

7650 Power Tube

UHF Power Amplifier Tube

- Ruggedized
- Matrix-Type Cathode
- 800 Watts CW at 400 MHz
- CERMOLOX®
- Forced-Air-Cooled

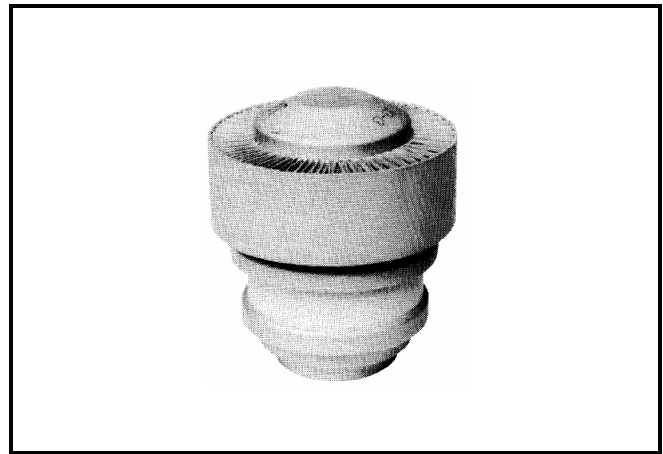
BURLE 7650 is a small, forced-air cooled UHF beam power tube designed for use where dependable performance under severe shock and vibration is essential. The tube features CERMOLOX construction, a uni-potential, matrix-type, oxide-coated cathode, and an integral, louvered-fin radiator. An integral ceramic pin holds grids No.1 and 2 and the cathode in fixed relationship to each other.

To assure compliance with the environmental requirements, sample tubes are subjected to 50 g-11 millisecond and 500 g 3/4 millisecond shock tests and to variable frequency vibration testing at up to 20 g and between 5 and 2000 Hertz.

The tube is rated as an AF power amplifier and modulator, and up to 1215 MHz as a linear RF power amplifier, an anode-modulated RF power amplifier in Class C telephony service, an RF power amplifier and oscillator in Class C telegraphy service, and an RF power amplifier in Class C FM telephony service. The 7650 may also be useful in a variety of other applications such as frequency multipliers, linear RF power amplifiers (AM or television), pulse modulators, pulsed RF amplifiers, regulators, or other special services.

This data sheet gives application information unique to the BURLE 7650. Information contained in the following publications will help to assure longer tube life and safer operation:

- TP-105 Application Guide for BURLE Power Tubes
- TP-118 Application Guide for Forced-Air Cooling of BURLE Power Tubes
- TP-122 Screen-Grid Current, Loading, and Bleeder Considerations



For copies of these publications, contact your BURLE representative or write BURLE INDUSTRIES, INC., Tube Products Division, 1000 New Holland Avenue, Lancaster, PA 17601-5688.

General Data Electrical

Heater-Cathode:

Type.....	Unipotential, Oxide Coated, Matrix Type		
Voltage ¹ (AC or DC).....	6.3	typ.	V
	6.9	max	V
Current at 6.3 volts.....	7.5		A
Minimum heating time ²	180		s

Mu-Factor, (Grid No.2 to grid No.1)..... 13

Direct Interelectrode Capacitances:

Grid No.1 to anode ³	0.12	max.	pF
Grid No.1 to cathode & heater.....	29		pF
Anode to cathode & heater ³	0.011	max.	pF
Grid No.1 to grid No.2.....	37		pF
Grid No.2 to anode.....	5.3		pF
Grid No.2 to cathode & heater ³	1.1	max	pF

Mechanical

Operating Attitude.....	Any		
Overall Length.....	6.10 mm (2.40 in)	max.	
Greatest Diameter.....	52.8 mm (2.08 in)	max.	
Terminal Connections.....	See Dimensional Outline		
Sockets.....	9806-002 ⁴ or CD89-083 ⁵ or equivalent		
Weight (Approx.).....	0.3 kg (3/4 lb)		

Thermal

Seal Temperature ⁶ (Anode, grid No.2, grid No.1, cathode-heater and heater).....	250	max.	°C
Anode-Core Temperature ⁶	250	max.	°C



**Linear RF Power Amplifier, Class AB₁⁷
Single-Sideband Suppressed-Carrier Service**

Peak envelope conditions for a signal having a minimum peak-to-average power ratio of 2.

