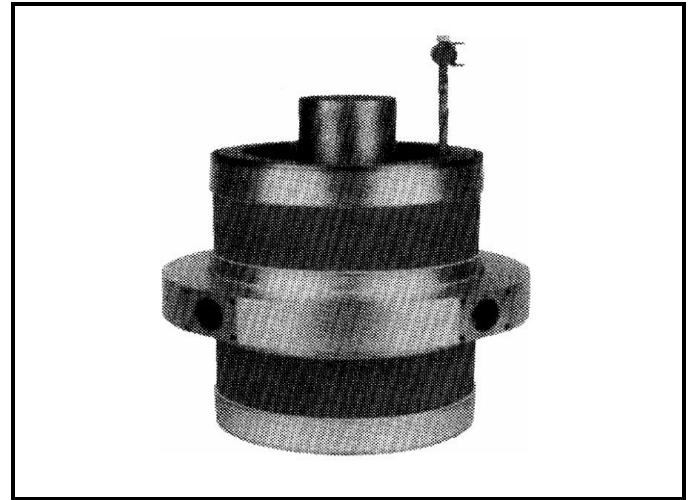


4617

Super Power Triode

- Matrix-Oxide-Type Cathode
- Double-Ended Terminal Configuration for Symmetrical Circuitry
- Liquid Cooled
- Peak Power Output - 8 MW



The PHOTONIS-4617 is a water-cooled super-power triode intended for use as an RF power amplifier in pulse service at frequencies up to 450 MHz. It is intended for use in long-range search radar, pulsed transmission in communications or control service, and particle accelerator service.

The matrix-oxide-type filamentary cathode is advantageous in providing high peak currents in pulse operation. The low filament current and voltage requirements provide savings in operating costs.

The 4617 can deliver 8 megawatts of peak power as a plate-pulsed RF amplifier in a cathode-drive circuit at 425 MHz. with rectangular-waveshape pulses of 25-microsecond duration at a duty factory of 0.01.

The 4617 features a symmetrical double-ended terminal configuration for coaxial RF circuitry (See Ref. 1 & 2). This arrangement enables the 4617 to deliver full power output at considerably higher frequencies than single-ended tubes of comparable size.

The 4617 features an internal electrode structure consisting of a precisely spaced cylindrical array of 96 identical triode units. Integral water ducts to all electrode areas provide effective cooling to the tube structure.

Other design features of the 4617 include low-inductance, large-area, RF electrode terminals insulated from each other by low-loss ceramic insulators; relatively low output capacitance; very low feedback capacitance; and high power gain.

General Data

Electrical

Filamentary Cathode, multistrand, matrix-oxide-type:

Current (DC):	
Typical operating value	1800 amp
Maximum value ¹	2000 amp
Maximum value for starting, even momentarily	2000 amp
Minimum time to reach operating current	30 seconds
Minimum time at normal operating current before plate voltage is applied	60 seconds

Voltage (DC):²

Typical value required to obtain 1800 amperes	1.5 volt
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Direct Interelectrode Capacitances:

Grid to plate	160 pF
Grid to cathode	1500pF
Plate to cathode	less than 1.0 pF

Mechanical

Operating Position	Tube axis vertical, either end up
Max. Overall Length	4.32 m (17 inches)
Maximum Width	610 mm (24 inches)
Terminal Connections	See Dimensional Outline
Weight:	
Uncrated	86.2 kg (190 lb)
Crated	161 kg (355 lb)

Thermal

Ceramic-Insulator Temperature	150 max. °C
Metal Surface Temperature	100 max. °C
Minimum Storage Temperature ³	-65 min. °C

Air Cooling:

It is important that the temperature of any external part of the tube not exceed its maximum temperature rating indicated above. In general, forced-air cooling of the ceramic insulators and the adjacent contact areas will be required if the tube is used in a confined space without free circulation of air. Under such conditions, provision should be made for blowing an adequate quantity of air across the ceramic insulators and adjacent terminal areas to limit their temperature within the maximum rating.

