

Features

- Precision reference voltage
 - AP431: $2.495V \pm 1\%$
 - AP431A: $2.495V \pm 0.5\%$
- Sink current capability: 200mA
- Minimum cathode current for regulation: $300\mu A$
- Equivalent full-range temp coefficient: 30 ppm/oC
- Fast turn-on response
- Low dynamic output impedance: 0.2Ω
- Programmable output voltage to 36V
- Low output noise
- Lead Free packages: SOT25, SC59, SC59R, SOT89-3L and TO92-3L
- SOT23, SOT23R, SOT25, SC59, SC59R, SOP-8L, SOT89-3L, TO92-3L: Available in "Green" Molding Compound (No Br, Sb)
- Lead Free Finish/ RoHS Compliant (Note 1)

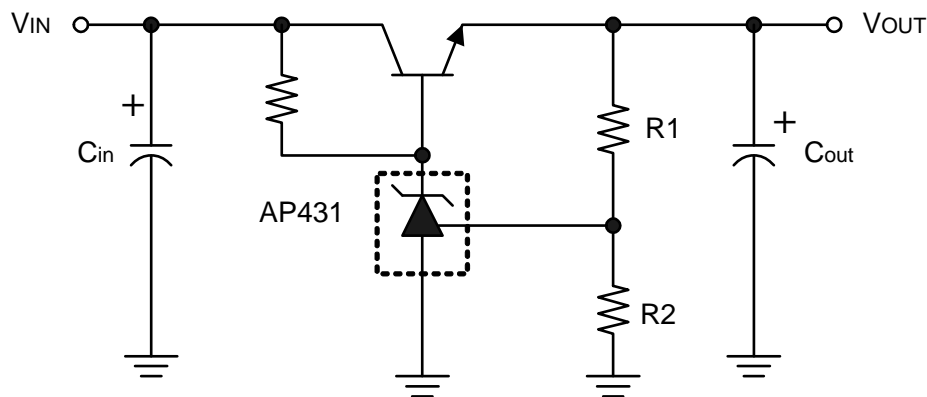
Description

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.

Notes: 1. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied. Please visit our website at http://www.diodes.com/products/lead_free.html.

