



GM432

1.24V ADJUSTABLE PRECISION SHUNT REGULATORS

Power Management

Description

The GM432's are low-voltage three-terminal adjustable precision shunt regulators with specified thermal stability over their full temperature range. Output voltage can be set to any value from V_{ref} (1.24V) to 16V using two external resistors. Their active output circuitry provides a very sharp turn-on characteristic, making them excellent replacements for zener diodes in many applications such as onboard regulation and adjustable power supplies. At home in a wide range of applications, these versatile darlings are ideal voltage references for 3.0V to 3.3V switching power supplies. With operational cathode current as low as 80μA, batteries keep on going. Whatever your application, the GM432's offer the optimum combination of performance, reliability, and economy.

Features

- ◆ Low-voltage operation, down to 1.24V
- ◆ 0.5%, 1% or 2% reference voltage tolerance
- ◆ Adjustable output voltage, $V_O = V_{ref}$ to 16V
- ◆ Wide operating current range, 80μA to 100mA
- ◆ Low dynamic output impedance, 0.05 typical
- ◆ Wide temperature range, -40°C to +85°C
- ◆ Pin-to-pin replacement for TLV431, SC431L
- ◆ Available in SOT-23, SOT-25, SOT-89, TO-92 and SOP-8

Application

Switching power supplies

Linear regulators

Adjustable supplies

Instrumentation

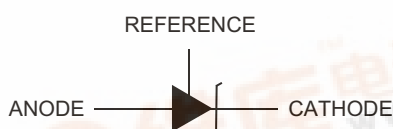
Battery-operated computers,

PDA's portable devices

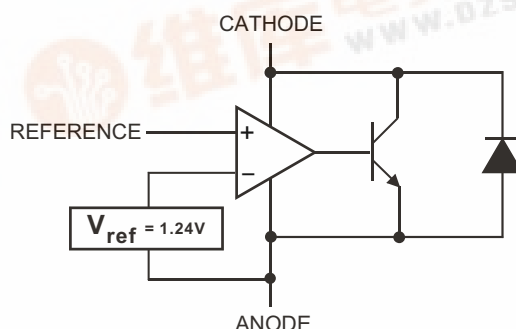
Monitors, TV's, camcorders

Computer disk drives

LOGIC SYMBOL

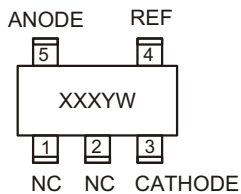


BLOCK DIAGRAM (POSITIVE LOGIC)

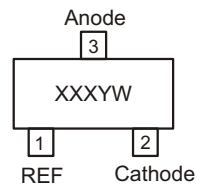


◆ MARKING INFORMATION & PIN CONFIGURATIONS (TOP VIEW)

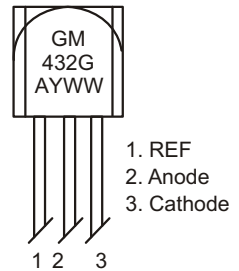
SOT-25(SOT-23-5)



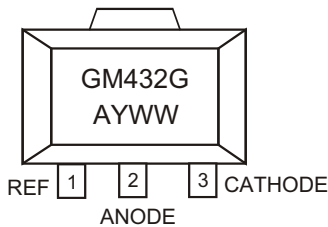
SOT-23



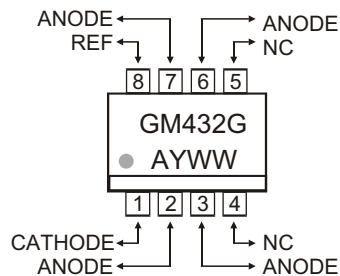
TO-92



SOT-89



SOP-8 (SO-8)



XXX = Specific Device Code
 G = Grade
 A = Assembly Location
 Y = Year
 WW, W= Work Week

◆ ORDERING INFORMATION

Ordering Number	Precision	Device code	Grade	Package	Shipping
GM432AT92B	0.5%	AAA	A	TO-92	1,000 Units/ ESD Bag
GM432AT92RL	0.5%	AAA	A	TO-92	2,000 Units/ Ammo Pack(Tape)
GM432AST23R	0.5%	AAA		SOT-23	3,000 Units/Tape &Reel
GM432AST25R	0.5%	AAA		SOT-25	3,000 Units/Tape &Reel
GM432AS8R	0.5%	AAA		SO-8	2,500 Units/Tape & Reel
GM432AST89R	0.5%	AAA		SOT-89	1,000 Units/ Tape & Reel
GM432BT92B	1%	AAB	B	TO-92	1,000 Units/ ESD Bag
GM432BT92RL	1%	AAB	B	TO-92	2,000 Units/ Ammo Pack(Tape)
GM432BST23R	1%	AAB		SOT-23	3,000 Units/Tape &Reel
GM432BST25R	1%	AAB		SOT-25	3,000 Units/Tape &Reel
GM432BS8R	1%	AAB		SO-8	2,500 Units/Tape & Reel
GM432BST89R	1%	AAB		SOT-89	1,000 Units/ Tape & Reel
GM432CT92B	2%	AAC	C	TO-92	1,000 Units/ ESD Bag
GM432CT92RL	2%	AAC	C	TO-92	2,000 Units/ Ammo Pack(Tape)
GM432CST23R	2%	AAC		SOT-23	3,000 Units/Tape &Reel
GM432CST25R	2%	AAC		SOT-25	3,000 Units/Tape &Reel
GM432CS8R	2%	AAC		SO-8	2,500 Units/Tape & Reel
GM432CST89R	2%	AAC		SOT-89	1,000 Units/ Tape & Reel

