

## Description

The ZXCT1008 is a high side current sense monitor. Using this device eliminates the need to disrupt the ground plane when sensing a load current.

It takes a high side voltage developed across a current shunt resistor and translates it into a proportional output current. A user defined output resistor scales the output current into a ground-referenced voltage.

The wide input voltage range of 20V down to as low as 2.5V make it suitable for a range of applications. The ability to withstand high voltage transients and reverse polarity connection makes this part very suitable for automotive and other transient rich environment.

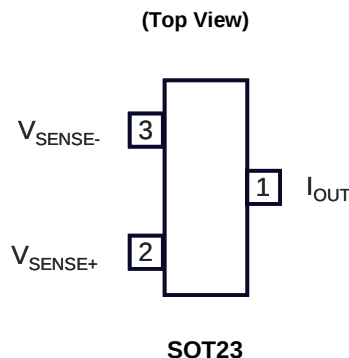
## Features

- Low Cost, Accurate High-Side Current Sensing
- -40 to +125°C Temperature Range
- Up to 500mV Sense Voltage
- 2.5V to 20V Supply Range
- 4μA Quiescent Current
- 1% Typical Accuracy
- SOT23
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **An Automotive-Compliant Part is Available Under Separate Data Sheet ([ZXCT1008Q](#))**

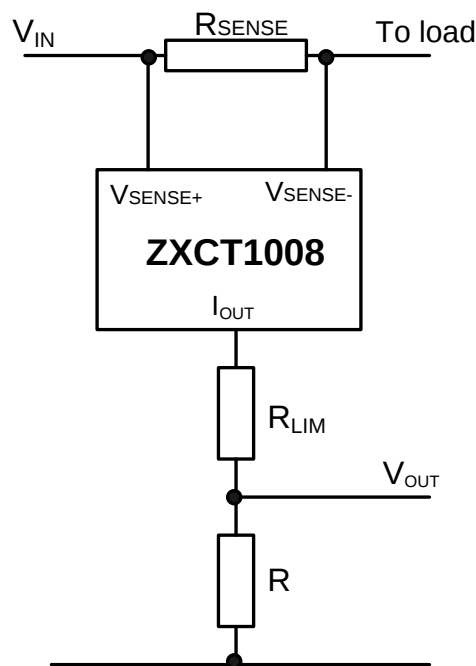
## Applications

- Automotive Current Measurement
- DC Motor and Solenoid Control
- Over Current Monitor
- Power Management

## Pin Assignments



## Application Circuit



### Notes:

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

## Pin Descriptions

| Pin Name            | Pin Function                                     |
|---------------------|--------------------------------------------------|
| V <sub>SENSE+</sub> | Connection to Supply Voltage                     |
| V <sub>SENSE-</sub> | Connection to Load                               |
| I <sub>OUT</sub>    | Output Current, Proportional to Measured Current |

## Absolute Maximum Ratings (@T<sub>A</sub> = +25°C, unless otherwise specified.)

| Description                                                                  | Rating      | Unit |
|------------------------------------------------------------------------------|-------------|------|
| Voltage on Any Pin (relative to I <sub>OUT</sub> )                           | -0.6 to 20  | V    |
| Continuous Output Current, I <sub>OUT</sub>                                  | 25          | mA   |
| Continuous Sense Voltage, V <sub>SENSE</sub> (Note 4)                        | -0.5 to 5   | V    |
| Operating Temperature, T <sub>A</sub>                                        | -40 to +85  | °C   |
| Storage Temperature                                                          | -55 to +125 | °C   |
| Package Power Dissipation @ T <sub>A</sub> = +25°C (Derate to Zero @ +125°C) | 450         | mW   |

Operation above the absolute maximum rating may cause device failure. Operation at the absolute maximum ratings for extended periods may reduce device reliability.