Typical Application Circuit

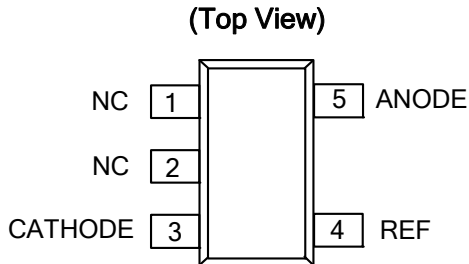


$$V_{OUT} = (1 + R1/R2)V_{REF}$$

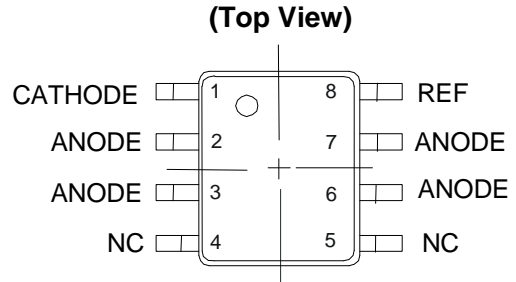
Precision Regulator

Pin Assignments

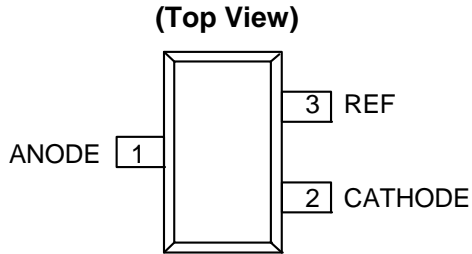
(1) SOT25



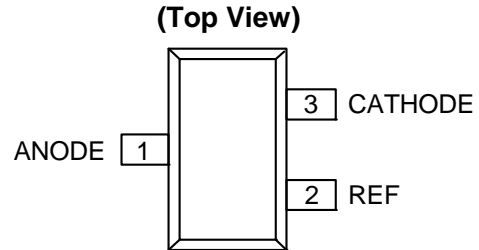
(2) SOP-8L



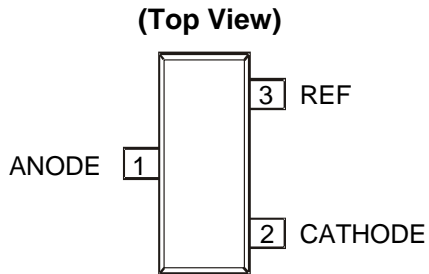
(3) SC59



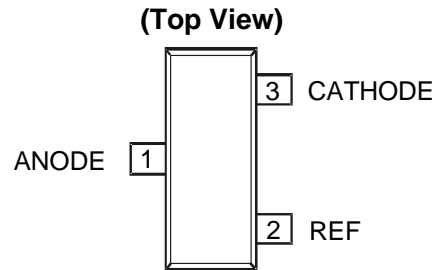
(4) SC59R



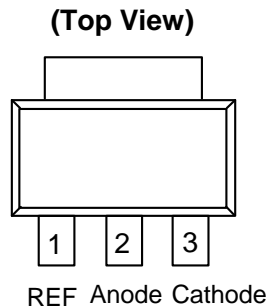
(5) SOT23



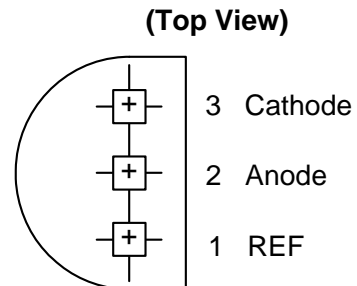
(6) SOT23R



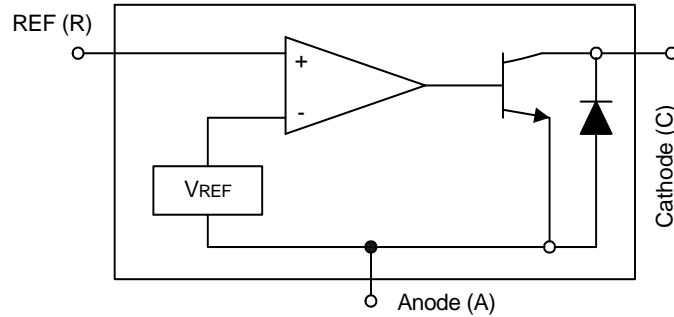
(7) SOT89-3L



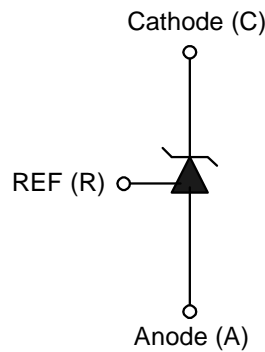
(8) TO92-3L



Functional Block Diagram



Symbol



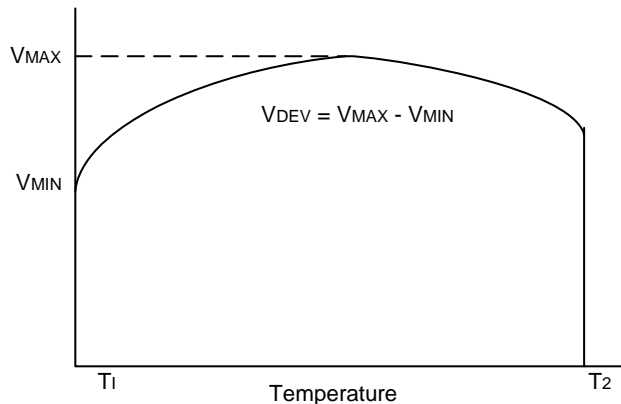
Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit	
V _{CV}	Cathode Voltage	+36	V	
I _{CC}	Continuous Cathode Current	-10 to +250	mA	
I _{REF}	Reference Input Current	10	mA	
T _{OP}	Operating Temperature	-20 to +85	°C	
T _{ST}	Storage Temperature	-65 to +150	°C	
P _D	Power Dissipation (Notes 2, 3)	SOT23(R)	400	mW
		SOT25	550	mW
		SC59(R)	400	mW
		SOP-8L	600	mW
		SOT89-3L	800	mW
		TO92-3L	780	mW

Notes: 2. T_J, max =150°C.
3. Ratings apply to ambient temperature at 25°C.

Electrical Characteristics ($T_A = 25^\circ\text{C}$, $V^+ = +5.0\text{V}$, unless otherwise stated)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
V_{REF}	Reference voltage	$V_{KA} = V_{REF}$, $I_{KA} = 10\text{mA}$ (Fig.1)	AP431 2.470 AP431A 2.482	2.495	2.520 2.507	V
V_{REF}	Deviation of Reference input voltage over temperature (Note 4)	$V_{KA} = V_{REF}$, $I_{KA} = 10\text{mA}$, $T_a = \text{Full range}$ (Fig.1)	—	8.0	20	mV
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of the change in Reference voltage to the change in Cathode voltage	$I_{KA} = 10\text{mA}$ (Fig. 2)	$V_{KA} = V_{REF}$ to 10V —	-1.4	-2.0	mV/V
			$V_{KA} = 10\text{V}$ to 36V —	-1	-2	mV/V
I_{REF}	Reference input current	$R1 = 10\text{K}\Omega$, $R2 = \infty$, $I_{KA} = 10\text{mA}$ (Fig. 2)	—	1.4	3.5	μA
αI_{REF}	Deviation of Reference input current over temperature	$R1 = 10\text{K}\Omega$, $R2 = \infty$, $I_{KA} = 10\text{mA}$, $T_a = \text{Full range}$ (Fig. 2)	—	0.4	1.2	μA
$I_{KA(MIN)}$	Minimum Cathode current for regulation	$V_{KA} = V_{REF}$ (Fig.1)	—	0.19	0.5	mA
$I_{KA(OFF)}$	Off-state current	$V_{KA} = 36\text{V}$, $V_{REF} = 0\text{V}$ (Fig. 3)	—	0.1	1.0	μA
$ Z_{KA} $	Dynamic output impedance (Note 5)	$V_{KA} = V_{REF}$, $V_{KA} = V_{REF}$, $\Delta I_{KA} = 0.1\text{mA} \sim 15\text{mA}$, Frequency $\leq 1\text{KHz}$ (Fig.1)	—	0.2	0.5	Ω



Notes: 4. 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:

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

Where:
 $T_2 - T_1$ = full temperature change.
 αV_{REF} can be positive or negative depending on whether the slope is positive or negative.

