

## Precision Adjustable Shunt Regulator

### FEATURES

- Trimmed Bandgap Reference to 0.4%
- Wide Operating Current 1mA to 150mA
- Extended Temperature Range: -55°C to 125°C
- Low Temperature Coefficient 30 ppm/°C
- Offered in TO-92, SOIC, SOT-89, SOT-23-5
- Improved Replacement in Performance for LT1431
- Low Cost Solution

### APPLICATIONS

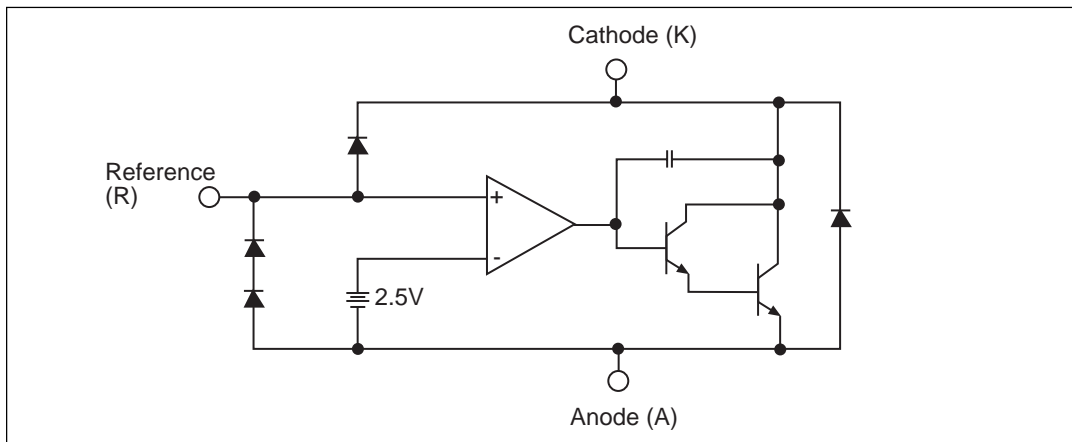
- Battery Operating Equipment
- Adjustable Supplies
- Switching Power Supplies
- Error Amplifiers
- Single Supply Amplifier
- Monitors / VCRs / TVs
- Personal Computers

### DESCRIPTION

The SPX1431 is a 3-terminal adjustable shunt voltage regulator providing a highly accurate bandgap reference. The SPX1431 acts as an open-loop error amplifier with a 2.5V temperature compensation reference. The SPX1431's thermal stability, wide operating current (150mA) and temperature range (-55°C to 125°C) makes it suitable for a variety of applications that require a low cost, high performance solution. SPX1431 tolerance of 0.4% is proven to be sufficient to overcome all of the other errors in the system to virtually eliminate the need for trimming in the power supply manufacturer's assembly lines and contributes a significant cost savings.

The output voltage may be adjusted to any value between  $V_{REF}$  and 36 volts with two external resistors. The SPX1431 is available in TO-92, SOIC-8, SOT-89, and SOT-23-5 packages.

### BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

Cathode-Anode Reverse Breakdown $V_{KA}$ .....	37V
Anode-Cathode Forward Current, (<10ms) $I_{AK}$ .....	1A
Operating Cathode Current $I_{KA}$ .....	150mA
Reference Input Current $I_{REF}$ .....	10mA
Continuous Power Dissipation at 25°C $P_D$	
TO-92 .....	775mW
SOT-23 .....	200 mW
SOIC-8 .....	750mW
SOT-89 .....	1000mW

Junction Temperature $T_J$ .....	150 °C
Storage Temperature $T_{STG}$ .....	-65 to 150 °C
Lead Temperature (Soldering 10 sec.) $T_L$ .....	300°C

**NOTE:** Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

## RECOMMENDED CONDITIONS

PARAMETER	SYMBOL	RATING	UNIT
Cathode Voltage	$V_{KA}$	$V_{REF}$ to 36	V
Cathode Current	$I_K$	10	mA

## TYPICAL THERMAL RESISTANCES

PACKAGE	$\theta_{JA}$	$\theta_{JC}$	TYPICAL DERATING
TO-92	160°C/W	80°C/W	6.3 mW/°C
SOT-23	575°C/W	150°C/W	1.7 mW/°C
SOIC-8	175°C/W	45°C/W	5.7 mW/°C
SOT-89	110°C/W	8°C/W	9.1mW/C°

Typical deratings of the thermal resistances are given for ambient temperature >25°C.

## ELECTRICAL CHARACTERISTICS

Electrical characteristics at 25°C  $I_K = 10mA$   $V_K = V_{REF}$ , unless otherwise specified.

