Low Voltage Adjustable Shunt Regulators

Features

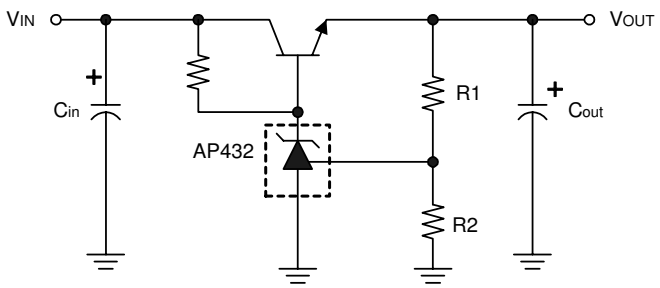
- Precision reference voltage
  - B : 1.24V ±1%
  - A : 1.24V ±0.5%
- Sink current capability: 200mA.
- Minimum cathode current for regulation: 150μA
- Equivalent full-range temp coefficient: 30 ppm/℃
- Fast turn-on response.
- Low dynamic output impedance: 0.2Ω
- Programmable output voltage to 20v
- Low output noise
- Packages: SOT-89, SOT-23, SOT-23-5L, SO-8 and TO-92
- RoHS-compliant, halogen-free (HF)

Description

The AP432-3 are 3-terminal adjustable precision shunt regulators with guaranteed temperature stability over the applicable extended commercial temperature range. The output voltage may be set at any level greater than 1.24V (VREF) 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 AP432x-B-3 makes it possible in many applications to avoid the use of a variable resistor, consequently saving cost and eliminating the drift and reliability problems associated with it.

Typical Application



VOUT = (1+R1/R2)VREF

Precision Regulator

Ordering information

AP432X-X-HF-3TX

Packing: TB = tubes (for TO-92)
TR = tape and reel (surface mount packages only)

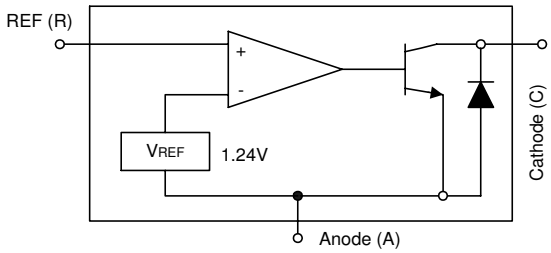
Reference Voltage and Tolerance:
A : 1.24V +/- 0.5%
B or omitted : 1.24V +/- 1%

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

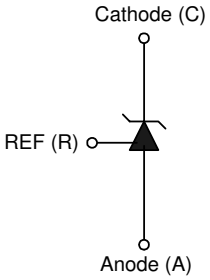
For example, AP432Y-A-HF-3TR:

AP432 0.5% tolerance in RoHS-compliant HF SOT-23-5L, packed in tape and reel

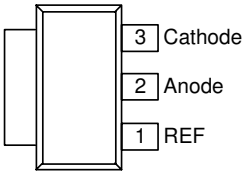
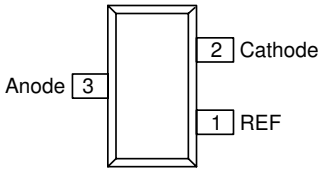
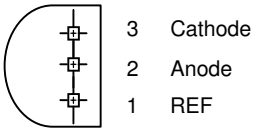
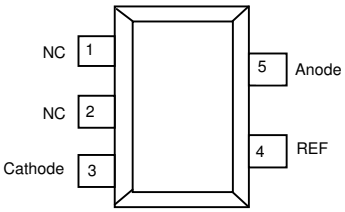
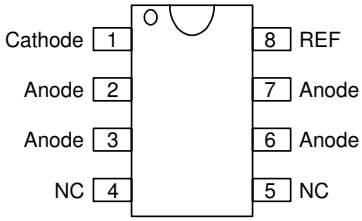
Block Diagram



