ZETEX SEMICONDUCTORS

ZXCT1050
Precision wide input range current monitor

Description

The ZXCT1050 is a wide input range current monitor, which operates over a range of input voltages from ground up to V_{CC}-2V. As a result the ZXCT1050 can be used on the high or low side of the load.

The ZXCT1050 provides variable gain by using two external resistors. The first of which sets the transconductance and the second setting the overall gain.

The very low offset voltage enables a typical accuracy of 1% for sense voltages of only 30mV, giving better tolerances for small sense resistors necessary at higher currents.

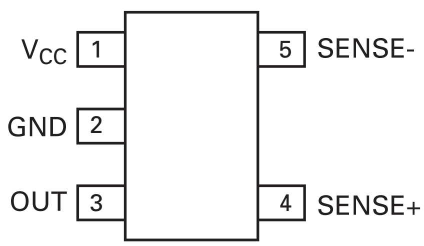
Features

- Accurate down to end current sensing
- Output voltage scaling x10
- 0 to V_{CC}-2V sense input range
- 2.7 to 20V supply range
- 50µA quiescent current
- SOT23-5 package

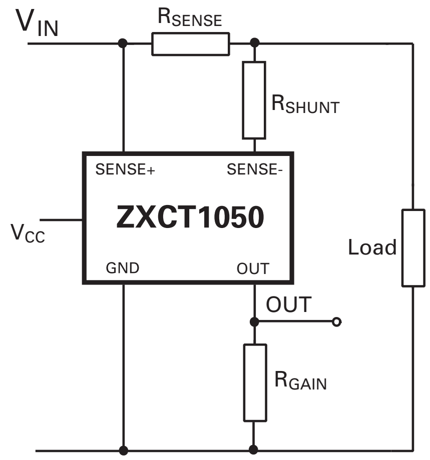
Applications

- Power supply
- DC motor and solenoid control
- Battery management
- Over current monitor
- Power management
- Short circuit detection

Pin connections



Typical application circuit



Ordering information

Order code	Pack	Part mark	Reel size (inches)	Tape width (mm)	Quantity per reel
ZXCT1050E5TA	SOT23-5	1050	7	8	3000

Absolute maximum ratings

V_{CC} max.	20V
Voltage on SENSE- and SENSE+	-0.6 to V_{CC}
Voltage on all other pins	-0.6V and V_{CC} +0.6V
V_{SENSE} = '(V_{SENSE}+) - (V_{SENSE}-)'	500mV
Operating temperature	-40 to 125°C
Storage temperature	-55 to 150°C
Maximum junction temperature	150°C
Package power dissipation	300mW* at T_A = 25°C (De-rate to zero for T_J = 150°C)

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

Parameter		Min.	Max.	Units
V_{SENSE+}	Common-mode sense input range	0	V_{CC}-2	V
V_{CC}	Supply voltage range	2.7	20	V
V_{SENSE}	Differential sense input voltage range	10	300	mV
V_{OUT}	Output voltage range	0	V_{CC}-2	V
T_A	Ambient temperature range	-40	125	°C

Recommended resistor gain setting combinations

Gain	R_{SH}	R_G
10	7.5kΩ	3.75kΩ
20	7.5kΩ	7.5kΩ
50	7.5kΩ	18.7kΩ
100	7.5kΩ	37.5kΩ
20	3.75kΩ	3.75kΩ
50	1.5kΩ	3.75kΩ
100	750Ω	3.75kΩ

Pin function table

PIN	Name	Description
1	V_{CC}	This is the analog supply and provides power to internal circuitry.
2	GND	Ground pin.
3	OUT	Output pin. A resistor, R_{GAIN}, connected from this pin pin down to ground develops an output voltage.
4	SENSE+	This is the positive input of the current monitor and has an input range from 0V up to V_{CC} – 2V.
5	SENSE-	This is the negative input of the current monitor and has an input range from 0V up to V_{CC} – 2V. The current through this pin varies with differential sense voltage. A resistor, R_{SHUNT}, from this pin to the rail being sensed set the transconductance of the current monitor.

