



AP432/AP432A

Adjustable Precision Shunt Regulator

■ Features

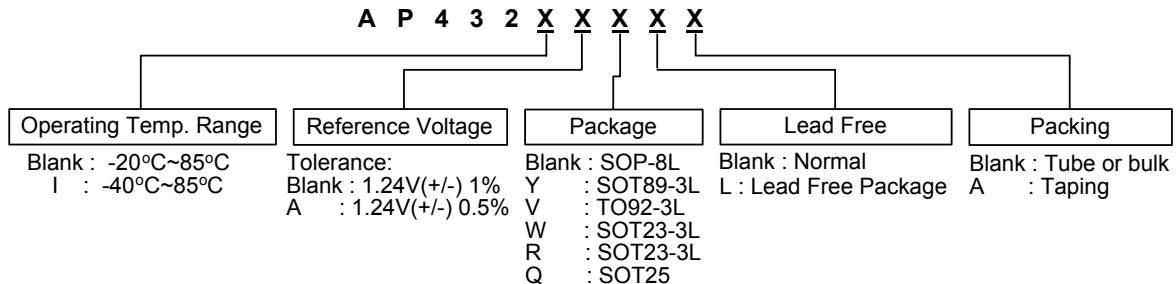
- Precision reference voltage
AP432 : 1.24V ± 1%
AP432A : 1.24V ± 0.5%
- Sink current capability: 200mA.
- Minimum cathode current for regulation: 150µA
- Equivalent full-range temp coefficient: 30 ppm/°C
- Fast turn-on Response.
- Low dynamic output impedance: 0.2Ω
- Programmable output voltage to 20v
- Low output noise
- Packages: SOT89, SOT23, SOT25, SOP8 and TO92

■ General Description

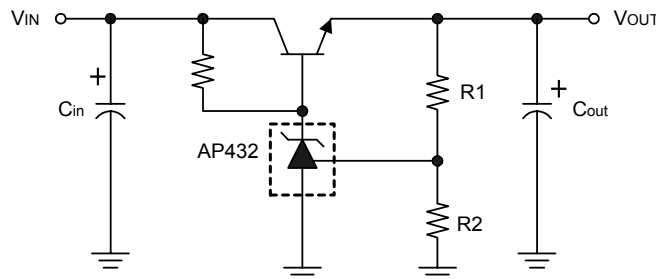
The AP432/432A are 3-terminal adjustable precision shunt regulators with guaranteed stable temperature over the applicable extended commercial temperature range. The output voltage may be set at any level greater than 1.24V (V_{REF}) up to 20V merely by selecting two external resistors that act as a 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



■ Typical Application Circuit

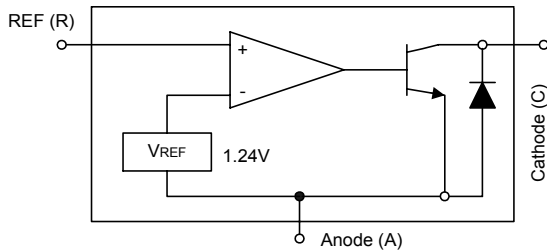


$$V_{OUT} = (1 + R1/R2)V_{REF}$$

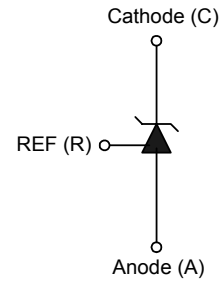
Precision Regulator

Adjustable Precision Shunt Regulator

■ Block Diagram



■ Symbol



■ Pin Configuration

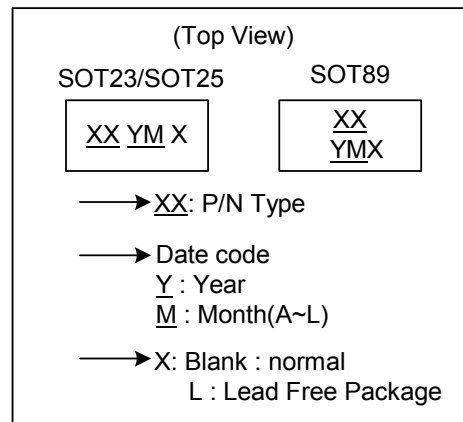
| Order Number | Pin Configuration (Top View) | Order Number | Pin Configuration (Top View) |
|---|------------------------------|---|------------------------------|
| AP432Y AP432AY AP432IY AP432IAY (SOT89) | | AP432R AP432AR AP432IR AP432IAR (SOT23) | |
| AP432V AP432AV AP432IV AP432IAV (TO92) | | AP432W AP432AW AP432IW AP432IAW (SOT23) | |
| AP432 AP432A AP432I AP432IA (SOP) | | AP432Q AP432AQ AP432IQ AP432IAQ (SOT25) | |

