

### Features

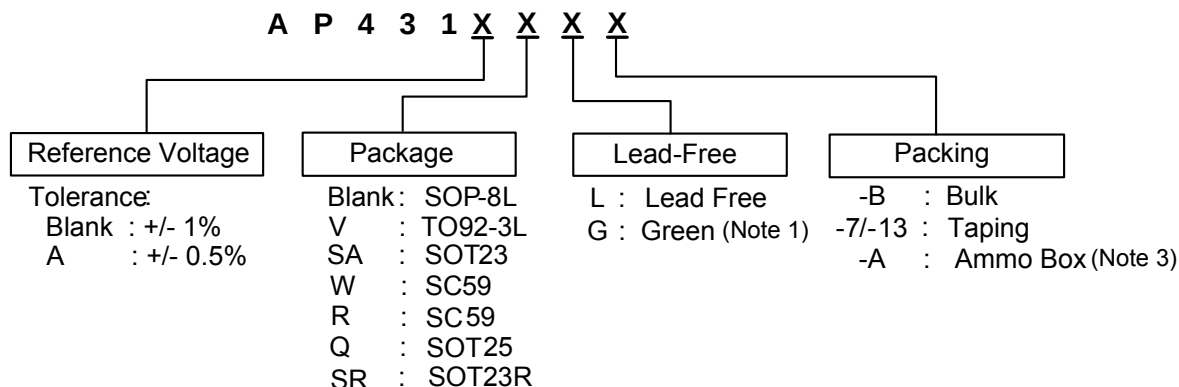
- Precision reference voltage  
AP431 :  $2.495V \pm 1\%$   
AP431A :  $2.495V \pm 0.5\%$
- Sink current capability: 200mA
- Minimum cathode current for regulation: 300 $\mu$ A
- Equivalent full-range temp coefficient: 30 ppm/ $^{\circ}$ C
- Fast turn-on response
- Low dynamic output impedance: 0.2 $\Omega$
- 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 0.2 $\Omega$ . 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<br>(Note 4) | Package<br>Code | Packaging<br>(Note 5) | 7" Tape and Reel    |                       | 13" Tape and Reel   |                       | Ammo Box |                       |
|--------------------|-----------------|-----------------------|---------------------|-----------------------|---------------------|-----------------------|----------|-----------------------|
|                    |                 |                       | Quantity            | Part Number<br>Suffix | Quantity            | Part Number<br>Suffix | Quantity | Part Number<br>Suffix |
| AP431(A)SA         | SA              | SOT23                 | 3000/Tape<br>& Reel | -7                    | NA                  | NA                    | NA       | NA                    |
| AP431(A)SR         | SR              | SOT23R                | 3000/Tape<br>& Reel | -7                    | NA                  | NA                    | NA       | NA                    |
| AP431(A)Q          | Q               | SOT25                 | 3000/Tape<br>& Reel | -7                    | NA                  | NA                    | NA       | NA                    |
| AP431(A)W          | W               | SC59                  | 3000/Tape<br>& Reel | -7                    | NA                  | NA                    | NA       | NA                    |
| AP431(A)R          | R               | SC59                  | 3000/Tape<br>& Reel | -7                    | NA                  | NA                    | NA       | NA                    |
| AP431(A)           |                 | SOP-8L                | NA                  | NA                    | 2500/Tape<br>& Reel | -13                   | NA       | NA                    |
| AP431(A)V          | V               | TO92-3L               | NA                  | NA                    | NA                  | NA                    | 2000/Box | -A                    |

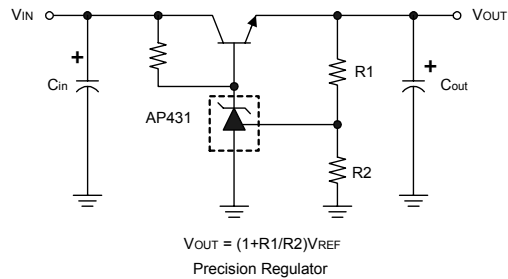
Notes: 3. Ammo Box is for TO92-3 Spread Lead.  
4. Suffix "A" denotes AP431A device.  
5. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.

