## GENERAL DESCRIPTION

The SPX431A is a three-terminal adjustable shunt voltage regulator providing a highly accurate bandgap reference.

The SPX431A acts as an open-loop error amplifier with a 2.5V temperature compensation reference. The SPX431A has thermal stability, wide operating current of 150mA and broad temperature range of -40°C to 125°C, making it suitable for a variety of applications which require a low-cost, high performance solution. The SPX431A tolerance of 0.5% is proven to be sufficient to overcome all 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 $V_{REF}$ and 36 volts with two external resistors.

The SPX431A is available in RoHS compliant, lead free TO-92 and SOT-89 packages.

The SPX431A product is obsolete.

## APPLICATIONS

- **Charger**
- **Switching Power Supplies**
- **Graphic Cards**
- **Monitors, VCRs, TVs**

## FEATURES

- **0.5% Precise Output Voltage**
  - Adjustable up to 36V
- **Wide Operating Current**
  - 1mA to 150mA
- **Low Temperature Coefficient at 30ppm/°C**
- **Extended Temperature Range**
  - -40°C to +125°C
- **Improved Replacement for TL431**
- **RoHS Compliant, Lead Free TO-92 and SOT-89 Packages**

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

## TYPICAL APPLICATION DIAGRAM

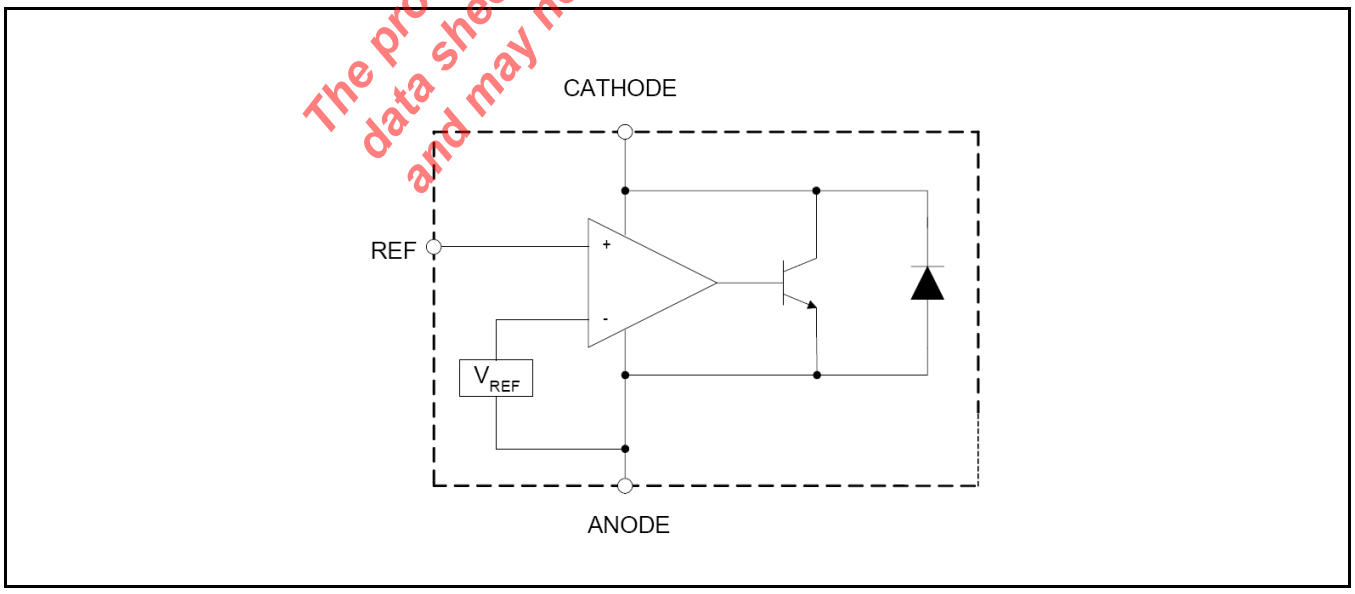



Fig. 1: SPX431A Application Diagram

## 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 Volt. $V_{KA}$ ..... 37V
Operating Cathode Current (cont.) $I_{KA}$ ..... 150mA
Reference Input Current Range $I_{REF}$ ..... 10mA
Power Dissipation SOT-89-TO-92 (Cont. 25°C) $P_D$ .. 770mW
Junction Temperature ..... 150°C
Storage Temperature $T_{STG}$ ..... -65°C to 150°C
ESD Rating (HBM - Human Body Model) ..... 2kV

