The ZXCT1032EV1 provides a very convenient means for evaluating the capabilities of the ZXCT1032 current monitor.

The ZXCT1032 is a high-side current monitor that drives a PMOS or PNP transistor to provide in-rush current limit and over-current protection. The ZXCT1032 includes a high accuracy high-side current monitor, a start-up timer and a re-try inhibit timer. The ZXCT1032 takes the voltage developed across a current shunt resistor and compares this with an externally set trip point. It works in three modes:

- Linear soft-start
- Over-current detector
- Over-current disconnect/fuse

For details on these and other features of the ZXCT1032, refer to the datasheet which is available on the Zetex Semiconductors’ web site.

The evaluation board is more complex than the typical application of the device. This is because it contains some features to aid with experimentation and visualisation of the operational status of the device. Some of these will be briefly explained with reference to Figure 1.
The sense resistor, $R_S$, consists of two resistors (R1 and R2) which are configured in parallel such that either one or both resistors could be connected by completing the solder-bridge link next to each one. R2 (0.5R) is connected by default.

A third resistor, R6, is in parallel with R1 and R2 consists of two pads with a hole in each pad. R6 provides means for connecting an external $R_S$ either alone or in parallel with R1 and R2.

**Trip current**

When the load current reaches or exceeds a certain value, transistor Q101 is switched off. The current at which this happens is given by,

$$I_{TRIP} = \frac{V_{ISET} - 0.15}{10 \cdot R_{SENSE}}$$

With the default values supplied on the evaluation board, this becomes

$$I_{TRIP} = \frac{2.1 - 0.15}{10 \cdot 0.5} = 390mA$$

The board is supplied without R7 which means that $V_{ISET}$ defaults to the internal 2.1V reference. An external $V_{ISET}$ can be imposed on terminal P2-2. A lower $V_{ISET}$ will lower the trip current and vice versa. A $V_{ISET}$ of less than 100mV will permanently turn the series transistor off.
On-board adjustment of $V_{\text{ISET}}$

As an alternative to using the on-board voltage reference for $V_{\text{ISET}}$, a multi-turn potentiometer, VR1, is provided on the evaluation board. This can be connected to the $V_{\text{ISET}}$ input by adding R7. R7 can be any value from 0 to 2.2k. It might however be best not to make R7 zero if external $V_{\text{ISET}}$ will also be used so that the external source of $V_{\text{ISET}}$ is not inadvertently shorted out when VR1 is set to 0Ω.

When VR1 is supplying $V_{\text{ISET}}$, the range will be adjustable from a minimum value up to a maximum value that is largely dependent on the supply voltage. The minimum and maximum values can be determined from the following expressions.

$$V_{\text{ISET}}(\text{min}) = \frac{V_{\text{REF}} \cdot R7}{R7 + R_{\text{VREF}}} = \frac{2.1 \cdot R7}{R7 + 50k}$$

where R7 is in kΩ and both $V_{\text{ISET}}$ and $V_{\text{REF}}$ are in Volts. $R_{\text{VREF}}$ is the source resistance of the on-chip voltage reference.

$$V_{\text{ISET}}(\text{max}) = \frac{V_{T} \cdot R_{\text{VREF}} + V_{\text{REF}} \cdot R_{T}}{R_{\text{VREF}} + R_{T}}$$

where $V_{T} = \frac{V_{\text{SUP}}}{2}$ and $R_{T} = 5k + R7$.

For R7 = 2.2kΩ, the above formulae simplify to

$$V_{\text{ISET}}(\text{min}) = \frac{2.1 \cdot 2.2}{2.2 + 50} = 92.7 mV \text{ (VR1 at minimum)}$$

$$V_{\text{ISET}}(\text{max}) = 0.437 \cdot V_{\text{SUP}} + 0.264 V \text{ (VR1 at maximum)}$$

Flags and indicators

The ZXCT1032 has an active low flag which goes low when the device has tripped. This flag is used to provide a number of indications regarding the status of the evaluation board.

LEDs

There are two LEDs labelled FOK (Flag OK - green) and FTP (Flag TriPped - yellow). These light to indicate their respective functions.

There is a third LED labelled PWR (PoWeR – red) which will be on as long as there is power on at the output, i.e. Q101 is on.

Flags

The device flag is buffered by a two stage transistor (Q2,3) to provide an active high (TRP) and active low (TRP) tripped flag which are available on terminals P4-2 and P4-4 respectively. Terminals P4-1 and P4-3 are ground pins.

Both the TRP and TRP pins can sink currents up to 500mA from a voltage not greater than (V_{SUP} + 5V) or 30V whichever is the lower.
Interfaces

The interfaces are as shown in Figure 1.

