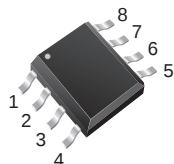
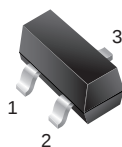


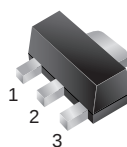
Adjustable Precision Shunt Regulators

SO-8


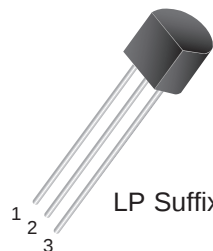
S Suffix

SOT-23


U Suffix

SOT-89


X Suffix

TO-92


LP Suffix

Features

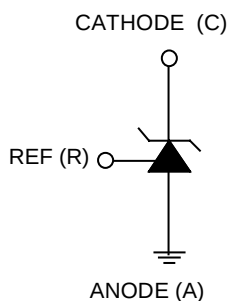
- Programmable Output Voltage to 30V
- Precision Reference Voltage
GS431B: 2.495V $\pm 0.5\%$
TL431A: 2.495V $\pm 1.0\%$
TL431: 2.495V $\pm 1.6\%$
- Sink Current Capability: 200mA.
- Minimum Cathode Current for Regulation: 250 μ A
- Equivalent Full-Range Temperature Coefficient: 50 ppm/ $^{\circ}$ C
- Fast Turn-On Response
- Low Dynamic Output Impedance: 0.08 Ω
- Low Output Noise

Description

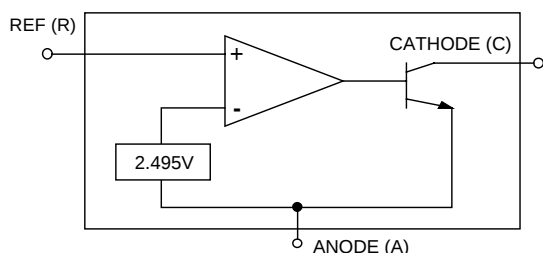
The GS431B/TL431A/TL431 are 3-terminal adjustable precision shunt regulators with guaranteed temperature stability over the applicable extended commercial temperature range. The output voltage may be set at any level greater than 2.495V (V_{REF}) up to 30V merely by selecting two external resistors that act as a voltage divider network. These devices have a typical output impedance of 0.08 Ω . Active output circuitry provides very sharp turn-on characteristics, making these devices excellent improved replacements for zener diodes in many applications.

The precise $\pm 0.5\%$ reference voltage tolerance of the GS431B makes it possible in many applications to avoid the use of a variable resistor, consequently saving cost and eliminating drift and reliability problems associated with it.

Symbol



Block Diagram



Applications

- Voltage Monitor
- Delay Timer
- Constant-Current Source/Sink
- High-Current Shunt Regulator
- Crow Bar
- Over-Voltage/Under-Voltage Protection

Mechanical Data

Case: SO-8, SOT-23, SOT-89, TO-92

High temperature soldering guaranteed:

260 $^{\circ}$ C/10 seconds at terminals

Case outlines are on the back pages

Vishay

formerly General Semiconductor

Ordering Information

GS431Bxxx

Package code

SO-8: S

TO-92: LP

SOT-89: X

SOT-23: U-1/U-2

U-1: Pin 1, Cathode

Pin 2, V_{ref}

Pin 3, Anode

U-2: Pin 1, V_{ref}

Pin 2, Cathode

Pin 3, Anode

TL431xLxx

Tolerance

Default: 1.6%

A: 1.0%

Package code

SO-8: S

TO-92: LP

SOT-89: X

SOT-23: U-1/U-2

Marking Information

SOT-23

GS431B,	(U-1)	DAxxxx*
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TL431A,	(U-1)	DBxxxx
---------	-------	--------

