FAIRCHILD
A Schlumberger Company

μA431A Adjustable Precision Zener Shunt Regulator

Linear Division Voltage Regulators

Description

The μA431A is a 3-terminal adjustable shunt regulator with guaranteed temperature stability over the entire temperature range of operation. The output voltage may be set at any level greater than 2.5 V (V_{REF}) up to 36 V merely by selecting two external resistors that act as a voltage divided network. Due to the sharp turn-on characteristics this device is an excellent replacement for many zener diode applications.

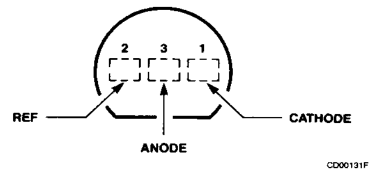
- **Average Temperature Coefficient 50 ppm/°C**
- **Temperature Compensated For Operation Over The Full Temperature Range**
- **Programmable Output Voltage**
- **Fast Turn-On Response**
- **Low Output Noise**

Absolute Maximum Ratings

Storage Temperature Range	−65°C to +150°C	
Operating Temperature Range		
Industrial (μA431AV)	−40°C to +85°C	
Commercial (μA431AC)	0°C to +70°C	
Lead Temperature		
TO-92 Package/SO-8 (soldering, 10 s)	265°C	
Internal Power Dissipation[1,2]		
TO-92 Package	0.78 W	
SO-8 Package	0.81 W	
Cathode Voltage	37 V	
Continuous Cathode Current	−10 mA to +150 mA	
Reference Voltage	−0.5 V	
Reference Input Current	10 mA	
Operating Conditions	Min	Max
Cathode Voltage	V_{REF}	37 V
Cathode Current	1.0 mA	100 mA

Notes
1. $T_{J\ Max}$ = 150°C.
2. Ratings apply to ambient temperature at 25°C. Above this temperature, derate the TO-92 at 6.2 mW/°C, and the S0-8 at 6.5 mW/°C.

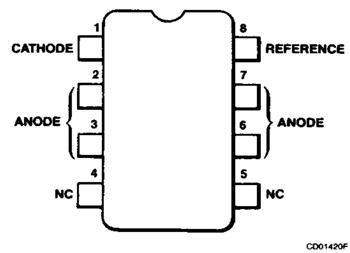
Connection Diagram
TO-92 Package
(Top View)



Order Information

Device Code	Package Code	Package Description
μA431AWC	EI	Molded
μA431AWV	EI	Molded

Connection Diagram
SO-8 Package
(Top View)



Order Information

Device Code	Package Code	Package Description
μA431ASC	KC	Molded Surface Mount

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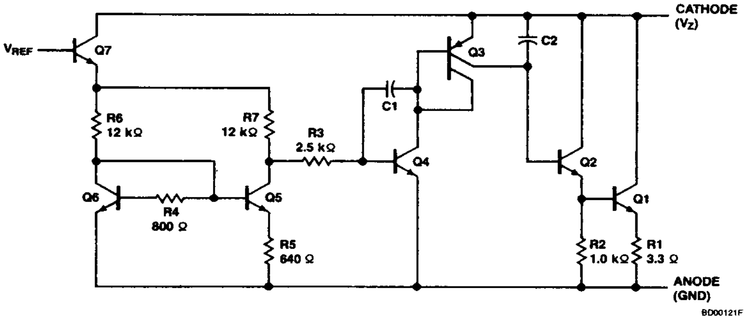
Equivalent Circuit



DC Test Circuits

Figure 1 Test Circuit For $V_Z = V_{REF}$

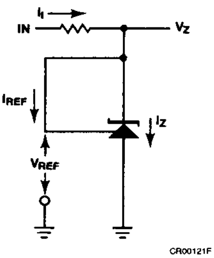


Figure 2 Test Circuit For $V_Z > V_{REF}$

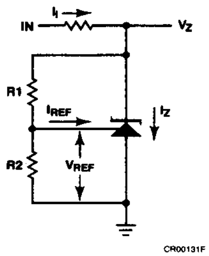
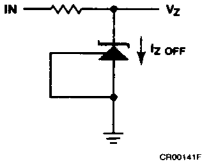


Figure 3 Test Circuit For Off-State Current



Note

$V_Z = V_{REF}\ (1 + R1/R2) + I_{REF} \cdot R1$

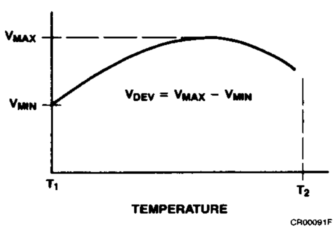
μA431A

Electrical Characteristics $T_A = 25°C$ unless otherwise specified.