## OPERATING RATINGS

Cathode-Anode Reverse Breakdown Volt. $V_{KA}$ ..... 36V
Operating Cathode Current (cont.) $I_{KA}$ ..... <100mA
Ambient Temperature Range ..... -40°C to 125°C

## ELECTRICAL SPECIFICATIONS

Specifications with standard type are for an Operating Ambient Temperature of $T_A$ = 25°C only; limits applying over the full Operating Ambient 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°C, and are provided for reference purposes only.

| Parameter | Min. | Typ. | Max. | Units | | Conditions |
|---|---|---|---|---|---|---|
| Reference Voltage | 2.493 | 2.503 | 2.515 | V | | Test circuit 1<br>$V_{KA}=V_{REF}$, $I_{KA}$=10mA |
| $\Delta V_{REF}$ with temperature $T_C$ | | 4.5 | 8 | mV | | Test circuit 1<br>$V_{KA}=V_{REF}$, $I_{KA}$=10mA, 0°C ≤ $T_A$ ≤ 70°C |
| $\Delta V_{REF}$ with temperature $T_C$ | | 4.5 | 16 | mV | • | Test circuit 1<br>$V_{KA}=V_{REF}$, $I_{KA}$=10mA |
| Ratio of change in $V_{REF}$ to Cathode Voltage $\Delta V_{REF}$ / $\Delta V_{KA}$ | -2.7 | -1.0 | | mV/V | | Test circuit 2<br>$V_{REF}$ ≤ $\Delta V_{KA}$ ≤ 10V, $I_{KA}$=10mA |
| | -2 | -0.4 | | | | Test circuit 2<br>10V ≤ $\Delta V_{KA}$ ≤ 36V, $I_{KA}$=10mA |
| Reference Input Current $I_{REF}$ | | 0.7 | 4 | µA | | Test circuit 2<br>$I_{KA}$=10mA, R1=10kΩ, R2=∞ |
| $I_{REF}$ Temperature Deviation $\Delta I_{REF}$ | | 0.4 | 1.2 | µA | • | Test circuit 2<br>$I_{KA}$=10mA, R1=10kΩ, R2=∞ |
| Minimum $I_{KA}$ for Regulation $I_{KA(MIN)}$ | | 0.4 | 1 | mA | | Test circuit 1<br>$V_{KA}=V_{REF}$ |
| Off State Leakage $I_{KA(OFF)}$ | | 40 | 250 | nA | | Test circuit 3<br>$V_{KA}$=0, $V_{REF}$=36V |
| Dynamic Outout Impedance $Z_{KA}$ | | 0.15 | 0.5 | Ω | | Test circuit 1<br>$f_Z$≤1KHz, $I_{KA}$=1 to 100mA |

