



ELECTRONIC TUBE REFERENCE

12Z3

Rectifier - Half Wave electronic tube

CONSOLIDATED TECHNICAL DATA

1 SECTION
CONSTRUCTION
RECTIFIER

Indirectly heated half-wave high-vacuum rectifier designed especially for transformerless universal receivers, providing modest DC output from line-operated power supplies.

GENERAL CHARACTERISTICS

BASE DESIGNATION	4G	BASE PINS	4
NOMINAL HEATER	12.6 V / 300 mA	PARALLEL HEATER	– / –
HEATING	Indirect	SERIES OPERATION	Not specified
CATHODE ARRANGEMENT	Separate cathodes	SECTION CONSTRUCTION	Similar

SECTION RATINGS

SECTION 1 Rectifier	
PEAK INVERSE VOLTAGE	700 V
NOMINAL OUTPUT CURRENT	55 mA
PEAK FORWARD CURRENT	330 mA
FORWARD VOLTAGE DROP	17 V
MAXIMUM HEATER-CATHODE VOLTAGE	350 V
<i>Published promoted fields populated semantically; identical repeated sections compressed.</i>	

12Z3 — Half-Wave High-Vacuum Rectifier

An indirectly heated, single-plate vacuum diode designed for half-wave rectifier service in transformerless AC-DC ("universal") radio receivers.

Overview

The **12Z3** is a high-vacuum half-wave rectifier tube featuring an indirectly heated, unipotential cathode. It is specifically engineered for service in "transformerless" or "universal" AC-DC receivers, where the tube heaters are connected in a series-string configuration directly across the power line.

By utilizing a nominal **12.6 V** heater rating, the 12Z3 reduces the total voltage drop—and consequently the heat dissipation—required across the series dropping resistor in the filament circuit. This design eliminates the need for a heavy, costly mains power transformer, allowing the receiver to operate interchangeably on either alternating or direct current.

Construction, Physical Dimensions, and Basing

The 12Z3 is constructed with a glass envelope designated as an **ST-12** bulb. The ST-12 shape features a characteristic "tee" section at the top, commonly referred to as a dome bulb. Based on standard bulb nomenclature, the "12" indicates a maximum envelope diameter of 12 eighths of an inch. This can be expressed mathematically as:

$$\text{Maximum Bulb Diameter} = \frac{12}{8} = 1.5 \text{ inches}$$

In practice, physical specifications for the envelope define a maximum overall height of **4-1/8 to 4-1/4 inches** (approximately 4.125 to 4.250 inches), a maximum seated height of **3-9/16 inches**, and a maximum outer diameter of **1-3/16 to 1-9/16 inches** (approximately 1.188 to 1.563 inches).

The tube is fitted with a **small 4-pin base** (also referred to as a UX base or S-4 base). The electrical connections are arranged in a **4G** configuration, which provides the following pinout when viewed from the bottom of the socket:

- **Pin 1:** Heater (H)
- **Pin 2:** Plate (P / Anode)
- **Pin 3:** Cathode (K)
- **Pin 4:** Heater (H)

The base pins are designed to fit a standard four-contact socket. The tube may be mounted and operated in **any position**. To prevent overheating and ensure long service life, the installation must provide sufficient ventilation to allow air to circulate freely around the glass bulb.

Heater Characteristics and Series-String Operation

The 12Z3 incorporates a coated, unipotential cathode that is electrically isolated from the heater filament. The nominal heater electrical characteristics are:

- **Heater Voltage (AC or DC):** 12.6 V
- **Heater Current:** 0.3 A
- **Calculated Heater Power:** $\text{Power} = 12.6 \text{ V} \times 0.3 \text{ A} = 3.78 \text{ W}$

The 12.6-volt heater is designed to operate reliably under normal line-voltage variations without materially affecting the tube's performance. When operating the 12Z3 in series with other tubes having a

0.3-ampere rating, the current in the heater circuit must be adjusted to exactly 0.3 A at the normal supply voltage.

Electrical Ratings and Limits

The maximum electrical ratings of the 12Z3 must be strictly observed to prevent premature failure. Depending on the specific rating system and operating conditions, the maximum limits are defined as follows:

- **Maximum AC Plate Voltage (RMS):** 235 V to 250 V
- **Maximum Peak Inverse Voltage:** 700 V
- **Maximum DC Output Current:** 55 mA to 60 mA
- **Maximum Steady-State Peak Plate Current:** 330 mA
- **Maximum DC Heater-to-Cathode Potential:** 350 V (though some general tables restrict this limit to 100 V under specific series-string conditions)
- **Internal Tube Voltage Drop:** The typical internal voltage drop across the conducting diode is documented as **17 V** at a plate current of 110 mA, or **18 V** at a plate current of 120 mA.

