ADJUSTABLE PRECISION SHUNT REGULATOR

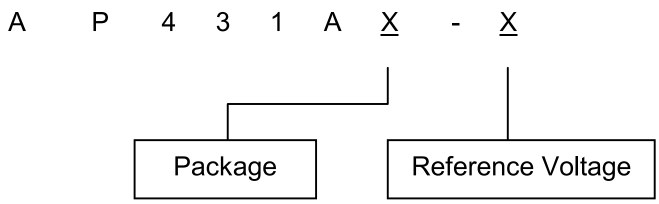
■ Features

- Precision reference voltage
  AP431A : 2.495V ± 0.5%
- Sink current capability: 200mA
- Minimum cathode current for regulation: 300 μA
- Equivalent full-range temp coefficient: 30 ppm/°C
- Fast turn-on response
- Low dynamic output impedance: 0.2Ω
- Programmable output voltage to 36V
- Low output noise.
- Packages: TO-92,SOT-23, SOT-25 and SOP-8
  SOT-89
- RoHS Compliant & Halogen Free Product

■ Description

The AP431A 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 36V merely by selecting two external resistors that act as a voltage divider network. These devices have a typical output impedance of 0.2Ω. Active output circuitry provides very sharp turn-on characteristics, making these devices excellent improved replacements for Zener diodes in many applications. The precise (+/-) 1% Reference voltage tolerance of the AP431A make 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.

