5946

POWER TRIODE
Forced-Air Cooled, Grounded-Grid Type

TENTATIVE DATA

RCA-5946 is a very compact, forced-air cooled power triode designed for uhf plate-pulsed oscillator and amplifier service. In such service, it has a maximum rated plate dissipation of 250 watts, and can be operated with full plate voltage at frequencies up to 1300 megacycles per second. Operation at higher frequencies is permissible with reduced ratings.

The 5946 features a coaxial-electrode structure designed especially for use with circuits of the coaxial-cylinder type. The design provides low-inductance, large-area, rf electrode terminals for insertion into the cylinders, and permits effective isolation of the plate from the cathode. The latter feature makes the 5946 particularly suitable for grounded-grid circuits.

GENERAL DATA

Electrical:

- Heater, for Unipotential Cathode: 6.3 volts
- Plate Supply Voltage: 5.4 volts
- Plate Current: 3.4 amperes
- Minimum Heating Time: 1 minute

Amplification Factor: 27
Direct Inter-electrode Capacitances:
Grid to Plate: 6 µuf
Grid to Cathode: 11 µuf
Plate to Cathode: 0.32 max. µuf

Mechanical:
Mounting Position: Vertical, with radiator up or down
Overall Length: 3-5/16" ± 3/32"
Greatest Diameter: 1.750" ± 0.010"
Radiator: Integral part of tube
Mounting: Special Air Flow:
The specified air flow for various plate dissipations, as indicated in the tabulation below, should be delivered by a blower onto the respective terminals and seals, and through the radiator before and during the application of any voltages. Heater power, plate power, and air may be removed simultaneously.
Plate Dissipation: 150 200 250 watts
Min. Air Flow: 5.7 10 16 cfm
Static Pressure: 0.15 0.4 0.85 in. of water

The above flow and pressure values are for conditions with radiator temperature held constant at 135°C rise above ambient temperature. The airflow must be adequate to limit the temperature of the radiator, grid terminal, cathode terminal, and seals to their respective maximum values.

Radiator Temperature (measured on core at end adjacent to plate ring): 180 max. °C
Grid-Terminal Temperature: 150 max. °C
Cathode-Terminal Temperature: 150 max. °C
Seal Temperature (Plate, grid, and cathode): 150 max. °C

PLATE-PULSED OSCILLATOR & AMPLIFIER - Class C

Maximum Ratings, Absolute Values:

For a maximum pulse duration of 5 microseconds

PEAK POSITIVE-PULSE
- PLATE SUPPLY VOLTAGE: 7500 max. volts
- GRID-BIAS VOLTAGE: 600 max. volts

PEAK PLATE CURRENT FROM PULSE SUPPLY:
- 5.5 max. amp

PEAK RECTIFIED GRID CURRENT:
- 1.0 max. amp

DC PLATE CURRENT:
- 0.045 max. amp

DC GRID CURRENT:
- 0.010 max. amp

PLATE DISSIPATION:
- 250 max. watts

Typical Operation with Rectangular Wave Shape

In Oscillator Circuit at 1250 Mc:

With duty factor of 0.01

Peak Positive-Pulse
- PLATE SUPPLY VOLTAGE: 5500 volts
- GRID-BIAS VOLTAGE: 375 volts
- CATHODE RESISTANCE: 100 ohms
- RF GRIP VOLTAGE: 625 volts
- PEAK PLATE CURRENT FROM PULSE SUPPLY: 3.5 amp
- PEAK RECTIFIED GRID CURRENT: 0.25 amp
- DC PLATE CURRENT: 0.035 amp
- DC GRID CURRENT: 0.0023 amp
- USEFUL POWER OUTPUT AT PEAK OF PULSE (APPROX.): 8000 watts

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TUBE DEPARTMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY
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Characteristics Range Values for Equipment Design:

<table>
<thead>
<tr>
<th></th>
<th>Note</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater Current</td>
<td>1</td>
<td>3.05</td>
<td>3.75</td>
</tr>
<tr>
<td>Amplification Factor</td>
<td>1.2</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Grid Plate Capacitance</td>
<td>5.5</td>
<td>6.5</td>
<td>μF</td>
</tr>
<tr>
<td>Plate-Cathode Capacitance</td>
<td>9.6</td>
<td>12.4</td>
<td>μF</td>
</tr>
<tr>
<td>Plate Voltage</td>
<td>1.2</td>
<td>550</td>
<td>850</td>
</tr>
<tr>
<td>Plate Voltage</td>
<td>1.5</td>
<td>750</td>
<td>1150</td>
</tr>
<tr>
<td>Grid Voltage</td>
<td>1.6</td>
<td>-</td>
<td>-75</td>
</tr>
<tr>
<td>Cathode Current</td>
<td>1.7</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Useful Power Output at Peak of Pulse</td>
<td>1.8</td>
<td>12</td>
<td>kw</td>
</tr>
</tbody>
</table>

