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, 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 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

A P 4 3 2 X X X X

Reference Voltage
Tolerance:
Blank : +/- 1%
A : +/- 0.5%

Package
Blank : SOP-8L
V : TO92-3L
SA : SOT23
W : SC59
R : SC59
Q : SOT25
SR : SOT23R

Lead-Free
L : Lead Free
G : Green (Note 1)

Packing
-B : Bulk
-7/-13 : Taping
-A : Ammo Box (Note 3)

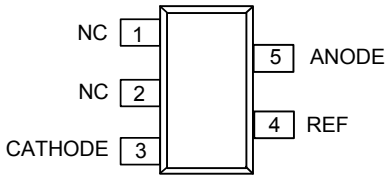
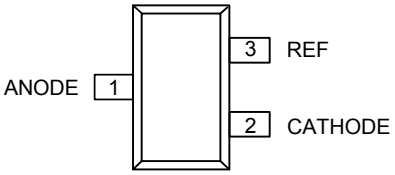
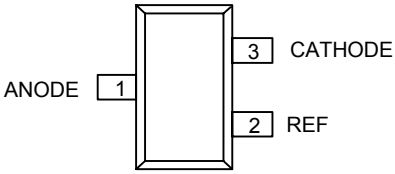
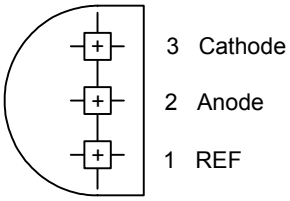
Note: 1. SOT23, SOT23R are "Green" products only.
2. RoHS revision 13.2.2003. Glass and High Temperature Solder Exemptions Applied, see *EU Directive Annex Notes 5 and 7.*

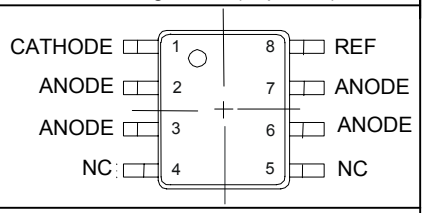
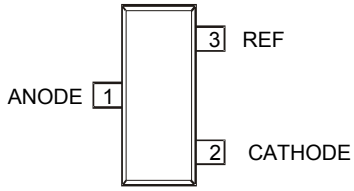
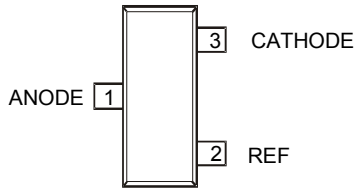
Device (Note 4)	Package Code	Packaging (Note 5)	7" Tape and Reel		13" Tape and Reel		Ammo Box	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix	Quantity	Part Number Suffix
AP432(A)SA	SA	SOT23	3000/Tape & Reel	-7	NA	NA	NA	NA
AP432(A)SR	SR	SOT23R	3000/Tape & Reel	-7	NA	NA	NA	NA
AP432(A)Q	Q	SOT25	3000/Tape & Reel	-7	NA	NA	NA	NA
AP432(A)W	W	SC59	3000/Tape & Reel	-7	NA	NA	NA	NA
AP432(A)R	R	SC59	3000/Tape & Reel	-7	NA	NA	NA	NA
AP432(A)		SOP-8L	NA	NA	2500/Tape & Reel	-13	NA	NA
AP432(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 AP432A 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.

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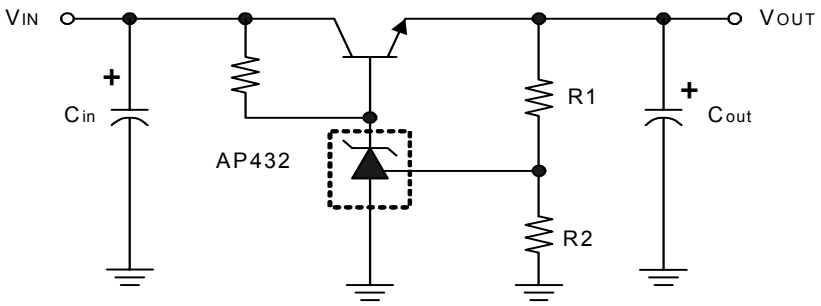
Pin Assignment

Package	Pin Configuration (Top View)
SOT25	
SC-59 (Package Code-W)	
SC-59 (Package Code-R)	
TO92-3L	

