

## Description

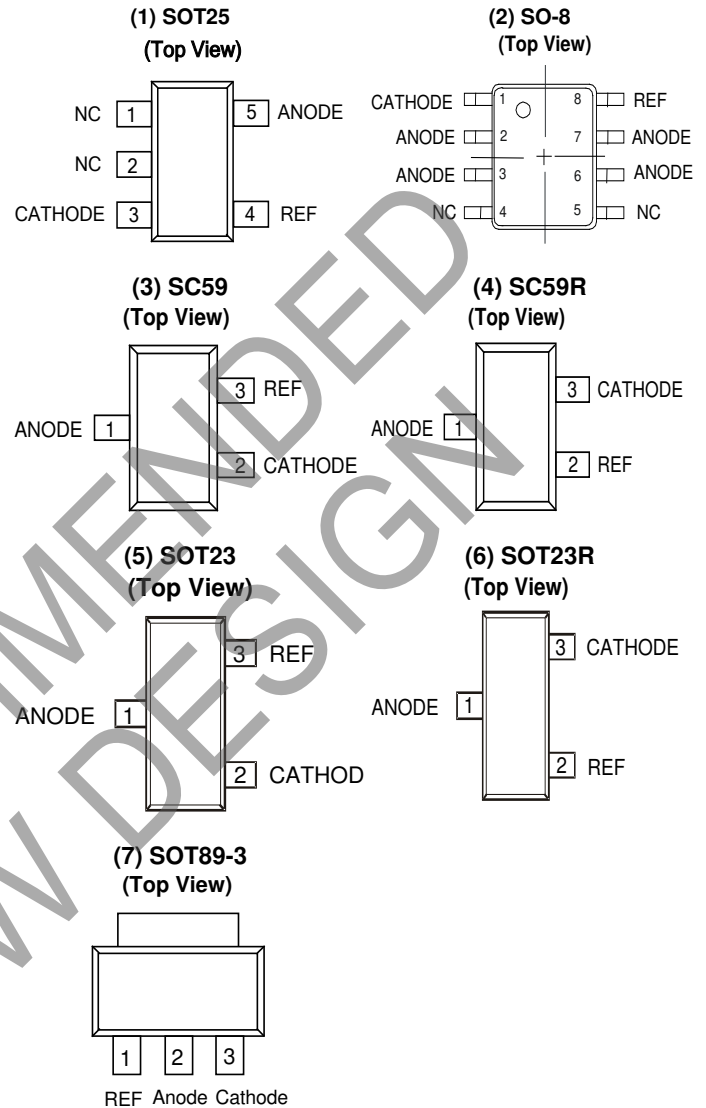
The AP432 and AP432A are 3-terminal adjustable precision shunt regulators with guaranteed stable temperature over the applicable extended commercial temperature range. The output voltage may be set at any level greater than 1.24V ( $V_{REF}$ ) up to 20V merely by selecting two external resistors that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

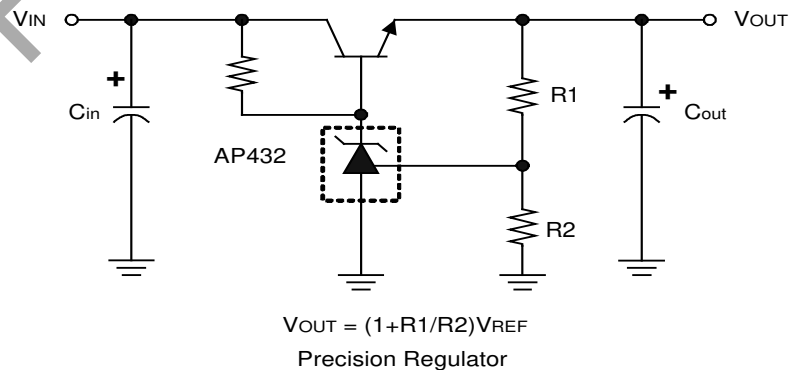
- Precision Reference Voltage
  - AP432 : 1.24V ± 1%
  - AP432A : 1.24V ± 0.5%
- Sink Current Capability: 200mA
- Minimum Cathode Current for Regulation: 150µA
- Equivalent Full-Range Temp Coefficient: 30 ppm/°C
- Fast Turn-On Response
- Low Dynamic Output Impedance: 0.2Ω
- Programmable Output Voltage 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