Symbol	Characteristic	Condition		Min	Typ	Max	Unit
V_{REF}	Reference Voltage	$V_Z = V_{REF}$, $I_I = 10$ mA, Fig. 1		2.440	2.495	2.550	V
V_{DEV}	Deviation of Reference Input Voltage Over Temperature[1]	$V_Z = V_{REF}$, $I_I = 10$ mA, T_A = full range, Fig. 1			8.0	17	mV
$\frac{\Delta V_{REF}}{\Delta V_Z}$	Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	$I_Z = 10$ mA, Fig. 2	V_Z from V_{REF} to 10 V		−1.4	−2.7	mV/V
			V_Z from 10 V to 36 V		−1.0	−2.0	
I_{REF}	Reference Input Current	$R_1 = 10$ kΩ, $R_2 = \infty$, $I_I = 10$ mA, Fig. 2			2.0	4.0	μA
$\propto I_{REF}$	Deviation of Reference Input Current over Temperature	$R_1 = 10$ kΩ, $R_2 = \infty$, $I_I = 10$ mA, T_A = Full Range, Fig. 2			0.4	1.2	μA
$I_{Z(MIN)}$	Minimum Cathode Current for Regulation	$V_Z = V_{REF}$, Fig. 1			0.4	1.0	mA
$I_{Z(OFF)}$	Off-State Current	$V_Z = 36$ V, $V_{REF} = 0$ V, Fig. 3			0.3	1.0	μA
r_Z	Dynamic Output Impedance[2]	$V_Z = V_{REF}$, Frequency = 0 Hz, Fig. 1				.75	Ω

Notes

1. Deviation of reference input voltage, V_{DEV}, is defined as the maximum variation of the reference input voltage over the full temperature range.



The average temperature coefficient of the reference input voltage, ∝VREF, is defined as:

$$\propto V_{REF}\,\frac{ppm}{°C} = \pm\frac{\left[\dfrac{V_{Max}-V_{Min}}{V_{REF}\ (\text{at }25°C)}\right]10^6}{T_2-T_1} = \pm\frac{\left[\dfrac{V_{DEV}}{V_{REF}\ (\text{at }25°C)}\right]10^6}{T_2-T_1}$$

Where:
$T_2 - T_1$ = full temperature change.

$\propto V_{REF}$ can be positive or negative depending on whether the slope is positive or negative.

Example: $V_{DEV} = 8.0$ mV, $V_{REF} = 2495$ mV, $T_2 - T_1 = 70°C$, slope is positive

$$\propto V_{REF} = \frac{\left[\dfrac{8.0\text{ mV}}{2495\text{ mV}}\right]10^6}{70°C} = +46\text{ ppm/°C}$$

2. The dynamic output impedance, r_Z, is defined as:

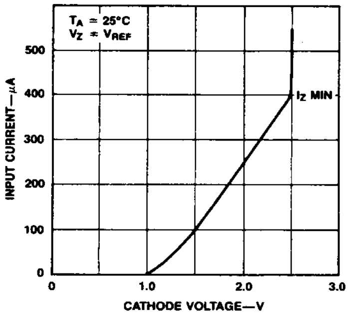
$$r_Z = \frac{\Delta V_Z}{\Delta I_Z}$$

When the device is programmed with two external resistors, R1 and R2, (*see Figure 2*), the dynamic output impedance of the overall circuit, r_Z, is defined as:

$$r_Z = \frac{\Delta V_Z}{\Delta I_Z} \cong \left[r_Z\ 1 + \frac{R1}{R2}\right]$$

