Advanced Power Electronics Corp.

AP431A

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-23-5L(SOT-25)
  and SO-8 SOT-89
- Halogen Free & RoHS Compliant 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.

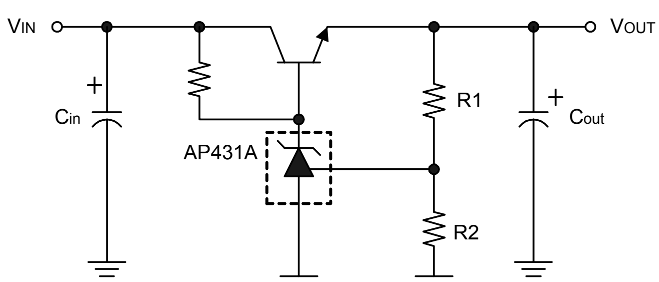
■ Ordering Information

AP431AX-X-HF

Halogen Free & RoHS product

Package	Reference Voltage
T : TO-92	Tolerance :
N/NR : SOT-23	A : +/- 0.5%
Y : SOT-23-5L(SOT-25)	B : +/- 1%
M : SO-8	
G: SOT-89	

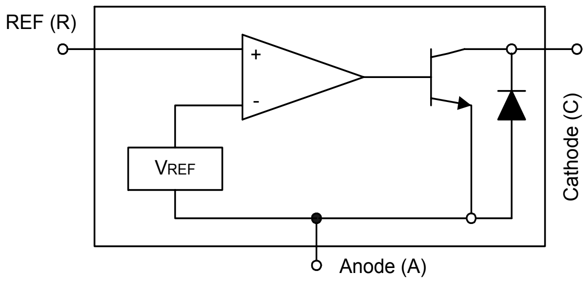
■ Typical Application Circuit



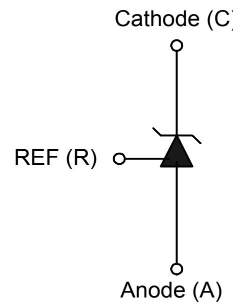
$V_{OUT} = (1+R1/R2)V_{REF}$

Precision Regulator

Block Diagram



Symbol

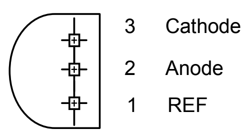


Pin Configuration

Order Number — Pin Configuration (Top View)

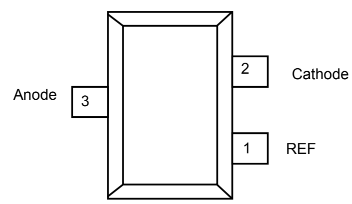
AP431AT
(TO-92)

Rthja=160°C/W
Rthjl=60°C/W



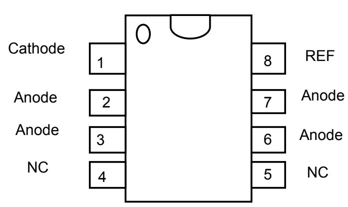
AP431AN
(SOT-23)

Rthja=500°C/W
Rthjc=180°C/W



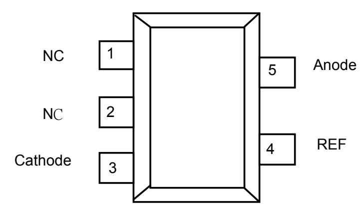
AP431AM
(SO-8)

Rthja=208°C/W
Rthjc=50°C/W



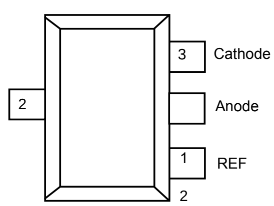
AP431AY
(SOT-23-5L)

Rthja=500°C/W
Rthjc=180°C/W



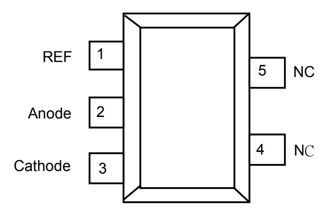
AP431AG
(SOT-89)

Rthja=250°C/W
Rthjc=110°C/W



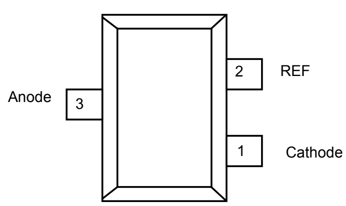
AP431AY5
(SOT-23-5L)

Rthja=500°C/W
Rthjc=180°C/W



AP431ANR
(SOT-23)

