

AUTOMOTIVE HIGH-SIDE CURRENT MONITOR

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 environments.

FEATURES

- Low cost, accurate high-side current sensing
- -40 to +125°C temperature range
- Up to 500mV sense voltage
- 2.5V – 20V supply range
- 4μA quiescent current
- 1% typical accuracy
- SOT23

ORDERING INFORMATION

| DEVICE | REEL SIZE | TAPE WIDTH | QUANTITY PER REEL |
|-------------|-----------|------------|-------------------|
| ZXCT1008FTA | 7" | 8mm | 3,000 units |

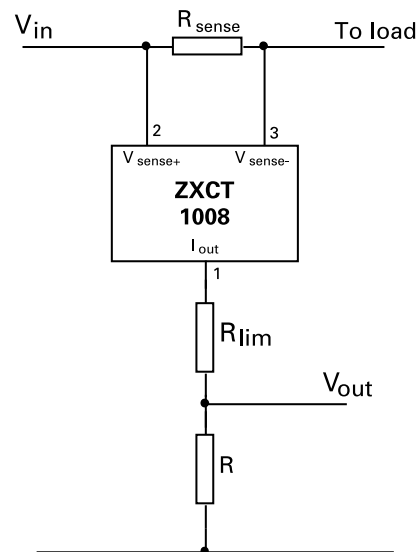
DEVICE MARKING

- 108

APPLICATIONS

- Automotive current measurement
- DC motor and solenoid control
- Over current monitor
- Power management

APPLICATION CIRCUIT



ZXCT1008

ABSOLUTE MAXIMUM RATINGS

| | |
|---|--|
| Voltage on any pin | -0.6V to 20V (relative to I _{out}) |
| Continuous output current, I _{OUT} , | 10mA |
| Continuous sense voltage, V _{SENSE} [†] , | -0.5V to +5V |
| Operating temperature, T _A , | -40 to 125°C |
| Storage temperature | -55 to 150°C |
| Package power dissipation (T _A = 25°C) | 450mW Derate to zero at 150°C |

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

Test Conditions T_A = 25°C, V_{in} = 5V, R_{out} = 100Ω.

| SYMBOL | PARAMETER | CONDITIONS | LIMITS | | | UNIT |
|---------------------------------|--|--|--------|-------|-------|------|
| | | | Min | Typ | Max | |
| V _{in} | V _{CC} range | | 2.5 | | 20 | V |
| I _{out} ¹ | Output current | V _{sense} =0V | 1 | 4 | 15 | μA |
| | | V _{sense} =10mV | 90 | 104 | 120 | μA |
| | | V _{sense} =100mV | 0.975 | 1.0 | 1.025 | mA |
| | | V _{sense} =200mV | 1.95 | 2.0 | 2.05 | mA |
| | | V _{sense} =500mV | 4.8 | 5.0 | 5.2 | mA |
| V _{sense} [†] | Sense voltage | | 0 | | 500 | mV |
| I _{sense} ⁻ | V _{sense} - input current | | | | 100 | nA |
| Acc | Accuracy | R _{sense} = 0.1Ω V _{sense} =200mV | -2.5 | | 2.5 | % |
| Gm | Transconductance, I _{out} / V _{sense} | | | 10000 | | μA/V |
| BW | Bandwidth | V _{SENSE(DC)} = 10mV, Pin = -40dBm ‡ | | 300 | | kHz |
| | | V _{SENSE(DC)} = 100mV, Pin = -20dBm ‡ | | 2 | | MH |

