Precision Adjustable Shunt Regulator

April 2013 Rev. 2.0.1

GENERAL 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 VREF and 36 volts with two external resistors. The SPX1431 is available in SOIC-8 and SOT-89-3 packages.

APPLICATIONS

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

FEATURES

- **Trimmed Bandgap Reference to 0.4%**
- **Wide Operating Current 1mA to 150mA**
- **-55°C to 125°C Extended Temperature Range**
- **30 ppm/°C Low Temperature Coefficient**
- **Improved Replacement in Performance for LT1431**
- **Low Cost Solution**
- **Offered in SOIC-8 and SOT-89**

TYPICAL APPLICATION DIAGRAM

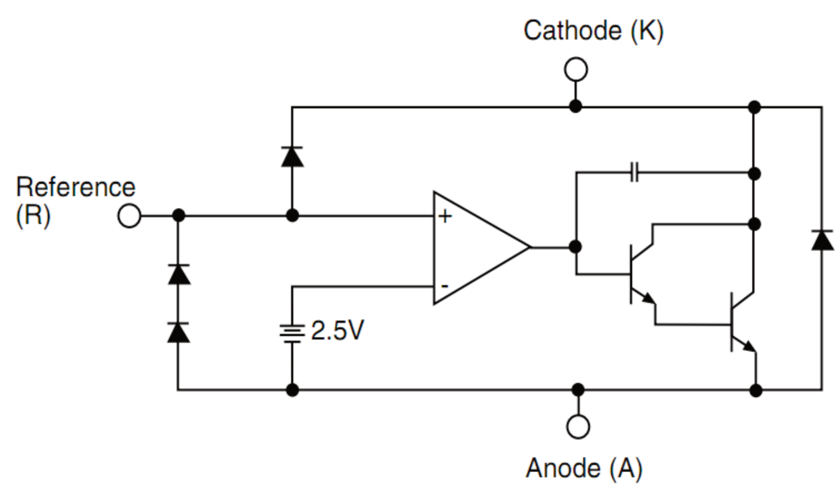

Fig. 1: SPX1431 Block Diagram

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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 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.........................
NSOIC-8 .... 750mW
SOT-89-3 .... 1000mW
Junction Temperature T_J..................................... 150°C
Storage Temperature T_{STG}........................ -65°C to 150°C
ESD Rating (HBM - Human Body Model) 2kV

OPERATING RATINGS

Cathode Voltage V_{KA} .... VREF to 36V
Cathode Current I_K 10mA
Operating Junction Temperature T_J............-55°C to 150°C
Thermal Resistance ....
θ_{JA} (NSOIC8) ....175°C/W
θ_{JC} (NSOIC8) .... 45°C/W
θ_{JA} (SOT89-3)...110°C/W
θ_{JC} (SOT89-3)... 8°C/W

ELECTRICAL SPECIFICATIONS

Specifications with standard type are for an Operating Junction Temperature of $T_A = T_J = 25°C$ only; limits applying over the full Operating Junction 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 $T_A = T_J = 25°C$, and are provided for reference purposes only. Unless otherwise indicated, $V_K = V_{REF}$, I_K = 10mAµF, T_A= 25°C.

Parameter	Min.	Typ.	Max.	Units		Conditions
Reference Voltage V_{REF}	2.490	2.500	2.510	V		Figure 5
	2.465		2.535			T_J= 0°C to 105°C, figure 5
ΔV_{REF} with Temperature TC		0.07	.20	mV/°C		Figure 5
Ratio of Change in V_{REF} to Cathode Voltage $\Delta V_{REF}/ \Delta V_K$	-2.0	-1.1		mV/V		V_K= 3V to 36V, figure 6
Reference Input Current I_{REF}		0.7	1.9	µA		Figure 6
I_{REF} Temp Deviation ΔI_{REF}		0.4	1.2	µA		T_J= 0°C to 105°C, figure 6
Min I_K for Regulation $I_{K(MIN)}$		0.4	1	mA		Figure 5
Off State Leakage $I_{K(OFF)}$		0.04	250	nA		V_{REF} = 0V, V_{KA} = 36V, figure 7
Dynamic Output Impedance Z_{KA}		0.15	0.5	Ω		$f_z \leq$ 1kHz, I_K= 1 to 150mA, figure 5

