

ELECTRONIC TUBE REFERENCE

0C3W

Voltage Regulator electronic tube

CONSOLIDATED TECHNICAL DATA

1 SECTION

CONSTRUCTION

VOLTAGEREGULATOR

Ruggedized cold-cathode inert-gas voltage regulator maintaining approximately 108 V over roughly 5-40 mA.

GENERAL CHARACTERISTICS

BASE DESIGNATION	4AJ	BASE PINS	8
NOMINAL HEATER	– / –	PARALLEL HEATER	– / –
HEATING	Indirect; cold cathode	SERIES OPERATION	Not specified
CATHODE ARRANGEMENT	Separate cathodes	SECTION CONSTRUCTION	Similar

4AJ - TERMINAL PINOUT

TERMINAL	SECTION	ELEMENT	STATUS
PIN2 – K	A	K – Cathode	CONNECTED
PIN5 – P	A	P – Plate (Anode)	CONNECTED

SECTION RATINGS

SECTION1 Voltage Regulator	
REGULATOR VOLTAGE	105 V
MINIMUM REGULATOR CURRENT	5 mA
MAXIMUM REGULATOR CURRENT	40 mA
STARTING VOLTAGE	133 V
MAINTAINING VOLTAGE	105 V
Published handbook ratings and operating characteristics reviewed.	

0C3W — Ruggedized Cold-Cathode Voltage Regulator

A cold-cathode, gas-filled diode designed for highly stable voltage regulation under severe environmental conditions, featuring a cushioned envelope and integrated safety jumper connections.

Overview

The **0C3W** (also designated as **0C3W** or **0C3-W**) is a ruggedized, cold-cathode, inert gas-filled diode designed to provide stable voltage regulation in demanding industrial and military applications. Operating on the glow-discharge principle, the tube maintains a substantially constant operating voltage of approximately 108 V over a wide current range of 5 to 40 mA.

Unlike standard voltage regulators such as the [0C3/VR-105](#), the 0C3W is specifically engineered to withstand extreme mechanical shock and vibration. To achieve this, the glass envelope is floated within the base shell using a specialized sponge rubber filler. This cushioning dampens external vibrations and minimizes the transmission of mechanical shock to the active electrodes. Combined with heavy-duty internal parts construction, the 0C3W is exceptionally well-suited for applications subjected to severe mechanical punishment.

Mechanical Design and Construction

The 0C3W is housed in a T-9 glass bulb with a specialized base designed for low electrical loss and high mechanical durability.

Physical Dimensions

- **Maximum Overall Height:** 4 1/8 inches (4.13 inches)
- **Maximum Seated Height:** 3 9/16 inches (3.403 inches)
- **Maximum Diameter:** 1 9/16 inches (1.57 inches)
- **Base Diameter:** 1.156 inches (maximum)
- **Skirt Diameter:** 1.32 inches (maximum)
- **Weight:** Approximately 2 ounces

Base and Pin Configuration

The tube features a special skirted, small shell octal 6-pin base constructed from low-loss phenolic material. It can be mounted in any physical position. The pin connections, viewed from the bottom of the base, are arranged as follows:

Pin Number	Connection	Function
Pin 1	NC	No Connection
Pin 2	K	Cathode

Pin Number	Connection	Function
Pin 3	J	Internal Jumper
Pin 5	P	Anode (Plate)
Pin 7	J	Internal Jumper
Pin 8	NC	No Connection

Note: Pins 4 and 6 are omitted from this 6-pin octal configuration.

The Safety Jumper Feature

Pins 3 and 7 are connected internally via a robust jumper wire. This design serves as an electrical interlock for system safety. By wiring the unregulated input voltage or the load return path through these pins, the circuit is automatically broken if the tube is removed from its socket. This prevents high, unregulated voltage from reaching sensitive downstream components when the regulator is absent.

Electrical Characteristics and Ratings

The 0C3W operates as a shunt regulator, maintaining a stable voltage across its terminals once ionization occurs. The electrical parameters and absolute maximum ratings are detailed below.

