AP431/AP431A

ADJUSTABLE PRECISION SHUNT REGULATOR

Features

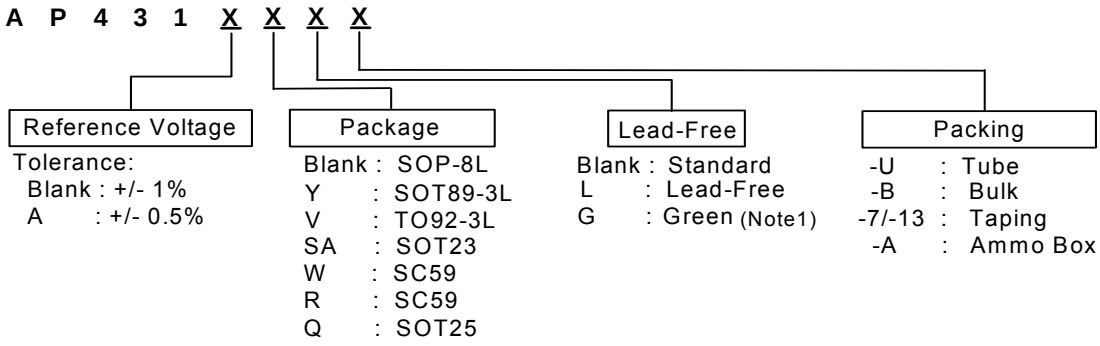
- Precision reference voltage
  AP431 : 2.495V ± 1%
  AP431A : 2.495V ± 0.5%
- Sink current capability: 200mA
- Minimum cathode current for regulation: 300μA
- Equivalent full-range temp coefficient: 30 ppm/°C
- Fast turn-on response
- Low dynamic output impedance: 0.2Ω
- Programmable output voltage to 36V
- Low output noise
- Packages: TO92-3L, SOT89-3L, SOP-8L, SOT23, SOT25, SC-59

Description

The AP431 and 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 AP431/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

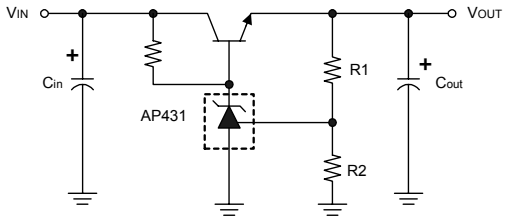


Note: 1. Only for SOT23 and SC59

Device (Note 2)	Package Code	Packaging (Note 3)	7" Tape and Reel		13" Tape and Reel		Ammo Box	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix	Quantity	Part Number Suffix
AP431(A)SA	SA	SOT23	3000/Tape & Reel	-7	10000/Tape & Reel	-13	NA	NA
AP431(A)Q	Q	SOT25	3000/Tape & Reel	-7	10000/Tape & Reel	-13	NA	NA
AP431(A)W	W	SC59	3000/Tape & Reel	-7	10000/Tape & Reel	-13	NA	NA
AP431(A)R	R	SC59	3000/Tape & Reel	-7	10000/Tape & Reel	-13	NA	NA
AP431(A)		SOP-8L	NA	NA	2500/Tape & Reel	-13	NA	NA
AP431(A)Y	Y	SOT89-3L	NA	NA	2500/Tape & Reel	-13	NA	NA
AP431(A)V	V	TO92-3L	NA	NA	NA	NA	2000/Box	-A

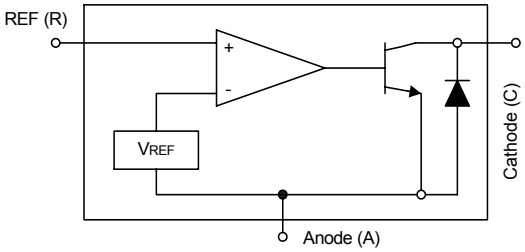
Notes: 2. Suffix "A" denotes AP431A device.
3. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at http://www.diodes.com/datasheets/ap02001.pdf.

Typical Application Circuit

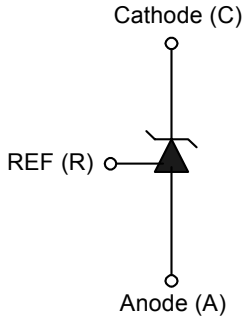


VOUT = (1+R1/R2)VREF
Precision Regulator

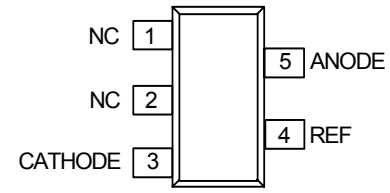
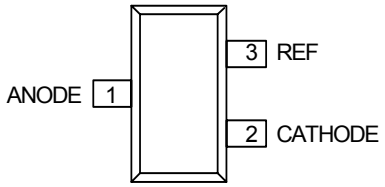
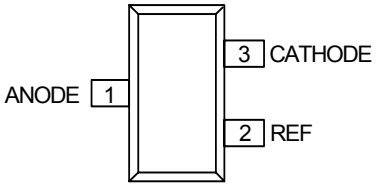
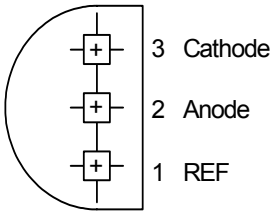
Typical Application Circuit

