**GENERAL DESCRIPTION**

The SPX3940 is a 1A, accurate voltage regulator with a low drop out voltage of 280mV (typical) at 1A.

These regulators are specifically designed for low voltage applications that require a low dropout voltage and a fast transient response. They are fully fault protected against overcurrent, reverse battery, and positive and negative voltage transients.

The SPX3940 is offered in 3-pin SOT223 and TO-263 packages. For a 3A version, refer to the SPX29300 data sheet.

**APPLICATIONS**

- Power Supplies
- LCD Monitors
- Portable Instrumentation
- Medical and Industrial Equipment

**FEATURES**

- Guaranteed 1.5A Peak Current
- 1% Output Accuracy SPX3940A
- Low Quiescent Current
- Low Dropout Voltage of 280mV at 1A
- Extremely Tight Load and Line Regulation
- Extremely Fast Transient Response
- Reverse-battery Protection
- Internal Thermal Protection
- Internal Short Circuit Current Limit
- Replacement for LM3940
- Standard SOT223 & TO-263 packages

**TYPICAL APPLICATION DIAGRAM**

Fig. 1: SPX3940 Application Diagram – Fixed Output Linear 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.

Input Voltage $V_{IN}$: $20V$

Storage Temperature: $-65°C$ to $150°C$

Lead Temperature (Soldering, 5 sec): $260°C$

---

**OPERATING RATINGS**

Input Voltage $V_{IN}$: $16V$

Junction 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 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 $T_A = 25°C$, and are provided for reference purposes only. Unless otherwise indicated, $V_{IN} = V_{IN} +1V$, $I_{OUT} = 10mA$, $C_{IN} = 6.8\mu F$, $C_{OUT} = 10\mu F$, $T_A = 25°C$.

<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><strong>1.8V version</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage - SPX3940A (1%)</td>
<td>1.782</td>
<td>1.8</td>
<td>1.818</td>
<td>V</td>
<td>$I_{OUT}=10mA$ 10mA$\leq I_{OUT} \leq 1A$, $6V \leq V_{IN} \leq 16V$</td>
</tr>
<tr>
<td>Output Voltage - SPX3940 (2%)</td>
<td>1.764</td>
<td>1.8</td>
<td>1.836</td>
<td>V</td>
<td>$\bullet$</td>
</tr>
<tr>
<td><strong>2.5V version</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage - SPX3940A (1%)</td>
<td>2.475</td>
<td>2.5</td>
<td>2.525</td>
<td>V</td>
<td>$I_{OUT}=10mA$ 10mA$\leq I_{OUT} \leq 1A$, $6V \leq V_{IN} \leq 16V$</td>
</tr>
<tr>
<td>Output Voltage - SPX3940 (2%)</td>
<td>2.450</td>
<td>2.5</td>
<td>2.550</td>
<td>V</td>
<td>$\bullet$</td>
</tr>
<tr>
<td><strong>3.3V version</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage - SPX3940A (1%)</td>
<td>3.267</td>
<td>3.3</td>
<td>3.333</td>
<td>V</td>
<td>$I_{OUT}=10mA$ 10mA$\leq I_{OUT} \leq 1A$, $6V \leq V_{IN} \leq 16V$</td>
</tr>
<tr>
<td>Output Voltage - SPX3940 (2%)</td>
<td>3.234</td>
<td>3.3</td>
<td>3.366</td>
<td>V</td>
<td>$\bullet$</td>
</tr>
<tr>
<td><strong>5.0V version</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage - SPX3940A (1%)</td>
<td>4.950</td>
<td>5.0</td>
<td>5.050</td>
<td>V</td>
<td>$I_{OUT}=10mA$ 10mA$\leq I_{OUT} \leq 1A$, $6V \leq V_{IN} \leq 16V$</td>
</tr>
<tr>
<td>Output Voltage - SPX3940 (2%)</td>
<td>4.900</td>
<td>5.0</td>
<td>5.100</td>
<td>V</td>
<td>$\bullet$</td>
</tr>
</tbody>
</table>

