

Description

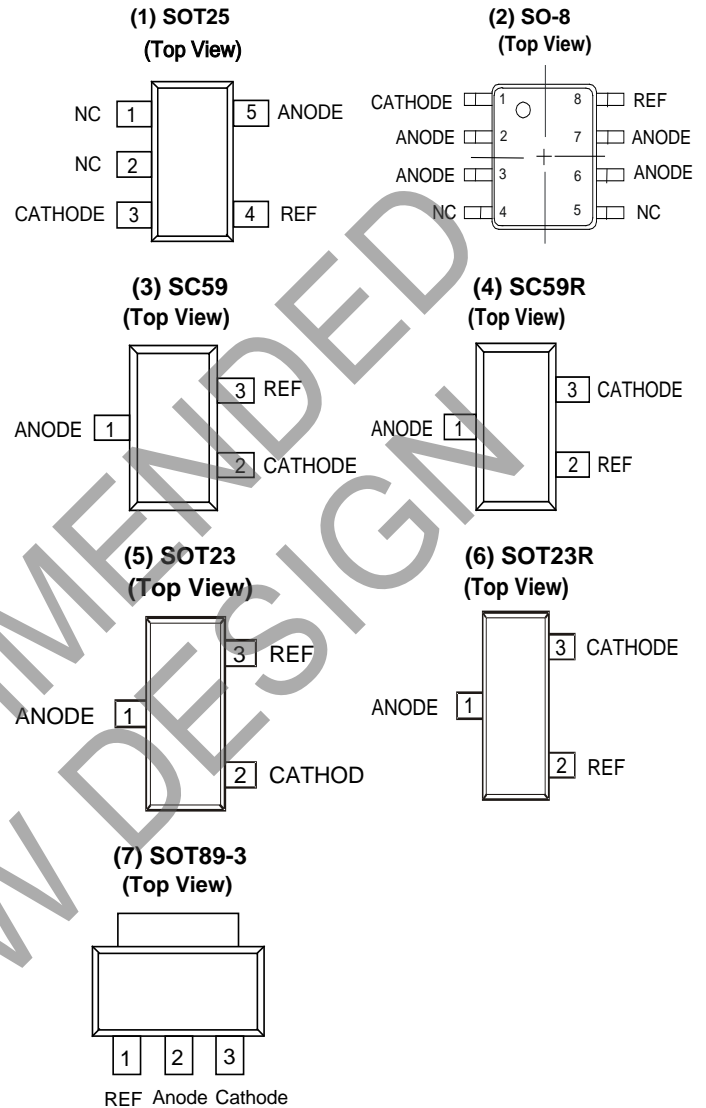
The AP432 and AP432A are 3-terminal adjustable precision shunt regulators with guaranteed stable temperature over the applicable extended commercial temperature range. The output voltage may be set at any level greater than 1.24V (V_{REF}) up to 20V merely by selecting two external resistors that act 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 AP432/AP432A 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.

Features

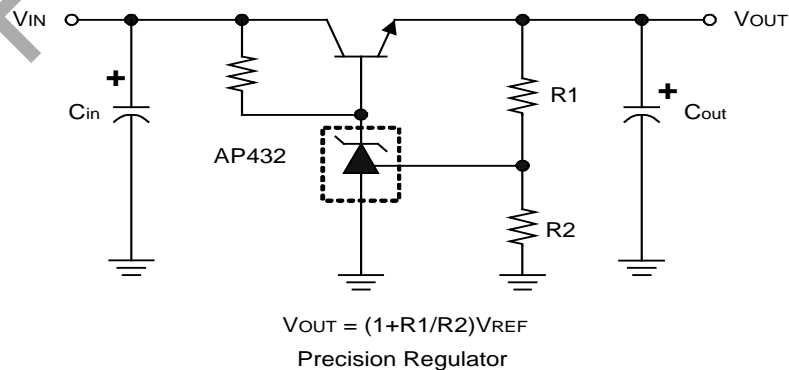
- Precision Reference Voltage
 - AP432 : 1.24V ± 1%
 - AP432A : 1.24V ± 0.5%
- Sink Current Capability: 200mA
- Minimum Cathode Current for Regulation: 150µA
- Equivalent Full-Range Temp Coefficient: 30 ppm/°C
- Fast Turn-On Response
- Low Dynamic Output Impedance: 0.2Ω
- Programmable Output Voltage to 20V
- Low Output Noise
- Lead Free packages: SOT25, SC59, SC59R and SOT89-3
 - **Lead-Free Finish; RoHS Compliant (Notes 1 & 2)**
- SOT23, SOT23R, SOT25, SC59, SC59R, SO-8 and SOT89: Available in "Green" Molding Compound (No Br, Sb)
 - **Halogen and Antimony Free. "Green" Device (Note 3)**