PARAMETER	SYMBOL	FIGURE	CONDITIONS	MIN	TYP	MAX	UNITS
<b>SPX1431</b>							
Reference Voltage	$V_{REF}$	2	$T_J = 0^\circ\text{C to } 105^\circ\text{C}$	2.490	2.500	2.510	V
		2		2.465		2.535	V
$\Delta V_{REF}$ with Temp.*	TC	2			0.07	0.20	mV/°C
Ratio of Change in $V_{REF}$ to Cathode Voltage	$\frac{\Delta V_{REF}}{\Delta V_K}$	3	$V_K = 3V \text{ to } 36V$	-2.0	-1.1		mV/V
Reference Input Current	$I_{REF}$	3			0.7	1.9	$\mu\text{A}$
$I_{REF}$ Temp Deviation	$\Delta I_{REF}$	3	$T_J = 0^\circ\text{C to } 105^\circ\text{C}$		0.4	1.2	$\mu\text{A}$
Min $I_K$ for Regulation	$I_{K(MIN)}$	2			0.4	1	mA
Off State Leakage	$I_{K(OFF)}$	4	$V_{REF} = 0V,$ $V_{KA} = 36V$		0.04	250	nA
Dynamic Output Impedance	$Z_{KA}$	2	$f_z \leq 1\text{kHz}$ $I_K = 1 \text{ to } 150\text{mA}$		0.15	0.5	$\Omega$

**Operating Range ( $T_J$ ) = - 55°C to 125°C.**

**\* See appropriate test circuit (Figure 2)**

# CALCULATING AVERAGE TEMPERATURE COEFFICIENT (TC)

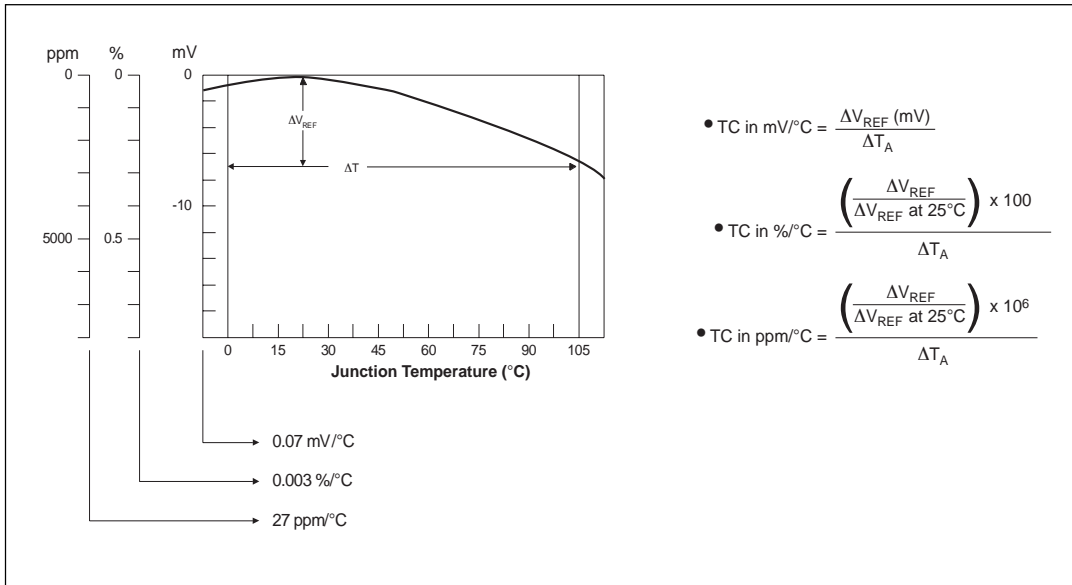


Figure 1.  $V_{REF}$  VS Temperature.

