

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.

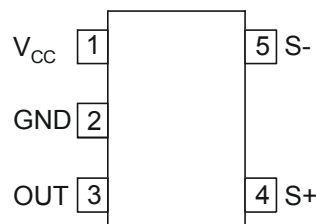
The wide input voltage range of 60V and 40V, respectively, down to as low as 3V make it suitable for a range of automotive applications with 60V and 40V load dump withstand capabilities.

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 including.

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

Pin Assignments



Features

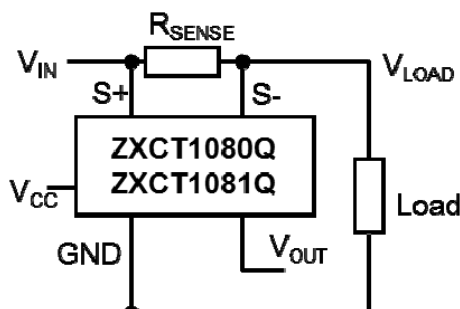
- Accurate high-side current sensing
 - ZXCT1080Q : 3V to 60V continuous high side voltage
 - ZXCT1081Q : 3V to 40V continuous high side voltage
- -40°C to $+125^{\circ}\text{C}$ temperature range
- Output voltage scaling x10
- 4.5V to 12V V_{CC} range
- Low quiescent current:
 - 80 μA supply pin
 - 27 μA I_{S+}
- Green Molding in SOT25
 - **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
 - **Halogen and Antimony Free. "Green" Device (Note 3)**
- Automotive Grade
 - **Qualified to AEC-Q100 Standards for High Reliability**
 - **PPAP Capable (Note 4)**

Applications

- Automotive current measurement
- Battery management
- Over-current measurement

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
 2. See http://www.diodes.com/quality/lead_free.html 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.
 4. Automotive products are AEC-Q100 qualified and are PPAP capable. Automotive, AEC-Q100 and standard products are electrically and thermally the same, except where specified. For more information, please refer to http://www.diodes.com/quality/product_compliance_definitions/.

Typical Application Circuit



Pin Descriptions

| Pin | Name | Function | | |
|-----|-----------------|---|---------------------------------|---------------------------------|
| | | Common | ZXCT1080Q | ZXCT1081Q |
| 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 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.)

| 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 |

Caution: Stresses greater than the 'Absolute Maximum Ratings' specified above, may cause permanent damage to the device. These are stress ratings only; functional operation of the device at conditions between maximum recommended operating conditions and absolute maximum ratings is not implied. Device reliability may be affected by exposure to absolute maximum rating conditions for extended periods of time.

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.

- Notes:
- ZXCT1080 has a maximum transient and continuous voltage of 65V on the S+ and S- pin. The ZXCT1081 has a maximum continuous of 45V, it however can withstand transient up to 65V.
 - V_{SENSE} is defined as the differential voltage between S+ and S- pins
 - Assumes $\theta_{JA} = 420^{\circ}\text{C/W}$

Recommended Operating Conditions

| Symbol | Parameter | Min | Max | Units |
|--------------------|--|-----|------|-------|
| V _{IN} | Common-mode Sense+ Input Range | 3 | 60 | V |
| | | | 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 6) = 100mV, $T_A = +25^\circ C$, unless otherwise specified.)

| Symbol | Parameter | Conditions | T_A | Min | Typ | Max | Units | |
|--------------|--------------------------------------|--------------------------------------|------------------------|------------|------|-----|---------|---------|
| 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 9) | | ZXCT1080Q ZXCT1081Q | +25°C | 0 | — | 35 | mV |
| $V_{O(10)}$ | Output Offset Voltage (Note 10) | $V_{SENSE} = 10mV$ | 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 | $\Delta V_{OUT} = -30mV$ | — | — | 1 | — | mA | |
| I_{OL} | Output Sink Current | $\Delta V_{OUT} = +30mV$ | — | — | 20 | — | μA | |
| PSRR | V_{CC} Supply Rejection Ratio | $V_{CC} = 4.5V$ 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 | $V_{SENSE (AC)} = 10mV_{pp}$ | — | — | 500 | — | kHz | |

- Notes: 6. $V_{SENSE} = "V_{S+}" - "V_{S-}"$
9. The ZXCT1080Q/81Q operates from a positive power rail and the internal voltage-current converter current flow is unidirectional; these result in the output offset voltage for $V_{SENSE} = 0V$ always being positive.
10. 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 (@ $V_{IN} = 12V$, $V_{CC} = 5V$, $V_{SENSE+} = 12V$, $V_{SENSE} = 100mV$, $T_A = +25^\circ C$, unless otherwise specified.)

