# AN45

## High voltage current monitoring using the ZXCT1009 and ZXCT1010 in power supplies

## Introduction

**Power supply monitoring requirements**

All power supplies and charging units have some current measurement requirement. The current levels measured will vary dependent upon the application. Operating input and required output voltage levels will differ in accordance with the system; for example, battery charger modules for PDA modules can operate below 20V, whilst measuring 1-2A, however a power supply for a bus converter will have much different requirements. A 700W power supply module will typically have current measuring requirements of ten's of amp's.

This highlights the problem of the need to measure various current levels over such a broad range of operating voltage levels. The circuits outlined demonstrate how a 20V current monitor can be used in applications with supply rails up to 250V.

## High voltage current monitoring

**ZXCT1009**

One of the key benefits of using a ZXCT1009 high side current monitor is its simplicity due to its low pin count. Figure 1.0 below shows how the ZXCT1009 can be configured to accommodate high voltages with the use of only three more additional components.

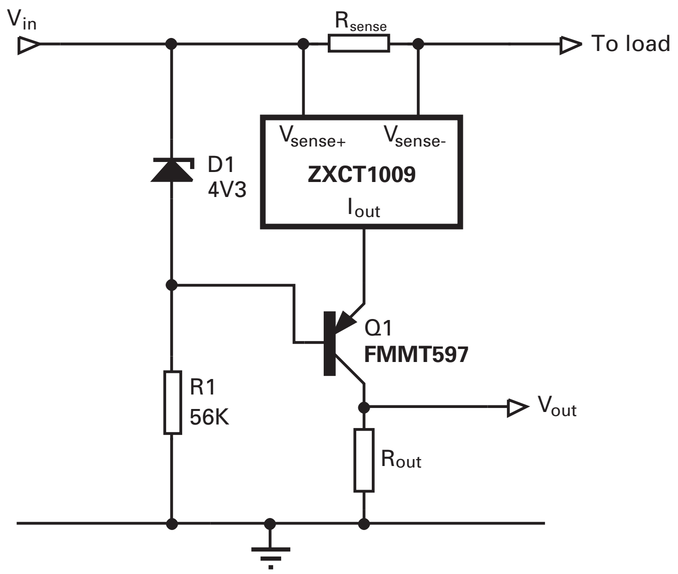


**Figure 1 High voltage current monitoring using the ZXCT1009**

For high voltage operation, a PNP transistor, a Zener diode and an additional resistor are configured around the device. The Zener diode D1 is used to limit the voltage between $V_{sense+}$ and $I_{out}$ pin, whilst providing a bias current for transistor Q1. D1 will maintain approximately 3.3V minus the Vbe of the transistor across the device. This allows a sufficient operating voltage of the device. R1's value will be chosen based upon the bias current of the Zener diode and the maximum power which can be dissipated in these components. A typical value of R1 being 56kΩ

The transistor Q1's purpose is to drop the higher voltage levels, once the supply begins to exceeded the normal operating supply rail of the ZXCT1009. The absolute maximum rating of this device is 20V.

The ZXCT1009 has a transconductance of 10mA/V. $R_{out}$ will scale the required output voltage to the desired level; $V_{out}= I_{out} \times R_{out}$. The current $I_{out}$ is directly proportional to the sense voltage which is dropped across $R_{sense}$ once current flows from $V_{in}$ to load.

**ZXCT1010**

In a similar way, the ZXCT1010 can also be used in a high voltage configuration as shown in figure 2.0. This arrangement can be used when there is a requirement for a high voltage configuration, whilst at the same time a need for an improved offset accuracy.

