



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

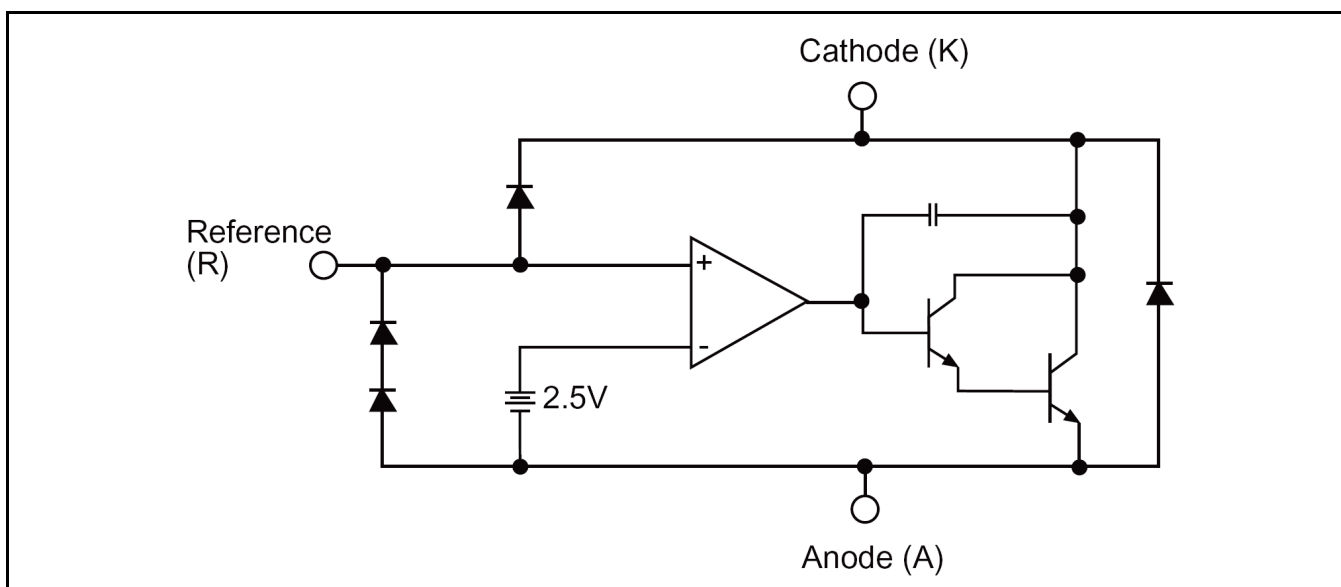


Fig. 1: SPX431L Precision Adjustable Shunt Regulator



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 | |
| θ_{JA} (TO-92) | 160°C/W |
| θ_{JC} (TO-92) | 80°C/W |
| Typical Derating (TO-92) | 6.3 mW/°C |
| θ_{JA} (SOT-89) | 110°C/W |
| θ_{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 |
|---|--------------|--------------|-------|---------------|---|
| SPX431LA | | | | | |
| Reference Voltage | 2.490 | 2.503 | 2.515 | V | |
| ΔV_{REF} with Temp. ¹ | | 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 | μA | |
| I_{REF} Temp Deviation | | 0.4 | 1.2 | μA | $T_J = 0^\circ\text{C}$ to 105°C |
| Min I_K for Regulation | | 0.4 | 1.0 | mA | |
| Off State Leakage | | 0.04 | 1.0 | μA | $V_{REF} = 0\text{V}$, $V_{KA} = 20\text{V}$ |
| Dynamic Output Impedance | | 0.15 | 0.5 | Ω | $f_z \leq 1\text{kHz}$ $I_K = 1$ to 100mA |
| SPX431L | | | | | |
| Reference Voltage | 2.470 | 2.495 | 2.520 | V | |
| ΔV_{REF} with Temp. ¹ | | 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 | μA | |
| I_{REF} Temp Deviation | | 0.4 | 1.2 | μA | $T_J = 0^\circ\text{C}$ to 105°C |
| Min I_K for Regulation | | 0.4 | 1.0 | mA | |
| Off State Leakage | | 0.04 | 1.0 | μA | $V_{REF} = 0\text{V}$, $V_{KA} = 20\text{V}$ |
| Dynamic Output Impedance | | 0.15 | 0.5 | Ω | $f_z \leq 1\text{kHz}$ $I_K = 1$ to 100mA |
| SPX431LC | | | | | |
| Reference Voltage | 2.445 | 2.495 | 2.520 | V | |
| ΔV_{REF} with Temp. ¹ | | 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 | μA | |
| I_{REF} Temp Deviation | | 0.4 | 1.2 | μA | $T_J = 0^\circ\text{C}$ to 105°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