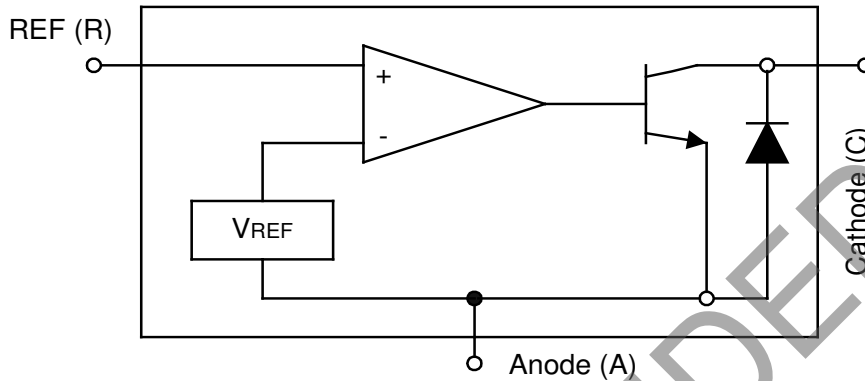


Notes: 1. EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant. All applicable RoHS exemptions applied.  
 2. See <http://www.diodes.com> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.  
 3. Halogen- and Antimony-free "Green"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

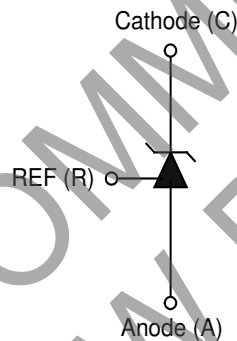
## Typical Applications Circuit



**Functional Block Diagram**



**Functional Block Diagram**



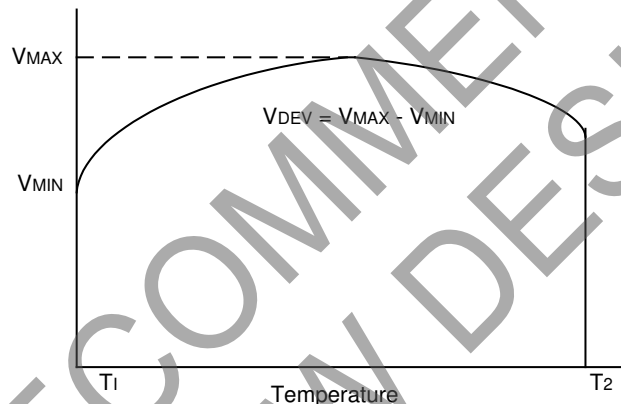
**Absolute Maximum Ratings** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

Symbol	Parameter	Rating	Unit	
V <sub>CV</sub>	Cathode Voltage	20	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 (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<sub>J</sub>, max = +150°C.  
5. Ratings apply to ambient temperature at +25°C.

**Electrical Characteristics** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

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



Notes: 6. Deviation of reference input voltage, V<sub>DEV</sub>, is defined as the maximum variation of the reference over the full temperature range. The average temperature coefficient of the reference input voltage αV<sub>REF</sub> is defined as:

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

Where:

T<sub>2</sub> – T<sub>1</sub> = full temperature change.

αV<sub>REF</sub> can be positive or negative depending on whether the slope is positive or negative.

