7296
METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

FOR VHF OSCILLATOR AND AMPLIFIER APPLICATIONS

The 7296 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as an oscillator, broadband radio-frequency amplifier, or VHF power amplifier. The 7296 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Voltage, AC or DC * 6.3 ± 0.3 Volts
Heater Current + 0.4 Amperes
Direct Interelectrode Capacitances ‡
  Grid to Plate: (g to p) 2.2 pf
  Input: g to (h + k) 5.0 pf
  Output: p to (h + k) 0.075 pf
  Heater to Cathode: (h to k) 2.8 pf

MECHANICAL

Mounting Position—Any $
**CHARACTERISTICS AND TYPICAL OPERATION**

**AVERAGE CHARACTERISTICS**

- Plate Voltage: 200 Volts
- Cathode-Bias Resistor: 68 Ohms
- Amplification Factor: 90
- Plate Resistance, approximate: 5450 Ohms
- Transconductance: 16500 Micromhos
- Plate Current: 17 Milliamperes
- Grid Voltage, approximate: 1b = 10 Microamperes
- Plate Current, approximate: −5.5 Volts

* The equipment designer should design the equipment so that the heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

§ One method of mounting the 7296 is to use a stainless-steel “T” bolt (see drawing) to attach the mounting base of the tube to a chassis or circuit board. The “T” bolt should be inserted in the slot in the base of the tube, turned 90 degrees, and attached to the chassis or circuit board with a 4-40 nut and lock washer. Torque used to tighten the nut should not exceed 3 inch-pounds.

Operation below the rated maximum envelope temperatures is recommended for applications requiring the longest possible tube life. The 7296 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

**INITIAL CHARACTERISTICS LIMITS**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Min.</th>
<th>Bogey</th>
<th>Max.</th>
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<tbody>
<tr>
<td>Heater Current</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ef = 6.3 volts</td>
<td>370</td>
<td>400</td>
<td>430</td>
</tr>
<tr>
<td>Plate Current</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ef = 6.3 volts, Eb = 200 volts, Rk = 68 ohms (bypassed)</td>
<td>10</td>
<td>17</td>
<td>24</td>
</tr>
<tr>
<td>Transconductance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ef = 6.3 volts, Eb = 200 volts, Rk = 68 ohms (bypassed)</td>
<td>13000</td>
<td>16500</td>
<td>20000</td>
</tr>
<tr>
<td>Amplification Factor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ef = 6.3 volts, Eb = 100 volts, Rk = 68 ohms (bypassed)</td>
<td>65</td>
<td>90</td>
<td>115</td>
</tr>
<tr>
<td>Zero-Bias Transconductance</td>
<td>13000</td>
<td>20000</td>
<td>Micromhos</td>
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<tr>
<td>Grid Voltage Cutoff</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ef = 6.3 volts, Eb = 200 volts, Ia = 10 μA</td>
<td>−5.5</td>
<td>−9.5</td>
<td>Volts</td>
</tr>
<tr>
<td>Interelectode Capacitances</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grid to Plate (g to p)</td>
<td>1.9</td>
<td>2.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Input: g to (h + k)</td>
<td>3.7</td>
<td>5.0</td>
<td>6.3</td>
</tr>
<tr>
<td>Output: p to (h + k)</td>
<td>0.05</td>
<td>0.075</td>
<td>0.1</td>
</tr>
<tr>
<td>Heater to Cathode: (h to k)</td>
<td>2.1</td>
<td>2.8</td>
<td>3.5</td>
</tr>
</tbody>
</table>

| Negative Grid Current |      |      |      |
| Ef = 6.3 volts, Eb = 200 volts, Ecc = −1.0 volts, Rk = 68 ohms (bypassed), Rg = 0.18 meg | 0.5 | Microamperes |

**Heater-Cathode Leakage Current**

- Ef = 6.3 volts, Ehk = 100 volts
- Heater Positive with Respect to Cathode: 20 Microamperes
- Heater Negative with Respect to Cathode: 20 Microamperes

**Interelectode Leakage Resistance**

- Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode emission results.
  - Grid to All at 100 volts d-c: 100 Megohms
  - Plate to All at 300 volts d-c: 100 Megohms

**Grid Emission Current**

- Ef = 7.0 volts, Eb = 200 volts, Ecc = −15 volts, Rg = 0.18 meg: 2.0 Microamperes
SPECIAL PERFORMANCE TESTS

400 Megacycle Oscillator Power Output ........................................... 1.6 2.0 ... Watts

Tubes are tested for power output as an oscillator under the following conditions: F = 400 mc, Ef = 6.3 volts, Eb = 300 volts, Rg = 1400 ohms, Ib = 20 ma maximum, Ic = 6.0–9.0 ma.

