Advanced Power Electronics Corp.

AP432

Adjustable Precision Shunt Regulator

■ Features

- Precision reference voltage
  B : 1.24V ± 1%
  A : 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: SOT-89, SOT-23, SOT-23-5L, SO-8 and TO-92
- RoHS & Halogen-FreeCompliant

■ General Description

The AP432 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 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.

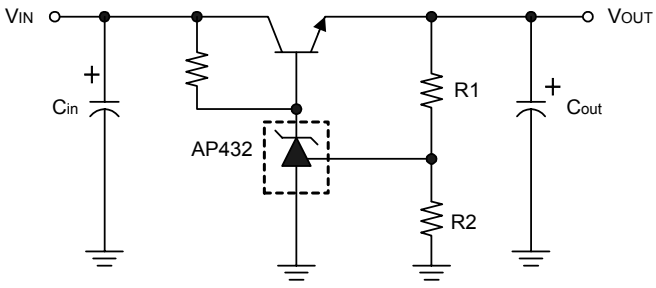
■ Ordering Information

A P 4 3 2 X - X - HF Halogen-Free

Package	
M	: SO-8
G	: SOT-89
T	: TO-92
N	: SOT-23
Y	: SOT-23-5L

Reference Voltage	
Tolerance:	
A	: 1.24V(+/-) 0.5%
B	: 1.24V(+/-)1%

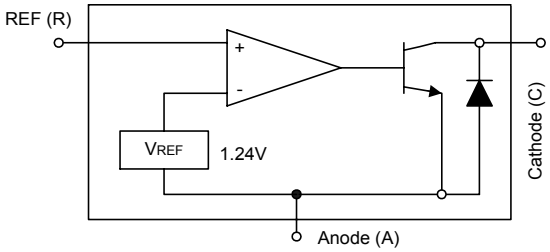
■ Typical Application Circuit



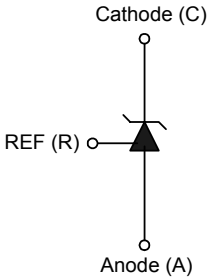
$V_{OUT} = (1+R1/R2)V_{REF}$

Precision Regulator

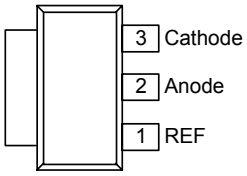
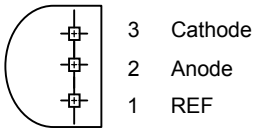
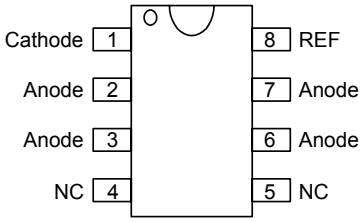
■ Block Diagram

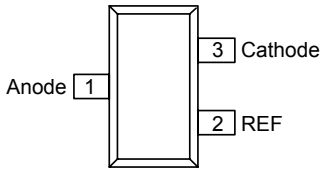
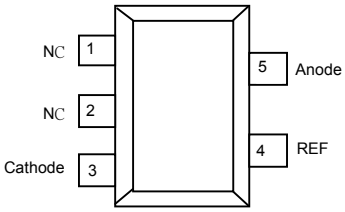


■ Symbol



■ Pin Configuration

Order Number	Pin Configuration (Top View)
AP432G (SOT-89)	
AP432T (TO-92)	
AP432M (SO-8)	

Order Number	Pin Configuration (Top View)
AP432N (SOT-23)	
AP432Y (SOT-23-5L)	

