

### Description

The GM432 is a low-voltage three-terminal adjustable precision shunt regulator with specified thermal stability over full temperature range. Output voltage can be set to any value from  $V_{ref}$  (1.24V) to 16V by using two external resistors. The active output circuitry provides a very unique turn-on characteristic, making them excellent replacements for zener diodes in many applications such as onboard regulation and adjustable power supplies. In a wide range of home applications, these versatile darlings are ideal voltage references for 3.0V to 3.3V switching power supplies. GM432 is available in SOT23, TO92 and SOT89 packages.

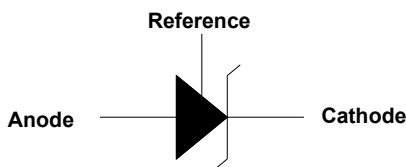
### Features

- ◆ Low-voltage operation, down to 1.24V
- ◆ 0.5%, and 1% reference voltage tolerance
- ◆ Adjustable output voltage, from  $V_{ref}$  to 16V
- ◆ Sink Current Capability 80 $\mu$ A to 100mA
- ◆ Low dynamic output impedance, 0.05W typical
- ◆ Wide temperature range, 0° to +70°C

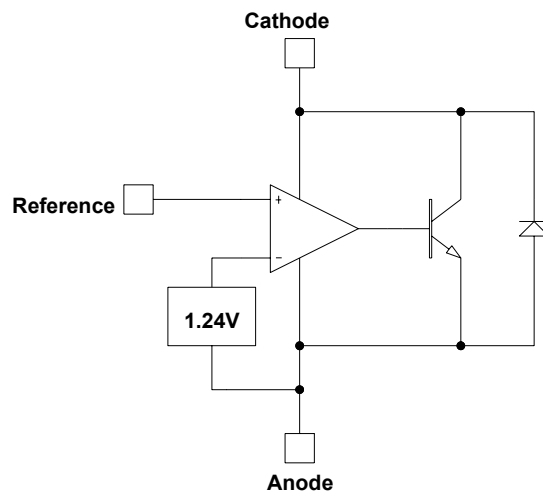
### Application

- Switching power supplies
- Linear regulators
- Adjustable supplies
- Instrumentation
- Battery-operated computers,
- PDA's portable devices
- Monitors, TV's, camcorders
- Computer disk drives

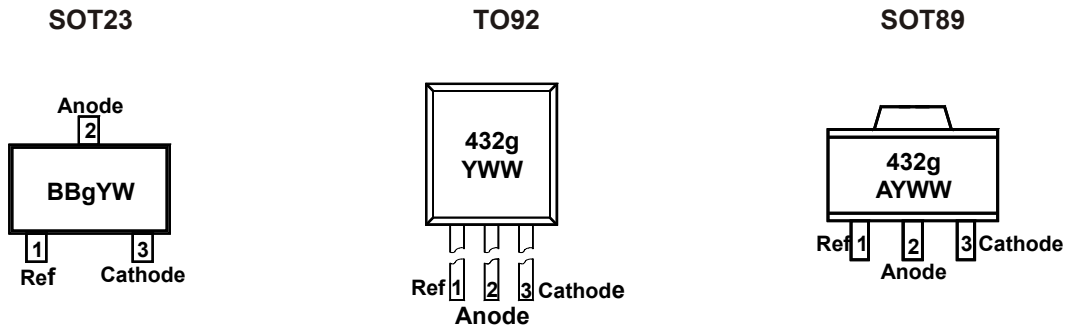
### Logic Symbol



### Block Diagram



### Marking Information and Pin Configurations (Top View)



BB: Product code

g: Grade Code (A: 0.5%, B: 1.0%)

A: Assembly/Test Site Code

Y: Year

W: Week code

WW: Week

### Ordering Information

Ordering Number	Precision	Device Code	Grade	Package	Shipping
GM432AT92BG	0.5%		A	TO-92	1,000 Units/Anti-ESD Bag
GM432AT92RLG	0.5%		A	TO-92	2,000 Units/Ammo Pack (Tape)
GM432AST23RG	0.5%	BBA	A	SOT-23	3,000 Units/Tape & Reel
GM432AST89RG	0.5%		A	SOT-89	1,000 Units/Tape & Reel
GM432AT92BG	1.0%		B	TO-92	1,000 Units/Anti-ESD Bag
GM432AT92RLG	1.0%		B	TO-92	2,000 Units/Ammo Pack (Tape)
GM432AST23RG	1.0%	BBB	B	SOT-23	3,000 Units/Tape & Reel
GM432AST89RG	1.0%		B	SOT-23	3,000 Units/Tape & Reel

