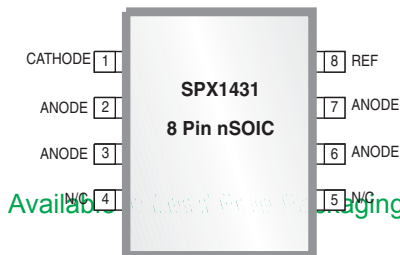


## Precision Adjustable Shunt Regulator

### 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



Available in Lead Free Packaging  
 Now Available in Lead Free Packaging

### APPLICATIONS

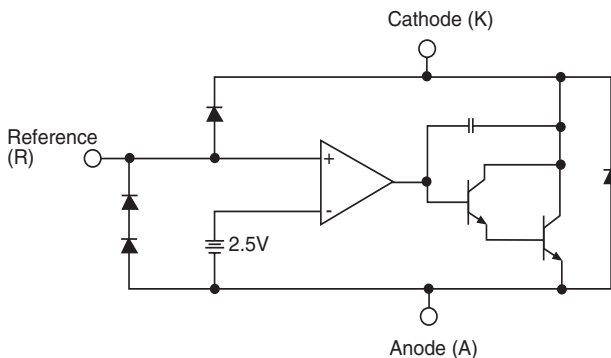
- Battery Operating Equipment
- Adjustable Supplies
- Switching Power Supplies
- Error Amplifiers
- Single Supply Amplifier
- Monitors / VCRs / TVs
- Personal Computers

### 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 $I_K$ .....	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

**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  $I_K=10\text{mA}$   $V_K=V_{REF}$ , unless otherwise specified.

PARAMETER	SYMBOL	FIGURE	CONDITIONS	MIN	TYP	MAX	UNITS
<b>SPX1431</b>							
Reference Voltage	$V_{REF}$	2	$T_J = 0\text{ °C to }105\text{ °C}$	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	$T_J = 0\text{ °C to }105\text{ °C}$		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)

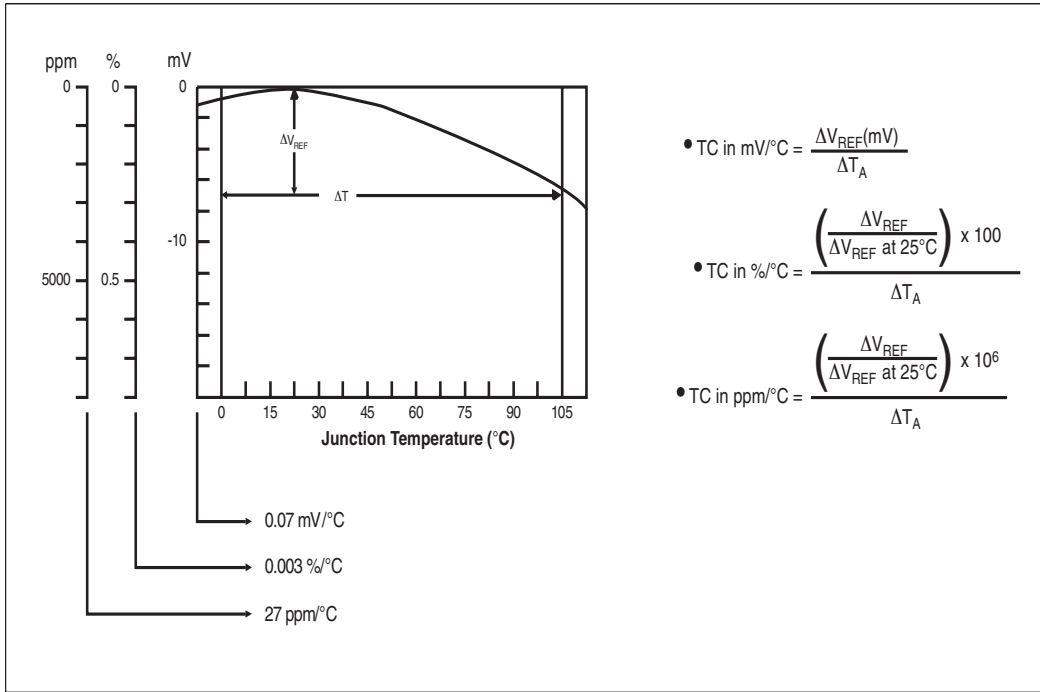


Figure 1.  $V_{REF}$  VS Temperature.