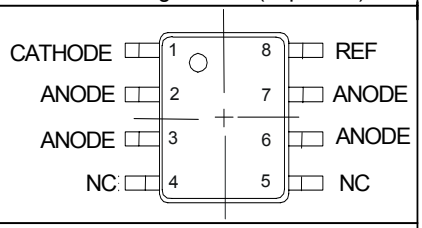
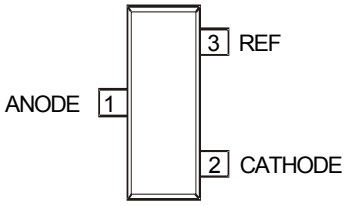
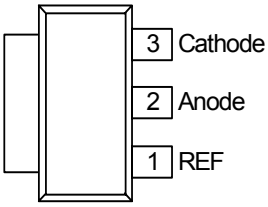


Typical Application Circuit



Pin Configuration

Package	Pin Configuration (Top View)
SOT25	
SC-59 (Package Code-W)	
SC-59 (Package Code-R)	
TO92-3L	

Package	Pin Configuration (Top View)
SOP-8L	
SOT23	
SOT89-3L	

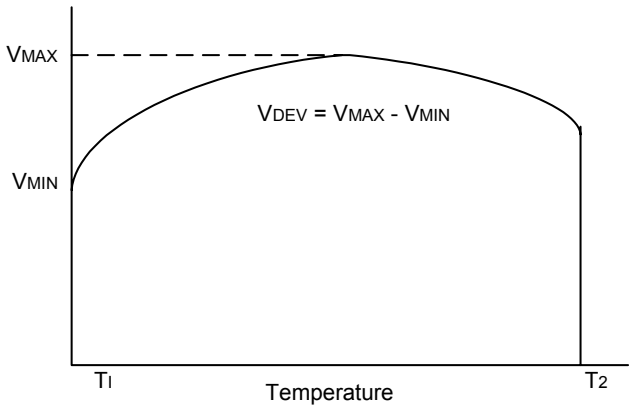
Absolute Maximum Ratings

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 4, 5)	SOT23 Package	250mW
	SOT25 Package	250mW
	SC59 Package	400mW
	SOP-8L Package	600mW
	SOT89-3L Package	800mW
	TO92-3L Package	780mW

Note 4. T_J, max =150°C
Note 5. Ratings apply to ambient temperature at 25°C

Electrical Characteristics (T_A = 25°C, V^+ = +5.0V, unless otherwise stated)

PARAMETER	TEST CONDITIONS		SYMBOL	MIN.	TYP.	MAX.	UNIT
Reference voltage	V_{KA} = V_{REF}, I_{KA} = 10mA (Fig.1)	AP431 AP431A	V_{REF}	2.470 2.482	2.495	2.520 2.507	V
Deviation of Reference input voltage over temperature (Note 6)	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 7)	V_{KA} = V_{REF} V_{KA} = V_{REF} ΔI_{KA} = 0.1mA ~ 15Ma Frequency ≤ 1KHz (Fig.1)		$\|Z_{KA}\|$	—	0.2	0.5	Ω



Note: 6. 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:

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

Where:
T2 – T1 = full temperature change.
αV_{REF} can be positive or negative depending on whether the slope is positive or negative.

