



### GENERAL DESCRIPTION

The SPX431L is a 3-terminal adjustable shunt voltage regulator providing a highly accurate bandgap reference. The SPX431L acts as an open-loop error amplifier with a 2.5V temperature compensation reference. The SPX431L's thermal stability, wide operating current (100mA) and temperature range (0°C to 105°C) makes it suitable for a variety of applications that require a low cost, high performance solution. SPX431L tolerance of 0.5% 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 line and contribute a significant cost savings.

The output voltage may be adjusted to any value between VREF and 20V with two external resistors. The SPX431L is available in TO-92, and SOT-89 packages.

### APPLICATIONS

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

### FEATURES

- **Tight Voltage Tolerance 0.5% at 10mA**
- **Wide Operating Current 1mA to 100mA**
- **Extended Temperature Range: 0°C to 105°C**
- **Low Temperature Coefficient 30 ppm/°C**
- **Improved Replacement in Performance for TL431 and AS431**
- **Low Cost Solution**

### TYPICAL BLOCK DIAGRAM

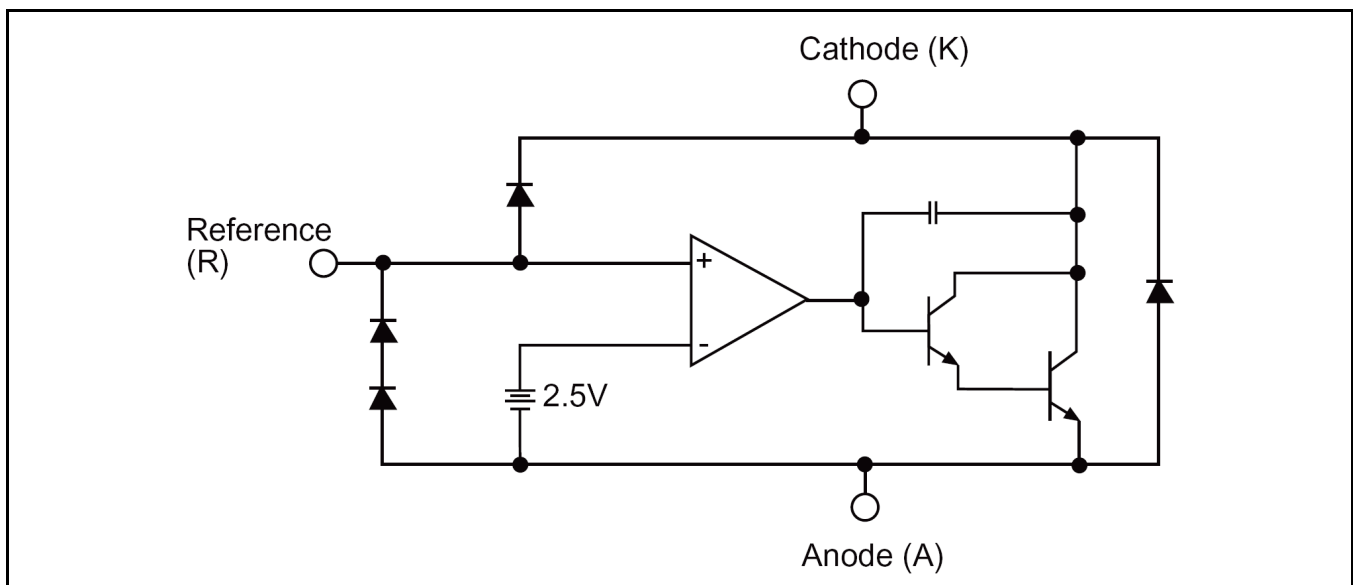


Fig. 1: SPX431L Precision Adjustable Shunt Regulator



A New Direction in Mixed-Signal

# SPX431L

## 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 $V_{KA}$ .....	20V
Anode-Cathode Forward Current, (<10ms) $I_{AK}$ .....	1A
Operating Cathode Current $I_{KA}$ .....	100mA
Reference Input Current $I_{REF}$ .....	10mA
Continuous Power Dissipation at 25°C PD	
TO-92 .....	775mW
SOT-89 .....	1000mW
Storage Temperature $T_{STG}$ .....	-65 to 150°C
Lead Temperature (Soldering 10 sec.) $T_L$ .....	300°C

