AIC

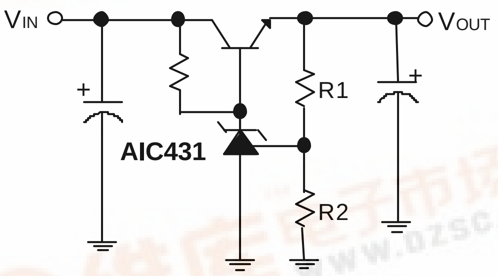
AIC431/TL431A/TL431

Adjustable Precision Shunt Regulators

FEATURES

- Unconditionally Stable.
- Precision Reference Voltage.
  AIC431 :2.495V ±0.5%
  TL431A :2.495V ±1.0%
  TL431 :2.495V ±1.6%
- Sink Current Capability: 200mA.
- Minimum Cathode Current for Regulation: 250μA.
- Equivalent Full-Range Temperature Coefficient: 50 ppm/°C.
- Fast Turn-On Response.
- Low Dynamic Output Impedance: 0.08Ω.
- Adjustable Output Voltage.
- Low Output Noise.
- Space Saving SOT-89, SOT-23, TO-92 and SO8 packages.

TYPICAL APPLICATION CIRCUIT



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

Precision Regulator

DESCRIPTION

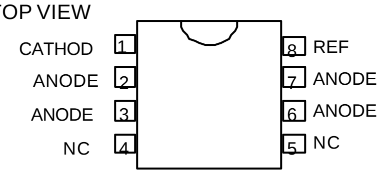
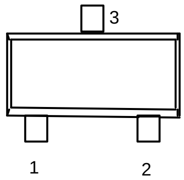
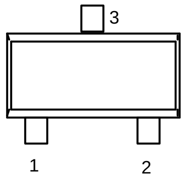
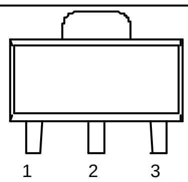
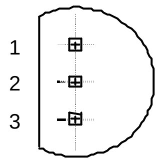
The AIC431/TL431A/TL431 are 3-terminal adjustable precision shunt regulators with guaranteed temperature stability over the applicable extended commercial temperature range. The output voltage may be set at any level greater than 2.495V (V_{REF}) up to 30V merely by selecting two external resistors that act as a voltage divider network. These devices have a typical output impedance of 0.08Ω. Active output circuitry provides a very sharp turn-on characteristics, making these devices excellent improved replacements for zener diodes in many applications.

The precise ±0.5% reference voltage tolerance of the AIC431 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.

ORDERING INFORMATION

AIC431 CX
TL431A CX
TL431 CX

PACKAGING TYPE
S: SMALL OUTLINE
U: SOT-23
X: SOT-89
Z: TO-92

ORDER NUMBER	PIN CONFIGURATION
AIC431CS TL431ACS TL431CS (SO-8)	TOP VIEW 
AIC431CUN TL431ACUN TL431CUN (SOT-23)	FRONT VIEW 1: CATHODE 2: VREF 3: ANODE 
AIC431CUS TL431ACUS TL431CUS (SOT-23)	FRONT VIEW 1: VREF 2: CATHODE 3: ANODE 
AIC431CX TL431ACX TL431CX (SOT-89)	FRONT VIEW 1: VREF 2: ANODE 3: CATHODE 
AIC431CZ TL431ACZ TL431CZ (TO-92)	FRONT VIEW 1: VREF 2: ANODE 3: CATHODE 

ABSOLUTE MAXIMUM RATINGS

Cathode Voltage 30V

Continuous Cathode Current .... -10mA ~ 250mA

Reference Input Current Range 10mA

Operating Temperature Range .... -40°C ~ 85°C

Lead Temperature .... 260°C

Storage Temperature .... -65°C ~ 150°C

Power Dissipation **(Notes 1, 2)** SOT-89 Package 0.80W

TO-92 Package 0.78W

Note 1: $T_{J,\ max}$ = 150°C.
Note 2: Ratings apply to ambient temperature at 25°C.