Note: 7. 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

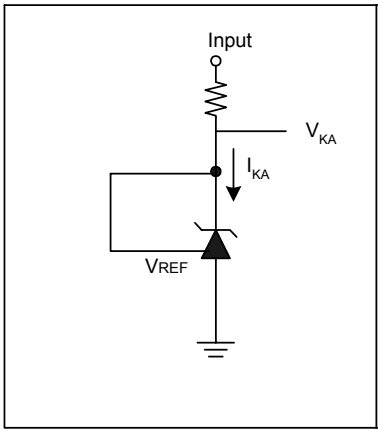


Fig 1. Test Circuit for $V_{KA} = V_{REF}$

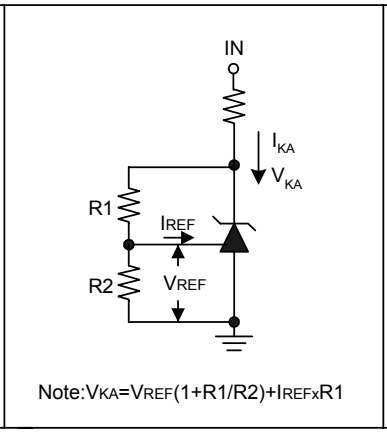


Fig 2. Test Circuit for $V_{KA} > V_{REF}$

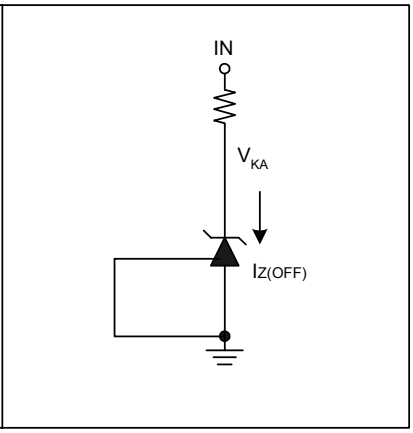
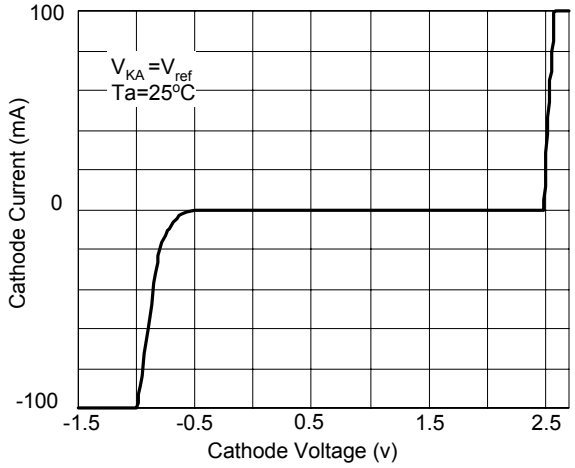


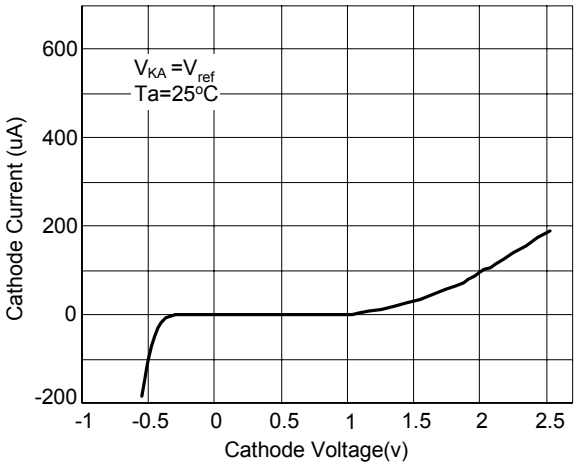
Fig 3. Test Circuit for Off-State Current

Typical Performance Characteristics

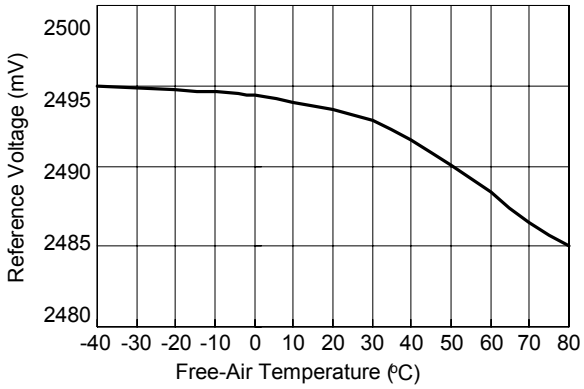
Cathode Current vs Cathode Voltage



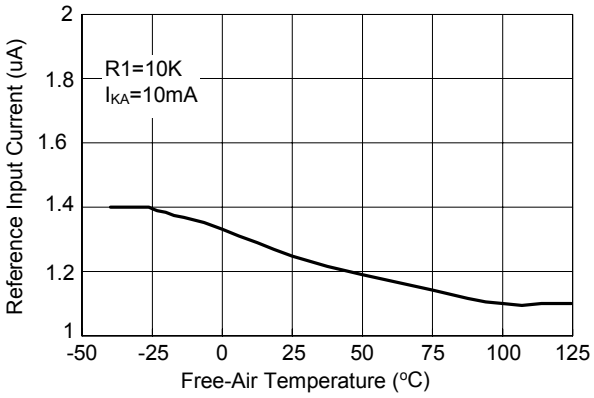
Cathode Current (uA) vs Cathode Voltage



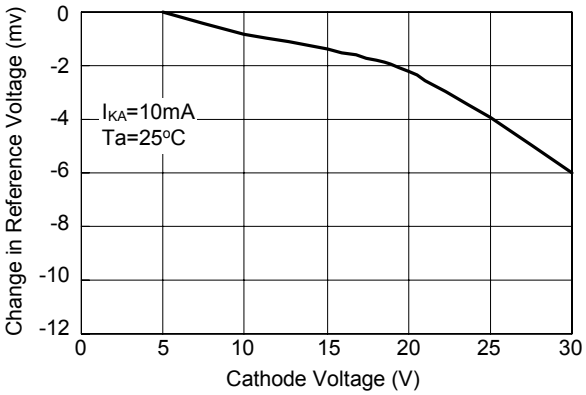
Reference Voltage vs Free-Air Temperature



