# 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)

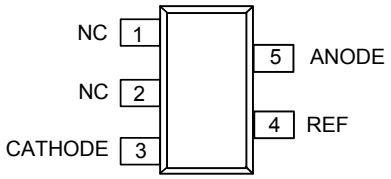
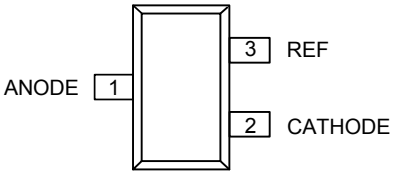
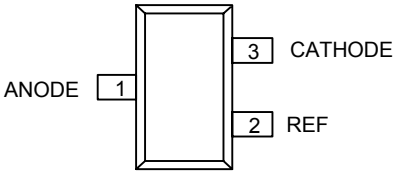
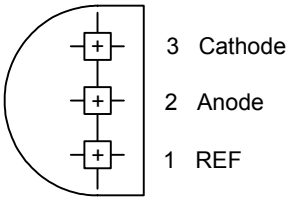
**Packing**
-B : Bulk
-7/-13 : Taping
-A : Ammo Box (Note 3)

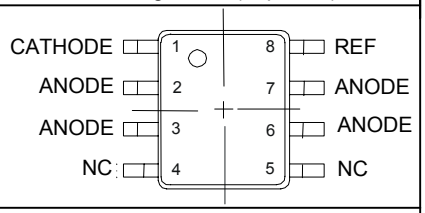
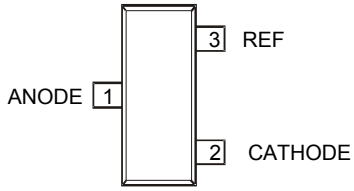
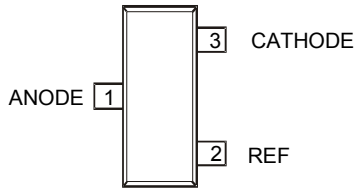
Note: 1. SOT23, SOT23R are "Green" products only.
2. RoHS revision 13.2.2003. Glass and High Temperature Solder Exemptions Applied, see *EU Directive Annex Notes 5 and 7.*

| 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 |

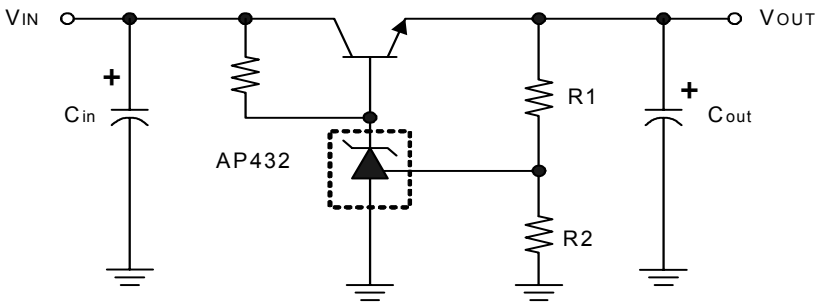
Notes: 3. Ammo Box is for TO92-3 Spread Lead.
4. Suffix "A" denotes AP432A device.
5. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at http://www.diodes.com/datasheets/ap02001.pdf.