■ TEST CIRCUITS

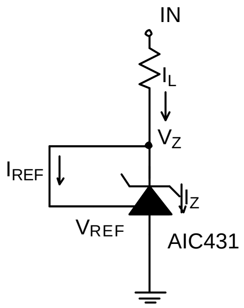
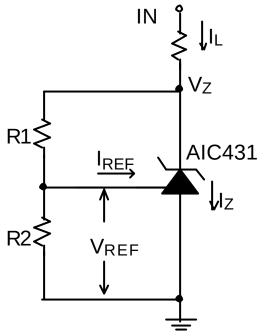


Fig. 1 Test Circuit for V_Z=V_{REF}



Note: $V_Z=V_{REF}(1+R1/R2)+I_{REF}xR1$

Fig. 2 Test circuit for V_Z>V_{REF}

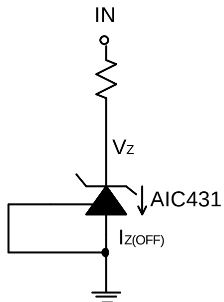


Fig. 3 Test circuit for off-state Current

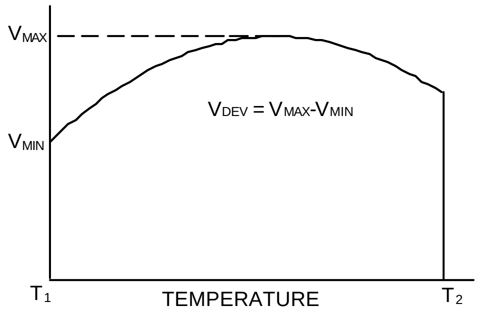
■ ELECTRICAL CHARACTERISTICS (Ta=25°C, unless otherwise specified.)

PARAMETER	TEST CONDITIONS		SYMBOL	MIN.	TYP.	MAX.	UNIT
Reference Voltage	V_Z=V_{REF}, IL =10mA (Fig. 1)	AIC431	V_{REF}	2.482	2.495	2.508	V
		TL431A		2.470	2.495	2.520	
		TL431		2.455	2.495	2.535	
Deviation of Reference Input Voltage Over Temperature **(Note 3)**	V_Z = V_{REF} , I_L =10mA, Ta = 0°C~ +85°C (Fig. 1)		V_{DEV}		9.0	20	mV
Ratio of the Change in Reference Voltage to the Change in Cathode voltage	I_Z=10mA (Fig. 2)	ΔV_Z=10V-V_{REF}	$\frac{\Delta V_{REF}}{\Delta V_Z}$		-0.5	-2.0	mV/V
		ΔV_Z=30V-10V			-0.35	-1.5	mV/V
Reference Input Current	R1 =10KΩ, R2=∞, I_L =10mA (Fig. 2)		I_{REF}		0.8	3.5	µA

Deviation of Reference Input Current over Temperature	R1 =10KΩ, R2=∞, I_L =10mA Ta =-20°C ~ +85°C (Fig. 2)	αI_{REF}		0.3	1.2	μA

ELECTRICAL CHARACTERISTICS (Continued)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Minimum Cathode current for Regulation	V_Z=V_{REF} (Fig. 1)	$I_{Z(MIN)}$		0.25	0.5	mA
Off-State Current	V_Z=20V, V_{REF} =0V (Fig. 3)	$I_{Z(OFF)}$		0.1	1.0	µA
Dynamic Output Impedance **(Note 4)**	V_Z=V_{REF} Frequency= 0Hz (Fig. 1)	R_Z		0.08	0.3	Ω



Note 3. 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, αV_{REF} is defined as:

$$\Delta V_{REF}\frac{ppm}{°C}=\frac{\pm\left[\frac{V_{MAX}-V_{MIN}}{V_{REF}(at\,25°C)}\right]10^6}{T2-T1}=\frac{\pm\left[\frac{V_{DEV}}{V_{REF}(at\,25°C)}\right]10^6}{T2-T1}$$

Where:

T_2–T_1=full temperature change.