Symbol



Pin Configurations

Order Number	Pin Configuration (Top View)	Order Number	Pin Configuration (Top View)
AP432G (SOT-89)		AP432N (SOT-23)	
AP432T (TO-92)		AP432Y (SOT-23-5L)	
AP432M (SO-8)			

Absolute Maximum Ratings

Cathode Voltage		20V
Continuous cathode current		-10mA ~ 250mA
Reference input current range		10mA
Operating temperature range		-20℃ ~ 85℃
Lead Temperature		260℃
Storage Temperature		-65℃ ~ 150℃
Power Dissipation (Notes 1, 2)	SOT-89	0. 80W
	TO-92	0.78W
	SOT-23	0.25W
	SOT-23-5	0.25W
	SO-8	0.6W

Note 1: Maximum junction temperature =150°C. .
Note 2: Ratings apply at ambient temperature of 25℃

Electrical Characteristics (Ta=25℃, unless otherwise specified.)

Parameter	Test conditions		Symbol	Min.	Typ.	Max.	Unit
Reference Voltage	V_{KA} = Vref, I_{KA} = 10mA (Fig.1)	AP432x-B	V_{REF}	1.227	1.24	1.252	V
		AP432x-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

Test Circuits

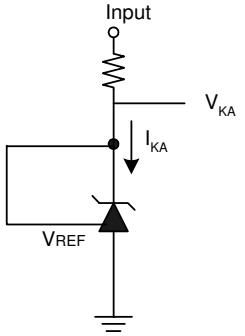
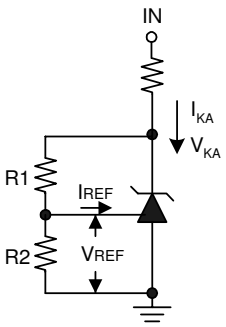


Fig1. Test Circuit for V_{KA}= V_{REF}



$$V_{KA} = V_{REF}\left(1 + \frac{R1}{R2}\right) + I_{REF} \times R1$$

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

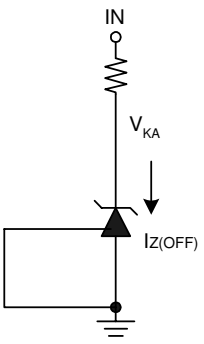
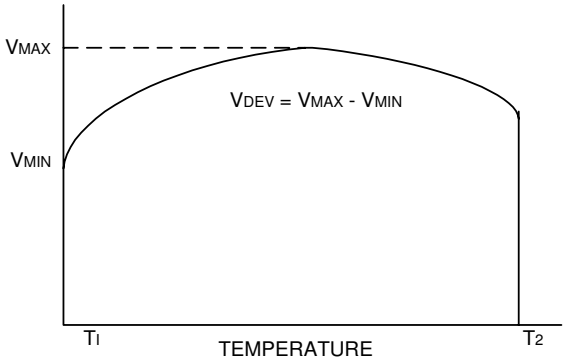


Fig3. Test Circuit for off-state Current

Electrical Characteristics (cont.) (Ta=25℃, unless otherwise specified.)

Note 3. Deviation of reference input voltage over temperature.



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:

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

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

The dynamic output impedance, R_Z, is defined as:

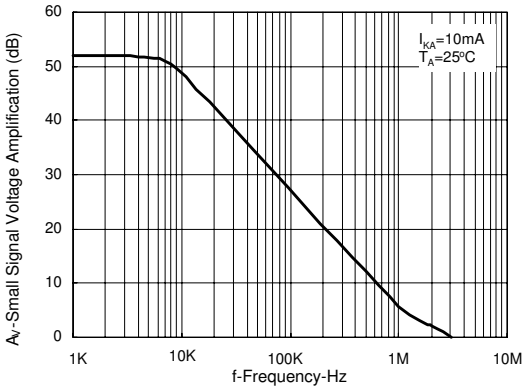
$$\left|Z_{KA}\right| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$$

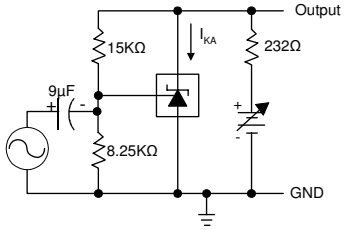
When the device is programmed with two external resistors R1 and R2 (see Figure 2.), the dynamic output impedance of the overall circuit, is defined as:

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

Electrical Characteristics (cont.) (Ta=25℃, unless otherwise specified.)