## 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 |  |

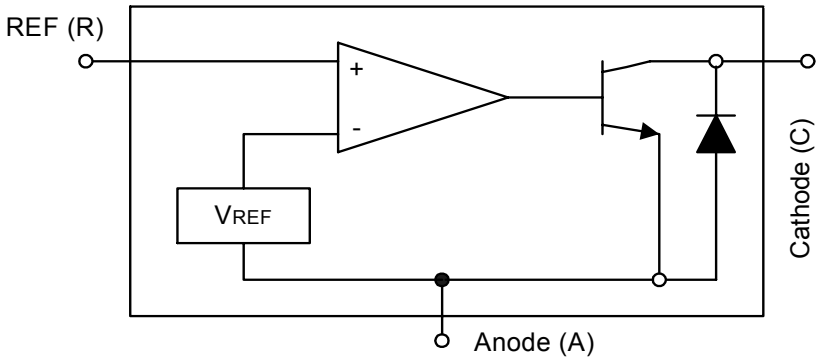
## Typical Application Circuit



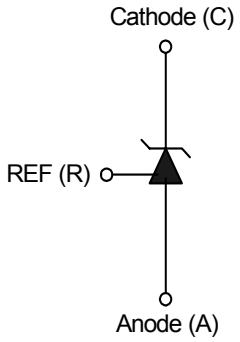

$V_{OUT} = (1+R1/R2)V_{REF}$

Precision Regulator

## Block Diagram




## Symbol



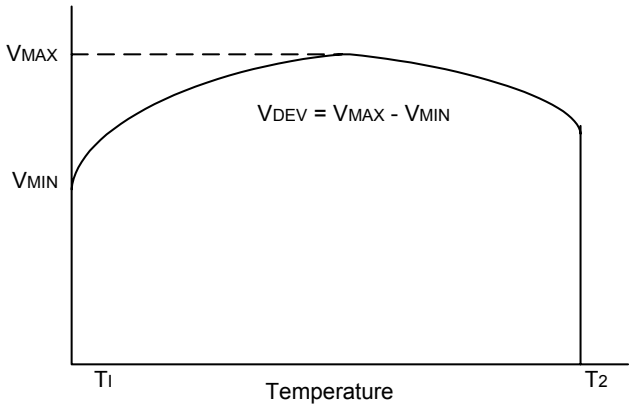
## Absolute Maximum Ratings

| 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 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

## 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) | | $\alpha I_{REF}$ | | 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 $\alpha V_{REF}$ 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.
$\alpha V_{REF}$ 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:

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

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

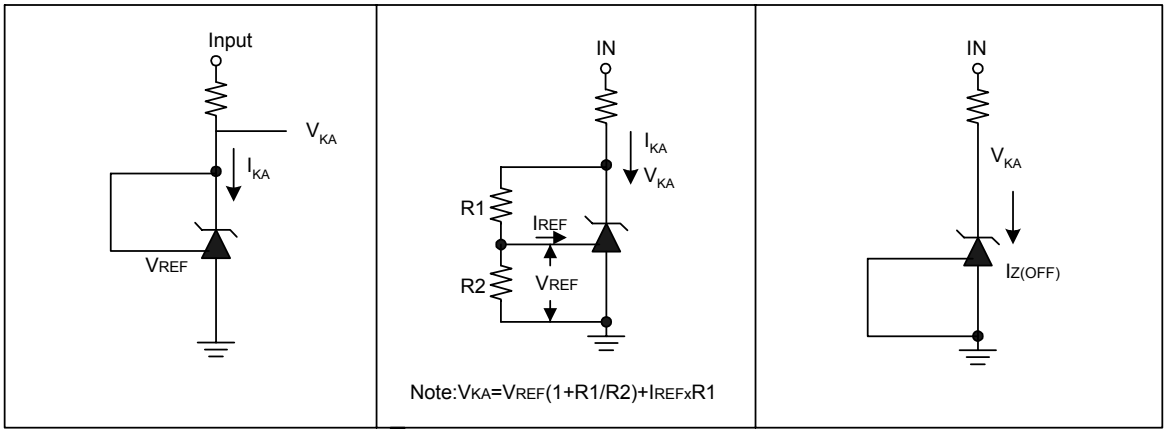


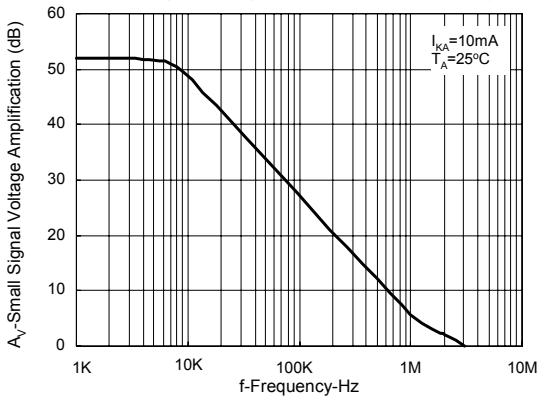

Fig 1. Test Circuit for $V_{KA}= V_{REF}$

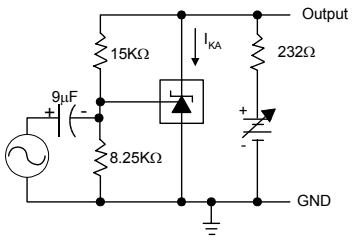
Fig 2. Test Circuit for $V_{KA} > V_{REF}$

Fig 3. Test Circuit for Off-State Current

## Typical Performance Characteristics

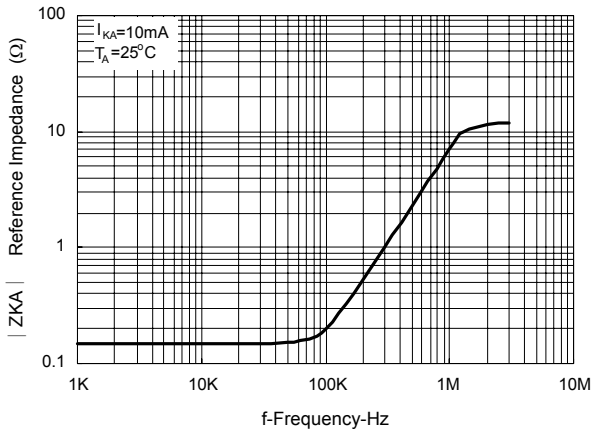
Small-Signal Voltage Amplification vs Frequency

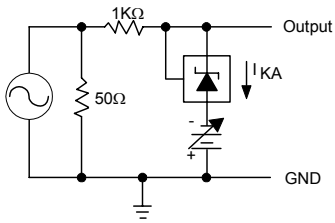



Test Circuit for Voltage Amplification

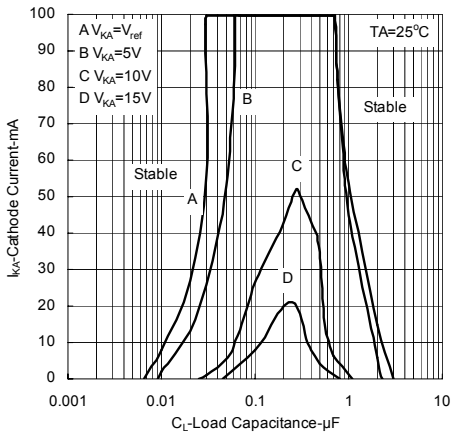
Reference Impedance vs Frequency



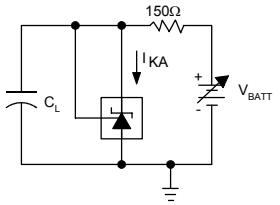




Test Circuit for Reference Impedance

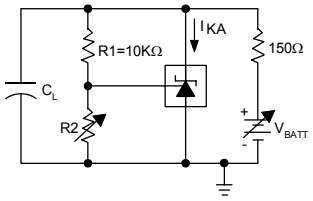
STABILITY BOUNDARY CONDITIONS†




†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.

