AP432/AP432A

ADJUSTABLE PRECISION SHUNT REGULATOR

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
- Packages: SOT23, SOT23R, SOT25, SOT89-3L, SC59, SC59R, SOP-8L and TO92-3L
- Lead Free packages: SOT25, SOT89-3L, SC59, SC59R and TO92-3L
- SOP-8L, SOT23 and SOT23R: Available in "Green" Molding Compound (No Br, Sb) (Note 2)
- Lead Free Finish/ RoHS Compliant (Note 3)

General Description

The AP432/432A 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 AP432/432A 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

AP432 X XX X - X

Reference Voltage	Package	Lead Free	Packing
Tolerance Blank : +/- 1% A : +/- 0.5%	SA : SOT23 SR : SOT23R Q : SOT25 W : SC59 R : SC59R Blank : SOP-8L Y : SOT89-3L V : TO92-3L	L : Lead Free (Note 1) G : Green (Note 2)	U : Tube 7/ 13 : Tape & Reel A : Ammo Box (Note 4)

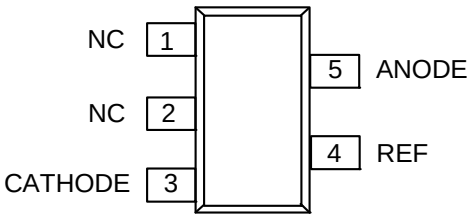
Device (Note 5)	Package Code	Packaging (Note 3, 6)	7" Tape and Reel		13" Tape and Reel		Ammo Box	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix	Quantity	Part Number Suffix
AP432(A)SAG-7	SA	SOT23	3000/Tape & Reel	-7	NA	NA	NA	NA
AP432(A)SRG-7	SR	SOT23R	3000/Tape & Reel	-7	NA	NA	NA	NA
AP432(A)QL-7	Q	SOT25	3000/Tape & Reel	-7	NA	NA	NA	NA
AP432(A)WL-7	W	SC59	3000/Tape & Reel	-7	NA	NA	NA	NA
AP432(A)RL-7	R	SC59R	3000/Tape & Reel	-7	NA	NA	NA	NA
AP432(A)G-13		SOP-8L	NA	NA	2500/Tape & Reel	-13	NA	NA
AP432(A)YL-13	Y	SOT89-3L	NA	NA	2500/Tape & Reel	-13	NA	NA
AP432(A)VL-A	V	TO92-3L	NA	NA	NA	NA	2000/Box	-A

Notes:
1. SOT25, SOT89-3L, SC59 (W package code), SC59 (R package code) and TO92-3L are "Lead Free" products only.
2. SOP-8L, SOT23 and SOT23R are available in "Green" products only.
3. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied, see *EU Directive 200/95/EC Annex Notes.*
4. Ammo Box is for TO92-3L Spread Lead.
5. Suffix "A" denotes AP431A device.
6. 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

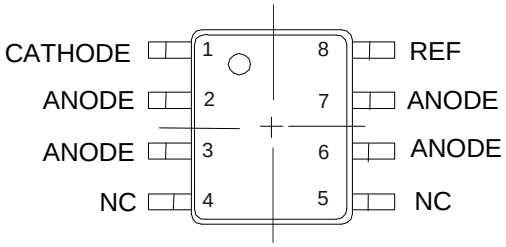
(1) SOT25

(Top View)



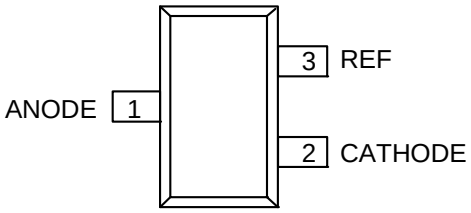
(2) SOP-8L

(Top View)



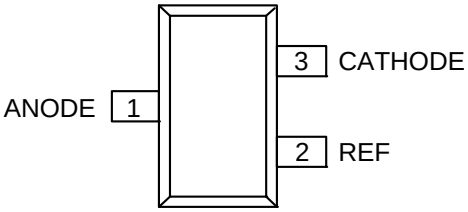
(3) SC59

(Top View)



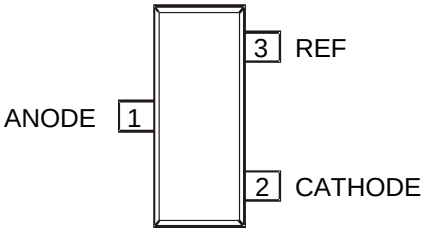
(4) SC59R

(Top View)



