Description
The ZXCT1080 is a high side current sense monitor with a gain of 10 and a voltage output. Using this device eliminates the need to disrupt the ground plane when sensing a load current.

The wide input voltage range of 60V down to as low as 3V make it suitable for a range of applications; including systems operating from industrial 24 to 28V rails and 48V rails.

The separate supply pin (VCC) allows the device to continue functioning under short circuit conditions, giving an end stop voltage at the output.

The ZXCT1080 has an extended ambient operating temperature range of -40°C to 125°C enabling it to be used in a wide range of applications including automotive.

Features
- 3V to 60V continuous high side voltage
- Accurate high-side current sensing
- -40 to 125°C temperature range
- AEC-Q100 Grade 1 qualified
- Output voltage scaling x10
- 4.5V to 12V VCC range
- Low quiescent current:
  - 80μA supply pin
  - 27μA IS+
- SOT25 package

Applications
- Industrial applications current measurement
- Battery management
- Over-current measurement
- Power management
- Automotive current measurement

Pin Assignments

Applications

Typical Application Circuit
Pin Descriptions

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VCC</td>
<td>This is the analogue supply and provides power to internal circuitry</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground pin</td>
</tr>
<tr>
<td>3</td>
<td>OUT</td>
<td>Output voltage pin. NMOS source follower with 20μA bias to ground</td>
</tr>
<tr>
<td>4</td>
<td>S+</td>
<td>This is the positive input of the current monitor and has an input range from 60V down to 3V. The current through this pin varies with differential sense voltage</td>
</tr>
<tr>
<td>5</td>
<td>S-</td>
<td>This is the negative input of the current monitor and has an input range from 60V down to 3V</td>
</tr>
</tbody>
</table>

Absolute Maximum Ratings (TA = 25°C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous voltage on S- and S+</td>
<td>-0.6 and 65</td>
<td>V</td>
</tr>
<tr>
<td>Voltage on all other pins</td>
<td>-0.6 and 14</td>
<td>V</td>
</tr>
<tr>
<td>Differential sense voltage, VSENSE (Note 1)</td>
<td>800</td>
<td>mV</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-40 to +125</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-55 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>125</td>
<td>°C</td>
</tr>
<tr>
<td>Package Power Dissipation (Note 2)</td>
<td>300 (@TA = 25°C)</td>
<td>mW</td>
</tr>
</tbody>
</table>

Note: 1. VSENSE is defined as the differential voltage between S+ and S- pins
2. Assumes θJA = 420°C/W

Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIN</td>
<td>Common-mode Sense+ Input Range</td>
<td>3</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>VCC</td>
<td>Supply Voltage Range</td>
<td>4.5</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>VSENSE</td>
<td>Differential Sense Input Voltage Range</td>
<td>0</td>
<td>0.15</td>
<td>V</td>
</tr>
<tr>
<td>VOUT</td>
<td>Output Voltage Range (Note 3)</td>
<td>0</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td>TA</td>
<td>Ambient Temperature Range</td>
<td>-40</td>
<td>125</td>
<td>°C</td>
</tr>
</tbody>
</table>