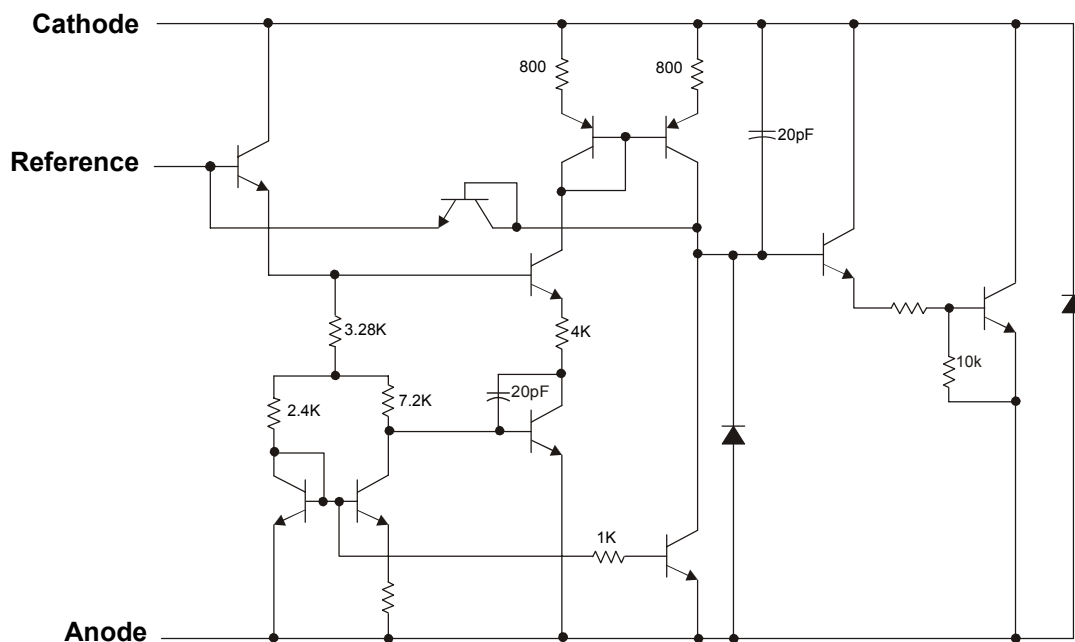
## Absolute Maximum Ratings

PARAMETER	SYMBOL	RATINGS	UNITS
Cathode Voltage	$V_{KA}$	20	V
Continuous Cathode Current Range	$I_K$	100	mA
Reference Input Current Range	$I_{REF}$	3mA	
Power Dissipation at $T_A = 25^\circ\text{C}$			
SOT-23	$P_D$	0.23	W
TO-92		0.78	
SOT-89		0.8	
Package Thermal Resistance			
SOT23	$\theta_{JA}$	336	$^\circ\text{C/W}$
TO92		132	
SOT89		132	
Operating Ambient Temperature Range	$T_A$	0 - 70	$^\circ\text{C}$
Storage Temperature		- 65 to 150	$^\circ\text{C}$
Lead Temperature (soldering 10 sec.)		260	$^\circ\text{C}$

## Recommended Operating Conditions

PARAMETER	SYMBOL	Min	Max
Cathode Voltage	$V_{KA}$	$V_{REF}$	16V
Cathode Current	$I_K$	80 $\mu\text{A}$	100mA