αV_{REF} can be positive or negative depending on whether the slope is positive or negative.

Example: V_{DEV}= 9.0mV, V_{REF}= 2495mV,

T_2–T_1= 70°C, slope is negative.

$$aV_{REF}=\frac{\left[\frac{9.0mV}{2495mV}\right]10^6}{70°C}=-50ppm/°C$$

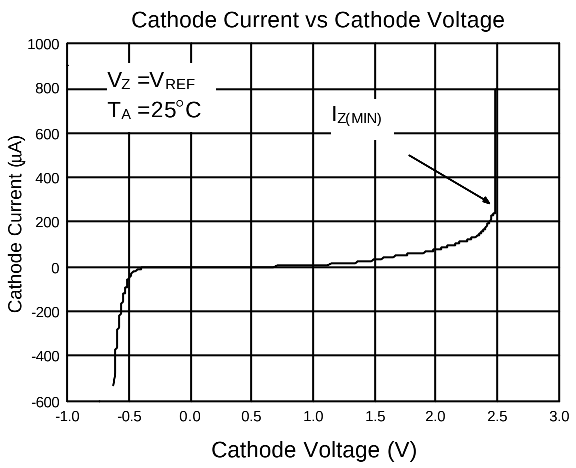
Note 4. The dynamic output impedance, R_Z, is defined as:

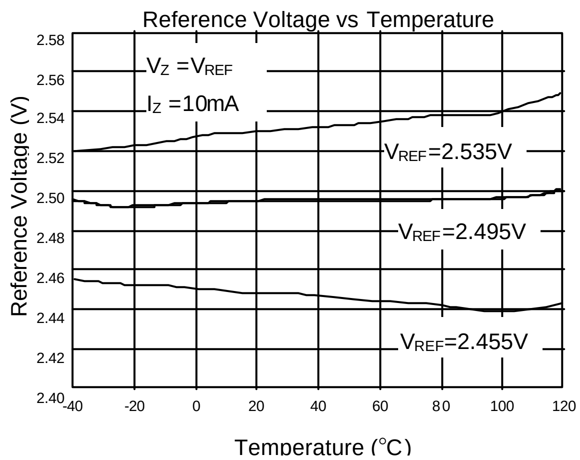
$$R_Z=\frac{\Delta V_Z}{\Delta I_Z}$$

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

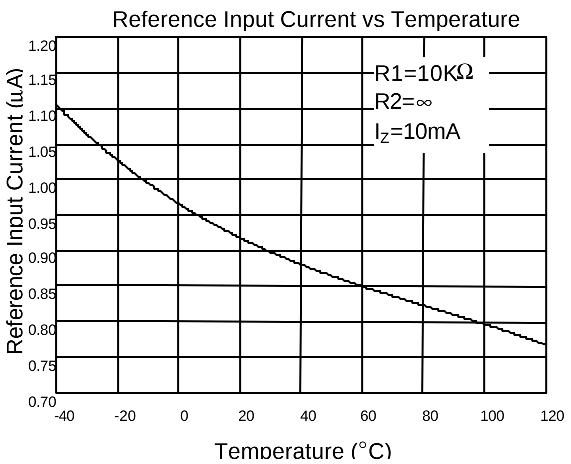
$$r_Z=\frac{\Delta V_Z}{\Delta I_Z}\cong R_Z\left[1+\frac{R1}{R2}\right]$$

