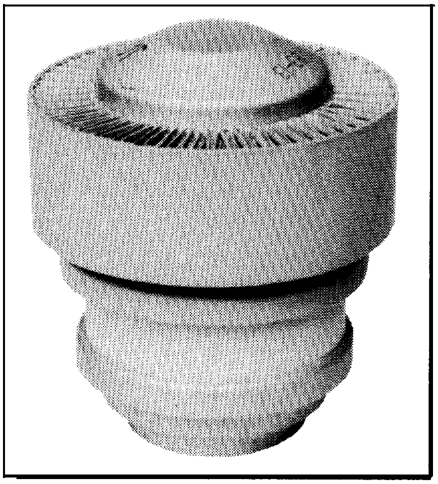
7651
Power Tube



UHF Pulsed Power Amplifier Tube

- CERMOLOX®
- Forced-Air-Cooled
- 39 Kilowatts Peak Output at 1215 MHz
- Ruggedized
- Matrix-Type Cathode

The BURLE 7651 is a small, forced-air-cooled UHF beam power tube designed for applications where dependable performance under severe shock and vibration is essential. It is intended for use in compact aircraft, mobile and stationary equipment.

The 7651 is rated as a pulsed RF amplifier at frequencies up to 1215 MHz. It is useful in applications such as: telemetry which requires pulse-amplitude, pulse-position, pulse-duration or pulse code modulation; accelerators, which require a unique wave shape; or other applications requiring high RF pulse power.

The 7651 features the CERMOLOX construction, a unipotential cathode of the oxide-coated, matrix type, and an integral, louvered-fin radiator. In addition, it employs an axial ceramic pin which holds the grids No.1 and 2 and the cathode in fixed relationship to each other.

To assure compliance with environmental design objectives, sample tubes are subjected to 50 g-11 millisecond and 500 g-3/4 millisecond shock tests and also a variable frequency vibration test at up to 20 g and from 5 to 2000 Hertz.

This data sheet gives application information unique to the BURLE-7651. Information contained in the following publications will help to assure longer tube life and safer operation:

TP-105	Applications Guide for BURLE Power Tubes.
TP-118	Applications 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]	120 s
Mu-Factor,(Grid No.2 to Grid No.1)	13

Direct Interelectrode Capacitances:

Grid No.1 to anode	0.16 max. pF
Grid No.1 to cathode & heater	28 pF
Anode to cathode & heater[3]	0.01 max. pF
Grid No.1 to grid No.2	36 pF
Grid No.2 to anode	6.5 pF
Grid No.2 to cathode & heater[3]	1.1 max. pF

Mechanical

Operating Attitude	Any
Overall Length	(6.10 mm) 2.40 max. in
Greatest Diameter	(52.8 mm) 2.08 max. in
Terminal Connections	See Dimensional Outline
Sockets	9806-002[4] or 89-083[5] or equiv.
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

BURLE Electron Tubes

Characteristics Range Values

	Min.	Max.	Units
Heater Current[8]	6.9	8.3	A
Direct Interelectrode Capacitances:			
Grid No. 1 to anode[3]	-	0.16	pF
Grid No.1 to cathode & heater	25	31	pF
Anode to cathode & heater[3]	-	0.01	pF
Grid No.1 to grid No.2	33	40	pF
Grid No.2 to anode	5.0	8.0	pF
Grid No.2 to cathode & heater[3]	-	1.1	pF
Reverse Grid No. 1 Current[8,9]	-	-50	mA
Peak Emission[8,10]	80		A
Interelectrode Leakage Resistance[8,11]	8.0	-	Mohms
Cutoff Grid Voltage[8,11]	-	-185	V

Pulsed RF Amplifier

Maximum Ratings, Absolute-Maximum Values

For frequencies up to 1215 MHz and for a maximum "ON" time of 10 microseconds in any 1000-microsecond interval.