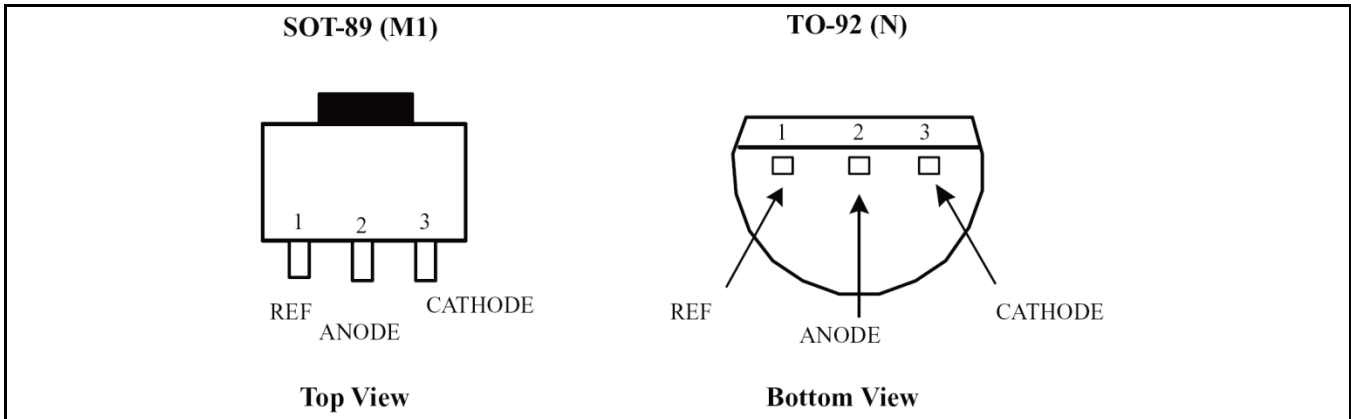


Fig. 2: SPX431L Pin Assignment

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.

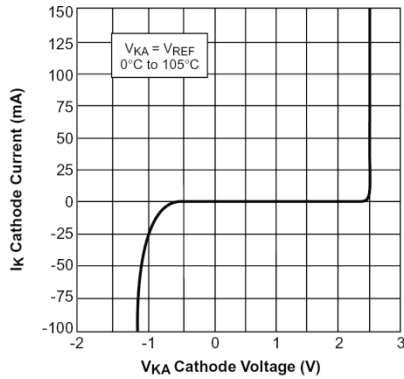


Fig. 3: High Current Operating Characteristics

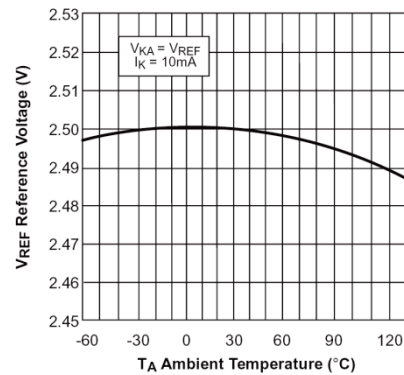


Fig. 4: Reference Voltage VS Ambient Temperature

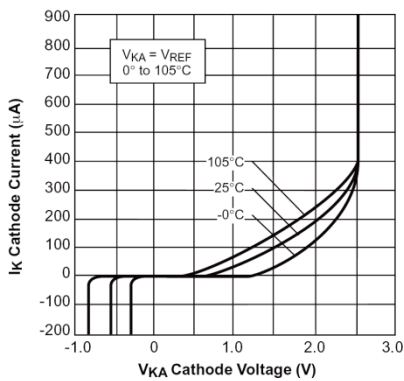


Fig. 5 Low Current Operating Characteristics.