◆ **ABSOLUTE MAXIMUM RATINGS** (over free-air temperature range except as noted)

PARAMETER	SYMBOL	VALUE	UNIT
Cathode Voltage ⁽¹⁾	V_{KA}	20	V
Continuous cathode current	I_K	100	mA
Reference input current	I_{ref}	3	mA
Power dissipation at $T_A = 25^\circ\text{C}$ SOT-23 SOP-8 TO-92	P_D	0.37 0.49 0.95	W
Package thermal impedance ^(2, 3) SOT-23 SOT-25 TO-92 SOP-8	J_A	336 256 132 97	$^\circ\text{C/W}$
Operating ambient temperature range	T_A	0 to + 70	$^\circ\text{C}$
Operating junction temperature range	T_J	-40 to +150	$^\circ\text{C}$
Lead temperature (soldering) 10 seconds	T_{LEAD}	260	$^\circ\text{C}$

These are stress ratings only. Functional operation of the device at these or any conditions beyond the "recommended operating conditions" is not implied. Exposure to absolute maximum rated conditions may affect device reliability.

NOTES:

1. Voltage values are with respect to the anode except as noted.
2. Maximum power dissipation is a function of $T_{J(max)}$, J_A and T_A . Maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_{J(max)} - T_A) / J_A$. Operation at absolute maximum T_J of 150°C can affect device reliability.
3. Package thermal impedance is calculated per JESD 51.

◆ **RECOMMENDED OPERATING CONDITIONS**

PARAMETER	SYMBOL	MINIMUM	MAXIMUM	UNIT
Cathode Voltage	V_{KA}	V_{ref}	16	V
Cathode Current	I_K	80 μA	100	mA

◆ **ELECTRICAL CHARACTERISTICS** ($T_A = 25^\circ\text{C}$ unless otherwise noted)

GM432A (0.5%)

PARAMETER		CONDITION	MIN	TYP	MAX	UNIT
Reference Voltage	V_{ref}	$V_{\text{KA}} = V_{\text{ref}}, I_K = 10 \text{ mA}, T_A = 25^\circ\text{C}^{(1)}$ $V_{\text{KA}} = V_{\text{ref}}, I_K = 10 \text{ mA}, T_A = -40 \text{ to } +85^\circ\text{C}^{(1)}$	1.234 1.222	1.240	1.246 1.258	V
V_{ref} temp deviation	V_{dev}	$V_{\text{KA}} = V_{\text{ref}}, I_K = 10 \text{ mA}^{(1)}$		10	25	mV
Ratio of change in V_{ref} to change in V_{KA}	$\frac{V_{\text{ref}}}{V_{\text{KA}}}$	$I_K = 10 \text{ mA}, V_{\text{KA}} = 16 \text{ V to } V_{\text{ref}}$	- 2.7	-1.0		mV/V
Reference input current	I_{ref}	$I_K = 10 \text{ mA}, R1 = 10 \text{ K}, R2 = \infty^{(2)}$		0.15	0.5	A
Deviation of reference input voltage over full temperature range	$I_{\text{ref(dev)}}$	$I_K = 10 \text{ mA}, R1 = 10 \text{ K}, R2 = \infty^{(2)}$ $T_A = \text{full range}$		0.1	0.4	A
Minimum operating current	$I_{K(\text{min})}$	$V_{\text{KA}} = V_{\text{ref}}^{(1)}$		20	80	A
Off-state cathode current	$I_{K(\text{off})}$	$V_{\text{KA}} = 6 \text{ V}, V_{\text{ref}} = 0 \text{ V}^{(3)}$ $V_{\text{KA}} = 16 \text{ V}, V_{\text{ref}} = 0 \text{ V}^{(3)}$		0.125 0.135	0.150 0.150	A
Dynamic impedance	$ Z_{\text{KA}} $	$f \leq 1 \text{ kHz}, V_{\text{KA}} = V_{\text{ref}}, I_K = 100 \text{ A to } 100 \text{ mA}^{(1)}$		0.05	0.15	

GM432B (1.0%)

PARAMETER		CONDITION	MIN	TYP	MAX	UNIT
Reference Voltage	V_{ref}	$V_{\text{KA}} = V_{\text{ref}}, I_K = 10 \text{ mA}, T_A = 25^\circ\text{C}^{(1)}$ $V_{\text{KA}} = V_{\text{ref}}, I_K = 10 \text{ mA}, T_A = -40 \text{ to } +85^\circ\text{C}^{(1)}$	1.228 1.215	1.240	1.252 1.258	V
V_{ref} temp deviation	V_{dev}	$V_{\text{KA}} = V_{\text{ref}}, I_K = 10 \text{ mA}^{(1)}$		10	25	mV
Ratio of change in V_{ref} to change in V_{KA}	$\frac{V_{\text{ref}}}{V_{\text{KA}}}$	$I_K = 10 \text{ mA}, V_{\text{KA}} = 16 \text{ V to } V_{\text{ref}}$	- 2.7	-1.0		mV/V
Reference input current	I_{ref}	$I_K = 10 \text{ mA}, R1 = 10 \text{ K}, R2 = \infty^{(2)}$		0.15	0.5	A
Deviation of reference input voltage over full temperature range	$I_{\text{ref(dev)}}$	$I_K = 10 \text{ mA}, R1 = 10 \text{ K}, R2 = \infty^{(2)}$ $T_A = \text{full range}$		0.1	0.4	A
Minimum operating current	$I_{K(\text{min})}$	$V_{\text{KA}} = V_{\text{ref}}^{(1)}$		20	80	A
Off-state cathode current	$I_{K(\text{off})}$	$V_{\text{KA}} = 6 \text{ V}, V_{\text{ref}} = 0 \text{ V}^{(3)}$ $V_{\text{KA}} = 16 \text{ V}, V_{\text{ref}} = 0 \text{ V}^{(3)}$		0.125 0.135	0.150 0.150	A
Dynamic impedance	$ Z_{\text{KA}} $	$f \leq 1 \text{ kHz}, V_{\text{KA}} = V_{\text{ref}}, I_K = 100 \text{ A to } 100 \text{ mA}^{(1)}$		0.05	0.15	

NOTES:

(1) See test circuit 1 on page 4.