## Pin Assignment

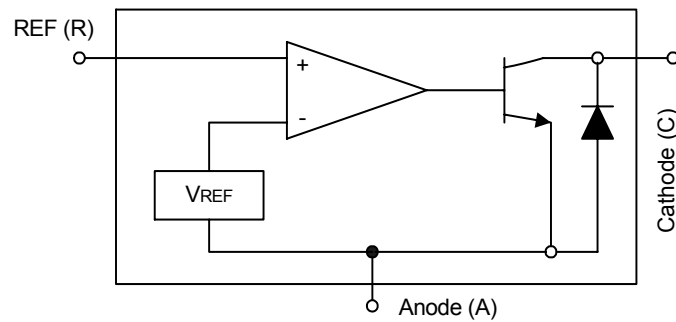
| Package                   | Pin Configuration (Top View)                     |
|---------------------------|--------------------------------------------------|
| SOT25                     | <p>NC 1 5 ANODE<br/>NC 2 4 REF<br/>CATHODE 3</p> |
| SC-59<br>(Package Code-W) | <p>ANODE 1 3 REF<br/>2 CATHODE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

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

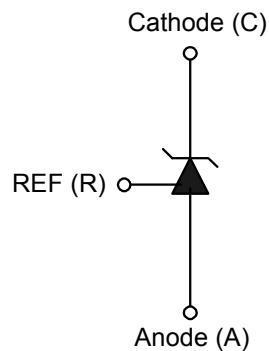
## Typical Application Circuit



## Block Diagram



## Symbol



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**Absolute Maximum Ratings**

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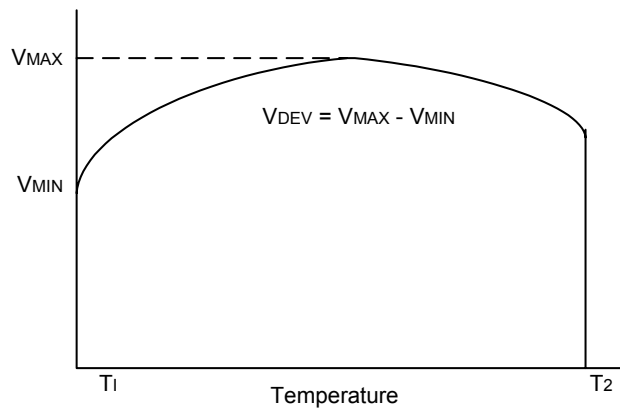
| Symbol           | Parameter                         |          | Rating      | Unit |
|------------------|-----------------------------------|----------|-------------|------|
| V <sub>CV</sub>  | Cathode Voltage                   |          | +36         | V    |
| I <sub>CC</sub>  | Continuous Cathode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

Note: 6. T<sub>J</sub>, 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                                                         | $V_{KA} = V_{REF}$ ,<br>$I_{KA} = 10\text{mA}$ (Fig.1)                                                                           | $V_{REF}$                             | 2.470<br>2.482 | 2.495 | 2.520<br>2.507 | V             |
| Deviation of Reference input voltage over temperature (Note 8)            | $V_{KA} = V_{REF}$ , $I_{KA} = 10\text{mA}$ ,<br>$T_a = \text{Full range}$ (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)                                                                                                  | $V_{KA} = 10\text{V} \sim V_{REF}$    | —              | -1.4  | -2.0           | mV/V          |
|                                                                           |                                                                                                                                  | $V_{KA} = 36\text{V} \sim 10\text{V}$ | —              | -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            | $\mu\text{A}$ |
| Deviation of Reference input current over temperature                     | $R1 = 10\text{K}\Omega$ , $R2 = \infty$ $I_{KA} = 10\text{mA}$<br>$T_a = \text{Full range}$ (Fig. 2)                             | $\alpha I_{REF}$                      | —              | 0.4   | 1.2            | $\mu\text{A}$ |
| 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            | $\mu\text{A}$ |
| Dynamic output impedance (Note 9)                                         | $V_{KA} = V_{REF}$ $V_{KA} = V_{REF}$<br>$\Delta I_{KA} = 0.1\text{mA} \sim 15\text{mA}$<br>Frequency $\leq 1\text{KHz}$ (Fig.1) | $ Z_{KA} $                            | —              | 0.2   | 0.5            | $\Omega$      |



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  $\alpha V_{REF}$  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.

$\alpha V_{REF}$  can be positive or negative depending on whether the slope is positive or negative.