Maximum CCS Ratings, Absolute-Maximum Values

Up to 1215 MHz		
DC Anode Voltage.....	2500	V
DC Grid-No.2 Voltage.....	1200	V
DC Anode Current at Peak of Envelope ¹³	700	mA
Anode Dissipation.....	600	V

Maximum Circuit Values

Grid No.1 Circuit Resistance Under Any Conditions:

With fixed bias.....	15,000 ohms
With fixed bias (In Class AB ₁ operation).....	50,000 ohms
With cathode bias.....	Not Recommended

**RF Power Amplifier & Osc. - Class C Telegraphy⁷ and
RF Power Amplifier - Class C FM Telephony⁷**

Maximum CCS Ratings, Absolute Values

Up to 1215 MHz		
DC Anode Voltage.....	2500	V
DC Grid-No.2 Voltage.....	1200	V
DC Grid-No.1 Voltage.....	-250	V
DC Anode Current.....	500	mA
DC Grid-No.1 Current.....	100	mA
Anode Input.....	1250	W
Grid-No.2 Input.....	25	W
Anode Dissipation.....	700	W

Maximum Circuit Values

Grid-No.1 Circuit Resistance:

Under any condition.....	15,000 ohms
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Typical CCS Operation In Cathode-Drive Circuit at 400 MHz

DC Anode Voltage.....	2250	2500	V
DC Grid-No.2 Voltage.....	400	400	V
DC Grid-No.1 Voltage.....	-45	-35	V
DC Anode Current.....	450	500	mA
DC Grid-No.2 Current.....	7	8	mA
DC Grid-No.1 Current (Approx.).....	10	12	mA
Output Circuit Efficiency (Approx.).....	80	80	%
Driver Power Output (Approx.).....	30	35	W
Useful Power Output (Approx.).....	650	800	W

Typical CCS Operation in Cathode-Drive Circuit at 1215 MHz

DC Anode Voltage.....	2500	V
DC Grid-No.2 Voltage.....	400	V
DC Grid-No. 1 Voltage.....	-50	V
DC Anode Current.....	500	mA
DC Grid-No.2 Current.....	6	mA
DC Grid-No. 1 Current.....	10	mA

Output Circuit Efficiency (Approx.)	70	%
Driver Power Output (Approx.)	80	W
Useful Power Output (Approx.)	375	W

AF Power Amplifier & Modulator⁷

Maximum CCS Ratings, Absolute-Maximum Values

DC Anode Voltage.....	3000	V
DC Grid-No.2 Voltage.....	1200	V
Max-Signal DC Anode Current.....	500	mA
Max-Signal Grid-No.1 Current.....	100	mA
Max-Signal Grid-No.2 Input.....	25	W
Anode Dissipation.....	600	W

Maximum Circuit Values

Grid-No.1 Circuit Resistance Under Any Condition:

With fixed bias.....	15,000 ohms
With cathode bias.....	Not Recommended

Typical CCS Operation

Values are for 2 tubes

DC Anode Voltage.....	2700	3000	V
DC Grid-No.2 Voltage.....	450	450	V
DC Grid-No.1 Voltage:			
From fixed-bias source.....	-40	-40	V
Peak AF Grid-No. 1 to Grid-No.1 Voltage.....	80	80	V
Zero-Signal DC Anode Current.....	200	200	mA
Max-Signal DC Anode Current.....	900	1000	mA
Zero-Signal DC Grid-No.2 Current.....	0	0	mA
Max-Signal DC Grid-No.2 Current.....	6	5	mA
Effective Load Resistance (Anode to anode)	6000	6400	ohms
Max-Signal Driving Power (Approx.)....	0	0	W
Max-Signal Power Output (Approx.)....	1400	1600	W