Pin Assignments

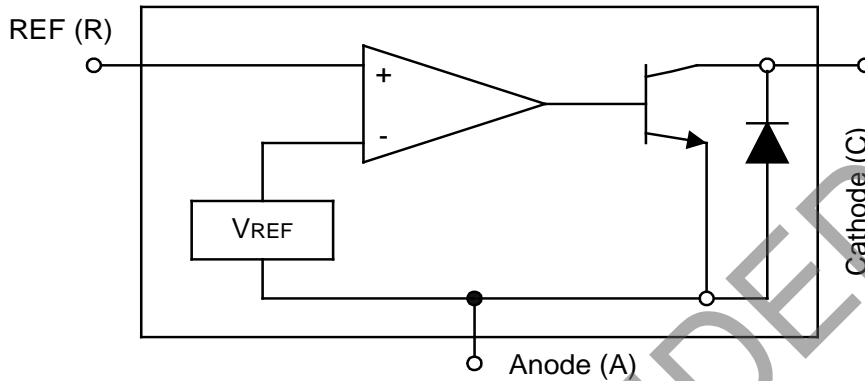


- Notes:
1. EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant. All applicable RoHS exemptions applied.
 2. See <http://www.diodes.com> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
 3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

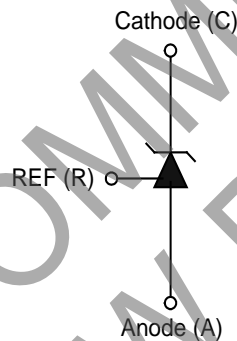
Typical Applications Circuit



Functional Block Diagram



Functional Block Diagram



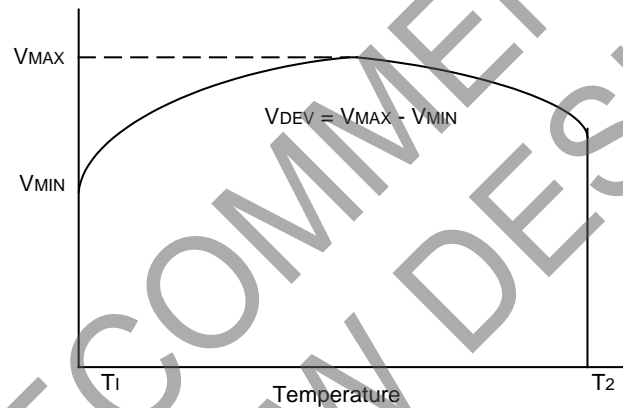
Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.)

| Symbol | Parameter | Rating | Unit | |
|------------------|-----------------------------------|-------------|------|----|
| V _{CV} | Cathode Voltage | 20 | 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 4, 5) | SOT23(R) | 400 | mW |
| | | SOT25 | 550 | mW |
| | | SC59(R) | 400 | mW |
| | | SO-8 | 600 | mW |
| | | SOT89-3 | 800 | mW |

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

Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

| Symbol | Parameter | Test Conditions | | Min | Typ | Max | Unit |
|--|---|---|---|----------------|------|----------------|------|
| V _{REF} | Reference voltage | V _{KA} = V _{REF} , I _{KA} = 10mA (Figure 1) | AP432 AP432A | 1.227 1.233 | 1.24 | 1.252 1.246 | V |
| V _{REF} | Deviation of reference input voltage over temperature (Note 4) | V _{KA} = V _{REF} , I _{KA} = 10mA, T _A = Full range (Figure 1) | | — | 3.0 | 20 | mV |
| $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ | Ratio of the change in reference voltage to the change in cathode voltage | I _{KA} = 10mA (Figure 2) | V _{KA} = 20 ~ V _{REF} | — | -1.4 | -2.0 | mV/V |
| I _{REF} | Reference input current | R1 = 10KΩ, R2 = ∞ I _{KA} = 10mA (Figure 2) | | — | 1.4 | 3.5 | μA |
| αI _{REF} | Deviation of reference input current over temperature | R1 = 10KΩ, R2 = ∞ I _{KA} = 10mA T _A = Full range (Figure 2) | | — | 0.4 | 1.2 | μA |
| I _{KA(MIN)} | Minimum cathode current for regulation | V _{KA} = V _{REF} (Figure 1) | | — | 0.15 | 0.3 | mA |
| I _{KA(OFF)} | Off-state current | V _{KA} = 36V, V _{REF} = 0V (Figure 3) | | — | 0.1 | 1.0 | μA |
| Z _{KA} | Dynamic output impedance (Note 5) | V _{KA} = V _{REF} V _{KA} = V _{REF} ΔI _{KA} = 0.1mA ~ 15mA Frequency ≤ 1KHz (Figure 1) | | — | 0.2 | 0.5 | Ω |