Water Cooling:

Water cooling of the upper and lower grid terminals, the grid-cathode structure, and the plate is required. The water flow must start before application of any voltages in order to purge the system of bubbles and should continue for several minutes after removal of all voltages. Interlocking of the water flow through each of the cooled elements with all power supplies is recommended to prevent tube damage in case of failure of adequate water flow. The use of distilled water or properly filtered deionized water is essential.

Water Flow:

	Maximum Pressure		
	Absolute Differential		
	Typical Minimum for Typical		
	Flow	Flow	Flow⁴
	gpm	gpm	psi

To plate:

Total flow for two parallel input and output coolant courses			
For plate dissipation up to 50 kw (Av.)	40	35	4
For plate dissipation of 150 kw (Av.)	100	90	25
To upper grid coolant course	3	2	25
To lower grid coolant course	3	2	25
To grid-cathode coolant course	12	10	6

Resistivity of Water at 25 °C:

Through plate and grid coolant courses	1 min. megohm-cm
Through grid-cathode coolant course	5 min. megohm-cm

Water Temperature from any outlet	70 max. °C
External Gas Pressure ^{5,6}	65 max. psig

Maximum Water Pressure at any inlet⁶ 90 max. psig

Pulsed RF Amplifier

Maximum Ratings, Absolute-Maximum Values

For frequencies up to 450 MHz and for a maximum "ON" time of 25 microseconds in any 2500-microsecond interval.

Peak Positive-Pulse Plate Voltage ^{7,9}	40,000	volts
Peak Negative Grid Voltage	200	volts
Peak Plate Current	500	amp
Peak Cathode Current ⁸	750	amp
DC Plate Current	5.0	amp
DC Cathode Current ⁸	7.5	amp
Plate Input (Average)	200,000	watts
Plate Dissipation (Average)	150,000	watts

Typical Plate-Pulsed Operation

In Class B service, in a cathode-drive circuit, with rectangular waveshape pulses, at 425 MHz, with duty factor of 0.01, and pulse duration of 25 microseconds.

Peak Positive-Pulse Plate-to-Grid Voltage ^{7,9}	30,000	35,000	volts
Peak Cathode-to-Grid Voltage ^o	60	70	volts
Peak Plate Current	310	400	amp
Peak Cathode Current ⁸	525	680	amp
DC Plate Current	3.1	4.0	amp
DC Cathode Current ⁸	5.2	6.8	amp
Peak Driver Power Output ¹¹	250,000	350,000	watts
Useful Peak Power Output	5,000,000	8,000,000	watts

Characteristics Range Values

	Min.	Max.
Filament Voltage ¹²	1.0	1.8 volts
Input Strap-Resonant Frequency ^{13,14}	90	120 MHz
Output Strap-Resonant Frequency ^{13,15}	240	280 MHz
Direct Interelectrode Capacitances:		
Grid to plate	120	180 pF
Grid to cathode	1250	1700 pF

1. The specified maximum filament current is a maximum rating which should not be exceeded, even momentarily, during operation of the tube. The life of the tube can be conserved by operating the filament at the lowest current which will enable the tube to provide the desired power output. Because the filament when operated near the maximum value usually provides emission in excess of any requirements within the tube ratings, the filament current should be reduced to a value that will give adequate but not excessive emission for any particular application. Good regulation of the filament current is, in general, economically advantageous from the viewpoint of tube life.