Adjustable Precision Shunt Regulator

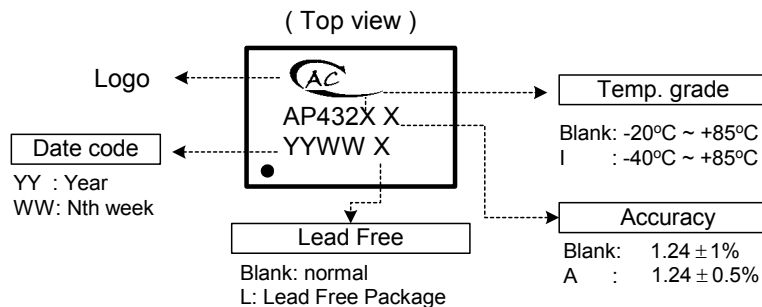
■ Marking Information

(1) SOT23 / SOT25 / SOT89

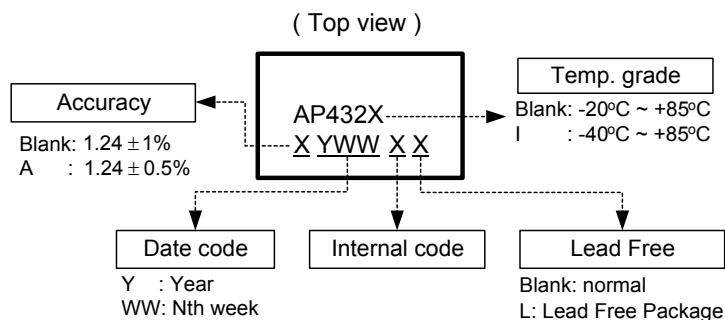
| P/N Type | X X |
|----------|-----|
| AP432Y | B1 |
| AP432AY | B2 |
| AP432IY | BA |
| AP432IAY | BB |
| AP432W | B3 |
| AP432AW | B4 |
| AP432IW | BC |
| AP432IAW | BD |
| AP432R | B5 |
| AP432AR | B6 |
| AP432IR | BE |
| AP432IAR | BF |
| AP432Q | B7 |
| AP432AQ | B8 |
| AP432IQ | BG |
| AP432IAQ | BH |



(2) SOP



(3) TO92





Adjustable Precision Shunt Regulator

■ Absolute Maximum Ratings

| | | |
|---|-------------|---------------|
| Cathode Voltage..... | | 20V |
| Continuous cathode current | | -10mA ~ 250mA |
| Reference input current range | | 10mA |
| Operating temperature range (AP432) | | -20°C ~ 85°C |
| (AP432A)..... | | -40°C~85°C |
| Lead Temperature..... | | 260°C |
| Storage Temperature | | -65°C ~ 150°C |
| Power Dissipation (Notes 1, 2) | SOT89 | 0.80W |
| | TO92 | 0.78W |
| | SOT23 | 0.25W |
| | SOT25..... | 0.25W |
| | SOP..... | 0.6W |

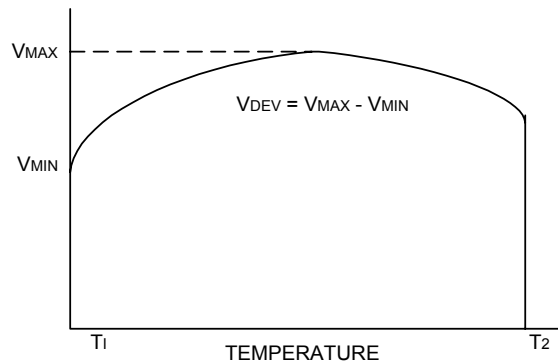
Note 1: T_J, max =150°C. .

Note 2: Ratings apply to ambient temperature at 25°C.

■ Electrical Characteristics (T_a=25°C, unless otherwise specified.)

| Parameter | Test conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|--|-------|------|-------|------|
| Reference voltage | V _{KA} = V _{ref} , I _{KA} = 10mA (Fig.1) | AP432 | 1.227 | 1.24 | 1.252 | V |
| | | AP432A | 1.233 | | 1.246 | |
| Deviation of reference input voltage over temperature (Note 3) | V _{KA} = V _{REF} , I _{KA} = 10mA, T _a = 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 T _a = Full range (Fig.2) | α _{IREF} | | 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 4) | V _{KA} = V _{REF} ΔI _{KA} = 0.1mA ~ 15mA Frequency ≤ 1KHz (Fig.1) | Z _{KA} | | 0.2 | 0.5 | Ω |

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Note 3. 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:

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

Where:

$T_2 - T_1$ = full temperature change.

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

Note 4. The dynamic output impedance, R_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