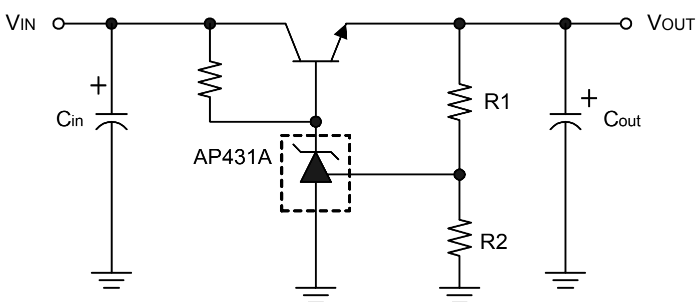
■ Ordering Information



T : TO-92
N/NR : SOT-23
Y : SOT-25
M : SOP-8
G: SOT-89

Tolerance :
A : +/- 0.5%
B : +/- 1%

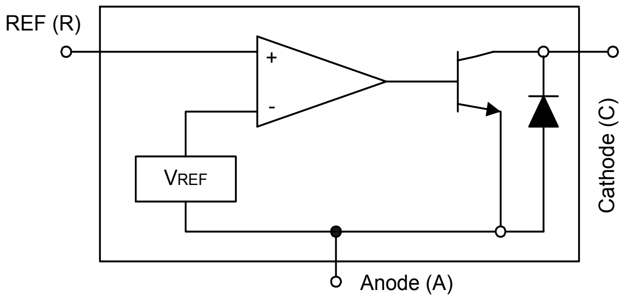
■ Typical Application Circuit



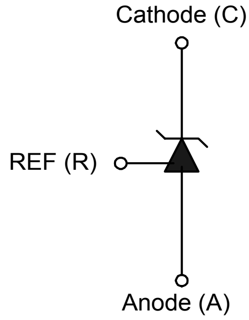
$V_{OUT} = (1+R1/R2)V_{REF}$

Precision Regulator

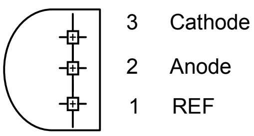
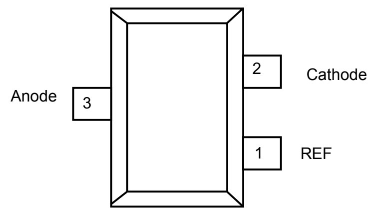
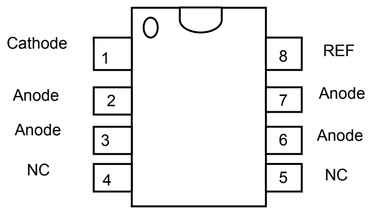
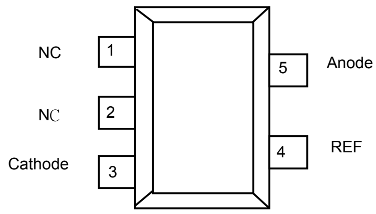
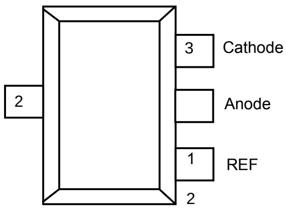
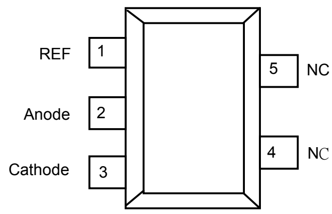
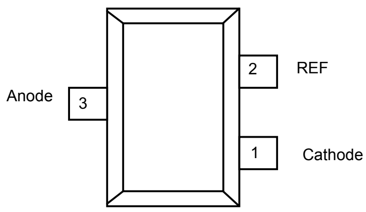
■ Block Diagram



■ Symbol



■ Pin Configuration

Order Number	Pin Configuration (Top View)	Order Number	Pin Configuration (Top View)
AP431AT (TO-92) Rthja=160°C/W Rthjl=60°C/W		AP431AN (SOT-23) Rthja=500°C/W Rthjc=180°C/W	
AP431AM (SO-8) Rthja=208°C/W Rthjc=50°C/W		AP431AY (SOT-23-5L) Rthja=500°C/W Rthjc=180°C/W	
AP431AG (SOT-89) Rthja=250°C/W Rthjc=110°C/W		AP431AY5 (SOT-23-5L) Rthja=500°C/W Rthjc=180°C/W	
AP431ANR (SOT-23) Rthja=500°C/W Rthjc=180°C/W			

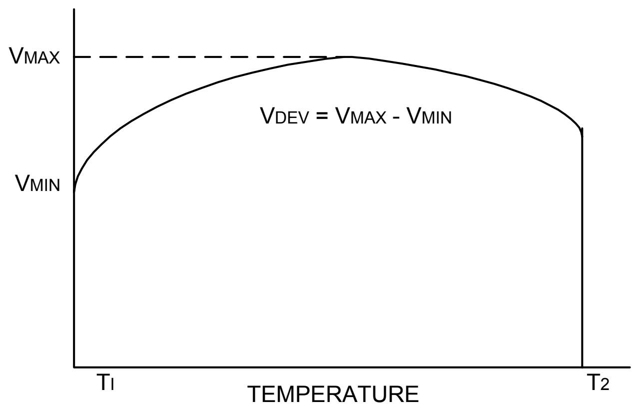
■ Absolute Maximum Ratings

Cathode Voltage 36V
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) TO-92 Package 0.78W