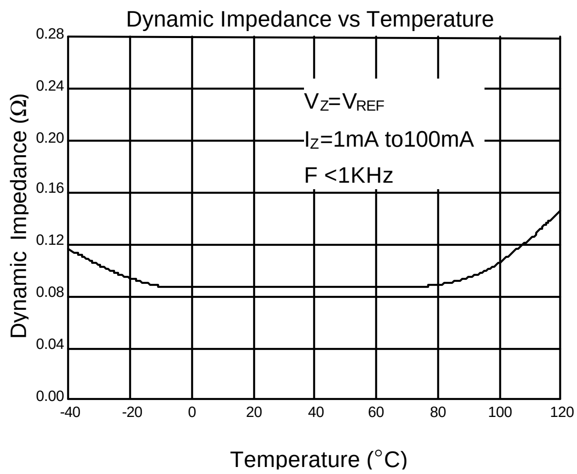
TYPICAL PERFORMANCE CHARACTERISTICS

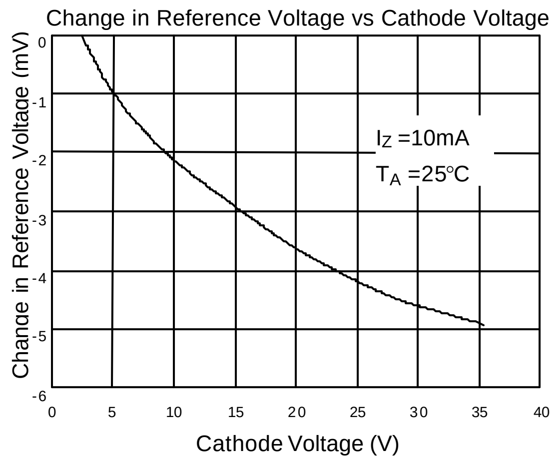


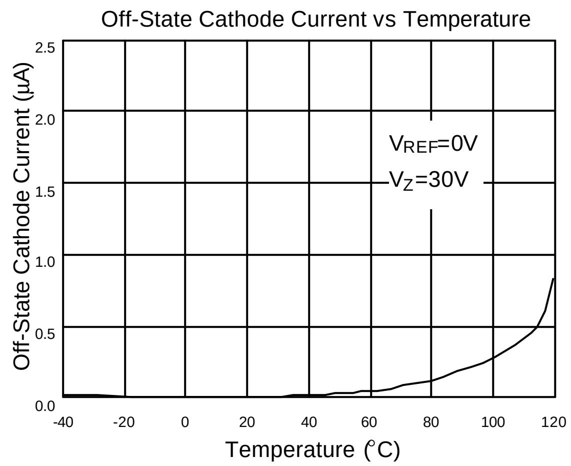


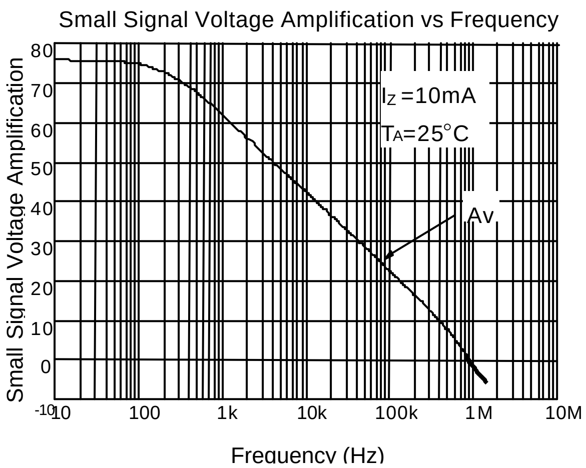
■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

