

ELECTRONIC TUBE REFERENCE

0A3

Voltage Regulator electronic tube

CONSOLIDATED TECHNICAL DATA

1 SECTION

CONSTRUCTION

VOLTAGEREGULATOR

Cold-cathode gas voltage regulator providing approximately 75 V stabilization over roughly 5-40 mA for shunt-regulator and reference service.

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                                                  | 75 V  |
| MINIMUM REGULATOR CURRENT                                          | 5 mA  |
| MAXIMUM REGULATOR CURRENT                                          | 40 mA |
| STARTING VOLTAGE                                                   | 105 V |
| MAINTAINING VOLTAGE                                                | 75 V  |
| Published handbook ratings and operating characteristics reviewed. |       |

# 0A3 — Cold-Cathode Gas-Discharge Voltage Regulator

## Overview

The **0A3** (also designated as **0A3/VR75** or **GL-0A3**) is a cold-cathode, gas-discharge diode designed for voltage regulator applications. Its primary function is to maintain a constant DC output voltage across a load, independent of variations in load current and moderate fluctuations in line voltage. In addition to voltage regulation, the 0A3 can be utilized as a relaxation oscillator or for spark-over protection.

As a glow-discharge tube, the 0A3 operates without a heated filament, relying instead on a partial atmosphere of inert gas or vapor and a high potential gradient to initiate and maintain conduction. It is housed in an ST-12 glass bulb with a small shell octal 6-pin base.

## Construction and Physical Characteristics

The 0A3 consists of two primary electrodes—an anode and a cold cathode—sealed within a glass envelope containing a low-pressure inert gas or vapor.

## Electrode and Emission Mechanism

Unlike vacuum tubes with thermionic heaters, the 0A3 does not have a heater or filament. Electron emission is achieved entirely from the cold cathode. When a sufficient potential gradient is established at the cathode surface, electrons are literally pulled out of the cathode material. To facilitate this process, the cathode is sometimes coated with a material possessing a low work function, allowing electrons to be emitted with comparative ease.

## Physical Dimensions and Mounting

The tube is constructed in an ST-12 glass bulb with a small shell octal 6-pin base. It can be mounted in any position.

| Physical Parameter       | Value         |
|--------------------------|---------------|
| Maximum Overall Length   | 4-1/8 inches  |
| Maximum Seated Height    | 3-9/16 inches |
| Maximum Diameter         | 1-9/16 inches |
| Net Weight (Maximum)     | 1.3 ounces    |
| Net Weight (Approximate) | 2 ounces      |
| Mounting Position        | Any           |

## Pinout and Base Connections

The 0A3 utilizes a standard octal base with a 6-pin configuration (often designated as the **4AJ** or **B6-3** outline). A key feature of its construction is an internal jumper wire connecting two of the pins.

### Pin Assignment Table

Viewed from the bottom of the tube base, the pin connections are as follows:

| Pin Number | Connection | Description                          |
|------------|------------|--------------------------------------|
| 1          | NC         | No Connection                        |
| 2          | K          | Cathode                              |
| 3          | Jumper     | Internal Jumper (connected to Pin 7) |
| 5          | P          | Anode                                |
| 7          | Jumper     | Internal Jumper (connected to Pin 3) |
| 8          | NC         | No Connection                        |

### The Internal Jumper Safety Feature

The internal jumper wire connecting Pin 3 and Pin 7 is typically employed as a safety switch. By wiring this jumper in series with the primary winding of the power supply transformer, the AC power supply is automatically shut off when the 0A3 tube is removed from its socket. This prevents unregulated, high voltage from reaching downstream components and protects the circuit from damage.

## Electrical Characteristics and Operating Principles

The operation of the 0A3 relies on the physics of gas discharge, which exhibits distinct regions of conduction.

### Glow Discharge vs. Arc Discharge

Two types of electrical discharge can occur within the tube:

- 1. Glow Discharge:** This is the normal operating state of the 0A3. It is characterized by a uniform glow covering all or part of the cathode surface. In this region, the voltage drop across the tube (the operating voltage) remains essentially constant and independent of the current flowing through it. The exact voltage drop is determined by the spacing of the electrodes and the specific composition and pressure of the gas fill.
- 2. Arc Discharge:** If the current through the tube is increased beyond its maximum rating, the discharge transitions into an arc. In this state, a highly concentrated "cathode spot" forms on the cathode surface, and the voltage drop across the tube plummets to a very low value (typically 10 to 20

volts). Operating the 0A3 in the arc discharge region must be avoided, as it will materially shorten the life of the tube.