Characteristics Range Values

	Min.	Max.	
Heater Current ⁸	6.9	8.3	A
Direct Interelectrode Capacitances:			
Grid No.1 to anode ³	-	0.12	pF
Grid No.1 to cathode & heater.....	26	32	pF
Anode to cathode & heater ³	-	0.011	pF
Grid No.1 to grid No.2.....	34	41	pF
Grid No.2 to anode.....	4.3	6.3	pF
Grid No.2 to cathode & heater ³	-	1.1	pF
Reverse Grid-No.1 Current ^{8,9}	-	-50	uA
Grid-No.1 Voltage ^{8,9}	-20	-42	V
Grid-No.2 Current ^{8,9}	-8.0	+5.0	mA
Peak Emission ^{8,10}	8.0	-	A
Interelectrode Leakage Resistance ¹¹ ...	8.0	-	Mohms
Cut-off Grid-No.1 Voltage ^{8,12}	-	-87	V

Anode-Modulated RF Power Amplifier -Class C Telephony⁷

Carrier conditions per tube for use with max. modulation factor of 1 .0.

Maximum CCS Ratings, Absolute-Maximum Values

Up to 1215 MHz

DC Anode Voltage.....	2000	V
DC Grid-No.2 Voltage.....	1200	V
DC Grid-No.1 Voltage.....	-250	V
DC Anode Current.....	500	mA
DC Grid-No.1 Current.....	100	mA
Anode Input.....	1000	W
Grid-No.2 Input.....	17	W
Anode Dissipation.....	400	W

Maximum Circuit Values

Grid No.1 Circuit Resistance:

Under any conditions..... 15,000 ohms

Typical CCS Operation in Cathode-Drive Circuit at 400 MHz

DC Anode Voltage	1800	2000	V
DC Grid-No.2 Voltage.....	400	400	V
DC Grid-No.1 Voltage.....	-45	-35	V
DC Anode Current	450	500	mA
DC Grid-No.2 Current	6	8	mA
DC Grid-No.1 Current (Approx.)	15	12	mA
Output Circuit Efficiency (Approx.)	80	80	%
Driver Power Output (Approx.)	35	35	W
Useful Power Output (Approx.)	500	600	W

1. Measured at the tube terminals. For accurate data the heater voltage should be measured using an accurate RMS type meter such as an iron-vane or thermocouple type meter. The DC voltage should be measured using a high input impedance type meter. For maximum life, the heater power should be regulated at the lowest value that will give stable performance.
2. Sequence for applying voltage is as follows:
Heater
Bias
Anode
Screen
RF Drive
3. As measured with a special shielded adapter. This is the true tube internal capacity and does not include external stray capacitance.
4. As manufactured by Erie Specialty Products, Inc., 645 West Eleventh Street, Erie, PA 16512.
5. As manufactured by Jettron Products, Inc., 65 Route 10, P.O. Box 337, East Hanover, NJ 07938.
6. See Dimensional Outline for Temperature Measurement points.
7. The maximum voltage ratings must be modified for operation at altitudes higher than sea level and for temperatures in excess of 20° C in accordance with the curves of **Figure 1**.

8. With 6.3 volts, AC or DC on heater.
9. With DC anode voltage of 2500 volts, DC grid-No.2 voltage of 400 volts, and DC grid-No.1 voltage adjusted to give anode current of 240 mA.
10. For conditions with grid No.1, grid No.2, and anode tied together; and pulse voltage source of 850 peak volts between anode and cathode. Pulse duration is 2 microseconds, pulse repetition frequency is 60 pps, and duty factor is 0.00012. Peak emission current is read one minute after application of pulse voltage.
11. Under conditions with tube at 20 to 30 °C for at least 30 minutes without any voltages applied to the tube. The minimum resistance between any two electrodes (except across heater terminals) is measured with a 200-volt Megger-type ohmmeter having an internal impedance of 1.0 megohm.
12. With DC anode voltage of 2500 volts, DC grid-No.2 voltage of 400 volts, and DC grid-No.1 voltage adjusted to give anode current of 5 mA.
13. The maximum rating for a signal having a minimum peak-to-average power ratio less than 2, such as is obtained in "SingleTone" operation, is 500 mA.