## TEST CIRCUITS

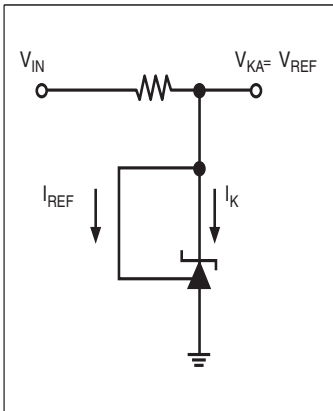


Figure 2. Test Circuit for  $V_{KA} = V_{REF}$

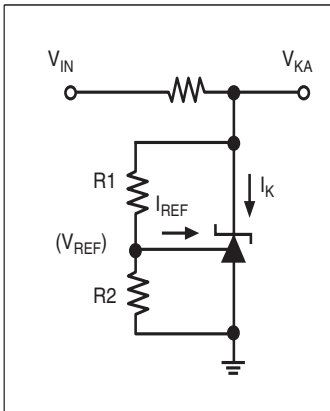


Figure 3. Test Circuit for  $V_{KA} > V_{REF}$

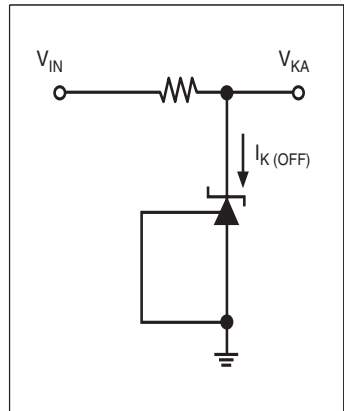


Figure 4. Test Circuit for  $I_{K(OFF)}$

# TYPICAL PERFORMANCE CHARACTERISTICS

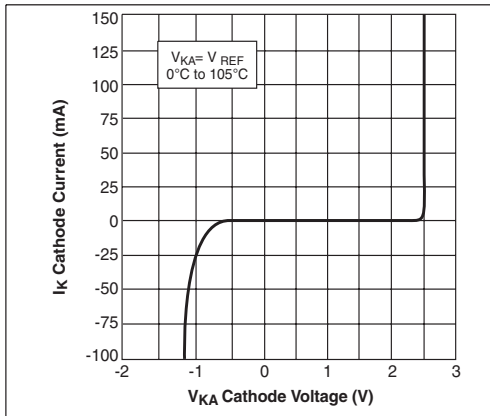


Figure 5. High Current Operating Characteristics

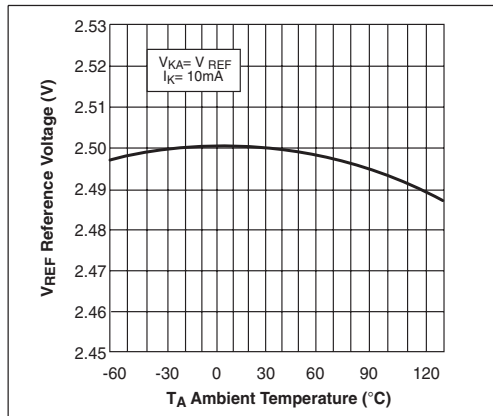


Figure 6. Reference Voltage VS Ambient Temperature

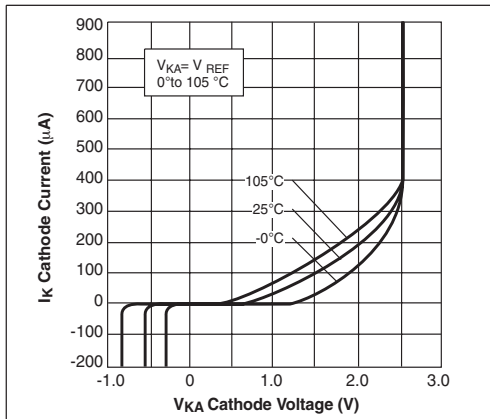


Figure 7. Low Current Operating Characteristics