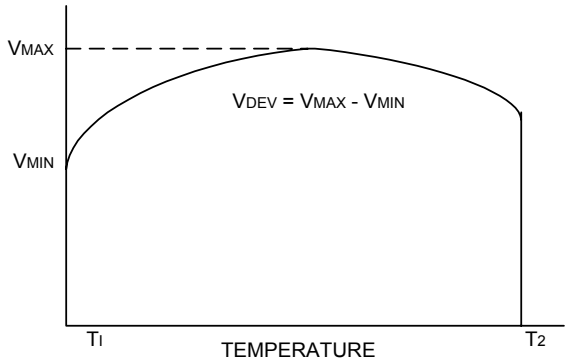
■ Absolute Maximum Ratings

Cathode Voltage……20V
Continuous cathode current ……-10mA ~ 250mA
Reference input current range ……10mA
Operating temperature range ……-20 °C ~ 85°C
Lead Temperature……260°C
Storage Temperature ……-65°C ~ 150°C
Power Dissipation (Notes 1. 2) SOT-89 …… 0. 80W
TO-92…… 0.78W
SOT-23 …… 0.25W
SOT-25……0.25W
SOP-8…… 0.6W

Note 1: T_J, max =150°C. .
Note 2: Ratings apply to ambient temperature at 25°C.

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

Parameter	Test conditions		Symbol	Min.	Typ.	Max.	Unit
Reference Voltage	V_{KA} = Vref, I_{KA} = 10mA (Fig.1)	-B	V_{REF}	1.227	1.24	1.252	V
		-A		1.233		1.246	
Deviation of Reference Input Voltage over Temperature (Note 3)	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 4)	V_{KA} = V_{REF} Frequency ≤ 1KHz (Fig.1)		$\lvert Z_{KA} \rvert$		0.2	0.5	Ω



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:

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

Where:

T2 – T1 = 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:

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

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

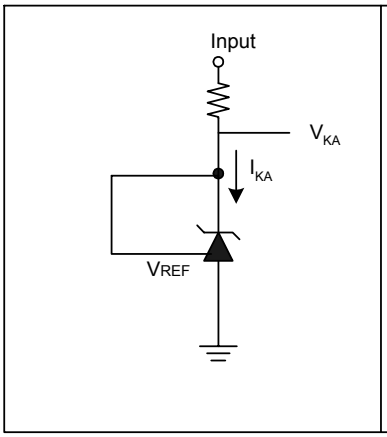


Fig1. Test Circuit for $V_{KA} = V_{REF}$

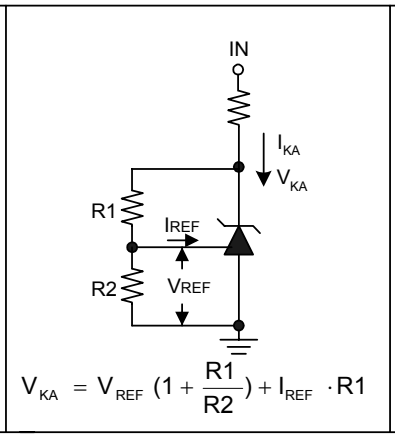


Fig2. Test circuit for $V_{KA} > V_{REF}$

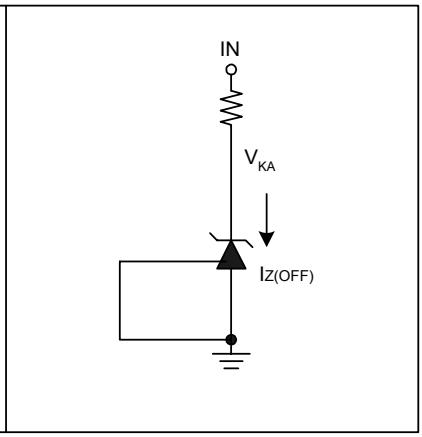
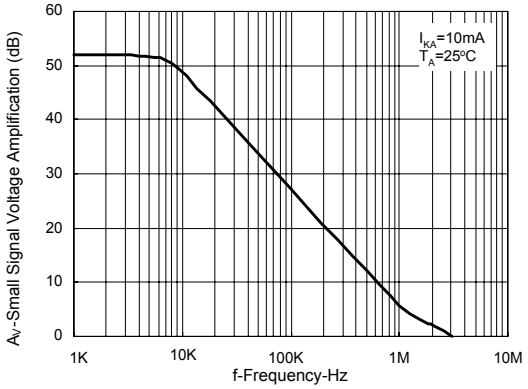
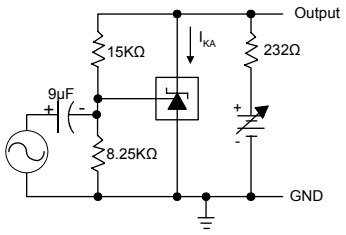


