



# 8986 Power Tube

## Beam Power Tube

- **FM Broadcast Service**  
15 kW Output  
20 dB Gain  
80% Efficiency
- **High Efficiency-Low Pressure Radiator**

The BURLE 8986 is designed specifically for use in high-gain, high-efficiency FM service.

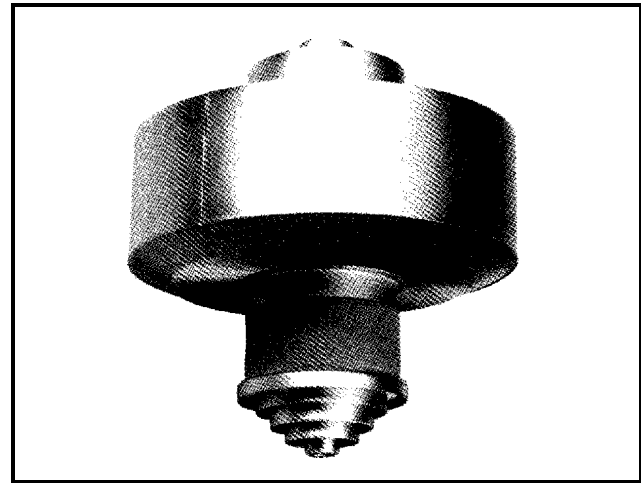
Rated for full input to 150 MHz, the tube is easily circuited to this frequency. The terminals are coaxial for operation in the TEM mode and the radiator location avoids restriction of the resonant cavity circuits in VHF operation.

Its sturdy, coaxial construction and thoriated-tungsten mesh filament minimize tube inductances and feed-thru capacitances. They make possible the use of simple, economical, broadband circuit techniques in VHF operation.

This data sheet gives application information unique to the BURLE 8986. It is to be used in conjunction with the publication, "Application Guide for BURLE Power Tubes", TP-105, for general application information for tubes of this type.

Additional information of a general nature applicable to tubes of this type is given in the following publications:

- TP-105 Application Guide for BURLE Power Tubes
- TP-122 Screen-Grid Current, Loading and Bleeder Considerations
- TP-117 Handling and Operating Considerations When Using BURLE Tetrodes
- TP-118 Application Guide for Forced Air Cooling BURLE Power Tubes



Close attention to the instructions contained in these publications will assure longer tube life, safer operation, less equipment downtime and fewer tube handling accidents. For copies of these publications, specific information or application assistance, contact your nearest BURLE Representative or write BURLE INDUSTRIES INC., New Holland Avenue, Lancaster, PA 17601.

### General Data

#### Electrical

All voltages referenced to cathode, unless otherwise specified.

Filamentary Cathode, Thoriated-Tungsten Mesh Type:		
Voltage (ac or dc).....	See Note 1	
Current:		
Typical value at 11.0 volts <sup>2</sup> .....	105	A
Maximum value for starting, even momentarily <sup>14</sup> .....	220	A
Cold resistance.....	0.01	ohm
Recommended heating time <sup>3</sup> .....	30	sec
Mu-Factor <sup>4</sup> , (Grid No.2 to grid No.1).....	11	
Direct Interelectrode Capacitances:		
Grid No.1 to plate <sup>5</sup> .....	0.7	pF
Grid No.1 to filament.....	85	pF
Plate to filament <sup>5</sup> .....	0.1	pF
Grid No.1 to grid No.2.....	90	pF
Grid No.2 to plate.....	17	pF
Grid No. 2 to filament <sup>6</sup> .....	4.2	pF



**Mechanical**

Operating Attitude.....	Vertical, anode up
Overall Length (Max.).....	199.39 mm (7.85 in)
Greatest Diameter.....	180.20 mm (7.1 in)
Socket.....	CD89-085 <sup>7</sup> or equivalent
Radiator.....	Integral part of tube
Weight (Approx.).....	55 kg (12 lbs)

**Thermal**

Seal Temperature <sup>8</sup> .....	250	max.	°C
(Plate, Grid No.2, Grid No.1, Cathode-Filament, and Filament)			
Plate-Core Temperature <sup>8</sup> .....	250	max.	°C