SOT-23 Package 0.25W
SOT-25 Package..0.25W
SOP-8 Package.. 0.6W
SOP-89 Package.. 0.5W

Note 1: TJ, max =150°C
Note 2: Ratings apply to ambient temperature at 25°C

■Electrical Characteristics (Ta=25°C , unless otherwise specified.)

PARAMETER	TEST CONDITIONS		SYMBOL	MIN.	TYP.	MAX.	UNIT
Reference voltage	V_{KA} = V_{REF}, I_{KA} = 10mA (Fig.1)	-B	V_{REF}	2.470	2.495	2.520	V
		-A		2.482		2.507	
Deviation of Reference input voltage over temperature (Note 3)	V_{KA} = V_{REF}, I_{KA} = 10mA, Ta = Full range (Fig.1)		V_{REF}		8.0	20	mV
Ratio of the change in Reference voltage to the change in Cathode voltage	I_{KA} = 10mA (Fig.2)	V_{KA} = 10V ~V_{REF}	ΔV_{REF}		-1.4	-2.0	mV/V
		V_{KA}= 36V ~10V	ΔV_{KA}		-1	-2	mV/V
Reference input current	R1 = 10KΩ,R2 = ∞ I_{KA}= 10mA (Fig.2)		I_{REF}		1.4	3.5	μA
Deviation of Reference input current over temperature	R1 = 10KΩ,R2 = ∞ I_{KA} = 10mA Ta = Full range (Fig.2)		αI_{REF}		0.4	1.2	μA
Minimum Cathode current for regulation	V_{KA} = V_{REF} (Fig.1)		$I_{KA(MIN)}$		0.19	0.5	mA
Off-state current	V_{KA} = 36V, V_{REF} = 0V (Fig.3)		$I_{KA(OFF)}$		0.1	1.0	μA
Dynamic output impedance (Note 4)	V_{KA} = V_{REF} Frequency≤ 1KHz (Fig.1)		$\lvert Z_{KA}\rvert$		0.2	0.5	Ω



