

## GENERAL DESCRIPTION

The SPX431A is a three-terminal adjustable shunt voltage regulator providing a highly accurate bandgap reference.

The SPX431A acts as an open-loop error amplifier with a 2.5V temperature compensation reference. The SPX431A has thermal stability, wide operating current of 150mA and broad temperature range of -40°C to 125°C, making it suitable for a variety of applications which require a low-cost, high performance solution. The SPX431A tolerance of 0.5% is proven to be sufficient to overcome all other errors in the system to virtually eliminate the need for trimming in the power supply manufacturer's assembly line and contribute a significant cost savings. The output voltage may be adjusted to any value between  $V_{REF}$  and 36 volts with two external resistors.

The SPX431A is available in RoHS compliant, lead free TO-92 and SOT-89 packages.

The SPX431A product is obsolete.

## APPLICATIONS

- **Charger**
- **Switching Power Supplies**
- **Graphic Cards**
- **Monitors, VCRs, TVs**

## FEATURES

- **0.5% Precise Output Voltage**
  - Adjustable up to 36V
- **Wide Operating Current**
  - 1mA to 150mA
- **Low Temperature Coefficient at 30ppm/°C**
- **Extended Temperature Range**
  - -40°C to +125°C
- **Improved Replacement for TL431**
- **RoHS Compliant, Lead Free TO-92 and SOT-89 Packages**

## TYPICAL APPLICATION DIAGRAM

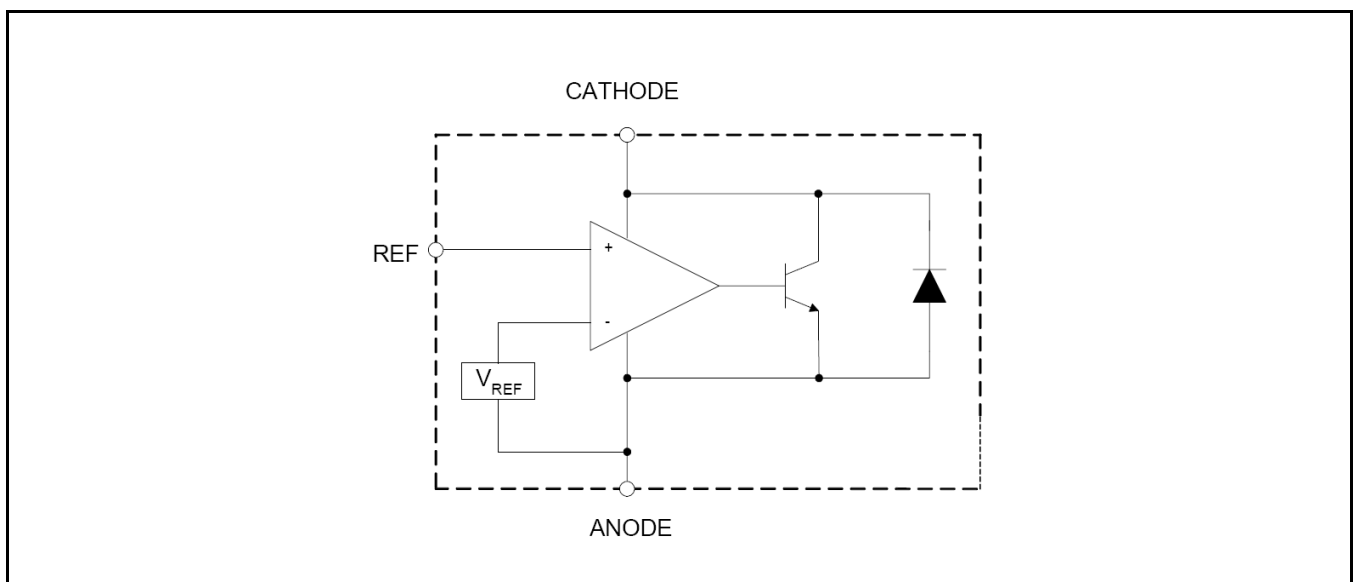


Fig. 1: SPX431A Application Diagram

## Precision Adjustable Shunt Regulator

### ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

Cathode-Anode Reverse Breakdown Volt.  $V_{KA}$  ..... 37V  
 Operating Cathode Current (cont.)  $I_{KA}$  ..... 150mA  
 Reference Input Current Range  $I_{REF}$  ..... 10mA  
 Power Dissipation SOT-89-TO-92 (Cont. 25°C)  $P_D$ .. 770mW  
 Junction Temperature ..... 150°C  
 Storage Temperature  $T_{STG}$ ..... -65°C to 150°C  
 ESD Rating (HBM - Human Body Model) ..... 2kV