Notes: 5. 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:

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

Test Circuits

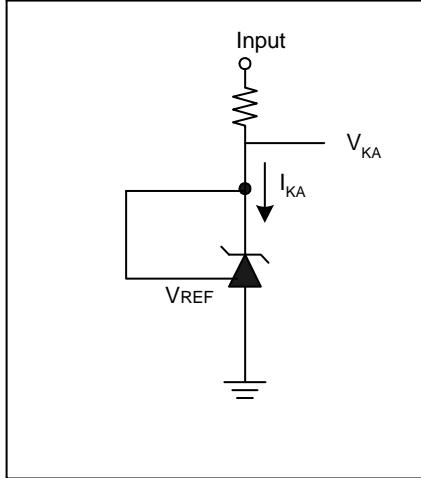
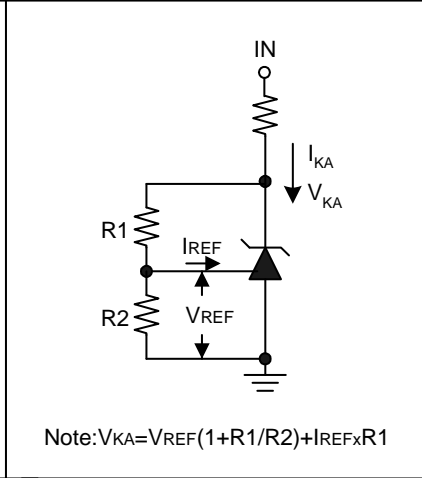


Fig 1. Test Circuit for $V_{KA} = V_{REF}$



Note: $V_{KA} = V_{REF}(1 + R1/R2) + I_{REF} \times R1$

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

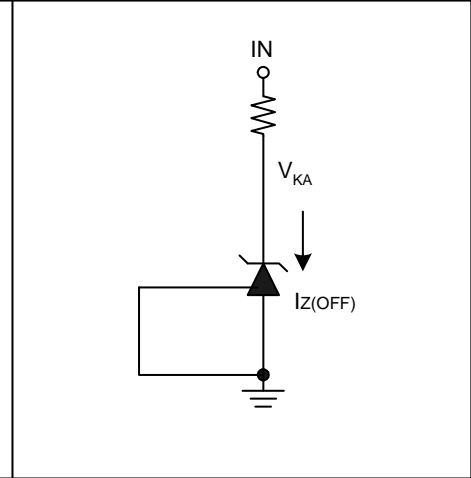
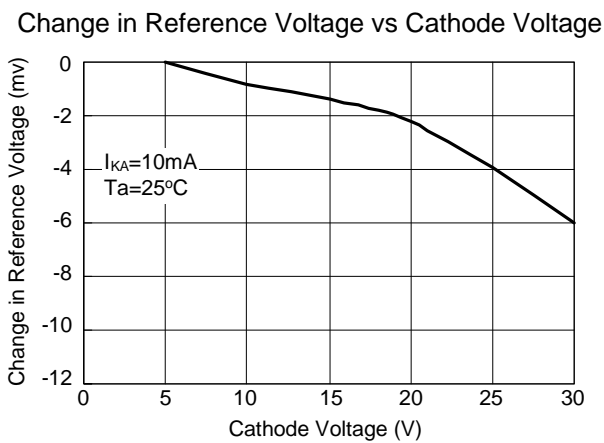
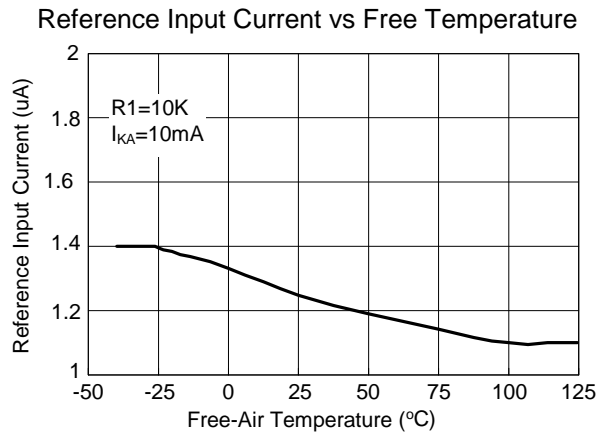
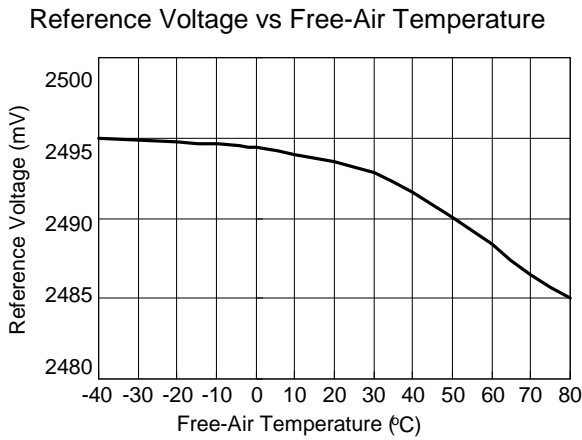
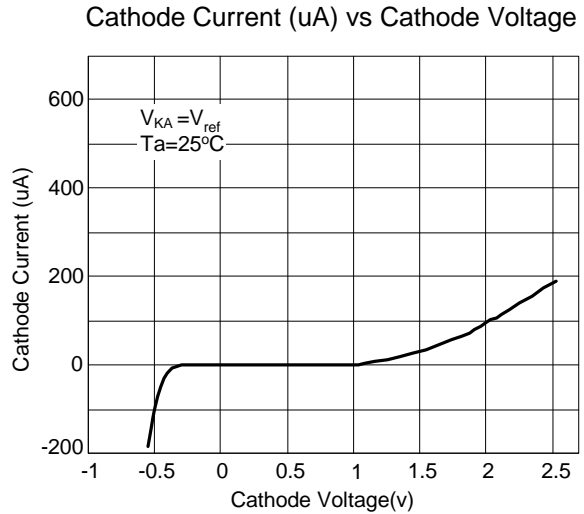
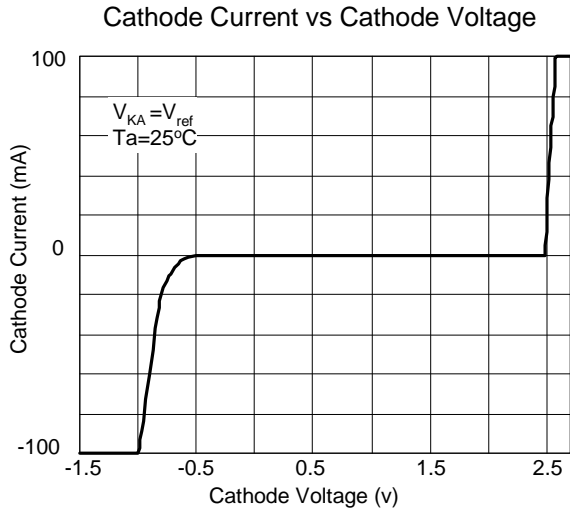


