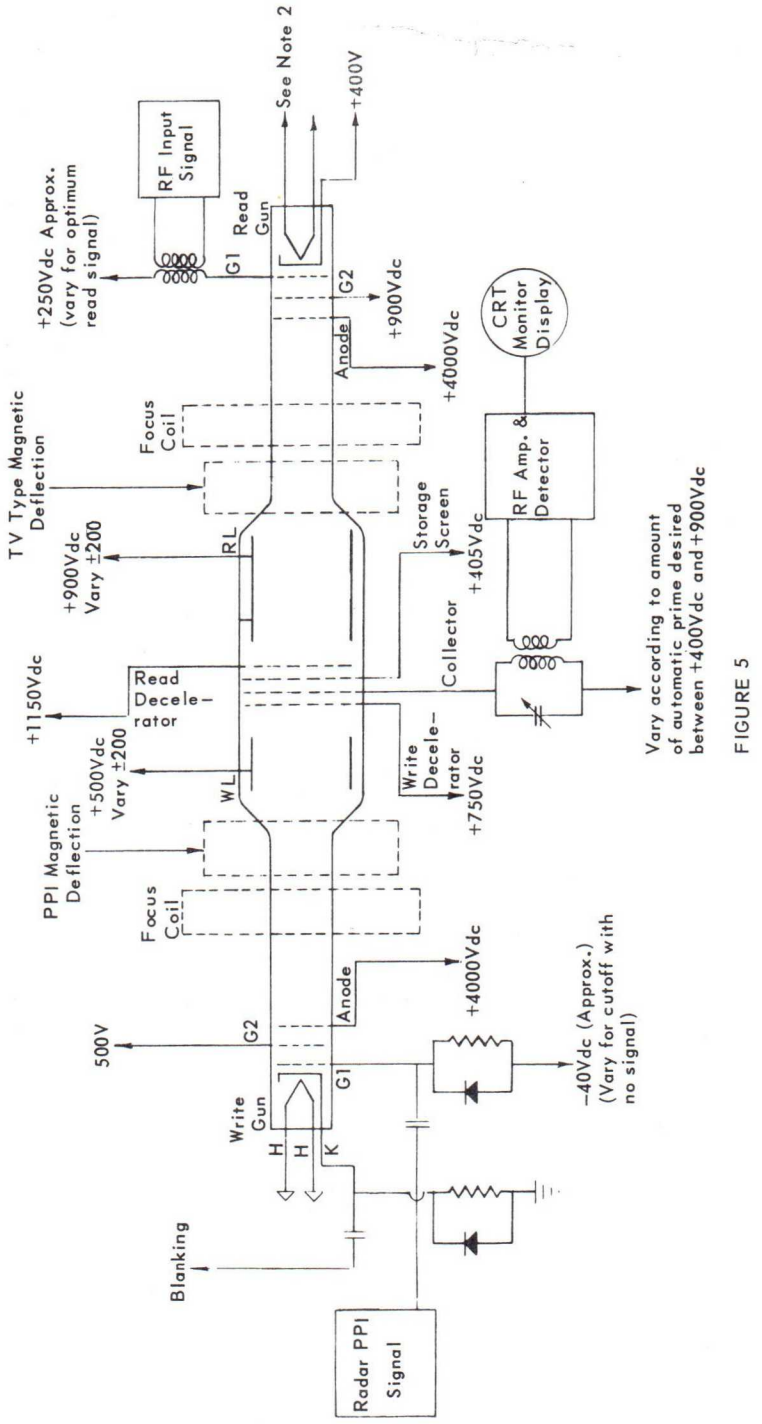
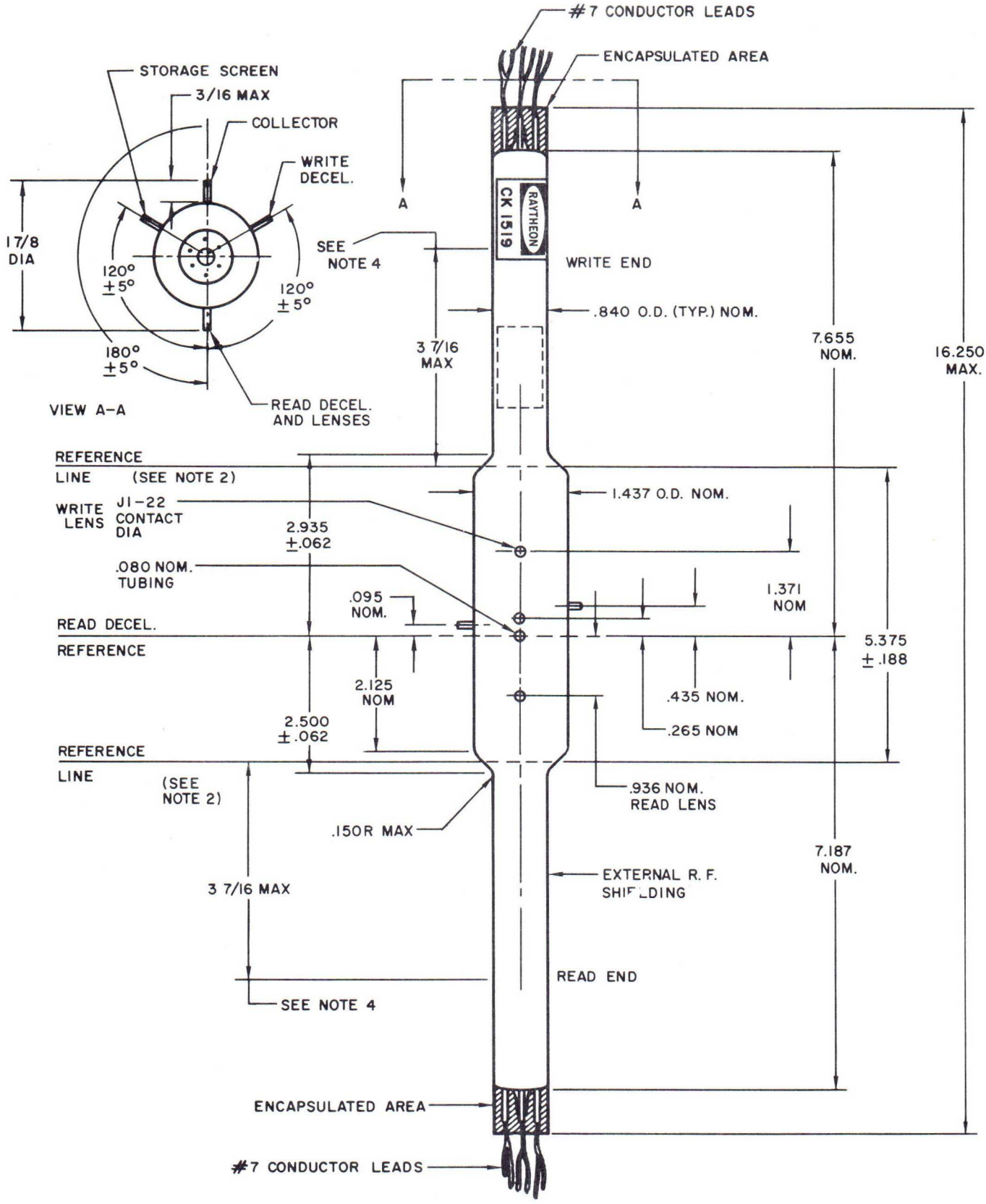


FIGURE 5

ALL VOLTAGES WITH RESPECT TO GROUND


#7 CONDUCTOR LEADS
ENCAPSULATED AREA
STORAGE SCREEN
3/16 MAX
COLLECTOR
WRITE DECEL.
17/8 DIA
120° ±5°
120° ±5°
180° ±5°
VIEW A-A
READ DECEL. AND LENSES
A
A
CK 1519
RAYTHEON
SEE NOTE 4
WRITE END
.840 O.D. (TYP.) NOM.
3 7/16 MAX
7.655 NOM.
16.250 MAX.
REFERENCE LINE (SEE NOTE 2)
WRITE LENS
J1-22 CONTACT DIA
2.935 ±.062
1.437 O.D. NOM.
.080 NOM. TUBING
.095 NOM.
1.371 NOM
READ DECEL. REFERENCE
5.375 ±.188
2.125 NOM
.435 NOM.
.265 NOM
2.500 ±.062
REFERENCE LINE (SEE NOTE 2)
.936 NOM. READ LENS
.150R MAX
7.187 NOM.
EXTERNAL R. F. SHIELDING
3 7/16 MAX
READ END
SEE NOTE 4
ENCAPSULATED AREA
#7 CONDUCTOR LEADS

NOTES FOR CK1519 OUTLINE DRAWING ON PAGE SEVEN

1. Basing Color Code

Lead	Write End	Read End
H1	Brown	Brown
H2	Brown	Brown
Anode	Red	Red
G1	Green	Green
G2	Orange	Orange
K	Clear	White

2. Reference Line is determined by that point where a ring gauge .995–.000 + .003 I.D. and 1.500 long comes to rest on neck flare.
3. Aluminum R.F. shielding on Read End of tube.
4. Magnetic deflection yoke and focus coil should be mounted so that they do not fall beyond this dimension. Beam current and resolution can be seriously reduced if the focus coils are too close to the electron guns.
5. The air gap of the focus coil is adjacent to deflection yoke. The magnetic fields of both should not interact on each other. Follow yoke manufacturer's recommendations.

NEW—Raytheon Amplitron

Now—peak power 800 kw, bandwidths of 10% with efficiencies of 50-70% over entire band

QK520 Amplitron
Typical Operation (Pulsed)

Anode Voltage	40 kV
Anode Current	35 amps
Peak Power Output	800 kw
Average Power Output	1200 watts
Efficiency	55%
Operating Band (±1 db)	1225-1350 Mc
Peak Power Input	80 kw
Phase Stability with Anode Current	1°/amp

The Amplitron is a new type of tube capable of power amplification at microwave frequencies. Amplification is obtained over a broad range of frequencies without need of mechanical or electrical adjustments. The Amplitron is a derivative of the magnetron and retains many of its advantages—high operating efficiency, simple construction, small size, light weight, low operating voltage.

The Amplitron uses crossed electric and magnetic fields, a reentrant beam produced by a magnetron-type cathode, and a non-reentrant broadband circuit matched at either end to external circuits.

Variations in anode current or voltage have little effect upon the total phase shift. This results in very low phase pushing and excellent reproduction of the input spectrum even under pulse conditions with slow rise time and ripple. Because of low insertion loss, duplexing may be accomplished at the input rather than the output of the final rf amplifier.

A limited quantity of preliminary literature is now available. To be sure of your copy, write now. *Amplitrons in other frequency bands are currently in development. Inquiries are invited.*

RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section PT-00
Waltham 54, Massachusetts

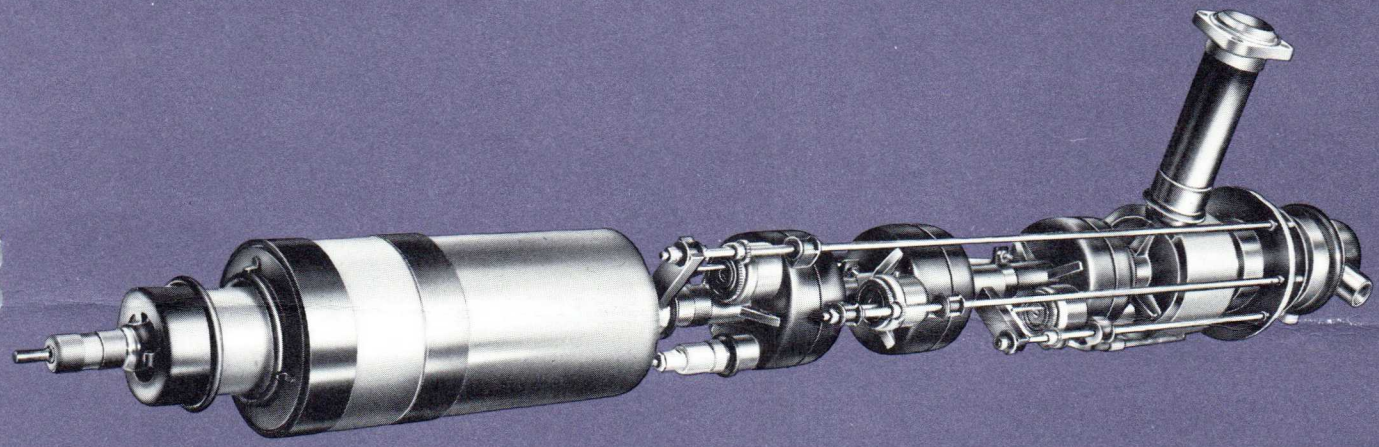
RAYTHEON
Excellence in Electronics

Regional Sales Offices: 9501 W. Grand Avenue, Franklin Park, Illinois. 5236 Santa Monica Blvd., Los Angeles 29, California
Raytheon makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Miniature and Sub-Miniature Tubes, Semiconductor Products, Ceramics and Ceramic Assemblies

RAYTHEON

MICROWAVE AND
POWER TUBE DIVISION

information bulletin



NEW
RAYTHEON KLYSTRON
USES HOLLOW BEAM
MAGNETRON
INJECTION GUN

The QKK932 is the first klystron to employ a hollow beam magnetron injection gun and modulating anode. A 35 kilowatt L-band tube, it offers system designers the advantages of:

- **longer tube life**
- **modulating anode mu of 3**
- **extremely low interpulse noise**
- **long pulse operation**
- **high duty cycle**

Magnetron Injection Gun.

The magnetron injection gun, developed by Raytheon Company Spencer Laboratory engineers, represents an important advance in the state-of-the-art of high power klystrons. Used in conjunction with a modulating anode and hollow beam design, it may well provide a means of greatly extending the superpower capabilities of klystrons. Even at moderate powers this combination is extremely valuable, as evidenced by Raytheon's new QKK932; a four-cavity, mechanically-tunable, solenoid-focused klystron designed for use as a driver or final stage in medium and high power radar and pulse compression systems.

Efficient Heater Design

The cylindrical geometry of the magnetron injection gun cathode permits a heater design of greatly increased efficiency. The result is increased heater life and reliability and reduced heater power. More of the radiated heat controls the cathode temperature than with conventional cathodes which do not surround the heater.

Large Cathode Area Increases Life and Pulse Duration Capability

Greater cathode area, compared with conventional designs, increases life and pulse duration capability. The greater current capability of the QKK932 cathode permits high performance operation up to 1000 microseconds pulse width or longer. The large cathode area allows long pulse operation and at the same time provides for long cathode life.

The configuration of the magnetron injection gun is such that very nearly all ion back-bombardment strikes the non-emissive end of the cathode. A considerably longer tube life is the result.

Low Input Capacitance Reduces Pulse Distortion

The geometry of a hollow beam magnetron injection gun with modulating anode yields an unusually low modulating electrode capacitance. For the QKK932, it is on the order of 35 uuf. Since this is very low compared to the modulator output capacitance, negligible pulse distortion and other transient behavior can be expected from this source.

High Perveance Increases Bandwidth and Reduces Beam Voltage

By virtue of its high current capability, the magnetron injection gun provides very high perveance which (a) increases bandwidth (b) lowers operating voltage, and (c) decreases x-radiation. The QKK932 gun has a microperveance of 6.4 which is high compared to figures on the order of 2.0 for conventional klystrons. Bandwidth increases because of the beam conductivity factor, which is related to perveance and appears in tube frequency calculations.

Superior Modulating Anode Gives High Mu and Negligible Interpulse Noise

The superior type of modulating anode possible with the magnetron injection gun provides a high mu (ratio of beam voltage to switching voltage) and complete cutoff. These two characteristics result in a lower modulating voltage requirement and very low interpulse noise respectively.

The mu of the QKK932 is approximately 3.0.

The degree of cutoff possible with the modulating anode design used with the magnetron injection gun results in less than 0.2 microamperes interpulse current, much lower than would be otherwise attainable. Furthermore, with about 100 db of isolation between input and output during cutoff, negligible interpulse RF is present.

Construction

The QKK932 is constructed with materials compatible with high temperature bakeout procedures. Copper and stainless steel are used extensively throughout the tube. All insulators and windows are of high purity alumina ceramic. All brazes and solders in the tube are copper-gold alloys to permit high temperature processing. On request, an ion pump can be incorporated in the tube to serve the dual purpose of an active gettering device and a vacuum ion gauge, thus assisting equipment engineers and adding to tube life and reliability.

The cavities of the tube are of conventional design and integral to the tube. Simple ring tuners are used for tuning.

Other Magnetron Injection Gun Klystrons

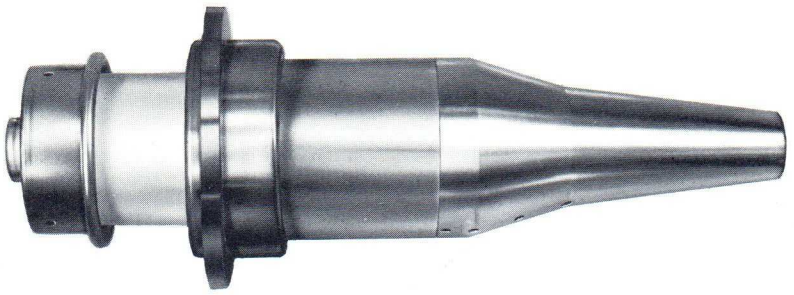
A series of klystrons using hollow beam magnetron injection guns are currently in advanced stages of development. They range from eight watts CW to two megawatts pulsed power. A one megawatt L-band klystron has been operated with an efficiency of 48%. The QKK932 is the first of this series of tubes to be made available as a product.

QKK932 SPECIFICATIONS

Peak power	35 kw min
Frequency (tunable)	1250-1350 Mc
Gain	40 db min
Pulse width	1000 microseconds
Duty cycle	.04
Efficiency	35%
Electronic bandwidth	10 Mc min (at −3 db)
Beam voltage	25 kv max
Beam current	4 amps peak
Modulating anode (with respect to cathode)	+7.85 kv peak (beam on) −2.0 kv bias (beam off)
Modulating anode capacitance	35 uuf
Heater	5.5 volts 7.5 amps
Input connection	Type N coax
Output connection	1⅝" coax
Coolant	Liquid
Overall tube length	36 inches
Tube weight	45 lbs
Solenoid power	1000 watts
Solenoid ID	4⅞ inches
Solenoid OD	13 inches
Solenoid length	29 inches

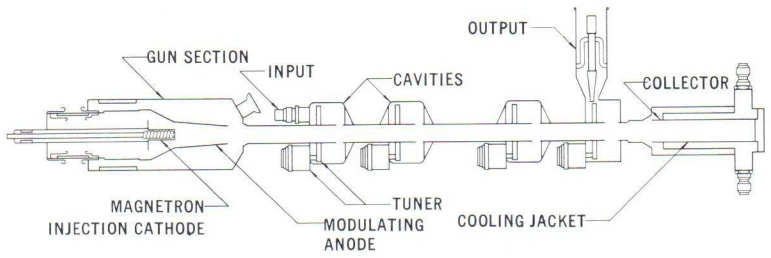
FOR FURTHER INFORMATION, YOU ARE INVITED TO CONTACT YOUR NEAREST RAYTHEON REGIONAL OFFICE.

Gun — Showing Modulating Anode



Cathode

QKK932 LAYOUT



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IN OTHER AREAS OF THE WORLD
Raytheon Company, International Sales and Service, Lexington 73, Massachusetts

TENTATIVE TECHNICAL INFORMATION

RAYTHEON

PROJECTORAY™ CATHODE RAY TUBE

CK1459P-

The CK1459P– is a special purpose CRT for use in projecting television or other video presentations to a 10 to 20 square foot display size. It is designed to yield very high light output simultaneously with good resolution and 500 hours of operating life. It is typically used with conventional refractive optics and with front–lit or rear–projection viewing screens.

The novel item incorporated in the CK1459P– is a special high thermal–conductivity face panel surrounded by a heat exchanger. The efficient cooling of the phosphor screen accomplished thereby results in the ability to continuously operate the tube at high light–output levels with a minimum of phosphor burn or other life–limiting factors.

GENERAL DATA

Phosphor	Special
Fluorescence	Yellowish green
Phosphorescence	Yellowish green
Persistence (Tube is available with other phosphors)	Medium
Focusing Method	Magnetic
Deflecting Method	Magnetic
Deflection Angle (Approx.)	Maximum 40°

HEATER CHARACTERISTICS:

Heater Voltage	6.3 ± 10% Volts
Heater Current	0.6 Amps.
Heater–Cathode Voltage: (Max.)	
Heater Negative with Respect to Cathode	180v DC
Heater Positive with Respect to Cathode	180v DC

DIRECT INTERELECTRODE CAPACITANCE: (pf) (approx.)

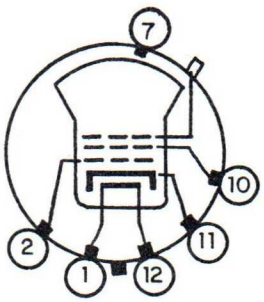
Grid #1 to all other Electrodes	6
Cathode to all other Electrodes	5

MECHANICAL DATA

BASE . . . . . Small Shell Duodecal 7–Pin

MOUNTING POSITION . . . Any

BASING



BOTTOM VIEW

TERMINAL CONNECTIONS

Pin 1 Heater
Pin 2 Grid #1
Pin 7 No Connection
Pin 10 Grid #2
Pin 11 Cathode
Pin 12 Heater
Cap Anode

DESIGN CENTER MAXIMUM RATINGS:

Anode Voltage	50,000 Volts DC
Grid #2 Voltage	700 Volts DC
Grid #1 Voltage	
Negative–Bias Value	250 Volts DC
Positive–Bias Value	0 Volts DC
Positive–Peak Value	0 Volts DC

CHARACTERISTICS AND TYPICAL OPERATION: (With Cooling System Operating)

Anode Voltage	40,000 Volts DC
Grid #2 Voltage	+600 Volts DC
Grid #1 Voltage (for beam cut–off)	−100 to −200 VDC
Resolution (Typical)	600 lines
Light Output *Typical.	15,000 ft Lamberts
Anode Current with typical TV program material	500μa avg.

MAXIMUM CIRCUIT VALUES:

Grid #1 Circuit Resistance.	1.5 max. megohms

Cathode should be returned to one side or to the mid–top of heater transformer winding.

NOTES:

* 525 line raster, retrace blanked, 2.4" x 3.2", IA_2 at 1000 μa approximately.

APPLICATION DATA

1. OPTICAL DATA:

CK1459P– is designed for use with refractive optics. With an f/1.0 lens and a focal length of 185 mm, 15 foot–lamberts of high–light brightness has been obtained on a flat white projection screen. The display size was 3' x 4'.

Lenticular Projection screens and rear–projection screens can add brightness gains. These are recommended in applications where the viewing angle can be restricted.

Manufacturer of screens is:

Polacoat Inc.
9752 Conkin Road
Cincinnati, Ohio

The lens was designed and made by:

Pacific Optical, Div. of
Chicago Aerial Industries, Inc.
5521 W. 102nd St.
Inglewood, California

2. HEAT EXCHANGER DATA:

Liquid heat exchangers are manufactured by REMCOR PRODUCTS, CHICAGO, ILL.

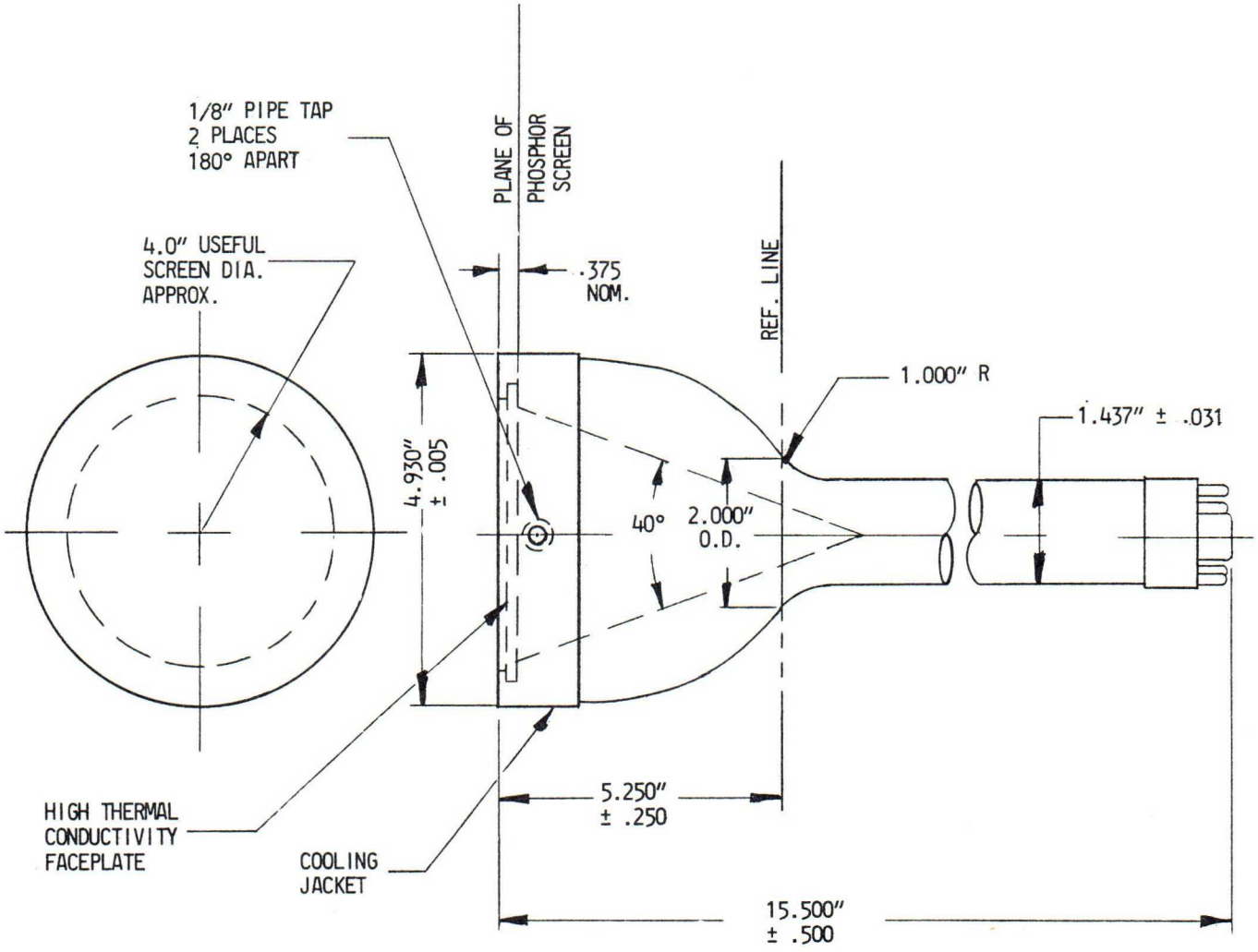
Cooling capacity of system must be sufficient for 40 watts maximum heat dissipation at 18°C on center of faceplate. A suggested coolant is Tetra 2 Ethyl Butyl Ortho Silicate made by Chemicals Division of Union Carbide, New York, New York 10017.

If anode is operated above ground potential flexible insulating type tubing should be used. "Tygon" tubing made by U.S.. Stoneware or equivalent is recommended.

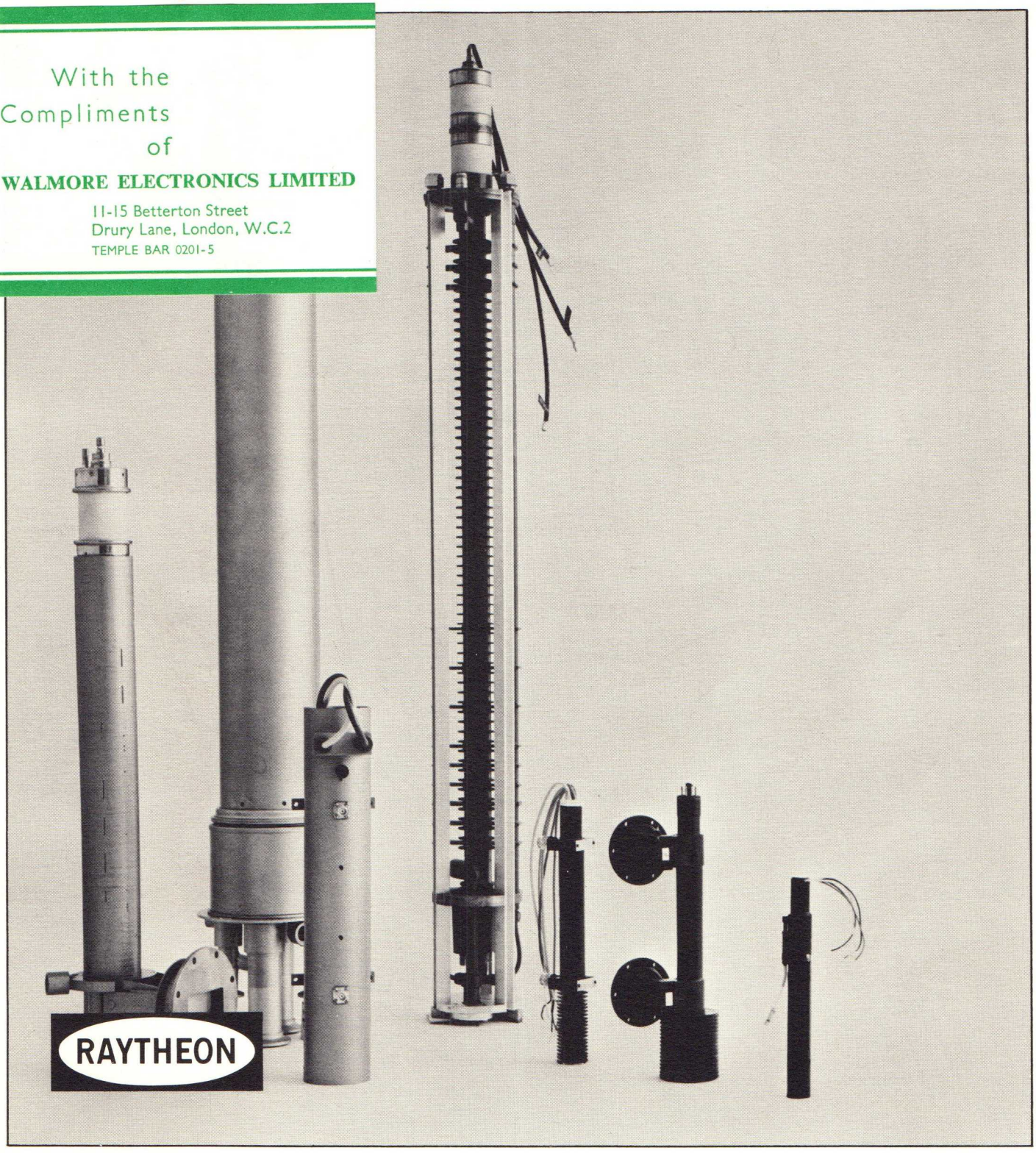
3. CAUTION – OPERATION AT HIGH VOLTAGE

Presents potential X–ray and shock hazard. Suitable X–ray shielding should be provided for tube equipment to safeguard personnel.

4. A failure of the scan circuit while the electron beam is on may cause permanent damage to the screen. In the event of scan failure, an automatic fast–operating protection circuit should cutoff the beam.


1/8" PIPE TAP
2 PLACES
180° APART
4.0" USEFUL
SCREEN DIA.
APPROX.
PLANE OF
PHOSPHOR
SCREEN
.375
NOM.
REF. LINE
1.000" R
1.437" ± .031
4.930"
± .005
40°
2.000"
O.D.
HIGH THERMAL
CONDUCTIVITY
FACEPLATE
COOLING
JACKET
5.250"
± .250
15.500"
± .500

Proven Capabilities in TWT's



Raytheon's Microwave and Power Tube Division is a major supplier of a broad range of microwave tubes. Included are such basic tubes as magnetrons, amplitrons and stabilotrons, backward wave oscillators, klystrons, and traveling wave tubes.

As complementary products, Raytheon's Microwave and Power Tube Division also offers a number of special tubes, infrared detectors, ceramic parts and test equipment.

An acknowledged leader in the industry since 1942, Raytheon's Microwave and Power Tube Division has pioneered many of the advance techniques of microwave technology. Today, the Microwave and Power Tube Division continues to expend considerable time and talent on developmental work — to prepare the way for future innovations.

TWT Applications

Traveling wave tubes are specifically recommended for use as high-gain, long-life microwave amplifiers. Among the features of TWT's that make them especially suitable for such applications are:

Broad Bandwidths

At low power, where a helix can be used, TWT's offer octave bandwidths. At high power, TWT's with bandwidths as great as 30% are available.

High Gain

TWT's generally have a 30-50 db gain but can be made with gains to 70 db.

Long Life

Low power TWT's offer very long life, on the order of 10,000 hours. High power TWT's have life comparable with other high power tubes.

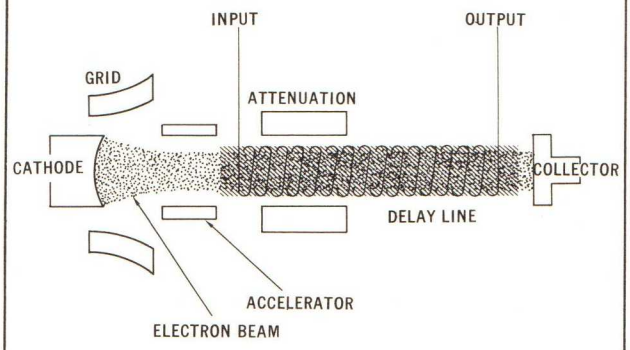
Low Noise

By utilizing known techniques, extremely low noise levels can be achieved with low power TWT's. This feature, in combination with high gain and broad bandwidths, makes low power TWT's ideal for applications in microwave receivers and communication relay links.

TWT's Combine High Gain and Broad Bandwidth

Only TWT's at their specified power levels combine both the high gain and broad bandwidth features in a single device.

TWT operation principles



Low Power TWT's

Military Types

Low power TWT's are available to meet MIL-E-5400 specifications. The coaxial designs for military applications are particularly suitable for ECM equipment and are capable of meeting airborne and missile environments. PPM (periodic permanent magnet) focusing decreases size and weight, eliminates the need for external magnet mounts, and reduces problems of magnetic field interference.

Communications Types

These low power TWT's incorporate special characteristics for communications applications. For example, the QKW1058 has its hot input and output match factory preset to a maximum of 1.5/1 over the entire band. Because of this, field matching adjustments are never required. To replace tubes with the PPM feature, all that is required is plugging in the new tube and making RF connections. Match adjustments are not necessary in any communications applications.

Additional Features of Low Power TWT's

1. Direct output coupling to helix permits good matching over a broad band.
2. Metal and ceramic construction increases storage life.
3. Long life.
4. A number of different input and output connectors and flanges are available.
5. Mechanical configuration of tubes can be altered to meet your needs.