Note 1: With 6.3 volts on heater.
Note 2: With dc grid voltage of -15 volts, and dc plate voltage adjusted to give dc plate current of 250 milliamperes.
Note 3: With external shield connected to grid terminal.
Note 4: With dc grid voltage of -10 volts, and dc plate voltage adjusted to give dc plate current of 250 milliamperes.
Note 5: With dc grid voltage of -20 volts, and dc plate voltage adjusted to give dc plate current of 250 milliamperes.
Note 6: With dc plate voltage of 1250 volts, and dc grid voltage adjusted to give dc plate current of 1.0 milliampere.
Note 7: Represents the maximum value of cathode current (plate current and grid current) for the tube under any condition of operation.
Note 8: With peak positive-pulse plate-supply voltage of 7500 volts, cathode-bias resistor of 300 ± 100 ohms, peak plate current from pulse supply of 4.5 amperes, peak rectified grid current of 0.5 amperes, duty factor of 0.01, and frequency of 1250 Mc.

Ratings vs Operating Frequency:

<table>
<thead>
<tr>
<th>Operating Frequency</th>
<th>Maximum Permissible Percentage of Maximum Rated Plate Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1300 Mc</td>
<td>100</td>
</tr>
<tr>
<td>2000 Mc</td>
<td>75</td>
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</table>

With external shield connected to grid terminal.

Pulse duration is defined as the time interval between the two points on the pulse at which the instantaneous value is 70% of the peak value. The pulse period is defined as the maximum value of a smooth curve through the average of fluctuations over the top portion of the pulse. The magnitude of any spike on the plate voltage pulse should not exceed a value of 820 volts with respect to cathode and its duration should not exceed 0.5 microsecond measured at the peak-pulse value level.

Duty factor is the product of pulse duration and repetition rate. For variable pulse durations and pulse repetition rates, the duty factor is defined as the ratio of time "on" to total elapsed time in any 500-microsecond interval.

It is recommended that the entire bias be obtained from a cathode resistor. In certain applications, partial grid-resistor bias may be used.

The power output at peak of pulse is obtained from the average power output using the duty factor of the peak power output pulse. This procedure is necessary since the power output pulse duty factor may be less than the applied voltage pulse duty factor because of a delay in the start of rf power output.

**INSTALLATION and APPLICATION**

The maximum ratings shown in the tabulated data are limiting values above which the serviceability of the 5946 may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed these absolute ratings, the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by an amount such that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself.

The maximum radiator temperature of 180°C as well as the maximum terminal and seal temperatures of 150°C are tube ratings and are to be observed in the same manner as other ratings. The temperature of the radiator should be measured on the core at the end adjacent to the plate ring (see Outline Drawing). The temperature may be measured either with a thermocouple or with temperature-sensitive paint, such as Tempilax. The latter is made by the Tempil Corporation, 132 W. 22nd Street, New York 11, N. Y., in the form of liquid and stick, and is stated by the maker to have an accuracy of 1 per cent.

In transportation and storage of the 5946, care should be taken to protect the tube from rough handling that would damage the glass-to-metal seals or dent or mar the rf contact surfaces. Particular care should be taken not to subject the tube to severe shock which might permanently deform the internal elements. It is recommended that the tube be tested upon receipt in the equipment in which it is to be used.

The mounting should support the 5946 in a vertical position with the radiator either up or down. The tube may be supported by the plate ring or by the radiator in any convenient way, but the mounting arrangement used must not subject the grid, cathode, and heater terminals to undue stress.

Because the terminals of the 5946 have progressively smaller diameters from plate to grid to cathode to heater as shown in the Outline Drawing, it is possible to insert the 5946 into coaxial and cavity circuits from one end without disassembly of the circuit. In such circuits, the 5946 is supported by the plate ring as shown in Fig.1.
In the design of this mounting, it is to be noted that the hole in part A, which limits movement of the tube in directions parallel to the plate contact surface, is approximately 0.050" larger than the maximum diameter of the plate ring in order to allow the tube to seek its position freely when being inserted into the grid, cathode, and heater contacts, and to seat properly on the plate contact surface of part B. After the tube is in place, the removable clamp C is brought into position and closed to make the plate contact secure and to anchor the tube firmly in place.

Cooling of the 5946 is accomplished by delivering a stream of clean air from a blower onto the respective terminals and seals, and through the radiator before and during the application of any voltages. The air flow through the radiator may be in either direction. The minimum rate of air flow for various plate dissipations is shown in the tabulated data. A suitable air filter is required in the air supply. Care should be given to cleaning or replacing the filter at intervals in order that accumulated dirt will not obstruct the required flow of air through the radiator. When the 5946 is operated at full ratings, a flow of 16 cubic feet per minute at a pressure of about 0.85 inch of water is recommended.

