

ELECTRONIC TUBE REFERENCE

12FR8

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

CONSOLIDATED TECHNICAL DATA

3 SECTIONS

CONSTRUCTION

DIODE-PENTODE-TRIODE

Pentode-triode-diode for automobile receivers, providing IF amplification, audio-frequency amplification, and second-detector service directly from a 12-volt battery.

GENERAL CHARACTERISTICS

BASE DESIGNATION	9KU	BASE PINS	9
NOMINAL HEATER	12.6 V / 320 mA	PARALLEL HEATER	– / –
HEATING	Indirect	SERIES OPERATION	Not specified
CATHODE ARRANGEMENT	Common cathode	SECTION CONSTRUCTION	Dissimilar

9KU - TERMINAL PINOUT

TERMINAL	SECTION	ELEMENT	STATUS
PIN1	B	G1 – Control Grid	CONNECTED
PIN2	B	K – Cathode	CONNECTED
PIN2	C	K – Cathode	CONNECTED
PIN3	A	G1 – Control Grid	CONNECTED
PIN4	–	H – Heater	CONNECTED
PIN5	A	G3 – Suppressor Grid	CONNECTED
PIN5	A	K – Cathode	CONNECTED
PIN5	–	H – Heater	CONNECTED
PIN5	–	IS – Internal Screen	CONNECTED
PIN6	A	G2 – Screen Grid	CONNECTED
PIN7	A	P – Plate (Anode)	CONNECTED
PIN8	C	P – Plate (Anode)	CONNECTED
PIN9	B	P – Plate (Anode)	CONNECTED

SECTION RATINGS

SECTION1 Pentode	
PLATE RESISTANCE	400000 Ω
TRANSCONDUCTANCE	0.0027 S
MAXIMUM PLATE VOLTAGE	16 V
MAXIMUM SCREEN VOLTAGE	16 V
<i>Pentode IF-amplifier section; published ratings/characteristics promoted where applicable.</i>	

SECTION2 Triode	
TRANSCONDUCTANCE	0.0012 S
AMPLIFICATION FACTOR	10
MAXIMUM PLATE VOLTAGE	16 V
<i>Triode AF-amplifier section; published ratings/characteristics promoted where applicable.</i>	

SECTION3 Diode	
<i>No fixed ratings recorded.</i>	
<i>Detector diode section; published ratings/characteristics promoted where applicable.</i>	

12FR8 — Diode-Triode-Pentode Miniature Vacuum Tube

The **12FR8** is a multi-unit miniature vacuum tube containing a diode, a triode, and a pentode within a single glass envelope. It is specifically designed for service in automobile receivers as a combined intermediate-frequency (IF) amplifier, detector (second detector), and audio-frequency (AF) voltage amplifier. The primary design feature of the 12FR8 is its ability to operate with its heater, plate, and screen grid potentials obtained directly from a nominal 12-volt automotive storage battery, eliminating the need for a high-voltage vibrator power supply.

Construction, Heater, and Pinout

The 12FR8 is constructed in a T-6 1/2 glass bulb with a small button 9-pin base (E9-1). It features coated unipotential cathodes and can be mounted in any position.

The heater is designed to withstand the wide voltage variations typical of automotive electrical systems. While the nominal heater rating is **12.6 V** at **0.32 A** (for either AC or DC supply), the heater is engineered to operate over a range of **10.0 to 15.9 V**. Operating near the extreme limits of this range is acceptable

for short periods, though prolonged operation at the lower limit reduces performance, and operation at the upper limit reduces the tube's life expectancy.

The 9-pin base configuration (EIA 9KU) provides the following terminal connections:

Pin	Connection
Pin 1	Triode Grid
Pin 2	Triode and Diode Cathode
Pin 3	Pentode Grid Number 1
Pin 4	Heater
Pin 5	Heater, Pentode Cathode, Pentode Grid Number 3 (Suppressor), and Internal Shield
Pin 6	Pentode Grid Number 2 (Screen Grid)
Pin 7	Pentode Plate
Pin 8	Diode Plate
Pin 9	Triode Plate

This pinout reveals that the triode and diode sections share a common cathode connected to Pin 2. The pentode section has an independent cathode connected to Pin 5, which is internally tied to one side of the heater, the pentode's suppressor grid (Grid Number 3), and the internal shield.

Direct Interelectrode Capacitances

The direct interelectrode capacitances of the 12FR8, measured without an external shield, are detailed below. These values illustrate the degree of isolation between the three active sections and are critical for stable high-frequency and audio operation.