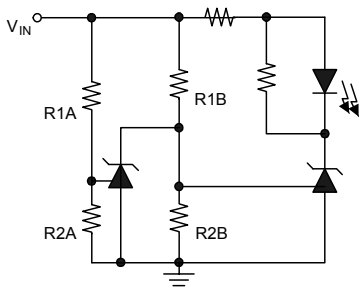



Test Circuit for Curve A



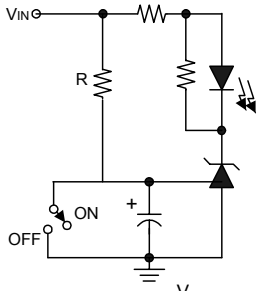

Test Circuit for Curve B, C, and D

## Application Examples



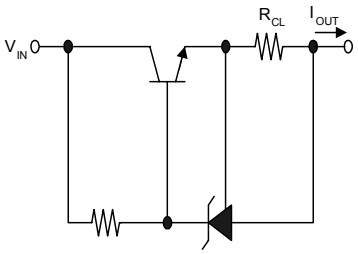

LED on when Low Limit< $V_{IN}$ < High Limit
Low Limit ≈ $V_{REF}$ (1+R1B/R2B)
High Limit ≈ $V_{REF}$ (1+R1A/R2A)

Fig. 4 Voltage Monitor



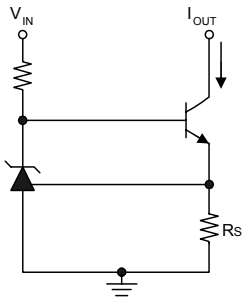

Delay = RC x ln ( $\frac{V_{IN}}{V_{IN}-V_{REF}}$ )

Fig. 5 Delay Timer



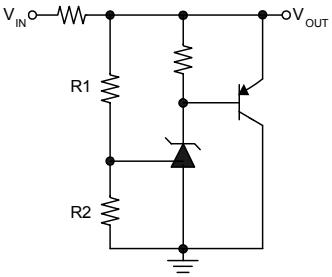

$I_{OUT} = V_{REF} / R_{CL}$

Fig. 6 Current Limiter or Current Source



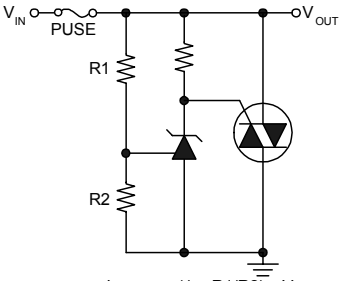

$I_{OUT} = V_{REF} / R_S$

Fig. 7 Constant-Current Sink



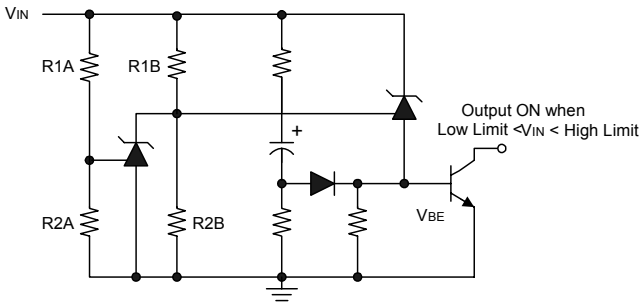

$V_{OUT} = (1 + R1/R2) \times V_{REF}$

Fig. 8 Higher-Current Shunt Regulator




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

Fig. 9 Crow Bar

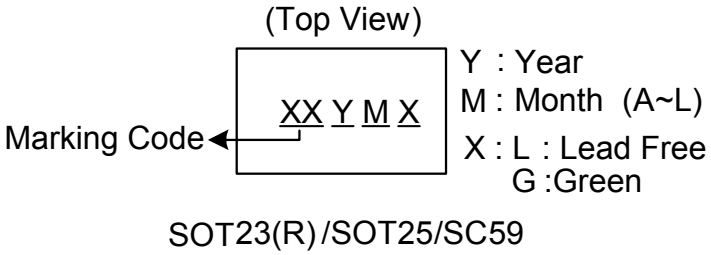



Low Limit ≈ $V_{REF}$ (1 + R1B/R2B) +$V_{BE}$
High Limit ≈ $V_{REF}$ (1 + R1A/R2A)

