

Features

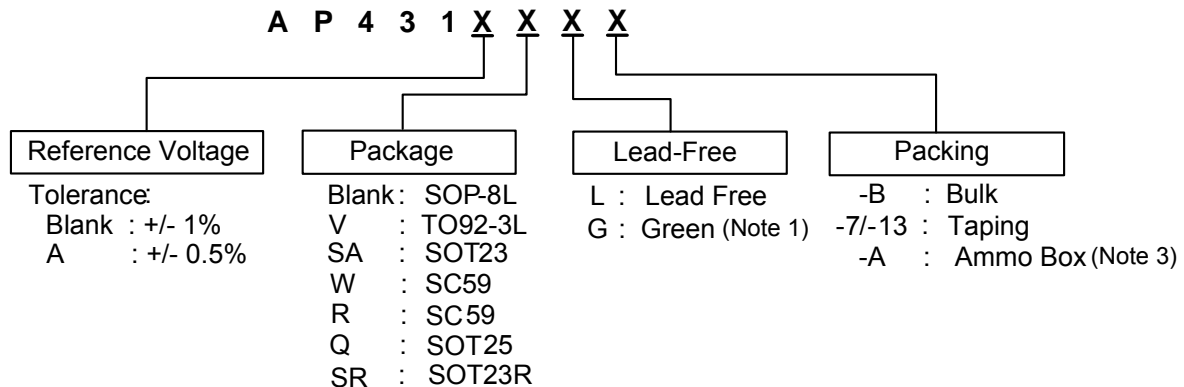
- Precision reference voltage
AP431 : 2.495V ± 1%
AP431A : 2.495V ± 0.5%
- Sink current capability: 200mA
- Minimum cathode current for regulation: 300µA
- Equivalent full-range temp coefficient: 30 ppm/°C
- Fast turn-on response
- Low dynamic output impedance: 0.2Ω
- Programmable output voltage to 36V
- Low output noise
- Packages: SOT23, SOT23R, SOT25, SC59 (W package code), SC59 (R package code), SOP-8L and TO92-3L
- SOT23, SOT23R, SOP-8L and SC59: Available in "Green" Molding Compound (No Br, Sb) (Note 1)
- Lead Free Finish/RoHS Compliant for Lead Free and "Green" Products (Note 2)

General 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. SOT23, SOT23R are "Green" products only.
2. RoHS revision 13.2.2003. Glass and High Temperature Solder Exemptions Applied, see *EU Directive Annex Notes 5 and 7*.

| Device (Note 4) | Package Code | Packaging (Note 5) | 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 | NA | NA | NA | NA |
| AP431(A)SR | SR | SOT23R | 3000/Tape & Reel | -7 | NA | NA | NA | NA |
| AP431(A)Q | Q | SOT25 | 3000/Tape & Reel | -7 | NA | NA | NA | NA |
| AP431(A)W | W | SC59 | 3000/Tape & Reel | -7 | NA | NA | NA | NA |
| AP431(A)R | R | SC59 | 3000/Tape & Reel | -7 | NA | NA | NA | NA |
| AP431(A) | | SOP-8L | NA | NA | 2500/Tape & Reel | -13 | NA | NA |
| AP431(A)V | V | TO92-3L | NA | NA | NA | NA | 2000/Box | -A |

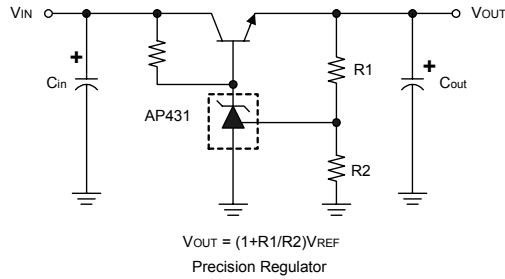
Notes: 3. Ammo Box is for TO92-3 Spread Lead.
4. Suffix "A" denotes AP431A device.
5. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.