During short periods of circuit adjustment under "Single-Tone" conditions, the average anode current may be as high as 700 mA.

Safety Precautions

Protection circuits serve a threefold purpose: safety of personnel, protection of the tube in the event of abnormal circuit operation, and protection of the tube circuits in the event of abnormal tube operation.

Warning - Personal Safety Hazards

Electrical Shock - Operating voltages applied to this device present a shock hazard.

RF Radiation - This device in operation produces RF radiation which may be harmful to personnel.

Power tubes require mechanical protective devices such as interlocks, relays, and circuit breakers. Circuit breakers alone may not provide adequate protection in certain power-tube circuits when the power-supply filter, modulator, or pulse-forming network stores much energy. Additional protection may be achieved by the use of high-speed electronic circuits to bypass the fault current until mechanical circuit breakers are opened. These circuits may employ a controlled gas tube, such as thyatron or ignitron, depending on the amount of energy to be handled.

Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel cannot possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies and discharge high-voltage capacitors when any gate or door on the protective housing is opened, and should prevent the closing of this primary circuit until the door is again locked.

A time delay should be provided in the anode-supply circuit to delay application of the anode voltage until the heater has reached normal operating temperature.

An interlocking relay system should be provided to prevent application of anode voltage prior to the application of sufficient bias voltage otherwise, with insufficient bias, the resultant high anode current may cause excessive anode dissipation with consequent damage to the tube. RF load shorts or other causes of high output VSWR may also cause high dissipations, excessive voltage gradients, or insulator flashover. The load VSWR should be monitored and the detected signal used to actuate the interlock system to remove the anode voltage in less than 10 milliseconds after the fault occurs.

Forced Air Cooling

Cooling air flow is necessary to limit the anode-core and terminal-seal temperatures to values that will assure long reliable life. A sufficient quantity of air should be directed past each of these terminals so that its temperature does not approach the absolute-maximum limit. The absolute-maximum temperature rating for this tube is 250° C. It is recommended that a safety factor of 25° to 50° be applied to compensate for all probable system and component variations throughout life.

The cooling air must be delivered by the blower through the radiator and at the terminal seals during the application of power and for a minimum of three minutes after the power has been removed.

To Heater-Cathode and Heater Terminals - A sufficient

quantity of air should be blown directly at these terminals so that their temperature does not approach the absolute-maximum limit of 250° C.

The Cooling Characteristic Curve, **Figure 6**, indicates the air flow and pressure requirements of a system sufficient to limit the core temperature to specific values for various levels of plate dissipation.

Because the cooling capacity of air varies with its density, factors must be applied to the air flow to compensate for operation at altitude or in high temperature environments.

During Standby Operation -Cooling air is required when only the filament voltage is applied to the tube.

For further information on forced air cooling, see TP-118.

Mounting

Fixed mounting using commercial sockets referenced under **General Data, Mechanical** or the design of **Figure 7** is recommended. Separate contact ring assemblies, each transversely adjustable, are not recommended for this tube type.