Pentode Section Capacitances

- **Grid-Number 1 to Plate (maximum):** 0.015 μF
- **Input (Grid-Number 1 to Heater, Pentode Cathode, Screen Grid, Suppressor Grid, and Internal Shield):** 8.5 μF
- **Output (Plate to Heater, Pentode Cathode, Screen Grid, Suppressor Grid, and Internal Shield):** 5.5 μF

Triode Section Capacitances

- **Grid to Plate:** 1.7 μF
- **Input (Grid to Triode Cathode, Heater, Pentode Cathode, Suppressor Grid, and Internal Shield):** 2.6 μF

- **Output (Plate to Triode Cathode, Heater, Pentode Cathode, Suppressor Grid, and Internal Shield):** 2.0 μF

Inter-Section Coupling Capacitances

- **Pentode Grid-Number 1 to Triode Grid (maximum):** 0.012 μF
- **Pentode Grid-Number 1 to Diode Plate (maximum):** 0.004 μF
- **Triode Grid to Diode Plate (maximum):** 0.17 μF
- **Triode Plate to Diode Plate:** 0.8 μF

Maximum Ratings

The maximum ratings for the 12FR8 are established under the Design-Center System. Because the tube is designed to run directly from an automotive battery, its maximum voltage ratings are exceptionally low compared to conventional vacuum tubes.

Rating	Pentode Section	Triode Section	Diode Section
Plate Voltage	16 V	16 V	—
Screen Voltage (Grid #2)	16 V	—	—
Screen Supply Voltage (Grid #2 Supply)	16 V	—	—
Heater-Cathode Voltage (Heater Positive)	16 V	16 V	—
Heater-Cathode Voltage (Heater Negative)	16 V	16 V	—
Grid-Number 1 Circuit Resistance	10 M Ω	10 M Ω	—
Continuous Diode Plate Current	—	—	5.0 mA

These design-center limits represent the maximum values that should not be exceeded under normal operating conditions in a bogey tube, taking into account typical battery voltage fluctuations (from 10.0 to 15.9 V) and component tolerances.

Typical Operating Conditions and Characteristics

Under typical operating conditions, the 12FR8 runs with a nominal supply voltage of **12.6 V** applied to the heaters, plates, and screen grid. The control grids of both the pentode and triode sections develop

bias via contact potential across high-value grid resistors.

Parameter	Pentode Section	Triode Section	Diode Section
Heater Voltage	12.6 V	12.6 V	—
Heater Current	0.32 A	0.32 A	—
Plate Voltage	12.6 V	12.6 V	10 V (DC applied)
Screen Voltage (Grid #2)	12.6 V	—	—
Grid #1 Voltage	-0.8 V*	-0.6 V*	—
Plate Current	1.9 mA	1.0 mA	2.0 mA (average)
Screen Current	0.7 mA	—	—
Transconductance	2700 μmhos	1200 μmhos	—
Plate Resistance (approximate)	0.40 M Ω	—	—
Amplification Factor	—	10	—

Note: The typical Grid #1 voltages of -0.8 V for the pentode and -0.6 V for the triode represent the average contact potential developed across a 2.2-megohm grid resistor.

Cutoff Characteristics

- **Pentode Section:** The grid-number 1 voltage required to reduce transconductance to **30 μmhos** is **-2.8 V**.
- **Triode Section:** The grid voltage required to reduce the plate current to **10 μA** is **-3.5 V**.

Characteristic Curves and Interpretation

The performance of the 12FR8 at low operating voltages is illustrated by its characteristic curves.

Pentode Section Curves

The plate characteristics of the pentode section show plate current plotted against plate voltage for various grid-number 1 voltages at a constant heater voltage of 12.6 V.

- At a plate voltage of 12.6 V and zero grid bias (0 V), the plate current reaches approximately 5.5 mA.
- As the grid-number 1 bias is increased negatively, the plate current drops significantly: to approximately 3.0 mA at -0.5 V, 1.0 mA at -1.0 V, and near 0.3 mA at -1.5 V.
- The curves demonstrate typical pentode behavior, where the plate current flattens out (saturates) above a plate voltage of approximately 10 V, indicating high plate resistance (approximately 0.40 M Ω).

Triode Section Curves

The triode section curves display plate current against plate voltage for grid bias values ranging from 0 V to -3.5 V.

- At a plate voltage of 12.6 V and zero grid bias (0 V), the triode plate current is approximately 2.1 mA.
- With a grid bias of -0.5 V, the plate current is approximately 1.1 mA.
- Increasing the negative bias further reduces the current: to 0.5 mA at -1.0 V, and 0.2 mA at -1.5 V.
- The triode section approaches complete cutoff (10 μ A) at a grid bias of -3.5 V across the typical plate voltage range up to 20 V.

Technical Summary

The **12FR8** is a specialized **9-pin miniature diode-triode-pentode** designed for low-voltage automotive receiver applications. By combining an IF amplifier (pentode), a detector (diode), and an AF amplifier (triode) into a single envelope, it enables compact receiver designs that operate directly from a **12.6 V** automotive battery. The tube features a robust heater designed to withstand supply variations from **10.0 to 15.9 V**, a maximum plate and screen rating of **16 V**, and typical transconductances of **2700 μ mhos** (pentode) and **1200 μ mhos** (triode).