Rthja=500°C/W
Rthjc=180°C/W



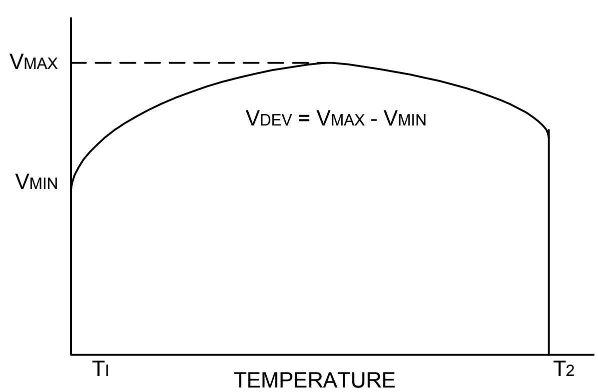
■ Absolute Maximum Ratings

Cathode Voltage ………………………………………………………………………36V
Continuous Cathode Current ……………………………………………… -10mA ~ 250mA
Reference Input Current Range ……………………………………………… 10mA
Operating Temperature Range ………………………………………… -20°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-23-5L Package…………………………………………… 0.25W
SO-8 Package…………………………………………………… 0.6W
SOT-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:

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

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:

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

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:

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

■ Test Circuits

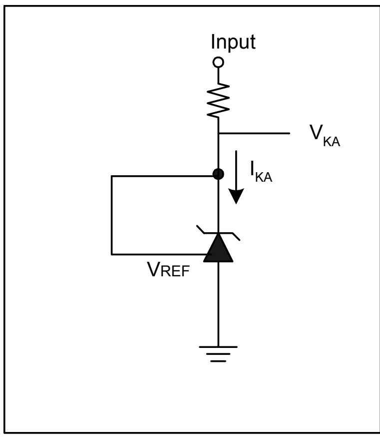


Fig1. Test Circuit for $V_{KA} = V_{REF}$

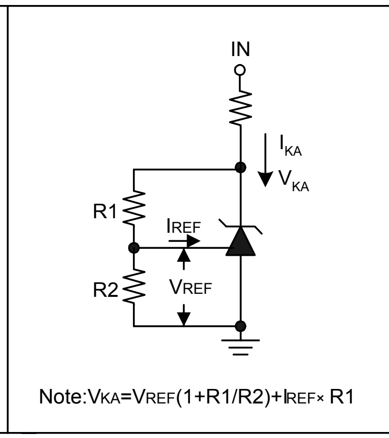


Fig2. Test circuit for $V_{KA} > V_{REF}$

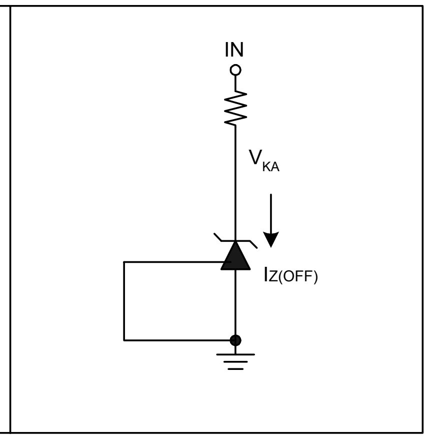
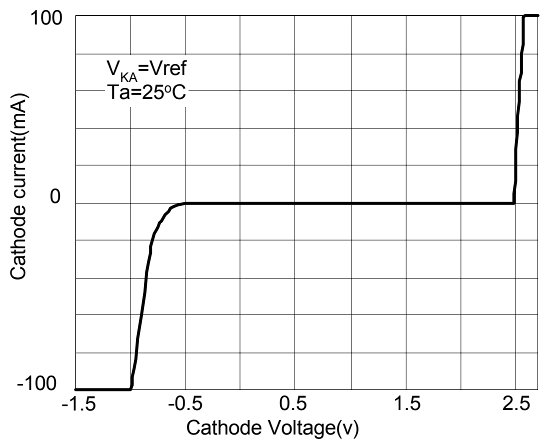