Peak Positive-Pulse Anode Voltage[7]	8000	V
DC Anode Voltage[7]	5000	V
DC or Peak Positive-Pulse Grid No.2 Voltage	1200	V
DC Grid No.1 Voltage	-250	V
DC Anode Current During Pulse	9	A
DC Anode Current	500	mA
Grid No.2 Input (Average)	25	W
Grid No.1 Input (Average)	10	W
Anode Dissipation (Average)	600	W

Typical Operation

In a class AB_2 cathode-drive circuit with pulsed grid-No.2 voltage supply, rectangular wave shape pulses, duty factor of 0.01, pulse duration of 10 microseconds, and at a frequency of 1215 MHz.

DC Anode Voltage	3600	4000	V
Peak Positive-Pulse Grid No.2 Voltage	800	1000	V
DC Grid No.1 Voltage	0	0	V
DC Anode Current During Pulse	8	9	A
DC Anode Current	145	165	mA
DC Grid No.2 Current	3	6	mA
DC Grid No.1 Current	17	17	mA
Output Circuit Efficiency (Approx.)	80	80	%
Driver Power Output at Peak of Pulse (Approx.)	2.4	2.9	kW
Useful Power Output at Peak of Pulse (Approx.)	11	15	kW

Typical Operation

In a class B cathode-drive circuit with rectangular wave shape pulses, duty factor of 0.01, pulse duration of 10 microseconds, and at a frequency of 1215 MHz.

DC Anode Voltage	3600	4000	V
DC Grid No.2 Voltage	800	1000	v
DC Grid No.1 Voltage	-100	-120	V
DC Anode Current During Pulse	8	9	A
DC Anode Current	190	200	mA
DC Grid No.2 Current	5	6	mA
DC Grid No.1 Current	20	20	mA
Output Circuit Efficiency (Approx.)	80	80	%
Driver Power Output at Peak of Pulse (Approx.)	5.2	6.3	kW
Useful Power Output at Peak of Pulse (Approx.)	15	20	kW

Typical Operation

In a class AB_2 cathode-drive circuit with pulsed anode and grid-No.2 voltage supplies, rectangular wave shape pulses, with duty factor of 0.01, pulse duration of 10 microseconds, and at a frequency of 1215 MHz.

Peak Positive-Pulse Anode Voltage	7200	8000	V
Peak Positive-Pulse Grid No.2 Voltage	800	1000	V
DC Grid No.1 Voltage	-75	-80	V
DC Anode Current During Pulse	8	9	A
DC Anode Current	90	100	mA
DC Grid No.2 Current	3	4	mA
DC Grid No.1 Current	19	20	mA
Output Circuit Efficiency (Approx.)	80	80	%
Driver Power Output at Peak of Pulse (Approx.)	4.5	5.3	kW
Useful Power Output at Peak of Pulse (Approx.)	30	39	kW

and

Peak Positive-Pulse Anode Voltage	7200	8000	V
Peak Positive-Pulse Grid No.2 Voltage	800	1000	V
DC Grid No.1 Voltage	0	0	V
DC Anode Current During Pulse	8	9	A
DC Anode Current	90	100	mA
DC Grid No.2 Current	3	8	mA
DC Grid No.1 Current	15	16	mA
Output Circuit Efficiency (Approx.)	80	80	%
Driver Power Output as Peak of Pulse (Approx.)	1.8	2.2	kW
Useful Power Output as Peak of Pulse (Approx.)	22	28	kW

Notes

1. Measured at the tube terminals. For accurate data the ac heater voltage should be measured using as 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., 56 Route Ten, PO Box 337
   East Hanover, NJ 07836
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 a DC anode current of 240 mA.

10. For conditions with grid-No. 1, grid-No.2, and anode tied together; and pulse voltage source connected between anode and cathode. Pulse voltage is 850 volts peak, duration is 2 microseconds, pulse repetition frequency is 60 pps, and duty factor is 0.00012. Peak emission is measured 1 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 resistance between any two electrodes is measured with a 200-volt Megger type ohm meter having an internal impedance of 1 .O megohm.
12. With DC anode voltage of 2500 volts, DC grid-No.2 voltage of 1000 volts, and a DC grid-No.1 voltage adjusted to give a DC anode current of 5 mA.

