



ELECTRONIC TUBE REFERENCE

12AF6

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

CONSOLIDATED TECHNICAL DATA

1 SECTION

CONSTRUCTION

PENTODE

Remote-cutoff miniature pentode for automobile-radio RF/IF amplification, designed for direct plate and screen operation from a 12 V storage battery.

GENERAL CHARACTERISTICS

BASE DESIGNATION	7BK	BASE PINS	7
NOMINAL HEATER	12.6 V / 150 mA	PARALLEL HEATER	– / –
HEATING	Indirect	SERIES OPERATION	Not specified
CATHODE ARRANGEMENT	Separate cathodes	SECTION CONSTRUCTION	Similar

7BK - TERMINAL PINOUT

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

SECTION RATINGS

SECTION1 Pentode	
PLATE RESISTANCE	350000 Ω
TRANSCONDUCTANCE	0.0015 S
MAXIMUM PLATE VOLTAGE	16 V
MAXIMUM SCREEN VOLTAGE	16 V
12-V automobile RF/IF service.	

12AF6 — Remote Cutoff Pentode Vacuum Tube

A miniature, indirectly heated pentode designed for radio-frequency and intermediate-frequency amplifier applications in mobile and automotive receivers operating directly from a 12-volt battery system.

Overview

The **12AF6** is a miniature glass-envelope pentode, classified as a remote cutoff pentode. It is specifically engineered for use as a radio-frequency (RF) or intermediate-frequency (IF) amplifier in automobile radio receivers. The primary design feature of the 12AF6 is its ability to operate with both plate and screen (grid number 2) voltages supplied directly from a nominal 12-volt storage battery, eliminating the need for a high-voltage vibrator power supply or step-up DC-DC converter for these stages.

The tube features a coated unipotential cathode and a heater rated for nominal **12.6 V** operation. It is housed in a standard T-5 1/2 glass envelope with a 7-pin miniature button base, utilizing the **7BK** basing arrangement.

Mechanical Specifications and Pin Connection

The 12AF6 is designed for compact physical layouts and can be mounted in **any position**. Its physical dimensions conform to the following limits:

- **Maximum Diameter:** 0.750 inches (3/4")
- **Maximum Seated Height:** 1.875 inches (1 7/8")
- **Maximum Overall Height:** 2.125 inches (2 1/8")
- **Envelope:** T-5 1/2 Glass
- **Base:** E7-1, Miniature Button 7-Pin

The terminal connections, viewed from the bottom of the tube base (basing diagram 7BK), are allocated as follows:

Pin	Connection
Pin 1	Grid Number 1 (Control Grid)

Pin	Connection
Pin 2	Internal Shield and Grid Number 3 (Suppressor Grid)
Pin 3	Heater
Pin 4	Heater
Pin 5	Plate
Pin 6	Grid Number 2 (Screen Grid)
Pin 7	Cathode

The internal shield is tied directly to Grid Number 3 (suppressor) and brought out to Pin 2, which helps minimize internal feedback and capacitive coupling in high-frequency amplifier stages.

Heater Characteristics and Automotive Voltage Tolerances

The heater of the 12AF6 is designed to operate on either AC or DC power. Because the tube is intended for direct automotive service, the heater is designed to withstand the voltage fluctuations typical of vehicle electrical systems.

Heater Parameter	Value
Nominal Heater Voltage	12.6 V
Nominal Heater Current	0.15 A (150 mA)
Heating Method	Indirect
Cathode Type	Coated unipotential

Automotive Service Voltage Limits

When operated from a 12-volt vehicle storage battery, the heater voltage is subject to wide variations depending on the state of charge and generator/alternator output. The absolute limits for heater operation are:

- **Minimum Heater Voltage:** 10.0 V
- **Maximum Heater Voltage:** 15.9 V

Under no circumstances should the heater voltage fall outside this range. While these extreme variations can be tolerated for short periods, operating the tube near these limits has distinct consequences:

- **Low-voltage operation (near 10.0 V):** Results in a sacrifice in electrical performance due to reduced cathode emission.

- **High-voltage operation (near 15.9 V):** Significantly reduces the life expectancy of the heater and cathode.
- Improving the supply-voltage regulation in the equipment significantly increases overall tube and equipment reliability.

Maximum Ratings

The maximum ratings for the 12AF6 are established under the Design-Maximum Rating System (or Design Center System). These values represent the limiting operating conditions for a bogie tube, ensuring satisfactory life and performance.

Parameter	Design-Maximum Value
Maximum Plate Voltage	16 V
Maximum Screen (Grid No. 2) Voltage	16 V
Maximum Positive DC Grid No. 1 Voltage	0 V
Maximum Heater-Cathode Voltage (Heater Positive)	16 V
Maximum Heater-Cathode Voltage (Heater Negative)	16 V
Maximum Grid No. 1 Circuit Resistance	2.2 MΩ

The low maximum plate and screen voltage ratings (16 V) reflect the tube's optimization for direct 12-volt battery operation, and these limits must not be exceeded under the worst probable operating conditions, including supply-voltage variations, component tolerances, and environmental changes.

Electrical Characteristics and Typical Class A1 Operation

The 12AF6 operates as a Class A1 amplifier with plate and screen voltages set to the nominal battery potential of 12.6 V. Depending on the manufacturer, typical characteristics vary slightly, reflecting normal production spreads and design targets.