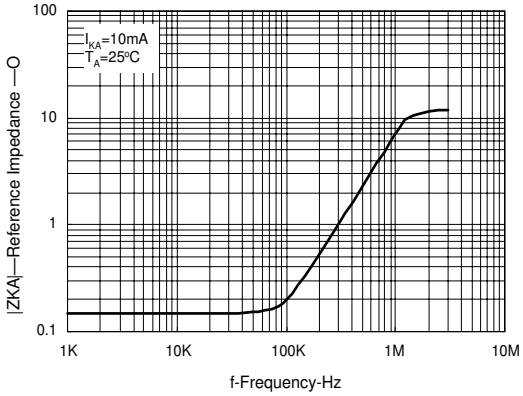
SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY

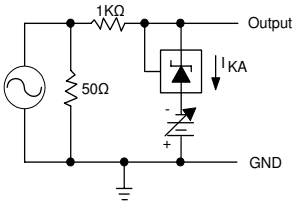




TEST CIRCUIT FOR VOLTAGE AMPLIFICATION

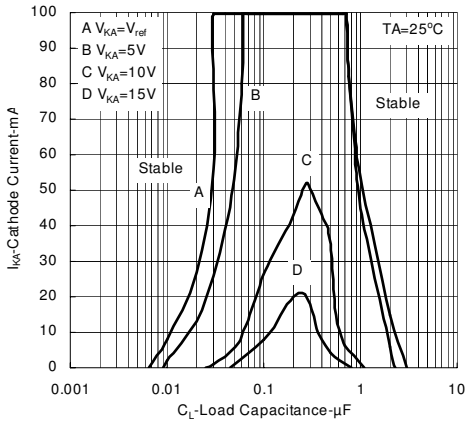
REFERENCE IMPEDANCE vs. FREQUENCY

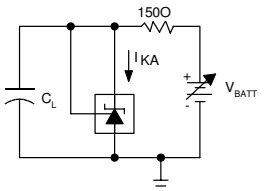




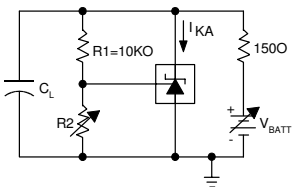
TEST CIRCUIT FOR REFERENCE IMPEDANCE

STABILITY BOUNDARY CONDITIONS†





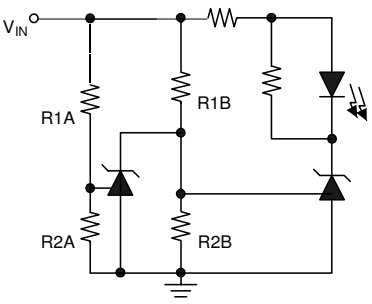
TEST CIRCUIT FOR CURVE A



TEST CIRCUIT FOR CURVE B, C, AND D

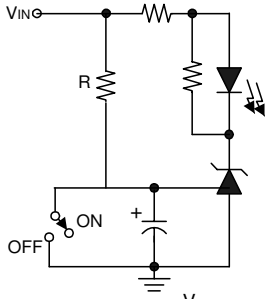
†The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial V_{KA} and I_{KA} conditions with C_L=0.V_{BATT} and C_L were then adjusted to determine the ranges of stability.