Reference Input Current vs Free Temperature

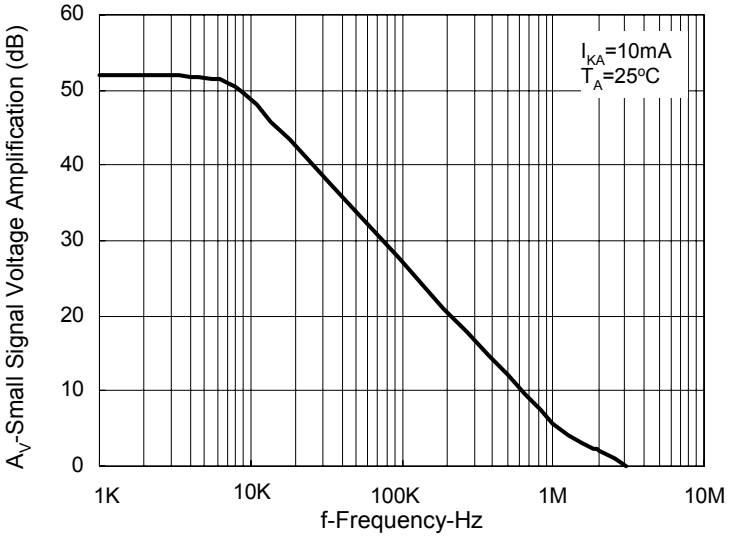


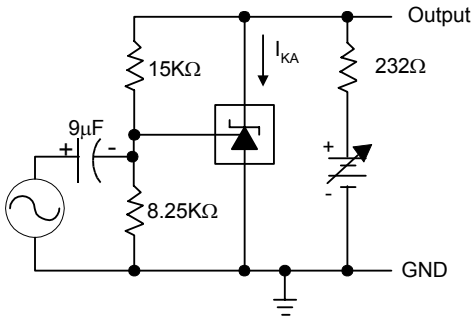
Change in Reference Voltage vs Cathode Voltage



Typical Performance Characteristics (Continued)

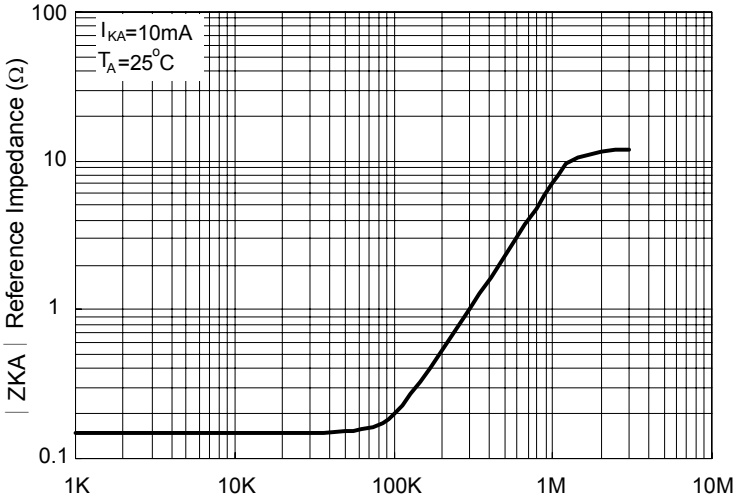
Small-Signal Voltage Amplification vs Frequency