### OPERATING RATINGS

Input Voltage Range $V_{KA}$ .....	$V_{REF}$ to 20V
Cathode Current $I_K$ .....	10ma
Junction Temperature Range .....	150 °C
Thermal Resistance	
$\theta_{JA}$ (TO-92) .....	160°C/W
$\theta_{JC}$ (TO-92) .....	80°C/W
Typical Derating (TO-92) .....	6.3 mW/°C
$\theta_{JA}$ (SOT-89) .....	110°C/W
$\theta_{JC}$ (SOT-89) .....	8°C/W
Typical Derating (SOT-89) .....	9.1 mW/°C

### ELECTRICAL SPECIFICATIONS

Specifications with standard type are for an Operating Junction Temperature of  $T_A = 25^\circ\text{C}$  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  $T_A = 25^\circ\text{C}$ , and are provided for reference purposes only. Unless otherwise indicated,  $I_K = 10\text{mA}$   $V_K = V_{REF}$ .

Parameter	Min.	Typ.	Max.	Units	Conditions
<b>SPX431LA</b>					
Reference Voltage	2.490	2.503	2.515	V	
$\Delta V_{REF}$ with Temp. <sup>1</sup>		0.07	0.20	mV/°C	
Ratio of Change in $V_{REF}$ to Cathode Voltage	-2.7 -2.0	-1.0 -0.4	0.3	mV/V	$V_{REF}$ to 10V $V_{REF}$ to 10V
Reference Input Current		0.7	4.0	$\mu\text{A}$	
$I_{REF}$ Temp Deviation		0.4	1.2	$\mu\text{A}$	$T_J = 0^\circ\text{C}$ to $105^\circ\text{C}$
Min $I_K$ for Regulation		0.4	1.0	mA	
Off State Leakage		0.04	1.0	$\mu\text{A}$	$V_{REF} = 0\text{V}$ , $V_{KA} = 20\text{V}$
Dynamic Output Impedance		0.15	0.5	$\Omega$	$f_z \leq 1\text{kHz}$ $I_K = 1$ to $100\text{mA}$
<b>SPX431L</b>					
Reference Voltage	2.470	2.495	2.520	V	
$\Delta V_{REF}$ with Temp. <sup>1</sup>		0.07	0.20	mV/°C	
Ratio of Change in $V_{REF}$ to Cathode Voltage	-2.7 -2.0	-1.0 -0.4	0.3	mV/V	$V_{REF}$ to 10V $V_{REF}$ to 10V
Reference Input Current		0.7	4.0	$\mu\text{A}$	
$I_{REF}$ Temp Deviation		0.4	1.2	$\mu\text{A}$	$T_J = 0^\circ\text{C}$ to $105^\circ\text{C}$
Min $I_K$ for Regulation		0.4	1.0	mA	
Off State Leakage		0.04	1.0	$\mu\text{A}$	$V_{REF} = 0\text{V}$ , $V_{KA} = 20\text{V}$
Dynamic Output Impedance		0.15	0.5	$\Omega$	$f_z \leq 1\text{kHz}$ $I_K = 1$ to $100\text{mA}$
<b>SPX431LC</b>					
Reference Voltage	2.445	2.495	2.520	V	
$\Delta V_{REF}$ with Temp. <sup>1</sup>		0.07	0.20	mV/°C	
Ratio of Change in $V_{REF}$ to Cathode Voltage	-2.7 -2.0	-1.0 -0.4	0.3	mV/V	$V_{REF}$ to 10V $V_{REF}$ to 10V
Reference Input Current		0.7	4.0	$\mu\text{A}$	
$I_{REF}$ Temp Deviation		0.4	1.2	$\mu\text{A}$	$T_J = 0^\circ\text{C}$ to $105^\circ\text{C}$

**Precision Adjustable Shunt Regulator**

Parameter	Min.	Typ.	Max.	Units	Conditions
Min IK for Regulation		0.4	1.0	mA	
Off State Leakage		0.04	1.0	μA	VREF = 0V, VKA = 20V
Dynamic Output Impedance		0.15	0.5	Ω	fz ≤ 1kHz Ik = 1 to 100mA

Note 1: See appropriate test circuit (Figures 25, 26, 27)