QKW928

Operational Characteristics

Tube Type	Frequency (Mc)	Saturated Power (W)	Small Sig. Gain (db)	Helix Voltage (V)	Collector Current (mA)	Collector Voltage (V)	Noise Figure (db Max.)	Anode Voltage (V)	Grid Voltage (V)	Weight (Lbs.)	Output
QKW1033	2200–2700	10.0	45	1150–1300	44	800–900	28	1150–1300	0 to —26	1.0	Coax. Coupling
QKW1081	2500–3200	7.0	37	1100–1300	50	1100–1300	32	1100–1300	0 to —300	3.0	Type N
QKW1054	4800–6500	10.0	35	2550–2950	50	2550–2950	30	2600–3000	0 to —300	3.0	Type N
QKW1058	5925–6425	10.0	37	2550–2950	50	1800–2950	28	2600–3000	0 to —300	4.0	RG50/U
QKW928	5925–7125	10.0	35	2550–2950	50	1800–2950	28	2600–3000	0 to —300	4.0	RG50/U
QKW1049	7100–8500	10.0	37	2800–3200	50	2800–3200	28	2850–3250	0 to —300	4.0	RG51/U

High Power TWT's

The RK8128/QKW750B traveling wave tube makes possible a complete high-power MOPA chain at S-band by serving as a driver for the RK8129/QKS622 Amplitron. Designed for pulsed operation over the 2900 to 3100 Mc range, the tube has a duty cycle capability of .021. Minimum peak power is 60 kw and minimum gain is 20 db. Bandwidth and peak and average power capability are in excess of specified values. A solenoid and rf terminations are available for use with this tube.

The QKW782, a companion tube for the QKW750B, covers the 2700 to 2900 Mc range. Still more advance-design, high-power TWT's available from Raytheon are listed in the specification chart.

RK8128/QKW750B

Operational Characteristics

Tube Type	Frequency (Mc)	Power (kw)	Duty Cycle	Pulse Width (μ sec.)	Gain (db)	Beam Voltage (kv)	Peak Beam Current (a)	Heater Power (watts)	Input Connection	Output Connection	Coolant	Length (inches)	Diam-meter (inches)	Weight (lbs.)	Magnetic Field
QKW1192	510–690	3	0.009	8	30	10	28	36	Type "N"	Type "N"	Liquid	38	3.5	18	Solenoid
QKW1193	510–690	200	0.0084	7.5	20	40	50	210	⅞" Coax.	1½"Coax.	Liquid	50	7.0	60	Solenoid
RK8128/ QKW750B	2900–3100	60	0.021	30	20	34.5	12.0	65	Type "N"	UG54A/U	Liquid	30	2.6	20	Solenoid
RK8427/ QKW1070	2700–3200	1.3	0.025	38	33	7.5	1.0	24	TNC	TNC	Forced Air	16.75	3.0	11	PPM
QKW1095	4000–8000	1	0.02	5	36	9.5–10.5	1.75	25	TNC	TNC	Forced Air	15.5	3	9.5	PPM
QKW1011	7000–11000	1	0.01	5	40	10.5–11.5	1.5	25	TNC	TNC	Forced Air	15.5	3	9.5	PPM

Phased Array TWT

Raytheon's Type QKW1013 is a TWT specifically designed for phased array applications. The QKW1013 has a phase vs. frequency characteristic that varies less than ±10° across its operating band. Sensitivity to beam voltage is less than 0.5 degrees/volt. To insure minimum phase and gain deviation, the QKW1013 utilizes a slow wave structure having high gain per unit length. For flexibility, a modulating anode and isolated collector are used. The modulating anode helps avoid difficulties normally associated with intercepting-type grids at higher average power levels. The QKW1013's modulating anode has a mu of unity. Type QKW1013 is an ideal driver for Raytheon's QKS1012 Amplitron.

QKW1013

QKW1013 Operational Characteristics

Frequency	1215–1400 Mc
Power	5 kw min.
Duty cycle	0.08
Pulse width	1–750 us
Gain	50 db
Beam voltage	9–12 kv
Peak beam current	2.5 amp. (nom.)
Modulating anode with respect to cathode	Bias 0 Pulse 9–12 kv
Heater power	75 watts max
Input connection	TYPE "N"
Output connection	⅞" coax.
Coolant	Liquid
Length	50°
Diameter	3" max.
Weight	25 lbs (nom.)
Magnetic Field	Lattice structure or solenoid

For further information, contact your nearest Raytheon Regional Office.

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MICROWAVE AND POWER TUBE DIVISION

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RAYTHEON

TECHNICAL INFORMATION SERVICE

Technical Information

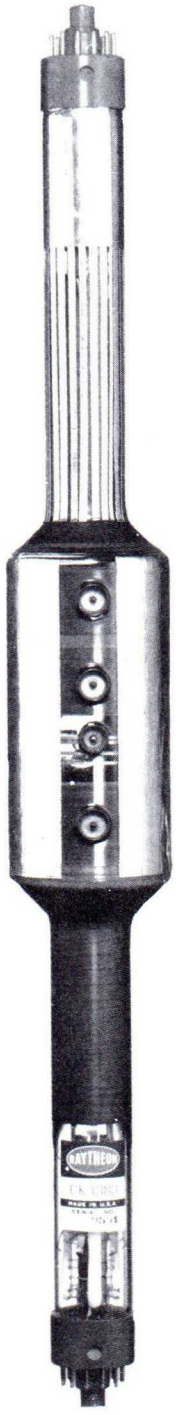
CK1383

RECORDING STORAGE TUBE

The CK1383 is a dual–gun cathode–ray recording storage tube capable of simultaneous writing and reading. It is an electronic input–electronic output storage device which combines high output signal with high resolution. The major application is scan conversion such as radar PPI to tele–vision type presentation. This type of system yields a bright video display, with high resolution and adjustable automatic priming or erasing, which may be used to generate target trails indicating elapsed time position. It is similar to the CK7702 except that no electrostatic focus elements are used. Stored signals can be held for a long period, read several thousand times, or erased in a fraction of a second if desired. The storage capabilities permit additional coherence of target information under conditions of high noise levels.

Both the writing and reading guns use magnetic deflection and magnetic focus. For uniform resolution over the storage surface, dynamic focus correction is recommended.

The design of the tube results in a wide dynamic range of gray shades, fast writing speeds, and selective erasure of the stored information is desired.



ELECTRICAL DATA

GENERAL CHARACTERISTICS

Gun Locations	Co–axial
Gun Type (Both Guns)	Tetrode High Resolution
Deflection (Both Guns)	Magnetic
Max. Deflection Angle (Both Guns)	30°
Focusing	Magnetic
Mounting Position	Any
Resolution (Magnetic Focus)	
TV lines per diameter	1200 lines minimum
Output Capacitance	
(Collector and Write Decelerator to all other elements)	19 pf (approx.)
Erasing Technique	By Switching or Automatic

MECHANICAL CHARACTERISTICS

Seated Length	22 ½" Nominal
Bulb Diameter	3" Maximum
Neck Diameters	1.450" Maximum
Bases (Both Ends)	Special High Altitude
Sockets (Both Ends – not supplied)	See Note 2
Storage Assembly Buttons	JEDEC Type J1–22

ELECTRICAL CHARACTERISTICS

RATINGS – ABSOLUTE MAXIMUM VALUES

Heater Voltage	6.3 ± 5% Volts
Anode Voltage (Either Gun)	5200 Vdc
Grid Voltage Positive (Either Gun)	0 Vdc
Write Control Grid Voltage Negative	–150 Vdc

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ELECTRICAL CHARACTERISTICS

RATINGS – ABSOLUTE MAXIMUM VALUES (Cont'd.)

Read Control Grid Voltage	–275 Vdc
Write Grid #2 Voltage	500 Vdc
Read Grid #2 Voltage	650 Vdc
Inter Screen Voltage (Between any pair)	1000 Vdc
Grid Circuit Resistance	0.5 Meg.
Heater Cathode Voltage	
Heater Positive	+10 Vdc
Heater Negative	–125 Vdc
Write Collimating Lens Voltage	800 Vdc
Read Collimating Lens #1 Voltage	800 Vdc
Read Collimating Lens #2 Voltage	700 Vdc
Read Decelerator Voltage	800 Vdc
Write Decelerator Voltage	1000 Vdc

NOTE: Except for heater rating and interscreen voltages, all voltages shown above are referenced to the respective gun cathode.

TYPICAL OPERATING CHARACTERISTICS

Deflection drive must be applied to both guns whenever the tube is conducting to avoid damage to the storage assembly.

All Voltages except RF drive and read G1 with respect to write cathode.

WRITE GUN

Cathode Voltage	0 Vdc
G–1 Cut–off	–20 Vdc to –50 Vdc
G–2	450 Vdc
Anode	4500 Vdc
Collimating Lens	400 Vdc
Write Decelerator	800 Vdc
Collector	Variable – See Note 1.

READ GUN

Cathode Voltage	+400 Vdc
Cathode Current (nominal)	80 μA
G–1 Cut–off (with respect to Read K)	–100 Vdc to –250 Vdc
G–1 RF Drive (see Special Application Notes section on RF separation)	30 Vrms See Note 3.
G–2	1000 Vdc
Anode	4500 Vdc
Decelerator	900 Vdc
Collimating Lens 1	900 Vdc
Collimating Lens 2	800 Vdc
Storage Screen	405 Vdc

NOTE 1: Gradual automatic priming is controllable by varying the value of collector voltage from 900 Vdc (for slow priming) down to 400 Vdc (for fast priming.)

NOTE 2: Sockets obtainable from Alden Products Co., 117 N. Main St., Brockton, Mass., part no. 212 FTSISL.

NOTE 3: To adjust for proper RF drive, set read G1 bias for a read cathode current of apprx. 10 μA dc with RF drive at zero. Increase RF drive until the read cathode current is apprx. 80 μA.

PRINCIPLES OF OPERATION

When an electron beam strikes any material, secondary electrons are emitted. The quantity of secondary electrons emitted is a function of the velocity of the primary electron beam.

The secondary electron emitting surface in the Recording Storage Tube is a dielectric that has been deposited on a metal mesh or screen. Figure 1 illustrates this storage screen mesh. This screen has more than 2000 cross wires per diameter.

Figure 2 shows the characteristic curve for secondary to primary emission ratio for the dielectric material used. Since the velocity of the electron beam will be proportional to the voltage on the dielectric material the ordinate of velocity in Figure 2 can be voltage. The crossover, called critical potential, where the secondary to primary ratio is unity occurs at approximately 50 volts.

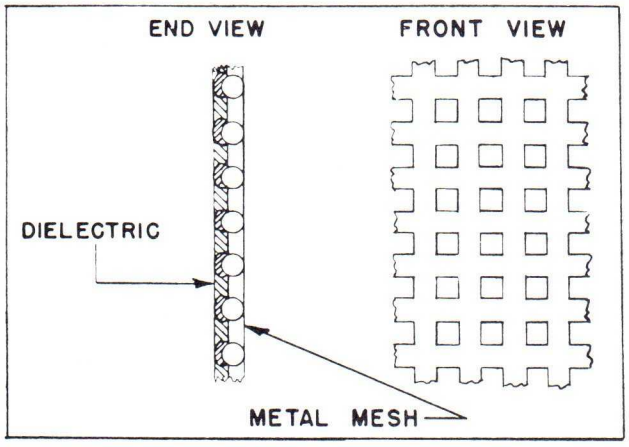


FIGURE 1
MAGNIFIED SECTION OF STORAGE SCREEN

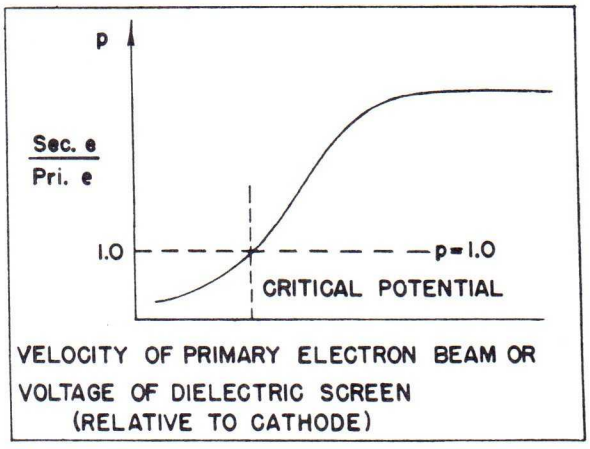


FIGURE 2
SECONDARY EMISSION CHARACTERISTIC OF RECORDING STORAGE TUBE DIELECTRIC

Using the secondary emission character shown by Figure 2, the dielectric screen surface can be discretely charged or discharged as a function of the potential on the metal screen and the position and magnitude of the primary electron beam.

The various modes of operation are described as follows:

PRIME – This is the basic form of erasure and prepares the storage screen for subsequent writing. It is accomplished by scanning the storage screen dielectric with an unmodulated beam. The storage screen mesh is operated at a voltage below critical potential and since the secondary to primary emission ratio is less than unity the dielectric surface can store electrons and become negatively charged to cathode gun potential. A total prime can be used if complete erasure of old patterns is desired or a partial prime can be used if it is desired to gradually decrease old signals in amplitude (e.g.: to generate target trails in radar). Selective priming of only part of the storage screen can be accomplished by only scanning the area where it is desired to erase previously stored information. Typical storage screen voltage for prime is +5 volts. Priming can be accomplished with either beam. When the writing beam is used for priming, the storage screen is switched to +5 volts above write cathode and the beam is turned on and scanned over the area to be primed.

When the read beam is used it is only necessary to switch the collector to or more negative than read cathode potential and the read beam is then scanned over the area to be erased. Unter these conditions, the read beam primes the dielectric surface by reflection from the collector after it has passed through the storage screen. The read beam electrons recharge the dielectric surface.

WRITE – "Writing" of the charge pattern is accomplished by modulation of a scanning electron beam and operation at a storage screen voltage that yields a high secondary to primary emission ratio. This is any voltage above critical potential and is nominally 400 volts. Since during the prime mode the dielectric surface was negatively charged, the surface is discretely discharged towards the positive direction by the writing beam. As the modulated beam scans over the surface varying amounts of secondary electrons, depending on the instantaneous beam amplitude, are emitted at the surface and the stored pattern is established.

READ – Once a charge pattern has been written in, it can be read out by scanning the storage screen with an unmodulated beam. The storage screen is operated at 5 volts with respect to the reading gun cathode. Depending on the charged pattern the electron beam is therefore modulated as it passes through the storage screen to the collector element. By selecting the proper storage screen voltage the most negative areas of the dielectric (established by the prime mode) can completely cut off the electron beam from the collector and thus the "black" level is established. Various gray shades will appear in any areas where the dielectric is less negative.

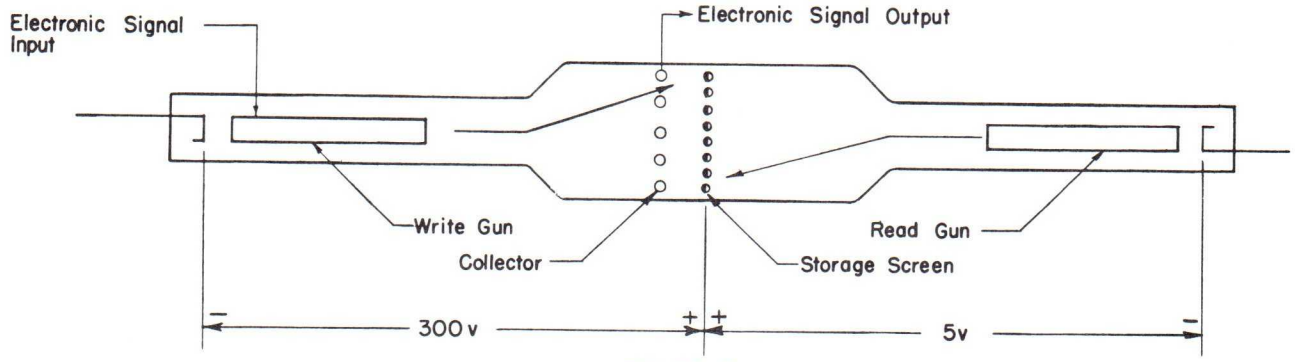


FIGURE 3
TWO GUN RECORDING STORAGE TUBE — SIMPLIFIED DRAWING

Simultaneous Write and Read modes are possible with the use of the two electron guns. This is desirable in most scan–conversion applications. Since two independent potentials can be maintained on the storage screen with respect to the two electron gun cathodes, the tube can be truly writing a charge pattern and reading it at the same time. (This is shown in Fig. 3.)

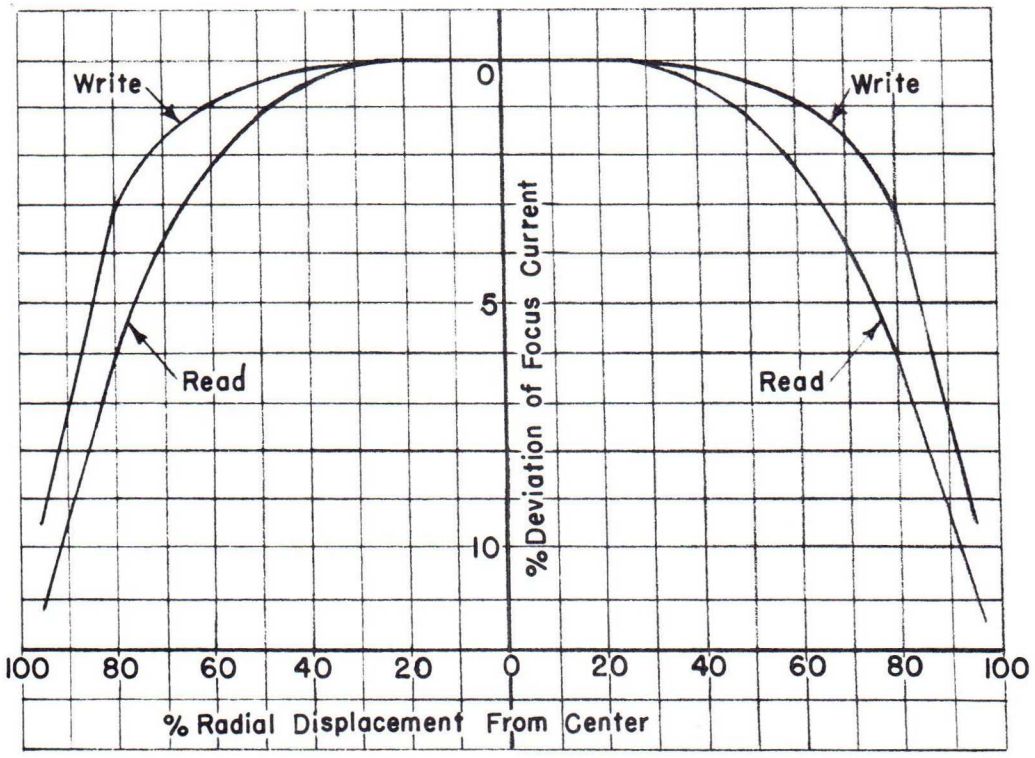


FIGURE 4
MAGNETIC DYNAMIC FOCUS CHARACTERISTIC

ERASE – Where total erasure is needed, it is frequently desirable to operate the tube in the positive erase mode. To accomplish this, the storage screen voltage is set at or above the value used for Write and the storage surface is scanned with an unmodulated electron–beam. This action discharges any stored pattern, bringing the whole storage surface to a uniform equilibrium potential. The tube must then be primed prior to subsequent writing.

SPECIAL APPLICATION NOTES: (See Figure 6)

RF SEPARATION – Since the collector intercepts the writing beam as well as the reading beam, a spurious output signal will result from the writing signal at the collector. This can be removed by cancellation techniques or by RF separation. RF separation is accomplished by modulating the read beam with insertion of an RF signal at the read gun control grid. As the RF read beam passes through the storage screen it is amplitude modulated by the stored charge pattern. This amplitude modulated signal then appears at the collector. The center frequency chosen is much higher than the highest write video frequencies and therefore a tuned circuit will reject the writing signal and accept only the read signal. This is amplified and typical amplitude–modulation detection re–establishes a read–out video signal with no writing signal. Typical RF center frequencies used are 30 mc and 50 mc.

AUTOMATIC PRIME – (Controlable erasure while reading) – During simultaneous writing and reading the tube can be operated at conditions that will allow either short or long storage of the charge pattern. It can also be variable for storage time between the two limits. Thus, in PPI to TV scan–conversion, target trails can be generated and the length of these trails are controllable by adjusting the storage time. This gradual automatic prime is obtained by varying the value of collector voltage from a high voltage for long storage (slow Prime) to a low voltage for short storage (fast Prime). The priming is accomplished by some of the read beam electrons between the collector and storage–screen dielectric returning to the dielectric to recharge it negatively in the specific areas where the negative charge was reduced by the written–in pattern.

COLLIMATION – Electrostatic lenses and deceleration screens are provided to collimate the beam as it arrives in the region of the storage screen. For optimum shading characteristics the reading and writing beam should arrive at the storage screen dielectric orthognally to it. The voltage on the lenses should therefore be adjusted for the most uniform background shading.

SHIELDING – Since any extraneous fields will cause unwanted deflection, it is recommended that good magnetic and electrostatic shielding techniques be used in the design of the tube mount.

RESOLVING POWER – The resolution of the storage tube at the 50% modulation level is usually in excess of 1200 TV lines across the diameter and is obtainable when the minimum current for writing a fully modulated signal is employed and the focus coils designed to minimize astigmatism. Resolution is also dependent on the orientation of the focus coil with respect to the gun, and the sharpness of focus across the storage screen. Therefore, for applications requiring optimum resolution, dynamic focusing is often needed.

STORAGE ABILITY – The length of time a tube will retain the stored information is a function of the operating conditions and varies inversely as the reading current. When reading with a low beam current at standard television repetition rate and scan, several thousand consecutive readings can be made without any appreciable deterioration of the stored signal. The tube is capable of storing information for many hours without appreciable change or deterioration when not reading.

FOCUSING TECHNIQUE – Raytheon type BM–411 focus coils (Figure 5) should be used. This provides a tickler coil for dynamic focus correction for optimum resolution across the diameter of the storage surface. Typical current correction curves are shown in Figure 4.

The focus coil mounting should be mechanically adjustable in all directions for proper positioning. A suggested mount is shown in Figure 7.

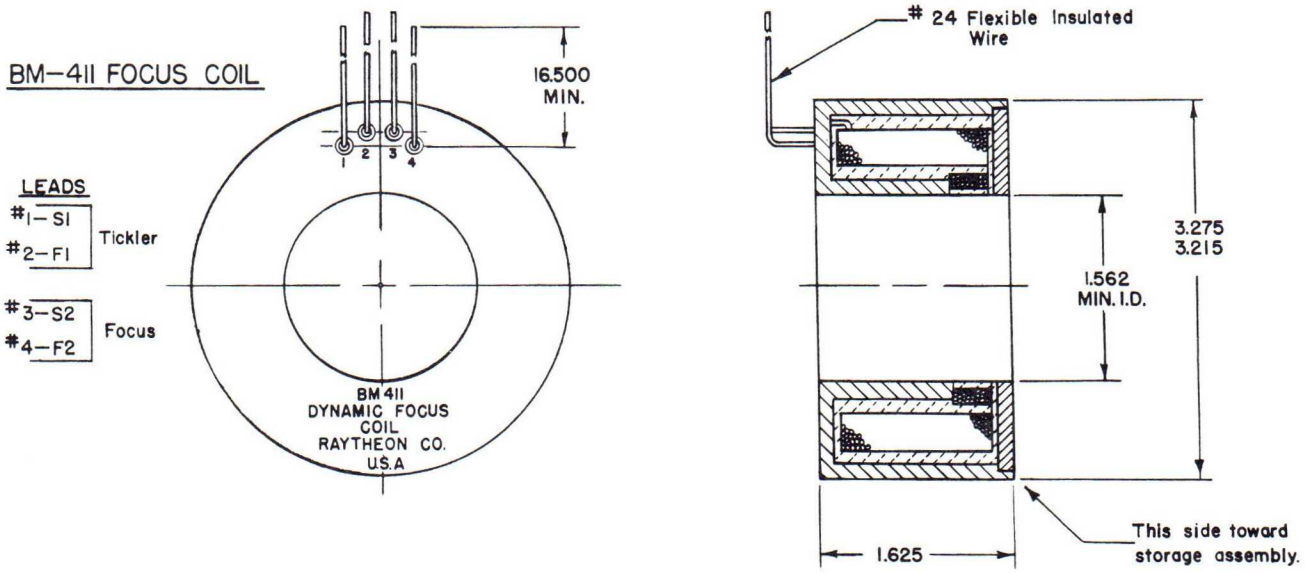


FIGURE 5

FOCUS COIL

Resistance – 6500 to 9000 ohms (at 20° C)
Max. Current – 25 madc
Voltage Rating – 250 V

TICKLER COIL

Resistance – 105 to 145 ohms (at 20° C)
Max. Current – 30mA RMS
Voltage Rating – 25 OV
Inductance – 45 Millihenries Approx.

NOTES:

1. For use with recording storage tubes and simulators.
2. Tickler coil is provided to permit dynamic focus correction. See Fig. 4.
3. When not required, the tickler coil may be left unconnected.
4. Shell material – annealed swedish iron or equivalent.

TYPICAL SCHEMATIC

Radar PPI to TV Scan Conversion, Simultaneous Write and Read with automatic prime (erasure) and RF separation.

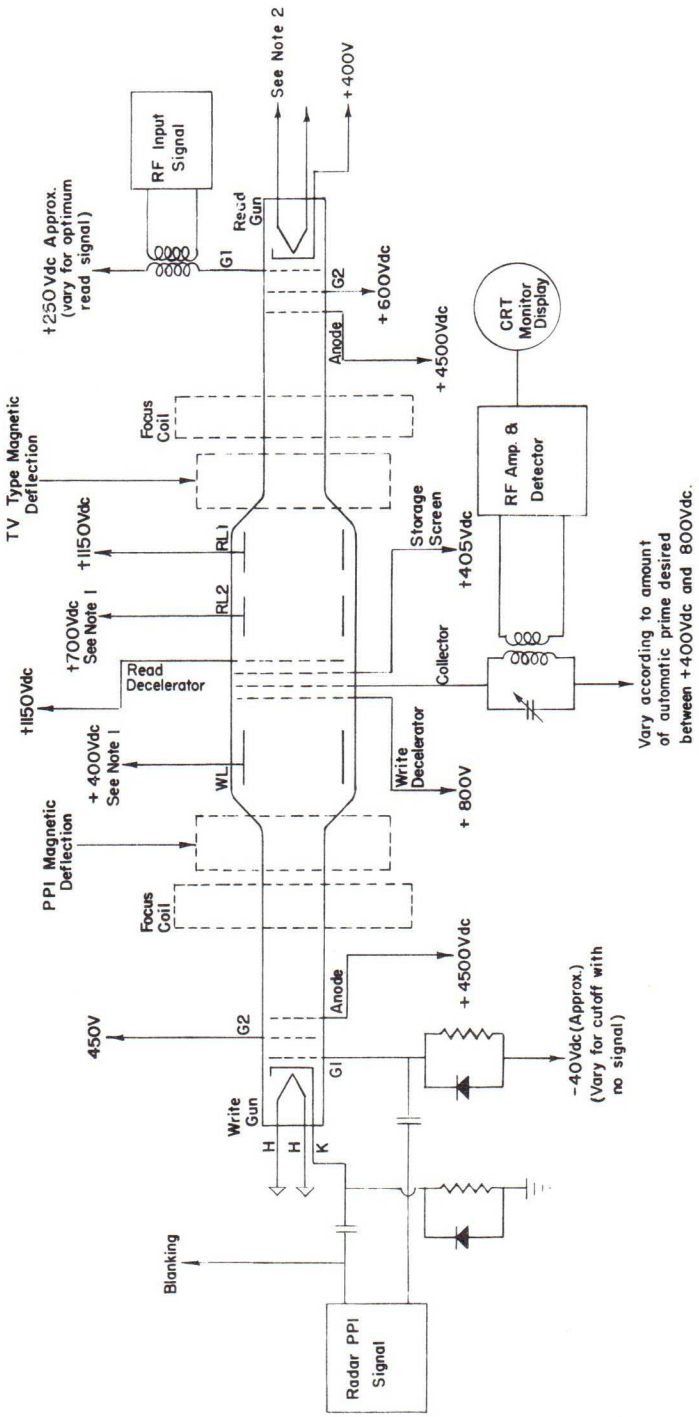
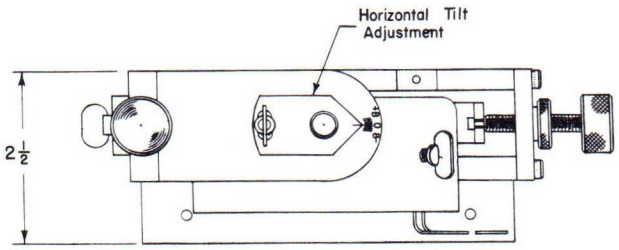
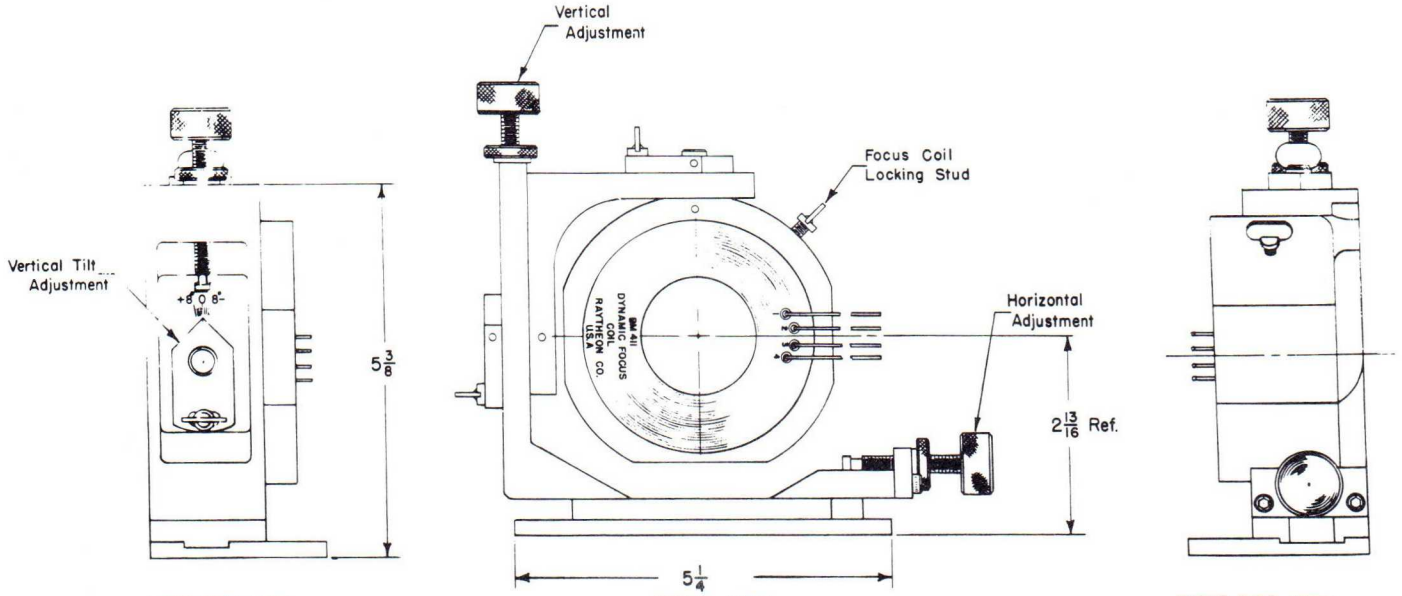


FIGURE 6



TOP VIEW



LEFT SIDE VIEW

FRONT VIEW

RIGHT SIDE VIEW

FIGURE 7

RECOMMENDED FOCUS COIL
MOUNTING ASSEMBLY

MECHANICAL OUTLINE

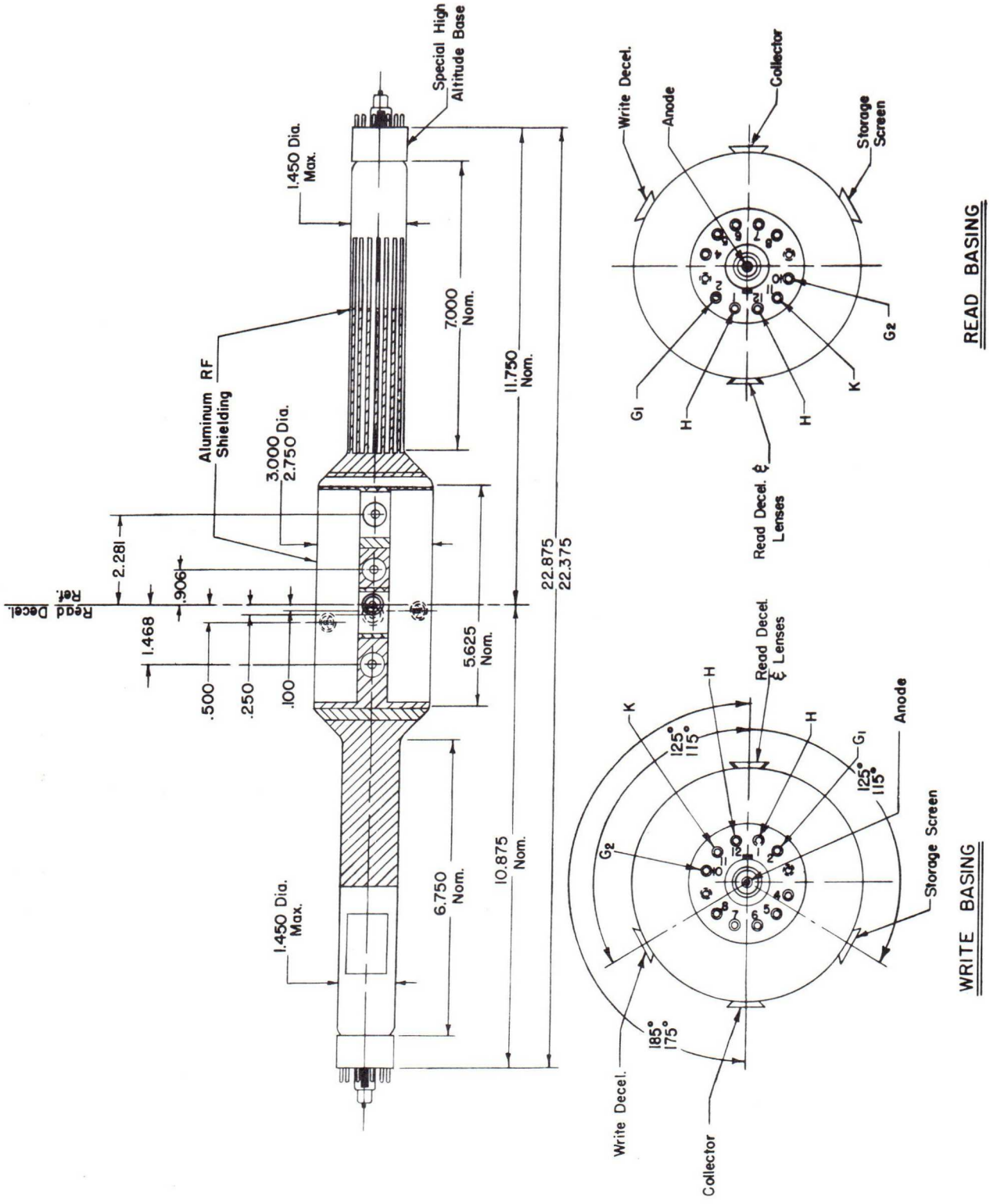


FIGURE 8

RAYTHEON

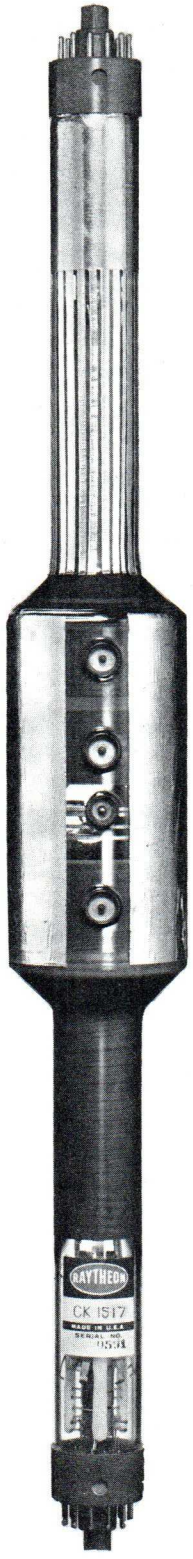
RECORDING STORAGE TUBE CK1517

The CK1517 is a high resolution, rugged dual–gun cathode–ray recording storage tube capable of simultaneous writing and reading. It is an electronic input–electronic output storage device which combines high output signal with high resolution. The major application is scan conversion such as radar PPI to television type presentation. This type of system yields a bright video display, with high resolution and adjustable automatic priming or erasing, which may be used to generate target trails indicating elapsed time position. It is similar to the CK1383 except that it provides higher resolution and ruggedized design. Stored signals can be held for a long period, read several thousand times, or erased in a fraction of a second if desired. The storage capabilities permit additional coherence of target information under conditions of high noise levels.

