ZXCT1051
Precision wide input range current monitor

Description

The ZXCT1051 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 ZXCT1051 can be used on the high or low side of the load.

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.

The ZXCT1051 provides a fixed gain of 10 thereby removing the need for an additional resistor.

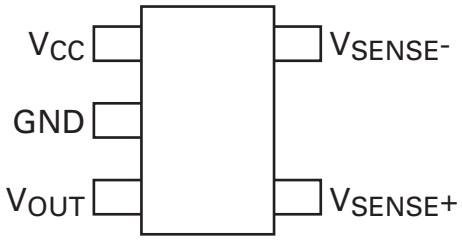
Features

- Accurate down to end current sensing
- Output voltage scaling x10
- 0 to V_{CC}-2V sense input range
- 2.7 to 20V supply range
- 50 µA quiescent current
- 1% typical accuracy
- SOT23-5 package

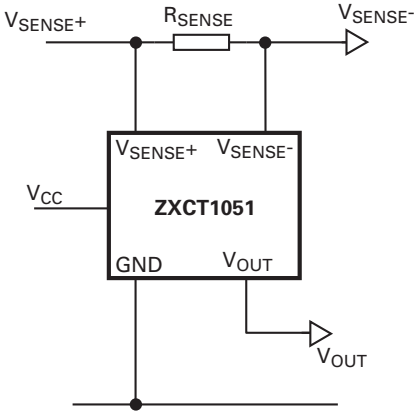
Applications

- 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	Package	Partmark	Reel size (inches)	Tape width (mm)	Quantity per reel
ZXCT1051E5TA	SOT23-5	1051	7	8	3,000

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Absolute maximum ratings

V_{CC} max.	20V
Voltage on V_{SENSE}- and V_{SENSE}+	-0.6 to V_{CC}
Voltage on all other pins	-0.6V and V_{CC} +0.6V
V_{SENSE} "(V_{SENSE}+) - (V_{SENSE}-)	500 mV
Operating temperature, T_A	-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 at 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	0	0.3	V
V_{OUT}	Output voltage range	0	V_{CC} - 2	V
T_A	Ambient temperature range	-40	125	°C

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 voltage pin. NMOS source follower with 20µA bias to ground
4	V_{SENSE}+	This is the positive 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
5	V_{SENSE}-	This is the negative input of the current monitor and has an input range from 0V up to V_{CC} – 2V

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Electrical characteristics

Test conditions T_A = 25°C, V_{SENSE}+ = 10V, V_{CC} = 12V, V_{SENSE} = 100mV

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		0 291 0.98 1.45	3 300 1.00 1.50	10 309 1.02 1.55	mV mV V V
I_{SENSE}+	V_{SENSE+} input current	V_{SENSE} = 0V			TBD	TBD	µA
I_{SENSE}-	V_{SENSE-} input current	V_{SENSE} = 0V			15	150	nA
V_{OUT} TC	V_{OUT} variation with temperature	See note (b)				300	ppm/°C
R_{OUT}	Output resistance			2.5	3.75	5	kΩ
Gain	V_{OUT}/V_{SENSE}				10		
Accuracy	Total output error			-2		2	%
BW	Bandwidth	$V_{SENSE(DC)}$ = 10mV	$V_{SENSE(AC)}$ = 10mV_{PP} CL = 5pF,		300		kHz
		$V_{SENSE(DC)}$ = 100mV			1		MHz
PSRR	Power supply rejection ratio	V_{CC} = 2.7V to 20V V_{SENSE}+ = 0.7V		TBD	TBD		dB
CMRR	Common mode rejection ratio	V_{CC} = 20V V_{SENSE}+ = 0 to 18V		TBD	TBD		dB

NOTES:
(a) V_{SENSE} = "V_{SENSE}+" - "V_{SENSE}-"
(b) Temperature dependent measurements are extracted from characterization and simulation results.

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Typical characteristics

Test conditions unless otherwise stated: T_A = 25°C, V_{CC} = 12V, V_{SENSE}+ =10V, V_{SENSE} = 100mV

DC characteristics		
Y-axis	**X-axis**	**Variables**
I_{CC}	V_{CC} (0 to 20V)	T_A = -40, 25, 85, 125°C, V_{SENSE} = 0V V_{SENSE}+ = 0V
	V_{CC} (2 to 20V)	T_A = -40, 25, 85, 125°C, V_{SENSE} = 0V V_{SENSE}+ = V_{CC} - 2V
I_{SENSE}+	V_{SENSE}+ (0 to 18V)	T_A=25°C, V_{SENSE} = 0V, V_{CC} = 20V
I_{SENSE}+	T_A	V_{SENSE} = 0V, V_{SENSE}+ = 18V V_{CC} = 20V
I_{SENSE}-	V_{SENSE}+ (0 to 18V)	T_A=25°C, V_{SENSE} = 0V, V_{CC} = 20V
V_{OUT}	V_{SENSE}	T_A = -40°C, 0°C, 25°C, 85°C, 125°C.
V_{OUT}	T_A	V_{SENSE} = 10mV, 50mV, 100mV.
V_{OH}	I_{OH} source	Output source current swept T_A = -40°C, 25°C, 125°C.
V_{OL}	I_{OL} sink	
Differential gain	V_{SENSE}	Differential sense voltage swept and differential gain calculated
ΔV_{OUT}	V_{SENSE}+ (0 to 18V)	V_{SENSE} = 10mV, 50mV, 100mV, 150mV T_A = -40°C, 0°C, 25°C, 85°C, 125°C.
ΔV_{OUT}	V_{CC} (0 to 20V)	V_{SENSE} = 10mV, 50mV, 100mV, 150mV T_A = -40°C, 0°C, 25°C, 85°C, 125°C.
AC and transient characteristics		
Small signal bandwidth	Frequency	$V_{SENSE(DC)}$ = 10mV, $V_{SENSE(AC)}$ = 10mV_{PP} $V_{SENSE(DC)}$ = 100mV, $V_{SENSE(AC)}$ = 10mV_{PP}
Large signal response	Time	V_{SENSE}+ = 12V, V_{SENSE}- = 0V to -0.2V to +0.2V to 0V
Small signal response	Time	V_{SENSE}+ = 12V, V_{SENSE}- = 0V to -0.01V to +0.1V to 0V
PSRR	Frequency	$V_{CC(AC)}$ = 10mV_{PP}
CMRR	Frequency	$V_{SENSE+(AC)}$ = 10mV_{PP}

