



ELECTRONIC TUBE REFERENCE

12R5

Power - TV Vertical Output electronic tube

CONSOLIDATED TECHNICAL DATA

1 SECTION

CONSTRUCTION

BEAMPOWER

Miniature beam pentode designed primarily as a pentode-connected vertical-deflection amplifier in television receivers, featuring high zero-bias plate current at relatively low plate voltage.

GENERAL CHARACTERISTICS

BASE DESIGNATION	—	BASE PINS	7
NOMINAL HEATER	12.6 V / 300 mA	PARALLEL HEATER	— / —
HEATING	Indirect	SERIES OPERATION	Not specified
CATHODE ARRANGEMENT	Separate cathodes	SECTION CONSTRUCTION	Similar

SECTION RATINGS

SECTION 1 Beam Power	
PLATE RESISTANCE	13000 Ω
MAXIMUM PLATE VOLTAGE	150 V
MAXIMUM SCREEN VOLTAGE	150 V
MAXIMUM PLATE DISSIPATION	4.5 W
MAXIMUM SCREEN DISSIPATION	1 W
MAXIMUM CATHODE CURRENT	155 mA

12R5 — Miniature Beam Pentode

The **12R5** is a miniature beam pentode designed primarily for service as a pentode-connected vertical-deflection amplifier in television receivers. A key design feature of the 12R5 is its ability to deliver high zero-bias plate current at relatively low plate and screen voltages, which is highly advantageous in vertical deflection circuits. Additionally, the tube incorporates a controlled heater warm-up characteristic, making it well-suited for television receivers utilizing series-connected heater strings.

Mechanical Construction and Physical Dimensions

The 12R5 is housed in a T-5 1/2 glass envelope with a miniature button 7-pin base (E7-1 designation). The physical dimensions of the tube are compact, conforming to the EIA 5-3 outline:

- **Maximum Overall Length:** 2 5/8 inches
- **Maximum Seated Height:** 2 3/8 inches
- **Maximum Diameter:** 3/4 inches

The tube can be mounted and operated in any position.

Heater Characteristics and Controlled Warm-up

The 12R5 features a coated unipotential cathode and a heater designed for either AC or DC operation. The heater is specifically engineered with a controlled warm-up time to ensure reliable operation and minimize voltage surges in series-connected heater strings.

Heater Parameter	Value
Nominal Heater Voltage	12.6 V
Nominal Heater Current	0.6 A
Heater Warm-up Time	11 Seconds

The heater warm-up time is defined under specific test conditions. When applying 4 times the rated heater voltage (calculated as $4 * 12.6 \text{ V} = 50.4 \text{ V}$) to a circuit consisting of the heater in series with a resistance equal to 3 times the nominal heater resistance, the voltage across the heater reaches 80% of its rated value in 11 seconds.

The series resistance used for this test is calculated from the nominal heater voltage and current:

- Nominal Heater Resistance (R_h) = $12.6 \text{ V} / 0.6 \text{ A} = 21 \text{ Ohms}$
- Series Test Resistance = $3 * R_h = 3 * 21 \text{ Ohms} = 63 \text{ Ohms}$

Pinout and Terminal Connections

The 12R5 utilizes the EIA 7CV basing diagram. The 7-pin miniature base provides the following electrical connections, viewed from the underside of the tube:

Pin Number	Connection
Pin 1	Cathode and Beam Plates
Pin 2	Grid Number 1 (Control Grid)
Pin 3	Heater
Pin 4	Heater

Pin Number	Connection
Pin 5	Grid Number 1 (Control Grid)
Pin 6	Grid Number 2 (Screen Grid)
Pin 7	Plate (Anode)

The beam-forming plates (which function as the suppressor grid) are internally connected to the cathode and exit through Pin 1. The control grid (Grid Number 1) is connected to both Pin 2 and Pin 5, providing layout flexibility or redundant connections.

Electrical Characteristics and Typical Operation

The 12R5 is characterized by high transconductance and low plate resistance under typical operating conditions. The manufacturer documents two distinct operating points to illustrate the tube's performance:

Parameter	Operating Point A (Transient)	Operating Point B (Class A)
Plate Voltage	45 V	110 V
Screen Voltage (Grid-Number 2)	110 V	110 V
Grid-Number 1 Voltage	0 V (2 seconds max)	-8.5 V
Plate Resistance (Approximate)	—	13,000 Ohms
Transconductance	—	7,000 Micromhos
Plate Current	120 mA	40 mA
Screen Current	17 mA	3.3 mA
Grid-Number 1 Cutoff Voltage (Ib = 0.5 mA)	—	-22 V (Approximate)

Analysis of Operating Point A

Operating Point A demonstrates the high zero-bias current capability of the 12R5, which is critical for driving the deflection coils during the peak of the vertical scan. At a plate voltage of only 45 V and a screen voltage of 110 V, the plate current reaches 120 mA with the control grid at 0 V.

However, this operating point is highly stressful to the tube. The calculated instantaneous plate dissipation is:

- $P_p = 45\text{ V} * 0.120\text{ A} = 5.4\text{ Watts}$

This exceeds the maximum continuous plate dissipation rating of 4.5 Watts. Similarly, the instantaneous screen dissipation is:

- $P_{g2} = 110 \text{ V} * 0.017 \text{ A} = 1.87 \text{ Watts}$

This exceeds the maximum continuous screen dissipation rating of 1.0 Watt. Consequently, this zero-bias condition must only be applied for a short interval (a maximum of 2 seconds) to prevent permanent thermal damage to the tube structure.