Note 3. Deviation of reference input voltage, V_{DEV}, is defined as the maximum variation of the reference over the full temperature range.

The average temperature coefficient of the reference input voltage αV_{REF} is defined as:

$$|\alpha V_{REF}| = \frac{\left(\frac{V_{DEV}}{V_{REF}(25°C)}\right)\cdot 10^{6}}{T_2 - T_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; (ppm/°C)$$

Where:

T2 – T1 = full temperature change.

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

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

$$|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$$

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

$$|Z_{KA}'| = \frac{\Delta v}{\Delta i} \approx |Z_{KA}| \quad (1 + \frac{R1}{R2})$$

■ Test Circuits

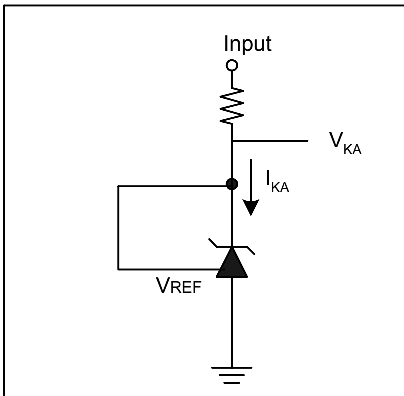


Fig1. Test Circuit for $V_{KA} = V_{REF}$

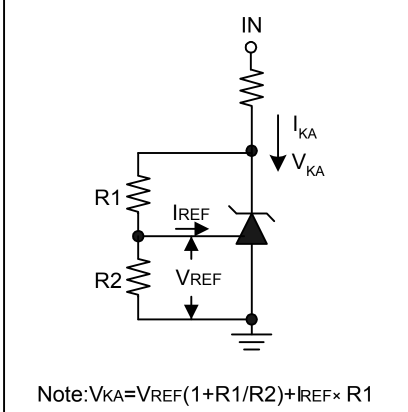


Fig2. Test circuit for $V_{KA} > V_{REF}$

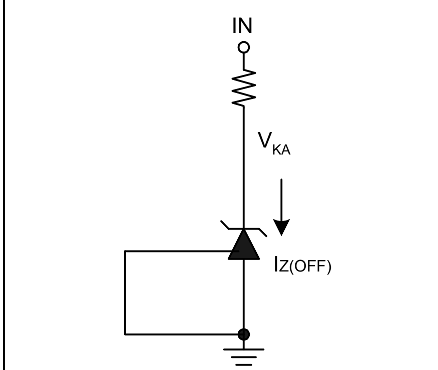
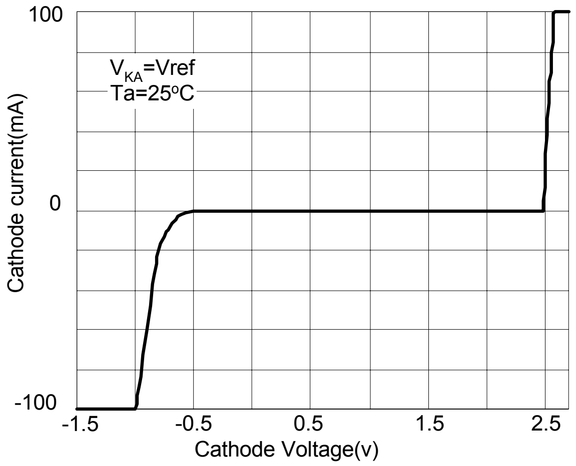