## TEST CIRCUITS

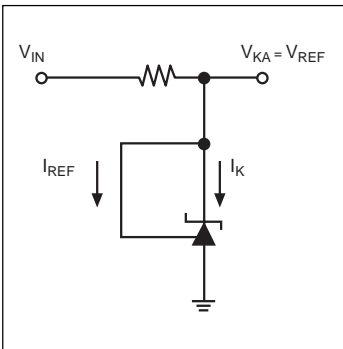


Figure 2. Test Circuit for  $V_{KA} = V_{REF}$

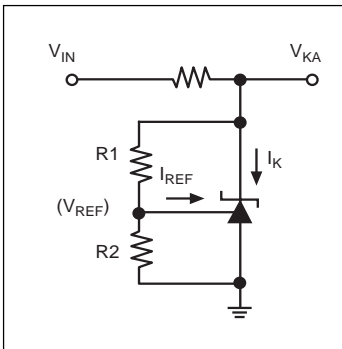


Figure 3. Test Circuit for  $V_{KA} > V_{REF}$

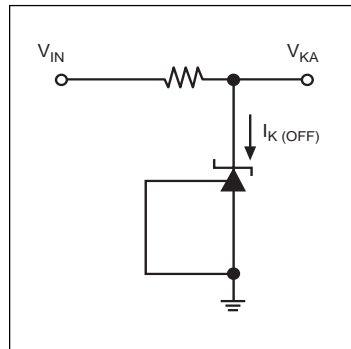


Figure 4. Test Circuit for  $I_{KOFF}$

# TYPICAL PERFORMANCE CHARACTERISTICS

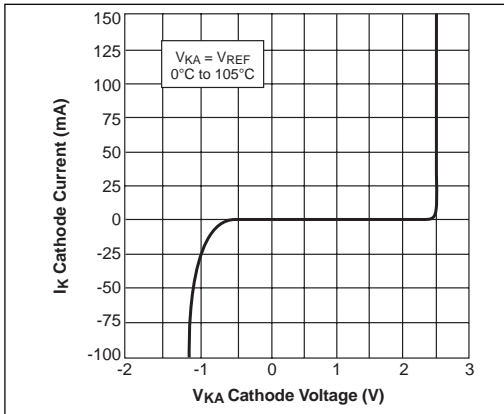


Figure 5. High Current Operating Characteristics

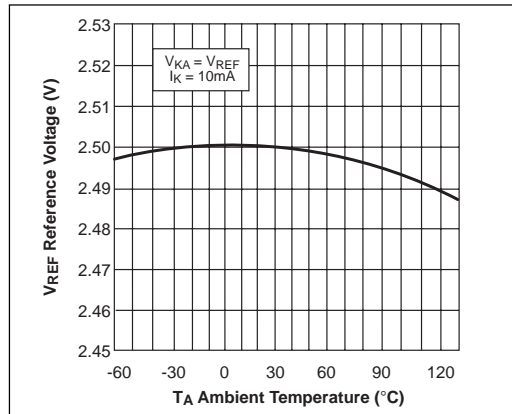


Figure 6. Reference Voltage VS Ambient Temperature

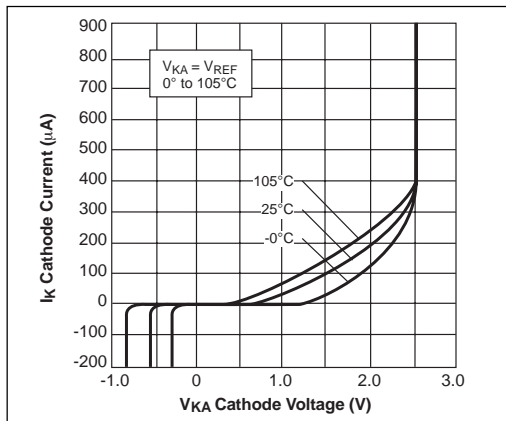


Figure 7. Low Current Operating Characteristics

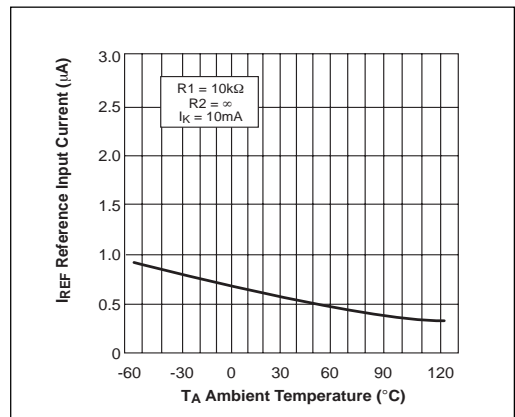


Figure 8. Reference Input Current VS Ambient Temperature

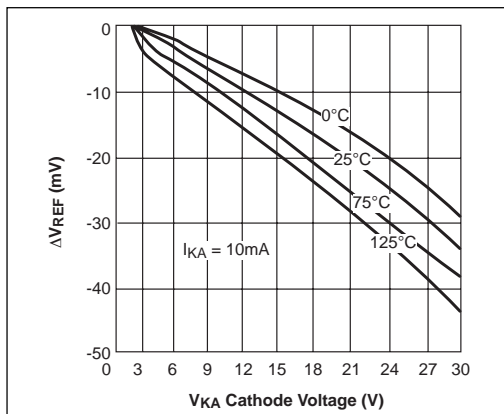


Figure 9. Reference Voltage Line Regulation VS Cathode Voltage and  $T_{AMBIENT}$