**RF Power Amplifier - Class C, FM Telephony  
Maximum CCS Ratings, Absolute-Maximum Values**

**Up to 150 MHz**

DC Plate Voltage <sup>9</sup> .....	13,000	V
DC Grid-No.2 Voltage <sup>10</sup> .....	2000	V
DC Grid-No.1 Voltage <sup>13</sup> .....	-600	V
DC Plate Current.....	3	A
DC Grid-No.1 Current.....	0.3	A
Grid-No.1 Input.....	100	W
Grid-No.2 Input.....	250	W
Plate Dissipation <sup>11</sup> .....	12,500	W

**Grid Driven, Class C, CCS Operation**

Typical Data at 108 MHz

DC Plate Voltage.....	9000	V
DC Grid-No.2 Voltage.....	1000	V
DC Grid-No. 1 Voltage.....	-300	V
DC Plate Current.....	2.1	A
DC Grid-No.2 Current.....	0.10	A
DC Grid-No.1 Current.....	0.06	A
Driver Power Output <sup>12</sup> .....	135	W
Useful Power Output.....	15,200	W
Overall Plate Efficiency.....	80	%
Gain.....	20.5	dB

1. The typical filament voltage is 11.0 volts, ac or dc. The maximum filament voltage, measured at the tube terminals, is 11.5 volts. For maximum life, the filament power should be regulated at the lowest value that will give satisfactory performance.

For accurate data, ac filament voltage should be measured using an RMS type meter such as an iron-vane or thermocouple type. DC voltage should be measured using a high input impedance type meter.

For those applications where hum is a critical consideration, dc filament voltage or hum-bucking circuits are recommended. See Application Note TP-117 for further information.

2. It is recommended that additional current be available to allow for both product variation and the normal reduction of filament resistance with life. Thus the filament supply adjustment should be designed for a capability of 130 amperes at 11.5 volts.

3. Recommended starting procedure for maximum stability and longest life:  
Standard: Filament heating time of 30 seconds followed by grid-No.1, plate, grid-No.2, and RF drive.  
Emergency: Filament heating time of 15 seconds followed by grid-No 1, plate, grid-No.2, and RF drive.

4. For plate voltage = 2000 V, grid-No.2 voltage = 1200 V, and plate current = 12 A.

5. With external flat metal shield 200 mm (8") in diameter having a center hole 76 mm (3") in diameter. Shield is

located in plane of the grid-No.2 terminal, perpendicular to the tube axis, and is connected to grid No.2

6. With external flat metal shield 200 mm (8") in diameter having a center hole 60 mm (2-3/8") in diameter. Shield is located in plane of the grid-No.1 terminal, perpendicular to the tube axis, and is connected to grid No.1.

7. As manufactured by: Jettron Products Inc.

65 Route 10  
P.O. Box 337  
East Hanover, NJ 07938

8. See Dimensional Outline for Temperature Measurement Points. For good contact-finger life, a maximum temperature of 180 °C at the terminal is recommended when using commercially-available beryllium-copper socket contacts.

9. 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**. For altitude derating of the plate voltage, use the voltage difference between plate and grid No.2. The fault energy dissipated within the tube during a high-voltage arc or fault must be limited by resistors or fault protection circuitry such as spark gaps or electronic "crowbars". This is especially important where large capacitors storing high energy are used. The following current limiting resistance values are recommended:

- Plate - 10 to 50 ohms
- Grid No.2 - Fifty ohms minimum
- Grid No.1 - Fifty ohms minimum

For additional information, see TP-105, "Application Guide for BURLE Power Tubes".

10. See TP-105 and TP-122. Protection devices such as spark gaps should be used.

11. Permitted plate dissipation is a function of cooling. For specific ratings see Forced-Air Cooling information in this data sheet

12. Driver power output represents circuit losses in the grid input circuit in addition to the power necessary to drive the tube.

13. See TP-105. Protection devices such as spark gaps or positive clamping diodes should be used.

14. To limit filament surge current, a series resistor is recommended; the resistor can then be shorted after 15 seconds.

**Operating Considerations**

**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.

**X-Ray Warning** - This device in operation produces X-rays which can constitute a health hazard unless the device is adequately shielded for radiation.

**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 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 can not 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.

The screen circuit requires special attention because the heating power of the current and voltage on this electrode is not the algebraic product of the current and voltage elements as observed at the terminal. For analysis of the circuit, review TP-122.

A time-delay relay should be provided in the grid-No.1 supply circuit to delay application of this voltage until the filament has reached normal operating temperature.