2. Measured between KLRF and KUFR (See Terminal Connections).
3. The tube coolant ducts must be free of water before storage or shipment of the tube to prevent damage from freezing.
4. Measured directly across cooled element for the indicated typical flow.
5. This pressure is related to the output-cavity pressurization when required to prevent corona or external flash-over.
6. With the gauge located in an area where the maximum pressure external to the gauge is one atmosphere absolute.
7. The magnitude of any spike on the plate voltage pulse should not exceed its peak value by more than 10%, and the duration of any spike when measured at the peak-value level should not exceed 5% of the pulse duration.
8. Peak or average cathode current is the total of the peak or average plate current and the peak or average rectified grid current. (Pulses may not be coincident, hence they may not necessarily be added directly).
9. Under most conditions, pressurized cavities will be required for operation at the indicated typical voltages to prevent flash-over at the tube seals.
10. Preferably obtained from a cathode bias resistor.
11. The driver stage is required to supply tube losses, RF circuit losses, and RF power added to the plate circuit. The driver stage should be designed to provide an excess of power above the indicated value to take care of variations in line voltage, in components, in initial tube characteristics, and in tube characteristics during life.
12. With 1000 amperes through filament.
13. With the calibrated RF generator shown in **Figure 2** varied in frequency for the resonant peak to be observed on the standing wave indicator, resonant frequency is read on the calibrated RF generator.
14. An output-strap-resonant cavity, as shown in **Figure 3**, is mounted at each end of the plate terminal of the 4617.
15. An input strap-resonant cavity, as shown in **Figure 4**, is mounted at each end of the 4617.

Definitions

Rating System -The maximum ratings in the tabulated data are established in accordance with the following definition of the Absolute-Maximum Rating System for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment-control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

“ON” Time - The sum of duration of all individual pulses which occur during the indicated interval.

Pulse Duration -The time interval between the two points on the pulse at which the instantaneous value is 70% of the peak voltage value.

Peak Value - The maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

Duty Factor - Product of the pulse duration and repetition rate.

Repetition Rate - Quantity of pulses per second.

Considerations

For considerations common to all PHOTONIS super-power hf triodes, see Considerations PHOTONIS Power Tubes, booklet TP105. Additional considerations specifically for the 4617 are given below.

General Considerations Handling

Never support the tube by nor allow it to rest on the filament terminals, the upper RF cathode terminal, or the ceramic insulators. Rest the tube only in the original shipping container, or equivalent.

Mounting

PHOTONIS
Defense

The mounting used for the 4617 should hold the tube vertically. The entire weight of the tube should be supported by the upper or lower mounting surfaces. (See **Dimensional Outline**).

Connections

The use of coaxial filament connectors is recommended. The connector for the coaxial terminals of the filament should be of the coil-spring, pressure-contact type. (See **Detail of Filament Terminals**). The filament connectors should make firm, large-surface contact. Caution should be exercised during assembly or disassembly of the filament connectors so that the filament terminals are not loosened. To avoid loosening of filament terminals, always rotate connectors clockwise when viewing tube from filament-terminals end, both for assembly and disassembly of filament connectors.

Flexible connectors of the spring-contact type are also required for the grid terminals, the RF plate terminals, the RF cathode terminals, and their associated cavities.

Electrical Considerations

Protection Circuits

A high-speed electronic protective device must be used to remove the plate voltage within 10 microseconds in the event of abnormal operation such as internal arcing. In addition, the RF-power-input transmission line should be provided with VSWR protection to remove drive power and plate voltage within 10 milliseconds in the event of abnormal changes in input VSWR during operation.

Circuit Returns

Circuit return from the anode should be made to the output-circuit-return grid terminals.

The filament voltage is across the upper and lower RF cathode terminals. Therefore, provision must be made to avoid short-circuiting the filament power supply with RF circuit returns to the RF cathode terminals.