Notes: 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:

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

Where:

T₂ – T₁ = full temperature change.

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

Notes: 7. The dynamic output impedance, Z_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

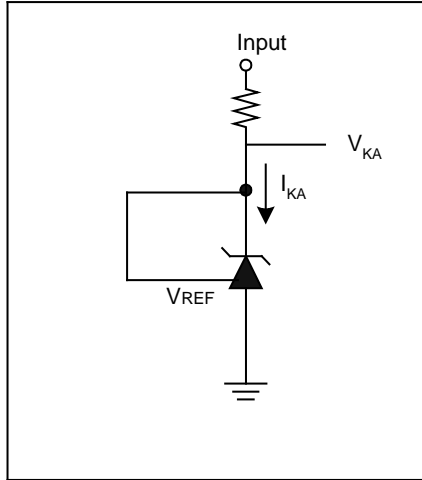
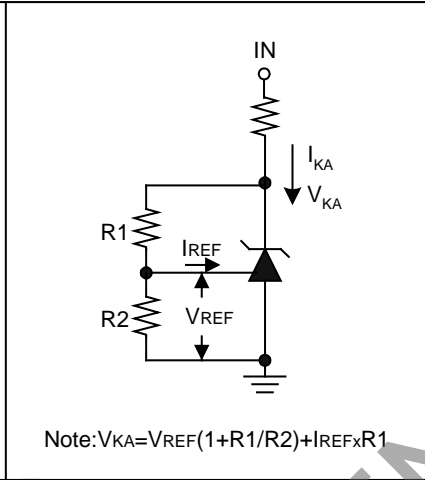