Typical Performance Curves

Input Current vs V_Z



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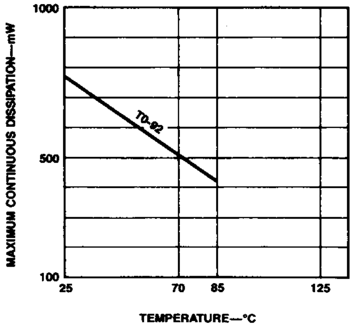
Thermal Information



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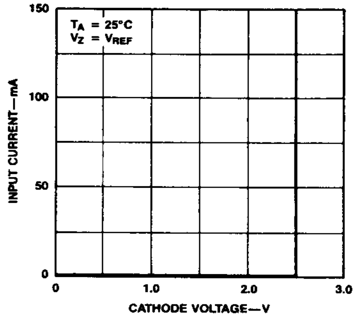
Input Current vs V_Z



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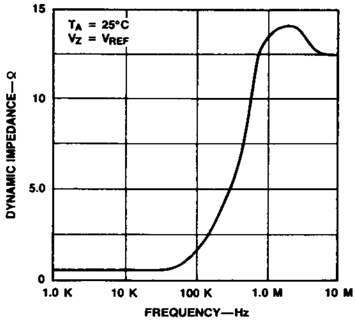
Dynamic Impedance vs Frequency



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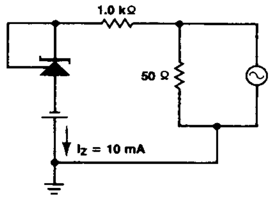

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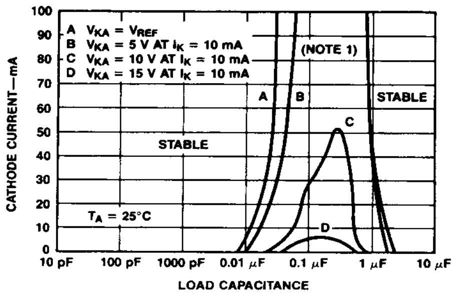
Stability Boundary Conditions



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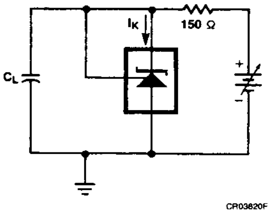
Note

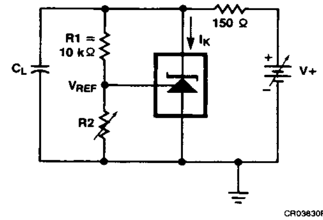
1. The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial V_{KA} and I_K conditions with $C_L = 0$. V+ and C_L were then adjusted to determine the ranges of stability.

Typical Characteristics

Test Circuit For Curve A Below

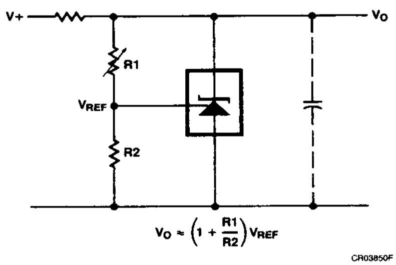


Test Circuit for Curves B, C, And D Below

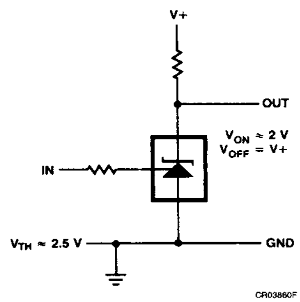


Typical Applications

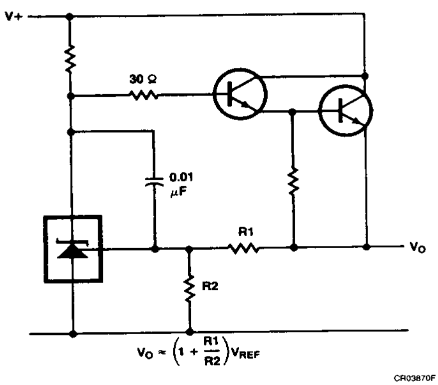
Shunt Regulator



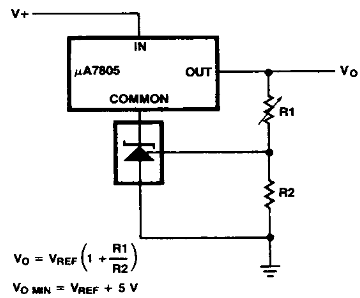
Single Supply Comparator With Temperature Compensated Threshold