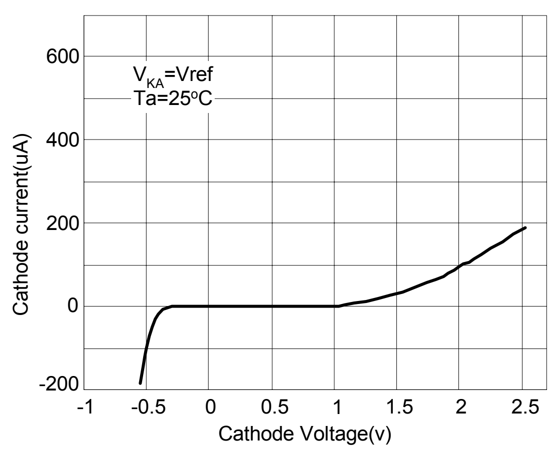
Fig3. Test Circuit for off-state Current

■ Typical Performance Characteristics

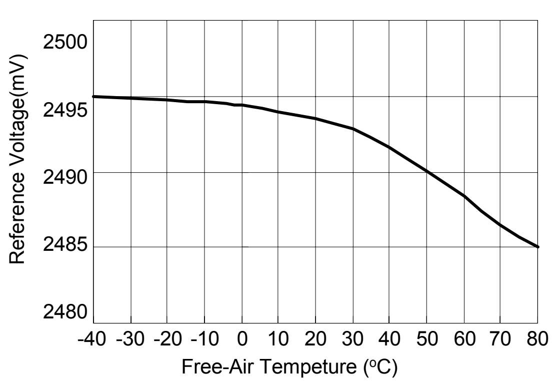
Cathode current Vs Cathode Voltage



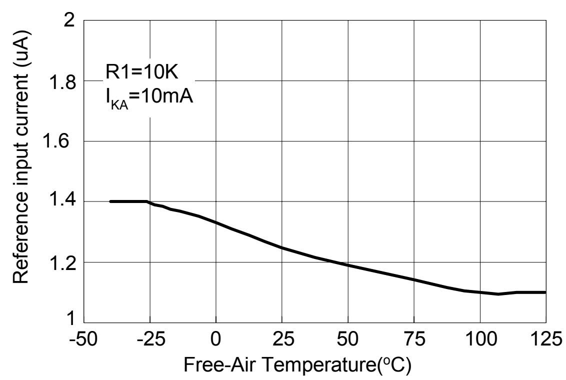
Cathode current (uA) Vs Cathode Voltage



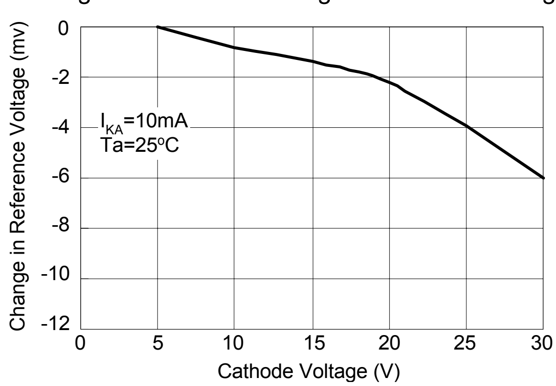
Reference Voltage Vs Free-Air Temperature



Reference input current Vs free Temperature

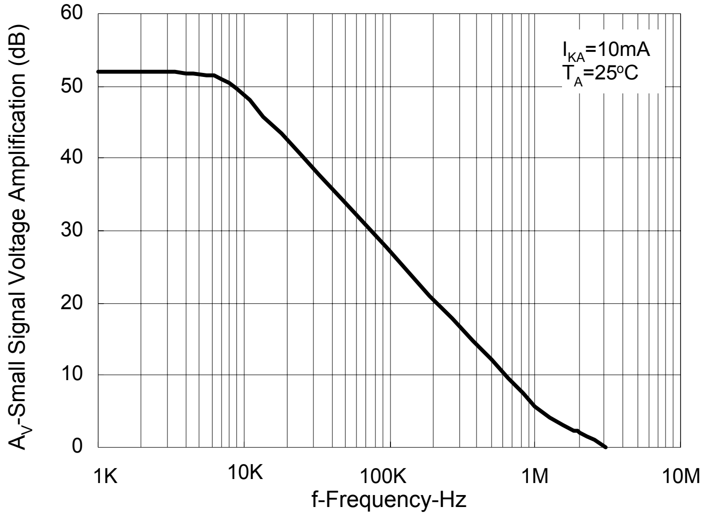


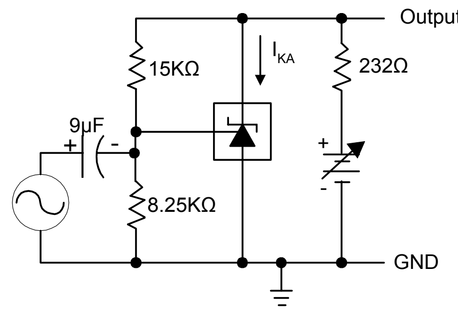
Change in Reference Voltage vs Cathode Voltage