Fig 1. Test Circuit for $V_{KA} = V_{REF}$



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

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

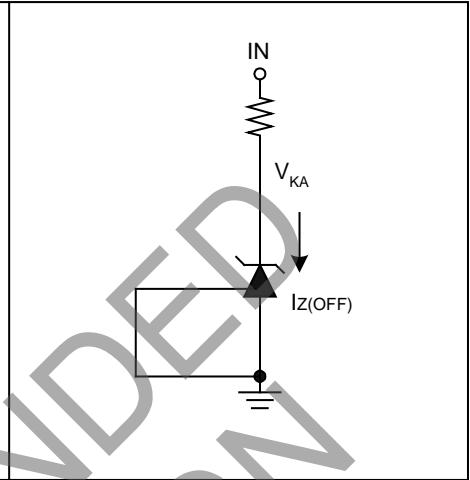
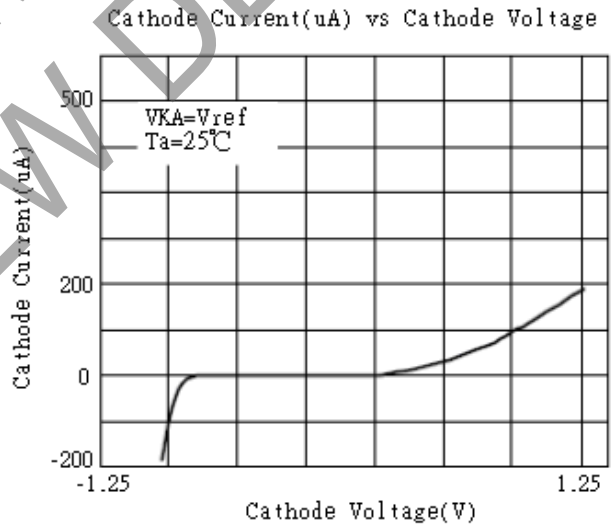
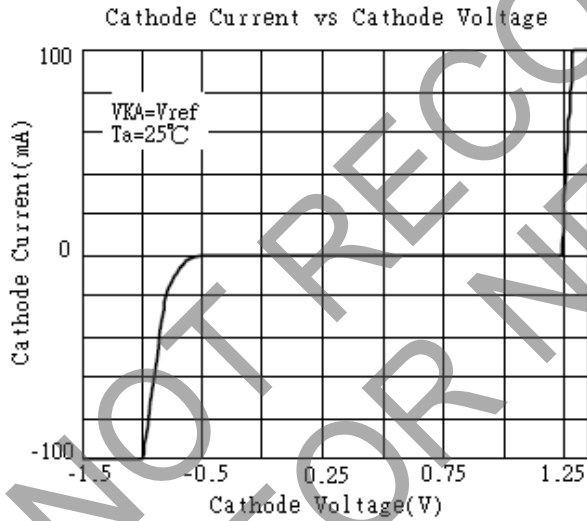
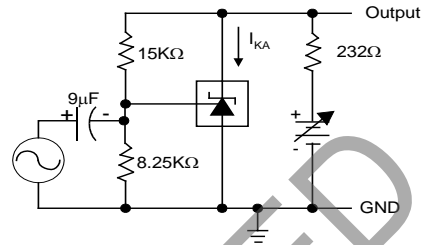
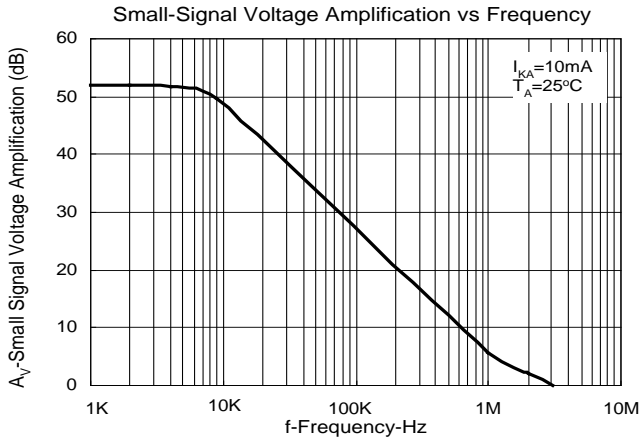


Fig 3. Test Circuit for Off-State Current

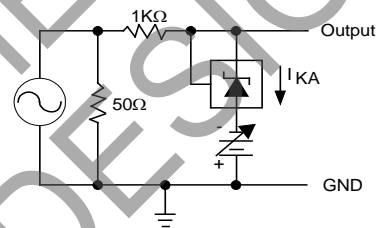
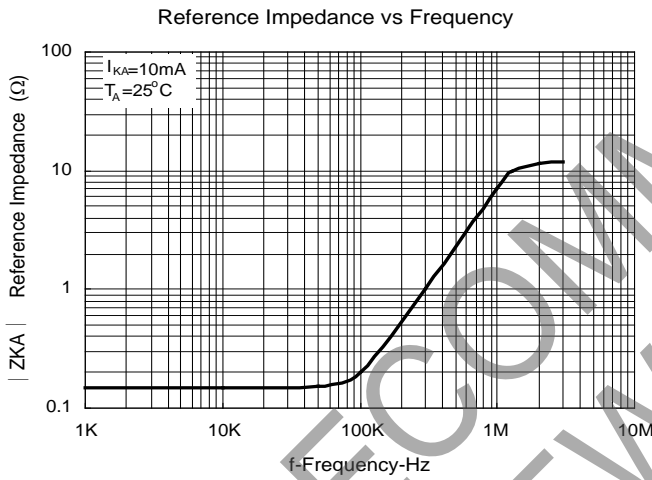
Typical Performance Characteristics