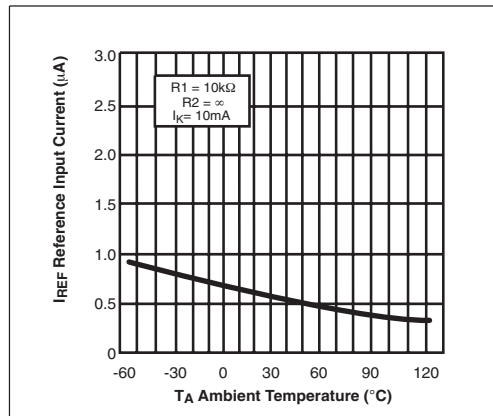


Figure 8. Reference Input Current VS Ambient Temperature

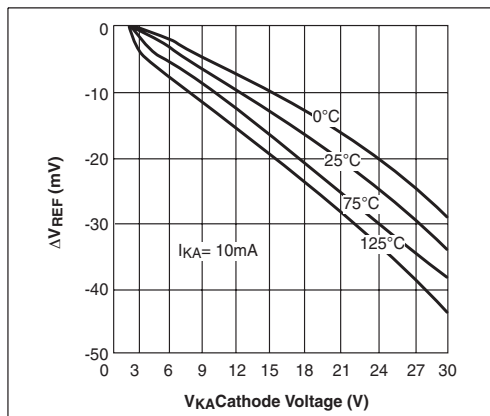


Figure 9. Reference Voltage Line Regulation VS Cathode Voltage and  $T_{AMBIENT}$

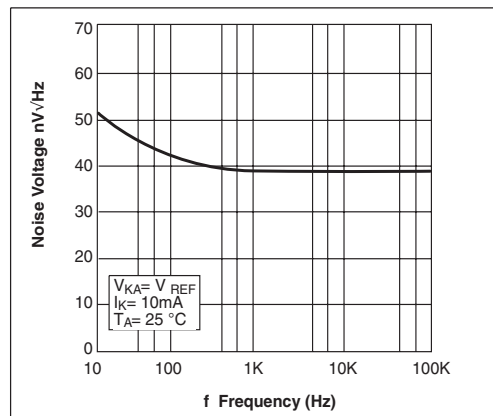


Figure 10. Noise Voltage VS Frequency

# TYPICAL PERFORMANCE CHARACTERISTICS

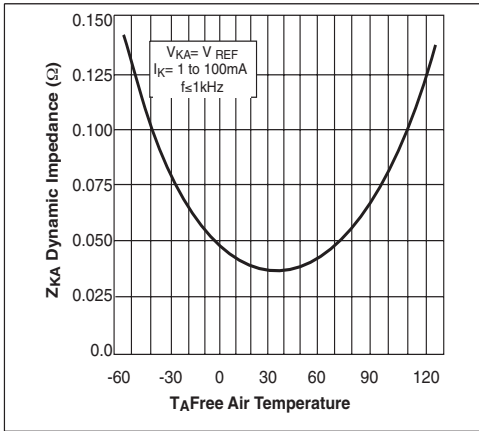


Figure 11. Low Frequency Dynamic Output Impedance VS  $T_{AMBIENT}$

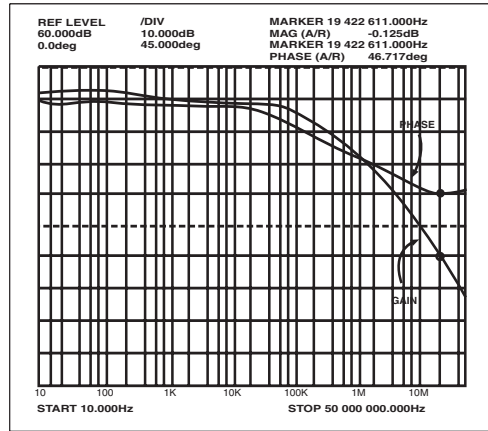


Figure 12. Small Signal Gain and Phase VS Frequency;  $I_K = 10mA, T_A = 25^\circ C$