■ Typical Performance Characteristics(Continued)

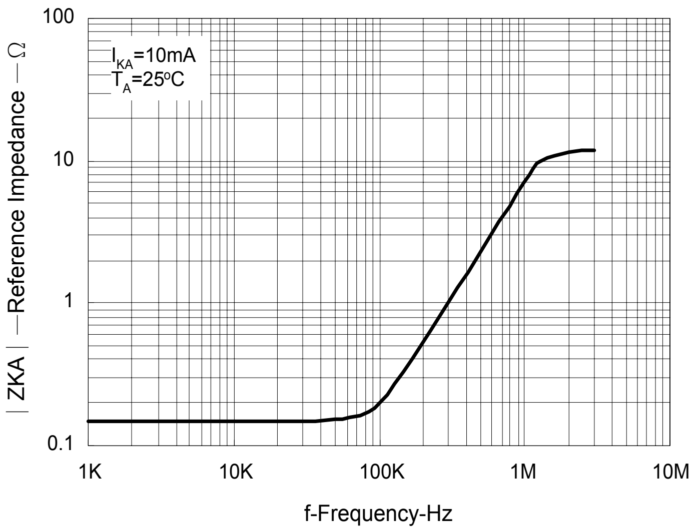
SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY

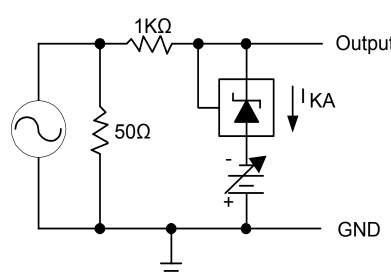




TEST CIRCUIT FOR VOLTAGE AMPLIFICATION

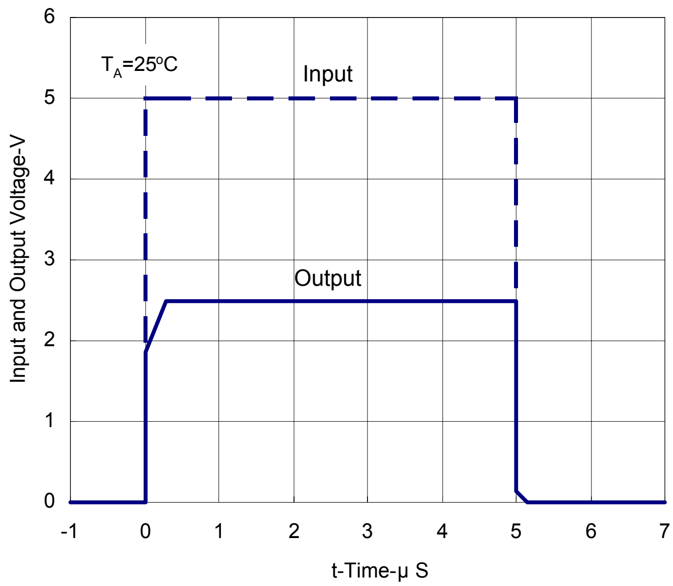
REFERENCE IMPEDANCE vs. FREQUENCY

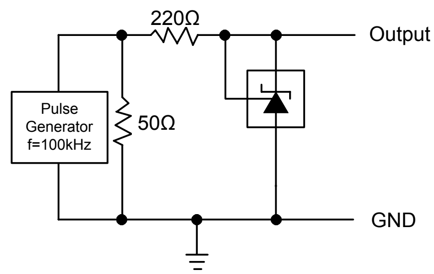




TEST CIRCUIT FOR REFERENCE IMPEDANCE

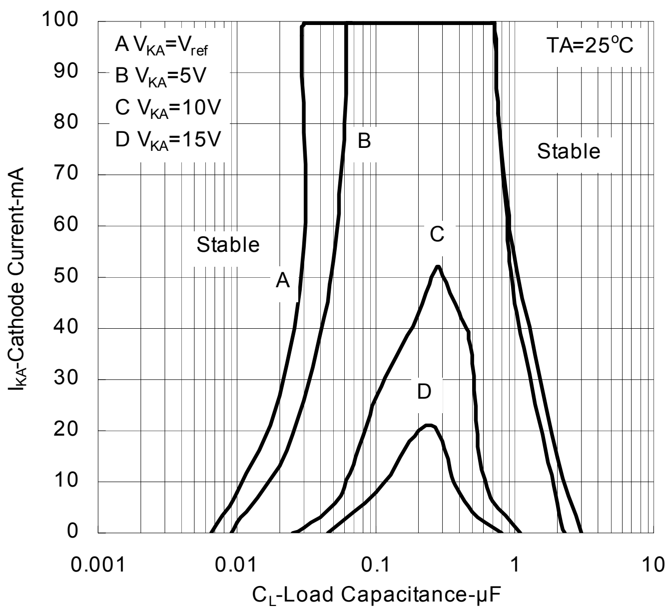
PULSE RESPONSE

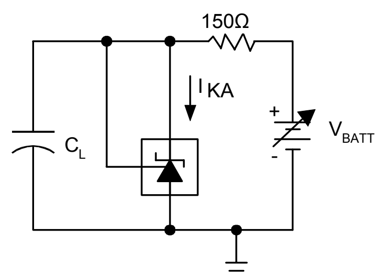




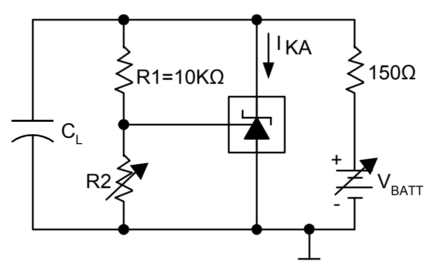
TEST CIRCUIT FOR PULSE RESPONSE

STABILITY BOUNDARY CONDITIONS†





