

ELECTRONIC TUBE REFERENCE

12FX5

Power - Pentode Single (NOT beam) (under 10W) electronic tube

CONSOLIDATED TECHNICAL DATA

1 SECTION
CONSTRUCTION
PENTODE

Miniature beam-power pentode designed for audio-amplifier output stages, emphasizing high power sensitivity for record players and other low-voltage consumer equipment.

GENERAL CHARACTERISTICS

BASE DESIGNATION	7CV	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

7CV - TERMINAL PINOUT

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

SECTION RATINGS

SECTION1 Pentode	
PLATE RESISTANCE	17000 Ω
TRANSCONDUCTANCE	0.0135 S
MAXIMUM PLATE VOLTAGE	150 V
MAXIMUM SCREEN VOLTAGE	130 V
MAXIMUM PLATE DISSIPATION	5.5 W
MAXIMUM SCREEN DISSIPATION	2 W
MAXIMUM CATHODE CURRENT	50 mA
Audio-output beam pentode.	

12FX5 — High-Sensitivity Beam Power Pentode

Overview

The **12FX5** is a miniature seven-pin vacuum tube designed primarily for service in the audio output stages of electronic equipment, such as record players and television receivers. Classified as both a power pentode and a beam power pentode, its defining technical feature is its exceptionally high power sensitivity, which allows it to deliver substantial audio power output with a very low grid-drive voltage.

The tube is engineered to operate efficiently at relatively low plate and screen-grid voltages, making it highly effective in compact or cost-sensitive designs. It is particularly well-suited for series-connected heater strings, where its controlled warm-up characteristic helps minimize voltage surges across other tubes in the circuit. The 12FX5 shares identical electrical characteristics and ratings with the [19FX5](#) and [60FX5](#), differing only in its heater voltage and current requirements.

Construction, Mechanical Design, and Basing

The 12FX5 is constructed with a coated unipotential cathode and is housed in a T-5 1/2 glass bulb. It utilizes a standard seven-pin miniature button base (JEDEC E7-1) and conforms to the JEDEC 5-3 outline. The tube is robustly designed and can be mounted and operated in any physical position.

Physical Dimensions

- **Maximum overall length:** 2.625 inches (approximately 66.7 mm)
- **Maximum seated height:** 2.375 inches (approximately 60.3 mm)
- **Maximum bulb diameter:** 0.750 inches (approximately 19.1 mm)

Pinout and Basing Diagram (JEDEC 7CV)

The JEDEC 7CV basing arrangement provides the following connections, viewed from the bottom of the tube:

Pin	Connection	Description
1	K, G3	Cathode and Grid No. 3 (Suppressor Grid / Beam Plates)
2	G1	Grid No. 1 (Control Grid)
3	H	Heater
4	H	Heater
5	G1	Grid No. 1 (Control Grid - internal tie)
6	<u>G2</u>	Grid No. 2 (Screen Grid)
7	P	Plate (Anode)

The control grid (Grid No. 1) is internally connected to both Pin 2 and Pin 5, which provides flexibility in circuit layout and helps with heat dissipation or RF decoupling.

Heater Characteristics and Series-String Operation

The 12FX5 is specifically designed for series-string heater applications, particularly in television receivers where the picture-tube heater and other tube heaters are connected in series. In such configurations, tubes with uncontrolled warm-up times can experience severe voltage surges. The 12FX5 incorporates a controlled heater warm-up characteristic to ensure that the heater resistance rises at a rate that minimizes these transient surges across individual tubes in the string.

Heater Specifications and Ratings

Parameter	12FX5	<u>19FX5</u>	<u>60FX5</u>
Nominal Heater Voltage (AC or DC)	12.6 V	18.9 V	60 V
Permissible Heater Voltage Range	12.6 ± 1.3 V	—	$60 \pm 10\%$ V
Nominal Heater Current	0.450 A	0.3 A	0.10 A
Permissible Heater Current Range	0.450 ± 0.030 A (or $\pm 6\%$)	—	—
Average Heater Warm-up Time	11 seconds	11 seconds	—

Heater Warm-up Time Calculation and Definition

The 11-second heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value (10.08 V for the 12FX5) after applying four times the rated heater voltage (50.4 V) to a test circuit. This test circuit consists of the tube heater connected in series with a resistance equal to three times the rated heater voltage divided by the rated heater current.