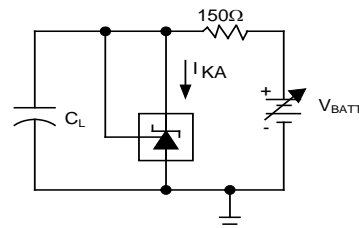
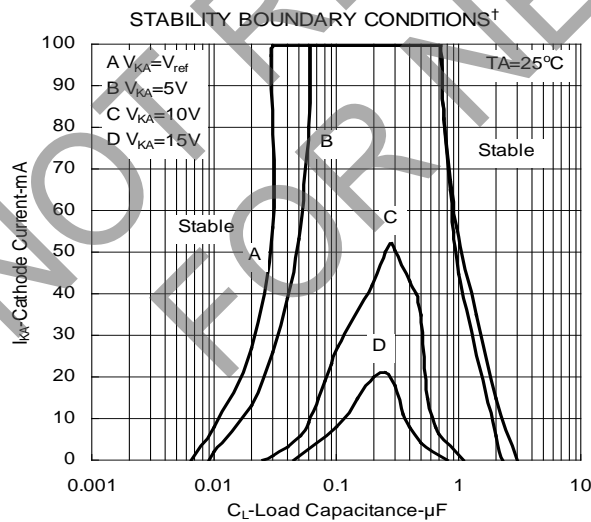
Typical Performance Characteristics (cont.)



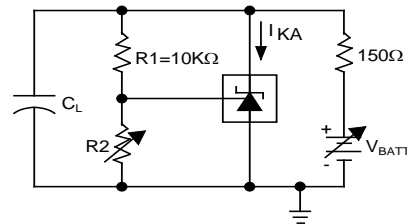
Test Circuit for Voltage Amplification



Test Circuit for Reference Impedance



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 $\approx V_{REF} (1 + R1B/R2B)$
 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 $\approx (1 + R1/R2) \times V_{REF}$

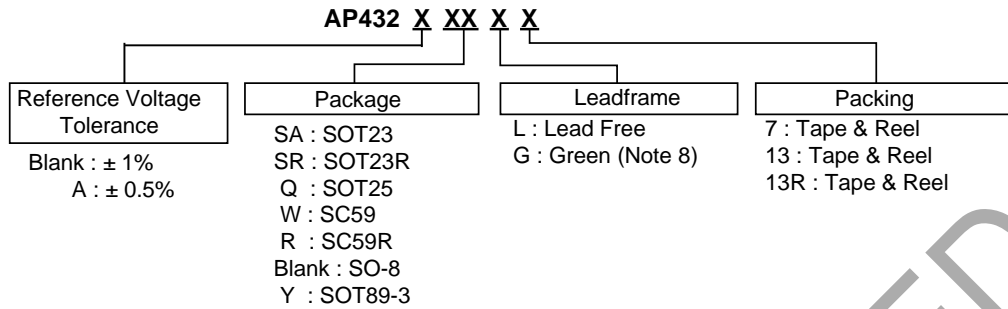
Fig. 9 Crow Bar

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



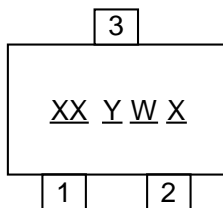
| Part Number (Note 10) | Package Code | Packaging | 7"/13 Tape and Reel | | Ammo Box | |
|-----------------------|--------------|-----------|---------------------|--------------------|----------|--------------------|
| | | | Quantity | Part Number Suffix | Quantity | Part Number Suffix |
| AP432(A)SAG-7 | SA | SOT23 | 3000/Tape & Reel | -7 | NA | NA |
| AP432(A)SRG-7 | SR | SOT23R | 3000/Tape & Reel | -7 | NA | NA |
| AP432(A)QL-7 | Q | SOT25 | 3000/Tape & Reel | -7 | NA | NA |
| AP432(A)QG-7 | Q | SOT25 | 3000/Tape & Reel | -7 | NA | NA |
| AP432(A)WL-7 | W | SC59 | 3000/Tape & Reel | -7 | NA | NA |
| AP432(A)WG-7 | W | SC59 | 3000/Tape & Reel | -7 | NA | NA |
| AP432(A)RL-7 | R | SC59R | 3000/Tape & Reel | -7 | NA | NA |
| AP432(A)RG-7 | R | SC59R | 3000/Tape & Reel | -7 | NA | NA |
| AP432(A)G-13 | | SO-8 | 2500/Tape & Reel | -13 | NA | NA |
| AP432(A)YL-13 | Y | SOT89-3 | 2500/Tape & Reel | -13 | NA | NA |
| AP432(A)YG-13 | Y | SOT89-3 | 2500/Tape & Reel | -13 | NA | NA |
| AP432(A)YG-13R | Y | SOT89-3 | 2500/Tape & Reel | -13R | NA | NA |

Notes: 8. SO-8, SOT23 and SOT23R are available in "Green" products only.
9. Suffix "A" denotes AP432A device.