Note: 3. Based on 10x VSENSE
### Electrical Characteristics

\[ T_A = 25^\circ C, V_{IN} = 12V, V_{CC} = 5V, V_{SENSE} \text{ (Note 4)} = 100mV \] (unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>( T_A )</th>
<th>Min (Note 5)</th>
<th>Typ.</th>
<th>Max (Note 5)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_{CC} )</td>
<td>( V_{CC} ) Supply Current</td>
<td>( V_{CC} = 12V, V_{SENSE} = 0V ) (Note 4)</td>
<td>25°C</td>
<td>40</td>
<td>80</td>
<td>120</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>( I_{S+} )</td>
<td>S+ Input Current</td>
<td>( V_{SENSE} = 0V ) (Note 4)</td>
<td>25°C</td>
<td>15</td>
<td>27</td>
<td>42</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>( I_{S-} )</td>
<td>S- Input Current</td>
<td>( V_{SENSE} = 0V ) (Note 4)</td>
<td>25°C</td>
<td>15</td>
<td>40</td>
<td>80</td>
<td>nA</td>
</tr>
<tr>
<td>( V_{O(0)} )</td>
<td>Zero ( V_{SENSE} ) error (Note 4, 6)</td>
<td>( V_{SENSE} = 0V ) (Note 4)</td>
<td>25°C</td>
<td>0</td>
<td>35</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>( V_{O(10)} )</td>
<td>Output Offset Voltage (Note 7)</td>
<td>( V_{SENSE} = 10mV ) (Note 4)</td>
<td>25°C</td>
<td>-25</td>
<td>+25</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>( \Delta V_{OUT}/\Delta V_{SENSE} ) (Note 4)</td>
<td>( V_{SENSE} = 10mV ) to 150mV (Note 4)</td>
<td>25°C</td>
<td>9.9</td>
<td>10</td>
<td>10.1</td>
<td>V/V</td>
</tr>
<tr>
<td>( V_{OUT TC} ) (Note 8)</td>
<td>( V_{OUT} ) variation with temperature</td>
<td></td>
<td></td>
<td>30</td>
<td>ppm/°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( A_{CC} )</td>
<td>Total output error</td>
<td></td>
<td></td>
<td>-3</td>
<td>3</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>( I_{OH} )</td>
<td>Output Source Current</td>
<td>( \Delta V_{OUT} = -30mV )</td>
<td></td>
<td>1</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{OL} )</td>
<td>Output Sink Current</td>
<td>( \Delta V_{OUT} = +30mV )</td>
<td></td>
<td>20</td>
<td>( \mu A )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSRR</td>
<td>( V_{CC} ) Supply Rejection Ratio</td>
<td>( V_{CC} = 4.5V ) to 12V</td>
<td></td>
<td>54</td>
<td>60</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>CMRR</td>
<td>Common-Mode Sense Rejection Ratio</td>
<td>( V_{IN} = 60V ) to 3V</td>
<td></td>
<td>68</td>
<td>80</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>BW</td>
<td>-3dB small signal bandwidth</td>
<td>( V_{SENSE (AC)} = 10mVpp ) (Note 4)</td>
<td></td>
<td>500</td>
<td></td>
<td>kHz</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. \( V_{SENSE} = "V_{S+} - V_{S-}" \)
2. All Min and Max specifications over full temperature range are guaranteed by design and characterization.
3. The ZXCT1080 operates from a positive power rail and the internal voltage-current converter current flow is unidirectional; these result in the output offset voltage for \( V_{SENSE} = 0V \) always being positive.
4. For \( V_{SENSE} > 10mV \), the internal voltage-current converter is fully linear. This enables a true offset to be defined and used. \( V_{O(10)} \) is expressed as the variance about an output voltage of 100mV.
5. Temperature dependent measurements are extracted from characterization and simulation results.

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ZXCT1080

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Typical Characteristics

Test conditions unless otherwise stated: $T_A = 25°C$, $V_{IN} = 12V$, $V_{CC} = 5V$, $V_{SENSE+} = 12V$, $V_{SENSE} = 100mV$

**Fig. 1 Supply Current**

**Fig. 2 Input Current**

**Fig. 3 Current**

**Fig. 4 Sense Current**

**Fig. 5 Output Voltage**

**Fig. 6 Output Voltage**
Typical Characteristics (cont.)

Test conditions unless otherwise stated: \( T_A = 25°C, V_{IN} = 12V, V_{CC} = 5V, V_{SENSE+} = 12V, V_{SENSE} = 100mV \)

![Graph 1: \( \Delta V_{OUT} \) vs \( I_{O\text{C}} \) (Output Sink Current)]

![Graph 2: \( \Delta V_{OUT} \) vs \( I_{OH} \) (Output Source Current)]

![Graph 3: Gain vs \( V_{SENSE} \) (Sense Voltage)]

![Graph 4: \( \Delta V_{OUT} \) vs \( V_{S\text{+}} \) (Input Voltage)]

![Graph 5: \( \Delta V_{OUT} \) vs \( V_{S\text{+}} \) (Input Voltage)]
**Typical Characteristics (cont.)**

Test conditions unless otherwise stated: $T_A = 25^\circ C$, $V_{IN} = 12V$, $V_{CC} = 5V$, $V_{SENSE+} = 12V$, $V_{SENSE} = 100mV$

![Graph 1](image1)

- Fig. 12 Normalized Output Voltage

![Graph 2](image2)

- Fig. 13 Normalized Output Voltage

![Graph 3](image3)

- Fig. 14 Small Signal Bandwidth

![Graph 4](image4)

- Fig. 15 Large Signal Pulse Response

![Graph 5](image5)

- Fig. 16 Load Dump Waveform

![Graph 6](image6)

- Fig. 17 Small Signal Pulse Response
Typical Characteristics (cont.)