Notes: 7. The dynamic output impedance, R<sub>z</sub>, 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**

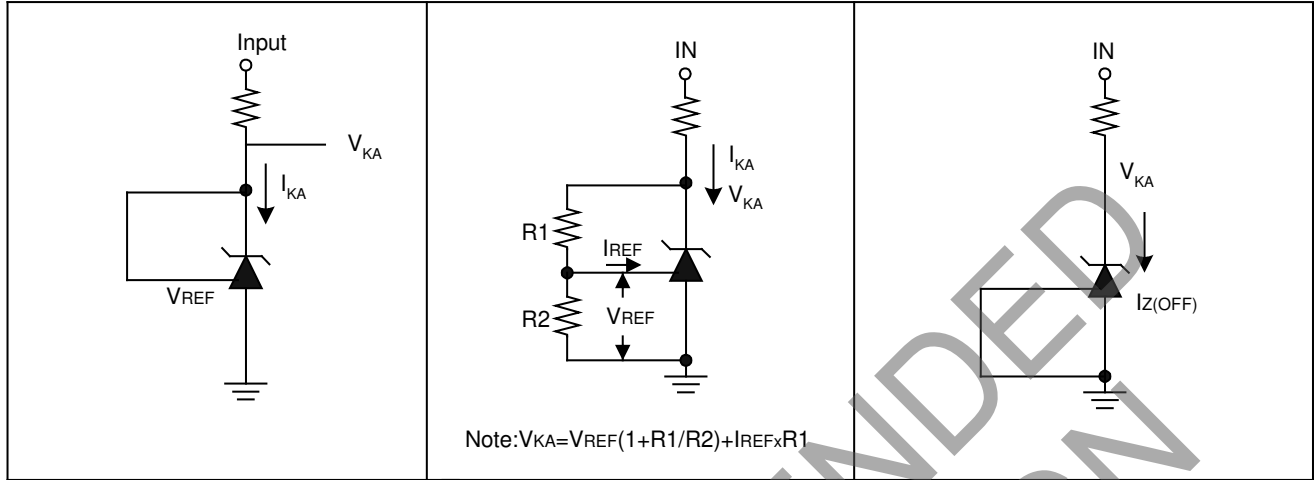
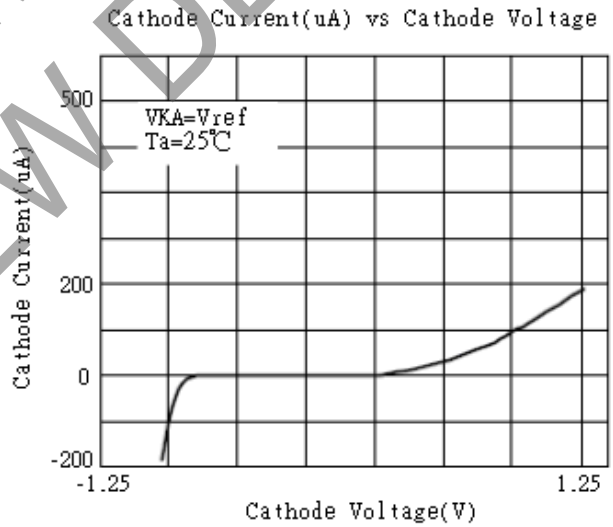
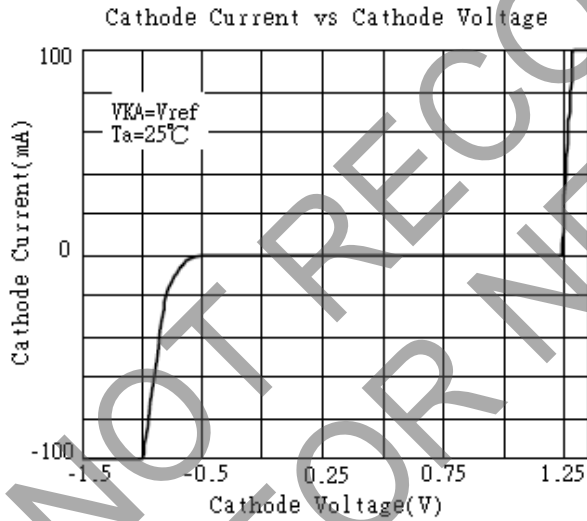