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 · Pentode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Heater voltage	12.6 V	—
Heater current	320 mA	—

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Input capacitance	8.5 pF	—

1961 TUNG SOL

Section 2 · Triode

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Grid-to-plate capacitance	1.7 pF	—

1961 TUNG SOL

Section 3 · Diode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Maximum plate current	5 mA	Diode



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.

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Section 1 · Pentode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
SECOND DETECTOR	1 s	Published datasheet
HEATER VOLTAGEA	12.6 V	Maximum ratings; published column 1
MAXIMUM PLATE VOLTAGE	16 V	Maximum ratings; published column 1
MAXIMUM GRIDS #2	8 V	Maximum ratings; published column 1
MAXIMUM GRIDS #2	16 V	Maximum ratings; published column 2
MAXIMUM GRIDS #2 k #4 SU PPLY VOLTAGE	16 V	Maximum ratings
MAXIMUM PENTODE GRID CIRCUIT RESISTANCE	10000000 ohm	Maximum ratings
HEATER VOLTAGE	12.6 V	Typical operating conditions; published column 1
HEATER CURRENT	320 mA	Typical operating conditions; published column 1
PLATE VOLTAGE	12.6 V	Typical operating conditions; published column 1
PLATE VOLTAGE	10 V	Typical operating conditions; published column 3
GRID #2 VOLTAGE	12 V	Typical operating conditions
GRID #1 VOLTAGE	0 V	Typical operating conditions; published column 1
GRID #1 VOLTAGE	-0.6 V	Typical operating conditions; published column 2
PLATE CURRENT Z	9 mA	Typical operating conditions; published column 1
PLATE CURRENT Z	1 mA	Typical operating conditions; published column 2
PLATE CURRENT Z	0 mA	Typical operating conditions; published column 3
PLATE CURRENT Z	2 mA	Typical operating conditions; published column 4

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
TRANSCONDUCTANCE	2700 μ S	Typical operating conditions; published column 1
TRANSCONDUCTANCE	1200 μ S	Typical operating conditions; published column 2
PLATE RESISTANCE (AP PROX. J	4000000 ohm	Typical operating conditions; published column 1
PLATE RESISTANCE (AP PROX. J	0 ohm	Typical operating conditions; published column 2
TRANSCONDUCTANCE =	30 V	Typical operating conditions
GRID VOLTAGE FOR PLATE CURRENT	0 V	Typical operating conditions; published column 1
GRID VOLTAGE FOR PLATE CURRENT	10 V	Typical operating conditions; published column 2
GRID VOLTAGE FOR PLATE CURRENT	-3 V	Typical operating conditions; published column 3
C AVERAGE BI AS	0 ohm	Typical operating conditions; published column 1
C AVERAGE BI AS	2200000 ohm	Typical operating conditions; published column 2
E ₋ =	12.6 V	Typical operating conditions
E _f =	12.6 V	Typical operating conditions
Maximum plate voltage	16 V	Published datasheet; promoted section value
Maximum screen voltage	16 V	Published datasheet; promoted section value

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
PENTODE GRID #1 TO PLATE (MAX.)	15 pF	Interelectrode capacitances
PENTODE	0 pF	Interelectrode capacitances; published column 1
PENTODE	5.5 pF	Interelectrode capacitances; published column 2

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate resistance	400000 ohm	Published datasheet; promoted section value
Transconductance	0.0027 A/V	Published datasheet; promoted section value

Section 2 · Triode

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
TRIODE	1 pF	Interelectrode capacitances; published column 1
TRIODE	2.6 pF	Interelectrode capacitances; published column 2
TRIODE	0 pF	Interelectrode capacitances; published column 1
TRIODE	2 pF	Interelectrode capacitances; published column 2
COUPLING, PENTODE GRID #1 TO TRIODE GRID (MAX.)	12 pF	Interelectrode capacitances

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
MAXIMUM TRIODE GRID CIRCUIT RESISTANCE	10000000 ohm	Maximum ratings
Maximum plate voltage	16 V	Published datasheet; promoted section value

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Transconductance	0.0012 A/V	Published datasheet; promoted section value
Amplification factor	10	Published datasheet; promoted section value

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Section 3 · Diode

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
COUPLING, PENTODE GRID #1 TO DIODE PLATE (MAX.)	4 pF	Interelectrode capacitances
COUPLING, TRIODE GRID TO DIODE PLATE (MAX.) •	17 mA	Interelectrode capacitances
COUPLING, TRIODE PLATE TO DIODE PLATE	8 pF	Interelectrode capacitances

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Typical diode plate voltage	10 V	Diode detector section

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