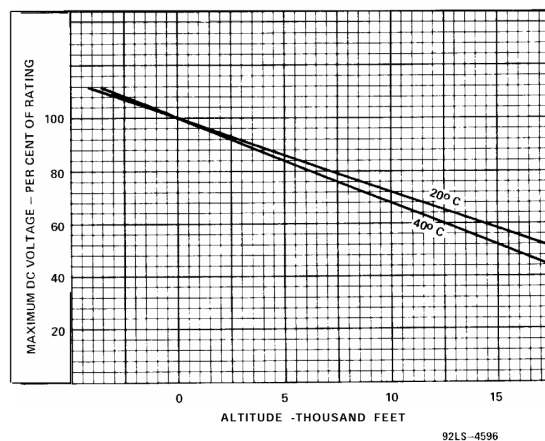
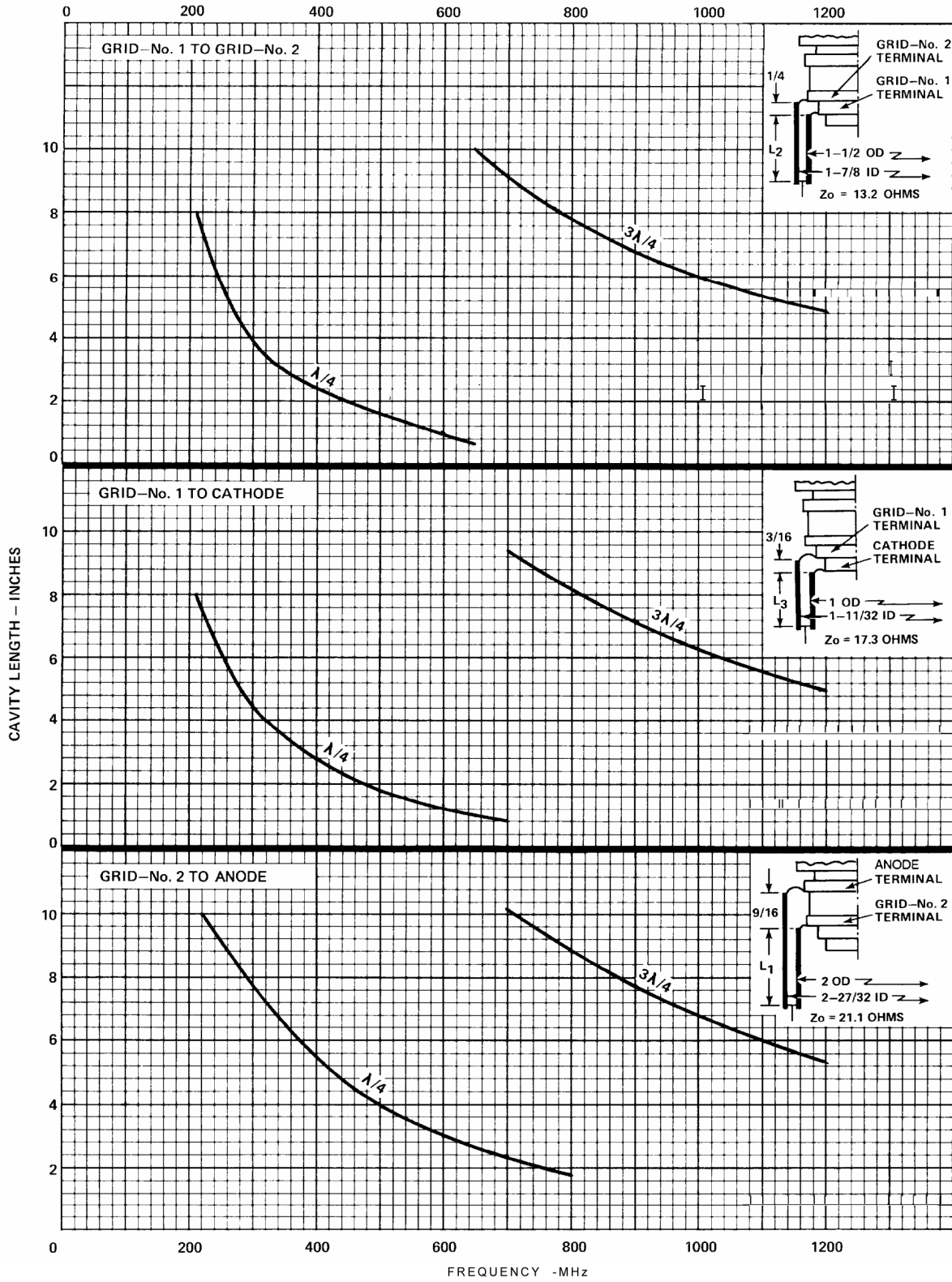


Figure 1 - Maximum DC Voltage With Respect to Altitude



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Figure 2 - Tuning Characteristics