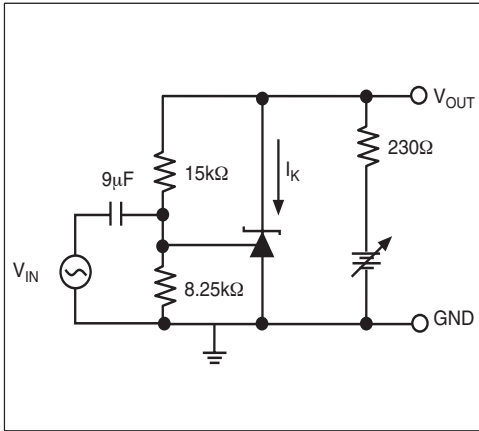


Figure 13. Test Circuit for Gain and Phase Frequency Response

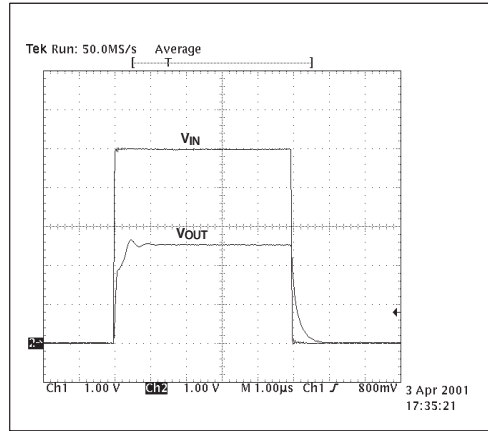


Figure 14. Frequency = 100kHz,  $I_K = 10mA, T_A = 25^\circ C$

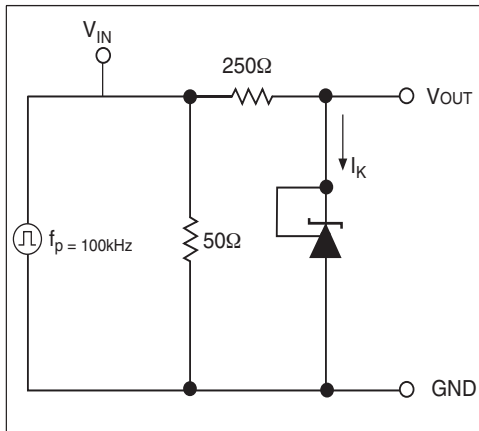


Figure 15. Test Circuit for Pulse Response

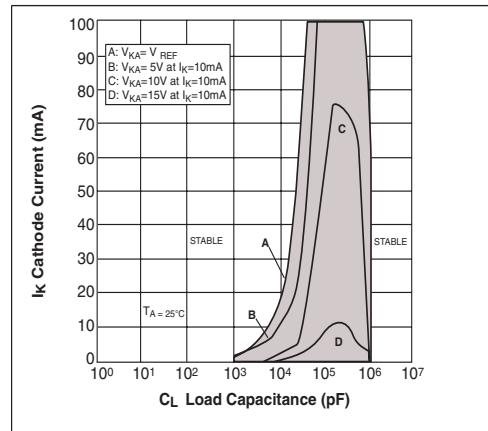


Figure 16. Stability Boundary Conditions

# TYPICAL PERFORMANCE CHARACTERISTICS

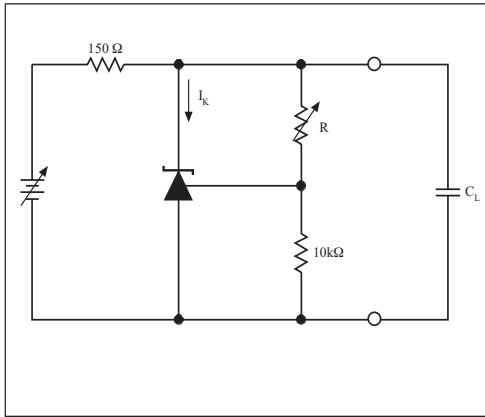


Figure 17. Test Circuit for Stability

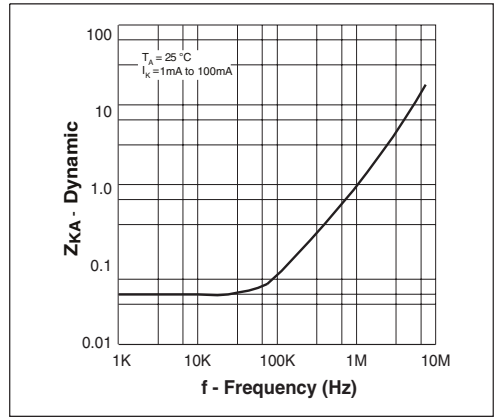


Figure 18. Dynamic Output Impedance  $T_A = 25^\circ\text{C}$ ,  $I_k = 1$  to  $100\text{mA}$