An interlocking relay system should be provided to prevent application of plate voltage prior to the application of sufficient bias voltage otherwise, with insufficient bias, the resultant high plate current may cause excessive plate 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 plate 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 275 °C with a maximum average temperature around the anode of 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-Filament and Filament 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. A value of at least 60 cfm is recommended.

The Cooling Characteristic Curve, **Figure 5**, 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-122 and also TP-118 "Application Guide for Forced Air Cooling of BURLE Power Tubes".

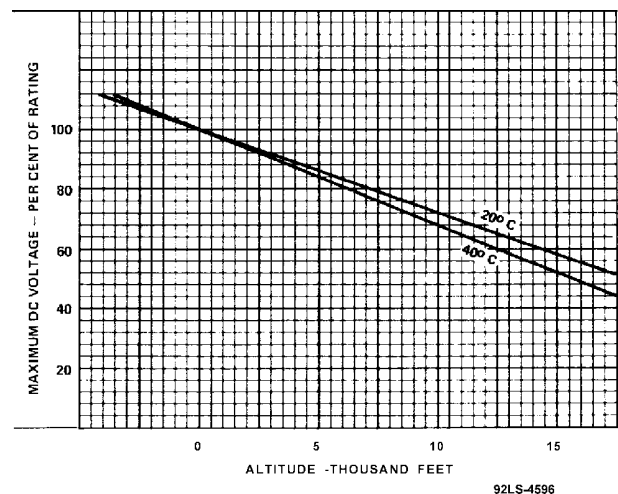


Figure 1 - Maximum DC Voltage with Respect to Altitude

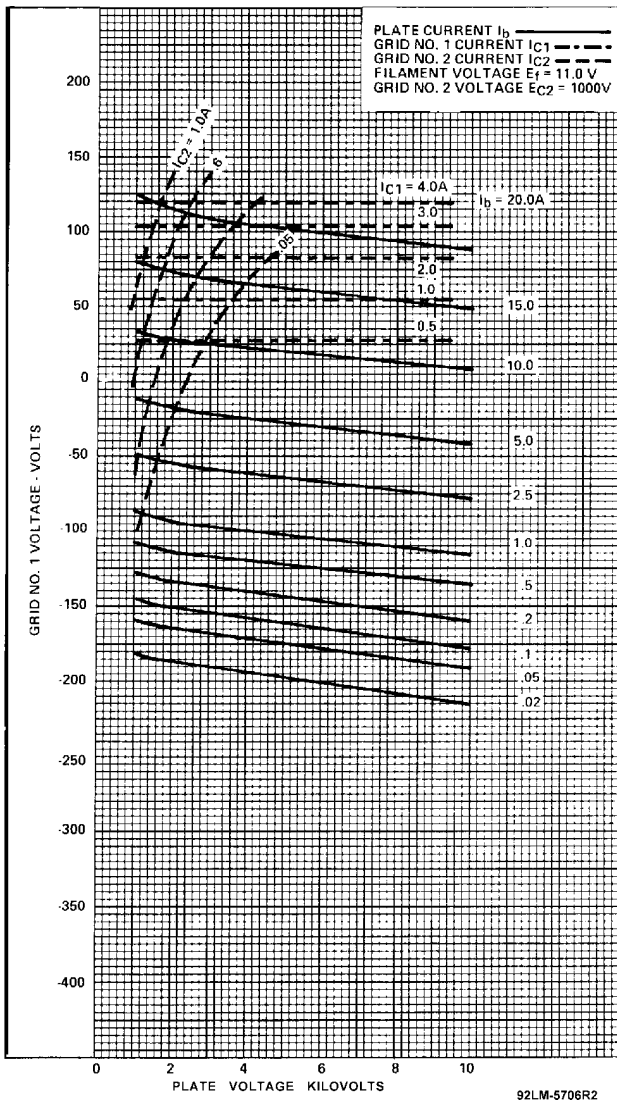


Figure 2 - Typical Constant Current Characteristics

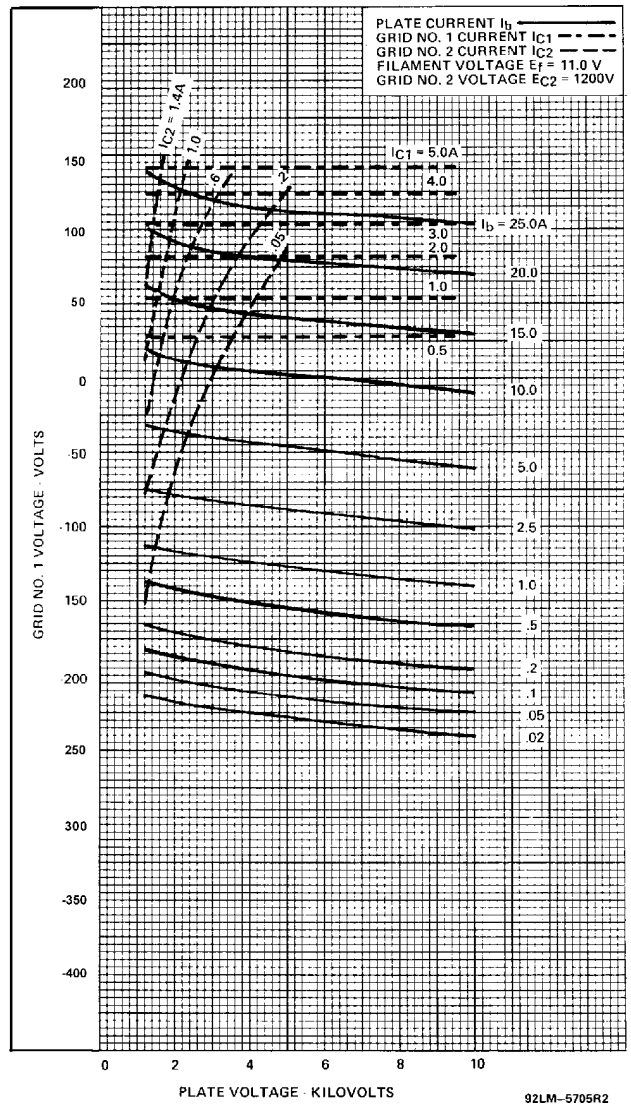
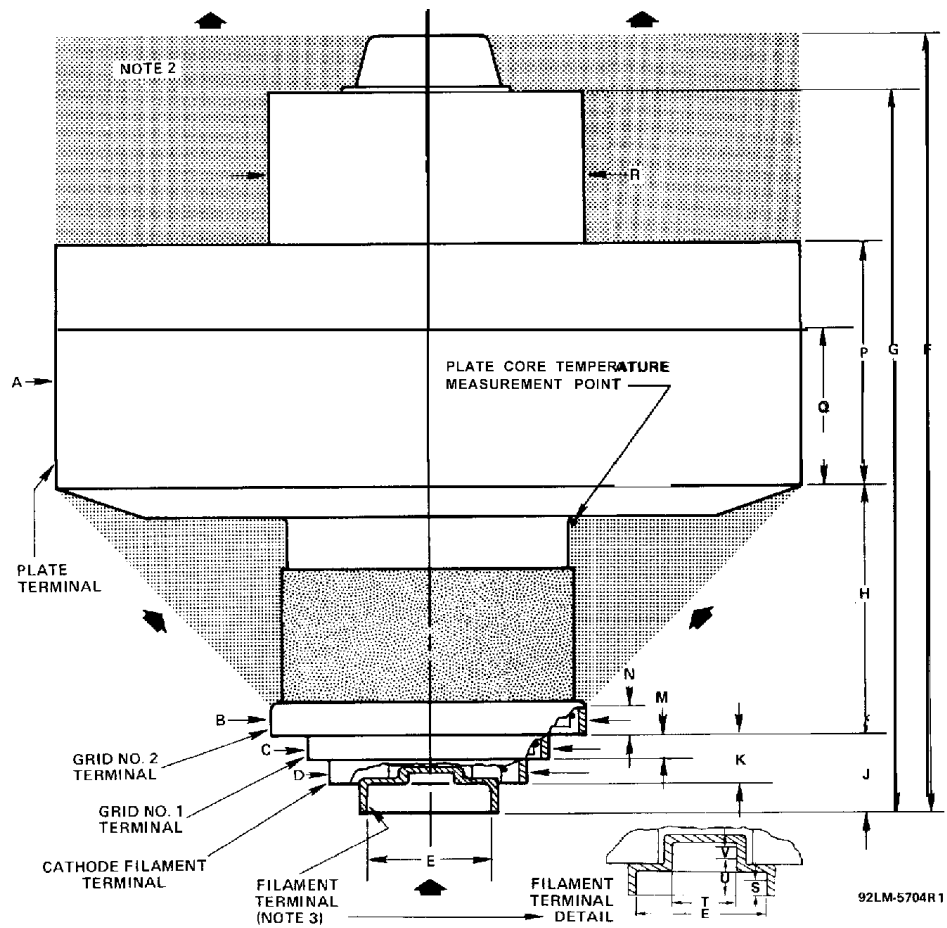