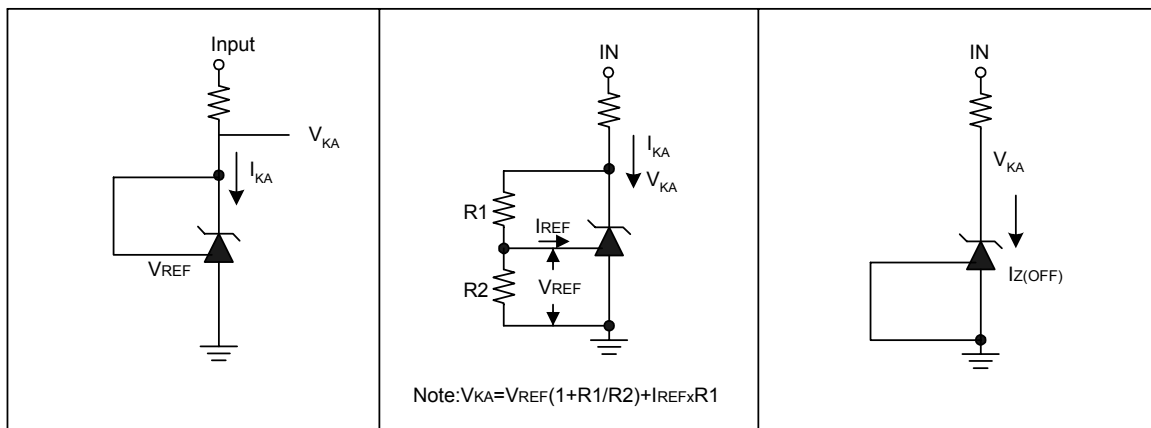
Note: 9. The dynamic output impedance,  $R_Z$ , is defined as:

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

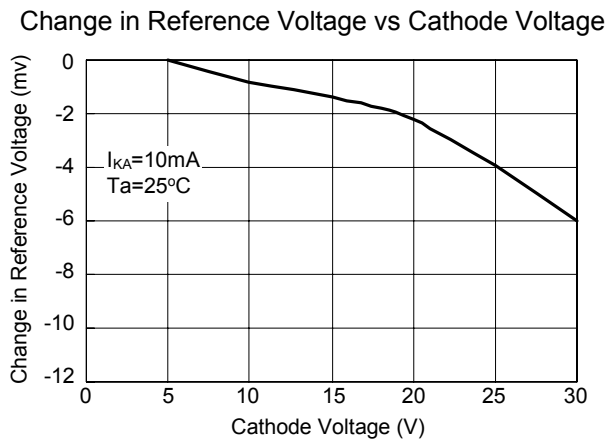
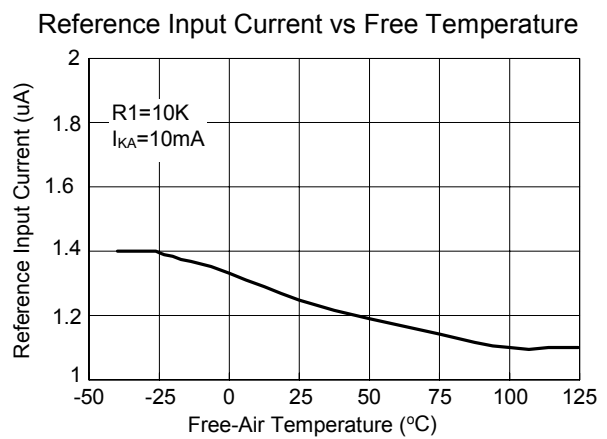
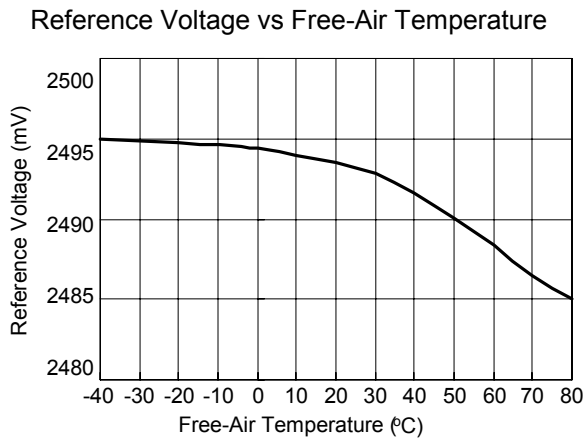
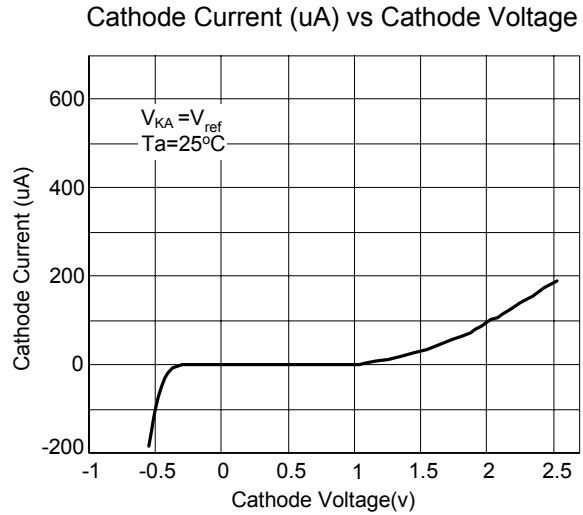
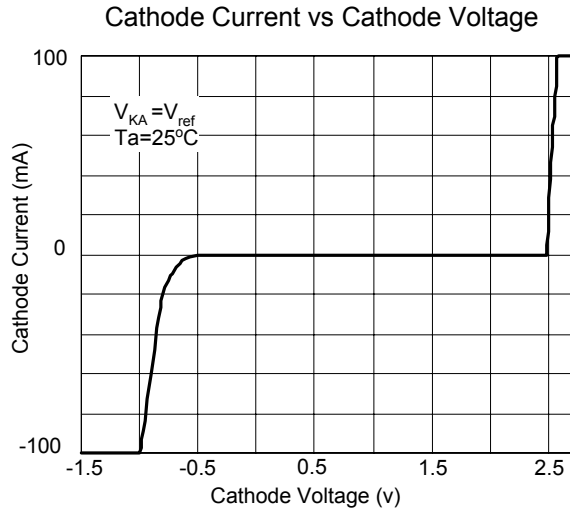
When the device is programmed with two external resistors  $R1$  and  $R2$  (see Figure 2.), the dynamic output impedance of the overall circuit, is defined as:

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

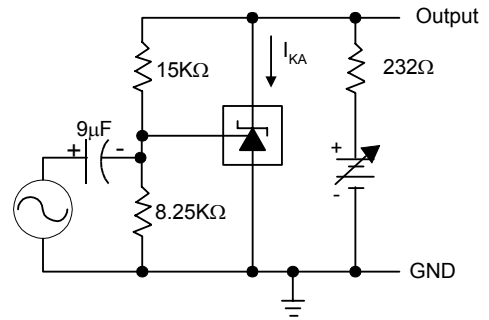
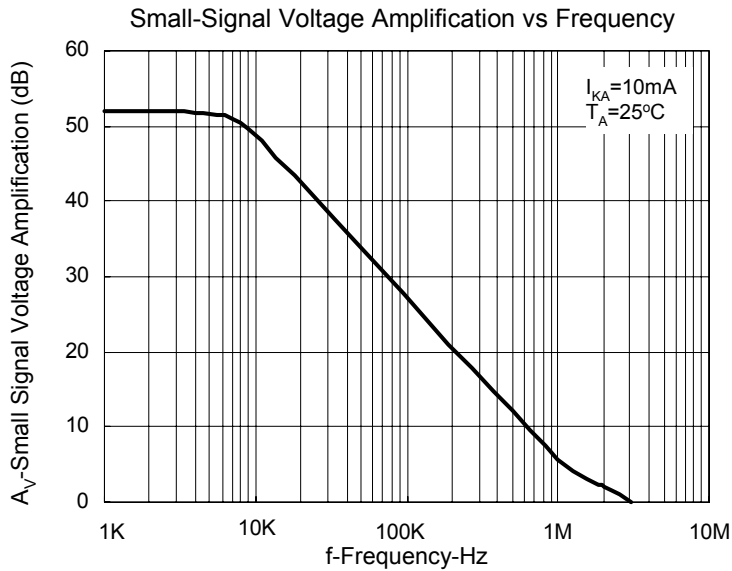
## Test Circuits