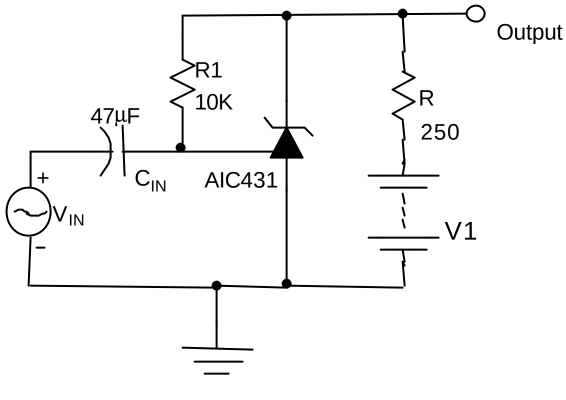








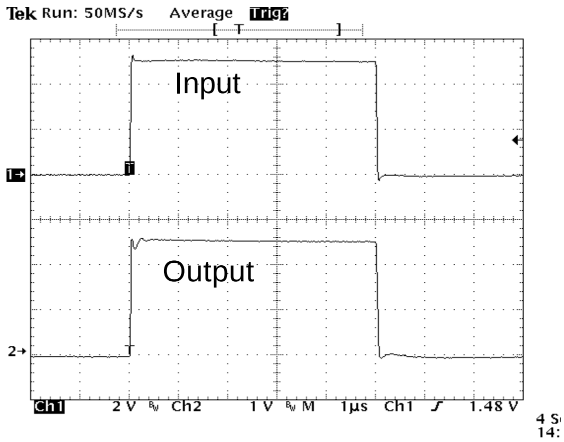


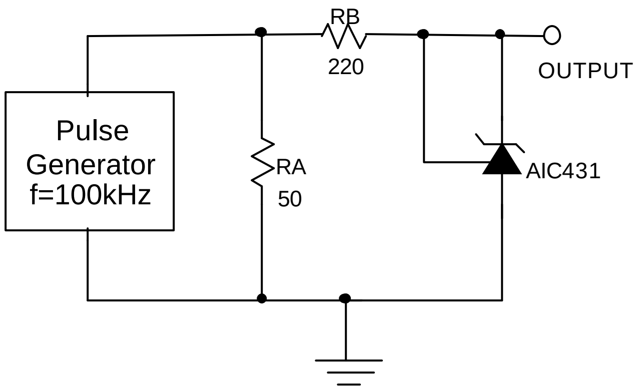


Test Circuit For Frequency Response

■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

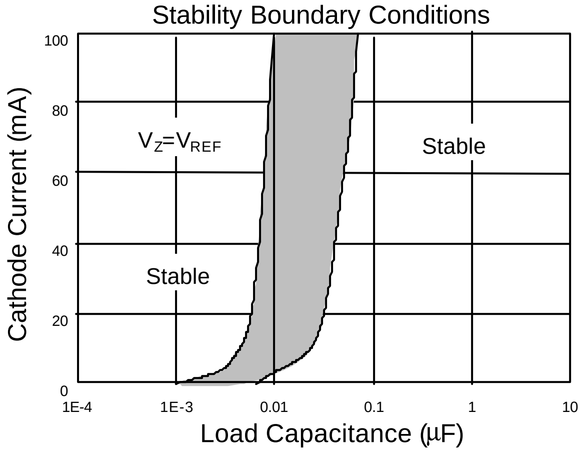
Pulse Response



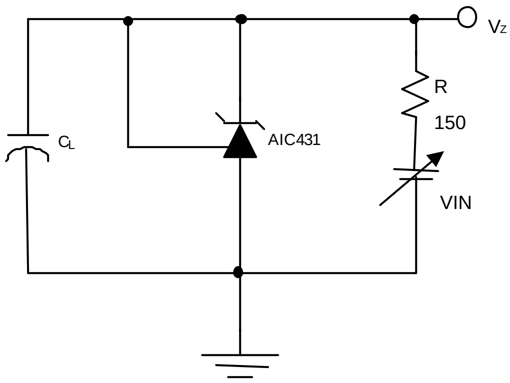


Test Circuit For Pulse Respnose

Stability Boundary Conditions

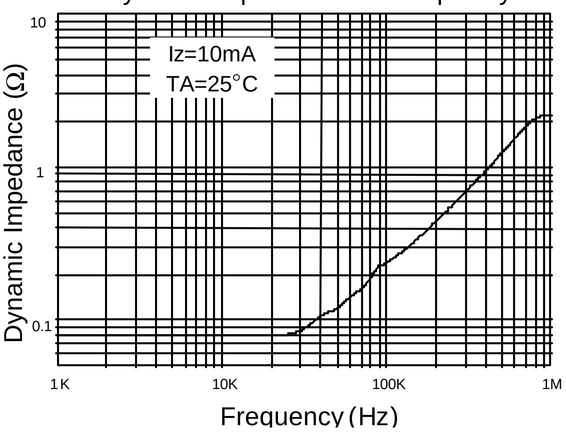


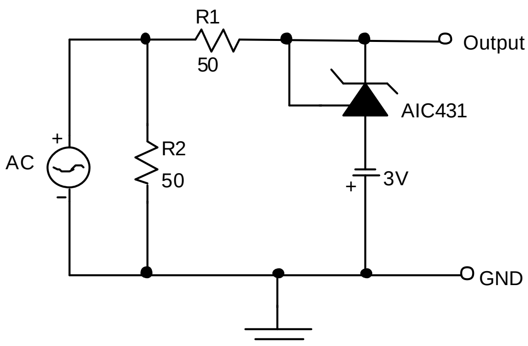
The areas between the curves represent condition that may cause the device oscillate



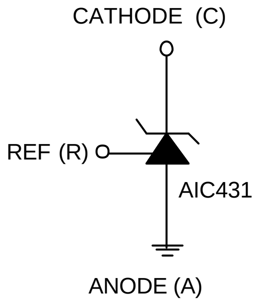
