



AP432/AP432A

Adjustable Precision Shunt Regulator

■ Features

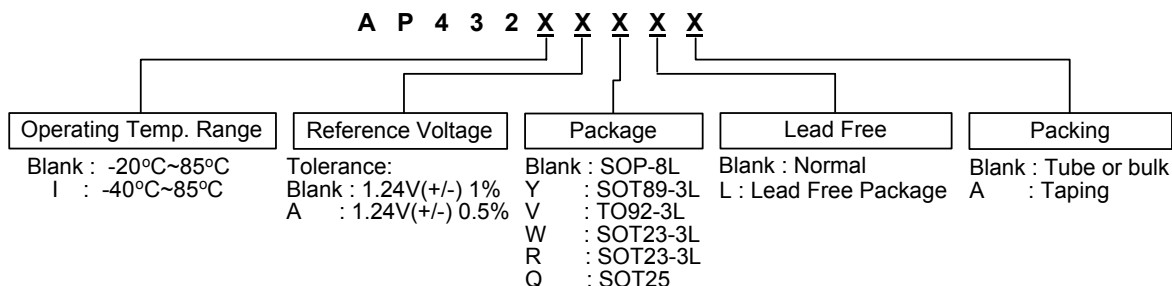
- Precision reference voltage
 - AP432 : $1.24V \pm 1\%$
 - AP432A : $1.24V \pm 0.5\%$
- Sink current capability: 200mA.
- Minimum cathode current for regulation: $150\mu A$
- Equivalent full-range temp coefficient: $30 \text{ ppm}/^{\circ}C$
- Fast turn-on Response.
- Low dynamic output impedance: 0.2Ω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

■ General Description

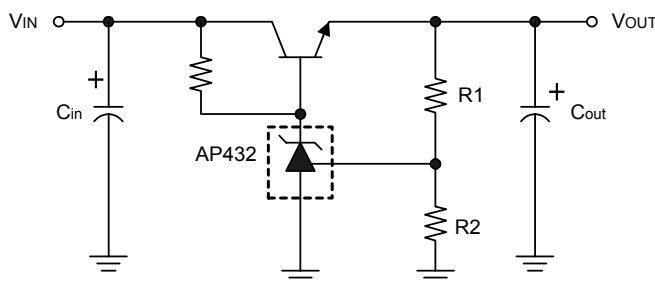
The AP432/432A are 3-terminal adjustable precision shunt regulators with guaranteed stable temperature over the applicable extended commercial temperature range. The output voltage may be set at any level greater than $1.24V (V_{REF})$ up to 20V merely by selecting two external resistors that act as 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 $\pm 1\%$ 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



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

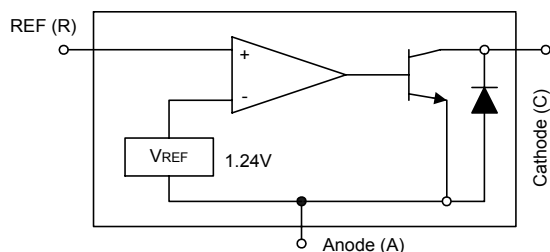
Precision Regulator



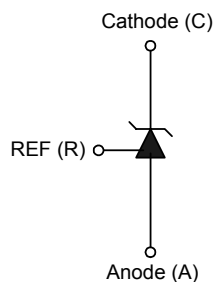
AP432/AP432A

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■ Block Diagram



■ Symbol



■ Pin Configuration

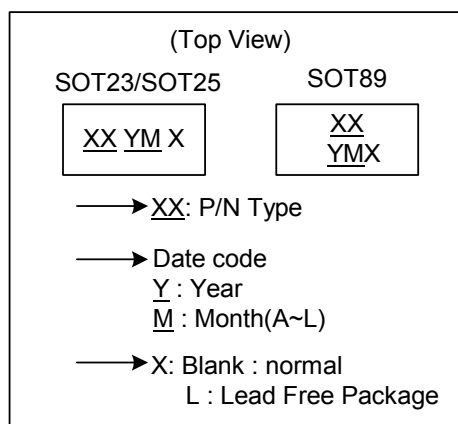
Order Number	Pin Configuration (Top View)
AP432Y AP432AY AP432IY AP432IAY (SOT89)	
AP432V AP432AV AP432IV AP432IAV (TO92)	
AP432 AP432A AP432I AP432IA (SOP)	