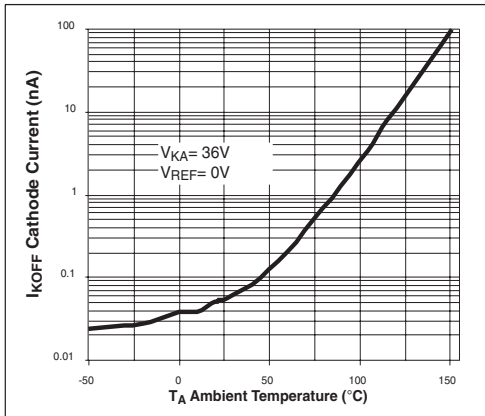


Figure 19. Off State Leakage

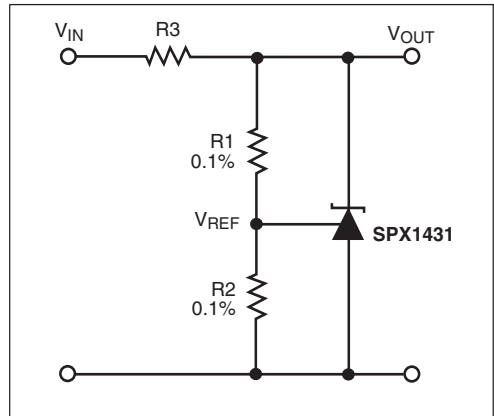


Figure 20. Shunt Regulator  $V_{OUT} = (1 + R1/R2)V_{REF}$

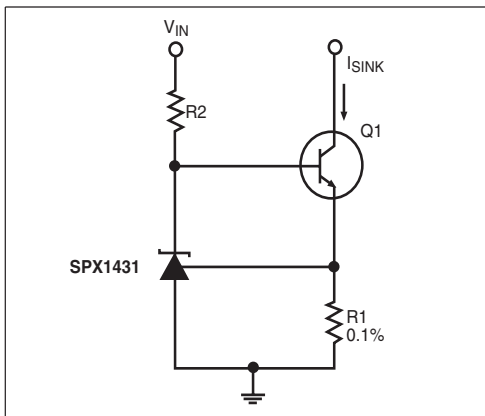


Figure 21. Constant Current, Sink,  $I_{\text{SINK}} = V_{REF}/R1$

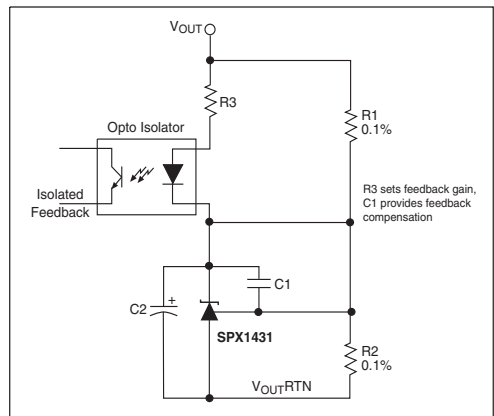


Figure 22. Reference Amplifier for Isolated Feedback in Off-Line DC-DC Converters

## TYPICAL PERFORMANCE CHARACTERISTICS

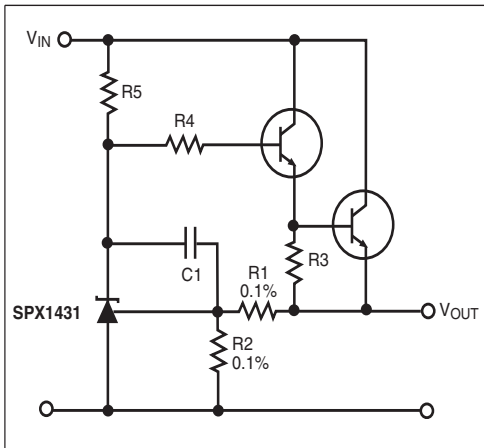


Figure 23. Precision High Current Series Regulator

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

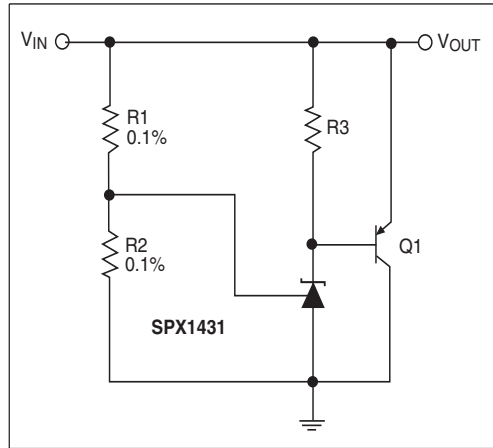


Figure 24. High Current Shunt Regulator

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

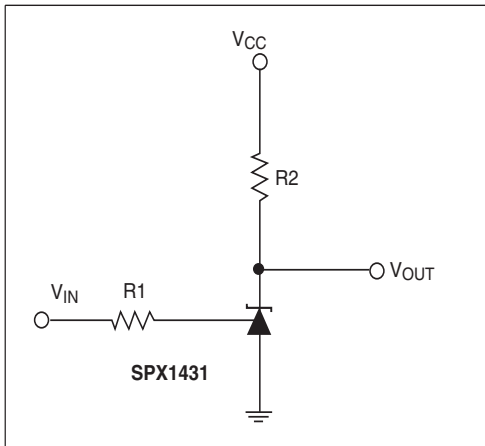
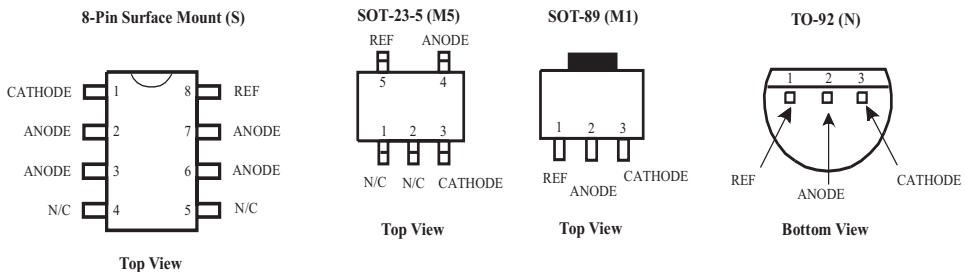