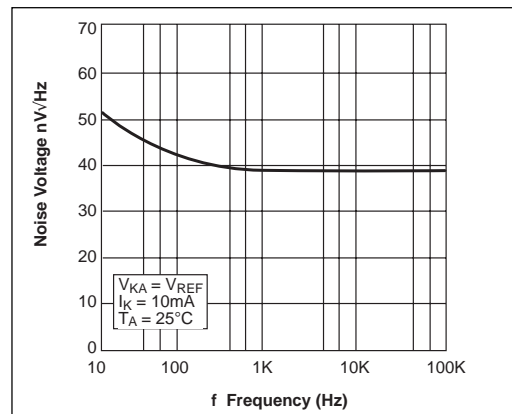


Figure 10. Noise Voltage VS Frequency

# TYPICAL PERFORMANCE CHARACTERISTICS (continued)

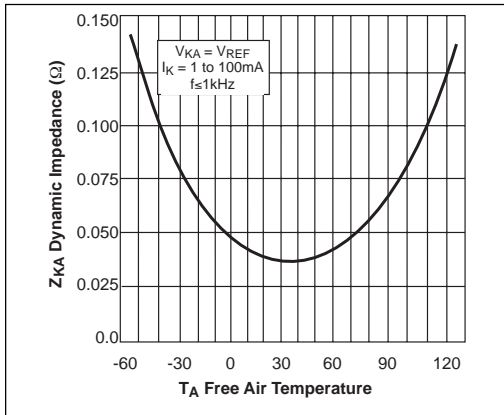


Figure 11. Low Frequency Dynamic Output Impedance VS  $T_{AMBIENT}$

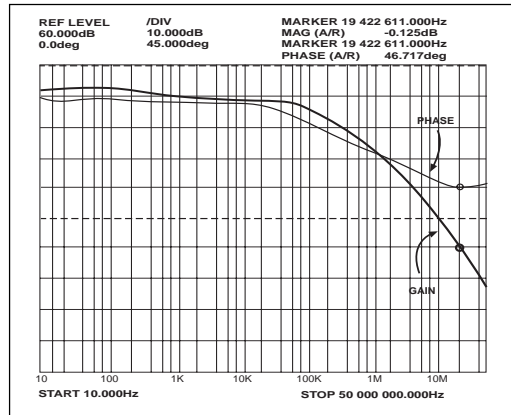


Figure 12. Small Signal Gain and Phase VS Frequency;  $I_K = 10mA, T_A = 25^\circ C$