Pin Assignment

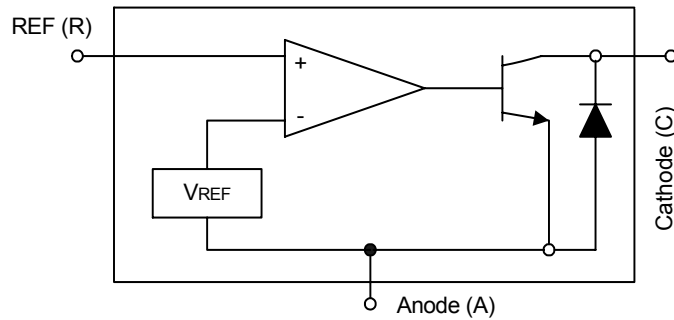
| Package | Pin Configuration (Top View) |
|---------------------------|--|
| SOT25 | <p>NC 1 NC 2 CATHODE 3 4 REF 5 ANODE</p> |
| SC-59 (Package Code-W) | <p>ANODE 1 2 CATHODE 3 REF</p> |
| SC-59 (Package Code-R) | <p>ANODE 1 2 REF 3 CATHODE</p> |
| TO92-3L | <p>3 Cathode 2 Anode 1 REF</p> |

| Package | Pin Configuration (Top View) |
|---------|--|
| SOP-8L | <p>CATHODE 1 ANODE 2 ANODE 3 NC 4 5 NC 6 ANODE 7 ANODE 8 REF</p> |
| SOT23 | <p>ANODE 1 2 CATHODE 3 REF</p> |
| SOT23R | <p>ANODE 1 2 REF 3 CATHODE</p> |

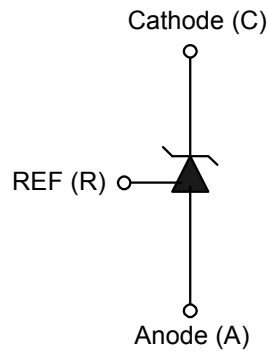
Typical Application Circuit



Block Diagram



Symbol



Absolute Maximum Ratings

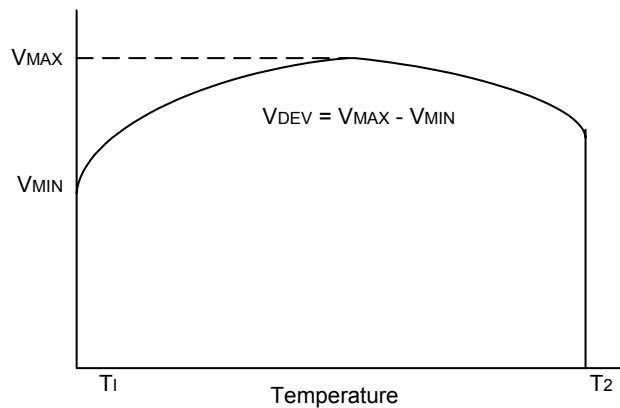
| Symbol | Parameter | Rating | Unit | |
|------------------|-----------------------------------|-------------|------|----|
| V _{CV} | Cathode Voltage | +36 | V | |
| I _{CC} | Continuous Cathode Current | -10 to +250 | mA | |
| I _{REF} | Reference Input Current | 10 | mA | |
| T _{OP} | Operating Temperature | -20 to +85 | °C | |
| T _{ST} | Storage Temperature | -65 to +150 | °C | |
| P _D | Power Dissipation (Notes 6, 7) | SOT23(R) | 250 | mW |
| | | SOT25 | 250 | mW |
| | | SC59 | 400 | mW |
| | | SOP-8L | 600 | mW |
| | | TO92-3L | 780 | mW |