Application Examples



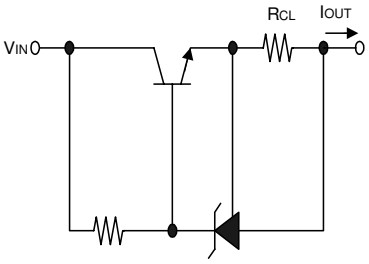
LED on when Low Limit <V_{IN}<High Limit
Low Limit ≈ V_{REF} (1+R1B/R2B)
High Limit ≈ V_{REF} (1+R1A/R2A)

Fig.4 Voltage Monitor



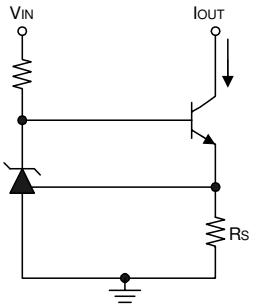
Delay = $RC \times \ln\left(\frac{V_{IN}}{V_{IN}-V_{REF}}\right)$

Fig.5 Delay Timer



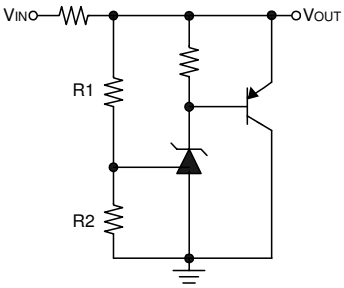
$I_{OUT} = V_{REF} / R_{CL}$

Fig.6 Current Limiter or Current Source



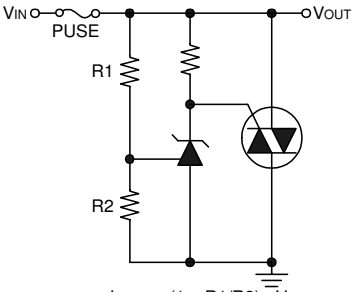
$I_{OUT} = V_{REF} / R_S$

Fig.7 Constant-Current Sink



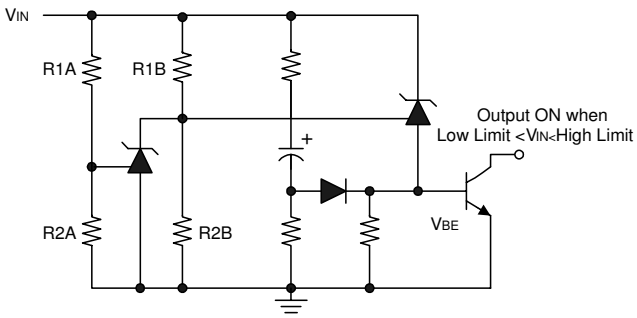
$V_{OUT} = (1 + R1/R2) \times V_{REF}$

Fig.8 Higher-Current Shunt Regulator



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

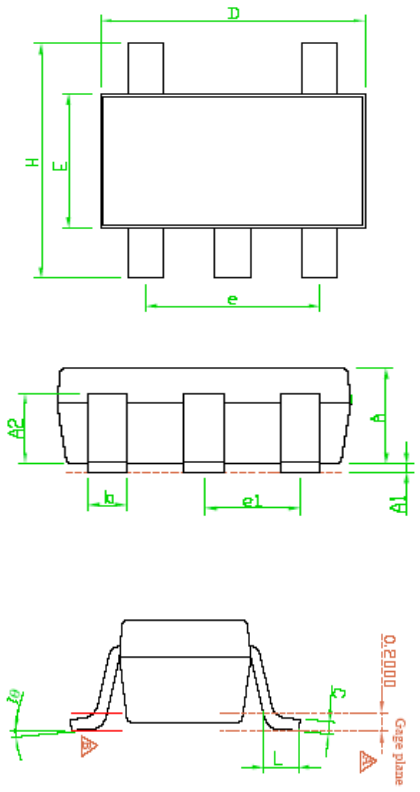
Fig.9 Crow Bar



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 Dimensions: 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	0.35	0.40	0.50
C	0.10	0.15	0.25
D	2.70	2.90	3.10
E	1.50	1.60	1.80
e	---	1.90(TYP)	---
H	2.60	2.80	3.00
L	0.37	---	---
θ1	1°	5°	9°
e2	---	0.95(TYP)	---

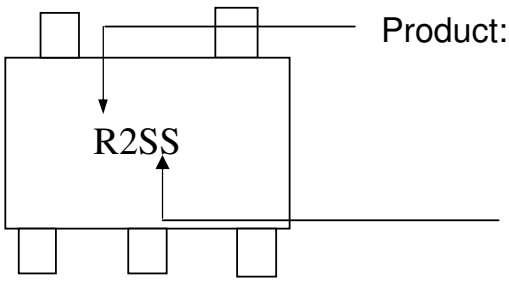
Note 1: Package body sizes exclude mold flash protrusions or gate burrs.