The product (or product(s) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

## BLOCK DIAGRAM

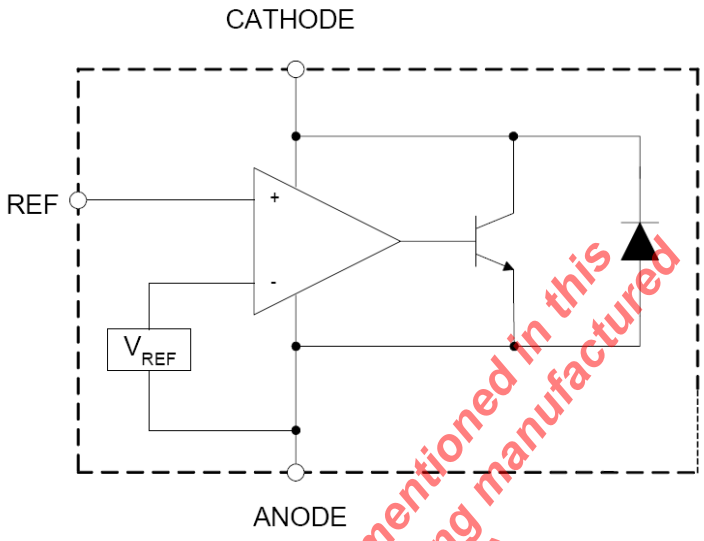



Fig. 2: SPX431A Block Diagram

## PIN ASSIGNMENT




Fig. 3: SPX431A Pin Assignment

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

## ORDERING INFORMATION

| Part Number | Temperature Range | Package | Packing Quantity | Note 1 | Note 2 |
|---|---|---|---|---|---|
| SPX431AM1-L/TR | -40°C≤$T_A$≤+125°C | SOT-89 | 2.5K/Tape & Reel | RoHS Compliant Lead Free | |
| SPX431AN-L/TR | -40°C≤$T_A$≤+125°C | TO-92 | 2K/Tape & Reel | RoHS Compliant Lead Free | Ammo Pack |

**Note:** The SPX431AM1-L/TR and SPX431AN-L/TR part numbers are obsolete. For more information about part numbers, as well as the most up-to-date ordering information and additional information on environmental rating, go to www.maxlinear.com/SPX431A.

## TYPICAL PERFORMANCE CHARACTERISTICS

All data taken at $T_A$ = 25°C, unless otherwise specified - Schematic and BOM from Application Information section of this datasheet.

