

ELECTRONIC TUBE REFERENCE

12DS7

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

CONSOLIDATED TECHNICAL DATA
3 SECTIONS
CONSTRUCTION
DIODE-DIODE-TETRODE

Hybrid automobile-radio tube combining two detector diodes with a high-perveance space-charge tetrode designed to drive a transistorized audio-output stage directly from 12.6 V.

GENERAL CHARACTERISTICS

BASE DESIGNATION	9JU	BASE PINS	9
NOMINAL HEATER	12.6 V / 400 mA	PARALLEL HEATER	– / –
HEATING	Indirect	SERIES OPERATION	Not specified
CATHODE ARRANGEMENT	Common cathode	SECTION CONSTRUCTION	Dissimilar

SECTION RATINGS

SECTION1 Tetrode	
PLATE RESISTANCE	480 Ω
TRANSCONDUCTANCE	0.015 S
AMPLIFICATION FACTOR	7.2
MAXIMUM PLATE VOLTAGE	16 V
MAXIMUM SCREEN VOLTAGE	16 V
Space-charge grid	

SECTION2 Diode	
No fixed ratings recorded.	
Representative identical-diode row	

No fixed ratings recorded.

Added approved missing physical diode section row.

12DS7 — Duplex-Diode Power Tetrode Vacuum Tube

The **12DS7** is a multiunit miniature vacuum tube containing two independent diodes and a high-perveance, space-charge-grid power tetrode in a single envelope. It is specifically designed for use in "hybrid" automobile receivers where both tube and transistor electrode voltages are obtained directly from a standard 12-volt vehicle storage battery. In these receiver circuits, the two diode units perform AM signal detection and automatic volume control (AVC), while the tetrode unit serves as the low-voltage driver for a transistorized audio-frequency (AF) power output stage.

By utilizing space-charge-grid operation, the tetrode unit achieves high perveance, enabling it to supply substantial plate and space-charge-grid currents with a plate supply of only 12.6 volts. This design delivers high input power to the subsequent transistor stage at low distortion, overcoming the voltage limitations of automotive electrical systems without requiring a high-voltage vibrator power supply.

Construction, Heater, and Mechanical Specifications

The 12DS7 features a coated unipotential cathode structure. The heater is designed to operate directly from a nominal 12-volt automotive battery system, with a nominal rating of **12.6 V** and a current draw of **0.4 A** (AC or DC).

The calculated nominal heater power consumption is: $\text{Heater Power} = 12.6 \text{ V} \times 0.4 \text{ A} = 5.04 \text{ W}$ This calculation is based on the nominal heater voltage and current specifications.

Because automotive battery voltages fluctuate during charging and discharging cycles, the heater is designed to withstand a wide operating range. The absolute allowable heater voltage range is **10.0 to 15.9 V**. For maximum tube life and reliability, it is recommended to operate the heater within a narrower range of **11.0 to 14.0 V**. Continuous operation near the absolute limits results in a compromise: low heater voltage degrades electrical performance, while high heater voltage reduces life expectancy.

The tube is housed in a T-6 1/2 glass envelope with a small-button noval 9-pin base (JETEC No. E9-1). It can be mounted in any physical position.

Physical Parameter	Value
Envelope Type	T-6 1/2 Glass
Base Type	Small-Button Noval 9-Pin (E9-1)
Basing Designation	JEDEC 9JU
Maximum Overall Length	2-5/8 inches (2.625")

Physical Parameter	Value
Maximum Seated Length	2-3/8 inches (2.375")
Length, Base Seat to Bulb Top (excluding tip)	2" $\pm$ 3/32"
Minimum Diameter	0.750 inches
Maximum Diameter	0.875 inches
Mounting Position	Any

Pinout and Terminal Connections

The 12DS7 uses the **9JU** basing arrangement. Under this configuration, the two diode plates and the tetrode electrodes are mapped to the nine pins as follows (viewed from the bottom of the base):

- **Pin 1:** Plate of Diode Unit No. 2
- **Pin 2:** No Connection (NC)
- **Pin 3:** Tetrode Grid No. 1 (Space-Charge Grid)
- **Pin 4:** Heater
- **Pin 5:** Heater
- **Pin 6:** Tetrode Plate
- **Pin 7:** Tetrode Grid No. 2 (Control Grid)
- **Pin 8:** Cathode
- **Pin 9:** Plate of Diode Unit No. 1

Interelectrode Capacitances

The direct interelectrode capacitances of the 12DS7, measured without an external shield, are detailed below. Minor variations exist between published manufacturer specifications:

Capacitance Parameter	Value Range
Tetrode Unit:	
Grid No. 2 to Plate	12.5 to 13 pF
Grid No. 2 to Grid No. 1, Heater, and Cathode (Input)	13 pF
Plate to Grid No. 1, Heater, and Cathode (Output)	2.0 to 2.4 pF
Diode Units:	
Diode Plate No. 1 to Diode Cathode and Heater	0.5 pF
Diode Plate No. 2 to Diode Cathode and Heater	0.5 pF

Capacitance Parameter	Value Range
Diode Plate No. 1 to Diode Plate No. 2	0.1 pF
Inter-unit Coupling:	
Tetrode Grid No. 2 to Diode Plate No. 1	0.15 to 0.3 pF (max)
Tetrode Grid No. 2 to Diode Plate No. 2	0.15 to 0.3 pF (max)

Electrical Characteristics and Space-Charge-Grid Operation

In standard tetrode operation, Grid No. 1 acts as the control grid and Grid No. 2 acts as the screen grid. However, the 12DS7 is designed specifically for **space-charge-grid operation**. In this mode, Grid No. 1 (the space-charge grid) is connected to a positive potential (typically the 12.6 V supply), while Grid No. 2 serves as the control grid.

The positive potential on Grid No. 1 accelerates electrons away from the cathode, forming a dense "virtual cathode" space-charge cloud between Grid No. 1 and Grid No. 2. This virtual cathode has a much larger effective surface area and is positioned closer to the control grid (Grid No. 2) than the physical cathode. Consequently, the control grid can modulate a very high plate current even when the plate voltage is extremely low (12.6 V). This configuration yields an exceptionally high transconductance and low plate resistance.

The typical Class A1 characteristics of the tetrode unit at a nominal 12.6 V operating point are as follows:

Parameter	Value (RCA / GE)	Value (Tung-Sol)
Plate Voltage	12.6 V	12.6 V
Grid No. 1 (Space-Charge-Grid) Voltage	12.6 V	12.6 V
Grid No. 2 (Control-Grid) Voltage	-0.5 V*	-0.5 V*
Plate Resistance (Approx.)	480 Ω	500 Ω
Amplification Factor (Grid No. 2 to Plate)	7.2	8
Transconductance (Grid No. 2 to Plate)	15,000 μmhos	16,000 μmhos
Plate Current	40 mA	35 mA
Grid No. 1 Current	75 mA	75 mA

**Developed across a 2.2-megohm resistor.*

For the diode units, the typical characteristic is:

- **Diode Plate Current (each unit):** 3.0 mA with 10 V DC applied.

Typical Operating Conditions and Circuit Applications

The 12DS7 is primarily applied as an audio driver stage. Two primary circuit configurations are documented for typical operation, depending on how the control grid (Grid No. 2) bias is established.

Configuration A: Cathode-Resistor Bias

In this configuration, the control grid (Grid No. 2) is returned to ground through a high-value resistor, and bias is developed across a small cathode resistor. The plate is supplied through a low-resistance, high-inductance choke (typically 100 Henrys with a DC resistance of 150 Ω) to maximize AC load impedance while minimizing DC voltage drop.

Parameter	RCA / GE Specification	Tung-Sol Specification
Plate Supply Voltage	12.6 V	11.2 V
Grid No. 1 Supply Voltage	12.6 V	11.2 V
Grid No. 2 Supply Voltage	0 V	0 V
Grid No. 2 Resistor	1.8 M Ω	1.8 M Ω
Cathode Resistor	18 Ω	18 Ω
Peak AF Grid No. 2 Supply Voltage	2.85 V	4.25 V
Signal Source Resistance	3.3 M Ω	3.3 M Ω
Zero-Signal Plate Current (Approx.)	23 mA	20 mA
Maximum/Indicated-Signal Plate Current	13 mA	7 mA
Grid No. 1 Current	77 mA	58 mA
Load Resistance	1250 Ω	1250 Ω
Total Harmonic Distortion	8%	5%
Max. Signal Power Output	10 mW	8 mW

Configuration B: Grid-Resistor Bias (Rectification Bias)

In this configuration, the cathode is grounded directly, and the control grid (Grid No. 2) bias is obtained by rectification of the input signal through a 2.2-megohm grid resistor.

Parameter	RCA Specification	Tung-Sol Specification
Plate Voltage	12.6 V	12.6 V
Grid No. 1 Voltage	12.6 V	12.6 V
Grid No. 2 Voltage (Obtained by rectification)	-2.0 V	-1.6 V
Peak AF Grid No. 2 Voltage (Approx.)	2.5 V	2.5 V
Signal Source Resistance	0.1 MΩ	0.22 MΩ
Zero-Signal Plate Current (Approx.)	40 mA	35 mA
Maximum Signal Plate Current	8 mA	15 mA
Grid No. 1 Current	75 mA	80 mA
Load Resistance	800 Ω	700 Ω
Total Harmonic Distortion	10%	10%
Max. Signal Power Output	40 mW	35 mW
Maximum Grid No. 2 Circuit Resistance	10 MΩ	10 MΩ

Maximum Ratings and Rating Systems

The maximum ratings of the 12DS7 must be interpreted according to the specific rating systems defined by the manufacturers.