Both the writing and reading guns use magnetic deflection and magnetic focus. For uniform resolution over the storage surface, dynamic focus correction is recommended.

The design of the tube results in a wide dynamic range, fast writing speeds, and selective erasure of the stored information is desired.

Rugged design makes the tube suitable for military airborne and shipboard applications.



ELECTRICAL DATA

GENERAL CHARACTERISTICS

Gun Locations	Co–axial
Gun Type (Both Guns)	Tetrode High Resolution
Deflection (Both Guns)	Magnetic
Max. Deflection Angle (Both Guns)	30°
Focusing	Magnetic
Mounting Position	Any
Resolution (Magnetic Focus)	
TV lines per diameter	1600 lines minimum
Output Capacitance	
(Collector and Write Decelerator to all other elements)	19 pf (approx.)
Erasing Technique	Switching or Automatic

MECHANICAL CHARACTERISTICS

Seated Length	23 1/2" Nominal
Bulb Diameter	3" Maximum
Neck Diameters	1.450" Maximum
Bases (Both Ends)	Special High Altitude
Sockets (Both Ends – not supplied)	See Note 1
Storage Assembly Buttons	JEDEC Type J1–22

RAYTHEON RECORDING STORAGE TUBE CK1517

ELECTRICAL CHARACTERISTICS

RATINGS – ABSOLUTE MAXIMUM VALUES

Heater Voltage	6.3 ± 5% Volts
Anode Voltage (Either Gun)	5200 Vdc
Grid Drive Voltage (Write Gun)	90% Eco (cut–off)
(Read Gun)	75% Eco (cut–off)
Write Control Grid Voltage Negative	–150 Vdc
Read Control Grid Voltage	–275 Vdc
Write Grid # 2 Voltage	650 Vdc
Read Grid # 2 Voltage	650 Vdc
Inter Screen Voltage (Between any pair)	1000 Vdc
Grid Circuit Resistance	0.5 Meg.
Heater Cathode Voltage	± 125 Vdc
Write Collimating Lens Voltage	1000 Vdc
Read Collimating Lens # 1 Voltage	1000 Vdc
Read Collimating Lens # 2 Voltage	1000 Vdc
Read Decelerator Voltage	1000 Vdc
Write Decelerator Voltage	1000 Vdc

(Except for heater rating and interscreen voltages, all voltages shown above are referenced to the respective gun cathode.)

TYPICAL OPERATING CHARACTERISTICS – (See Note 2)

Deflection drive must be applied to both guns whenever the tube is conducting to avoid damage to the storage assembly.

All Voltages except read G1 with respect to write cathode.

WRITE GUN

Cathode Voltage	0 Vdc
G–1 Cut–off	–30 Vdc to –80 Vdc
G–2	600 Vdc
Anode	4500 Vdc
Collimating Lens	400 Vdc
Write Decelerator	800 Vdc
Collector	+400 to +1000 Vdc

READ GUN

Cathode Voltage	400 Vdc
Cathode Current (nominal)	80 μA
G–1 Cut–off (with respect to Read K)	–100 Vdc to –250 Vdc
G–2	1000 Vdc
Anode	4500 Vdc
Decelerator	900 Vdc
Collimating Lens 1	900 Vdc
Collimating Lens 2	800 Vdc
Storage Screen	405 Vdc

NOTE 1: Sockets obtainable from Alden Products Co., 117 N. Main St. Brockton, Mass., part no. 212 FTSISL.

NOTE 2: For principles of operation and additional information see Raytheon Dual Gun Application Bulletin.

MECHANICAL OUTLINE

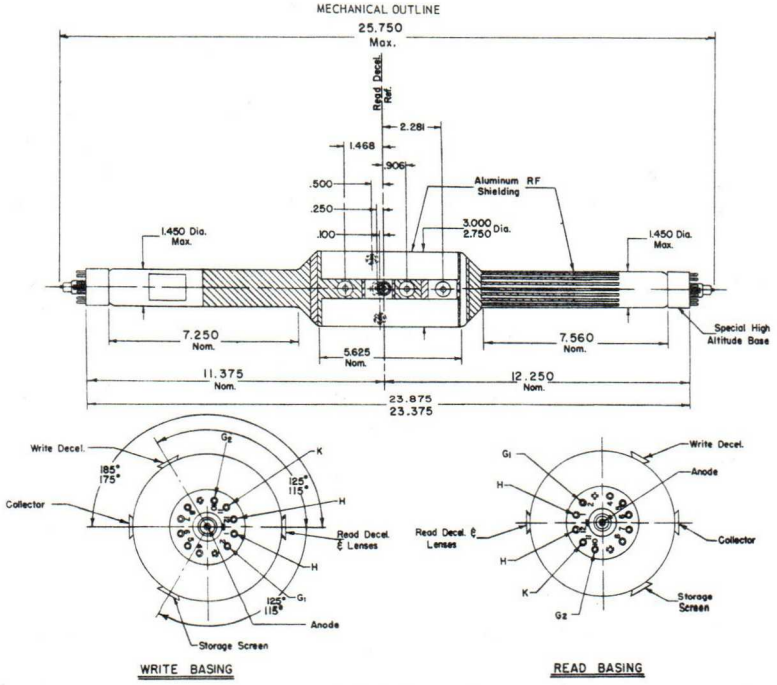


FIGURE 8

RAYTHEON

RECORDING STORAGE TUBE CK1521

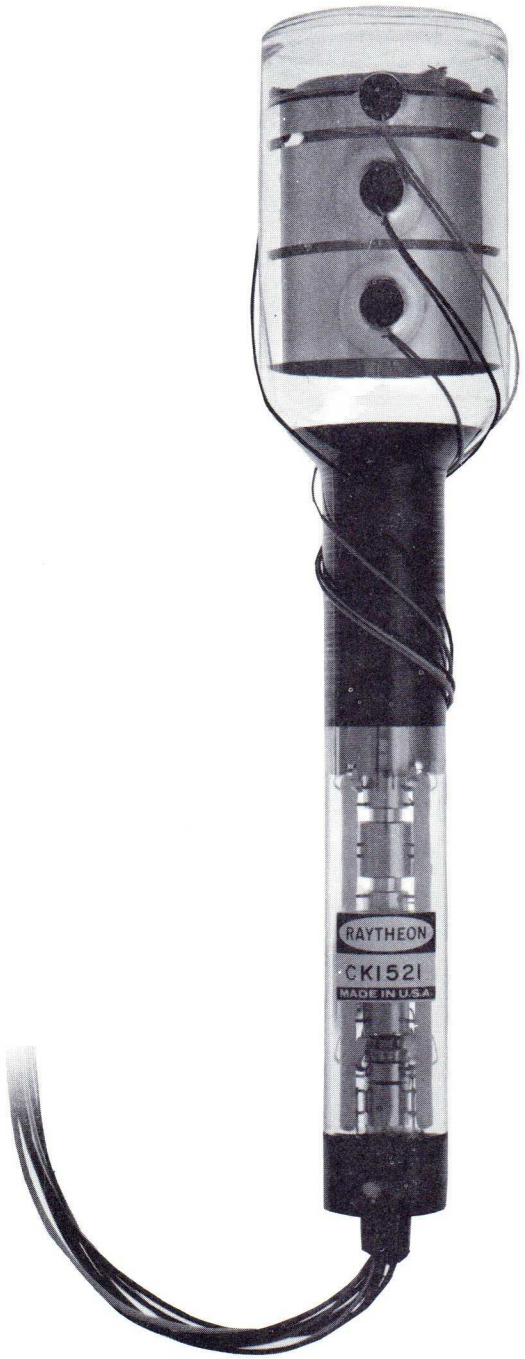
The CK1521 is an ultra–high resolution, high output–signal, electronic output single–gun recording storage tube. The CK1521 is similar to the 7571/QK685 in operating principle. Rugged design makes the CK1521 suitable for operation in environments such as military airborne applications.

A unique electron gun design makes possible fast erasure, fast writing speed, high output–signal amplitude, and wide dynamic range, all at very high resolution. At intermediate levels of output–signal, the CK1521 is capable of long storage of information. Several thousand readouts are possible without serious deterioration of signal strength or quality. Without readout, signals may be stored for many hours.

Output uniformity or shading characteristics have been enhanced in the CK1521 through the use of very accurately spaced and aligned elements in an improved collimating lens system.

The CK1521 design yields important improvements in virtually all critical storage tube operating parameters, suggesting its use in improved versions of existing systems and allowing its use in new applications demanding extended storage tube capabilities.

The CK1521 employs magnetic deflection and magnetic and/or electrostatic focus. For highest resolution magnetic focus is recommended. For uniform resolution over the storage surface, dynamic focus correction is necessary.



MECHANICAL CHARACTERISTICS

See Page 4

Overall Length	13½'' Maximum
Bulb Diameter	3'' Maximum
Neck Diameter	1½'' Maximum
Electrode Connections	Teflon–insulated Flying Leads

PERFORMANCE CHARACTERISTICS

Resolution (Magnetic Focus) TV lines per diameter	2500 Minimum*
Resolution (Electrostatic Focus) TV lines per diameter	1800 Nominal*
Writing Speed – nanoseconds per element	40 Nominal
Erasure Speed – nanoseconds per element	100 Nominal
Output Signal – microamps peak	0.5 Nominal
Output Capacitance	16pf Nominal
Beam & Cathode Current Transfer Characteristics	Figure 1

*At 50% Modulation.

GENERAL CHARACTERISTICS

Deflection	Magnetic
Focusing	Magnetic and/or Electrostatic
Max. Deflection Angle	30°
Gun Type	Tetrode, High Resolution
Mounting Position	Any

RECORDING STORAGE TUBE CK1521

ELECTRICAL CHARACTERISTICS

HEATER

Heater Voltage	6.3V ± 5%
Heater Current	0.6 amp. Nominal

RATINGS – ABSOLUTE MAXIMUM VALUES

All voltages with respect to cathode unless otherwise noted.

Anode Voltage	5000 Vdc
Focus Anode Voltage	5000 Vdc
Condenser Lens Voltage	5000 Vdc
Grid #2 Voltage	1000 Vdc
Grid #1 Voltage Positive	0 Vdc
Grid #1 Voltage Negative	–150 Vdc
Heater Cathode Voltage	
Positive	+10 Vdc
Negative	–125 Vdc
Storage Assembly Voltage (between adjacent elements in storage assembly)	1000 Vdc
Collimating Lens #1	1000 Vdc
Collimating Lens #2	1000 Vdc

TYPICAL OPERATING CONDITIONS

All voltages with respect to cathode unless otherwise noted.

Cathode (with respect to ground)	0 Vdc
Grid #1 (cutoff)	–30 to –80 Vdc
Grid #2	600 Vdc
Anode	3500 Vdc
Focus Electrode (Magnetic Focus) Note 1	3500 Vdc
Focus Electrode (Electrostatic Focus) Note 2	100 to 500 Vdc
Focus Electrode (Magnetic and Electrostatic Focus) Note 3	1000 Vdc
Condenser Lens (Write & Read Modes) Note 4	3500 Vdc
Condenser Lens (Erase & Prime Modes) Note 4	400 Vdc
Collimating Lens #1	750 Vdc
Collimating Lens #2 Note 5	200 to 500 Vdc
Decelerator Screen	750 Vdc
Storage Screen Note 6	Adjust Vdc
Collector (Signal Electrode)	750 Vdc

NOTES

1. Operation with all magnetic focus is necessary to achieve highest resolution. Magnetic dynamic focus is necessary to obtain uniform resolution over the storage surface. The approximate shape and amplitude of the magnetic dynamic focus waveform are given in Figure 2.

2. If electrostatic focus is used, focus electrode voltage is adjusted for best focus. For the anode voltage given, best focus will be obtained with focus voltage between the limits shown in typical operating conditions.

3. For certain applications, the combined use of electrostatic and magnetic focus is desirable. The principle purpose of this mode of operation is to facilitate dynamic focus correction by superimposing a time varying voltage on the quiescent value of focus voltage noted in typical operating conditions. The approximate shape and amplitude of the electrostatic dynamic focus waveform are given in Figure 3.

4. The condenser lens is used as a beam current enhancement electrode in the electron gun to achieve the high levels of beam current necessary to accomplish fast erasure. This electrode is operated at anode voltage in the write and read modes. During erasure (erase and prime modes) the condenser lens voltage is pulsed from anode voltage to the level noted in typical operating conditions. The condenser lens voltage for optimum beam–current enhancement varies with anode voltage as shown in Figure 4.

5. Output uniformity is controlled by the voltages of the elements in the collimating lens system of the storage tube. For the operating conditions given in typical operating conditions, output uniformity is optimized by the adjustment of the collimating lens #2. Optimum output uniformity will be obtained with a setting of collimating lens #2 voltage between limits shown in typical operating conditions.

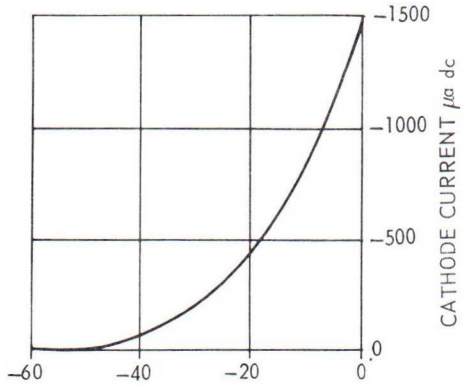
6. In the storage assembly, storage screen voltage is switched to achieve the various modes of operation (erase, prime, write, read) in the storage tube. The following table shows typical operating conditions for the storage screen voltage:

Erase	Prime	Write	Read
750 Vdc	20 Vdc	500 Vdc	15 Vdc (approx)

The exact setting of storage screen voltage in the read mode is determined experimentally by adjustment to the value at which output signal on the collector electrode is uniformly cut off across the storage surface.

RECORDING STORAGE TUBE CK1521

TYPICAL ELECTRON GUN TRANSFER CHARACTERISTICS



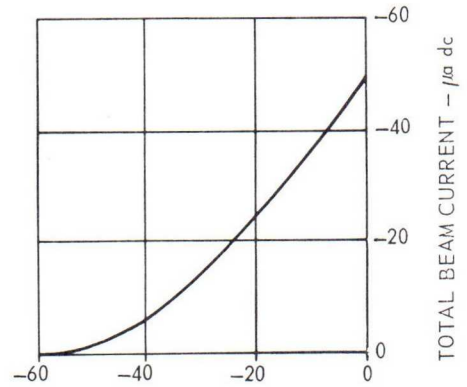


FIGURE 1

TYPICAL MAGNETIC DYNAMIC FOCUS CHARACTERISTIC

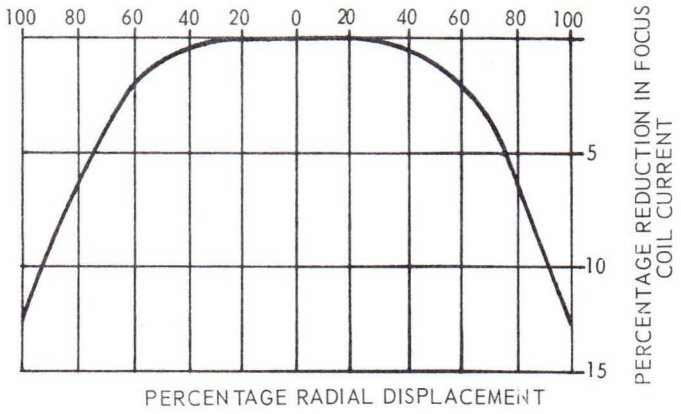


FIGURE 2

TYPICAL ELECTROSTATIC DYNAMIC FOCUS CHARACTERISTIC

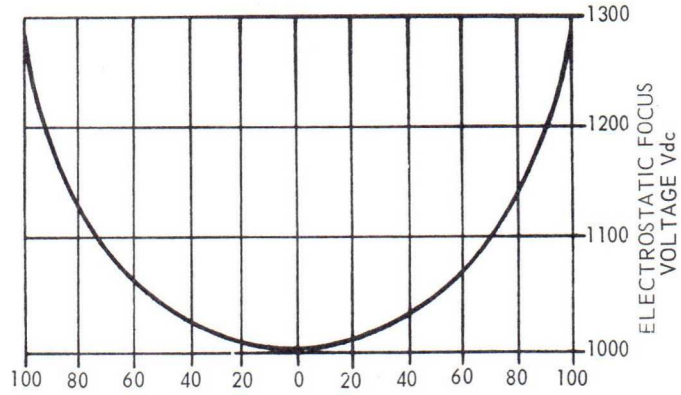


FIGURE 3

TYPICAL BEAM CURRENT ENHANCEMENT CHARACTERISTIC

$$\text{ENHANCEMENT \%} = \frac{\text{TOTAL BEAM CURRENT}}{\text{CATHODE CURRENT}} \times 100\%$$

E_{A_1} = ACCELERATING ANODE VOLTAGE

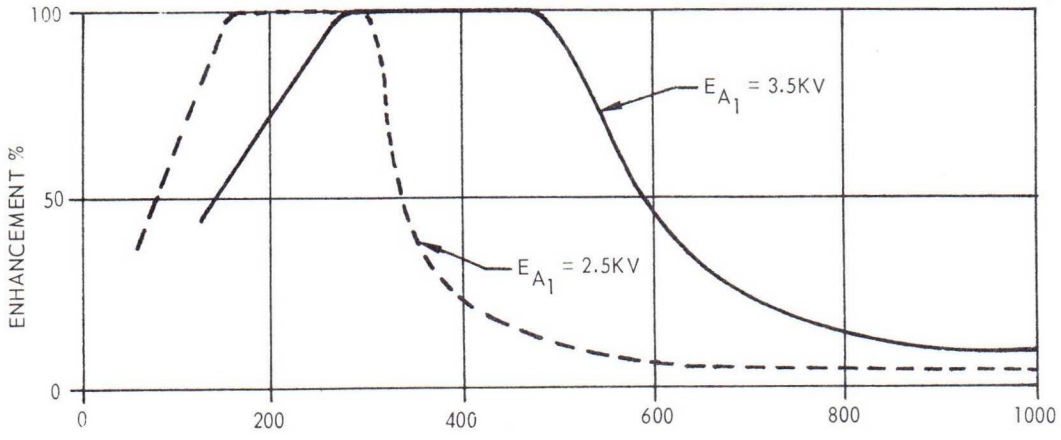
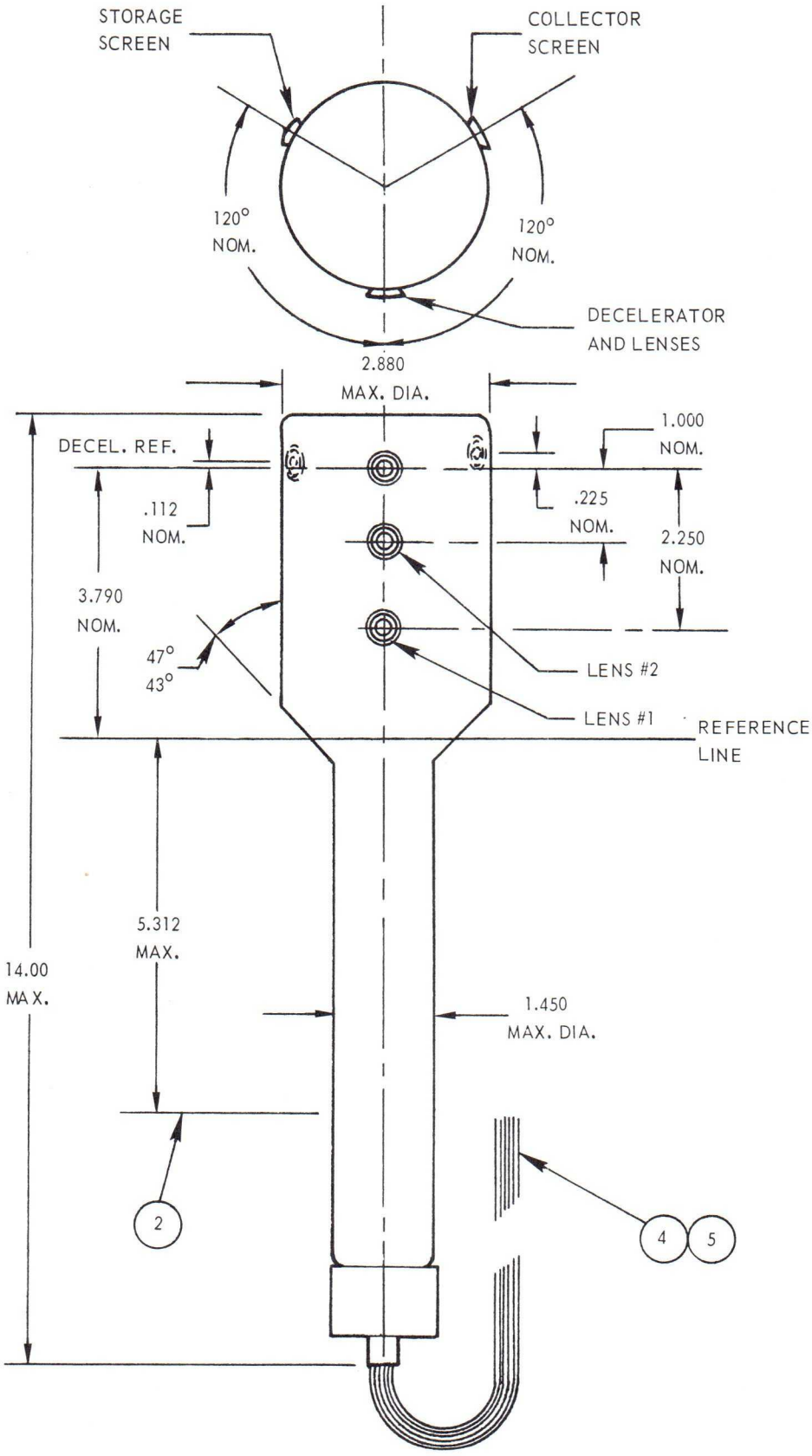


FIGURE 4

NOTES:

1. All contact buttons are JEDEC type J1–22.
2. Dimensions applies to plane nearest base beyond which magnetic focus or centering coils should not be located due to possible interference from internal gun structures.
3. Reference line is defined as that plane where a ring gauge 2.000 I.D. and parallel to neck axis comes to rest on neck flare.
4. Wire color coding as follows:
   Heaters – Brown
   Cathode – Clear
   Grid #1 – Green
   Grid #2 – Orange
   Condenser Lens – White
   Electrostatic Focus – Blue
   Anode – Red
5. Wire length: 12.000 in. approx.



RAYTHEON

RECORDING STORAGE TUBE CK1540

The CK1540 is a single-gun Recording Storage Tube of advanced design featuring high resolution, high output signal amplitude, fast erasing, priming and writing speeds, and long readout.

The CK1540 design brings about improvement in virtually all critical storage tube operating parameters, suggesting its use in improved versions of existing systems and allowing its use in new applications demanding extended storage tube capabilities. Typical applications for this tube type include image and data storage, scan conversion, and signal processing. Ruggedized construction makes the CK1540 suitable for use in environments such as military airborne and shipboard applications.

The CK1540 employs electromagnetic deflection and focus. For highest and most uniform resolution over the storage surface, dynamic focus correction is necessary.

MECHANICAL DATA

See Page 3

Overall Length	14¾"
Bulb Diameter	31/8" Maximum
Neck Diameter	1½" Maximum
Electrode Connections	JEDEC J1-22 or flying leads

GENERAL CHARACTERISTICS

Deflection	Magnetic
Max. Deflection Angle	30^0
Gun Type	High Resolution
Mounting Position	Any

PERFORMANCE CHARACTERISTICS

Resolution-TV Lines Per Diameter, 50% Modulation, Orthogonal Read	1600 Minimum
Erase and Prime Time-Milliseconds to 1% or less Residual Signal	30 Minimum
Output Signal-Microamps Peak at Stated Resolution	1.0 Nominal
Writing Speed-Microseconds per Diameter at Stated Resolution	50 Minimum
Readout Time-Minutes to 50% Signal Remaining	3 Nominal
Output Capacitance-Picofarads	15 Nominal

ELECTRICAL CHARACTERISTICS

HEATER

Heater Voltage	6.3 ± 5%V
Heater Current at 6.3 volts	0.6A

MAXIMUM RATINGS, Absolute–Maximum Values

All Voltages given with respect to cathode unless otherwise noted.

Peak Heater–Cathode Voltage:	
Heater negative with respect to cathode	125 Max. V
Heater positive with respect to cathode	10 Max. V
Grid-No. 1 Voltage	
Negative Bias Value	150 Max. V
Positive Bias Value	0 Max. V

ELECTRICAL CHARACTERISTICS (Cont'd.)

Grid-No. 2 Voltage	1000 Max. V
Grid-No. 3 (Accelerator) Voltage	2000 Max. V
Grid-No. 4 (Beam Enhancement Electrode) Voltage	2000 Max. V
Collimating Lens No. 1 Voltage	1000 Max. V
Collimating Lens No. 2 Voltage	1000 Max. V
Storage Assembly-Voltage between adjacent electrodes	1200 Max. V

TYPICAL OPERATING CONDITIONS

All voltages given with respect to cathode.

Cathode Voltage	0 V
Grid-No. 1 (Cutoff) Voltage	−40 to −90 V
Grid-No. 2 Voltage	600 V
Grid-No. 3 (Accelerator) Voltage	950 V
Grid-No. 4 (Beam Enhancement Electrode) Voltage:	
Write and Read Modes (Note 1)	950 V
Erase and Prime Modes (Note 1)	100 V
Collimating Lens No. 1 Voltage	500 V
Collimating Lens No. 2 Voltage (Note 2)	300 to 600 V
Grid-No. 6 (Screen) Voltage:	
Erase Mode	500 V
Prime, Write and Read Modes	1000 V
Storage Screen Voltage:	
Erase and Write Modes	500 V
Prime Mode	20 V
Read Mode (Note 3)	12 to 18 V
Collector (Output Signal Electrode) Voltage	500 V
Dynode (Metal End Cap) Voltage	300 V

NOTES:

Note 1: The beam enhancement electrode (Grid—No. 4) is used to achieve the high levels of beam current necessary to accomplish fast erasure. This electrode is operated at accelerator voltage in the Write and Read modes. During Erase and Prime modes, the beam enhancement electrode voltage is pulsed from accelerator voltage down to the level noted. At the lower voltage, the beam enhancement electrode increases the efficiency of the electron gun by reducing the size of the electron beam at the accelerator limiting aperture.

Note 2: Output signal amplitude uniformity is controlled by the voltages of the elements in the collimating lens system of the storage tube. For the operating conditions given, output uniformity is optimized by the adjustment of the collimating lens No. 2 voltage. Optimum output uniformity will be obtained with a setting of collimating lens No. 2 voltage between limits shown.

Note 3: The storage screen voltage is switched to achieve the various modes of operation (Erase, Prime, Write, Read) in the storage tube. The storage screen voltage in the Read mode is adjusted to the value at which output signal on the collector electrode is uniformly cut off across the unwritten storage screen surface.

RECORDING STORAGE TUBE CK1540

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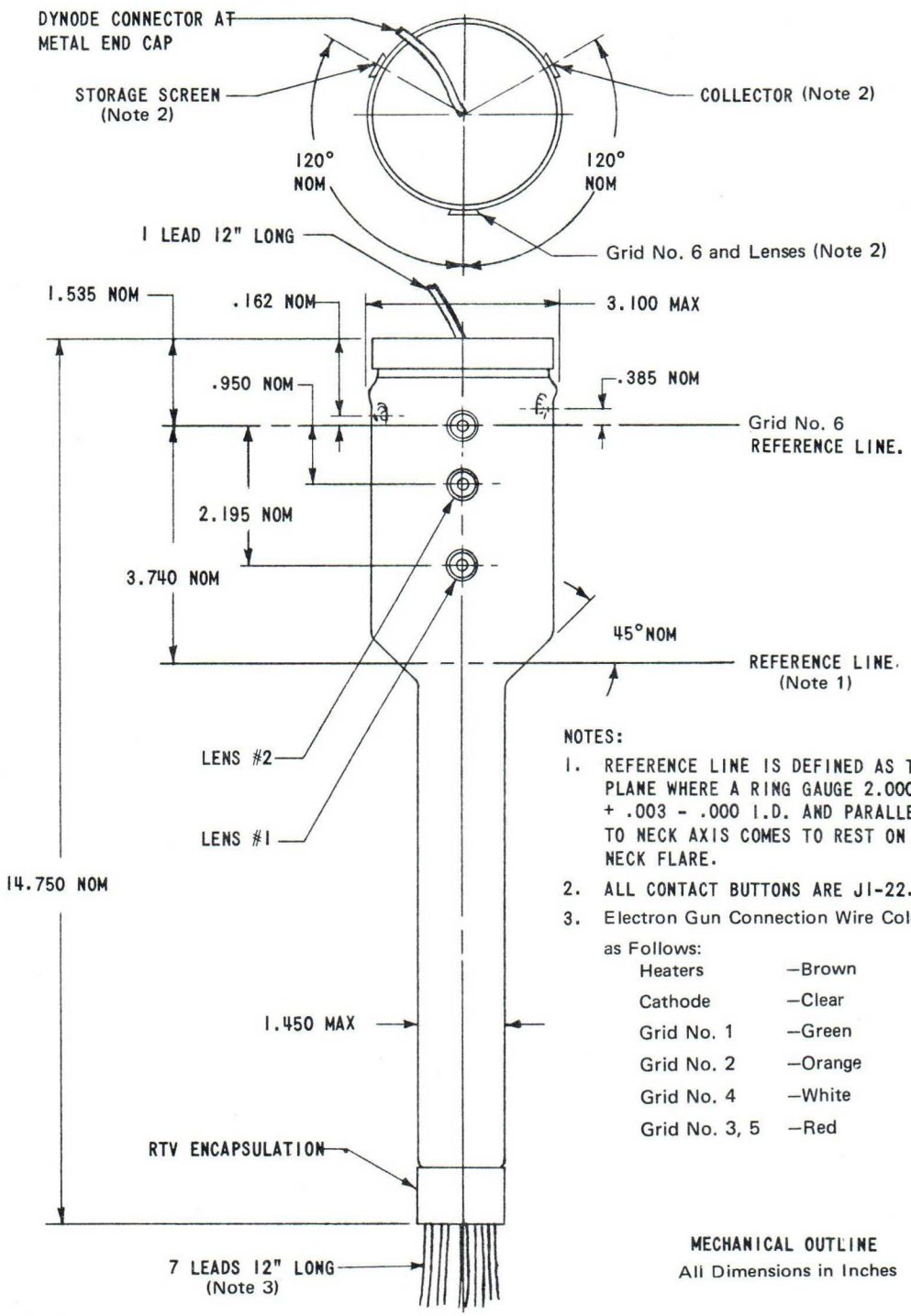


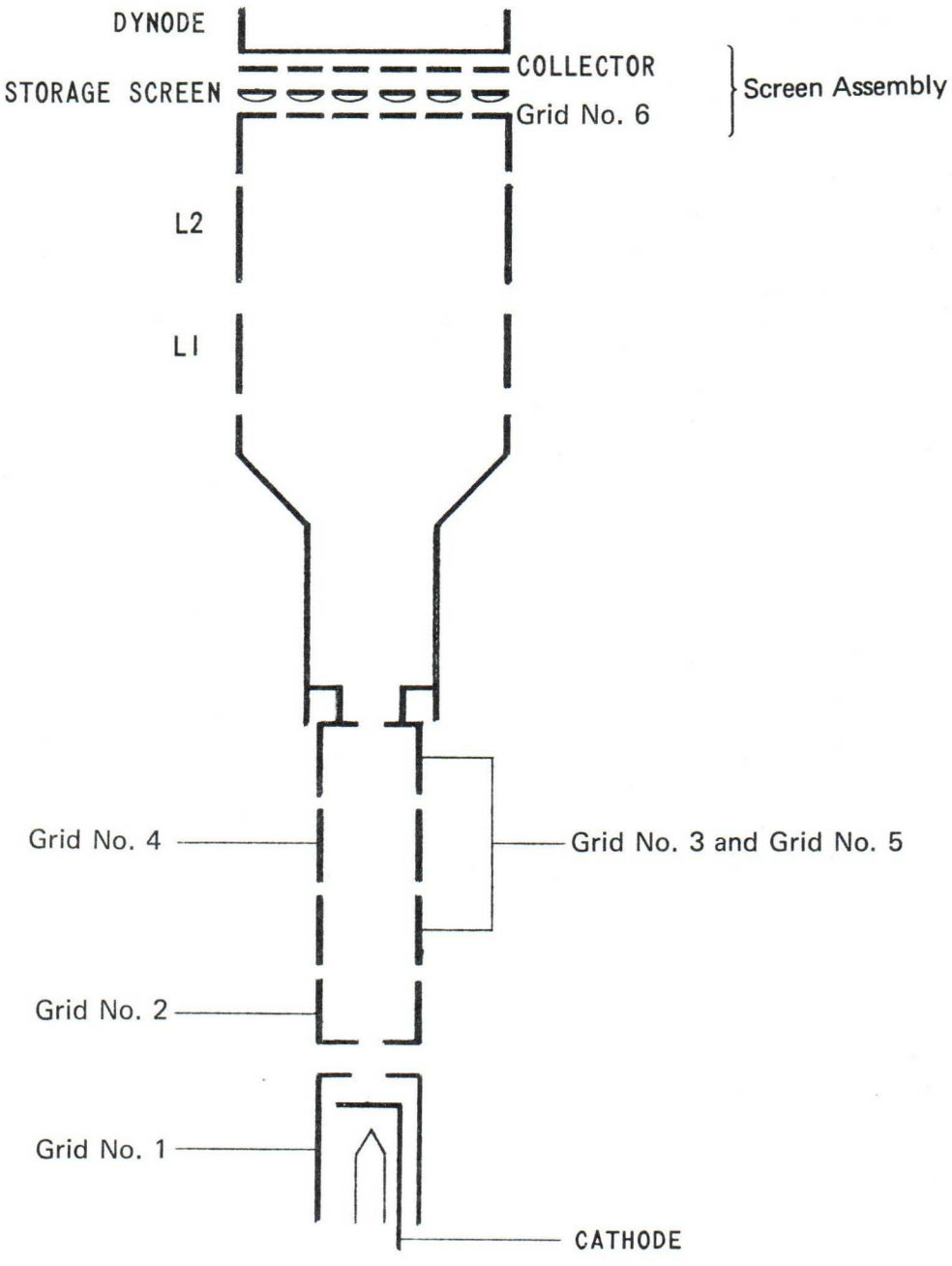
NOTES:

1. REFERENCE LINE IS DEFINED AS THAT PLANE WHERE A RING GAUGE 2.000 + .003 - .000 I.D. AND PARALLEL TO NECK AXIS COMES TO REST ON NECK FLARE.
2. ALL CONTACT BUTTONS ARE J1-22.
3. Electron Gun Connection Wire Color Coding as Follows:

Heaters	—Brown
Cathode	—Clear
Grid No. 1	—Green
Grid No. 2	—Orange
Grid No. 4	—White
Grid No. 3, 5	—Red

MECHANICAL OUTLINE
All Dimensions in Inches

RAYTHEON RECORDING STORAGE TUBE CK1540



PICTORIAL SCHEMATIC

CK7571/ QK685

RECORDING STORAGE TUBE

GENERAL DESCRIPTION

The CK7571/QK685 is a high resolution electrical output Recording Storage Tube capable of repeating information stored for many hours up to 20,000 times without serious deterioration of signal strength or quality. It requires magnetic deflection but it can be focused either magnetically or electro-statically, or using a combination of both. The properties of integration ability, dynamic range, storage duration and speed of operation in the various modes are approximately equivalent quantitatively with those found in the prototype tube CK6835/QK464A.

