AUTOMOTIVE GRADE 60/40V HIGH-SIDE CURRENT MONITOR

Description

The ZXCT1080Q and ZXCT1081Q are high-side current sense monitors with a voltage output and a fixed gain of 10. Using this device eliminates the need to disrupt the ground plane when sensing a load current.

The wide input voltage range of 60V and 40V, respectively, down to as low as 3V makes it suitable for a range of automotive applications with 60V and 40V load dump withstand capabilities.

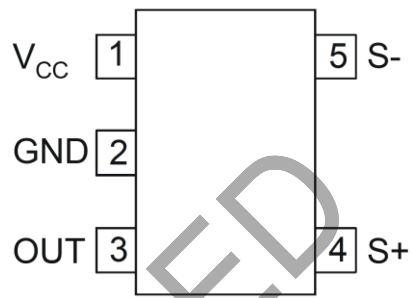
The separate supply pin (V_{CC}) allows the device to continue functioning under short-circuit conditions.

The ZXCT1080Q and ZXCT1081Q have an extended ambient operating temperature range of -40°C to +125°C, enabling it to be used in a wide range of automotive applications.

The ZXCT1080Q and ZXCT1081Q have been qualified to AEC-Q100 Grade 1 and are Automotive Grade supporting PPAPs.

Pin Assignments

(Top View)



SOT25

Features

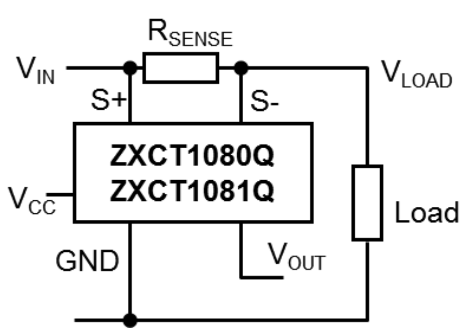
- Accurate high-side current sensing
  - ZXCT1080Q: 3V to 60V continuous high-side voltage
  - ZXCT1081Q: 3V to 40V continuous high-side voltage
- -40°C to +125°C temperature range
- Output voltage scaling x10
- 4.5V to 12V V_{CC} range
- Low quiescent current:
  - 80µA supply pin
  - 27µA I_{S+}
- Green Molding in SOT25
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. “Green” Device (Note 3)**
- **The ZXCT1080Q and ZXCT1081Q are suitable for automotive applications requiring specific change control; these parts are AEC-Q100 qualified, PPAP capable, and manufactured in IATF16949 certified facilities. https://www.diodes.com/quality/product-definitions/**

Applications

- Automotive current measurement
- Battery management
- Overcurrent measurement

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated’s definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Typical Application Circuit



Pin Descriptions

Pin Number	Pin Name	Function		
		Common	ZXCT1080Q	ZXCT1081Q
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	S+	This is the positive input of the current monitor. The current through this pin varies with differential sense voltage.	Input range from 60V down to 3V	Input range from 40V down to 3V
5	S-	This is the negative input of the current monitor.		

Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.) (Note 4)

Parameter		Rating	Unit
Continuous Voltage on S- and S+	ZXCT1080Q (Note 5)	-0.6 to 65	V
	ZXCT1081Q (Note 5)	-0.6 to 45	
Transient Voltage on S- and S+	ZXCT1081Q (Note 5)	-0.6 to 65	V
Voltage on All Other Pins		-0.6 to +14	V
Differential Sense Voltage, V_{SENSE} (Note 6)		800	mV
Operating Temperature		-40 to +125	°C
Storage Temperature		-55 to +150	°C
Maximum Junction Temperature		+125	°C
Package Power Dissipation (Note 7)		300 (@ T_A = +25°C)	mW
ESD Ratings			
HBM ESD	Human Body Model	1000	V
MM ESD	Machine Model	150	V
CDM ESD	Charged Device Model	TBD	V

Notes:
4. Stresses greater than those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to *Absolute Maximum Ratings* for extended periods can affect device reliability.
Semiconductor devices are ESD sensitive and may be damaged by exposure to ESD events. Suitable ESD precautions should be taken when handling and transporting these devices.
5. ZXCT1080Q has a maximum transient and continuous voltage of 65V on the S+ and S- pin. The ZXCT1081Q has a maximum continuous of 45V, it however can withstand transient up to 65V.
6. V_{SENSE} is defined as the differential voltage between S+ and S- pins.
7. Assumes θ_{JA} = 420°C/W.

