ZETEX SEMICONDUCTORS

ZXCT1041
Bidirectional precision high-side current monitor

Description

The ZXCT1041 is a bidirectional precision high-side current sense monitor. The output voltage is proportional to the differential input voltage. Direction of current flow is indicated by the Flag pin.

The ZXCT1041 provides a fixed gain of 10 for applications where minimal sense voltage is required.

The very low offset voltage enables a typical accuracy of 2% for sense voltages of only 10mV, giving better tolerances for small sense resistors necessary at higher currents.

The wide input voltage range of 18V down to as low as 2.7V make it suitable for a range of applications.

A minimum operating current of just 40μA, combined with a SOT23-5 package makes this part suitable for portable battery equipment.

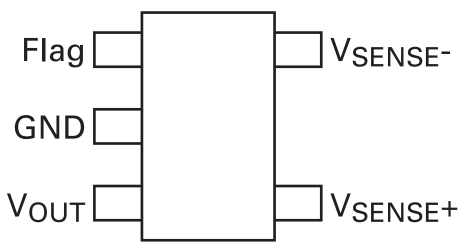
Features

- Bidirectional high side measurement
- Output voltage scaling x10
- 2.7V to 20V high side voltage
- 35μA quiescent current
- 1% typical accuracy
- SOT23-5 package

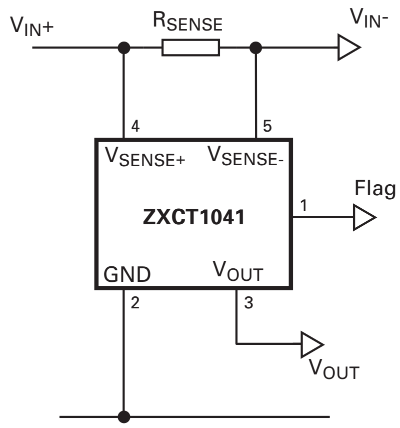
Applications

- Battery management
- Over current monitor
- Battery gas gauging
- Motor control

Pin connections



Typical application circuit



Ordering information

Order code	Package	Partmark	Reel size (inches)	Tape width (mm)	Quantity per reel
ZXCT1041E5TA	SOT23-5	1041	7	8	3000

Absolute maximum ratings

Voltage on V_{SENSE-} and V_{SENSE+}	-0.6 to 20V
Voltage on all other pins	-0.6V to (V_{SENSE+}/ V_{SENSE-}) +0.6V
Vsense [(V_{SENSE}+) - (V_{SENSE}-)]	+/-6V
Operating temperature, T_A	-40 to 125°C
Storage temperature	-55 to 150°C
Maximum junction temperature, T_J	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
$V_{SENSE\pm}$	Common-mode sense input range	2.7	20	V
Flag	Current direction flag output	0	$V_{SENSE\pm}$	V
V_{SENSE}	Differential sense input voltage range	0	±0.8	V
V_{OUT}	Output voltage range	0	$V_{SENSE\pm}$ -1.5	V
T_A	Ambient temperature range	-40	125	°C

Pin function table

Pin	Name	Description
1	Flag	This is the current direction pin. It is open collector and allows the logic high level to be set independent of V_{SENSE+} voltage. Low indicates V_{SENSE+} is greater than V_{SENSE-}
2	GND	Ground pin
3	OUT	Output voltage pin
4	V_{SENSE+}	This is the positive input of the current monitor. It also acts as the supply voltage pin providing current for internal circuitry. The current through this pin varies with differential sense voltage
5	V_{SENSE-}	This is the negative input of the current monitor. The current through this pin varies with differential sense voltage