Fig3. Test Circuit for off-state Current

■ Typical Performance Characteristics

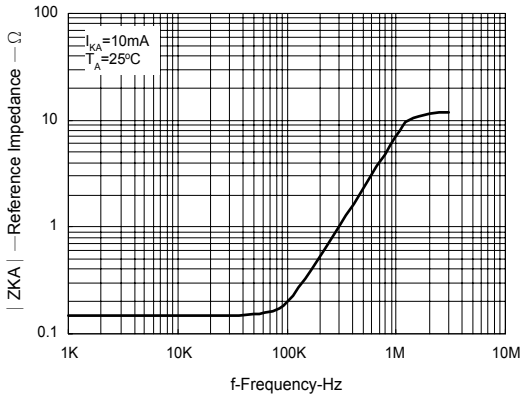
SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY

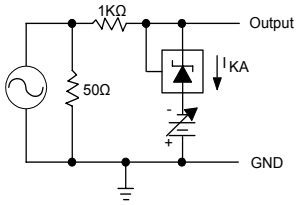




TEST CIRCUIT FOR VOLTAGE AMPLIFICATION

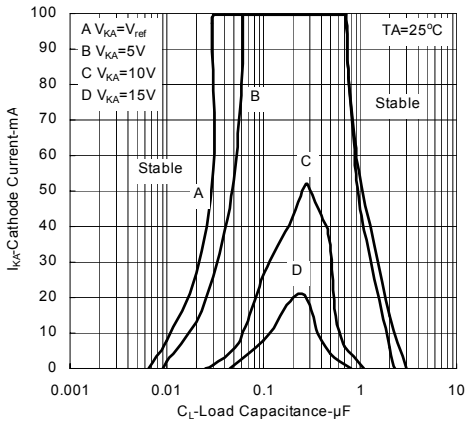
REFERENCE IMPEDANCE vs. FREQUENCY



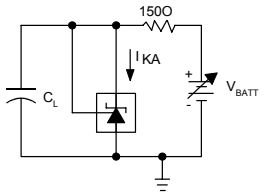


TEST CIRCUIT FOR REFERENCE IMPEDANCE

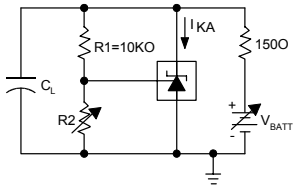
STABILITY BOUNDARY CONDITIONS†



†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.

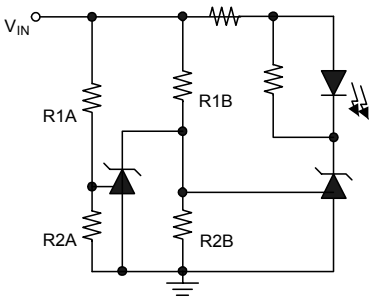


TEST CIRCUIT FOR CURVE A



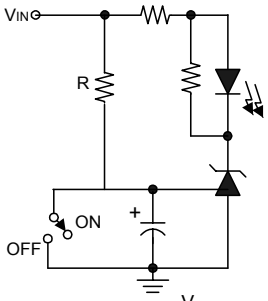
TEST CIRCUIT FOR CURVE B, C, AND D

■ Application Examples



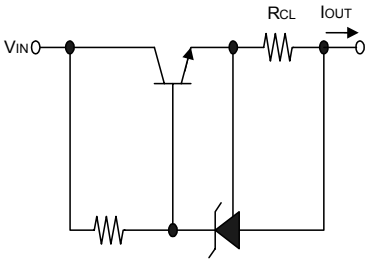
LED on when Low Limit < V_{IN} < High Limit
Low Limit ≈ V_{REF} (1+R1B/R2B)
High Limit ≈ V_{REF} (1+R1A/R2A)