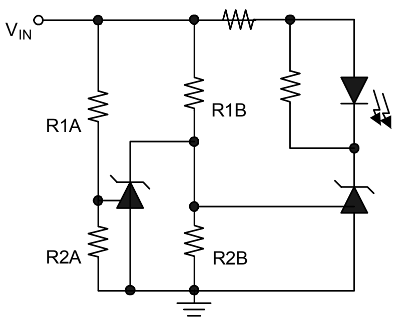
TEST CIRCUIT FOR CURVE A



TEST CIRCUIT FOR CURVE B, C, AND D

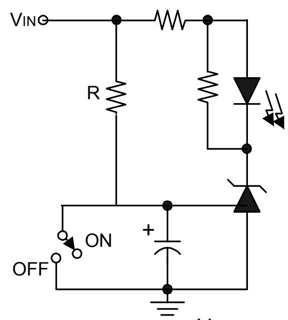
The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial V_{KA} and I_{KA} conditions with C_L=0.V_{BATT} and C_L were then adjusted to determine the ranges of stability.

■ Application Examples



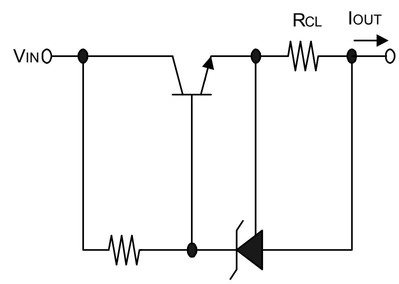
LED on when Low Limit < V_{IN} < High Limit
Low Limit ≈ V_{REF} (1+R1B/R2B)
High Limit ≈ V_{REF} (1+R1A/R2A)

Fig.4 Voltage Monitor



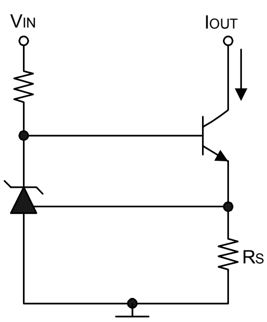
Delay = $RC \times \ln\left(\frac{V_{IN}}{V_{IN} - V_{REF}}\right)$