Fig 1. Test Circuit for  $V_{KA} = V_{REF}$

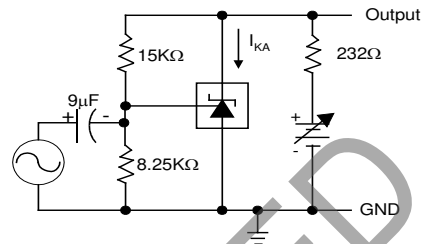
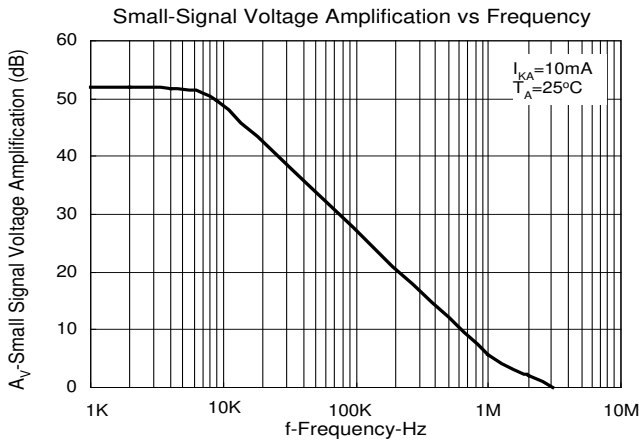
Fig 2. Test Circuit for  $V_{KA} > V_{REF}$

Fig 3. Test Circuit for Off-State Current

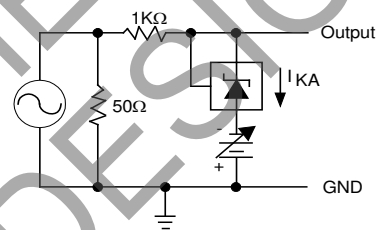
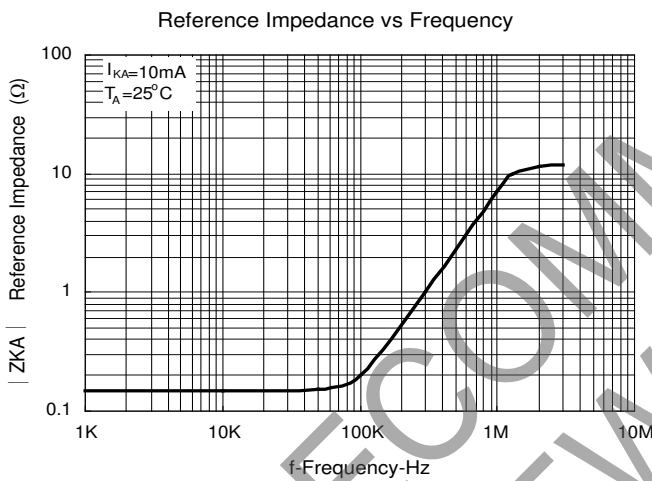
**Typical Performance Characteristics**



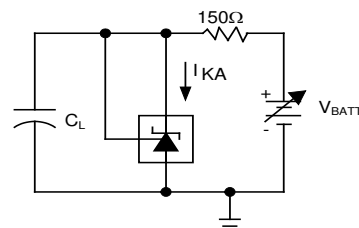
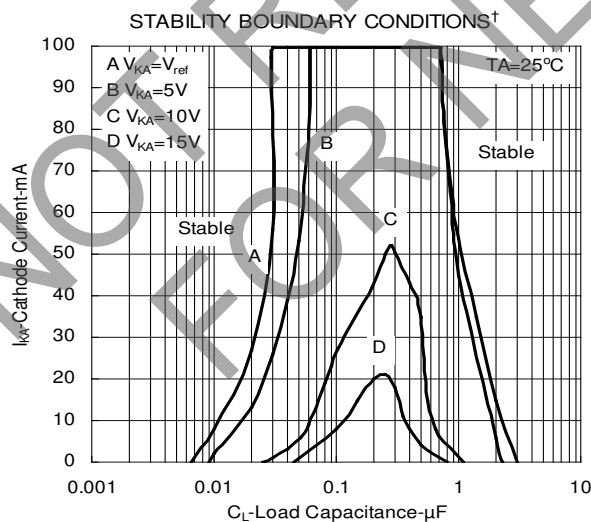
**Typical Performance Characteristics (cont.)**



