

ELECTRONIC TUBE REFERENCE

12CU5

Power - Beam (NOT sweep) electronic tube

CONSOLIDATED TECHNICAL DATA

1 SECTION
CONSTRUCTION
BEAMPOWER

Miniature beam-power tube for Class-A audio output service in consumer receivers, designed for substantial current at relatively low plate and screen voltages.

GENERAL CHARACTERISTICS

BASE DESIGNATION	7CV	BASE PINS	7
NOMINAL HEATER	12.6 V / 600 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 Beam Power	
PLATE RESISTANCE	73000 Ω
TRANSCONDUCTANCE	0.0048 S
MAXIMUM PLATE VOLTAGE	315 V
MAXIMUM SCREEN VOLTAGE	117 V
MAXIMUM PLATE DISSIPATION	10 W
MAXIMUM SCREEN DISSIPATION	2.2 W
<i>Published Westinghouse ratings, characteristics, capacitances, pulse/deflection data, and typical operating conditions promoted where applicable; additional values retained as parameters.</i>	

12CU5 — Beam Power Pentode

Overview

The **12CU5** (also designated as **12CU5/12C5**) is a miniature 7-pin beam power pentode designed primarily for use in the audio output stage of television, amplitude-modulated (AM), and frequency-modulated (FM) receivers. It is characterized by high power sensitivity and high plate efficiency at the relatively low plate and screen voltages typically available in power-transformerless (AC/DC) receivers.

A key design feature of the 12CU5 is its controlled heater warm-up characteristic. This makes it highly suitable for series-connected heater strings, particularly in television receivers where the picture-tube heater is wired in series with other receiving tubes. By matching the warm-up rates of all tubes in the series string, the 12CU5 minimizes transient heater voltage surges across individual tubes during the warm-up cycle.

Mechanical Construction and Basing

The 12CU5 is constructed in a miniature glass envelope. Depending on the manufacturer's specification, the bulb is designated as a T-5 1/2 or T-6 1/2 type. It utilizes a small-button miniature 7-pin base (JEDEC E7-1) and conforms to the JEDEC 7CV basing diagram. The tube is designed to operate in any mounting position.

Physical Dimensions

- **Maximum Overall Length:** 2.625 inches
- **Maximum Seated Height:** 2.375 inches
- **Maximum Diameter:** 0.750 to 0.875 inches

Pin Connection Diagram (7CV)

The 7-pin base connections, viewed from the bottom of the tube, are allocated as follows:

- **Pin 1:** Cathode and Grid No. 3 (Beam-Confining Electrodes)
- **Pin 2:** Grid No. 1 (Control Grid)
- **Pin 3:** Heater
- **Pin 4:** Heater
- **Pin 5:** Grid No. 1 (Control Grid)
- **Pin 6:** Grid No. 2 (Screen Grid)
- **Pin 7:** Plate

The internal connection of Grid No. 1 to both Pin 2 and Pin 5 provides flexibility in circuit layout and helps minimize lead inductance.

Heater Characteristics and Controlled Warm-up

The 12CU5 features an indirectly heated, coated unipotential cathode. The heater is designed for operation from either an AC or DC supply.

Heater Specifications

- **Nominal Heater Voltage:** 12.6 $\pm$ 1.3 V
- **Nominal Heater Current:** 0.6 A (600 mA)
- **Calculated Heater Power:** 7.56 W (calculated as 12.6 V * 0.6 A)
- **Average Heater Warm-up Time:** 11 seconds

Controlled Warm-up Measurement

The controlled heater warm-up time is defined by a standardized test. The warm-up time is the period required for the voltage across the heater to reach 80% of its rated value (10.08 V) when four times the rated heater voltage (50.4 V) is applied to a test circuit. This circuit consists of the tube heater connected in series with an external resistance.

The value of this series resistance is calculated as three times the nominal heater operating resistance:

- **Nominal Heater Operating Resistance (Rh):** 12.6 V / 0.6 A = 21 Ohms (calculated)
- **Series Test Resistance (Rs):** 3 * 21 Ohms = 63 Ohms (calculated)

Heater-Cathode Voltage Ratings

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

- **Heater Negative with Respect to Cathode:** 200 V maximum (Total DC + Peak)
- **Heater Positive with Respect to Cathode:**
 - DC Component: 100 V maximum
 - Total DC + Peak: 200 V maximum
 - Average Value: 100 V maximum

Electrical Ratings

The maximum ratings of the 12CU5 are defined under both the Design-Center and Design-Maximum rating systems. These values represent the limits within which the tube can be operated reliably.

Parameter	Design-Center Value	Design-Maximum Value
Plate Voltage	135 V max	150 V max
Grid No. 2 (Screen Grid) Voltage	117 V max	130 V max
Grid No. 1 (Control Grid) Positive-Bias Voltage	—	0 V max
Plate Dissipation	6.0 W max	7.0 W max
Grid No. 2 Dissipation	1.25 W max	1.4 W max
Bulb Temperature (at hottest point)	—	220 °C max

Grid No. 1 Circuit Resistance Limits

To prevent thermal runaway caused by grid emission, the maximum resistance in the control-grid circuit is restricted based on the biasing method:

- **For Fixed-Bias Operation:** 0.1 Megohm maximum
- **For Cathode-Bias Operation:** 0.5 Megohm maximum

High ambient temperatures or the use of close-fitting tube shields may require a reduction in operating dissipation. If a shield is used, it is recommended to paint both its inner and outer surfaces a dull black and provide ventilation slots to facilitate heat dissipation.