Note: 6. T_J, max =150°C

7. Ratings apply to ambient temperature at 25°C

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

| PARAMETER | TEST CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT | |
|---|--|---------------------------------------|------------------|-------|----------------|---------------|------|
| Reference voltage | $V_{KA} = V_{REF}$, $I_{KA} = 10\text{mA}$ (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 8) | $V_{KA} = V_{REF}$, $I_{KA} = 10\text{mA}$, $T_a = \text{Full range}$ (Fig.1) | V_{REF} | — | 8.0 | 20 | mV | |
| Ratio of the change in Reference voltage to the change in Cathode voltage | $I_{KA} = 10\text{mA}$ (Fig. 2) | $V_{KA} = 10\text{V} \sim V_{REF}$ | ΔV_{REF} | — | -1.4 | -2.0 | mV/V |
| | | $V_{KA} = 36\text{V} \sim 10\text{V}$ | ΔV_{KA} | — | -1 | -2 | mV/V |
| Reference input current | $R1 = 10\text{K}\Omega$, $R2 = \infty$ $I_{KA} = 10\text{mA}$ (Fig. 2) | I_{REF} | — | 1.4 | 3.5 | μA | |
| 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) | 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 | $V_{KA} = 36\text{V}$, $V_{REF} = 0\text{V}$ (Fig. 3) | $I_{KA(OFF)}$ | — | 0.1 | 1.0 | μA | |
| Dynamic output impedance (Note 9) | $V_{KA} = V_{REF}$ $V_{KA} = V_{REF}$ $\Delta I_{KA} = 0.1\text{mA} \sim 15\text{mA}$ Frequency $\leq 1\text{KHz}$ (Fig.1) | $ Z_{KA} $ | — | 0.2 | 0.5 | Ω | |



Note: 8. 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:

$T_2 - T_1 = \text{full temperature change}$.