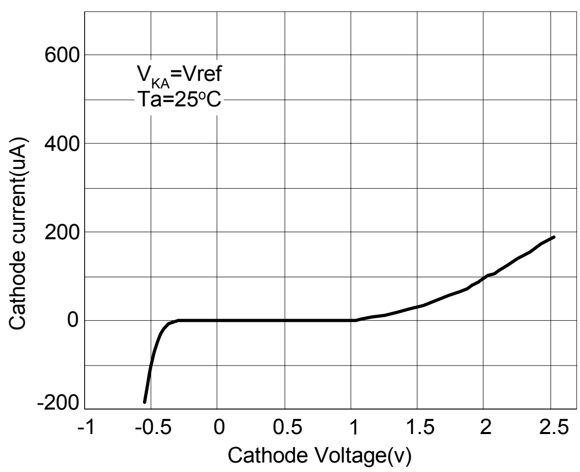
Fig3. Test Circuit for off-state Current

■ Typical Performance Characteristics

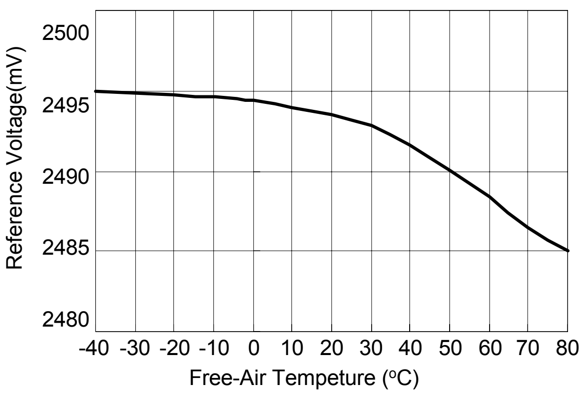
Cathode current Vs Cathode Voltage



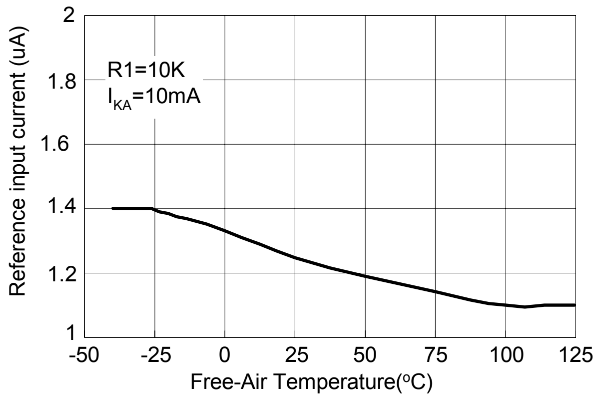
Cathode current (uA) Vs Cathode Voltage



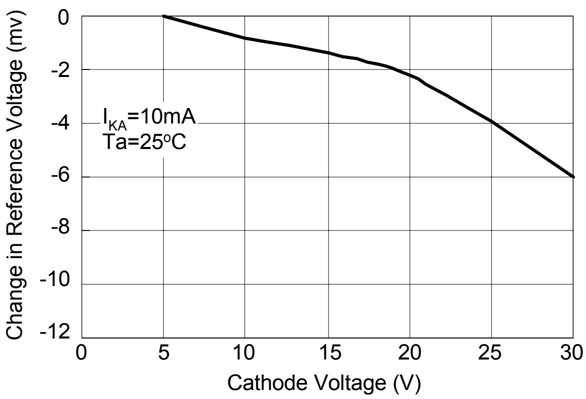
Reference Voltage Vs Free-Air Temperature