Order Number	Pin Configuration (Top View)
AP432R AP432AR AP432IR AP432IAR (SOT23)	
AP432W AP432AW AP432IW AP432IAW (SOT23)	
AP432Q AP432AQ AP432IQ AP432IAQ (SOT25)	

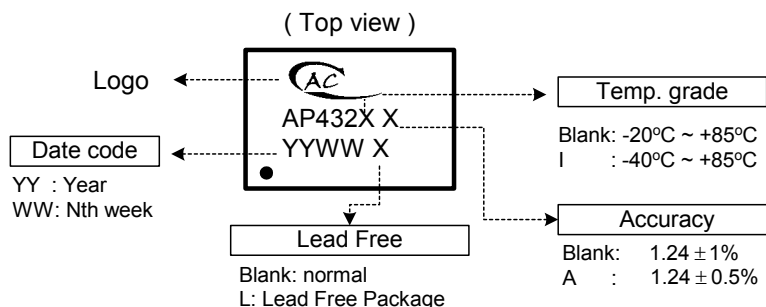
■ Marking Information

(1) SOT23 / SOT25 / SOT89

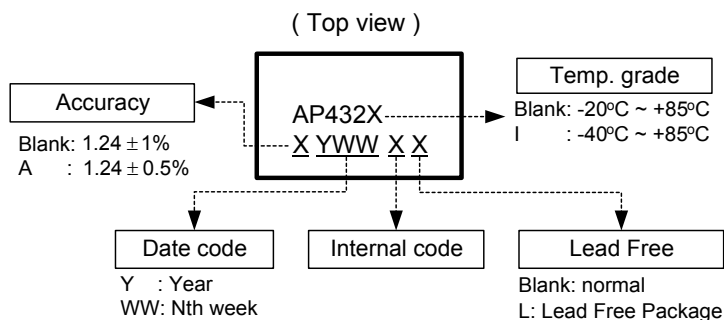
P/N Type	X X
AP432Y	B1
AP432AY	B2
AP432IY	BA
AP432IAY	BB
AP432W	B3
AP432AW	B4
AP432IW	BC
AP432IAW	BD
AP432R	B5
AP432AR	B6
AP432IR	BE
AP432IAR	BF
AP432Q	B7
AP432AQ	B8
AP432IQ	BG
AP432IAQ	BH



(2) SOP



(3) TO92





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■ 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

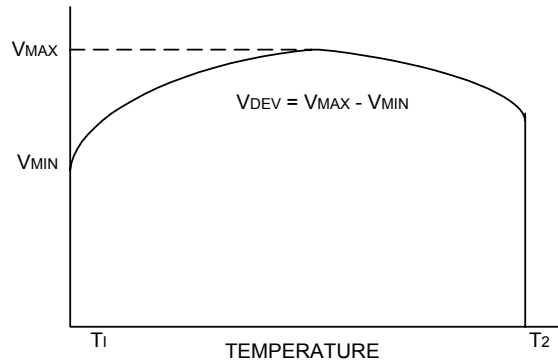
Note 1: T_J , max = 150°C.

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

■ Electrical Characteristics ($T_a=25^\circ\text{C}$, unless otherwise specified.)

Parameter	Test conditions	Symbol	Min.	Typ.	Max.	Unit
Reference voltage	$V_{KA} = V_{REF}$, $I_{KA} = 10\text{mA}$ (Fig.1)	AP432	1.227	1.24	1.252	V
		AP432A	1.233		1.246	
Deviation of reference input voltage over temperature (Note 3)	$V_{KA} = V_{REF}$, $I_{KA} = 10\text{mA}$, $T_a = \text{full range}$ (Fig.1)	V_{REF}		3.0	20	mV
Ratio of the change in reference voltage to the change in cathode voltage	$I_{KA} = 10\text{mA}$ (Fig.2)	$V_{KA} = 20 \sim V_{REF}$ $\frac{\Delta V_{REF}}{\Delta V_{KA}}$		-1.4	-2.0	mV/V
Reference input current	$R1 = 10\text{K}\Omega$, $R2 = \infty$ $I_{KA} = 10\text{mA}$ (Fig.2)	I_{REF}		1.4	3.5	μA
Deviation of reference input current over temperature	$R1 = 10\text{K}\Omega$, $R2 = \infty$ $I_{KA} = 10\text{mA}$ $T_a = \text{Full range}$ (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	$V_{KA} = 20\text{V}$, $V_{REF} = 0\text{V}$ (Fig.3)	$I_{KA(\text{off})}$		0.1	1.0	μA
Dynamic output impedance (Note 4)	$V_{KA} = V_{REF}$ $\Delta I_{KA} = 0.1\text{mA} \sim 15\text{mA}$ Frequency $\leq 1\text{KHz}$ (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 R_1 and R_2 (see Figure 2.), the dynamic output impedance of the overall circuit, is defined as:

$$|Z_{KA}'| = \frac{\Delta V}{\Delta I} \approx |Z_{KA}| \left(1 + \frac{R_1}{R_2} \right)$$

■ Test Circuits

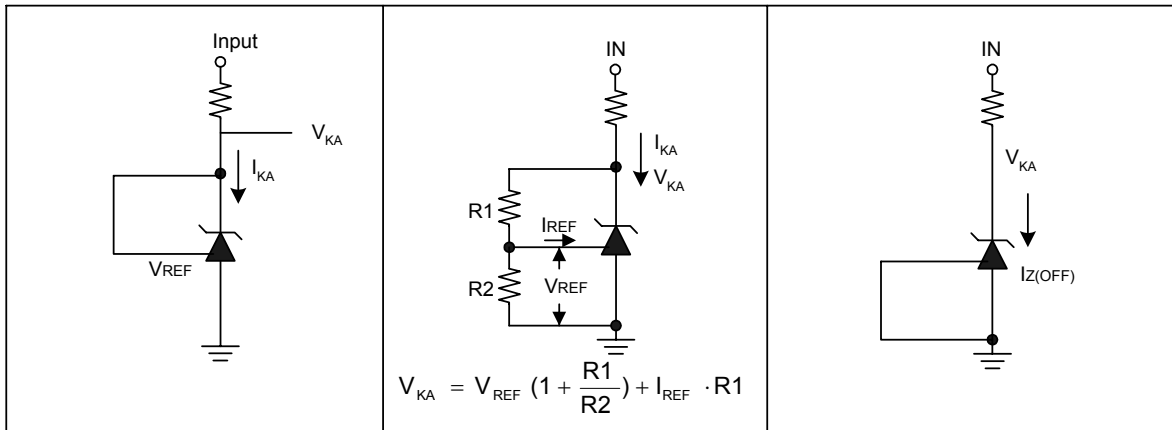


Fig1. Test Circuit for $V_{KA} = V_{REF}$

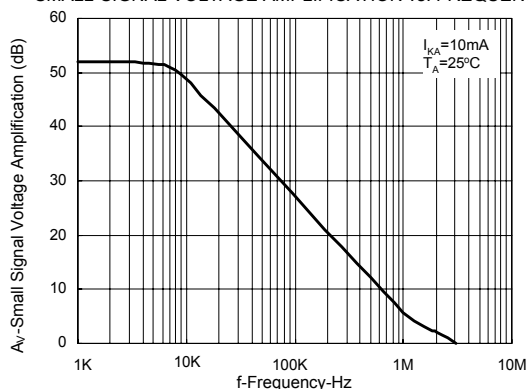
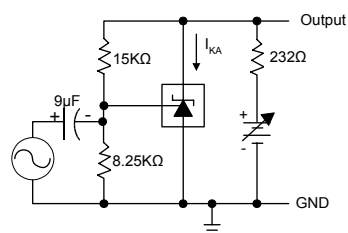
Fig2. Test circuit for $V_{KA} > V_{REF}$

Fig3. Test Circuit for off-state Current



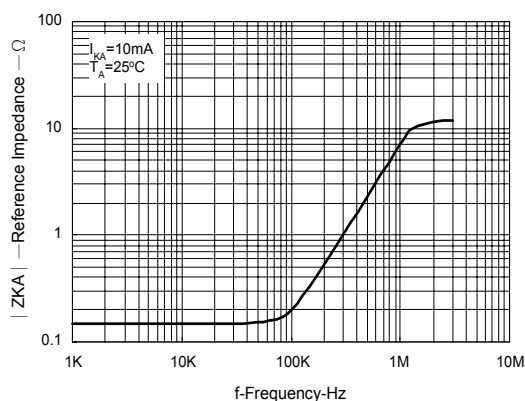
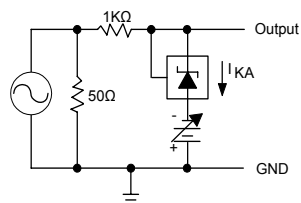
■ Typical Performance Characteristics

SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY



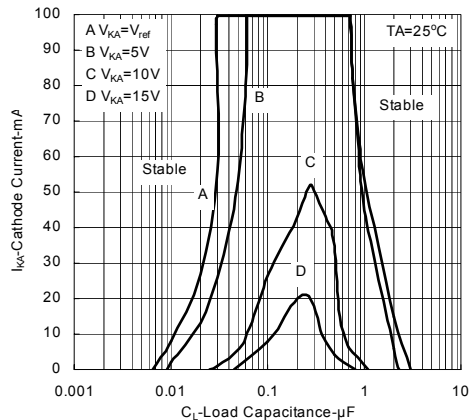
TEST CIRCUIT FOR VOLTAGE AMPLIFICATION

REFERENCE IMPEDANCE vs. FREQUENCY

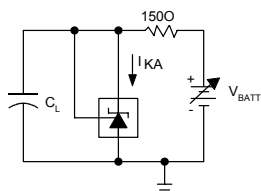


TEST CIRCUIT FOR REFERENCE IMPEDANCE

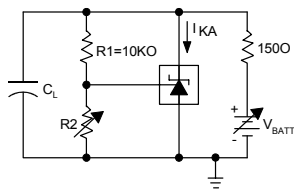
STABILITY BOUNDARY CONDITIONS†



†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.