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

Note: 9. 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

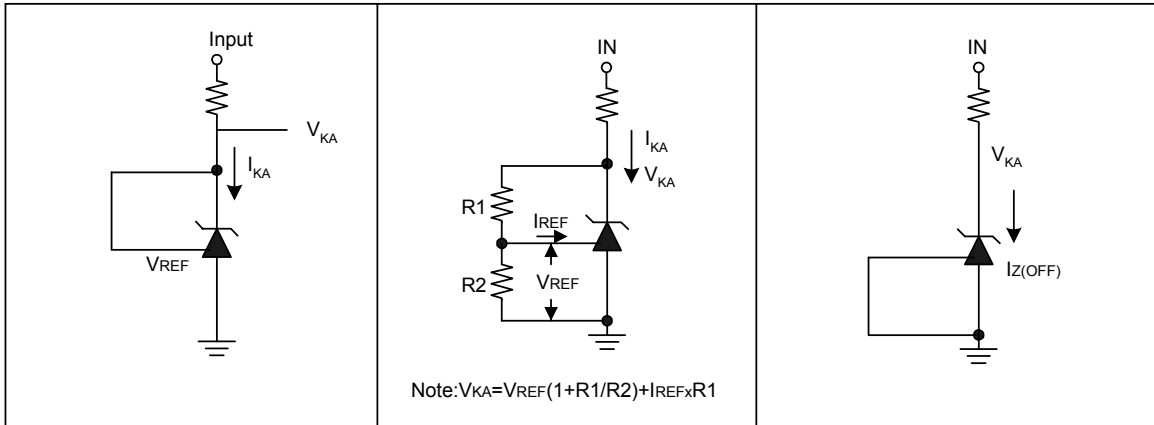
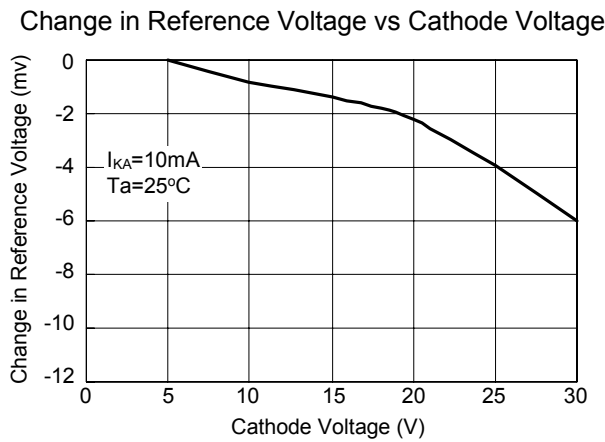
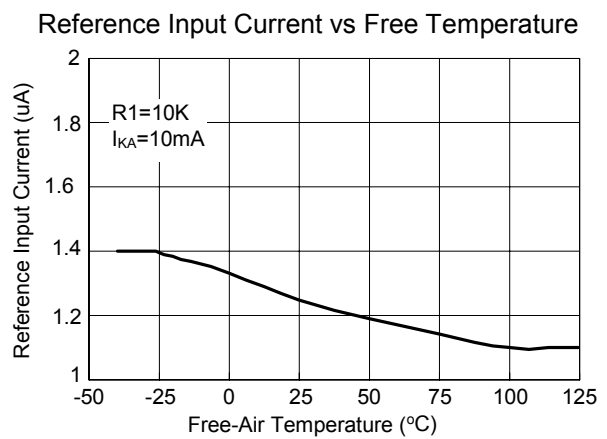
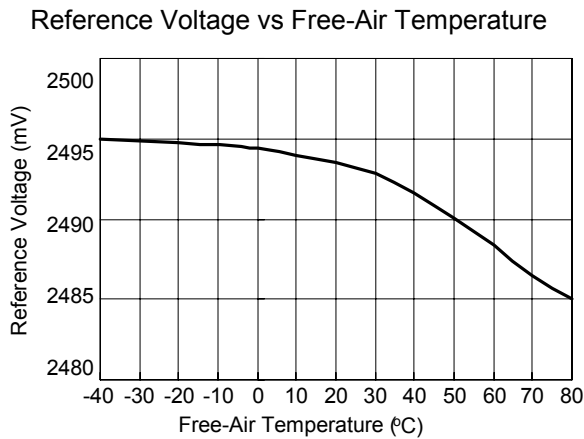
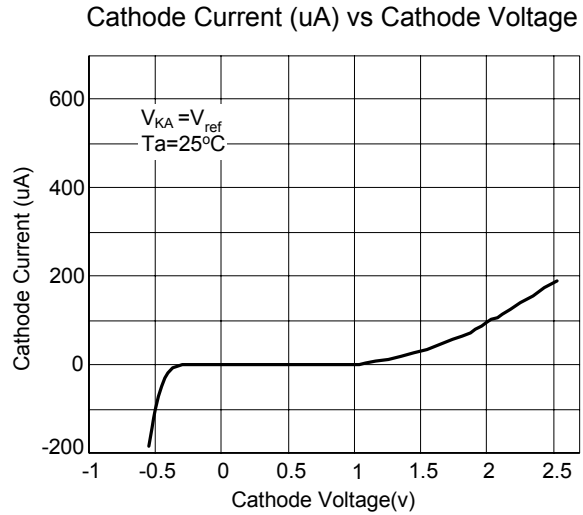
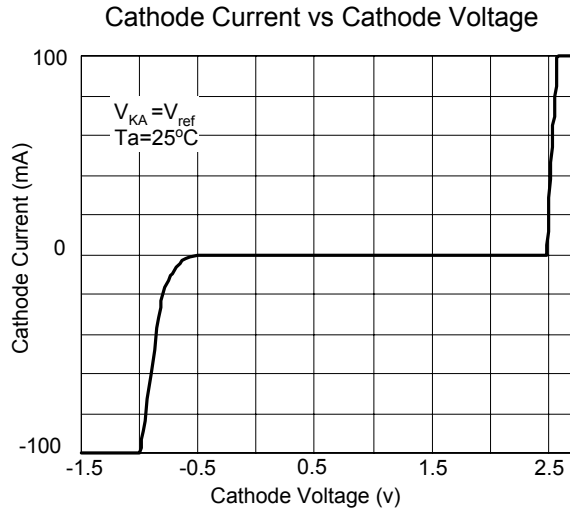