Test Circuit for Stability Boundary Conditions

Dynamic impedance vs. Frequency

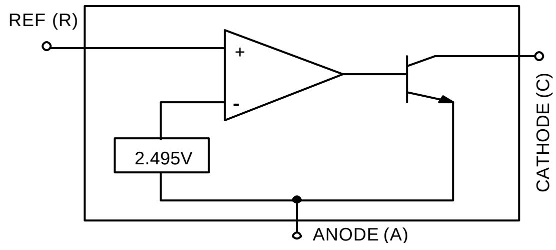




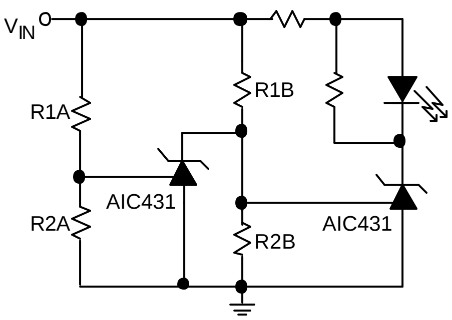
SYMBOL



BLOCK DIAGRAM



APPLICATION EXAMPLES

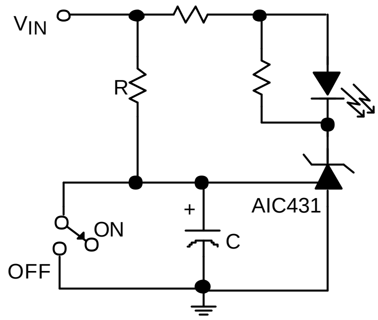


LED on when Low Limit $< V_{IN} <$ High Limit

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

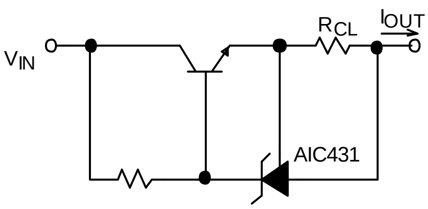
High Limit $\cong V_{REF}$ (1+R1A/R2A)

Fig. 4 Voltage Monitor



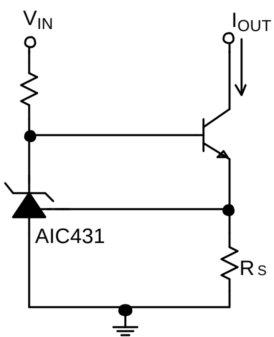
Delay=R x C x $\ell n \left(\frac{V_{IN}}{V_{IN}-V_{REF}}\right)$