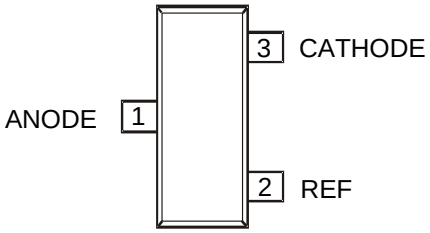
(5) SOT23

(Top View)



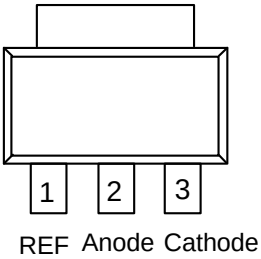
(6) SOT23R

(Top View)



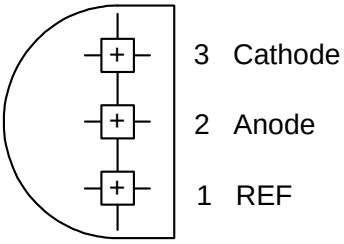
(7) SOT89-3L

(Top View)

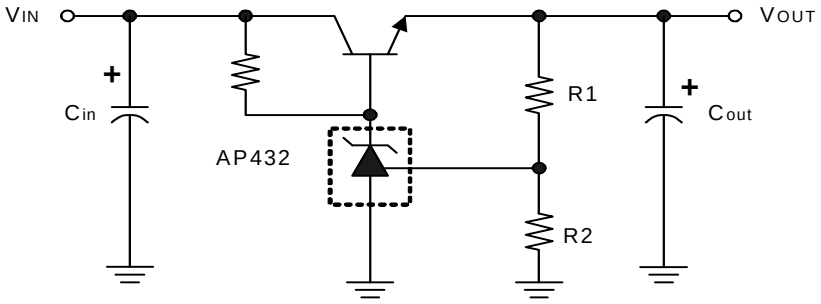


(8) TO92-3L

(Top View)



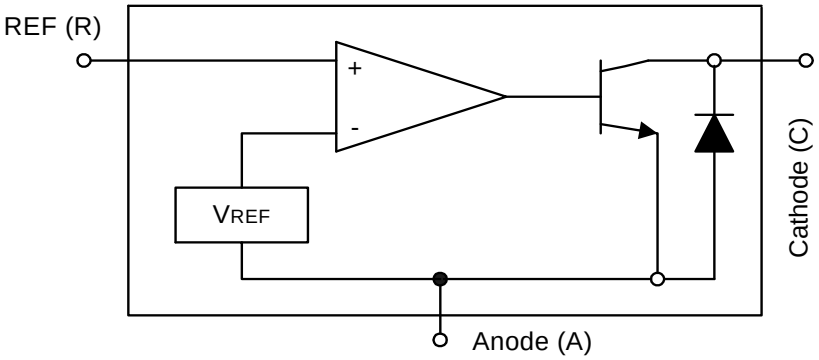
Typical Application Circuit



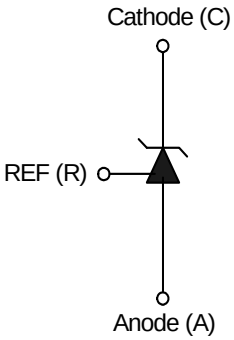
VOUT = (1+R1/R2)VREF

Precision Regulator

Block Diagram



Symbol



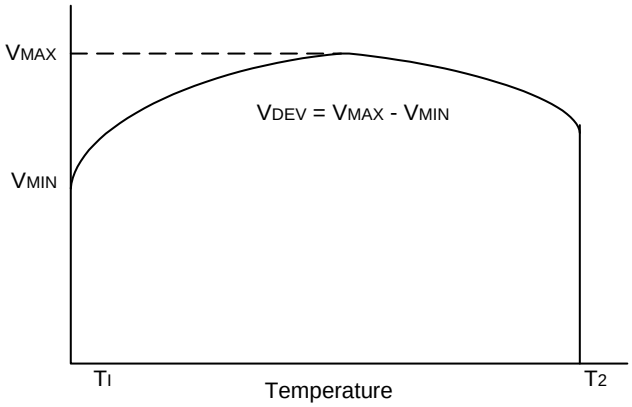
Absolute Maximum Ratings

Symbol	Parameter		Rating	Unit
Vcv	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 7, 8)	SOT23(R)	400	mW
		SOT25	550	mW
		SC59(R)	400	mW
		SOP-8L	600	mW
		SOT89-3L	800	mW
		TO92-3L	780	mW

Notes: 7. T_J, max =150°C
8. Ratings apply to ambient temperature at 25°C.