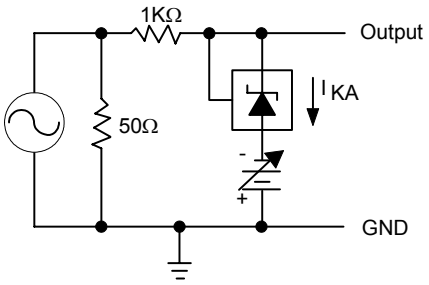




Test Circuit for Voltage Amplification

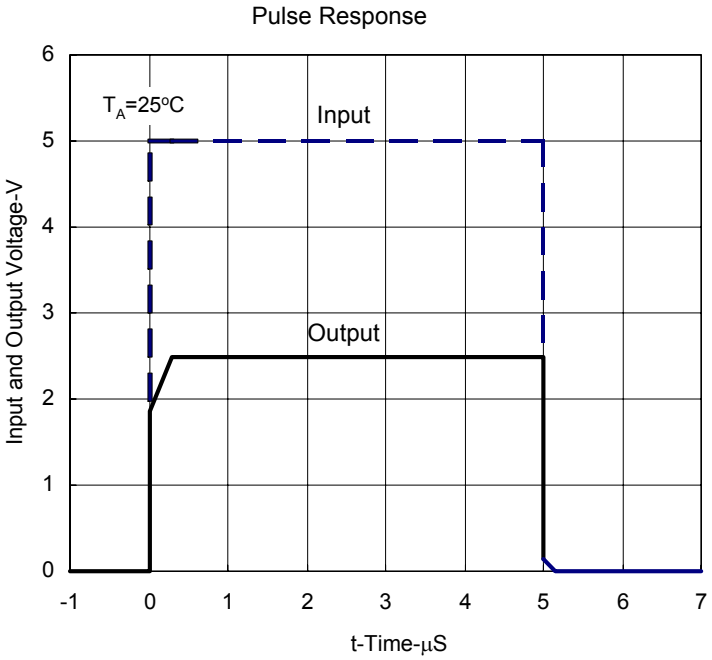
Reference Impedance vs Frequency

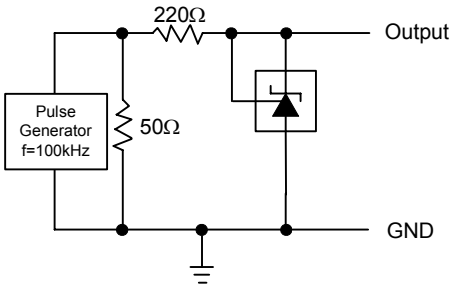




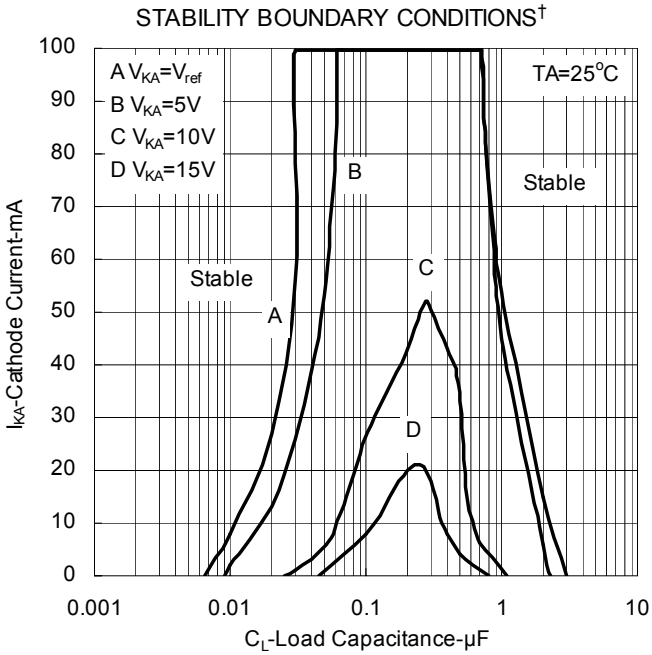
Test Circuit for Reference Impedance

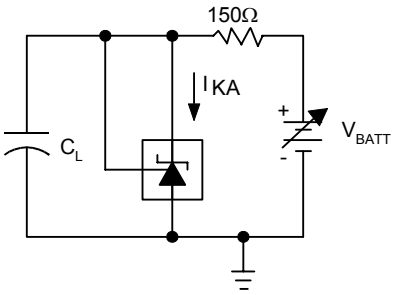
Typical Performance Characteristics (Continued)



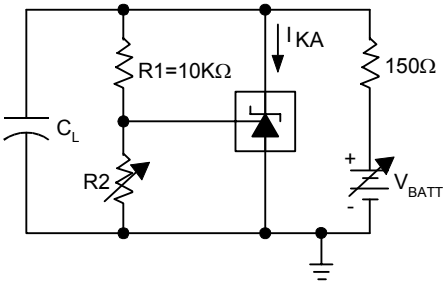


Test Circuit for Pulse Response





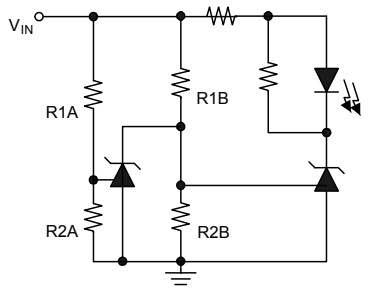
Test Circuit for Curve A



Test Circuit for Curve B, C, and D

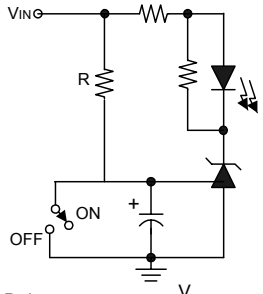
†The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial V_{KA} and I_{KA} conditions with C_L=0.V_{BATT} and C_L were then adjusted to determine the ranges of stability.