Fig 1. Test Circuit for $V_{KA} = V_{REF}$

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

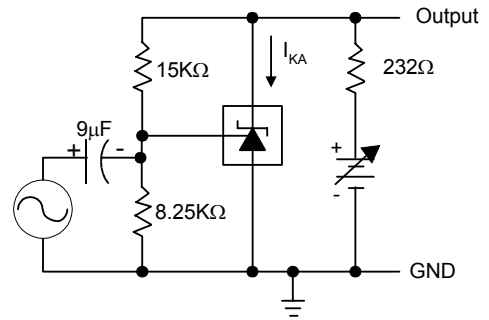
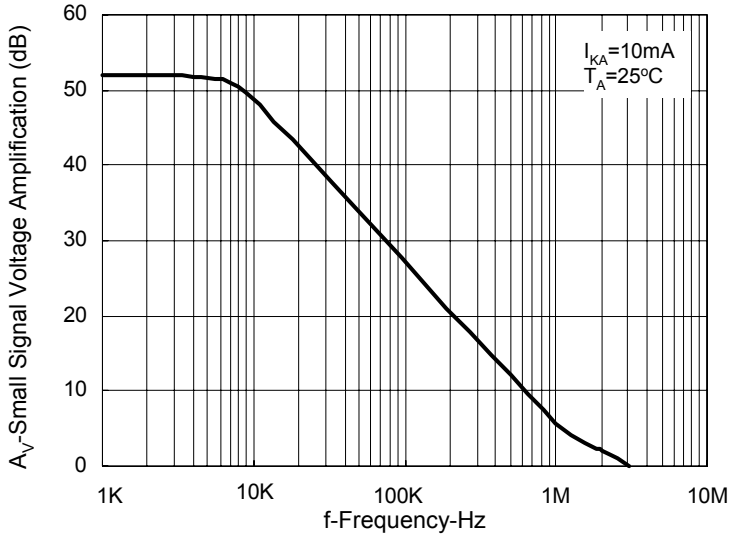
Fig 3. Test Circuit for Off-State Current

Typical Performance Characteristics



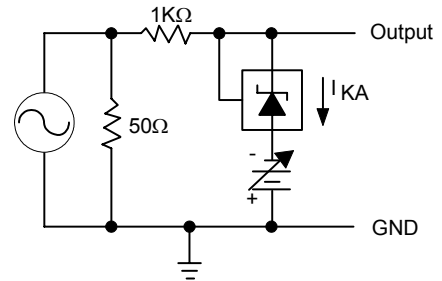
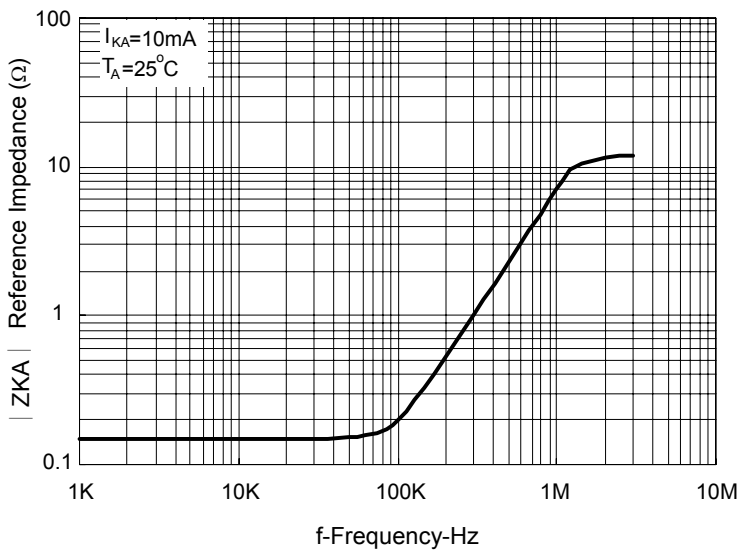
Typical Performance Characteristics (Continued)