GENERAL CHARACTERISTICS

Resolution (Magnetic Focus)	1000 Lines Minimum
Resolution (Electrostatic Focus)	700 Lines Nominal
Output Capacitance	12 uuf Nominal
Grey Levels	5
Gun Type	Tetrode
Deflection	Magnetic
Max. Defl. Angle	30°
Focusing	Electrostatic or Magnetic
Mounting Position	Any

MECHANICAL CHARACTERISTICS

Overall Length	13-3/16 Nominal
Bulb Diameter	2¾" Nominal
Neck Diameters	1½" Maximum
Storage Screen Diameter	2"
Base	Small Shell Duodecal
Lens Buttons	JETEC Type J1-22

Printed in USA

DETAILED ELECTRICAL INFORMATION

CONDITIONS OF OPERATION

Application of the recording storage tube involves four operations, namely: prime, write, read and erase. Any form of scanning may be utilized for the above operations. These operations are performed in the following manner and sequence:

Prime — Priming is accomplished by uniformly charging the storage surface. To prime the storage screen reduce the screen voltage below the critical potential (usually 30 V) and scan the raster with 10 to 50 uA depending on priming speed desired.

Write — Set control grid bias at cutoff either manually or automatically and apply signal to be stored. Signal voltage amplitude required will depend on the sweep speed employed and is measured in terms of average cathode current.

Read — Set grid bias to permit an unmodulated beam current of approximately 2 uA. If the storage screen voltage is properly set, the stored signal will modulate the beam and an output can be taken from the signal electrode.

Erase — Erasing is performed by writing a DC signal into the tube, thus normalizing the storage element at full modulation level. The signal electrode and storage screen voltages should be the same for this operation. A beam current of 10 uA is normally used. This operation can be eliminated in many applications where only partial erasures are desired or where the time which can be allotted *priming* is one second or more.

STORAGE ABILITY

The length of time a tube will retain the stored information is a function of the operating conditions and varies inversely as the cathode current.

When reading with a low beam current of about 1.0 uA at a television repetition rate and scan, several thousand consecutive readings can be made without any appreciable deterioration of the stored signal. This indicates that a single spot element can be read continuously for approximately 5 milliseconds without significant fading or reorientation of the charge.

The tube is capable of storage information for many hours without appreciable change or deterioration and may be read up to 20,000 times after the delay period and still yield satisfactory results.

RESOLVING POWER

The resolution of the storage tube at the 50% modulation level is usually in excess of 1000 lines across the diameter and is obtainable when the minimum current for writing a fully modulated signal is employed and the focus coil magnetic shell is designed to minimize astimagtism. Resolution is also dependent on the orientation of the focus coil with respect to the gun, and the sharpness of focus across the storage screen. Therefore, for applications requiring optimum resolution, dynamic focusing is often desirable.

FOCUS

Using a standard BM411 focus coil, approximately 19 MA of current will be required for dc magnetic focusing. If dc electrostatic focus is used, the focus voltage will be approximately 400 volts. For magnetic dc focus and electrostatic dynamic focus, it is recommended that the electrostatic focus electrode be set at 1000 volts dc and that the magnetic focus current be adjusted for optimum spot size in the center of the storage screen (approximately 16 MA will be required). With these static conditions, the dynamic waveform applied to the electrostatic focus element will rise from the 1000 volts dc value to approximately 1150 volts dc as the beam is scanned from the center of the screen to the edge. (The rise will be slow for the first half of this distance and then at an increasing rate.)

ELECTRICAL

(All Voltages Measured With Respect to Cathode)

Heater

Heater Voltage	6.3 V±10%
Heater Current	0.6 A

Maximum Ratings

Anode Voltage (A1)	5000 Vdc
Grid #1 (control electrode) Voltage	
Negative Bias	−125 Vdc
Positive Bias	0 Vdc
Positive Peak Value	+2 Vdc
Grid #2	1000 Vdc
Focus Anode Voltage (A2)	5000 V
Lens #1	800 Vdc
Lens #2	500 Vdc
Decelerator Screen	800 Vdc
Storage Screen	500 Vdc

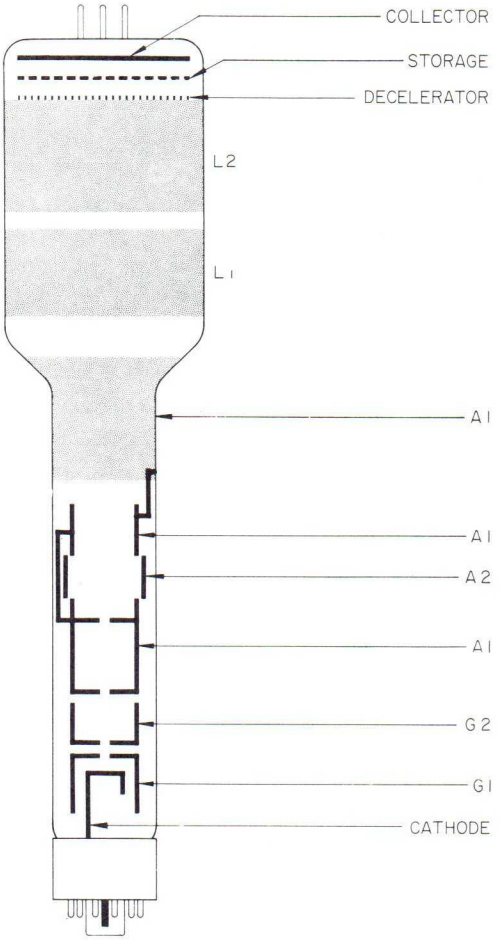
Typical Operating Conditions

Cathode	0 V
G1 (Control Grid) Cutoff	−30 V
G2 (Screen Grid)	400 V
L1 (Collimating Lens)	750 V
L2 (Collimating Lens)	400 V
Anode (A1)	3500 V
Focus Anode (A2)	
Electrostatic	400 V
Magnetic	3500 V
Decelerator	750 V
Collector	750 V

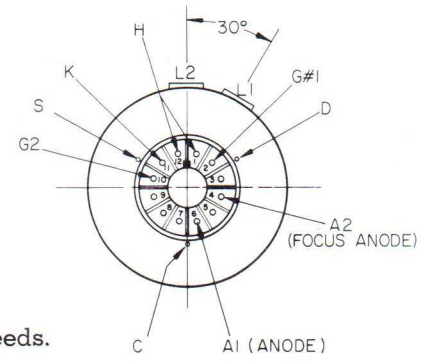
	Prime	Read	Erase	Write
Storage Screen	20 V	15 V	†	300 V
Cathode Current	25 μa	5 μa	50 μa	*
Signal Electrode Current (peak)		0.5 μa		

* This value must be determined experimentally depending on scan speeds.

† Should be shorted to Decelerator Screen during Erase.



S-STORAGE SCREEN (BLACK DOT), C-COLLECTOR (RED DOT), D-DECELERATOR (YELLOW DOT)

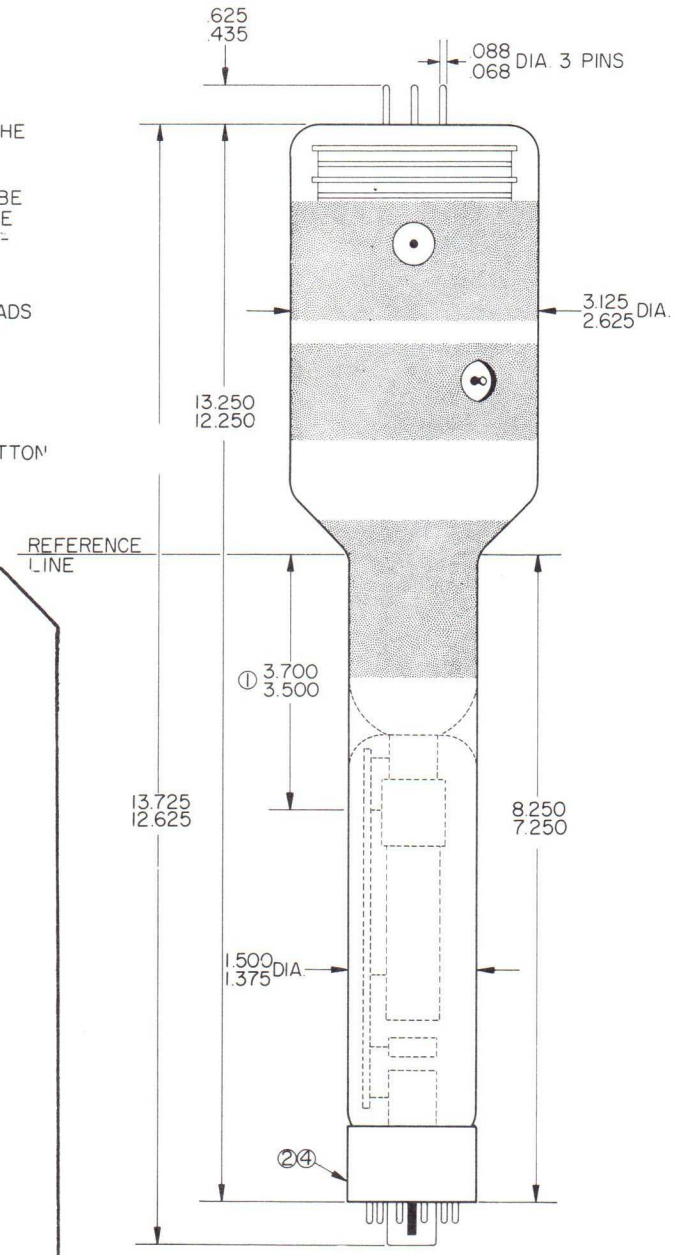


RAYTHEON

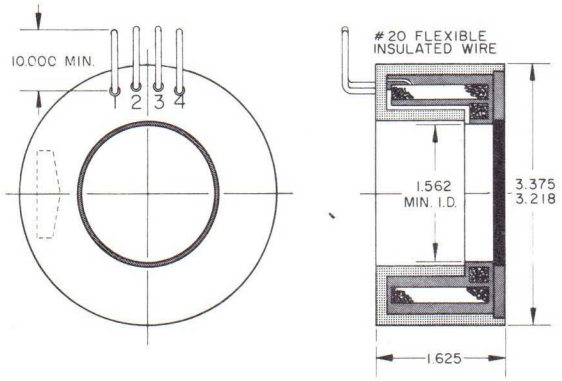
RECORDING STORAGE TUBE

NOTES:

1) LOCATION OF DEFLECTION YOKE AND THE GAP OF THE FOCUSING COIL MUST BE WITHIN THIS SPACE
2) SOCKET FOR THIS BASE SHOULD NOT BE RIGIDLY MOUNTED; IT SHOULD HAVE FLEXIBLE LEADS AND BE ALLOWED TO MOVE FREELY BOTTOM CIRCUMFERENCE OF BASE SHELL WILL FALL WITHIN A CIRCLE CONCENTRIC WITH CONE AXIS, AND HAVING A DIAMETER OF 2.000
3) TOP PIN CONNECTIONS SHOULD HAVE FLEXIBLE LEADS AND BE ALLOWED TO MOVE FREELY
   S - STORAGE SCREEN (BLACK DOT)
   C - COLLECTOR (RED DOT)
   D - DECELERATOR (YELLOW DOT)
4) B12-43 12 PIN BASE
5) LENS BUTTONS JETEC TYPE J1-22 LENS #2 BUTTON NEAR STORAGE ASSEMBLY



BM-411 FOCUS COIL



LEADS

#1 - S1
#2 - F1
#3 - S2
#4 - F2

TICKLER COIL

RESISTANCE - 35 TO 50 OHMS (AT 20°C)
MAX. CURRENT - 30 mA RMS
VOLTAGE RATING - 250 V.
INDUCTANCE - 45 MILLIHENRIES APPROX.

FOCUS COIL

RESISTANCE - 6500 TO 9000 OHMS (AT 20°C.)
MAX. CURRENT - 25 mAdc.
VOLTAGE RATING - 250 V.

NOTES:

1) - FOR USE WITH CK6835/QK464A, CK7571, OR CK7572 RECORDING STORAGE TUBES.
2) - TICKLER COIL IS PROVIDED TO PERMIT COMPENSATING FOR IMPROPER FOCUS AT THE EDGES OF A PATTERN CAUSED BY THE VARIATION IN DISTANCE FROM THE CENTER OF DEFLECTION TO a) THE CENTER OF A STORAGE AREA OF A STORAGE TUBE, AND b) THE PERIPHERY OF A STORAGE AREA. THIS TICKLER COIL USEFUL ONLY FOR SLOW SCANNING SPEEDS.
3) - WHEN NOT REQUIRED, THE TICKLER COIL MAY BE LEFT UNCONNECTED
4) - SHELL MATERIAL - ANNEALED SWEDISH IRON OR EQUIVELENT.

Preliminary Data*

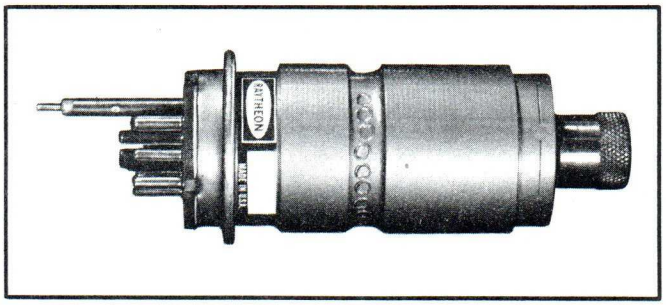
ISSUED 1/68

RAYTHEON

QKK1235 REFLEX KLYSTRON

GENERAL DESCRIPTION

The type QKK1235 is a velocity modulated oscillator of the single cavity (integral) reflex type designed for operation in the 10.7 to 11.7 GHz. range with a minimum power output of 1.0 watt. The tube is of the coaxial output type and is connected to standard WR75 waveguide as indicated on the attached drawing. In order to provide sufficient cooling, the tube can be equipped with either a heat sink or vapor cooler, QK1320A.



GENERAL CHARACTERISTICS

ELECTRICAL

Heater Characteristics

Heater Voltage	6.3 V
Heater Current	0.675 A

Maximum Ratings

Resonator Voltage	800 Vdc
Resonator Current	100 mAdc
Reflector Voltage	
Minimum	-200 Vdc
Maximum	-600 Vdc
Heater-Cathode Voltage	±100 Vdc

The values specified above must not be exceeded under any service condition. The ratings are limiting values above which the serviceability of any individual tube may be impaired. It does not necessarily follow that combinations of maximum ratings can be achieved simultaneously.

Typical Operating Conditions (VSWR 1.1 Max.)

Resonator Voltage	750 Vdc
Resonator Current	75 mAdc
Reflector Voltage	-350 -600 Vdc
Electronic Tuning Range	30 MHz
Modulation Sensitivity	0.4 MHz/Volt
Frequency Range	10.7-11.7 GHz
Power Output	1.0 Watt

MECHANICAL

Mounting Position	Any Position
Dimensions	See Drawing
Base	Standard Octal with Enlarged No. 4 Pin
Maximum Shell Temperature	135°C

*The specifications for this device have not been finalized. For current information contact the nearest Microwave and Power Tube Regional Sales Representative.

Printed in U. S. A.

REFLECTOR

The power supply furnishing the reflector potential must be insulated to withstand the total resonator and reflector voltage. In cases where modulating potentials bring the reflector voltage close to the minimum voltage, or where an extremely high reflector circuit impedance is required, a diode should be connected between cathode and reflector to prevent the reflector from going positive. If this precaution is not observed, damage to the reflector may result.

ELECTRONIC TUNING

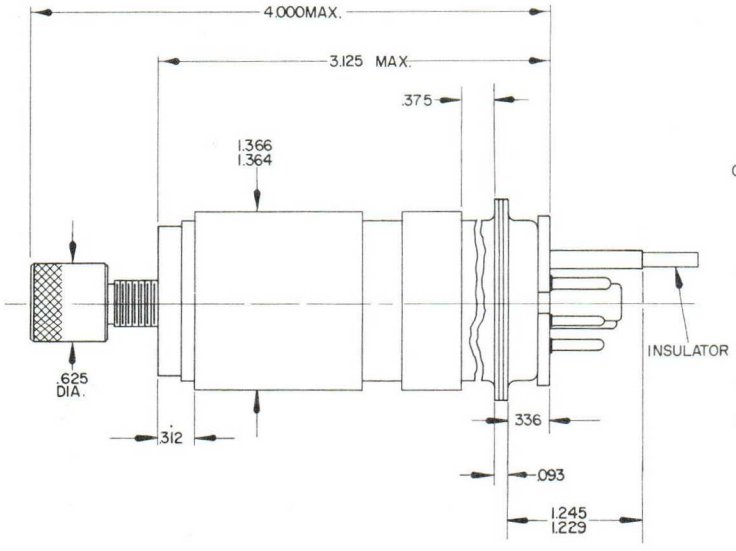
With the mechanical tuning mechanism set near the desired frequency, vernier adjustment of the frequency may be accomplished by varying the reflector voltage. Maximum power output for a fixed mechanical tuner position, however, will be obtained at only one reflector value. If the mechanical tuning mechanism and the reflector voltage are mutually adjusted for a maximum power output, at a given frequency, and if the reflector voltage is then varied above and below the value for maximum power output, such that the power output is reduced to one-half, the frequency change between the half-power values is defined as electronic tuning range.

INSTALLATION

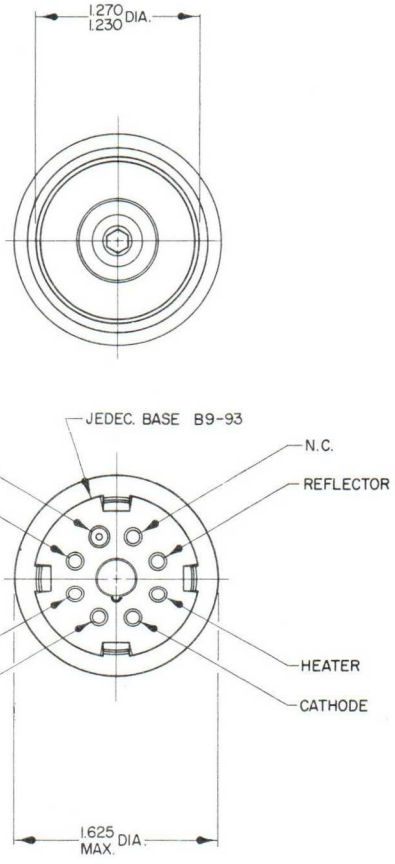
The tubes can be supplied with a vapor cooler, QK1320A, or with an adapter to be attached to a heat sink. In either case, care should be taken to insure that the shell temperature does not exceed 135°C.

The operating characteristics listed herein will be achieved only if the tube is used with the recommended coax to waveguide transducer operating into a VSWR of 1.1 or less.

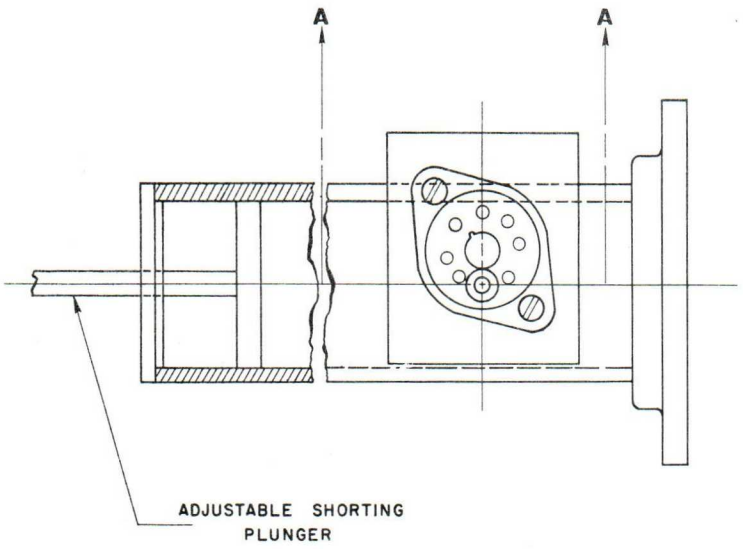
OUTLINE DRAWING



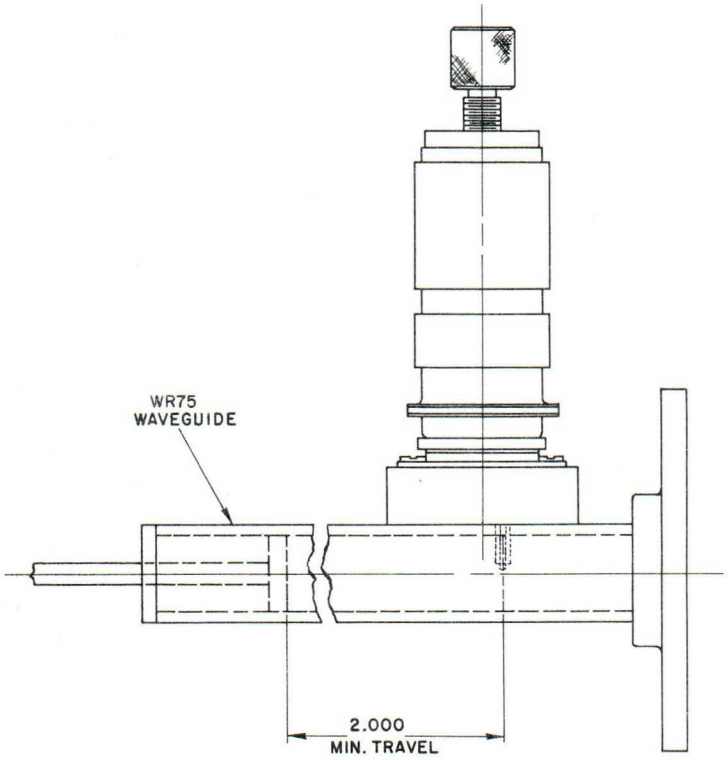
TOP VIEW



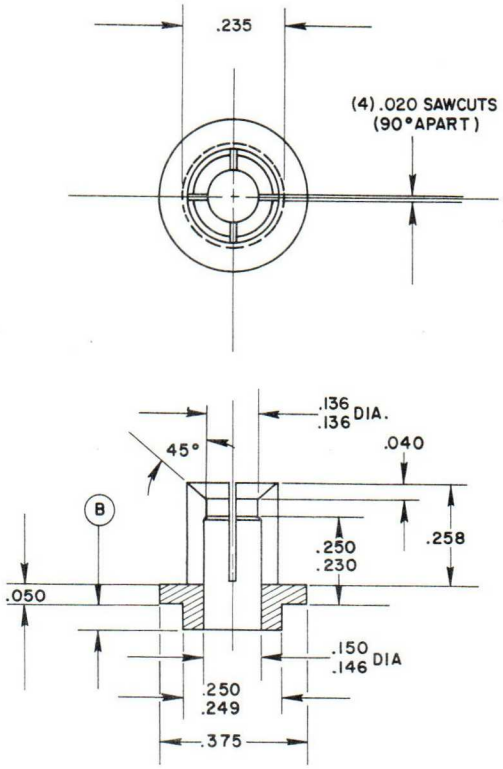
OUTLINE DRAWING OF TUBE MOUNT



A—ALL DIMENSIONS SHOWN ARE AFTER PLATING



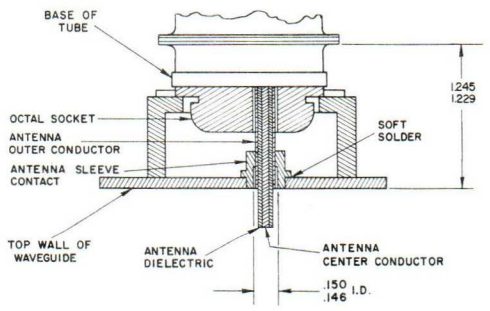
ANTENNA SLEEVE CONTACT



A-All dimensions are given as finished allow .0005 on each surface for silver plating.

B-This dimension to match thickness of waveguide wall.

DETAIL OF TUBE MOUNT



SECTION "A"—"A"

Preliminary Data*

ISSUED 6/64

RAYTHEON

QKH1014 ROTARY TUNED MAGNETRON

GENERAL DESCRIPTION

The QKH1014 is an integral magnet, air cooled, rotary tuned L-Band magnetron with a peak power output of 1.0 megawatt. System applications include frequency agile radars, frequency scan systems, and mutual interference reduction. Simplicity of design permits direct field replacement of fixed or manually tuned tubes.

The rotary tuning mechanism comprises a slotted disk suspended above the anode cavities and magnetically coupled to a variable speed motor located outside the tube. As the disk rotates, the slots alternately vary both the inductance and capacitance of the anode producing a frequency sweep across the tuning range. Completely random frequency agility can be obtained by modulating the motor speed or by varying the modulator pulse rate. Receiver tracking information is obtained from an integral transducer.

TYPICAL ELECTRICAL CHARACTERISTICS

Frequency Range	1250-1350 Mcs
Peak Power Output	1.0 Megawatts minimum
Anode Voltage	55 Kilovolts
Peak Anode Current	50 Amperes
Pulse Width	5.0 usec maximum
Duty Cycle	.00112

ROTARY TUNING CHARACTERISTICS

Time to tune full band at 2400 RPM	1/800 sec.
Tuner Life	720,000,000 cycles (minimum)
Rotation Rate	up to 3000 RPM

MECHANICAL CHARACTERISTICS

Cooling	Forced Air
Weight	90 lbs.
Output	Waveguide

*The specifications for this tube have not been finalized. The tube is being manufactured in limited quantities and is available for engineering analysis purposes only. This engineering information does not imply availability of tubes with the same electrical and/or mechanical characteristics. For current information concerning this tube contact the nearest Microwave and Power Tube Regional Sales Representative.

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Preliminary Data*

ISSUED 10/64

RAYTHEON

QKH1214 MAGNETRON

The QKH1214 is an integral magnet, air cooled, C-Band magnetron with a peak power output of 1.0 megawatts. The tube is tunable from 5665 Mc to 5715 Mc. The tube is designed for use in tracking radars. It is a direct replacement for the fixed frequency QK539 magnetron. This preliminary data sheet is intended only to acquaint the reader with the basic characteristics of this magnetron and should not be used solely in the system design. Detailed information may be obtained by contacting the Product Programs Department, Microwave and Power Tube Division, Raytheon Company Burlington, Massachusetts.

TYPICAL ELECTRICAL CHARACTERISTICS

Frequency Range	5665-5715 Mcs
Peak Power Output	1 MW
Anode Voltage	35 KV
Peak Anode Current	65 Amperes
Pulse Width	1 usec
Duty Cycle	.001

MECHANICAL CHARACTERISTICS

Cooling	Forced Air
Weight	50 lbs.
Output	Waveguide

*The specifications for this tube have not been finalized. The tube is being manufactured in limited quantities and is available for engineering analysis purposes only. This engineering information does not imply availability of tubes with the same electrical and/or mechanical characteristics. For current information concerning this tube contact the nearest Microwave and Power Tube Regional Sales Representative.

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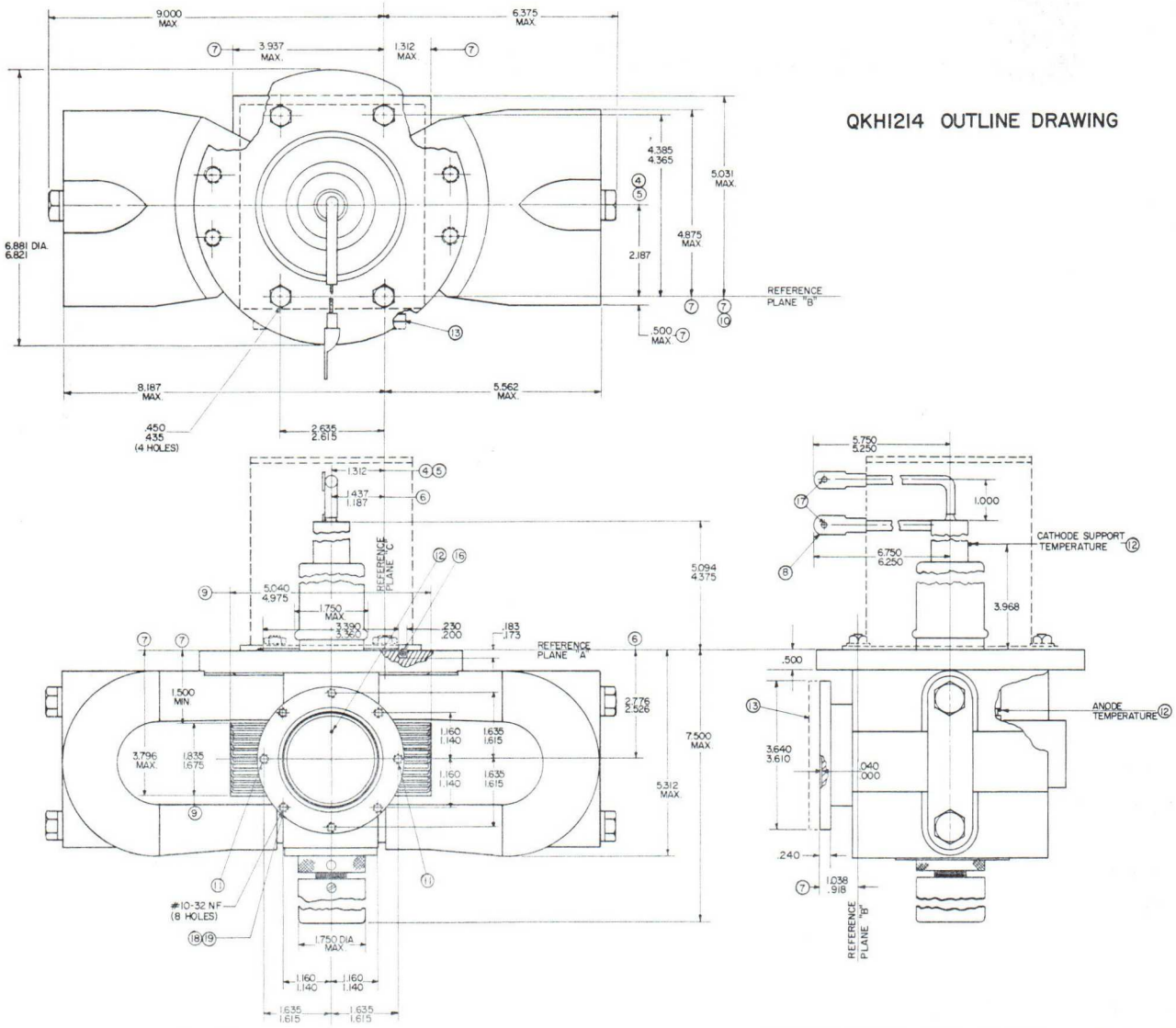
QKH1214 OUTLINE DRAWING



1 - REFERENCE PLANE "A" IS DEFINED AS A PLANE PASSING ALONG THE FACE OF THE MOUNTING PLATE.

2 - REFERENCE PLANE "B" IS DEFINED AS A PLANE PERPENDICULAR TO PLANE "A" PASSING THROUGH THE CENTER OF HOLES AS SHOWN.

3 - REFERENCE PLANE "C" IS DEFINED AS A PLANE MUTUALLY PERPENDICULAR TO PLANES "A" AND "B" PASSING THROUGH THE CENTER OF THE HOLE AS SHOWN.

4 - THIS DIMENSION APPLIES TO THE CENTERLINE OF THE TUBE.

5 - PARTS ON THIS CENTERLINE MAY VARY FROM TRUE LOCATION BY .125.

6 - REFERS TO THE CENTERLINE OF THE WAVEGUIDE FLANGE AS DETERMINED BY THE 3.610 - 3.640 DIA.

7 - THIS DIMENSION INCLUDES ANGULAR AS WELL AS LATERAL DEVIATIONS.

8 - COMMON CATHODE CONNECTION TO BE IDENTIFIED BY BROWN PAINT.

9 - THESE DIMENSIONS APPLY TO RADIATOR SIZE ONLY.

10 - THIS DIMENSION INDICATES BACK OF RADIATOR.

11 - THESE TWO TAPPED HOLES MUST LIE WITHIN .025 OF A LINE PARALLEL TO REFERENCE PLANE "A".

12 - TEMPERATURE MEASUREMENTS TO BE MADE AT POINTS INDICATED.

13 - GUARD FOR SHIPPING PURPOSES ONLY.

14 - ALL JOINTS ON MOUNTING PLATE AND OUTPUT SECTION SHALL BE SUCH AS TO PROVIDE AN HERMETIC SEAL.

15 - WAVEGUIDE FLANGE SHALL BE PARALLEL TO REFERENCE PLANE "B" WITHIN .062.

16 - GROOVE FOR O-RING AN6227-843.

17 - CLEARANCE HOLE FOR A .250 DIA. BOLT.

18 - PITCH DIA. MUST ACCEPT CLASS 2 "GO-GAGE" ONLY.

19 - MINOR DIAMETER MUST NOT BE GREATER THAN .166.

S. Ricks. 7

RAYTHEON COMPANY

Microwave & Power Tube Division

Waltham 54, Massachusetts

SPECIFICATIONS FOR ELECTRON TUBE TYPE QKH942

The provisions of MIL-E-1 apply to this specification. Note 22.