Recommended Operating Conditions

Symbol	Parameter		Min	Max	Units
V_{IN}	Common-Mode Sense+ Input Range	ZXCT1080Q	3	60	V
		ZXCT1081Q		40	
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 (Note 8)		0	1.5	V
T_A	Ambient Temperature Range		-40	+125	°C

Note: 8. Based on 10x V_{SENSE}.

Electrical Characteristics (@ V_{IN} = V_{S+} = 12V, V_{CC} = 5V, V_{SENSE} (Note 9) = 100mV, T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Conditions		T_A	Min	Typ	Max	Unit
I_{CC}	V_{CC} Supply Current	V_{CC} = 12V V_{SENSE} = 0V	ZXCT1080Q ZXCT1081Q	+25°C	40	80	120	µA
			ZXCT1080Q	Full range	—	—	145	
I_{S+}	S+ Input Current	V_{SENSE} = 0V	ZXCT1080Q	+25°C	15	27	42	µA
			ZXCT1081Q		15	30	60	
			ZXCT1080Q	Full range	—	—	60	
I_{S-}	S- Input Current	V_{SENSE} = 0V	ZXCT1080Q	+25°C	15	40	80	nA
			ZXCT1081Q		10			
$V_{O(0)}$	Zero V_{SENSE} Error (Note 10)		ZXCT1080Q ZXCT1081Q	+25°C	0	—	35	mV
$V_{O(10)}$	Output Offset Voltage (Note 11)	V_{SENSE} = 10mV	ZXCT1080Q	+25°C	-25	—	+25	mV
			ZXCT1081Q		-30		+30	
			ZXCT1080Q	Full range	-55	—	+55	
Gain	$\Delta V_{OUT}/\Delta V_{SENSE}$	V_{SENSE} = 10mV to 150mV	ZXCT1080Q	+25°C	9.9	10	10.1	V/V
			ZXCT1081Q		9.95		10.05	
			ZXCT1080Q	Full range	9.8	—	10.2	
V_{OUT} TC	V_{OUT} Variation with Temperature	—		—	—	30	—	ppm/°C
A_{CC}	Total Output Error	—		—	-3	—	3	%
I_{OH}	Output Source Current	ΔV_{OUT} = -30Mv		—	—	1	—	mA
I_{OL}	Output Sink Current	ΔV_{OUT} = +30mV		—	—	20	—	µA
PSRR	V_{CC} Supply Rejection Ration	V_{CC} = 4.5V to 12V		—	54	60	—	dB
CMRR	Common-Mode Sense Rejection Ratio	V_{S+} = 60V to 3V	ZXCT1080Q	—	68	80	—	dB
		V_{S+} = 40V to 3V	ZXCT1081Q		60	75		
BW	-3dB Small-Signal Bandwidth	$V_{SENSE (AC)}$ = 10mVpp		—	—	500	—	kHz

Notes:
9. V_{SENSE} = "V_{S+}" - "V_{S-}".
10. The ZXCT1080Q/81Q operates from a positive power rail and the internal voltage-current converter current flow is uni-directional; these result in the output offset voltage for V_{SENSE} = 0V always being positive.
11. For V_{SENSE} > 10mV, 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>.

Typical Characteristics (@ V_{IN} = 12V, V_{CC} = 5V, V_{SENSE+} = 12V, V_{SENSE} = 100mV, T_A = +25°C, unless otherwise specified.)