Electrical characteristics

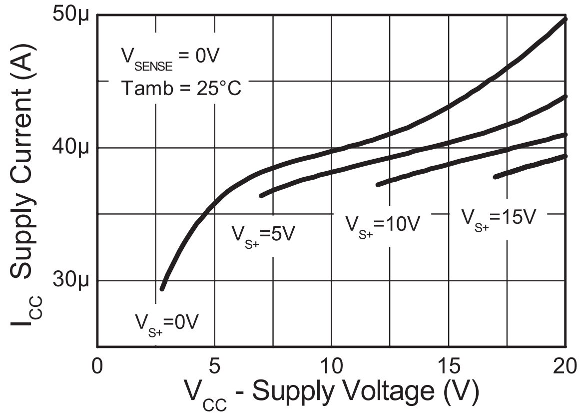
Test conditions T_A = 25°C, V_{SENSE+} = 10V, V_{CC} = 12V, V_{SENSE} = 100mV, R_{SH} = 7.5kΩ, R_G = 3.75kΩ.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
I_Q	V_{CC} pin current	V_{SENSE} = 0V		45	70	μA
V_{OUT}	Output voltage	V_{SENSE} = 0V =30mV =100mV =150mV	0 285 0.97 1.45	3 300 1.00 1.50	15 315 1.03 1.55	mV mV V V
I_{SENSE+}	V_{SENSE+} input current	V_{SENSE} = 0V		60	150	nA
I_{SENSE-}	V_{SENSE-} input current	V_{SENSE} = 0V		15	150	nA
V_{OUT} TC	V_{OUT} variation with temperature	See note (*)			300	ppm/°C
Gain	V_{OUT}/V_{SENSE}			10		
Accuracy	Total output error		-3		3	%
BW	Bandwidth	$V_{SENSE(DC)}$ = 10mV; $V_{SENSE(AC)}$ = 10mV_{PP} CL = 5pF,		300		kHz
		$V_{SENSE(DC)}$ = 100mV; $V_{SENSE(AC)}$ = 10mV_{PP} CL = 5pF,		0.8		MHz
PSRR	Power supply rejection ratio	V_{CC} = 2.7V to 20V V_{SENSE+} = 0.7V		60		dB
CMRR	Common mode rejection ratio	V_{CC} = 20V V_{SENSE+} = 0 to 18V		70		dB

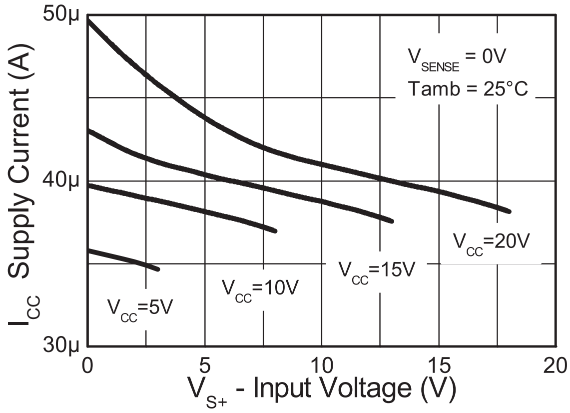
NOTES:
(*) Temperature dependent measurements are extracted from characterisation and simulation results.

Typical characteristics

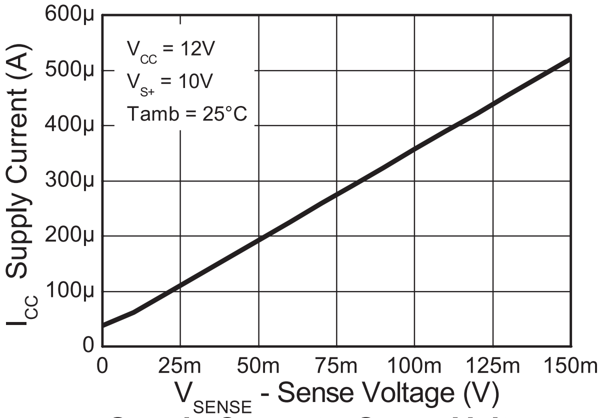
R_G = 3.75kΩ, R_{SH} = 7.5kΩ unless otherwise stated.