**PIN ASSIGNMENT**

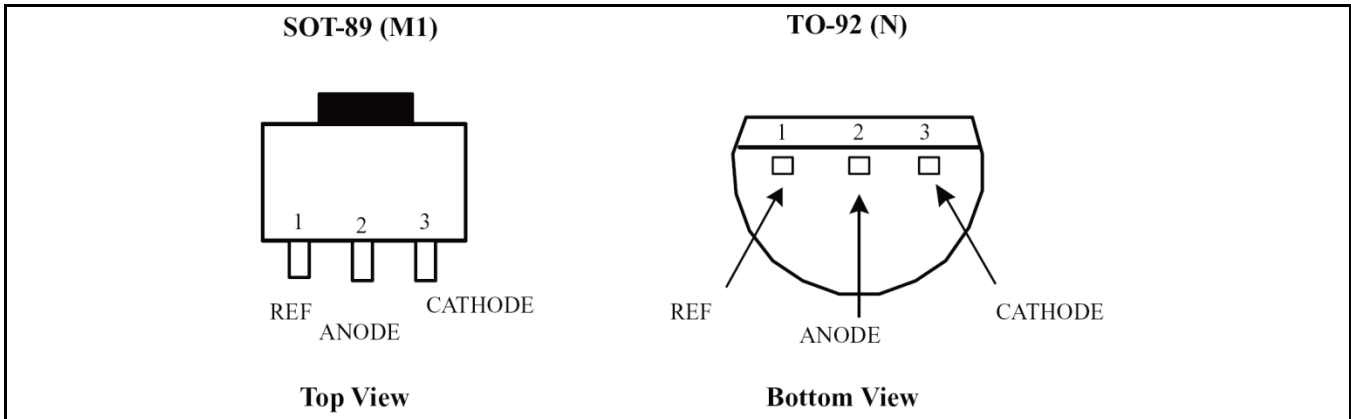


Fig. 2: SPX431L Pin Assignment

**PIN DESCRIPTION**

Name	Pin Number	Description
NAME	1	Reference
NAME	2	Anode
NAME	3	Cathode

**ORDERING INFORMATION**

Part Number	Temperature Range	Marking	Package	Packing Quantity	Note 1	Note 2
SPX431LAN-L	0°C to 105°C	Sipex 431LAN 25 YYWWLX	TO-92-3	Bulk	Halogen Free	2.503V 0.5% Acc
SPX431LAN-L/TR				Tape & Reel		
SPX431LM1-L	0°C to 105°C	P011 YWWXXX	SOT-89-3	Bulk	Halogen Free, bar on left side of marking denotes "-L" lead free product	2.495V 1.0% Acc
SPX431LM1-L/TR				Tape & Reel		
SPX431LN-L	0°C to 105°C	Sipex 431LN 25 YYWWLX	TO-92-3	Bulk	Halogen Free	2.495V 1.0% Acc
SPX431LN-L/TR				Tape & Reel		

"YY" = Year (Last 2 digits) - "Y" = Year (Last Digit)

"WW" = Work Week

"L" = Lead free designator

"X" = Lot Number (example AA234567) - "XXX" = Lot Number (example AA23456Z)

No bottom marking

**TYPICAL PERFORMANCE CHARACTERISTICS**

Schematic and BOM from Application Information section of this datasheet. Resistor values are chosen such that the effect to  $I_{REF}$  is negligible.

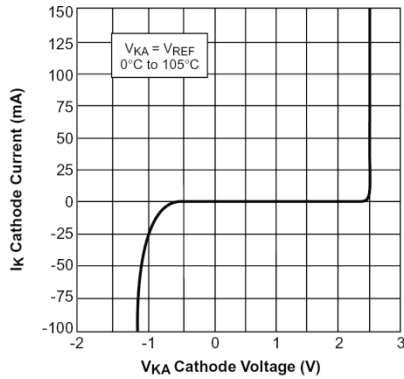


Fig. 3: High Current Operating Characteristics

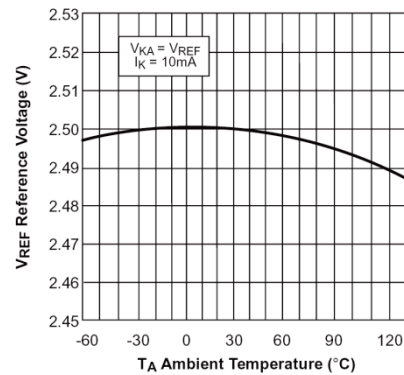


Fig. 4: Reference Voltage VS Ambient Temperature

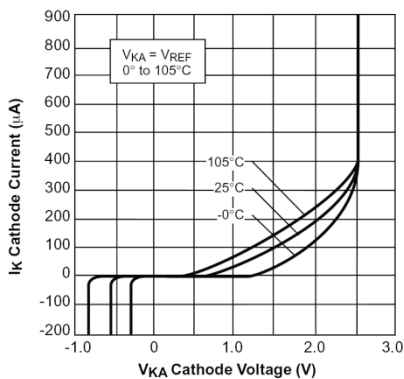


Fig. 5 Low Current Operating Characteristics.