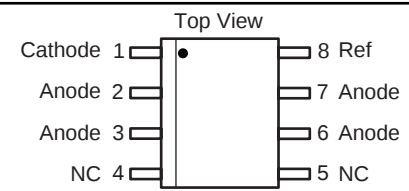
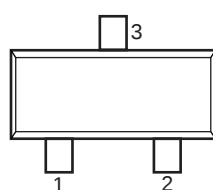
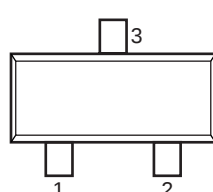
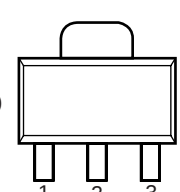
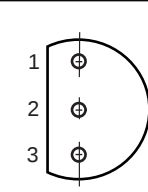
TL431,	(U-1)	DCxxxx
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GS431B,	(U-2)	DDxxxx
---------	-------	--------

TL431A,	(U-2)	DExxxx
---------	-------	--------

TL431,	(U-2)	DGxxxx
--------	-------	--------

*Last two digits denote datecode

SO-8	Top View 
SOT-23 (U-1)	Top View 
SOT-23 (U-2)	Top View 
SOT-89	Top View 
TO-92	Top View 

**Absolute Maximum Ratings** $T_A = 25^\circ\text{C}$ unless otherwise noted.

Parameter	Symbol	Value	Unit
Cathode voltage	V _Z	30	V
Continuous cathode current	I _Z	−10 to 250	mA
Reference Input Current Range	I _{REF}	−0.05 to10	mA
Operating Temperature Range	T _{oper}	−40 to 85	°C
Junction Temperature	T _J	150	°C
Lead Temperature	T _L	260	°C
Storage Temperature	T _{stg}	−65 to 150	°C
Thermal Resistance	R _{θJA}	TO-92 Package	°C/W
		SOT-23 Package	
		SO-8 Package	
		SOT-89 Package	

Electrical Characteristics $T_A = 25^\circ\text{C}$ unless otherwise noted.

Parameter	Symbol	Test Conditions			Min	Typ	Max	Unit
Reference Voltage	V _{REF}	V _Z = V _{REF} I _L = 10mA (Fig. 1) T _A = 25°C		GS431B	2.482	2.495	2.508	V
				TL431A	2.470	2.495	2.520	
				TL431	2.455	2.495	2.535	
		V _Z = V _{REF} I _L = 10mA (Fig. 1) T _A = −40°C to +85°C		GS431B	2.475	–	2.520	
				TL431A	2.445	–	2.545	
				TL431	2.43	–	2.56	
Deviation of reference Input voltage over temperature ⁽¹⁾	ΔV _{REF}	V _Z = V _{REF} I _L = 10mA	T _A = 0°C to 70°C		–	9.0	20	mV
			T _A = −40°C to +85°C (Fig. 1)		–	15.0	50	
Ratio of the change in reference voltage to the change in cathode voltage	ΔV _{REF} ΔV _Z	I _Z = 10mA (Fig. 2)	V _Z = V _{REF} ~ 10V		–	0.5	2.0	mV/V
			V _Z = 10V ~ 30V		–	0.35	1.5	
Reference input current	I _{REF}	R1 = 10KΩ, R2 = ∞ I _L = 10mA (Fig. 2)	T _A = 25°C		–	0.8	3.5	μA
			T _A = −40°C to +85°C		–	–	4.5	
Deviation of reference input current over temperature	αI _{REF}	R1 = 10KΩ, R2 = ∞ I _L = 10mA T _A = −40°C to +85°C (Fig. 2)			–	0.3	1.2	μA
Minimum cathode current for regulation	I _{Z(MIN)}	V _Z = V _{REF} (Fig. 1)			–	0.25	0.5	mA
Off-state current	I _{Z(OFF)}	V _Z = 30V, V _{REF} = 0V (Fig 3)			–	0.1	1.0	μA
Dynamic output impedance ⁽²⁾	R _Z	V _Z = V _{REF} , f = 1.0KHZ ΔI _Z = 1.0mA to 50mA			–	0.08	0.3	Ω