## Electrical Specifications

The electrical characteristics of the 0A3/[VR75](#) under typical operating conditions are summarized below:

| Parameter                                    | Minimum | Bogey (Typical) | Maximum | Unit |
|----------------------------------------------|---------|-----------------|---------|------|
| DC Anode Supply Voltage (to ensure starting) | 105     | —               | —       | V    |
| DC Starting Voltage (Breakdown Voltage)      | —       | 100             | 105     | V    |
| DC Operating Voltage (Anode Voltage Drop)    | 68      | 75              | 85      | V    |
| DC Operating Current (Continuous)            | 5.0     | —               | 40      | mA   |
| Regulation (5 to 30 mA current range)        | —       | 3.0             | —       | V    |
| Regulation (5 to 40 mA current range)        | —       | 5.0             | 6.5     | V    |
| Ambient Temperature Range                    | -55     | —               | +90     | °C   |

## Voltage Regulation Definition

The regulation voltage is defined as the maximum variation in voltage drop across the glow tube over a specified current range. It is calculated as the difference between the voltage drop obtained at the maximum operating current and the voltage drop obtained at the minimum operating current:

$$\text{Regulation} = V_{\text{drop at } I_{\text{max}}} - V_{\text{drop at } I_{\text{min}}}$$

For the 0A3, the regulation is typically 3.0 V over a 5 to 30 mA current range, and 5.0 V (with a maximum limit of 6.5 V) over the full 5 to 40 mA range.

# Ratings and Operating Limits

To ensure reliable operation and maximize tube life, several absolute limits must be observed.

## Minimum Supply Voltage

A minimum DC anode supply voltage of **105 V** must be available to guarantee that the tube will "start" (ionize and begin conducting) throughout its operating life. If the supply voltage is below this threshold, the tube may fail to strike, leaving the load unregulated.

## Current Limits

- **Continuous Operating Current:** The continuous current through the tube must be maintained between **5.0 mA** and **40 mA**. Operating below 5.0 mA results in unstable ionization, causing erratic voltage regulation. Operating above 40 mA causes excessive heating of the electrodes, leading to rapid degradation of the tube and erratic regulation.
- **Maximum Average Starting Current:** During initial circuit turn-on, a transient current of up to **100 mA** is permissible for a maximum averaging time of **10 seconds**. This allows associated equipment (such as vacuum tubes with heaters) to warm up and begin drawing current, provided that this starting period is followed by a steady-state operating period of at least several minutes.

## Temperature Effects and Hysteresis

The 0A3 is rated for operation across an ambient temperature range of **-55 °C to +90 °C**.

Additionally, the precise operating voltage and regulation of the tube are somewhat dependent on its immediate operational history. For example, if the tube is operated at a low current (e.g., 5 mA) for a protracted period and then suddenly subjected to a high current (e.g., 35 mA), the resulting regulation value may differ slightly from the value obtained after a long period of continuous operation at 35 mA. A similar shift in regulation characteristics can occur after the tube has been idle for a long period.

## Application Circuits

### Voltage-Regulated Power Supply

The most common application of the 0A3 is as a shunt voltage regulator. In this configuration, the tube is placed in parallel with the load.

A series resistor must always be connected between the unregulated DC source and the 0A3. The value of this series resistance is calculated to limit the current through the glow tube so that it remains within the 5.0 to 40 mA range under all expected load and line voltage conditions.

The series resistance  $R_s$  can be calculated using the following formula:

$$R_s = \frac{V_{\text{supply}} - V_{\text{reg}}}{I_{\text{total}}}$$

where  $V_{\text{supply}}$  is the unregulated input voltage,  $V_{\text{reg}}$  is the nominal operating voltage of the 0A3 (75 V), and  $I_{\text{total}}$  is the sum of the load current and the tube's operating current. The input voltage must be high

enough to ensure that even under worst-case low-line conditions, the voltage across the tube before conduction exceeds the starting voltage (105 V), and the current through the tube does not drop below 5.0 mA.

## Series Operation for Higher Voltages

To obtain higher regulated voltages than a single tube can provide, multiple glow-discharge tubes can be connected in series. The tubes do not need to be of the same type. For example, an **0A3** (75 V) and an **0B3** (90 V) can be connected in series to provide a regulated output of approximately 165 V.

When operating tubes in series, the maximum current of the combination is limited by the tube with the lowest maximum current rating. For instance, since the **0B3** has a maximum current rating of 30 mA (compared to the 0A3's 40 mA), the current through the series string must be limited to a maximum of **30 mA**.

## Parallel Operation Warning

Operating glow-discharge tubes in parallel to achieve higher current capacity is **not recommended**. Because individual tubes have slightly different starting (breakdown) voltages, the tube with the lowest starting voltage will ionize first. Once it conducts, the voltage across the parallel combination drops to the operating voltage (approx. 75 V), which is well below the starting voltage of the remaining tube. Consequently, the second tube will never ionize, and the first tube will be forced to carry the entire load current, likely exceeding its maximum rating and causing premature failure.

## Relaxation Oscillator

The 0A3 can also be used in a relaxation oscillator circuit. In this application, a DC voltage source charges a capacitor through a series resistor. The 0A3 is connected in parallel with the capacitor.