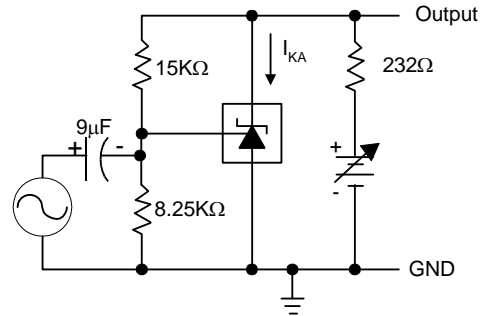
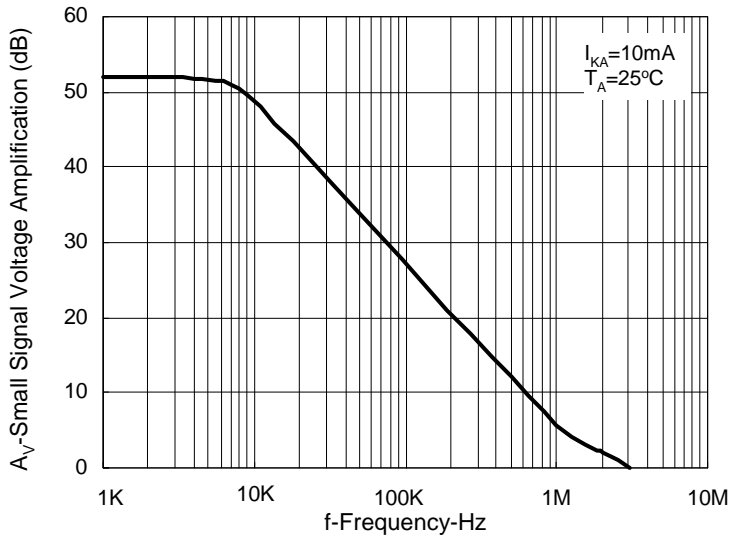
Fig 3. Test Circuit for Off-State Current

Typical Performance Characteristics



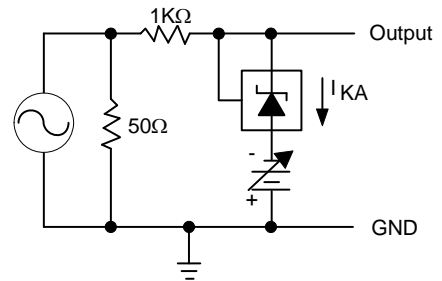
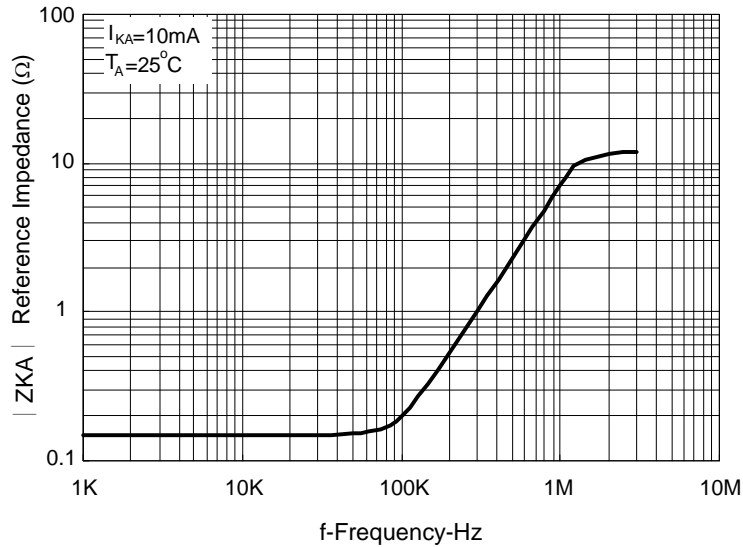
Typical Performance Characteristics (Continued)