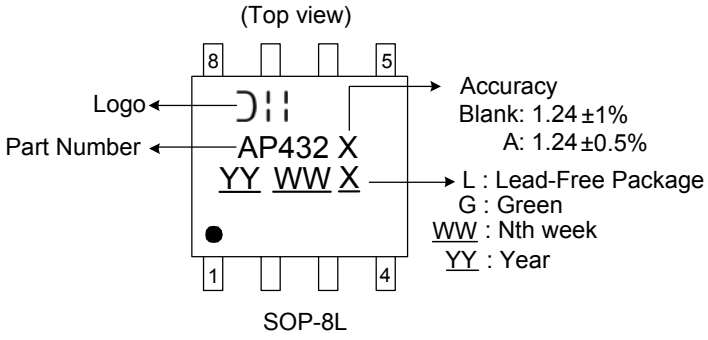
Fig.10 Over-Voltage / Under-Voltage Protection Circuit

## Marking Information

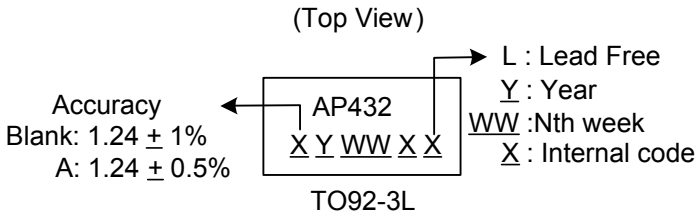
**(1) SOT23(R) /SOT25/SC59**




**(2) SOP-8L**




**(3) TO92-3**



## Marking Information (Continued)

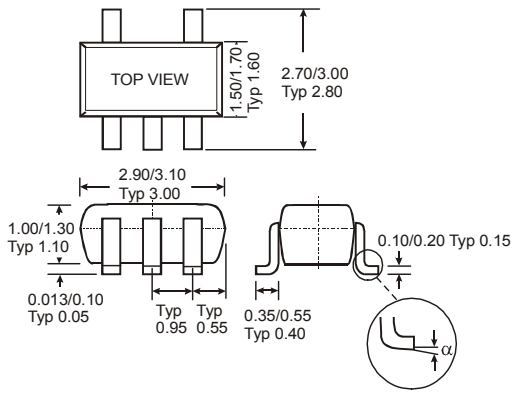
**Marking Code Table**

| Device | Package (Note 10) | Marking 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 | SC59 | B5 | YM |
| AP432AR | SC59 | B6 | YM |

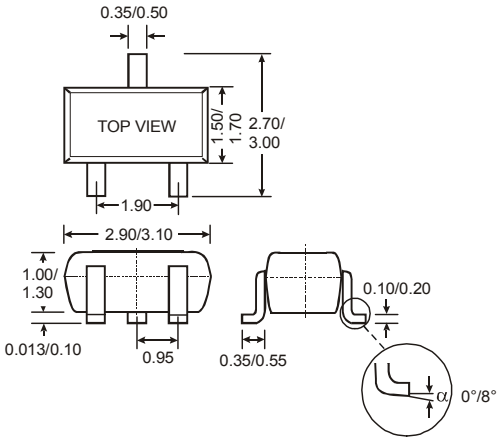
Note: 10. For Packaging Details, go to our website at http://www.diodes.com/datasheets/ap02007.pdf.