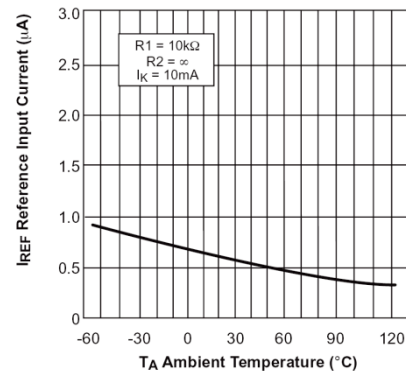


Fig. 6 Reference Input Current VS Ambient Temperature.

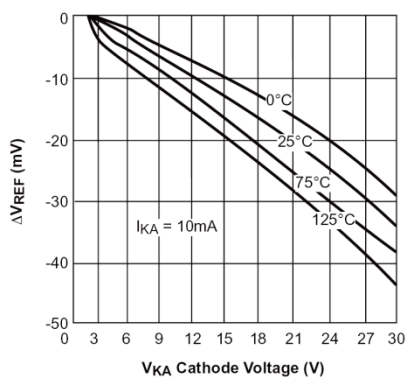


Fig. 7 Reference Voltage Line Regulation VS Cathode Voltage and  $T_{AMBIENT}$

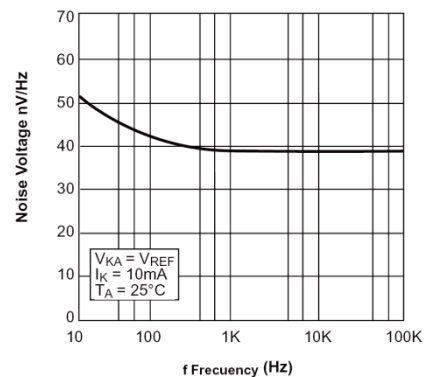


Fig. 8 Noise Voltage VS Frequency



Precision Adjustable Shunt Regulator

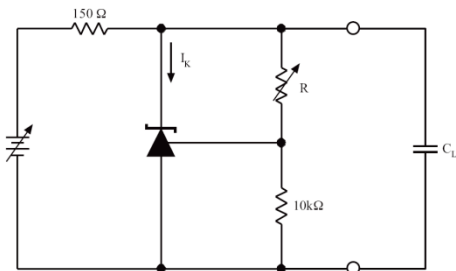


Fig. 55 Test Circuit for Stability

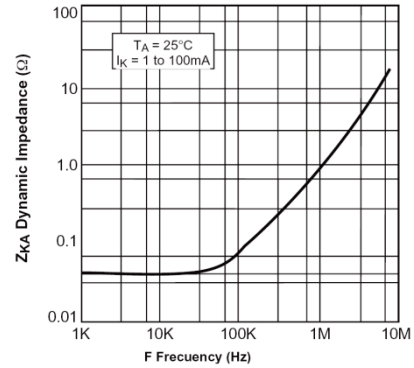


Fig. 66 Dynamic Output Impedance  $T_A = 25^\circ\text{C}$ ,  $I_k = 1$  to  $100\text{mA}$