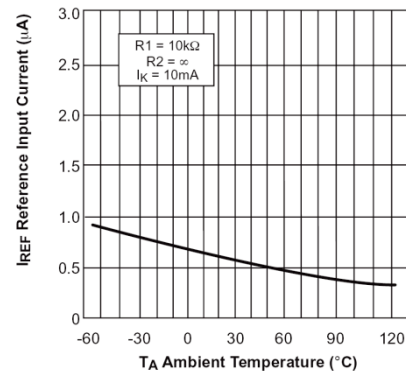


Fig. 6 Reference Input Current VS Ambient Temperature.

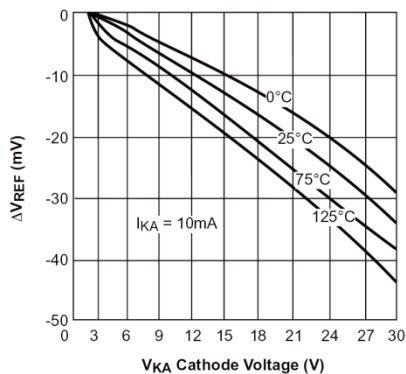


Fig. 7 Reference Voltage Line Regulation VS Cathode Voltage and $T_{AMBIENT}$

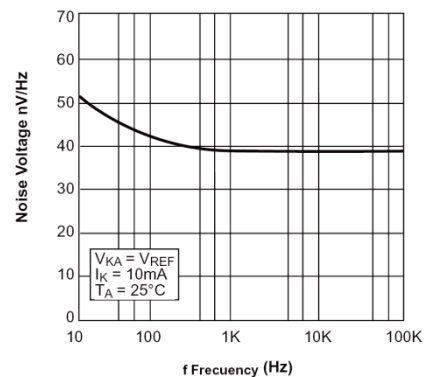


Fig. 8 Noise Voltage VS Frequency

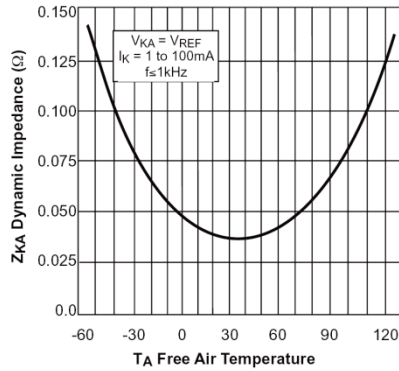


Fig. 9 Low Frequency Dynamic Output Impedance VS AMBIENT

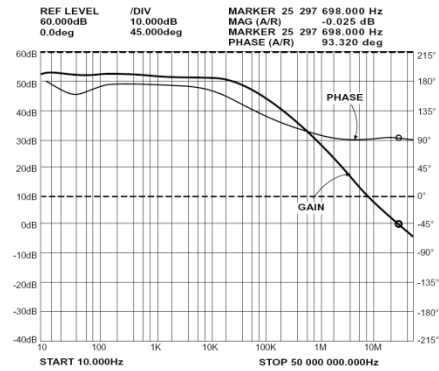


Fig. 10 Small Signal Gain and Phase VS Frequency; $I_K = 10\text{mA}$, $T_A = 25^\circ\text{C}$