Description: Magnetron, 5.0 Mw (nominal), Servo tunable 1250-1350 Mc, pulsed type, liquid-cooled, integral magnet.

Dependent Absolute Ratings

Parameter:	ib	Pi	pi	Du	tpc
Unit:	a	kW	Mw	--	us
Maximum:	162	24.4	12.2	.002	7.0
Minimum:	100	--	--	--	1.5
					Note 1

Caution: The dependent absolute ratings are interrelated, and it does not necessarily follow that combinations of ratings can be attained simultaneously. The provisions of MIL-E-1 6.5 apply in the selection of the operating point.

Independent Absolute Ratings

Parameter:	eb	If	tk	Load	Anode T
Unit:	kv	A	sec	VSWR	oC
Maximum:	90	175	--	1.5	125
Minimum:	--	--	600	--	--
		Note 2			Note 22
		Note 3			

Parameter:	Bushing T	Output	Pressurization	Coolant Pressure
Unit:	oC		psia	psia
Maximum:	150		60	95
Minimum:	--		50	--
	Notes 22, 16		Note 4	

Caution: The independent absolute ratings are limiting values beyond which the serviceability of any individual tube may be impaired, and they must not be exceeded.

Storage, Handling and Installation

Input Bushing:	Note 5, 22	Output Coupling:	Note 22
Magnet Isolation:	Note 6, 22	Input Connections:	Note 22
Mounting Support:	Note 22	Vibration, Shock:	Note 8
Mounting Position:	Note 7	Weight:	120 lbs. max.

ef..	Test	Condition	Sym.	Min.	Max.	Unit
	GENERAL TESTS					
.1	Qualification Approval	Required for JAN marking				
.7	Marking	Made in USA: QK942 (Serial No.)				
.5	Holding Period	t = 168 hours				
.9.2	Dimensions	Per Electron Tube Drawing				
	QUALIFICATION TESTS					
4.9.8	Salt Spray Corrosion		OMIT			
4.9.14	Temperature Coefficient		$\Delta F/\Delta T$ at 1300 Mc		0.1	Mc/°C
	Cooling Test (Anode)	With the tube operating under Oscillation 1 conditions, the following cooling characteristics shall be obtained. The coolant shall be of a mixture of 40% water and 60% ethlyene glycol.				

	Anode	Output Flange	Tuner
Coolant Flow (gpm-min.)	3.0	0.75	0.5
Pressure Drop (psi-max.)	20	20	40
Temperature Rise (deg. C above coolant inlet temperature - max.)	80		

Ambient Air Temperature, deg. C - 0 to 55

Ref.	Test	Condition	Sym.	Min.	Max.	Unit
	MEASUREMENT ACCEPTANCE TEST - Part 1 (Production)					
4.9.13	Pressurizing (Output)	50 psia (min.)				
4.10.8	Heater Voltage	I_f = 160A; tk = 600 sec (min.)	Ef	12.5	17.0	V
4.16.3	Oscillation (1)					
	Standing Wave Ratio	VSWR = 1.1 max. (unless otherwise noted)				
4.16.3.2	Heater Cathode Warmup Time	tk = 600 sec (max.) Notes 3, 7				
4.16.3.3	Pulse Characteristics	tpc = 5.5 to 6.5 us Du = 0.0018 Notes 1, 9, 10				
4.16.3.6	Power Output	Method B F1 1250 Mc (approx) F3 1300 Mc (approx) F5 1350 Mc (approx)	Po:	8.1	----	KW
4.16.3.4	Average Anode Current	Ib = 280 mAdc				
4.16.3.5	Pulse Voltage	F1, F3, F5	epy	62	75	kv
4.16.3.7	RF Bandwidth	F1, F3, F5 Note 11	BW:	----	2.5/tp	Mc
4.16.3.2	Tunable Frequency	Anode Temp. 95°C ± 25°C Notes 18, 19, 20	F:	1250	1350	Mc
4.16.5	Pulling Factor	F1, F3, F5 VSWR - 1.3 min. Note 12	F:	----	3.5	Mc
	Side Lobe	F1, F3, F5 Note 11	---	6	----	db
4.16.7.2	General RF Energy Stability	F1, F3, F5 VSWR - 1.3 min. Note 13	Missing Pulses	----	.75	%

Ref.	Test	Condition	Sym.	Min.	Max.	Unit
	DESIGN TESTS - Part 2					
	Frequency Drift	F1, F3, F5 Note 17	F:	----	5.0	Mc
4.16.6	Pushing Factor	ib = 128 - 150 amp	-F	----	15	kc/a
	ACCEPTANCE LIFE TEST					
4.11	Life Test	Group D: Osc (1) Notes 14, 15	t	500	----	hrs
4.11.4	Life Test End Points					
4.16.3.6	Power Output	Method B F1, F3, F5	Po	6.5		Kw
4.16.7.2	General RF Energy Stability	F1, F3, F5 VSWR - 1.3 min. Note 13		Missing Pulses	1.0	%
4.16.3.7	RF Bandwidth	F1, F3, F5 Note 11	BW	----	3.0/tp	Mc
4.16.3.5	Pulse Voltage	F1, F3, F5	epy:	60	77	Kv
	Highest Side Lobe	F1, F3, F5 Notes 11, 21		6		db

Notes:

1. The characteristics of the applied pulse must be those which result in proper starting and oscillation. The rate of pulse voltage rise, the percentage of pulse voltage ripple, and the rate of pulse voltage fall are among the more important considerations. Negative post pulse voltage oscillations may cause leakage current and noise. These oscillations should be minimized to prevent excessive post pulse noise and to maintain reasonably close agreement between actual peak current values and those calculated from average current and duty cycle measurements. Where suitable pulse characteristics may be required beyond the limits of Oscillation 1, the tube manufacturer must be consulted with regard to specific applications.

2. The maximum value specified is for a non-oscillating condition. Heater surge current shall not exceed 250 amperes.

Notes (Cont'd.)

3. Proper value of preheat and oscillate current will be stamped on the tube. Heater current must be maintained within ± 3.5% of recommended value.

4. During operation the gas used in pressurization shall provide insulating properties at least equal to that of clean, dry air at the pressures indicated. A gas flow at least equal to 2 liters of air per minute shall be directed across the face of the magnetron output window.

5. During operation the high voltage bushing must be immersed in a fluid insulating medium with properties equivalent to Esso Univolt 35 oil.

6. In handling and mounting the magnetron, care must be exercised to prevent demagnetization. Ferromagnetic materials must not be permitted at any time closer than 8 inches from the magnet, except at the ends where clearance may be 3 inches. Energized magnets must not be permitted at any time closer than 12 inches from the tube magnet.

7. The tube shall be mounted with the cathode vertical within 15° during test.

8. Reasonable care should be used in the storage, installation, and use of the tube to avoid imparting vibration or shock in excess of the values which it is designed to withstand.

9. This test need be conducted only under one set of conditions within the limits stated for the oscillation specified.

10. The pulse characteristics for Oscillation 1 shall be as follows:

	Min.	Max.		
trc:	0.25	.6	us	(measured 20 to 85%)
tfc:	----	1.75	us	(measured 0 to 75%)
trv:	0.6	1.4	us	(measured 20 to 85%)
tfv:	----	4.0	us	(measured 0 to 75%)

No spike or ripple shall exceed ± 7% of the average peak value of voltage or current. Inverse voltage must not exceed 25% of the forward voltage. The negative amplitude of any post pulse voltage oscillations must not exceed 10% of the average peak value.

11. Stability will not be measured under this test. The rf bandwidth shall be within the limits specified when a VSWR of 1.3/1 is introduced in the load at a distance of approximately 1 meter from the magnetron coupling flange, the phase being adjusted for the widest spectrum. The ratio of the amplitude of the main lobe to the amplitude of the highest side lobe shall be within the limit specified.

12. The pulling measurement shall be made in such a manner that thermal effects do not introduce appreciable errors.

Notes (Cont'd.)

13. No more than the specified percentage of pulses shall result in rf output pulses each having less than 70% of the energy content of a normal pulse. The test will be conducted for a period not to exceed 15 minutes, and satisfactory operation must be obtained for 5 successive minutes of the test period. A missing pulse is defined as one of the energy of which, with a + 1% frequency band at the mean normal test frequency, is 70% or less than that of a normal pulse. Observations shall be made for load phase positions corresponding to maximum instability.

14. The VSWR shall be 1.3/1. The interpretation of the value of the VSWR as used by the manufacturer and as used by others shall be as defined in MIL-E-1, 4.16.5. The standing wave introducer shall be moved during the test so that operation is obtained for load phase positions corresponding to maximum power output, minimum power output, maximum frequency, and minimum frequency. If automatically driven, the standing wave introducer shall be cycled through the four load phase positions corresponding to maximum power, minimum power, maximum frequency and minimum frequency at least once during the specified life of the tube, spending approximately equal periods of time in each phase position.

15. Power input to the tube during life test shall be cycled as follows:

PREHEAT	600 seconds
OSCILLATE	7 hours
ALL VOLTAGES OFF	50 minutes

Heater power may be varied during life but in no case should exceed the specified values.

16. Temperature to be measured at the point indicated on the electron tube drawing.

17. The frequency drift shall not exceed the amount specified during the minimum specified life. This test shall be performed in such a manner as to exclude thermal effects.

18. The tube shall be provided with a tuning mechanism which will permit the output frequency to be varied over a range of at least 100 Mc centered about 1300 Mc. The tuner movement or stroke required to tune from 1250 to 1350 Mc shall be .359 inch minimum and .413 inch maximum. The total stroke between internal mechanical tuner stops shall not be less than 0.530 inch.

19. The tuning curve showing frequency vs tuner position shall be linear within ± 6 Mc, and it shall have negligible hysteresis.

20. The tube shall operate satisfactorily when, by means of a suitable servo system, its frequency is controlled in the following manner:

Mode I - The frequency shall be set at any fixed frequency from 1250 to 1350 Mc.

Mode II - The frequency shall be varied continuously over a range of 0 to 100 Mc at a cyclic rate of 0 to 10 cps. It

Notes (Cont'd.)

shall be possible to set the center of the varying frequency range at any frequency from 1250 to 1350 Mc. The allowable amplitude of tuning sweep will decrease from 100 Mc to 0 as the center frequency is moved from 1300 Mc to either end of the tuning band. The curve of frequency vs time shall be essentially triangular in shape except for the portions where reversals of direction occur. These portions shall be rounded off to reduce the accelerations imposed on the tuner. Maximum acceleration of tuner shall not exceed 75 g's.

21. Normal operation of tube will be limited to the range of 1250 to 1350 Mc.

22. The following drawings form a part of these specifications:

D614268 Revision 6 - Electron Tube QKH942

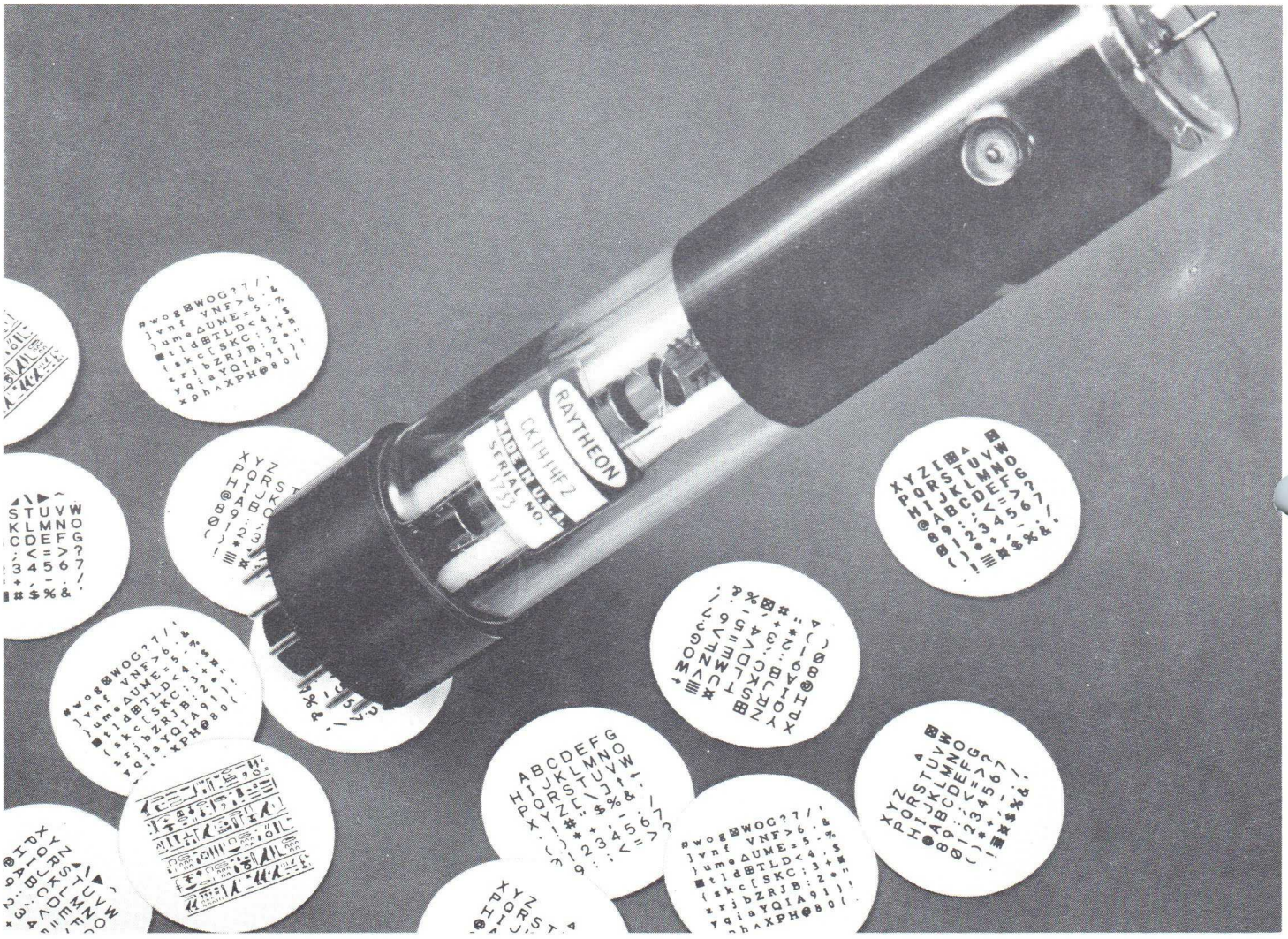
D614268 Revision 6 - Electron Tube (Installation Details)

RAYTHEON

SYMBOLRAY™ APPLICATION NOTES

RAYTHEON COMPANY, INDUSTRIAL COMPONENTS OPERATION, 465 CENTRE ST., QUINCY, MASS. 02169

Data Display Devices from Raytheon



A Symbolray* monoscope can generate almost any presentation you can think of. (Hieroglyphics, anyone?)

With a Raytheon Symbolray, you can meet almost any data display requirement for different characters and/or symbols—ranging from standard ASCII† to custom data displays and even hieroglyphics. And we can meet the requirements with only an inexpensive change in the target font design.

An economical method of generating characters. The Symbolray monoscope provides a much more economical method of generating displays than using circuit cards. Only 2" by 12", it costs less than $100 in quantities of 1,000.

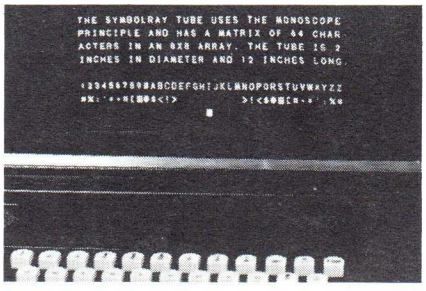
The output of the Symbolray is obtained by electrically deflecting the electron beam to the desired characters on the targets. The characters are scanned sequentially with a small TV raster. The display cathode-ray tube, on which the output is viewed, is scanned in synchronism. The monoscope uses electrostatic deflection and focus.

Full messages can be displayed—as shown at right—when the Symbolray method is used with buffer memory techniques. The monoscope is currently available with 64 and 96 character matrices.

Raytheon Dataray* CRTs include screen sizes from 7" to 24". Electrostatic, magnetic and combination deflection types are available for writing alphanumeric characters while raster scanning.

For Symbolray data—or a demonstration—call your Raytheon regional sales office. Or write: ***Raytheon Company, Components Division, Quincy, Mass. 02169.***

†American Standard Code for Information Interchange.



A-4541

INTRODUCTION

The SYMBOLRAY™ tube is a cathode-ray device which can be used to generate alphanumeric characters for cathode-ray displays or for hard copy print-out. It provides an inexpensive means for generating well-formed alphanumeric information. It is now in use in a large number of CRT Displays that are the communications links with digital computers. Figure 1 shows such an equipment.

Cathode-ray displays are becoming an important communications link between computer systems and human operators. The major advantage of a CRT display is the fast presentation of information. This is extremely useful for temporary display. These Displays will not replace hard-copy print-out, but are an important supplementary device. A few examples of their use:

Airlines ticket agencies—for reservations control
Government—air traffic control
Production line inventory control information
Remote engineering mathematical computations
Stock market quotations
Hospital—medical consultations
Business report editing

In an airline ticket agency, the ticket agent checks with a centralized computer (perhaps in another city) to find out if seats are available on a specific flight for a customer who wishes to buy a ticket immediately. No permanent record at the agency is required. The computer memory records the seat reservation.

FIGURE 1

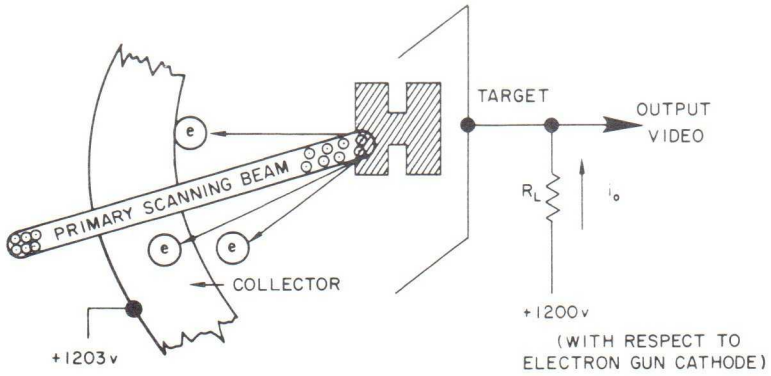
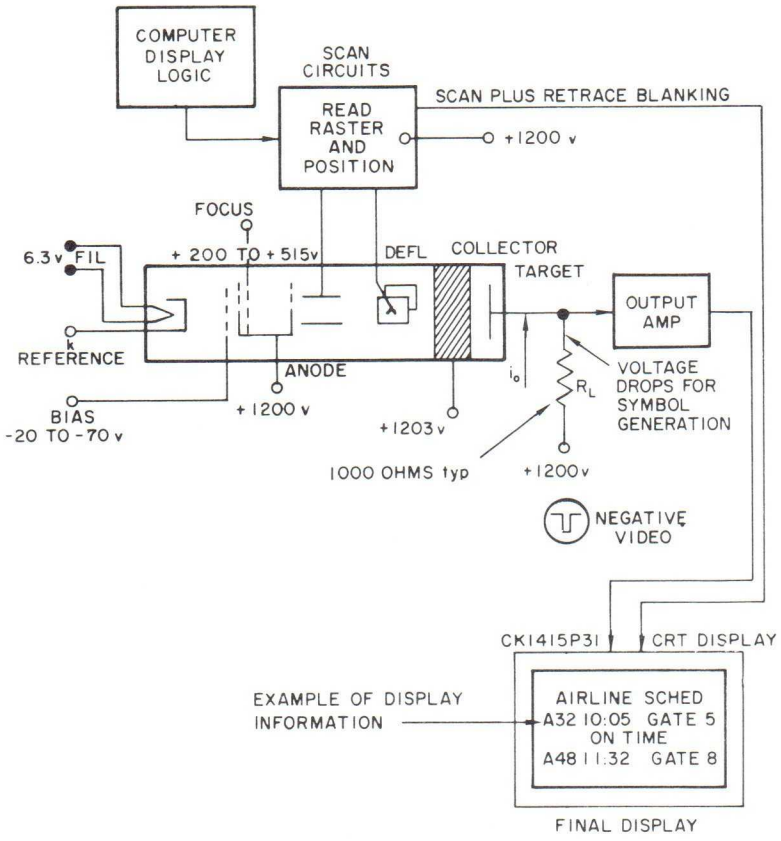


FIGURE 2

FIGURE 3



The heart of this system and the alphanumeric generator is the Raytheon SYMBOLRAY Tube, CK1414F.

This tube is operated as a monoscope with an output signal which is generated by a difference in secondary emission between the target background and printed characters. Figure 2 illustrates this principle. Secondary electrons emitted from the target are attracted to the collector which is at a more positive voltage than the target.

Figure 3 shows the operating voltages together with a block diagram of the operation of the tube. Depending upon logic information from the computer memory, the proper characters to be generated are selected by the scan circuits. By means of a digital-to-analog converter, the proper voltages are developed for the deflection plates and the beam is thereby positioned to the specific character. A small raster is generated by the scan circuits and the deflection voltage causes the electron beam to just over-scan slightly more than the character to be generated. A change in electron current flow through R_L creates the output video signal. This is used (with proper synchronization of scan) to unblank the cathode-ray beam in the CRT display. The fact that a standard magnetic deflection cathode-ray tube similar to television-type picture tubes can be used for the CRT display adds to the simplicity and economy of this type of equipment.

It is recommended that a magnetic shield be used around the SYMBOLRAY tube to nullify effects of stray magnetic fields from nearby transformers and motors. The James B. Millen Company—Malden, Massachusetts is a manufacturer for these shields.

DIGITAL DISPLAY—PRINCIPLE OF OPERATION

Figure 4 shows a block diagram for a Digital Information CRT Display. The original information can be generated from a key-board or be obtained from a computer. When a key on the key-board is touched, a six bit parallel code is generated that is fed to the logic generator. This unit generates the six bit code in time-serial form.

This unit may contain a crystal controlled oscillator that can be both the "clock" for the digital code and the synchronizing signal for cathode-ray sweep. In addition, it can be the generator for the vertical sine-wave sweep used on the CRT and SYMBOLRAY tube. The frequency of the oscillator will be determined by a number of factors such as the field/frame rate of display, the number of characters and symbols in the display, and the number of sine-wave cycles used to scan the "raster" over the symbol to be generated. The frequency can be determined by the following equation:

$$F_o = (L + R_v)\,(C + R_h)Nf$$

Where:

F_o = *Oscillator frequency in Hertz*
L = *Number of lines in the message*
C = *Number of characters/line*
R_v = *Number of lines used during vertical retrace*
R_h = *Number of characters (time) used in horizontal retrace*
f = *Fields per second (refresh rate of the display)*
N = *Number of cycles of sine wave per symbol (including inter-symbol spacing)*

As an example, we might consider a display with a message of 800 characters—20 lines at 40 characters per line—at a refresh rate of 60 fields per second. In order to generate characters that appear completely "filled in," we will use 12 cycles of a sine wave for vertical scan of the raster.

Therefore:

$N = 12$
$L = 20$
$C = 40$
$R_v = 2$
$R_h = 4$
$f = 60$

R_v and R_h will primarily be determined by the characteristics of the deflection circuits and the deflection yoke used with the CRT. The above figures are typical

$$F_o = (20 + 2) \cdot (40 + 4) \cdot 12 \cdot 60$$
$$= 696{,}960\ Hz$$

The crystal-controlled oscillator would be designed to operate at this frequency. It is also possible to obtain additional "fill-in" by a 180° phase shift of the sine-wave scan on alternate fields. This is similar to interlace used on standard television.

N is chosen as a multiple of 6 so that this frequency may also be the "clock" for the digital circuits as previously stated.

In this manner, the scanning for the CRT display tube and the SYMBOLRAY tube can be synchronized with the digital bit code.

This serial 6 bit code is transferred to a memory device which is capable of storing an entire message in digital form. The digital code bit information is circulated in the memory system at the repetition field rate for the entire message as it appears in the final cathode-ray display. This is the refresh rate and should be high enough (60 frames per second) so that no flicker is seen by the operator.

Flicker might also be reduced by operation with long persistence phosphors or the new "Square Wave" phosphors. This type of operation would permit slower scan rates allowing narrower band-width with more economic designs. There will, however, be a loss of light output and slightly longer editing time.

A suggested memory device can be a magnetostrictive torsional delay line that produces the proper delay. The signals are regenerated and fed back into the memory device. These are manufactured by:

Digital Devices, Inc.
Syosett
Long Island, New York

Anderson Labs
Hartford,
Connecticut

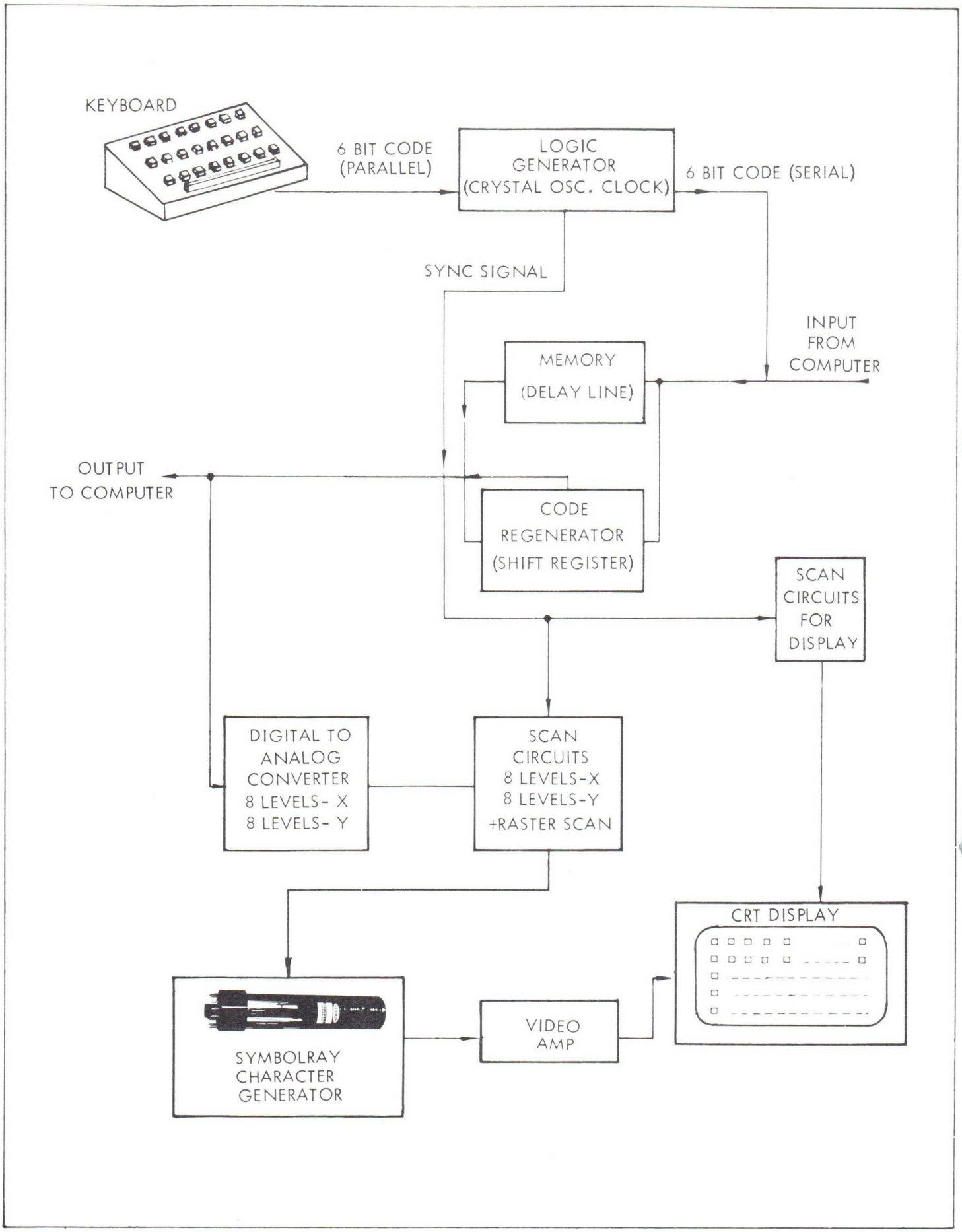

KEYBOARD
6 BIT CODE (PARALLEL)
LOGIC GENERATOR (CRYSTAL OSC. CLOCK)
6 BIT CODE (SERIAL)
SYNC SIGNAL
INPUT FROM COMPUTER
MEMORY (DELAY LINE)
OUTPUT TO COMPUTER
CODE REGENERATOR (SHIFT REGISTER)
SCAN CIRCUITS FOR DISPLAY
DIGITAL TO ANALOG CONVERTER 8 LEVELS- X 8 LEVELS- Y
SCAN CIRCUITS 8 LEVELS-X 8 LEVELS-Y +RASTER SCAN
CRT DISPLAY
SYMBOLRAY CHARACTER GENERATOR
VIDEO AMP

FIGURE 4

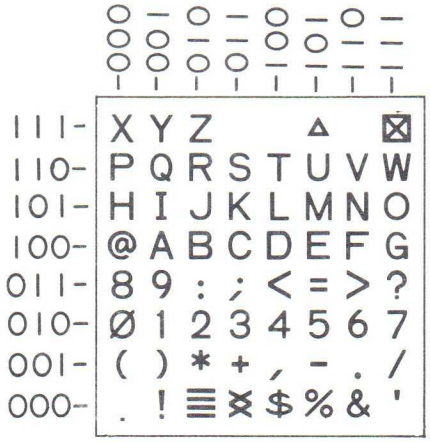


FIGURE 5

MODIFIED ASCII CHARACTER MATRIX
SHOWING DIGITAL CODE

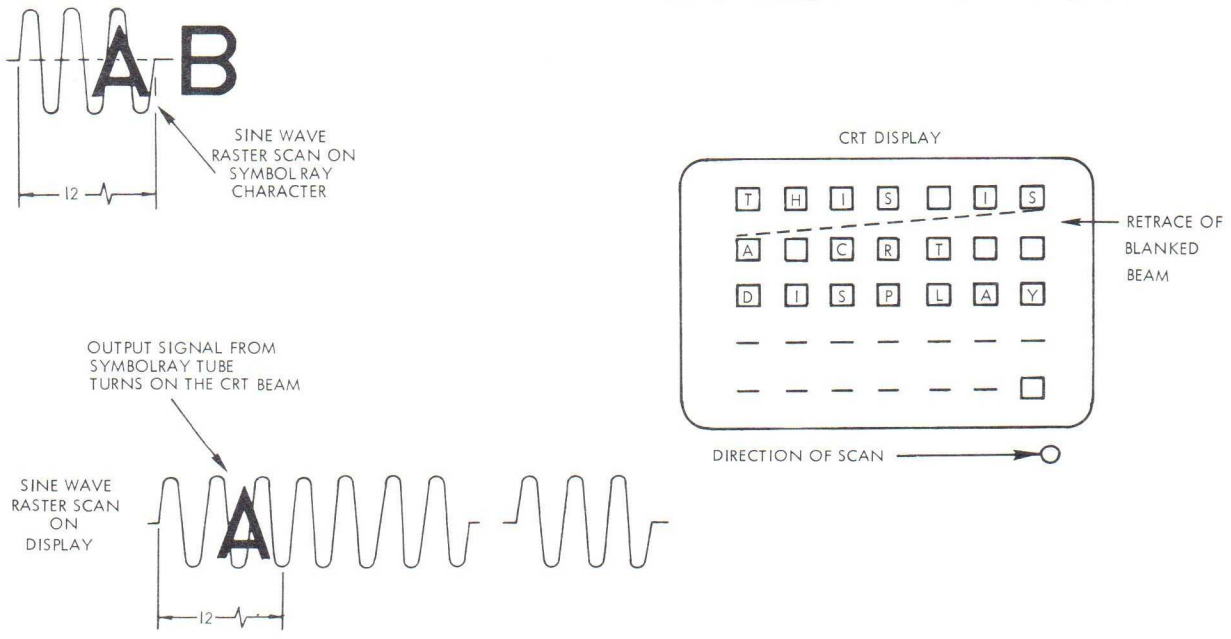
The digital code signals are then fed to the digital-to-analog converter. The purpose of this digital-to-analog conversion is to sequentially select and generate voltage to deflect the SYMBOLRAY beam to symbols on the target. Figure 5 represents a typical target pattern matrix with the digital code for this matrix. This is a modified ASCII (American Standard Code for Information Interchange).

Thus the digital-to-analog converter will change the code 100001 to the proper deflection plate voltages to center on the letter "A". 001 represents the *column* to be scanned and 100 the *row.* Similarly, the number "4" will be selected from the code 100 for the *column* and 010 for the *row.*

As the digital-to-analog converter generates the proper voltages for the deflection plates, the small sine wave raster appears in voltage form on the SYMBOLRAY deflection plates so that the electron beam is scanned over the symbol. The fast vertical scan of the high frequency sine wave together with a linear horizontal scan is used. See figure 6. The electron beam of the CRT display is being scanned in synchronism. The same sine-wave vertical scan is used in a line-by-line scanned raster. The CRT display is then unblanked with the amplified video from the monoscope tube to display the character. As stated earlier, the entire message is repeated at the refresh rate as determined by the recycling to the memory system. Thus a flickerless display is generated. A typical display format may have 20 lines in the message made up of 40 characters per line. This adds up to a message total of 800 characters. Displays have been made with as many as 2000 characters for the whole displayed message.

Since the digital information CRT display has its own digital code generator and memory, it can generate messages which can be transmitted to a central computer and in turn receive messages from a central computer.