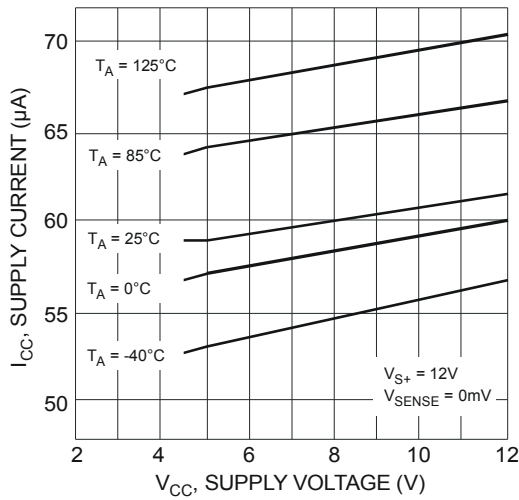


Fig. 1 Supply Current

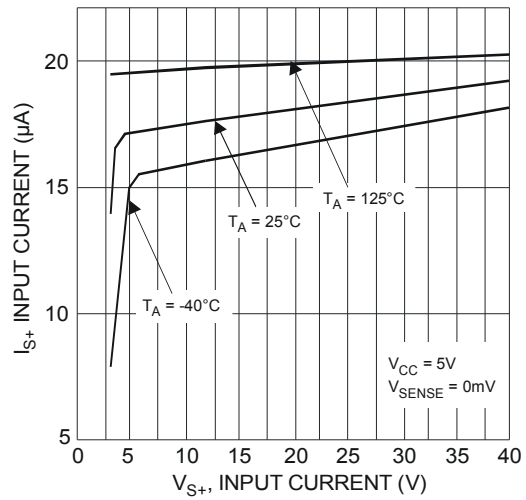


Fig. 2 Input Current

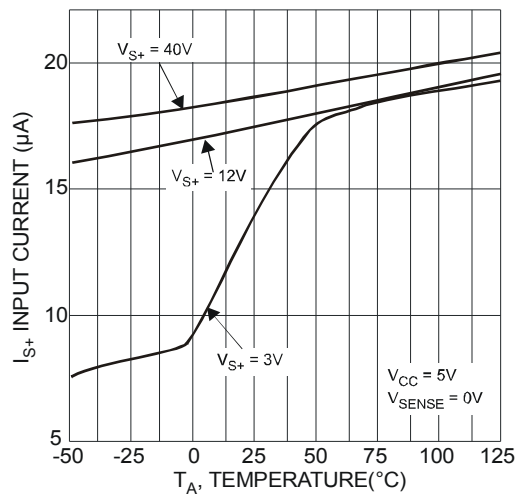


Fig. 3 Input Current

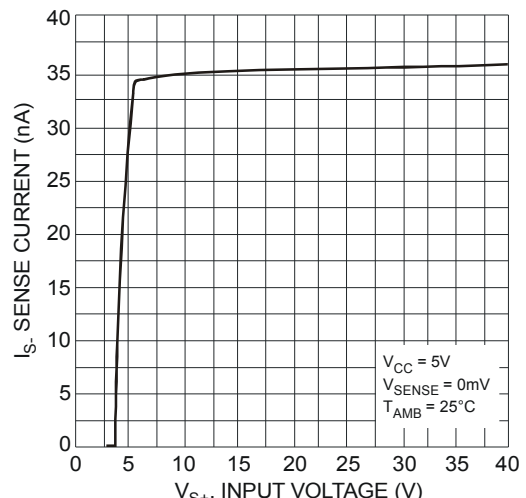


Fig. 4 Sense Current

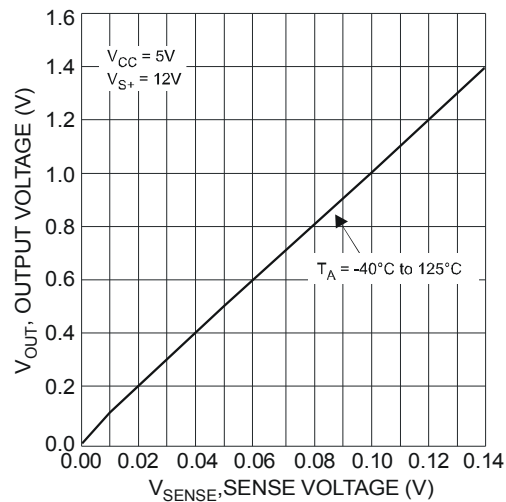


Fig. 5 Output Voltage

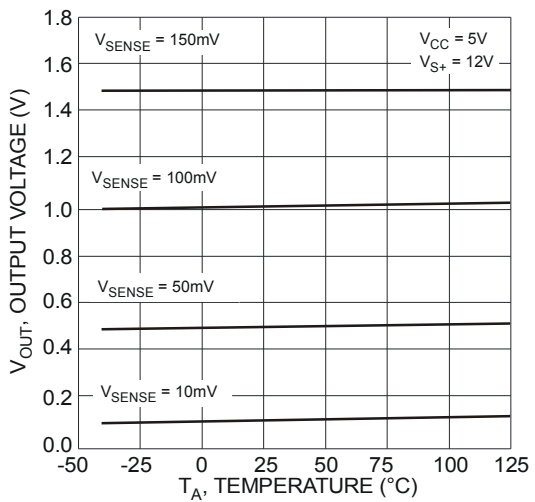