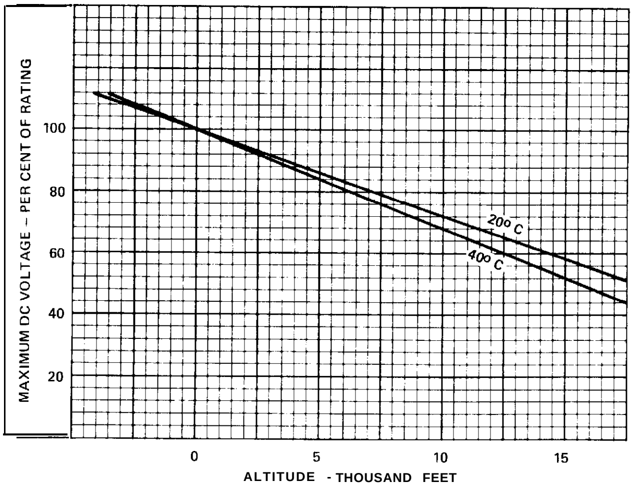


Figure 1 - Maximum DC Voltage with Respect to Altitude

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 Cathode-Heater 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, **Figure 2,** indicates the air flow and pressure requirements of a system sufficient to limit the core temperature to specific values for various levels of anode 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-105 and TP-118.

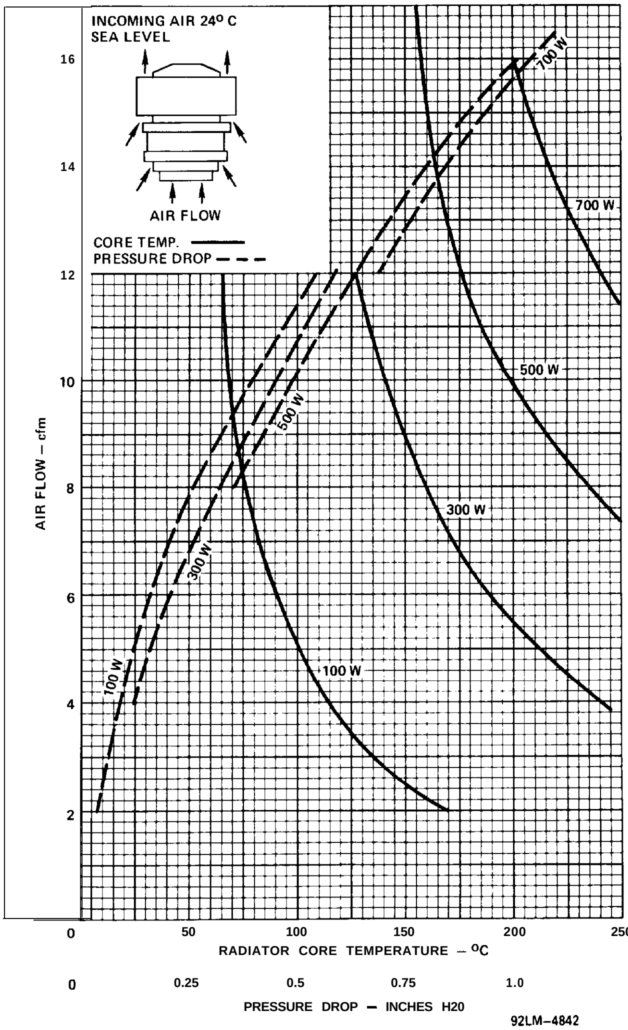


Figure 2 - Cooling Characteristic

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.

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 a thyratron 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 relay should be provided in the anode supply circuit to delay application of anode voltage until the cathode 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.