Package	Pin Configuration (Top View)
SOP-8L	
SOT23	
SOT23R	

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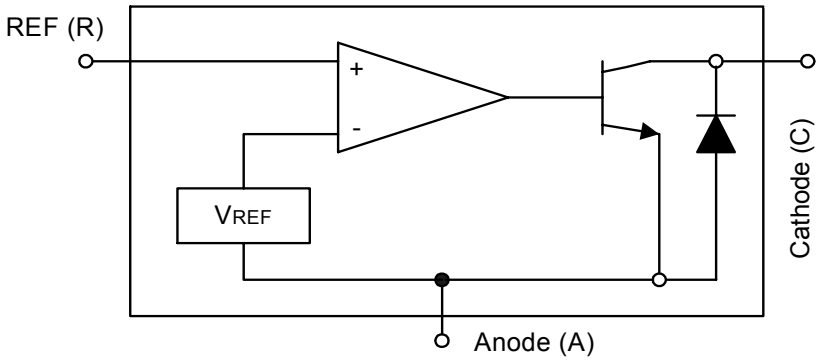
Typical Application Circuit



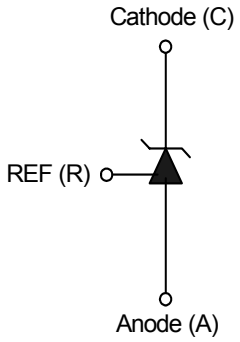
$V_{OUT} = (1+R1/R2)V_{REF}$

Precision Regulator

Block Diagram



Symbol



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Absolute Maximum Ratings

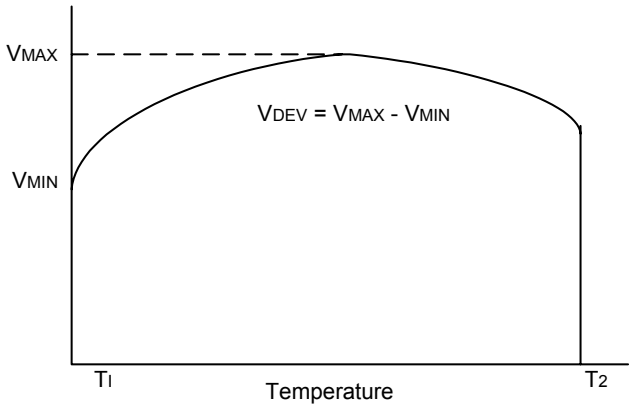
Symbol	Parameter		Rating	Unit
Vcv	Cathode Voltage		+20	V
I_{CC}	Continuous Cathode Current		-10 to +250	mA
I_{REF}	Reference Input Current		10	mA
T_{OP}	Operating Temperature		-20 to +85	°C
T_{ST}	Storage Temperature		-65 to +150	°C
P_D	Power Dissipation (Notes 6, 7)	SOT23(R)	250	mW
		SOT25	250	mW
		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

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

Parameter	Test conditions		Symbol	Min.	Typ.	Max.	Unit
Reference Voltage	V_{KA} = Vref, I_{KA} = 10mA (Fig.1)	AP432	V_{REF}	1.227	1.24	1.252	V
		AP432A		1.233		1.246	
Deviation of Reference Input Voltage over Temperature (Note 8)	V_{KA} = V_{REF} , I_{KA} = 10mA , Ta = full range (Fig.1)		V_{REF}		3.0	20	mV
Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	I_{KA} = 10mA (Fig.2)	V_{KA} = 20 ~V_{REF}	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$		-1.4	-2.0	mV/V
Reference Input Current	R1 = 10KΩ,R2 = ∞ I_{KA}= 10mA (Fig.2)		I_{REF}		1.4	3.5	μA
Deviation of Reference Input Current over Temperature	R1 = 10KΩ,R2 = ∞ I_{KA} = 10mA Ta = Full range (Fig.2)		αI_{REF}		0.4	1.2	μA
Minimum Cathode Current for Regulation	V_{KA} = V_{REF} (Fig.1)		$I_{KA(min)}$		0.15	0.3	mA
Off-state Current	V_{KA} = 20V , V_{REF} = 0V (Fig.3)		$I_{KA(off)}$		0.1	1.0	μA
Dynamic Output Impedance (Note 9)	V_{KA} = V_{REF} Frequency ≤ 1KHz (Fig.1)		$\lvert Z_{KA} \rvert$		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:

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

Where:

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

Note: 9. 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:

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

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Test Circuits

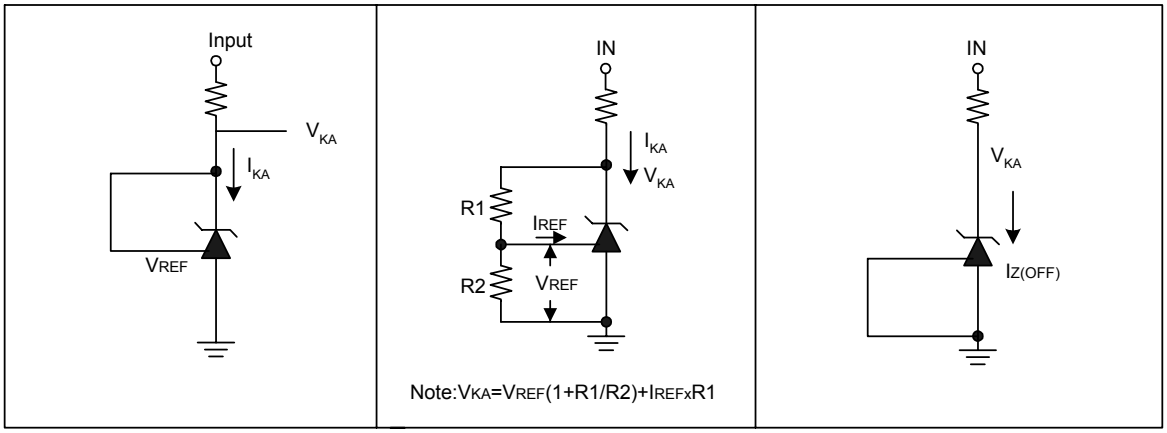


Fig 1. Test Circuit for $V_{KA}= V_{REF}$

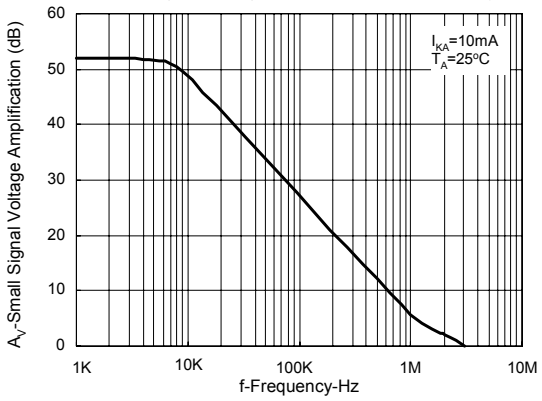
Fig 2. Test Circuit for $V_{KA} > V_{REF}$

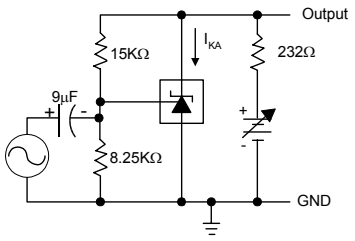
Fig 3. Test Circuit for Off-State Current

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Typical Performance Characteristics

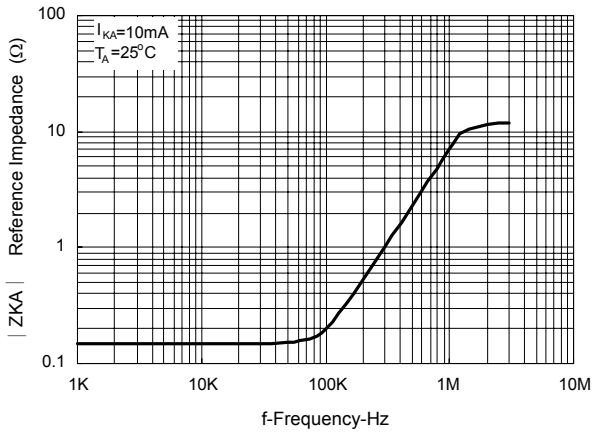
Small-Signal Voltage Amplification vs Frequency