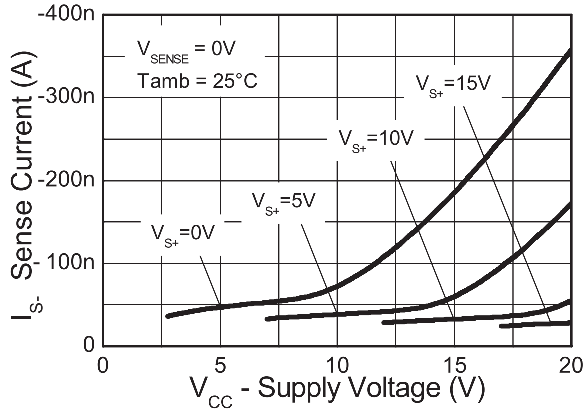
Supply Current v Supply Voltage



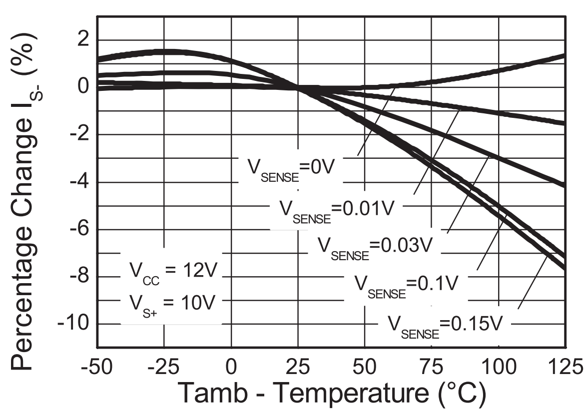
Supply Current v Input Voltage



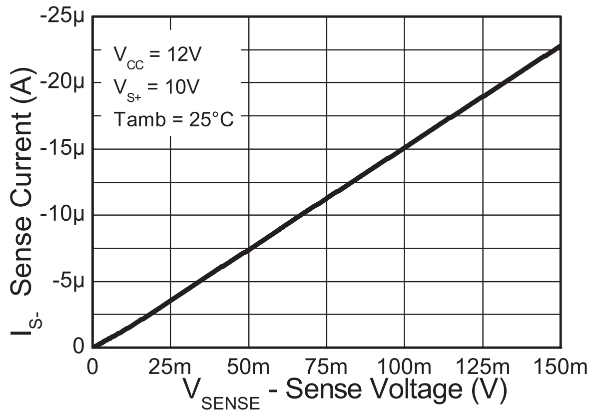
Supply Current v Sense Voltage



Sense- Current v Supply Voltage



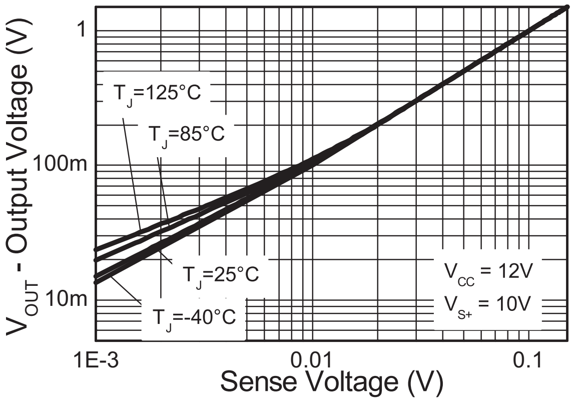
Sense- Current v Temperature



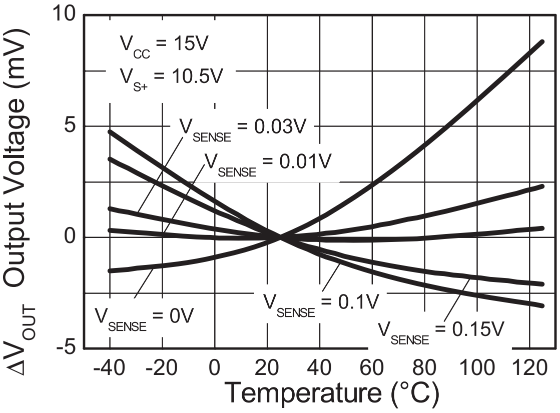
Sense- Current v Sense Voltage

Typical characteristics

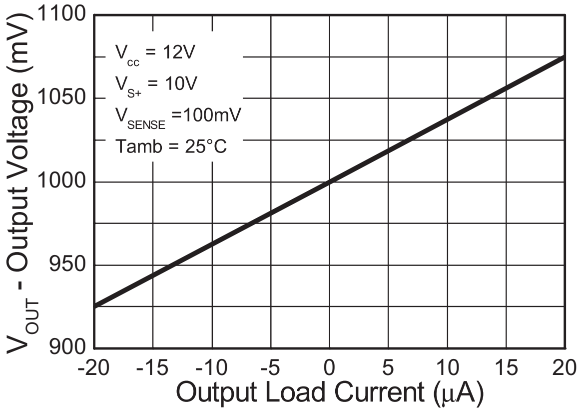
R_G = 3.75kΩ, R_{SH} = 7.5kΩ unless otherwise stated.