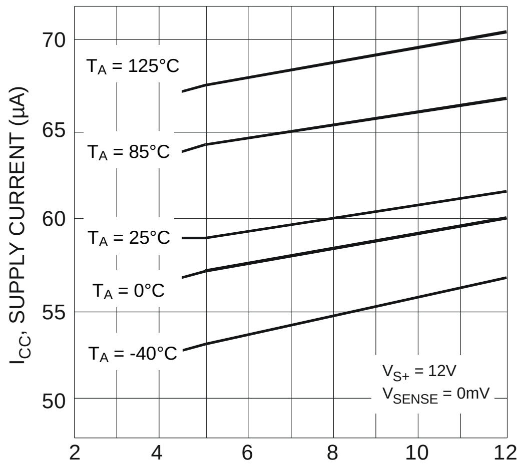


Fig. 1 Supply Current

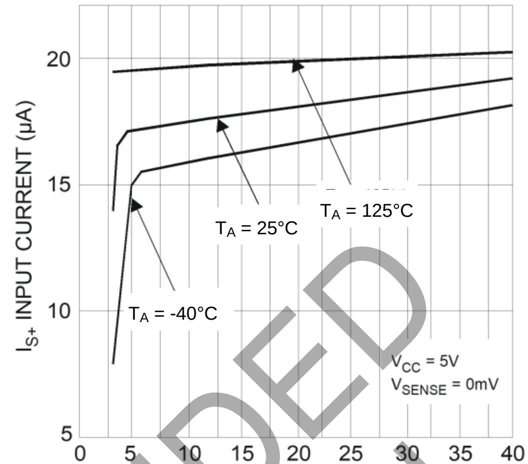


Fig. 2 Input Current

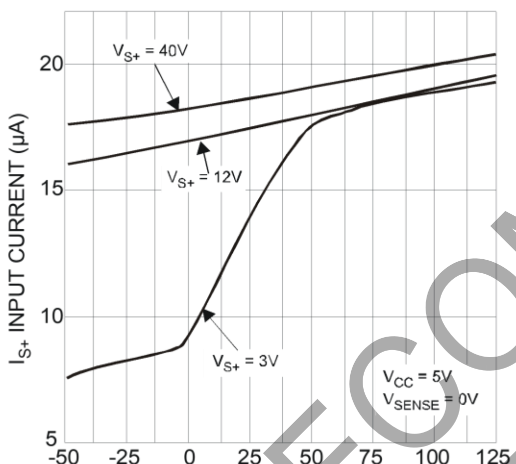


Fig. 3 Input Current

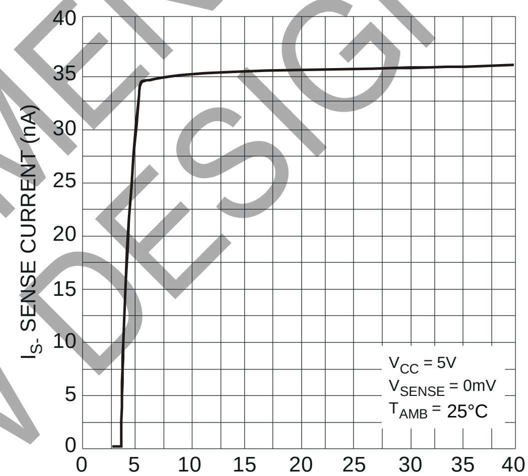


Fig. 4 Sense Current

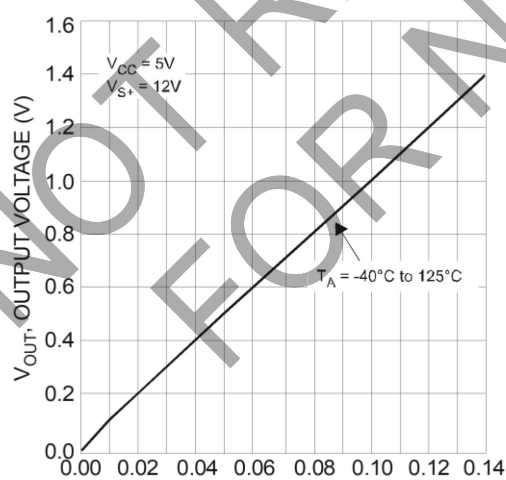


Fig. 5 Output Voltage

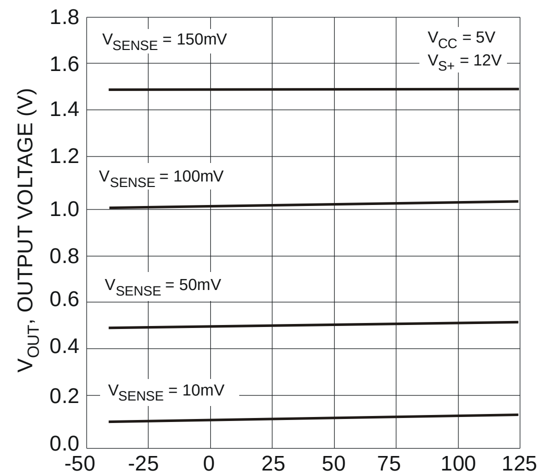


Fig. 6 Output Voltage

Typical Characteristics (continued) (@ V_{IN} = 12V, V_{CC} = 5V, V_{SENSE+} = 12V, V_{SENSE} = 100mV, T_A = +25°C, unless otherwise specified.)