As a calculation, using the nominal values for the 12FX5:

$$\text{Series Resistance} = 3 \times \frac{12.6 \text{ V}}{0.450 \text{ A}} = 84 \Omega$$

Heater-Cathode Voltage Limits

To prevent insulation breakdown between the heater and the cathode, strict voltage limits must be maintained:

- **Heater Negative with Respect to Cathode:** Maximum total DC and peak voltage of **200 V**.
- **Heater Positive with Respect to Cathode:** Maximum DC component of **100 V**, with a maximum total DC and peak voltage of **200 V**.

Electrical Characteristics and Class A1 Operation

The 12FX5 is optimized for Class A1 audio amplification. At its typical operating point, it exhibits high transconductance and moderate plate resistance, allowing it to be driven to full output by a very small input signal.

Typical Operating Conditions and Performance

Parameter	Value
Plate Supply Voltage	110 V
Grid No. 2 (Screen Grid) Supply Voltage	115 V
Cathode Bias Resistor	62 Ω
Peak AF Grid No. 1 Voltage	3 V
Zero-Signal Plate Current	36 mA
Maximum-Signal Plate Current	35 mA
Zero-Signal Grid No. 2 Current	10 mA
Maximum-Signal Grid No. 2 Current	12 mA
Plate Resistance (Approximate)	17,500 Ω
Transconductance	13,500 μmhos

Parameter	Value
Load Resistance	3,000 Ω
Maximum-Signal Power Output	1.3 W
Total Harmonic Distortion (THD)	8%

The extremely high transconductance of 13,500 μmhos at a plate voltage of 110 V is the key factor behind the tube's high power sensitivity. A peak audio drive voltage of only 3 V is required to achieve the full 1.3 W of power output.

Maximum Ratings and Circuit Design Constraints

The maximum ratings of the 12FX5 are established under the Design-Maximum System. Operating the tube beyond these limits can significantly shorten its operating life or cause immediate failure.

Design-Maximum Ratings

- **Plate Voltage:** 150 V max.
- **Grid No. 2 (Screen-Grid) Voltage:** 130 V max.
- **Positive DC Grid No. 1 Voltage:** 0 V max.
- **Plate Dissipation:** 5.5 W max.
- **Grid No. 2 Dissipation:** 2 W max.
- **Bulb Temperature (at hottest point):** 225 °C max.

Grid No. 1 Circuit Resistance Limits

To prevent thermal runaway caused by grid emission, the resistance in the control-grid circuit must not exceed the following values:

- **For Fixed-Bias Operation:** 0.1 M Ω max.
- **For Cathode-Bias (Self-Bias) Operation:** 0.5 M Ω max.

Thermal and Shielding Considerations

Operating the tube near its maximum dissipation limits in high ambient temperatures or within a tight shield can cause the bulb temperature to exceed the 225 °C limit. If a tube shield is required, it is recommended to paint both the inner and outer surfaces of the shield a dull black and to provide ventilation slots to facilitate heat dissipation.

Interelectrode Capacitances

The direct interelectrode capacitances of the 12FX5, measured without an external shield, are approximately:

- **Grid No. 1 to Plate (C_{g1-p}):** 0.6 to 0.65 pF

- **Input (C_{in}):** 17 pF — Grid No. 1 to Cathode, Heater, Grid No. 2, and Grid No. 3
- **Output (C_{out}):** 9 pF — Plate to Cathode, Heater, Grid No. 2, and Grid No. 3

The relatively low grid-to-plate capacitance minimizes Miller effect feedback, while the high input capacitance is typical of high-transconductance power pentodes.

Characteristic Curves and Interpretation

The plate characteristic curves for the 12FX5 (plotted at a constant Grid No. 2 voltage of 115 V) illustrate its high power sensitivity:

- At a control grid bias ($E_{c1}(/tubes/C1)$) of 0 V, the plate current (I_b) rises extremely rapidly at very low plate voltages, reaching approximately 70 to 80 mA at a plate voltage of only 25 V.
- The curves for grid bias steps from 0 V down to -6 V show that the plate current is highly responsive to small changes in grid voltage. At the typical operating bias of approximately -3 V (developed across the 62 Ω cathode resistor), the plate current is centered around 36 mA.
- The screen-grid current (I_{c2}) remains relatively low and stable across the normal operating range of plate voltages, typically staying near 10 mA under zero-signal conditions and rising slightly to 12 mA under maximum-signal conditions.