(2) See test circuit 2 on page 4.

(3) See test circuit 3 on page 4.



◆ ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

GM432C (2.0%)

PARAMETER		CONDITION	MIN	TYP	MAX	UNIT
Reference Voltage	V_{ref}	$V_{KA} = V_{\text{ref}}, I_K = 10 \text{ mA}, T_A = 25^\circ\text{C}^{(1)}$ $V_{KA} = V_{\text{ref}}, I_K = 10 \text{ mA}, T_A = -40 \text{ to } +85^\circ\text{C}^{(1)}$	1.215 1.200	1.240	1.265 1.280	V
V_{ref} temp deviation	V_{dev}	$V_{KA} = V_{\text{ref}}, I_K = 10 \text{ mA}^{(1)}$		10	35	mV
Ratio of change in V_{ref} to change in V_{KA}	$\frac{V_{\text{ref}}}{V_{KA}}$	$I_K = 10 \text{ mA}, V_{KA} = 16 \text{ V to } V_{\text{ref}}$	- 2.7	-1.0		mV/V
Reference input current	I_{ref}	$I_K = 10 \text{ mA}, R1 = 10 \text{ K}, R2 = \infty^{(2)}$		0.15	0.5	A
Deviation of reference input voltage over full temperature range	$I_{\text{ref(dev)}}$	$I_K = 10 \text{ mA}, R1 = 10 \text{ K}, R2 = \infty^{(2)}$ $T_A = \text{full range}$		0.1	0.4	A
Minimum operating current	$I_{K(\text{min})}$	$V_{KA} = V_{\text{ref}}^{(1)}$		20	80	A
Off-state cathode current	$I_{K(\text{off})}$	$V_{KA} = 6 \text{ V}, V_{\text{ref}} = 0 \text{ V}^{(3)}$ $V_{KA} = 16 \text{ V}, V_{\text{ref}} = 0 \text{ V}^{(3)}$		0.125 0.135	0.150 0.150	A
Dynamic impedance	$ Z_{KA} $	$f \leq 1 \text{ kHz}, V_{KA} = V_{\text{ref}}, I_K = 100 \text{ A to } 100 \text{ mA}^{(1)}$		0.05	0.15	

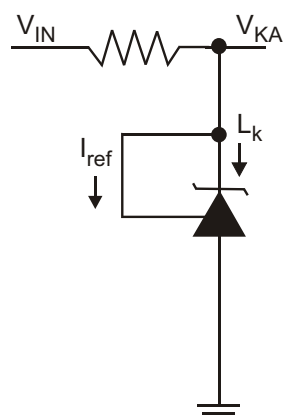
NOTES:

(1) See test circuit 1.

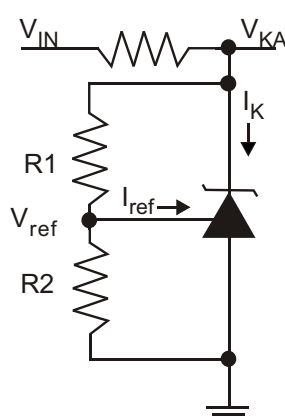
(2) See test circuit 2.

(3) See test circuit 3.