**All Voltage Options**

- **Line Regulation**: 0.2 - 1.0 %
- **Load Regulation**: 0.3 - 1.5 %
- **$\Delta V$** - Output Voltage temperature Coefficient: 20 - 100 ppm/°C
- **Dropout Voltage**
  - (except 1.8V version): 70 - 200 mV, $I_{OUT}=100mA$
  - 280 - 550 mV, $I_{OUT}=1A$
- **Ground Current**
  - 12 - 25 mA, $I_{OUT}=750mA$, $V_{IN} = V_{OUT} +1V$
  - 18 mA, $I_{OUT}=1A$
- **$I_{GND00}$** - Ground Pin Current at Dropout: 1.2 mA, $V_{IN} = 0.1V$ less than specified $V_{OUT}$
- **Current Limit**: 1.5 - 2.2 A
- **Output Noise Voltage**
  - 400 µV_{RMS}, 10Hz-100kHz, $I_{L}=100mA$, $C_{L}=10\mu F$
  - 260 µV_{RMS}, 10Hz-100kHz, $I_{L}=100mA$, $C_{L}=33\mu F$
Note 2: Dropout voltage is defined as the input to output differential when the output voltage drops to 99% of its normal value.

Note 3: Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the load current to the ground current.

Note 4: \( V_{IN} = V_{OUT(\text{NOMINAL})} + 1 \text{V} \). For example, use \( V_{IN} = 4.3 \text{V} \) for a 3.3V regulator. Employ pulse-testing procedures to minimize temperature rise.

**BLOCK DIAGRAM**

![Block Diagram](image)

Fig. 2: SPX3940 Block Diagram

**PIN ASSIGNMENT**

![Pin Assignment](image)

Fig. 3: SPX3940 Pin Assignment
ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Temperature Range</th>
<th>Package</th>
<th>Package Method</th>
<th>Lead Free</th>
<th>Note 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPX3940AM3-L-3-3/TR</td>
<td>-40°C ≤ T ≤ +125°C</td>
<td>3-pin SOT-223</td>
<td>2.5k/Tape &amp; Reel</td>
<td>Yes</td>
<td>3.3V Output Voltage – 1%</td>
</tr>
<tr>
<td>SPX3940AM3-L-5-0-TR</td>
<td>-40°C ≤ T ≤ +125°C</td>
<td>3-pin SOT-223</td>
<td>2.5k/Tape &amp; Reel</td>
<td>Yes</td>
<td>5.0V Output Voltage – 1%</td>
</tr>
<tr>
<td>SPX3940AT-L-3-3/TR</td>
<td>-40°C ≤ T ≤ +125°C</td>
<td>3-pin TO-263</td>
<td>500/Tape &amp; Reel</td>
<td>Yes</td>
<td>3.3V Output Voltage – 1%</td>
</tr>
<tr>
<td>SPX3940M3-L-2-5/TR</td>
<td>-40°C ≤ T ≤ +125°C</td>
<td>3-pin SOT-223</td>
<td>2.5k/Tape &amp; Reel</td>
<td>Yes</td>
<td>2.5V Output Voltage – 2%</td>
</tr>
<tr>
<td>SPX3940M3-L-5-0/TR</td>
<td>-40°C ≤ T ≤ +125°C</td>
<td>3-pin SOT-223</td>
<td>2.5k/Tape &amp; Reel</td>
<td>Yes</td>
<td>5.0V Output Voltage – 2%</td>
</tr>
<tr>
<td>SPX3940T-L-3-3/TR</td>
<td>-40°C ≤ T ≤ +125°C</td>
<td>3-pin TO-263</td>
<td>500/Tape &amp; Reel</td>
<td>Yes</td>
<td>3.3V Output Voltage – 2%</td>
</tr>
</tbody>
</table>

**NOTE:** For more information about part numbers, as well as the most up-to-date ordering information and additional information on environment rating, go to [www.maxlinear.com/SPX3940](http://www.maxlinear.com/SPX3940)
TYPICAL PERFORMANCE CHARACTERISTICS

Schematic and BOM from Application Information section of this datasheet.