### OPERATING RATINGS

Cathode-Anode Reverse Breakdown Volt.  $V_{KA}$  ..... 36V  
 Operating Cathode Current (cont.)  $I_{KA}$  ..... <100mA  
 Ambient Temperature Range ..... -40°C to 125°C

### ELECTRICAL SPECIFICATIONS

Specifications with standard type are for an Operating Ambient Temperature of  $T_A = 25^\circ\text{C}$  only; limits applying over the full Operating Ambient Temperature range are denoted by a "•". Minimum and Maximum limits are guaranteed through test, design, or statistical correlation. Typical values represent the most likely parametric norm at  $T_A = 25^\circ\text{C}$ , and are provided for reference purposes only.

Parameter	Min.	Typ.	Max.	Units	Conditions
Reference Voltage	2.493	2.503	2.515	V	Test circuit 1 $V_{KA}=V_{REF}, I_{KA}=10\text{mA}$
$\Delta V_{REF}$ with temperature $T_C$		4.5	8	mV	Test circuit 1 $V_{KA}=V_{REF}, I_{KA}=10\text{mA}, 0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$
$\Delta V_{REF}$ with temperature $T_C$		4.5	16	mV	• Test circuit 1 $V_{KA}=V_{REF}, I_{KA}=10\text{mA}$
Ratio of change in $V_{REF}$ to Cathode Voltage $\Delta V_{REF} / \Delta V_{KA}$	-2.7	-1.0		mV/V	Test circuit 2 $V_{REF} \leq \Delta V_{KA} \leq 10\text{V}, I_{KA}=10\text{mA}$
	-2	-0.4			Test circuit 2 $10\text{V} \leq \Delta V_{KA} \leq 36\text{V}, I_{KA}=10\text{mA}$
Reference Input Current $I_{REF}$		0.7	4	$\mu\text{A}$	Test circuit 2 $I_{KA}=10\text{mA}, R1=10\text{k}\Omega, R2=\infty$
$I_{REF}$ Temperature Deviation $\Delta I_{REF}$		0.4	1.2	$\mu\text{A}$	• Test circuit 2 $I_{KA}=10\text{mA}, R1=10\text{k}\Omega, R2=\infty$
Minimum $I_{KA}$ for Regulation $I_{KA(MIN)}$		0.4	1	mA	Test circuit 1 $V_{KA}=V_{REF}$
Off State Leakage $I_{KA(OFF)}$		40	250	nA	Test circuit 3 $V_{KA}=0, V_{REF}=36\text{V}$
Dynamic Outout Impedance $Z_{KA}$		0.15	0.5	$\Omega$	Test circuit 1 $f_z \leq 1\text{KHz}, I_{KA}=1 \text{ to } 100\text{mA}$