P1 – \( V_{\text{SENSE}} \) - Provides a convenient point to monitor \( V_{\text{SENSE}} \). Do not use this terminal for shunt resistors especially when handling high currents. Use R6 instead.

<table>
<thead>
<tr>
<th>P1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S-</td>
</tr>
<tr>
<td>2</td>
<td>S+</td>
</tr>
</tbody>
</table>

P2 – Input

<table>
<thead>
<tr>
<th>P2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>( V_{\text{ISET}} )</td>
</tr>
<tr>
<td>3</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>Supply voltage</td>
</tr>
</tbody>
</table>

P3 – Output

<table>
<thead>
<tr>
<th>P3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>Output</td>
</tr>
</tbody>
</table>

P4 – Flags

<table>
<thead>
<tr>
<th>P4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>Tripped</td>
</tr>
<tr>
<td>3</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>\textit{Tripped}</td>
</tr>
</tbody>
</table>

P5 – Timing capacitor \( C_T \). There is an on-board 0.1\( \mu \)F capacitor. Any addition across P5 will appear in parallel with this 0.1\( \mu \)F capacitor.

<table>
<thead>
<tr>
<th>P5</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>( C_T )</td>
</tr>
</tbody>
</table>

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>ORDER NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZXCT1032EV1</td>
</tr>
</tbody>
</table>

Please note evaluation boards are subject to availability and qualified leads.
ZXCT1032EV1 Summary

Sense resistor

The board has been designed with two selectable values of sense resistor. The value of the sense resistor can be chosen by using the solder links SL1 and SL2.

The board is also tracked for a user-defined through-hole resistor (R6).

The 50mΩ resistor (R1) is selected by shorting SL1 and opening SL2.

The 500mΩ resistor (R2) is selected by shorting SL2 and opening SL1.

If both links are shorted the effective resistance is 45.45mΩ.

If both links are open, the optional leaded resistor R6 can be exclusively used as the sense resistor.

The maximum power dissipation rating of the resistor must be appropriate to the load current level.

For further information on choosing a value of sense resistor please refer to the ZXCT1032 datasheet.

Trip current sensitivity and its adjustment

The current at which the ZXCT1032EV1 trips (DRIVE goes high and FLAG goes low) for a given $R_S$ is changed by setting $V_{SET}$.

This trip current is given by,

$$I_{TRIP} = \frac{V_{SET} - 0.15}{10 \cdot R_S}$$

Configuration table for ZXCT1032EV1

<table>
<thead>
<tr>
<th>$R_S$ (mΩ)</th>
<th>Trip Current</th>
<th>SOLDER LINK CONFIGURATION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>3.9</td>
<td>Short SL2</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>0.39</td>
<td>Short SL1</td>
<td></td>
</tr>
<tr>
<td>45.45</td>
<td>4.3</td>
<td>Short SL1 &amp; SL2</td>
<td></td>
</tr>
</tbody>
</table>

Configuration for different trip currents.

The board can be configured for different trip currents by changing the SMD resistors or fitting a suitable wire ended resistor and opening both solder links. It is important to ensure an appropriate value of $R_S$ is selected to obtain the desired accuracy for a given output current.

Choosing a larger value for $R_S$ gives a higher output voltage for a given current resulting in better resolution but at the expense of increased voltage drop and higher dissipation in $R_S$.

The ZXCT1032 is optimized for values of $V_{SENSE}$ around 200mV.

Accuracy

The accuracy of the trip current will be influenced by the tolerance of the external sense resistors used. The ZXCT1032EV1 utilizes 1% sense resistors.
COMPONENTS LIST