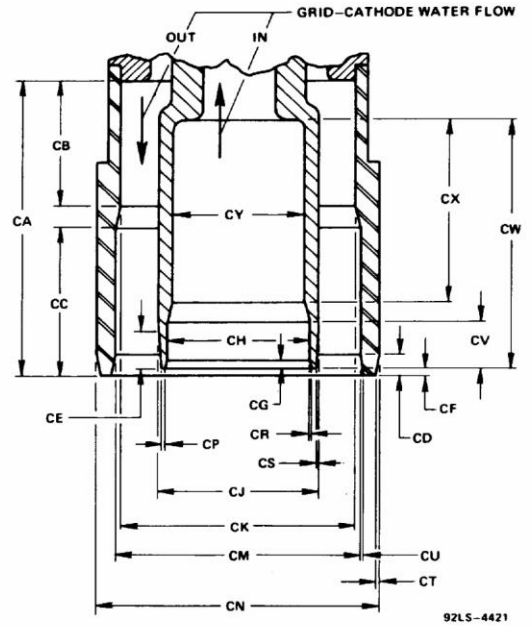
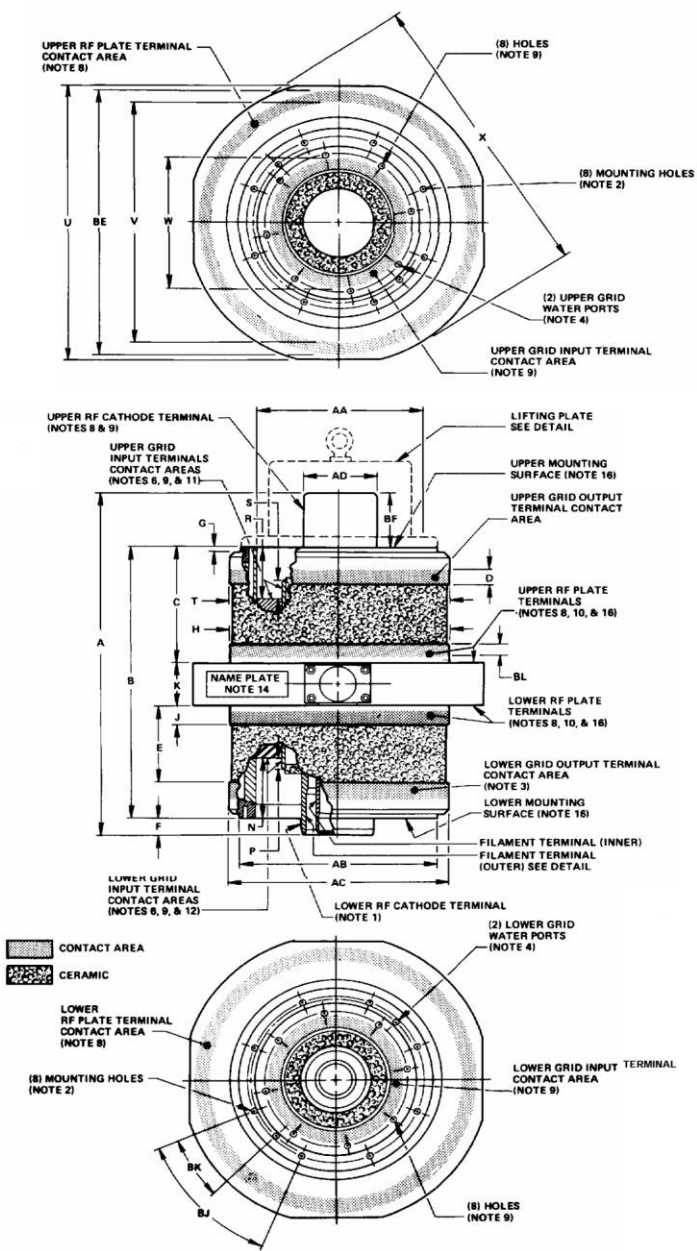
Cooling Considerations