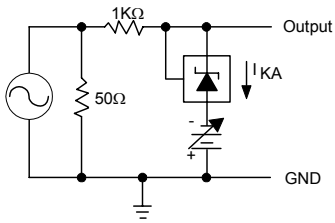




Test Circuit for Voltage Amplification

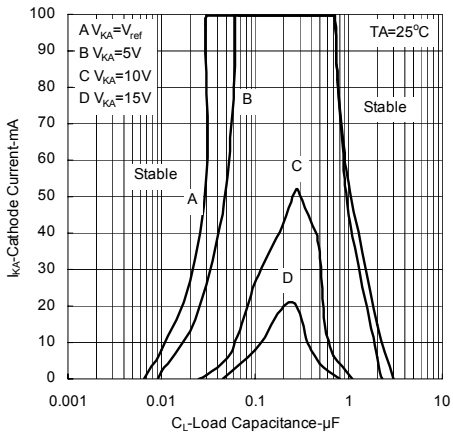
Reference Impedance vs Frequency



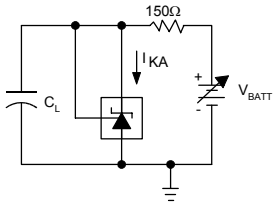


Test Circuit for Reference Impedance

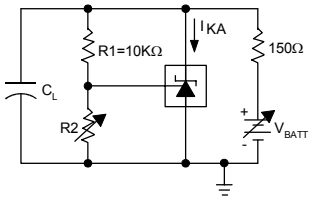
STABILITY BOUNDARY CONDITIONS†



†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.



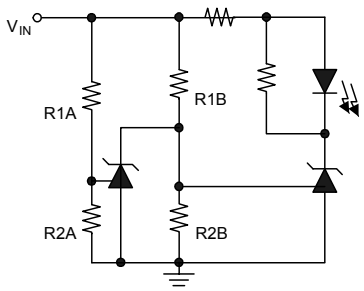
Test Circuit for Curve A



Test Circuit for Curve B, C, and D

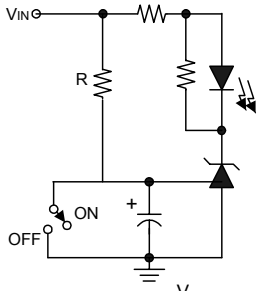
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Application Examples



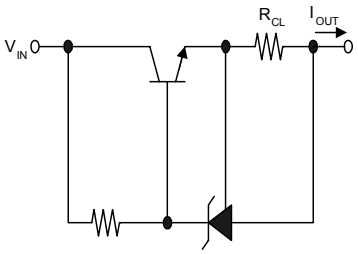
LED on when Low Limit< V_{IN} < High Limit
Low Limit ≈ V_{REF} (1+R1B/R2B)
High Limit ≈ V_{REF} (1+R1A/R2A)

Fig. 4 Voltage Monitor



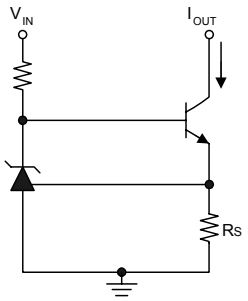
Delay = RC x ln ($\frac{V_{IN}}{V_{IN}-V_{REF}}$)

