



ELECTRONIC TUBE REFERENCE

12K5

Voltage - Pentode or Tetrode (under 100V) electronic tube

CONSOLIDATED TECHNICAL DATA

1 SECTION

CONSTRUCTION

TETRODE

Space-charge-grid tetrode power-amplifier driver designed for direct operation from an automotive battery, providing useful low-voltage power gain without a conventional high-voltage plate supply.

GENERAL CHARACTERISTICS

BASE DESIGNATION	—	BASE PINS	7
NOMINAL HEATER	12.6 V / 450 mA	PARALLEL HEATER	— / —
HEATING	Indirect	SERIES OPERATION	Not specified
CATHODE ARRANGEMENT	Separate cathodes	SECTION CONSTRUCTION	Similar

SECTION RATINGS

SECTION 1 Tetrode	
PLATE RESISTANCE	480 Ω
TRANSCONDUCTANCE	0.007 S
MAXIMUM PLATE VOLTAGE	30 V
MAXIMUM SCREEN VOLTAGE	16 V
Space-charge-grid output tetrode.	

12K5 — Space-Charge Tetrode Power Amplifier Driver

The **12K5** is a miniature tetrode designed specifically for space-charge grid operation in low-voltage applications. Its primary intended use is as an audio-frequency (A.F.) power amplifier driver stage in automotive radio receivers. The tube is engineered to operate directly from a nominal 12-volt vehicle battery system, eliminating the need for a high-voltage vibrator power supply (H.T. system) for the plate and grid potentials.

Construction, Physical Specifications, and Pinout

The 12K5 is constructed in a compact T-5 1/2 glass envelope with a 7-pin miniature button base (JEDEC E7-1 outline). It features a coated unipotential cathode and can be mounted in any physical position.

The heater is designed to operate under the wide voltage variations typical of automotive electrical systems. While the nominal heater rating is **12.6 V**, the heater is designed to function over a range of **10.0 V to 15.9 V**. Operating near these extreme limits for extended periods can affect performance and reduce the tube's life expectancy. The heater current is rated between **0.40 A and 0.45 A** (400 mA to 450 mA) depending on the manufacturer, and can run on either AC or DC.

The JEDEC **7FD** (or **7EK**) basing diagram provides the following pin connections, viewed from the bottom of the tube:

Pin	Connection
1	Cathode (K)
2	Grid No. 2 (<u>G2</u>) — Control Grid
3	Heater (H)
4	Heater (H)
5	Grid No. 1 (G1) — Space-Charge Grid
6	Grid No. 1 (G1) — Space-Charge Grid
7	Plate (P) / Anode (a)

Both Pin 5 and Pin 6 are internally connected to the space-charge grid (G1), providing flexibility in circuit layout.

Space-Charge Grid Operation

Unlike conventional tetrodes where the first grid acts as the control grid and the second grid acts as a screen grid, the 12K5 utilizes a **space-charge grid** configuration to achieve high performance at extremely low operating voltages.

In this design, Grid No. 1 (G1) is positioned closest to the cathode and is operated at a positive potential (typically +12.6 V). This positive charge accelerates electrons away from the cathode, effectively neutralizing the space-charge cloud that normally limits current flow in low-voltage tubes. Grid No. 2 (G2) is positioned further out and functions as the control grid, regulating the electron flow to the plate. This arrangement allows the 12K5 to deliver high transconductance and substantial plate current even when the plate voltage is as low as 12.6 V.

Maximum Ratings

The maximum electrical ratings for the 12K5, interpreted according to the Design Center System, are established to ensure reliable operation under automotive supply fluctuations:

Parameter	Rating
Maximum Plate (Anode) Voltage	30 V
Maximum Grid No. 1 (Space-Charge Grid) Supply Voltage	30 V
Maximum Positive Grid No. 1 Voltage (Absolute Maximum)	16 V
Maximum Negative Grid No. 2 (Control Grid) Voltage	-20 V
Maximum Grid No. 2 Circuit Resistance	2.2 M Ω to 10 M Ω
Maximum Heater-Cathode Voltage	± 30 V

Electrical Characteristics and Operating Points

The 12K5 exhibits different electrical characteristics depending on the chosen bias point for the control grid (G2). Two primary Class A1 operating points are documented:

Operating Point A (Low-Bias, High-Transconductance)

At this operating point, the control grid is biased closer to zero volts, maximizing transconductance and plate current:

- **Plate Voltage:** 12.6 V
- **Grid No. 1 (Space-Charge Grid) Voltage:** 12.6 V
- **Grid No. 2 (Control Grid) Voltage:** -0.5 V (representing average contact potential developed across a 2.2 M Ω resistor)
- **Plate Current:** 40 mA
- **Grid No. 1 Current:** 75 mA
- **Plate Resistance:** 480 Ω
- **Amplification Factor (G2 to Plate):** 7.2
- **Transconductance (G2 to Plate):** 15,000 μmhos

Operating Point B (Standard Bias)

At this operating point, a higher negative bias is applied to the control grid, reducing idle current:

- **Plate Voltage:** 12.6 V
- **Grid No. 1 (Space-Charge Grid) Voltage:** 12.6 V

- **Grid No. 2 (Control Grid) Voltage:** -2.0 V
- **Plate Current:** 8.0 mA
- **Grid No. 1 Current:** 75 mA to 85 mA
- **Plate Resistance / Anode Impedance:** 800 Ω
- **Amplification Factor (G2 to Plate):** 5.6
- **Transconductance (G2 to Plate):** 7,000 μmhos (7 mA/V)

Typical Operation in a Driver Stage

When configured as an audio-frequency driver stage, the 12K5 typically utilizes grid-leak bias (grid current rectification) across a high-value resistor to establish its operating point. Typical operating parameters for this service are:

- **Plate Voltage:** 12.6 V
- **Grid No. 1 (Space-Charge Grid) Voltage:** 12.6 V
- **Grid No. 2 Resistor:** 2.2 M Ω
- **Input Coupling Capacitor:** 0.1 μF
- **Signal Source Impedance:** 100 k Ω
- **Optimum Load Resistance:** 800 Ω
- **Peak AF Grid No. 2 Voltage:** 2.5 V
- **Plate Current (Zero Signal):** 35 mA to 40 mA
- **Plate Current (Maximum Signal):** 8.0 mA
- **Grid No. 1 Current:** 75 mA to 85 mA
- **Power Output:** 35 mW to 40 mW
- **Total Harmonic Distortion:** 10% maximum

Under zero-signal conditions, the plate current remains high (around 35 mA to 40 mA) due to the low bias. When a signal is applied, Grid No. 2 rectification increases the negative bias, causing the average plate current to drop to approximately 8.0 mA at maximum signal.

Interelectrode Capacitances

The direct interelectrode capacitances of the 12K5, measured without an external shield, are:

- **Input (G2 to K + H + G1):** 13.0 pF
- **Output (P to K + H + G1):** 1.8 pF
- **Grid to Plate (G2 to P):** 11.0 pF

These capacitances are stable and reflect the physical geometry of the space-charge tetrode structure.

Analysis of Characteristic Curves

The published transfer and plate characteristics of the 12K5 illustrate the unique behavior of space-charge tubes:

- **Average Transfer Characteristics:** Plotting plate current (I_b) against Grid No. 2 voltage shows that at a fixed space-charge grid voltage ($E_{c1}(\text{tubes}/C1) = 12.6 \text{ V}$), plate current rises rapidly as the control grid voltage approaches 0 V. For plate voltages ranging from 10 V to 60 V, the curves demonstrate that the tube remains highly active and capable of delivering tens of milliamperes of current even at very low anode potentials.
- **Average Plate Characteristics:** When Grid No. 2 is held at 0 V, the plate current is plotted against plate voltage for various Grid No. 1 voltages ($E_{c1}(\text{tubes}/C1)$ from 0 V to 16 V). These curves show that plate current is highly dependent on the positive potential applied to the space-charge grid. Conversely, when Grid No. 1 is held at 12.6 V, the plate characteristics for different Grid No. 2 control voltages (0 V to -8 V) show triode-like curves with low plate resistance, confirming the tube's suitability for driving low-impedance loads.

Technical Summary

The **12K5** is a specialized **7-pin miniature space-charge tetrode** designed to operate directly from a **12.6 V** automotive battery supply. By utilizing its first grid (G1) as a positive space-charge grid (typically at **+12.6 V**) and its second grid (G2) as the control grid, the tube overcomes low-voltage limitations to deliver a transconductance of up to **15,000 μmhos** and a plate resistance as low as **480 Ω** .

With a heater designed to withstand the **10.0 V to 15.9 V** fluctuations of automotive service, the 12K5 serves as an efficient, low-voltage audio driver capable of delivering **35 mW to 40 mW** of power into an **800 Ω** load. This unique design allowed mid-20th-century car radios to operate their audio preamplifier and driver stages directly from the vehicle's battery without requiring complex high-voltage power generation.



SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1958 Brimar Radio Valve No 7

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

1958 BRIMAR RADIO VALVE NO 7

Section 1 · Tetrode

CHARACTERISTICS		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Anode Voltage	12.6 V	—
Anode Current	8 mA	—
Space Charge Grid Voltage	12.6 V	—
Space Charge Grid Current	85 mA	—
Control Grid Voltage	-2 V	—



SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1961 Tung Sol

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

1961 TUNG SOL

Section 1 · Tetrode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Heater voltage	12.6 V	Nominal



1966 Tung Sol Electronic Tubes 3 of 4

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

1966 TUNG SOL ELECTRONIC TUBES 3 OF 4
Section 1 · Tetrode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate voltage	12.6 V	ClassA;Automotive
Control-grid voltage	-0.5 V	ClassA;Automotive
Space-charge-grid voltage	12.6 V	ClassA;Automotive
Plate current	40 mA	ClassA;Automotive
Space-charge-grid current	75 mA	ClassA;Automotive
Peak AF control-grid voltage	2.5 V	ClassA;Automotive
Load resistance	800 ohm	ClassA;Automotive
Power output	40 mW	ClassA;Automotive
Total harmonic distortion	10 %	ClassA;Automotive

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate resistance	480 ohm	ClassA;Automotive
Amplification factor	7.2	ClassA;Automotive
Transconductance	15000 uS	ClassA;Automotive

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Input capacitance	13 pF	—
Output capacitance	1.8 pF	—
Control-grid-to-plate capacitance	11 pF	—

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and their source documents.

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