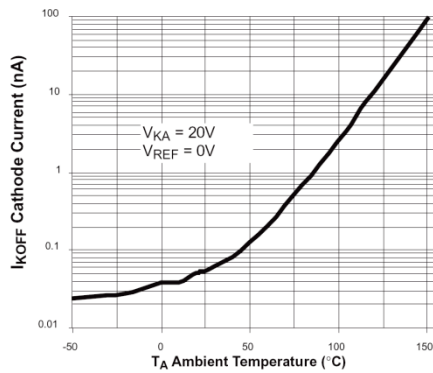


Fig. 77 Off State Leakage

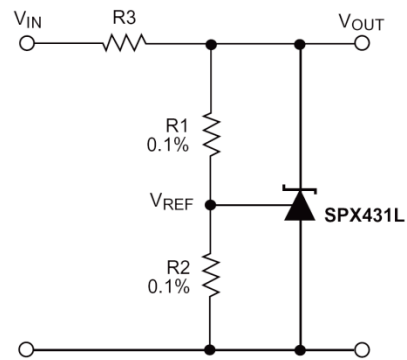


Fig. 88 Shunt Regulator  $V_{OUT} = (1 + R1/R2)V_{REF}$

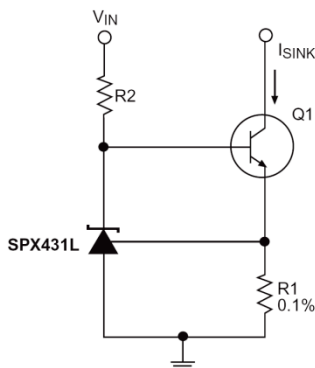


Fig. 199 Constant Current Sink,  $I_{SINK} = V_{REF}/R1$

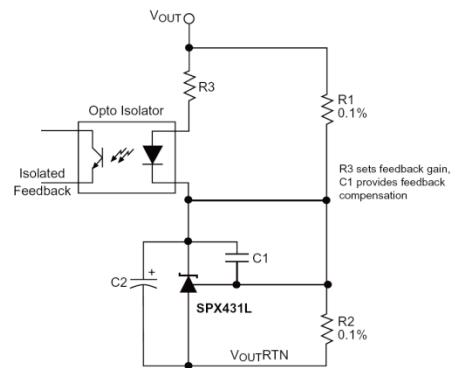


Fig. 100 Reference Amplifier for Isolated Feedback in Off-Line DC-DC Converters

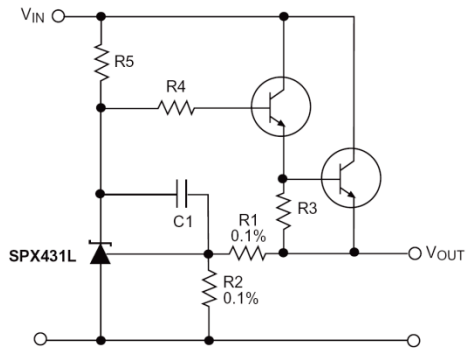


Fig. 111 Precision High Current Series Regulator  
 $V_{OUT} = (1 + R1/R2)V_{REF}$

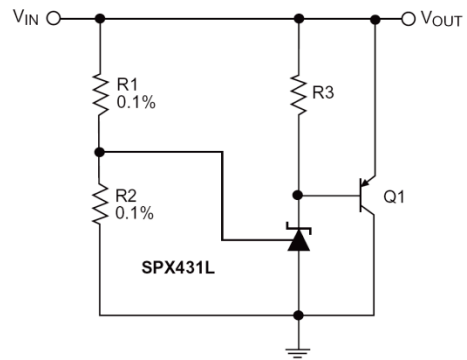


Fig. 122 High Current Shunt regulator  
 $V_{OUT} = (1 + R1/R2)V_{REF}$

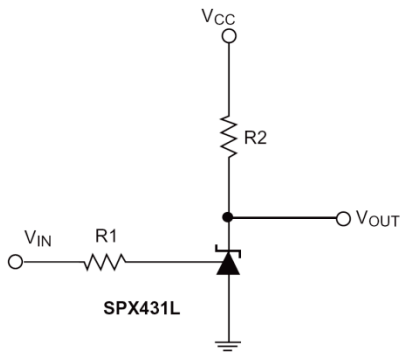


Fig. 133 Single Supply Comparator with Temperature Compensated Threshold.  $V_{IN}$  threshold = 2.5V.