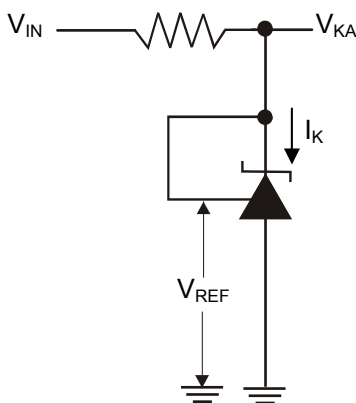
## Equivalent Schematics



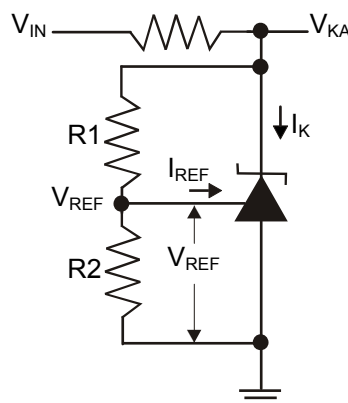
### Electrical Characteristics ( $T_A = 25^\circ\text{C}$ unless otherwise specified)

Parameter		Symbol	Condition	Min	Typ	Max	Unit
Reference Voltage	GM432A	$V_{REF}$	$V_{KA} = V_{REF}$ , $I_K = 10\text{mA}$ , <b>Test circuit 1</b>	1.234	1.240	1.246	V
	GM432B			1.228	1.240	1.252	
$V_{REF}$ Deviation over Temperature		$V_{REF(DEV)}$	$V_{KA} = V_{REF}$ , $I_K = 10\text{mA}$ , $T_A = 0$ to $70^\circ\text{C}$		10	25	mV
Ratio of change in $V_{REF}$ to change in $V_{KA}$		$\Delta V_{REF}/\Delta V_{KA}$	$I_K = 10\text{mA}$ $\Delta V_{KA} = 16\text{V to } V_{REF}$	-2.7	-1.0		mV/V
Reference Input Current		$I_{REF}$	$I_K = 10\text{mA}$ , $R1 = 10\text{K}$ , $R2 = \infty$ <b>Test circuit 2</b>		0.15	0.5	$\mu\text{A}$
$I_{REF}$ Deviation over Temperature		$V_{REF(DEV)}$	$I_K = 10\text{mA}$ , $R1 = 10\text{K}$ , $R2 = \infty$ $T_A = \text{Full range}$ , <b>Test circuit 2</b>		0.1	0.4	$\mu\text{A}$
Minimum Cathode Current		$I_{K(MIN)}$	$V_{KA} = V_{REF}$ <b>Test circuit 1</b>		20	80	$\mu\text{A}$
Off-state cathode Current		$I_{K(OFF)}$	$V_{KA} = 6\text{V}$ , $V_{REF} = 0\text{V}$ <b>Test circuit 3</b>		0.125	0.150	$\mu\text{A}$
			$V_{KA} = 16\text{V}$ , $V_{REF} = 0\text{V}$ <b>Test circuit 3</b>		0.135	0.150	
Dynamic Impedance		$ Z_{KA} $	$V_{KA} = V_{REF}$ , $I_K = 1\text{mA to } 10\text{mA}$ , $f \leq 1\text{kHz}$ , <b>Test circuit 1</b>		0.05	0.15	$\Omega$

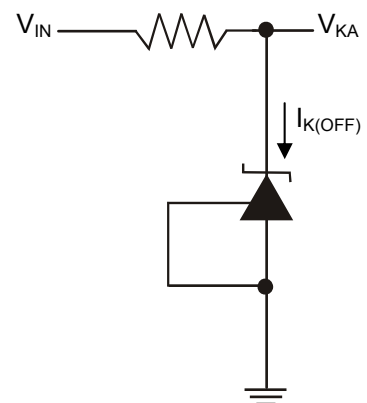
### Test Circuits



**Test Circuit 1**  
 $V_{KA} = V_{REF}$

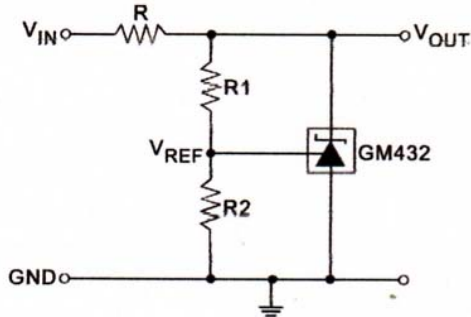


**Test Circuit 2**  
 $V_{KA} > V_{REF}$



**Test Circuit 3**  
Off-State

### Applications Note



1. Set  $V_{OUT}$  according to the follow equation:

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

2. Select proper R

- The maximum limit for R should be such that the cathode current  $I_K$  is greater than the minimum operating current (80A) at  $V_{IN(MIN)}$
- The minimum limit for R should be such that the cathode current,  $I_K$  does not exceed 100mA under all load conditions, and the instantaneous turn-on value for  $I_K$  does not exceed 150mA.