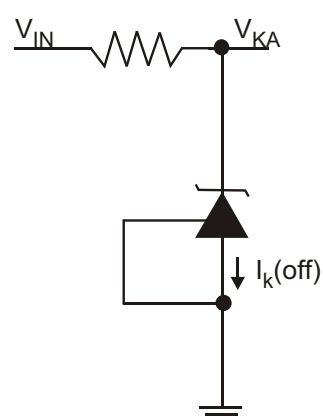
◆ TEST CIRCUITS



Test Circuit 1
 $V_{KA} = V_{\text{ref}}$



Test Circuit 2
 $V_{KA} > V_{\text{ref}}$



Test Circuit 3
Off-State

◆ TYPICAL APPLICATIONS GM432A, GM432B

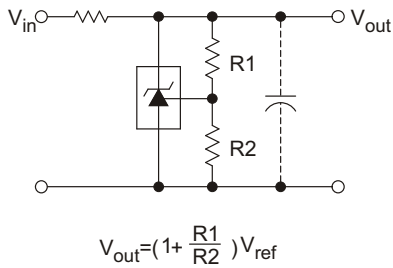


Figure 1. Shunt Regulator

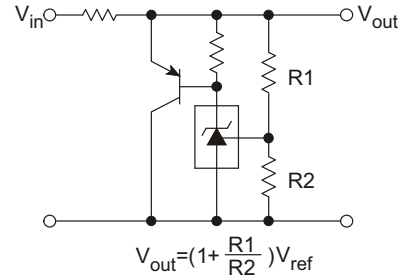


Figure 2. High Current Shunt Regulator

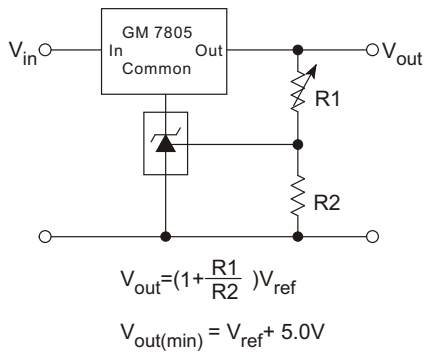


Figure 3. Output Control for a Three Terminal Fixed Regulator

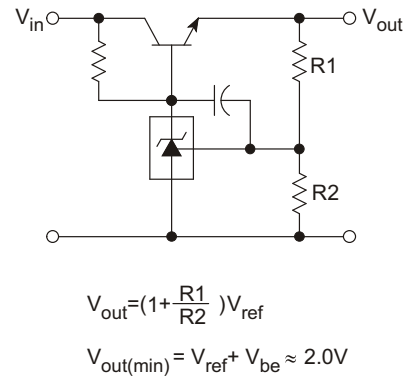


Figure 4. Series Pass Regulator

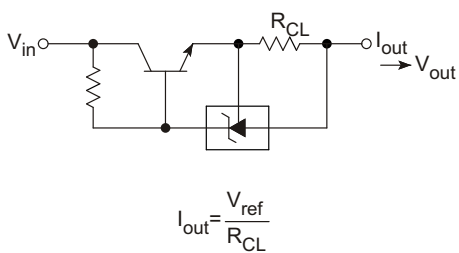


Figure 5. Constant Current Source

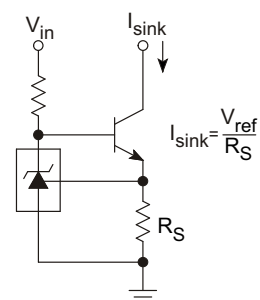


Figure 6. Constant Current Sink

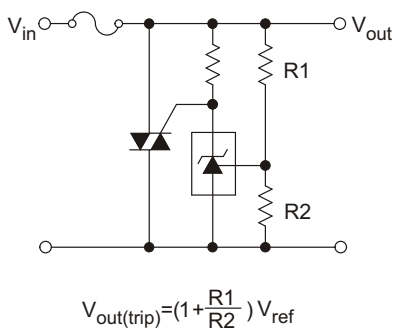


Figure 7. TRIAC Crowbar

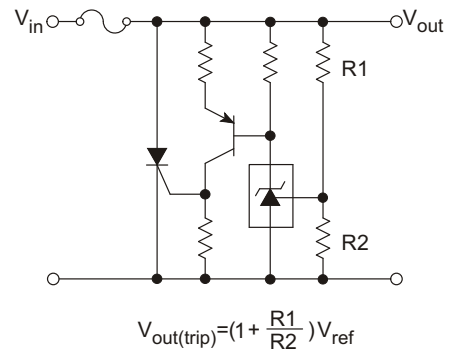
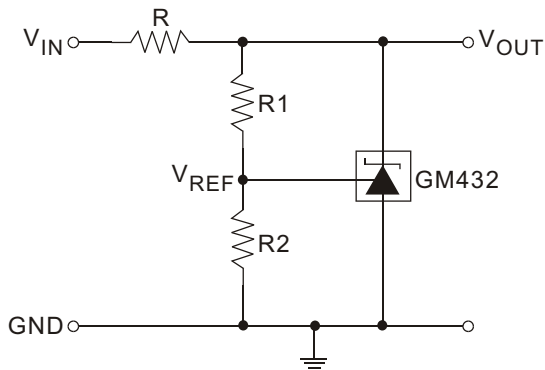


Figure 8. SRC Crowbar

◆ TYPICAL APPLICATION CIRCUIT



Notes:

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

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

2. Choose the value for R as follows:

- ◆ The maximum limit for R should be such that the cathode current, I_K , is greater than the minimum operating current ($80\mu A$) 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 150 mA. Both of the following conditions must be met:

$$R_{min} \geq \frac{V_{IN(max)}}{150mA} \quad (\text{to limit instantaneous turn-on } I_K)$$

$$R_{min} \geq \frac{V_{IN(max)} - V_{OUT}}{I_{OUT(min)} + 100mA} \quad (\text{to limit } I_K \text{ under normal operating conditions})$$