Application Examples



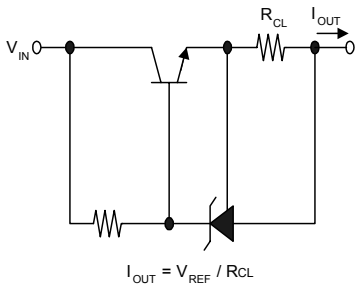
LED on when Low Limit< V_{IN} <High Limit
Low Limit ≈ V_{REF} (1+R1B/R2B)
High Limit ≈ V_{REF} (1+R1A/R2A)

Fig. 4 Voltage Monitor



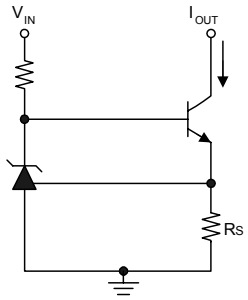
Delay = RC x ln ($\frac{V_{IN}}{V_{IN}-V_{REF}}$)

Fig. 5 Delay Timer



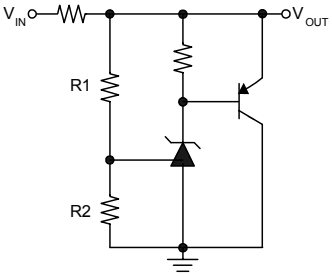
$I_{OUT} = V_{REF} / R_{CL}$

Fig. 6 Current Limiter or Current Source



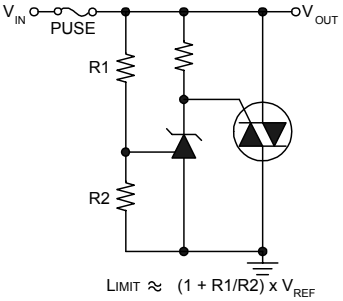
$I_{OUT} = V_{REF} / R_S$

Fig. 7 Constant-Current Sink



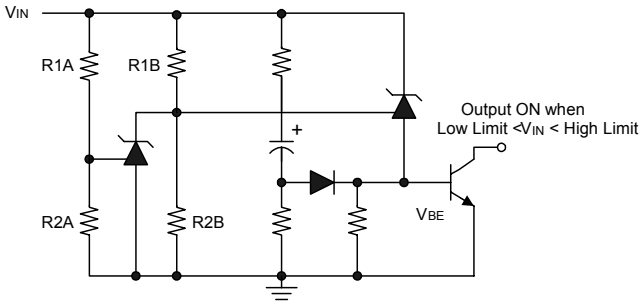
$V_{OUT} = (1 + R1/R2) \times V_{REF}$

Fig. 8 Higher-Current Shunt Regulator



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

Fig. 9 Crow Bar

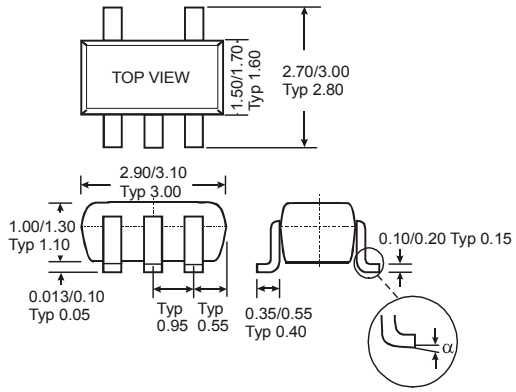


Low Limit ≈ V_{REF} (1 + R1B/R2B) +V_{BE}
High Limit ≈ V_{REF} (1 + R1A/R2A)

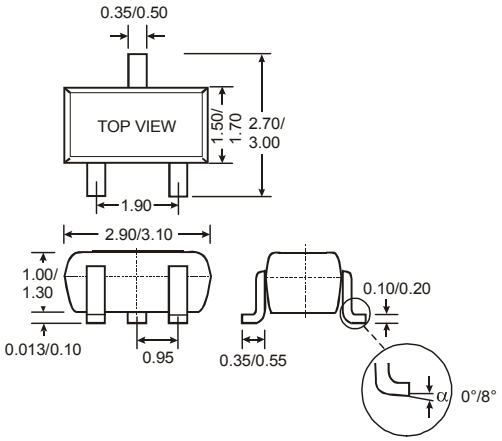
Fig.10 Over-Voltage / Under-Voltage Protection Circuit

Package Diagrams (All Dimensions in mm)