Absolute Maximum and Minimum Ratings

These limits represent absolute values that must not be exceeded under any operating conditions:

- **Maximum Average Starting Current:** 100 mA DC (restricted to a starting period not exceeding 10 seconds; normal operation must continue for at least 20 minutes at rated current after passing this starting current to allow the tube to stabilize)
- **Maximum Continuous Cathode Current:** 40 mA DC
- **Minimum Continuous Cathode Current:** 5 mA DC
- **Maximum Inverse Voltage:** -50 VDC
- **Ambient Temperature Range:** -55°C to +70°C
- **Maximum Operating Altitude:** 10,000 feet
- **Maximum Shock Impact:** 900 G / msec
- **Maximum Vibration Rating:** 10 G (at 50 CPS with a displacement of 0.08 inches)

Equipment Design and Range Values

For circuit design, the following typical, minimum, and maximum values are established:

- **Anode Supply Voltage (Darkness):** 210 VDC minimum (required to guarantee starting/ionization throughout the operating life of the tube)
- **Anode Supply Voltage (Light):** 133 VDC minimum
- **Anode Breakdown Voltage:** 123 VDC typical, 133 VDC maximum

- **Tube Voltage Drop (at 40 mA):** 108.5 VDC typical, 114 VDC maximum
- **Tube Voltage Drop (at 30 mA):** 113 VDC maximum
- **Tube Voltage Drop (at 5 mA):** 103 VDC minimum, 107.8 VDC typical
- **Regulation (5 to 40 mA):** 0.7 VDC typical, 4.0 VDC maximum
- **Maximum Noise Output:** 15 mVAC
- **Maximum Leakage Current (at $E_b = 50$ VDC, $R_p = 100$ k Ω):** 10 μ A
- **Maximum Current through Interconnected Leads:** 2.0 Amperes

Reliability and Environmental Testing

To ensure high reliability in military and rugged industrial environments, production samples of the 0C3W are subjected to rigorous standardized testing protocols:

- **High-Impact Shock:** Tested using a Navy Flyweight High Impact Machine at a 60° hammer angle, delivering a shock impact of 900 G/msec.
- **Vibration:** Subjected to a swept frequency of 10-50-10 CPS with a total displacement of 0.08 inches in each of three mutually perpendicular planes, reaching a peak acceleration of 10 G.
- **Fatigue Vibration:** Operated at 25 CPS with a total displacement of 0.08 inches for 32 hours in each of three mutually perpendicular planes under a 2.5 G load.
- **Life Testing:** Evaluated over a 500-hour operational period at a continuous DC cathode current of 30 mA.

Post-Test Limits

Following shock, fatigue, and life testing, the tube must still conform to strict performance limits:

- **Maximum Ionization Voltage:** 133 VDC
- **Tube Voltage Drop Range:** 103 to 113 VDC
- **Regulation (5 to 40 mA):** 4.0 VDC maximum
- **Regulation (5 to 30 mA):** 2.5 VDC maximum

Application and Circuit Design

Series Resistor Calculations

A glow-discharge regulator tube must always be operated with a series current-limiting resistor (R_1) to prevent thermal runaway and keep the operating current within the rated 5 to 40 mA range.

To calculate the boundaries of the series resistor, the designer must consider the maximum and minimum limits of the unregulated supply voltage (V_1), the load current (I_L), and the tube's voltage drop (V_2).

1. **Minimum Resistance Limit ($R_{1 \min}$):** To prevent the tube current from exceeding the maximum rating of 40 mA ($I_{T \max}$) when the supply voltage is at its maximum ($V_1 \max$), the load current is at its minimum ($I_L \min$), and the tube voltage drop is at its minimum ($V_2 \min$): $R_1 > \frac{V_1 \max - V_2 \min}{I_{T \max} - I_L \min}$

2. **Maximum Resistance Limit ($R_{1 \text{ max}}$):** To ensure the tube current does not drop below the minimum maintaining current of 5 mA ($I_{T \text{ min}}$) when the supply voltage is at its minimum ($V_{1 \text{ min}}$), the load current is at its maximum ($I_{L \text{ max}}$), and the tube voltage drop is at its maximum ($V_{2 \text{ max}}$): $R_1 < \frac{V_{1 \text{ min}} - V_{2 \text{ max}}}{I_{T \text{ min}} + I_{L \text{ max}}}$
3. **Starting Voltage Verification:** Once R_1 is selected, the designer must verify that the voltage across the tube prior to ionization (when the tube is an open circuit) exceeds the maximum starting voltage (V_{starting}) under minimum supply voltage conditions: $V_{1 \text{ min}} \cdot \frac{R_2}{R_1 + R_2} > V_{\text{starting}}$ Where R_2 represents the minimum equivalent resistance of the variable load. If this condition is not met, a lower load current must be specified, or the supply voltage must be increased, and the calculations repeated.