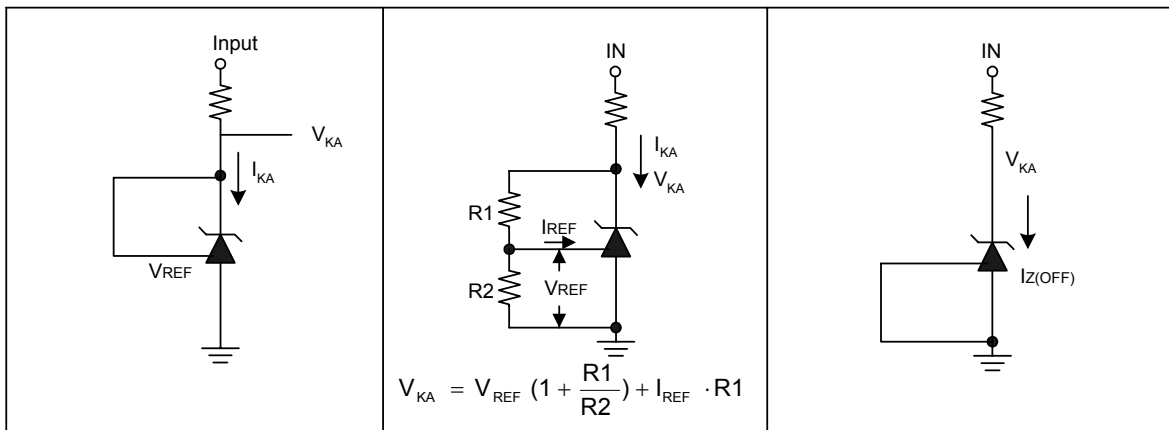


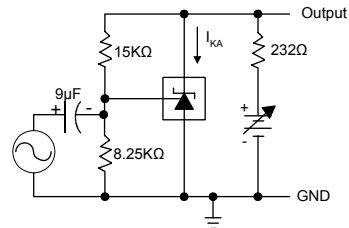
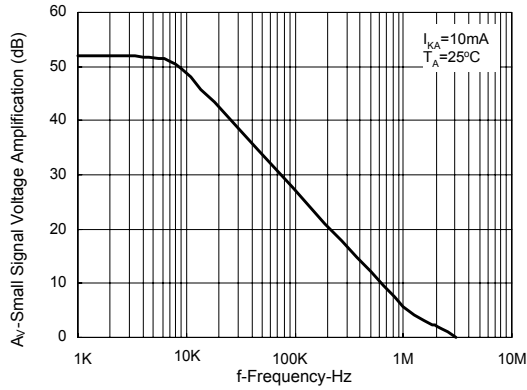
Fig1. Test Circuit for $V_{KA} = V_{REF}$

Fig2. Test circuit for $V_{KA} > V_{REF}$

Fig3. Test Circuit for off-state Current

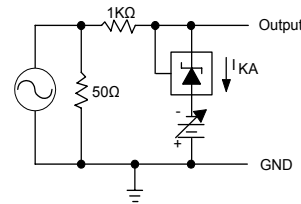
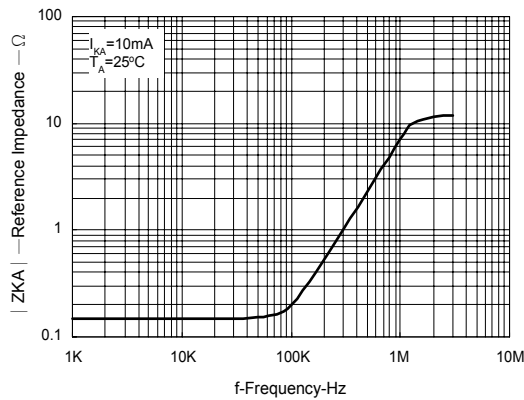
Typical Performance Characteristics

SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY



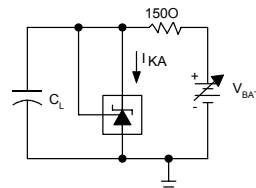
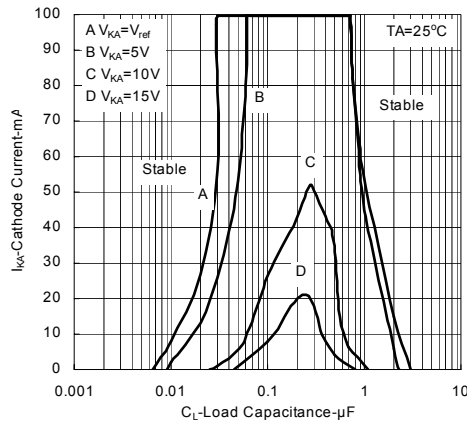
TEST CIRCUIT FOR VOLTAGE AMPLIFICATION