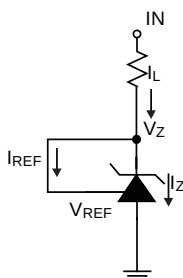


Fig. 1 Test Circuit for $V_Z = V_{REF}$

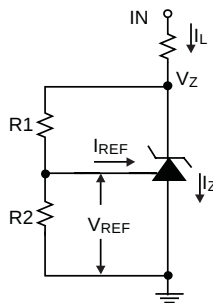


Fig. 2 Test Circuit for $V_Z > V_{REF}$

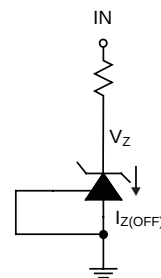
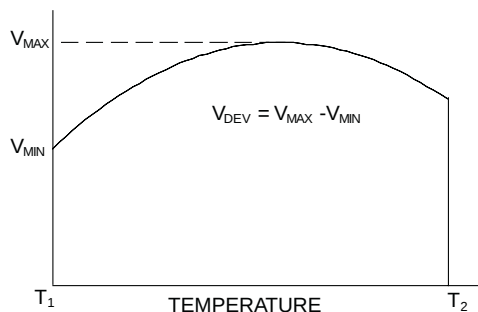


Fig. 3 Test Circuit for off-state current

Note 1. Deviation of reference input voltage, ΔV_{REF} , 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, αV_{REF} is defined as:

$$\alpha V_{REF} \frac{\text{ppm}}{^{\circ}\text{C}} = \frac{\pm \left[\frac{V_{MAX} - V_{MIN}}{V_{REF}(\text{at } 25^{\circ}\text{C})} \right] 10^6}{T_2 - T_1} = \frac{\pm \left[\frac{V_{DEV}}{V_{REF}(\text{at } 25^{\circ}\text{C})} \right] 10^6}{T_2 - T_1}$$

Where:

$T_2 - T_1$ = full temperature change.

The slope can be positive or negative depending on whether V_{MAX} or V_{MIN} occurs at the lower ambient temperature.

Example: $\Delta V_{REF} = 9.0\text{mV}$, $V_{REF} = 2495\text{mV}$,
 $T_2 - T_1 = 70^{\circ}\text{C}$, slope is positive.

$$\alpha V_{REF} = \frac{\left[\frac{9.0\text{mV}}{2495\text{mV}} \right] 10^6}{70^{\circ}\text{C}} = 50\text{ppm}/^{\circ}\text{C}$$

Note 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, R_1 and R_2 , (see Fig. 2), the dynamic output impedance of the overall circuit, is defined as:

$$r_Z = \frac{\Delta V_Z}{\Delta I_Z} \approx R_Z \left[1 + \frac{R_1}{R_2} \right]$$