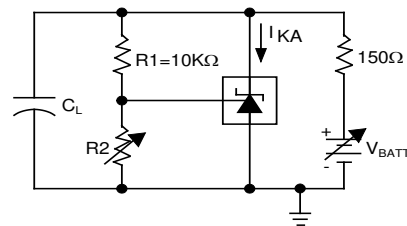
Test Circuit for Voltage Amplification



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<sub>KA</sub> and I<sub>KA</sub> conditions with C<sub>L</sub>=0. V<sub>BATT</sub> and C<sub>L</sub> 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**

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

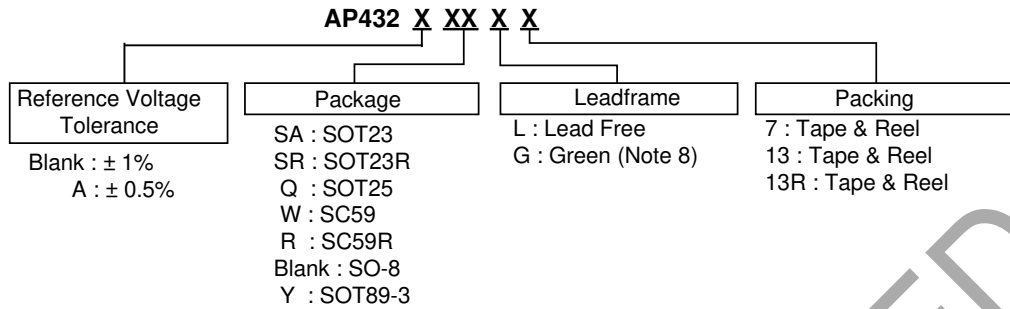
**Fig. 9 Crow Bar**

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



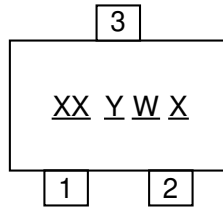
Part Number (Note 10)	Package Code	Packaging	7"/13 Tape and Reel		Ammo Box	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix
AP432(A)SAG-7	SA	SOT23	3000/Tape & Reel	-7	NA	NA
AP432(A)SRG-7	SR	SOT23R	3000/Tape & Reel	-7	NA	NA
AP432(A)QL-7	Q	SOT25	3000/Tape & Reel	-7	NA	NA
AP432(A)QG-7	Q	SOT25	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

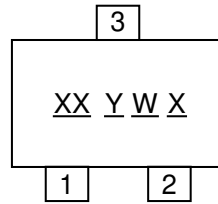
( Top View )



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

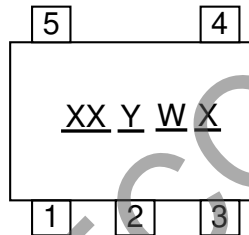
( Top View )



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

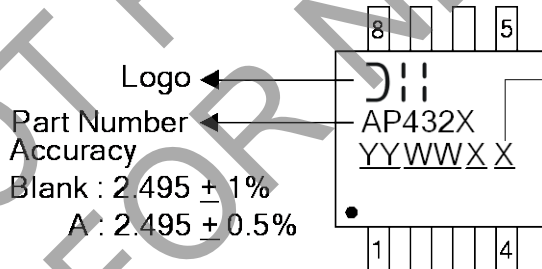
( Top View )



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 )



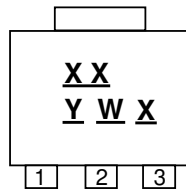
G : Green  
YY : Year : 08, 09, 10~  
WW : Week : 01~52; 52  
 represents 52 and 53 week  
X : Internal Code

