ZXCT1009

HIGH-SIDE CURRENT MONITOR

DESCRIPTION

The ZXCT1009 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. A minimum operating current of just 4μA, combined with its SOT23 package make it a unique solution for portable battery equipment.

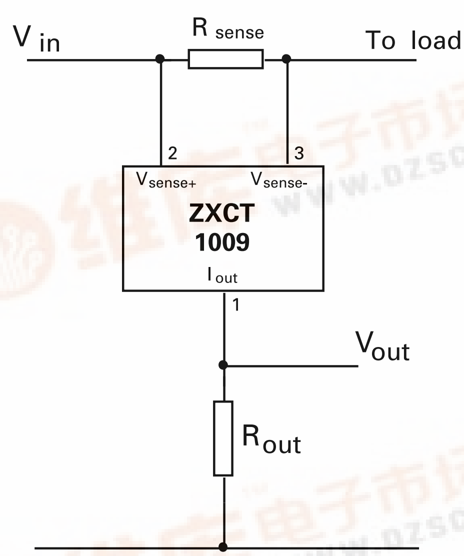
FEATURES

- Low cost, accurate high-side current sensing
- Output voltage scaling
- Up to 2.5V sense voltage
- 2.5V – 20V supply range
- 4μA quiescent current
- 1% typical accuracy
- SOT23 and SM8 packages

APPLICATIONS

- Battery chargers
- Smart battery packs
- DC motor control
- Over current monitor
- Power management
- Level translating
- Programmable current source

APPLICATION CIRCUIT



ORDERING INFORMATION

DEVICE	REEL SIZE	TAPE WIDTH	QUANTITY PER REEL	PARTMARKING	PACKAGE
ZXCT1009FTA	7″	8mm	3,000 units	109	SOT23
ZXCT1009T8TA	7″	12mm	1,000 units	ZXCT1009	SM8

ABSOLUTE MAXIMUM RATINGS

Voltage on any pin	-0.6V to 20V (relative to I_{out})
Continuous output current, I_{OUT},	25mA
Continuous sense voltage, V_{SENSE}†,	-0.5V to +5V
Operating temperature, T_A,	-40 to 85°C
Storage temperature	-55 to 125°C
Package power dissipation	(T_A = 25°C)
SOT23	450mW - derate to zero at 125°C
SM8	2W

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	1.002	1.025	mA
		V_{SENSE} =200mV	1.95	2.0	2.05	mA
		V_{SENSE} =1V	9.6	9.98	10.2	mA
V_{sense}†	Sense voltage		0		2500	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		MHz

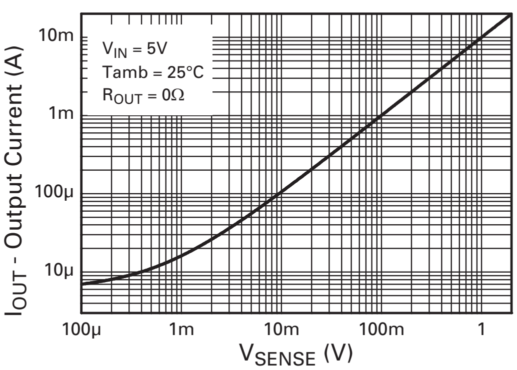
[1] Includes input offset voltage contribution

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

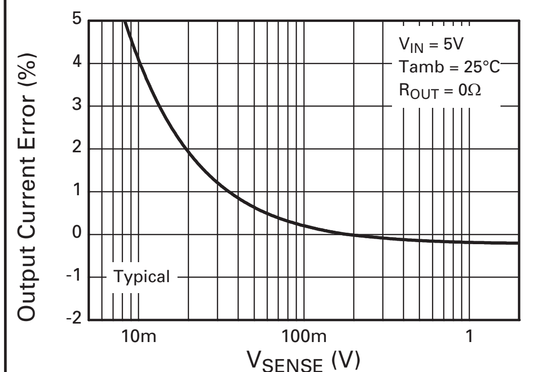
$V_{SENSE} = V_{SENSE+} - V_{SENSE-}$
$= V_{IN} - V_{LOAD}$
$= I_{LOAD} \times R_{SENSE}$