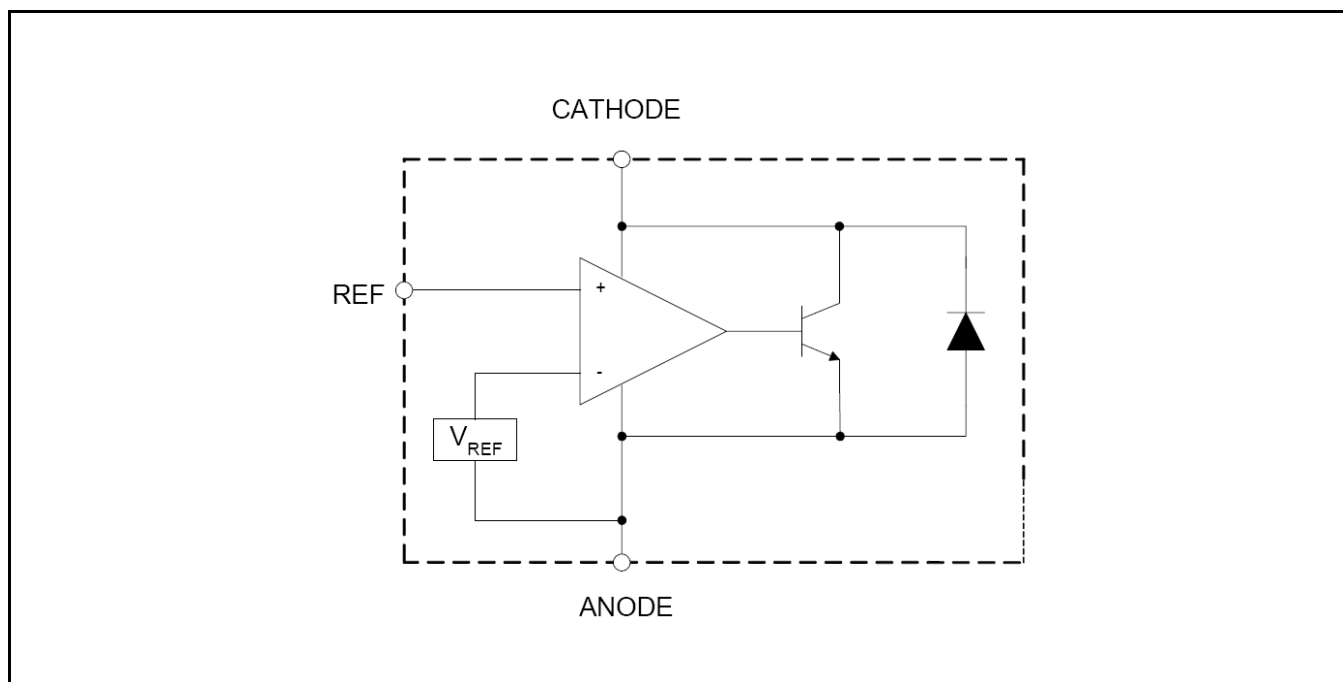
**BLOCK DIAGRAM**


Fig. 2: SPX431A Block Diagram

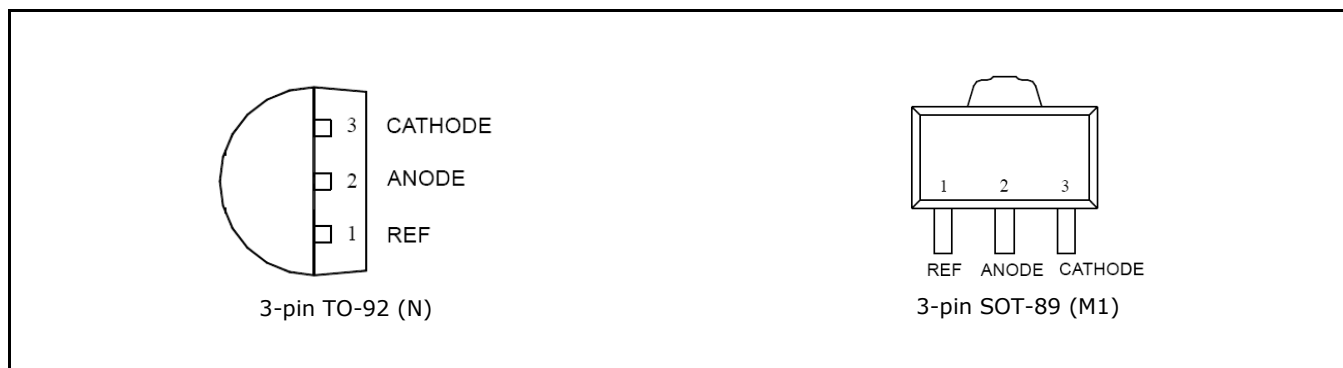
**PIN ASSIGNMENT**


Fig. 3: SPX431A Pin Assignment

**ORDERING INFORMATION**

Part Number	Temperature Range	Package	Packing Quantity	Note 1	Note 2
SPX431AM1-L/TR	$-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$	SOT-89	2.5K/Tape & Reel	RoHS Compliant Lead Free	
SPX431AN-L/TR	$-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$	TO-92	2K/Tape & Reel	RoHS Compliant Lead Free	Ammo Pack

**Note:** The SPX431AM1-L/TR and SPX431AN-L/TR part numbers are obsolete. For more information about part numbers, as well as the most up-to-date ordering information and additional information on environmental rating, go to [www.maxlinear.com/SPX431A](http://www.maxlinear.com/SPX431A).

**TYPICAL PERFORMANCE CHARACTERISTICS**

All data taken at  $T_A = 25^\circ\text{C}$ , unless otherwise specified - Schematic and BOM from Application Information section of this datasheet.