Related Designations and Variants

The 12FX5 is part of a family of identical power pentodes designed for different heater supply systems:

- **12FX5:** Designed for 12.6 V, 0.45 A series-string or parallel heater circuits.
- **19FX5:** Designed for 18.9 V, 0.3 A series-string heater circuits.
- **60FX5:** Designed for 60 V, 0.1 A series-string heater circuits.

These three types are identical in their internal structure, mechanical dimensions, basing, and electrical characteristics, except for their heater ratings. They cannot be directly substituted for one another without modifying the heater supply circuit.

Technical Summary

The **12FX5** is a high-sensitivity, miniature seven-pin beam power pentode designed for Class A1 audio output service. Operating at a moderate plate voltage of 110 V and screen voltage of 115 V, it delivers **1.3 W** of audio power with only **3 V** of peak grid drive, thanks to its high transconductance of **13,500 μmhos** . Featuring a controlled heater warm-up time of **11 seconds** at **12.6 V / 0.45 A**, it is optimized for series-string television and radio receivers. Its design-maximum ratings include a maximum plate voltage of **150 V**, plate dissipation of **5.5 W**, and screen dissipation of **2 W**, requiring careful thermal management and grid circuit resistance limits to ensure reliable operation.



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	450 mA	—
Maximum signal power output	1.3 W	ClassA

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Input capacitance	17 pF	—
Output capacitance	9 pF	—



SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1965 Westinghouse Data Book

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

1965 WESTINGHOUSE DATA BOOK

Section 1 · Pentode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Typical plate voltage	110 V	ClassA
Typical screen voltage	115 V	ClassA
Cathode bias resistor	62 ohm	ClassA
Peak AF grid1 signal	3 V	ClassA
Zero-signal plate current	36 mA	ClassA

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Maximum-signal plate current	35 mA	ClassA
Zero-signal screen current	10 mA	ClassA
Maximum-signal screen current	12 mA	ClassA
Power output	1.3 W	ClassA

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Grid1-to-plate capacitance	0.65 pF	—
Input capacitance	17 pF	—
Output capacitance	9 pF	—

APPLICATION		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Application	High-sensitivity audio output amplifier	—


SOURCE DATA APPENDIX

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

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
GRID TO PLATE: G1 TO P	0.6 pF	Interelectrode capacitances
AVERAGE CHARACTERISTICS	12.5 V	Interelectrode capacitances; published column 1
AVERAGE CHARACTERISTICS	450 V	Interelectrode capacitances; published column 2
HEATER WARM-UP TIME	11 s	Interelectrode capacitances
TOTAL DC AND PEAK	200 V	Interelectrode capacitances
DC COMPONENT	100 V	Interelectrode capacitances

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
PLATE VOLTAGE	150 V	Maximum ratings
GRID k2 VOLTAGE	130 V	Maximum ratings
POSITIVE DC GRID X] VOLTAGE	0 V	Maximum ratings
PLATE DISSIPATION	5.5 W	Maximum ratings
GRID	112 W	Maximum ratings; published column 1
GRID	2 W	Maximum ratings; published column 2
FIXED BIAS	100000 ohm	Maximum ratings
CATHODE BIAS	500000 ohm	Maximum ratings
PLATE VOLTAGE	110 V	Maximum ratings
GRID	2 V	Maximum ratings; published column 1
GRID	115 V	Maximum ratings; published column 2
CATHODE BIAS RESISTOR	62 ohm	Maximum ratings; published column 1
CATHODE BIAS RESISTOR	0 ohm	Maximum ratings; published column 2
PLATE CURRENT	36 mA	Maximum ratings
GRID	2 mA	Maximum ratings; published column 1
GRID	10 mA	Maximum ratings; published column 2
PLATE RESISTANCE - APPROX	17500 ohm	Maximum ratings; published column 1
PLATE RESISTANCE - APPROX	0 ohm	Maximum ratings; published column 2
PLATE VOLTAGE	1 V	Typical operating conditions; published column 1
PLATE VOLTAGE	10 V	Typical operating conditions; published column 2
GRID q2 VOLTAGE	115 V	Typical operating conditions
CATHODE BIAS RESISTOR - BY PASSED	62 ohm	Typical operating conditions; published column 1
CATHODE BIAS RESISTOR - BY PASSED	0 ohm	Typical operating conditions; published column 2
PEAK AF GRID A1 VOLTAGE	3 V	Typical operating conditions
MAXIMUM SIGNAL PLATE CURRENT	35 mA	Typical operating conditions
MAXIMUM SIGNAL GRID N2 CURRENT	12 mA	Typical operating conditions
TOTAL HARMONIC DISTORTION	8 percent	Typical operating conditions