◆ Typical Performance Characteristics

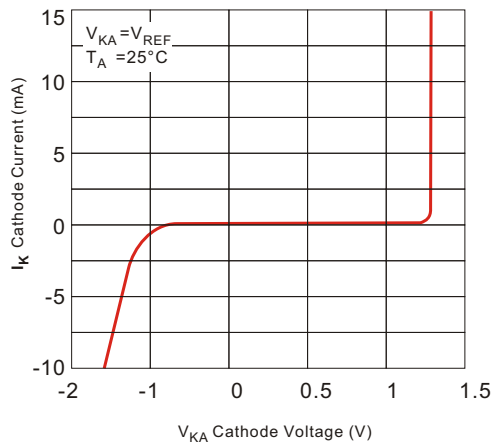


Figure 9. Cathode Current vs. Cathode Voltage

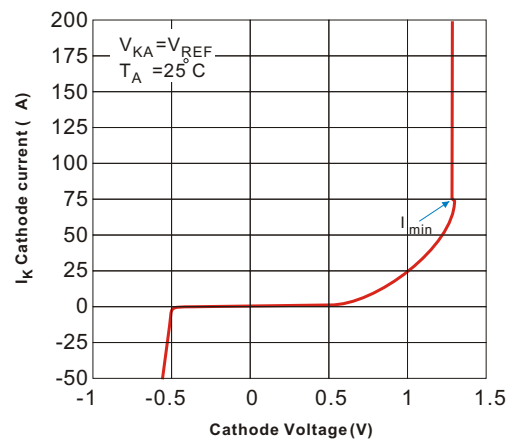


Figure 10. Cathode Current vs. Cathode Voltage

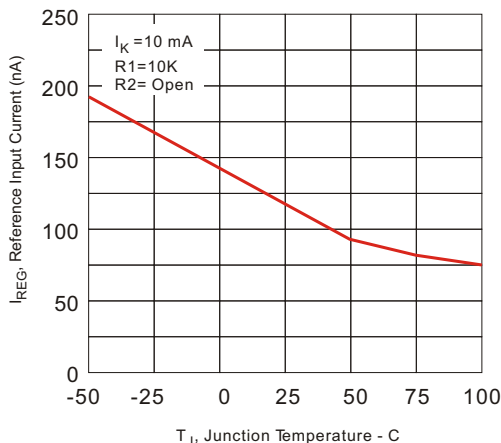


Figure 11. Ref. Voltage vs. Junction Temperature

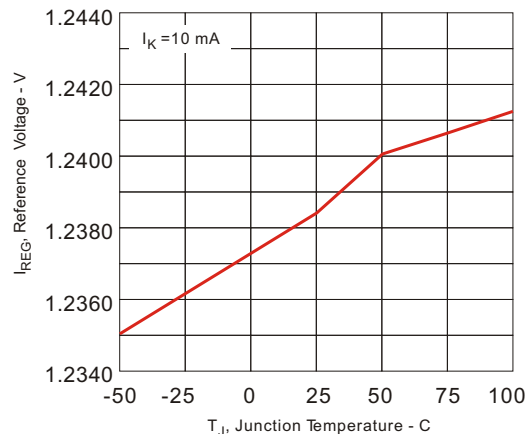
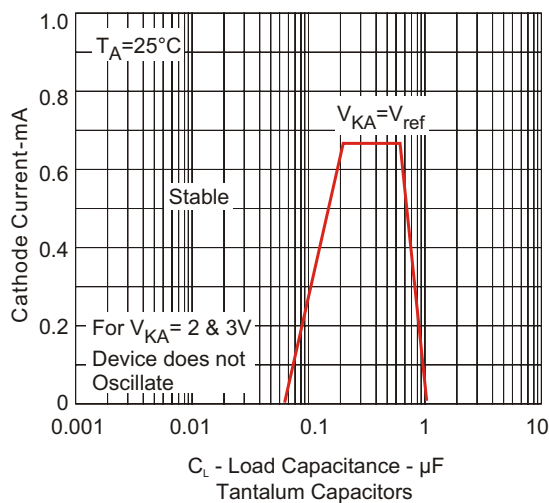
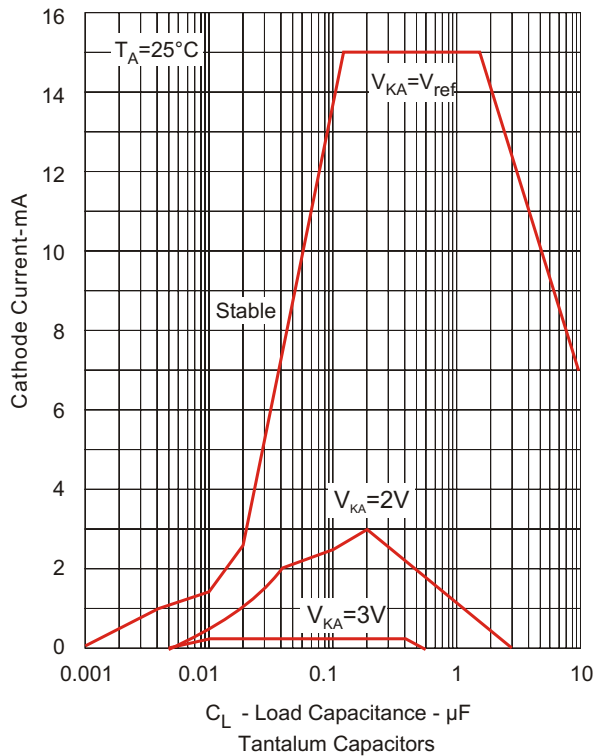


Figure 12. Ref. Input Current vs. Junction Temperature

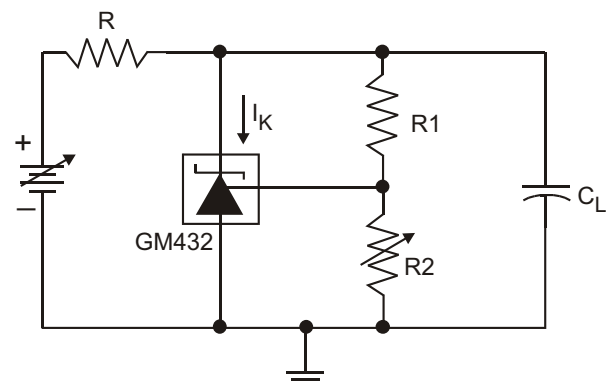
◆ Stability Boundary Conditions



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

A Note About Stability

When using the GM432 as a shunt regulator, you can optimize stability 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 μF when cathode currents are less than 3mA or so, with instability increasing as cathode current is reduced. So, while the GM432 is happily stable at, for example, cathode current of 10mA with a 0.1 μF 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 μF) 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 and vias will prevent local load decoupling from causing transient oscillation during start-up. If you place the GM432 right next to the load, with the load decoupling capacitor directly across it, you must use a capacitor of $\leq$ nF or $\leq$ 10 μF .