FIGURE 6



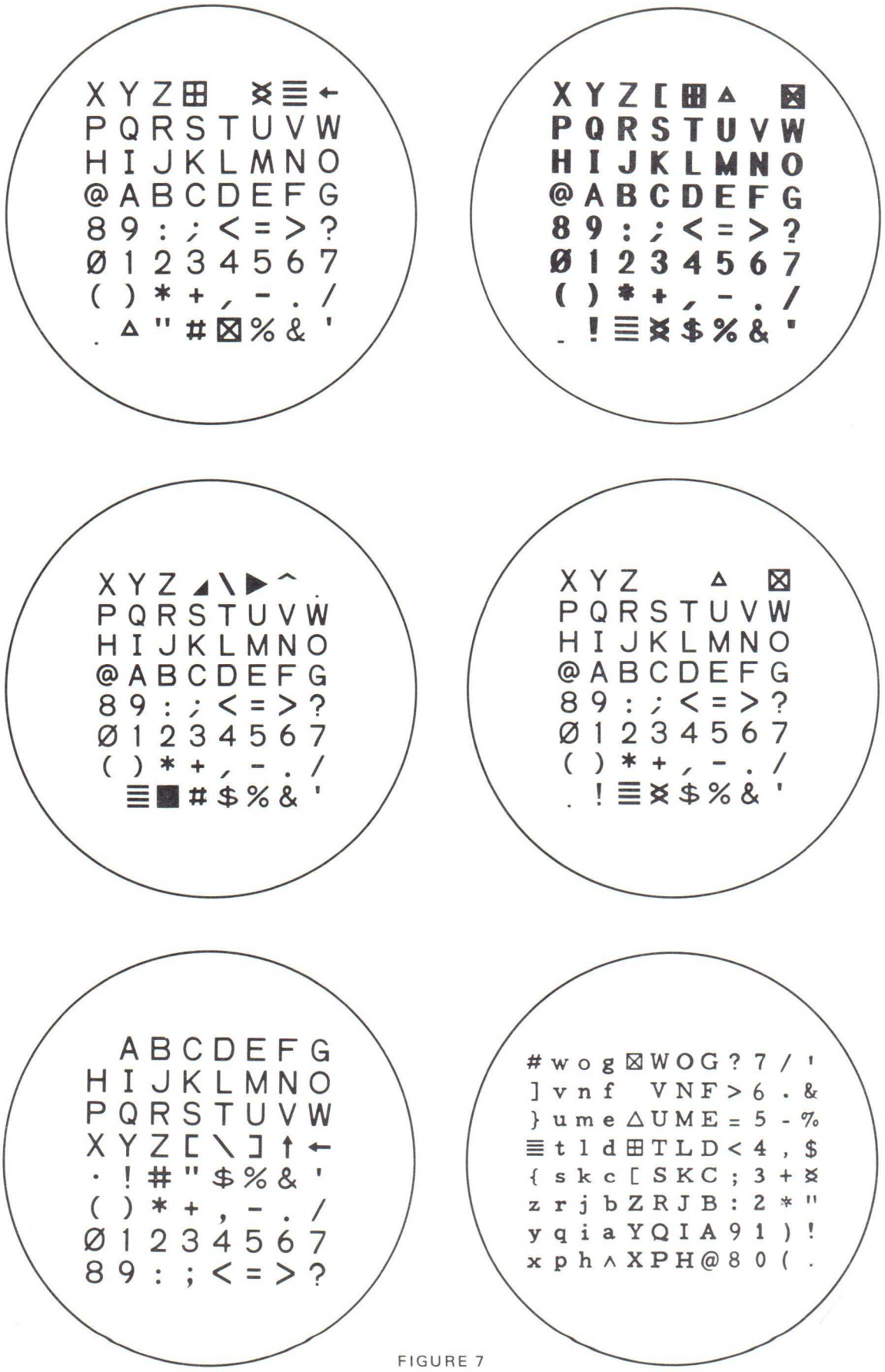


FIGURE 7

VARIOUS TARGET FONTS AVAILABLE FOR SYMBOLRAY TUBE

The SYMBOLRAY tube design permits flexibility in character style to be used in a system. Figure 7 shows samples of different fonts that have been used.

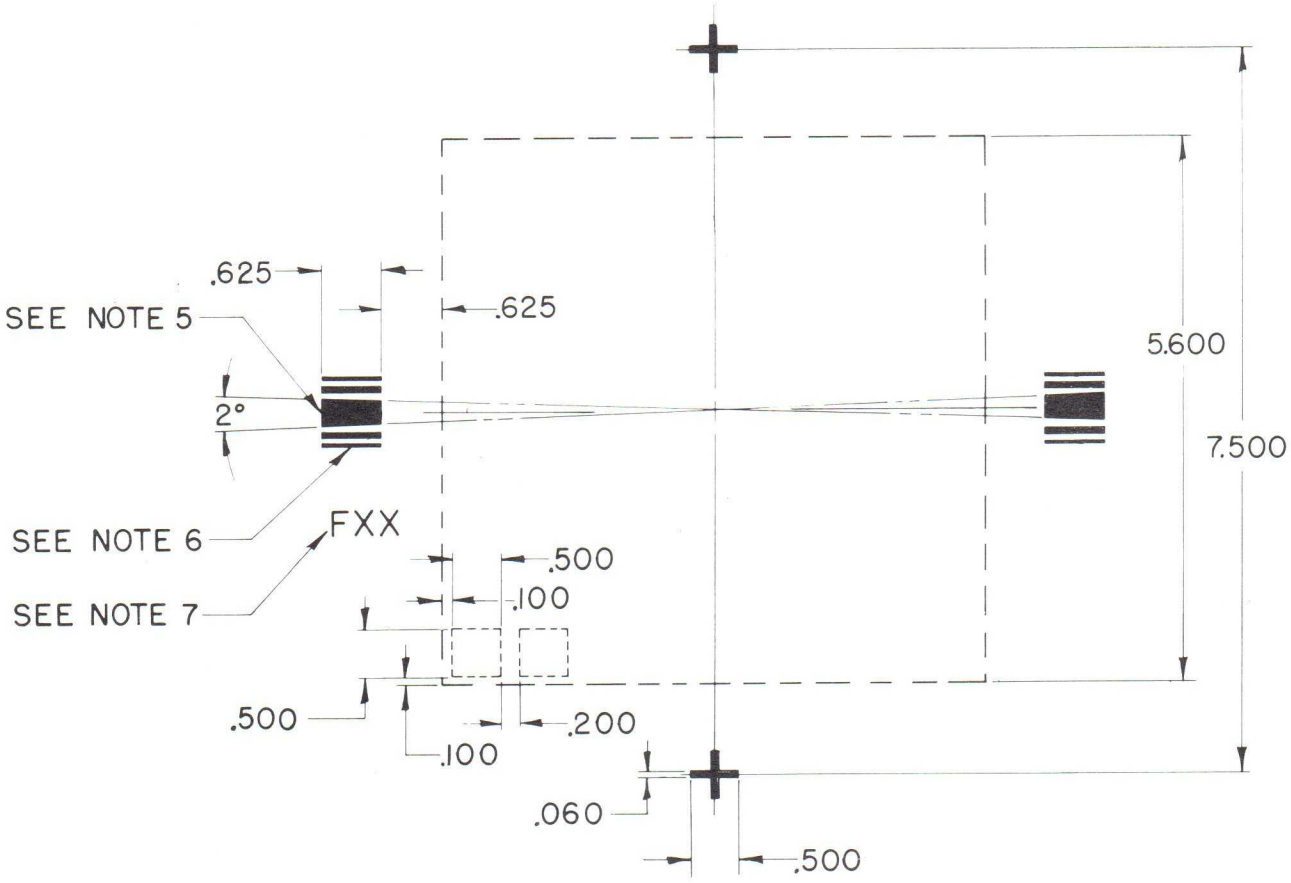
The layout in the matrix of the position of the characters can ease circuit design in the digital-to-analog converter. Most of the targets shown in Figure 7 were laid out to work with a modified ASCII code. The target (upper right hand corner) with thicker vertical lines was designed for an application where, because of time limitations, there were only a few cycles in the raster covering each character. This improves the final display of characters on the CRT display. It is also possible to change the aspect ratio of the scan on characters to make the characters higher or wider on the final display.

It should be noted that targets have been designed to contain an 8 x 12 matrix or as many as 96 characters. This includes all standard punctuation, capital letters and small letters of the alphabet.

Most applications of computer digital displays require some variation in the character font. Figure 8 shows the information needed to design the art work for these special fonts. Many equipment designers have facilities to design fonts for the SYMBOLRAY tube. However, if desired, Raytheon will do the font design at a nominal charge.

SPECIAL APPLICATIONS:

The SYMBOLRAY tube has been used to generate alphanumerics on a time-shared basis on radar displays and with vector information. In these instances, the alphanumeric identified either targets or points on the vectors. Since this is a fast method to generate symbols, it lends itself to this type of application.



NOTES:

1. ORIGINAL ARTWORK SHOULD BE 4X TO 5X THE SCALE SHOWN FOR SHARP CHARACTERS; THEN PHOTOGRAPHICALLY REDUCED TO DIMENSIONS SHOWN.
2. OUTLINE IS QUALITY AREA FOR CHARACTERS.
3. NOMINAL LINE THICKNESS FOR CHARACTERS = .060".
4. CHARACTER ALIGNMENT (ROWS AND COLUMNS) IS IMPORTANT.
5. WEDGE IS 2° ANGLE. (FOR TRACE ALIGNMENT).
6. RESOLUTION BARS: .060"AND .030" THICK; SPACING .060".
7. REQUEST "F" NUMBER FROM RAYTHEON. TO BE PRINTED IN THIS AREA. THIS IS YOUR FONT DESIGNATION AND SHOULD BE USED WHEN ORDERING SYMBOLRAY® TUBE., E. G. CK1414F33.
8. RAYTHEON WILL PHOTOGRAPHICALLY REDUCE BY A FACTOR OF 5.
9. FOR A TYPICAL FONT, CHARACTER HEIGHT TO LINE WIDTH RATIO IS 8:1.

FIGURE 8

CATHODE-RAY TUBE—FINAL DISPLAY

Raytheon manufactures a wide range of cathode-ray tubes for use in digital CRT displays. These are electrostatic focus and magnetic deflection tubes of rather standard design. This permits economical final display. Particular types that are offered are the CK1415P31 and CK1439P31. The P31 phosphor is offered because it has very high efficiency and high light output. However, other standard phosphors are also available.

Obviously, any available CRT could be used in the final display. Choice of the particular tube depends on the ease of designing scan circuits to operate it.

RAYTHEON KEY SWITCHES AND KEYBOARDS

Raytheon makes available switches and complete keyboards for use in Digital CRT Display controls. Write for technical information.

RAYTHEON

RAYTHEON Regional Sales Offices

CALIFORNIA
Suite 520
2930 West Imperial Highway
Inglewood, California 90303
Tel.: 213-757-0251
TWX: 910-321-3964

120 El Camino Real
San Carlos, California 94070
Tel.: 415-593-1021
TWX: 910-376-4395

ILLINOIS
3158 Des Plaines Avenue
Des Plaines, Illinois 60018
Tel.: 312-296-6677
TWX: 910-233-2780

MARYLAND
104 Roesler Road
Glen Burnie, Maryland 21061
Tel.: 301-761-0450
TWX: 710-861-0505

MASSACHUSETTS
130 Second Avenue
Waltham, Massachusetts 02154
Tel.: 617-899-8080
TWX: 710-324-6568

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475 South Dean Street
Englewood, New Jersey 07631
Tel.: 201-567-4911
TWX: 710-991-9741
(In Manhattan dial 947-6400)

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333 West First Street
Dayton, Ohio 45401
Tel.: 513-223-8128
TWX: 810-459-1635

TEXAS
Suite 609, Stemmons Tower West
Dallas, Texas 75207
Tel.: 214-631-3745
TWX: 910-861-4918

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Washington, D. C. 20036
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TWX: 610-365-3469

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TWX: 710-324-6568
Telex: Waltham 92-3455
Cable: Raytheonex

SP-1178

PRINTED IN U.S.A.

RAYTHEON

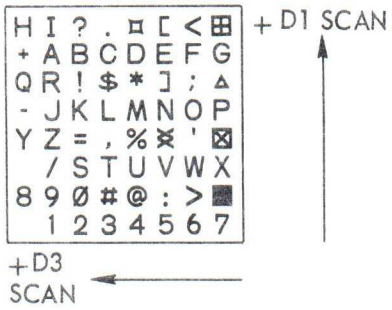
SYMBOLRAY* CHARACTER GENERATING CATHODE RAY TUBE

CK1414

GENERAL DATA

The CK1414 is a cathode ray device used for electrical generation of alphanumeric characters and symbols. The tube is operated in the monoscope mode and output signals are generated by scanning the symbol that appears on the target pattern.

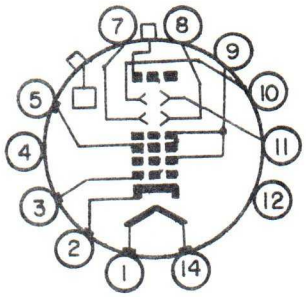
This type has applications with business data processing equipments as an economical method for generating characters for hard copy print-out or for cathode ray display.



TARGET PATTERN
(Actual Size)

ELECTRON GUN:
Focus Method – Electrostatic
Deflection – Electrostatic

MECHANICAL DATA



BASE:.....Medium Shell Dihoptal 12-pin No. B12-37
MOUNTING POSITION:.....Any
BASING.....14J

ELECTRICAL DATA

DIRECT INTERELECTRODE CAPACITANCES: ($\mu\mu$fds. approx.)

Grid #1 to all other electrodes	6
Cathode to all other electrodes	4.5
D1 to D2	2.4
D3 to D4	1.0
D1 to all other electrodes except D2	4.4
D2 to all other electrodes except D1	4.4
D3 to all other electrodes except D4	3.1
D4 to all other electrodes except D3	3.6
Collector to all other electrodes	6.0
Target to all other electrodes	2.5

RATINGS – ABSOLUTE MAXIMUM VALUES:

Heater Voltage	6.3±10 % volts
Peak Heater–Cathode Voltage, Max.	
Heater Negative with respect to cathode	200 volts
Heater Positive with respect to cathode	200 volts
Anode, Target, and Collector Voltage	2850 volts DC
Focus Electrode Voltage	1100 volts DC
Grid #1 Voltage	
Negative – Bias Value	220 volts DC
Positive – Bias Value	0 volts DC
Positive – Peak Value	0 volts
Peak Voltage Between Anode and Any Deflecting Electrode	550 volts DC

TERMINAL CONNECTIONS:

Pin 1	Heater
Pin 2	Cathode
Pin 3	Grid #1
Pin 4	Do not use
Pin 5	Focus
Pin 7	D3
Pin 8	D4
Pin 9	Anode
Pin 10	D2
Pin 11	D1
Pin 12	No Connection
Pin 14	Heater
Cap 1	Collector
Cap 2	Target Pattern

*Trademark

ELECTRICAL DATA (Cont'd.)

CHARACTERISTICS AND TYPICAL OPERATION: (See Caution Note)

Anode and Target Voltage	1200 volts DC
Collector Voltage (vary)	+1203 VDC
Focusing Electrode	150 to 515 volts DC
Grid #1 Voltage required for cutoff of beam current (vary)	25 to 65 volts DC
Deflection Factors: (See Note 3)	
D1–D2 (vertical scan of 1 symbol)	9.0 volts nominal
D3–D4 (horizontal scan of 1 symbol)	6.5 volts nominal
D1–D2 Deflection Voltage required to scan from lower row (1,2,3,---) to Upper Row (H,I,?,---) Note 2	90 volts nominal
D3–D4 Deflection Voltage required to scan from left row (H+Q--) to right row (⊞ GΔ---) Note 2	55 volts nominal
Target Output Resistance	500 ohms
Typical Peak Output Signal	5 μa

ALIGNMENT OF TRACES:

D1–D2 trace aligns with pin #5 and collector button	
Positive Voltage on D1 deflects beam toward top row of target (HI---⊞)	
Positive Voltage on D3 deflects beam toward left side of target (H+Q---)	
Angle between D3, D4 and D1, D2 traces	90 degrees ± 1 degree
Angle between traces and target symbols	±1 degree

MAXIMUM CIRCUIT VALUES:

Grid #1 Circuit Resistance	1.5 meg.
Resistance in any deflecting electrode current (Note 1)	5.0 meg.

NOTE 1: It is recommended that the deflecting–electrode–circuit resistances be approximately equal.
NOTE 2: Undeflected beam normally dwells on center of target pattern between L, M, (comma) and % symbols.
NOTE 3: Nominal voltage of deflection plates should be approximately equal to anode voltage (+1200 Vdc).

CAUTION: Electron beam should be cut–off when no raster is being developed. A blemish may be generated by a change in secondary emission of the target.

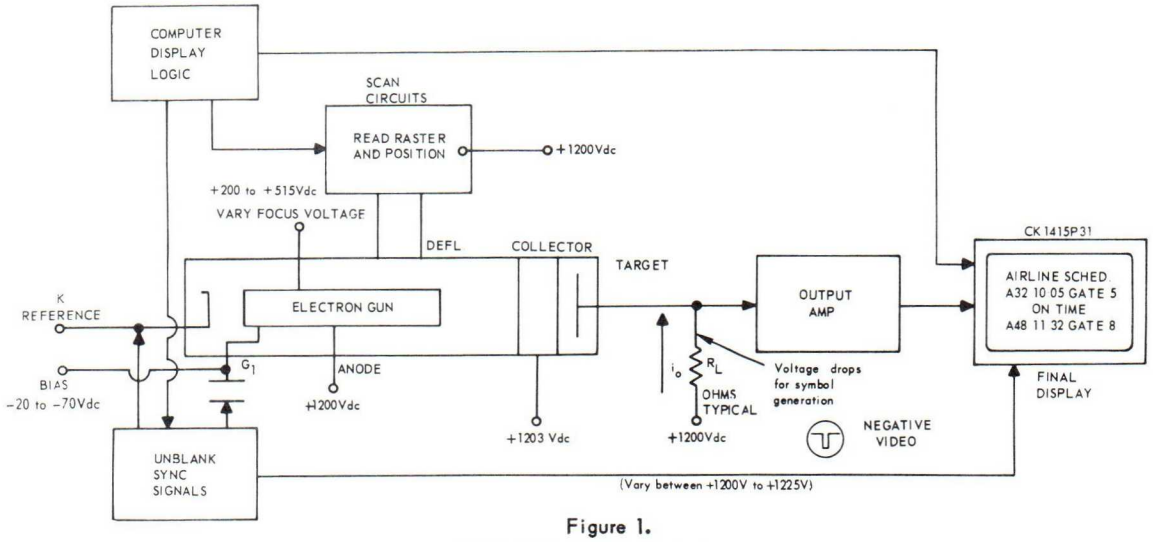


Figure 1.
OPERATION BLOCK DIAGRAM
***Trademark**

APPLICATION DATA

Figure 1 shows basic circuit for operation of the tube.

A small TV type raster is generated in the scan circuit block. This raster is just large enough to scan a single symbol on the target. The scan circuit also selects and positions the beam on the character to be generated.

As the electron beam lands on the target surface a difference in secondary emission of electrons from that surface is caused by the printed portion of the symbols which lowers the current flow from the target. The secondary electrons emitted are attracted to the collector which is at a more positive voltage. See Figure 2.

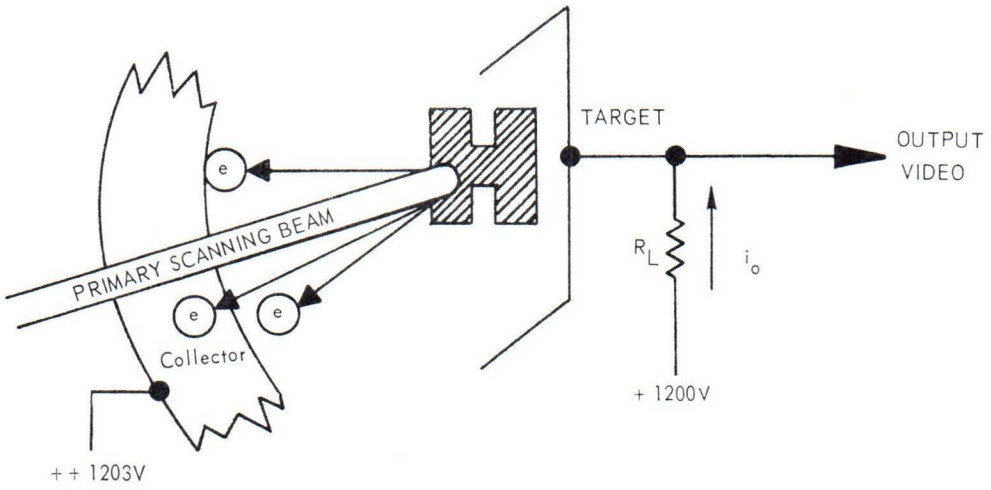
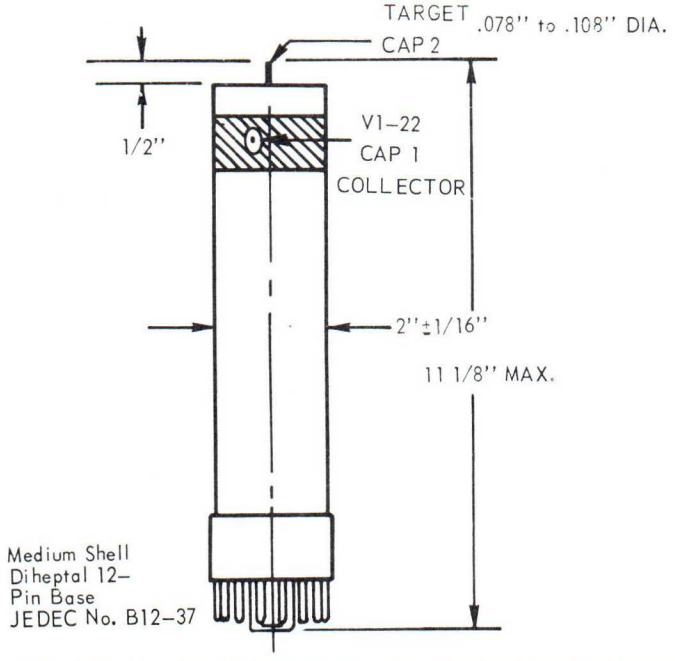


Figure 2.

A lower secondary emission occurs when the cathode ray beam scans the lines of the symbol. Therefore, the current through RL changes and the output video signal is created. By proper synchronization of scan and scan position, the entire character is recreated on the final display cathode ray tube.

Figure #1 shows a system application using the CK1414 Symbolray* tube and a Dataray cathode ray display tube of CK1415P31, featuring magnetic and electric deflection for high quality character display. The Symbolray* tube provides instant access to information retrieved from a computer.



*Trademark

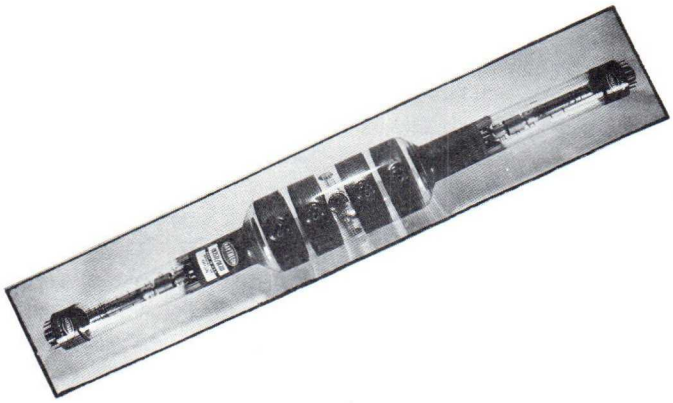
RAYTHEON
TECHNICAL INFORMATION SERVICE

Technical Information Bulletin

THE DUAL-GUN RECORDING STORAGE TUBE

By

A. S. Luftman
Industrial Components Division
55 Chapel St., Newton 58, Mass.



Since the invention of the Recording Storage Tube by R. C. Hergenrother and B. C. Gardner in 1948, the design has passed through many stages and phases. In the early experiments, both direct view and electronic output tubes were designed in types using from one to three electronic guns. Raytheon decided in 1950 that it would specialize in the most versatile type-the single gun electronic output version-for commercial production. Though each of the basic storage-tube types presently being sold was invented a decade ago, the era of the storage tube is just beginning.

Continuing improvements in such characteristics as the resolution (or amount of detail that can be stored) and the accuracy in reproduction of shades of gray have vastly increased the number of applications for storage tubes. Some of the most important advances made in the design of the Recording Storage Tube were described in detail in articles published between 1950 and 1956.[1,2,3] The latest innovation, however, is perhaps the most dramatic and useful of them all. This development is, in brief, an improvement in the resolution of Recording Storage Tubes from 600 lines per diameter to 1000 lines per diameter, along with marked improvements in other characteristics such as background uniformity.

What are some of the important applications for such storage tubes? The article entitled "Electronic Plotting of Moving Targets" (September-October 1957 issue of ELECTRONIC PROGRESS) described an equipment designed to convert a radar picture into a constant brightness display wherein moving targets appeared as typical radar returns, but with long trails behind them showing their history. Many other applications have added to the importance of the storage tube as a basic component in radar systems. Among these must be included typical scan-conversion of PPI radar information into a television-type raster scan for display on commercial monitors, slow scanning of stored radar or TV type pictures to reduce the bandwidth of their frequency components and permit retransmittal of the pictures over narrow-band communication lines such as commercial telephone circuits, and applications where it is desired to store radar for one antenna rotation and then use the stored picture for navigation.

The current requirement for storage tubes which has received most emphasis has been to make flying safer by means of effective air traffic control. For this application it is desired to store radar pictures simultaneously from more than one source, show target trails for the moving airplanes, scan-convert the radar picture into TV, and then display the television image on a large number of monitors. It is necessary that the storage device be able to simultaneously write radar information and transmit or read out the stored TV pictures. The resolution of the storage device and, in fact, of the whole system must be as high as possible, to permit storing a large area on the indicator and yet be able to separate aircraft that are relatively close together. With the CAA requirements in mind and knowledge that there were many similar applications, Raytheon began a company-sponsored program to redevelop a dual-gun Recording Storage Tube fundamentally similar to the ones made in the earliest days of storage tubes but with sufficient resolution, background uniformity, and control of erasure characteristics to make the proposed radar-display system practical.

Fortunately, a parallel development project had been in process for several months aimed at improving the basic single gun Recording Storage Tube to have 1000 lines resolution and other desired characteristics. Thus, with the advantages of ten years experience in storage tube design, the newly developed cathode ray electron gun suitable for producing 1000 lines resolution on a storage screen, and a newly perfected collimation lens system capable of minimizing background shading or non-uniformity to 10% of peak amplitude signals, Raytheon was able to produce a high resolution scan-converter storage device within only a few short months of the date the project was initiated.

An indication of what is actually meant by a resolution (measured, according to IRE Standards, at 50% output level) of 1000 TV (or black and white) lines is seen in the three-step series of photographs labelled Figure 1. The first photograph in this series shows a test pattern which has been stored in a Recording Storage Tube and is being played back onto a typical TV monitor. In the second photograph we can see that the pattern was, in fact, stored on only a small area of the total storage screen. The resolution across a diameter of the storage tube is, therefore, the resolution across the stored pattern times the ratio of the usable storage tube diameter to the portion of the diameter actually used in a horizontal direction. In the third photograph of the series, we have blown up the central area of the same stored picture to show that the lines in the vertical wedges can actually be resolved down to the base circle. (The converging lines are a measure of resolution, and the numbers beside the wedge pattern, such as 35 and 45, indicate a resolution of 350 lines and 450 lines respectively, if they can be distinguished as separate lines.) The fact that we can resolve lines right down to the base circle indicates that 500 lines could be resolved in the size of the stored picture or that well over 1000 TV lines can be resolved across the diameter of the stored surface. (The photographs shown were taken using a single gun kiloline Recording Storage Tube since adequate equipment to run this test was not available for the dual-gun tube at that time. Were the equipment available, the same test results would have been obtained with the dual-gun tube).

The photographic series of Figure 2 shows a picture stored from a live television broadcast and then played back to the TV monitor and photographed. Again we see that only a portion of the storage tube area was required to store television quality pictures. More important, however, we can see that the gray shades in the television picture were maintained. It should be noted here that the Recording Storage Tube does not merely stop the action of the picture and then allow the stored image to be played back once, but can play back the stored image thousands of times without substantial deterioration. Moreover, the stored picture can be held for periods of hours prior to retransmittal. Now with an understanding of some of the more dramatic capabilities of such storage devices, perhaps a brief explanation of the theory of operation is desired.

Typically, a three-or four-step cycle is used in the operation of recording tubes. When a four-step cycle is desired, the steps are erase, prime, write and read. For the three-step cycle the functions of erase and prime are combined for circuit simplicity, though at a slight loss in the degree of erasure which can be obtained. During the erase, prime, and write modes of operation, an electron beam from a gun is used to vary the charge level on the storage surface, while during read, the charge pattern previously written amplitude modulates a constant beam from a gun. (Naturally, the electron beam is being scanned during these operations.)

In Figure 3 we see a typical secondary-emission curve of a dielectric surface. Along the horizontal axis is plotted the velocity of electrons striking the surface or, by simple conversion, the voltage of that surface. In the vertical axis the secondary emission ratio (or ratio of the number of electrons which bounce off the dielectric surface to the number of electrons which strike it) is plotted. Below a certain value of voltage called the "critical potential", each electron striking drives off, on the average, less than one secondary electron and so the surface being struck would be charged negatively. On the other hand, if the dielectric surface of the storage screen is above critical potential, each electron striking knocks off more than one secondary electron. The surface will therefore charge in a positive direction as long as the voltage field directly before that surface is sufficiently positive to draw off the secondary electrons thus emitted. Utilizing this phenomenon of being able to charge either positively or negatively depending upon the dc voltage of the storage surface, we can now cycle the tube through its various modes.

In Figure 4 we can see a schematic representation of the CK7572/QK703 dual-gun tube. In an expanded view of the storage assembly (Figure 5) we can see that it is made up of three fine mesh (750 wires per inch) screens. The center screen is coated on one side with a thin layer of dielectric capable of holding an impressed charge for many hours without leakage. The electron gun facing the dielectric surface is used for writing and erasing operations, whereas the gun on the opposite side is used for reading the stored picture. As is true in the single-gun tube, priming can be accomplished by setting the storage screen voltage so that it is below critical potential with respect to the writing-gun cathode. Thus, each electron striking the surface will charge that surface negatively towards cathode potential. To switch the tube to a writing mode, it is necessary either to switch the storage screen positively above critical potential or conversely, to lower the cathode potential of the writing gun to a point where the storage screen is above critical potential with respect to this writing gun cathode. With the writing beam modulated by a typical signal and scanned in a radar or TV type pattern, a complete picture can be "painted" onto the storage surface or, in other words, stored.

Meanwhile, throughout this priming and writing operation, the reading gun can be simultaneously used to produce an output from the storage tube for display on a typical monitor. While the writing gun is being driven in PPI fashion, the reading gun is typically being scanned in a

television-type raster pattern, though possibly with more scanning lines per frame than is used in commercial television so that the high resolution capabilities of the tube can be fully utilized. The reading-gun cathode is operated at a sufficiently high potential for the storage surface, in areas where nothing has been written, to appear so negative that the reading-gun's beam is prevented from passing through. In areas where the storage surface has been charged positively by the writing process, however, a percentage of the reading beam passes through the storage screen to the output electrode. The portion of the beam which has penetrated the storage screen strikes the output screen - developing the output signal voltage.

It can be readily understood that, though a signal is being impressed on the output screen from the reading beam, a portion of the writing beam also strikes this screen. If no provisions were made to separate these two signals, the output developed from the two currents impinging on the screen would result in what is called "cross-talk". To permit separation of the writing and reading video signals, the reading beam is modulated with a high frequency carrier, perhaps 30 megacycles. When the output is then fed through an IF amplifier tuned to the carrier frequency, only those signals developed by the reading beam can pass through this amplifier, and effective discrimination against the writing signal is accomplished.

Though the single-gun kiloline Recording Storage Tube was, in itself, a remarkable advance in the state of the art, the dual-gun type has additional advantages. First, we see that reading can be performed at all times, even when new video signals are being written. Moreover, it is never necessary to switch the storage screen potential. (In single-gun types, a basic problem results from the fact that the switching of the storage screen voltage provides transients in the output electrode signal). When it is desired to partially or totally prime the storage tube using the write gun, only the writing gun voltages need be shifted and so reading can still be achieved while the priming operation is going on.

One especially important feature of the dual-gun storage tube which has not been mentioned is the fact that, in another mode of operation, automatic or gradual priming can be accomplished without switching the potential on any electrode in the storage tube. This automatic erasure is continuously controllable in rate and so can be used to gradually decay stored signals. Target trails will then appear brightest at the target's present position and will get progressively dimmer in the direction of past history. Thus, in an application where this phenomenon can be utilized, even the mode-switching to accomplish prime is made unnecessary and so the tube can be used for continuous uninterrupted writing and reading with gradual erasure being effortlessly accomplished at a controllable rate.

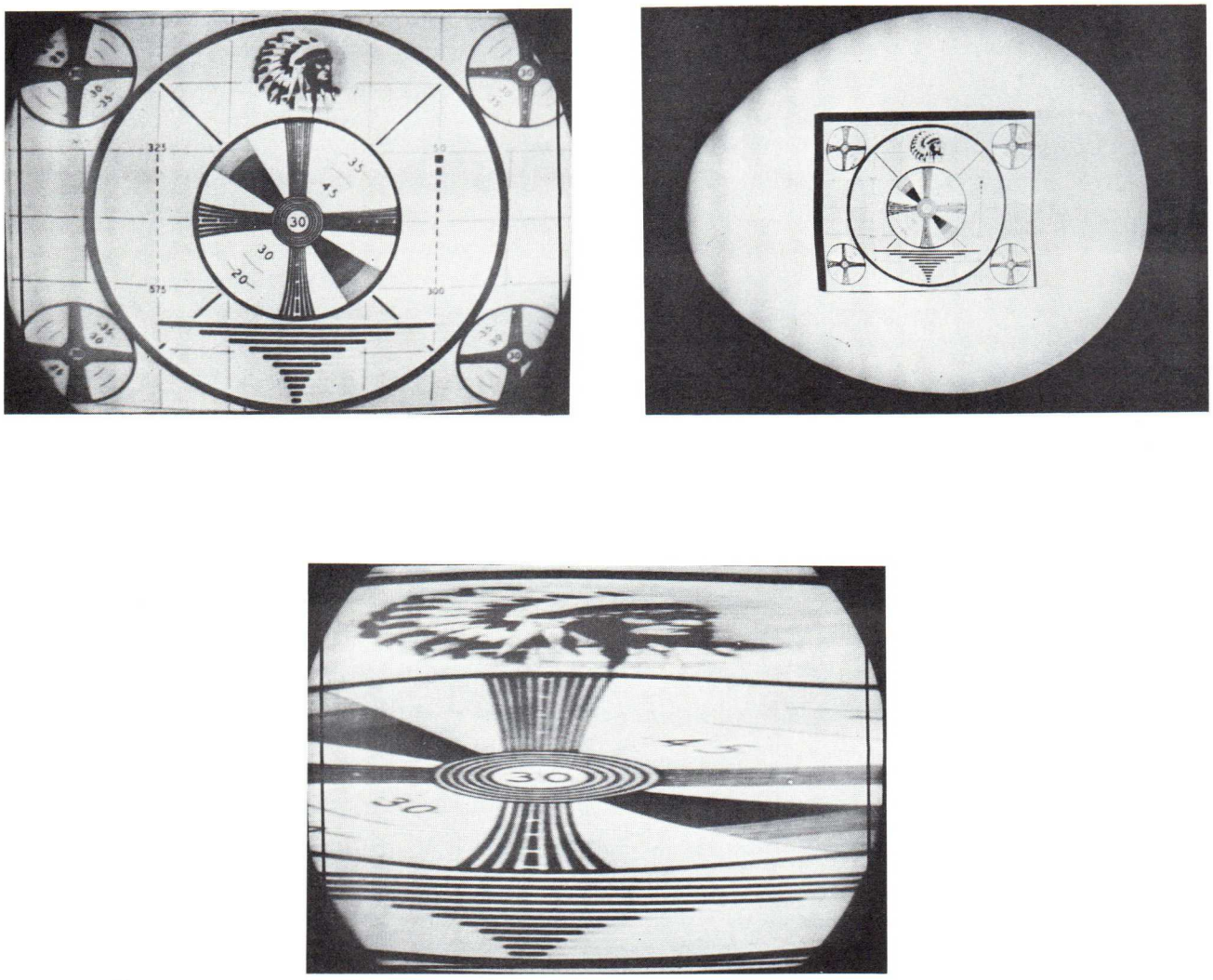
It is expected that the combination of these many valuable features in a single Recording Storage Tube, the CK7572/QK703, vastly increases the usefulness and practicability of storage tubes to scan-convert as well as record and integrate signals.