Electrical Characteristics (T_A = 25°C, V^+ = +5.0V, unless otherwise stated)

Symbol	Parameter	Test Conditions		Min	Typ.	Max	Unit
V_{REF}	Reference voltage	$V_{KA} = V_{REF}$, I_{KA} = 10mA (Fig.1)	AP432 AP432A	1.227 1.233	1.24	1.252 1.246	V
V_{REF}	Deviation of Reference input voltage over temperature (Note 9)	$V_{KA} = V_{REF}$, I_{KA} = 10mA, Ta = Full range (Fig.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 (Fig. 2)	V_{KA} = 20~ V_{REF}	—	-1.4	-2.0	mV/V
I_{REF}	Reference input current	R1 = 10KΩ,R2 = ∞ I_{KA}= 10mA (Fig. 2)		—	1.4	3.5	μA
αI_{REF}	Deviation of Reference input current over temperature	R1 = 10KΩ,R2 = ∞ I_{KA} = 10mA Ta = Full range (Fig. 2)		—	0.4	1.2	μA
$I_{KA(MIN)}$	Minimum Cathode current for regulation	$V_{KA} = V_{REF}$ (Fig.1)		—	0.15	0.3	mA
$I_{KA(OFF)}$	Off-state current	V_{KA} = 36V, V_{REF} = 0V (Fig. 3)		—	0.1	1.0	μA
$\lvert Z_{KA} \rvert$	Dynamic output impedance (Note 10)	$V_{KA} = V_{REF}$ $V_{KA} = V_{REF}$ ΔI_{KA} = 0.1mA ~ 15mA Frequency ≤ 1KHz (Fig.1)		—	0.2	0.5	Ω



Notes: 9. 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:

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

Where:

T2 – T1 = full temperature change.
αV_{REF} can be positive or negative depending on whether the slope is positive or negative.

Notes: 10. The dynamic output impedance, R_Z, is defined as:

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

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:

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

Test Circuits

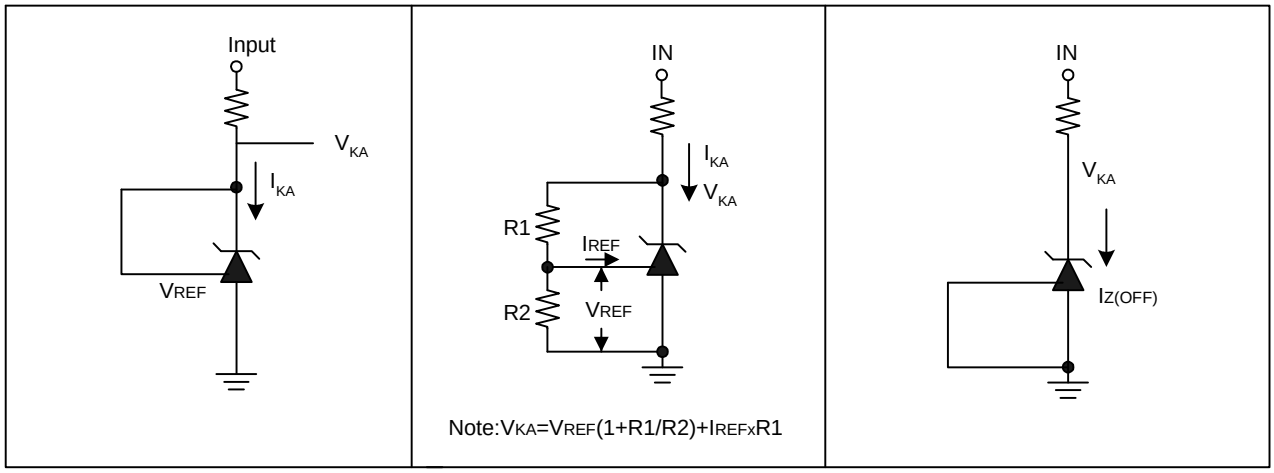
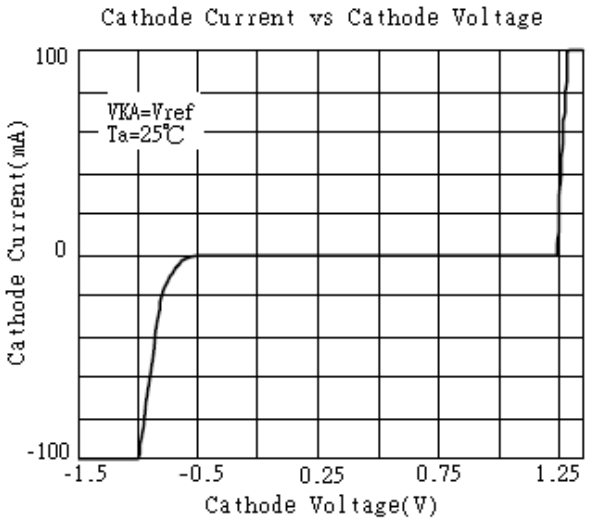