Electrical characteristics

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

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
I_Q	Ground pin current		15	35	50	μA
$I_{SENSE}+$	$V_{SENSE}+$ input current	V_{SENSE} = 0V	10	17	24	μA
$I_{SENSE}-$	$V_{SENSE}-$ input current	V_{SENSE} = 0V	10	17	24	μA
V_{OUT}	Output voltage [flag high]	V_{SENSE} = +150mV	1.55	1.5	1.45	V
		V_{SENSE} = +100mV	1.02	1	0.98	V
		V_{SENSE} = +30mV	309	300	291	mV
		V_{SENSE} = 0V	0		15	mV
	[flag low]	V_{SENSE} = -30mV	285	300	315	mV
		V_{SENSE} = -100mV	0.95	1	1.05	V
		V_{SENSE} = -150mV	1.42	1.50	1.58	V
V_{OUT} TC	V_{OUT} variation with temperature	V_{SENSE} = ±100mV		30		ppm/°C
Gain	V_{OUT}/V_{SENSE}			10		
Accuracy	Total output error (Gain + offset)	V_{SENSE} = 100mV	-2		2	%
Accuracy	Total output error (Gain + offset)	V_{SENSE} = -100mV	-5		5	%
BW	Bandwidth	$V_{SENSE(DC)}$ = 100mV $V_{SENSE(AC)}$ = 63mV$_{PP}$		300		kHz
CMRR	V_{SENSE+} common mode rejection ratio	V_{IN} = 2.7 to 20V	TBD	60		dB
Flag TP	Flag trip point	Referred to V_{SENSE}	-2.5		+2.5	mV
V_{FL}	Flag low output voltage	I_{SINK} = 100μA		60	200	mV
I_{FH}	Flag high leakage current	V_{OH} = 5V			1	μA

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

Typical characteristics

$V_{SENSE}+$ = 10V, V_{SENSE} = 100mV, TA = 25°C unless otherwise stated

Y-axis	X-axis	Conditions
V_{OUT}	V_{SENSE}	T_A = -40°C, 0°C, 25°C, 85°C, 125°C. V_{SENSE+} = 10V and 3.6V
V_{OUT}	T_A	V_{SENSE} = 10mV, 30mV, 100mV. V_{SENSE+} = 10V and 3.6V
V_{OUT}	V_{SENSE+}	T_A = -40°C, 0°C, 25°C, 85°C, 125°C. $V_{SENSE}+$ = 100mV and -100mV. V_{SENSE+} swept from 0 to 20V
V_{OUT}	V_{SENSE+}	V_{SENSE+} = 100mV and -100mV. T_A = 0°C, 25°C and 85°C V_{SENSE+} zoomed in 2.6V to 4.2V
Error	+ve V_{SENSE}	T_A = -40°C, 0°C, 25°C, 85°C, 125°C
Error	-ve V_{SENSE}	T_A = -40°C, 0°C, 25°C, 85°C, 125°C
V_{OUT}	V_{SENSE+}	V_{SENSE} = ±10mV, ±0.1, ±0.2, ±0.4, ±0.5V. V_{SENSE+} = 10V and 3.6V
I_{SENSE+}	V_{SENSE}	T_A = -40°C, 25°C, 85°C, 125°C. V_{SENSE+} = 10V and 3.6V
I_{SENSE+}	V_{SENSE+}	T_A = -40°C, 25°C, 85°C, 125°C. V_{SENSE} = 0
I_{SENSE-}	V_{SENSE}	T_A = -40°C, 25°C, 85°C, 125°C. V_{SENSE+} = 10V and 3.6V
I_{SENSE-}	V_{SENSE+}	T_A = -40°C, 25°C, 85°C, 125°C. V_{SENSE} = 0
Diff gain	V_{SENSE}	V_{SENSE+} = 10V and 3.6V. T_A = -40°C, 25°C, 85°C, 125°C
V_{OUT}	I_{OUT}	T_A = -40°C, 0°C, 25°C, 85°C, 125°C. V_{SENSE+} = 10V and 3.6V. V_{SENSE} = ±100mV
Flag	V_{SENSE}	T_A = -40°C, 25°C, 85°C, 125°C. V_{SENSE+} = 10V and 3.6V V_{SENSE} swept over ±5mV
AC and transients		
Small signal bandwidth	Frequency	T_A = -40°C, 25°C, 85°C, 125°C. V_{SENSE+} = 10V and 3.6V $V_{SENSE(DC)}$ = 10mV and 100mV. $V_{SENSE(AC)}$ = 10mV_{PP}
CMRR	Frequency	T_A = -40°C, 25°C, 85°C, 125°C. $V_{SENSE+(DC)}$ = 10V and 3.6V. $V_{SENSE+(AC)}$ = 10$mV_{PP.}$ $V_{SENSE(DC)}$ = 10mV and 100mV
Large signal	time	V_{SENSE} = 0 to 200mV to 0
		V_{SENSE} = 0 to -200mV to 0
		V_{SENSE} = 200mV to -200mV to 200mV
Small signal	Time	V_{SENSE} = 0 to 20mV to 0
		V_{SENSE} = 0 to -20mV to 0
		V_{SENSE} = 20mV to -20mV to 20mV
Flag	Time	V_{SENSE} = 200mV to -200mV to 200mV
		V_{SENSE} = 20mV to -20mV to 20mV