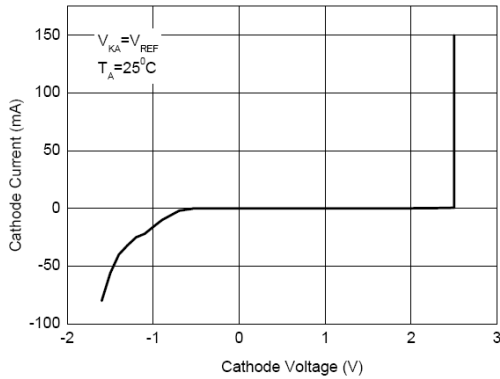


Fig. 4: Cathode Current vs Cathode Voltage

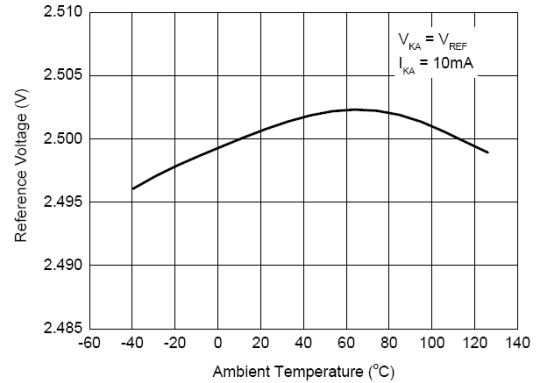


Fig. 5: Reference Voltage vs Ambient Temperature

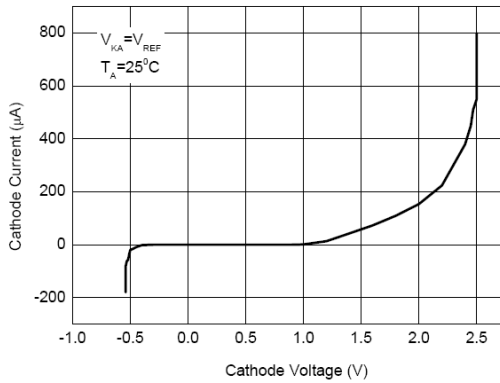


Fig. 6: Low Current Operating Characteristics

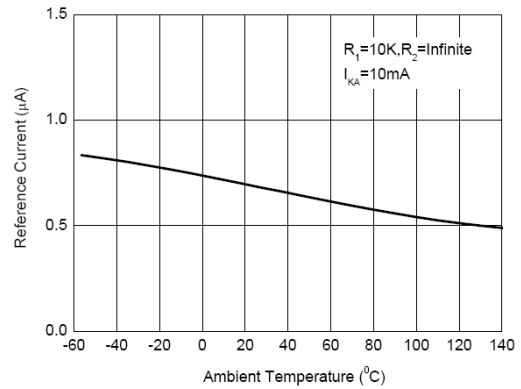


Fig. 7: Reference Input Current vs Ambient Temperature

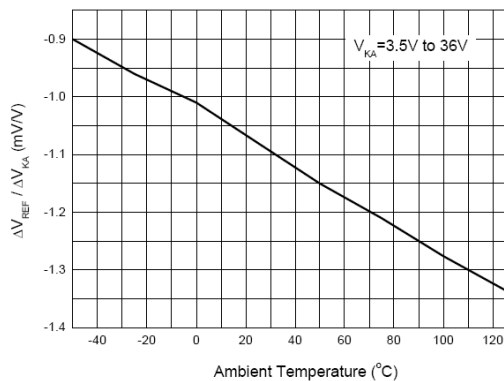


Fig. 8:  $\Delta$ Reference Voltage to  $\Delta$ Cathode Voltage Ratio

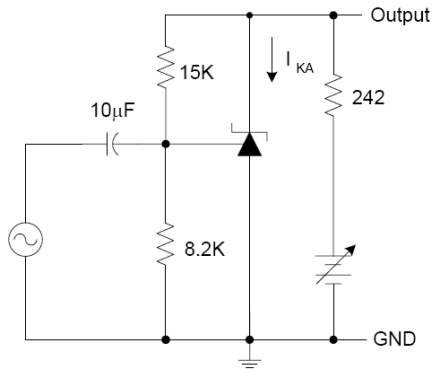


Fig. 9: Test Circuit for Gain vs Frequency Response

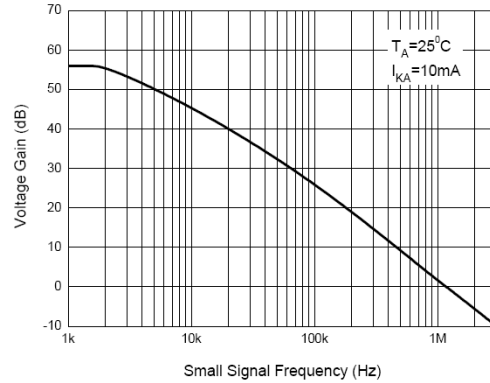