BLOCK DIAGRAM

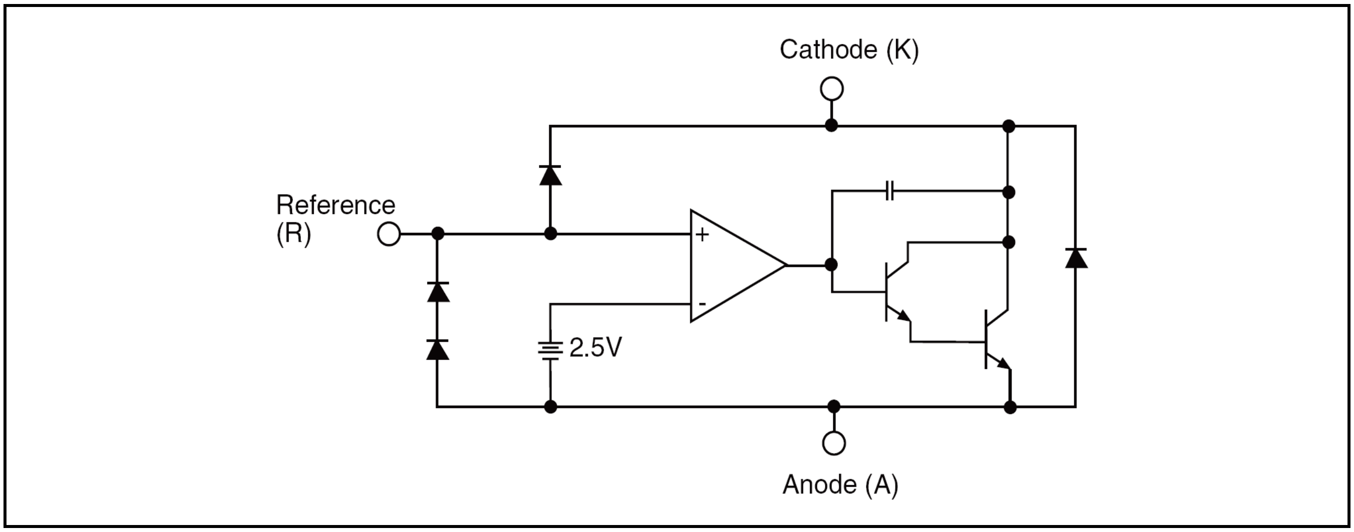


Fig. 2: SPX1431 Block Diagram

PIN ASSIGNMENT

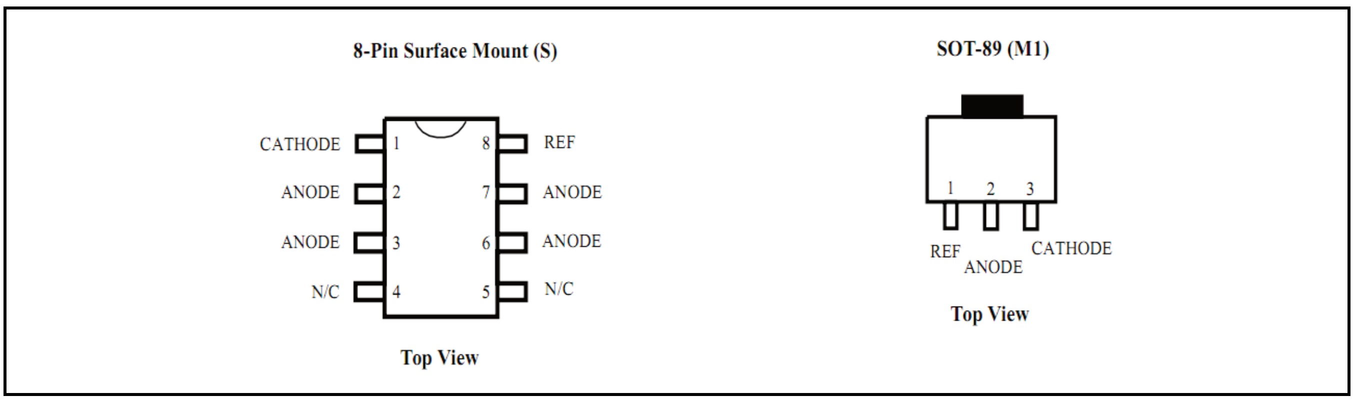


Fig. 3: SPX1431 Pin Assignment

ORDERING INFORMATION

Part Number	Temperature Range	Marking	Package	Packing Quantity	Note 1	Note 2
SPX1431M1-L	-55°C≤T_J≤+125°C	N011 YWWXXX	SOT-89-3	Bulk	Halogen Free	Bar on left side of marking denotes "–L" Pb free product
SPX1431M1-L/TR				2.5K/Tape & Reel		
SPX1431S-L	-55°C≤T_J≤+125°C	SPX1431 25YYWWL XXXXXXX	NSOIC8	Bulk	Halogen Free	
SPX1431S-L/TR				2.5K/Tape & Reel		

"YY" = Year (Last two digits) – "Y" = Year (Last Digit)

"WW" = Work Week

"XXX" = Lot Number (Example AA234567)

"XXXXXX" = Lot Number (Example AA234567)

These products have no bottom side marking.