Typical Class A1 Operating Conditions and Characteristics

When operated as a Class A1 audio power amplifier, the 12CU5 delivers high power output with low input signal requirements. Typical operating parameters are detailed below:

Parameter	Typical Value
Plate Voltage	120 V
Grid No. 2 Voltage	110 V
Grid No. 1 Voltage	-8.0 V
Peak AF Grid No. 1 Voltage	8.0 V

Parameter	Typical Value
Zero-Signal Plate Current	49 mA
Maximum-Signal Plate Current	50 mA
Zero-Signal Grid No. 2 Current	4.0 mA
Maximum-Signal Grid No. 2 Current	8.5 mA
Plate Resistance (Approximate)	10,000 Ohms
Transconductance	7,500 μ mhos
Load Resistance	2,500 Ohms
Total Harmonic Distortion	10%
Maximum-Signal Power Output	2.3 W

Direct Interelectrode Capacitances (Unshielded)

- **Grid No. 1 to Plate:** 0.6 pF
- **Grid No. 1 to Cathode, Heater, Grid No. 2, and Grid No. 3:** 13 pF
- **Plate to Cathode, Heater, Grid No. 2, and Grid No. 3:** 8.5 pF

Performance Curves and Operation Analysis

The electrical behavior of the 12CU5 is illustrated by its average plate characteristics and operation curves.

Average Plate Characteristics

The plate current (I_b) versus plate voltage curves demonstrate classic pentode behavior. At low plate voltages, the plate current rises sharply, forming a distinct knee around 30 to 40 Volts, after which the current remains relatively constant across a wide range of plate voltages.

- At a control grid bias (E_{c1}) of 0 V, the plate current peaks near 110 to 120 mA.
- At the typical bias of -8.0 V, the plate current stabilizes at approximately 50 mA.
- The screen grid current (I_{c2}) is inversely related to the plate voltage at low anode potentials; it is highest when the plate voltage is near zero and drops to a steady value of approximately 4 to 8.5 mA as the plate voltage exceeds the knee.

Operation Characteristics with Load Resistance

The relationship between load resistance and performance parameters (Power Output, Total Harmonic Distortion, Plate Current, and Screen Current) is highly non-linear:

- **Power Output:** Under typical operating conditions (Plate Volts = 110, Grid 2 Volts = 110, Grid 1 Volts = -7.5, RMS Signal Volts = 5.3), the power output rises rapidly as the load resistance increases from 1000 Ohms, peaking at approximately 2.1 to 2.3 Watts near the recommended load of 2500 Ohms. Beyond this point, the power output gradually declines.
- **Total Harmonic Distortion:** Distortion exhibits a distinct minimum (around 5% to 10%) near the optimal load resistance of 2500 Ohms. It rises sharply if the load resistance falls below 1500 Ohms or rises above 4000 Ohms.
- **Current Variations:** As the load resistance increases, the maximum-signal plate current decreases, while the screen grid current increases slightly.

Family Relationships and Heater Variants

The 12CU5 belongs to a family of identical beam power pentodes that differ only in their heater ratings. These variants were developed to accommodate different receiver power supply configurations, such as parallel AC heater circuits or various series-string current ratings:

- **6CU5:** Designed for parallel heater circuits, requiring a 6.3 V supply at 1.2 A.
- **12C5 / 12CU5:** Designed for 600 mA series-string or 12.6 V parallel circuits, requiring 12.6 V at 0.6 A.
- **17CU5 / 17C5:** Designed for 450 mA series-string circuits, requiring 16.8 V at 0.45 A.
- **25C5:** Designed for 300 mA series-string circuits, requiring 25.0 V at 0.3 A.
- **50C5:** Designed for 150 mA series-string circuits, requiring 50.0 V at 0.15 A.

All of these types share the same internal electrode structure, physical dimensions, basing configuration (7CV), and Class A1 electrical characteristics.

Technical Summary

The **12CU5** is a high-sensitivity, high-efficiency miniature beam power pentode designed for audio output service in television and radio receivers. Operating with a 12.6 V, 0.6 A heater, it features a controlled 11-second warm-up time optimized for series-string applications. With a maximum plate dissipation of 7.0 Watts and a screen dissipation of 1.4 Watts, the tube typically operates at a plate voltage of 120 V and screen voltage of 110 V. Under these conditions, it delivers 2.3 Watts of audio power into a 2500 Ohm load with 10% total harmonic distortion, utilizing a high transconductance of 7500 μ mos.