Figure 3 - Typical Constant Current Characteristics



**Figure 4 - Dimensional Outline**  
**Tabulated Dimensions**

Dimensions	Millimeters	Inches
A Dia. <sup>1</sup>	17920 ±1.02	7.055 ±.040
B Dia. <sup>1</sup>	7691 ±.036	3.028 ±.014
C Dia. <sup>1</sup>	5890 ±.030	2.319 ±.012
D Dia. <sup>1</sup>	4699 ±.030	1.850 ±.012
E Dia. <sup>1</sup>	3048 ±.025	1.200 ±.010
F	199.39 max.	7.850 max.
G	184.15 max.	7.250 max.
H	61.60 ±2.54	2.425 ±.100
J	18.42 ±1.02	0.725 ±.040
K	12.70 ±0.76	0.500 ±.030
M	5.08 ±0.64	0.200 ±.025
N	5.59 min.	0.220 min.
P	57.15 ref.	2.250 ref.
Q	38.10 ref.	1.500 ref.
R Dia.	75.56 ref.	2.975 ref.
S	6.35 min.	0.250 min.
T Dia. <sup>1</sup>	1590 ±0.25	0625 ±.010
U	14.60 ±0.64	0.575 ±.025
V	5.08 min.	0.200 min.

**Note 1** - The diameter of each terminal is maintained only over the indicated minimum length of its contact surface.

**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 Applications Engineering, Lancaster, PA.

**Note 3** - Contact must be made on both diameters E and T.

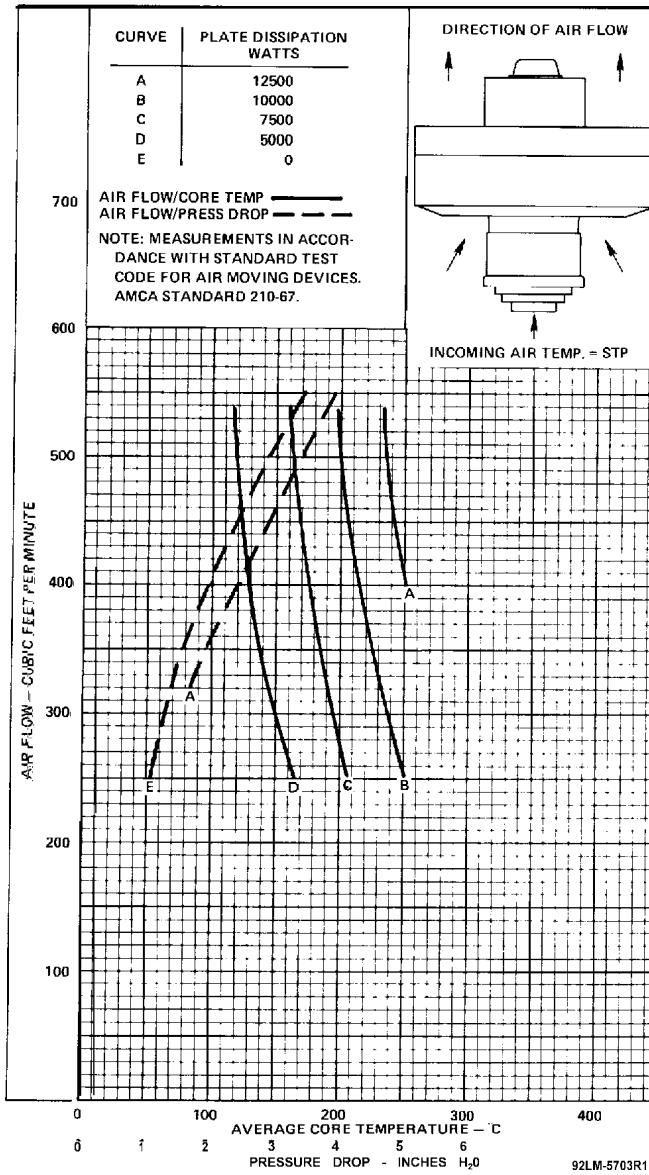


Figure 5 - Air Flow Characteristics