CALCULATING AVERAGE TEMPERATURE COEFFICIENT (TC)

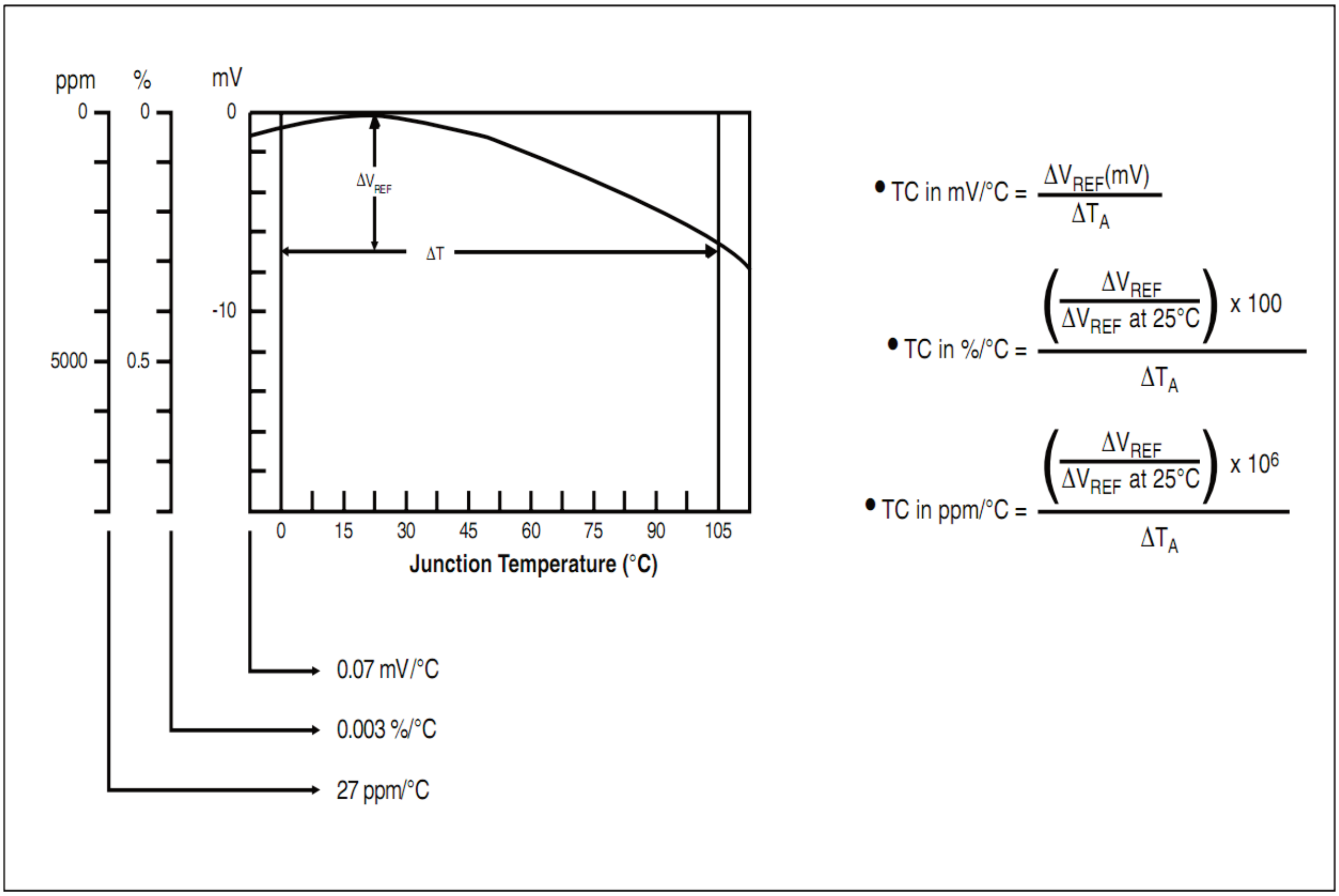


Fig. 4: V_{REF} vs. Temperature

TEST CIRCUITS

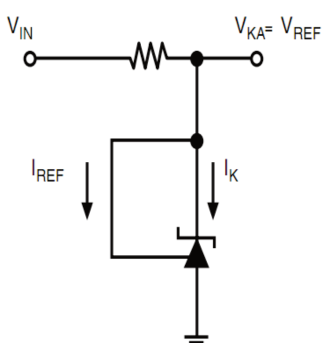


Fig. 5: Test Circuit for $V_{KA}=V_{REF}$

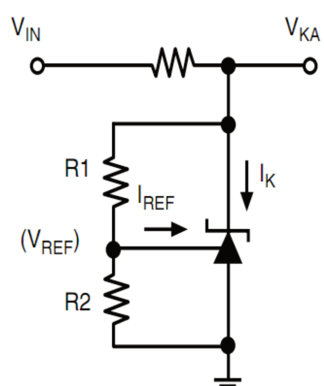


Fig. 6: Test Circuit for $V_{KA}>V_{REF}$

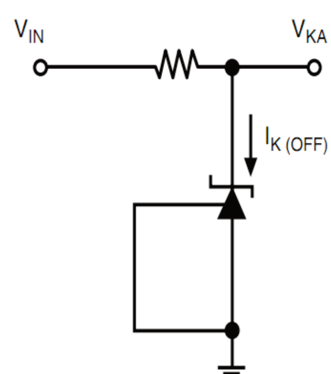


Fig. 7: Test Circuit for I_{KOFF}

TYPICAL PERFORMANCE CHARACTERISTICS

All data taken at Unless otherwise indicated, $V_K = V_{REF}$, I_K = 10mAµF, T_A= 25°C.