### Typical Applications

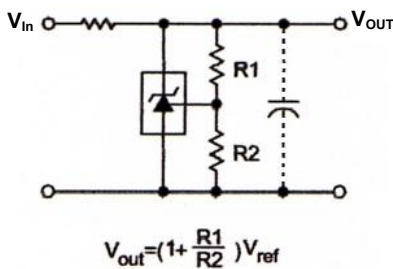


Figure 1. Shunt Regulator

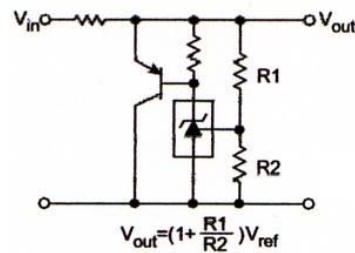


Figure 2. High Current Shunt Regulator

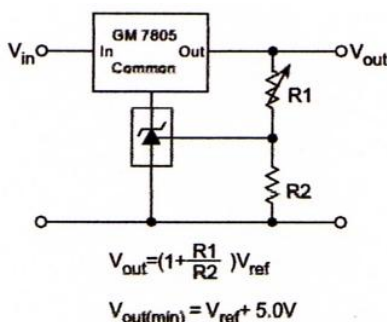


Figure 3. Output Control for a Three Terminal Fixed Regulator

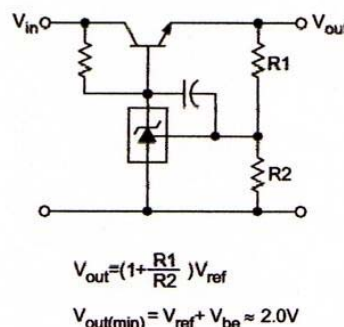


Figure 4. Series Pass Regulator

**Typical Applications**

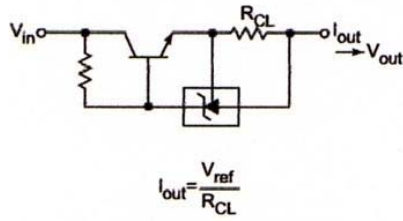


Figure 5. Constant Current Source

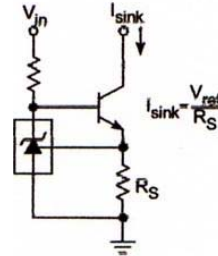


Figure 6. Constant Current Sink