<table>
<thead>
<tr>
<th>Ref</th>
<th>Qty</th>
<th>Value</th>
<th>Pkg</th>
<th>Part Number</th>
<th>Manufacturer</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>1</td>
<td>0.1µF/25v</td>
<td>0805</td>
<td>LGR971-Z</td>
<td>Osram</td>
<td>FEC 122-6373</td>
</tr>
<tr>
<td>D1</td>
<td>1</td>
<td>LED Grn</td>
<td>0805</td>
<td>LGR971-Z</td>
<td>Osram</td>
<td>FEC 122-6420</td>
</tr>
<tr>
<td>D2</td>
<td>1</td>
<td>LED Yel</td>
<td>0805</td>
<td>LSR976</td>
<td>Osram</td>
<td>FEC 122-6392</td>
</tr>
<tr>
<td>D3</td>
<td>1</td>
<td>LED Red</td>
<td>0805</td>
<td>ZHC5500</td>
<td>Zetex</td>
<td></td>
</tr>
<tr>
<td>D4,5</td>
<td>2</td>
<td>Schottky</td>
<td>SOT-23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC1</td>
<td>1</td>
<td>Current Monitor</td>
<td>SO8</td>
<td>ZXCT1032N8</td>
<td>Zetex</td>
<td></td>
</tr>
<tr>
<td>P1,5</td>
<td>2</td>
<td>2-W STB</td>
<td>MPT2</td>
<td>1725656</td>
<td>Phoenix</td>
<td>FEC 304-1359</td>
</tr>
<tr>
<td>P3</td>
<td>1</td>
<td>3-W STB</td>
<td>MPT3</td>
<td>1725669</td>
<td>Phoenix</td>
<td>FEC 304-1360</td>
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<tr>
<td>P2,4</td>
<td>2</td>
<td>4-W STB</td>
<td>MPT4</td>
<td>1725672</td>
<td>Phoenix</td>
<td>FEC 304-1414</td>
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<tr>
<td>Q101</td>
<td>1</td>
<td>FET</td>
<td>SOT-23-6</td>
<td></td>
<td>Zetex</td>
<td></td>
</tr>
<tr>
<td>Q2,3</td>
<td>2</td>
<td>FET</td>
<td>SOT-23</td>
<td></td>
<td>Zetex</td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>1</td>
<td>50mΩ</td>
<td>2512</td>
<td>LR2512-R050FW</td>
<td>Welwyn</td>
<td>SMD Sense Resistor 1%</td>
</tr>
<tr>
<td>R2</td>
<td>1</td>
<td>500mΩ</td>
<td>2512</td>
<td>LR2512-R500FW</td>
<td>Welwyn</td>
<td>SMD Sense Resistor 1%</td>
</tr>
<tr>
<td>R3,4,5</td>
<td>3</td>
<td>2.2k</td>
<td>0805</td>
<td></td>
<td>Standard 0805 1%</td>
<td></td>
</tr>
<tr>
<td>R8,9,10</td>
<td>3</td>
<td>10k</td>
<td>0805</td>
<td></td>
<td>Standard 0805 1%</td>
<td></td>
</tr>
<tr>
<td>R11</td>
<td>1</td>
<td>47k</td>
<td>0805</td>
<td></td>
<td>Standard 0805 1%</td>
<td></td>
</tr>
<tr>
<td>RV1</td>
<td>1</td>
<td>Trim-pot</td>
<td></td>
<td>T93YB 10k 10%TU</td>
<td>Vishay</td>
<td>FEC 114-1419</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SET-UP AND TEST

The board is preset to trip at a load current of 390mA (SL2 is shorted to connect in R2, 500mΩ, sense resistor and internal VREF is used).

Required Equipment

1. 1 x 30R 15W resistor (load – it may be necessary to mount resistor on heat sink).
2. 1 x adjustable bench PSU. (A second PSU can optionally be used to vary VSET to change the trip current - see Error! Reference source not found. – or the on-board variable resistor may be used instead.)
3. 2 x DVM’s (one for voltage measurement and one for current measurement)
4. 1.5/1.8mm flat jeweller’s screw driver (for terminal blocks).

420mA load test  (Refer to Error! Reference source not found. for test diagram.)

1. Ensure SL2 is shorted.
2. Set PSU1 to 0V and limit its current to 500mA.
3. Connect PSU1 to VSUP.
4. Connect the resistor in series with the ammeter set to a suitable range for measuring up to 500 mA DC.
5. Switch on PSU1 and adjust until the ammeter reads 350 mA ±1 mA. LED’s PWR and FOK should be lit.
6. On terminal P4, measure pin TRP with a DVM. It should be high.
7. On terminal P4, measure pin TRP with a DVM. It should be low.
8. Increase PSU1 until ammeter current drops to less than 40mA. Make sure that this happens around 390mA ±30mA (the yellow LED will light whilst the red and green LED’s will glow at a reduced brightness - some flickering may be observed).
9. On terminal P4, measure pin TRP(1) with a DVM. It should be low. Low means less than 0.15V SUP.
10. On terminal P4, measure pin TRP with a DVM. It should be high. High means greater than 0.85V SUP.

End of Test

1 The voltage on pins TRP and TRP are square waves with complementary low and high duty cycles respectively. The duty cycle is governed by capacitor C. Therefore, the coefficient of V SUP given for these tests will change if a different value of C is used. The same thing applies to the 40mA limit in Test 8.
Figure 3 Test diagram for ZXCT1032EV1

EVALUATION BOARD
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