

# ZXCT1080

## High voltage high-side current monitor

### Description

The ZXCT1080 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 60V down to as low as 3V make it suitable for a range of applications; including systems operating from industrial 24-28V rails and -48V rails.

The separate supply pin ( $V_{CC}$ ) allows the device to continue functioning under short circuit conditions, giving an end stop voltage at the output.

The ZXCT1080 has an extended ambient operating temperature range of  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  enabling it to be used in a wide range of applications including automotive.

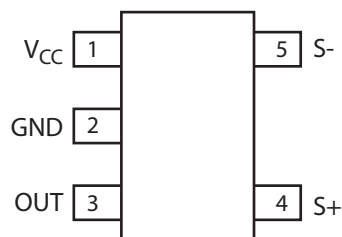
### Features

- 3V to 60V continuous high side voltage
- Accurate high-side current sensing
- $-40$  to  $125^{\circ}\text{C}$  temperature range
- Output voltage scaling  $\times 10$
- 4.5V to 12V  $V_{CC}$  range
- Low quiescent current:
  - $80\mu\text{A}$  supply pin
  - $27\mu\text{A}$   $I_{S+}$
- SOT23-5 package

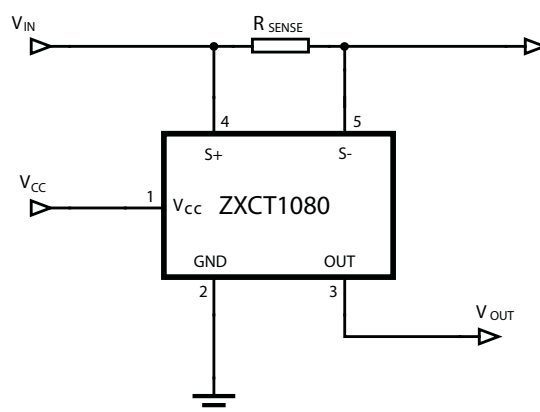
### Applications

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

### Pin connections



### Typical application circuit



### Ordering information

Device	Package	Part mark	Reel size (inches)	Tape width (mm)	Quantity per reel
ZXCT1080E5TA	SOT23-5	1080	7	8	3000

## Absolute maximum ratings

Continuous voltage on S- and S+	-0.6 and 65V
Voltage on all other pins	-0.6V and +14V
Differential sense voltage, $V_{SENSE}$	800mV
Operating temperature	-40 to 125°C
Storage temperature	-55 to 150°C
Maximum junction temperature	125°C
Package power dissipation	300mW* at $T_A = 25^\circ\text{C}$

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

$V_{SENSE}$  is defined as the differential voltage between S+ and S- pins.

\* Assumes  $\Theta_{JA} = 420^\circ\text{C/W}$

## Recommended operating conditions

Parameter		Min.	Max.	Units
$V_{IN}$	Common-mode sense+ input range	3	60	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
$T_A$	Ambient temperature range	-40	125	°C

### NOTES:

(\*) Based on  $10 \times V_{SENSE}$

## Pin function table

Pin	Name	Description
1	$V_{CC}$	This is the analogue supply and provides power to internal circuitry
2	GND	Ground pin
3	OUT	Output voltage pin. NMOS source follower with 20µA bias to ground
4	S+	This is the positive input of the current monitor and has an input range from 60V down to 3V. The current through this pin varies with differential sense voltage
5	S-	This is the negative input of the current monitor and has an input range from 60V down to 3V

## 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	Conditions	$T_A$	Min <sup>(e)</sup>	Typ.	Max <sup>(e)</sup>	Units
$I_{CC}$	$V_{CC}$ supply current	$V_{CC} = 12\text{V}$ , $V_{SENSE}^{(a)} = 0\text{V}$	$25^\circ\text{C}$	40	80	120	$\mu\text{A}$
			full range			145	
$I_{S+}$	S+ input current	$V_{SENSE}^{(a)} = 0\text{V}$	$25^\circ\text{C}$	15	27	42	$\mu\text{A}$
			full range			60	
$I_{S-}$	S- input current	$V_{SENSE}^{(a)} = 0\text{V}$	$25^\circ\text{C}$	15	40	80	nA
$V_{O(0)}$	Zero $V_{SENSE}^{(a)}$ error <sup>(b)</sup>		$25^\circ\text{C}$	0		35	mV
$V_{O(10)}$	Output offset voltage <sup>(c)</sup>	$V_{SENSE}^{(a)} = 10\text{mV}$	$25^\circ\text{C}$	-25		+25	mV
			full range	-55		+55	
Gain	$\Delta V_{OUT}/\Delta V_{SENSE}^{(a)}$	$V_{SENSE}^{(a)} = 10\text{mV}$ to 150mV	$25^\circ\text{C}$	9.9	10	10.1	V/V
			full range	9.8		10.2	
$V_{OUT\ TC}^{(d)}$	$V_{OUT}$ variation with temperature				30		ppm/ $^\circ\text{C}$
Acc	Total output error			-3		3	%
$I_{OH}$	Output source current	$\Delta V_{OUT} = -30\text{mV}$			1		mA
$I_{OL}$	Output sink current	$\Delta V_{OUT} = +30\text{mV}$			20		$\mu\text{A}$
PSRR	$V_{CC}$ supply rejection ratio	$V_{CC} = 4.5\text{V}$ to 12V		54	60		dB
CMRR	Common-mode sense rejection ratio	$V_{IN} = 60\text{V}$ to 3V		68	80		dB
BW	-3dB small signal bandwidth	$V_{SENSE}^{(a)} (AC) = 10\text{mV}_{PP}$			500		kHz

### NOTES:

(a)  $V_{SENSE} = "V_{S+}" - "V_{S-}"$

(b) The ZXCT1080 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.

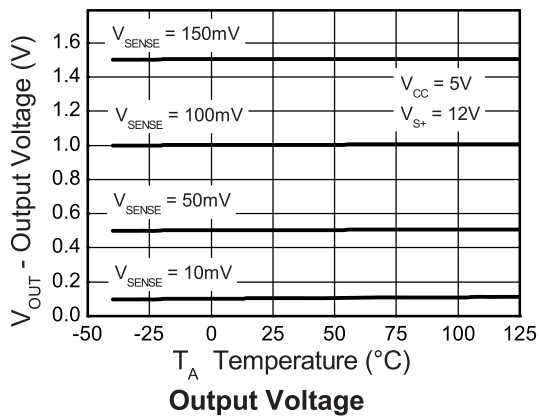
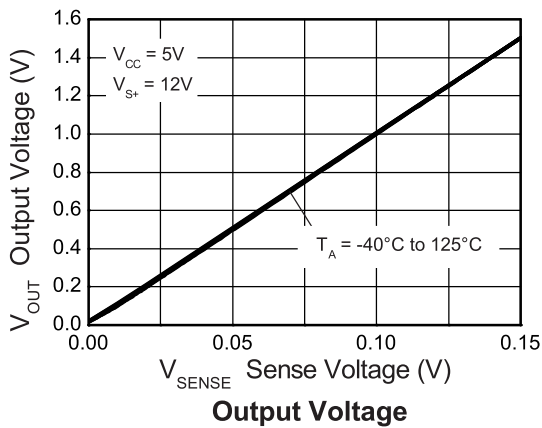
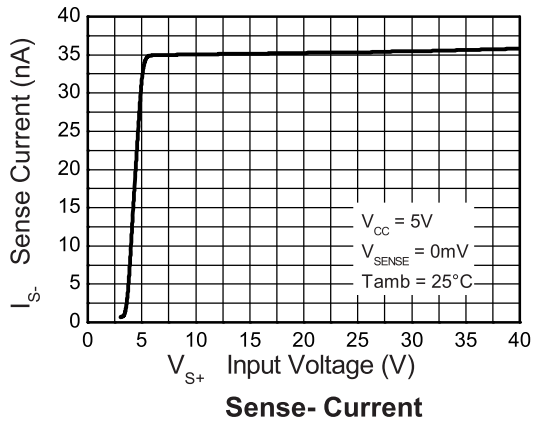
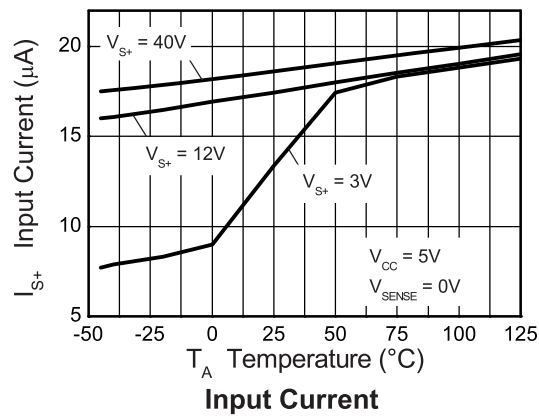
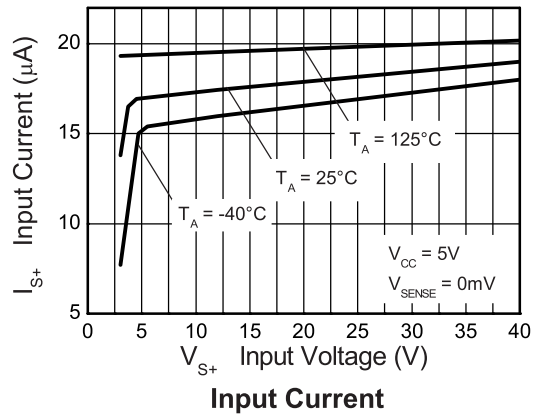
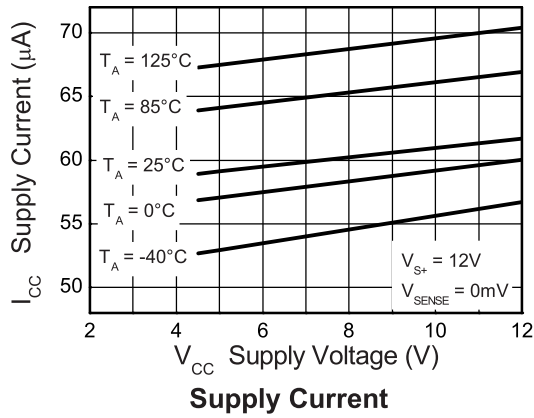
(c) For  $V_{SENSE} > 10\text{mV}$ , the internal voltage-current converter is fully linear. This enables a true offset to be defined and used.  $V_{O(10)}$  is expressed as the variance about an output voltage of  $100\text{mV}$ .

(d) Temperature dependent measurements are extracted from characterization and simulation results.

(e) All Min and Max specifications over full temperature range are guaranteed by design and characterisation

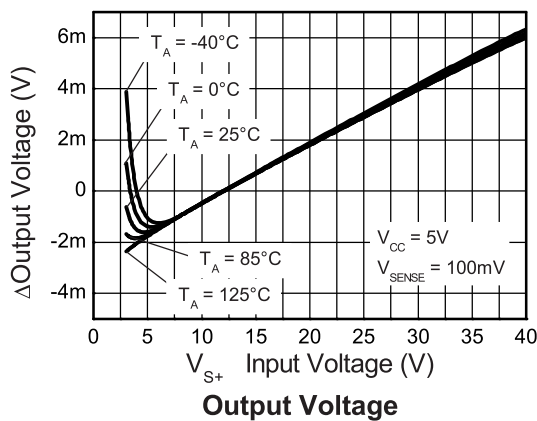
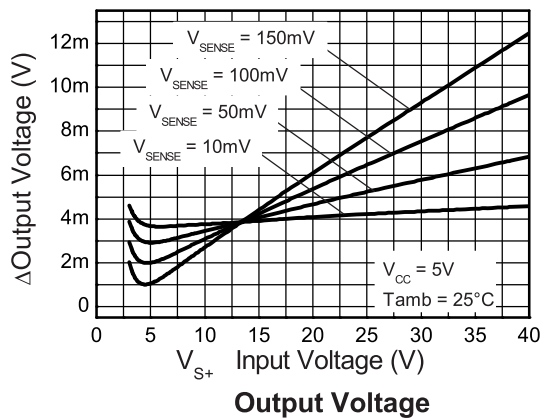
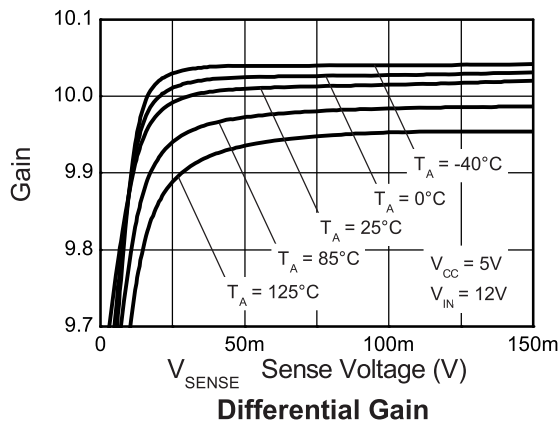
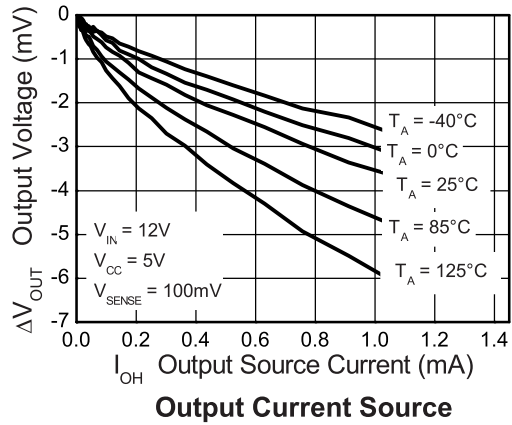
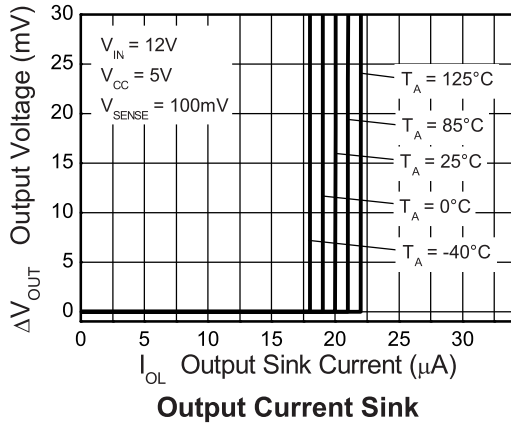
## Typical characteristics

Test conditions unless otherwise stated:  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ ,  $V_{S+} = 12\text{V}$ ,  $V_{SENSE} = 100\text{mV}$



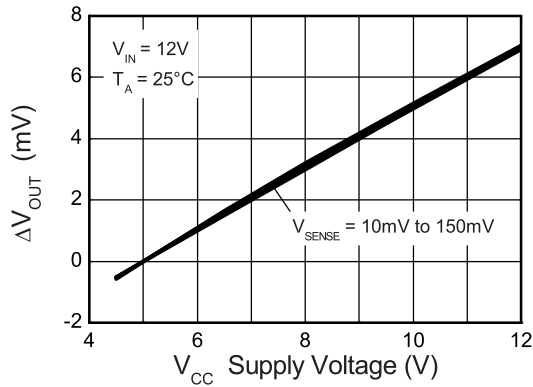
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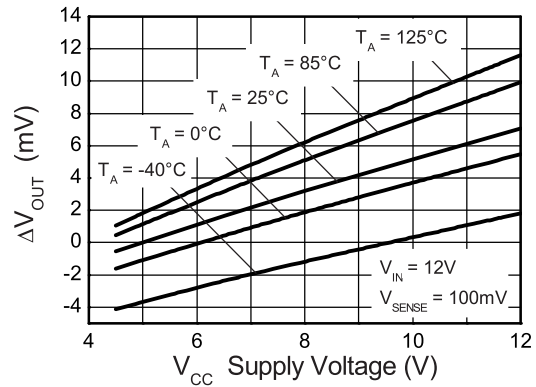


## Typical characteristics

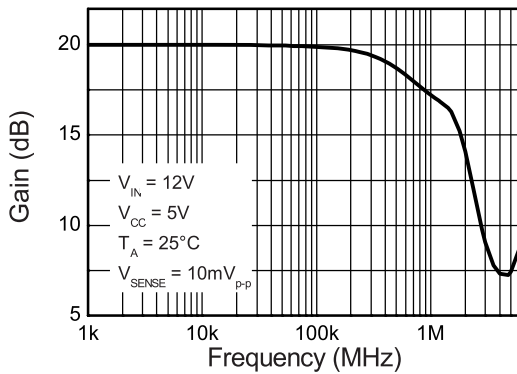
Test conditions unless otherwise stated:  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ ,  $V_{\text{SENSE}+} = 12\text{V}$ ,  $V_{\text{SENSE}} = 100\text{mV}$



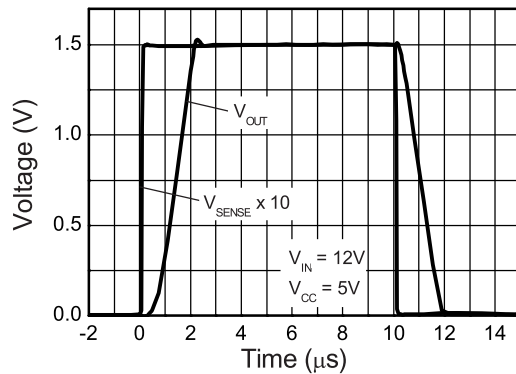
**Normalised Output Voltage**



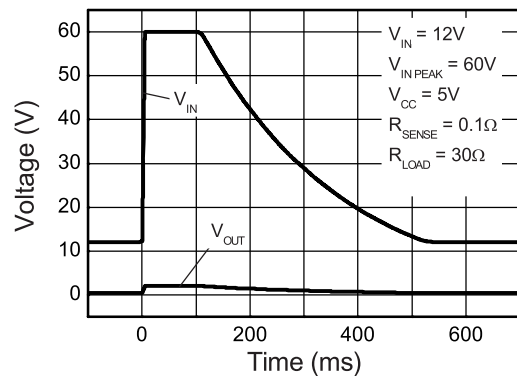
**Normalised Output Voltage**



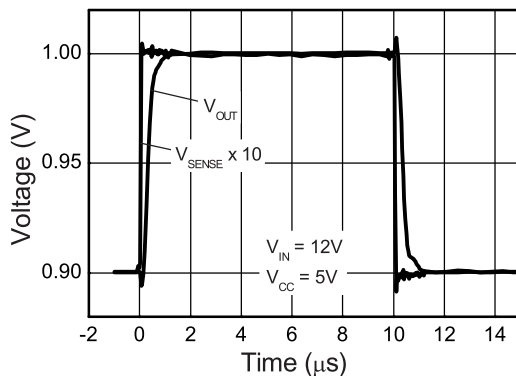
**Small Signal Bandwidth**



**Large Signal Pulse Response**



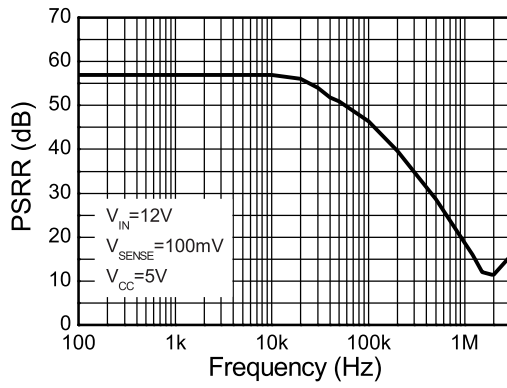
**Load Dump Waveform**



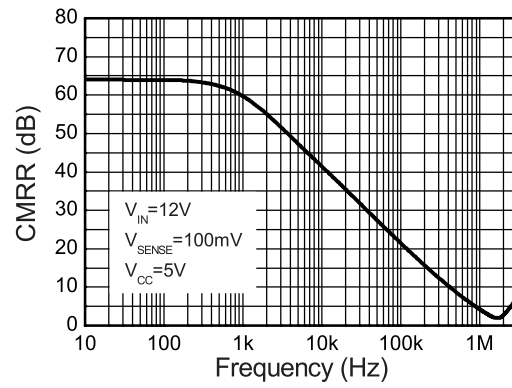
**Small Signal Pulse Response**

## Typical characteristics

Test conditions unless otherwise stated:  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ ,  $V_{\text{SENSE}+} = 12\text{V}$ ,  $V_{\text{SENSE}} = 100\text{mV}$



**Supply Rejection**



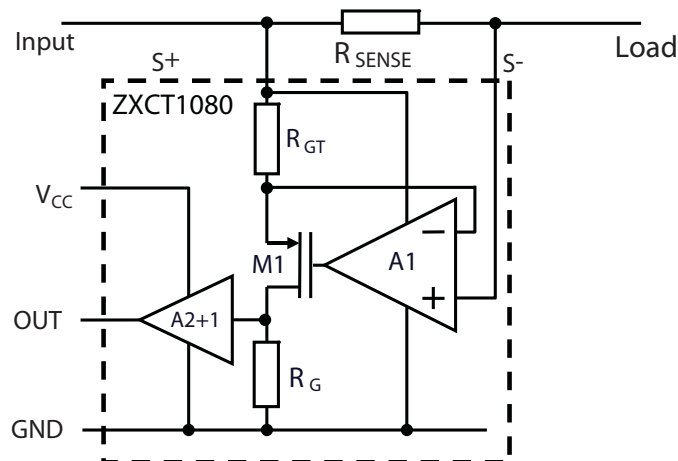
**Common Mode Rejection**

## Application information

The ZXCT1080 has been designed to allow it to operate with 5V supply rails while sensing common mode signals up to 60V. 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  $V_{CC}$  pin can be used independently of S+.

Figure 1 shows the basic configuration of the ZXCT1080.



**Figure 1 Typical configuration of ZXCT1080**

Load current from the input is drawn through  $R_{SENSE}$  developing a voltage  $V_{SENSE}$  across the inputs of the ZXCT1080.

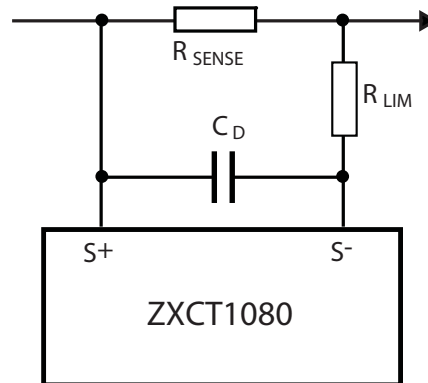
The internal amplifier forces  $V_{SENSE}$  across internal resistance  $R_{GT}$  causing a current to flow through MOSFET M1. This current is then converted to a voltage by  $R_G$ . A ratio of 10:1 between  $R_G$  and  $R_{GT}$  creates the fixed gain of 10. The output is then buffered by the unity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

The gain equation of the ZXCT1080 is:

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

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 S- pin and the load; typical value is of the order of 10k .





**Figure 2 Protection/error sources for ZXCT1080**

Capacitor C<sub>D</sub> provides high frequency transient decoupling when used with R<sub>LIM</sub>; typical values are of the order 10pF

For best performance R<sub>SENSE</sub> should be connected as close to the S+ (and SENSE ) pins; minimizing any series resistance with R<sub>SENSE</sub>.

When choosing appropriate values for R<sub>SENSE</sub> a compromise must be reached between in-line signal loss (including potential power dissipation effects) and small signal accuracy.

Higher values for R<sub>SENSE</sub> gives better accuracy at low load currents by reducing the inaccuracies due to internal offsets. For best operation the ZXCT1080 has been designed to operate with V<sub>SENSE</sub> 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 ZXCT1080 has been specified to operate in a linear manner over a V<sub>SENSE</sub> range of 10mV to 150mV range, however it will still be monotonic down to V<sub>SENSE</sub> of 0V.

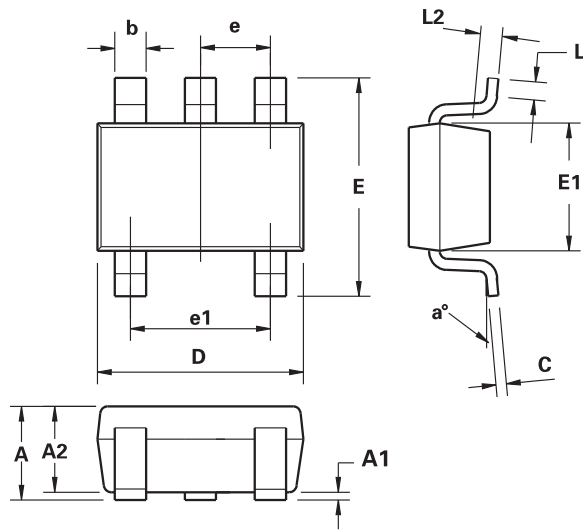
It is for this very reason that Zetex has specified an input offset voltage (V<sub>O(10)</sub>) at 10mV. The output voltage for any V<sub>SENSE</sub> voltage from 10mV to 150mV can be calculated as follows:

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

Alternatively the load current can be expressed as:

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

## Package details - 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	1.30	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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