## Electrical Characteristics (@T<sub>A</sub> = +25°C, V<sub>IN</sub> = 5V, R<sub>OUT</sub> = 100Ω, unless otherwise specified.)

| Symbol              | Parameter                                                 | Conditions                                                                                                                                     | Min                             | Typ                           | Max                               | Unit                       |
|---------------------|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-------------------------------|-----------------------------------|----------------------------|
| V <sub>IN</sub>     | V <sub>CC</sub> Range                                     | —                                                                                                                                              | 2.5                             | —                             | 20                                | V                          |
| I <sub>OUT</sub>    | Output Current<br>(Note 5)                                | V <sub>SENSE</sub> = 0V<br>V <sub>SENSE</sub> = 10mV<br>V <sub>SENSE</sub> = 100mV<br>V <sub>SENSE</sub> = 200mV<br>V <sub>SENSE</sub> = 500mV | 1<br>90<br>0.975<br>1.95<br>4.8 | 4<br>104<br>1.0<br>2.0<br>5.0 | 15<br>120<br>1.025<br>2.05<br>5.2 | μA<br>μA<br>mA<br>mA<br>mA |
| V <sub>SENSE</sub>  | Sense Voltage (Note 4)                                    | —                                                                                                                                              | 0                               | —                             | 500                               | mV                         |
| I <sub>SENSE-</sub> | V <sub>SENSE</sub> - Input Current                        | —                                                                                                                                              | —                               | —                             | 100                               | nA                         |
| A <sub>CC</sub>     | Accuracy                                                  | R <sub>SENSE</sub> = 0.1Ω, V <sub>SENSE</sub> = 200mV                                                                                          | -2.5                            | —                             | 2.5                               | %                          |
| G <sub>M</sub>      | Transconductance,<br>I <sub>OUT</sub> /V <sub>SENSE</sub> | —                                                                                                                                              | —                               | 10,000                        | —                                 | μA/V                       |
| BW                  | Bandwidth                                                 | V <sub>SENSE(DC)</sub> = 10mV, RF P <sub>IN</sub> = -40dBm<br>(Note 6)                                                                         | —                               | 300                           | —                                 | kHz                        |
|                     |                                                           | V <sub>SENSE(DC)</sub> = 100mV, RF P <sub>IN</sub> = -20dBm<br>(Note 6)                                                                        | —                               | 2                             | —                                 | MHz                        |

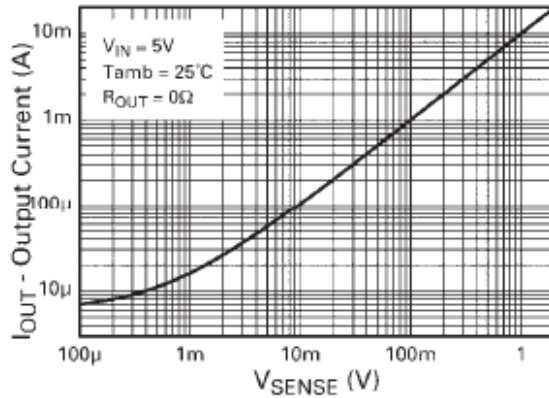
Notes: 4. V<sub>SENSE</sub> is defined as the differential voltage between V<sub>SENSE+</sub> and V<sub>SENSE-</sub>.

$$\begin{aligned}
 V_{SENSE} &= V_{SENSE+} - V_{SENSE-} \\
 &= V_{IN} - V_{LOAD} \\
 &= I_{LOAD} \times R_{SENSE}
 \end{aligned}$$

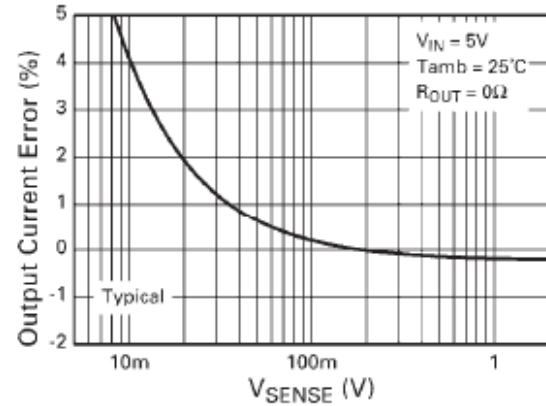
5. Includes input offset voltage contribution.