**Marking Information** (cont.)



(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

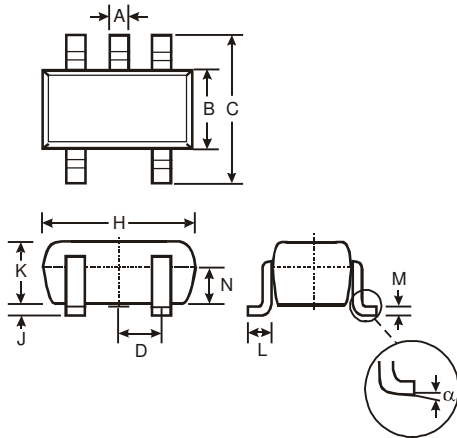
Device	Package (Note 11)	Identification Code	Date Code
AP432SA	SOT23	D3	YM
AP432ASA	SOT23	D4	YM
AP432SR	SOT23R	D7	YM
AP432ASR	SOT23R	D8	YM
AP432Q	SOT25	B7	YM
AP432AQ	SOT25	B8	YM
AP432W	SC59	B3	YM
AP432AW	SC59	B4	YM
AP432R	SC59R	B5	YM
AP432AR	SC59R	B6	YM
AP432Y	SOT89	B1	YM
AP432AY	SOT89	B2	YM

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

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

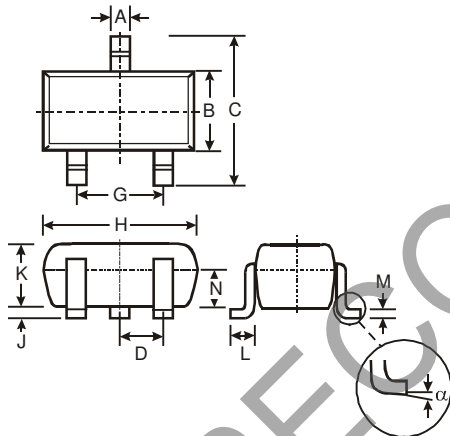
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.

**(1) SOT25**



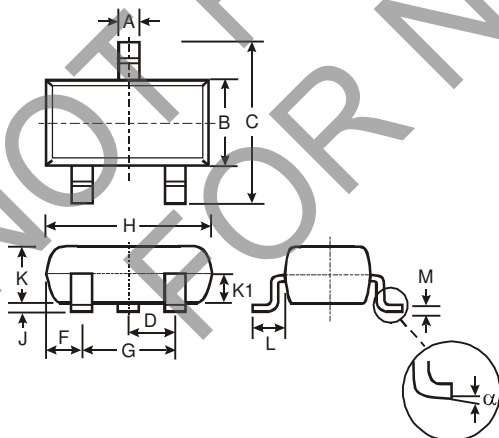
SOT25			
Dim	Min	Max	Typ
A	0.35	0.50	0.38
B	1.50	1.70	1.60
C	2.70	3.00	2.80
D	—	—	0.95
H	2.90	3.10	3.00
J	0.013	0.10	0.05
K	1.00	1.30	1.10
L	0.35	0.55	0.40
M	0.10	0.20	0.15
N	0.70	0.80	0.75
α	0°	8°	—
All Dimensions in mm			