Operating Conditions and Filter Requirements

The 12Z3 is typically operated as a half-wave rectifier with a condenser-input filter to obtain the highest possible DC output voltage. Under these conditions, the minimum required plate supply impedance depends on the applied AC plate voltage to limit peak inrush currents:

- **At 117 V RMS input:** Maximum DC output current is 55 mA, with a minimum effective plate supply impedance of **0 ohms**.
- **At 150 V RMS input:** Maximum DC output current is 55 mA, with a minimum effective plate supply impedance of **30 ohms**.
- **At 235 V RMS input:** Maximum DC output current is 55 mA, with a minimum effective plate supply impedance of **75 ohms**.

To maximize the rectified DC output voltage, a large input filter capacitance is recommended, with a value in the order of **16 μ F** being highly desirable. However, when using filter condensers larger than **40 μ F**, the peak charging currents increase significantly. In such cases, it may be necessary to add additional series impedance in the plate supply circuit to protect the tube from exceeding its maximum peak current rating.

Rectification Curves and Output Characteristics

The average output characteristics of the 12Z3 illustrate the relationship between the rectified DC output voltage and the DC load current (ranging from 0 to 75 mA) for various input filter capacitances (typically 2 μ F, 4 μ F, 8 μ F, and 16 μ F):

- **With an AC input of 115 V / 117 V RMS:** The DC output voltage ranges from approximately 150 V at light loads down to 100 V at a 60 mA load when using a 16 μ F input condenser. Smaller

capacitances (such as 4 μF) result in a more pronounced voltage drop, falling below 80 V at higher current loads.

- **With an AC input of 230 V / 250 V RMS:** The DC output voltage is significantly higher, starting near 320 V at light loads and maintaining approximately 240 V to 280 V at a 60 mA load, depending on whether an 8 μF or 16 μF condenser is employed.
- **Direct Current (DC) Line Operation:** When the receiver is operated directly from a 117 V DC power line, the 12Z3 acts as a passive series element rather than an active rectifier. Under DC operation, the output voltage is lower than under AC operation with a condenser-input filter, as shown by the characteristic dashed line on the output curves, which starts around 115 V and drops linearly to about 90 V at a 60 mA load.

The average plate characteristic curve shows that the diode begins conducting at 0 V plate potential and exhibits a non-linear increase in plate current as plate voltage rises. At a DC plate potential of 20 V, the plate current reaches approximately 130 mA, and it rises to approximately 180 mA at 25 V.

Technical Summary

The **12Z3** is an **ST-12 glass, small 4-pin (UX) base, half-wave high-vacuum rectifier** featuring an indirectly heated unipotential cathode. With its **12.6 V, 0.3 A heater**, it is optimized for transformerless AC-DC series-string applications. It supports a maximum peak inverse voltage of **700 V**, a maximum steady-state peak plate current of **330 mA**, and a maximum DC output current of **55 mA to 60 mA**. When configured with a recommended condenser-input filter (typically 16 μF), it provides efficient half-wave rectification for universal receivers, with an average internal tube voltage drop of **17 V to 18 V** under typical load conditions.



SOURCE OPERATING CONDITIONS

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1937 Raytheon Radio Receiving Tubes

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

1937 RAYTHEON RADIO RECEIVING TUBES

Section 1 · Rectifier

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Maximum AC plate voltage RMS	250 V	HalfWave; CapacitorInputFilterOrChokeInputFilter
Maximum inverse peak voltage	700 V	HalfWave
Maximum DC output current	60 mA	HalfWave
Maximum heater-cathode DC voltage	350 V	—

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Average tube voltage drop	18 V	AtOutputCurrent=120mA



SOURCE OPERATING CONDITIONS

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1940 RCA

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

1940 RCA

Section 1 · Rectifier

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
AC Input Voltage	250 V RMS	HalfWave



SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1948 Brimar Radio Valve Manual

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

1948 BRIMAR RADIO VALVE MANUAL

Section 1 · Rectifier

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
RMS Input	235 V	Maximum
Supply Impedance	75 ohm	Minimum



SOURCE OPERATING CONDITIONS

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1950 Sylvania

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

1950 SYLVANIA

Section 1 · Rectifier

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Peak Inverse Voltage	700 V	—
Nominal DC Output Current	55 mA	—
Maximum Heater-Cathode Voltage	350 V	—
AC Plate Voltage	117 V	CapacitorInputFilter
DC Output Current	55 mA	CapacitorInputFilter
AC Plate Voltage	235 V	CapacitorInputFilter

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Forward Voltage Drop	17 V	—

SOURCE OPERATING CONDITIONS

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195X General Electric Essential Characteristics

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

195X GENERAL ELECTRIC ESSENTIAL CHARACTERISTICS

Section 1 · Rectifier

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Heater voltage	12.6 V	Published heater rating
Heater current	300 mA	Published heater rating
Tube voltage drop	17 V	At 110 mA DC

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
DC output current	55 mA	RectifierService
Peak inverse voltage	700 V	RectifierService
RMS supply voltage	235 V	RectifierService
Peak current	330 mA	RectifierService

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 · Rectifier

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Peak Inverse Voltage	700 V	—

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
DC Output Current	55 mA	—

TUBE TINKER

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and their source documents.

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