Marking Information

(1) SC59 and SC59R

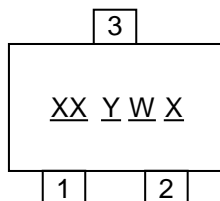
(Top View)



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

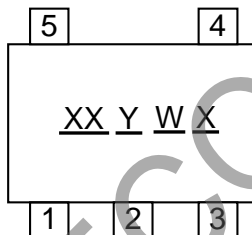
(Top View)



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

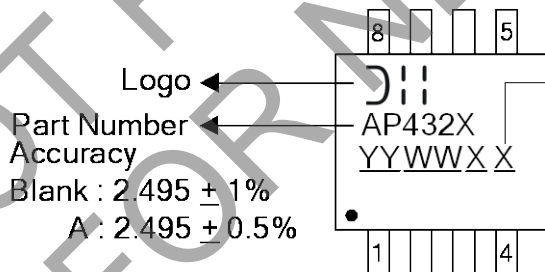
(Top View)



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) SO-8

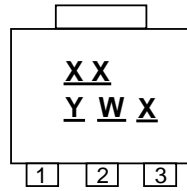
(Top View)



G : Green
YY : Year : 08, 09, 10~
WW : Week : 01~52; 52
 represents 52 and 53 week
X : Internal Code

(5) SOT89-3

(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 : Internal code
 A~Z : Green
 a~z : Lead Free

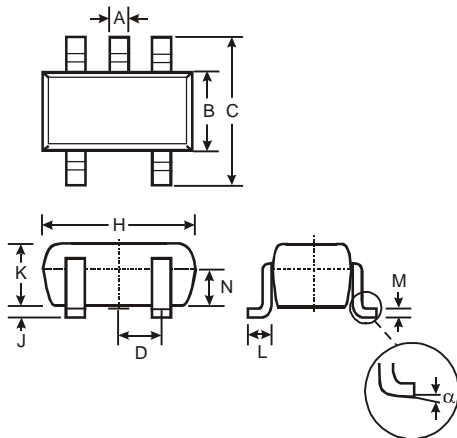
| Device | Package (Note 11) | Identification Code | Date Code |
|----------|-------------------|---------------------|-----------|
| AP432SA | SOT23 | D3 | YM |
| AP432ASA | SOT23 | D4 | YM |
| AP432SR | SOT23R | D7 | YM |
| AP432ASR | SOT23R | D8 | YM |
| AP432Q | SOT25 | B7 | YM |
| AP432AQ | SOT25 | B8 | YM |
| AP432W | SC59 | B3 | YM |
| AP432AW | SC59 | B4 | YM |
| AP432R | SC59R | B5 | YM |
| AP432AR | SC59R | B6 | YM |
| AP432Y | SOT89 | B1 | YM |
| AP432AY | SOT89 | B2 | 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.)

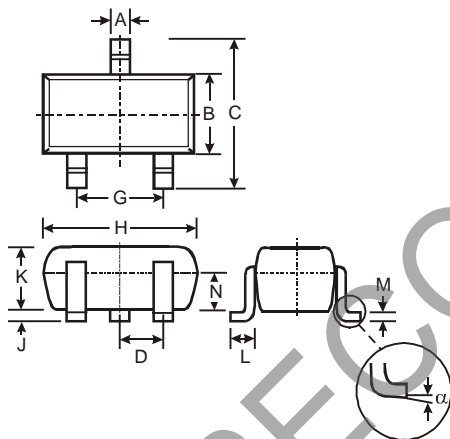
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.

(1) SOT25



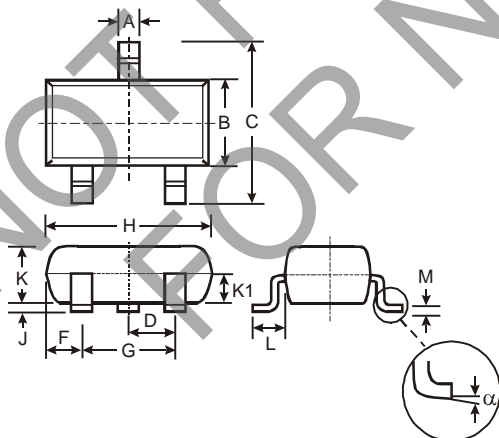
| SOT25 | | | |
|----------------------|-------|------|------|
| Dim | Min | Max | Typ |
| A | 0.35 | 0.50 | 0.38 |
| B | 1.50 | 1.70 | 1.60 |
| C | 2.70 | 3.00 | 2.80 |
| D | — | — | 0.95 |
| H | 2.90 | 3.10 | 3.00 |
| J | 0.013 | 0.10 | 0.05 |
| K | 1.00 | 1.30 | 1.10 |
| L | 0.35 | 0.55 | 0.40 |
| M | 0.10 | 0.20 | 0.15 |
| N | 0.70 | 0.80 | 0.75 |
| α | 0° | 8° | — |
| All Dimensions in mm | | | |