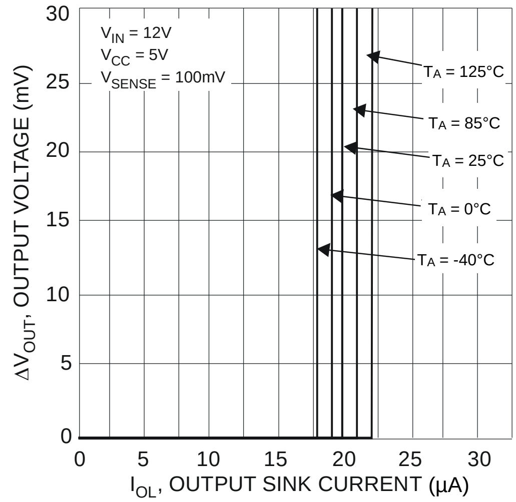


Fig. 7 Output Current Sink

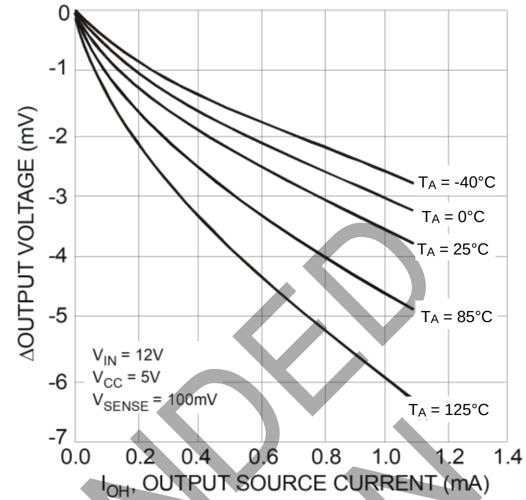


Fig. 8 Output Current Source

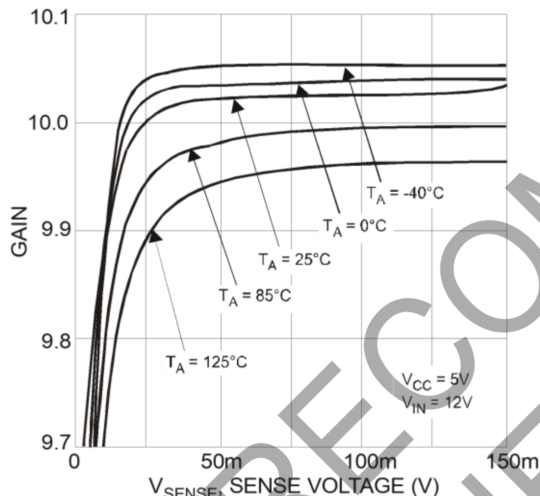


Fig. 9 Differential gain

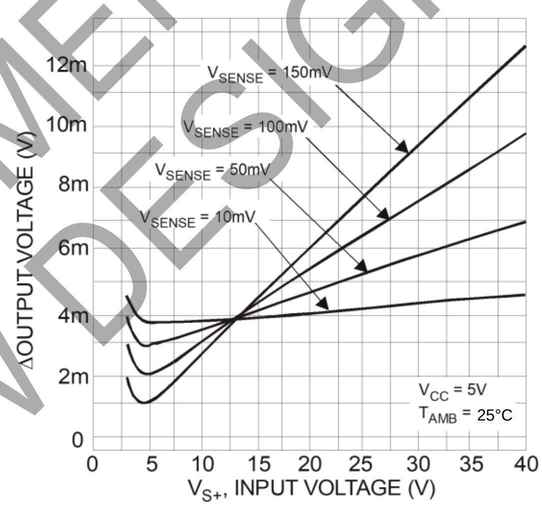


Fig. 10 Output Voltage

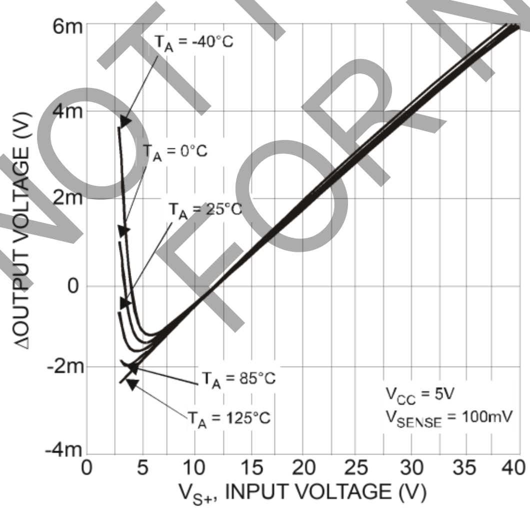


Fig. 11 Output Voltage

Typical Characteristics (continued) (@ V_{IN} = 12V, V_{CC} = 5V, V_{SENSE+} = 12V, V_{SENSE} = 100mV, T_A = +25°C, unless otherwise specified.)