Typical Performance Characteristics

Fig. 4 – Cathode Current vs. Cathode Voltage

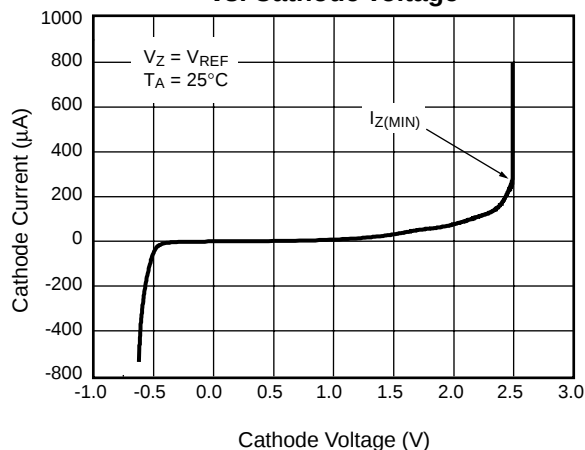


Fig. 5 – Reference Voltage vs. Temperature

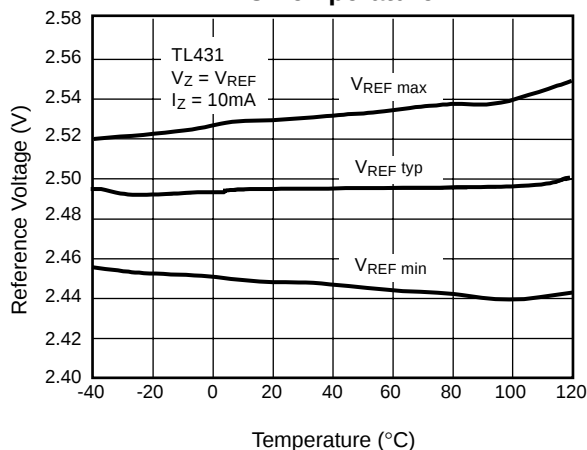


Fig. 6 – Reference Input Current vs. Temperature

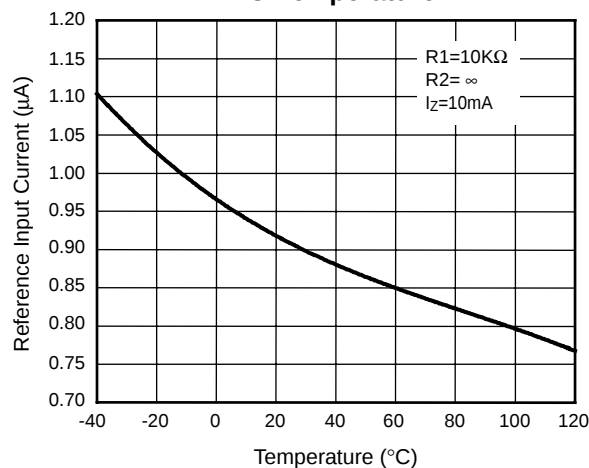


Fig. 7 – Dynamic Impedance vs. Temperature

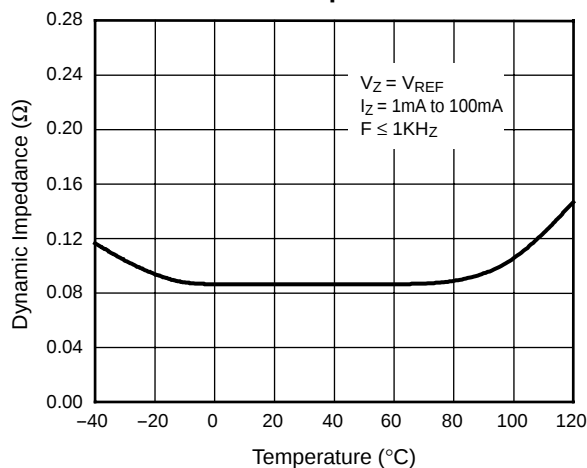


Fig. 8 – Change in Reference Voltage vs. Cathode Voltage

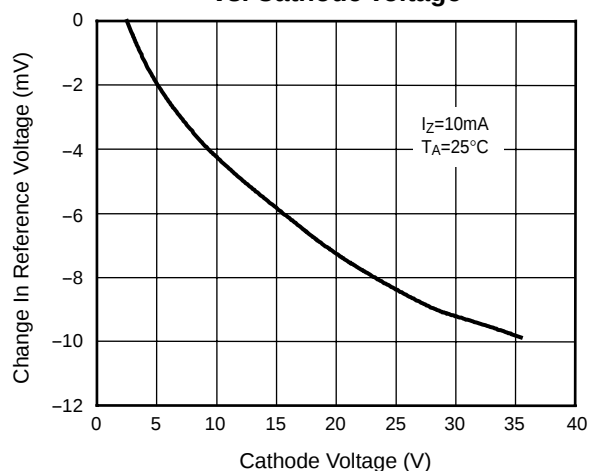