Fig.4 Voltage Monitor



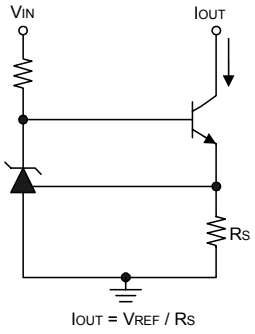
Delay = $RC \times \ln\left(\frac{V_{IN}}{V_{IN}-V_{REF}}\right)$

Fig.5 Delay Timer



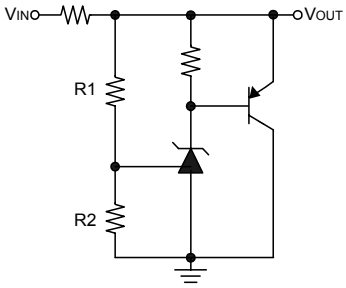
$I_{OUT} = V_{REF} / R_{CL}$

Fig.6 Current Limiter or Current Source



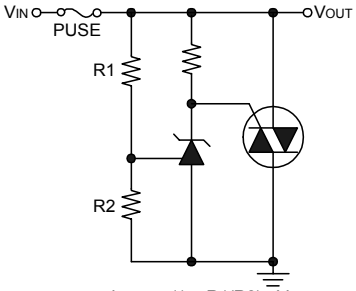
$I_{OUT} = V_{REF} / R_S$

Fig.7 Constant-Current Sink



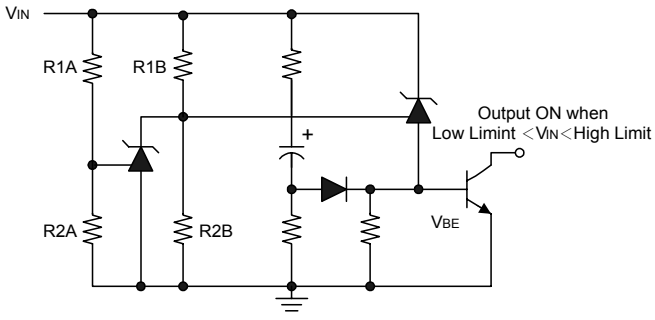
$V_{OUT} = (1 + R1/R2) \times V_{REF}$

Fig.8 Higher-Current Shunt Regulator



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

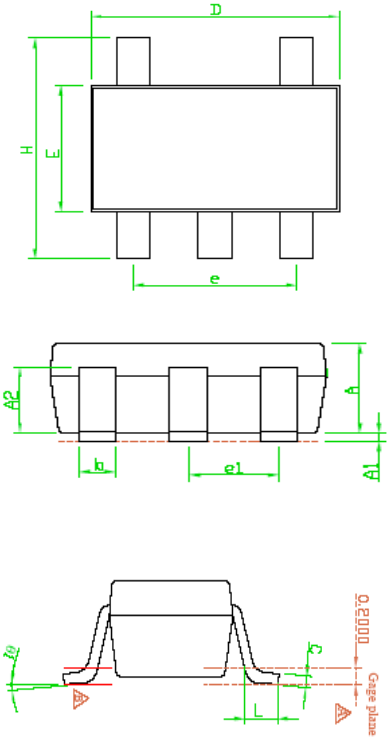
Fig.9 Crow Bar



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

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

Package Outline : SOT-23-5L



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.00	1.10	1.30
A1	0.00	---	0.10
A2	0.70	0.80	0.90
b	0.30	0.40	0.50
C	0.10	0.15	0.25
D	2.70	2.90	3.10
E	1.40	1.60	1.80
e	---	1.90(TYP)	---
H	2.60	2.80	3.00
L	0.37	---	---
θ1	0°	5°	9°
e1	---	0.95(TYP)	---

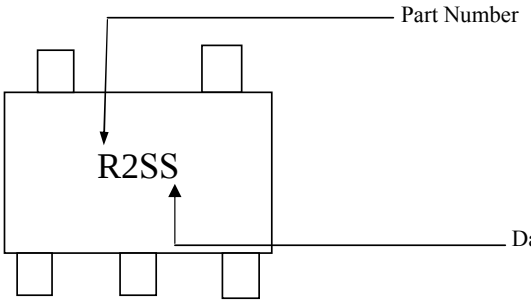
Note 1：Package Body Sizes Exclude Mold Flash Protrusions or Gate Burrs.