Typical Operating Conditions

Parameter	Value (Tung-Sol / Sylvania)	Value (General Electric)
Heater Voltage	12.6 V	12.6 V
Plate Voltage	12.6 V	12.6 V
Grid No. 3 (Suppressor) Voltage	0 V	0 V

Parameter	Value (Tung-Sol / Sylvania)	Value (General Electric)
Grid No. 2 (Screen) Voltage	12.6 V	12.6 V
Grid No. 1 Supply Voltage	0 V	0 V
Grid No. 1 Resistor (Bypassed)	2.2 MΩ	2.2 MΩ
Plate Resistance (Approx.)	0.35 MΩ	0.3 MΩ
Transconductance	1500 μmhos	1150 μmhos
Plate Current	1.1 mA	0.75 mA
Screen Current	0.45 mA	0.35 mA
Grid No. 1 Voltage for $G_m = 40$ μmhos (Approx.)	-2.7 V	-2.7 V
Grid No. 1 Voltage for $G_m = 10$ μmhos (Approx.)*	-3.5 V	—

Calculated Total Cathode Current

The total cathode current (I_k) is the sum of the plate current (I_b) and the screen current (I_{c2}).

- **Calculation (Tung-Sol / Sylvania data):** $I_k = I_b + I_{c2} = 1.1 \text{ mA} + 0.45 \text{ mA} = 1.55 \text{ mA}$
- **Calculation (General Electric data):** $I_k = I_b + I_{c2} = 0.75 \text{ mA} + 0.35 \text{ mA} = 1.10 \text{ mA}$

Direct Interelectrode Capacitances

The capacitances of the 12AF6 are specified without an external shield. These values are critical for determining input loading and stability in RF and IF stages:

- **Grid No. 1 to Plate (Maximum):** 0.006 μμF (pF)
- **Input (Grid No. 1 to all other electrodes except Plate):** 5.5 μμF (pF)
- **Output (Plate to all other electrodes except Grid No. 1):** 4.8 μμF (pF)

The extremely low grid-to-plate capacitance (0.006 pF max) is achieved through the internal shielding structure, which minimizes feedback and allows high stable gain in RF and IF amplifier circuits without neutralization.

Analysis of Characteristic Curves

The published characteristic curves for the 12AF6 illustrate its performance under low-voltage conditions.

Average Plate Characteristics

The plate characteristics plot plate current (I_b) and screen current (I_{c2}) against plate voltage (E_b) for various control grid bias voltages (E_{cc1}) ranging from 0 V to -2.8 V.

- **Pentode Knee:** The plate current rises sharply as plate voltage increases from 0 V to approximately 4 V. Above 4 V, the curves flatten out significantly, demonstrating the high dynamic plate resistance characteristic of a pentode.
- **Screen Current Behavior:** Screen current is highest at low plate voltages (where the plate is less effective at attracting electrons) and decreases to a stable, lower value once the plate voltage exceeds approximately 5 V.
- **Bias Control:** Incremental changes in Grid No. 1 voltage produce smooth, predictable decreases in plate current, confirming the remote cutoff characteristic.

Average Transfer Characteristics

The transfer characteristics plot plate current, screen current, and transconductance (G_m) against Grid No. 1 supply voltage from -2.8 V to 0 V.

- At 0 V bias, transconductance reaches its peak value of 1150 to 1500 μmhos .
- As the control grid is biased more negatively, the transconductance decreases gradually rather than cutting off sharply. This remote cutoff characteristic is essential for automatic volume control (AVC) or automatic gain control (AGC) circuits, allowing the receiver to handle a wide range of signal strengths without introducing severe cross-modulation or audio distortion.

Technical Summary

The **12AF6** is a **miniature, 7-pin remote cutoff pentode** designed specifically for low-voltage operation in automotive RF and IF amplifier stages. By operating directly from a **12.6 V** storage battery, it eliminates the need for high-voltage power supplies in car radios. The tube features a **12.6 V, 150 mA** heater capable of tolerating the typical **10.0 V to 15.9 V** automotive voltage range.

With a maximum plate and screen rating of **16 V**, the 12AF6 typically operates at **12.6 V** on both elements, delivering a transconductance of **1150 to 1500 μmhos** and a plate resistance of **0.3 to 0.35 M Ω** . Its low grid-to-plate capacitance of **0.006 pF** ensures stable, high-gain amplification in high-frequency receiver circuits.



SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

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 · Pentode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate voltage	12.6 V	ClassA1;RFIF
Screen voltage	12.6 V	ClassA1;RFIF
Suppressor voltage	0 V	ClassA1;RFIF
Grid 1 supply voltage	0 V	ClassA1;RFIF
Grid 1 resistor	2.2 Mohm	ClassA1;RFIF
Plate current	2.1 mA	ClassA1;RFIF
Screen current	0.65 mA	ClassA1;RFIF

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Grid 1 voltage at 90 μ S transconductance	-2.7 V	ClassA1;RFIF
Grid 1 cutoff test voltage	-3.5 V	ClassA1;RFIF



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.

1968 GENERAL ELECTRIC CO

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate Voltage	16 V	DesignMaximum
Screen Voltage	16 V	DesignMaximum
Plate Voltage	12.6 V	ClassA
Screen Voltage	12.6 V	ClassA
Plate Resistance	300000 ohm	ClassA
Transconductance	1150 uS	ClassA
Plate Current	0.75 mA	ClassA
Screen Current	0.35 mA	ClassA

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