Fig. 9 – Off-State Cathode Current vs. Temperature

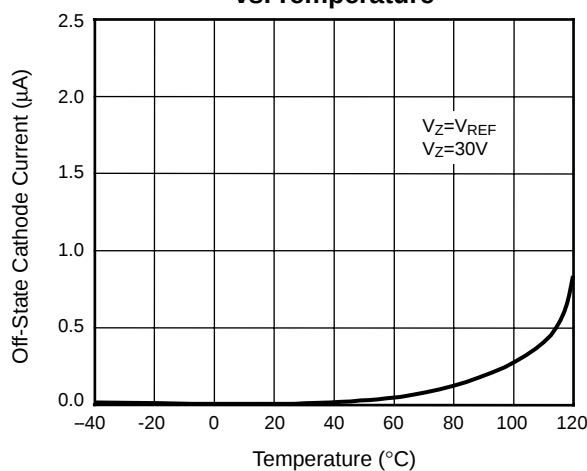


Fig. 10 – Small Signal Voltage Amplification vs. Frequency

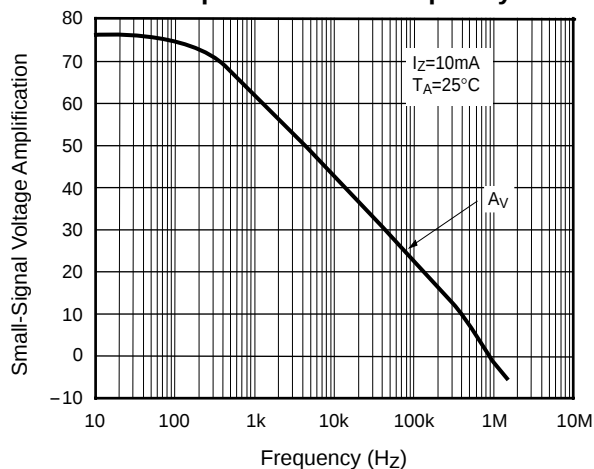


Fig. 11 – Test Circuit Frequency Response

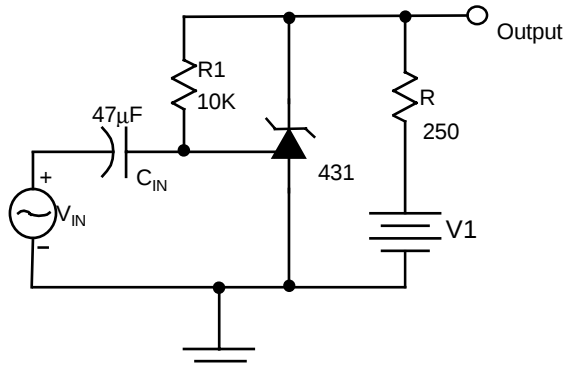


Fig. 12 – Pulse Response

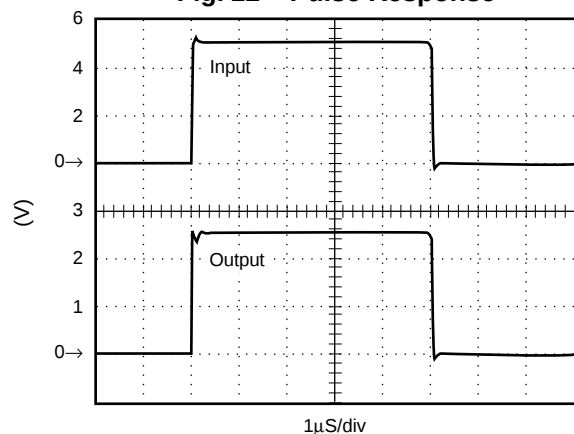


Fig. 13 – Test Circuit For Pulse

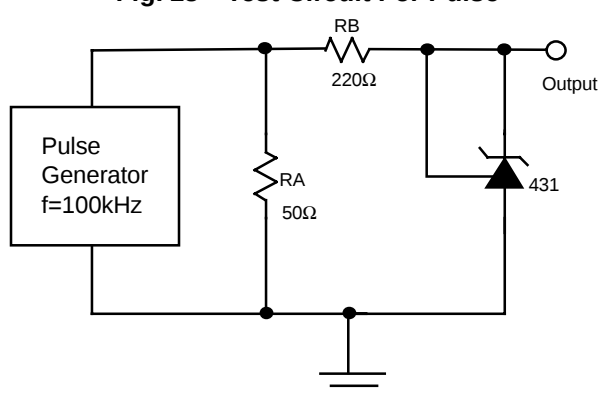


Fig. 14 – Dynamic Impedance vs.

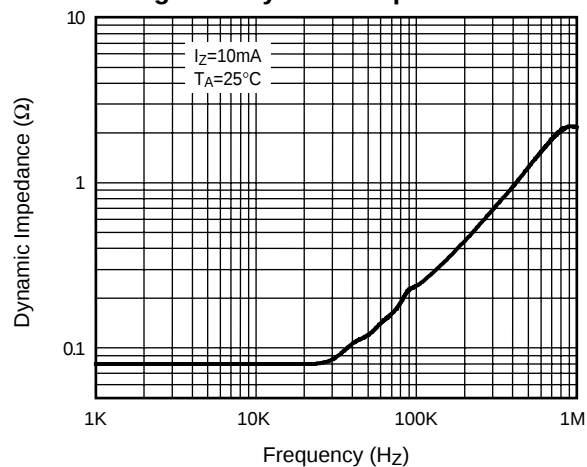