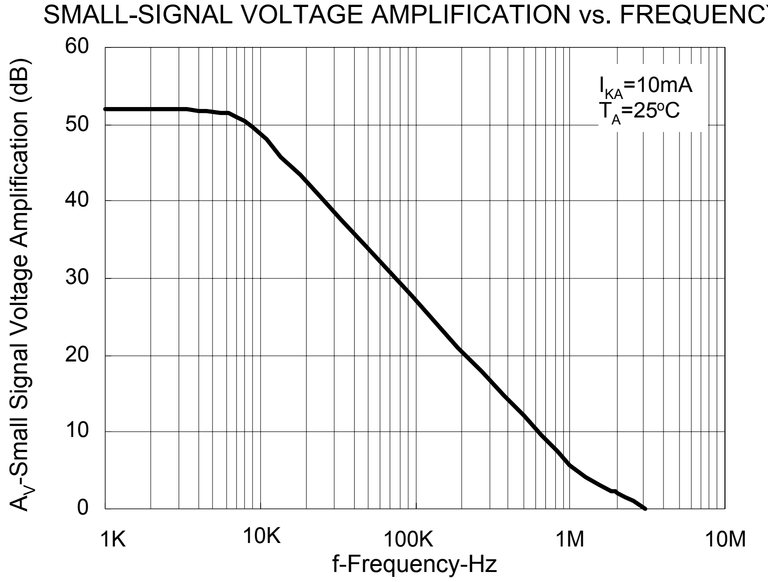
Reference input current Vs free Temperature

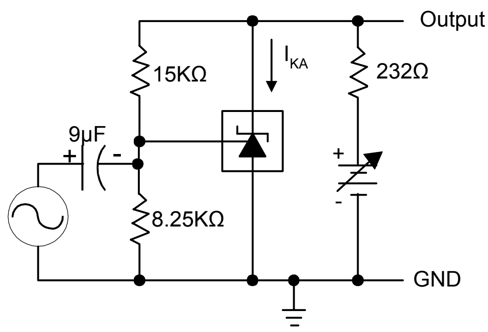


Change in Reference Voltage vs Cathode Voltage

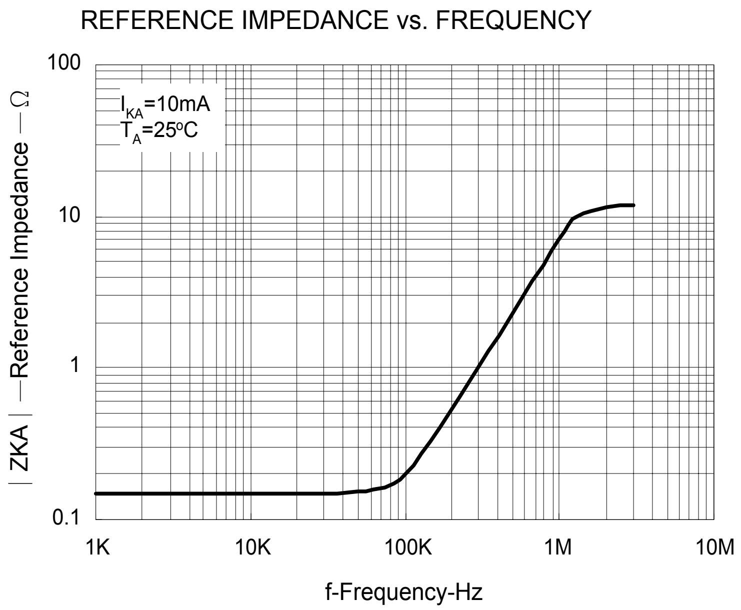


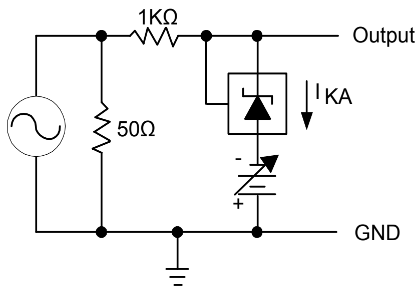
■ Typical Performance Characteristics(Continued)