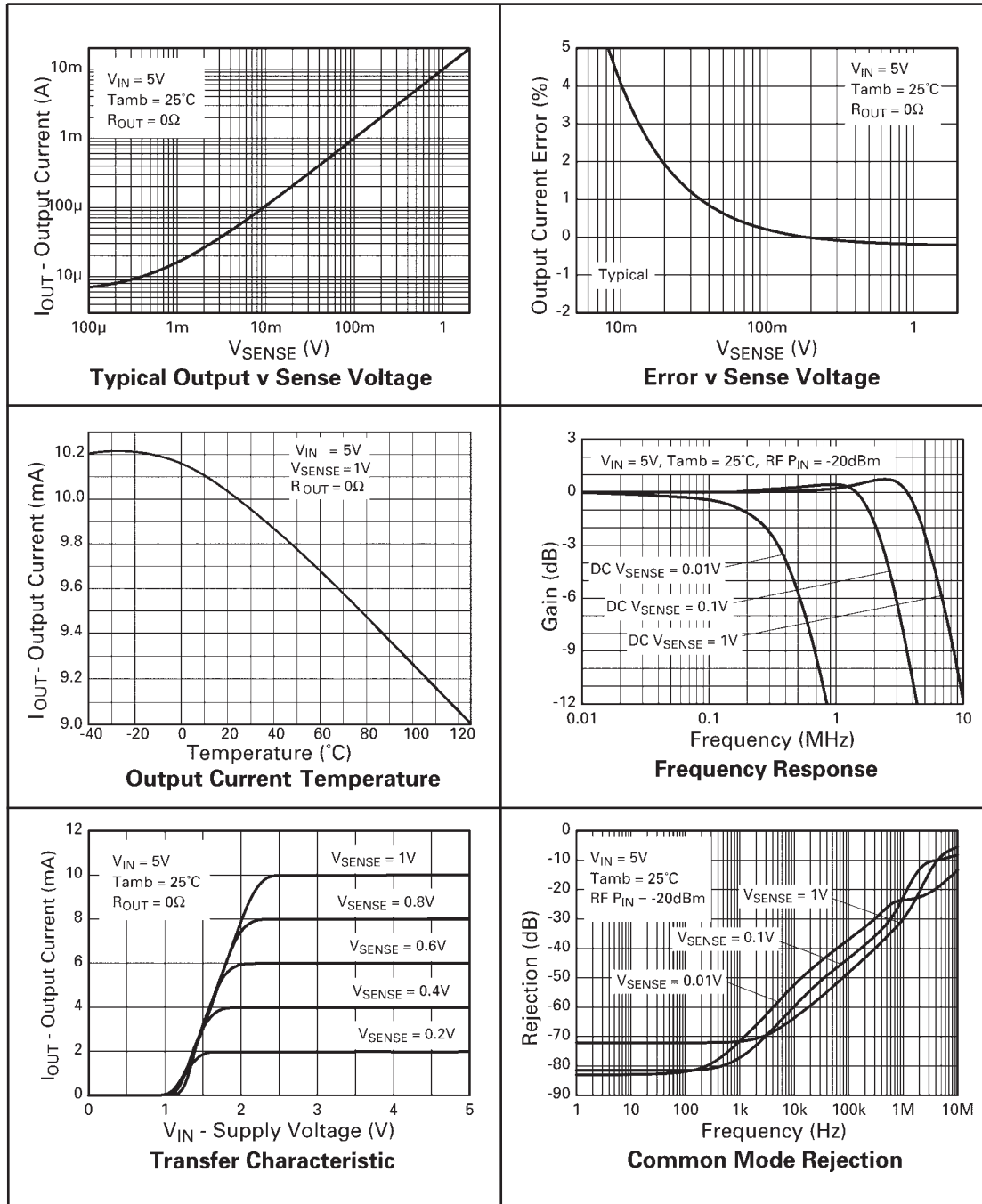
¹ Includes input offset voltage contribution

[†] V_{SENSE} is defined as the differential voltage between V_{SENSE+} and V_{SENSE-}.