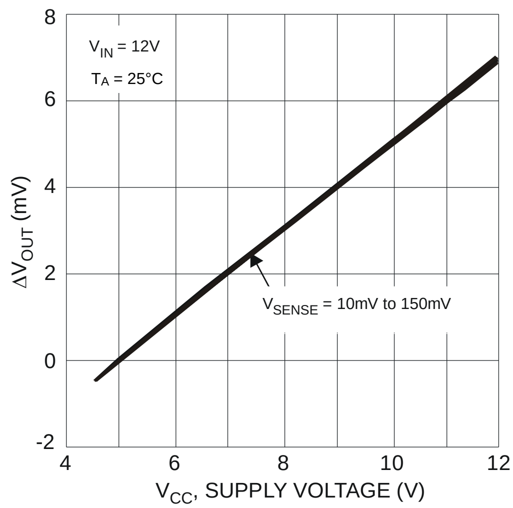


Fig. 12 Normalized Output Voltage

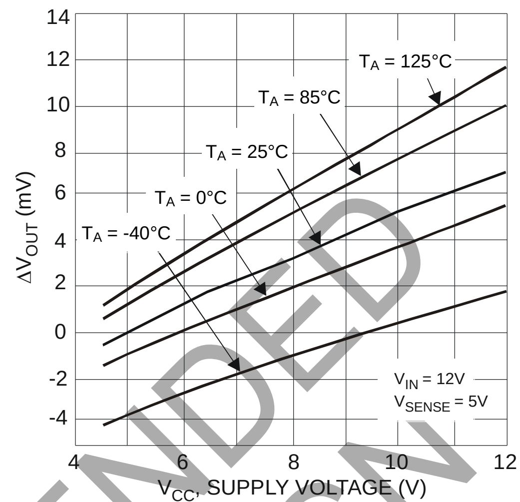


Fig. 13 Normalized Output Voltage

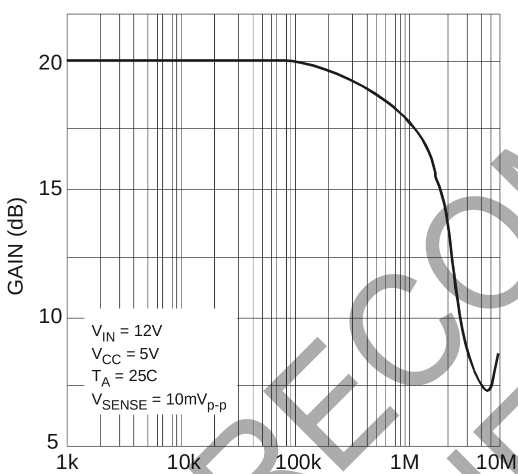


Fig. 14 Small Signal Bandwidth

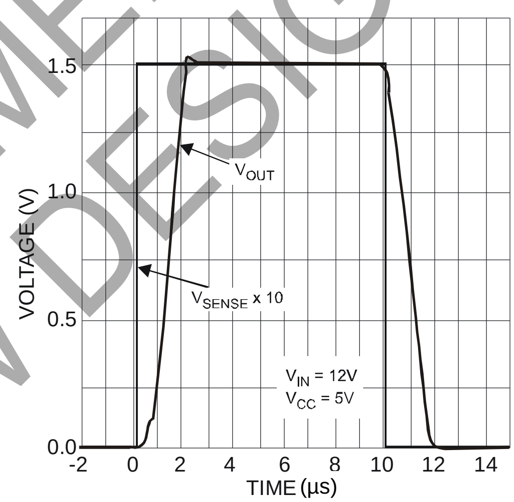


Fig. 15 Large Signal Pulse Response