Note 2：Tolerance ± 0.1000 mm(4mil) Unless Otherwise Spe- cified.

Note 3：Coplanarity：0.1000 mm

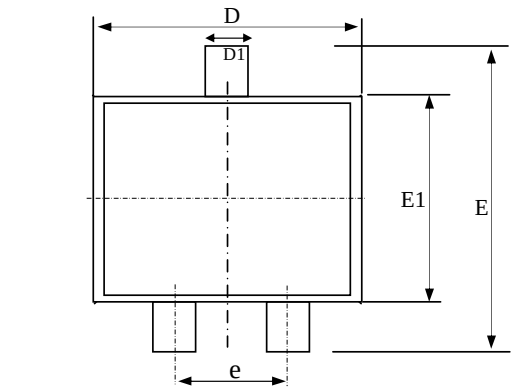
Note 4：Dimension L Is Measured in Gage plane.

Part Marking Information & Packing : SOT-23-5L

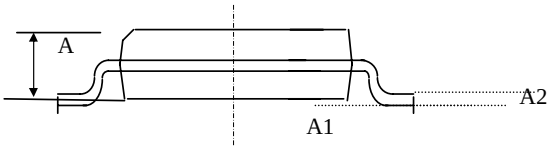


SS:2004,2008,2012…
SS:2003,2007,2011…
SS:2002,2006,2010…
SS:2001,2005,2009…

Package Outline : SOT-23



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.00	1.15	1.30
A1	0.00	--	0.10
A2	0.10	0.15	0.25
D1	0.30	0.40	0.50
e	1.70	2.00	2.30
D	2.70	2.90	3.10
E	2.40	2.65	3.00
E1	1.40	1.50	1.60

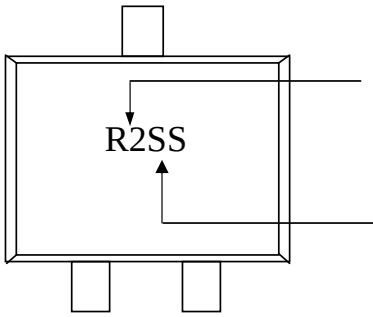


1.All Dimension Are In Millimeters.

2.Dimension Does Not Include Mold Protrusions.

Part Marking Information & Packing : SOT-23

Laser Marking



Part Number : R2

Date Code :