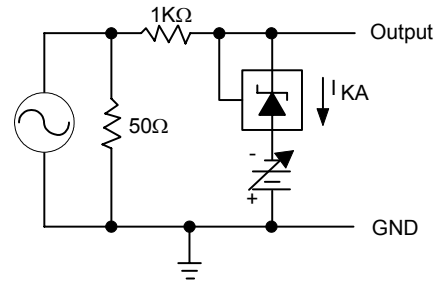
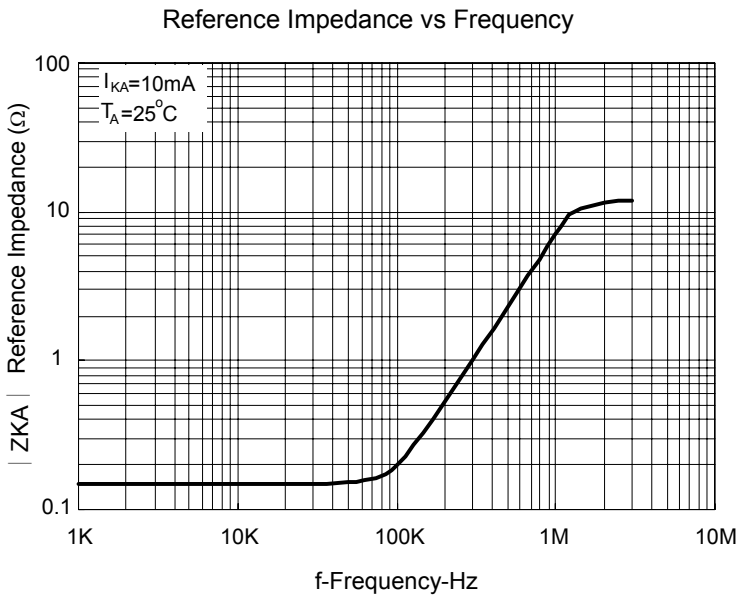
## Typical Performance Characteristics



**Typical Performance Characteristics** ( Continued )

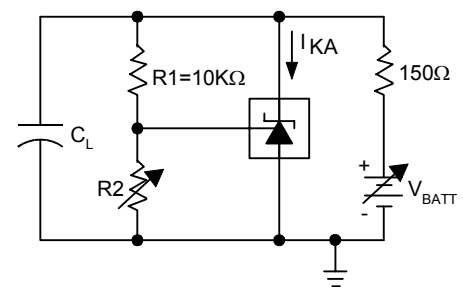
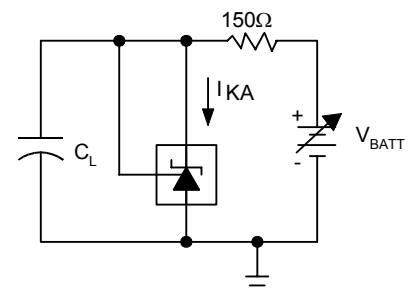
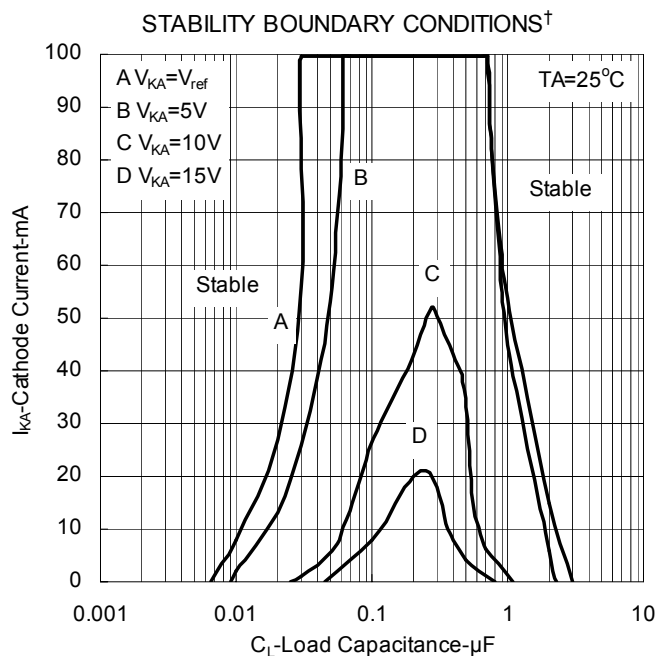
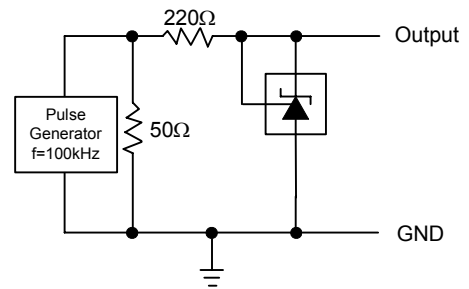
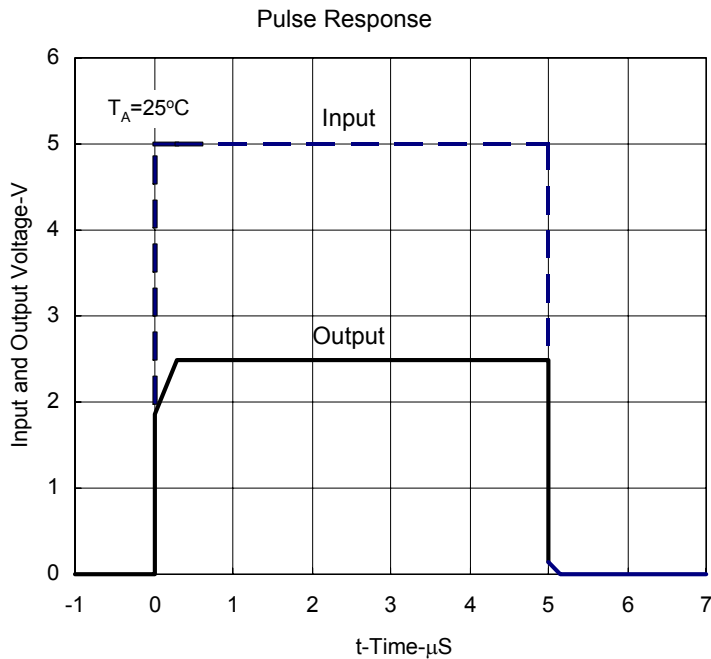


