

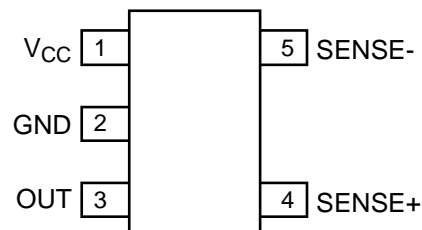
**ZXCT1081**  
**HIGH VOLTAGE HIGH-SIDE CURRENT MONITOR**

## Description

The ZXCT1081 is a high side current sense monitor with a gain of 10 and a voltage output. Using this device eliminates the need to disrupt the ground plane when sensing a load current.

The wide input voltage range of 40V down to as low as 3V make it suitable for a range of applications; including systems operating from industrial 24-28V rails and power supplies.

## Pin Assignments



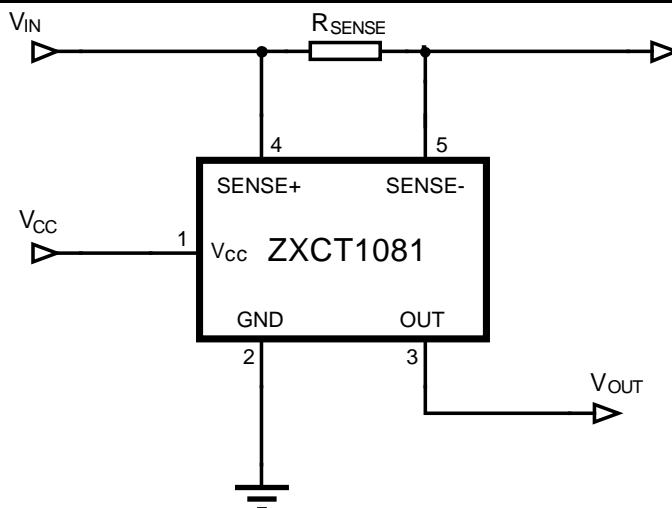
## Features

- 3V to 40V continuous high side voltage
- Accurate high-side current sensing
- Output voltage scaling x10
- 4.5V to 12V  $V_{CC}$  range
- Low quiescent current:
  - 80  $\mu$ A supply pin
  - 30  $\mu$ A  $I_{SENSE+}$
- SOT23-5 package
- -40°C to 125°C ambient temperature range

## Applications

- Automotive current measurement
- Industrial applications current measurement
- Battery management
- Over current monitor
- Power management
- Power adapters

## Typical Application Circuit



## Pin Description

Pin	Name	Description
1	VCC	This is the analogue supply and provides power to internal circuitry
2	GND	Ground pin
3	OUT	Output voltage pin. NMOS source follower with 20 $\mu$ A bias to ground
4	SENSE+	This is the positive input of the current monitor and has an input range from 40V (60V transient) down to 3V. The current through this pin varies with differential sense voltage
5	SENSE-	This is the negative input of the current monitor and has an input range from 40V (60V transient) down to 3V

## Absolute Maximum Ratings

Parameter	Rating	Unit
Continuous Voltage on SENSE+ and SENSE-	-0.6 and 45	V
Transient Voltage on SENSE+ and SENSE-	-0.6 and 65	V
Voltage On All Other Pins	-0.6 and 14	V
Differential Sense Voltage, $V_{SENSE}$	800	mV
Operating Temperature	-40 to 125	$^{\circ}$ C
Storage Temperature	-55 to 150	$^{\circ}$ C
Maximum Junction Temperature	125	$^{\circ}$ C
Package Power Dissipation	300 @ $T_A = 25^{\circ}$ C (de-rate to zero at 125 $^{\circ}$ C)	mW

