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

[Diagram of SPX1431 Block Diagram]

Fig. 1: SPX1431 Block 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 $V_{KA}$ .................... 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 ..............................................
$\theta JA$ (NSOIC8) .............................................. 175°C/W
$\theta JC$ (NSOIC8) .............................................. 45°C/W
$\theta JA$ (SOT89-3) ............................................ 110°C/W
$\theta JC$ (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, $V_K = V_{REF}$, $I_K = 10mA$, $T_A = 25°C$.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Voltage $V_{REF}$</td>
<td>2.490</td>
<td>2.500</td>
<td>2.510</td>
<td>V</td>
<td>Figure 5</td>
</tr>
<tr>
<td>$\Delta V_{REF}$ with Temperature $T_C$</td>
<td>2.465</td>
<td>2.535</td>
<td></td>
<td>mV/°C</td>
<td>$T_J = 0°C$ to $105°C$, figure 5</td>
</tr>
<tr>
<td>Ratio of Change in $V_{REF}$ to Cathode Voltage $\Delta V_{REF}/\Delta V_K$</td>
<td>-2.0</td>
<td>-1.1</td>
<td>mV/V</td>
<td>$V_K = 3V$ to $36V$, figure 6</td>
<td></td>
</tr>
<tr>
<td>Reference Input Current $I_{REF}$</td>
<td>0.7</td>
<td>1.9</td>
<td>μA</td>
<td>Figure 6</td>
<td></td>
</tr>
<tr>
<td>$I_{REF}$ Temp Deviation $\Delta I_{REF}$</td>
<td>0.4</td>
<td>1.2</td>
<td>μA</td>
<td>$T_J = 0°C$ to $105°C$, figure 6</td>
<td></td>
</tr>
<tr>
<td>Min $I_K$ for Regulation $I_{K(MIN)}$</td>
<td>0.4</td>
<td>10</td>
<td>mA</td>
<td>Figure 5</td>
<td></td>
</tr>
<tr>
<td>Off State Leakage $I_{K(OFF)}$</td>
<td>0.04</td>
<td>2500</td>
<td>nA</td>
<td>$V_{REF} = 0V$, $V_{KA} = 36V$, figure 7</td>
<td></td>
</tr>
<tr>
<td>Dynamic Output Impedance $Z_{KA}$</td>
<td>0.15</td>
<td>0.5</td>
<td>Ω</td>
<td>$f = 1$kHz, $I_K = 1$ to $150mA$, figure 5</td>
<td></td>
</tr>
</tbody>
</table>
**BLOCK DIAGRAM**

![Block Diagram](image1)

Fig. 2: SPX1431 Block Diagram

**PIN ASSIGNMENT**

![Pin Assignment](image2)

Fig. 3: SPX1431 Pin Assignment

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Temperature Range</th>
<th>Marking</th>
<th>Package</th>
<th>Packing Quantity</th>
<th>Note 1</th>
<th>Note 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPX1431M1-L</td>
<td>-55°C ≤ T_J ≤ +125°C</td>
<td>N011 YWWXXX</td>
<td>SOT-89-3</td>
<td>Bulk</td>
<td>Halogen</td>
<td>Bar on left side of marking denotes “-L”</td>
</tr>
<tr>
<td>SPX1431M1-L/TR</td>
<td></td>
<td></td>
<td></td>
<td>2.5K/Tape &amp; Reel</td>
<td>Pb free product</td>
<td></td>
</tr>
<tr>
<td>SPX1431S-L</td>
<td>-55°C ≤ T_J ≤ +125°C</td>
<td>SPX1431 25YYWWL XXXXXX</td>
<td>NSOIC8</td>
<td>Bulk</td>
<td>Halogen</td>
<td></td>
</tr>
<tr>
<td>SPX1431S-L/TR</td>
<td></td>
<td></td>
<td></td>
<td>2.5K/Tape &amp; Reel</td>
<td>Pb free product</td>
<td></td>
</tr>
</tbody>
</table>

“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)

\[ TC \text{ in } \text{mV/}^\circ C = \frac{\Delta V_{\text{REF}}(\text{mV})}{\Delta T_A} \]

\[ TC \text{ in } \text{%/}^\circ C = \left( \frac{\Delta V_{\text{REF}}}{\Delta V_{\text{REF}} \text{ at } 25^\circ C} \right) \times 100 \]

\[ TC \text{ in } \text{ppm/}^\circ C = \left( \frac{\Delta V_{\text{REF}}}{\Delta V_{\text{REF}} \text{ at } 25^\circ C} \right) \times 10^6 \]

Fig. 4: \( V_{\text{REF}} \) vs. Temperature

TEST CIRCUITS

Fig. 5: Test Circuit for \( V_KA = V_{\text{REF}} \)

Fig. 6: Test Circuit for \( V_KA > V_{\text{REF}} \)

Fig. 7: Test Circuit for \( I_{\text{OFF}} \)
TYPICAL PERFORMANCE CHARACTERISTICS

All data taken at Unless otherwise indicated, $V_k = V_{REF}$, $I_k = 10\text{mA}$, $T_A = 25^\circ\text{C}$.

![Fig. 8: High Current Operating Characteristics](image_url)

![Fig. 9: Reference Voltage vs. Ambient Temperature](image_url)

![Fig. 10: Low Current Operating Characteristics](image_url)

![Fig. 11: Reference Input Current vs. Ambient Temperature](image_url)

![Fig. 12: Reference Voltage Line Regulation vs. Cathode Voltage and $T_{\text{Ambient}}$](image_url)

![Fig. 13: Noise Voltage vs. Frequency](image_url)
**Fig. 14:** Low Frequency Dynamic Output Impedance vs. $T_{\text{Ambient}}$

**Fig. 15:** Small Signal Gain and Phase vs. Frequency; $I_K = 10\, mA$, $T_A = 25^\circ C$

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

**Fig. 17:** Frequency = 100kHz; $I_K = 10\, mA$, $T_A = 25^\circ C$

**Fig. 18:** Test Circuit for Pulse Response

**Fig. 19:** Stability Boundary Conditions
Fig. 20: Test Circuit for Stability

Fig. 21: Dynamic Output Impedance
T<sub>A</sub> = 25°C, I<sub>K</sub> = 1 to 100mA

Fig. 22: Off State Leakage

Fig. 23: Shunt Regulator V<sub>OUT</sub> = (1+R<sub>1</sub>/R<sub>2</sub>).V<sub>REF</sub>

Fig. 24: Constant Current, Sink, I<sub>SINK</sub> = V<sub>REF</sub>/R<sub>1</sub>

Fig. 25: Reference Amplifier for Isolated Feedback in Off-Line DC-DC Converters
Fig. 26: Precision High Current Series Regulator
\[ V_{OUT} = (1 + \frac{R1}{R2})V_{REF} \]

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

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.
Precision Adjustable Shunt Regulator

REVISION HISTORY

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Description</th>
</tr>
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</table>
| 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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