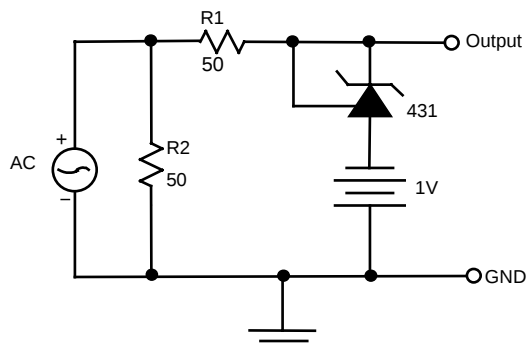
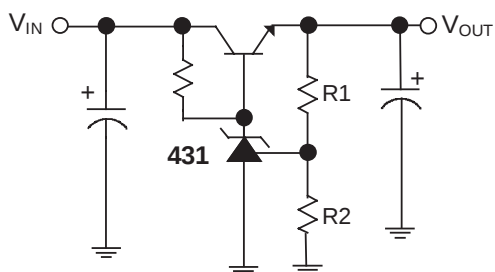


Fig. 15 – Test Circuit for Dynamic

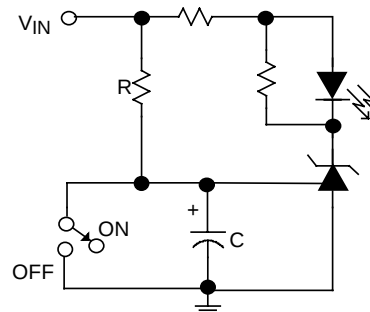


Application Examples

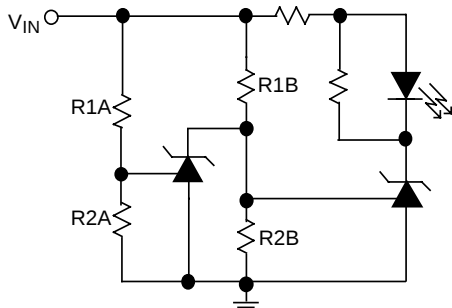
Fig. 16 – Typical Application Circuit


$$V_{OUT} = (1 + R1/R2) \times V_{REF}$$

Precision Regulator

Fig. 17 – Delay Timer


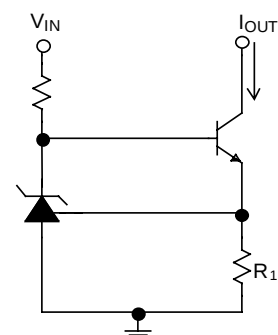
$$\text{Delay} = R \times C \times n \left(\frac{V_{IN}}{V_{IN} - V_{REF}} \right)$$