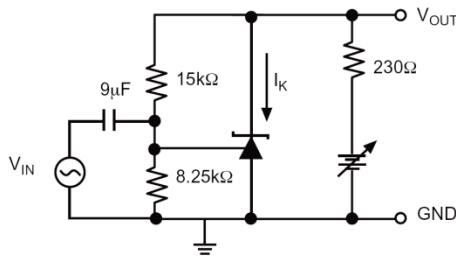


Fig. 11 Test Circuit for Gain and Phase Frequency Response

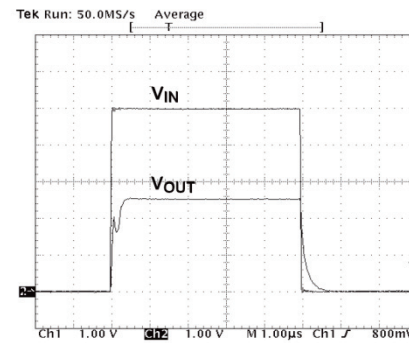


Fig. 2 $F_z = 100\text{kHz}$, $I_K = 10\text{mA}$, $T_A = 25^\circ\text{C}$

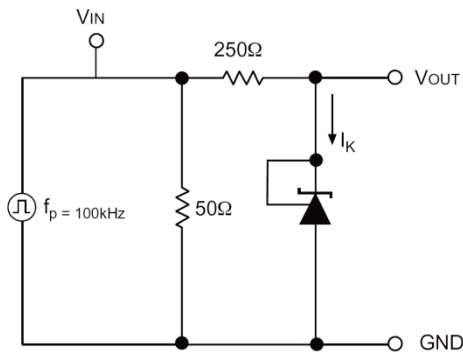


Fig. 33 Test Circuit for Pulse Response

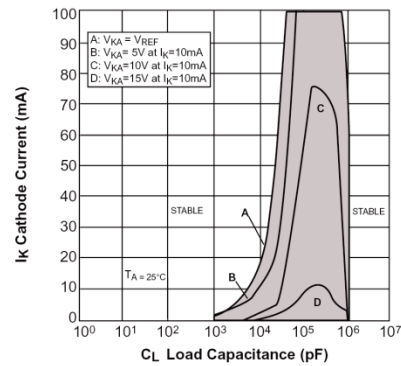


Fig. 44 Stability Boundry Conditions

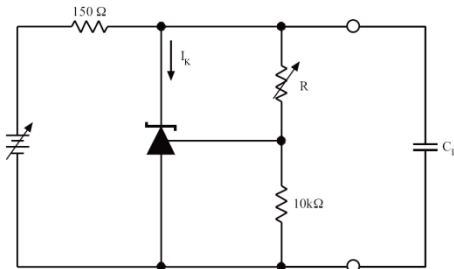


Fig. 55 Test Circuit for Stability

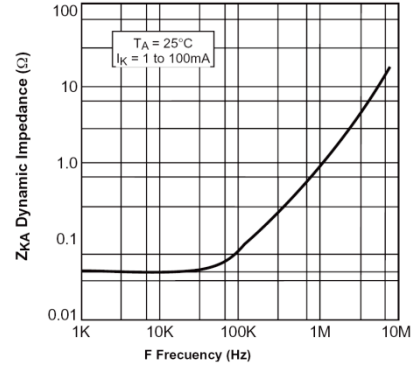


Fig. 66 Dynamic Output Impedance $T_A = 25^\circ\text{C}$, $I_K = 1$ to 100mA

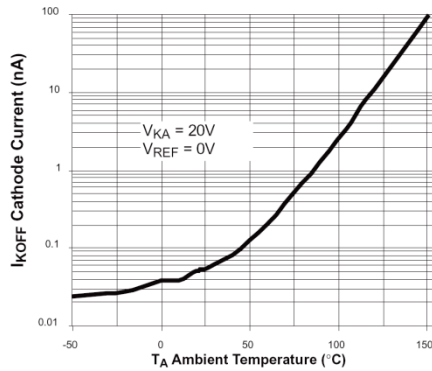


Fig. 77 Off State Leakage

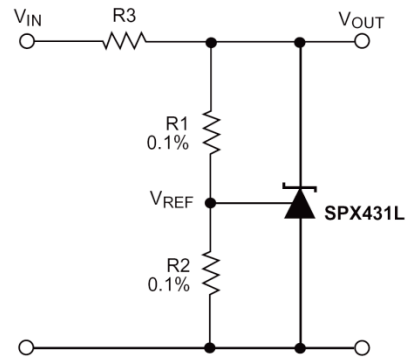