Test Circuit for Voltage Amplification



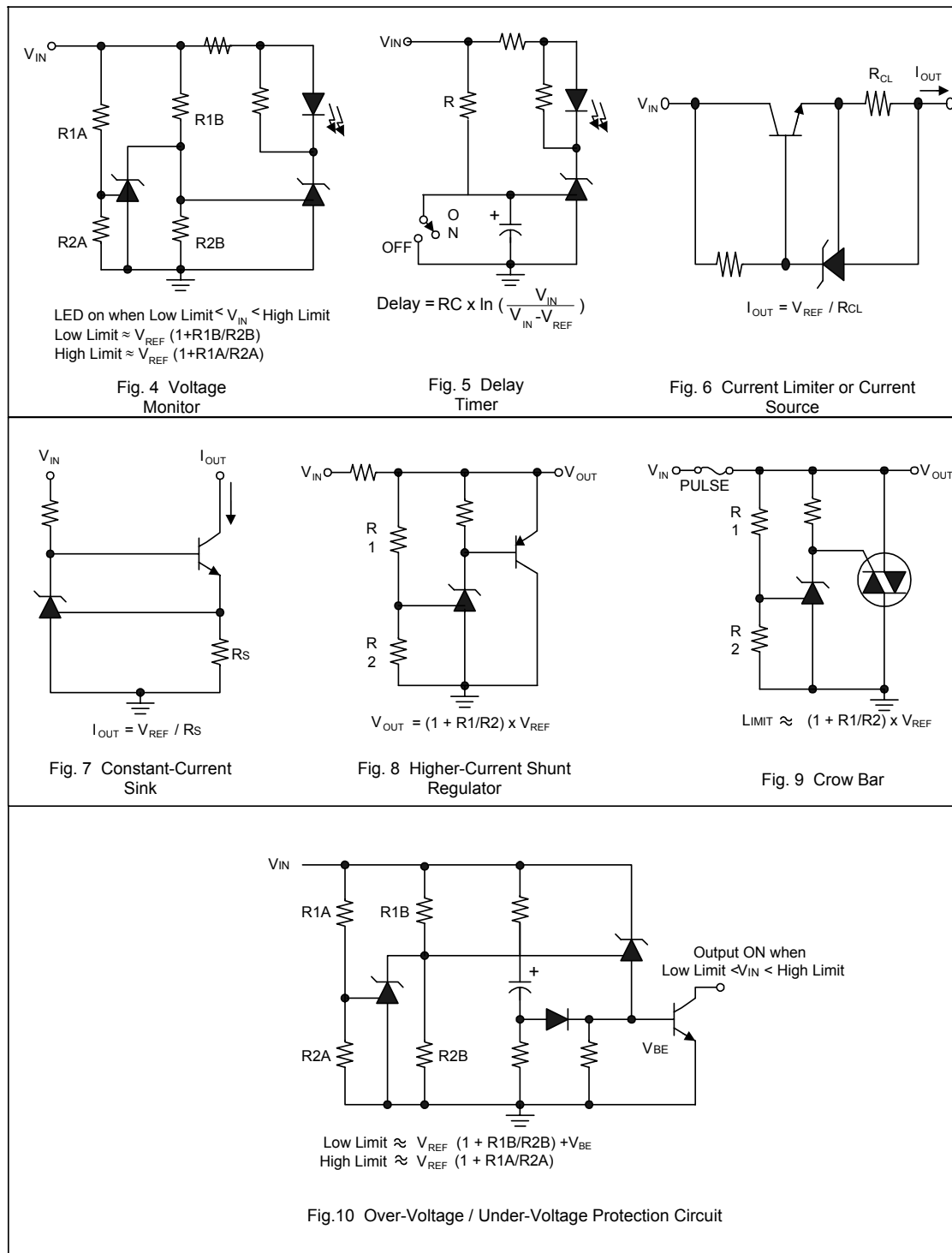
Test Circuit for Reference Impedance

### Typical Performance Characteristics (Continued)



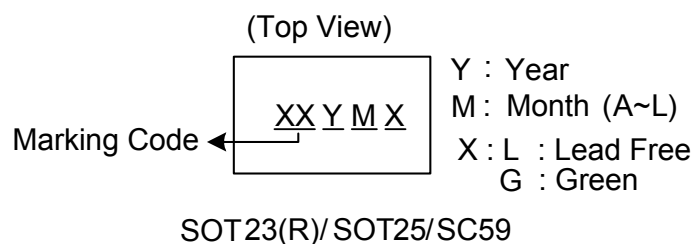
<sup>†</sup>The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial  $V_{KA}$  and  $I_{KA}$  conditions with  $C_L=0$ .  $V_{BATT}$  and  $C_L$  were then adjusted to determine the ranges of stability.