Fig.5 Delay Timer



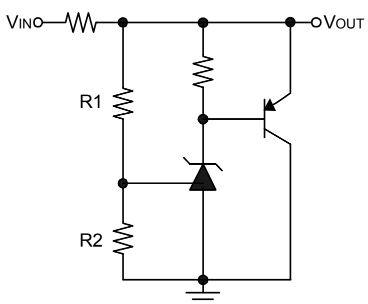
$I_{OUT} = V_{REF} / R_{CL}$

Fig.6 Current Limiter or Current Source



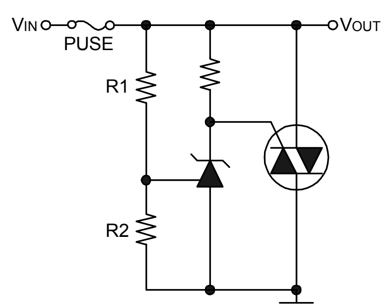
$I_{OUT} = V_{REF} / R_S$

Fig.7 Constant-Current Sink



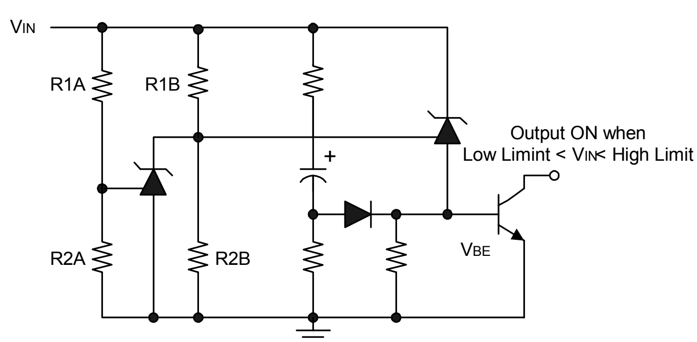
$V_{OUT} = (1 + R1/R2) \times V_{REF}$

Fig.8 Higher-Current Shunt Regulator



LIMIT ≈ (1 + R1/R2) x V_{REF}

Fig.9 Crow Bar

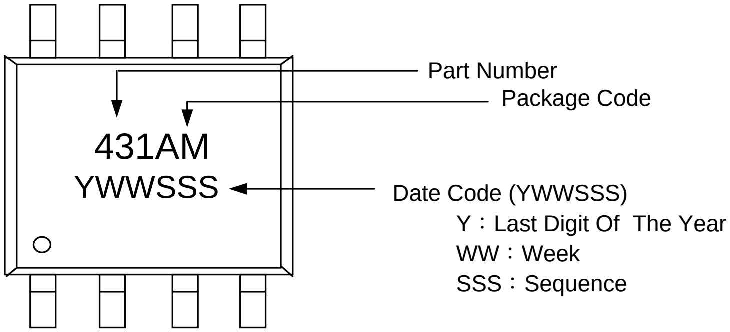


Low Limit ≈ V_{REF}(1 + R1B/R2B) +V_{BE}
High Limit ≈ V_{REF}(1 + R1A/R2A)

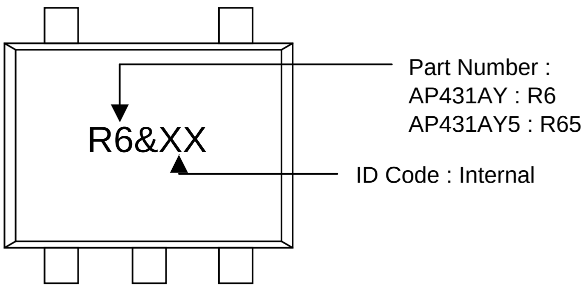
Fig.10 Over-Voltage / Under-Voltage Protection Circuit

MARKING INFORMATION

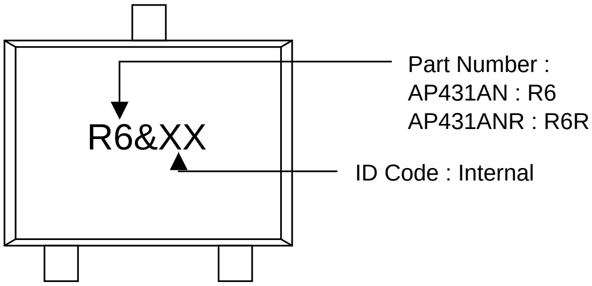
SO-8



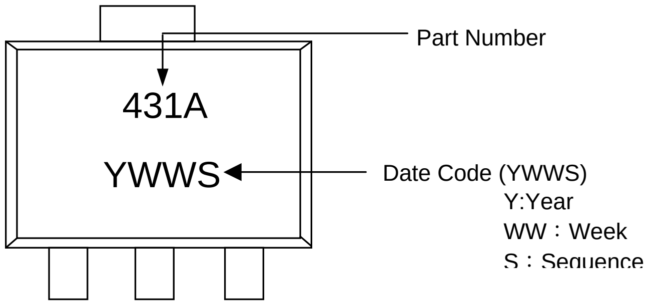
SOT-23-5L



SOT-23



SOT-89



MARKING INFORMATION

TO-92