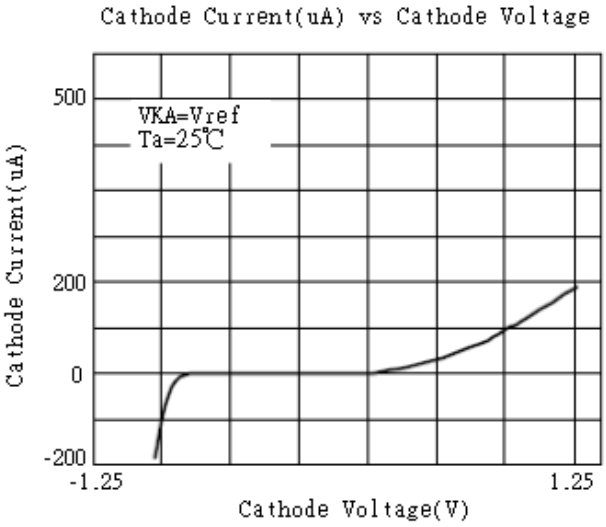
Fig 1. Test Circuit for $V_{KA} = V_{REF}$

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

Fig 3. Test Circuit for Off-State Current

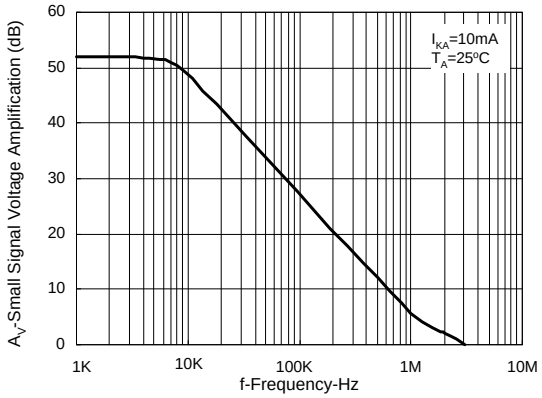
Typical Performance Characteristics

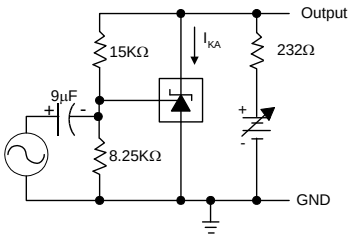




Typical Performance Characteristics (Continued)

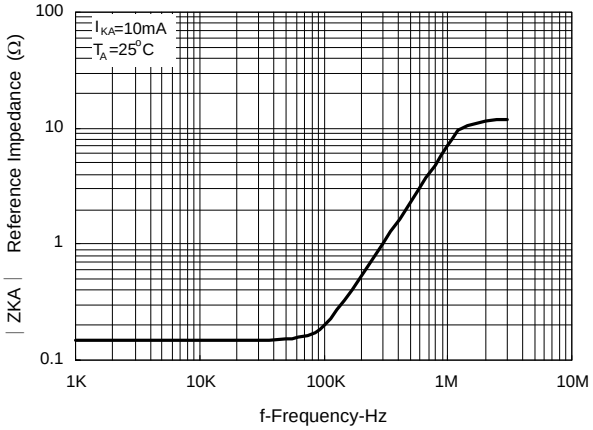
Small-Signal Voltage Amplification vs Frequency

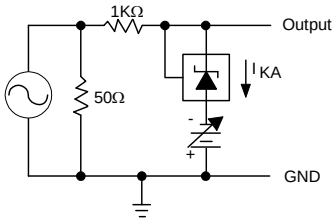




Test Circuit for Voltage Amplification

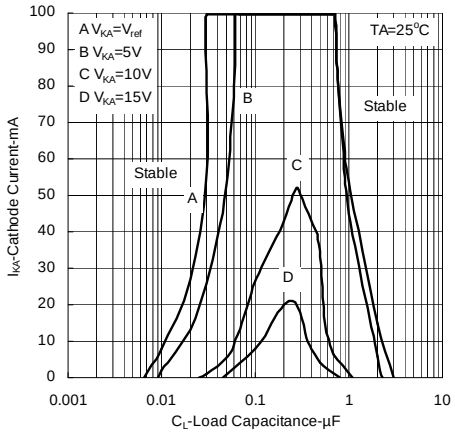
Reference Impedance vs Frequency



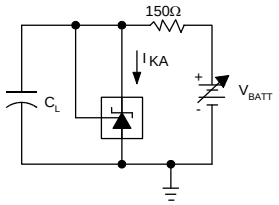


Test Circuit for Reference Impedance

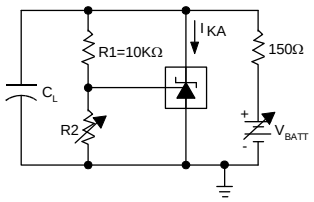
STABILITY BOUNDARY CONDITIONS†



†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.