Small-Signal Voltage Amplification vs Frequency



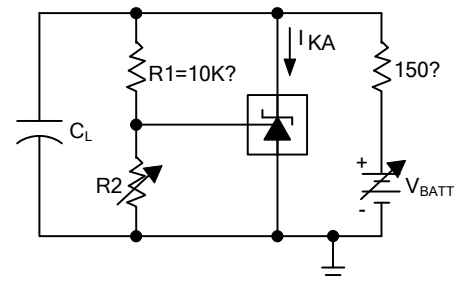
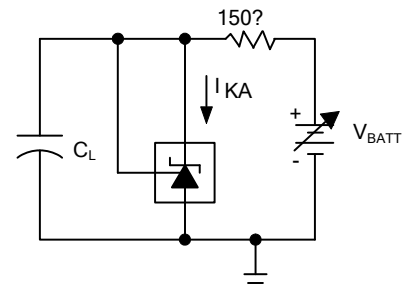
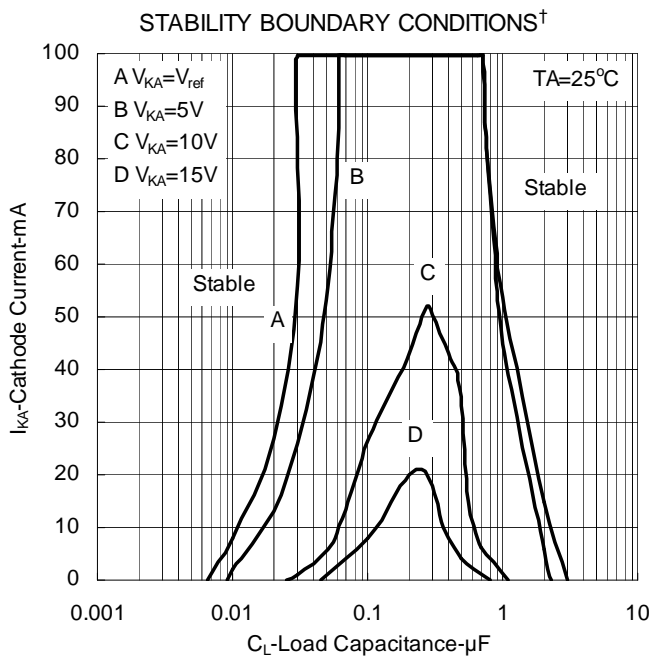
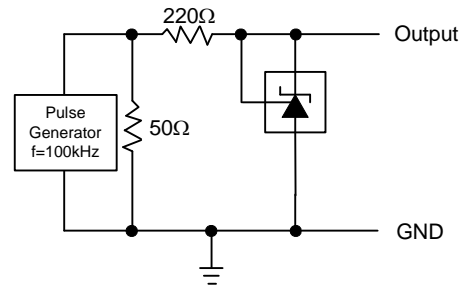
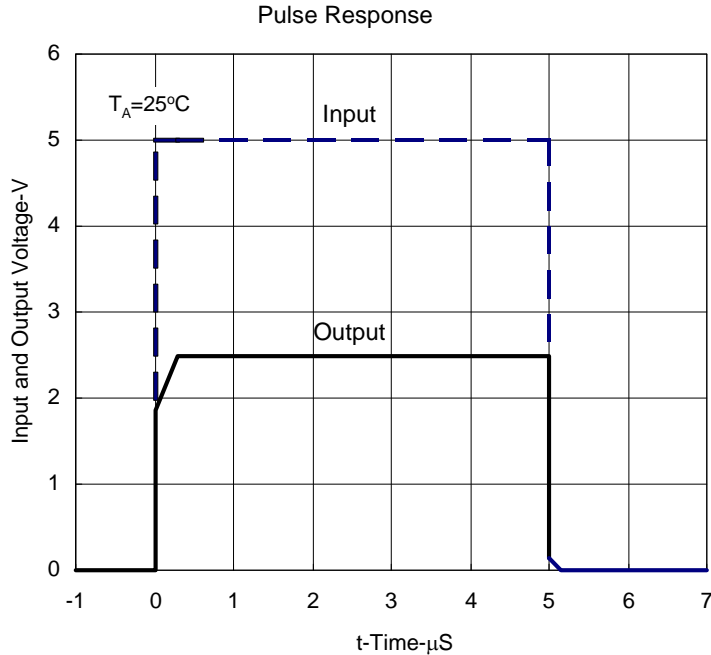
Test Circuit for Voltage Amplification

Reference Impedance vs Frequency



Test Circuit for Reference Impedance

Typical Performance Characteristics (Continued)



[†] 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 $\approx V_{REF} (1+R1B/R2B)$
 High Limit $\approx V_{REF} (1+R1A/R2A)$