(2) SC59 and SC59R



| SC59 | | | |
|----------------------|-------|------|------|
| Dim | Min | Max | Typ |
| A | 0.35 | 0.50 | 0.38 |
| B | 1.50 | 1.70 | 1.60 |
| C | 2.70 | 3.00 | 2.80 |
| D | - | - | 0.95 |
| G | - | - | 1.90 |
| H | 2.90 | 3.10 | 3.00 |
| J | 0.013 | 0.10 | 0.05 |
| K | 1.00 | 1.30 | 1.10 |
| L | 0.35 | 0.55 | 0.40 |
| M | 0.10 | 0.20 | 0.15 |
| N | 0.70 | 0.80 | 0.75 |
| α | 0° | 8° | - |
| All Dimensions in mm | | | |

(3) SOT23 and SOT23R

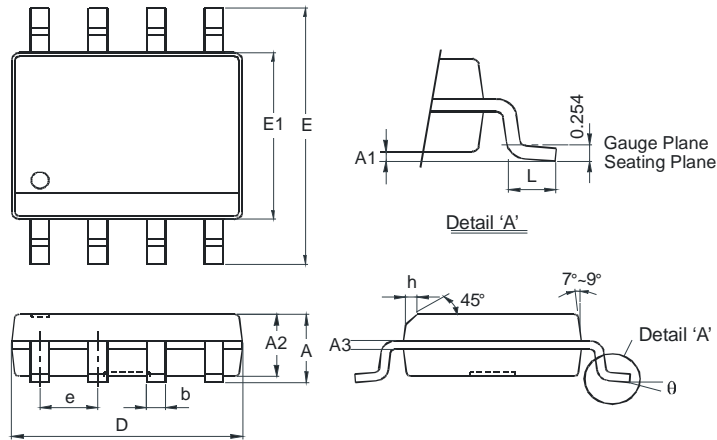


| SOT23 | | | |
|----------------------|-------|------|-------|
| Dim | Min | Max | Typ |
| A | 0.37 | 0.51 | 0.40 |
| B | 1.20 | 1.40 | 1.30 |
| C | 2.30 | 2.50 | 2.40 |
| D | 0.89 | 1.03 | 0.915 |
| F | 0.45 | 0.60 | 0.535 |
| G | 1.78 | 2.05 | 1.83 |
| H | 2.80 | 3.00 | 2.90 |
| J | 0.013 | 0.10 | 0.05 |
| K | 0.903 | 1.10 | 1.00 |
| K1 | - | - | 0.400 |
| L | 0.45 | 0.61 | 0.55 |
| M | 0.085 | 0.18 | 0.11 |
| α | 0° | 8° | - |
| All Dimensions in mm | | | |

Package Outline Dimensions (cont.) (All dimensions in mm.)

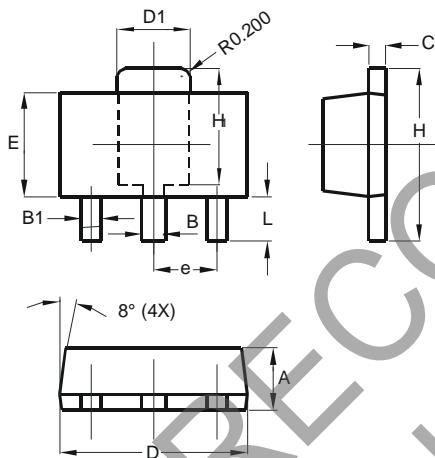
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.