Figure 25. Single Supply Comparator with Temperature Compensated Threshold.  $V_{IN}$  threshold = 2.5V

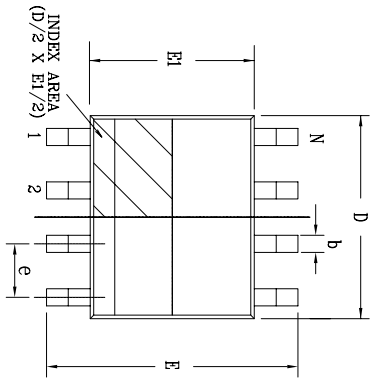
\* Resistor values are chosen such that the effect to  $I_{REF}$  is negligible .

## PACKAGE PINOUTS

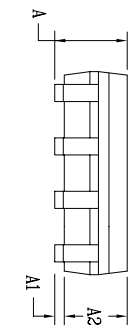


REVISION HISTORY			
REV	DESCRIPTION	DATE	APP'D
A	DRAWING ORIGINATION	08/16/05	JL
B	DRAWING FORMAT MODIFICATION	07/19/06	JL

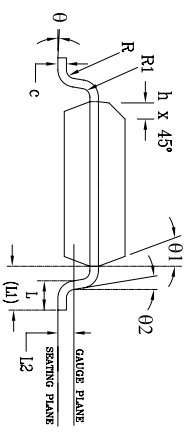
8 Pin SOICN		JEDEC MS-012		Variation AA	
SYMBOLS	DIMENSIONS IN MM (Control Unit)		DIMENSIONS IN INCH (Reference Unit)		MAX
	MIN	NOM	MIN	NOM	
A	1.35	—	1.75	0.053	—
A1	0.10	—	0.25	0.004	—
A2	1.25	—	1.65	0.049	—
b	0.31	—	0.51	0.012	—
c	0.17	—	0.25	0.007	—
E	6.00 BSC		0.236 BSC		—
E1	3.90 BSC		0.154 BSC		—
e	1.27 BSC		0.050 BSC		—
h	0.25	—	0.50	0.010	—
L	0.40	—	1.27	0.016	—
L1	1.04 REF		0.041 REF		—
L2	0.25 BSC		0.010 BSC		—
R	0.07	—	—	0.003	—
R1	0.07	—	—	0.003	—
θ	0°	—	8°	0°	—
θ1	5°	—	15°	5°	—
θ2	0°	—	—	0°	—
D	4.90 BSC		0.193 BSC		—
N	8		8		—




Top View



Side View

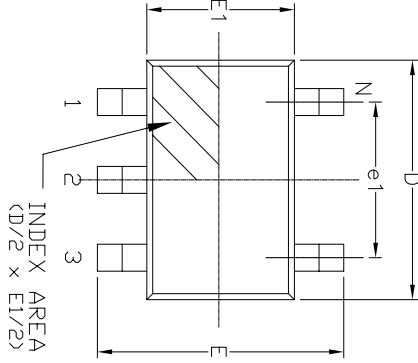


Front View

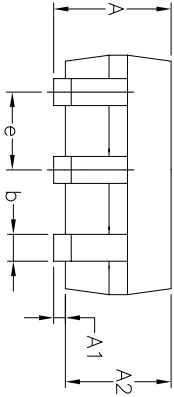
		<b>SIPLEX CORPORATION</b>	
Packaging Approval:		Drawing No.:	
By: JL	Date: 07/19/06	Revision: B	Sheet: 1 OF 1