Fig. 88 Shunt Regulator $V_{OUT} = (1 + R1/R2)V_{REF}$

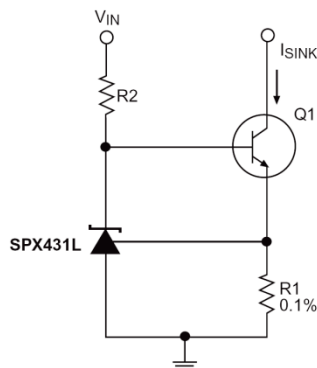


Fig. 199 Constant Current Sink, $I_{SINK} = V_{REF}/R1$

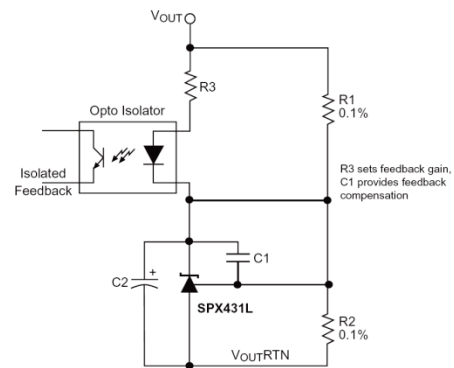


Fig. 100 Reference Amplifier for Isolated Feedback in Off-Line DC-DC Converters

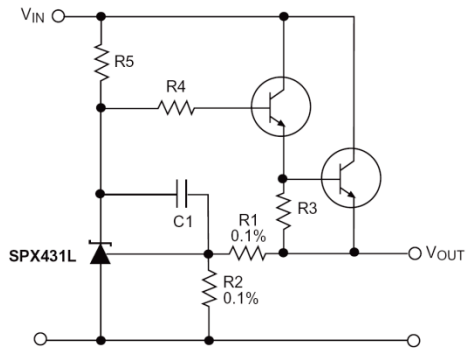


Fig. 111 Precision High Current Series Regulator
 $V_{OUT} = (1 + R1/R2)V_{REF}$

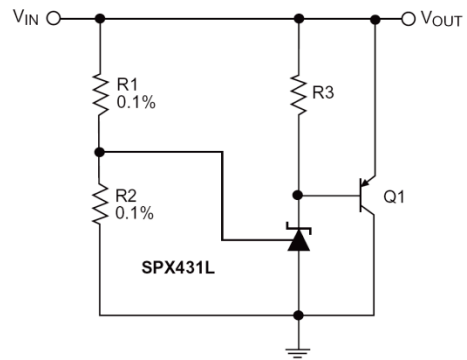


Fig. 122 High Current Shunt regulator
 $V_{OUT} = (1 + R1/R2)V_{REF}$

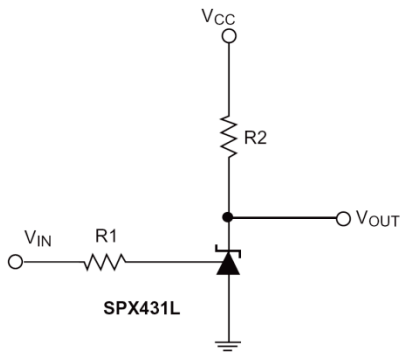


Fig. 133 Single Supply Comparator with Temperature Compensated Threshold. V_{IN} threshold = 2.5V.

