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: SOT89, SOT23, SOT25, SOP8 and TO92
- RoHS Compliant & Halogen Free Product

■ 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

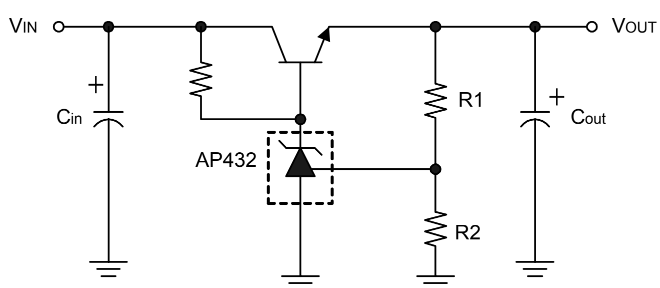
Package

M : SOP-8
G : SOT89
T : TO92
N : SOT23
Y : SOT25

Reference Voltage

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

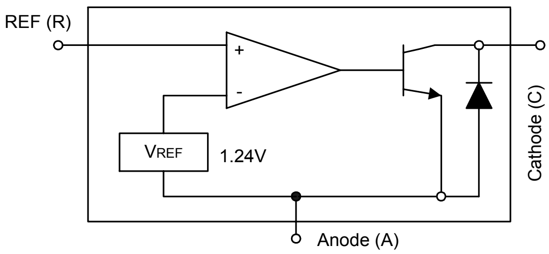
■ Typical Application Circuit



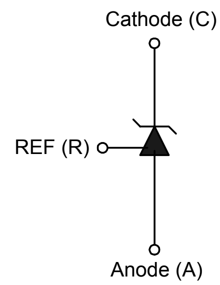
$V_{OUT} = (1+R1/R2)V_{REF}$

Precision Regulator

■ Block Diagram



■ Symbol



■ Pin Configuration

Order Number	Pin Configuration (Top View)
AP432G (SOT-89)	3 Cathode 2 Anode 1 REF
AP432T (TO-92)	3 Cathode 2 Anode 1 REF
AP432M (SOP-8)	Cathode 1 / 8 REF Anode 2 / 7 Anode Anode 3 / 6 Anode NC 4 / 5 NC

Order Number	Pin Configuration (Top View)
AP432N (SOT-23)	Anode 1 3 Cathode 2 REF
AP432Y (SOT-25)	NC 1 NC 2 Cathode 3 5 Anode 4 REF

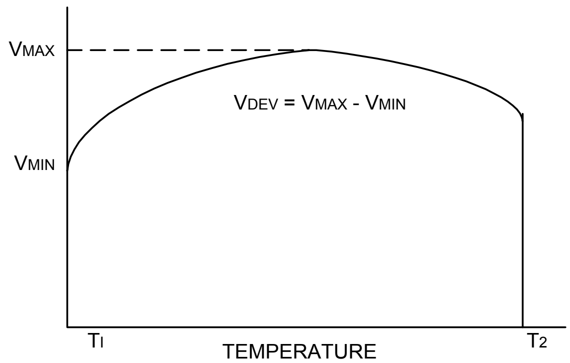
■ Absolute Maximum Ratings

Cathode Voltage……………………………………………………………………………………20V
Continuous cathode current ……………………………………………………………-10mA ~ 250mA
Reference input current range ………………………………………………………………………10mA
Operating temperature range ……………………………………………………………… -40 °C ~ 85°C
Lead Temperature…………………………………………………………………………………260°C
Storage Temperature ………………………………………………………………………-65oC ~ 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)		$\|Z_{KA}\|$		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:

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

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:

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

■ Test Circuits

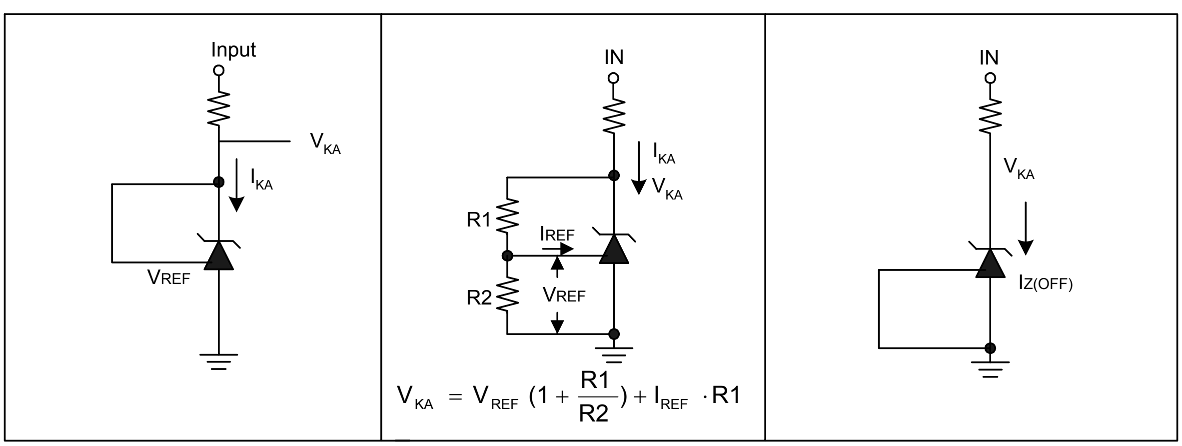
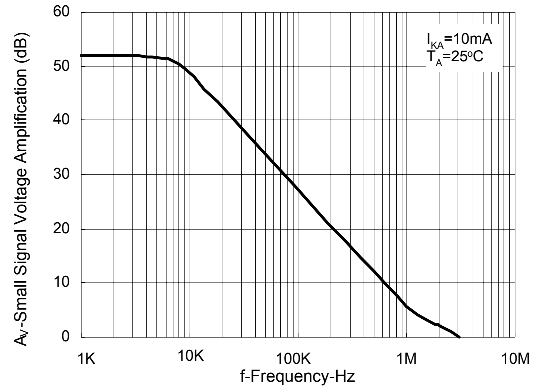
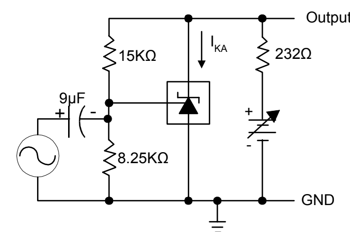


Fig1. Test Circuit for $V_{KA} = V_{REF}$ Fig2. Test circuit for $V_{KA} > V_{REF}$ Fig3. Test Circuit for off-state Current

■ Typical Performance Characteristics

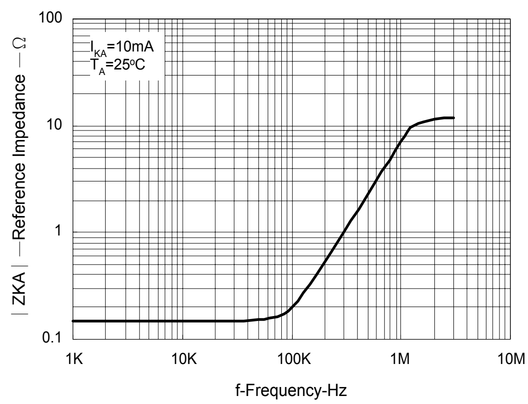
SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY

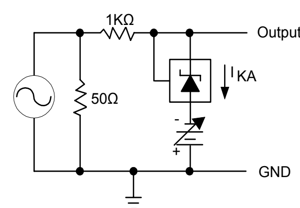




TEST CIRCUIT FOR VOLTAGE AMPLIFICATION

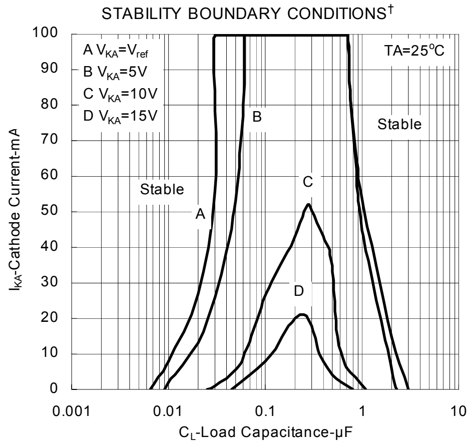
REFERENCE IMPEDANCE vs. FREQUENCY

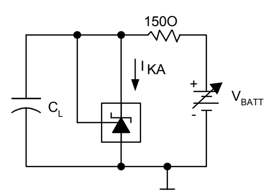




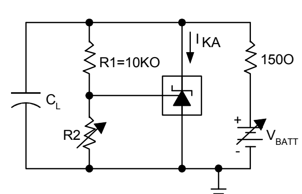
TEST CIRCUIT FOR REFERENCE IMPEDANCE

STABILITY BOUNDARY CONDITIONS†





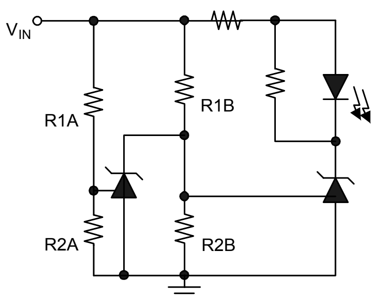
TEST CIRCUIT FOR CURVE A



TEST CIRCUIT FOR CURVE B, C, AND D

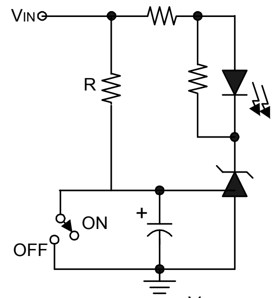
†The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial V_{KA} and I_{KA} conditions with C_L=0.V_{BATT} and C_L were then adjusted to determine the ranges of stability.

■ Application Examples



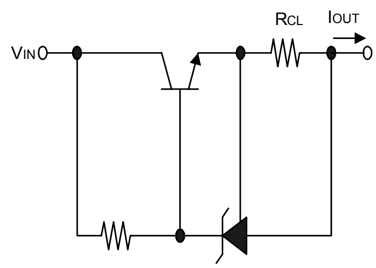
LED on when Low Limit < V_{IN} < High Limit
Low Limit ≈ V_{REF} (1+R1B/R2B)
High Limit ≈ V_{REF} (1+R1A/R2A)

Fig.4 Voltage Monitor



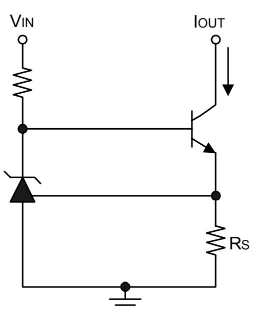
$$\text{Delay} = RC \times \ln\left(\frac{V_{IN}}{V_{IN} - V_{REF}}\right)$$

