

# 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.

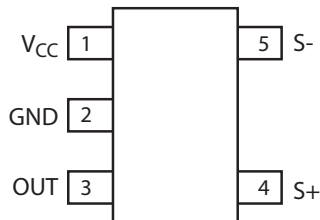
### Features

- 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

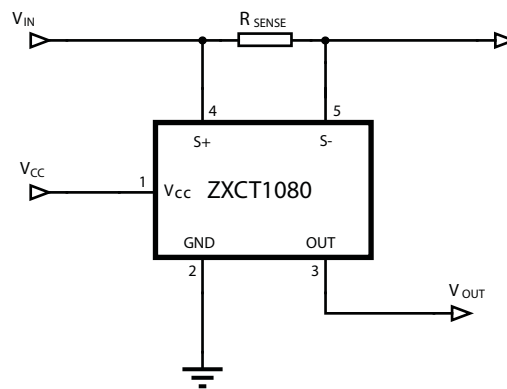
### Applications

- 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 20 $\mu\text{A}$ 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.

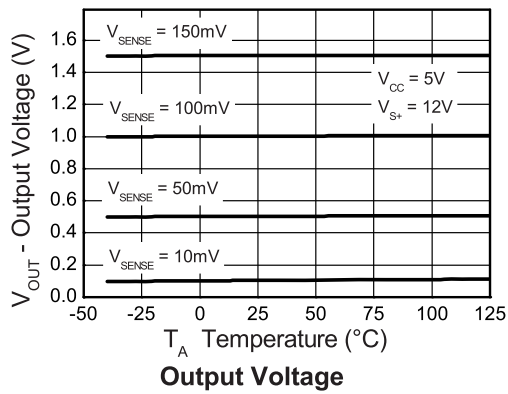
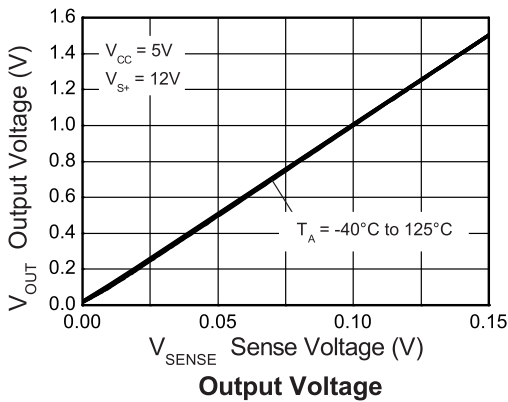
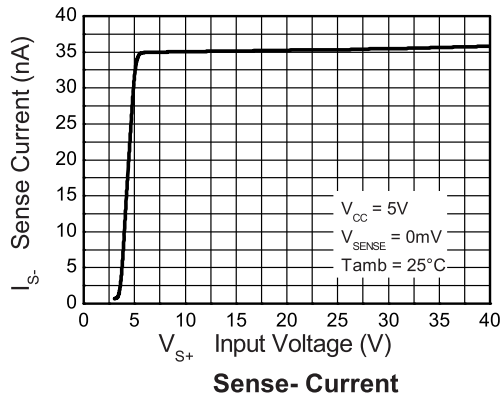
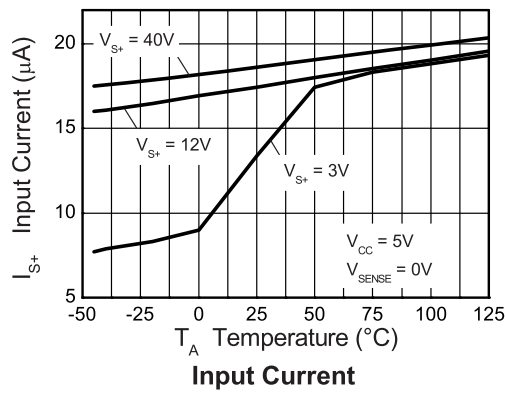
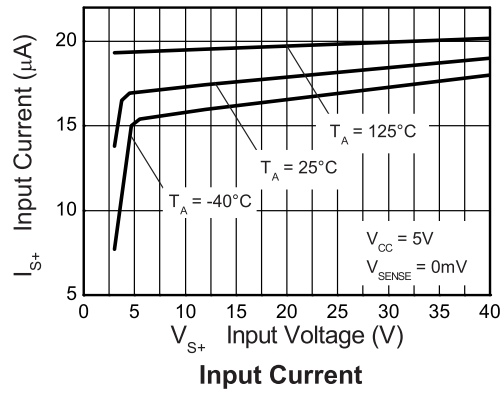
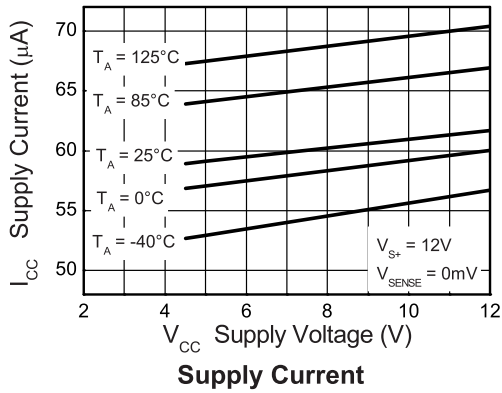
(c) For  $V_{SENSE} > 10\text{mV}$ , the internal voltage-current converter is fully linear. This enables a true offset to be defined and used.  $V_{O(10)}$  is expressed as the variance about an output voltage of 100mV