Small-Signal Voltage Amplification vs Frequency



Test Circuit for Voltage Amplification

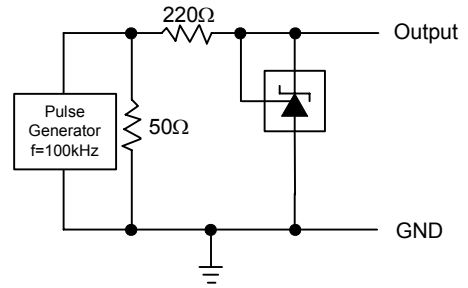
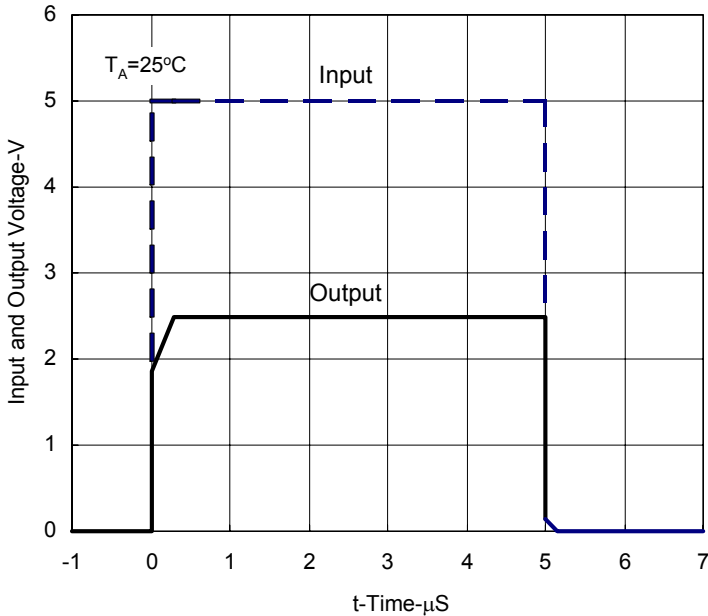
Reference Impedance vs Frequency



Test Circuit for Reference Impedance

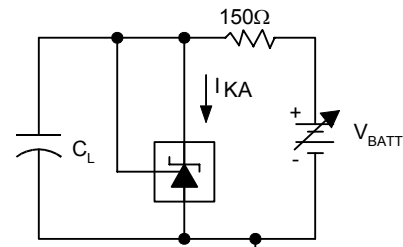
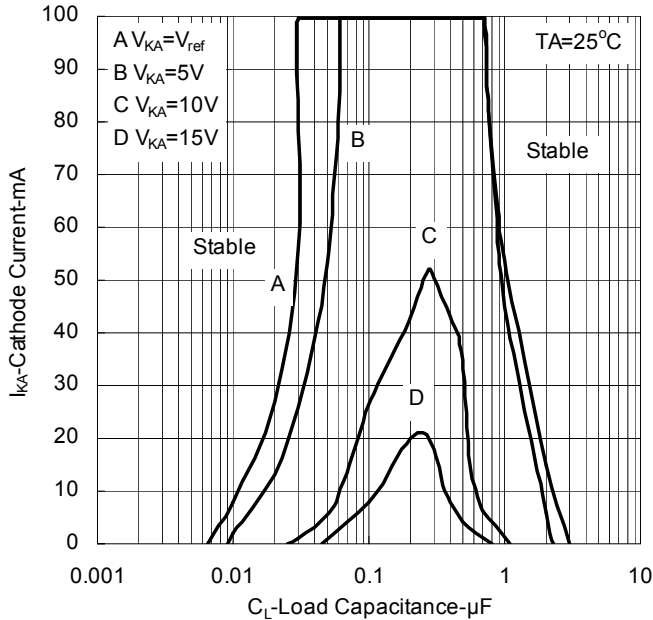
Typical Performance Characteristics (Continued)