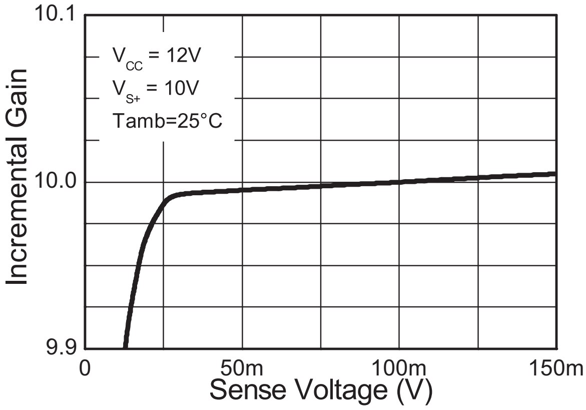
Output Voltage v Sense Voltage



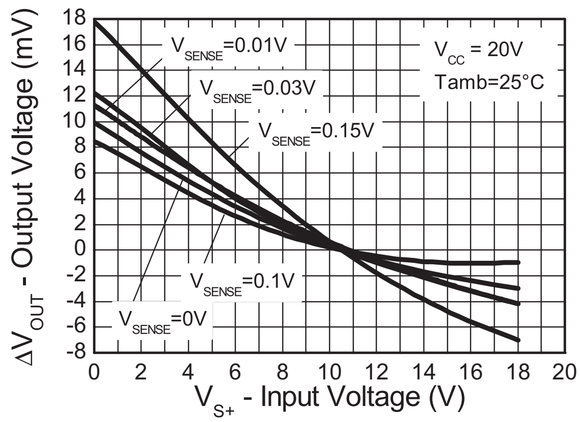
Temperature Characteristic



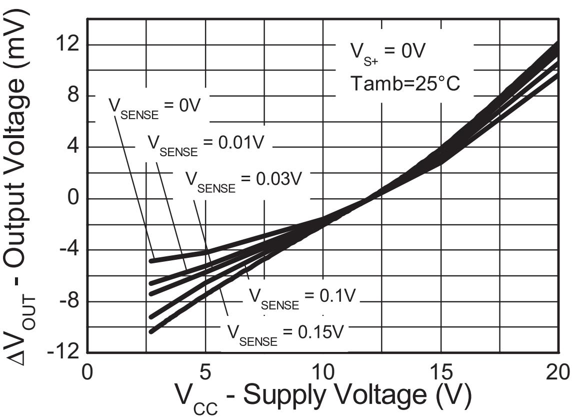
V_{OUT} v Load Current



Incremental Gain v Sense Voltage



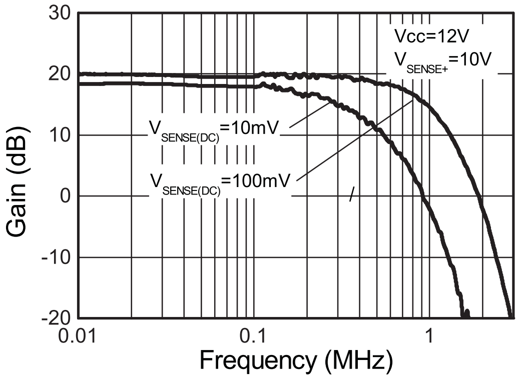
Common Mode Characteristic



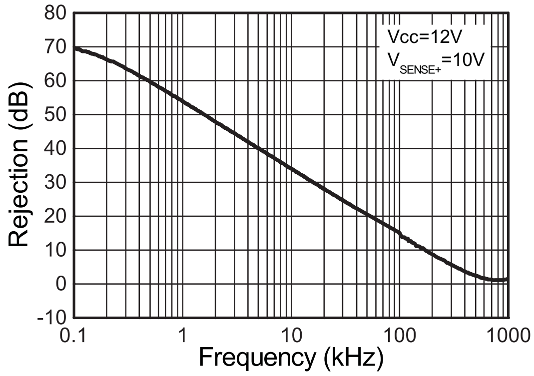
Supply Characteristic

Typical characteristics

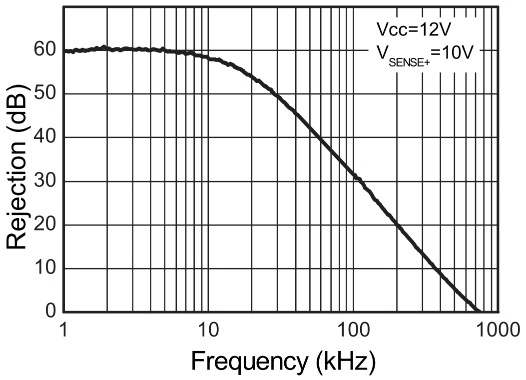
R_G = 3.75kΩ, R_{SH} = 7.5kΩ unless otherwise stated.