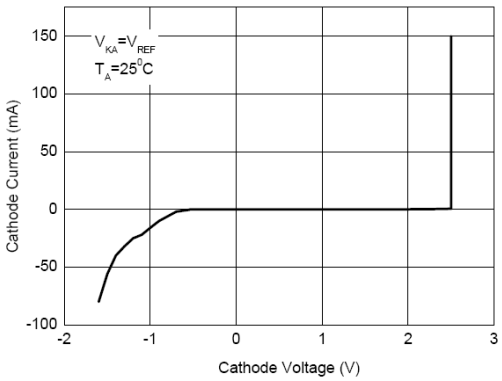



Fig. 4: Cathode Current vs Cathode Voltage

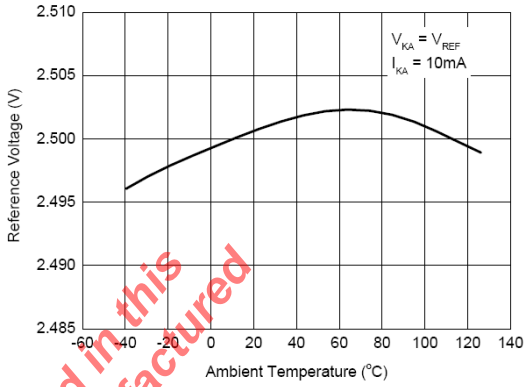



Fig. 5: Reference Voltage vs Ambient Temperature

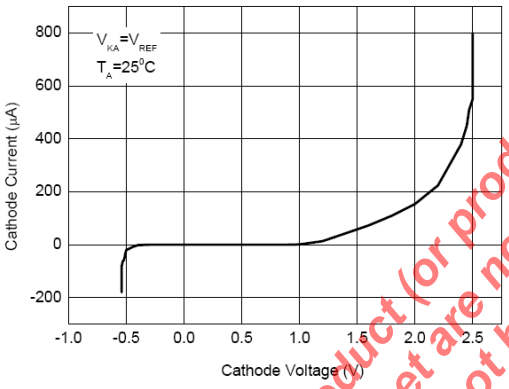



Fig. 6: Low Current Operating Characteristics

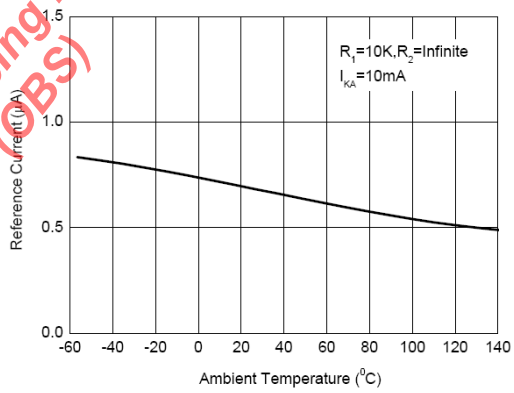



Fig. 7: Reference Input Current vs Ambient Temperature

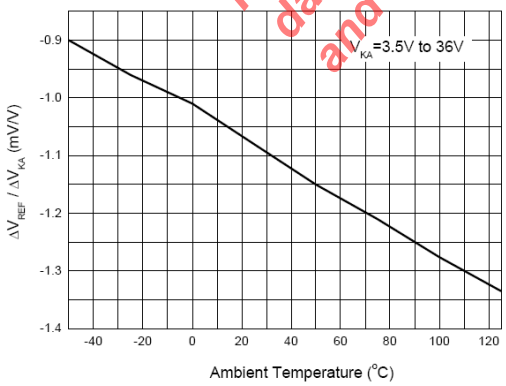



Fig. 8: ΔReference Voltage to ΔCathode Voltage Ratio

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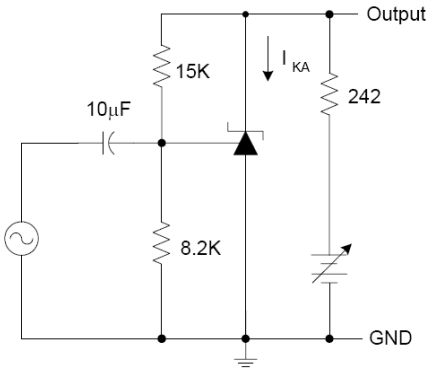