APPLICATION INFORMATION

CALCULATING AVERAGE TEMPERATURE COEFFICIENT (TC)

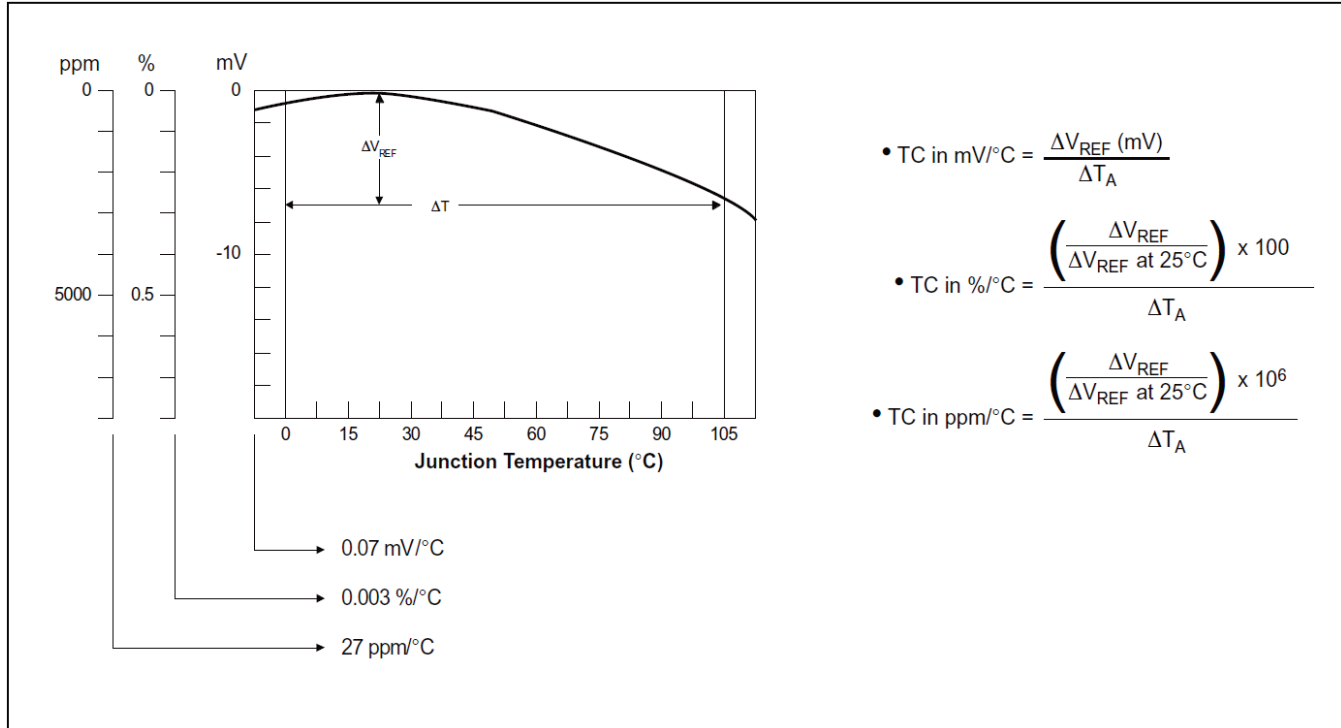


Fig. 24: V_{REF} VS Temperature.