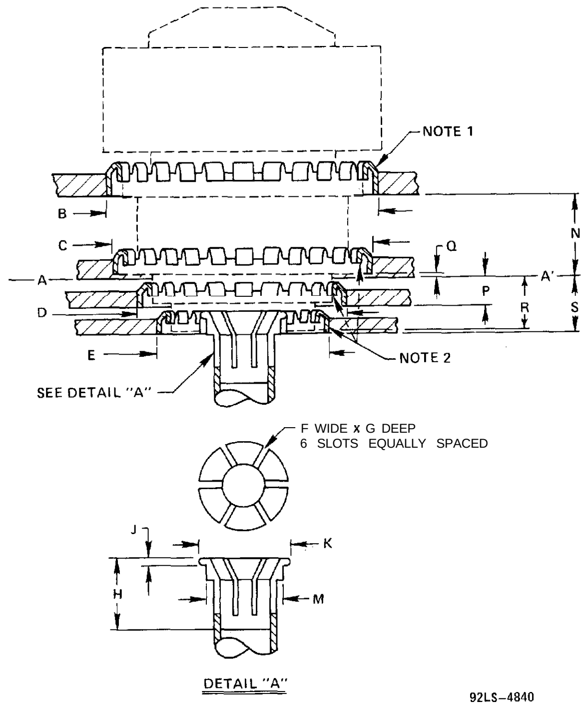
Mounting

Seethe preferred mounting arrangement below. See TP-105 for a description of the fixed method of mounting. The adjustable method is not recommended for the 7651.

Warning-Personal Safety Hazards

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

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



Tabulated Dimensions

Dimension	Inches	Millimeters
B Dia.	1.938 ± .001	(49.23 ± .03)
C Dia.	1.746 ± .001	(44.35 ± .03)
D Dia.	1.448 ± .001	(36.78 ± .03)
E Dia.	1.148 ± .001	(29.16 ± .03)
F	0.02 ± .01	(0.51 ± .25)
G	0.40 ± .02	(10.16 ± .51)
H	0.50 ± .05	(12.7 ± 1.3)
J	0.050 ± .005	(1.27 ± .13)
K Dia.	0.670 ± .001	(17.02 ± .03)
M Dia.	0.565 ± .005	(14.35 ± .13)
N	0.591 ± .005	(15.01 ± .13)
P	0.184 ± .005	(4.67 ± .13)
Q	0.040 ± .005	(1.02 ± .13)
R	0.385 ± 2.005	(9.78 ± .13)
S	0.400 ± .005	(10.16 ± .13)

Note 1 - Contact strip part number. Cat. No.97-360.

Note 2 - Contact strip part number. Cat. No.97-380.

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

Dimensions are in inches unless otherwise stated. Dimensions in parentheses are in millimeters and are derived from the basic inch dimension (1 inch = 25.4 mm).