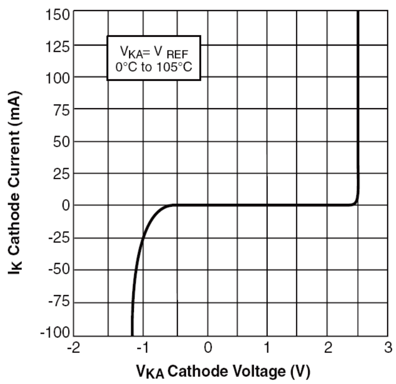


Fig. 8: High Current Operating Characteristics

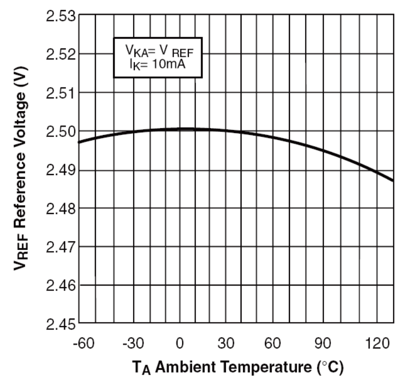


Fig. 9: Reference Voltage vs. Ambient Temperature

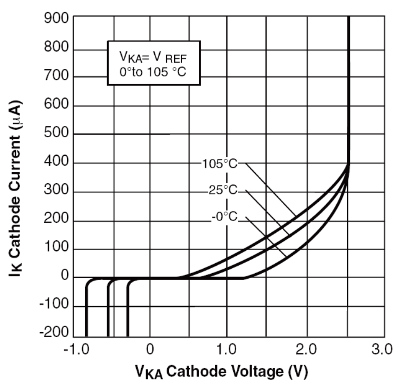


Fig. 10: Low Current Operating Characteristics

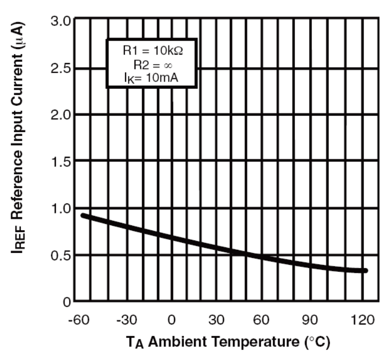


Fig. 11: Reference Input Current vs. Ambient Temperature

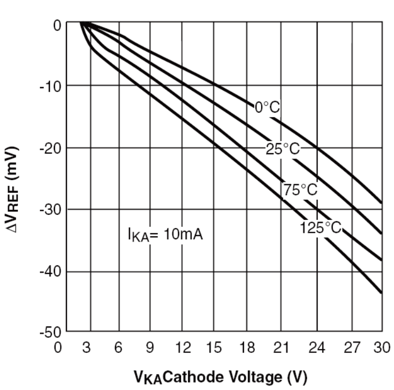


Fig. 12: Reference Voltage Line Regulation vs. Cathode Voltage and $T_{AMBIENT}$

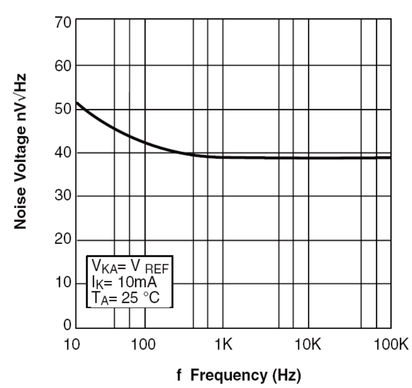


Fig. 13: Noise Voltage vs. Frequency

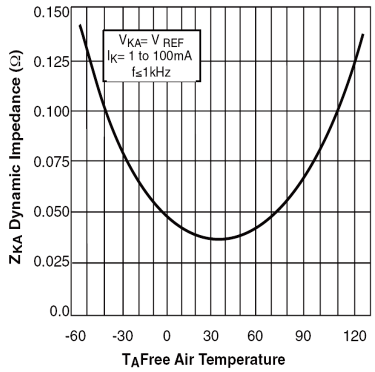