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

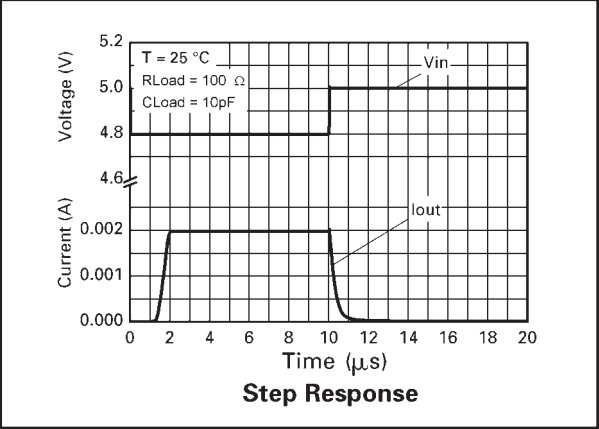
‡ -20dBm=63mVp-p into 50Ω

TYPICAL CHARACTERISTICS

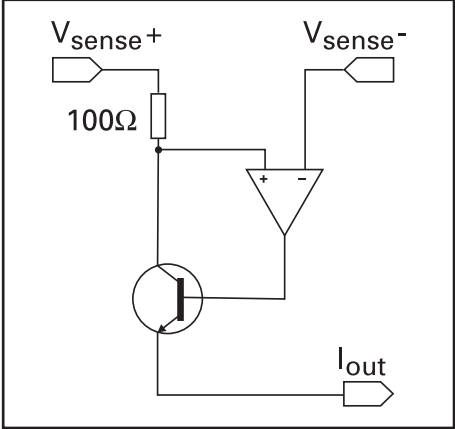


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TYPICAL CHARACTERISTICS (Cont.)



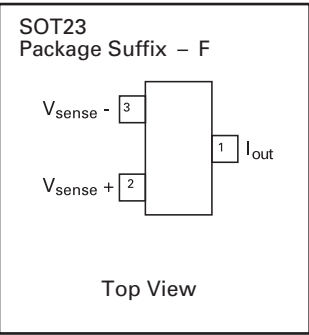
SCHEMATIC DIAGRAM



PIN DESCRIPTION

| Pin Name | Pin Function |
|--------------|---|
| V_{sense+} | Supply voltage |
| V_{sense-} | Connection to load/battery |
| I_{out} | Output current, proportional to $V_{in}-V_{load}$ |

CONNECTION DIAGRAM



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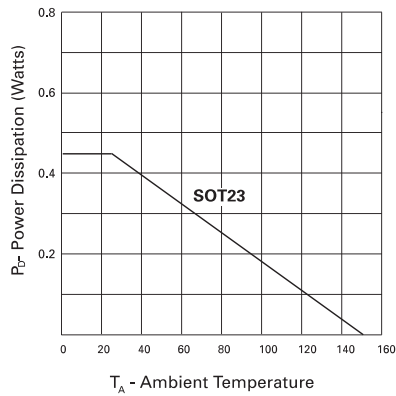
POWER DISSIPATION

The maximum allowable power dissipation of the device for normal operation (P_{max}), is a function of the package junction to ambient thermal resistance (θ_{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:

$$P_D = I_{out} \cdot (V_{in} - V_{out}) \text{ Watts}$$



APPLICATIONS INFORMATION

The following lines describe how to scale a load current to an output voltage.

$$V_{sense} = V_{in} - V_{load}$$

$$V_{out} = 0.01 \times V_{sense} \times R_{out}^1$$

E.g.

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

- 1) Choose the value of R_{sense} to give 50mV > $V_{sense} > 500mV$ at full load.

For example $V_{sense} = 100mV$ at 1.0A.
 $R_{sense} = 0.1/1.0 \Rightarrow 0.1 \Omega$

- 2) Choose R_{out} to give $V_{out} = 100mV$, when $V_{sense} = 100mV$.

Rearranging ¹ for R_{out} gives:
 $R_{out} = V_{out} / (V_{sense} \times 0.01)$

$$R_{out} = 0.1 / (0.1 \times 0.01) = 100 \Omega$$

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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} (figure 1.0), 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:-

$$R_{lim}(min) = \frac{V_{pk} - V_{max}}{I_{pk}}$$

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 ZXCT1009 :-

$$R_{lim}(max) = \frac{R_{out}[V_{in}(min) - (V_{dp} + V_{out}(max))]}{V_{out}(max)}$$

$V_{in}(min)$ = Minimum Supply Operating Voltage
 V_{dp} = Dropout Voltage
 $V_{out}(max)$ = Maximum Operating Output Voltage