‡ -20dBm=63mVp-p into 50Ω

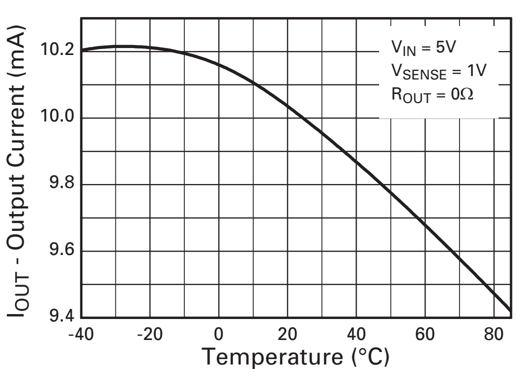
TYPICAL CHARACTERISTICS



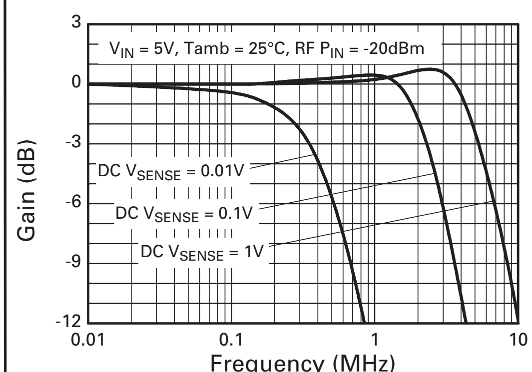
Typical Output v Sense Voltage



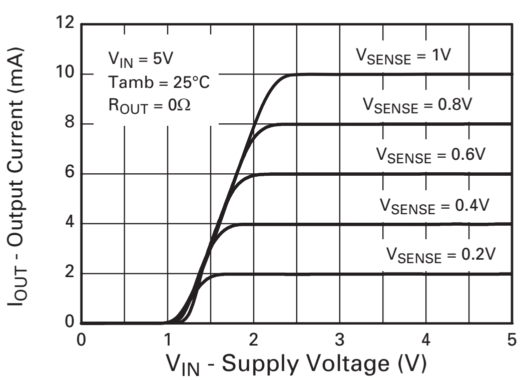
Error v Sense Voltage



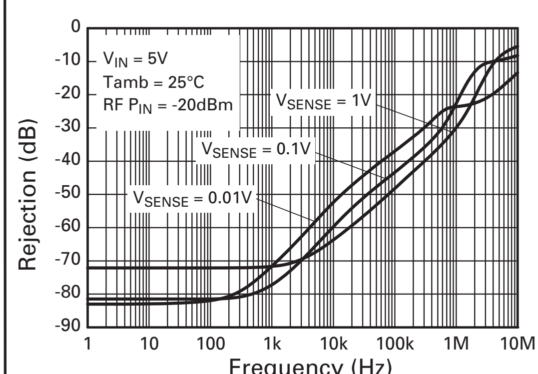
Output Current v Temperature



Frequency Response

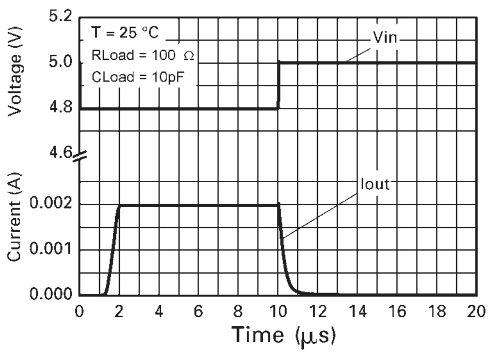


Transfer Characteristic



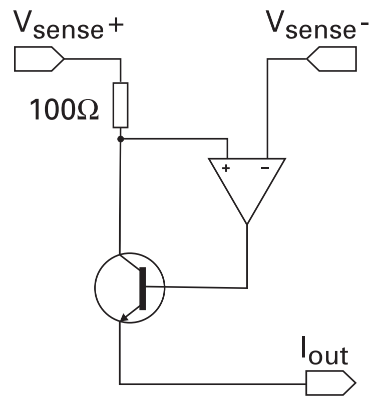
Common Mode Rejection

TYPICAL CHARACTERISTICS (Cont.)