### Application Examples

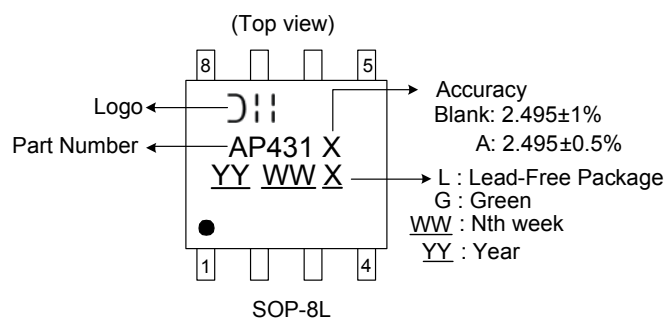


## Marking Information

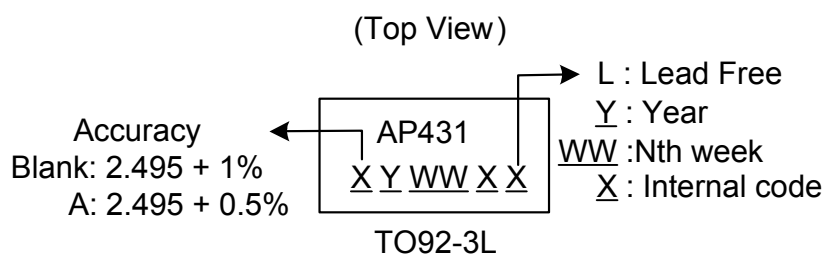
### (1) SOT23(R)/SOT25/SC59



### (2) SOP-8L



### (3) TO92-3L



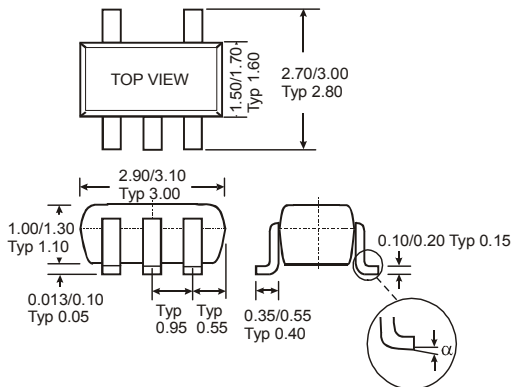
**Marking Code Table**

| 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        |

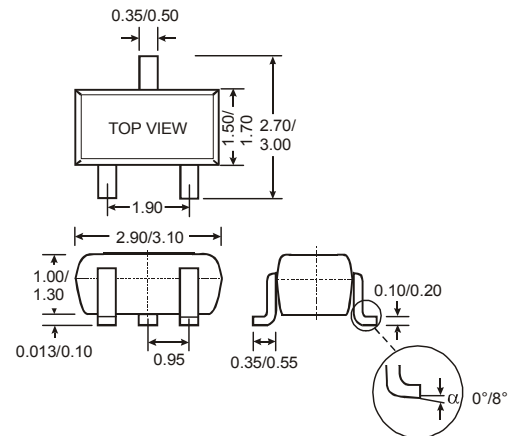
Note: 10. For Packaging Details, go to our website at <http://www.diodes.com/datasheets/ap02007.pdf>.