TEST CIRCUITS

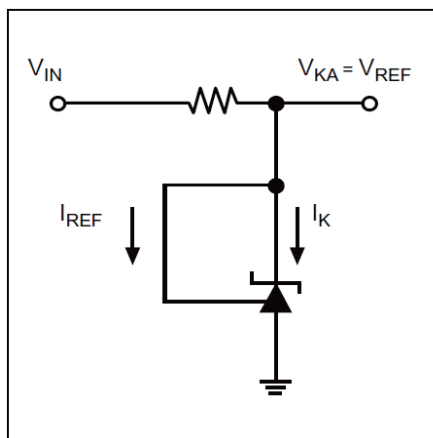


Fig. 25: Test Circuit for V_{KA} = V_{REF}

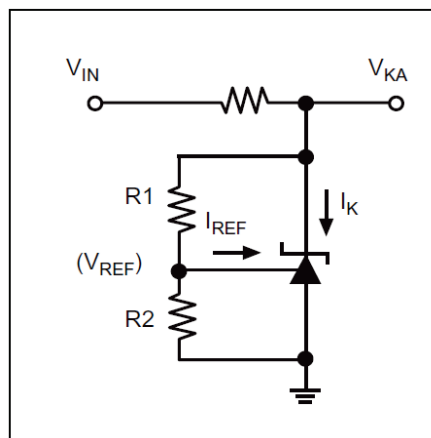


Fig. 26: Test Circuit for V_{KA} > V_{REF}

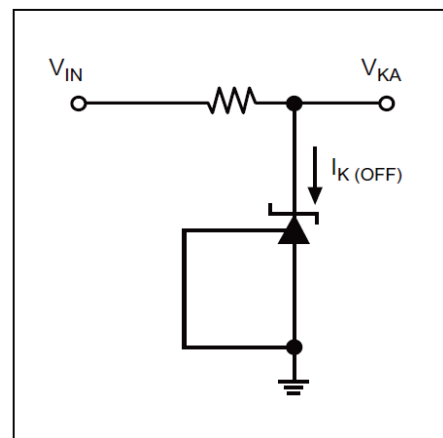


Fig. 27: Test Circuit for I_{K(OFF)}



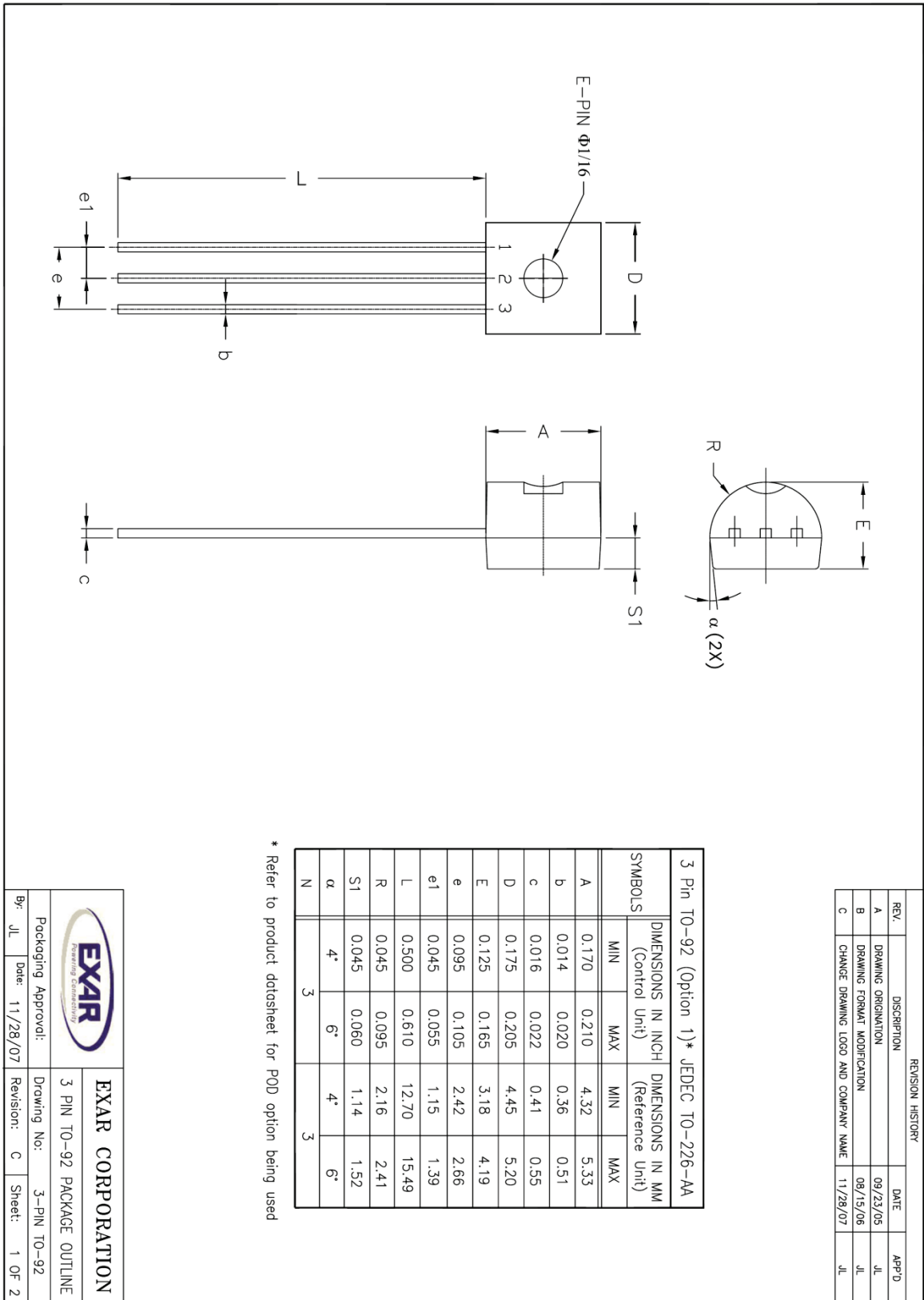
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SPX431L