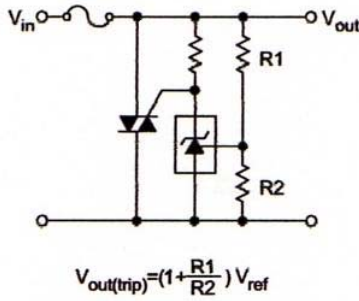


Figure 7. TRIAC Crowbar

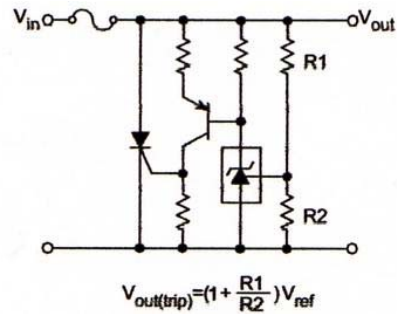
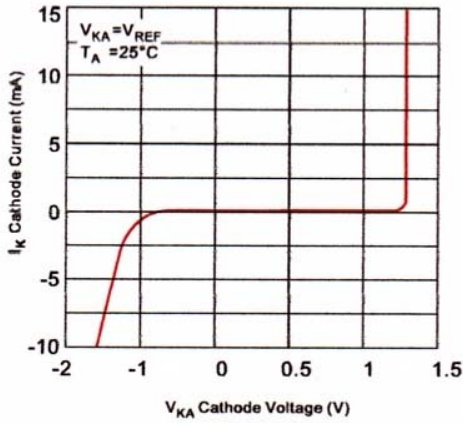
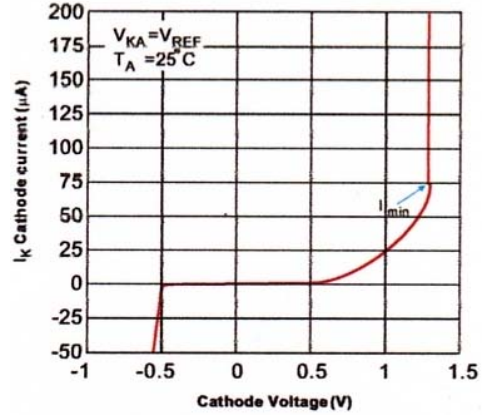


Figure 8. SRC Crowbar

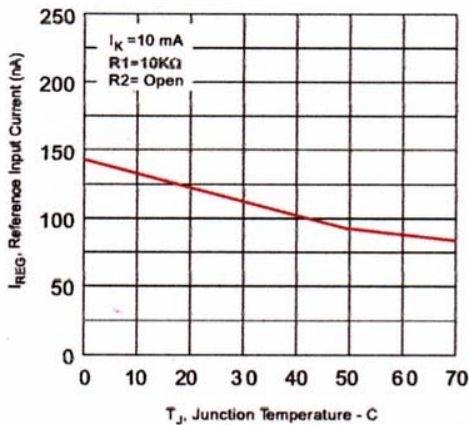
**Typical Characteristics**



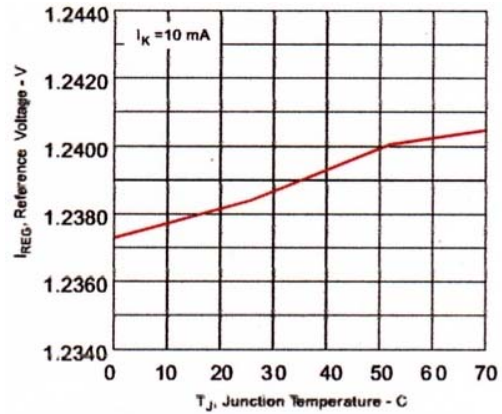
**Figure 9. Cathode Current vs Cathode Voltage**



**Figure 10. Cathode Current vs Cathode Voltage**

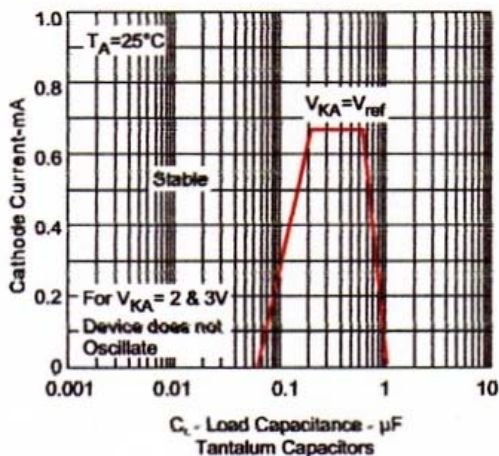
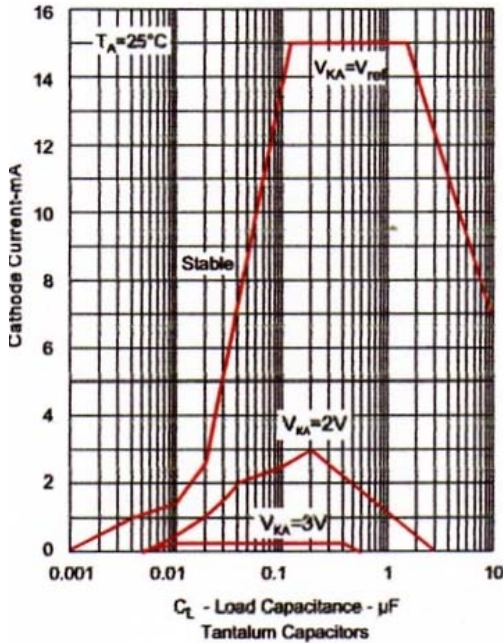