[1] R. C. Hergenrother and B. C. Gardner, "The Recording Storage Tube," Proc. IRE, Volume 38, Page 740, July 1950.

[2] R. C. Hergenrother and A. S. Luftman, "Single-Gun Storage Tube Writes, Reads and Erases," ELECTRONICS, Page 126, March 1953.

[3] R. C. Hergenrother, A. S. Luftman and C. E. Sawyer, "Improved Storage Tube Design," ELECTRONIC INDUSTRIES, Page 82, March 1956.

FIGURE 1



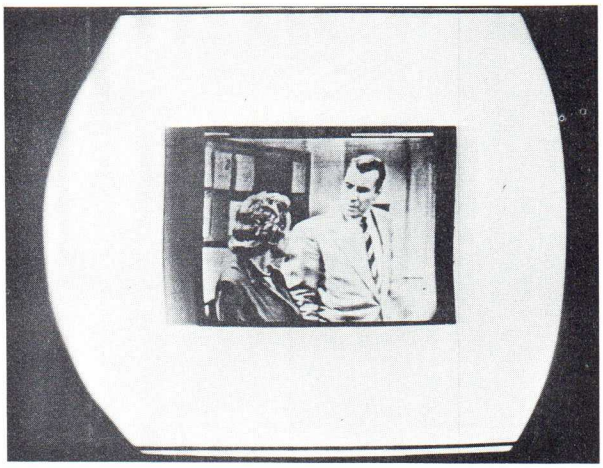


FIGURE 2

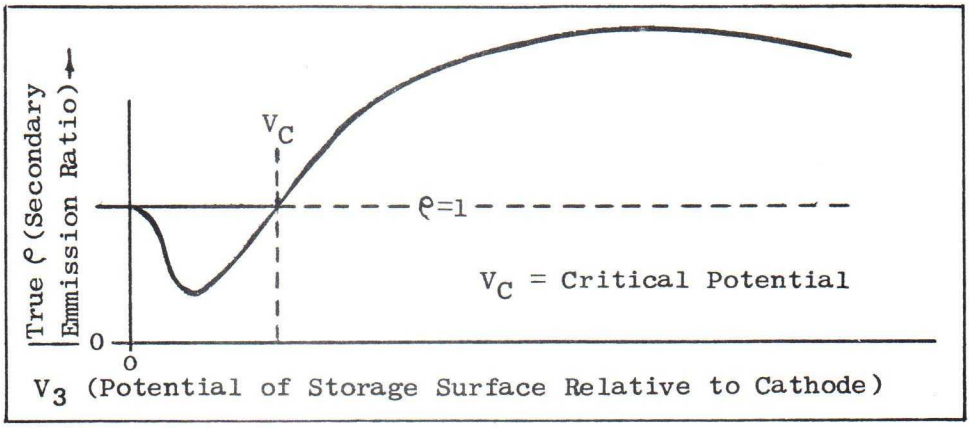


FIGURE 3

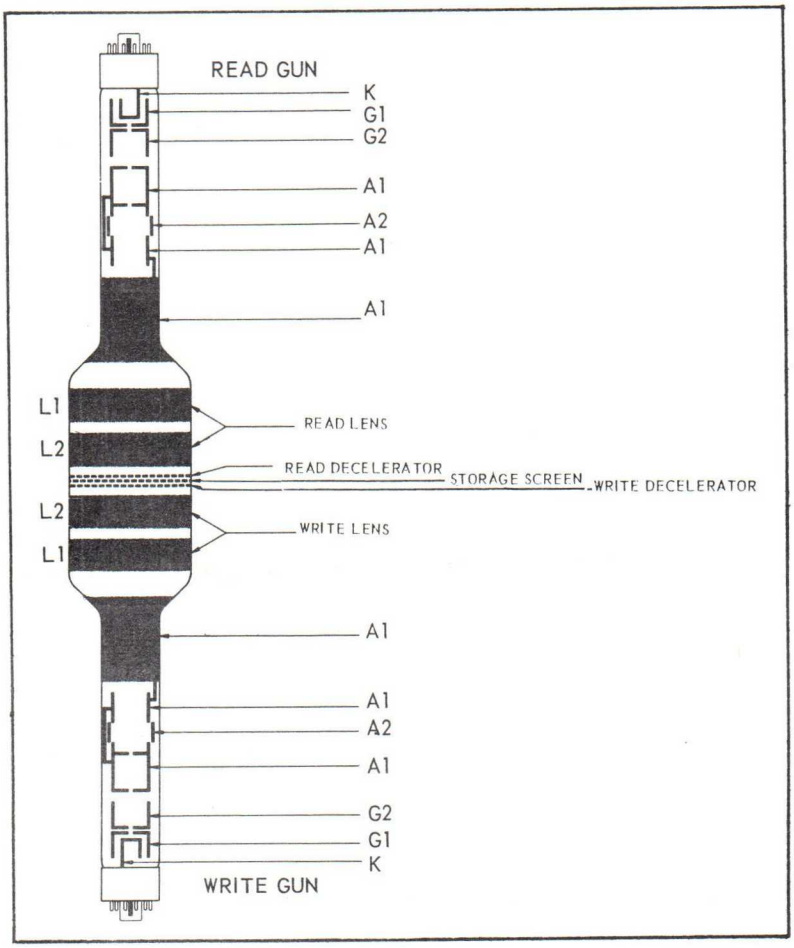


FIGURE 4

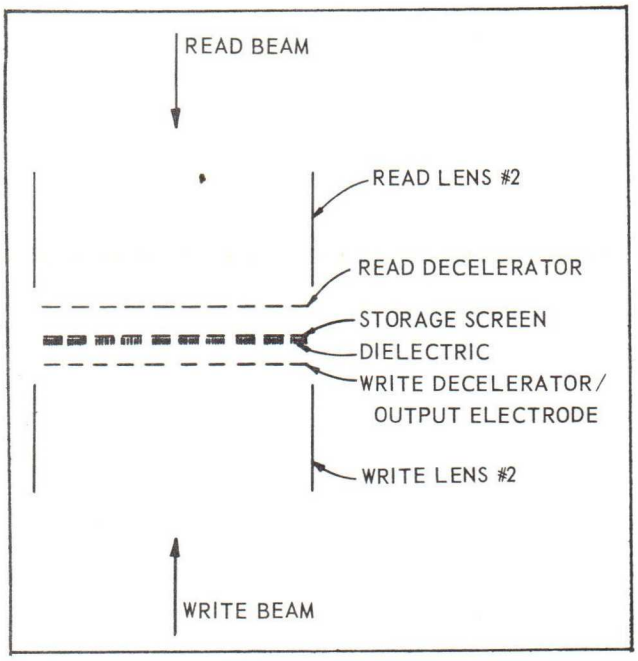
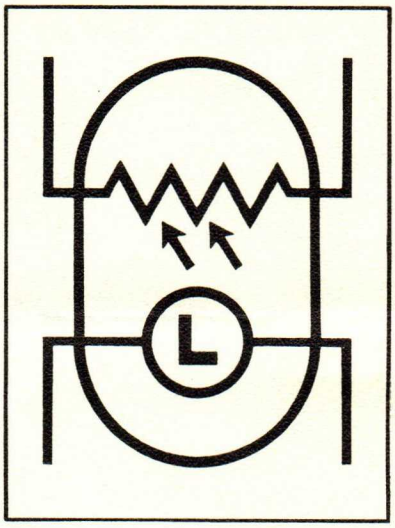


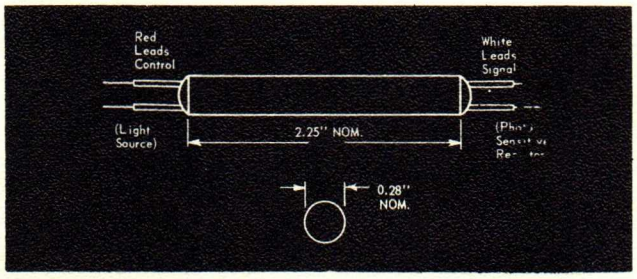
FIGURE 5

RAYTHEON the raysistor®

The Raysistor is a four terminal optoelectronic device which performs a variety of control functions, providing noise-free control of AC or DC signals over a wide dynamic range without transients or contact (or wiper) chatter. Since there are no moving parts, Raysistors are exceptionally rugged and have inherently long life in typical applications as variable resistors, solid state switches, relays, and voltage or signal isolators.

Operation of the Raysistor is on the principle of controlled light acting on a photoresistive element. No electrical or mechanical connection exists between the control and signal circuits.

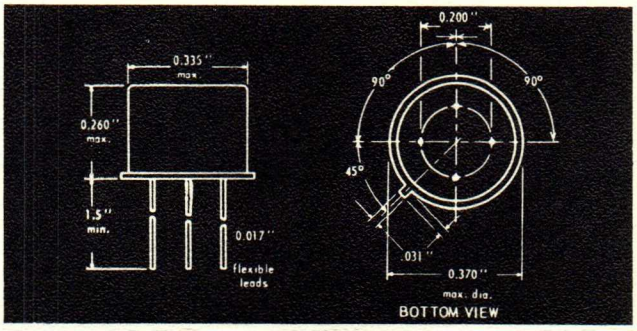




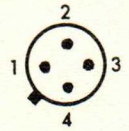
TERMINAL CONNECTIONS

Red leads to control circuit (Light Source)
White leads to signal circuit (Photocell)

CK1101, CK1102, CK1103, CK1104, CK1111, CK1112



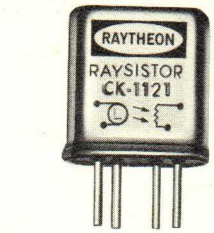
TERMINAL CONNECTIONS

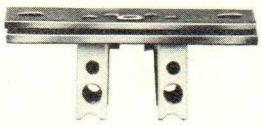


BOTTOM VIEW

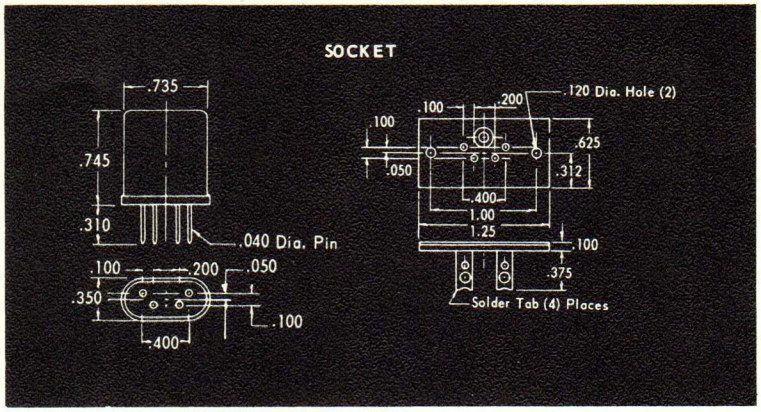
CK1114, CK1115, CK1116

Leads 2 and 4 . . Control Circuit (Light Source)
Leads 1 and 3 . . . . Signal Circuit (Photocell)

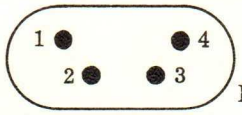




CK1121, CK1122,
CK1123, CK1124

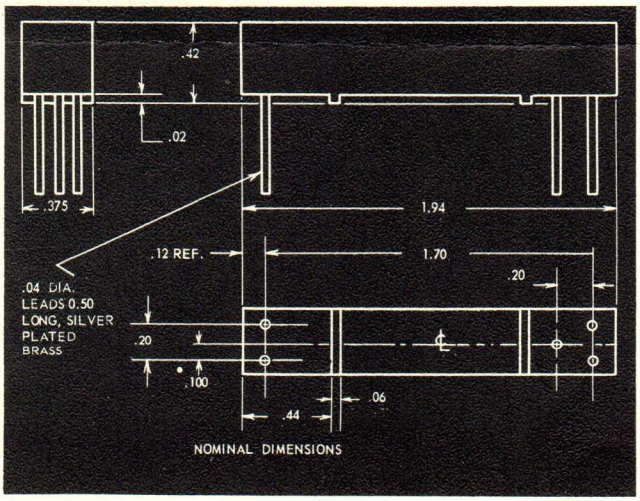


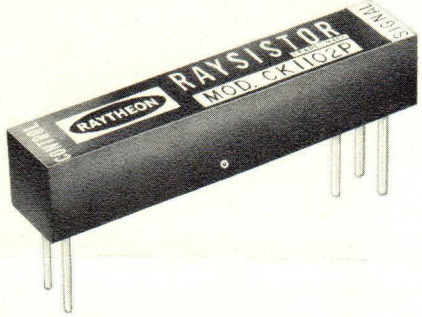
TERMINAL CONNECTIONS



Bottom View

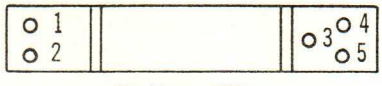
Pins 1, 2 Control Circuit (Light Source)
Pins 3, 4 Signal Circuit (Photoresistor)





CK1101P, CK1102P, CK1103P,
CK1104P, CK1111P, CK1112P

TERMINAL CONNECTIONS



Bottom View.

Pins 1, 2. Control Circuit (Light Source)
Pin 3. Shield (Ground)
Pins 4, 5. Signal Circuit (Photocell)

MODEL	CONTROL LAMP		SIGNAL—PHOTOCELL								GENERAL				MODEL
	VOLTAGE	NOMINAL CURRENT RANGE (MA)	RESISTANCE IN OHMS				VOLTAGE (MAX.)	MAX. POWER[I] (MW)	TYPICAL SWITCHING TIME[H] (SECONDS)		SHUNT CAPACITY (pf)	COUPLING CAPACITY (pf)	WEIGHT (OZ.)	LIGHT SOURCE TYPE[A]	
			ON[D]		OFF[E] 50V				ON[F]	OFF[G]					
			TYP.	MAX.	TYP.	MIN.									
CK1101 CK1101P	120[B]	1-3[C]	600	1000	5×10^7	10^7	60	75	.0012[K]	.060	4	.001	.2	N	CK1101 CK1101P
CK1102 CK1102P	0-1	0-50	550	700	10^7	10^6	60	75	.020	.300	4	.003	.2	I	CK1102 CK1102P
CK1103 CK1103P	0-5	0-175	55	150	10^7	10^6	60	75	.020	.800	4	.005	.2	I	CK1103 CK1103P
CK1104 CK1104P	0-25	0-37	55	150	10^7	10^6	60	75	.010	.450	4	.01	.2	I	CK1104 CK1104P
CK1111 CK1111P	120[B]	1-3[C]	14K	30K	7×10^8	2.5×10^7	300	75	.002[K]	.105	.8	.002	.2	N	CK1111 CK1111P
CK1112 CK1112P	0-10	0-17	340	700	10^7	10^6	60	50	.030	.400	4	.04	.2	I	CK1112 CK1112P
CK1114	0-1	0-17	450	850	3×10^8	10^6	100	100	.018	.060	1.5	1.0	.04	I	CK1114
CK1115	0-4	0-55	100	200	10^8	10^7	200	100	.010	.300	2	1.0	.04	I	CK1115
CK1116	0-4	0-14	200	350	10^8	10^7	200	100	.010	.200	2	1.0	.04	I	CK1116
CK1121	0-5	0-55	100	150	10^9	5×10^7	200	100	.004	.250	2	.1	.1	I	CK1121
CK1122	0-10	0-17	650	1000	10^9	5×10^7	200	100	.030	.225	2	.1	.1	I	CK1122
CK1123	0-25	0-37	100	150	10^9	5×10^7	200	100	.010	.300	2	.1	.1	I	CK1123
CK1124[J]	150[B]	.1-1.2	2500	3000	10^8	2×10^7	200	100	.002[K]	.100	2	.1	.1	N	CK1124[J]

NOTES

A. Letter "N" designates a gas discharge type light source; "I" designates an incandescent type light source.

B. Voltage stated is DC or Peak. A current limiting resistor must be used in series with the control lamp. A typical value is 20 K ohms. (100 K ohms for CK1124).

C. The control current is linear with voltage over the stated range. It is possible to operate the light source below the lower limit, but either a constant current source must be used or the supply voltage and series limiting resistor must be increased to improve stability.

D. The nominal "on" resistance is the typical value of resistance of the photocell when the nominal voltage is applied at the control terminals, measured at 25° C. Under these conditions the "on" resistance will not exceed the maximum value indicated.

E. The "off" resistance has a negative temperature coefficient. Typical values of "off" resistance are 100 megohms at 25° C, 20 megohms at +65° C, and 1000 megohms at −55° C, measured with a 50 volt signal voltage.

F. The "on" switching time is defined as the time required for the voltage across the photocell to fall to 10 per cent of its initial value, measured from the instant that maximum rated control voltage is applied to the lamp. It is a function of both the signal voltage and of the signal circuit load. In general, "switch-on" time decreases with lower signal voltages and decreases with increased load resistance.

G. The "off" switching time is defined as the time required for the voltage across the photocell to rise to 90 per cent of its final value from the instant that maximum rated control voltage is removed from the lamp. It is also a function of both the signal voltage and of the signal circuit load. In general, "switch-off" time decreases with lower signal voltages and increases with increased load resistance.

H. Test conditions for switching time:
signal voltage— 50 volts
signal circuit load—100K Ohms

I. The 100 milliwatt rating on the photocell applies only to room ambient temperatures and below. Maximum dissipation at 65° C is 25 milliwatts.

J. Correct polarity must be observed to realize performance specified. Pin number 1 must be positive with respect to pin number 2.

K. Switch-on time is dependent upon rate of successive firing of the lamp. Initial switch-on time may vary up to 100 ms. Specified values apply when control circuit is energized at a rate of 2 cps or faster.

Distributors of Raytheon Components in the United Kingdom

WALMORE ELECTRONICS LIMITED

11-15 BETTERTON ST., DRURY LANE, LONDON, WC2

RAYTHEON

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TENTATIVE SPECIFICATIONS FOR ELECTRON TUBE TYPE RK7460

Issued: December 20, 1960: Note 3

The provisions of MIL-E-1 apply to this specification. Note 21

Description: Magnetron, 5450 to 5825 megacycles, 250 kilowatts (minimum), mechanically tunable, pulsed type, air-cooled, integral magnet, unipotential cathode.

Dependent Absolute Ratings Note 2

Parameter:	Ib	ib	Pi	pi	Du	tp
Unit:	mAdc	a	W	kw		us
Maximum:	30	30	750	750	0.0012	2.5
Minimum:	--	--	--	--	--	--
						Note 5

Independent Absolute Ratings Note 1

Parameter:	Ef	epy	tk	VSWR	Pressure
Unit:	V	kv	sec	--	psia
Maximum:	5.5	28	--	1.5	--
Minimum:	--	--	180	--	10
	Note 4			Note 7	

Parameter:	Tuner Torque	Anode T	Bushing T	Output Pressurization
Unit:	in-oz	°C	°C	psia
Maximum:	200	120	270	35
Minimum:	--	--	--	12
		Note 8	Note 8	Note 9

STORAGE, HANDLING, AND INSTALLATION

Input Bushing:	Note 8	Output Coupling:	Note 21
Mounting Support:	Note 21	Input Connections:	Note 21
Cooling:	Note 13	Vibration, Shock:	Note 11
Mounting Position:	Any	Weight:	35 lbs. Approx.
		Magnet:	Note 10

RAYTHEON COMPANY
Microwave and Power Tube Division
Waltham 54, Massachusetts

Ref.	Test	Condition	Sym.	Min.	Max.	Unit
	GENERAL TESTS					
3.1	Qualification Approval	Required for JAN Marking				
4.9.2	Dimensions	Note 21				
3.7	Marking	Raytheon RK7460				
4.5	Holding Period	t = 168 hours				
	QUALIFICATIONS TESTS					
4.9.8	Salt Spray Corrosion	Omit				
4.9.19.2	High-Frequency Vibration	No Voltage				
---	Shock Test	Note 12; G = 15				
---	Anode-Cathode Capacity		C	10	17	uuf
4.9.14	Temperature Coefficient	Anode T: 50 to 120 °C F1, F3 Note 8, 15	ΔF/°C	---	-0.2	Mc
	MEASUREMENTS ACCEPTANCE TESTS - PART ONE - (PRODUCTION)					
4.9.7	Water-vaporproof Barrier	Required				
4.9.13	Pressurizing	30 psia min.				
4.10.8	Heater Current	Ef = 5.0 V tk = 180 sec. min.	If	4.5	5.4	A
4.16.3	Oscillation I					

Ref.	Test	Condition	Sym.	Min.	Max.	Unit
---	Standing Wave Ratio	VSWR = 1.1 max. except as specified herein				
4.16.3.2	Heater-Cathode Warmup Time	tk = 180 sec. max. at EF = 5.0 V; Note 4 Ef = 5.0 operate				
4.16.3.3	Pulse Characteristics	tp = 0.45 to 0.55 us Du = .000342; trv = 0.1 us (min.) to 0.7 us (max.); Note 14, 5, 6				
4.16.3.4	Average Anode Current	Ib = 8.6 mAdc				
4.10.7.3.2	Tunable Frequency		F	5450	5825	Mc
4.16.3.6	Power Output	F1: = 5450 Mc F2: = 5660 Mc F3: = 5825 Mc	Po	87	---	W
4.16.3.5	Pulse Voltage	F1	epy	23	26	kv
4.16.3.7	R.F. Bandwidth	F1, F2, F3 Note 16	BW	—	$\frac{2}{tpc}$	Mc
4.16.7.3	Starting Stability	F3; Note 20	MP	—	5.0	%
4.16.7.1	General (RF) Energy Stability	F1, F2, F3 VSWR = 1.5/1 Note 18	MP	—	0.25	%
4.16.5	Pulling Factor	F3, Note 17	ΔF	—	15	Mc
	MEASUREMENT ACCEPTANCE TEST - PART TWO - (DESIGN)					
4.9.19.1	Low Frequency Vibration	No Voltage				
	ACCEPTANCE LIFE TEST					
4.11	Life Test	Cathode Horizontal Group D, Note 19		72		Cylces

Ref.	Test	Condition	Sym.	Min.	Max.	Unit
4.11.4	Life Test End Points					
4.16.3.6	Power Output	F1, F2, F3	Po	69.0		W
4.16.3.5	Pulse Voltage	F1	epy	22	27	kv
4.16.3.7	R.F. Bandwidth	F1, F2, F3; Note 16	BW	—	2.5 tpc	Mc
4.[illegible]7.1	Stability	F1, F2, F3 VSWR = 1.5/1, Note 18	MP	—	0.5	%
	PACKAGING INFORMATION					
4.9.18.1.8	Carton Drop	Required				

1. The independent absolute ratings shall not be exceeded if the life specified herein is to be obtained. These independent absolute ratings are limiting values beyond which the serviceability of any individual tube may be impaired.

2. The dependent absolute ratings are interrelared, and it does not necessarily follow that combinations of ratings can be attained simultaneously. The provisions of 6.5 Specification MIL-E-1 shall apply in the selection of the operating point.

3. These tentative specifications are subject to revision. The tube manufacturer should be consulted with regard to details of application.

4. The maximum value specified herein is for a non-oscillating condition. Heater surge current shall not exceed 12 amperes.

5. The characteristics of the applied pulse shall be those which result in proper starting and oscillation. The rate of pulse voltage rise, the percentage of pulse voltage ripple, and the rate of pulse voltage fall shall be among the more important considerations. The manufacturer will be consulted with regard to specific applications where pulse characteristics differ from those used in this specification.

6. The pulse characteristics of Oscillation (1) shall be as follows: trv = 0.1 to 0.17 us, measured between 20 and 85 percent levels of the steepest tangent above the 50% level. No spike or ripple shall exceed ± 5% of the average peak value of voltage or current. The current pulse fall time shall not exceed 0.2 us (max.) as measured between 0 and 85 percent levels. Pulse shall be applied directly to plates of oscilloscope.

7. Frequency skipping or unstable operation may be encountered at some phase positions when the mismatch occurs at the end of a "long line".

8. The temperature shall be measured at the point shown on Drawing D-82221.

9. The gas used in pressurization shall provide insulating properties at least equal to that of clean, dry air at the pressure specified herein.

10. In handling and mounting the magnetron, care shall be taken to prevent demagnetization. Ferromagnetic materials shall not at any time be permitted to come closer than 8 inches from the magnet, except at the ends where the clearance may be 3 inches minimum. Energized magnets shall not at anytime be permitted to come closer than 12 inches from the tube magnet.

11. Care shall be used in the storage, installation, and handling of the tube to avoid imparting vibration or shock in excess of the values for which it is designed to withstand.

12. The magnetron shall be mounted on a test plate and dropped five times on each of three mutually perpendicular axes parallel to the reference planes shown on Drawing D-82221. The shock pulse shall have a duration of approximately 11 milliseconds as measured at the quarter amplitude points of the acceleration shock wave.

13. Cooling requirements, where the ambient temperature does not exceed 50°C, shall be as follows: In no case shall the temperature of the anode exceed 120°C.

Average Anode Power input watts	Air Flow c.f.m.	Back Pressure (Inches of H_2O)
0	2.5	0.06
100	7.5	.16
200	10.0	.28
300	15.0	.44
400	19.5	.63
500	24.0	.87
600	29.0	1.13

14. This test may be conducted only under one set of conditions within the limits for the oscillation specified herein.

15. Measurements of temperature and frequency shall be made after conditions of thermal equilibrium have been reached.

16. Stability shall not be measured under this test. The r.f. bandwidth shall be within the limits specified herein when a VSWR of 1.5/1.0 is introduced in the load at a distance of not greater than 0.5 meter from the magnetron coupling flange, the phase being adjusted for maximum bandwidth.

17. The pulling measurement shall be made in such a manner that thermal effects do not introduce appreciable errors.

18. Not more than the percentage of pulses specified herein shall result in r.f. output pulses, each having less than 70 percent of the energy content of a normal pulse. Missing pulses shall be counted within a range of plus or minus 1 percent of the test frequency during the last 3 minutes of a test interval not to exceed 6 minutes. Observations shall be made for the load phase position corresponding to maximum missing pulses.

19. The VSWR shall be 1.5/1.0. The interpretation of the value of the VSWR shall be as specified in paragraph 4.16.5 of Specification MIL-E-1. The standing wave introducer shall be cycled continuously through a line length approximately 1/2 wavelength long at an approximate rate of 4 cycles per hour. Application of operating voltages shall be in accordance with the following cycle:

a)	Cathode preheat	-3 minutes
b)	Pulse voltage	-7 hours
c)	Off	-57 minutes

The frequency shall be changed at the start of each running period and shall be cycled between 5450 mc., 5525 mc, 5675 mc, 5750 mc, and 5825 mc, spending one 7-hour period at each frequency.

20. Immediately after the non-operational holding period and after a 180 second heater warm-up time, the anode voltage as specified in Oscillation (1) shall be instantaneously applied and the magnetron missing pulse count shall not exceed 5% over the first minute of operation. A missing pulse is defined as an r.f. pulse whose average energy is 70% or less than that of a normal pulse.

21. The following drawing forms a part of these specifications:

Electron Tube, Raytheon D-82221.

Preliminary Data*

ISSUED 8/68

RAYTHEON

QKH1495 TUNABLE X-BAND COAXIAL MAGNETRON

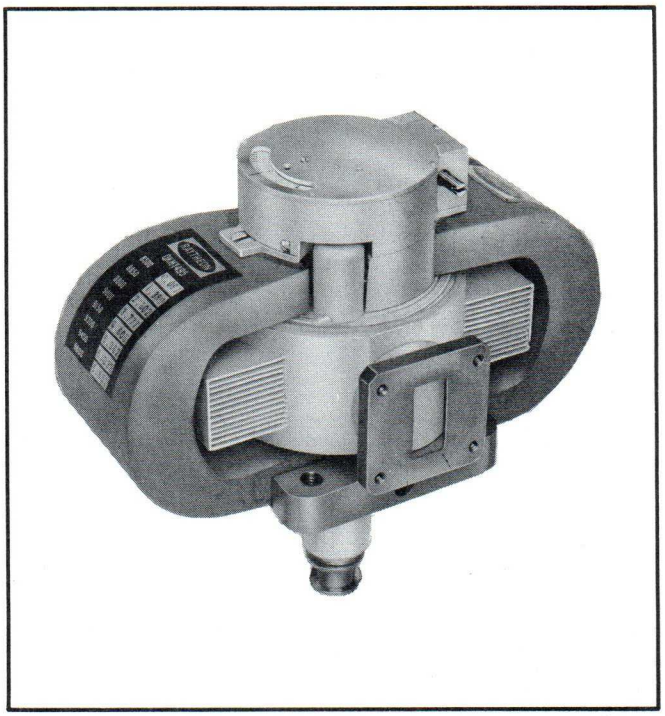
- Tunable 8.5 to 9.6 GHz
- 200 KW Peak Power Output

The QKH1495 has a typical power output of approximately 200 kilowatts over its entire frequency range. Pulse widths up to 3.0 microseconds may be used. The QKH1495 provides excellent spectrum shape and excellent stability of operation. The pulling figure, or variation in frequency with mismatch, of coaxial magnetrons is lower, by a factor of 3 or 4 times, than that of conventional magnetrons. The pushing figure is also very low in coaxial magnetrons which is due to the stabilizing cavity.

Structurally, the QKH1495 employs a slotted vane type anode. Tuning is accomplished by means of a plunger which is coupled to the main resonator. Tuning is therefore accomplished remote from the interaction space greatly improving the electrical and thermal stability.

An impregnated cathode is used which is arc resistant and has excellent life properties. The QKH1495 has a waveguide type output which is designed to couple to a modified UG-52/A choke flange. The output should be pressurized to two atmospheres absolute.

The QKH1495 is designed for transmitter service in radar systems. The tube is useful in ground as well as airborne installations where a high performance X-band power source is required.



ELECTRICAL

Heater, for Unipotential Cathode:

Voltage (ac) . . . . . 13.75 Volts

Current at 13.75 Volts . . . . . Min. 2..7
Max. 3.5 Amperes

Starting Current . . . Maximum instantaneous starting current must never exceed 12 amperes.

Min. Cathode Heating Time . . . . . 150 Sec.

Frequency . . . . . 8.5 to 9.6 GHz

Max. Frequency Pulling at VSWR of 1.5 . . . . . 5 MHz

MECHANICAL

Mounting Position . . . . . Any

Dimensions . . . . . See outline drawing

Air Flow . . An air stream should be directed along the cooling fins toward the body of the tube. Adequate flow should be provided so that the temperature of the anode block does not exceed 160°C.

Cathode Bushing (Note 1). . . Oil immersed or air pressurized.

Waveguide Output Flange . . . . . Mates with modified JAN UG-52/U

Cathode Connector. . . The cathode connector should contain a built-in capacitor such as the No. 9000-C manufactured by Jettron Products, Hanover, New Jersey.

Tuner . . . Calibrated, with Worm Servo Drive

Max. Shaft Speed . . . . . 1800 RPM

Net Weight (Approx.) . . . . . 14 lbs.

*The specifications for this device have not been finalized. For current information contact the nearest Microwave and Power Tube Regional Sales Representative.

Printed in U. S. A.

PULSED OSCILLATOR SERVICE

RATINGS	Min.	Max.
Peak Anode Voltage	-	28 kv
Peak Anode Current	12	30 a
Peak Power Input	-	850 kw
Average Power Input	-	850 W
Duty	-	0.0015
Pulse Duration	0.1	3.0 μsec
Rate of Rise of Voltage Pulse (Note 3)	80	160 kV/μsec
Anode Block Temp.	-	160°C
Cathode Bushing Temp.	-	165°C

TYPICAL OPERATION WITH LOAD VOLTAGE STANDING WAVE RATIO EQUAL TO OR LESS THAN 1.05 EXCEPT AS NOTED

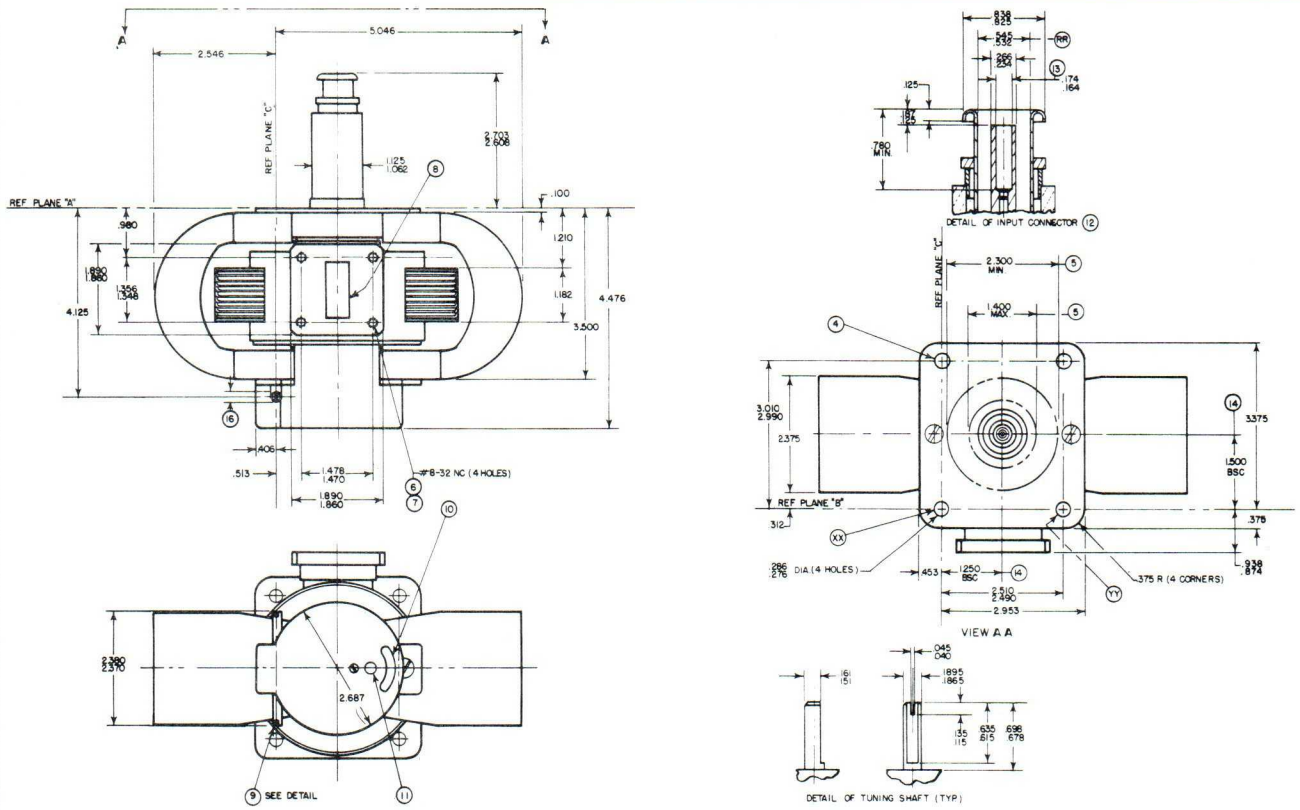
WITH DUTY CYCLE OF 0.001

	Min.	Typ.	Max.
Heater Voltage (Note 2)	-	-	-
Peak Anode Voltage	20	22	23 kv
Peak Anode Current	-	27.5	- a
Pulse Duration	0.1	-	3.0 μsec
RF Bandwidth with worst phasing of 1.5 VSWR	-	-	2/tp MHz
Side Lobes	9	12	- db
Pulling Figure at VSWR of 1.5	-	3	5 MHz
Pushing Factor (20 to 30A)	-	-	0.1 MHz/A
Thermal Factor for any 30° range between -55°C and 150°C	-	-	0.25/°C
Peak Power Output	200	250	270 kw

Heater Voltage	(Note 2)
Peak Anode Voltage	22 kv
Peak Anode Current	27.5 a
RF Bandwidth with worst phasing of 1.5 VSWR	2/tp MHz
Side Lobes	12 db
Pulling Figure at VSWR of 1.5	3 MHz
Pushing Factor for any 30° range between -55°C and 150°C	0.25 MHz/°C
Peak Power Output	225 kw

NOTES

1. No breakdown will occur if pressure is maintained above 600 mm Hg. Air flow must be sufficient to keep bushing below 165°C.
2. Heater voltage should be 0 volts for maximum life at 27.5 ma and 0.001 duty.
3. The QKH1495 will operate satisfactorily over this range. However, use of a higher rate of voltage rise may lead to objectionable leading edge jitter.