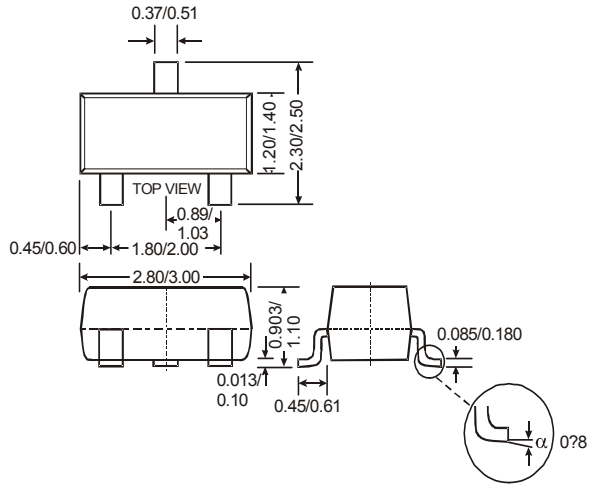
(1) SOT25



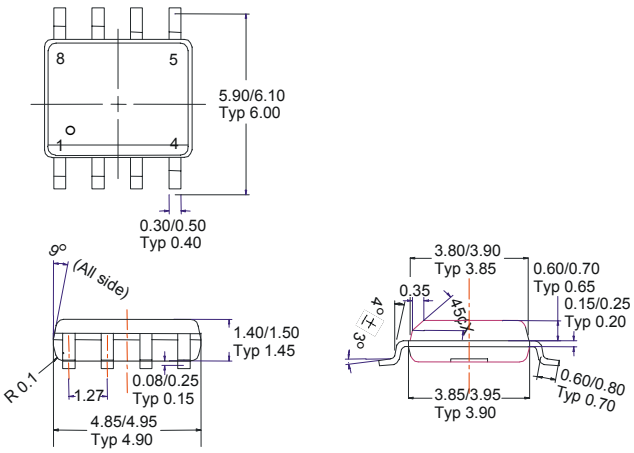
(2) SC59



(3) SOT23

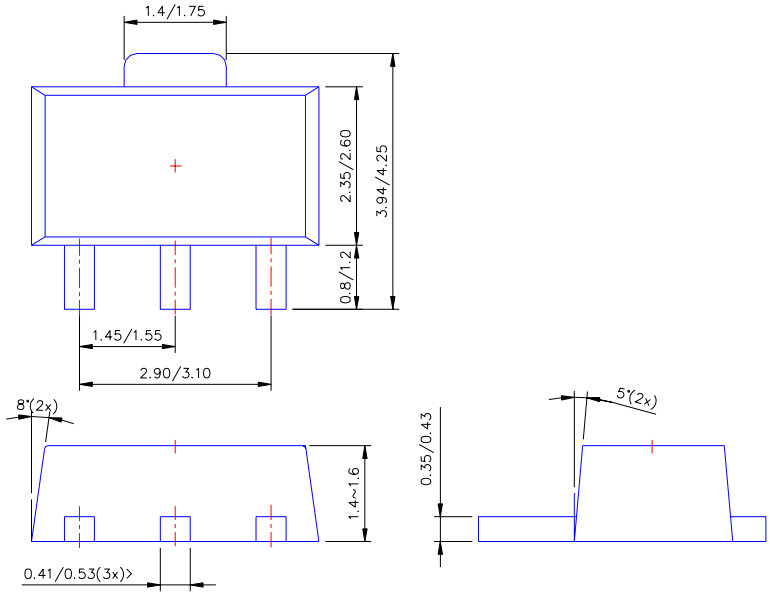


(4) SOP-8L

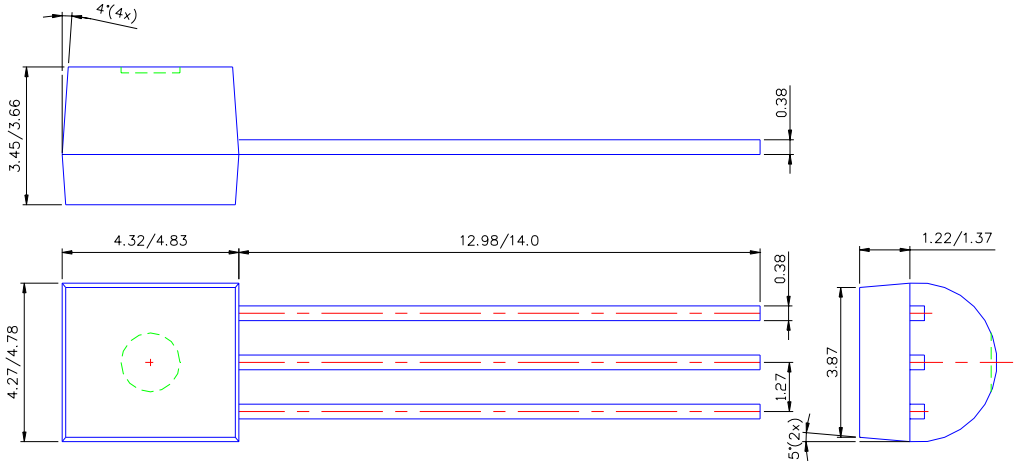


Package Diagrams (Continued) (All Dimensions in mm)