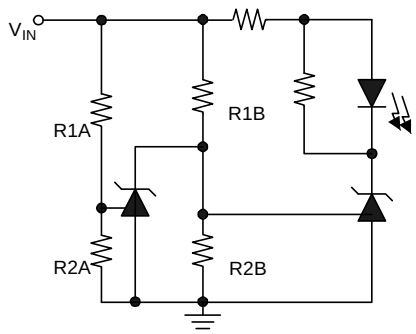


Test Circuit for Curve A



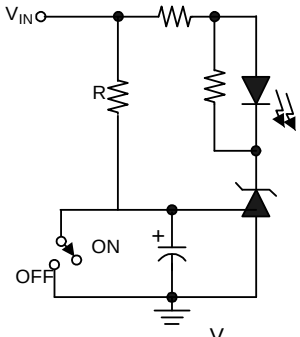
Test Circuit for Curve B, C, and D

Application Examples



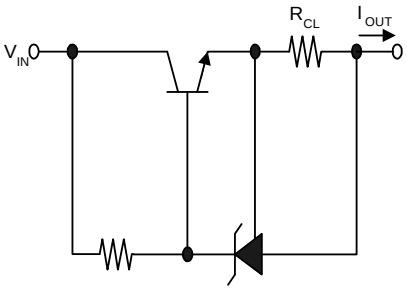
LED on when Low Limit<V_{IN}<High Limit
Low Limit ≈ V_{REF} (1+R1B/R2B)
High Limit ≈ V_{REF} (1+R1A/R2A)

Fig. 4 Voltage Monitor



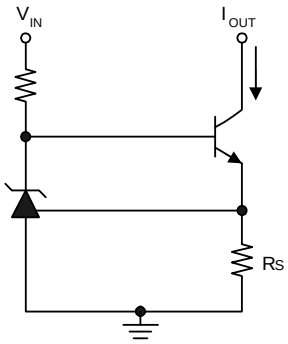
Delay = RC x ln ($\frac{V_{IN}}{V_{IN}-V_{REF}}$)

Fig. 5 Delay Timer



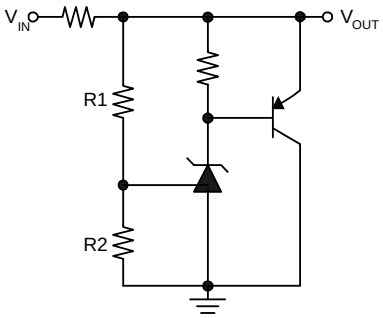
$I_{OUT} = V_{REF} / R_{CL}$

Fig. 6 Current Limiter or Current Source



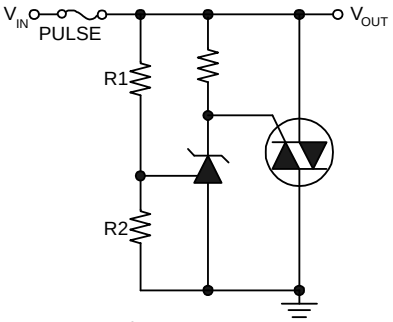
$I_{OUT} = V_{REF} / R_S$

Fig. 7 Constant-Current Sink



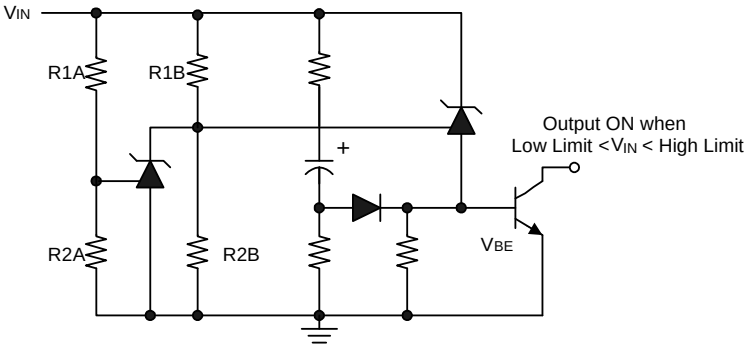
$V_{OUT} = (1 + R1/R2) \times V_{REF}$

Fig. 8 Higher-Current Shunt Regulator



LIMIT ≈ $(1 + R1/R2) \times V_{REF}$

Fig. 9 Crow Bar



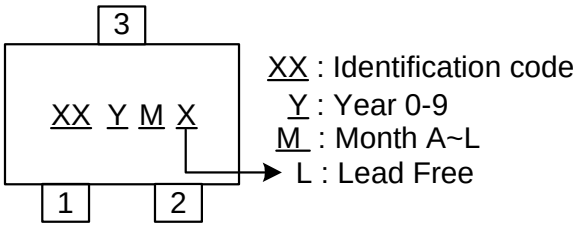
Low Limit ≈ V_{REF} (1 + R1B/R2B) +V_{BE}
High Limit ≈ V_{REF} (1 + R1A/R2A)