Fig. 6 Output Voltage

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

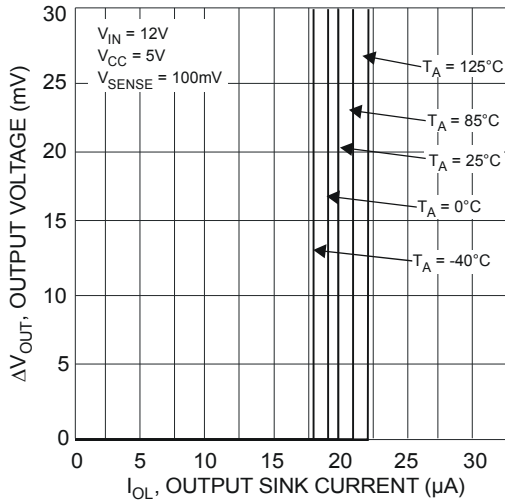


Fig. 7 Output Current Sink

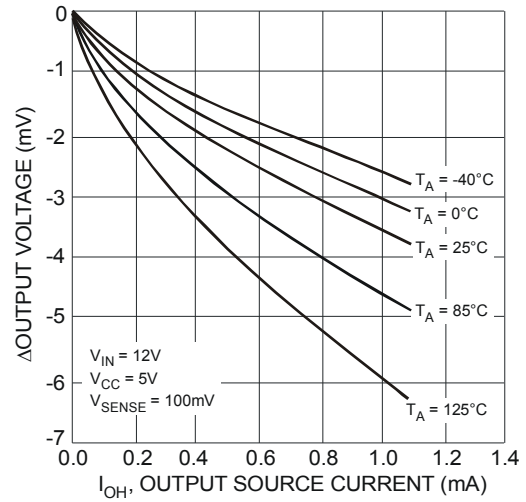


Fig. 8 Output Current Source

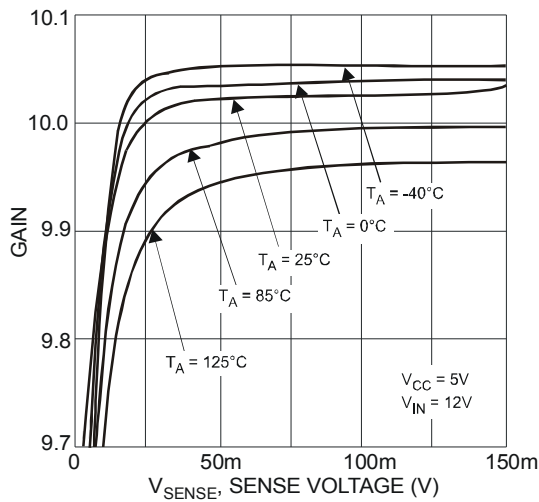


Fig. 9 Differential gain

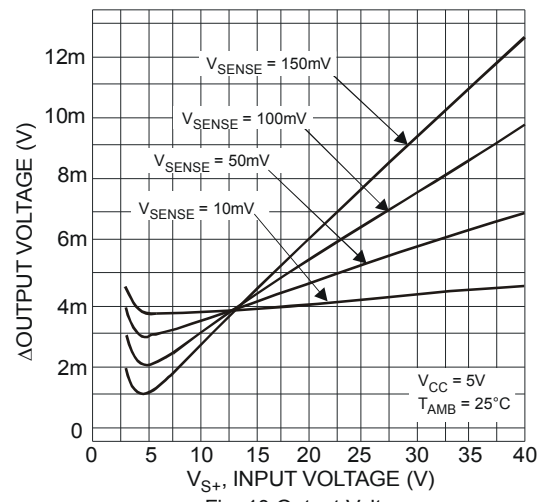


Fig. 10 Output Voltage