Figure 3 - Preferred Mounting Arrangement and Layout of Associated Contacts

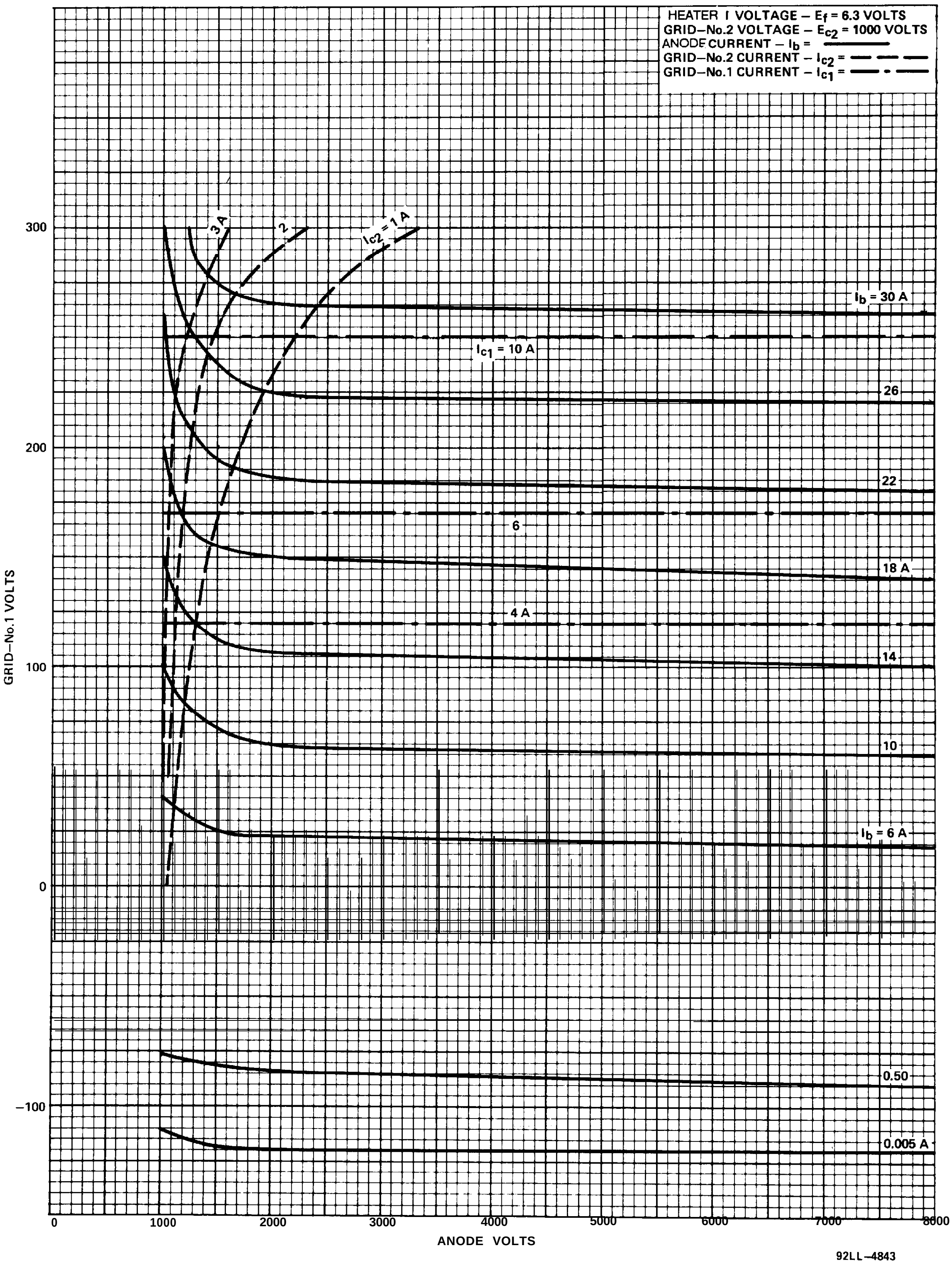


Figure 4 - Typical Constant Current Characteristics (For Grid-No.2 Voltage = 1000 V)