Note 2: Tolerance ± 0.1000 mm (4mil) unless otherwise specified.

Note 3: Coplanarity: 0.1000 mm

Note 4: Dimension L is measured in gage plane.

Marking Information

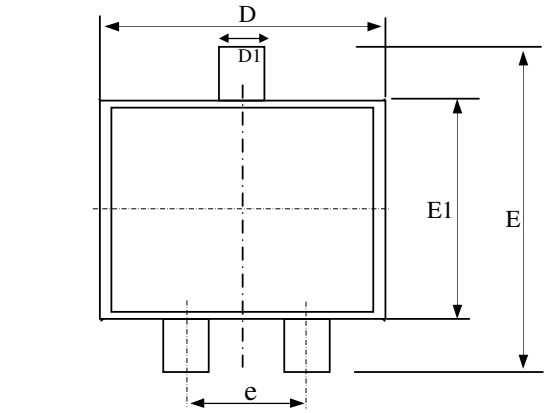


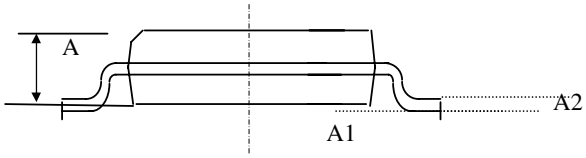
Product: R2 = AP432

Date/lot code

For details of how to convert this to standard YYWW date code format, please contact us directly.

Package Dimensions: SOT-23

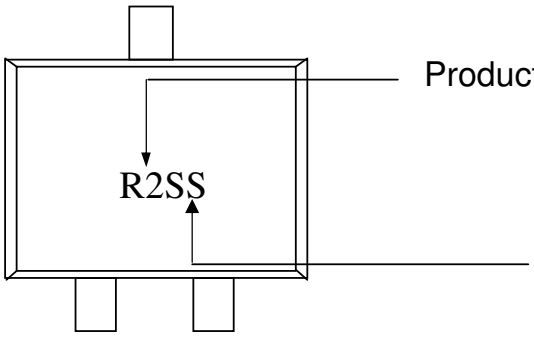




SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.00	1.15	1.30
A1	0.00	--	0.10
A2	0.10	0.15	0.25
D1	0.30	0.40	0.50
e	1.70	2.00	2.30
D	2.70	2.90	3.10
E	2.40	2.65	3.00
E1	1.40	1.50	1.60

1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

Marking Information

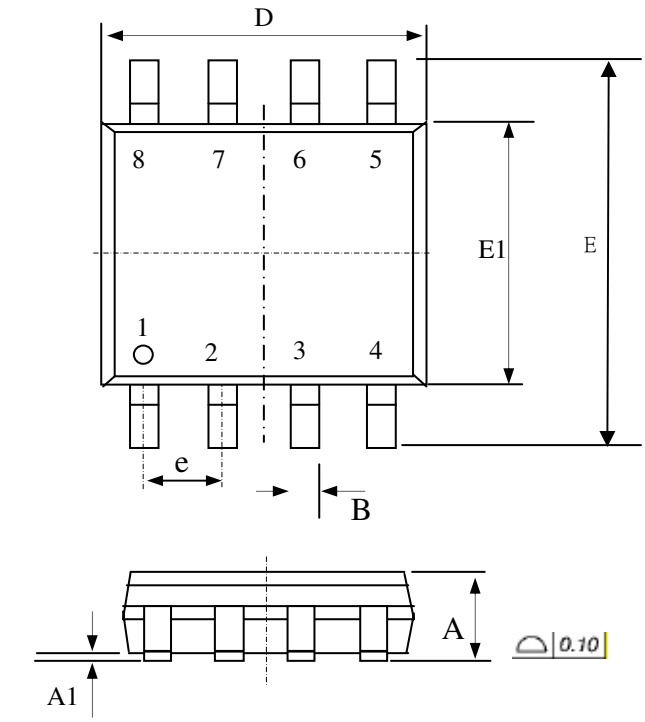


Product: R2 = AP432

Date/lot code

For details of how to convert this to standard YYWW date code format, please contact us directly.