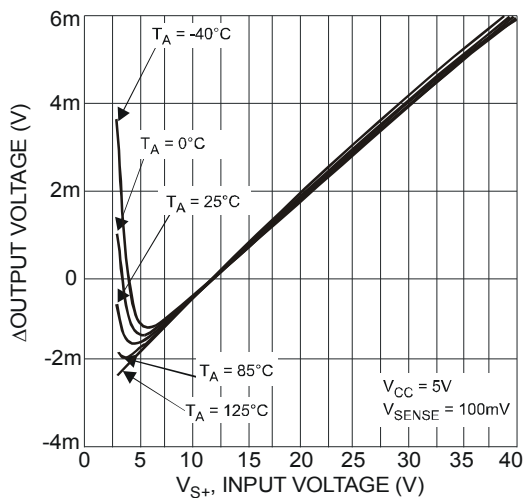


Fig. 11 Output Voltage

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

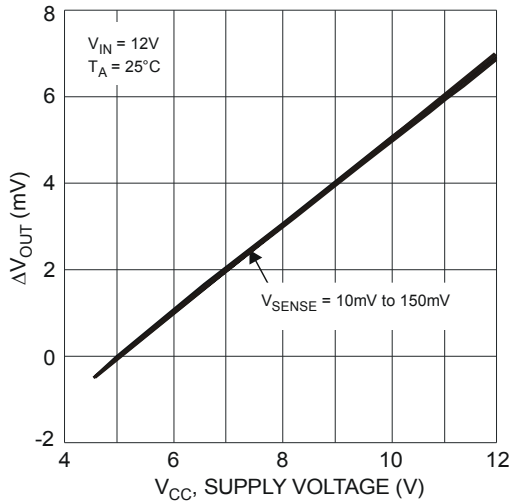


Fig. 12 Normalized Output Voltage

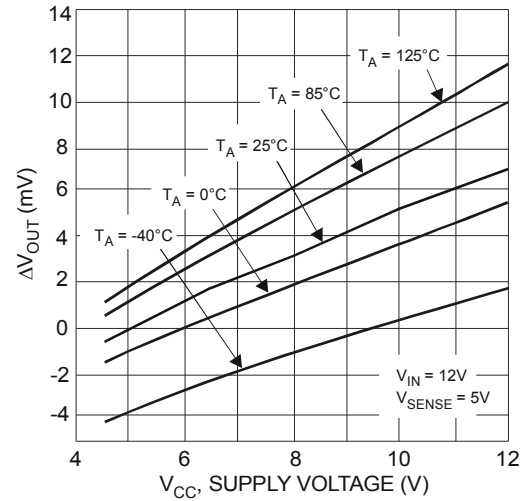


Fig. 13 Normalized Output Voltage

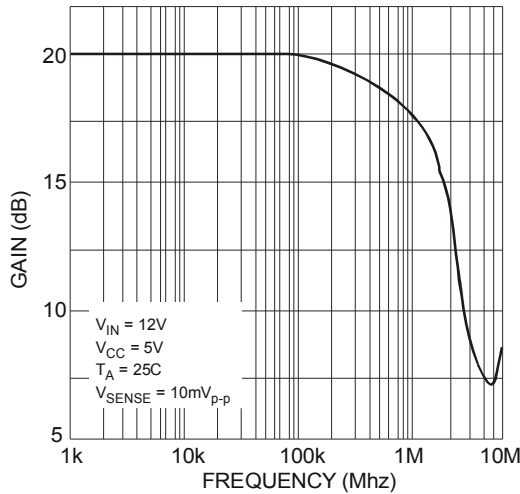


Fig. 14 Small Signal Bandwidth

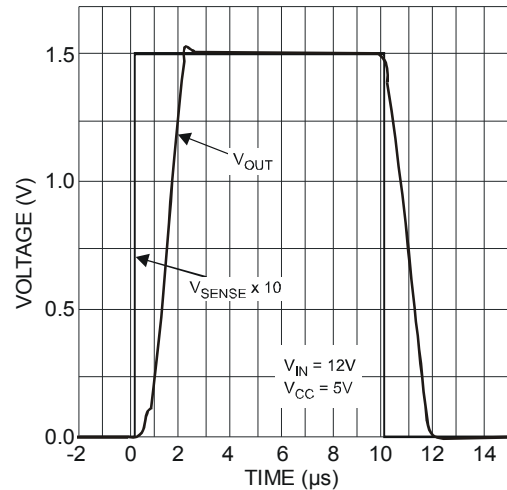