Fig. 10: Small Signal Gain vs Frequency

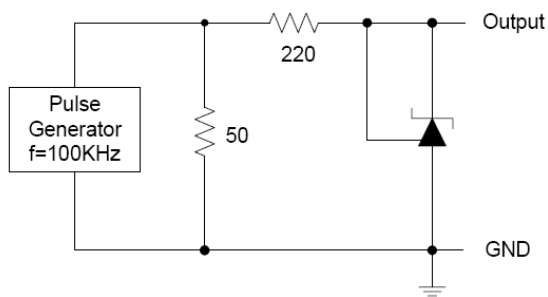


Fig. 11: Test Circuit for Pulse Response

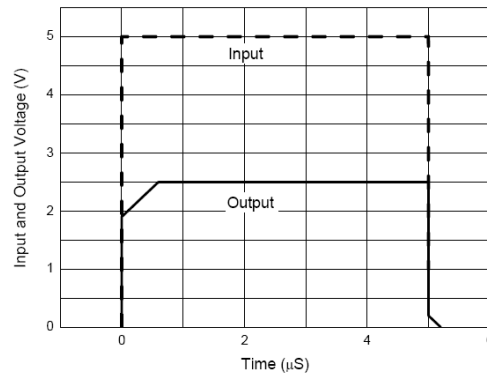


Fig. 12: Pulse Response

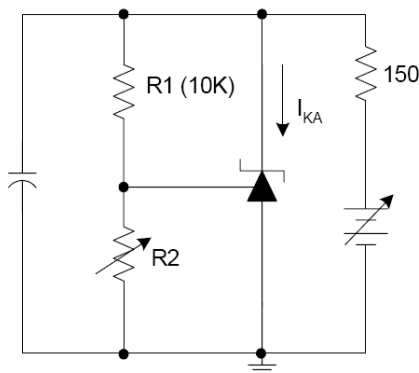


Fig. 13: Test Circuit for Stability

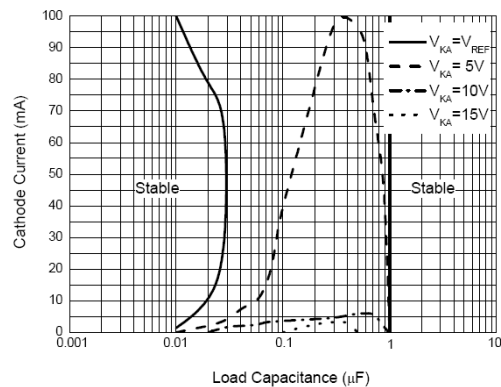


Fig. 14: Stability Boundary Conditions

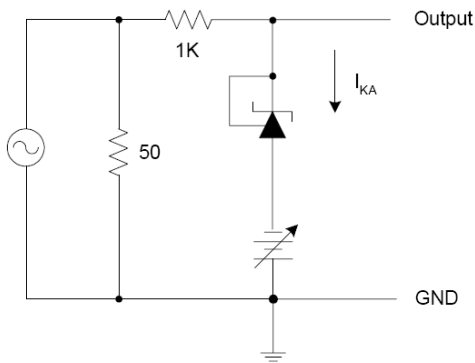


Fig. 15: Test Circuit for Dynamic Output Impedance

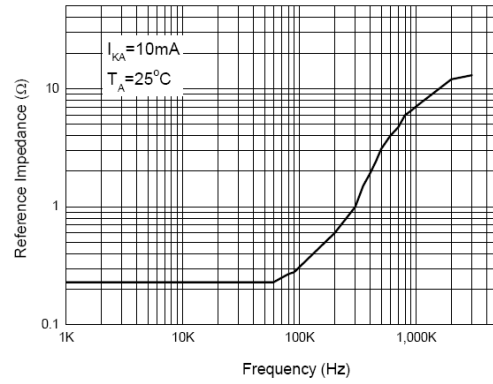


Fig. 16: Dynamic Output Impedance

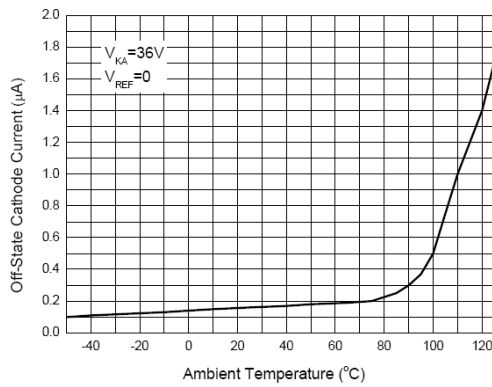


Fig. 17: Off State Leakage

**TYPICAL APPLICATION SCHEMATICS**

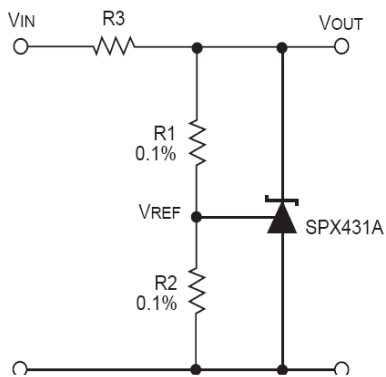