Shunt Capacitance Limitations

While a bypass capacitor is often placed in parallel with a voltage regulator to reduce high-frequency noise, the shunt capacitance across the 0C3W must be strictly limited to a maximum of **0.1 μF** . Capacitance values exceeding this limit can form a relaxation oscillator with the tube's negative resistance characteristic, causing severe voltage instability and oscillation.

Parallel and Series Operation

- **Parallel Operation:** Operating multiple 0C3W tubes in parallel to handle higher load currents is generally not recommended. Because individual tubes have slightly different ionization and maintaining voltages, one tube will typically ionize first and clamp the voltage, preventing the other tubes from starting. If parallel operation is unavoidable, a current-equalizing resistor of approximately 100 ohms must be placed in series with each individual tube. This forced current sharing, however, significantly degrades the overall voltage regulation of the circuit.
- **Series Operation:** Multiple tubes can be connected in series to achieve higher regulated voltages. For example, an 0C3W (108 V maintaining voltage) can be connected in series with an OD3W (150 V maintaining voltage) to provide a combined regulated output of 258 VDC. When using series-connected tubes, the designer must ensure that the unregulated supply voltage is high enough to initiate ionization across the entire series string.

Typical Application in Regulated Power Supplies

In high-stability power supplies, the 0C3W is frequently employed as a voltage reference source. A typical circuit configuration utilizes a [5R4WGB](#) full-wave rectifier feeding a 6528 twin-triode series regulator. A [6AU6WA](#) pentode serves as an error amplifier, comparing a sample of the output voltage against the stable reference potential maintained at its cathode by the 0C3W. The error amplifier then adjusts the grid bias of the 6528 series regulator to maintain a constant output voltage (e.g., 300 VDC at 265 mA) despite fluctuations in line voltage or load current.

Technical Summary

The **0C3W** is a ruggedized, cold-cathode, gas-filled voltage regulator tube designed to maintain a stable **108 V** output over an operating current range of **5 to 40 mA**. Featuring a unique shock-absorbing sponge rubber cushion within its T-9 envelope and a low-loss 6-pin octal base, the tube is highly resistant to severe mechanical environments, withstanding up to **900 G** of shock and **10 G** of continuous vibration.

Its electrical design incorporates internal safety jumpers on pins 3 and 7 to protect downstream circuitry upon tube removal. While highly reliable, successful implementation requires careful calculation of the series current-limiting resistance, strict adherence to the **0.1 μF** maximum shunt capacitance limit to prevent relaxation oscillations, and proper consideration of starting voltage requirements in darkness versus light.

SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

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 · Voltage Regulator

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Minimum anode supply voltage	133 V	VoltageRegulatorService
Maximum operating current	40 mA	VoltageRegulatorService

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Minimum operating current	5 mA	VoltageRegulatorService
Operating voltage	105 V	VoltageRegulatorService
Ionization voltage	115 V	VoltageRegulatorService
Regulation	2 V	5 to 40 mA

SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

1966 Tung Sol Electronic Tubes 3 of 4

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

1966 TUNG SOL ELECTRONIC TUBES 3 OF 4

Section 1 · Voltage Regulator

OTHER		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Minimum DC anode supply voltage	133 V	RegulatorService
Maximum DC cathode current	40 mA	—

PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Minimum DC cathode current	5 mA	—
Maximum average starting current	100 mA	StartingPeriod
Maximum inverse voltage	-50 V	—
Maximum shunt capacitor	0.1 uF	—

CHARACTERISTIC		
PARAMETER	PUBLISHED VALUE	CONDITION / NOTE
Average anode breakdown voltage	125 V	RegulatorService
Tube voltage drop minimum	103 V	RegulatorService
Tube voltage drop average	108 V	RegulatorService
Tube voltage drop maximum	114 V	RegulatorService

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