Fig. 14: Low Frequency Dynamic Output Impedance vs. $T_{AMBIENT}$

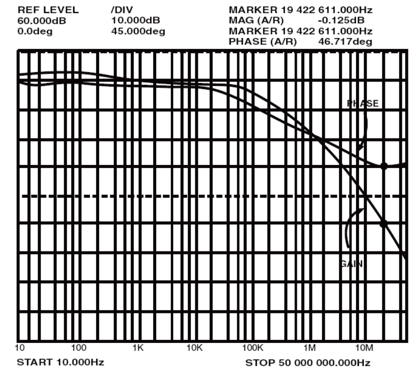


Fig. 15: Small Signal Gain and Phase vs. Frequency; I_K= 10mA, T_A= 25°C

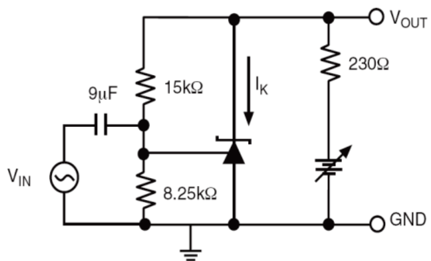


Fig. 16: Test Circuit for Gain and Phase Frequency Response

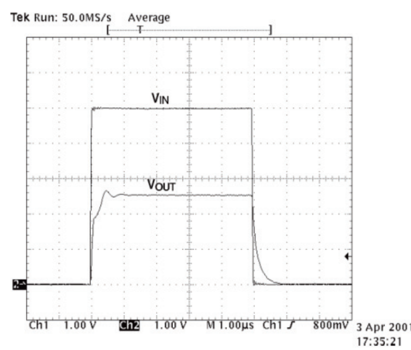


Fig. 17: Frequency = 100kHz
I_K = 10mA, T_A= 25°C

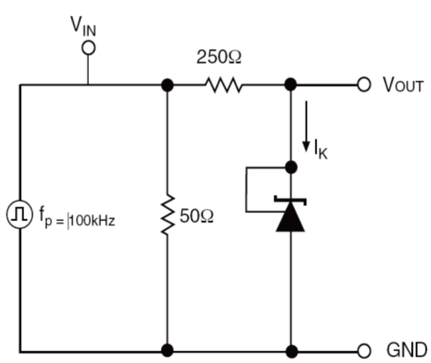


Fig. 18: Test Circuit for Pulse Response

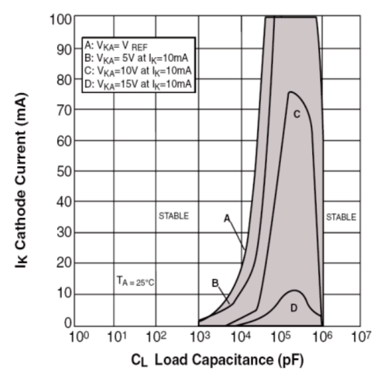


Fig. 19: Stability Boundary Conditions

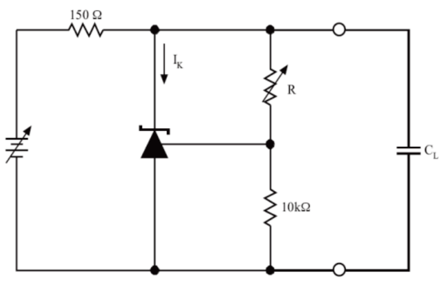


Fig. 20: Test Circuit for Stability