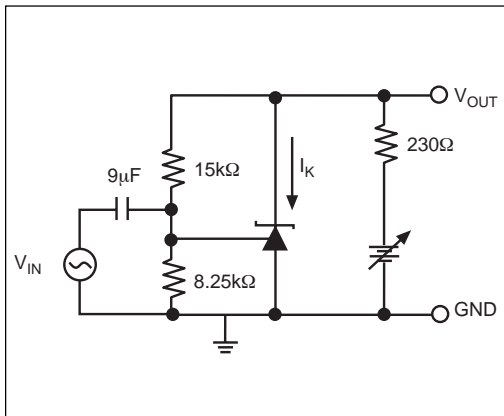


Figure 13. Test Circuit for Gain and Phase Frequency Response

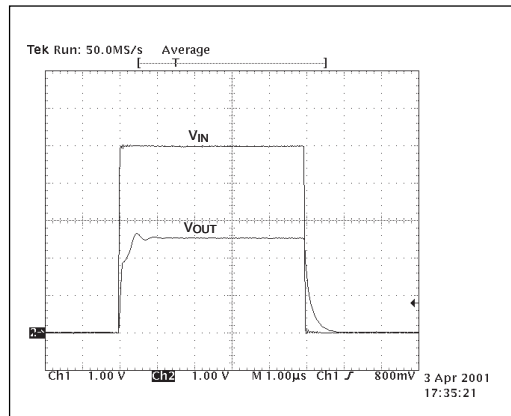


Figure 14. Frequency = 100kHz,  $I_K = 10mA, T_A = 25^\circ C$

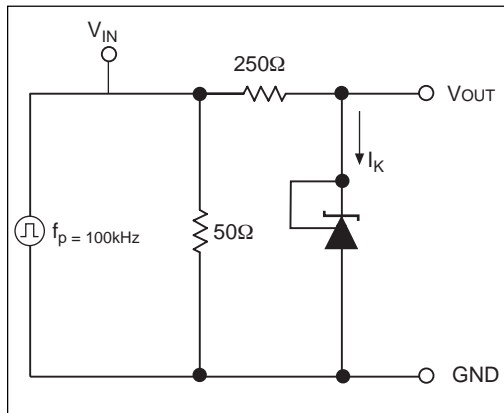


Figure 15. Test Circuit for Pulse Response

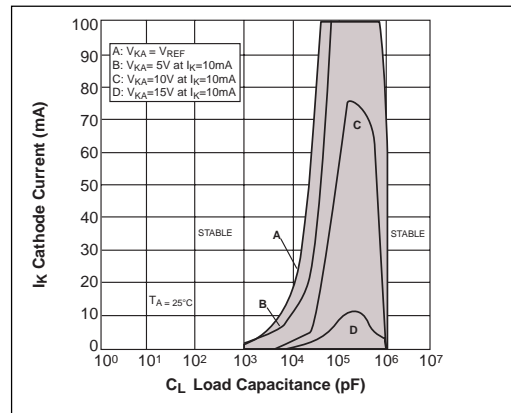


Figure 16. Stability Boundary Conditions

# TYPICAL PERFORMANCE CHARACTERISTICS (continued)

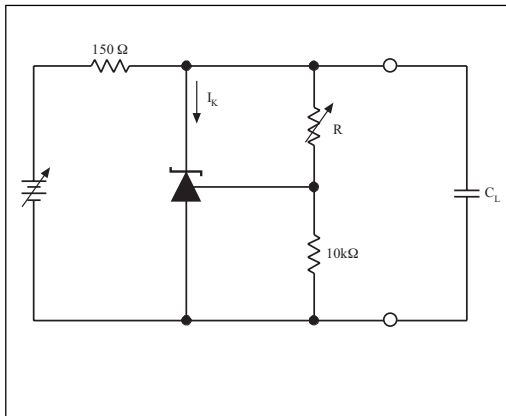


Figure 17. Test Circuit for Stability

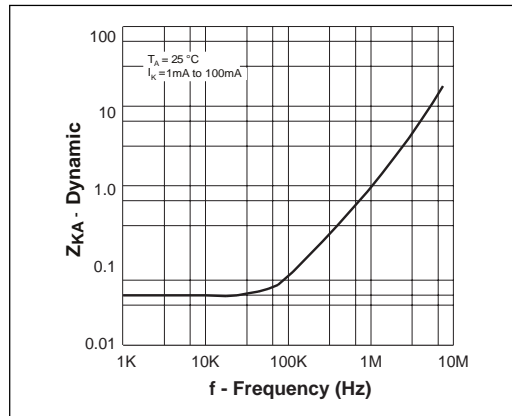


Figure 18. Dynamic Output Impedance  $T_A = 25^\circ\text{C}$ ,  $I_k = 1$  to  $100\text{mA}$

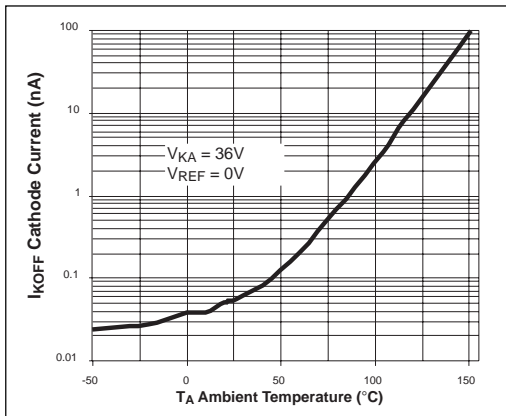


Figure 19. Off State Leakage

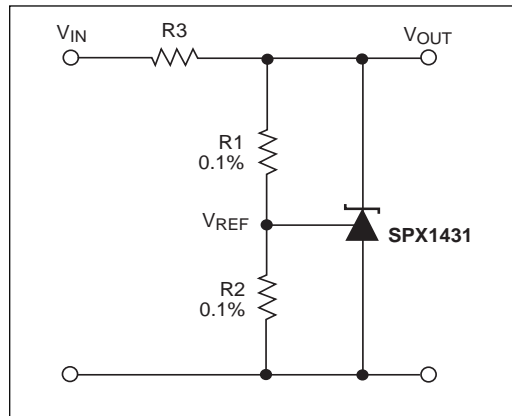


Figure 20. Shunt Regulator  $V_{OUT} = (1+R1/R2)V_{REF}$

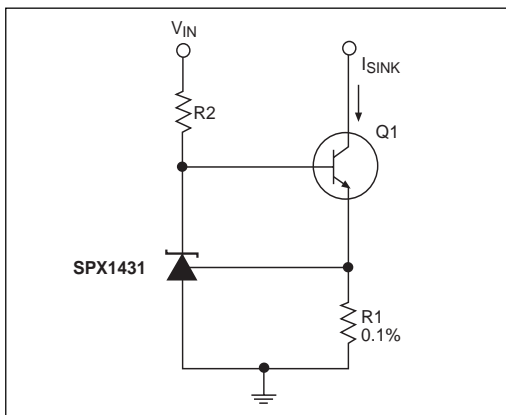


Figure 21. Constant Current, Sink,  $I_{SINK} = V_{REF}/R1$

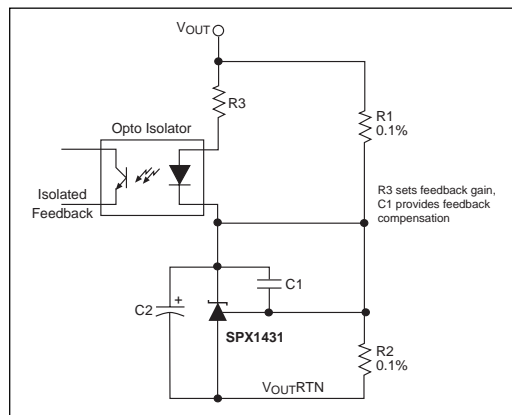
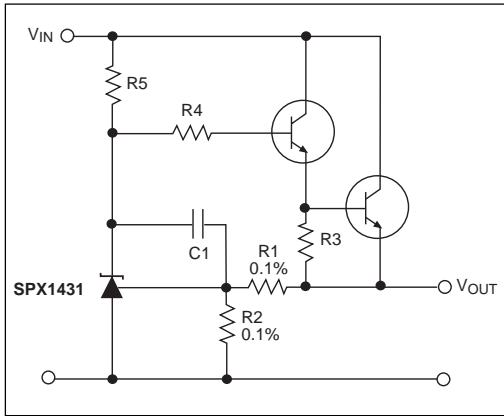
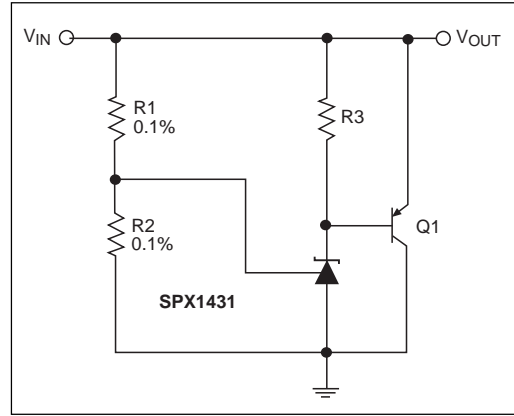