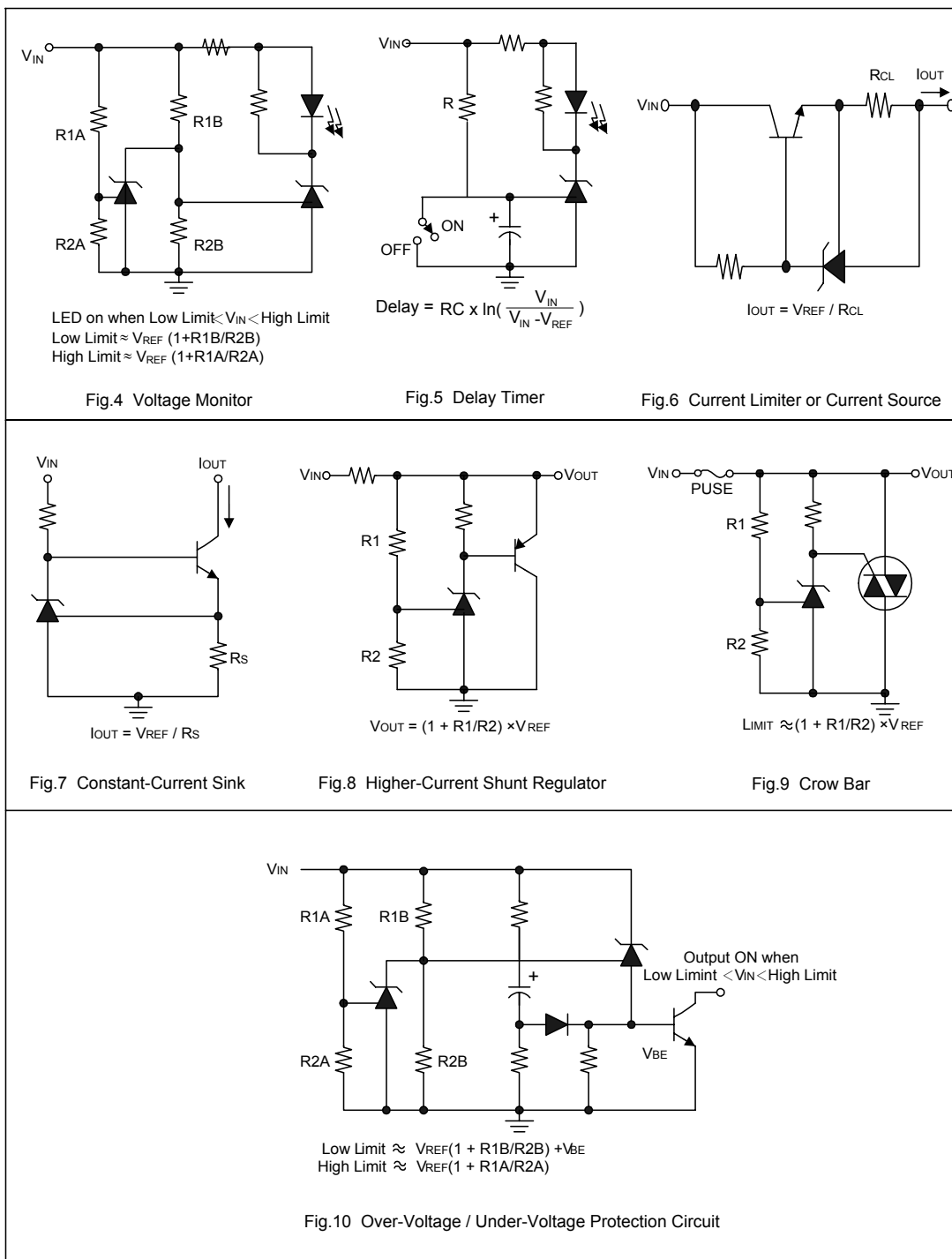


TEST CIRCUIT FOR CURVE A



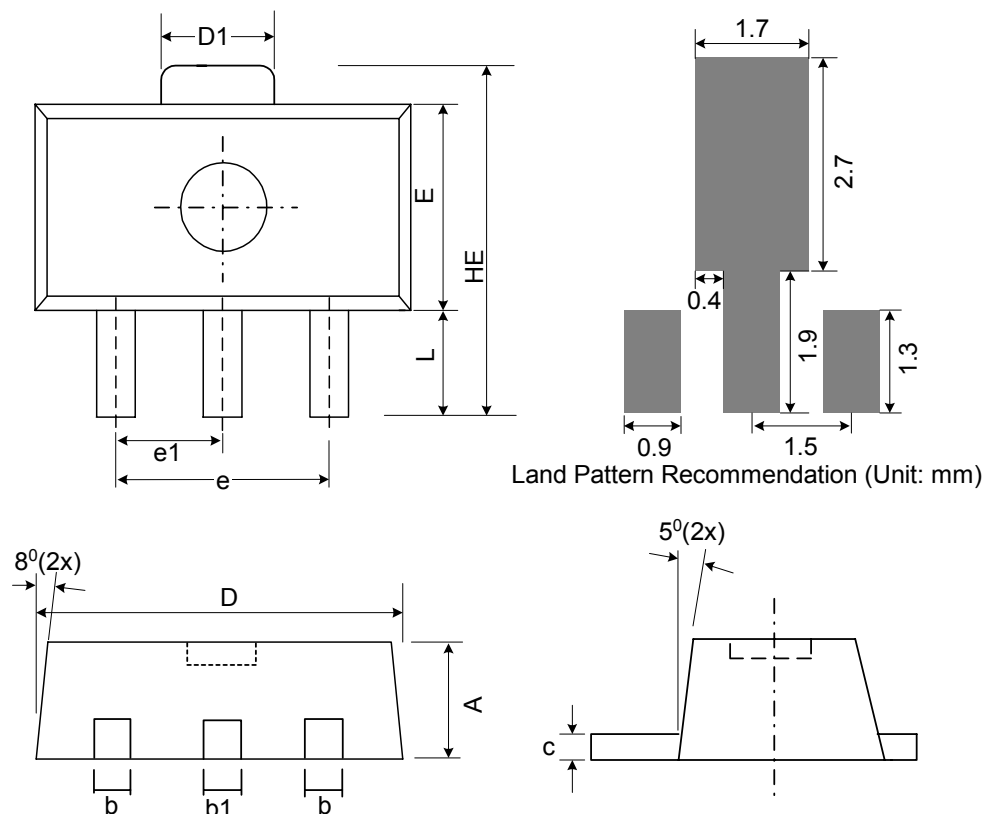
TEST CIRCUIT FOR CURVE B, C, AND D

■ Application Examples



■ Package Diagrams

(1) SOT89-3L Package Outline Dimension



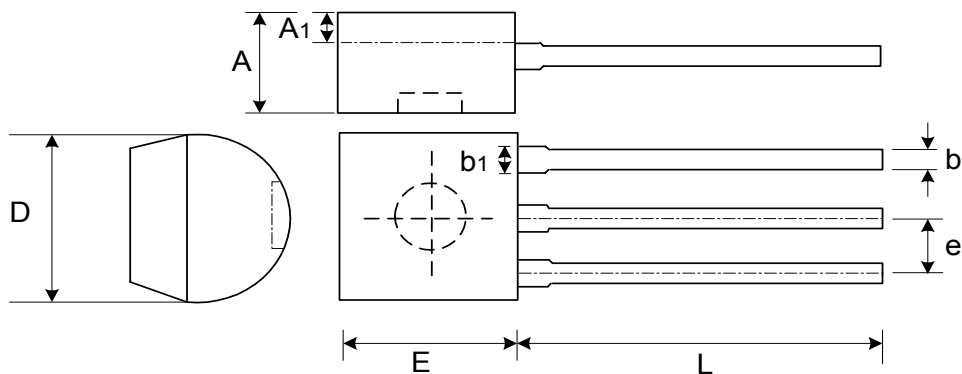
Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.40	1.50	1.60	0.055	0.059	0.063
b	0.36	0.42	0.48	0.014	0.016	0.018
b1	0.41	0.47	0.53	0.016	0.043	0.051
C	0.35	0.39	0.43	0.014	0.015	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