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 · Beam Power

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Heater voltage	12.6 V	Nominal
Heater current	600 mA	Nominal
Plate voltage	150 V	Typical operating conditions
Screen voltage	110 V	Typical operating conditions
Plate current	49 mA	Typical operating conditions

SOURCE OPERATING CONDITIONS

1965 Sylvania Electronic Tubes Vol3

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

1965 SYLVANIA ELECTRONIC TUBES VOL3

Section 1 · Beam Power

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate voltage	120 V	ClassA
Plate current	49 mA	ClassA

CHARACTERISTICS		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate resistance	10000 Ohm	—
Transconductance	7500 uS	—



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 · Beam Power

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Typical plate voltage	120 V	ClassA
Typical screen voltage	110 V	ClassA
Maximum signal power output	2.3 W	ClassA

CHARACTERISTICS		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate resistance	10000 ohm	—

APPLICATION		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Application	Audio output amplifier	—



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 · Beam Power

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Plate voltage	110 V	ClassA1
Screen voltage	110 V	ClassA1

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Grid 1 voltage	-5 V	ClassA1
Plate current	49 mA	ClassA1
Signal power output	2.3 W	ClassA1

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Heater warm-up time	11 s	WholeTube



SOURCE DATA APPENDIX

SOURCE OPERATING CONDITIONS

1975 RCA RC30

SOURCE PDF

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

1975 RCA RC30

Section 1 · Beam Power

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Heater Voltage (ac/dc) 6.3 12.6	16.8 V	Published in approved 17CU5 target datasheet entry; Section1
Heater Current 1.2 0.6	450 mA	Published in approved 17CU5 target datasheet entry; Section1
Heater Warm-up Time (Average) 11	11 seconds	Published in approved 17CU5 target datasheet entry; Section1
Plate Voltage	150 V	Published in approved 17CU5 target datasheet entry; Section1
Grid-No.2 (Screen-Grid) Voltage	130 V	Published in approved 17CU5 target datasheet entry; Section1
Grid-No.1 (Control-Grid) Voltage, Positive-bias value	0 V	Published in approved 17CU5 target datasheet entry; Section1
Plate Dissipation	7 W	Published in approved 17CU5 target datasheet entry; Section1
Grid-No.2 Input	1.4 W	Published in approved 17CU5 target datasheet entry; Section1
Plate Voltage	120 V	Published in approved 17CU5 target datasheet entry; Section1

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Grid-No.2 Voltage	110 V	Published in approved 17CU5 target datasheet entry; Section1
Grid-No.1 Voltage	-8 V	Published in approved 17CU5 target datasheet entry; Section1
Peak AF Grid-No.1 Voltage	8 V	Published in approved 17CU5 target datasheet entry; Section1
Zero-Signal Plate Current	49 mA	Published in approved 17CU5 target datasheet entry; Section1
Zero-Signal Grid-No.2 Current	4 mA	Published in approved 17CU5 target datasheet entry; Section1
Maximum-Signal Grid-No.2 Current	8.5 mA	Published in approved 17CU5 target datasheet entry; Section1
Plate Resistance (Approx.)	10000 Ω	Published in approved 17CU5 target datasheet entry; Section1
Transconductance	7500 μS	Published in approved 17CU5 target datasheet entry; Section1
Load Resistance	2500 Ω	Published in approved 17CU5 target datasheet entry; Section1
Total Harmonic Distortion	10 %	Published in approved 17CU5 target datasheet entry; Section1
Maximum-Signal Power Output	2.3 W	Published in approved 17CU5 target datasheet entry; Section1
For fixed-bias operation	0.1 MΩ	Published in approved 17CU5 target datasheet entry; Section1
For cathode-bias operation	0.5 MΩ	Published in approved 17CU5 target datasheet entry; Section1
Heater Voltage (ac/dc) 2.1 6.3	13.5 V	Published in approved 17CU5 target datasheet entry; Section1
Heater Current 0.45 0.135	60 mA	Published in approved 17CU5 target datasheet entry; Section1
Plate Voltage	135 V	Published in approved 17CU5 target datasheet entry; Section1
Negative-bias value	55 V	Published in approved 17CU5 target datasheet entry; Section1
Peak positive value	0 V	Published in approved 17CU5 target datasheet entry; Section1
Cathode Current	15 mA	Published in approved 17CU5 target datasheet entry; Section1
Plate Dissipation	1.5 W	Published in approved 17CU5 target datasheet entry; Section1

CAPACITANCE		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Grid No.1 to Plate	0.6 pF	Published in approved 17CU5 target datasheet entry; Section1
Grid No.1 to Cathode, Heater, Grid No.2, and Grid No.3	13 pF	Published in approved 17CU5 target datasheet entry; Section1
Plate to Cathode, Heater, Grid No.2, and Grid No.3	8.5 pF	Published in approved 17CU5 target datasheet entry; Section1
Grid to Plate	0.92 pF	Published in approved 17CU5 target datasheet entry; Section1
Grid to Cathode. Heater, and Shell	4.3 pF	Published in approved 17CU5 target datasheet entry; Section1
Plate to Cathode, Heater, and Shell	1.8 pF	Published in approved 17CU5 target datasheet entry; Section1
Plate to Cathode	0.18 pF	Published in approved 17CU5 target datasheet entry; Section1
Heater to Cathode	1.6 pF	Published in approved 17CU5 target datasheet entry; Section1