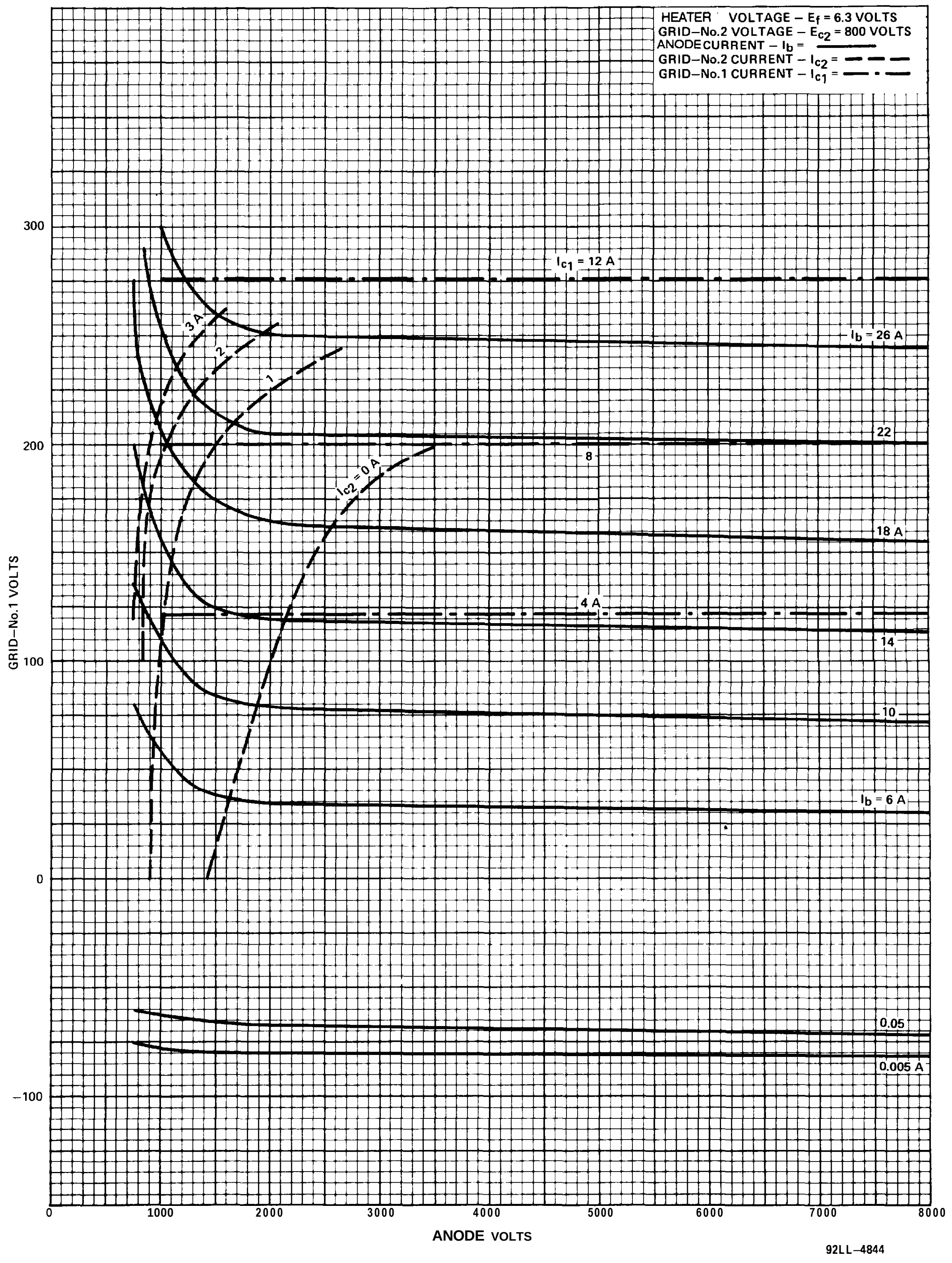


Figure 5 • Typical Constant-Current Characteristics (For Grid-No.2 Voltage = 800 V)