(4) SO-8



| SO-8 | | |
|----------------------|----------|------|
| Dim | Min | Max |
| A | - | 1.75 |
| A1 | 0.10 | 0.20 |
| A2 | 1.30 | 1.50 |
| A3 | 0.15 | 0.25 |
| b | 0.3 | 0.5 |
| D | 4.85 | 4.95 |
| E | 5.90 | 6.10 |
| E1 | 3.85 | 3.95 |
| e | 1.27 Typ | |
| h | - | 0.35 |
| L | 0.62 | 0.82 |
| θ | 0° | 8° |
| All Dimensions in mm | | |

(5) SOT89-3



| SOT89 | | |
|----------------------|----------|------|
| Dim | Min | Max |
| A | 1.40 | 1.60 |
| B | 0.44 | 0.62 |
| B1 | 0.35 | 0.54 |
| C | 0.35 | 0.44 |
| D | 4.40 | 4.60 |
| D1 | 1.62 | 1.83 |
| E | 2.29 | 2.60 |
| e | 1.50 Typ | |
| H | 3.94 | 4.25 |
| H1 | 2.63 | 2.93 |
| L | 0.89 | 1.20 |
| All Dimensions in mm | | |

Package Outline Dimensions (cont.) (All dimensions in mm.)

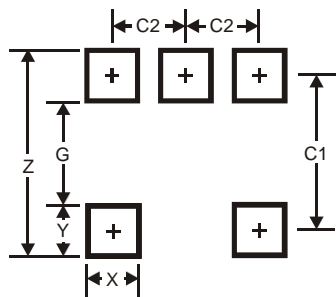
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.

NOT RECOMMENDED
FOR NEW DESIGN

Suggested Pad Layout

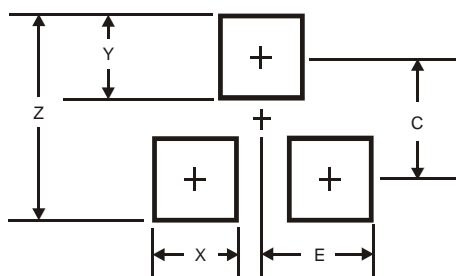
Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.

(1) SOT25



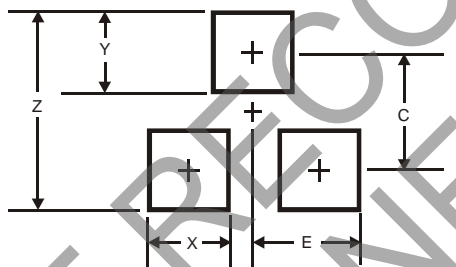
| Dimensions | Value (in mm) |
|------------|---------------|
| Z | 3.20 |
| G | 1.60 |
| X | 0.55 |
| Y | 0.80 |
| C1 | 2.40 |
| C2 | 0.95 |

(2) SC59 and SC59R



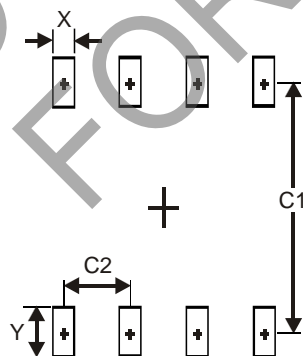
| Dimensions | Value (in mm) |
|------------|---------------|
| Z | 3.4 |
| X | 0.8 |
| Y | 1.0 |
| C | 2.4 |
| E | 1.35 |

(3) SOT23 and SOT23R



| Dimensions | Value (in mm) |
|------------|---------------|
| Z | 2.9 |
| X | 0.8 |
| Y | 0.9 |
| C | 2.0 |
| E | 1.35 |

(4) SO-8

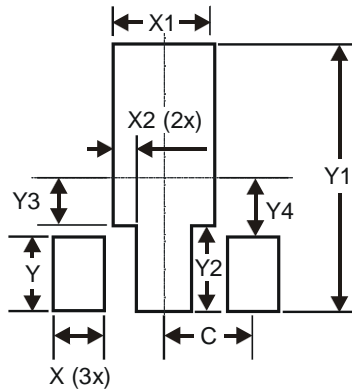


| Dimensions | Value (in mm) |
|------------|---------------|
| X | 0.60 |
| Y | 1.55 |
| C1 | 5.4 |
| C2 | 1.27 |

Suggested Pad Layout (cont.)

Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.

(5) SOT89-3



| Dimensions | Value (in mm) |
|------------|---------------|
| X | 0.900 |
| X1 | 1.733 |
| X2 | 0.416 |
| Y | 1.300 |
| Y1 | 4.600 |
| Y2 | 1.475 |
| Y3 | 0.950 |
| Y4 | 1.125 |
| C | 1.500 |

NOT RECOMMENDED FOR NEW DESIGN

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