Figure 22. Reference Amplifier for Isolated Feedback in Off-Line DC-DC Converters

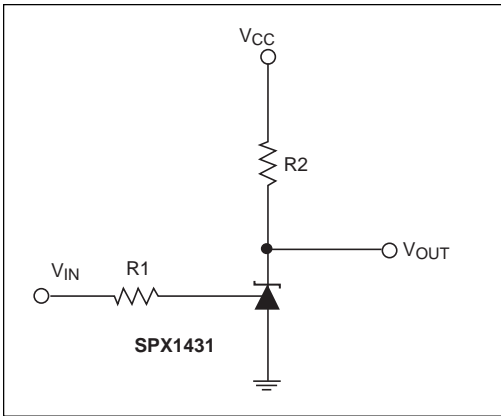
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)



**Figure 23. Precision High Current Series Regulator**  
 $V_{OUT} = (1 + R1/R2)V_{REF}$



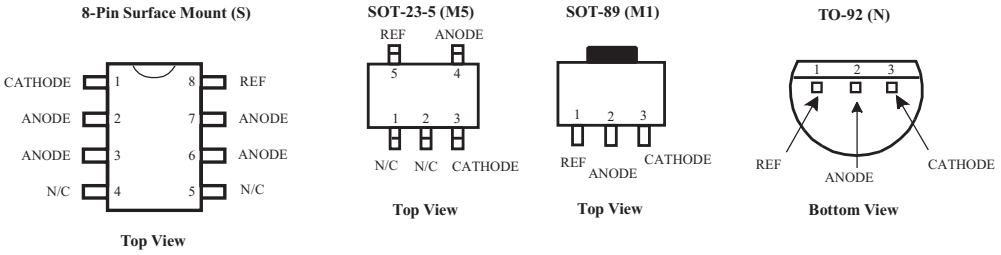
**Figure 24. High Current Shunt Regulator**  
 $V_{OUT} = (1 + R1/R2)V_{REF}$



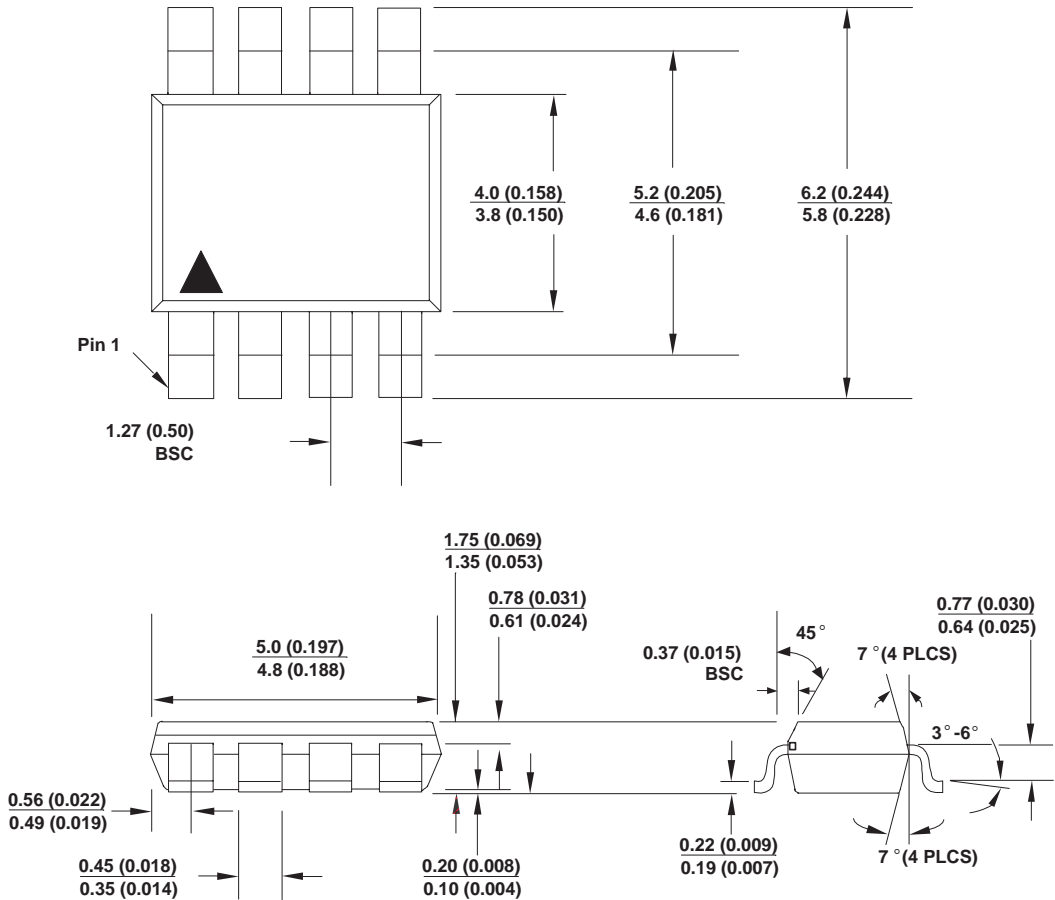
**Figure 25. Single Supply Comparator with Temperature Compensated Threshold.  $V_{IN}$  threshold = 2.5V**

*\* Resistor values are chosen such that the effect to  $I_{REF}$  is negligible.*

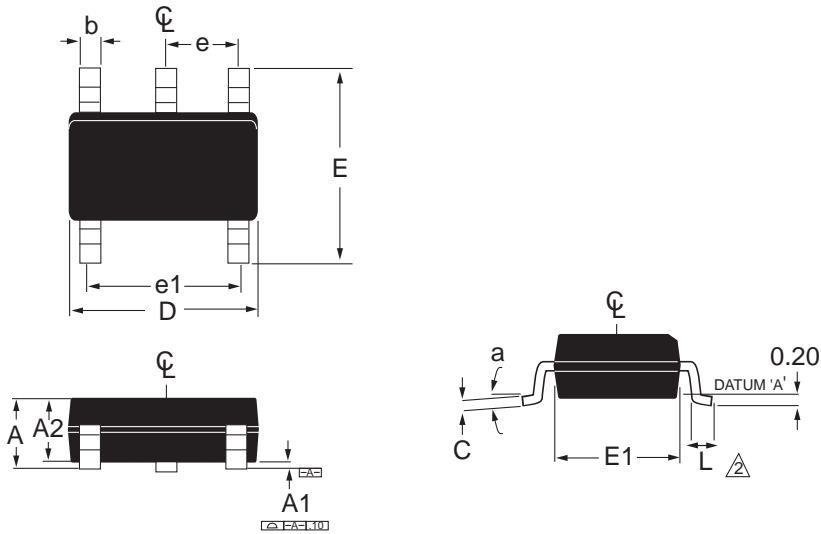
# PACKAGES



## PACKAGE: 8 PIN PLASTIC SMALL OUTLINE (SOIC) (NARROW)

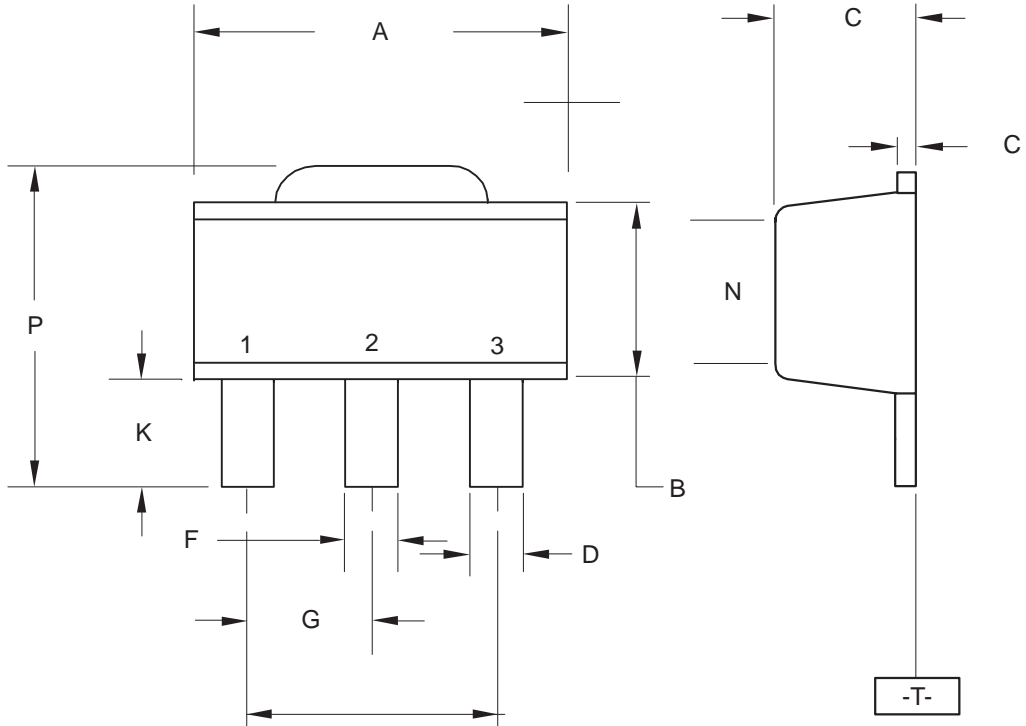


# PACKAGE: 5 Lead SOT23



SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.25	0.50
C	0.09	0.20
D	2.80	3.10
E	2.60	3.00
E1	1.50	1.75
L	0.35	0.55
e	0.95ref	
e1	1.90ref	
a	0°	10°

# PACKAGE: 3 Lead SOT-89



### STYLE 1

- PIN 1. BASE
- 2. COLLECTOR
- 3. EMITTER

### STYLE 3

- PIN 1. GATE
- 2. ANODE
- 3. CATHODE

### STYLE 2

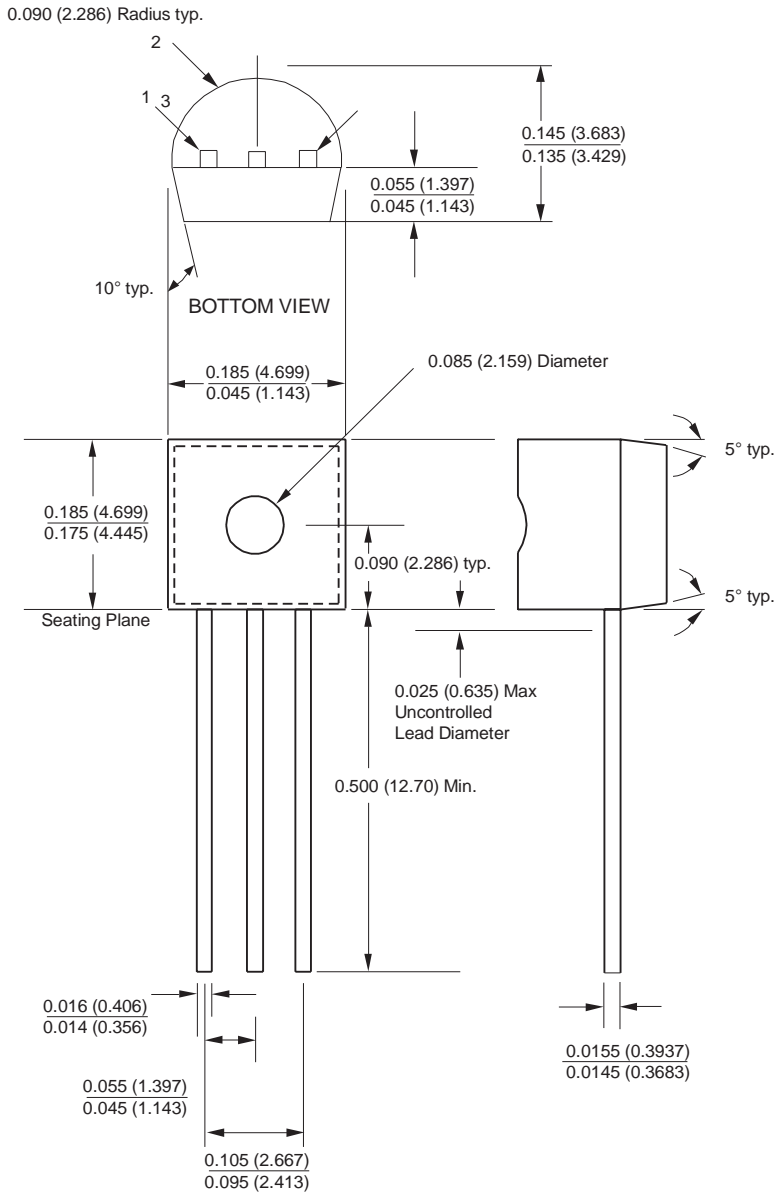
- PIN 1. ANODE
- 2. CATHODE
- 3. NO CONNECTION

### STYLE 4

- PIN 1. DRAIN
- 2. GATE
- 3. SOURCE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.40	4.60	0.174	0.181
B	2.29	2.60	0.091	0.102
C	140	160	0.056	0.062
D	0.36	0.48	0.015	0.018
E	1.62	1.80	0.064	0.070
F	0.44	0.53	0.018	0.020
G	150 BSC		0.059 BSC	
J	0.35	0.44	0.014	0.017
K	0.80	1.04	0.032	0.040
L	300 BSC		0.118 BSC	
N	2.04	2.28	0.081	0.089
P	3.94	4.25	0.156	0.167

# PACKAGE: TO-92



## ORDERING INFORMATION

PART NUMBER	ACCURACY	OUTPUT VOLTAGE	PACKAGES
SPX1431M5 .....	0.4% .....	2.5V .....	5-Pin SOT-23
SPX1431M1 .....	0.4% .....	2.5V .....	3-Pin SOT-89
SPX1431S .....	0.4% .....	2.5V .....	8-Pin SOIC
SPX1431N .....	0.4% .....	2.5V .....	3-Pin TO-92



SIGNAL PROCESSING EXCELLENCE

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