Fig. 9: Test Circuit for Gain vs Frequency Responce

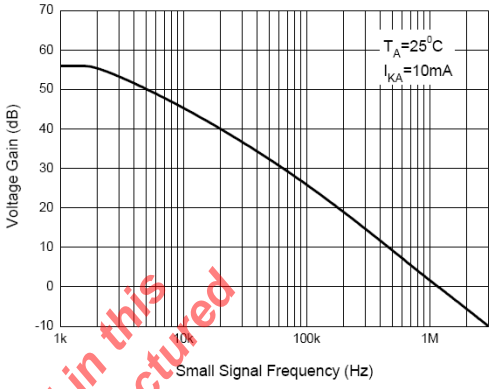



Fig. 10: Small Signal Gain vs Frequency

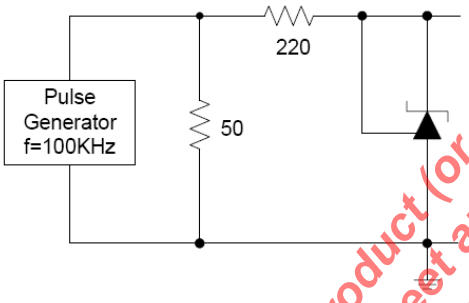



Fig. 11: Test Circuit for Pulse Response

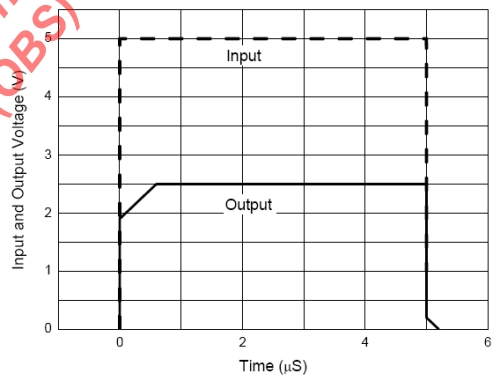



Fig. 12: Pulse Response

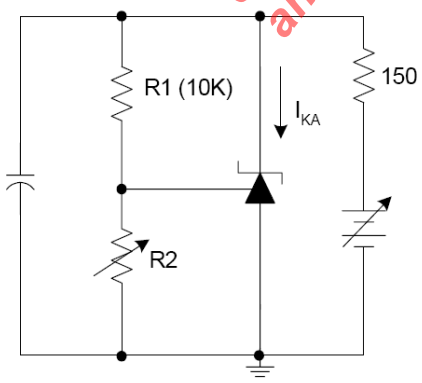



Fig. 13: Test Circuit for Stability

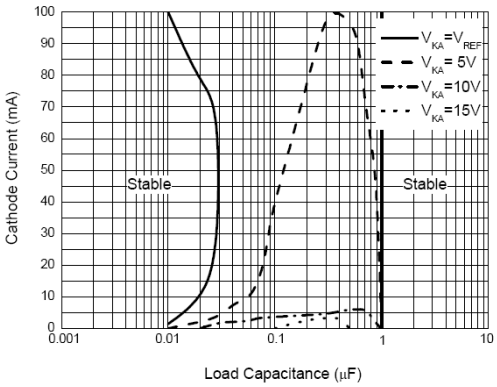



Fig. 14: Stability Boundary Conditions

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

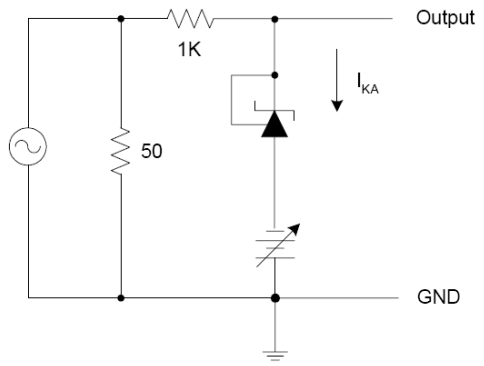



Fig. 15: Test Circuit for Dynamic Output Impedance

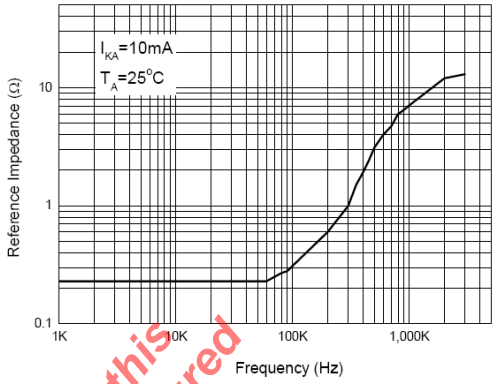



Fig. 16: Dynamic Output Impedance

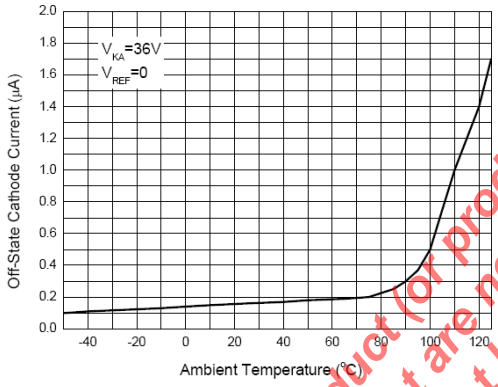



Fig. 17: Off State Leakage

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## TYPICAL APPLICATION SCHEMATICS