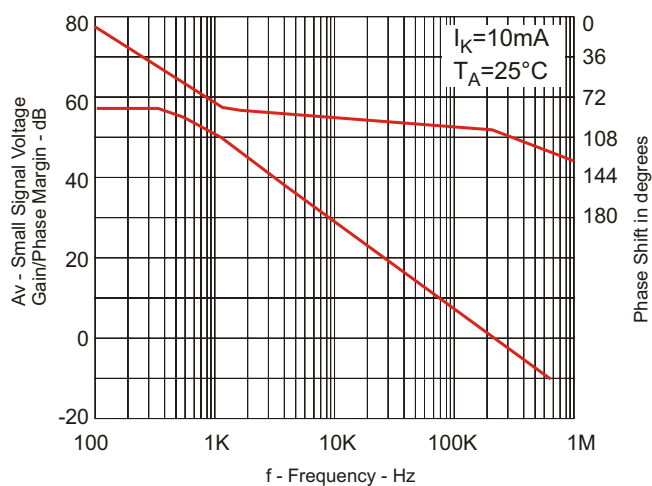


Figure 13. Small Signal Voltage Gain/ Phase Margin vs. Frequency

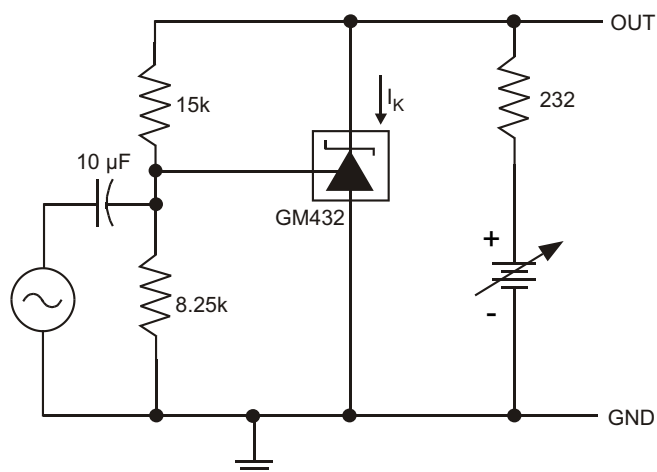
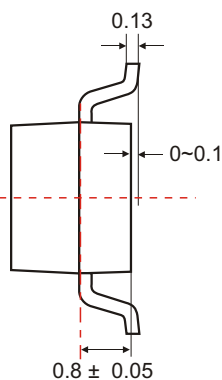
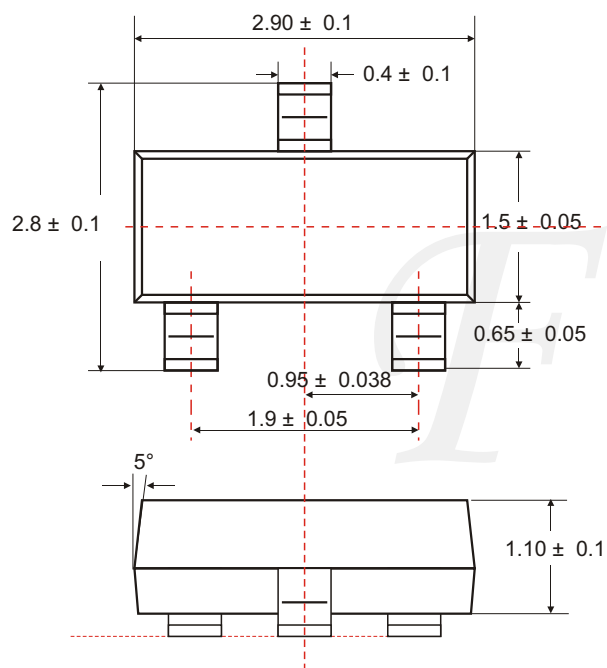
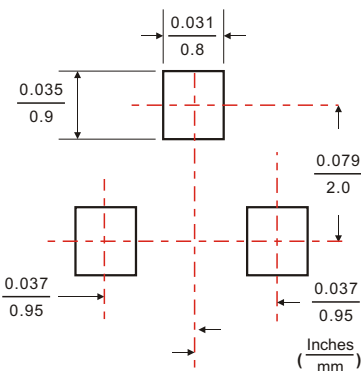