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

Marking Information

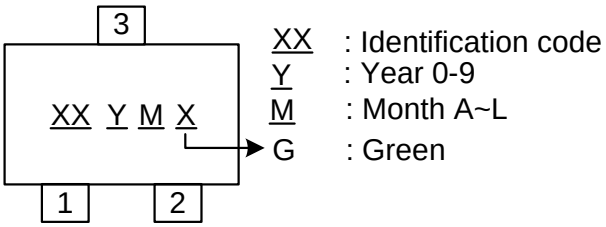
(1) SC59 and SC59R

(Top View)



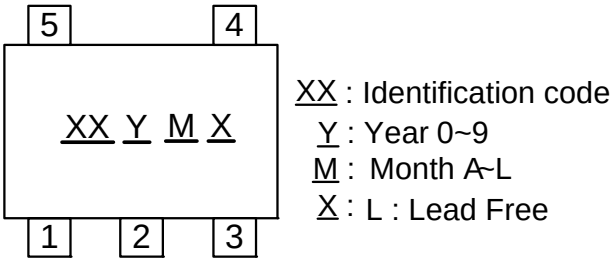
(2) SOT23 and SOT23R

(Top View)



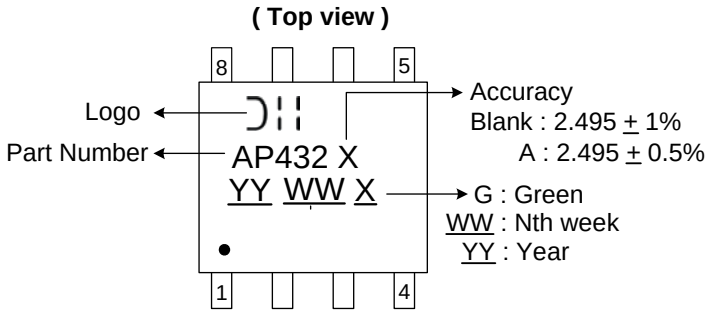
(3) SOT25

(Top View)

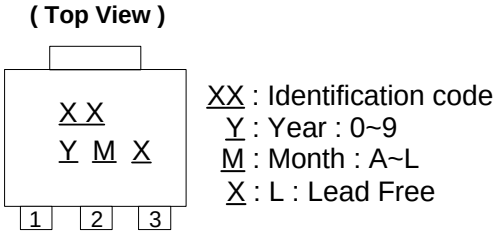


Marking Information (Continued)