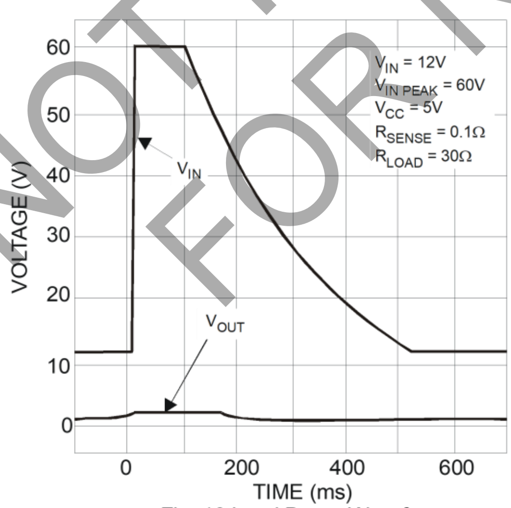


Fig. 16 Load Dump Waveform

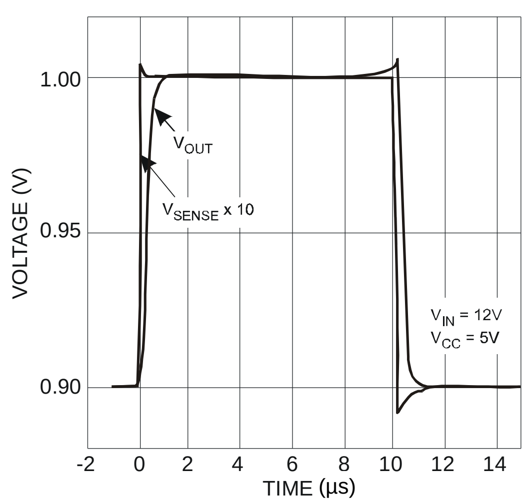


Fig. 17 Small Signal Pulse Response

Typical Characteristics (continued) (@ V_{IN} = 12V, V_{CC} = 5V, V_{SENSE+} = 12V, V_{SENSE} = 100mV, T_A = +25°C, unless otherwise specified.)