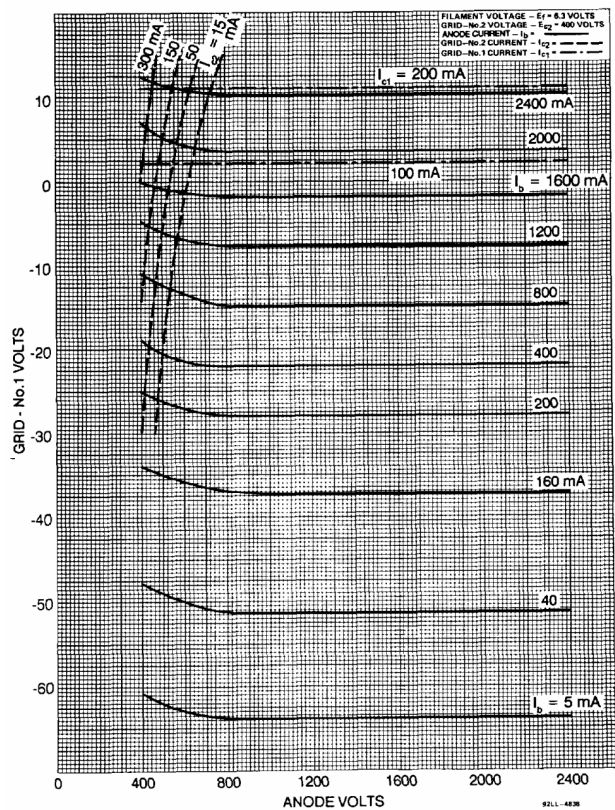


Figure 3 - Typical Constant-Current Characteristics For Grid-No.2 Voltage = 400 Volts

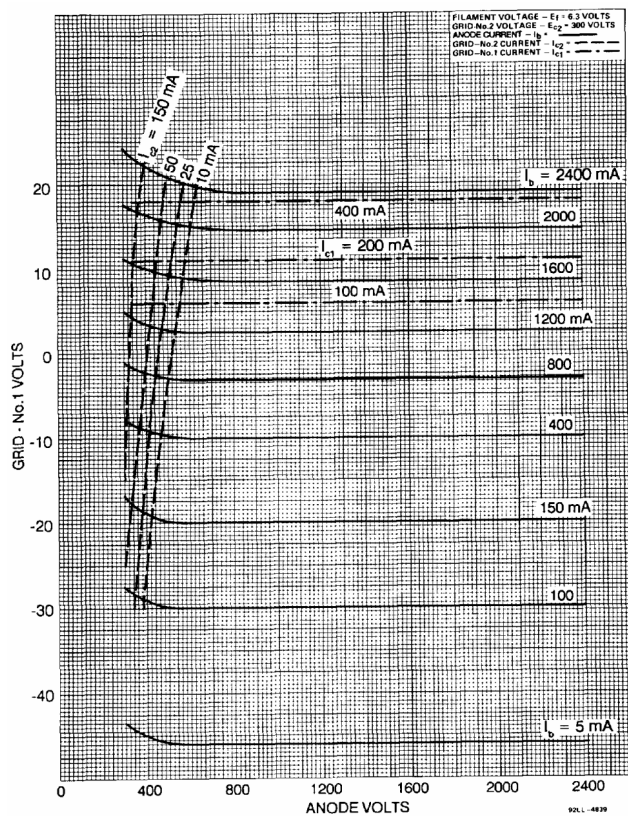
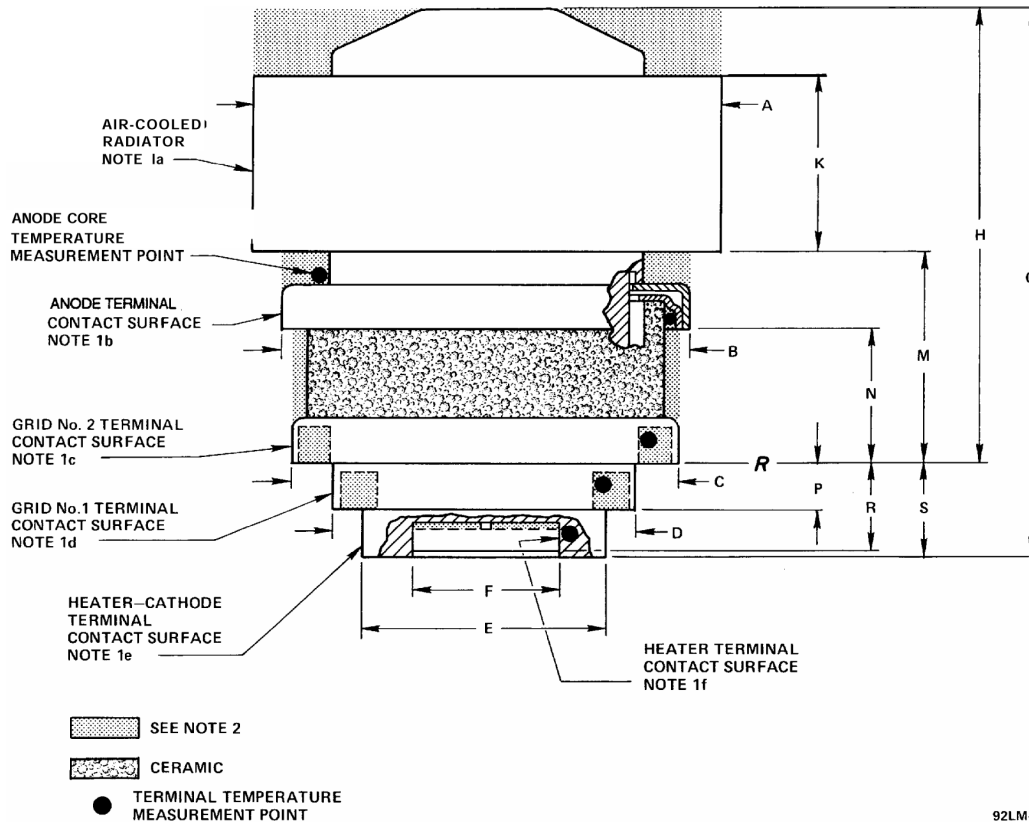