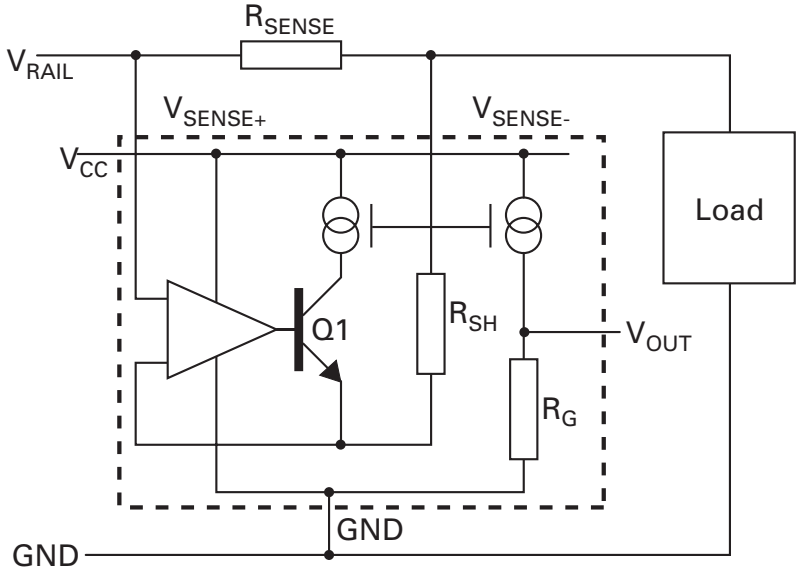
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Application information

The ZXCT1051 is Zetex' first current monitor with 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 ZXCT1051 draws very little current (<1µA) from the lines being sensed.

The separate V_{CC} pin enables the ZXCT1051 to be operated at sense line voltages down to 0V, where the ZXCT1021 would switch off. This feature enables the ZXCT1051 to be used to sense the currents flowing through lines that have been shorted to ground and is Zetex' first current monitor to do this.



Basic operation

Load current from V_{IN} is drawn through R_{SENSE} developing a voltage V_{SENSE} across the ZXCT1051.

The internal amplifier forces V_{SENSE} across internal resistance R_{SH} causing a current to flow through transistor Q1. This current is then converted to a voltage by R_G. A ratio of 10:1 between R_{SH} and R_G creates the fixed gain of 10 with an output impedance equal to R_G (see electrical characteristics for output current-voltage characteristics).

The gain equation of the ZXCT1051 is:

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

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 V_{SENSE}- pin and the load.

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

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The ZXCT1051 has been designed to allow it to operate from supplies (V_{CC}) ranging from 2.7V to 20V while sensing common mode signals from 0V up to V_{CC} -2V.

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 ZXCT1051 has been designed to operate with V_{SENSE} of the order of 50mV to 150mV.

Due to the very nature of current monitors they tend to saturate at very low sense voltages. This is due to them being operated from single supply and that the basic configuration is that of a unipolar voltage to current to voltage converter. The internal amplifiers at the heart of the current monitor may well have a bipolar offset voltage but the output cannot go negative.

For this reason the ZXCT1051 has been designed 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.

The device has a fixed DC voltage gain of 10; no external scaling resistors are required for the output. Output voltage is simply defined as:

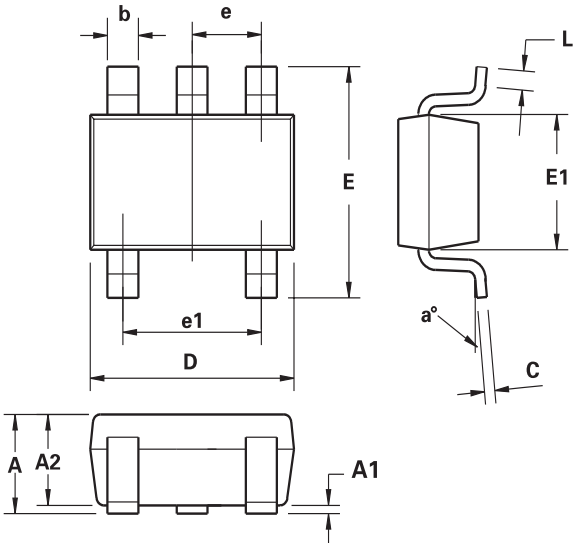
$$V_{OUT} = \text{gain} \times V_{SENSE} \text{ (V)}$$

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Packaging 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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