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

## Recommended Operating Conditions

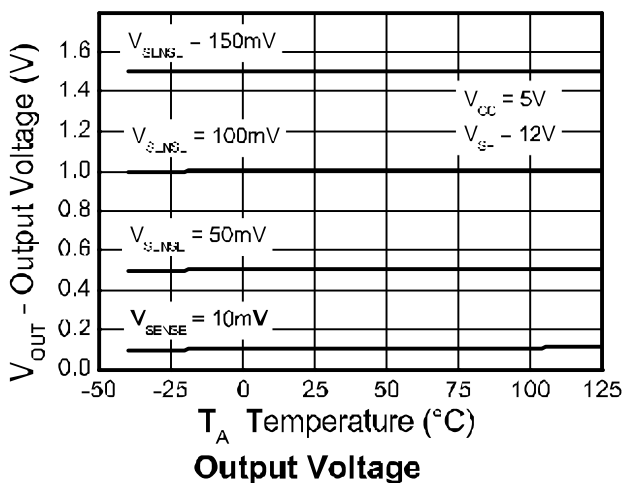
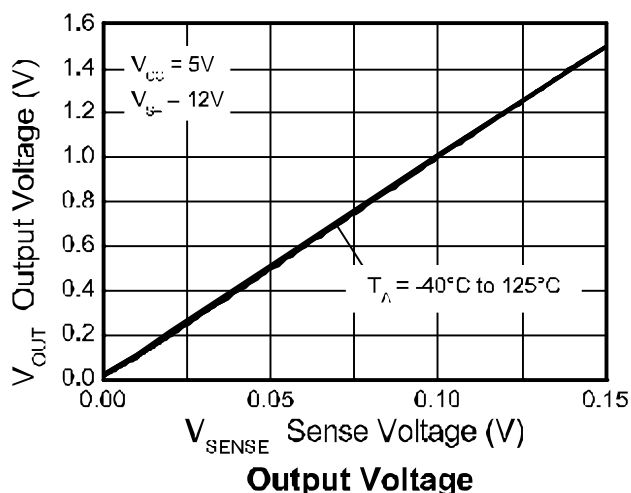
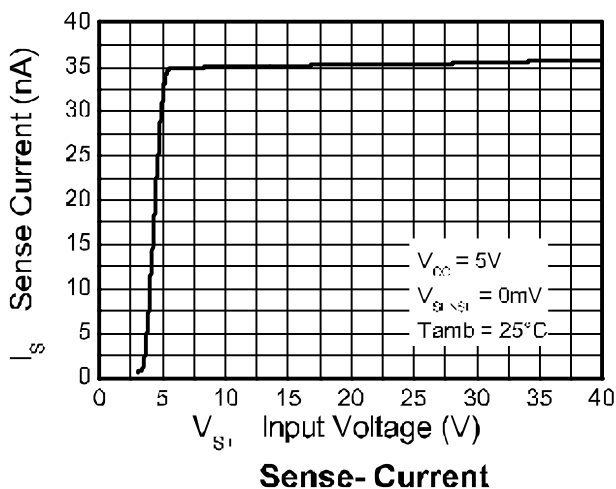
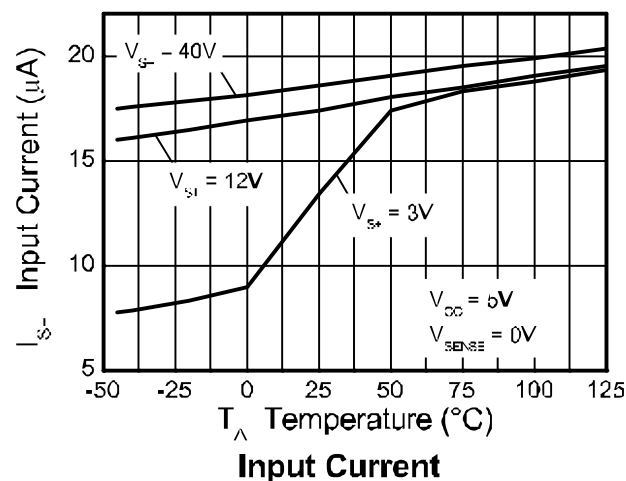
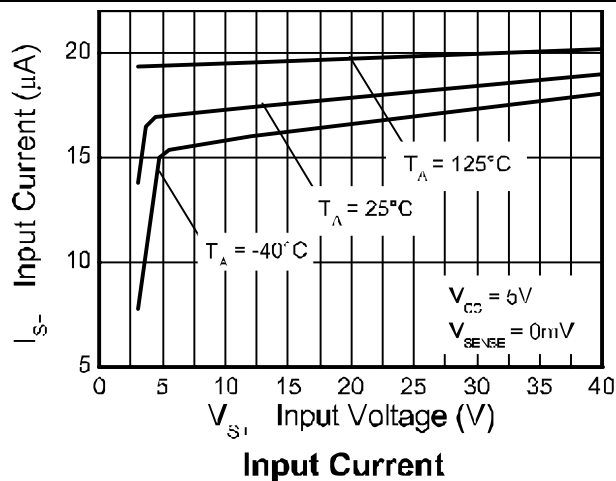
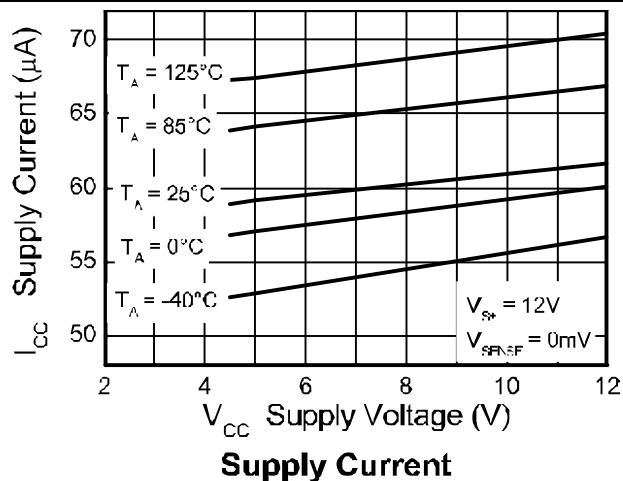
Symbol	Parameter	Min	Max	Units
$V_{IN}$	Common-Mode Sense+ Input Range	3	40	V
$V_{CC}$	Supply Voltage Range	4.5	12	V
$V_{SENSE}$	Differential Sense Input Voltage Range	0	0.15	V
$V_{OUT}$	Output Voltage Range	0	1.5	V
$T_J$	Ambient Temperature Range	-40	125	$^{\circ}$ C