6. -20dBm=63mV<sub>pp</sub> into 50Ω.

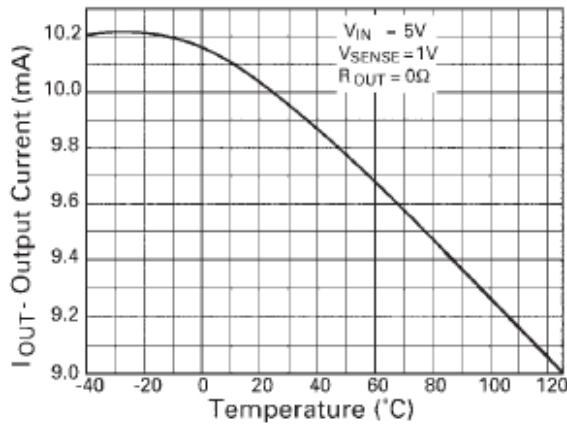
## Typical Characteristics



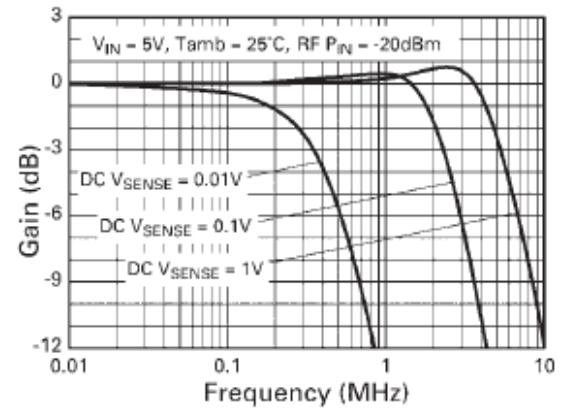
Typical Output v Sense Voltage



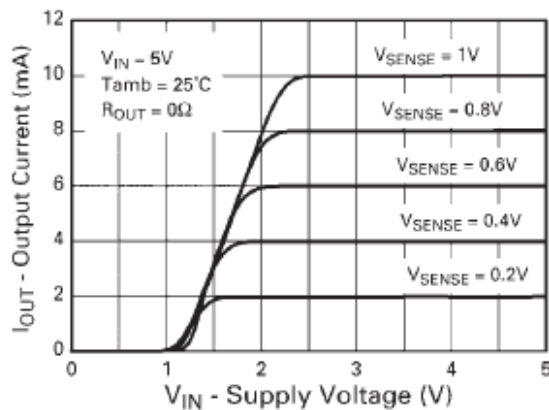
Error v Sense Voltage



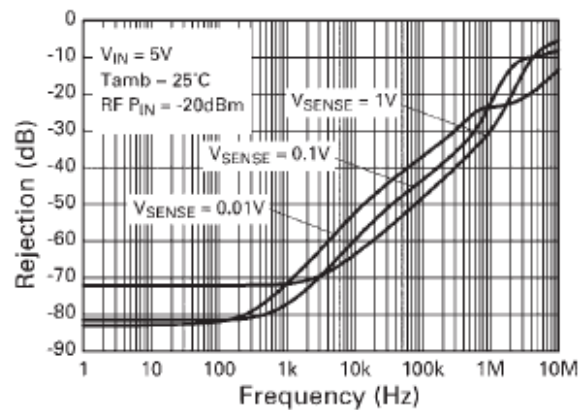
Output Current Temperature



Frequency Response

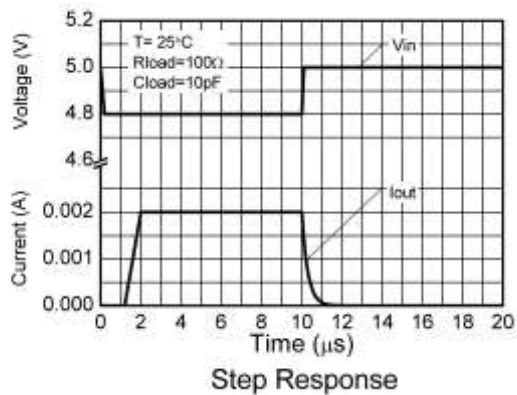


Transfer Characteristic



Common Mode Rejection

## Typical Characteristics (Continued)



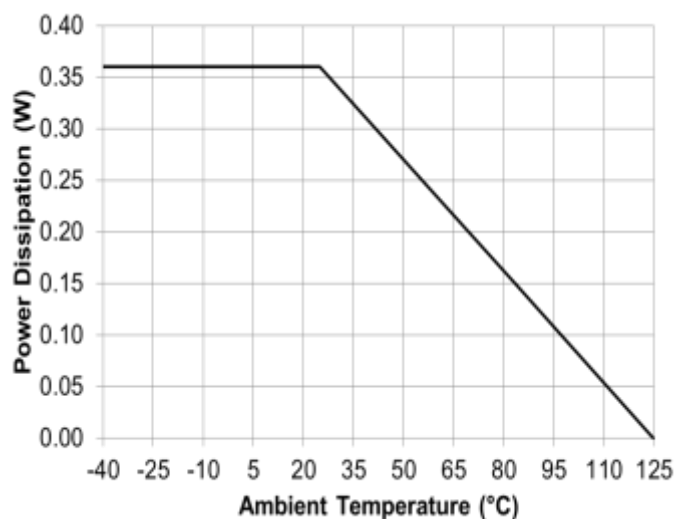
## Power Dissipation

The maximum allowable power dissipation of the device for normal operation ( $P_{MAX}$ ), is a function of the package junction to ambient thermal resistance ( $\theta_{JA}$ ), maximum junction temperature ( $T_{JMAX}$ ), and ambient temperature ( $T_{AMB}$ ), according to the expression:

$$P_{MAX} = (T_{JMAX} - T_{AMB}) / \theta_{JA}$$

The device power dissipation,  $P_D$  is given by the expression:

$$P_D = I_{OUT} \times (V_{IN} - V_{OUT}) W$$



## Application Information

The following text describes how to scale a load current to an output voltage.