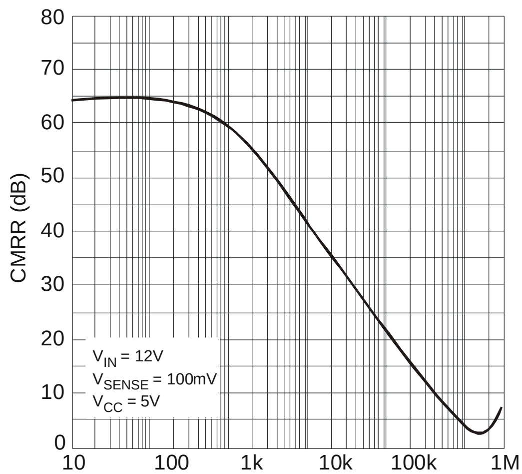


Fig. 18 Common Mode Rejection

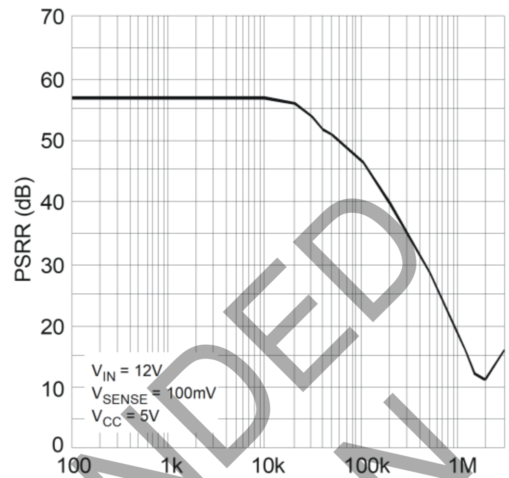


Fig. 19 Supply Rejection

Application Information

The ZXCT1080Q and ZXCT1081Q have been designed to allow them to operate with 5V supply rails while sensing common mode signals up to 60V and 40V respectively. This makes it well suited to a wide range of current measuring/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+.

Fig. 20 shows the basic configuration of the ZXCT1080Q and ZXCT1081Q.

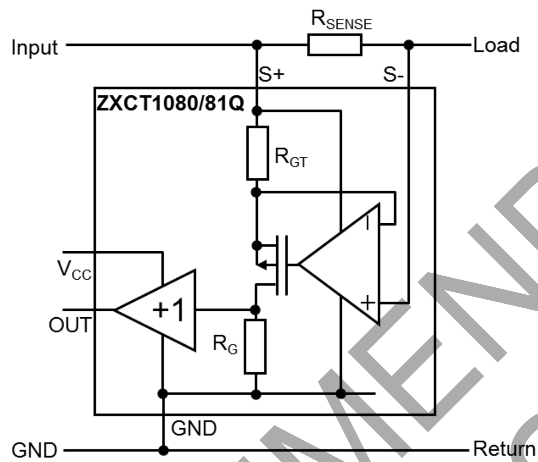


Fig. 20 Typical Configuration of ZXCT1080Q/81Q

Load current from the input is drawn through R_{SENSE} developing a voltage V_{SENSE} across the inputs of the ZXCT1080Q/81Q.

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 ZXCT1080Q and ZXCT1081Q 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 (see Fig. 21); typical value is of the order of 10k.

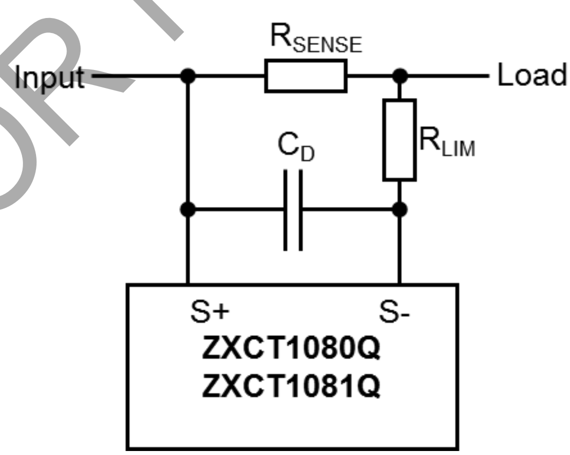


Fig. 21 Protection/Error Sources for ZXCT1080Q/81Q

Capacitor C_D provides high frequency transient decoupling when used with R_{LIM}; typical values are of the order 10pF.