D1	1.40	1.60	1.75	0.055	0.062	0.069
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



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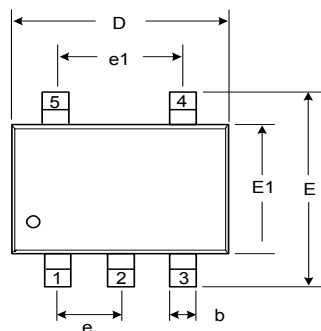
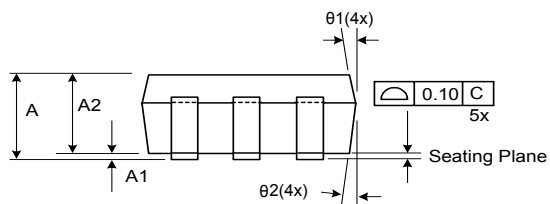
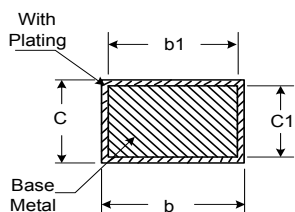
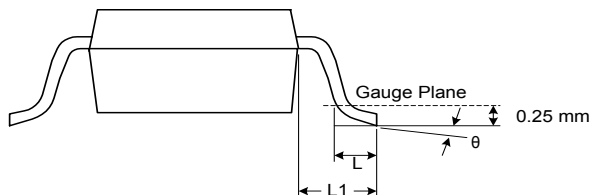
(2) TO92-3L Package Outline Dimension



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

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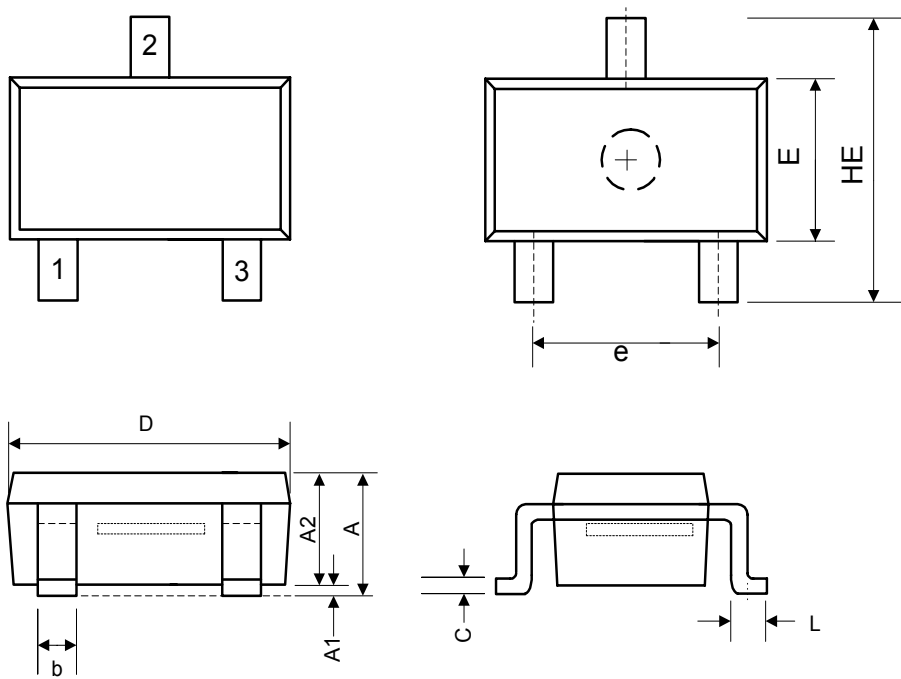
(3) SOT23-5L Package Outline Dimension