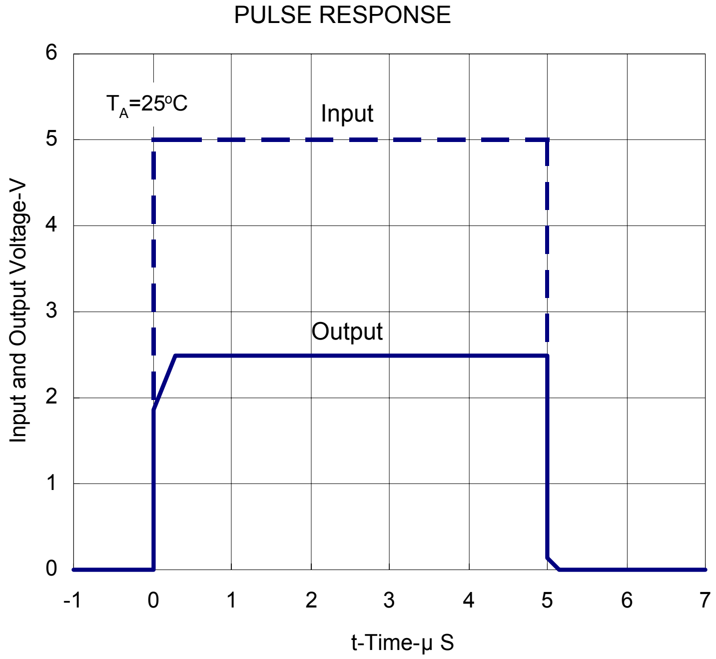


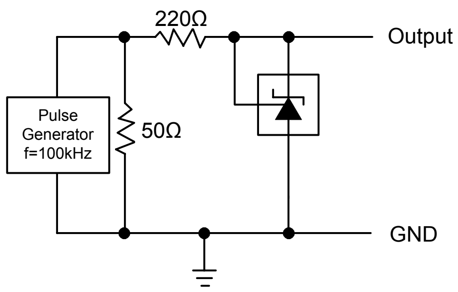
TEST CIRCUIT FOR VOLTAGE AMPLIFICATION



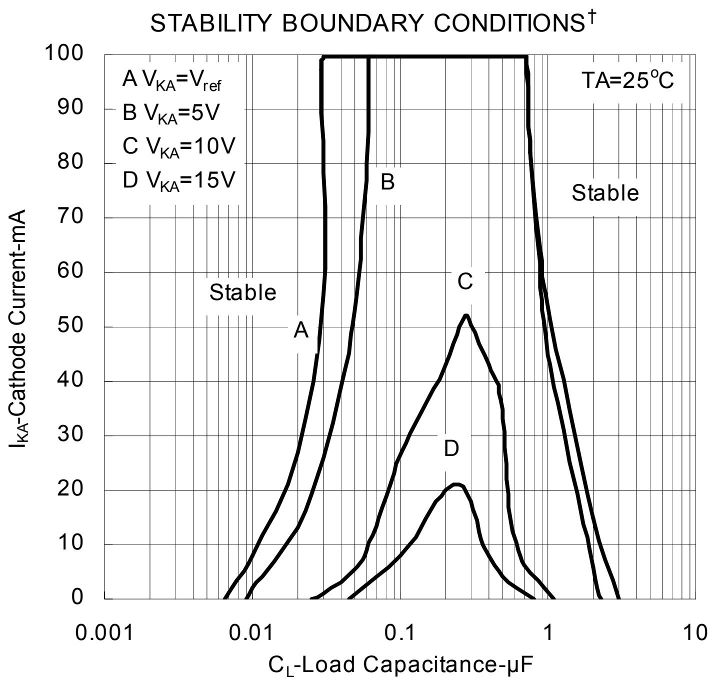


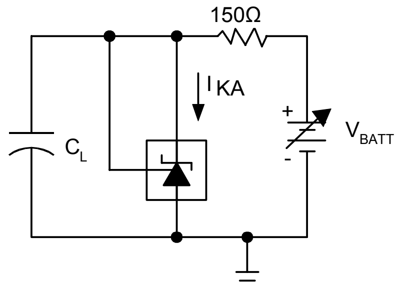
TEST CIRCUIT FOR REFERENCE IMPEDANCE



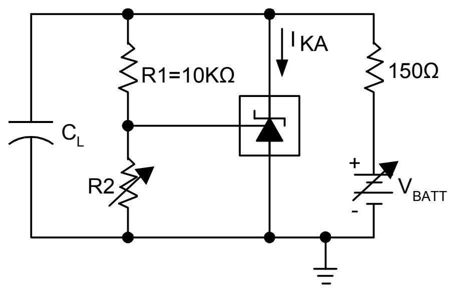


TEST CIRCUIT FOR PULSE RESPONSE





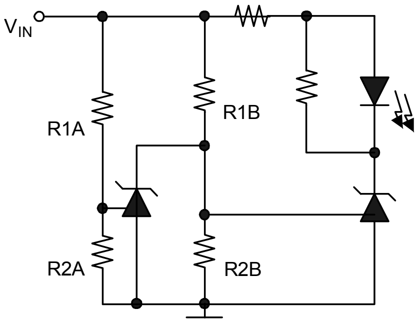
TEST CIRCUIT FOR CURVE A



TEST CIRCUIT FOR CURVE B, C, AND D

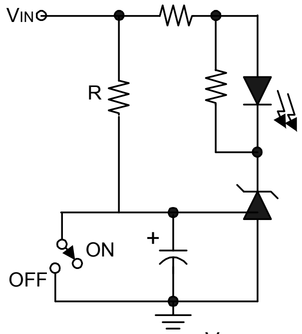
†The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial V_{KA} and I_{KA} conditions with C_L=0.V_{BATT} and C_L were then adjusted to determine the ranges of stability.

■ Application Examples



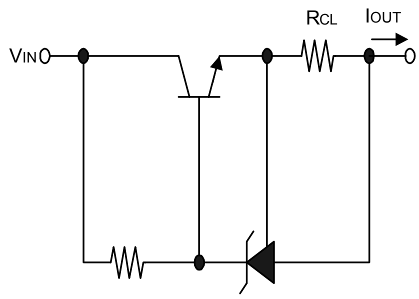
LED on when Low Limit < V_{IN} < High Limit
Low Limit ≈ V_{REF} (1+R1B/R2B)
High Limit ≈ V_{REF} (1+R1A/R2A)

Fig.4 Voltage Monitor



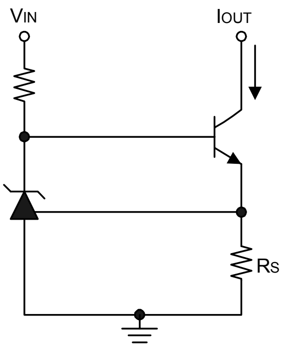
$$\text{Delay} = RC \times \ln\left(\frac{V_{IN}}{V_{IN} - V_{REF}}\right)$$