Figure 4 - Typical Constant-Current Characteristics For Grid-No.2 Voltage = 300 Volts



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**Figure 5 - Dimensional Outline
Tabulated Dimensions**

Dim.	Millimeters	Inches
A Dia.	52.45 ± .38	(2.065 ± .015)
B Dia.	44.32 min.	(1.745 min.)
C Dia.	40.38 min.	(1.59 min.)
D Dia.	32.76 min.	(1.29 min.)
E Dia.	25.14 min.	(0.99 min.)
F Dia.	17.02 max.	(0.67 max.)
G	61.0 max.	(2.40 max.)
H	49.3 ± 1.0	(1.94 ± .04)
K	19.18 ± .51	(0.755 ± .020)
M	22.73 ± .89	(0.895 ± .035)
N	14.48 ± .76	(0.57 ± .03)
P	5.08 ± .51	(0.20 ± .02)
R	9.78 ± .64	(0.385 ± .025)
S	10.16 ± .51	(0.40 ± .02)

Note 1: The contact distance* indicated is the minimum uniform length as measured from the edge of the terminal.

	Contact Distance
1.a Radiator	18.7 (0.735)
1.b Anode Terminal	3.68 (0.145)
1.c Grid No.2 Terminal	3.81 (0.150)
1.d Grid No.1 Terminal	4.57 (0.180)
1.e Heater-Cathode Terminal	4.06 (0.160)
1.f Heater Terminal	2.92 (0.115)

Note 2: Keep all stippled regions clear. In general, do not allow contacts to protrude into these annular regions. If special connectors are required which may intrude on these regions, contact BURLE Power Tube Application Engineering, Engineering for guidance.

*Dimensions in millimeters, dimensions in parentheses are inches.