Pulse Emission ........................................... 320 .................................. Milliamperes

Tubes are tested for pulse emission under the following conditions: Ef = 6.3 volts, Eb = 200 volts, Ec = –20 volts, egk = +12 volts, prr = 1000 pps, duty cycle 1%. Pulse cathode current is measured.

Grid Recovery .......... Change in Average Plate Current .................................. 1.0 Milliamperes

Peak Plate Current Backswing ........................................... 2.0 Milliamperes

Tubes with poor grid recovery affect circuit operation, when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 7296 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, Rr = 0.01 meg. Ec is adjusted for Ib = 10 ma.

Upon application to the grid of a pulse driving it 3 volts positive with respect to cathode (prr = 60 pps, duty cycle = 0.12%) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current—time relationship for a tube (with poor grid recovery) subjected to this test:

Low Frequency Vibrational Output ........................................... 15 Millivolts RMS

Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15 G. Tube is operated with Ef = 6.3 volts, Ebb = 200 volts, Rk = 68 ohms (by-passed), Rr = 2000 ohms.

Variable Frequency Vibrational Output

The tube is designed to be free of vibrational outputs in excess of 100 mv RMS at any frequency within the range 100–2000 cps, when vibrated in either of two planes at 10 G peak acceleration. Electrical conditions for this test are the same as for Low Frequency Vibrational Output.

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8 mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.
DEGRADATION RATE TESTS

Fatigue
Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10 G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with \( \text{Ef} = 6.3 \) volts, \( \text{Eb} = 200 \) volts, and \( \text{Rk} = 68 \) ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Shock
Statistical sample subjected to 5 impact accelerations of approximately 600 G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 42° hammer angle. Tubes are mounted by T-bolt with 3 inch-pounds torque, and operated during the test with \( \text{Ef} = 6.3 \) volts, \( \text{Eb} = 200 \) volts, \( \text{Ehk} = +100 \) volts, \( \text{Rg} = 0.1 \) M\( \Omega \), and \( \text{Rk} = 68 \) ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Stability Life Test
The statistical sample subjected to the Dynamic Life Test is evaluated for percent change in zero-bias transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test
The combined statistical samples subjected to the Dynamic and Pulse Life Tests are evaluated for shorted and open elements following approximately 100 hours of life test.

Dynamic Life Test
Statistical sample operated, with a 60 cps grid signal, at maximum rated DC grid current and cathode current for a period of 1000 hours. Heater voltage is cycled (on \( 1\frac{3}{4} \) hours, off \( \frac{1}{4} \) hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, zero-bias transconductance, oscillator power output, and heater-cathode leakage.

Pulse Life Test
Statistical sample operated with 400 ma peak cathode current, \( 1\frac{1}{4} \) duty cycle, for 1000 hours. Heater voltage is cycled (on \( 1\frac{3}{4} \) hours, off \( \frac{1}{4} \) hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, pulse emission, and heater-cathode leakage.

Interface Life Test
Statistical sample operated for 1000 hours with \( \text{Ef} = 6.6 \) volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test
Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include \( \text{Ef} = 7.5 \) volts cycled for one minute on and one minute off, \( \text{Eb} = \text{Ec} = 0 \) volts, and \( \text{Ehk} = 70 \) volts with heater positive with respect to cathode. Following this test tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.
MOUNTING BOLT

APPROX. .020° RAD.

.130° R

.112° ± .005"

.035° ± .005"

-.280° ± .010

.005° ± .010

4-40 THREAD

.020" .040"

1/2" +0 -.064"

PHYSICAL DIMENSIONS

MOUNTING BASE

CATHODE

GRID

PLATE

HEATERS

Maximum eccentricity of insulators 0.015 in. from center line.

AVERAGE PLATE CHARACTERISTICS

E_T = RATED VALUE

PLATE CURRENT IN MILLIAMPERES

35

30

25

20

15

10

5

0

0 100 200 300 400 500

PLATE VOLTAGE IN VOLTS

AUGUST 8, 1961

K-55611-7053-18