Series Regulator

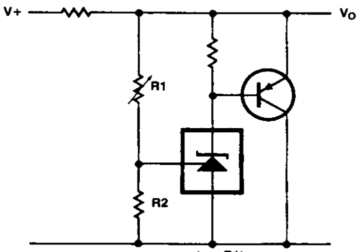


Output Control of a Three Terminal Fixed Regulator



Typical Applications (Cont.)

Higher Current Shunt Regulator



$$V_O = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

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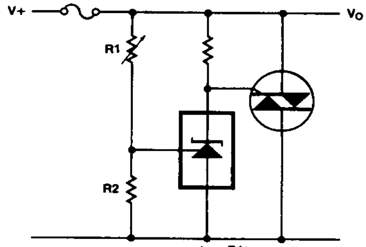
Crow Bar



$$V_{LIMIT} \approx \left(1 + \frac{R1}{R2}\right) V_{REF}$$

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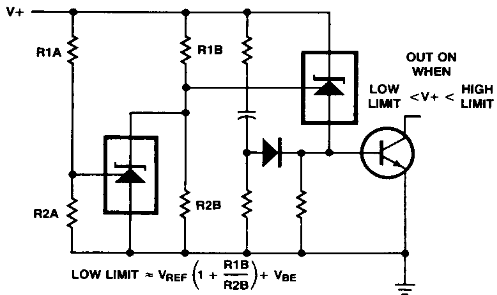
Over Voltage/Under Voltage Protection Circuit



$$\text{LOW LIMIT} \approx V_{REF}\left(1 + \frac{R1B}{R2B}\right) + V_{BE}$$

$$\text{HIGH LIMIT} \approx V_{REF}\left(1 + \frac{R1A}{R2A}\right)$$

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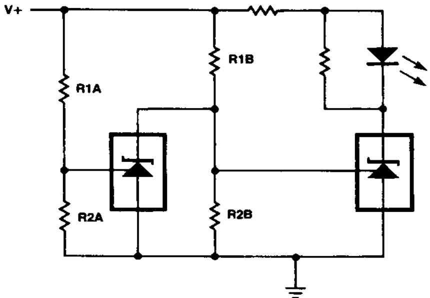
Voltage Monitor



$$\text{LOW LIMIT} \approx V_{REF}\left(1 + \frac{R1B}{R2B}\right)$$

$$\text{HIGH LIMIT} \approx V_{REF}\left(1 + \frac{R1A}{R2A}\right)$$

LED ON WHEN
LOW LIMIT <V+ < HIGH LIMIT

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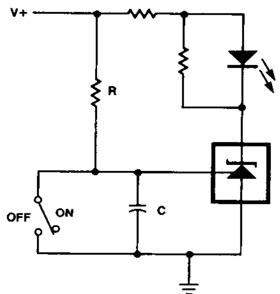
Delay Timer



$$\text{DELAY} = R \cdot C \cdot \text{IN}\ \frac{V+}{(V+) - V_{REF}}$$

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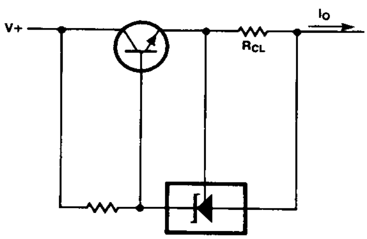
Current Limiter Or Current Source



$$I_O = \frac{V_{REF}}{R_{CL}}$$

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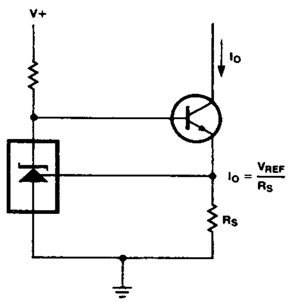
Constant Current Sink



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