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

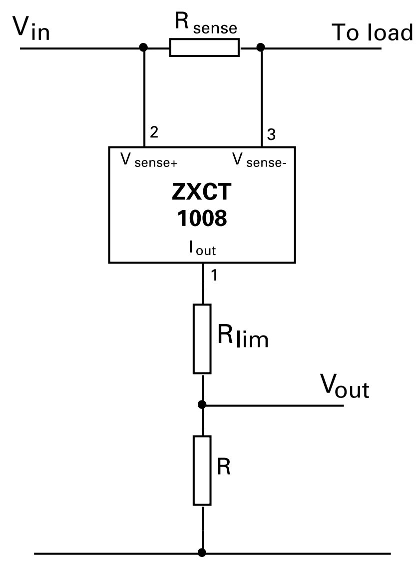
DEVICE MARKING

- 108

APPLICATIONS

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

APPLICATION CIRCUIT



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 extented 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

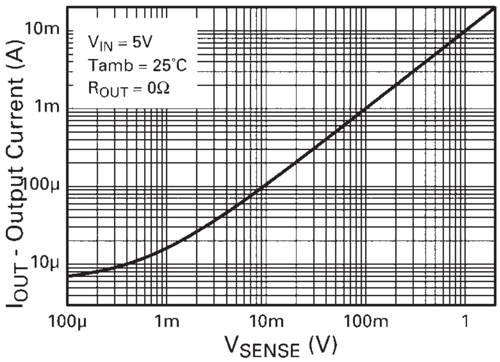
[1] Includes input offset voltage contribution

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

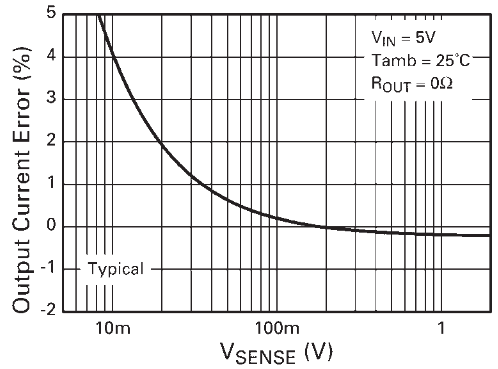
$V_{SENSE} = V_{SENSE+} - V_{SENSE-}$
$= V_{IN} - V_{LOAD}$
$= I_{LOAD} \times R_{SENSE}$

‡ -20dBm=63mVp-p into 50Ω

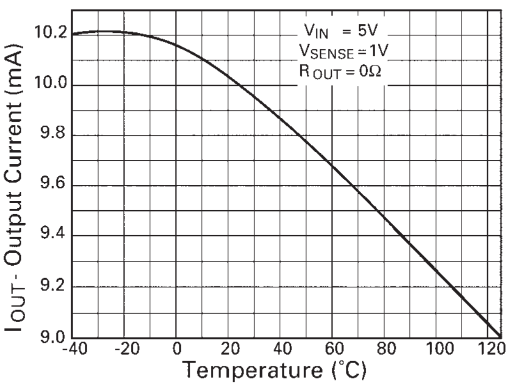
TYPICAL CHARACTERISTICS



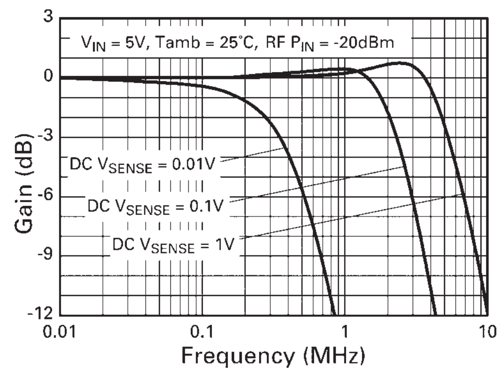
Typical Output v Sense Voltage



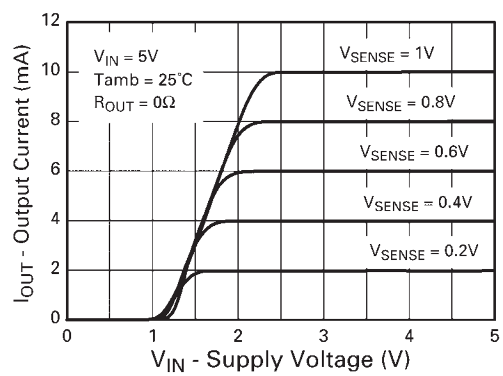
Error v Sense Voltage



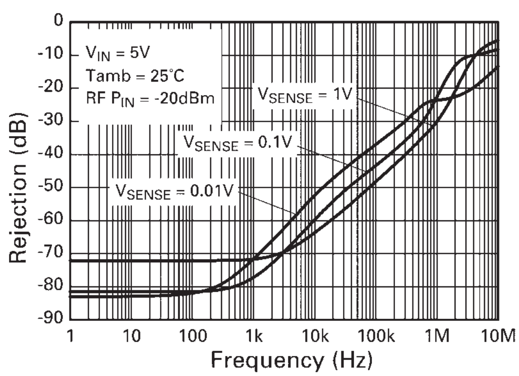
Output Current Temperature



Frequency Response



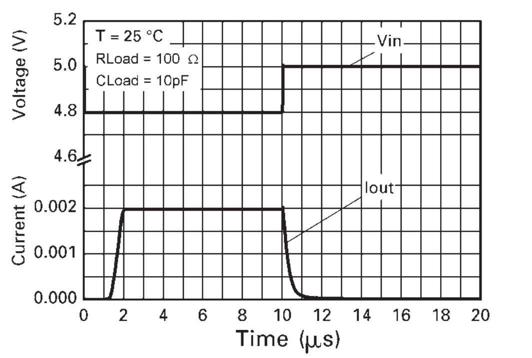
Transfer Characteristic



Common Mode Rejection

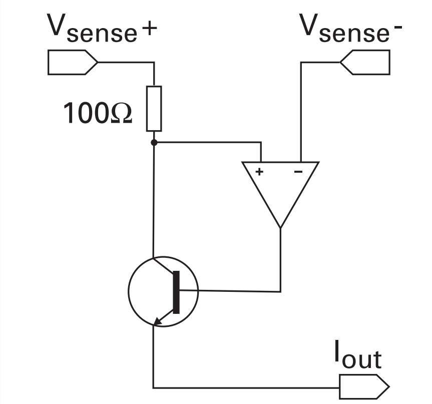
ZXCT1008

TYPICAL CHARACTERISTICS (Cont.)



Step Response

SCHEMATIC DIAGRAM

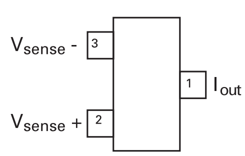


PIN DESCRIPTION

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

SOT23
Package Suffix – F



Top View

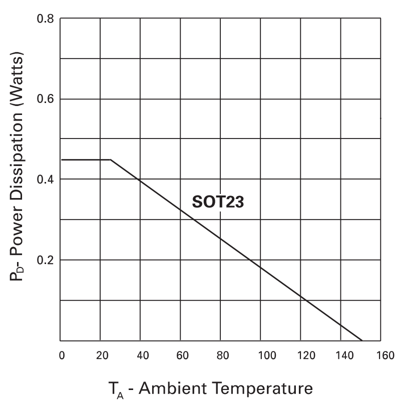
POWER DISSIPATION

The maximum allowable power dissipation of the device for normal operation (Pmax), is a function of the package junction to ambient thermal resistance (θja), maximum junction temperature (Tjmax), and ambient temperature (Tamb), according to the expression:

$P_{max} = (T_{jmax} - T_{amb}) / \theta_{ja}$

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

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



APPLICATIONS INFORMATION

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

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

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

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 => 0.1 Ω

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 x 0.01) = 100 Ω

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, Rlim can be added in series with Rout (figure 1.0), to limit the current from I_{out}. Any circuit connected to Vout 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

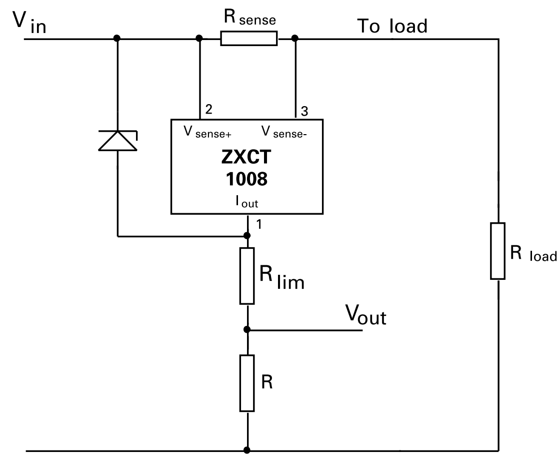


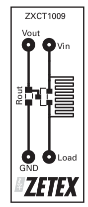
Figure 1.0

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

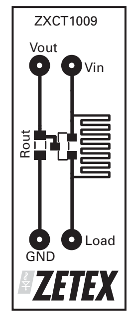
PCB trace shunt resistor for low cost solution.

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.

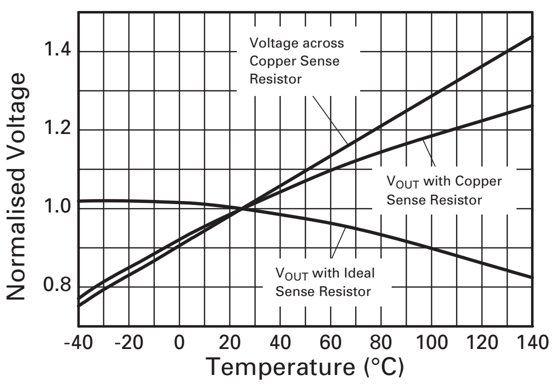
The figure opposite shows a PCB layout suggestion. The resistor section is 25mm x 0.25mm giving approximately 150mΩ using 1oz copper. The data for the normalised graph was obtained using a 1A load current and a 100Ω output resistor. An electronic version of the PCB layout is available at www.zetex.com/isense



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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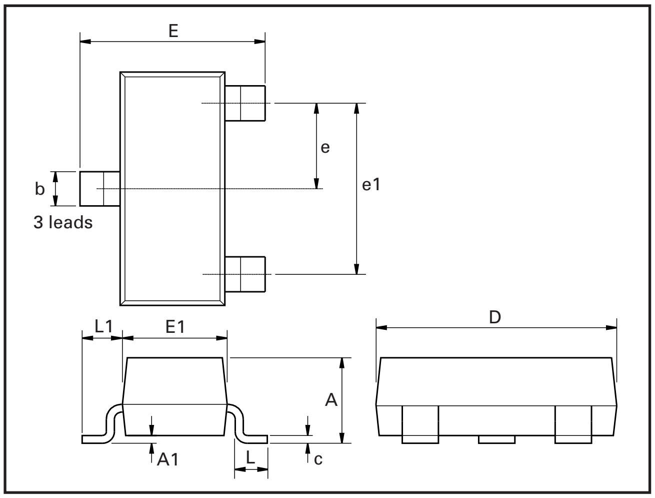
PACKAGE OUTLINE



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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