Step Response

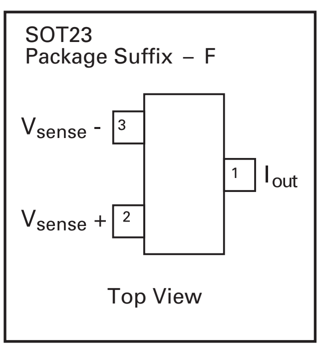
SCHEMATIC DIAGRAM

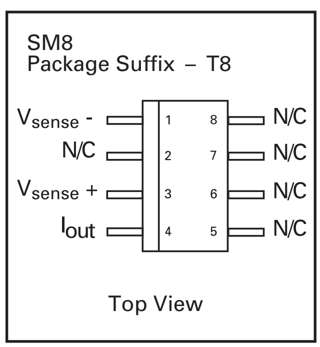


PIN DESCRIPTION

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 DIAGRAMS





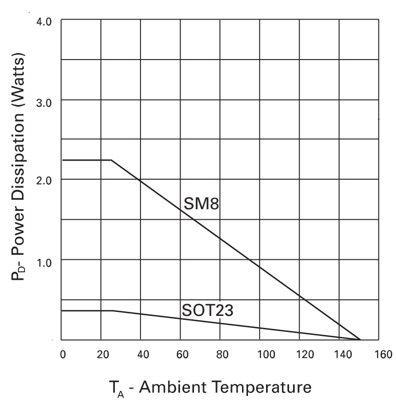
POWER DISSIPATION

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.

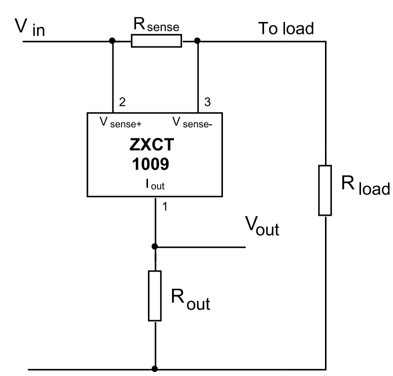
For example V_{sense} = 100mV at 1.0A. R_{sense} = 0.1/1.0 => 0.1 ohms.

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

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

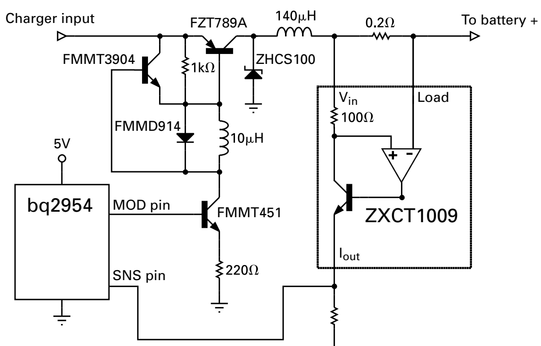
$R_{out} = 0.1 / (0.1 \times 0.01) = 100\ \Omega$

TYPICAL CIRCUIT APPLICATION



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.

APPLICATIONS INFORMATION (Continued)



Support components omitted for clarity

Li-Ion Charger Circuit

The above figure shows the ZXCT1009 supporting the Benchmarq bq2954 Charge Management IC. Most of the support components for the bq2954 are omitted for clarity. This design also uses the Zetex FZT789A high current Super-β PNP as the switching transistor in the DC-DC step down converter and the FMMT451 as the drive NPN for the FZT789A. The circuit can be configured to charge up to four Li-Ion cells at a charge current of 1.25A. Charge can be terminated on maximum voltage, selectable minimum current, or maximum time out. Switching frequency of the PWM loop is approximately 120kHz.

The ZXCT1009 is intended as a direct functional replacement for the ZDS1009, which is featured in a complete design from Unitrode/Texas Instruments on the Li-Ion charger circuit shown above. Reference: DVS2954S1H Li-Ion Charger Development System.

Transient Protection

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.

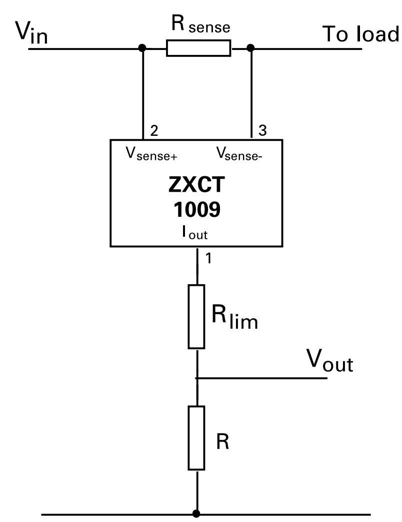


Figure 1.0
ZXCT1009 with additional current limiting Resistor Rlim.