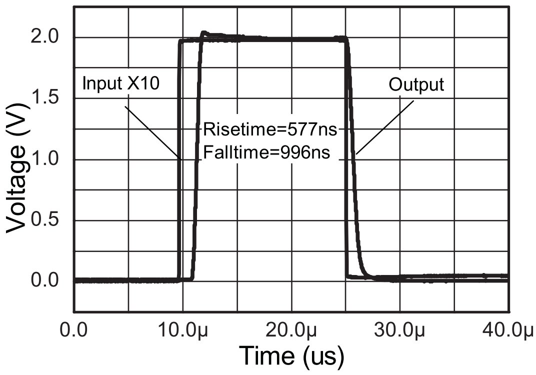
Small Signal Frequency Response



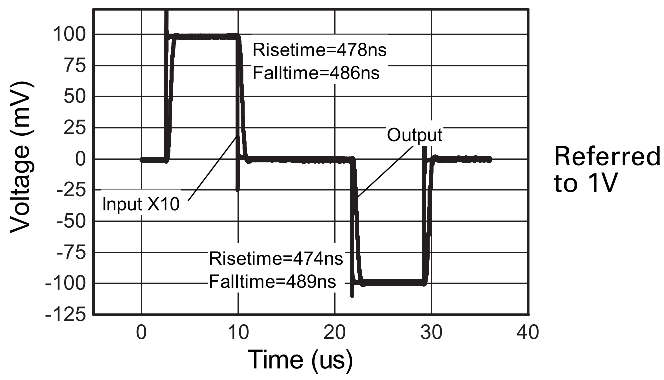
CMRR



PSRR



Large Signal Step Response



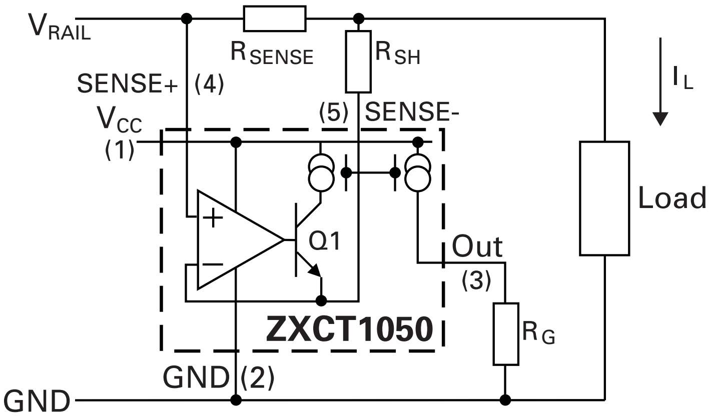
Small Signal Step Response

Applications information

The ZXCT1050 is a current output version of the ZXCT1051 and as such uses a separate power supply pin. All biasing for the internal amplifiers comes from its separate V_{CC} input and is not 'line powered', unlike the ZXCT1021.