Application Information (continued)

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 ZXCT1080Q/81Q 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 ZXCT1080Q/81Q 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.

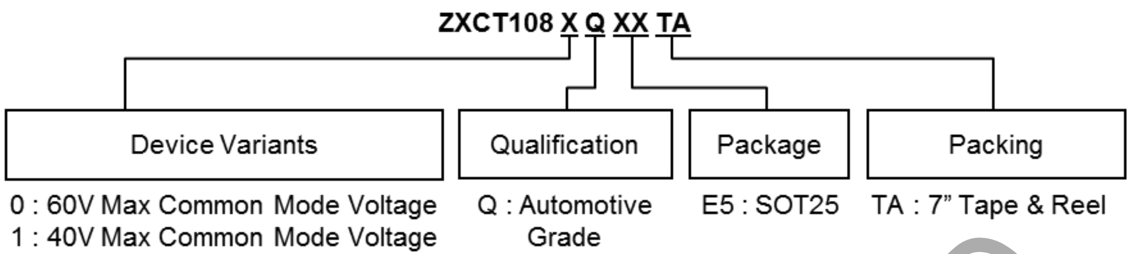
It is for this very reason that Diodes Incorporated has specified an input offset voltage ($V_{O(10)}$) at 10mV. The output voltage for any V_{SENSE} voltage from 10mV to 150mV can be calculated as follows:

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

Alternatively the load current can be expressed as:

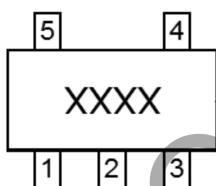
$$I_L = \frac{(V_{OUT} - V_{O(10)})}{G x R_{SENSE}}$$

Ordering Information



Orderable Part Number	Package	Package Code	Identification Code	Tape Width (mm)	Packing	
					Qty.	Carrier
ZXCT1080QE5TA	SOT25	E5	1080	8	3000	7” Tape & Reel
ZXCT1081QE5TA	SOT25	E5	1081	8	3000	7” Tape & Reel

Marking Information

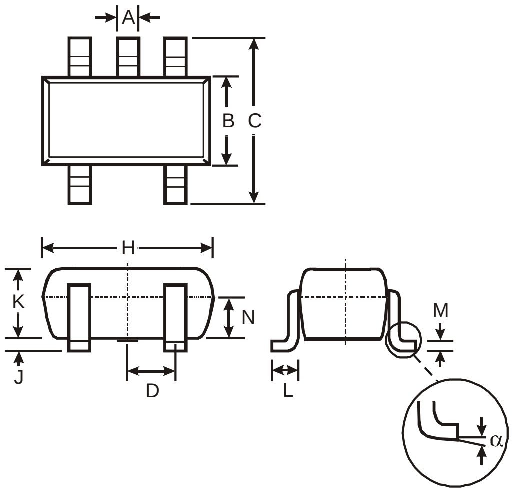


XXXX: Identification Code

Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT25

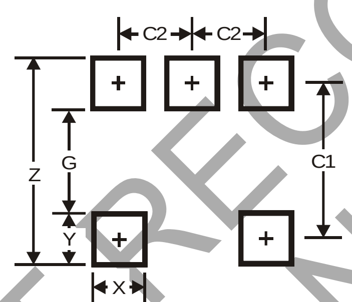


SOT25			
Dim	**Min**	**Max**	**Typ**
A	0.35	0.50	0.38
B	1.50	1.70	1.60
C	2.70	3.00	2.80
D	—	—	0.95
H	2.90	3.10	3.00
J	0.013	0.10	0.05
K	1.00	1.30	1.10
L	0.35	0.55	0.40
M	0.10	0.20	0.15
N	0.70	0.80	0.75
α	0°	8°	—
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT25



Dimensions	Value (in mm)
Z	3.20
G	1.60
X	0.55
Y	0.80
C1	2.40
C2	0.95

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