Fig. 18 – Voltage Monitor


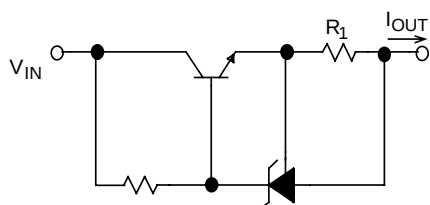
LED on when Low Limit < V_{IN} < High Limit

Low Limit $\equiv V_{REF} (1 + R1B/R2B)$

High Limit $\equiv V_{REF} (1 + R1A/R2A)$

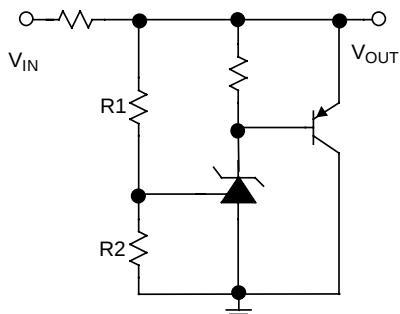
Fig. 19 – Constant-Current Sink


$$I_{OUT} = V_{REF} / R_1$$

Fig. 20 – Current Limiter or Current Source


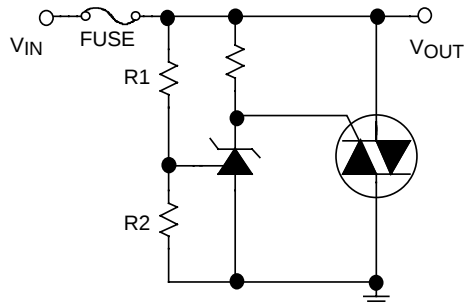
$$I_{OUT} = V_{REF} / R_1$$

**Fig. 21 – High-Current
Shunt Regulator**



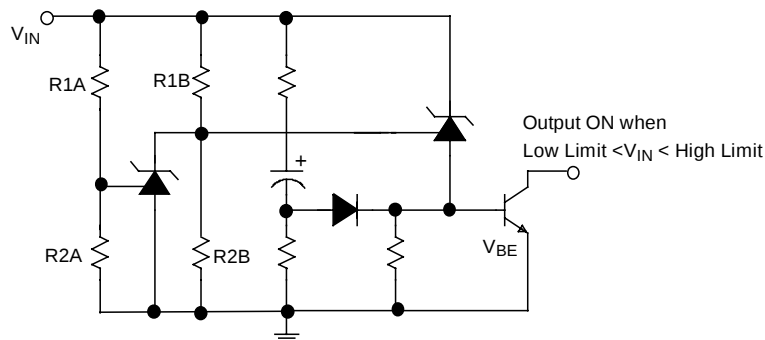
$$V_{OUT} = (1 + R1/R2) \times V_{REF}$$