This means that at very small sense voltages the ZXCT1050 draws very little current (<1μA) from the lines being sensed.

The separate V_{CC} pin enables the ZXCT1050 to be operated at sense line voltages down to 0V, where the ZXCT1021 would switch off. This feature enables the ZXCT1050 to be used to sense the currents flowing through lines that have been shorted to ground.



Basic operation

Load current, I_L, from V_{RAIL} is drawn through R_{SENSE} developing a voltage V_{SENSE} across the sense inputs of the ZXCT1050.

The internal amplifier forces V_{SENSE} across external resistance R_{SH} (internal on the ZXCT1051) causing a current to flow through transistor Q1 and out of the output pin, OUT. This current is then converted to a voltage by a resistor, R_G, between OUT and GND.

The overall gain of the ZXCT1050 is determined by the following expression:

$$GAIN = 20 \times \frac{R_G}{R_{SH}}$$

A ratio of 1:2 between R_{SH} and R_G creates the fixed gain of 10 with an output impedance equal to RG (see electrical characteristics for output current-voltage characteristics).

The ZXCT1050 has both R_G and R_{SH} external. This allows R_G and R_{SH} to be varied so that the required gain can be achieved at the required output impedance.

For low power applications both R_G and R_{SH} can be increased whereas for driving low impedance R_G and R_{SH} can be decreased.

The maximum recommended value for R_G is 40kΩ and the maximum recommended value for RSH is 10kΩ. Large values of R_{SH} start increasing the effective input offset error, while large values of R_G can created load errors and reduce bandwidths.

The maximum differential input voltage, V_{SENSE}, is 150mV (I_L * R_{SENSE}); however voltages up to 500mV will not damage it. This can be increased further by the inclusion of a resistor, R_{LIM}, between the SENSE+ pin and the rail being sensed, V_{RAIL}.

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

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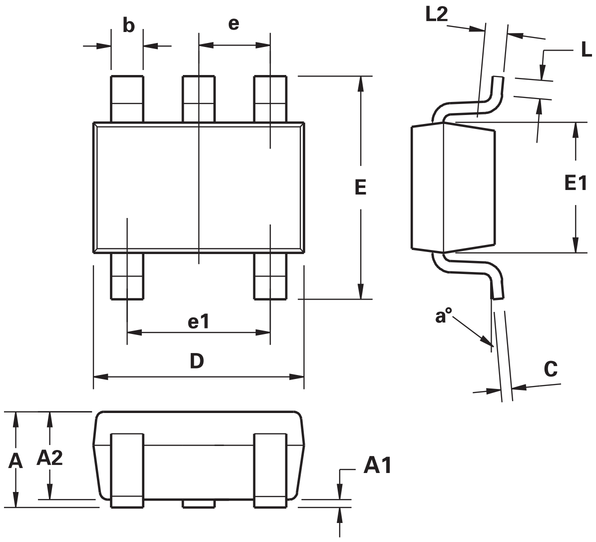
Package outline - SOT23-5



DIM	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	-	1.00	-	0.0393
A1	0.01	0.10	0.0003	0.0039
A2	0.84	0.90	0.0330	0.0354
b	0.30	0.45	0.0118	0.0177
c	0.12	0.20	0.0047	0.0078
D	2.90 BSC		0.114 BSC	
E	2.80 BSC		0.110 BSC	
E1	1.60 BSC		0.062 BSC	
e	0.95 BSC		0.0374 BSC	
e1	1.90 BSC		0.0748 BSC	
L	0.30	0.50	0.0118	0.0196
L2	0.25 BSC		0.010 BSC	
a°	4°	12°	4°	12°

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

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