(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

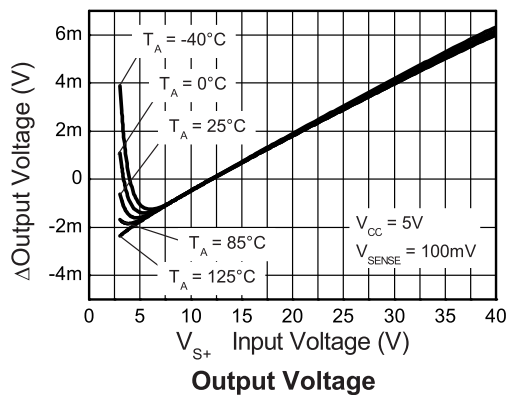
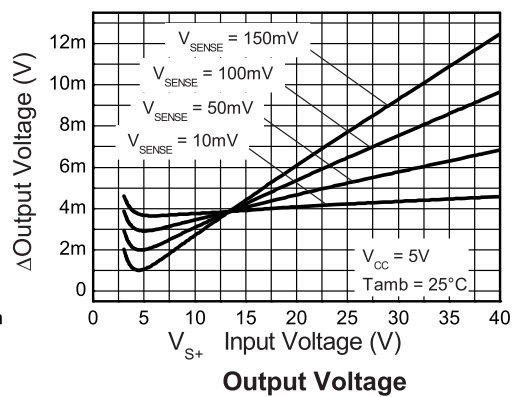
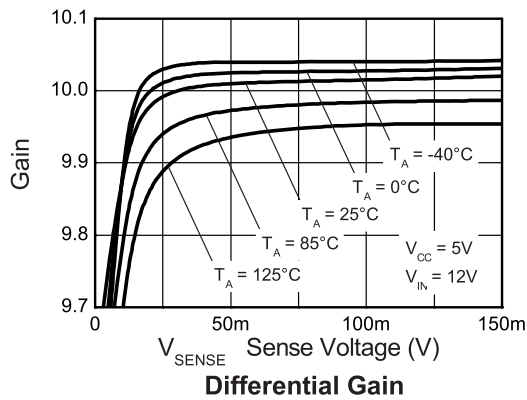
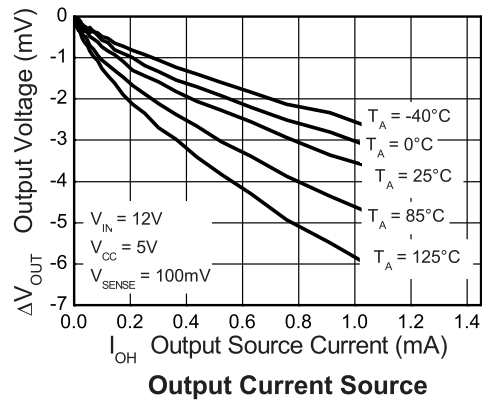
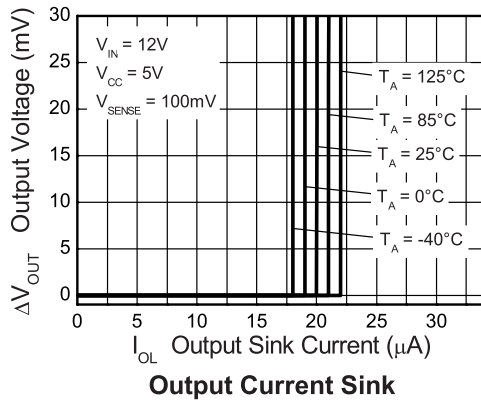
## Typical characteristics