**APPLICATION INFORMATION**

**CALCULATING AVERAGE TEMPERATURE COEFFICIENT (TC)**

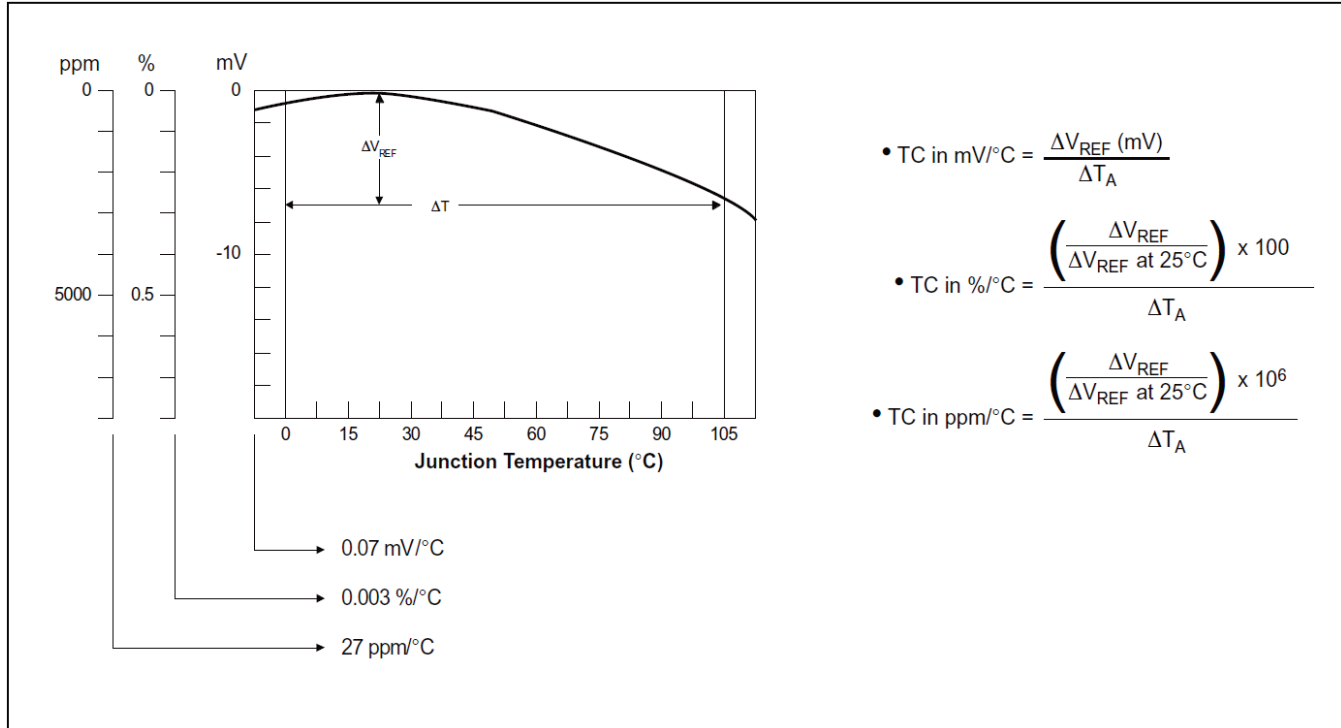


Fig. 24: V<sub>REF</sub> VS Temperature.