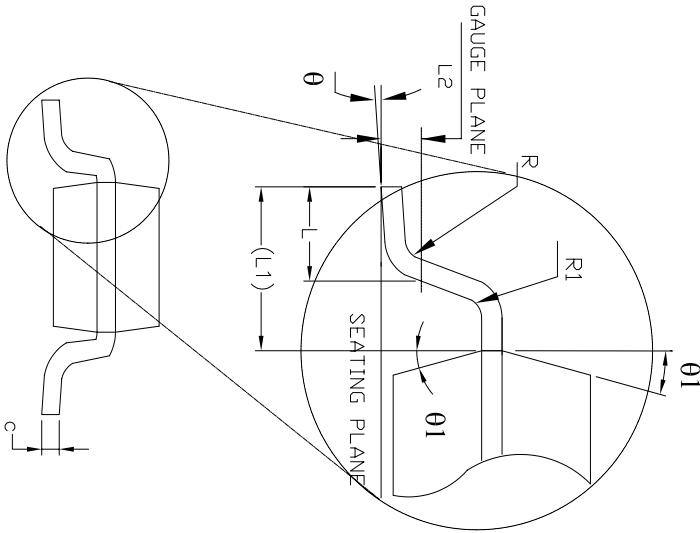
Top View



Side View




Front View

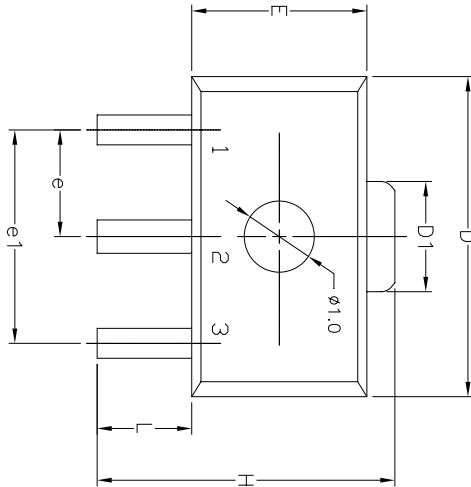


REVISION HISTORY			
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A	DRAWING ORIGINATOR	10/3/05	JL
B	DRAWING FORMAT MODIFICATION	07/25/06	JL

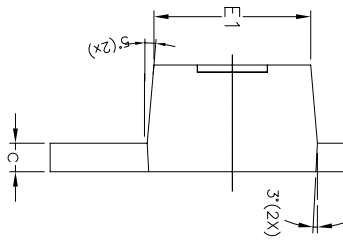
5 Pin SOT-23 JEDEC MO-178 Variation AA		DIMENSIONS IN MM		DIMENSIONS IN INCH	
SYMBOLS	MIN	NOM	MAX	MIN	MAX
A	—	1.45	—	—	0.057
A1	0.00	0.15	0.000	—	0.006
A2	0.90	1.15	1.30	0.036	0.045
b	0.30	—	0.50	0.012	—
c	0.08	—	0.22	0.003	—
D	—	2.90 BSC	—	—	0.115 BSC
E	—	2.80 BSC	—	—	0.111 BSC
E1	—	1.60 BSC	—	—	0.063 BSC
e	—	0.95 BSC	—	—	0.038 BSC
e1	—	1.90 BSC	—	—	0.075 BSC
L	0.30	0.45	0.60	0.012	0.018
L1	—	0.60 REF	—	—	0.024 REF
L2	—	0.25 BSC	—	—	0.010 BSC
R	0.10	—	—	0.004	—
R1	0.10	—	0.25	0.004	—
theta	0°	4°	8°	0°	4°
theta1	5°	10°	15°	5°	10°
N	—	5	—	—	5


**SIPLEX CORPORATION**  
 5 PIN SOT-23 PACKAGE OUTLINE  
 Packaging Approval: \_\_\_\_\_ Drawing No: 5-PIN SOT-23  
 By: JL Date: 07/25/06 Revision: B Sheet: 1 OF 1