**Figure 11. Ref Voltage vs. Junction Temperature**



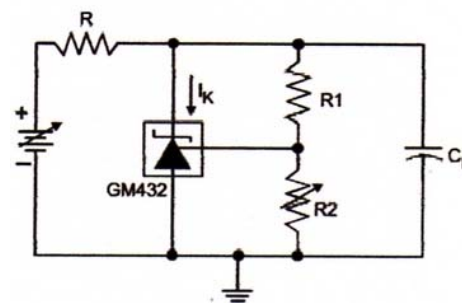
**Figure 12. Ref Input Current vs. Junction Temperature**

### Stability Boundary Conditions



When using the GM432 as a shunt regulator, the stability could be optimized by setting  $C_L$  either (1) no load capacitance across the GM432, decouple at the load; or (2) large capacitance across the GM432, optional decoupling at the load. The GM432 can become unstable with capacitances of approximately 10nF to 1 $\mu$ F when cathode current is less than 3mA or so, with instability increasing as cathode current is reduced.

For example, cathode current of 10mA with a 0.1 $\mu$ F capacitor across it, it can oscillate transiently as the cathode current rises through the region of instability. To avoid this problem completely, simply eliminate the capacitor or select a very low or very high (e.g. 10 $\mu$ F) capacitor  $C_L$ . Since you will probably want local decoupling at the load, the best idea is to use no capacitance across the device. Just the resistance and capacitance of the PCB traces will prevent local load decoupling from causing transient oscillation during start-up.



\* Stability boundary condition test shows that tantalum capacitors are recommended to minimize the conditions that may cause the device to oscillate.