Fig. 18: Shunt Regulator  $V_{OUT} = (1 + R1/R2)V_{REF}$

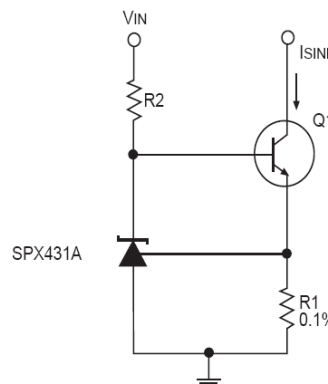


Fig. 19: Constant Current Sink  $I_{SINK} = V_{REF}/R1$

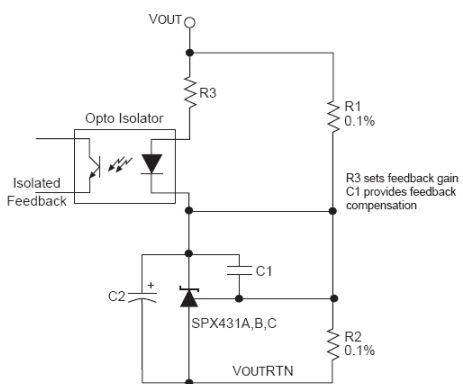


Fig. 20: Reference Amplifier for Isolated Feedback in Offline DC-DC Coinverters

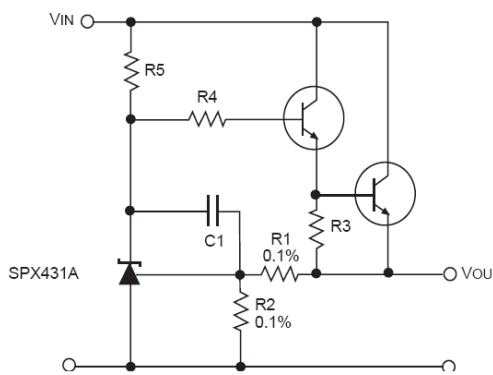


Fig. 21: Precision High Current Series Regulator  $V_{OUT} = (1 + R1/R2)V_{REF}$

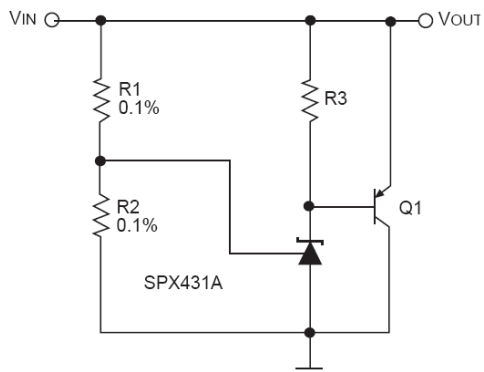


Fig. 22: High Current Shunt Regulator  $V_{OUT} = (1 + R1/R2)V_{REF}$

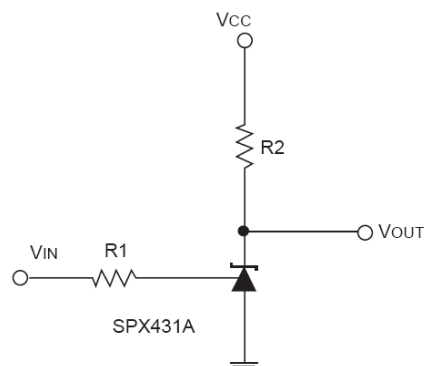
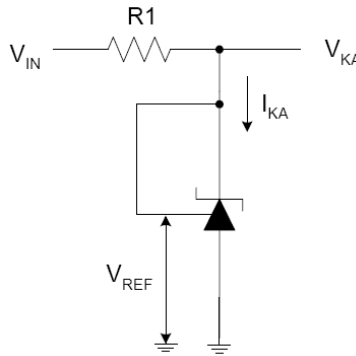