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

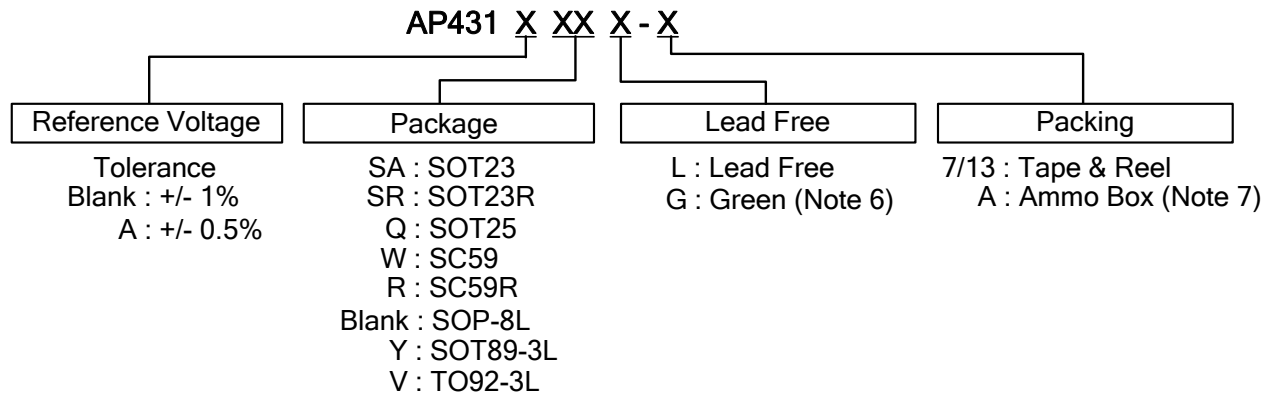
Fig. 9 Crow Bar














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

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

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

Ordering Information



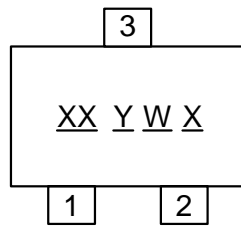
	Device (Note 8)	Package Code	Packaging (Note 9)	7"/13 Tape and Reel		Ammo Box	
				Quantity	Part Number Suffix	Quantity	Part Number Suffix
	AP431(A)SAG-7	SA	SOT23	3000/Tape & Reel	-7	NA	NA
	AP431(A)SRG-7	SR	SOT23R	3000/Tape & Reel	-7	NA	NA
	AP431(A)QL-7	Q	SOT25	3000/Tape & Reel	-7	NA	NA
	AP431(A)QG-7	Q	SOT25	3000/Tape & Reel	-7	NA	NA
	AP431(A)WL-7	W	SC59	3000/Tape & Reel	-7	NA	NA
	AP431(A)WG-7	W	SC59	3000/Tape & Reel	-7	NA	NA
	AP431(A)RL-7	R	SC59R	3000/Tape & Reel	-7	NA	NA
	AP431(A)RG-7	R	SC59R	3000/Tape & Reel	-7	NA	NA
	AP431(A)G-13		SOP-8L	2500/Tape & Reel	-13	NA	NA
	AP431(A)YL-13	Y	SOT89-3L	2500/Tape & Reel	-13	NA	NA
	AP431(A)YG-13	Y	SOT89-3L	2500/Tape & Reel	-13	NA	NA
	AP431(A)VL-A	V	TO92-3L	NA	NA	2000/Box	NA
	AP431(A)VG-A	V	TO92-3L	NA	NA	2000/Box	NA

- Notes:
6. SOP-8L, SOT23 and SOT23R are available in "Green" products only.
 7. Ammo Box is for TO92-3L Spread Lead.
 8. Suffix "A" denotes AP431A device.
 9. 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>.

Marking Information

(1) SC59 and SC59R

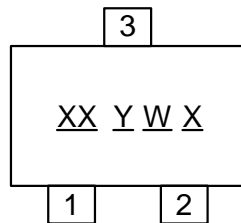
(Top View)



XX : Identification code
Y : Year 0~9
W : Week : A~Z : 1~26 week;
a~z : 27~52 week; z represents
52 and 53 week
X : A~Z : Green
a~z : Lead Free

(2) SOT23 and SOT23R

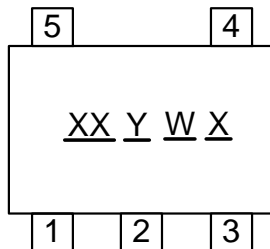
(Top View)



XX : Identification code
Y : Year 0~9
W : Week : A~Z : 1~26 week;
a~z : 27~52 week; z represents
52 and 53 week
X : A~Z : Green

(3) SOT25

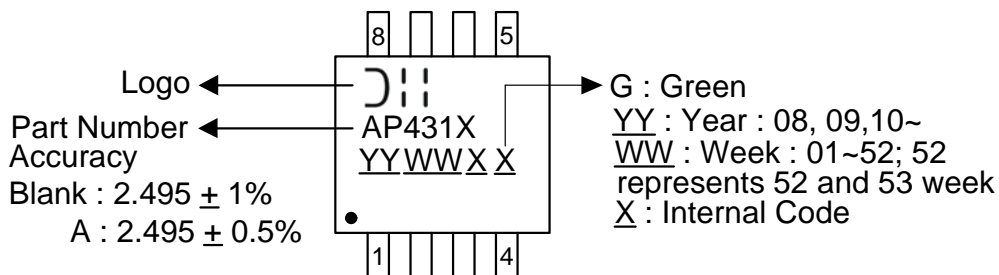
(Top View)



XX : Identification code
Y : Year 0~9
W : Week : A~Z : 1~26 week;
a~z : 27~52 week; z represents
52 and 53 week
X : A~Z : Green
a~z : Lead Free

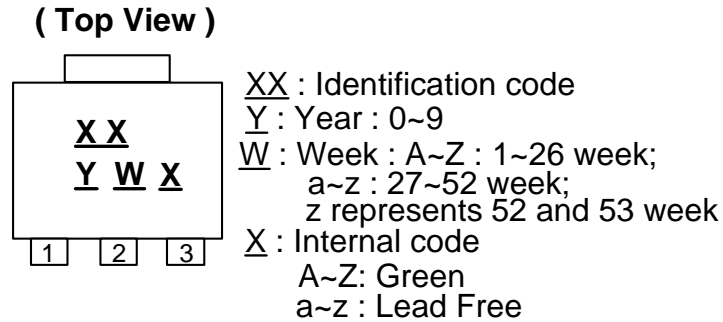
(4) SOP-8L

(Top View)

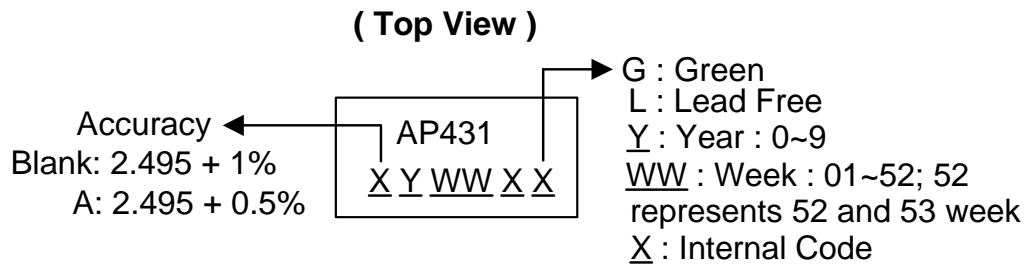


Marking Information (Continued)