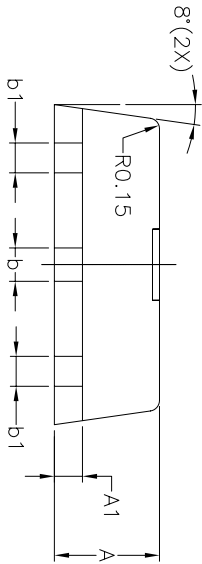
Top View



Front View




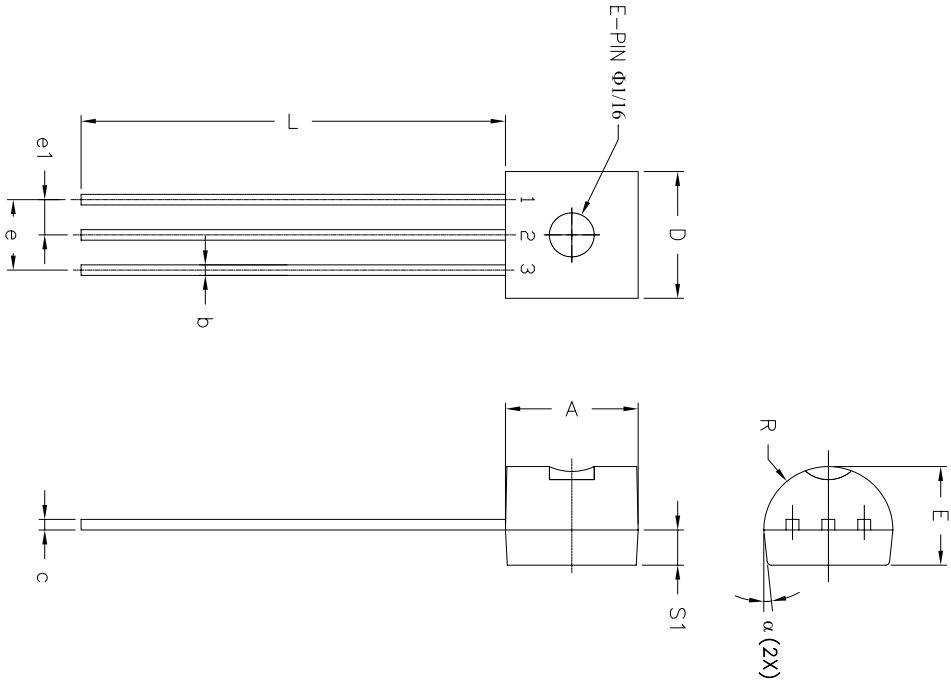
Side View



REVISION HISTORY			
REV.	DISCRIPTION	DATE	APP'D
A	DRAWING ORIGINATION	02/02/06	JL
B	DRAWING FORMAT MODIFICATION	09/11/06	JL

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	1.63	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		

		SIPLEX CORPORATION	
Packaging Approval:	By: JL	Date: 09/11/06	Drawing No: 3-PIN SOT-89
			Revision: B
			Sheet: 1 OF 1



3 Pin TO-92 JEDEC TO-226-AA					
SYMBOLS	DIMENSIONS IN INCH (Control Unit)		DIMENSIONS IN MM (Reference Unit)		
	MIN	MAX	MIN	MAX	MAX
A	0.170	0.210	4.32	5.33	
b	0.014	0.020	0.36	0.51	
c	0.016	0.022	0.41	0.55	
D	0.175	0.205	4.45	5.20	
E	0.125	0.165	3.18	4.19	
e	0.095	0.105	2.42	2.66	
e1	0.045	0.055	1.15	1.39	
L	0.500	0.610	12.70	15.49	
R	0.045	0.095	2.16	2.41	
S1	0.045	0.060	1.14	1.52	
$\alpha$	4°	6°	4°	6°	
N	3		3		

REVISION HISTORY			
REV.	DESCRIPTION	DATE	APP'D
A	DRAWING ORIGINATION	09/23/05	JL
B	DRAWING FORMAT MODIFICATION	08/15/06	JL

		<b>SIPEX CORPORATION</b>	
Packaging Approval:		3 PIN TO-92 PACKAGE OUTLINE	
Bpr: JL	Date: 08/15/06	Drawing No:	3-PIN TO-92
Revision: B		Sheet:	1 OF 1

Part Number	Package Code	RoHS	Status	Pack Quantity
SPX1431M1	SOT-89-3		Active	Bulk
SPX1431M1/TR	SOT-89-3		Active	2500 Tape & Reel
SPX1431M1-L	SOT-89-3	▪	Active	Bulk
SPX1431M1-L/TR	SOT-89-3	▪	Active	2500 Tape & Reel
SPX1431M5	SOT-23-5		EOL	Bulk
SPX1431M5/TR	SOT-23-5		EOL	2500 Tape & Reel
SPX1431M5-L	SOT-23-5	▪	EOL	Bulk
SPX1431M5-L/TR	SOT-23-5	▪	EOL	2500 Tape & Reel
SPX1431N	TO-92		EOL	Bulk
SPX1431N/TR	TO-92		OBS	2000 Tape & Reel
SPX1431N-L	TO-92	▪	EOL	Bulk
SPX1431N-L/TR	TO-92	▪	EOL	2000 Tape & Reel
SPX1431S	NSOIC8		EOL	Bulk
SPX1431S/TR	NSOIC8		EOL	2500 Tape & Reel
SPX1431S-L	NSOIC8	▪	EOL	Bulk
SPX1431S-L/TR	NSOIC8	▪	EOL	2500 Tape & Reel



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