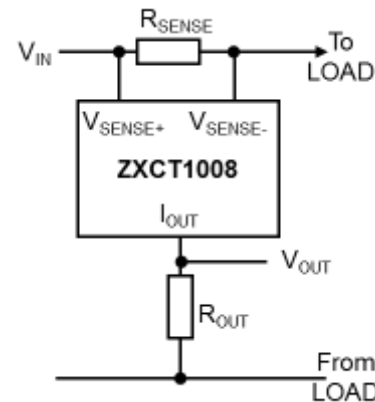


Figure 1. Generic ZXCT1008 Configuration

$$V_{SENSE} = V_{IN} - V_{LOAD} = I_{LOAD} \times R_{SENSE} \quad (1)$$

$$V_{OUT} = I_{OUT} \times R_{OUT} = 0.01 \times V_{SENSE} \times R_{OUT} \quad (2)$$

E.G.

A 1A current is to be represented by a 100mV output voltage:

- 1) Choose a value of  $R_{SENSE}$  so that at full load:

$$50mV > V_{SENSE} > 500mV.$$

For example, choose  $V_{SENSE} = 100mV$  at 1.0A.

$$\text{From (1)} R_{SENSE} = V_{SENSE} / I_{LOAD} = 0.1 / 1.0 = 0.1\Omega.$$

- 2) Choose  $R_{OUT}$  to give  $V_{OUT} = 100mV$  @  $V_{SENSE} = 100mV$

Rearranging (2) for  $R_{OUT}$  gives:

$$R_{OUT} = V_{OUT} / (V_{SENSE} \times 0.01) \\ = 0.1 / (0.1 \times 0.01) = 100\Omega$$

## Application Information (Continued)

### ZXCT1008 Application with High Transients

Where  $R_{LOAD}$  represents any load including DC motors, a charging battery or further circuitry that requires monitoring,  $R_{SENSE}$  can be selected on specific requirements of accuracy, size and power rating.