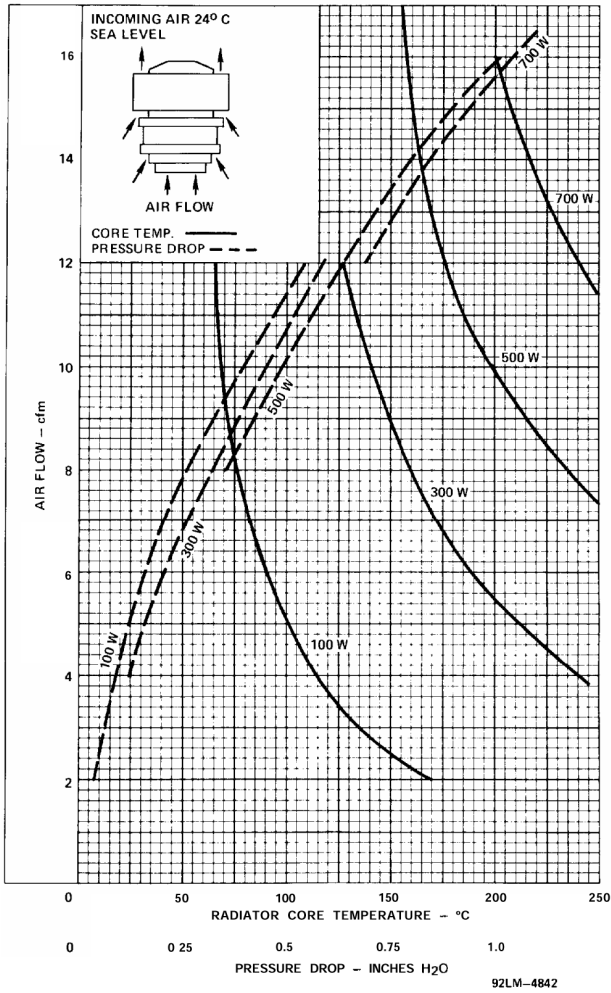


Figure 6 - Cooling Characteristics

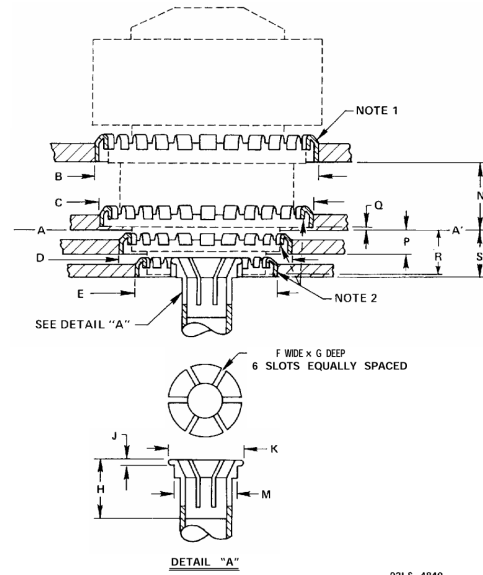


Figure 7 - Preferred Mounting Arrangement and Layout of Associated Contacts

Tabulated Dimensions

Dim.	Millimeters	Inches
B Dia.	49.23 ± .03	(1.938 ± .001)
C Dia.	44.35 ± .03	(1.746 ± .001)
D Dia.	36.78 ± .03	(1.448 ± .001)
E Dia.	29.16 ± .03	(1.148 ± .001)
F	0.51 ± .25	(0.02 ± .01)
G	10.16 ± .51	(0.40 ± .02)
H	12.7 ± 1.3	(0.50 ± .05)
J	1.27 ± .13	(0.050 ± .005)
K Dia.	17.02 ± .03	(0.670 ± .001)
M Dia.	14.35 ± .13	(0.565 ± .005)
N	15.01 ± .13	(0.591 ± .005)
P	4.67 ± .13	(0.184 ± .005)
O	1.02 ± .13	(0.040 ± .005)
R	9.78 ± .13	(0.385 ± .005)
S	10.16 ± .13	(0.400 ± .005)

Note 1: Contact strip part No. Cat. No.97-360*.

Note 2: Contact strip part No. Cat. No.97-380*.

* As made by Instrument Specialties Co., P.O. Box A, Delaware Water Gap, PA 18327.