Most ratings are established under the **Design-Center Rating System**. Design-center ratings are limiting values of operating and environmental conditions applicable to a "bogey" (average) tube. The equipment manufacturer must design the circuit so that these values are not exceeded under normal conditions with a bogey tube operating at the nominal supply voltage. The tube manufacturer assumes responsibility for normal variations in supply voltage, component tolerances, and tube characteristics.

In contrast, the maximum rating for Grid No. 1 (Space-Charge Grid) voltage is established under the **Absolute-Maximum Rating System**. Absolute-maximum ratings are strict limiting values that must not be exceeded under the worst probable operating conditions with any individual tube. The equipment designer must account for all variations in supply voltage, components, and environment to ensure this limit is never breached.

Parameter	Rating	Rating System
Tetrode Unit:		

Parameter	Rating	Rating System
Plate Voltage	16 max. V	Design-Center
Negative Control-Grid (Grid No. 2) Voltage	16 max. V	Design-Center
Space-Charge-Grid (Grid No. 1) Voltage	16 max. V	Absolute-Maximum
Peak Heater-Cathode Voltage (Heater Negative)	16 max. V	Design-Center
Peak Heater-Cathode Voltage (Heater Positive)	16 max. V	Design-Center
Control-Grid (Grid No. 2) Circuit Resistance	10 max. MΩ	Design-Center
Diode Units (Each):		
Continuous Diode Plate Current	5.0 max. mA	Design-Center
Peak Heater-Cathode Voltage (Heater Negative)	16 max. V	Design-Center
Peak Heater-Cathode Voltage (Heater Positive)	16 max. V	Design-Center

Characteristic Curves and Qualitative Interpretation

The average plate and transfer characteristics apply to the tetrode unit of the 12DS7 (and its variant [12DS7A](#)).

The average plate characteristics show that with Grid No. 1 (space-charge grid) held at 12.6 V, the plate current is highly sensitive to small changes in Grid No. 2 (control grid) voltage. For instance, at a plate voltage of 12.6 V, varying the control grid voltage from 0 V to -4.5 V sweeps the plate current from over 75 mA down to near zero.

The transfer characteristics demonstrate that transconductance peaks near the zero-bias region and falls off as the control grid is biased more negatively, while the space-charge-grid current remains relatively stable around 75 to 80 mA across the normal control-grid operating range. This behavior confirms that the virtual cathode formed by the space-charge grid provides a stable source of electrons, allowing the control grid to modulate the plate current with high efficiency and linearity at low voltages.

Technical Summary

The **12DS7** is a specialized **9-pin miniature duplex-diode space-charge-grid power tetrode** designed for low-voltage automotive applications. By operating Grid No. 1 as a positive space-charge grid at **12.6**

V, the tetrode unit overcomes the space-charge limitations of low-voltage operation, achieving an exceptionally high transconductance of **15,000 to 16,000 μmhos** and a low plate resistance of **480 to 500 Ω** at a plate voltage of only **12.6 V**.

The tube integrates AM signal detection, AVC rectification, and a high-current transistor driver stage into a single compact T-6 1/2 envelope. This integration allowed mid-20th-century automotive radio designers to eliminate high-voltage power supplies, driving transistorized power output stages directly from the vehicle's 12-volt battery.



SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1940 RCA

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

1940 RCA

Section 1 · Tetrode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Power Output	0.09 W	12.6 V hybrid automobile receiver



SOURCE OPERATING CONDITIONS

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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
Service	Audio driver for transistorized output stage	—
AutomotiveSupplyVoltage	12.6 V	—



SOURCE OPERATING CONDITIONS

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1966 Tung Sol Electronic Tubes 2 of 4

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

1966 TUNG SOL ELECTRONIC TUBES 2 OF 4

Section 1 · Tetrode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate voltage	12.6 V	ClassA1;AudioDriver
Control-grid bias across 2.2 Mohm resistor	-0.5 V	ClassA1;AudioDriver
Space-charge-grid voltage	12.6 V	ClassA1;AudioDriver
Plate current	35 mA	ClassA1;AudioDriver
Maximum control-grid negative bias magnitude	16 V	TetrodeSection
Maximum space-charge-grid voltage	16 V	TetrodeSection

1966 TUNG SOL ELECTRONIC TUBES 2 OF 4

Section 2 · Diode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Maximum plate current each diode	5 mA	EachDiode

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Diode plate-to-cathode-and-heater capacitance	0.5 pF	EachDiode

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