**Package Information** ( All Dimensions in mm )

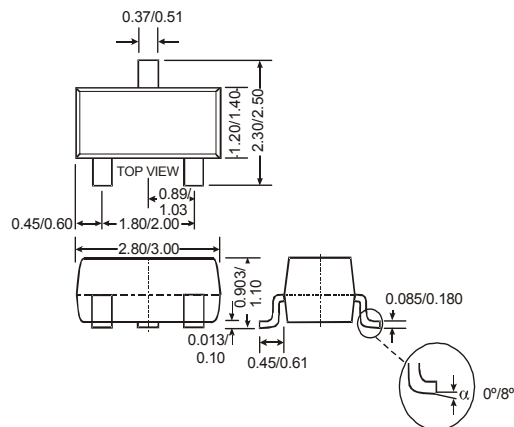
**(1) SOT25**



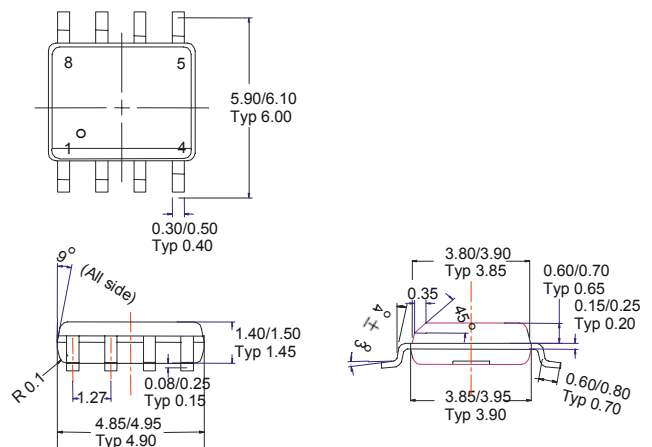
**(2) SC59**



**(3) SOT23(R)**

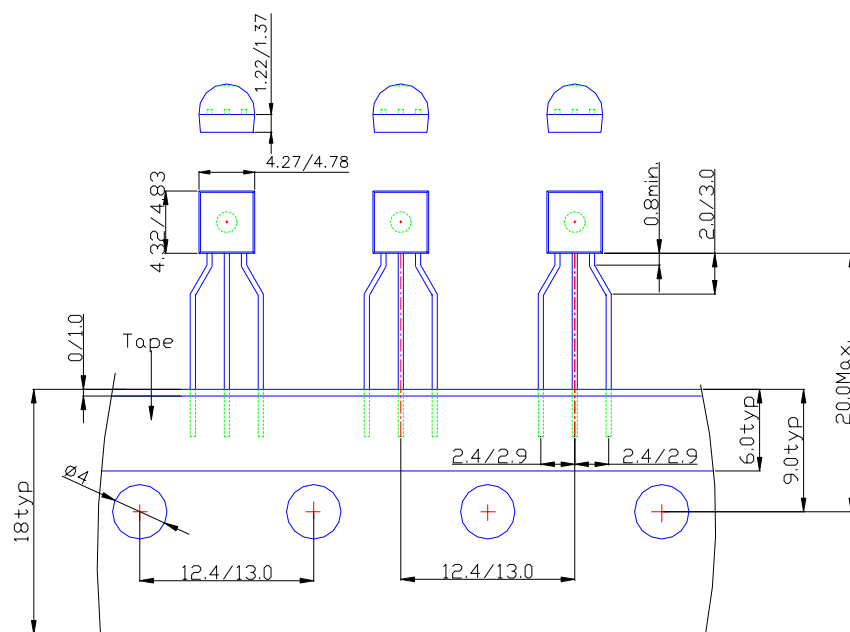


**(4) SOP-8L**



### Package Information (Continued) (All Dimensions in mm)

(5) TO92-3L for Ammo pack



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