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°
θ 1	3°	5°	7°	3°	5°	7°
θ 2	6°	8°	10°	6°	8°	10°

Adjustable Precision Shunt Regulator

(4) SOT23-3L Package Outline Dimension



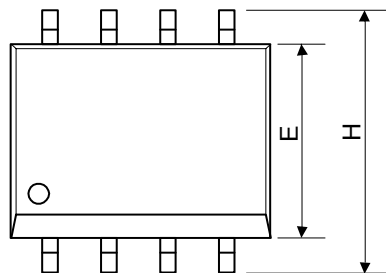
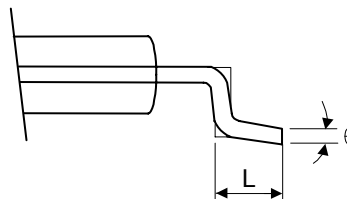
Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.00	1.20	1.40	0.039	0.047	0.055
A1	0.00	-	0.10	0.000	-	0.004
A2	1.00	1.15	1.30	0.039	0.045	0.051
b	0.35	-	0.50	0.014	-	0.020
C	0.10	0.175	0.25	0.004	0.007	0.010
D	2.70	2.90	3.10	0.106	0.114	0.122
E	1.40	1.60	1.80	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



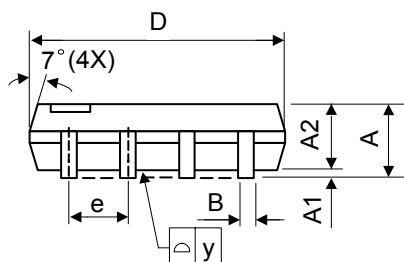
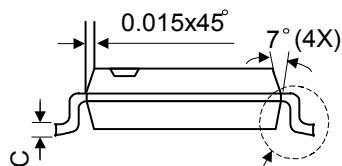
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(5) SOP-8L Package Outline Dimension



VIEW "A"

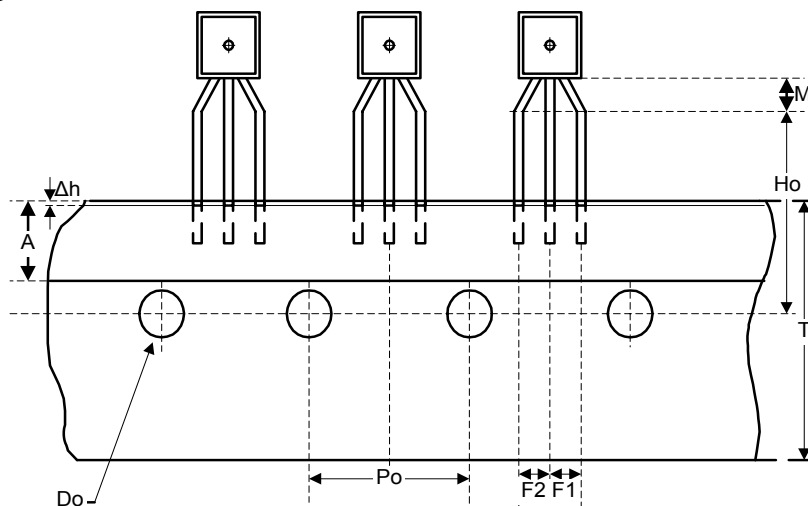


VIEW "A"