The cooling system should be properly installed to insure safe operation of the 5946 under all conditions and for this reason should be electrically interconnected with the heater and plate power supplies. This arrangement is necessary to make sure that the tube is supplied with air before any voltages are applied. Air pressure interlocks which open the power transformer primary of the heater supply and the pulse supply.

**Fig. 2** - Average Characteristics of Type 5946.

In addition to the dimensions shown in Fig. 1, the equipment designer should also observe the diameter tolerances on the grid, cathode, and heater terminals and the limits on concentricity defined by the gauge (see Outline Drawing) in order to provide for variation from tube to tube.
are desirable for protecting the tube when the air flow is insufficient or ceases.

The heater is designed to be operated at 6.3 volts under average line-voltage conditions. Rated heater voltage should be applied for at least one minute to allow the cathode to reach normal operating temperature before voltages are applied to the other electrodes. In circuits where the plate is grounded and the negative pulse is applied to the cathode, the heater supply must be insulated to withstand the peak positive-pulse plate-supply voltage, and it should also present a minimum amount of capacitance loading to the pulse-supply source.

The unipotential cathode is indirectly heated by the heater, one terminal of which is common to the cathode.

The grid of the 5946 in uhf service is subjected to heating caused not only by the normal electron bombardment as indicated by the grid current, but also by circulating rf currents. For these reasons, more than ordinary care must be taken during operation to prevent overheating the grid.

Average characteristics for the 5946 are shown by the curves in Fig. 2.

A typical pulsed oscillator circuit of the folded-back, coaxial-cylinder type employing the 5946 at 1250 megacycles per second is illustrated diagrammatically in Fig. 3. The structural arrangement of this circuit is shown in Fig. 4a with details of the cathode cylinder given in Fig. 4b. In this circuit, the plate is grounded, the negative pulse voltage is applied to the cathode and grid, and a minimum of capacitance loading is presented to the pulse-supply source. The heater supply must be insulated to withstand the pulse voltage and should also present minimum capacitance loading to the pulse-supply source.

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Fig. 4a - Structural Arrangement of Pulsed-Oscillator Circuit Shown in Fig. 3.
Fig. 4b - Details of the Cathode Cylinder Shown in Fig. 4a.
NOTE 1: WITH THE CYLINDRICAL SURFACES OF ITS GRID AND CATHODE TERMINALS CLEAN, SMOOTH, AND FREE OF BURRS, THE TUBE WILL ENTER A GAUGE AS SHOWN IN SKETCH G1. THE FOUR CYLINDRICAL HOLES H1, H2, H3, AND H4 HAVE AXES COINCIDENT WITHIN 0.0005", LENGTHS DETERMINED FROM THE OUTLINE DRAWING, AND SUCCESSIVELY SMALLER DIAMETERS AS SHOWN IN THE SKETCH.

THE PLATE RING WILL BE ENTIRELY ENGAGED BY HOLE H1, AND THE CONTACT SURFACE OF THE PLATE RING WILL CRUSH THE SHOULDER BETWEEN HOLES H1 AND H2. THE PLANE SURFACE OF THE SHOULDER IS 0.005 ± 0.002". THE HOLE AXES OF THE HOLES TO THE AXES OF THE HOLES, SEATING IS DETERMINED BY FAILURE OF A 0.005" THICKNESS GAUGE, 1/8" WIDE, TO ENTER MORE THAN 1/16" BETWEEN THE SHOULDER SURFACE AND THE PLATE CONTACT SURFACE. WITH THE TUBE PROPERLY SEATED AS DESCRIBED ABOVE, THE GRID TERMINAL WILL BE ENTIRELY ENGAGED BY HOLE H3, AND THE CATHODE TERMINAL WILL BE ENGAGED BY HOLE H2 TO A DEPTH OF AT LEAST 1/4".

NOTE 2: CONCENTRICITY OF THE HEATER TERMINAL WITH RESPECT TO THE CATHODE TERMINAL IS DETERMINED BY A GAUGE AS SHOWN IN SKETCH G2. THE CYLINDRICAL HOLES H5 AND THE ANNULAR HOLES H6 HAVE AXES COINCIDENT WITHIN 0.0005", LENGTHS DETERMINED FROM THE OUTLINE DRAWING, AND DIAMETERS AS SHOWN IN THE SKETCH. THE CATHODE TERMINAL AND THE HEATER TERMINAL WILL ENTER THIS GAUGE TO A DEPTH OF 3/8".

NOTE 3: ROUNDED OR BEVELED NOT TO EXCEED 1/16".

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