Precision Adjustable Shunt Regulator

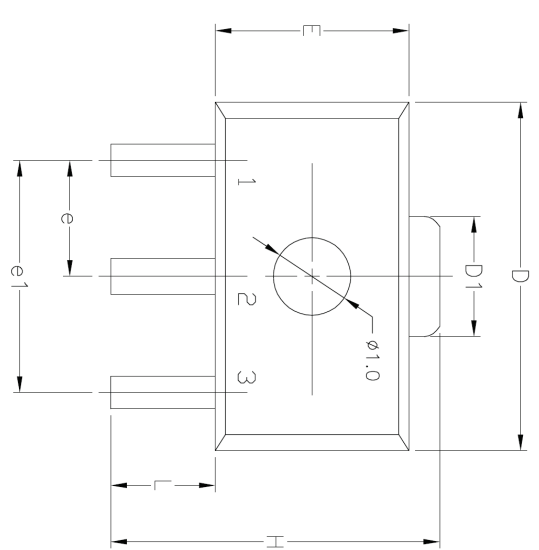
PACKAGE SPECIFICATION

3 PIN TO-92

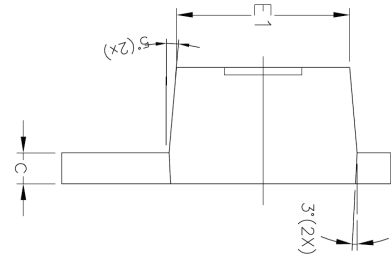


PACKAGE SPECIFICATION

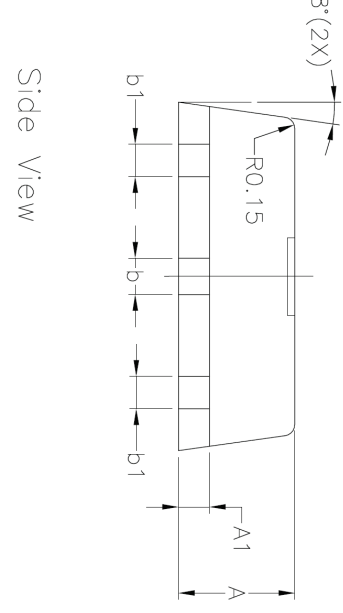
3 PIN SOT-89



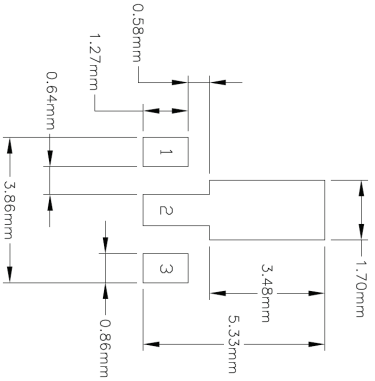
Top View



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
Precision Technology



A New Direction in Mixed-Signal

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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customersupport@exar.com

Exar Technical Documentation:

<http://www.exar.com/TechDoc/default.aspx>



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