System

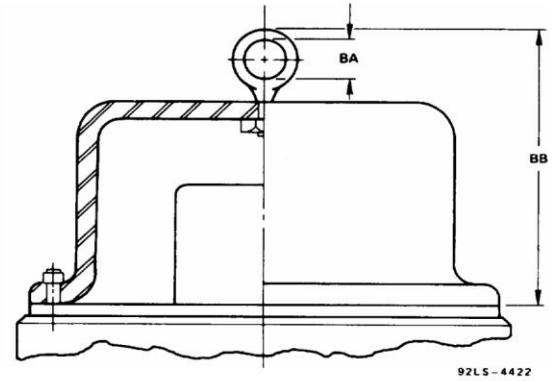
The low-volume water supply to the grid-cathode coolant courses requires a very high-quality water (minimum resistivity of 5 megohm-centimeters), whereas the high-volume water supply to the plate coolant course requires only high-quality water (minimum resistivity of 1-megohm-centimeter). Therefore, it may be economically feasible to tap a portion of the water to the plate coolant course, and by additional filtering, provide the water supply to the grid-cathode coolant course.

References

1. M.V. Hoover, "Advances in the Techniques and Applications of Very-High-Power Grid-Controlled Tubes," Proceedings of International Convention on Microwave Valves, May, 1958. Proceedings Institution of Electrical Engineers (London). Vo. 105. Part B Suppl. No. 10 1958.
2. R.E. Reed and A.C. Tunis, Superpower Ultrahigh-Frequency Amplifier-Tube Developments, "Communications and Electronics, October, 1962.



Detail of Filament Terminals



Detail of Lifting Plate

Figure 2 - Dimensional Outline

Notes for Dimensional Outline

1. DC filament current must not be permitted to flow in the upper RF-cathode terminal. The internal structure of the tube is such that the potential of the upper RF-cathode terminal differs from that of the lower RF-cathode terminal by the amount of the DC filament voltage. The circuit designer should take care, therefore, to avoid an external DC path between these two cathode terminals.
2. The tube may be conveniently handled and moved by means of the lifting plate which maybe attached to either mounting surface. The lifting plate should be removed prior to operating the tube. The mounting surface holes are .250" -20 UNC-1B x 0.25" (6.35 mm) minimum depth, and equally spaced on a bolt circle of 8.75" (222.25 mm) diameter.
3. Along the tapered contact length D, dimension AC will increase from a minimum diameter of 10.15" (257.8 mm) [average diameter at this point is 10.20" (259.1 mm)] to a maximum diameter at T 10.30" (261.6 mm) [average diameter at T is 10.25" (260.4 mm)]. The maximum diameter T is at the end toward the ceramic.
4. The direction of flow, IN or OUT, is stamped at the side of each port. The ports are 0.250" ±0.010" (6.35 ± 25 mm) diameter located 180° ± 1/2° apart on a circle of 8.25" (209.55 mm) diameter. The upper grid water ports are located on the mounting surface in the quadrant counterclockwise from each plate water inlet, as viewed from the upper RF-cathode terminal end. The lower grid water ports are located on the mounting surface in the same quadrant as viewed from upper RF-cathode terminal end.
6. Along the lengths Sand P, the contact areas are tapered, increasing diameter 'Y' from a 4.90" (124.46 mm) average (4.88" (123.95 mm) minimum) at the recessed end to a 4.96" (125.98 mm) average [5.02(127.5 mm) maximum] at the other end.
7. Circuit contacts should be made only over maximum length D 0.75" (19.1 mm) of the designated upper and lower output terminal contact areas as measured nearest the ceramic.
8. Contact of the upper and lower RF plate terminal contact areas should be made at a diameter less than 13.40" (340.4 mm) or greater than 12.00" (304.8 mm).
9. Contact of the upper and lower grid input terminal contact areas should be made at a diameter less than 6.75" (171.45 mm). The holes located outside the contact area are .250" -20 UNC-1Bx0.25" (6.35mm) minimum depth, equally spaced on a bolt circle of 7.25" (184.15 mm) diameter.
10. Circuit contact should be made at any point along the length BL 0.63" (16.0 mm) of designated upper and lower RF-plate terminals as measured nearest the ceramic.
11. Circuit contact should be made at any point along the length S 0.93" (23.62 mm) of the designated upper grid input terminal.