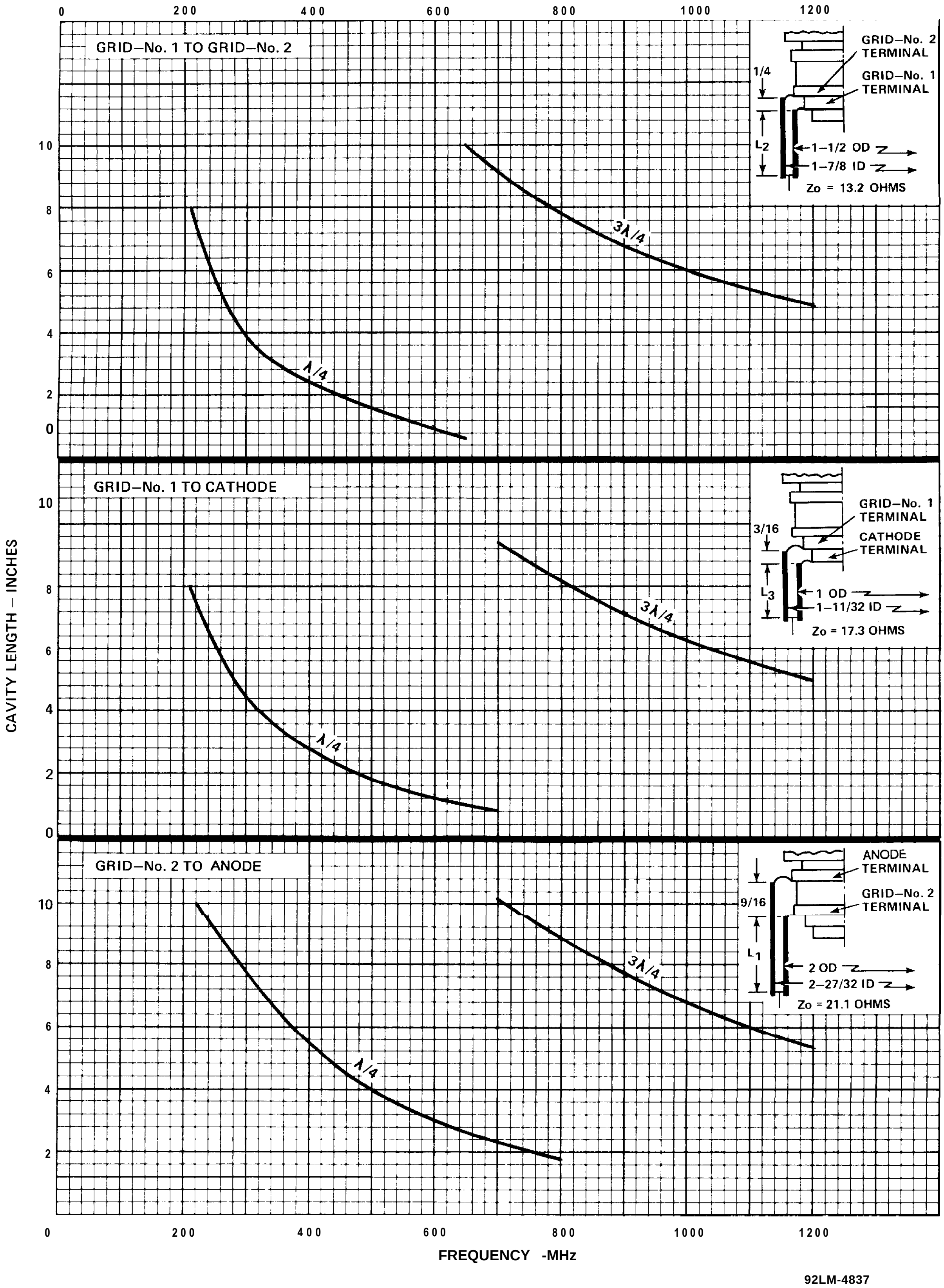
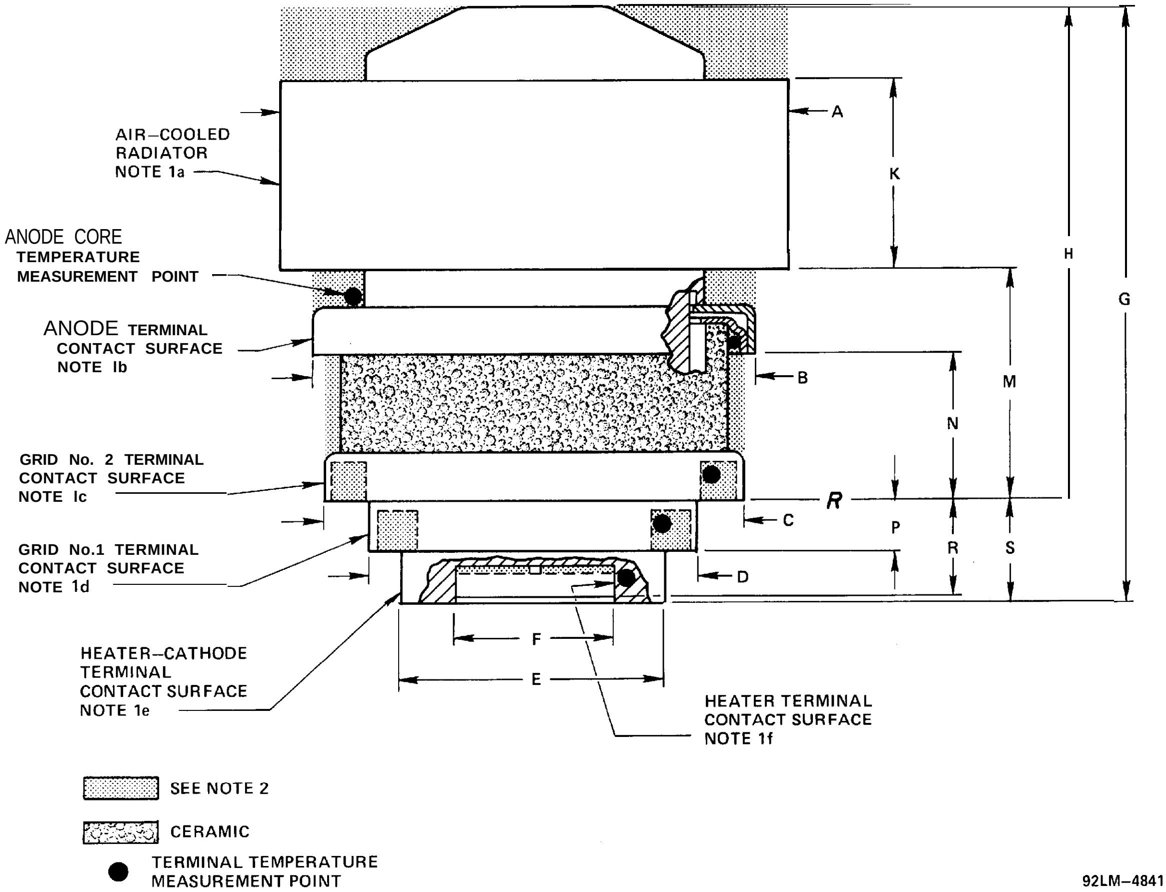