Fig. 23: Single Supply Comparator with Temperature Compensated Threshold

**TEST CIRCUITS**

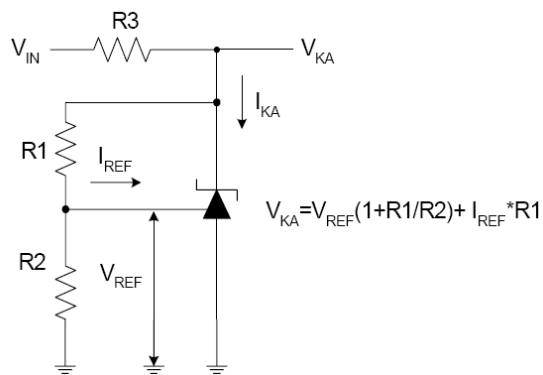
**TEST CIRCUIT 1**

Test circuit for  $V_{KA} = V_{REF}$



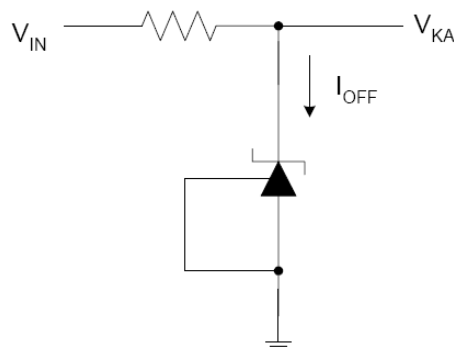
**TEST CIRCUIT 2**

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



**TEST CIRCUIT 3**

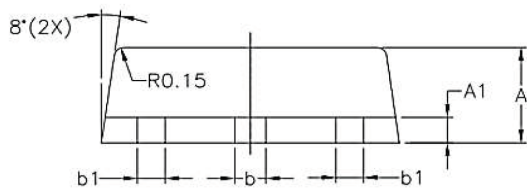
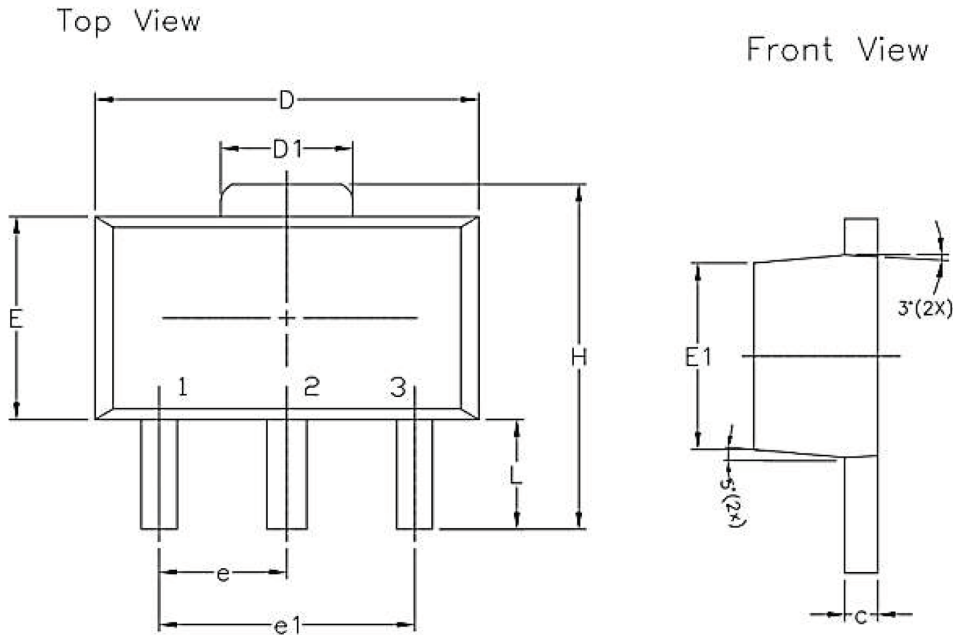
Test circuit for  $I_{KOFF}$





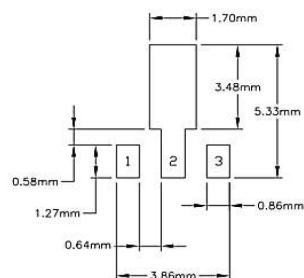
**PACKAGE SPECIFICATION**
**SOT-89**

Unit: mm (inch)