12. Circuit contact should be made at any point along the length P 0.50" (12.7 mm) of the designated lower grid input terminal.
13. Dimension applies to both ends of tube.
14. Name plate may be located between any two adjacent water connections.
15. Metric equivalents are given for general information only and are based on 1 inch - 25.4 mm.
16. The tube should be operated vertically with either end up. The entire weight of the tube should be supported by the RF plate terminal or by either mounting surface. Never support the tube by the filament terminals or by the upper RF-cathode terminal. Care should be taken to avoid distortion or damage to the filament terminals by bumping or improperly fitting connectors. Total indicator run-out between terminals will not exceed 0.10" (2.54 mm).

LTR	Inches*		Millimeters* (Note 15)	
	Minimum	Maximum	Minimum	Maximum
A	-	17.00	-	431.8
B	-	13.50	-	342.9
D	0.75	-	19.1	-
F	0.52	0.16	13.2	19.3
G	-	0.25	-	6.3
H Dia.	-	10.30	-	261.6
J	0.85	0.96	21.6	24.4
K	2.07	2.15	52.58	54.61
L	3.34	3.41	84.84	86.87
M	3.97	4.03	100.84	102.36
N	2.92	3.03	74.2	76.9
P	0.50	-	12.7	-
R	2.52	2.63	64.0	66.8
S	0.93	-	23.62	-
U	13.55	13.80	344.2	350.5
V Dia.	-	12.00	-	304.8
W Dia.	6.75	-	171.5	-
X Dia.	13.85	14.10	351.8	358.1
Y Dia.	-	5.02	-	127.5
AA Dia.	7.63	7.87	193.8	199.9
AB Dia.	9.40	9.64	238.8	244.8
AE	-	6.00	-	152.4
AF Dia.	0.875	-	22.23	-
AK Dia.	1.98	2.02	50.29	51.30
AP	1.63	1.61	41.40	42.42
AR	2.090	2.110	53.09	53.59
AS	2.490	2.510	63.25	63.75
AT	0.615	0.635	15.62	16.13
BE Dia.	13.40	-	340.4	-
BF	2.33	2.57	59.2	65.2
BG	-	0.10	-	2.5
BK	21.0	23.5°	-	-
BL	0.63	-	16.0	-

Inches*	Millimeters* (Note 15)			
LTR	Minimum	Maximum	Minimum	Maximum

Inches*	Millimeters* (Note 15)			
LTR	Minimum	Maximum	Minimum	Maximum

Quality Conformance Inspection,
Part 1:

C	5.51	5.68	140.0	144.2
E	3.79	3.96	96.3	100.5
T Dia.	-	10.30	-	261.6
AC Dia.	10.12	-	257.1	-
AD Dia.	3.59	3.65	91.19	92.71
AG Dia.	3.59	3.65	91.19	92.71
AH Dia.	3.121	3.131	79.28	79.52
AJ Dia.	2.997	3.007	76.13	76.37
AM Dia.	1.745	1.755	44.33	44.57
AN Dia.	1.695	1.705	43.05	43.30

Reference Dimensions:

AL	.03	.76
AU	.28	7.11
AV	.25	6.35
AW	.25	6.35
AX	.50	12.7
AV	.06	1.52
BA	.04	1.02
BB	.03	.76
BC	.04	1.02
BD	.10	2.5
BJ	45°	-