As the capacitor charges, the voltage across it rises. When this voltage reaches the breakdown (starting) voltage of the 0A3 (approximately 100 V), the tube ionizes and rapidly discharges the capacitor down to its maintaining voltage or until the discharge can no longer be sustained. The tube then extinguishes, and the charging cycle begins again. The frequency of oscillation can be adjusted by changing the capacitance, the series resistance, or the supply voltage.

## Related Designations

The 0A3 is closely related to other octal-based cold-cathode regulators in the same family, which differ primarily in their operating voltages:

- **0B3 / VR90**: 90 V nominal operating voltage, 30 mA maximum current.
- **0C3 / VR105**: 105 V nominal operating voltage, 40 mA maximum current.
- **0D3 / VR150**: 150 V nominal operating voltage, 40 mA maximum current.

These tubes share the same physical dimensions, octal 6-pin base configuration, and internal jumper safety feature, but they are not direct electrical substitutes due to their different regulated voltage levels.

## Technical Summary

The **0A3** (also known as **0A3/VR75** or **GL-0A3**) is an octal-based, cold-cathode, gas-discharge voltage regulator designed to maintain a stable **75 V** DC output. It operates within a continuous current range of **5.0 to 40 mA** and requires a minimum supply voltage of **105 V** to guarantee ionization. Housed in an ST-12 glass envelope, it features an internal jumper between Pin 3 and Pin 7 that can be wired as a safety interlock. The tube is highly versatile, finding use in shunt voltage regulators, series-connected high-voltage regulators, relaxation oscillators, and spark-over protection circuits.

## SOURCE OPERATING CONDITIONS

[SOURCE PDF](#)

# 1950 General Electric Transmitting Types

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

## 1950 GENERAL ELECTRIC TRANSMITTING TYPES

## Section 1 · Voltage Regulator

| OTHER                            |                 |                          |
|----------------------------------|-----------------|--------------------------|
| PARAMETER                        | PUBLISHED VALUE | CONDITION / NOTE         |
| Maximum average starting current | 100 mA          | 10 second averaging time |

## 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 | 105 V           | VoltageRegulatorService |
| Maximum operating current    | 40 mA           | VoltageRegulatorService |

| CHARACTERISTIC            |                 |                         |
|---------------------------|-----------------|-------------------------|
| PARAMETER                 | PUBLISHED VALUE | CONDITION / NOTE        |
| Minimum operating current | 5 mA            | VoltageRegulatorService |
| Operating voltage         | 75 V            | VoltageRegulatorService |
| Ionization voltage        | 100 V           | VoltageRegulatorService |
|                           |                 |                         |

| PARAMETER  | PUBLISHED VALUE | CONDITION / NOTE |
|------------|-----------------|------------------|
| Regulation | 5 V             | 5 to 40 mA       |



SOURCE DATA APPENDIX

#### SOURCE OPERATING CONDITIONS

# 195X Raytheon Special Purpose Tubes

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

#### 195X RAYTHEON SPECIAL PURPOSE TUBES

### Section 1 · Voltage Regulator

| CHARACTERISTIC     |                 |                  |
|--------------------|-----------------|------------------|
| PARAMETER          | PUBLISHED VALUE | CONDITION / NOTE |
| Operating voltage  | 75 V            | —                |
| Maximum regulation | 5 V             | 5to40mA          |

| OTHER                           |                 |                  |
|---------------------------------|-----------------|------------------|
| PARAMETER                       | PUBLISHED VALUE | CONDITION / NOTE |
| Minimum operating current       | 5 mA            | —                |
| Maximum operating current       | 40 mA           | —                |
| Minimum starting-voltage supply | 105 V           | —                |



SOURCE DATA APPENDIX

#### 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 · Voltage Regulator

| CHARACTERISTIC |                 |                  |
|----------------|-----------------|------------------|
| PARAMETER      | PUBLISHED VALUE | CONDITION / NOTE |
| Regulation     | 3 V             | 5 to 30 mA       |

## SOURCE OPERATING CONDITIONS

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# 1966 Tung Sol Electronic Tubes 1 of 4

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

## 1966 TUNG SOL ELECTRONIC TUBES 1 OF 4

## Section 1 · Voltage Regulator

| OTHER                        |                 |                  |
|------------------------------|-----------------|------------------|
| PARAMETER                    | PUBLISHED VALUE | CONDITION / NOTE |
| DC operating voltage         | 75 V            | —                |
| DC operating current minimum | 5— mA           | —                |
| DC operating current maximum | —40 mA          | —                |

| CHARACTERISTIC      |                 |                  |
|---------------------|-----------------|------------------|
| PARAMETER           | PUBLISHED VALUE | CONDITION / NOTE |
| DC starting voltage | 100 V           | Approximate      |
| Voltage regulation  | —3 V            | Ia=5-40mA        |

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