**Electrical Characteristics** (Test conditions:  $T_A = 25^\circ\text{C}$ ,  $V_{IN} = 12\text{V}$ ,  $V_{CC} = 5\text{V}$ ,  $V_{SENSE}^{(a)} = 100\text{mV}$  unless otherwise stated)

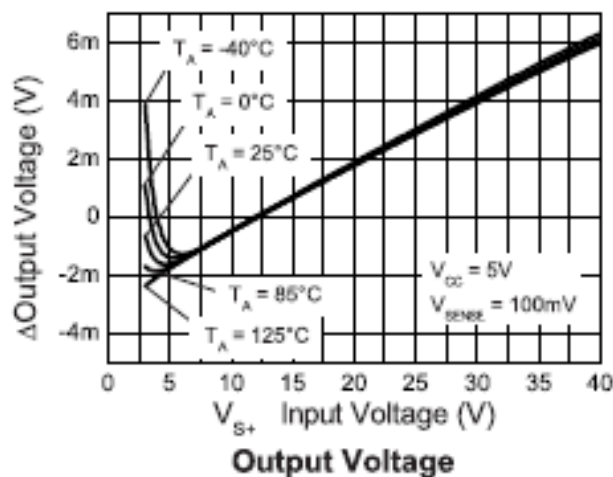
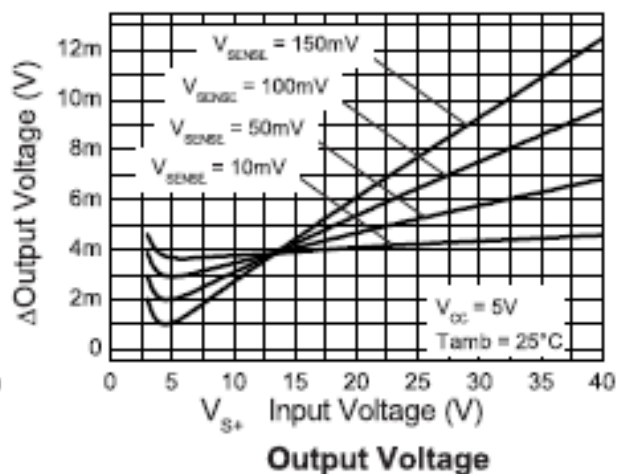
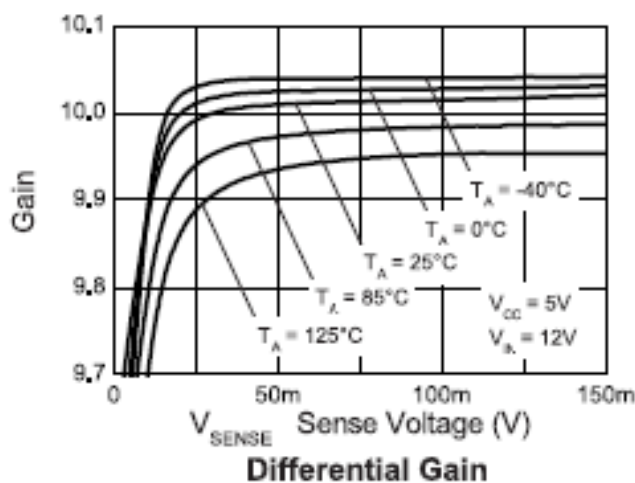
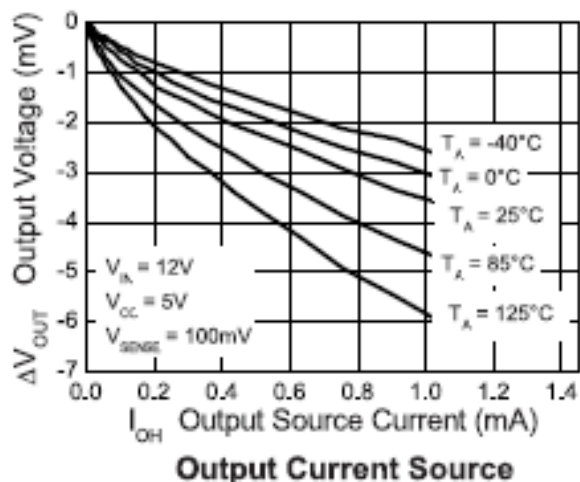
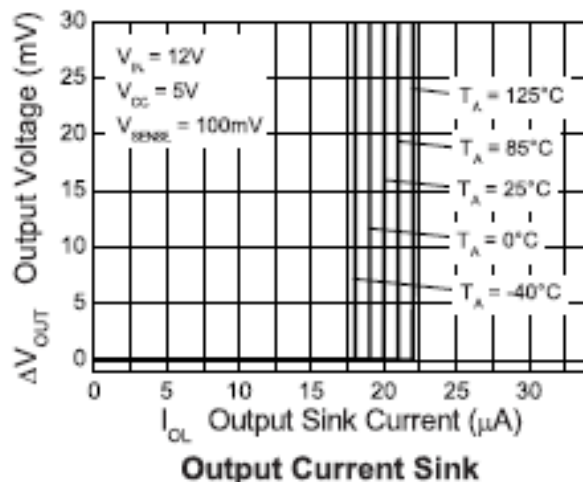
Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
$I_{CC}$	VCC Supply Current	$V_{CC} = 12\text{V}$	40	80	120	$\mu\text{A}$
$I_{SENSE+}$	SENSE+ Input Current		15	30	60	$\mu\text{A}$
$I_{SENSE-}$	SENSE- Input Current		10	40	80	$\text{nA}$
$V_{O(0)}$	Zero $V_{SENSE}^{(a)}$ error <sup>(b)</sup>	$V_{SENSE}^{(a)} = 0\text{V}$	0		35	$\text{mV}$
$V_{O(10)}$	Output Offset Voltage <sup>(c)</sup>	$V_{SENSE}^{(a)} = 10\text{mV}$	-30		+30	$\text{mV}$
Gain	$\Delta V_{OUT}/\Delta V_{SENSE}^{(a)}$	$V_{SENSE}^{(a)} = 10\text{mV to } 150\text{mV}$	9.95	10	10.05	
$V_{OUTTC}^{(d)}$	$V_{OUT}$ Variation with Temperature			30		$\text{ppm}/^\circ\text{C}$
$A_{CC}$	Total Output Error		-3		3	%
$I_{OH}$	Output Source Current	$V_{OUT} = 30\text{mV}$		1		$\text{mA}$
$I_{OL}$	Output Sink Current	$V_{OUT} = +30\text{mV}$		20		$\mu\text{A}$
PSRR	VCC Supply Rejection Ration	$V_{CC} = 4.5\text{V to } 12\text{V}$	54	60		$\text{dB}$
CMRR	Common-Mode Sense Rejection Ratio	$V_{IN} + 40\text{V to } 3\text{V}$	60	75		$\text{dB}$
BW	-3dB Small Signal Bandwidth	$V_{SENSE}^{(a)} (AC) = 10\text{mV}_{pp}$		50		$\text{kHz}$

- Notes:
- (a)  $V_{SENSE} = "V_{SENSE+}" - "V_{SENSE-}"$
  - (b) The ZXCT1081 operates from a positive power rail and the internal voltage-current converter current flow is unidirectional; these result in the output offset voltage for  $V_{SENSE} = 0\text{V}$  always being positive.
  - (c) For  $V_{SENSE} > 10\text{mV}$ , the internal voltage-current converter is fully linear. This enables a true offset to be defined and used.  $V_{O(10)}$  is expressed as the variance about an output voltage of  $100\text{mV}$ .
  - (d) Temperature dependent measurements are extracted from characterization and simulation results.

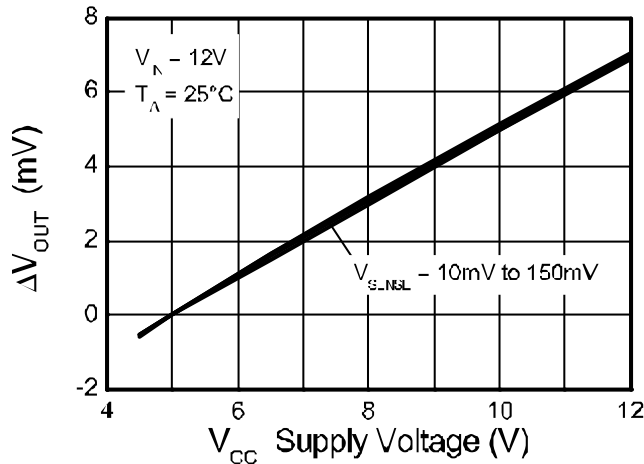
**Typical Operating Conditions** (Test conditions:  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ ,  $V_{S+} = 12\text{V}$ ,  $V_{SENSE} = 100\text{mV}$ )



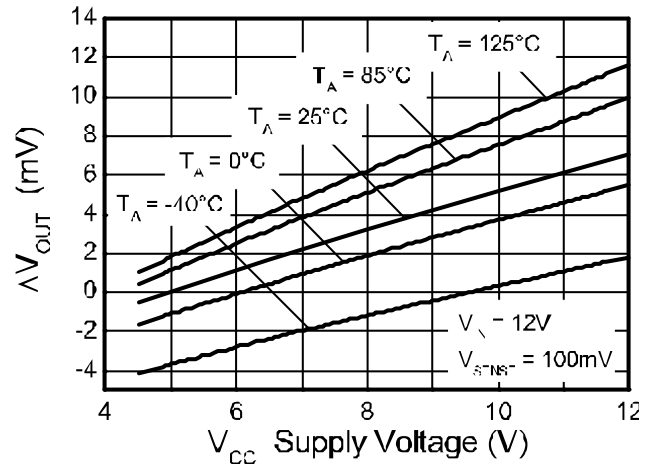
## Typical Operating Conditions (Cont.)



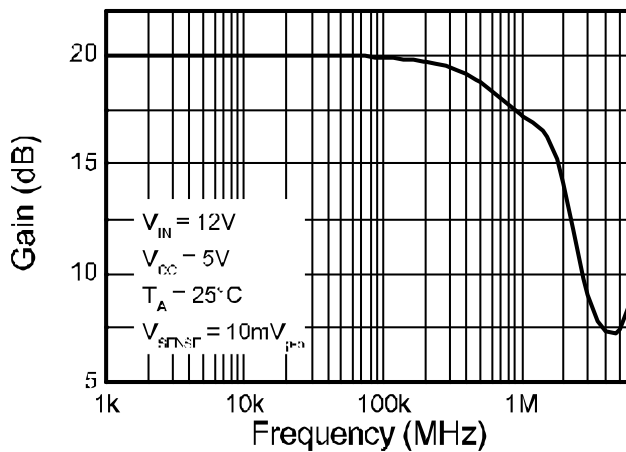
**Typical Operating Conditions (Cont.)**



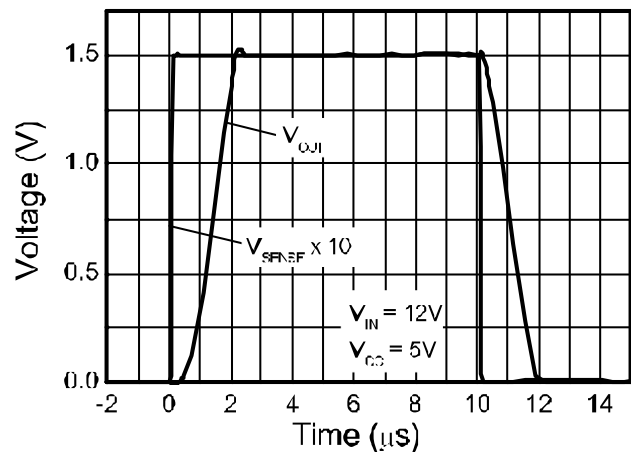
**Normalised Output Voltage**



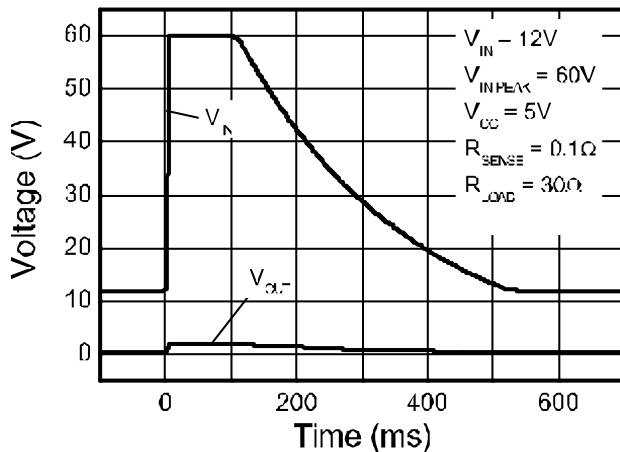
**Normalised Output Voltage**



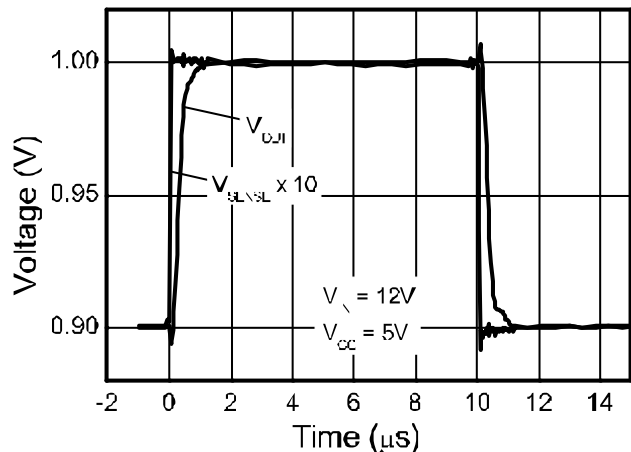
**Small Signal Bandwidth**



**Large Signal Pulse Response**

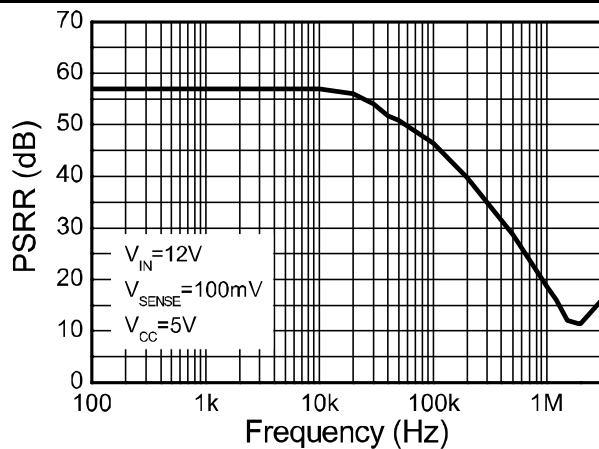


**Load Dump Waveform**

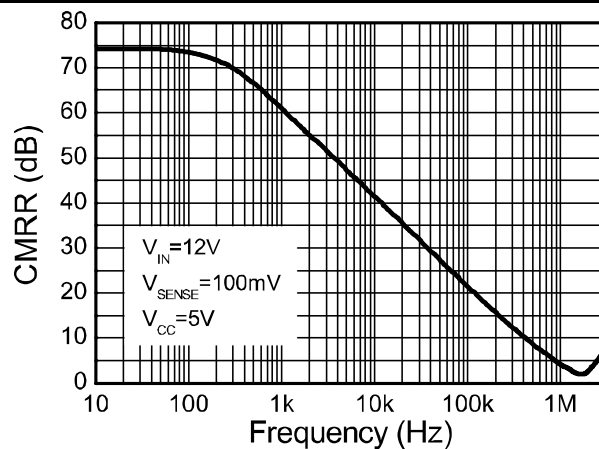


**Small Signal Pulse Response**

**Typical Operating Conditions (Cont.)**



**Supply Rejection**



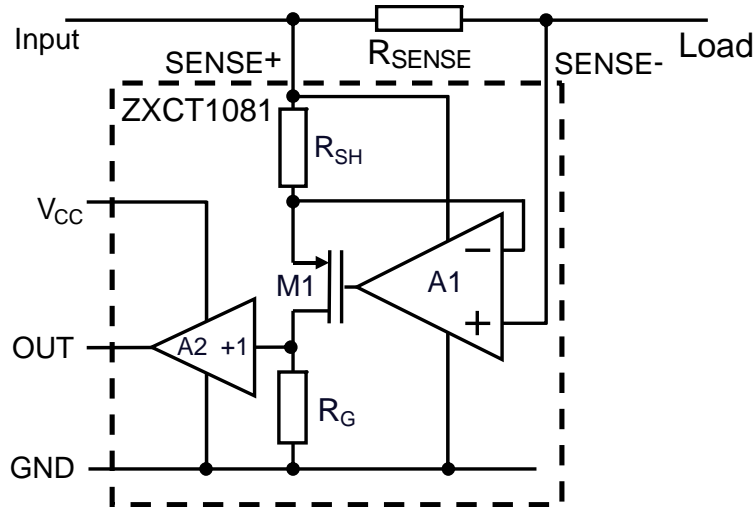
**Common Mode Rejection**

## Application Information

The ZXCT1081 has been designed to allow it to operate with 5V supply rails while sensing common mode signals up to 40V. This makes it well suited to a wide range of industrial and power supply monitoring applications that require the interface to 5V systems while sensing much higher voltages.