Fig.5 Delay Timer



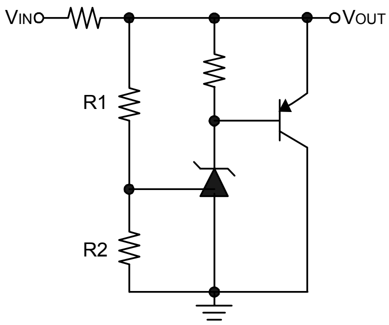
$I_{OUT} = V_{REF} / R_{CL}$

Fig.6 Current Limiter or Current Source



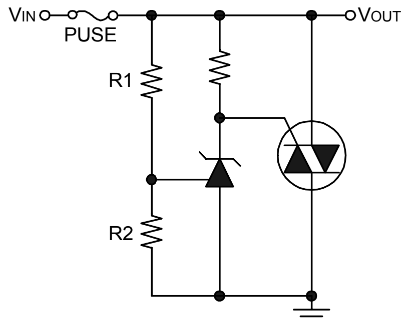
$I_{OUT} = V_{REF} / R_S$

Fig.7 Constant-Current Sink



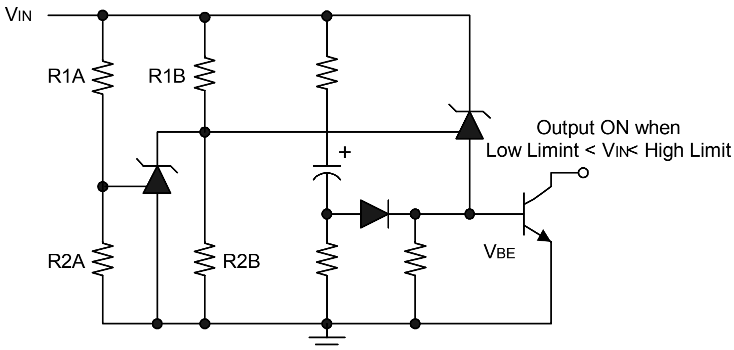
$V_{OUT} = (1 + R1/R2) \times V_{REF}$

Fig.8 Higher-Current Shunt Regulator



LIMIT ≈ $(1 + R1/R2) \times V_{REF}$

Fig.9 Crow Bar

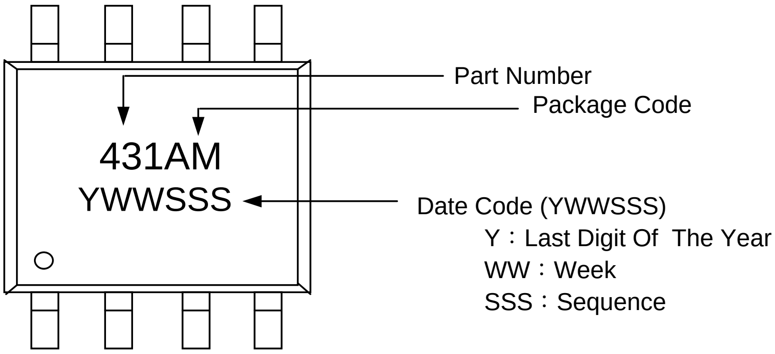


Low Limit ≈ $V_{REF}(1 + R1B/R2B) + V_{BE}$
High Limit ≈ $V_{REF}(1 + R1A/R2A)$

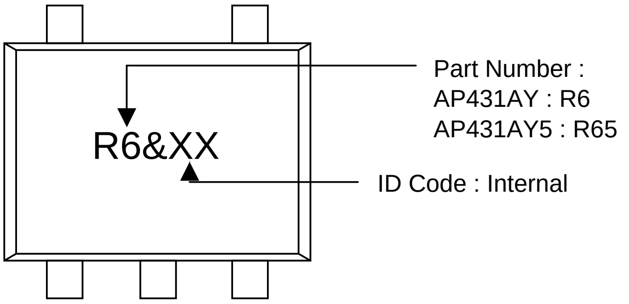
Fig.10 Over-Voltage / Under-Voltage Protection Circuit

MARKING INFORMATION

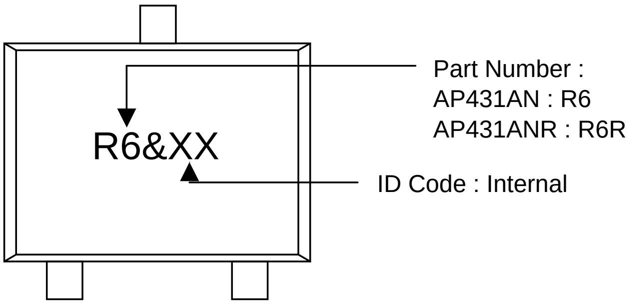
SO-8



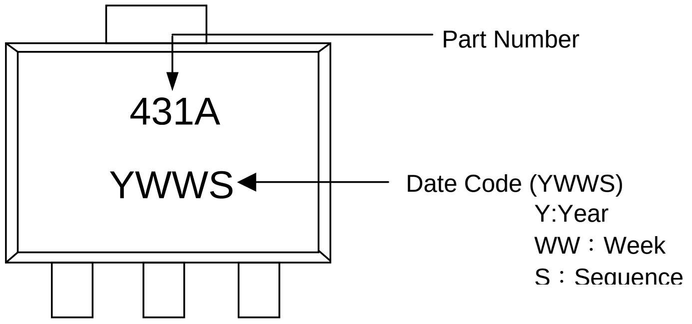
SOT-23-5L



SOT-23



SOT-89



MARKING INFORMATION

TO-92