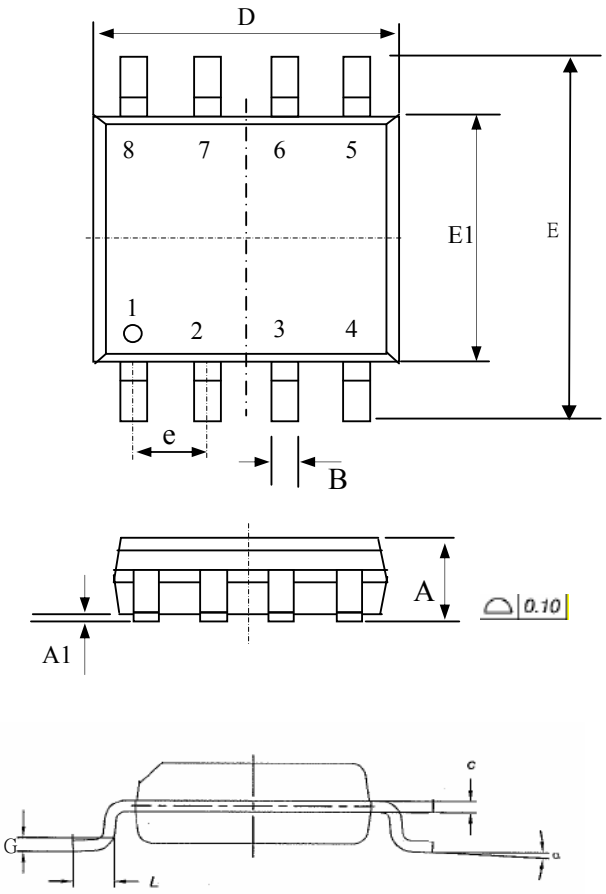
SS:2004,2008,2012…

SS:2003,2007,2011…

SS:2002,2006,2010…

SS:2001,2005,2009…

Package Outline : SO-8

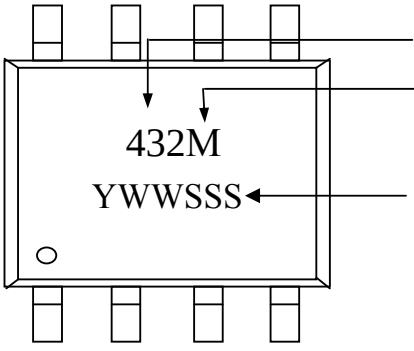


		Millimeters	
SYMBOLS	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.10	0.18	0.25
B	0.33	0.41	0.51
c	0.19	0.22	0.25
D	4.80	4.90	5.00
E	5.80	6.15	6.50
E1	3.80	3.90	4.00
e	1.27 TYP		
G	0.254 TYP		
L	0.38	—	0.90
α	0.00	4.00	8.00

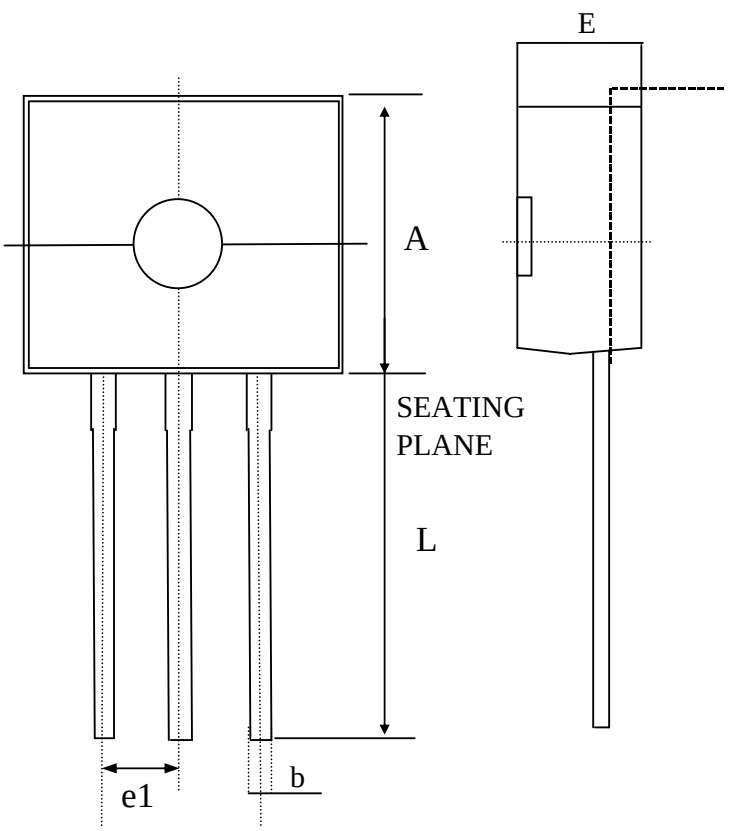
1.All Dimension Are In Millimeters.

2.Dimension Does Not Include Mold Protrusions.