REFERENCE IMPEDANCE vs. FREQUENCY

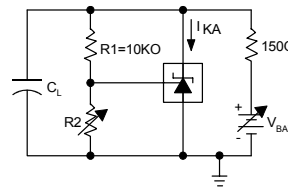


TEST CIRCUIT FOR REFERENCE IMPEDANCE

STABILITY BOUNDARY CONDITIONS†



TEST CIRCUIT FOR CURVE A

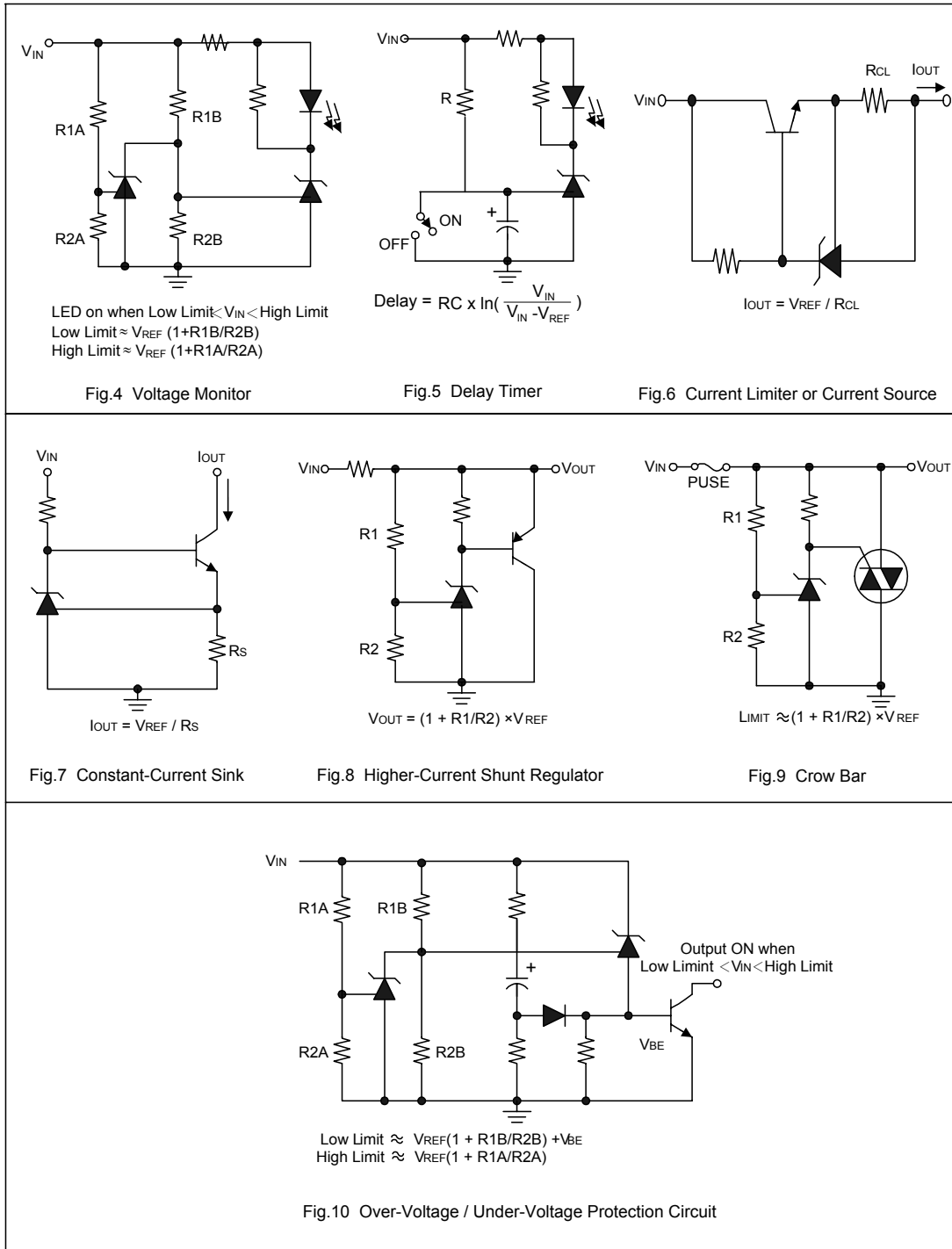


TEST CIRCUIT FOR CURVE B, C, AND D

†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 $C_L = 0.1 \mu F$ and V_{BATT} and C_L were then adjusted to determine the ranges of stability.