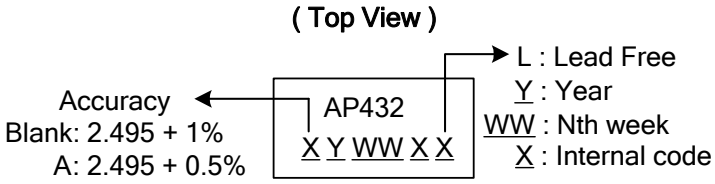
(4) SOP-8L



(5) SOT89-3L



(6) TO92-3L



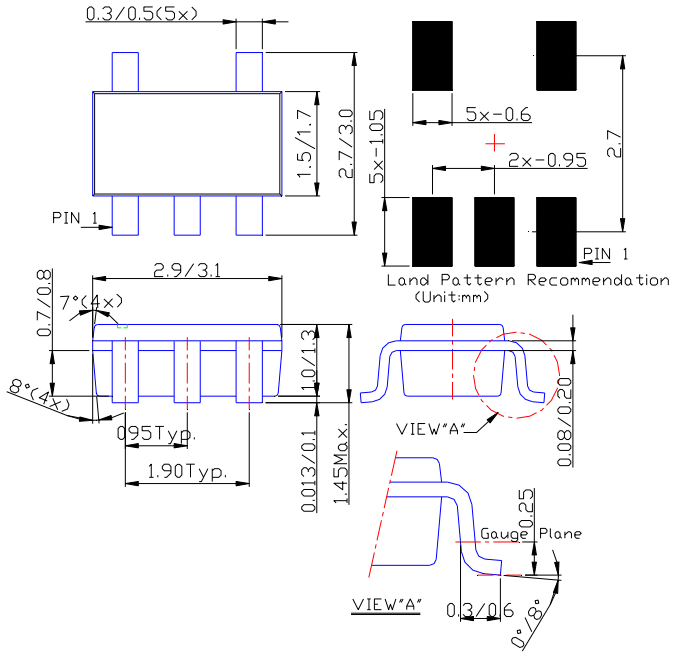
Identification Code Table

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

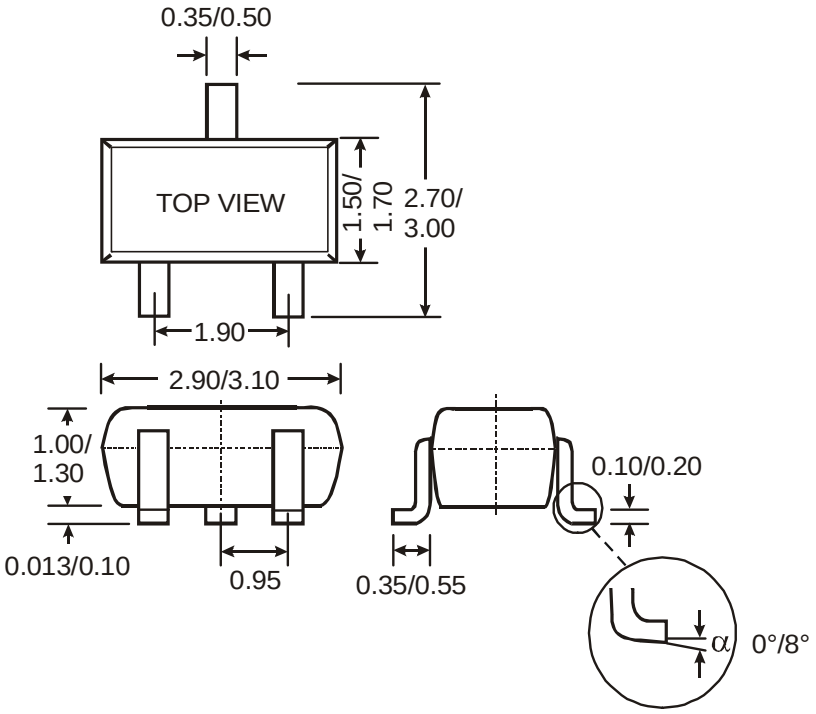
Notes: 11. For packaging details, go to our website at http://www.diodes.com/datasheets/ap02007.pdf.

Package Information (All Dimensions in mm)

(1) Package type: SOT25

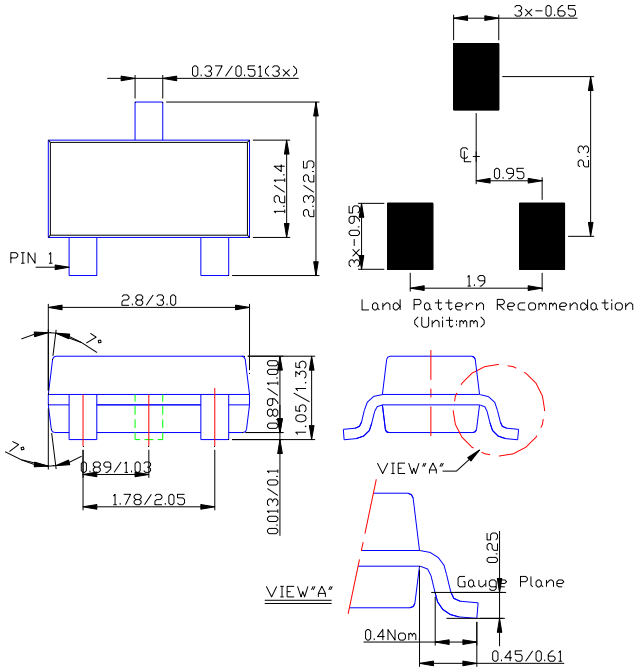


(2) Package Type: SC59 and SC59R

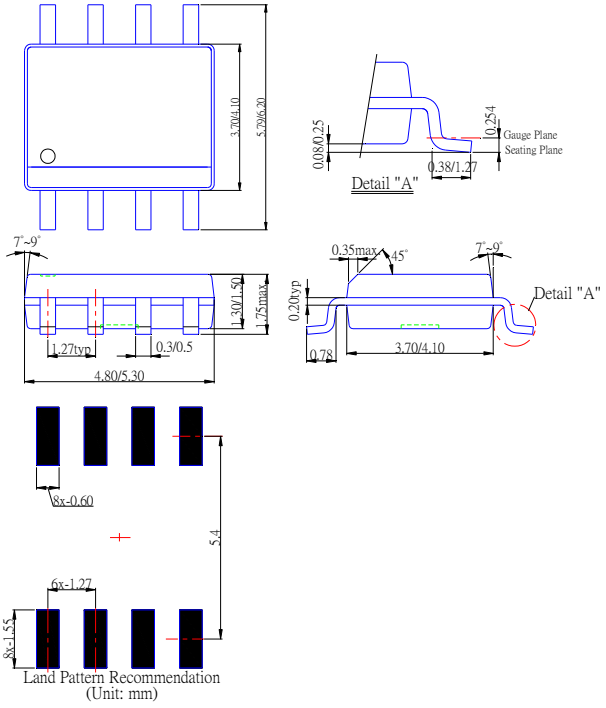


Package Information (Continued)