## Package Information ( All Dimensions in mm )

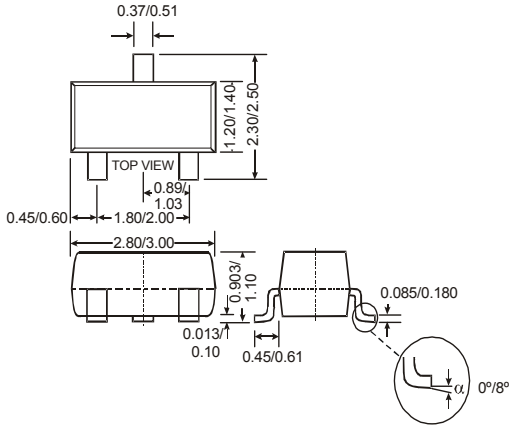
### (1) SOT25



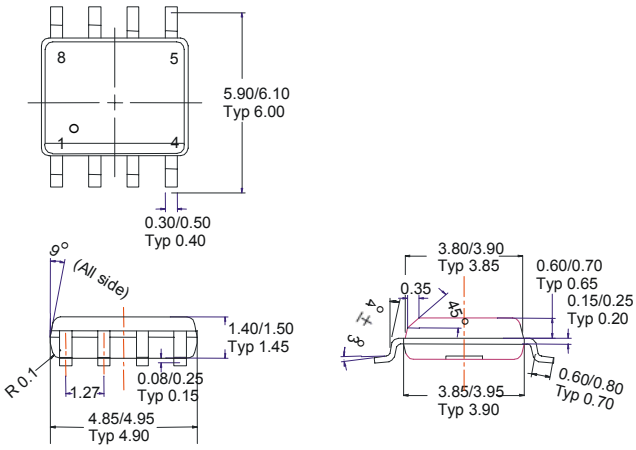

### (2) SC59




### (3) SOT23(R)

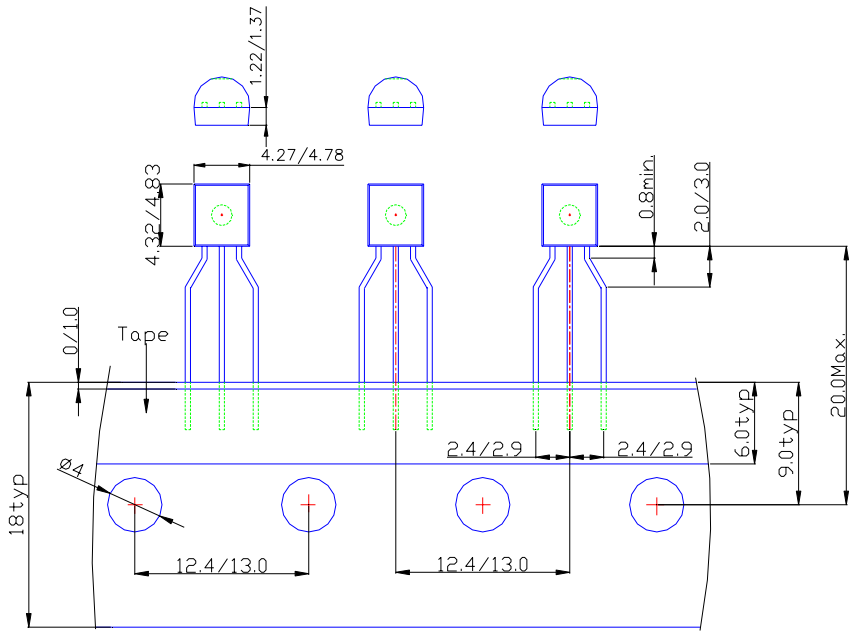



### (4) SOP-8L



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

### (5) TO92-3L for Ammo pack



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- *Сертификаты соответствия на поставляемую продукцию (по желанию клиента).*
- *Тестирование поставляемой продукции.*
- *Поставку компонентов, требующих военную и космическую приемку.*
- *Входной контроль качества.*
- *Наличие сертификата ISO.*

*В составе нашей компании организован Конструкторский отдел, призванный помогать разработчикам, и инженерам.*

*Конструкторский отдел помогает осуществить:*

- *Регистрацию проекта у производителя компонентов.*
- *Техническую поддержку проекта.*
- *Защиту от снятия компонента с производства.*
- *Оценку стоимости проекта по компонентам.*
- *Изготовление тестовой платы монтаж и пусконаладочные работы.*

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