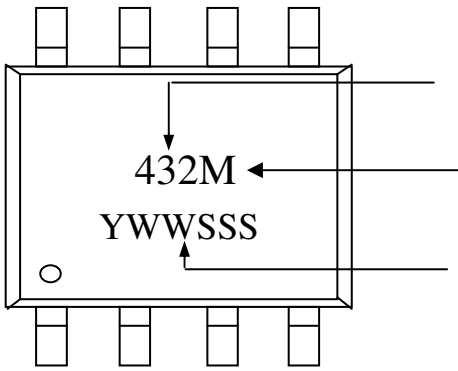
Package Dimensions: SO-8



		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 dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

Marking Information

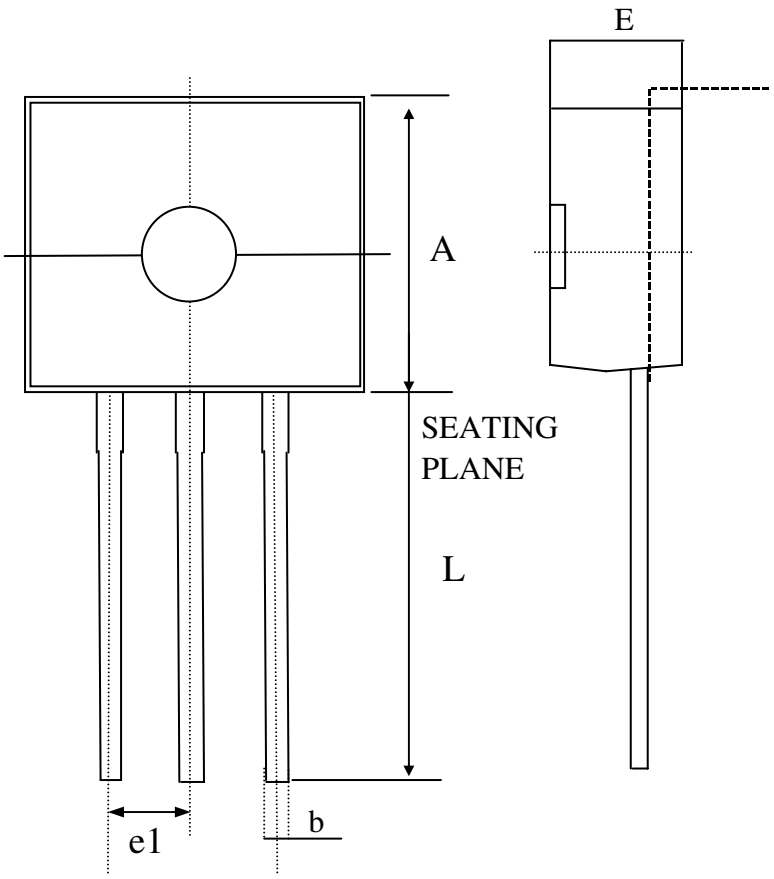


Product: AP432

Package code:
M = SO-8

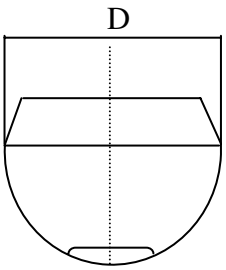
Date/lot code (YWWSSS)
Y: Last Digit Of The Year
WW: Work week
SSS: Lot code sequence
If last "S" is a number, the product is not HF.
If last "S" is a letter, the product is halogen free.

Package Dimensions: 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. Dimensions do not include mold protrusions.