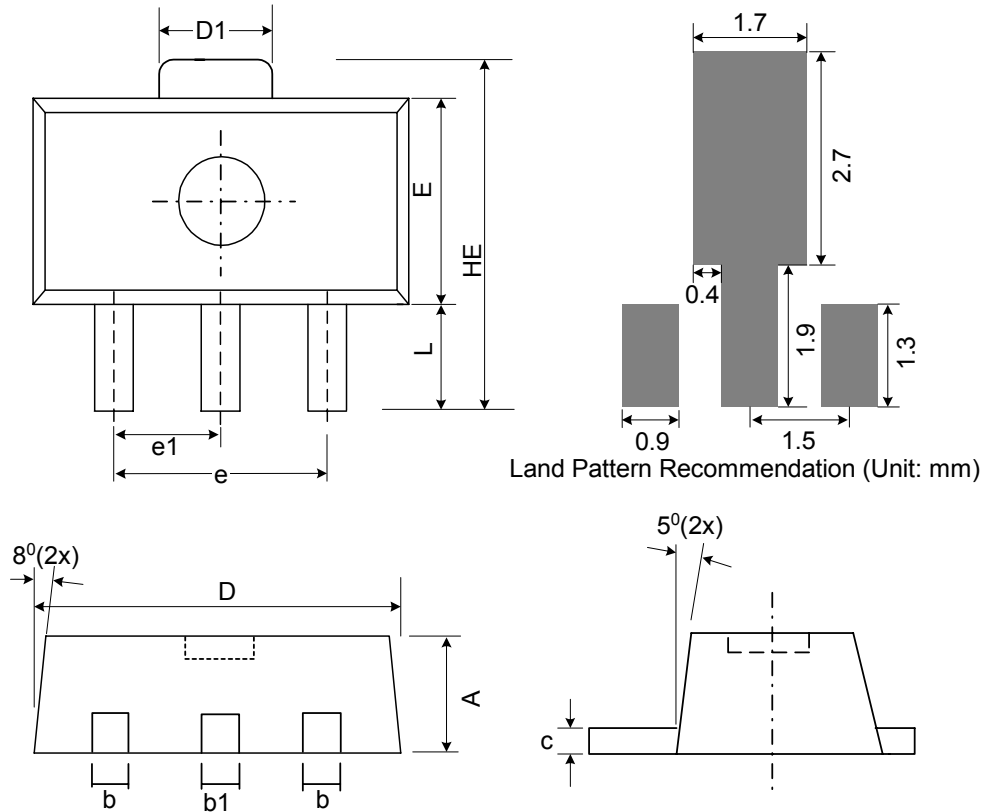
Adjustable Precision Shunt Regulator

Application Examples



■ Package Diagrams

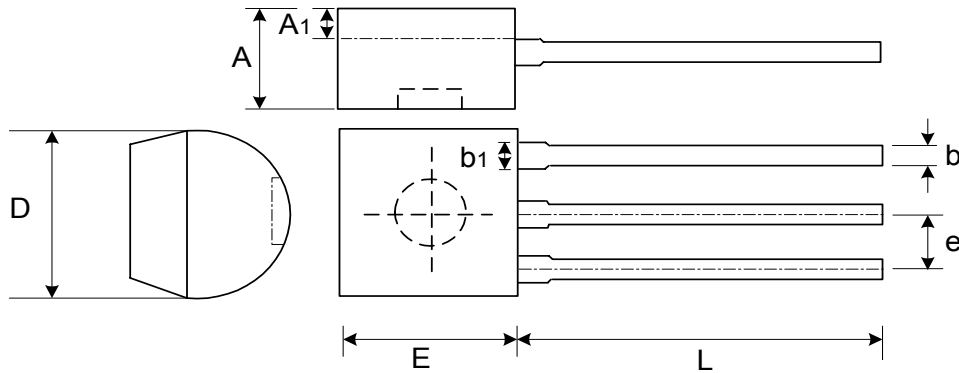
(1) SOT89-3L Package Outline Dimension



| Symbol | Dimensions In Millimeters | | | Dimensions In Inches | | |
|--------|---------------------------|------|------|----------------------|-------|-------|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | 1.40 | 1.50 | 1.60 | 0.055 | 0.059 | 0.063 |
| b | 0.36 | 0.42 | 0.48 | 0.014 | 0.016 | 0.018 |
| b1 | 0.41 | 0.47 | 0.53 | 0.016 | 0.043 | 0.051 |
| C | 0.35 | 0.39 | 0.43 | 0.014 | 0.015 | 0.017 |
| D | 4.40 | 4.50 | 4.60 | 0.173 | 0.177 | 0.181 |
| D1 | 1.40 | 1.60 | 1.75 | 0.055 | 0.062 | 0.069 |
| e | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| e1 | 1.45 | 1.50 | 1.55 | 0.057 | 0.059 | 0.061 |
| E | 2.35 | 2.48 | 2.60 | 0.093 | 0.098 | 0.102 |
| HE | 3.94 | - | 4.25 | 0.155 | - | 0.167 |
| L | 0.80 | - | 1.20 | 0.031 | - | 0.047 |

Adjustable Precision Shunt Regulator

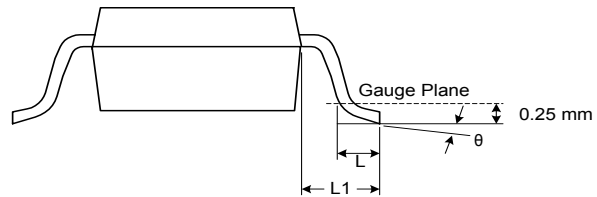
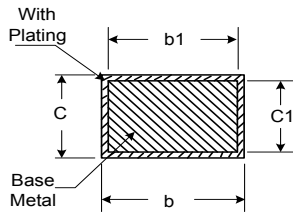
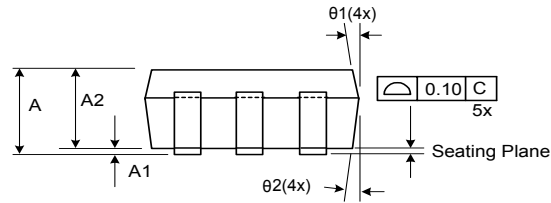
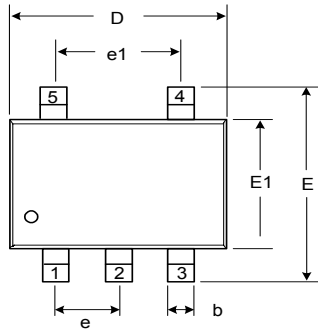
(2) TO92-3L Package Outline Dimension



| Symbol | Dimensions In Millimeters | | | Dimensions In Inches | | |
|--------|---------------------------|-------|--------|----------------------|-------|-------|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | 3.302 | 3.556 | 3.810 | 0.130 | 0.140 | 0.150 |
| A1 | 1.016 | - | - | 0.040 | - | - |
| b | 0.330 | 0.381 | 0.432 | 0.013 | 0.015 | 0.017 |
| b1 | 0.406 | 0.457 | 0.506 | 0.016 | 0.018 | 0.020 |
| D | 4.445 | 4.572 | 4.699 | 0.175 | 0.180 | 0.185 |
| E | 4.445 | 4.572 | 4.699 | 0.175 | 0.180 | 0.185 |
| L | 13.00 | - | 15.500 | 0.512 | - | 0.610 |
| e | 1.150 | 1.270 | 1.390 | 0.045 | 0.050 | 0.055 |