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



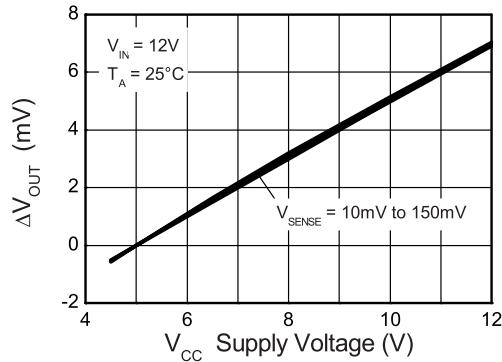
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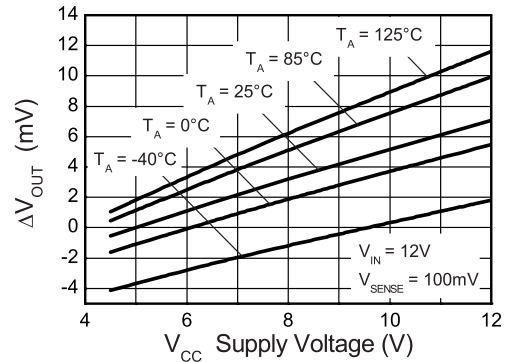


## Typical characteristics

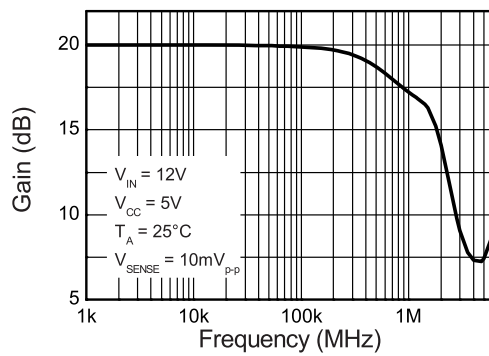
Test conditions unless otherwise stated:  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ ,  $V_{\text{SENSE}+} = 12\text{V}$ ,  $V_{\text{SENSE}} = 100\text{mV}$