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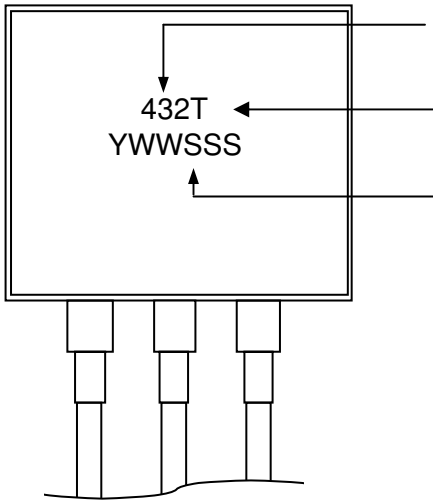
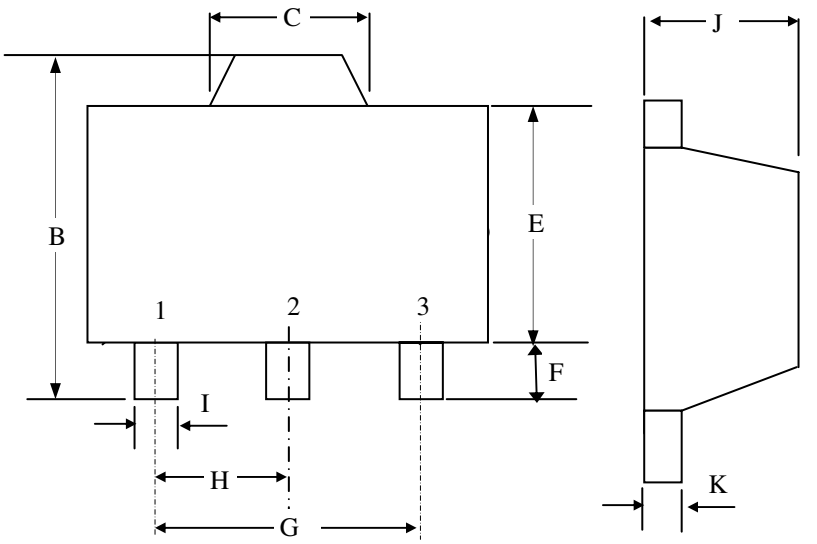
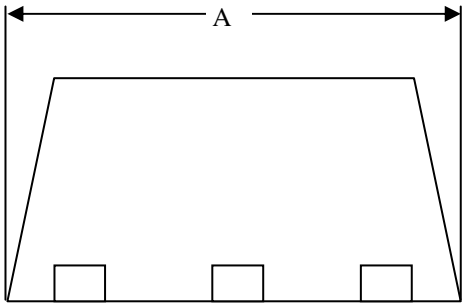


Package Dimensions: SOT-89

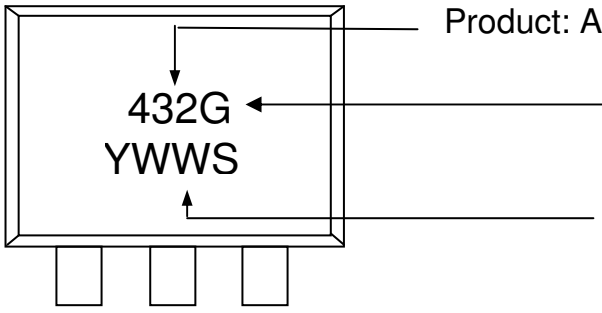


	Millimeters		
SYMBOLS	MIN	NOM	MAX
A	4.40	-	4.60
B	4.05	-	4.25
C	1.40	-	1.75
E	2.40	-	2.60
F	0.89	-	1.20
I	0.35	-	0.55
H	----	1.50	----
G	----	3.00	----
J	1.40	-	1.60
K	0.35	-	0.43



1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

Marking Information



Product: AP432

Package code:
G = SOT-89

Date/lot code (YWWS)
Y: Last Digit Of The Year
WW: Work week
S: Lot code sequence

If "S" has an underline, the product is halogen-free.
If "S" has no underline, the product is not HF.