Interelectrode Capacitances

The direct interelectrode capacitances of the 12R5, measured without an external shield, are as follows:

- **Grid-Number 1 to Plate:** 0.55 uuf
- **Input (Grid-Number 1 to Cathode, Heater, Grid-Number 2, and Beam Plates):** 13 uuf
- **Output (Plate to Cathode, Heater, Grid-Number 2, and Beam Plates):** 9.0 uuf

Maximum Ratings and Circuit Design Constraints

The maximum ratings for the 12R5 are specified under the Design-Center system for vertical-deflection amplifier service, with the exception of the peak pulse plate voltage, which is an Absolute Maximum rating.

Rating Parameter	Value	Rating System
DC Plate Voltage	150 V	Design-Center
Peak Pulse Plate Voltage	1500 V	Absolute Maximum
Screen Voltage (Grid-Number 2)	150 V	Design-Center
Peak Negative Grid-Number 1 Voltage	150 V	Design-Center
Plate Dissipation	4.5 W	Design-Center
Screen Dissipation	1.0 W	Design-Center
DC Cathode Current	45 mA	Design-Center
Peak Cathode Current	155 mA	Design-Center
Max Grid-Number 1 Circuit Resistance (Cathode Bias)	2.2 Megohms	Design-Center

Heater-to-Cathode Voltage Ratings

The insulation between the heater and the cathode is rated to withstand significant potential differences, which is crucial in series-string television receivers where the cathode potential may float relative to the heater supply:

- **Heater Positive with Respect to Cathode:**
 - DC Component: 100 V
 - Total DC and Peak: 200 V
- **Heater Negative with Respect to Cathode:**
 - Total DC and Peak: 300 V

Application-Specific Constraints

1. **Vertical Deflection Service:** The ratings are specified for operation in a standard 525-line, 30-frame television system. The duty cycle of the peak voltage pulse must not exceed 15% of one scanning cycle.
2. **Absolute Maximum Peak Pulse Plate Voltage:** The 1500 V limit is an Absolute Maximum. The combined effects of line voltage variations, component manufacturing tolerances, and user adjustments of equipment controls must never cause the actual peak pulse voltage to exceed this value.
3. **Grid-Leak Bias Protection:** In stages operating with grid-leak bias, an adequate cathode bias resistor or other protective circuitry must be implemented. This ensures that if the excitation signal is lost, the tube is protected from excessive current draw and thermal runaway.

Analysis of Characteristic Curves

The published characteristic curves for the 12R5 provide detailed graphical representations of its behavior across various operating regions.

Average Plate Characteristics

The plate characteristics show the relationship between plate current (I_b), screen current (I_{c2}), and plate voltage (E_b):

- **Varying Grid-Number 1 Voltage (E_{c1}):** At a fixed screen voltage ($E_{c2} = 110$ V), the curves demonstrate the sharp knee characteristic of a beam pentode. Above a plate voltage of approximately 30 to 40 V, the plate current curves flatten out, indicating high plate resistance. As the control grid voltage is made more negative (from 0 V down to -20 V), the plate current decreases in a highly non-linear fashion, typical of remote-cutoff or semi-remote-cutoff behavior, eventually approaching cutoff near -22 V.
- **Varying Screen Voltage (E_{c2}):** At zero grid bias ($E_{c1} = 0$ V), the curves illustrate the strong influence of screen voltage on the total current capacity. As the screen voltage is increased from 60 V to 120 V, the plate current knee shifts upward significantly, demonstrating that the screen grid acts as the primary accelerator controlling the space charge. The screen current (I_{c2}) curves show a typical inverse relationship to plate voltage at very low plate voltages (below the knee), where electrons are intercepted by the screen grid instead of reaching the plate.

Average Transfer Characteristics

The transfer characteristics plot plate current and screen current against Grid-Number 1 voltage (E_{c1}) at a fixed plate voltage ($E_b = 110$ V):

- **Plate Current vs. Grid-Number 1 Voltage:** The curves for screen voltages of 60, 80, 100, 110, and 120 V show that transconductance (the slope of the curve) is highest near zero bias and decreases as the grid is biased more negatively. Higher screen voltages shift the entire transfer curve upward, requiring a more negative grid voltage to achieve cutoff.
- **Screen Current vs. Grid-Number 1 Voltage:** The screen current curves mirror the plate current curves but at a much lower magnitude (typically around 10% or less of the plate current under normal biased conditions). This ratio increases as the control grid approaches zero bias.

Technical Summary

The **12R5** is a specialized miniature beam pentode designed for vertical-deflection amplifier service in television receivers. It features a 12.6 V, 0.6 A heater with an 11-second controlled warm-up characteristic optimized for series-connected heater strings. Housed in a 7-pin miniature T-5 1/2 envelope, it provides high peak current capability (up to 120 mA plate current at 45 V plate and 110 V screen) and high transconductance (7000 Micromhos at its nominal Class A operating point). Designers must adhere to the 4.5 W plate dissipation and 1.0 W screen dissipation limits, implement cathode bias protection when using grid-leak bias, and ensure that peak pulse plate voltages do not exceed the 1500 V absolute maximum limit during the vertical retrace interval.



SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1968 General Electric Co

Published test conditions and operating points. Values on this page are preserved as reported by this source.

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Section 1 · Beam Power

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Typical Plate Voltage	110 V	—
Typical Screen Voltage	110 V	—

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