Side View

Recommended PCB Land Pattern



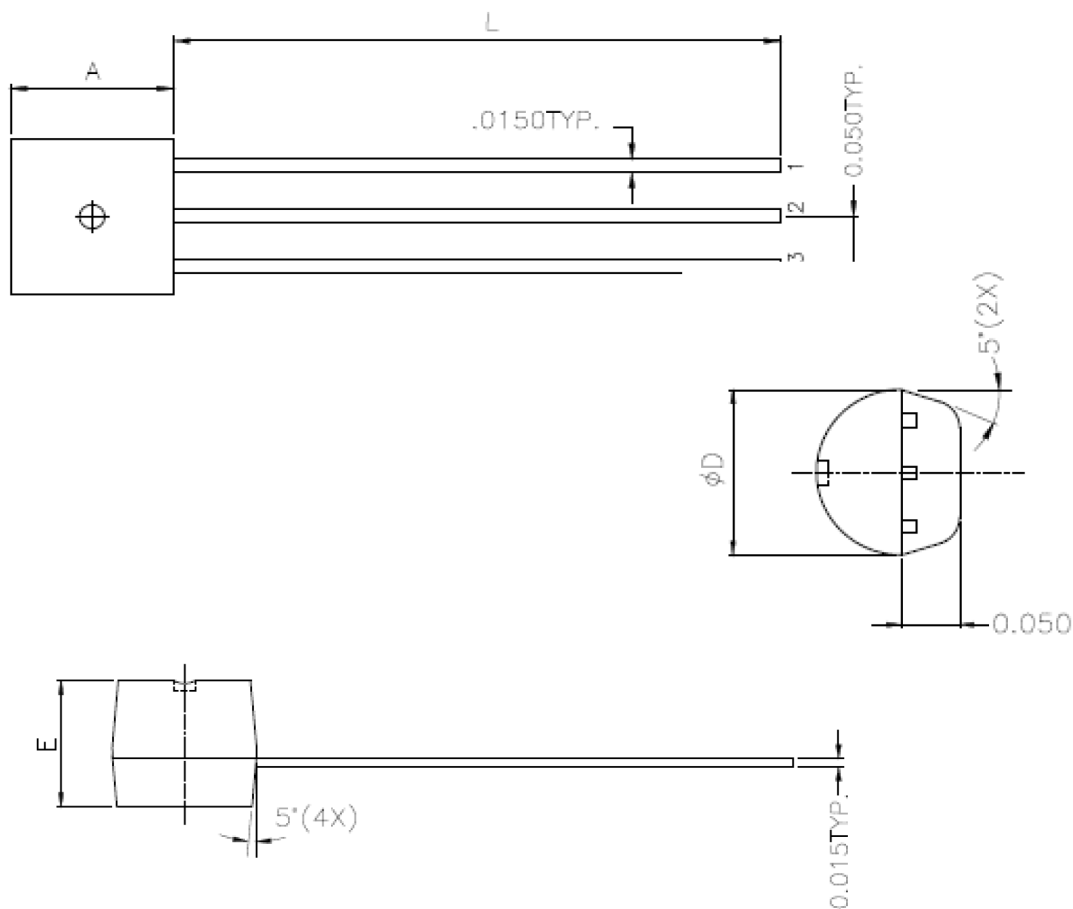
3 Pin SOT-89 JEDEC TO-243 Variation AA						
SYMBOLS	DIMENSIONS IN MM (Control Unit)			DIMENSIONS IN INCH (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.40	1.50	1.60	0.055	0.059	0.063
A1	0.30	0.40	0.50	0.011	0.015	0.019
b	0.44	0.47	0.56	0.017	0.018	0.022
b1	0.36	0.42	0.48	0.014	0.016	0.019
c	0.35	0.40	0.44	0.014	0.015	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
D1	1.62	1.60	1.83	0.064	0.062	0.072
E	2.29	2.50	2.60	0.090	0.098	0.102
E1	2.13	—	2.29	0.084	—	0.090
e	1.50 BSC			0.059 BSC		
e1	3.00 BSC			0.118 BSC		
H	3.94	—	4.25	0.155	—	0.167
L	0.89	—	1.20	0.035	—	0.047
N	3			3		

Drawing No.: POD-00000174

Revision: A

**TO-92**

Unit: mm (inch)



SYMBOL	INCHES		
	MIN.	NOR.	MAX.
A	.170	.180	.210
$\phi D$	.175	.180	.205
E	.125	.142	.165
L	.500	.580	

NOTE :  
1. JEDEC : TO-92.

Drawing No.: POD-00000173

Revision: A

**REVISION HISTORY**

Revision	Date	Description
2.0.1	11/08/22	<p><b>Updated:</b></p> <ul style="list-style-type: none"> <li>■ Note under the "Ordering Information" table.</li> <li>■ "SOT-89" POD.</li> <li>■ "TO-92" POD.</li> </ul> <p><b>Removed:</b></p> <ul style="list-style-type: none"> <li>■ In the "Ordering Information" table, "Marking" column.</li> </ul>
2.0.0	04/15/09	<p>Reformat of Datasheet            Updated ordering part numbers            Updated application and block diagram</p>



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