Fig.5 Delay Timer



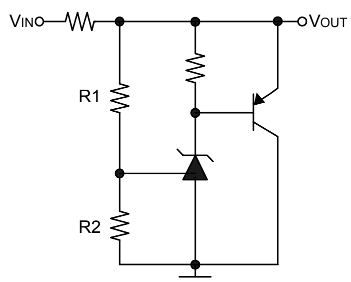
$I_{OUT} = V_{REF} / R_{CL}$

Fig.6 Current Limiter or Current Source



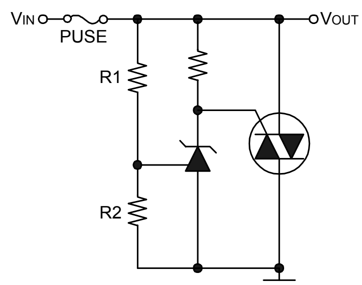
$I_{OUT} = V_{REF} / R_S$

Fig.7 Constant-Current Sink



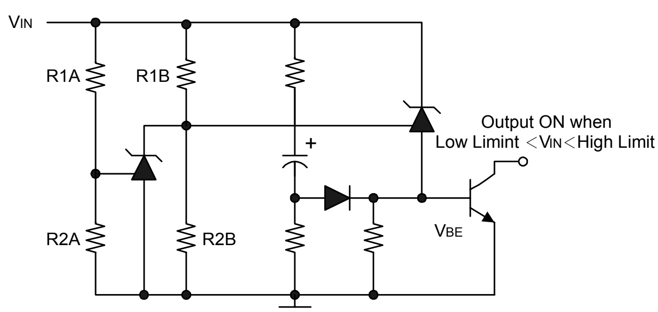
$V_{OUT} = (1 + R1/R2) \times V_{REF}$

Fig.8 Higher-Current Shunt Regulator



LIMIT ≈ $(1 + R1/R2) \times V_{REF}$

Fig.9 Crow Bar

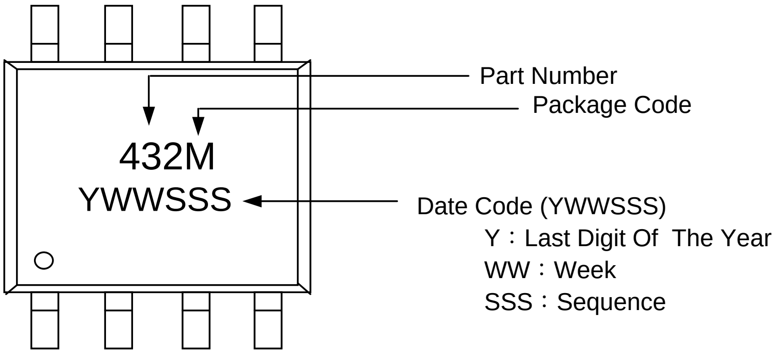


Low Limit ≈ $V_{REF}(1 + R1B/R2B) + V_{BE}$
High Limit ≈ $V_{REF}(1 + R1A/R2A)$

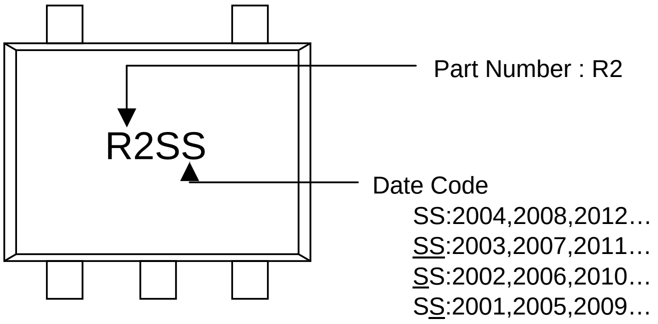
Fig.10 Over-Voltage / Under-Voltage Protection Circuit

MARKING INFORMATION

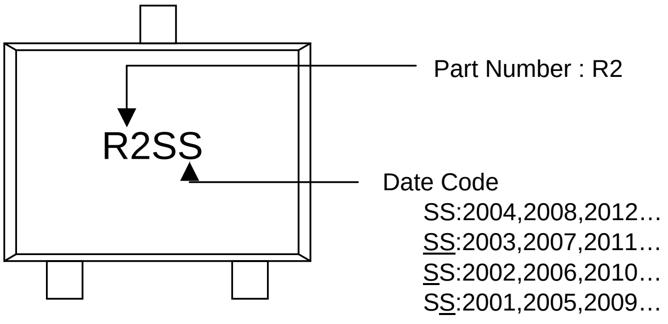
SO-8



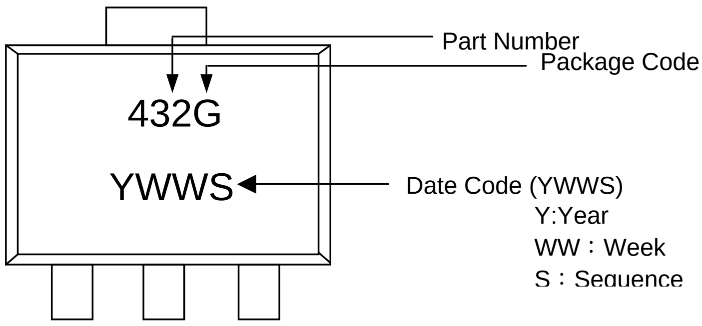
SOT-23-5L



SOT-23



SOT-89



MARKING INFORMATION

TO-92