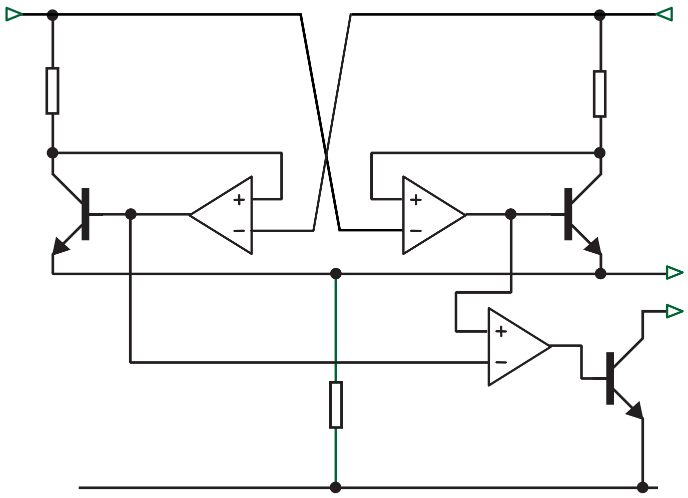
Application information

The ZXCT1041 uses two current monitors in anti-parallel to provide bidirectional current measurement. The integrated resistors while having a broad actual value variance provide very good matching to one another; this provides very tight gain matching from forward current measurement to reverse current management and removes the need to trim the resistor values.

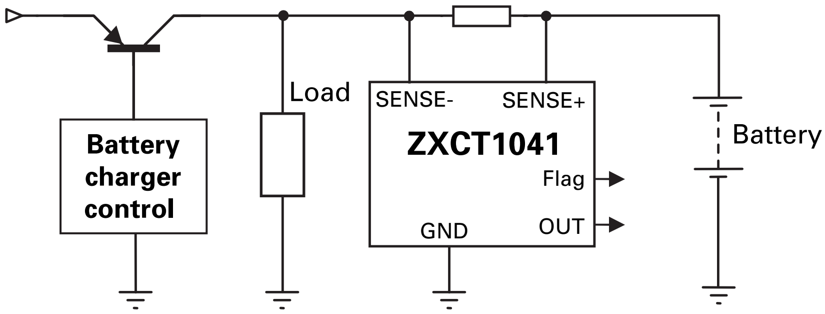
The internal transconductance setting resistors have a nominal value of 1.5kΩ thereby setting the internal transconductance to 1mA/V of V_{SENSE}. The outputs of both current monitors (current) are summed into an internal common gain-setting resistor of 15kΩ. This sets the overall gain to 10 which has a very small variance due to the very good matching of internal transistors.

To improve accuracy the offset of amplifier 1 is trimmed.

The direction of measured current flow is determined by comparing the voltages applied to the bases of transconductance transistors (Q1 and Q2). For maximum versatility the flag output uses an open collector; this allows the ZXCT1041 to monitor rails at a much higher potential than what the flag output is interfacing to.



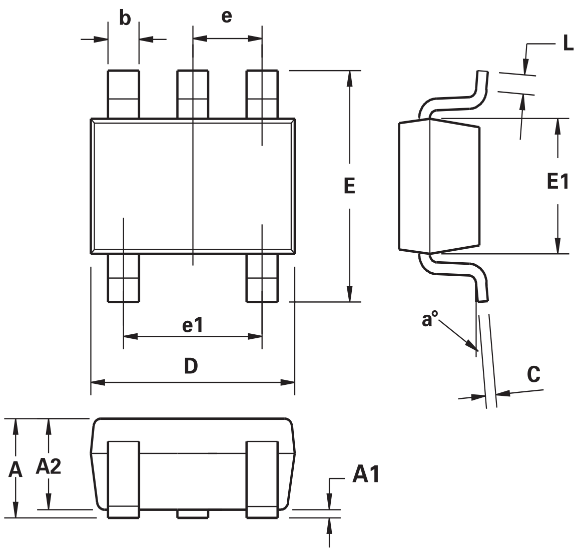
A common application for micro-power current monitors is measuring the discharge current of a rechargeable lithium ion/polymer battery. The ZXCT1041 enables measuring both the charge and discharge current into the battery and with its wide operating voltage of 2.5 to 20V enables it to measure the currents in to/ out of up to 4 cells connected in series.



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 ZXCT1041 has been designed to operate with VSENSE of the order of 50mV to 150mV.

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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