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
MAXIMUM SIGNAL POWER	0 W	Typical operating conditions; published column 1
MAXIMUM SIGNAL POWER	1.3 W	Typical operating conditions; published column 2
Maximum plate voltage	150 V	Published datasheet; promoted section value
Maximum screen voltage	130 V	Published datasheet; promoted section value
Maximum plate dissipation	5.5 W	Published datasheet; promoted section value
Maximum screen dissipation	2 W	Published datasheet; promoted section value

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate resistance	17500 ohm	Published datasheet; promoted section value
Transconductance	0.0135 A/V	Published datasheet; promoted section value



SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1971 RCA HB3 Binder 5 of 7

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

1971 RCA HB3 BINDER 5 OF 7

Section 1 · Pentode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Heater voltage	12.6 V	—
Heater current	450 mA	—
Plate voltage	110 V	ClassA
Screen voltage	115 V	ClassA
Cathode resistor	62 ohm	ClassA
Plate current	36 mA	ClassA
Screen current	10 mA	ClassA
Maximum plate voltage	150 V	—
Maximum screen voltage	130 V	—
Plate dissipation	5.5 W	—

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Screen input	2 W	—
Heater warm-up time	11 s	ControlledWarmup

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate resistance	17500 ohm	ClassA
Transconductance	13500 uS	ClassA

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Grid-to-plate capacitance	0.65 pF	—
Input capacitance	17 pF	—
Output capacitance	9 pF	—



SOURCE DATA APPENDIX

SOURCE OPERATING CONDITIONS

SOURCE PDF

1975 RCA RC30

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

1975 RCA RC30
Section 1 · Pentode

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Heater Voltage (ac/dc) 12.6 18.9	60 V	Published in approved 12FX5 target entry; Section1
Heater Current 0.45 0.3	100 mA	Published in approved 12FX5 target entry; Section1
Heater Warm-up Time (Average) 11	11 seconds	Published in approved 12FX5 target entry; Section1
Plate Voltage	150 V	Published in approved 12FX5 target entry; Section1
Grid-No.2 (Screen-Grid) Voltage	130 V	Published in approved 12FX5 target entry; Section1
Plate Dissipation	5.5 W	Published in approved 12FX5 target entry; Section1

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Grid-No.2 Input	2 W	Published in approved 12FX5 target entry; Section1
Plate Supply Voltage	110 V	Published in approved 12FX5 target entry; Section1
Grid-No.2 Supply Voltage	116 V	Published in approved 12FX5 target entry; Section1
Cathode-Bias Resistor	62 Ω	Published in approved 12FX5 target entry; Section1
Peak AF Grid-No.1 Voltage	3 V	Published in approved 12FX5 target entry; Section1
Zero-Signal Plate Current	36 mA	Published in approved 12FX5 target entry; Section1
Maximum-Signal Plate Current	35 mA	Published in approved 12FX5 target entry; Section1
Transconductance	13600 μS	Published in approved 12FX5 target entry; Section1
Load Resistance	3000 Ω	Published in approved 12FX5 target entry; Section1

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Grid No.1 to Plate	0.65 pF	Published in approved 12FX5 target entry; Section1
Grid No 1 to Cathode. Heater, Grid No.2, and Grid No.3	17 pF	Published in approved 12FX5 target entry; Section1
Plate to Cathode, Heater, Grid No.2, and Grid No.3	9 pF	Published in approved 12FX5 target entry; Section1

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