Fig. 5 Delay Timer



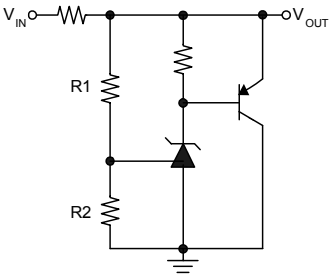
$I_{OUT} = V_{REF} / R_{CL}$

Fig. 6 Current Limiter or Current Source



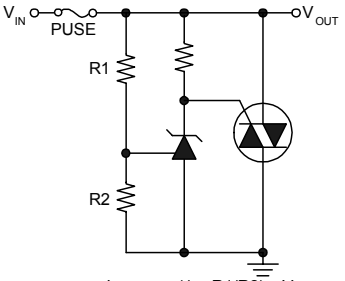
$I_{OUT} = V_{REF} / R_S$

Fig. 7 Constant-Current Sink



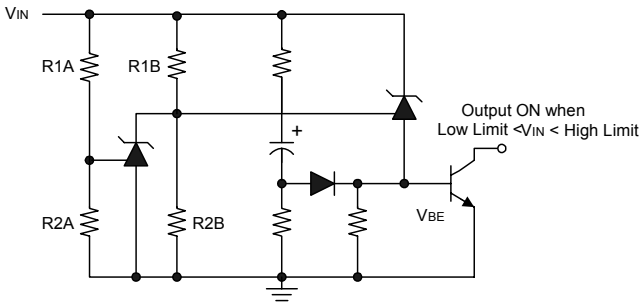
$V_{OUT} = (1 + R1/R2) \times V_{REF}$

Fig. 8 Higher-Current Shunt Regulator



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

Fig. 9 Crow Bar



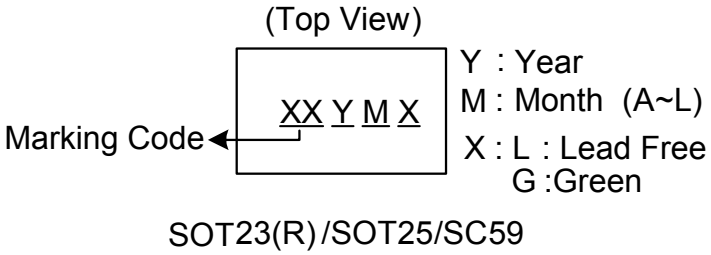
Low Limit ≈ V_{REF} (1 + R1B/R2B) +V_{BE}
High Limit ≈ V_{REF} (1 + R1A/R2A)

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

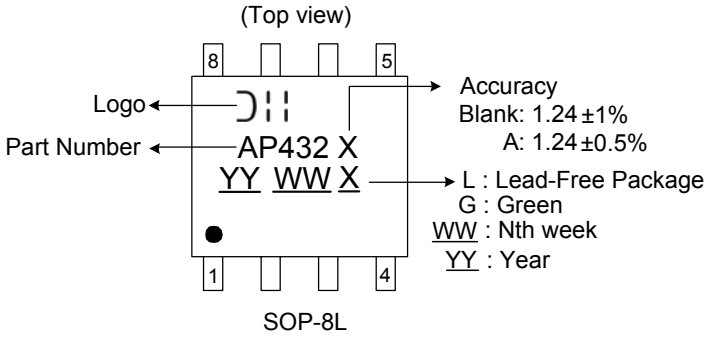
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Marking Information

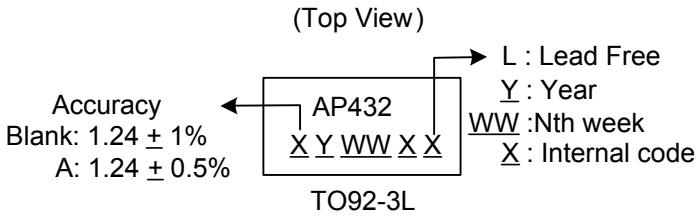
(1) SOT23(R) /SOT25/SC59



(2) SOP-8L



(3) TO92-3



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Marking Information (Continued)

Marking Code Table

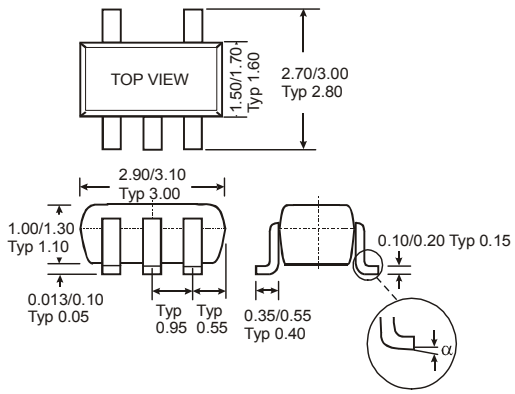
Device	Package (Note 10)	Marking Code	Date Code
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AP432ASA	SOT23	D4	YM
AP432SR	SOT23R	D7	YM
AP432ASR	SOT23R	D8	YM
AP432Q	SOT25	B7	YM
AP432AQ	SOT25	B8	YM
AP432W	SC59	B3	YM
AP432AW	SC59	B4	YM
AP432R	SC59	B5	YM
AP432AR	SC59	B6	YM