(3) Package Types: SOT23 and SOT23R

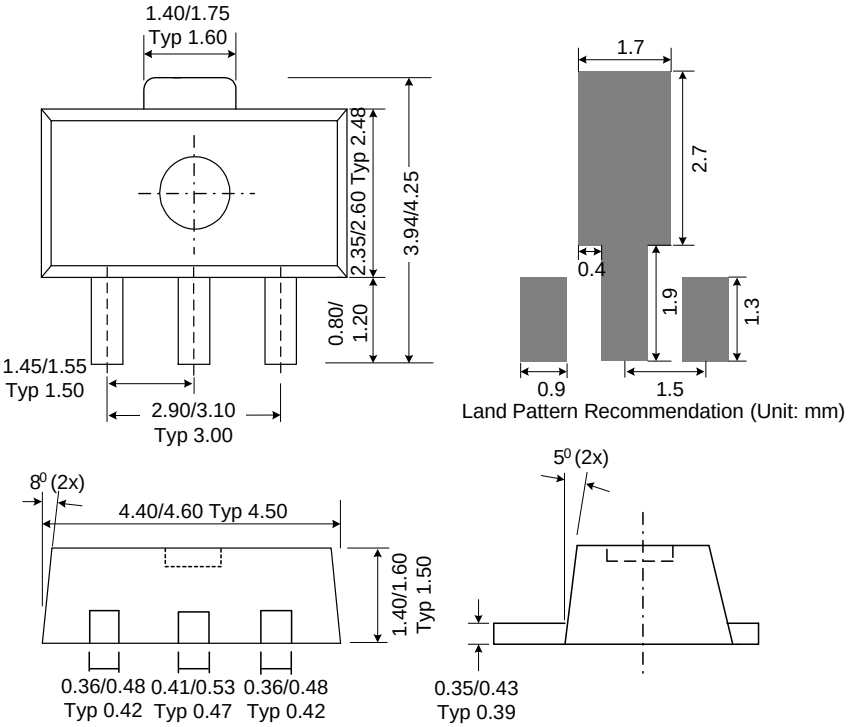


(4) Package Type: SOP-8L

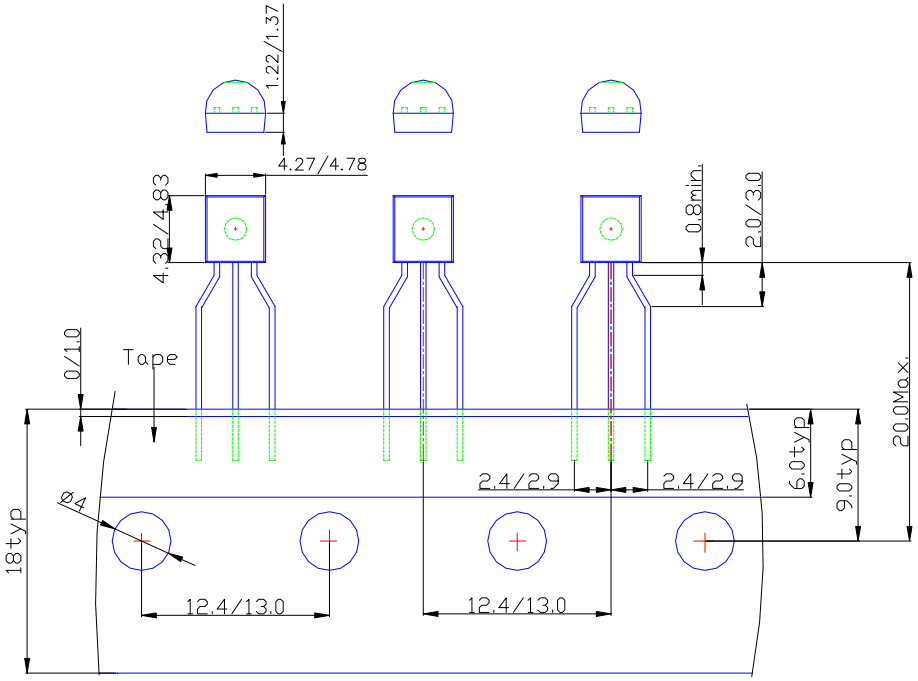


Package Information (Continued)

(5) Package Type: SOT89-3L



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



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