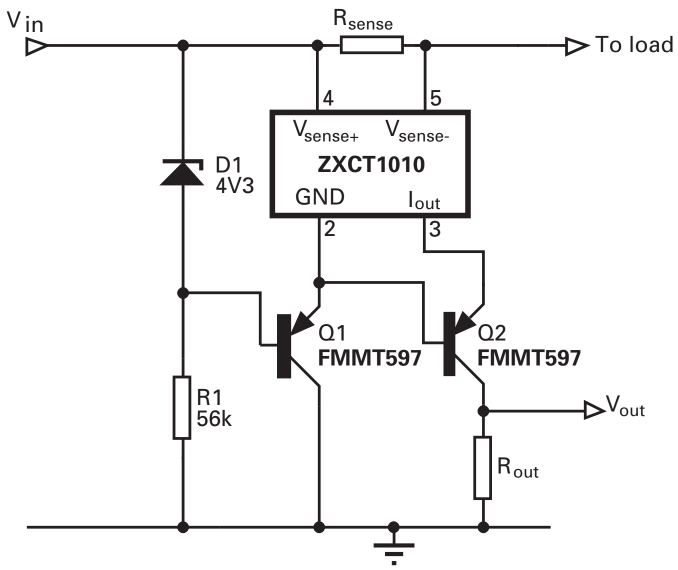


**Figure 2 High voltage current monitoring using the ZXCT1010**

**Offset and gain erors**

Two dominant errors are apparent in circuit when using current monitor IC's to measure current. Gain error and offset error. Offset error is more apparent at lower Vsense levels and gain error becomes more predominant at higher $V_{sense}$ levels.

The ZXCT1009 is a three terminal device, whereas the ZXCT1010 has an additional pin to allow the operating current of the device to flow to ground. This addition of a ground pin reduces the typical output offset. With the ZXCT1009, the operating current of the device flows out through the output scaling resistor. At low level sense values, this offset error may affect the required accuracy of the output.

Figure 3.0 shows a comparison of $I_{out}$ against a sweep of supply rail for a given load. The sense voltage dropped across the sense resistor in each case was 30mV. Both devices have a transconductance of 10mA/V.

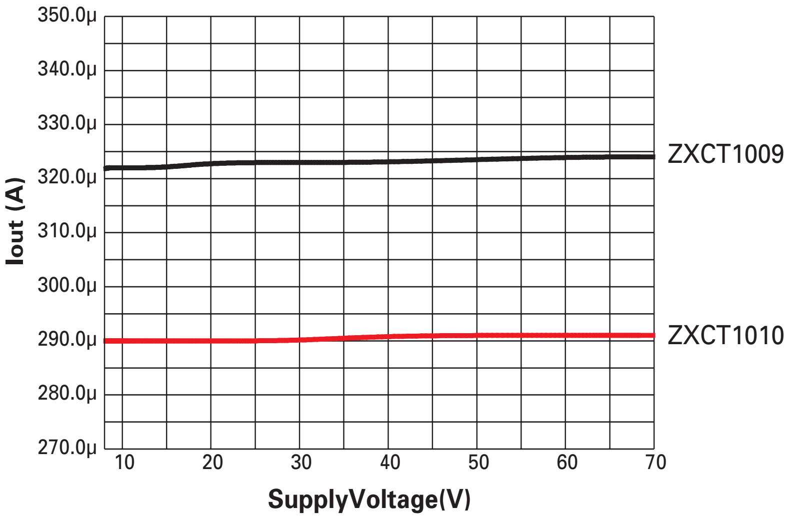


**Figure 3 Output current change for the ZXCT1009 and ZXCT1010 with a change in supply rail**

The circuit in figure 2.0 works in a similar manner to that of figure 1.0. This time the Zener diode, D1 is used to limit the voltage between $V_{sense+}$ and ground pin. The current flowing through this device is used with R1 to bias Q1. The FMMT597 is used because of its high voltage capability alongside its high gain capability.

Q2 utilizes the operating current of the ZXCT1010 for biasing. When in operation, the collector current closely follows the emitter current allowing $V_{out}$ to be accurately set.

For a 5V output required and 30mV $V_{sense}$ the scaling resistor $R_{out}$ will be;

**5 / (30E-3 x 10E-3) = 16.7kΩ**

The comparison in the above figure 3.0 not only shows how the ZXCT1010 will give a more accurate output current for a given load current, but also demonstrates the performance of the high voltage configurations over a wide input supply range.

## Conclusion

High voltage current measurement is possible with the ZXCT1009 and ZXCT1010 current monitor devices. Three or four additional external components can be used to measure current in circuit where supply rails work up to 250V.

In applications where the voltage across the sensing resistor is low, the output offset can be minimized by using the ZXCT1010.

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