Pulse Response

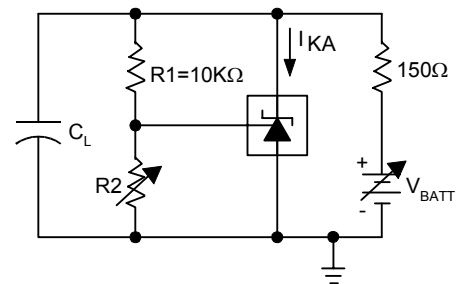


Test Circuit for Pulse Response

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, R_2 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

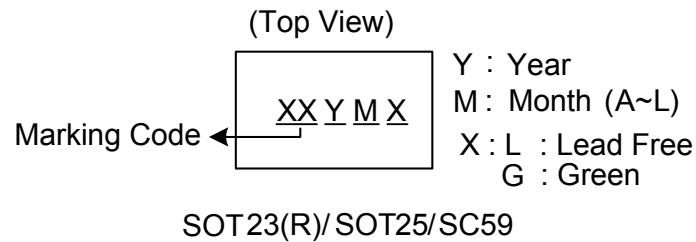
Output ON when Low Limit < V_{IN} < High Limit

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

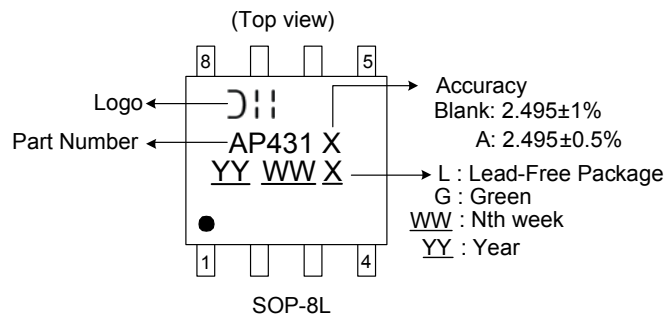
Fig. 10 Over-Voltage / Under-Voltage Protection Circuit

Marking Information

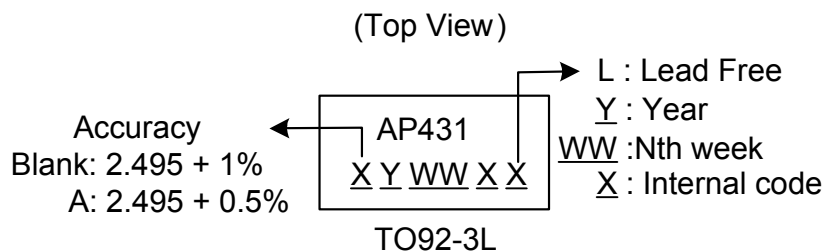
(1) SOT23(R)/SOT25/SC59



(2) SOP-8L



(3) TO92-3L



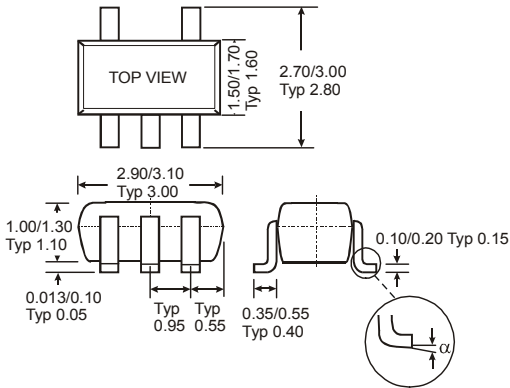
Marking Code Table

| Device | Package (Note 10) | Marking 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 |

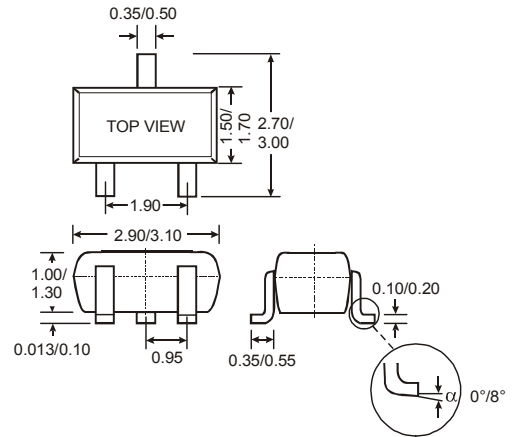
Note: 10. For Packaging Details, go to our website at <http://www.diodes.com/datasheets/ap02007.pdf>.