Part Marking Information & Packing : SO-8



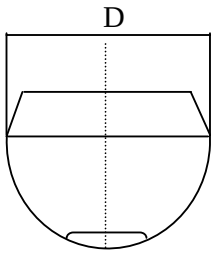
Package Outline : TO-92



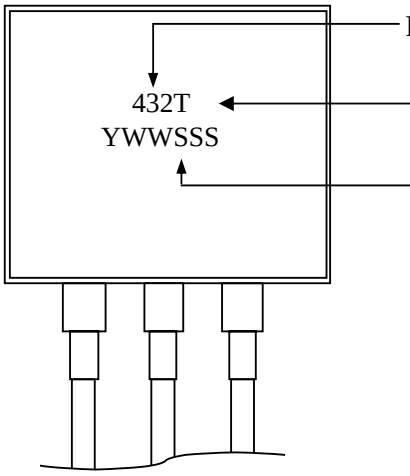
SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	4.32	4.83	5.34
D	4.1	4.8	5.3
E	3.1	3.9	4.7
b	----	0.38	-----
L	12.7	---	----
e1	----	1.27	----

1.All Dimensions Are in Millimeters.

2.Dimension Does Not Include Mold Protrusions.



Part Marking Information & Packing : TO-92



Y：Last Digit Of The Year

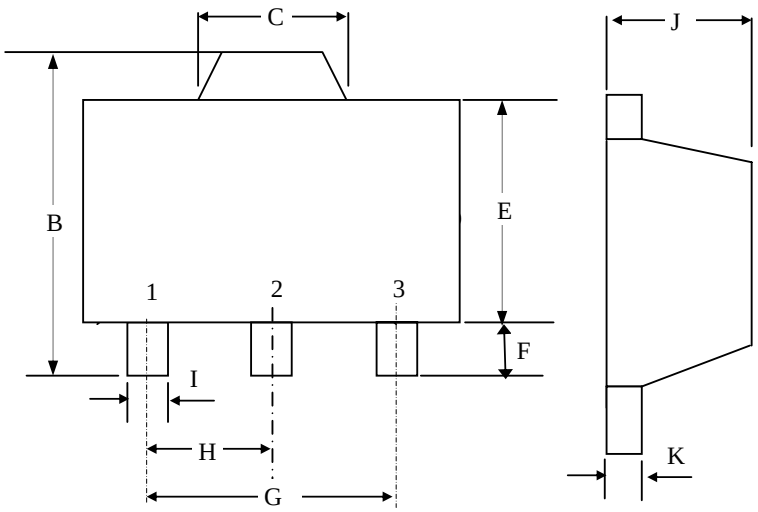
WW：Week

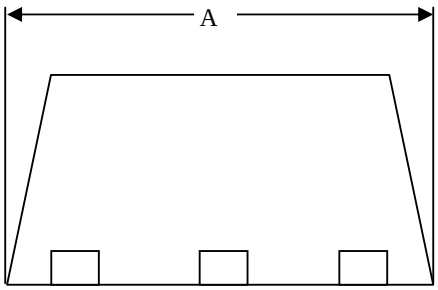
SSS：Sequence

If last "S" is numerical letter : Rohs product

If last "S" is English letter : HF & Rohs product

Package Outline & Packing : SOT-89



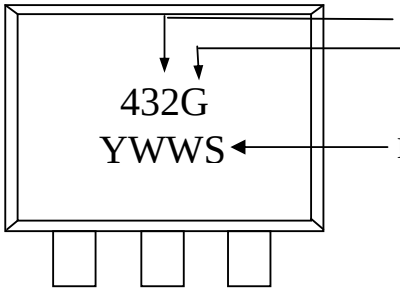


	Millimeters		
SYMBOLS	MIN	NOM	MAX
A	4.40	-	4.60
B	4.05	-	4.25
C	1.40	-	1.75
E	2.40	-	2.60
F	0.89	-	1.20
I	0.35	-	0.55
H	----	1.50	----
G	----	3.00	----
J	1.40	-	1.60
K	0.35	-	0.43

1.All Dimensions Are in Millimeters.

2.Dimension Does Not Include Mold Protrusions.

Part Marking Information : SOT-89



Y:Year

WW：Week

S：Sequence

If second letter has underline : HF & Rohs product

If second letter has not underline : Rohs product