Fig. 5 Delay Timer



$I_{OUT}=V_{REF}/R_{CL}$

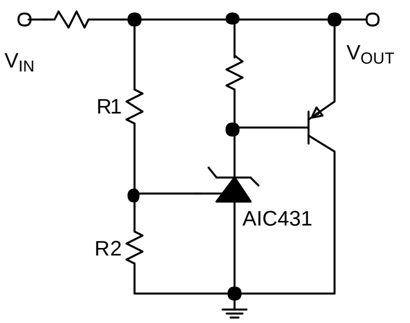
Fig. 6 Current Limiter or Current Source



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

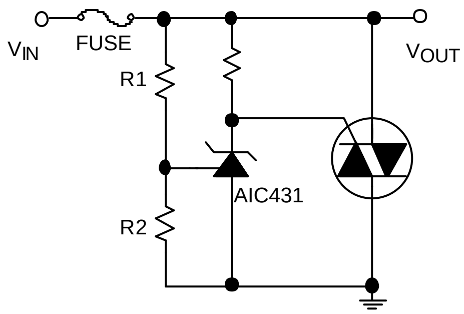
Fig. 7 Constant-Current Sink

■ APPLICATION EXAMPLES (Continued)



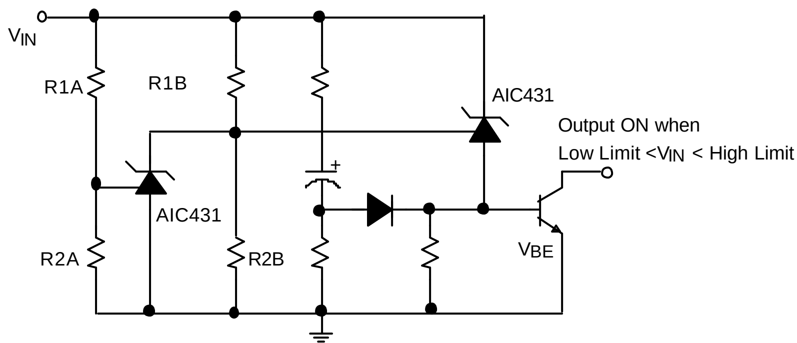
$V_{OUT} \cong (1+R1/R2) \times V_{REF}$

Fig 8. Higher-Current Shunt Regulator



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

Fig 9. Crow Bar

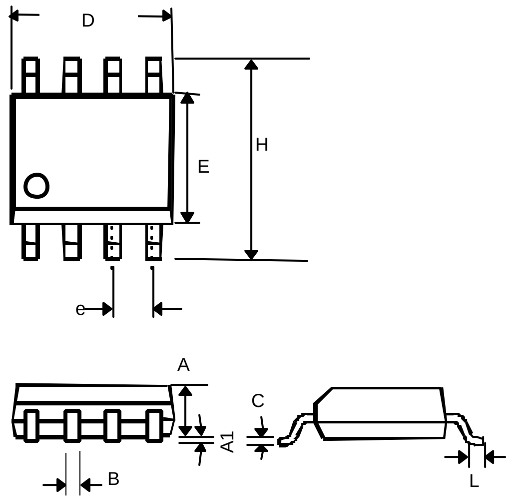


Low Limit $\cong V_{REF}$ (1+ R1B/ R2B)+ V_{BE}
High Limit $\cong V_{REF}$ (1+ R1A/ R2A)