Fig. 15 Large Signal Pulse Response

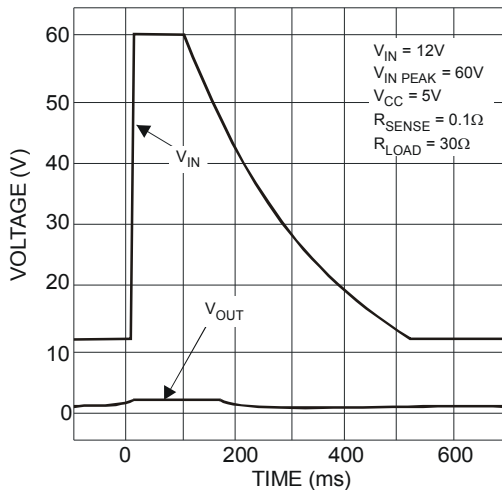


Fig. 16 Load Dump Waveform

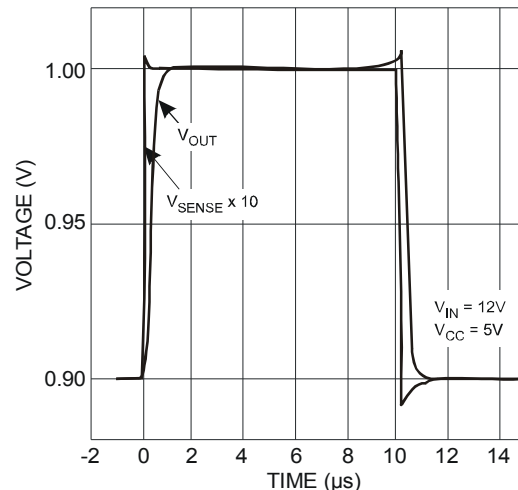


Fig. 17 Small Signal Pulse Response

Typical Characteristics (cont.) (@ $V_{IN} = 12V$, $V_{CC} = 5V$, $V_{SENSE+} = 12V$, $V_{SENSE-} = 100mV$, $T_A = +25^\circ C$, unless otherwise specified.)