Figure 6 - Tuning Characteristics



Tabulated Dimensions

Dimension	Inches	Millimeters
A Dia.	2.065 ± .015	(52.45 ± .38)
B Dia.	1.745 Min.	(44.32 Min.)
C Dia.	1.59 Min.	(40.39 Min.)
D Dia.	1.29 Min.	(32.77 Min.)
E Dia.	0.99 Min.	(25.14 Min.)
F Dia.	0.67 Max.	(17.02 Max.)
G	2.40 Max.	(61 .O Max.)
H	1.94 ± .04	(49.3 ± 1 .0)
K	0.755 ± .020	(19.18 ± .51)
M	0.895 ± .035	(22.73 ± .89)
N	0.57 ± .03 / -.02	(14.48 ± .76 / -.51)
P	0.20 ± .02	(5.08 v .51)
R	0.385 ± .025	(9.78 ± .64)
S	0.40 ± .02	(10.16 ± .51)

Figure 7- Dimensional Outline

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

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

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 for guidance.

Dimensions are in inches unless otherwise stated. Dimensions in parentheses are in millimeters and are derived from the basic inch dimension (1 inch = 25.4 mm).

For additional information call **I-800-366-2875**

BURLE INDUSTRIES, INC., Tube Products Division
1000 New Holland Ave., Lancaster, PA 17601-5688 U.S.A

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