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

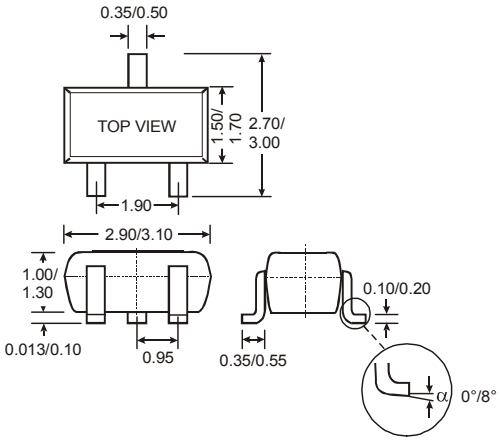
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Package Information (All Dimensions in mm)

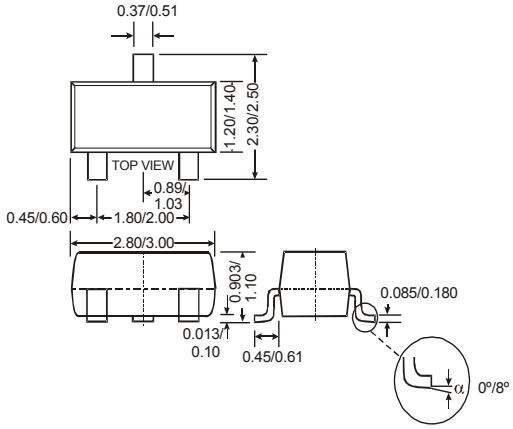
(1) SOT25



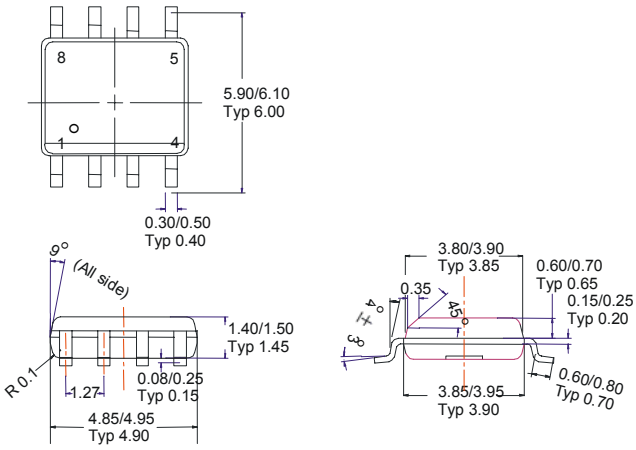
(2) SC59



(3) SOT23(R)



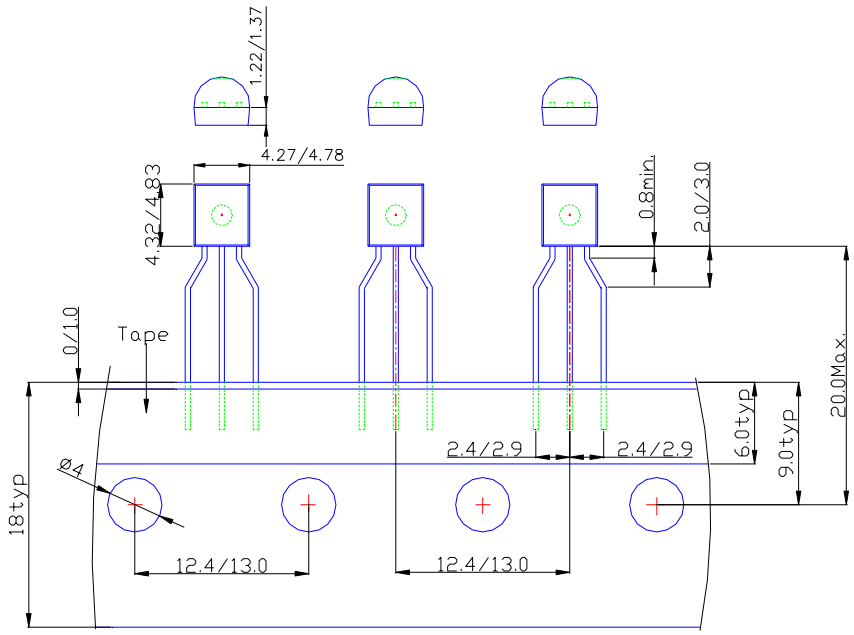
(4) SOP-8L



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Package Information (Continued) (All Dimensions in mm)

(5) TO92-3L for Ammo pack



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