Test conditions unless otherwise stated: $T_A = 25^\circ C$, $V_{IN} = 12V$, $V_{CC} = 5V$, $V_{SENSE+} = 12V$, $V_{SENSE} = 100mV$
Application Information

The ZXCT1080 has been designed to allow it to operate with 5V supply rails while sensing common mode signals up to 60V. This makes it well suited to a wide range of industrial and power supply monitoring applications that require the interface to 5V systems while sensing much higher voltages.

To allow this its VCC pin can be used independently of S+.

Figure 1 shows the basic configuration of the ZXCT1080.

![Fig. 20 Typical Configuration of ZXCT1080](image)

Load current from the input is drawn through RSENSE developing a voltage VSENSE across the inputs of the ZXCT1080.

The internal amplifier forces VSENSE across internal resistance RGT causing a current to flow through MOSFET M1. This current is then converted to a voltage by RG. A ratio of 10:1 between RG and RGT creates the fixed gain of 10. The output is then buffered by the unity gain buffer.

The gain equation of the ZXCT1080 is:

\[
V_{OUT} = I_{RSENSE} \times \frac{RG}{RGT} \times 10 = I \times RSENSE \times 10
\]

The maximum recommended differential input voltage, VSENSE, is 150mV; it will however withstand voltages up to 800mV. This can be increased further by the inclusion of a resistor, R_{LIM}, between S- pin and the load; typical value is of the order of 10k.
Capacitor \( C_D \) provides high frequency transient decoupling when used with \( R_{\text{LIM}} \); typical values are of the order 10pF.

For best performance \( R_{\text{SENSE}} \) should be connected as close to the \( S^+ \) (and SENSE) pins; minimizing any series resistance with \( R_{\text{SENSE}} \).

When choosing appropriate values for \( R_{\text{SENSE}} \) a compromise must be reached between in-line signal loss (including potential power dissipation effects) and small signal accuracy.

Higher values for \( R_{\text{SENSE}} \) gives better accuracy at low load currents by reducing the inaccuracies due to internal offsets. For best operation the ZXCT1080 has been designed to operate with \( V_{\text{SENSE}} \) of the order of 50mV to 150mV.

Current monitors’ basic configuration is that of a unipolar voltage to current to voltage converter powered from a single supply rail. The internal amplifier at the heart of the current monitor may well have a bipolar offset voltage but the output cannot go negative; this results in current monitors saturating at very low sense voltages.

As a result of this phenomenon the ZXCT1080 has been specified to operate in a linear manner over a \( V_{\text{SENSE}} \) range of 10mV to 150mV range, however it will still be monotonic down to \( V_{\text{SENSE}} \) of 0V.

It is for this very reason that Diodes has specified an input offset voltage (\( V_{O(10)} \)) at 10mV. The output voltage for any \( V_{\text{SENSE}} \) voltage from 10mV to 150mV can be calculated as follows:

\[
V_{\text{OUT}} = (V_{\text{SENSE}}) \times G + V_{(10)}
\]

Alternatively the load current can be expressed as:

\[
I_L = \frac{(V_{\text{OUT}} - V_{O(10)})}{G \times R_{\text{SENSE}}}
\]
Ordering Information

<table>
<thead>
<tr>
<th>Device</th>
<th>AEC-Q100</th>
<th>Package</th>
<th>Part Mark</th>
<th>Reel Size</th>
<th>Tape Width (mm)</th>
<th>Quantity per Reel</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZXCT1080E5TA</td>
<td>Grade 1</td>
<td>SOT25</td>
<td>1080</td>
<td>7</td>
<td>8</td>
<td>3000</td>
</tr>
</tbody>
</table>

Package Outline Dimensions (All Dimensions in mm)

SOT25

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ZXCT1080
HIGH VOLTAGE HIGH-SIDE CURRENT MONITOR

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