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 :-

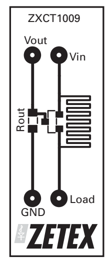
$$R_{lim}(max) = \frac{R_{out}[V_{in}(min) - (V_{dp} + V_{out}(max))]}{V_{out}(max)}$$

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

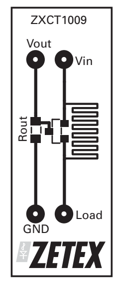
PCB trace shunt resistor for low cost solution

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.

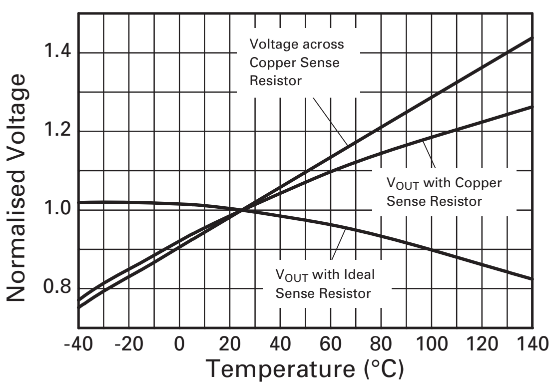
The figure opposite shows a PCB layout suggestion. The resistor section is 25mm x 0.25mm giving approximately 150mΩ using 1oz copper. The data for the normalised graph was obtained using a 1A load current and a 100Ω output resistor. An electronic version of the PCB layout is available at **www.zetex.com/isense**.



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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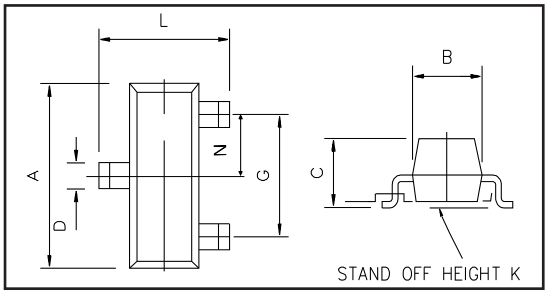
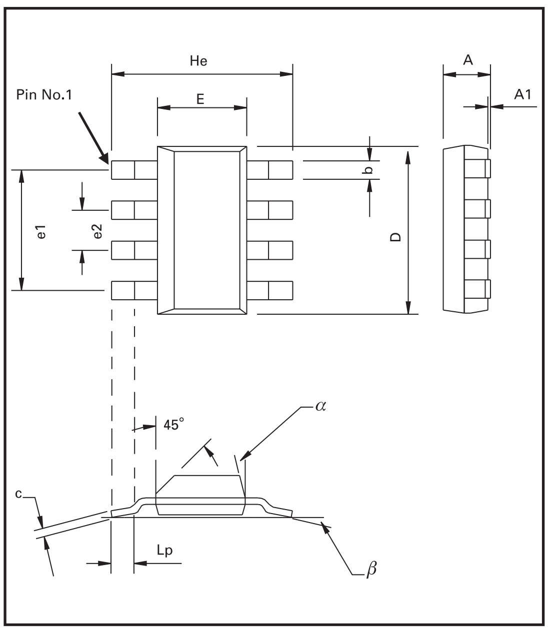
PACKAGE DIMENSIONS SOT23



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	2.67	3.05	0.105	0.120
B	1.20	1.40	0.047	0.055
C	–	1.10	–	0.043
D	0.37	0.53	0.0145	0.021
F	0.085	0.15	0.0033	0.0059
G	NOM 1.9		NOM 0.075	
K	0.01	0.10	0.0004	0.004
L	2.10	2.50	0.0825	0.0985
N	NOM 0.95		NOM 0.037	

PACKAGE DIMENSIONS SM8



DIM	Millimeters			Inches		
	Min	Typ	Max	Min	Typ	Max
A	–	–	1.7	–	–	0.067
A1	0.02	–	0.1	0.0008	–	0.004
b	–	0.7	–	–	0.028	–
c	0.24	–	0.32	0.009	–	0.013
D	6.3	–	6.7	0.248	–	0.264
E	3.3	–	3.7	0.130	–	0.145
e1	–	4.59	–	–	0.180	–
e2	–	1.53	–	–	0.060	–
He	6.7	–	7.3	0.264	–	0.287
Lp	0.9	–	–	0.035	–	–
α	–	–	15°	–	–	15°
β	–	10°	–	–	10°	–

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