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

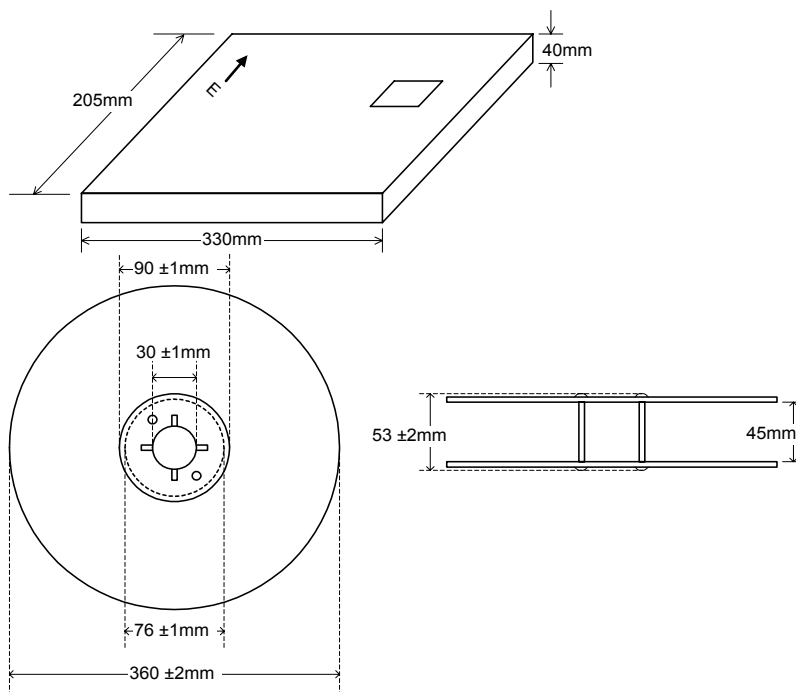


Symbol	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
Po	12.4	12.7	13.0	0.488	0.500	0.512
M	2.0	2.5	3.0	0.079	0.098	0.118
Ho	15.5	16.0	16.5	0.610	0.630	0.650
Do	-	4.0	-	-	0.157	-
A	-	6.0	-	-	0.236	-
Δh	0.0	-	1.0	0.000	-	0.039
T	-	18.0	-	-	0.709	-
F1	2.4	2.5	2.9	0.094	0.098	0.114
F2	2.4	2.5	2.9	0.094	0.098	0.114



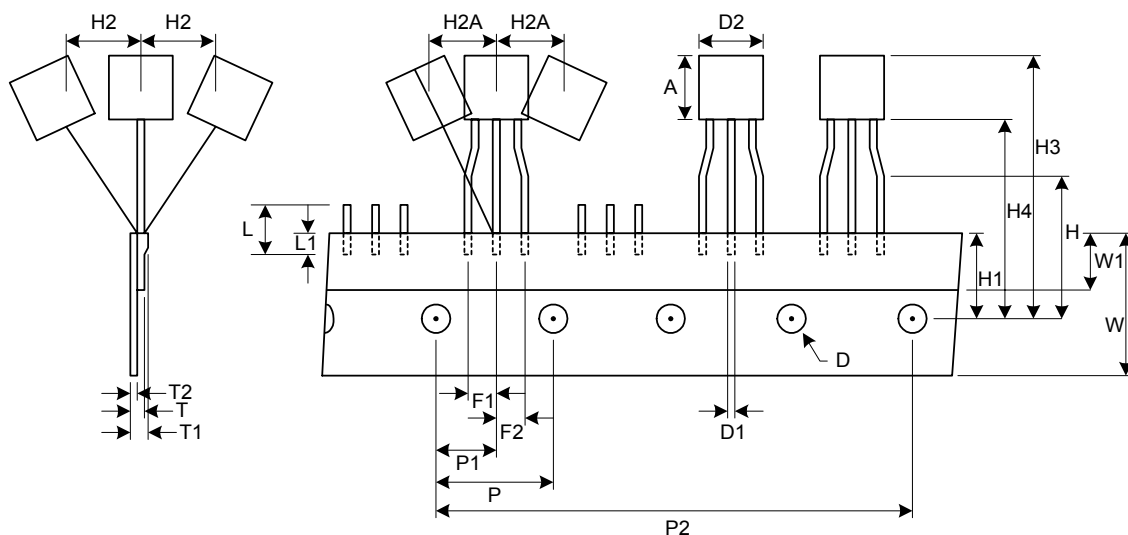
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(2) TO92 TAPING



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