**(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**

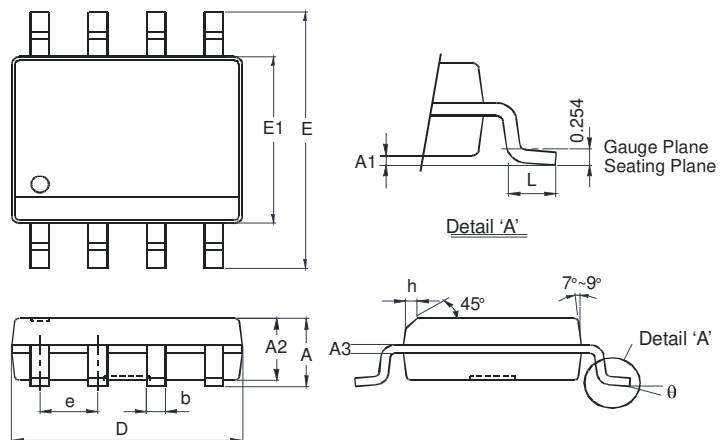


SOT23			
Dim	Min	Max	Typ
A	0.37	0.51	0.40
B	1.20	1.40	1.30
C	2.30	2.50	2.40
D	0.89	1.03	0.915
F	0.45	0.60	0.535
G	1.78	2.05	1.83
H	2.80	3.00	2.90
J	0.013	0.10	0.05
K	0.903	1.10	1.00
K1	—	—	0.400
L	0.45	0.61	0.55
M	0.085	0.18	0.11
α	0°	8°	—
All Dimensions in mm			

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

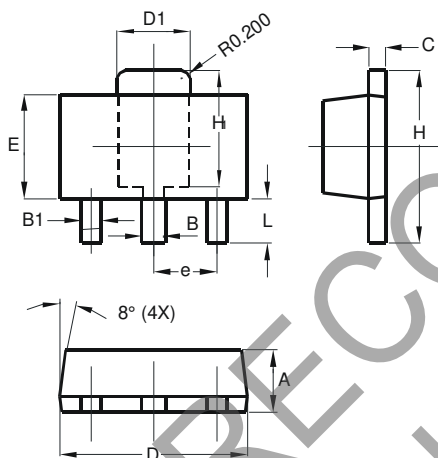
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.

**(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		

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

NOT RECOMMENDED  
FOR NEW DESIGN

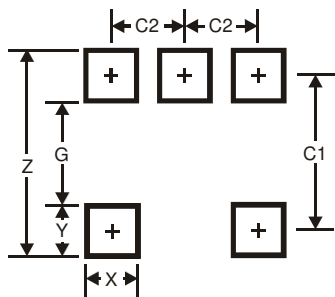
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## Suggested Pad Layout

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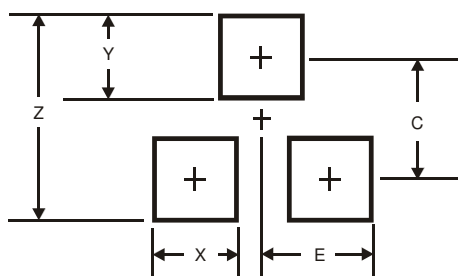
Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.

(1) SOT25



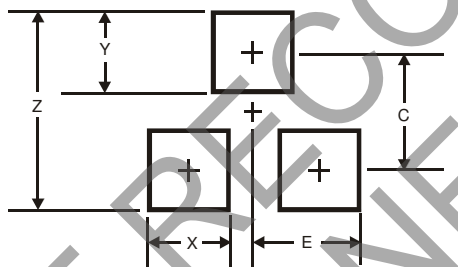
Dimensions	Value (in mm)
Z	3.20
G	1.60
X	0.55
Y	0.80
C1	2.40
C2	0.95

(2) SC59 and SC59R



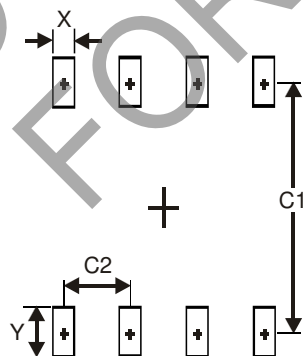
Dimensions	Value (in mm)
Z	3.4
X	0.8
Y	1.0
C	2.4
E	1.35

(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

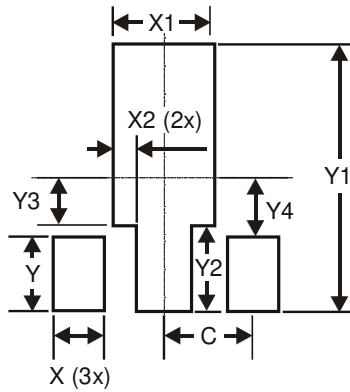


Dimensions	Value (in mm)
X	0.60
Y	1.55
C1	5.4
C2	1.27

**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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1. are intended to implant into the body, or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

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