**TEST CIRCUITS**

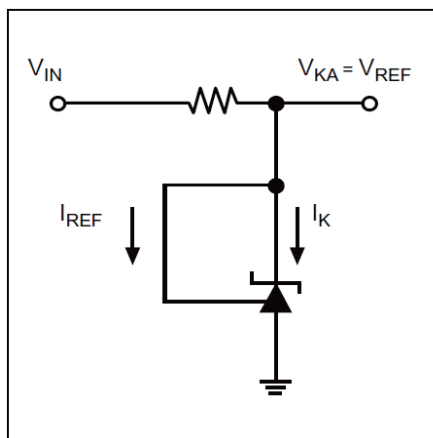


Fig. 25: Test Circuit for V<sub>KA</sub> = V<sub>REF</sub>

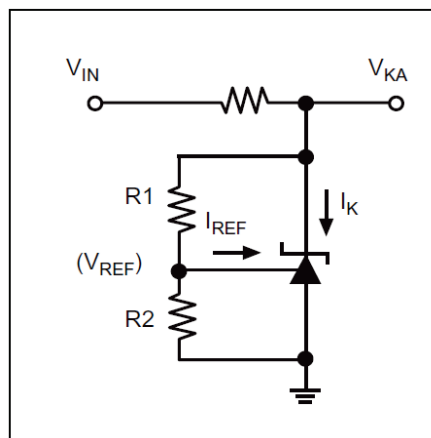


Fig. 26: Test Circuit for V<sub>KA</sub> > V<sub>REF</sub>

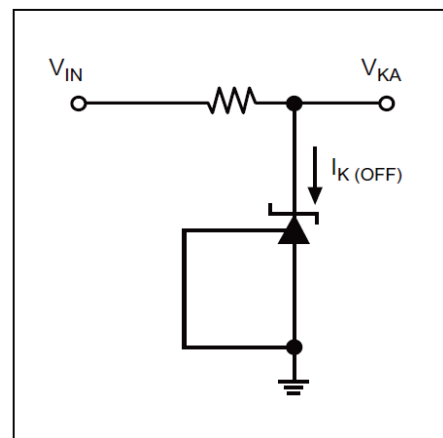


Fig. 27: Test Circuit for I<sub>K(OFF)</sub>





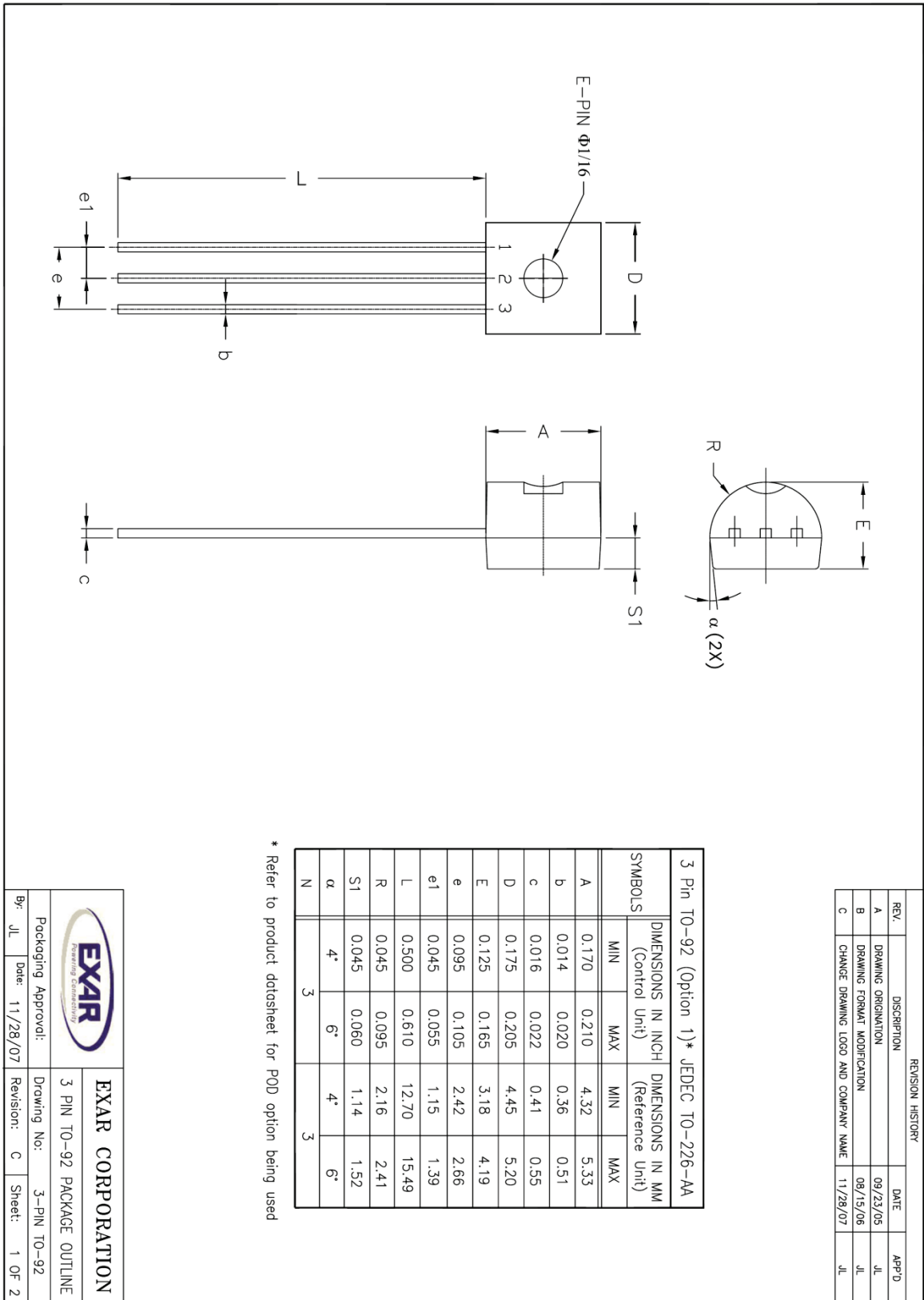
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**SPX431L**