Figure 14. Test Circuit - Small - Signal Gain and Phase

◆ SOT-23 PACKAGE OUTLINE DIMENSIONS

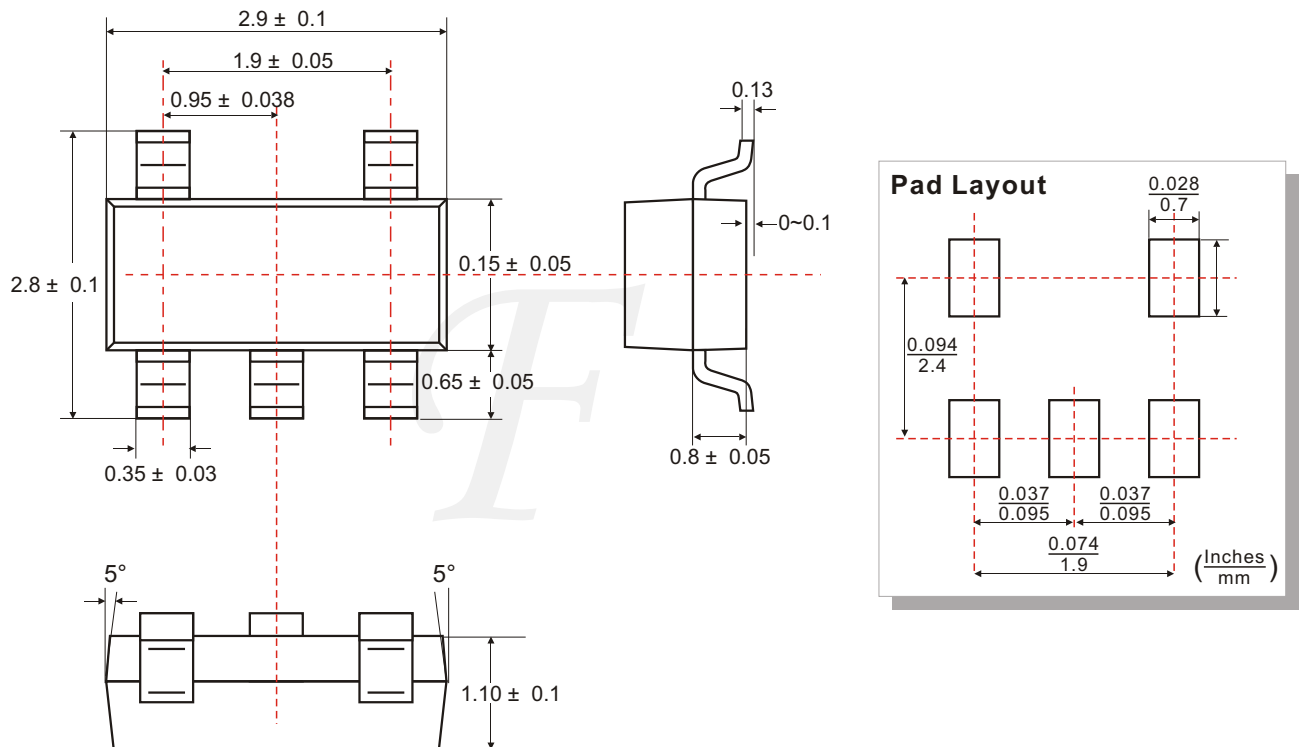


Pad Layout

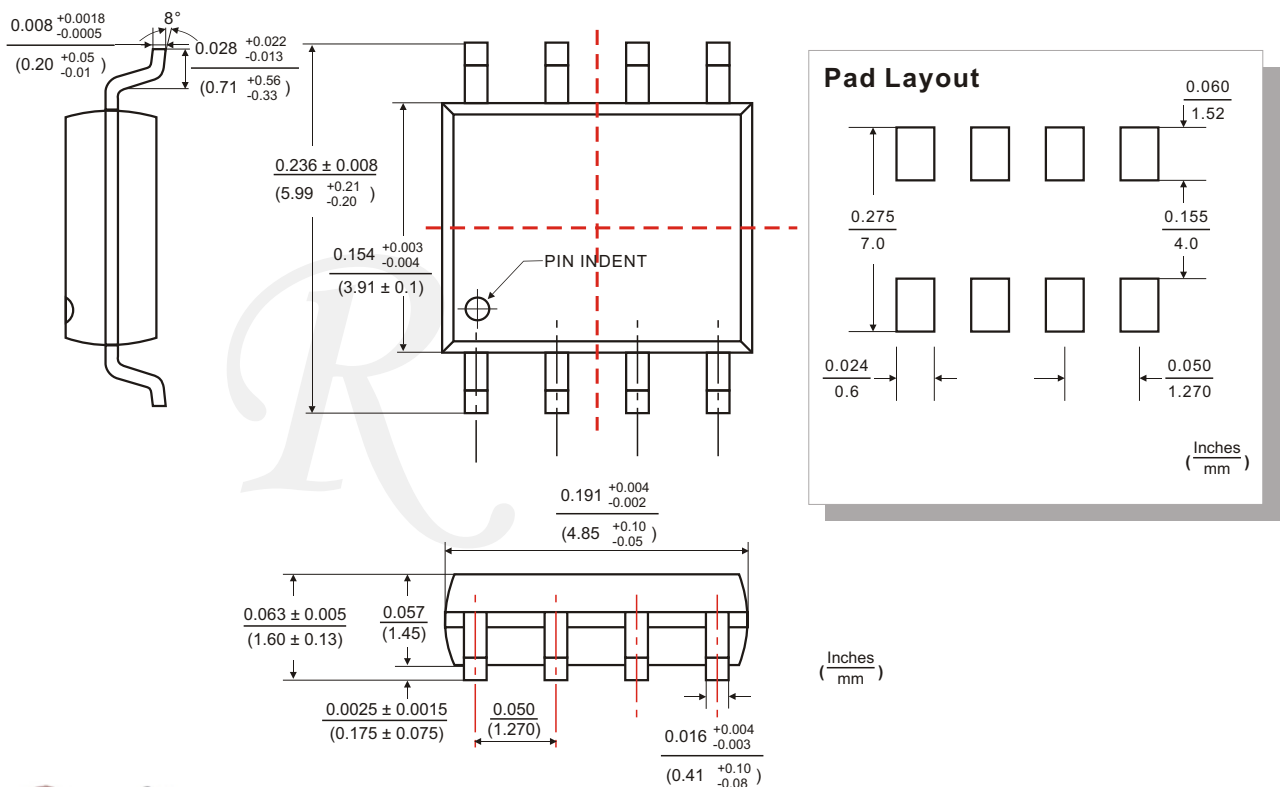


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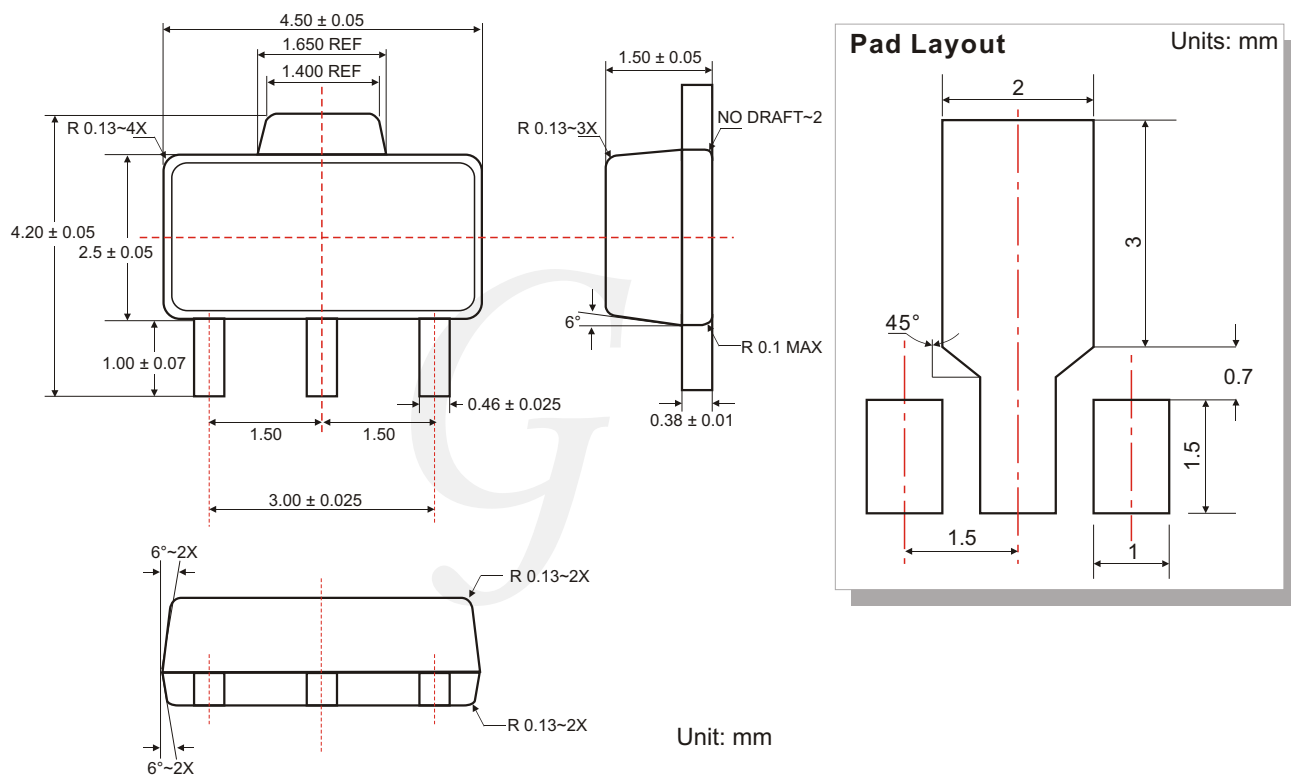