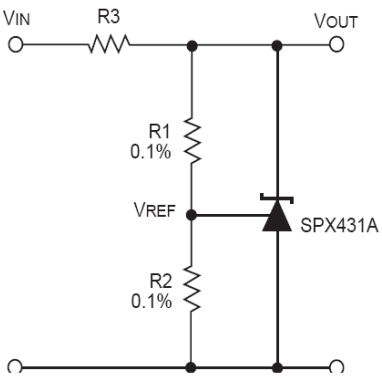



Fig. 18: Shunt Regulator $V_{OUT}=(1+R1/R2)V_{REF}$

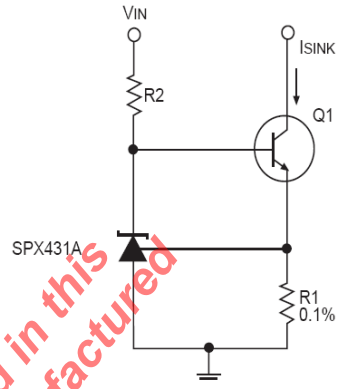



Fig. 19: Constant Current Sink $I_{SINK}=V_{REF}/R1$

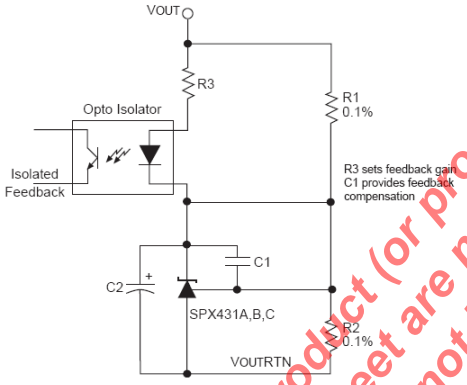



Fig. 20: Reference Amplifier for Isolated Feedback in Offline DC-DC Coinverters

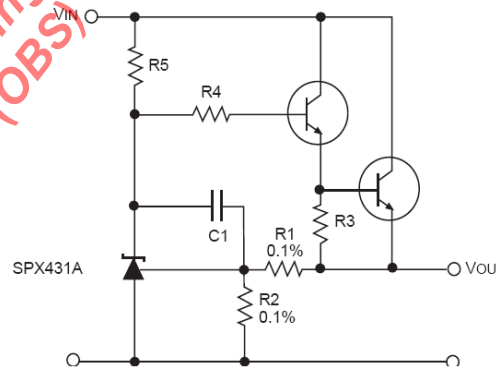



Fig. 21: Precision High Current Series Regulator $V_{OUT}=(1+R1/R2)V_{REF}$

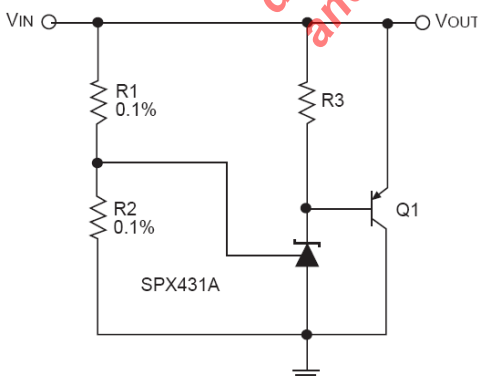



Fig. 22: High Current Shunt Regulator $V_{OUT}=(1+R1/R2)V_{REF}$

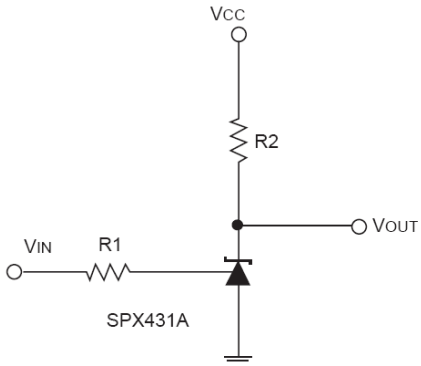


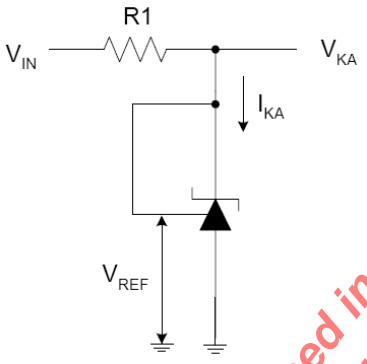