**Precision Adjustable Shunt Regulator**

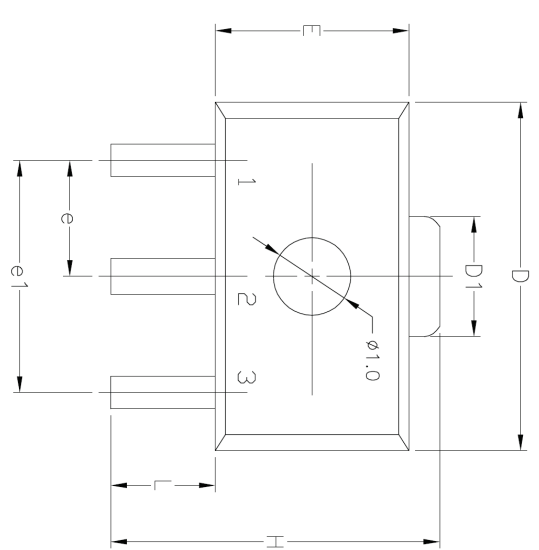
**PACKAGE SPECIFICATION**

**3 PIN TO-92**

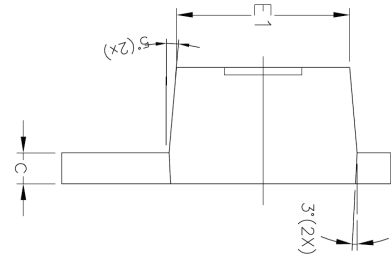


**PACKAGE SPECIFICATION**

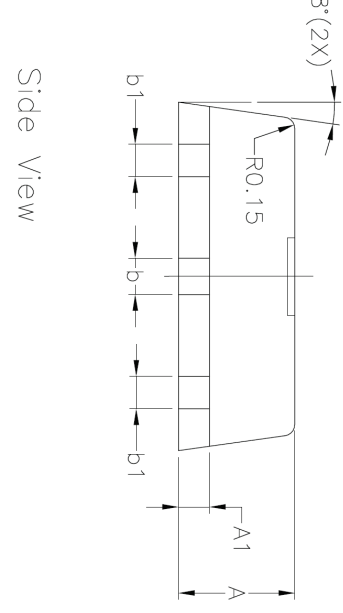
**3 PIN SOT-89**



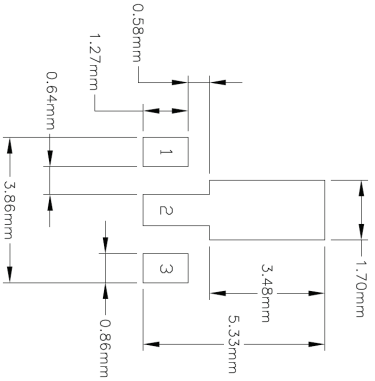
Top View



Front View



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		

REVISION HISTORY			
REV.	DESCRIPTION	DATE	APP'D
A	DRAWING ORIGINATOR	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

Packaging Approvals:		Drawing No:	
By: PC	Date: 01/28/10	Revision: D	Sheet: 1 OF 1



**EXAR CORPORATION**

3 PIN SOT-89 PACKAGE OUTLINE



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**SPX431L**

**Precision Adjustable Shunt Regulator**

**REVISION HISTORY**

Revision	Date	Description
2.0.0	06/12/2012	Reformatted Datasheet. Corrected Package Drawing
2.0.1	07/19/2013	Update package marking information and updated corporate logo.

**FOR FURTHER ASSISTANCE**

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[LTC6655BHLS8-4.096#PBF](#) [LT6660HCDC-5#TRMPBF](#) [LM336Z-2.5#PBF](#) [LT1021BMH-10](#) [SC431ILPRAG](#) [TLVH431MIL3T](#)  
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[TL4051C12QDCKR](#) [TL431ACZ](#) [KA431SLMF2TF](#) [KA431SMF2TF](#) [KA431SMFTF](#) [LM385BXZ/NOPB](#) [LM4040QCEM3-3.0/NOPB](#)  
[LM4041C12ILPR](#) [LM4050AEM3X-5.0/NOPB](#) [LM4050AIM3X-5.0/NOPB](#) [LM4120AIM5-2.5/NOP](#)