DN87
Maintaining a short term supply rail to the ZXCT1081 during a short-circuit load or overload event

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Introduction

Zetex ZXCT1080/ZXCT1081 high-side current monitors are capable of operating during short circuit current conditions. This design note shows how this can be achieved successfully and describes circuit considerstions with design examples.

Powering the device

To make sure that these devices continue to provide a valid output during a short circuit event, the ZXCT1080/1081 is equipped with a dedicated supply pin, V_{CC}, which is normally independent of the rail that is being monitored. There may however be times when V_{CC} can not be made totally independent of the monitored supply. For example, V_{CC} can be derived from the monitored supply as shown in Figure 1A. In this case, if a short circuit event causes the monitored rail to collapse, so will $V_{CC.}$ This makes it impossible for the current monitor to provide a valid output during the short circuit conditions.

The scheme in Figure 1A (and Figure 2A) can only be used if V_{SUPPLY} lies between 4.5V and 12V. Figure 1B (or Figure 2B) will have to be used if V_{SUPPLY} is greater than 12V. In both Figure 1B and Figure2B, Z1 is used to clamp V_{CC} to an acceptable value whilst allowing V_{SUPPLY} to range up to its design maximum.

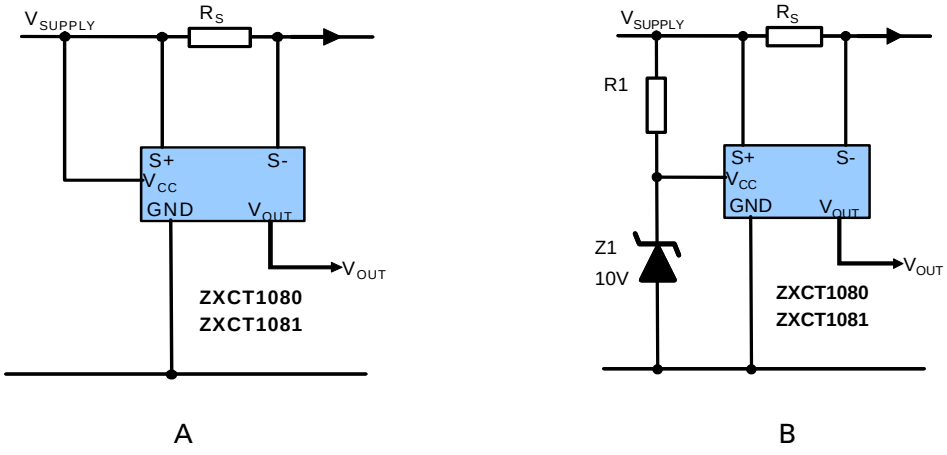

Figure 1 - Powering V_{cc} from the monitored supply

Solution

In most cases, all that will be needed is for V_{OUT} to remain valid long enough, following a short circuit or overload event, for action to be taken, e.g. for a microprocessor to read the output and either shut down the supply or raise a flag. The required hold-up time in such cases only needs to be of the order of 1ms to 100ms.

This can be achieved by providing a hold-up time on the V_{CC} pin as illustrated in Figure 2 below. In both circuits, Q1 is configured as a diode with relatively high reverse breakdown. Capacitor C1 is rapidly charged on application of V_{SUPPLY}. If V_{SUPPLY} collapses due to an overload, Q1 goes into blocking mode and C1 maintains supply to the V_{CC} pin for the time it takes it to discharge below the limit of operation of the current monitor. The only task is to choose an appropriate value of C1, the hold-up capacitor.

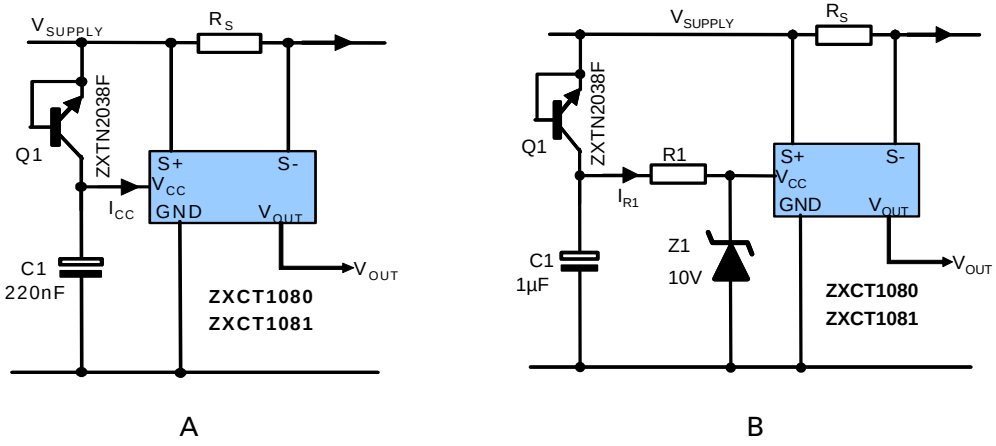

Figure 2 - Implementing hold-up time

Specifying C1

Specifying C1 is reasonably straightforward. Although C1 discharges exponentially, a worst case scenario can be considered by assuming that it discharges with a constant current.

Example 1. Assume the following conditions:

V_{supply}	10V
$I_{CC(max)}$	120 µA
$V_{cc(min)}$	4.5V
$t_{hold-up}$	10ms

From $C = \frac{I \cdot \Delta t}{\Delta V}$

$$C1 = \frac{120\mu A \cdot 10ms}{5.5V} = 218nF$$

Hence a 220nF will give a hold-up time well in excess of the required 10ms.

Example 2 (Figure 2B)

The calculation is identical for Figure 2B except that I_{R1} is used instead of I_{CC}. Since I_{R1} will be an order of magnitude higher than I_{CC}, it can be expected that C1 will be correspondingly higher. Also, V_{SUPPLY} in this case must be appropriately higher than 10V to maintain V_{CC} at 10V.

For example, assuming that I_{R1} = 1.2 mA, the computed value of C1 becomes 2.18 µF. Therefore, a 2.2 µF capacitor would be used. Again, the achieved hold-up time will be much longer than 10 ms because the discharge current will drop down to I_{CC} once the capacitor voltage drops below V_{Z1}.

Reasons for choosing Q1

A normal diode could have been used and the circuit would still work. However the ZXTN2038F is used for a number of reasons:

1. It can handle relatively high peak currents, up to 2A compared to 500mA, or less for most signal diodes. This is important when it comes to charging C1 quickly without degrading either the diode (Q1 in this case) or start-up time.

2. ZXTN2038F has a $I_{CES(max)}$ of only 100nA. It therefore offers a guaranteed low reverse leakage diode which aids achieving maximum hold-up time from a given capacitance value.

3.In place of a diode (or Q1), a resistor might be used instead. However, as well as a reduced hold-up time, there will also be a start-up delay which may or may not be acceptable.

Conclusion

The ZXCT1080 and ZXCT1081 can be used to monitor short circuit events. By making use of the independent V_{CC} pin in a controlled way, the short circuit signal can be maintained even though the monitored supply has collapsed. Improved performance can be achieved by using a bipolar transistor to charge the hold-up capacitor

Recommended further reading

• AN39 - Current Measurement Applications Handbook

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