*Unless otherwise specified

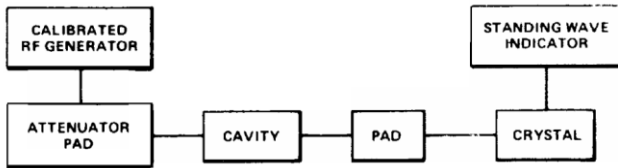
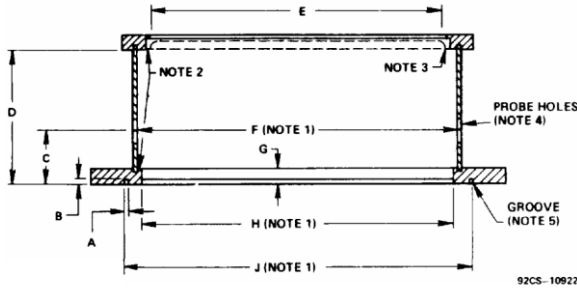
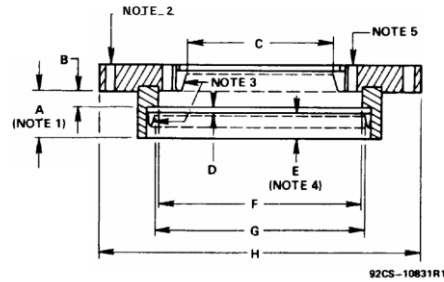


Figure 2 – Block Diagram of Resonant Frequency Test



Tabulated Dimensions*

Dimension	Inches	Millimeters
A	0.152 ± .005	3.86 ± .13
B	0.120 ± .005	3.05 ± .13
C	1.75 ± .02	44.5 ± .5
D	4.686 + .001 - .000	119.024 + .025 - .000
E Dia.	10.141 Ref.	257.58 Ref.
F Dia.	11.013 ± .005	279.73 ± .13
G	0.382 ± .001	9.703 ± .025
H Dia.	10.753 ± .001	273.126 ± .025
J Dia.	12.0 Ref.	304.8 Ref.

Note 1 -Runout on diameters indicated not to exceed 0.002" (0.051 mm).

Note 2 -Juncture must provide good rf electrical contact around its entire circumference, such as by a braze or soft solder connection. Maximum braze or solder fillet not to exceed 0.030" (0.76 mm) radius.

Note 3 - Spring contact ring, Catalog No.97-135 as made by Instrument Specialties Co., Little Falls, NJ 07424.

Note 4 - Two "Probe Holes" each 3/4" (19 mm) diameter.

Note 5 - Groove for braid contact ring, Catalog No.10-118 as made by Electronics Division, Metal Textile Corp., Roselle, NJ 07203. The braid must assure continuous contact.

*Dimensions are in inches unless otherwise specified. Metric equivalents are for information purposes only and are derived from the inch dimensions. (1.0 inch equals 25.4 mm).

Figure 3 - Full Section View of Output Cavity Required for Output Strap-Resonant Frequency Test

Tabulated Dimensions*

Dimension	Inches	Millimeters
A _c	1.55 ± 2.02	39.4 ± .5
A _f	1.13 ± .02	28.7 ± .5
B	0.40 Ref.	10.2 Ref.
C Dia.	3.598 Ref.	91.4 Ref.
D	0.120 ± .002	3.05 ± .05
E _c	1.03 ± .02	26.2 ± .5
E _f	0.61 ± .02	15.5 ± .5
F Dia.	4.825 ± .005	122.56 ± .13
G Dia.	4.935 Ref.	125.35 Ref.
H Dia.	7.63 ± .03	193.8 ± .8

Note 1 -Dimension A_c is the measurement for the cavity used at the upper-Fr-cathode-terminal end. Dimension A_f is the measurement for the cavity used at the filament terminal end.

Note 2 - Eight holes used for extracting cavity.

Note 3 - Spring contact ring, Catalog No.97-135 as made by Instrument Specialties Co., Little Falls, NJ 07424.

Note 4 -Dimension E_c is the measurement for the cavity used at the upper-rf-cathode-terminal end. Dimension E_f is the measurement for the cavity used at the filament terminal end.

Note 5 - Two "Probe Holes".

*Dimensions are in inches unless otherwise specified. Metric equivalents are for information purposes only and are derived from the inch dimensions. (1.0 inch equals 25.4 mm).

Figure 4 - Full Section View of Input Cavity Required for Input Strap-Resonant Frequency Test

Warning - Personal Safety Hazards
Electrical Shock - Operating voltages applied to this device present a shock hazard.