An additional resistor,  $R_{LIM}$  can be added in series with  $R_{OUT}$  (as below), to limit the current from  $I_{OUT}$ . Any circuit connected to  $V_{OUT}$  will be protected from input voltage transients. This can be of particular use in automotive applications where load dump and other common transients need to be considered. The Zener Z1 provides additional protection for local dump, reverse battery and high voltage transient incidents.

Assuming the worst case condition of  $V_{OUT} = 0V$ ; providing a low impedance to a transient, the minimum value of  $R_{LIM}$  is given by:

$$R_{LIM(min)} = (V_{PK} - V_{MAX})/I_{PK}$$

where

$V_{PK}$  = Peak transient voltage to be withstood

$V_{MAX}$  = Maximum working voltage = 20V

$I_{PK}$  = Peak output current = 40mA

The maximum value of  $R_{LIM}$  is set by  $V_{IN(MIN)}$ ,  $V_{OUT(MAX)}$  and the dropout voltage (see transfer characteristic on page 3) of the ZXCT1008:

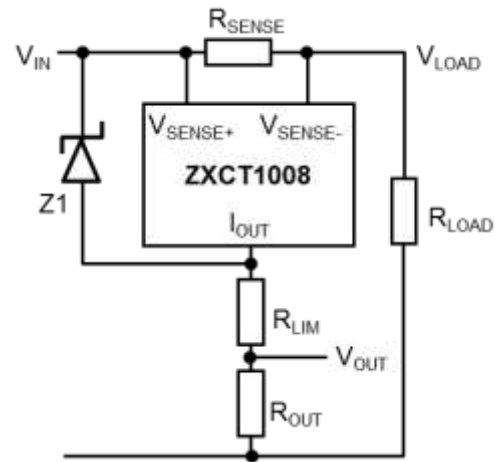


Figure 2. ZXCT1008 with Additional Current Limiting Resistor  $R_{LIM}$  and Zener Z1

$$R_{LIM(MAX)} = \frac{R_{OUT} \times (V_{IN(MIN)} - (V_{DP} + V_{OUT(MAX)}))}{V_{OUT(MAX)}}$$

Where

$V_{IN(MIN)}$  = Minimum Supply Operating Voltage

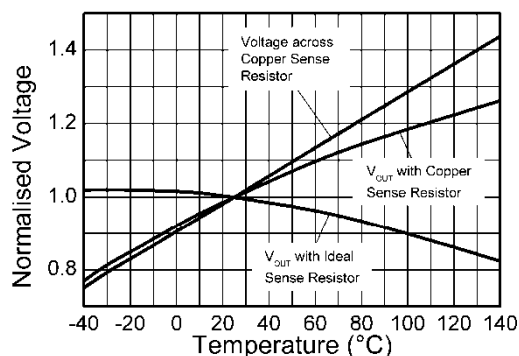
$V_{DP}$  = Dropout Voltage

$V_{OUT(MAX)}$  = Maximum Operating Output Voltage

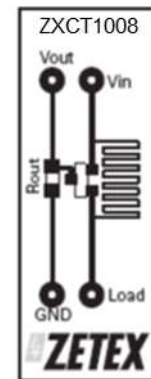
### PCB Trace Shunt Resistor for Low Cost Solution

The figure below shows output characteristics of the device when using a PCB resistive trace for a low cost solution in replacement for a conventional shunt resistor. The graph shows the linear rise in voltage across the resistor due to the PTC of the material and demonstrates how this rise in resistance value over temperature compensates for the NTC of the device.

The figure opposite shows a PCB layout suggestion. The resistor section is 25mm x 0.25mm giving approximately 150mΩ using 1oz copper. The data for the normalized graph was obtained using a 1A load current and a 100Ω output resistor. An electronic version of the PCB layout is available through Diodes applications group.

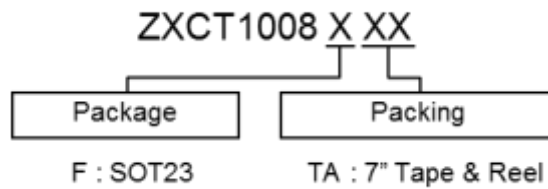


Effect of Sense Resistor Material on Temperature Performance



Layout shows area of shunt resistor compared to SOT23 package. Not actual size.