Fig. 23: Single Supply Comparator with Temperature Compensated Threshold

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## TEST CIRCUITS

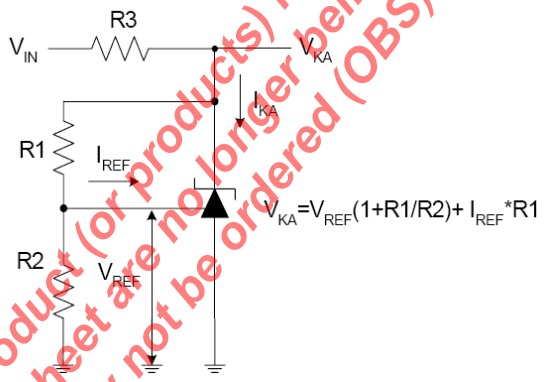
### TEST CIRCUIT 1

Test circuit for $V_{KA}=V_{REF}$



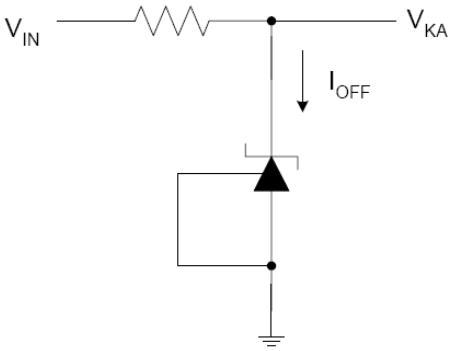

### TEST CIRCUIT 2

Test circuit for $V_{KA} > V_{REF}$




### TEST CIRCUIT 3

Test circuit for $I_{KOFF}$

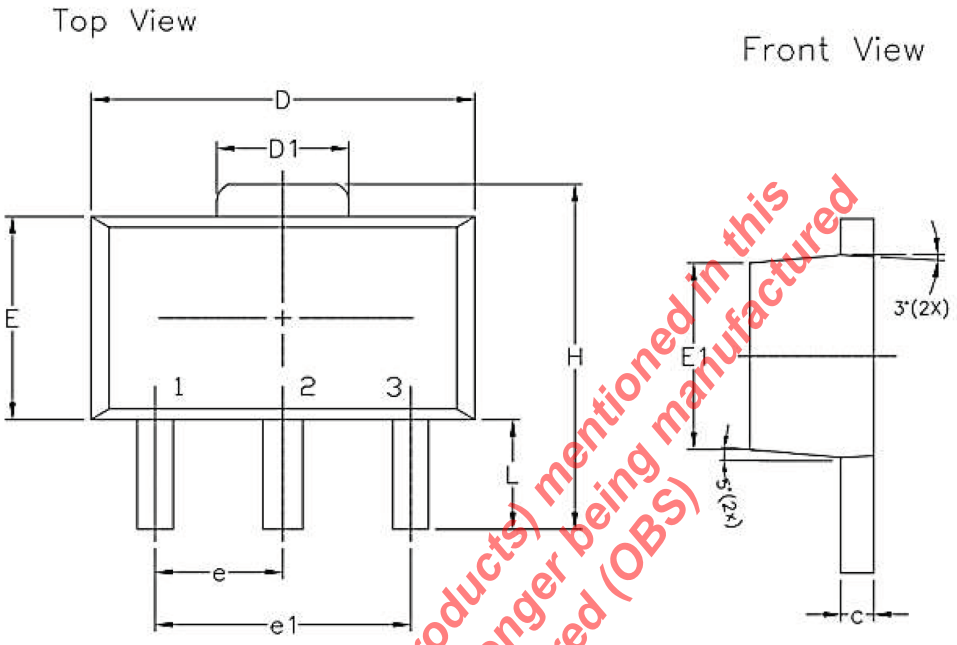


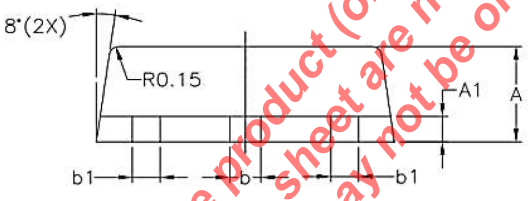

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## PACKAGE SPECIFICATION

### SOT-89

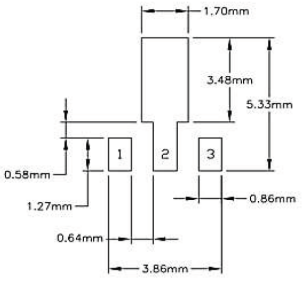
Unit: mm (inch)