(5) SOT89-3L



(6) TO92-3L



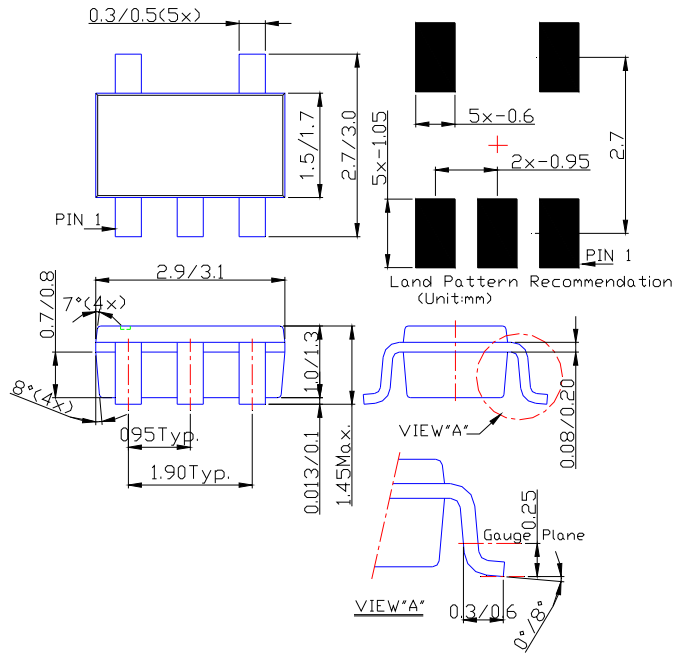
Identification Code Table

Device	Package (Note 10)	Identification Code	Date Code
AP431SA	SOT23	D1	YM
AP431ASA	SOT23	D2	YM
AP431SR	SOT23R	D5	YM
AP431ASR	SOT23R	D6	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

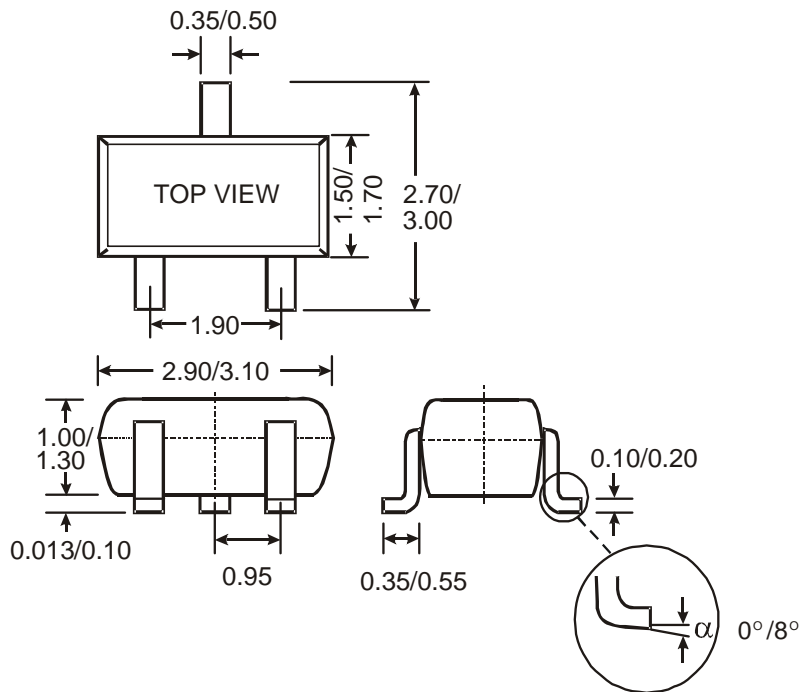
Notes: 10. For Packaging Details, go to our website at <http://www.diodes.com/datasheets/ap02007.pdf>.

Package Outline Dimensions (All Dimensions in mm)