Fig. 4: Line Regulation

Fig. 5: Load Regulation

Fig. 6: Ground Current vs Load Current

Fig. 7: Ground Current vs Input Voltage

Fig. 8: Ground Current vs Load Current in Dropout

Fig. 9: Dropout Voltage vs Load Current
Fig. 10: Ground Current vs Temperature
\( I_{\text{LOAD}} = 100\, \text{mA} \)

Fig. 11: Output Voltage vs Temperature
\( I_{\text{LOAD}} = 100\, \text{mA} \)

Fig. 12: Ground Current vs Temperature
\( I_{\text{LOAD}} = 500\, \text{mA} \)

Fig. 13: Ground Current vs Temperature
Dropout, \( I_{\text{LOAD}} = 750\, \text{mA} \)

Fig. 14: Ground Current vs Temperature
\( I_{\text{LOAD}} = 1.5\, \text{A} \)

Fig. 15: Ground Current vs Temperature
Dropout, \( I_{\text{LOAD}} = 1.5\, \text{A} \)
Fig. 16: Dropout Voltage vs Temperature
   $I_{LOAD}=750\,mA$

Fig. 17: Dropout Voltage vs Temperature
   $I_{LOAD}=1.5A$

Fig. 18: Enable Current vs Temperature
   $V_{EN}=16V$

Fig. 19: Enable Threshold vs Temperature
THEORY OF OPERATION
The SPX3940 incorporates protection against over-current faults, reversed load insertion, over temperature operation, and positive and negative transient voltage.

THERMAL CONSIDERATIONS
Although the SPX3940 offers limiting circuitry for overload conditions, it is still necessary to insure that the maximum junction temperature is not exceeded in the application. Heat will flow through the lowest resistance path, the junction-to-case path. In order to insure the best thermal flow of the component, proper mounting is required. Consult heatsink manufacturer for thermal resistance and design of heatsink.

TO-220 Design Example:
Assume that \( V_{IN} = 10V \), \( V_{OUT} = 5V \), \( I_{OUT} = 1.5A \), \( T_A = 50^\circ C/W \), \( \theta_{HA} = 1^\circ C/W \), \( \theta_{CH} = 2^\circ C/W \), and \( \theta_{JC} = 3^\circ C/W \).

Where \( T_A \) = ambient temperature
\( \theta_{HA} \) = heatsink to ambient thermal resistance
\( \theta_{CH} \) = case to heatsink thermal resistance
\( \theta_{JC} \) = junction to case thermal resistance

The power calculated under these conditions is:
\[
P_D = (V_{IN} - V_{OUT}) \times I_{OUT} = 7.5W.
\]

And the junction temperature is calculated as
\[
T_J = T_A + P_D \times (\theta_{HA} + \theta_{CH} + \theta_{JC}) \text{ or }
T_J = 50 + 7.5 \times (1 + 2 + 3) = 95^\circ C
\]
Reliable operation is insured.

CAPACITOR REQUIREMENTS
The output capacitor is needed to insure stability and minimize the output noise. The value of the capacitor varies with the load. However, a minimum value of 10\( \mu F \) aluminum capacitor will guarantee stability over all load conditions. A tantalum capacitor is recommended if a faster load transient response is needed.

If the power source has a high AC impedance, a 0.1\( \mu F \) ceramic capacitor between input & ground is recommended.

MINIMUM LOAD CURRENT
To ensure a proper behavior of the regulator under light load, a minimum load of 5mA for SPX3940 is required.

![Fig. 20: Fixed Output Linear Regulator](image)
PACKAGE SPECIFICATION

3-Pin SOT-223

TERMINAL DETAILS

NOTE: ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.
RECOMMENDED LAND PATTERN AND STENCIL

3-Pin SOT-223

TYPICAL RECOMMENDED LAND PATTERN

TYPICAL RECOMMENDED STENCIL

NOTE: ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.
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