## Ordering Information

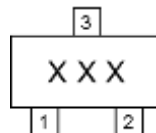


| Device      | Packaging<br>(Note 7) | Package<br>Code | Identification<br>Code | Packing: 7" Tape and Reel |            |                    |
|-------------|-----------------------|-----------------|------------------------|---------------------------|------------|--------------------|
|             |                       |                 |                        | Quantity                  | Tape Width | Part Number Suffix |
| ZXCT1008FTA | SOT23                 | F               | 108                    | 3,000 Units               | 8mm        | TA                 |

Note: 7. Pad layout as shown on Diodes' suggested pad layout per <http://www.diodes.com/package-outlines.html>.

## Marking Information

(1) Package Type: SOT23

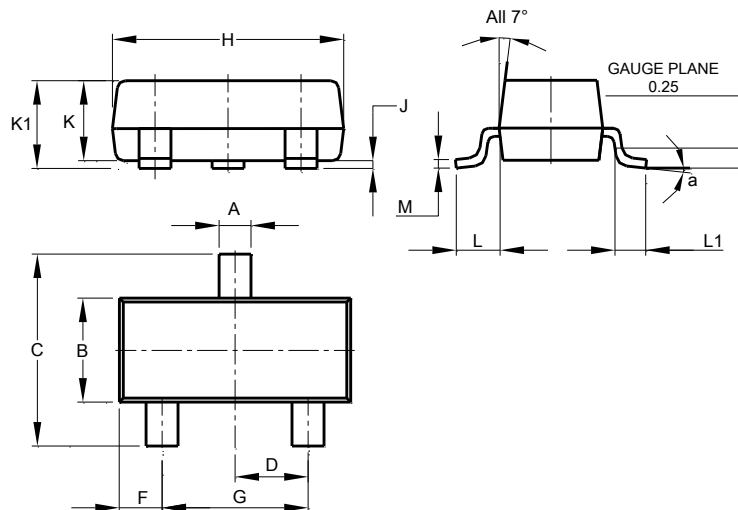


XXX : Identification Code: 108

## Package Outline Dimensions

Please see <http://www.diodes.com/package-outlines.html> for the latest version.

**SOT23**

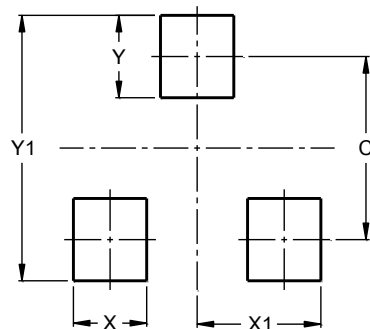


| SOT23                |       |       |       |
|----------------------|-------|-------|-------|
| Dim                  | Min   | Max   | Typ   |
| A                    | 0.37  | 0.51  | 0.40  |
| B                    | 1.20  | 1.40  | 1.30  |
| C                    | 2.30  | 2.50  | 2.40  |
| D                    | 0.89  | 1.03  | 0.915 |
| F                    | 0.45  | 0.60  | 0.535 |
| G                    | 1.78  | 2.05  | 1.83  |
| H                    | 2.80  | 3.00  | 2.90  |
| J                    | 0.013 | 0.10  | 0.05  |
| K                    | 0.890 | 1.00  | 0.975 |
| K1                   | 0.903 | 1.10  | 1.025 |
| L                    | 0.45  | 0.61  | 0.55  |
| L1                   | 0.25  | 0.55  | 0.40  |
| M                    | 0.085 | 0.150 | 0.110 |
| a                    | 0°    | 8°    | --    |
| All Dimensions in mm |       |       |       |

## Suggested Pad Layout

Please see <http://www.diodes.com/package-outlines.html> for the latest version.

**SOT23**



| Dimensions | Value (in mm) |
|------------|---------------|
| C          | 2.0           |
| X          | 0.8           |
| X1         | 1.35          |
| Y          | 0.9           |
| Y1         | 2.9           |

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