(1) Package type: SOT25

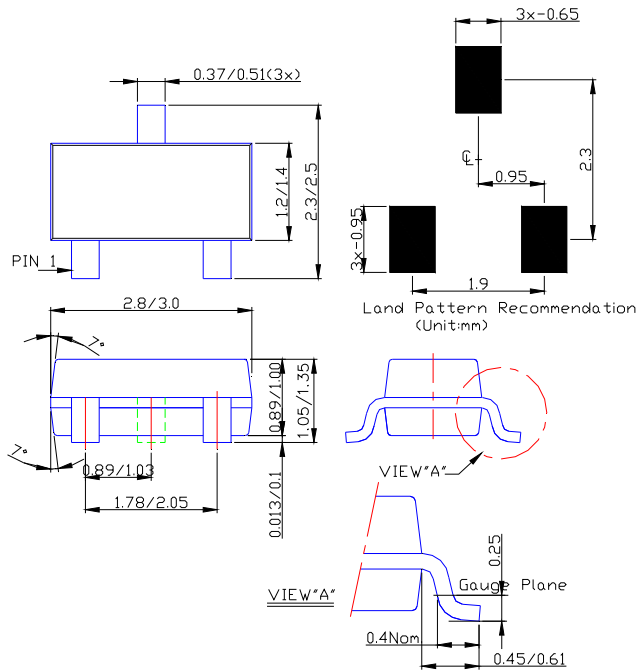


(2) Package Type: SC59 and SC59R

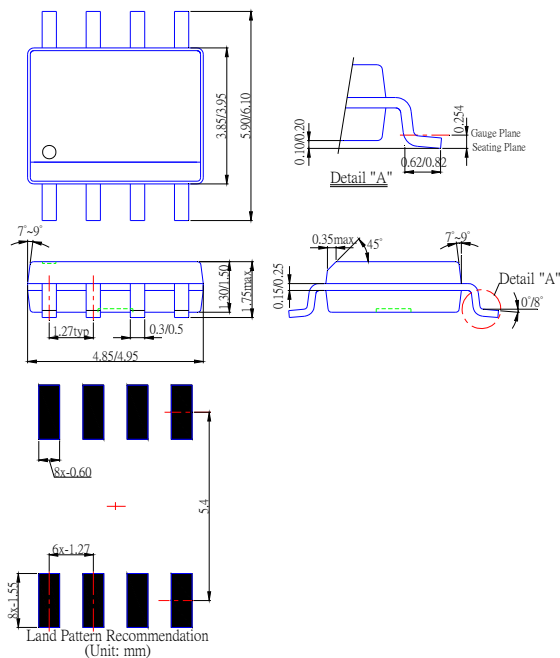


Package Outline Dimensions (Continued)

(3) Package Types: SOT23 and SOT23R

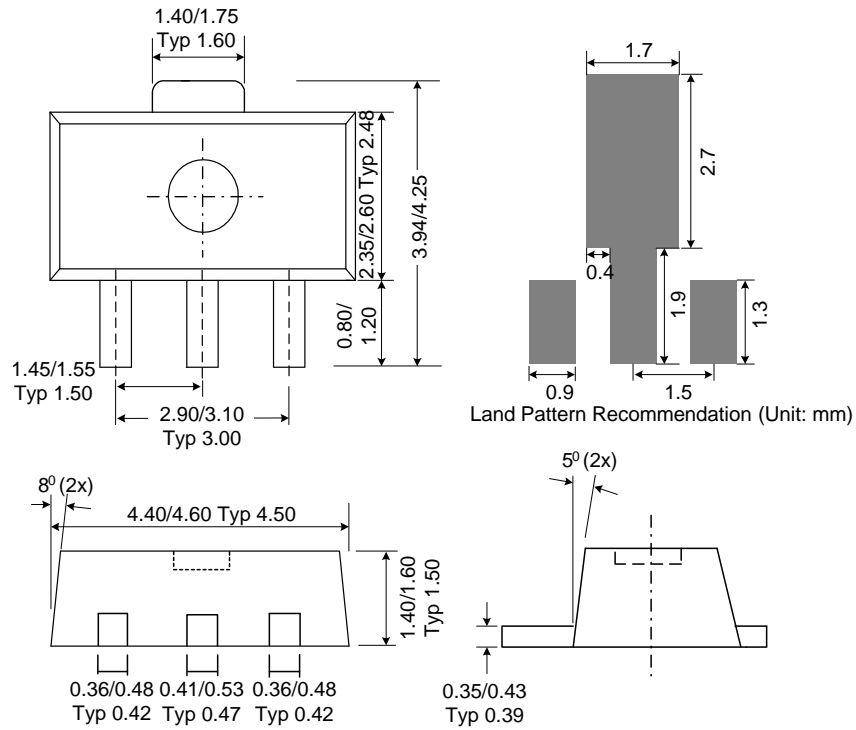


(4) Package Type: SOP-8L

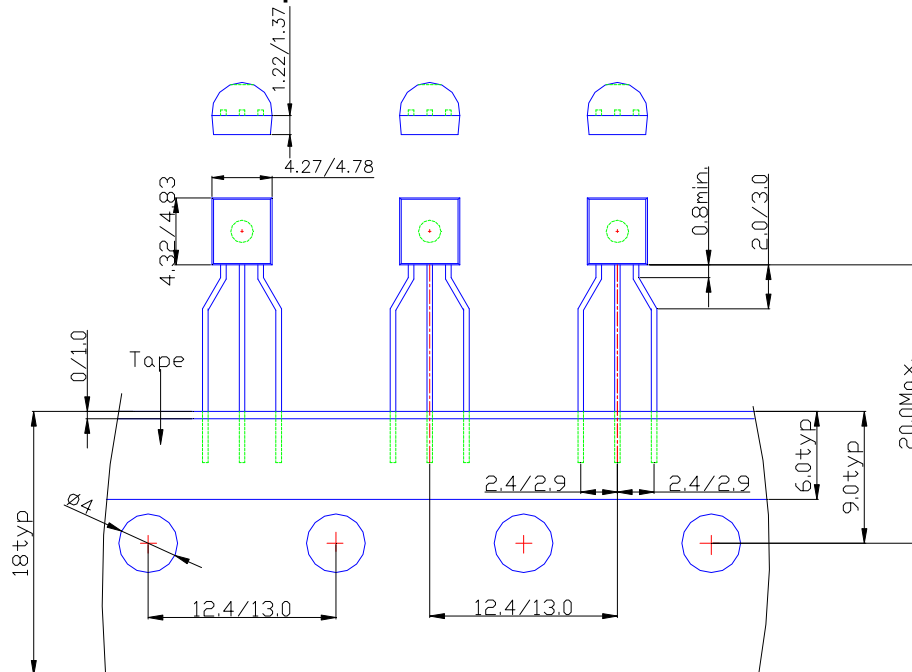


Package Outline Dimensions (Continued)

(5) Package Type: SOT89-3L



(6) Package Type: TO92-3L for Ammo pack



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