Adjustable Precision Shunt Regulator

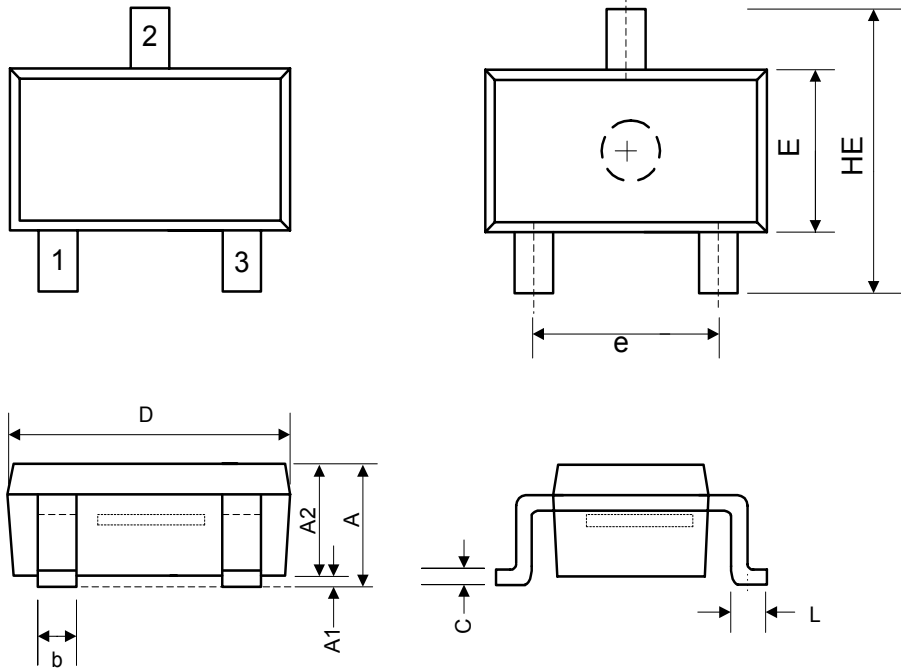
(3) SOT23-5L Package Outline Dimension



| Symbol | Dimensions In Millimeters | | | Dimensions In Inches | | |
|------------|---------------------------|------|------|----------------------|-------|-------|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | 1.05 | 1.20 | 1.35 | 0.041 | 0.047 | 0.053 |
| A1 | 0.05 | 0.10 | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 1.00 | 1.10 | 1.20 | 0.039 | 0.043 | 0.047 |
| b | 0.25 | - | 0.55 | 0.010 | - | 0.022 |
| b1 | 0.25 | 0.40 | 0.45 | 0.010 | 0.016 | 0.018 |
| c | 0.08 | - | 0.20 | 0.003 | - | 0.008 |
| c1 | 0.08 | 0.11 | 0.15 | 0.003 | 0.004 | 0.006 |
| D | 2.70 | 2.85 | 3.00 | 0.106 | 0.112 | 0.118 |
| E | 2.60 | 2.80 | 3.00 | 0.102 | 0.110 | 0.118 |
| E1 | 1.50 | 1.60 | 1.70 | 0.059 | 0.063 | 0.067 |
| L | 0.35 | 0.45 | 0.55 | 0.014 | 0.018 | 0.022 |
| L1 | 0.60 Ref. | | | 0.024 Ref. | | |
| e | 0.95 Bsc. | | | 0.037 Bsc. | | |
| e1 | 1.90 Bsc. | | | 0.075 Bsc. | | |
| θ | 0° | 5° | 10° | 0° | 5° | 10° |
| $\theta 1$ | 3° | 5° | 7° | 3° | 5° | 7° |
| $\theta 2$ | 6° | 8° | 10° | 6° | 8° | 10° |

Adjustable Precision Shunt Regulator

(4) SOT23-3L Package Outline Dimension



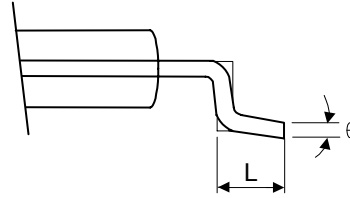
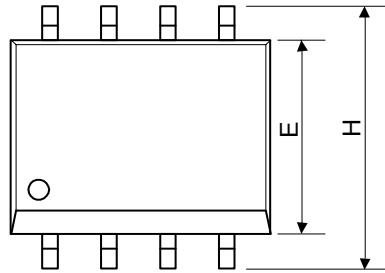
| Symbol | Dimensions In Millimeters | | | Dimensions In Inches | | |
|--------|---------------------------|-------|------|----------------------|-------|-------|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | 1.00 | 1.20 | 1.40 | 0.039 | 0.047 | 0.055 |
| A1 | 0.00 | - | 0.10 | 0.000 | - | 0.004 |
| A2 | 1.00 | 1.15 | 1.30 | 0.039 | 0.045 | 0.051 |
| b | 0.35 | - | 0.50 | 0.014 | - | 0.020 |
| C | 0.10 | 0.175 | 0.25 | 0.004 | 0.007 | 0.010 |
| D | 2.70 | 2.90 | 3.10 | 0.106 | 0.114 | 0.122 |
| E | 1.40 | 1.60 | 1.80 | 0.055 | 0.063 | 0.071 |
| e | 1.70 | 2.00 | 2.30 | 0.067 | 0.079 | 0.091 |
| HE | 2.40 | 2.70 | 3.00 | 0.094 | 0.106 | 0.118 |
| L | 0.30 | - | 0.55 | 0.012 | - | 0.022 |