**Small Signal Gain and Phase**

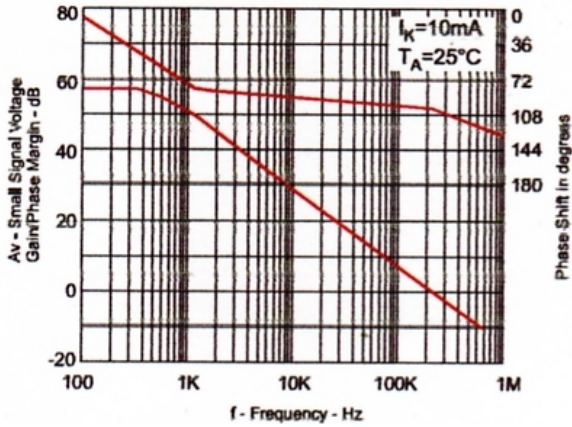


Figure 13. Small Signal Voltage Gain/Phase Margin vs. Frequency

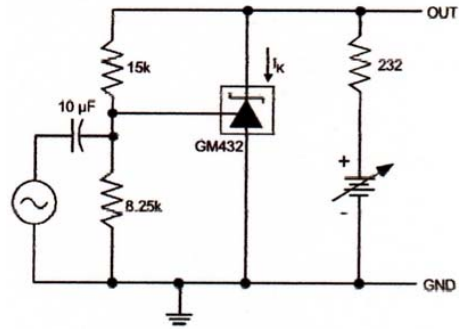
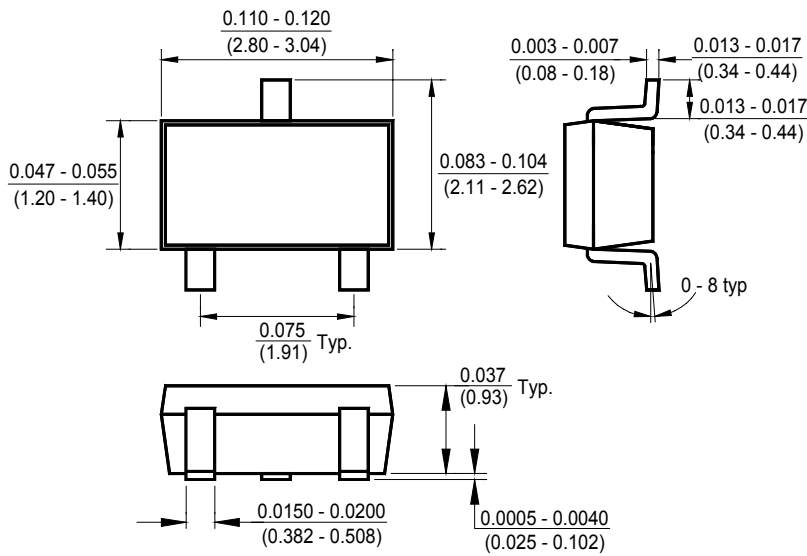
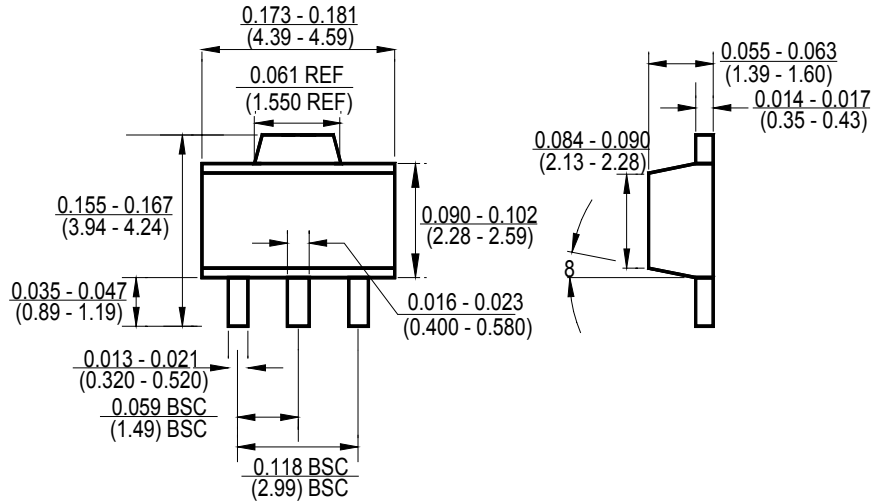


Figure 14. Test Circuit – Small Signal Gain and Phase

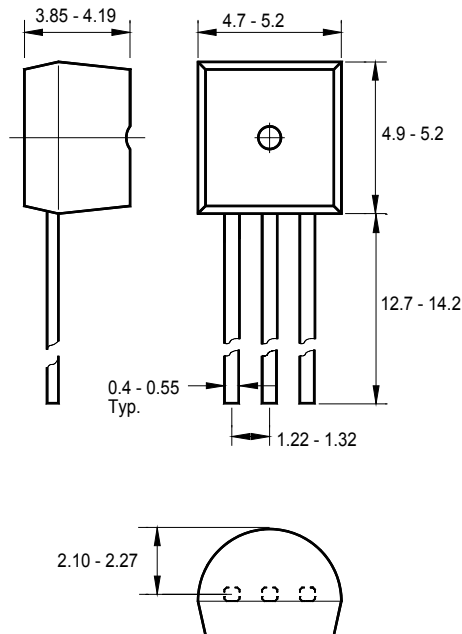
**Package Outline Dimensions – SOT 23**



### Package Outline Dimensions – SOT 89



### Package Outline Dimensions – TO 92



Dimensions are in millimeters

## Ordering Number

<b><u>GM</u></b>	<b><u>432</u></b>	<b><u>A</u></b>	<b><u>ST23</u></b>	<b><u>R</u></b>	<b><u>G</u></b>
APM Gamma Micro	Circuit Type	Output Accuracy	Package Type	Shipping Type	G:Green
		A: 0.5% B: 1.0%	T92: TO-92 ST23: SOT-23 ST89: SOT-89	B: Bag RL: Ammo Pack (Tape) T: Tube R: Tape & Reel	

Note:

**Pb-free products:**

- ◆ RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- ◆ Suitable for use in Pb-free soldering processes with 100% matte tin (Sn) plating.

**Green products:**

- ◆ Lead-free (RoHS compliant)
- ◆ Halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight)