

## 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)**
- **Qualified to AEC-Q100 Standards for High Reliability**

## Applications

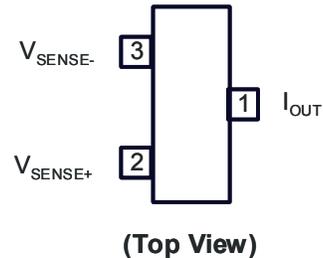
- Automotive current measurement
- DC motor and solenoid control
- Over current monitor
- Power management

- 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.

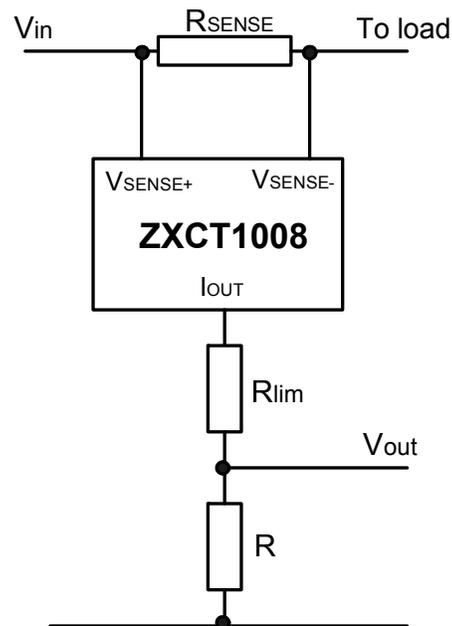
## Pin Assignments

SOT23

Package Suffix - F



## Application Circuit



## 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> <sup>†</sup>	-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)	SOT23	450	mW
	SM8	2	W

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.)

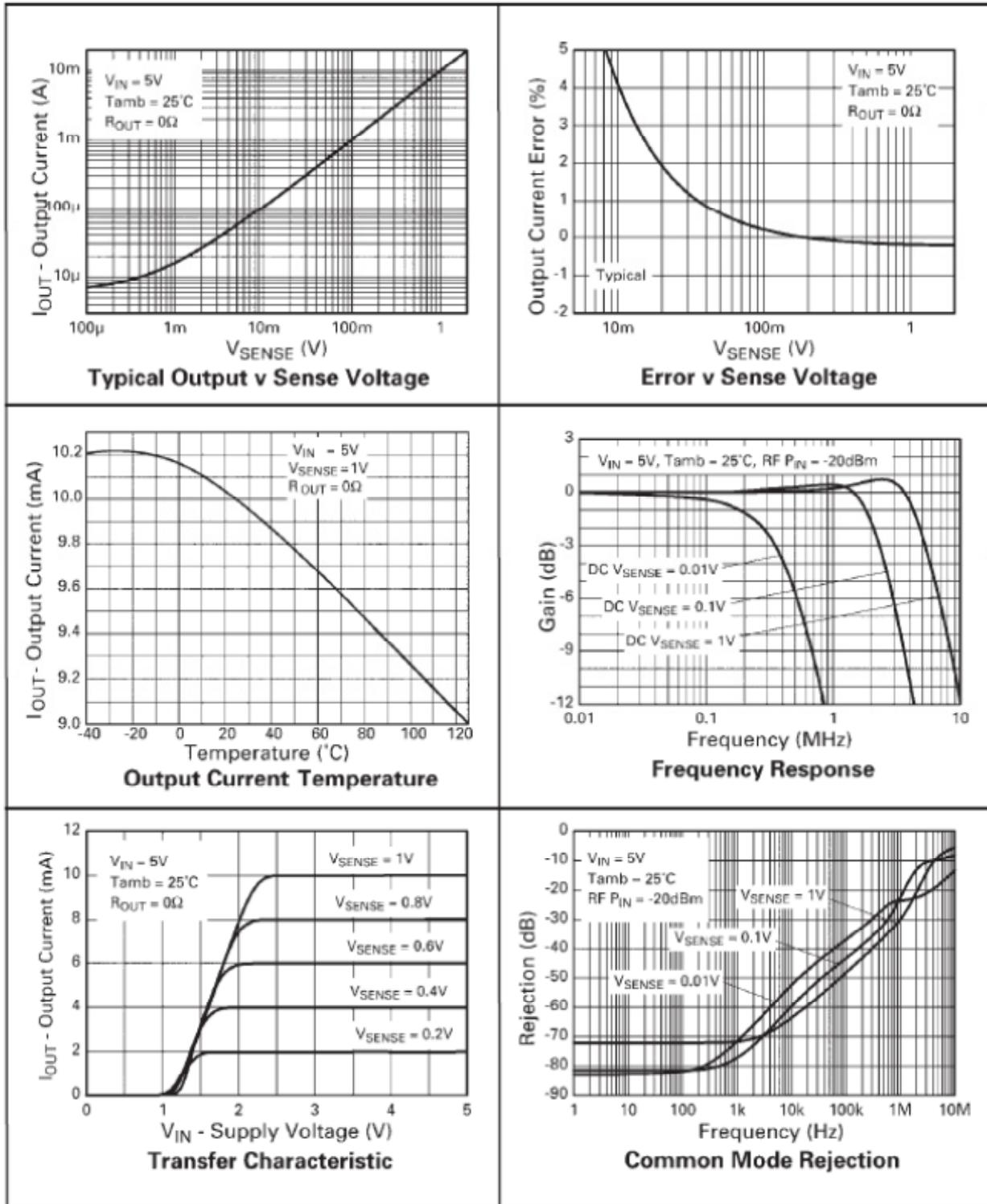
Symbol	Parameter	Conditions	Limits			Units
			Min	Typ	Max	
V <sub>IN</sub>	V <sub>CC</sub> range	–	2.5	–	20	V
I <sub>OUT</sub> <sup>1</sup>	Output Current	V <sub>SENSE</sub> = 0V	1	4	15	μA
		V <sub>SENSE</sub> = 10mV	90	104	120	μA
		V <sub>SENSE</sub> = 100mV	0.975	1.0	1.025	mA
		V <sub>SENSE</sub> = 200mV	1.95	2.0	2.05	mA
		V <sub>SENSE</sub> = 500mV	4.8	5.0	5.2	mA
V <sub>SENSE</sub> <sup>†</sup>	Sense Voltage	–	0	–	500	mV
I <sub>SENSE-</sub>	V <sub>SENSE-</sub> Input Current	–	–	–	100	nA
ACC	Accuracy	R <sub>SENSE</sub> = 0.1Ω V <sub>SENSE</sub> = 200mV	-2.5	–	2.5	%
G <sub>M</sub>	Transconductance, I <sub>OUT</sub> /V <sub>SENSE</sub>	–	–	10000	–	μA/V
BW	Bandwidth	V <sub>SENSE(DC)</sub> = 10mV, RF P <sub>IN</sub> = -40dBm <sup>‡</sup>	–	300	–	kHz
		V <sub>SENSE(DC)</sub> = 100mV, RF P <sub>IN</sub> = -20dBm <sup>‡</sup>	–	2	–	MHz

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

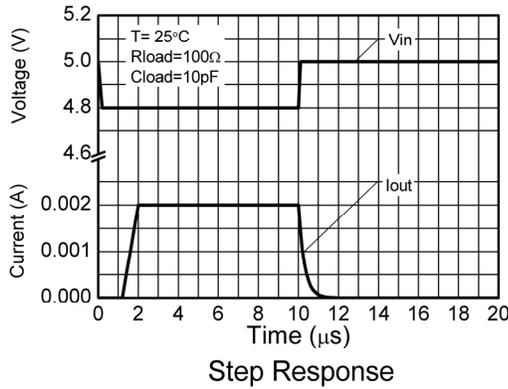
$$\begin{aligned}
 V_{SENSE} &= V_{SENSE+} - V_{SENSE-} \\
 &= V_{IN} - V_{LOAD} \\
 &= I_{LOAD} \times R_{SENSE}
 \end{aligned}$$

‡ -20dBm=63mVpp into 50Ω

**Typical Characteristics**



**Typical Characteristics (cont.)**



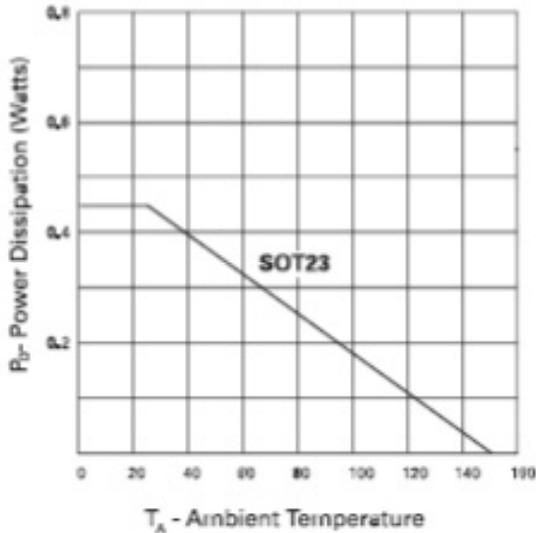
**Power Dissipation**

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:

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



**Application Information**

The following text describes 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 >

$$V_{SENSE} > 500mV \text{ at full load.}$$

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 <sup>1</sup> for  $R_{OUT}$  gives:

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

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

## Application Information (cont.)

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:

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

$V_{PK}$  = 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:

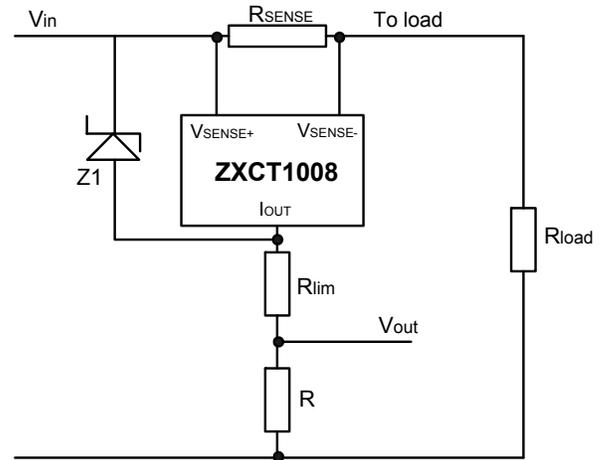
$$R_{LIM(MAX)} = R_{OUT}[V_{IN(MIN)} - (V_{DP} + V_{OUT(MAX)})]/V_{OUT(MAX)}$$

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

$V_{DP}$  = Dropout Voltage

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

## Typical Automotive Circuit Application



**Figure 1.0**

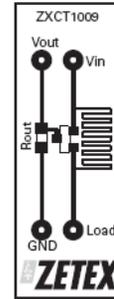
ZXCT1008 with additional current limiting Resistor  $R_{LIM}$  and Zener Z1.

**Application Information (cont.)**

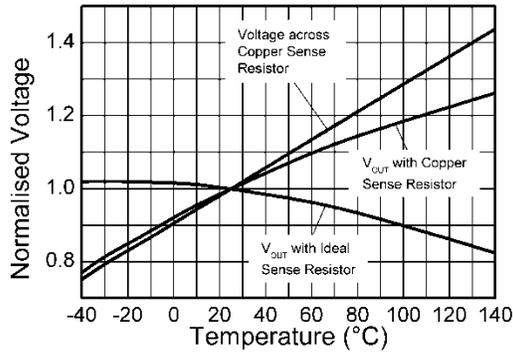
**PCB trace shunt resistor for low cost solution**

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.



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



Effect of Sense Resistor Material on Temperature Performance

**Effect of Sense Resistor Material on Temperature Performance**

**Ordering Information**

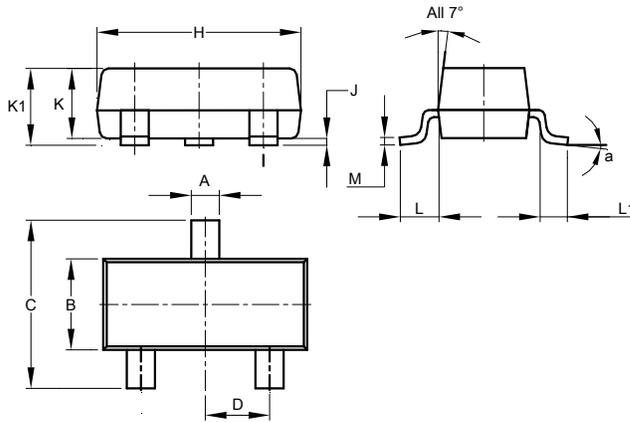
Device	AEC-Q100 level	Reel Size	Tape Width	Quantity per Reel	Part Marking	Package
ZXCT1008FTA	Grade 3	7"	8mm	3000 Units	108	SOT23
ZXCT1008F-7	None	7"	8mm	3000 Units	108	SOT23

Note: 5. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>

**Package Outline Dimensions** (All dimensions in mm.)

Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.

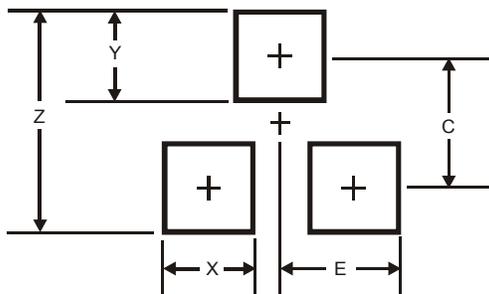
1) **SOT23**



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	8°		
All Dimensions in mm			

**Suggested Pad Layout**

Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.



Dimensions	Value (in mm)
Z	2.9
X	0.8
Y	0.9
C	2.0
E	1.35

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