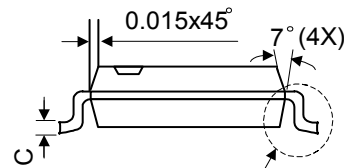
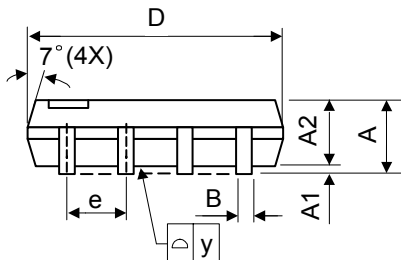
AP432/AP432A

Adjustable Precision Shunt Regulator

(5) SOP-8L Package Outline Dimension



VIEW "A"

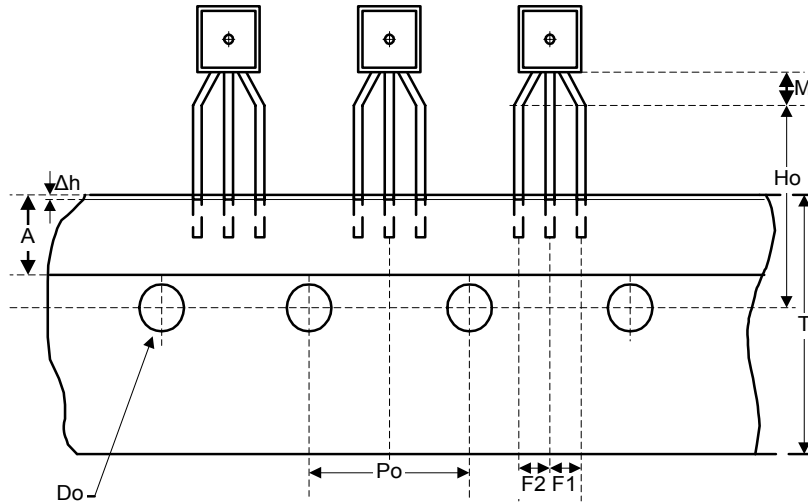


VIEW "A"

| Symbol | Dimensions In Millimeters | | | Dimensions In Inches | | |
|----------|---------------------------|------|-----------|----------------------|-------|-----------|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | 1.40 | 1.60 | 1.75 | 0.055 | 0.063 | 0.069 |
| A1 | 0.10 | - | 0.25 | 0.040 | - | 0.100 |
| A2 | 1.30 | 1.45 | 1.50 | 0.051 | 0.057 | 0.059 |
| B | 0.33 | 0.41 | 0.51 | 0.013 | 0.016 | 0.020 |
| C | 0.19 | 0.20 | 0.25 | 0.0075 | 0.008 | 0.010 |
| D | 4.80 | 5.05 | 5.30 | 0.189 | 0.199 | 0.209 |
| E | 3.70 | 3.90 | 4.10 | 0.146 | 0.154 | 0.161 |
| e | - | 1.27 | - | - | 0.050 | - |
| H | 5.79 | 5.99 | 6.20 | 0.228 | 0.236 | 0.244 |
| L | 0.38 | 0.71 | 1.27 | 0.015 | 0.028 | 0.050 |
| y | - | - | 0.10 | - | - | 0.004 |
| θ | 0° | - | 8° | 0° | - | 8° |