Fig 10. Over-Voltage/Under-Voltage Protection Circuit

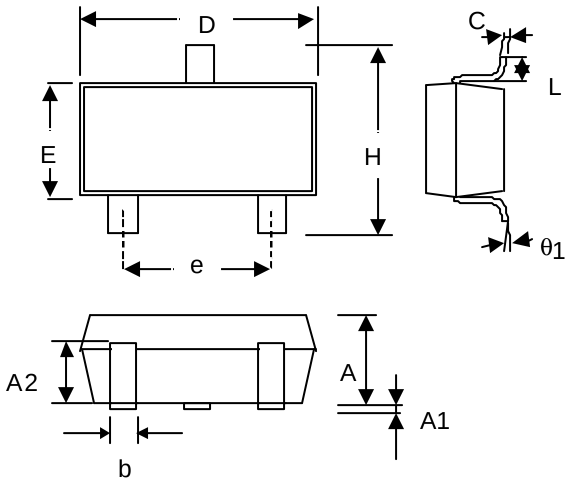
PHYSICAL DIMENSIONS

- **8 LEAD PLASTIC SO (unit: mm)**



SYMBOL	MIN	MAX
A	1.35	1.75
A1	0.10	0.25
B	0.33	0.51
C	0.19	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27(TYP)	
H	5.80	6.20
L	0.40	1.27

- **SOT-23 (unit: mm)**



SYMBOL	MIN	MAX
A	1.00	1.30
A1	—	0.10
A2	0.70	0.90
b	0.35	0.50
C	0.10	0.25
D	2.70	3.10
E	1.40	1.80
e	1.90 (TYP)	
H	2.60	3.00
L	0.37	—
θ1	1°	9°

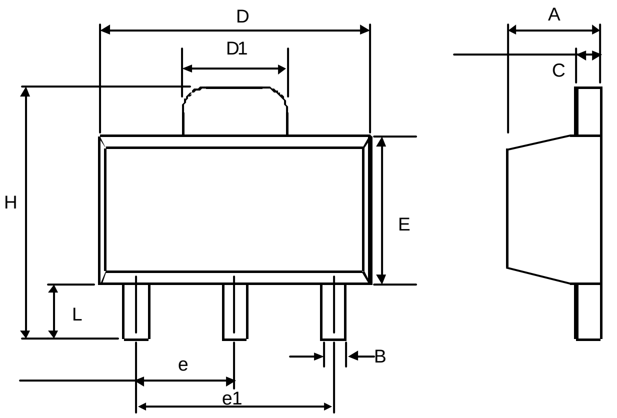
- **SOT-23 MARKING**

Part No.	Marking
AIC431CUN	AC1N
TL431CUN	AC2N
TL431ACUN	AC3N

Part No.	Marking
AIC431CUS	AC1S
TL431CUS	AC2S
TL431ACUS	AC3S

PHYSICAL DIMENSIONS (Continued)

- **SOT-89 (unit: mm)**

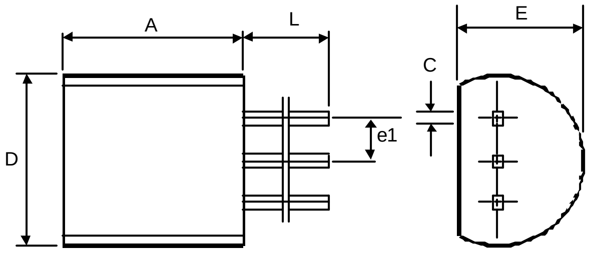


SYMBOL	MIN	MAX
A	1.40	1.60
B	0.36	0.48
C	0.35	0.44
D	4.40	4.60
D1	1.62	1.83
E	2.29	2.60
e	1.50 (TYP.)	
e1	3.00 (TYP.)	
H	3.94	4.25
L	0.89	1.20

- **SOT-89 MARKING**

Part No.	Marking
AIC431CX	AC01B
TL431CX	AC02B
TL431ACX	AC03B

- **TO-92 (unit: mm)**



SYMBOL	MIN	MAX
A	4.32	5.33
C	0.38 (TYP.)	
D	4.40	5.20
E	3.17	4.20
e1	1.27 (TYP.)	
L	12.7	-