(5) SOT89-3L

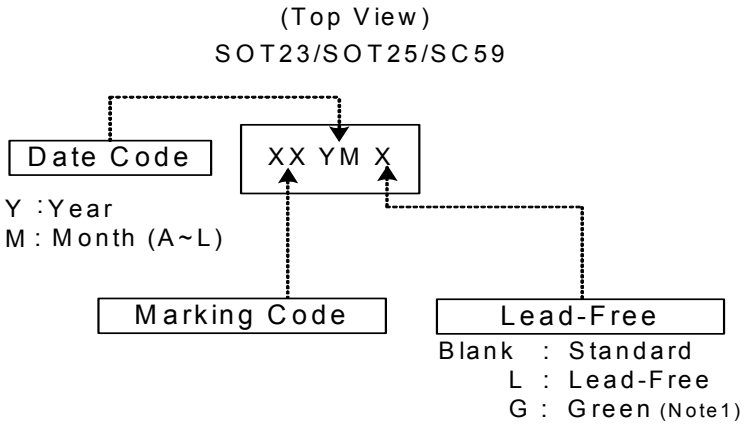


(6) TO92-3L



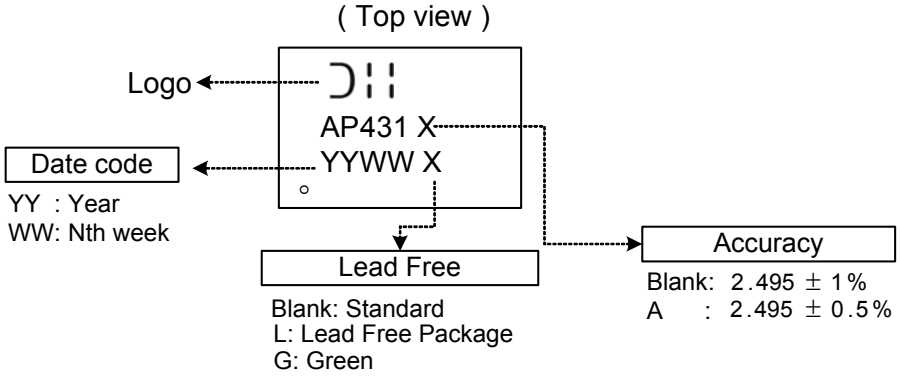
Marking Information

(1) SOT23/SOT25/SC59

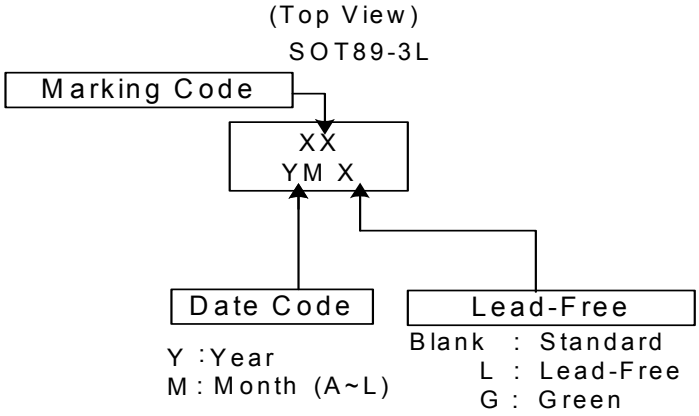


Note: 1. Only for SOT23 and SC59

(2) SOP

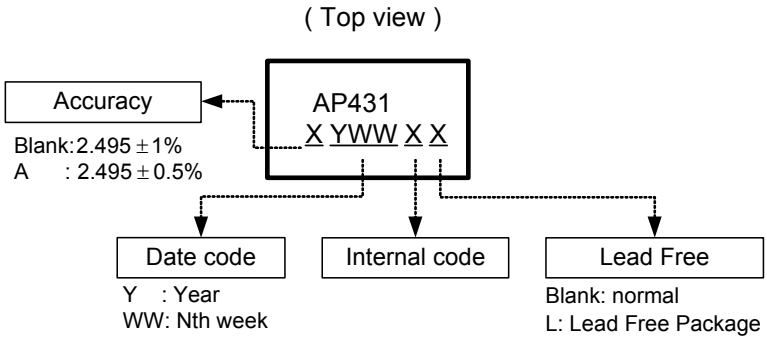


(3) SOT89-3L



Marking Information (Continued)

(4) TO92-3L



Marking Code Table

Device	Package(Note 8)	Marking Code	Date Code
AP431SA	SOT23	D1	YM
AP431ASA	SOT23	D2	YM
AP431Q	SOT25	A2	YM
AP431AQ	SOT25	A3	YM
AP431W	SC59	A6	YM
AP431AW	SC59	A7	YM
AP431R	SC59	A8	YM
AP431AR	SC59	A9	YM
AP431Y	SOT89-3L	A4	YM
AP431AY	SOT89-3L	A5	YM

Notes: 8. For Packaging Details, go to our website at http://www.diodes.com/datasheets/ap02007.pdf.