Package Information (All Dimensions in mm)

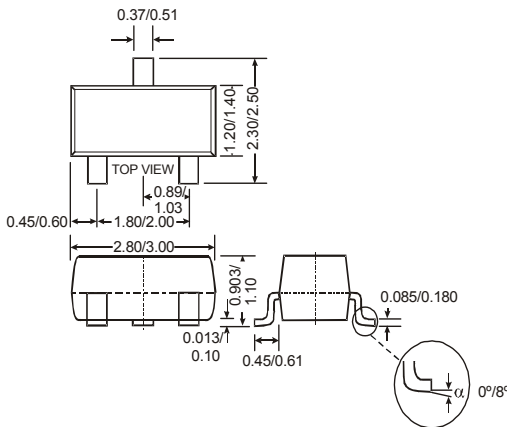
(1) SOT25



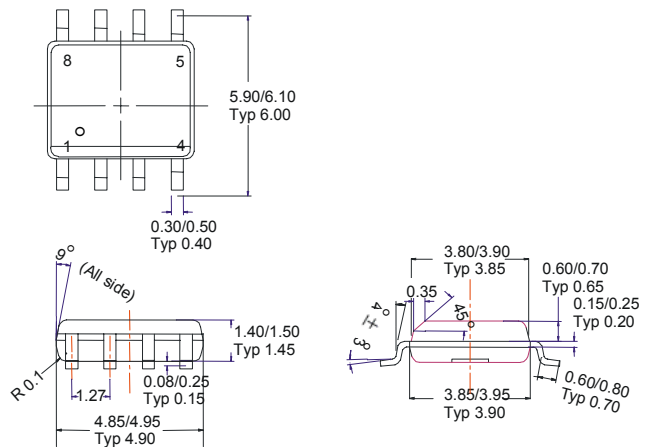
(2) SC59



(3) SOT23(R)

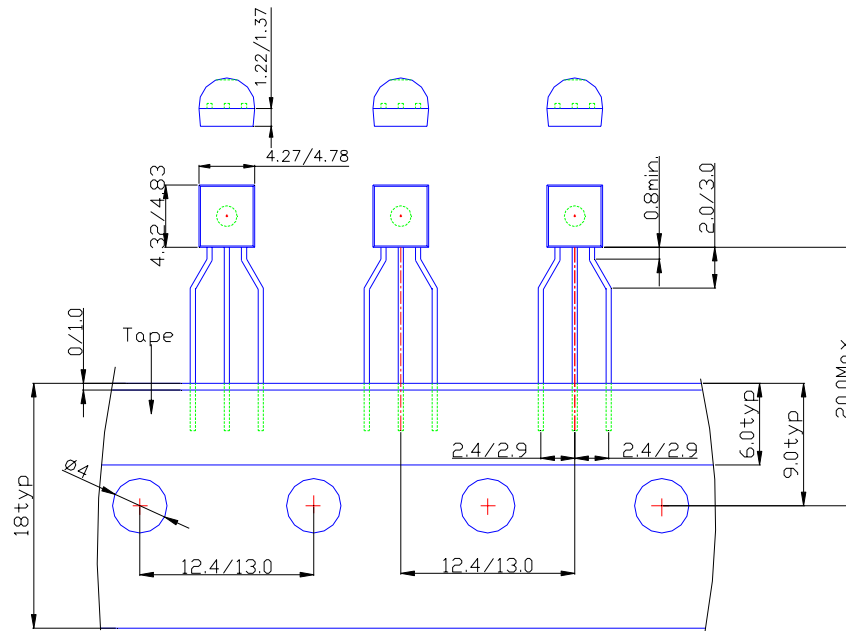


(4) SOP-8L



Package Information (Continued) (All Dimensions in mm)

(5) TO92-3L for Ammo pack



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