■ Taping Information

(1)TO92 TAPING

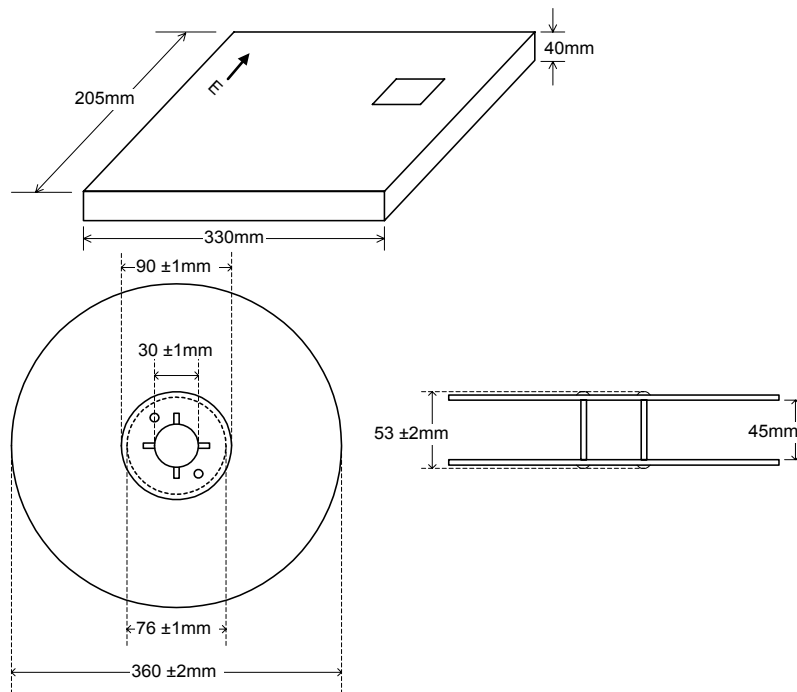


| Symbol | Millimeters | | | Inches | | |
|------------|-------------|------|------|--------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| P_o | 12.4 | 12.7 | 13.0 | 0.488 | 0.500 | 0.512 |
| M | 2.0 | 2.5 | 3.0 | 0.079 | 0.098 | 0.118 |
| H_o | 15.5 | 16.0 | 16.5 | 0.610 | 0.630 | 0.650 |
| D_o | - | 4.0 | - | - | 0.157 | - |
| A | - | 6.0 | - | - | 0.236 | - |
| Δh | 0.0 | - | 1.0 | 0.000 | - | 0.039 |
| T | - | 18.0 | - | - | 0.709 | - |
| F_1 | 2.4 | 2.5 | 2.9 | 0.094 | 0.098 | 0.114 |
| F_2 | 2.4 | 2.5 | 2.9 | 0.094 | 0.098 | 0.114 |



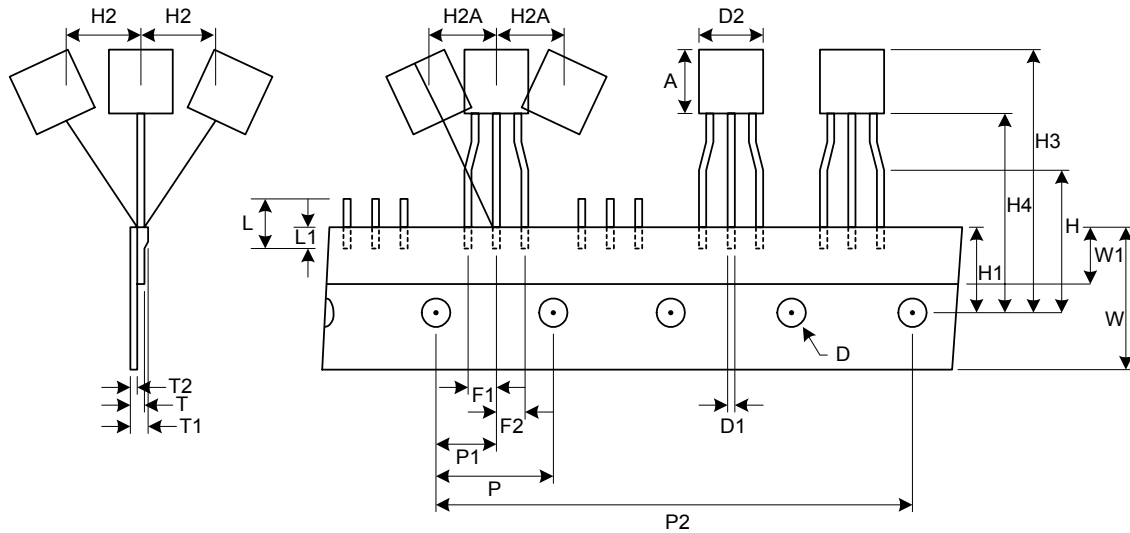
AP432/AP432A

Adjustable Precision Shunt Regulator



Adjustable Precision Shunt Regulator

(2) TO92 TAPING



| Symbol | Millimeters | | | Inches | | |
|--------|-------------|-------|------|--------|--------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 3.18 | 7.59 | 12 | 0.125 | 0.299 | 0.472 |
| D | 3.8 | 4 | 4.2 | 0.150 | 0.157 | 0.165 |
| D1 | 0.36 | 0.445 | 0.53 | 0.014 | 0.018 | 0.021 |
| D2 | - | - | 9.0 | - | - | 0.354 |
| F1,F2 | 2.4 | 2.5 | 2.7 | 0.094 | 0.098 | 0.106 |
| F1-F2 | - | 0.30 | - | - | ±0.012 | - |
| H | 15.5 | 16 | 16.5 | 0.610 | 0.630 | 0.650 |
| H1 | 8.5 | 9 | 9.5 | 0.335 | 0.354 | 0.374 |
| H2 | - | - | 0.5 | - | - | 0.020 |
| H2A | - | - | 0.5 | - | - | 0.020 |
| H3 | - | - | 27 | - | - | 1.063 |
| H4 | - | - | 20 | - | - | 0.787 |
| L | - | - | 11 | - | - | 0.433 |
| L1 | 2.5 | - | - | 0.098 | - | - |
| P | 12.5 | 12.7 | 12.9 | 0.492 | 0.500 | 0.508 |
| P1 | 5.95 | 6.35 | 6.75 | 0.234 | 0.250 | 0.266 |
| P2 | 50.3 | 50.8 | 51.3 | 1.980 | 2.000 | 2.020 |
| T | - | - | 0.55 | - | - | 0.022 |
| T1 | - | - | 1.42 | - | - | 0.056 |
| T2 | 0.36 | 0.52 | 0.68 | 0.014 | 0.020 | 0.027 |
| W | 17.5 | 18.25 | 19 | 0.689 | 0.719 | 0.748 |
| W1 | 5 | 6 | 7 | 0.197 | 0.236 | 0.276 |
| ----* | 253 | 254 | 255 | 9.961 | 10.000 | 10.039 |

----* = every 20 pcs distance.

■ BOX Dimension