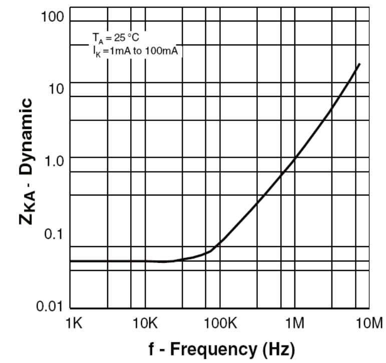


Fig. 21: Dynamic Output Impedance
T_A= 25°C, I_K= 1 to 100mA

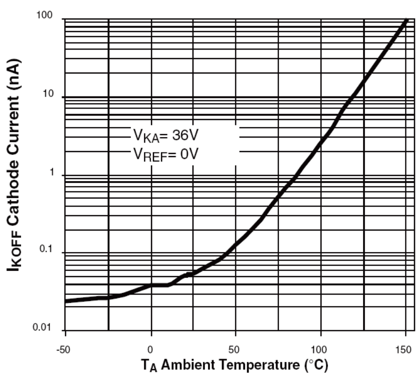


Fig. 22: Off State Leakage

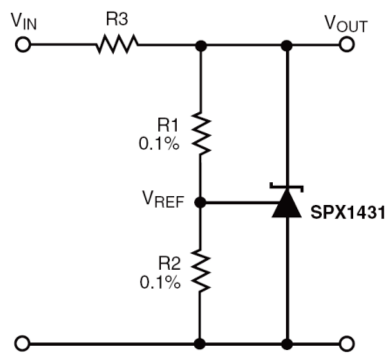


Fig. 23: Shunt Regulator V_{OUT} = (1+R1/R2).V_{REF}

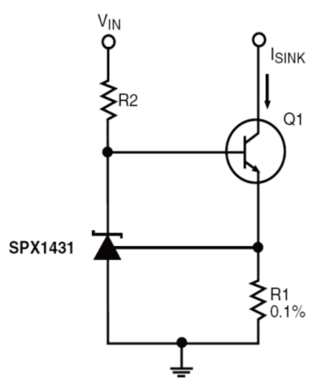


Fig. 24: Constant Current, Sink, I_{SINK}= V_{REF}/R1

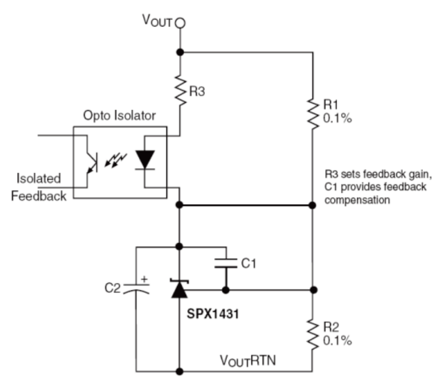


Fig. 25: Reference Amplifier for Isolated Feedback in Off-Line DC-DC Converters

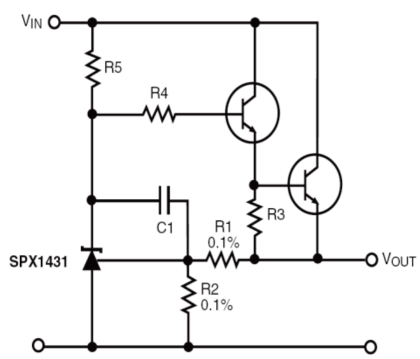


Fig. 26: Precision High Current Series Regulator
V_{OUT}= (1+R1/R2)V_{REF}

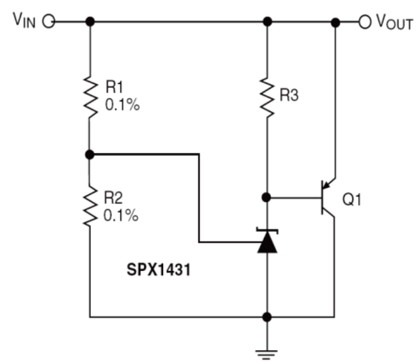


Fig. 27: High Current Shunt Regulator
V_{OUT}= (1+R1/R2)V_{REF}

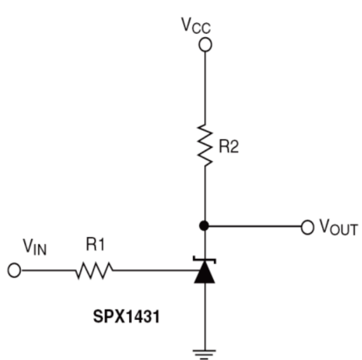
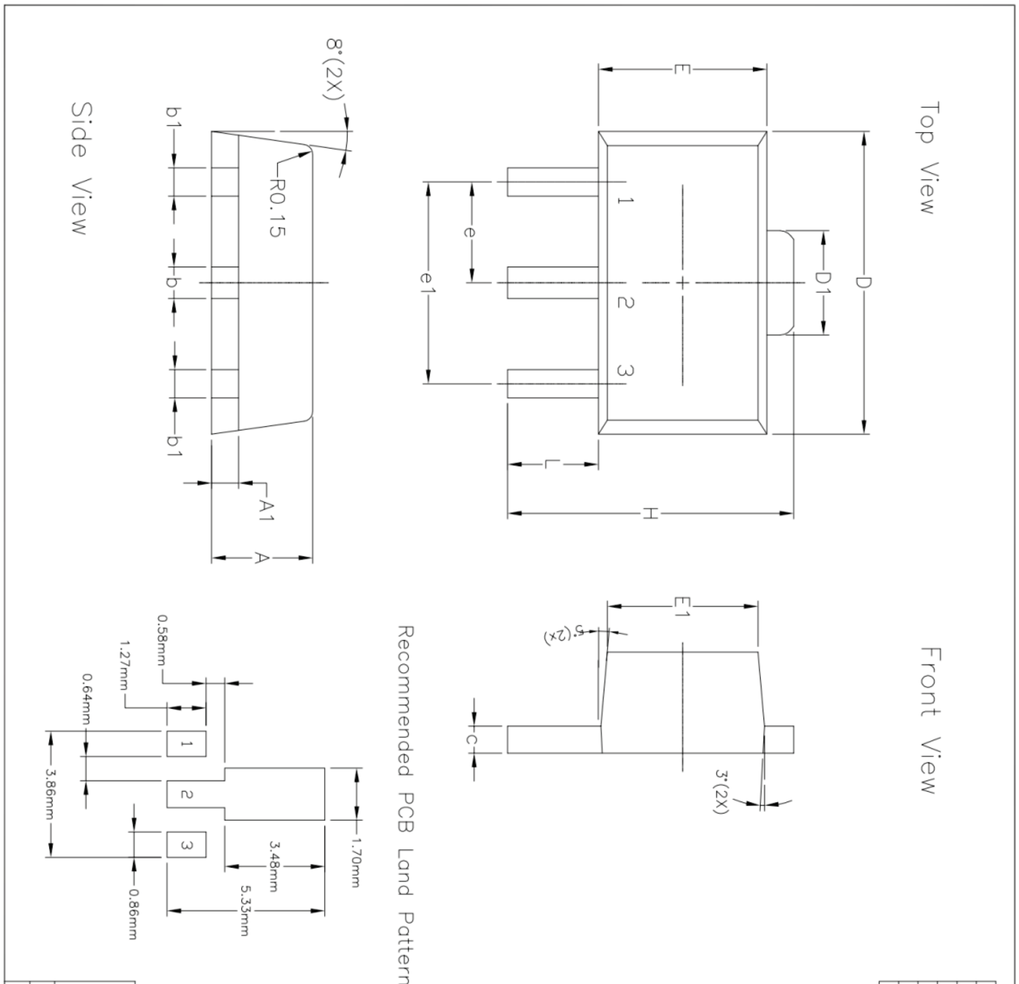


Fig. 28: Single Supply Comparator with Temperature Compensated Threshold. V_{IN} threshold = 2.5V

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

PACKAGE SPECIFICATION

SOT-89-3



REVISION HISTORY

REV.	DISCRIPTION	DATE	APP'D
A	DRAWING ORIGINATION	02/02/06	JL
B	DRAWING FORMAT MODIFICATION	09/11/06	JL
C	CHANGE DRAWING LOGO AND COMPANY NAME	11/28/07	JL
D	ADD RECOMMENDED PCB LAND PATTERN	01/28/10	PC
E	REMOVE ROUND INDENTATION	04/26/13	PC