◆ SOT-25(SOT-23-5) PACKAGE OUTLINE DIMENSIONS



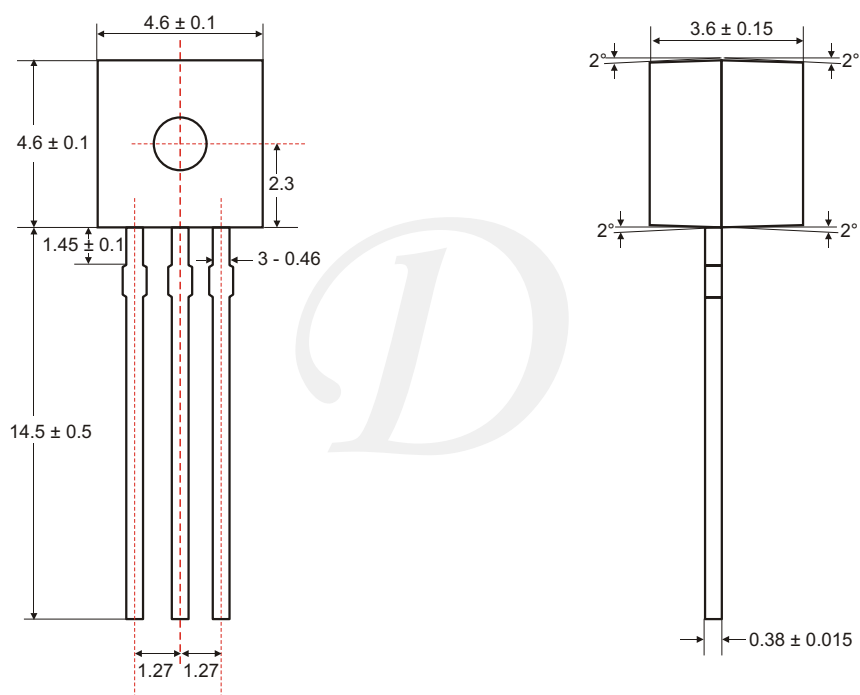
◆ SOP-8(SO-8) PACKAGE OUTLINE DIMENSIONS



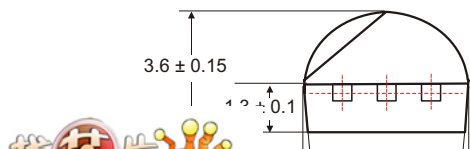
◆ SOT-89 PACKAGE OUTLINE DIMENSIONS



◆ TO-92 PACKAGE OUTLINE DIMENSIONS



Unit: mm



◆ ORDERING NUMBER