To allow this its VCC pin can be used independently of SENSE+.

Figure 1 shows the basic configuration of the ZXCT1081.



**Figure 1 Typical Configuration of ZXCT1081**

Load current from the input is drawn through  $R_{SENSE}$  developing a voltage  $V_{SENSE}$  across the inputs of the ZXCT1081.

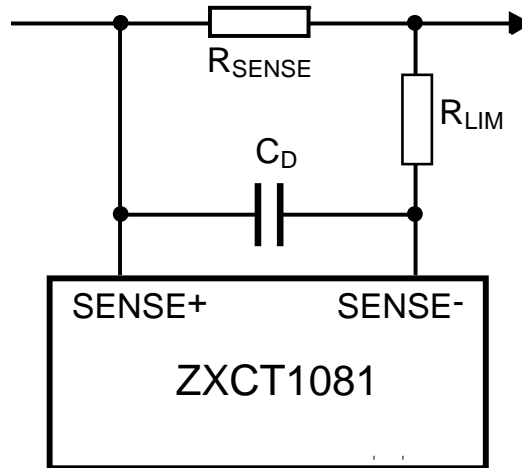
The internal amplifier forces  $V_{SENSE}$  across internal resistance  $R_{SH}$  causing a current to flow through MOSFET M1. This current is then converted to a voltage by  $R_G$ . A ratio of 10:1 between  $R_G$  and  $R_{SH}$  creates the fixed gain of 10. The output is then buffered by the unity gain buffer.