3 Pin SOT-89 JEDEC TO-243 Variation AA

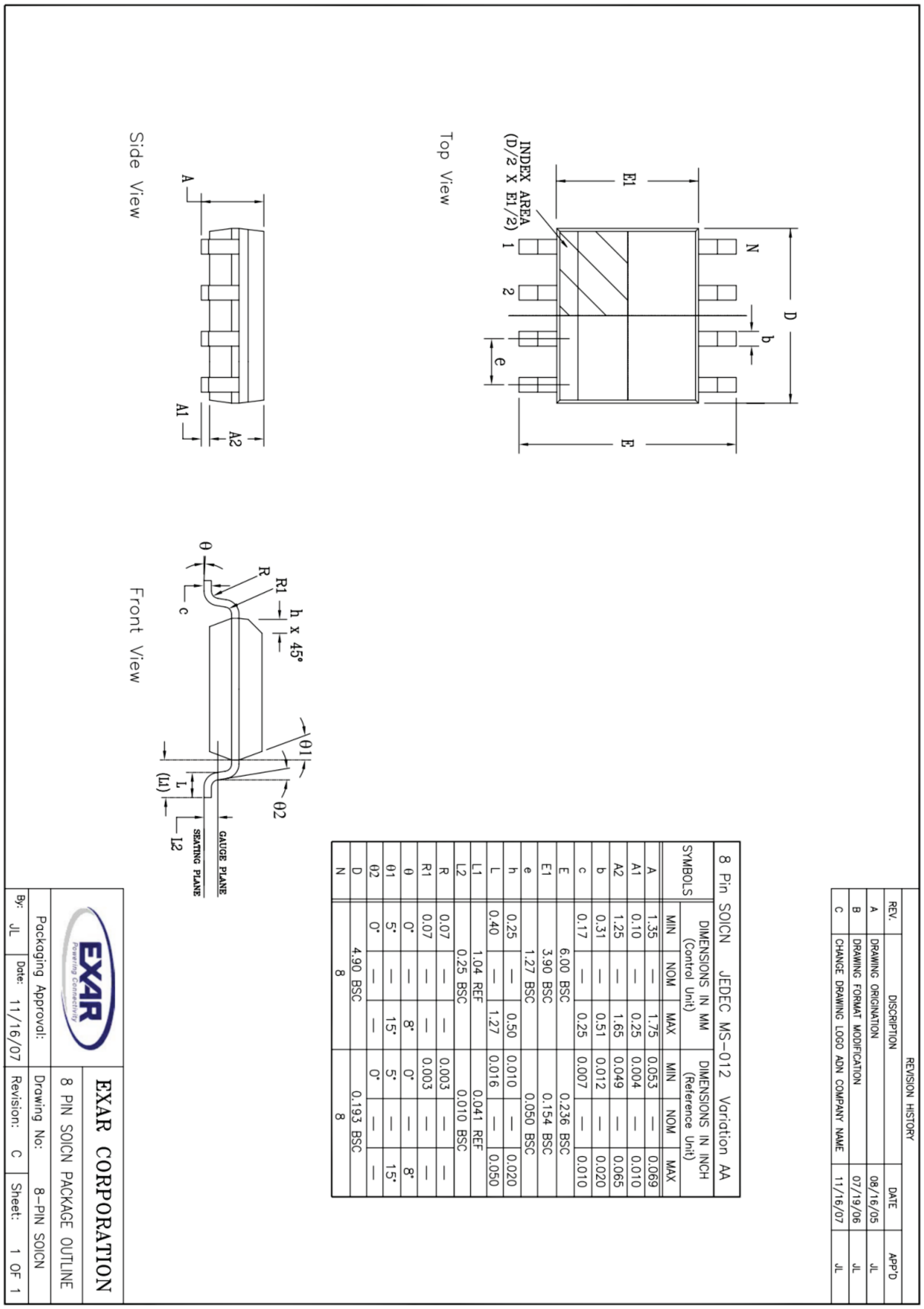
SYMBOLS	DIMENSIONS IN MM (Control Unit)			DIMENSIONS IN INCH (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.40	1.50	1.60	0.055	0.059	0.063
A1	0.30	0.40	0.50	0.011	0.015	0.019
b	0.44	0.47	0.56	0.017	0.018	0.022
b1	0.36	0.42	0.48	0.014	0.016	0.019
c	0.35	0.40	0.44	0.014	0.015	0.017
D	4.40	4.50	4.60	0.173	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		

EXAR CORPORATION

3 PIN SOT-89 PACKAGE OUTLINE

Packaging Approval:		Drawing No:	3-PIN SOT-89
By: PC	Date: 04/26/13	Revision: E	Sheet: 1 OF 1

NSOIC-8



REVISION HISTORY			
REV.	DISCRIPTION	DATE	APP'D
A	DRAWING ORIGINATION	08/16/05	JL
B	DRAWING FORMAT MODIFICATION	07/19/06	JL
C	CHANGE DRAWING LOGO ADN COMPANY NAME	11/16/07	JL

8 Pin SOICN JEDEC MS–012 Variation AA						
SYMBOLS	DIMENSIONS IN MM (Control Unit)			DIMENSIONS IN INCH (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	—	1.75	0.053	—	0.069
A1	0.10	—	0.25	0.004	—	0.010
A2	1.25	—	1.65	0.049	—	0.065
b	0.31	—	0.51	0.012	—	0.020
c	0.17	—	0.25	0.007	—	0.010
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	—	0.020
L	0.40	—	1.27	0.016	—	0.050
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°	—	8°
θ1	5°	—	15°	5°	—	15°
θ2	0°	—	—	0°	—	—
D	4.90 BSC			0.193 BSC		
N	8			8		

REVISION HISTORY

Revision	Date	Description
2.0.0	04/26/2013	Reformat of Datasheet Update of SOT89-3 package specification Added ESD rating in Absolute Maximum Ratings
2.0.1	07/19/2013	Updated Top Mark information and provided clarifying information

FOR FURTHER ASSISTANCE

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Exar Technical Documentation: http://www.exar.com/TechDoc/default.aspx?

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