TYPICAL AUTOMOTIVE CIRCUIT APPLICATION

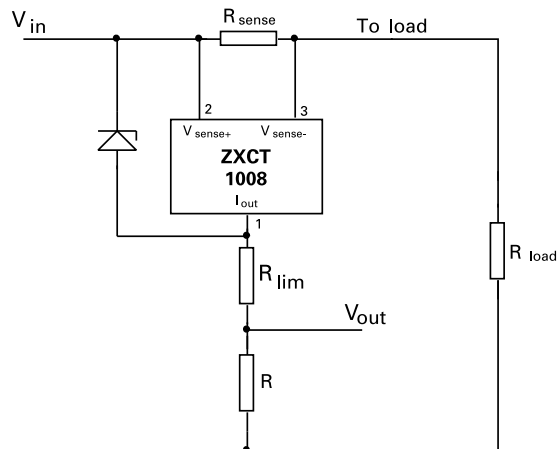


Figure 1.0
 ZXCT1009 with additional current limiting Resistor R_{lim} and zener Z1

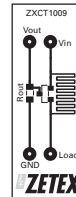
APPLICATIONS INFORMATION

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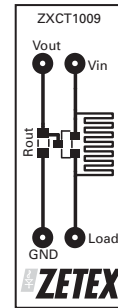
PCB trace shunt resistor for low cost solution.

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.

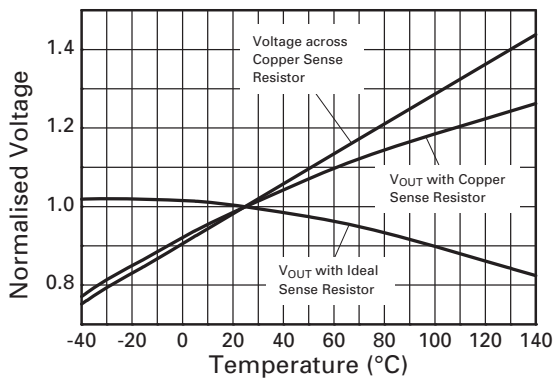
The figure opposite shows a PCB layout suggestion. The resistor section is 25mm x 0.25mm giving approximately 150mΩ using 1oz copper. The data for the normalised graph was obtained using a 1A load current and a 100Ω output resistor. An electronic version of the PCB layout is available at www.zetex.com/isense



Actual Size



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



Effect of Sense Resistor Material on Temperature Performance

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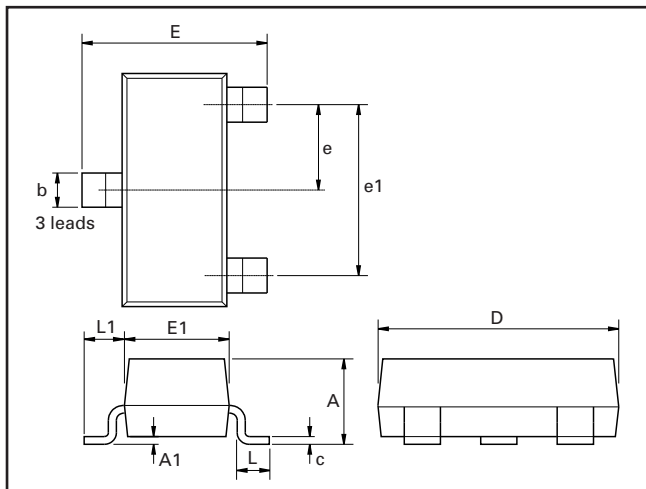
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PACKAGE OUTLINE



Controlling dimensions are in millimeters. Approximate conversions are given in inches

PACKAGE DIMENSIONS

| DIM | Millimeters | | Inches | | DIM | Millimeters | | Inches | |
|-----|-------------|-------|------------|-------|-----|-------------|------|-----------|-------|
| | Min. | Max. | Min. | Max. | | Min. | Max. | Max. | Max. |
| A | — | 1.12 | — | 0.044 | e1 | 1.90 NOM | | 0.075 NOM | |
| A1 | 0.01 | 0.10 | 0.0004 | 0.004 | E | 2.10 | 2.64 | 0.083 | 0.104 |
| b | 0.30 | 0.50 | 0.012 | 0.020 | E1 | 1.20 | 1.40 | 0.047 | 0.055 |
| C | 0.085 | 0.120 | 0.003 | 0.008 | L | 0.25 | 0.62 | 0.018 | 0.024 |
| D | 2.80 | 3.04 | 0.0110 | 0.120 | L1 | 0.45 | 0.62 | 0.018 | 0.024 |
| e | 0.95 NOM | | 0.0375 NOM | | — | — | — | — | — |

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