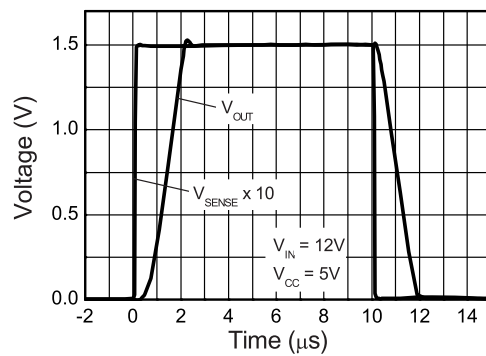
**Normalised Output Voltage**



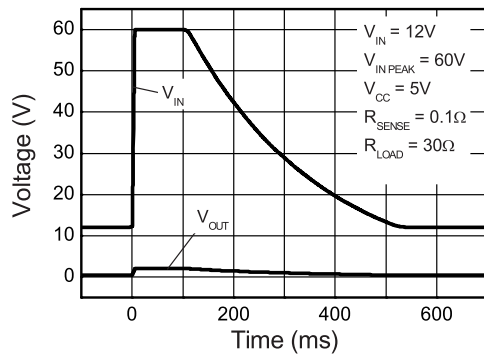
**Normalised Output Voltage**



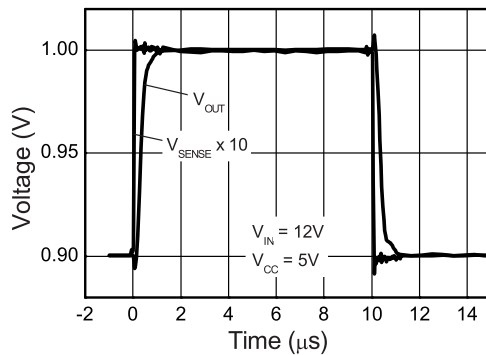
**Small Signal Bandwidth**



**Large Signal Pulse Response**



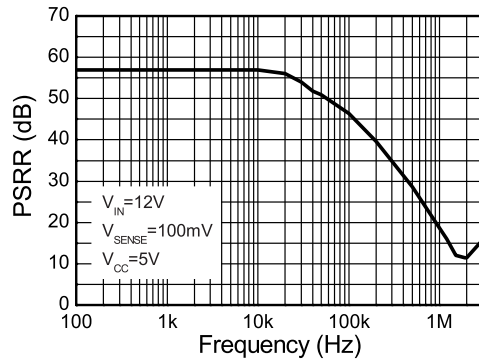
**Load Dump Waveform**



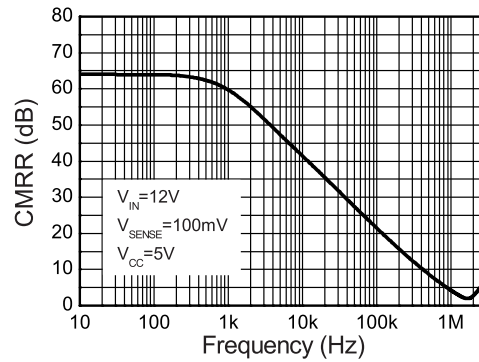
**Small Signal Pulse Response**

## 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**



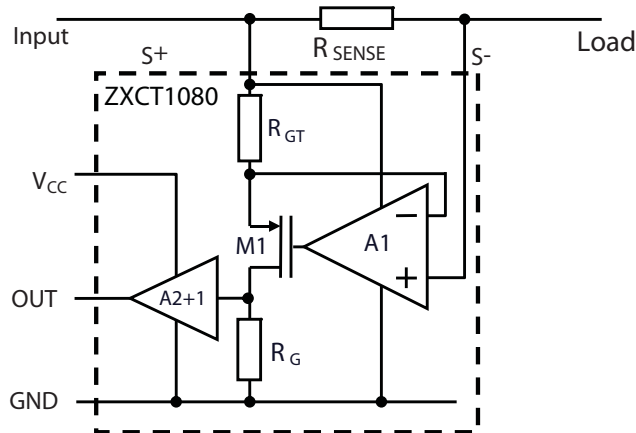
**Common Mode Rejection**

## 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.

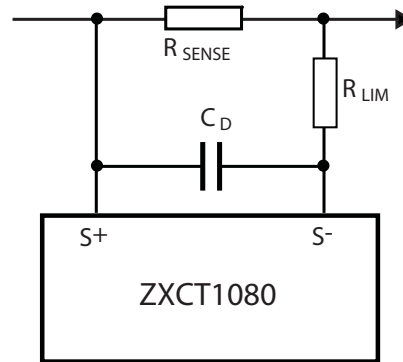
The internal amplifier forces  $V_{SENSE}$  across internal resistance  $R_{GT}$  causing a current to flow through MOSFET M1. This current is then converted to a voltage by  $R_G$ . A ratio of 10:1 between  $R_G$  and  $R_{GT}$  creates the fixed gain of 10. The output is then buffered by the unity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

The gain equation of the ZXCT1080 is:

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

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  $C_D$  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 S+ (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 ZXCT1080 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 ZXCT1080 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:

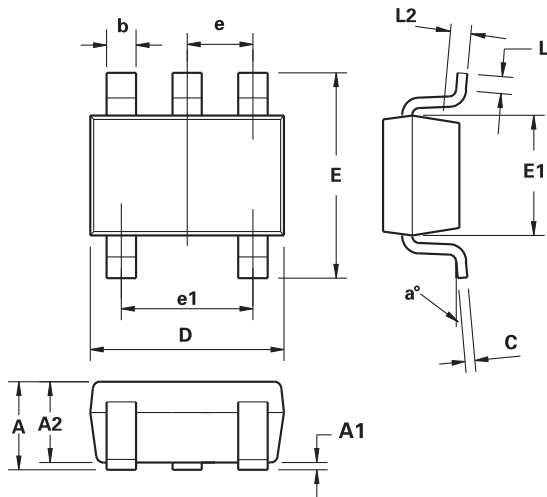
$$V_{OUT} = (V_{SENSE}) \times G + V_{O(10)}$$

Alternatively the load current can be expressed as:

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

# ZXCT1080

## 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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