The gain equation of the ZXCT1081 is:

$$V_{OUT} = I_L R_{SENSE} \frac{R_G}{R_{SH}} \times 1 = I_L R_{SENSE} \times 10$$

The maximum recommended differential input voltage,  $V_{SENSE}$ , is 150mV; it will however withstand voltages up to 800mV. This can be increased further by the inclusion of a resistor,  $R_{LIM}$ , between SENSE- pin and the load; typical value is of the order of 10k.





**Figure 2 Protection/Error Sources for ZXCT1081**

Capacitor  $C_D$  provides high frequency transient decoupling when used with  $R_{LIM}$ ; typical values are of the order 10pF.

For best performance  $R_{SENSE}$  should be connected as close to the  $SENSE+$  (and  $SENSE-$ ) pins; minimizing any series resistance with  $R_{SENSE}$ .

When choosing appropriate values for  $R_{SENSE}$  a compromise must be reached between in-line signal loss (including potential power dissipation effects) and small signal accuracy.

Higher values for  $R_{SENSE}$  gives better accuracy at low load currents by reducing the inaccuracies due to internal offsets. For best operation the ZXCT1081 has been designed to operate with  $V_{SENSE}$  of the order of 50mV to 150mV.

Current monitors' basic configuration is that of a unipolar voltage to current to voltage converter powered from a single supply rail. The internal amplifier at the heart of the current monitor may well have a bipolar offset voltage but the output cannot go negative; this results in current monitors saturating at very low sense voltages.

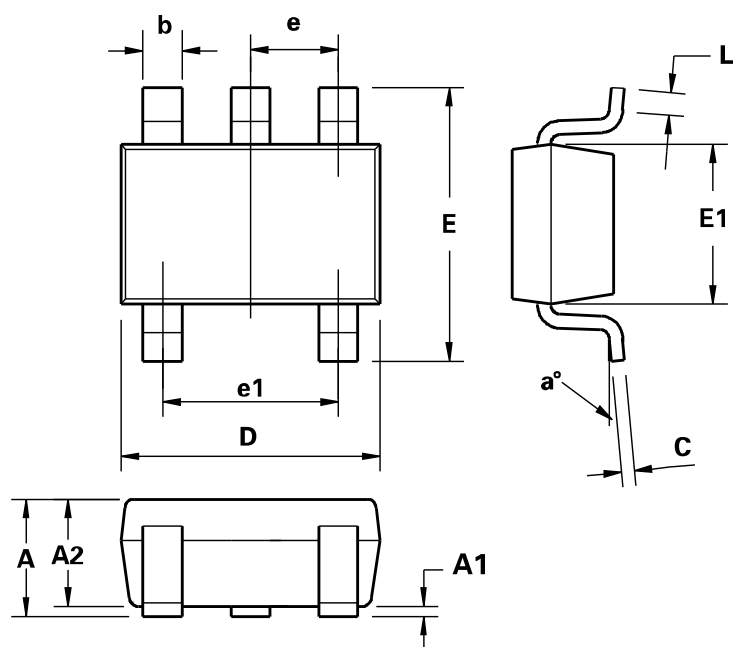
As a result of this phenomenon the ZXCT1081 has been specified to operate in a linear manner over a  $V_{SENSE}$  range of 10mV to 150mV range, however it will still be monotonic down to  $V_{SENSE}$  of 0V.

It is for this very reason that Zetex has specified an input offset voltage ( $V_{O(10)}$ ) at 10mV. The output voltage for any  $V_{SENSE}$  voltage from 10mV to 150mV can be calculated as follows:

$$V_{OUT} = (V_{SENSE}) \times G + V_{O(10)}$$

Alternatively the load current can be expressed as:

$$I_L = \frac{V_{OUT} - V_{O(10)}}{G \times R_{SENSE}}$$

**Package Outline – SOT23-5**


DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	0.90	1.45	0.0354	0.0570
A1	0.00	0.15	0.00	0.0059
A2	0.90	1.3	0.0354	0.0511
b	0.20	0.50	0.0078	0.0196
C	0.09	0.26	0.0035	0.0102
D	2.70	3.10	0.1062	0.1220
E	2.20	3.20	0.0866	0.1181
E1	1.30	1.80	0.0511	0.0708
e	0.95 REF		0.0374 REF	
e1	1.90 REF		0.0748 REF	
L	0.10	0.60	0.0039	0.0236
a°	0	30	0	30

Note: Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

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