1. REFERENCE PLANE "A" PASSES ALONG THE FACE OF THE MOUNTING PLATE AS SHOWN
2. REFERENCE PLANE "B" IS PERP TO PLANE "A" AND PASSES THROUGH THE CENTER OF HOLES "XX" AND "YY" AT PLANE "A"
3. REFERENCE PLANE "C" IS MUTUALLY PERP TO PLANES "A" & "B" AND PASSES THROUGH THE CENTER OF HOLE "XX" AT PLANE "A"
4. AXIS OF HOLE TO BE CENTERED ON PLANE "C" WITHIN .010
5. THIS AREA ON FACE OF MOUNTING PLATE TO BE FLAT WITHIN .005 AND HAVE A 32 MICRO INCH FINISH OR BETTER
6. PITCH DIA MUST ACCEPT CLASS 2 "GO" GAUGE ONLY
7. MINOR DIA MUST NOT BE GREATER THAN .140
8. MATES WITH MODIFIED CHOKE FLANGE UG-52B/U PER MIL-F-3922/25A (CLEARANCE INSTEAD OF THREADED HOLES)
9. OPERATOR TUNING SHAFT
10. FREQUENCY INDICATOR DIAL
11. REVOLUTION COUNTER
12. INPUT CONNECTOR MATES WITH JETTRON PROD. INC. PART #90-006 AND 90-030 OR EQUIVALENT
13. CONC WITH "R" WITHIN .010
14. AXIS OF DIA R-R TO BE LOCATED WITHIN .046 RADIUS OF TRUE POSITION
15. DIMENSIONS WITHOUT LIMITS ARE FOR INFORMATION AND CARRY NO IMPLIED TOLERANCES
16. AXIS OF DIA TO BE CENTERED ON PLANE "C" WITHIN (NYS)

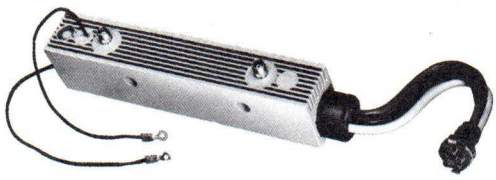
Preliminary Data*

ISSUED 12/64

RAYTHEON

8609 TRAVELING WAVE TUBE

The 8609 traveling wave tube employing a unifilar helix type wave propagating structure is a power amplifier for operation in the 7000 to 11000 Mc frequency range. The power output is approximately 1 kilowatt with an average gain of 40 db and the tube is conduction cooled. It is designed for pulsed operation with a maximum duty cycle of .01. The input and output fittings are designed to mate with TNC Male type connectors. A permanent magnet provides the magnetic field and is integral with the tube.



ELECTRICAL DATA GENERAL

Heater Voltage (ac or dc)	6.3 Volts
Heater Current at 6.3 Volts	3.5 Amps
Heater Cold Resistance (when applicable)	0.2 Ohms
Cathode Pre-Heating Time (before application of beam voltages)	60 Sec.

MECHANICAL DATA GENERAL

Base and Physical Dimensions	See Outline Drawing
Mounting Information Any Position	See Outline Drawing
Cooling Data	75°C Ambient Max. Conduction Cooled
RF Input and Output Impedance and Type Connector	50 ohms, TNC Female
Weight	Approximately 4.75 lbs

ABSOLUTE RATINGS

Heater Surge Current	13 Amps max.
Heater-Cathode Voltage	0 Volts
Cathode Current	2.0 Amps max.
Helix Voltage	12,000 Volts max.
Helix Current	0.4 Amps max.
Grid Voltage	+295 Volts max.
Grid Current	0.4 Amps max.
Collector Voltage (Ref. to helix)	150 Volts max.
Collector Dissipation	180 Watts max.
Collector (and/or other critical element) Temperature	125°C max.
Input RF Power	10 Watts max.
Duty Cycle	.01 max.
Altitude	40,000 Ft. max.

*The specifications for this device have not been finalized. For current information contact the nearest Microwave and Power Tube Regional Sales Representative.

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TYPICAL OPERATION - PULSED

Focusing Field Strength	2,600 Gauss
Operating Frequency Range	7,000-11,000 Mc
Cathode Current	1.6 Amps
Helix Voltage	10,000 Volts
Helix Current	0.2 Amps
Grid Voltage	+270 Volts
Grid Current	0.35 Amps
Collector Voltage Ref. to helix	0 Volts
Collector Current	1.2 Amps
Pulse Width	20 usec Max.
Duty Cycle	.01 Max.
Gain (Saturated)	40 db
Gain (Small Signal)	44 db
RF Output (Saturated)	1,250 Watts
Gross Small Signal Gain Variation	4 db
Saturated Power Variation	1.5 db
Fine Small Signal Gain Variation	2 db
Input VSWR (Cold)	2/1

TYPICAL OPERATION

Output VSWR (Cold)	2/1
Insertion Loss (Hot and/or Cold)	60 db Min.

An equalizer is recommended to minimize small signal gain variations.

NOTE: All Voltages are referenced to the cathode.

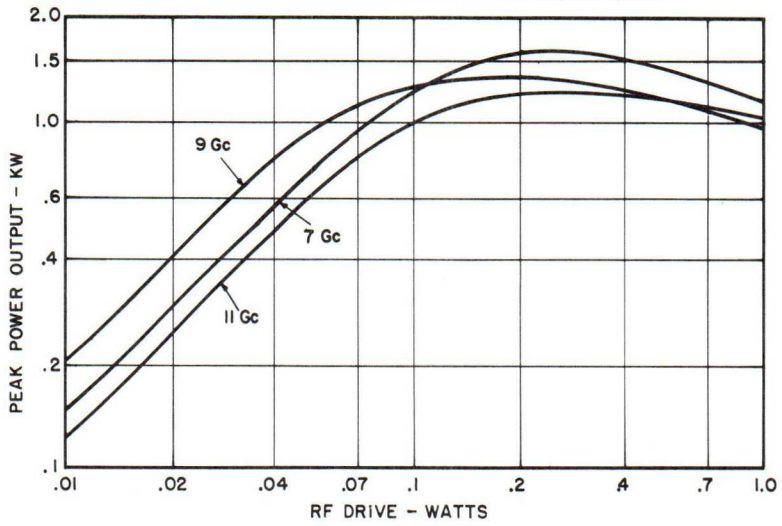
The 8609 is a broadband, X-band periodic permanent magnet focused helix traveling wave tube. This tube is of a ruggedized ceramic-metal construction, permitting operation in hot, cold, and high altitude environments. Cooling at high duty cycles is accomplished with forced air. The tube has minimum gain of 40 db with one kilowatt of r.f. output. Tube operation is controlled by means of a grid which is dc biased at -90 volts with respect to a negative cathode dc voltage which is in the range -9,500 to -10,500 volts. Anode and helix are at ground potential. The collector is isolated to permit operation at ground potential within 150 volts. The positive grid pulse voltage applied, (measured with respect to cathode) is specified on the tube along with the anode voltage. Voltages are applied to the tube in the following sequence:

1. Heater voltage - allow a minimum of 5 minutes for heater warmup.
2. Grid bias of -90 volts.
3. Anode voltage.
4. Grid pulse voltage.

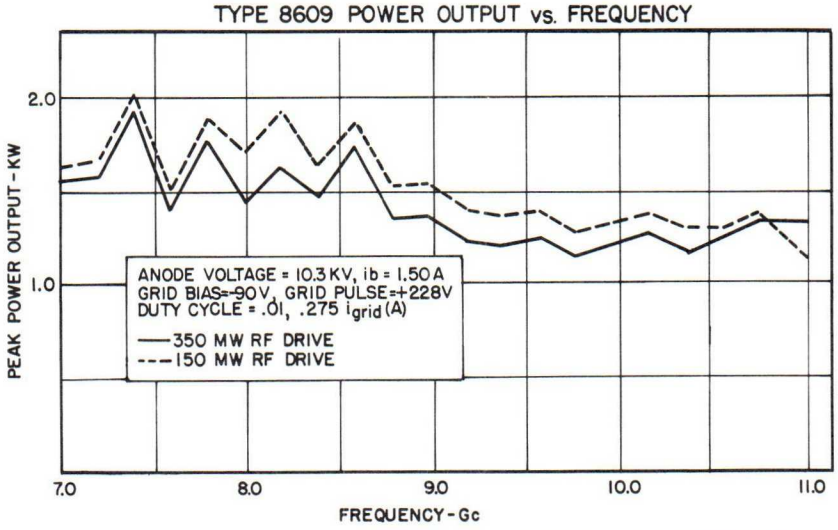
CAUTION: Under no circumstances is anode voltage to be applied without dc grid bias. Under no circumstance is positive grid pulse to be applied to the tube without anode voltage. In both cases, the tube may be permanently damaged.

Note: It is recommended that tube operating point be established by viewing peak collector current to ground without rf drive rather than precise setting of grid pulse voltage.

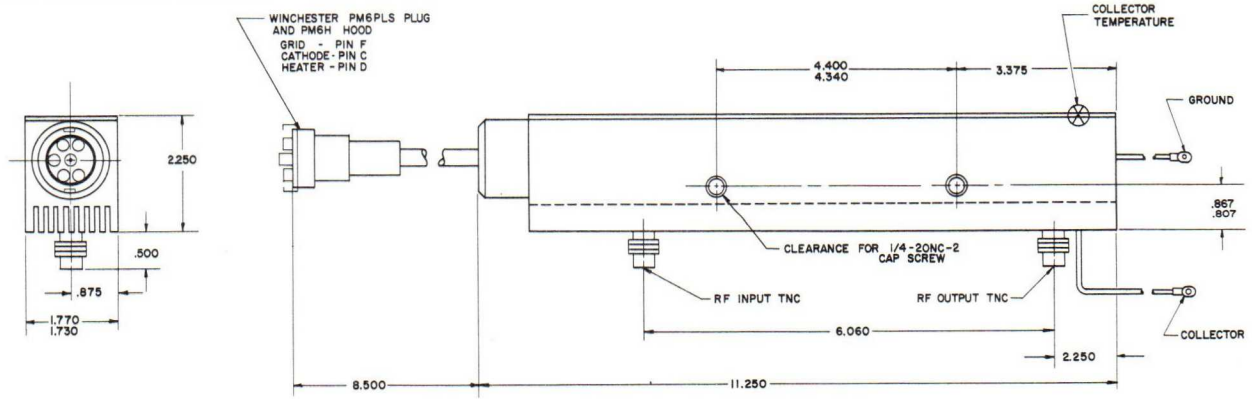
TYPE 8609 PERFORMANCE WITH EQUALIZER



TYPE 8609 POWER OUTPUT vs. FREQUENCY



OUTLINE DRAWING



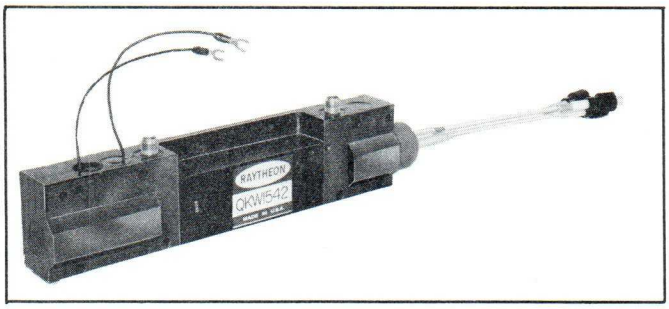
Preliminary Data*

ISSUED 6/68

RAYTHEON

QKW1542 TRAVELING WAVE TUBE

The QKW1542 traveling wave tube employing a unifilar helix type wave propagating structure is a power amplifier for operation in the 7000 to 11, 000 GHz frequency range. The power output is approximately 1.5 kilowatt with an average gain of 40 db and the tube is conduction cooled. It is designed for pulsed operation with a maximum duty cycle of .02. The input and output fittings are designed to mate with TNC Male type connectors. A permanent magnet provides the magnetic field and is integral with the tube.



ELECTRICAL DATA GENERAL

Heater Voltage (ac or dc)	6.3 Volts
Heater Current at 6.3 Volts	3.5 Amps
Cathode Pre-Heating Time (before application of beam voltage)	2 min.

MECHANICAL DATA GENERAL

Base and Physical Dimensions	See Outline Drawing
Mounting Information Any Position	See Outline Drawing
Cooling Data	75°C Ambient Max. Conduction Cooled
RF Input and Output Impedance and Type Connector	50 ohms, TNC Female
Weight	Approximately 6.0 lbs.

ABSOLUTE RATINGS

Heater Surge Current	13 Amps max.
Heater-Cathode Voltage	0 Volts
Cathode Current	2.0 Amps max.
Helix Voltage	12, 000 Volts max.
Helix Current	0.8 Amps max.
Grid Voltage	+290 Volts max.
Grid Current	0.4 Amps max.
Collector Voltage (Ref. to helix)	100 Volts max.
Collector Dissipation	180 Watts max.
Collector (and/or other critical element) Temperature	125°C max.
Input RF Power	10 Watts max.
Duty Cycle	.02 max.
Altitude	70, 000 Ft. max.

*The specifications for this device have not been finalized. For current information contact the nearest Microwave and Power Tube Regional Sales Representative.

Printed in U. S. A.

TYPICAL OPERATION - PULSED

Operating Frequency Range	9.0-10.0 GHz
Cathode Current	2.0 A
Helix Voltage	10,000 Volts
Helix Current	0.2 Amps
Grid Voltage	+270 Volts
Grid Current	0.35 Amps
Collector Voltage Ref. to helix	0 Volts
Collector Current	1.2 Amps
Pulse Width	10 μsec Max.
Duty Cycle	.02 Max.
Gain (Saturated)	40 db
Gain (Small Signal)	44 db
RF Output (Saturated)	1.5 KW
Gross Small Signal Gain Variation	4 db
Saturated Power Variation	2.0 db
Input VSWR (Cold)	2/1

TYPICAL OPERATION

Output VSWR (Cold)	2/1
Insertion Loss (Hot and/or Cold)	60 db Min.

An equalizer is recommended to minimize small signal gain variations.

NOTE: All Voltages are referenced to the cathode.

The QKW1542 is a broadband, X-band periodic permanent magnet focused helix traveling wave tube. This tube is of a ruggedized ceramic-metal construction, permitting operation in hot, cold, and high altitude environments. Tube operation is controlled by means of a grid which is dc biased at -90 volts with respect to a negative cathode dc voltage which is in the range -9,500 to -11,000 volts. Anode and helix are at ground potential. The collector is isolated to permit operation at ground potential within 150 volts. The positive grid pulse voltage applied, (measured with respect to cathode) is specified on the tube along with the anode voltage. Voltages are applied to the tube in the following sequence:

VOLTAGES APPLIED IN FOLLOWING MANNER

A. Set Ef = 6.3 V

B. Set Grid Bias (Ec) = -90 V

C. Set Pi (rf) to 9.5 GHz and adjust to 1.0 mW

D. Raise Ews to 9.5 kV

E. Raise ec and observe Po

F. Adjust Ews for best Po at rated ib undriven

G. Observe Po across band of 9.0 - 10.0 GHz and reoptimize Ews and ec to obtain the best performance across the band

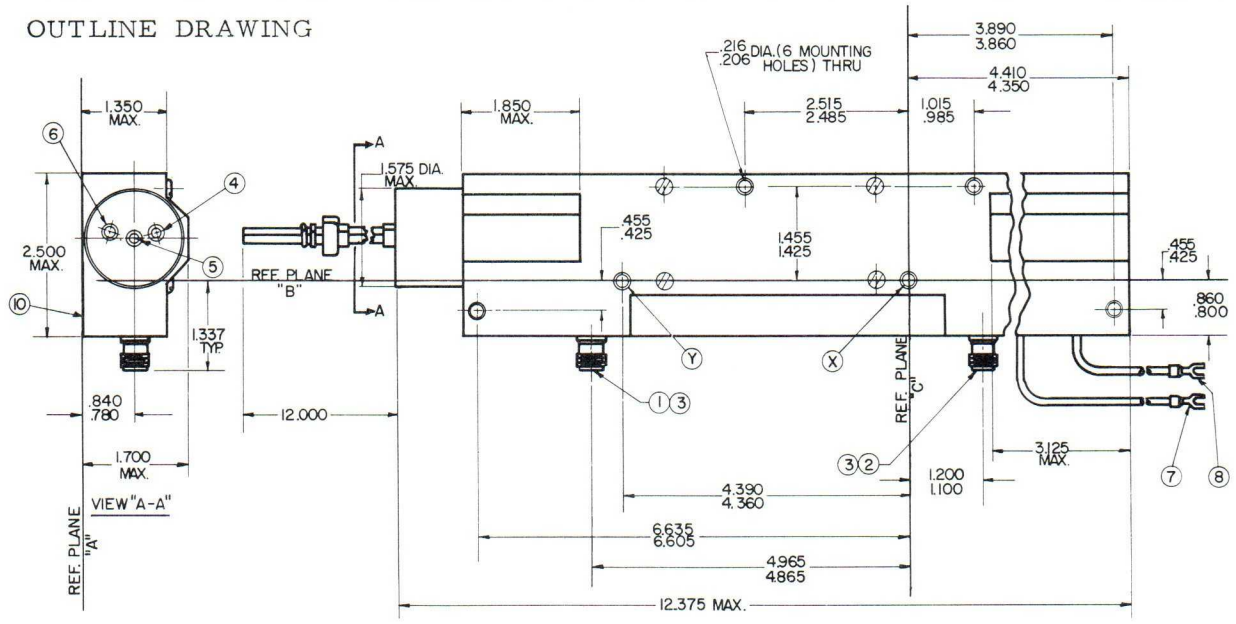
CAUTION: Under no circumstances is anode voltage to be applied without dc grid bias. Under no circumstance is positive grid pulse to be applied to the tube without anode voltage. In both cases, the tube may be permanently damaged.

Note: It is recommended that tube operating point be established by viewing peak collector current to ground without rf drive rather than precise setting of grid pulse voltage.

Note 1: Symbol Definitions:

Ec	Grid Voltage (bias)
Ews	Helix/Shell Voltage
Eb	Collector Voltage
Pb	Collector Dissipation
Pi (rf)	R. F. Power Input
iws	Helix plus Shell Current
tk	Cathode - Conditioning time necessary before the application of high voltage Capital letters denote D. C. or steady state values while lower case letters denote instantaneous or pulse values
ec	Peak Grid Pulse Voltage
ib	Peak Collector Current
ic	Peak Grid Current
ik	Peak Cathode Current
Po	Peak Power Output

OUTLINE DRAWING



REF. PLANE "A" PASSES ALONG THE FACE OF THE MOUNTING SURFACE AS SHOWN

REF. PLANE "B" IS PERP. TO PLANE "A" PASSING THROUGH THE AXES OF HOLES "X" & "Y" AT PLANE "A".

REF. PLANE "C" IS MUTUALLY PERP. TO PLANES "A" & "B" PASSING THROUGH THE AXIS OF HOLE "X" AT PLANE "A".

NOTES

1. RF INPUT
2. RF OUTPUT
3. THESE CONNECTORS TO BE TYPE TNC
4. HEATER CATHODE CONNECTION (YELLOW)
5. HEATER CONNECTION (BROWN)
6. GRID CONNECTION (GREEN)
7. COLLECTOR CONNECTION LUG TO ACCEPT A #6 SCREW
8. GROUND CONNECTION LUG TO ACCEPT A #6 SCREW
9. DIMENSIONS WITHOUT TOLERANCES ARE NOMINAL AND ARE GIVEN FOR INFORMATION PURPOSES ONLY
10. A WHITE THERMAL COMPOUND HAS BEEN APPLIED TO THE TUBE MOUNTING SURFACE. THE PROTECTIVE PAPER COVERING THIS THERMAL COMPOUND SHOULD BE REMOVED JUST PRIOR TO MOUNTING THE TUBE ON THE COOLING PLATE.

QKW574 OBJECTIVE DATA SHEET

RAYTHEON

The QKW574 traveling wave amplifier is designed for pulsed operation in the UHF frequency band. The tube is conservatively rated for 30 db gain over a 30% frequency band at 3.0 kilowatts peak power. It is ideally suited for broad band, frequency diversity systems.

The tube requires a solenoid for the magnetic field. Two external terminations are required for the slow wave structure.

This objective data sheet is intended only to acquaint the reader with the basic characteristics of the tube and should not be used solely in the system design. Detailed information may be obtained by contacting the Product Programs Department, Microwave and Power Tube Division, Raytheon Company, Burlington, Massachusetts.

GENERAL CHARACTERISITCS

Typical Electrical Data

Heater Voltage	6.0 Volts
Heater Current	6.0 Amperes
Cathode Heating Time	5 Minutes
Frequency Range	510-690 megacycles
Peak Power	3.0 kilowatts (min.)
Average Power Output	27 Watts (min.)
Magnetic Field	650 Gauss
Pulse Width	8.0 usec
Duty Cycle	.009
Pulse Voltage	10 kilovolts
Peak Current	2.5 amperes
Perveance	2.5 up
Load VSWR	1.5 Max.

Mechanical Data

Overall Dimensions	See Outline Drawing
Net Weight	18 Pounds (approx.)
Cooling	Liquid
RF Coupling	Type N
Mounting Position	Any
Magnetic Field	Solenoid
Termination	Bird Model 80A or equiv.

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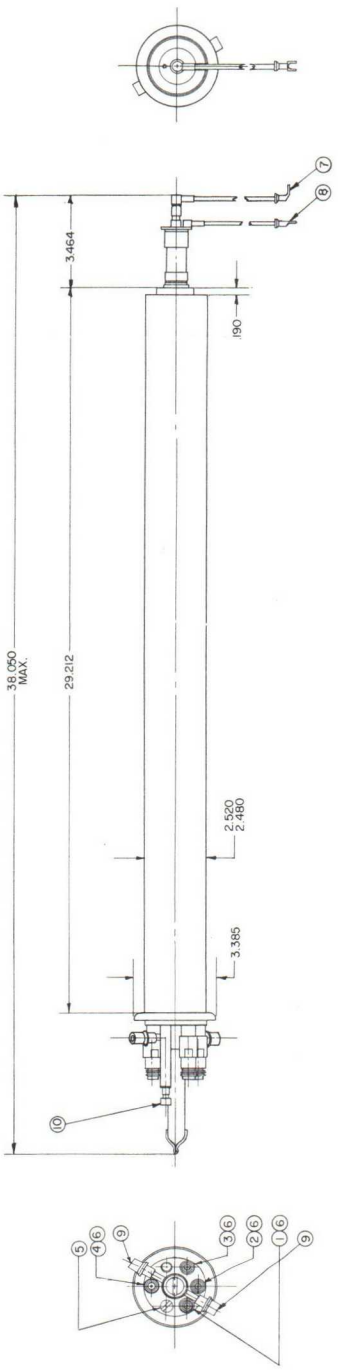
QKW574 OUTLINE DRAWING



1. INPUT HELIX TERMINATION. MATES WITH BIRD ELECTRONICS MODEL 80A OR EQUIVALENT.
2. RF POWER OUTPUT.
3. OUTPUT HELIX TERMINATION.
4. RF POWER INPUT.
5. GROUND.
6. UG-23 BU CONNECTOR.
7. HEATER-CATHODE CONNECTOR.
8. HEATER CONNECTOR.
9. COOLANT CONNECTOR, HANSEN SERIES 3000 OR EQUIVALENT.
10. GETTER BUSHING.

QKW575 OBJECTIVE DATA SHEET

RAYTHEON

The QKW575 traveling wave amplifier is designed for pulsed operation in the UHF frequency band. The tube is conservatively rated for 21 db gain over a 30% frequency band at 300 kilowatts peak power. It is ideally suited for broad band, frequency diversity systems. This tube requires a solenoid for the magnetic field. Two external terminations are required for the slow wave structure.

This objective data sheet is intended only to acquaint the reader with the basic characteristics of this tube and should not be used solely in the system design. Detailed information may be obtained by contacting the Product Program Department, Microwave and Power Tube Division, Raytheon Company, Burlington, Massachusetts.

GENERAL CHARACTERISTICS

Typical Electrical Data

Heater Voltage	30 Volts
Heater Current	7.0 Amperes
Cathode Heating Time	5 Minutes
Frequency Range	510-690 Megacycles
Peak Power	300 kilowatts (min.)
Average Power Output	1680 Watts (min.)
Magnetic Field	575 Gauss
Pulse Width	7.5 usec
Duty Cycle	.0056
Pulse Voltage	40 kilovolts
Peak Current	50 amperes
Perveance	2.0 up
Load VSWR	1.5 (max.)

Mechanical Data

Overall Dimensions	See Outline Drawing
New Weight	60 Pounds (approx.)
Cooling	Liquid
Input Coupling	7/8" coaxial line
Output Coupling	1 5/8" coaxial line
Mounting Position	Tube Axis Horizontal
Magnetic Field	Solenoid
Termination	Bird Model 82A or equiv.

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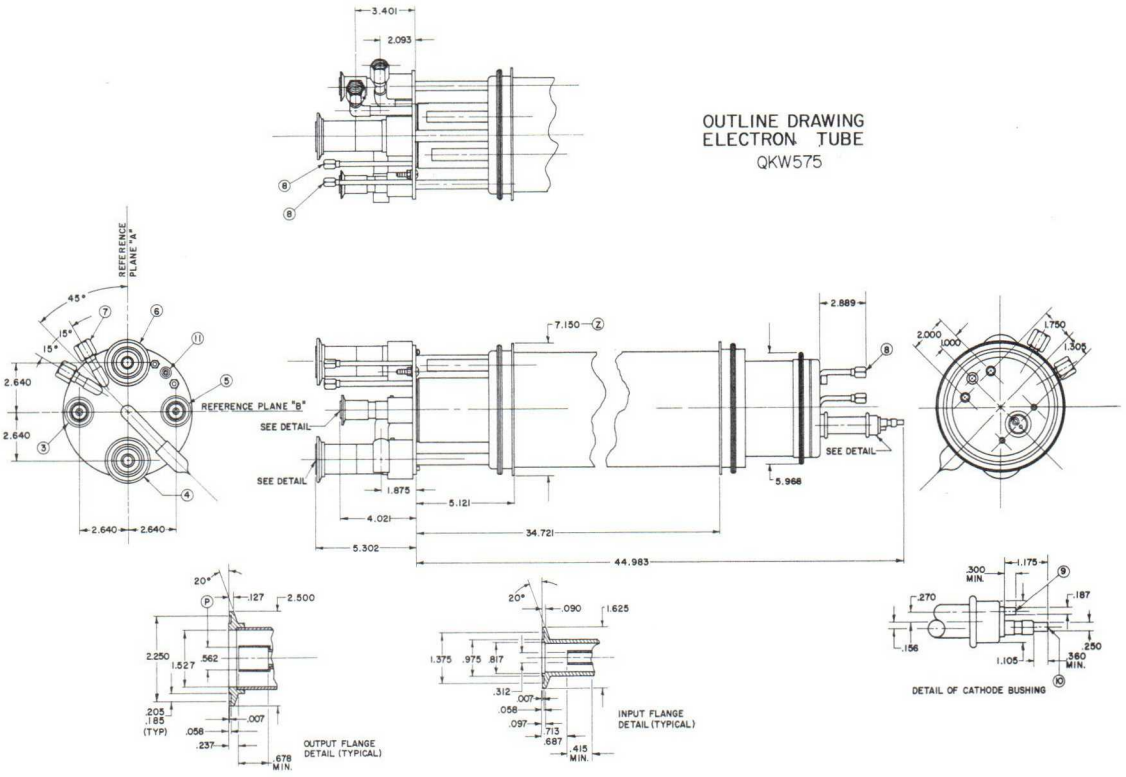

NOTES

1 - REFERENCE PLAN "A" IS A PLANE PASSING THRU THE AXIS OF REF "Z" AND THRU THE AXIS OF DIA. "P".
2 - REFERENCE PLANE "B" IS A PLANE PERPENDICULAR TO REF PLAN "A" AND PASSING THRU THE AXIS OF OF REF DIA. "Z".
3 - INPUT HELIX TERMINATION.
4 - OUTPUT HELIX TERMINATION.
5 - RF POWER INPUT
6 - RF POWER OUTPUT
7 - COOLING CONNECTORS, 37° FLARE TO MATE WITH 3/4-16 FITTING.
8 - COOLING CONNECTORS, 37° FLARE TO MATE WITH 7/16-20 FITTING.
9 - HEATER CATHODE CONNECTION
10 - HEATER CONNECTION
11 - GROUND, 1/4-20 ON 5.950 DIA. B.C.

TECHNICAL DATA

ULTRA-LONG LIFE DATAVUE TUBES

Absolute Ratings for all types: Supply voltage....170 min. DC volts. Ionization voltage....170 max. DC volts. Pre-bias voltage....50 min. and 120 max. DC volts.

	CK1900	CK1901°	CK1902	CK1903	CK1904	CK1905	CK1906	CK1907	CK1909†	CK1915	CK1916	CK1917	CK1918	CK1922†	CK1923†	CK1924†	6844A°	8037/ 5031	8421/ 5092	8422 5991	8650	8754	
Peak Cathode Current	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	7.5	3.5	3.5	3.5	3.5	7.5	7.5	7.5	4.0	3.5	3.5	3.5	3.5	3.5	ma.
Cathode Current, DC, Min.	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.0	1.5	1.5	1.5	1.5	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5	ma.
Cathode Current, DC, Max.	3.0	3.0	3.0	3.0	3.0	3.5	3.5	3.5	4.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	3.5	ma.
Displaying	±	±	±	±	0-9 L.H. dec.	0-9 L.H. dec.	0-9 R.H. dec.	±	0-9	A-E	0-9 L.H. dec.	0-9 R.H. dec.	0-9 L.&R.H. dec.	0-9 L.H. dec.	0-9 R.H. dec.	0-9 L.&R.H. dec.	0-9	0-9	0-9	0-9	0-9	0-9	
Anode Series Resistor for Supply Voltage*																							
170 Volts	10	15	10	20	8.2	10	10	8.2	7.0	8.2	8.2	8.2	8.2	7.0	7.0	7.0	15	10	10	8.2	10	8.2	K ohms
200 Volts	22	27	22	47	20	20	20	20	17.0	22	20	20	20	17.0	17.0	17.0	27	22	22	22	22	20	K ohms
250 Volts	47	51	47	91	39	36	36	43	33.0	47	35	35	35	30.0	30.0	30.0	51	47	47	47	47	43	K ohms
300 Volts	68	75	68	130	62	51	51	62	50.0	68	52	52	52	47.0	47.0	47.0	75	68	68	68	68	62	K ohms
Mechanical Data																							
Character Height	0.385	0.610	0.610	0.385	0.610	0.610	0.610	0.385	0.610	0.610	0.610	0.610	0.610	0.610	0.610	0.610	0.610	0.610	0.610	0.610	0.610	0.610	inch
Weight	0.35	0.4	0.4	0.4	0.4	0.35	0.35	0.3	0.4	0.35	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.35	0.4	oz.
Outline Drawing	A-2	A-6	A-6	A-7	A-5	A-1	A-1	A-2	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-3	A-4	A-4	A-4	A-5	A-1	A-3	
Basing	B-3	B-6	B-6	B-7	B-7	B-2	B-2	B-4	B-4	B-4	B-4	B-4	B-5	B-4	B-4	B-5	B-6	B-6	B-6	B-7	B-1	B-4	
Standard Sockets																							
Commercial Grade	Std. 9 pin	CK1822	CK1822	CK1818	CK1818	CK1810 CK1812	CK1810 CK1812	CK1829	CK1829	CK1829	CK1837	CK1837	CK1839	CK1837	CK1837	CK1839	CK1822	CK1822	CK1822	CK1818	CK1806 CK1808	CK1829	
MIL Grade	Std. 9 pin	CK1823	CK1823	CK1819	CK1819	CK1811 CK1813	CK1811 CK1813	CK1831	CK1831	CK1831	CK1838	CK1838	CK1840	CK1838	CK1838	CK1840	CK1823	CK1823	CK1823	CK1819	CK1807 CK1809	CK1831	
Printed Circuit Sockets																							
Commercial Grade	Std. 9 pin	CK1824	CK1824	CK1820	CK1820	CK1826 CK1828	CK1826 CK1828	CK1830	CK1830	CK1830	CK1833	CK1833	CK1835	CK1833	CK1833	CK1835	CK1824	CK1824	CK1824	CK1820	CK1816	CK1830	
MIL Grade	Std. 9 pin	CK1825	CK1825	CK1821	CK1821			CK1832	CK1832	CK1832	CK1834	CK1834	CK1836	CK1834	CK1834	CK1836	CK1825	CK1825	CK1825	CK1821		CK1832	
Designed for use with types indicated	CK1905 CK1906 8650	6844A	8037 8421	CK1904 8422				8754 CK1916 CK1917 CK1918		8754													

† These types designed and rated for "strobing" as well as for conventional d-c operation.

* Specified anode resistance value is for conventional d-c operation. For "strobing" resistor value varies as the duty cycle. For best results with either operating mode use the highest available supply voltage with appropriate anode resistor.

° Regular life type—not recommended for new equipment design.

ENVIRONMENTAL DESIGN DATA

1. Altitude	70,000 Ft.	
2. Temperature (1)	−20°C to +55°C	
(2) (Reduced life)	−65°C to +85°C	
3. Acceleration	20 G's	
4. Vibration (1) (in each axis)	10-50-10 cps at .08" D.A., 5 min.	
(2) (in each axis)	50-2000-50 cps at 10 G's, 5 min.	
5. Shock (1)	50 G's, 11 millisec.	
(2)	250 G's, 1 millisec.	
6. Salt Spray		MIL Std. 202, Method 101 Cond. A
7. Humidity		MIL Std. 202, Method 103 Cond. B
8. Vibration Fatigue		MIL-E-1E, Method 1031
9. High Voltage Breakdown		MIL-E-1E, Method 1002
10. Life Expectancy (Dynamic)		
(1) Standard life		5000 hours
(2) Ultra-long life		200,000 hours

ADDENDA TO SP1114 REV. 1-68
(Replaces page 6)