Fig. 22 – Crow Bar



$$V_{LIMIT} = (1 + R1/R2) \times V_{REF}$$

**Fig. 23 – Over-Voltage / Under-Voltage
Protection Circuit**

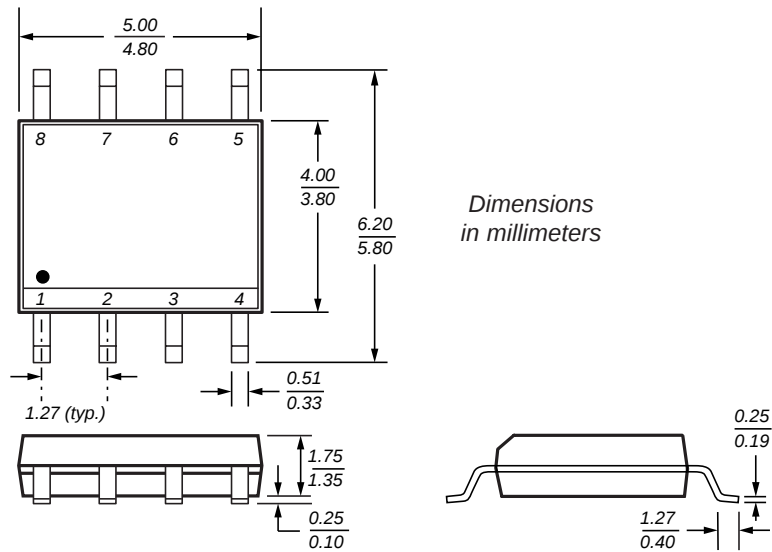


$$\text{Low Limit} \cong V_{REF} (1 + R1B/R2B) + V_{BE}$$

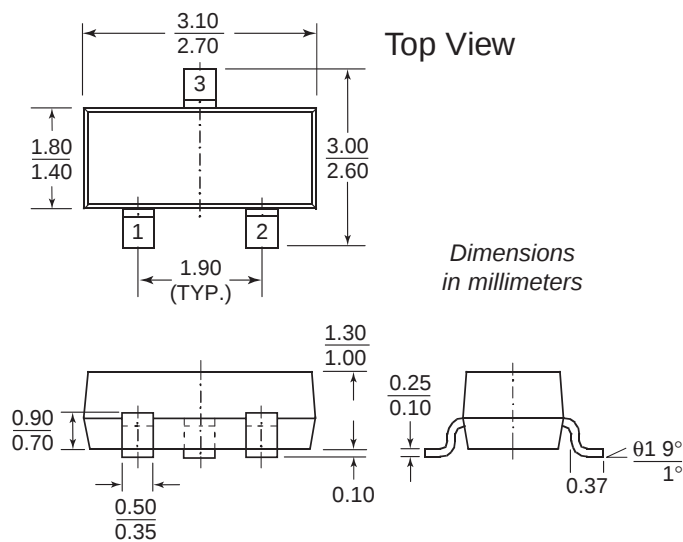
$$\text{High Limit} \cong V_{REF} (1 + R1A/R2A)$$

Output ON when
Low Limit < V_{IN} < High Limit

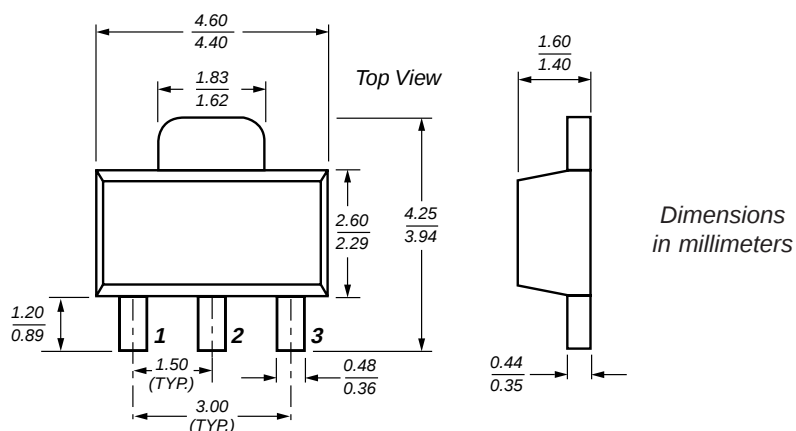
SO-8 Case Outline



SOT-23 Case Outline



SOT-89 Case Outline



TO-92 Case Outline