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 | | |

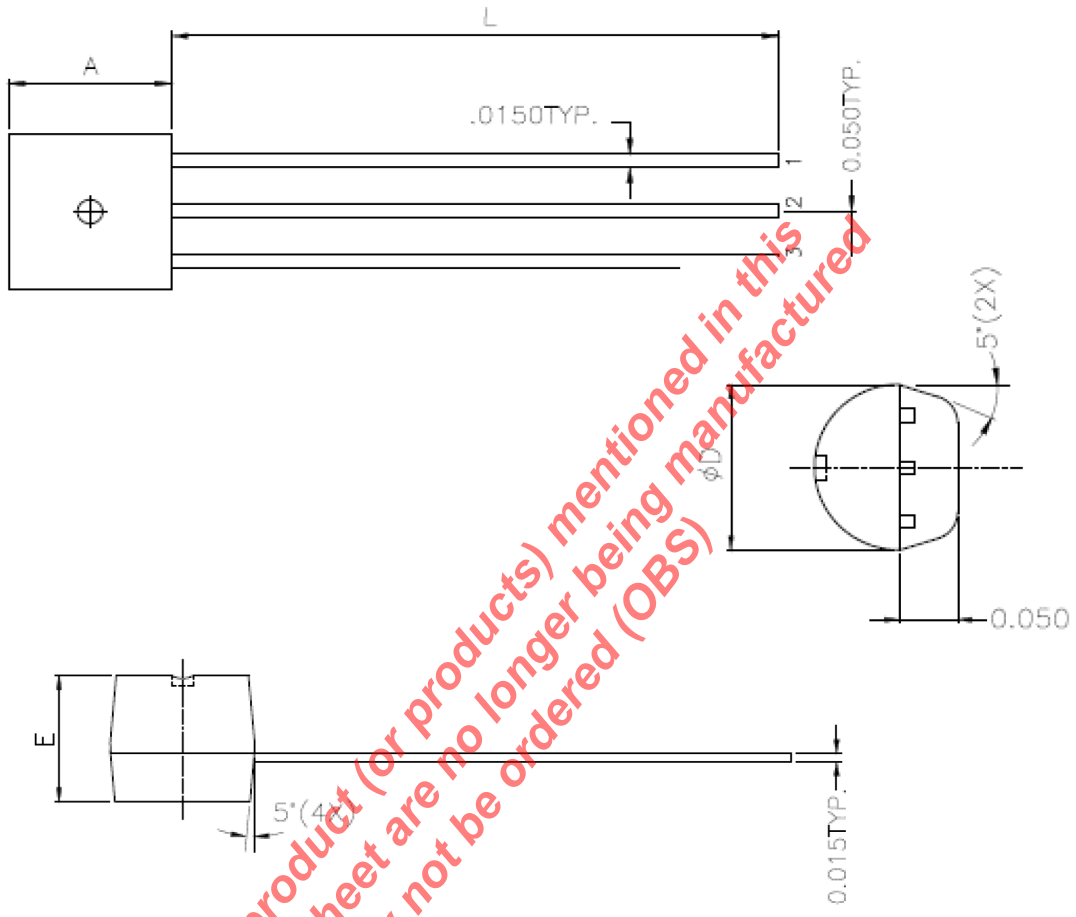
Drawing No.: POD-00000174

Revision: A

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## TO-92

Unit: mm (inch)




The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

| SYMBOL | INCHES | | |
|---|---|---|---|
| | MIN. | NOR. | MAX. |
| A | .170 | .180 | .210 |
| φD | .175 | .180 | .205 |
| E | .125 | .142 | .165 |
| L | .500 | .580 | |

NOTE :
1. JEDEC : TO-92.

Drawing No.: POD-00000173

Revision: A

## REVISION HISTORY

| Revision | Date | Description |
|---|---|---|
| 2.0.1 | 11/08/22 | **Updated:**<br>■ Note under the "Ordering Information" table.<br>■ "SOT-89" POD.<br>■ "TO-92" POD.<br>**Removed:**<br>■ In the "Ordering Information" table, "Marking" column. |
| 2.0.0 | 04/15/09 | Reformat of Datasheet<br>Updated ordering part numbers<br>Updated application and block diagram |

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

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