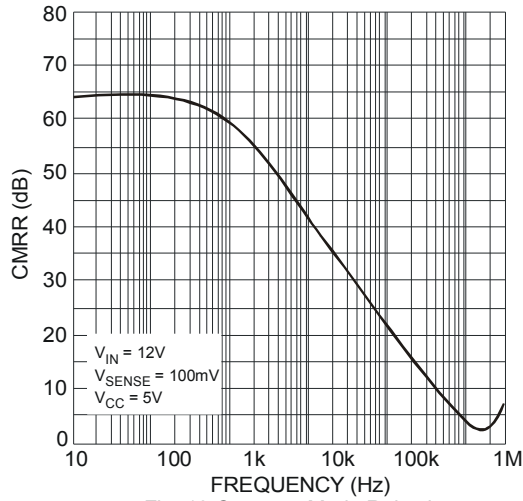


Fig. 18 Common Mode Rejection

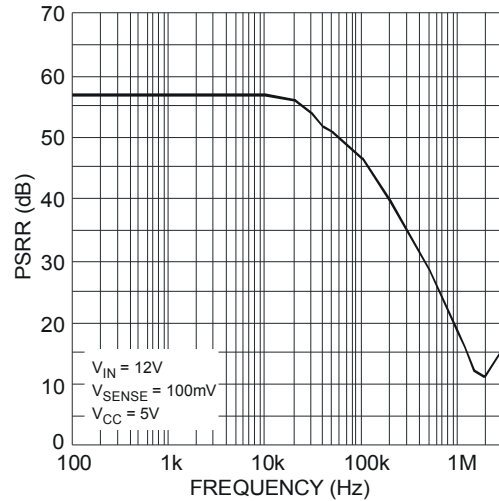


Fig. 19 Supply Rejection

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+.

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

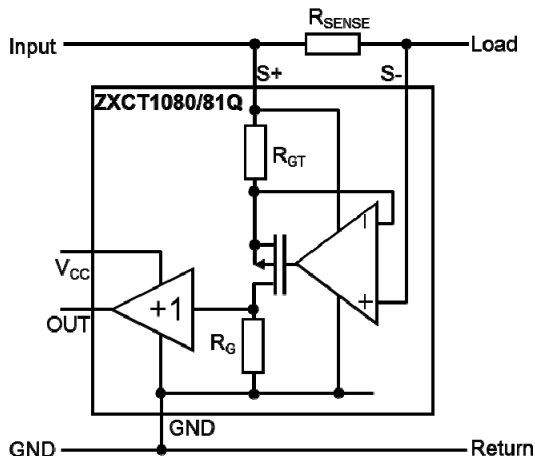


Fig. 20 Typical Configuration of ZXCT1080Q/81Q

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 figure 21); typical value is of the order of 10k.

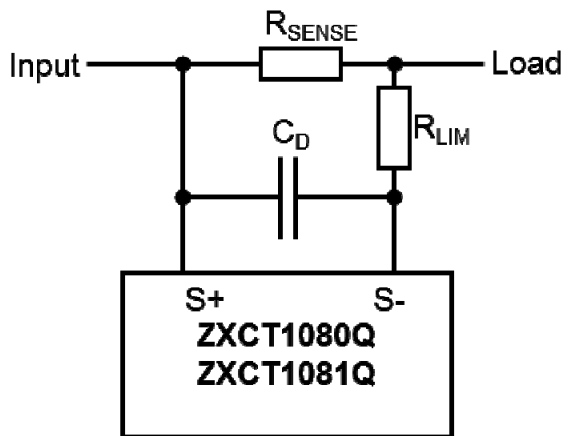


Fig. 21 Protection/Error Sources for ZXCT1080

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

Application Information (cont.)

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 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:

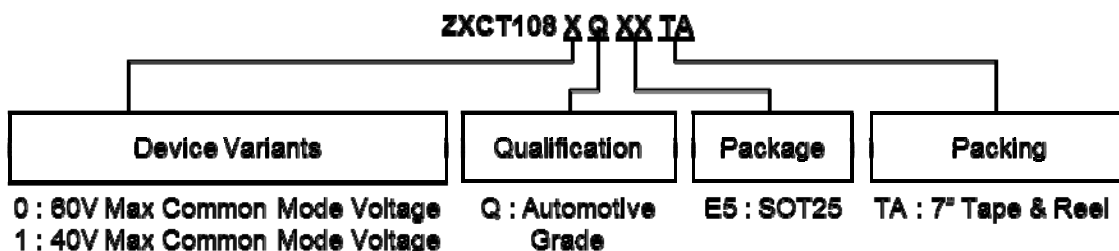
$$V_{OUT} = (V_{SENSE}) \times G + V_{(10)}$$

Alternatively the load current can be expressed as:

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

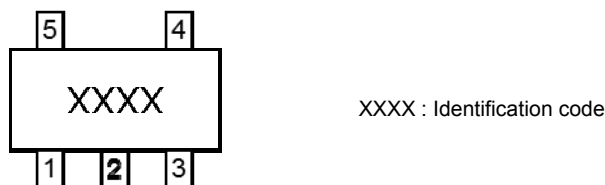
ZXCT1080Q/ ZXCT1081Q

Ordering Information



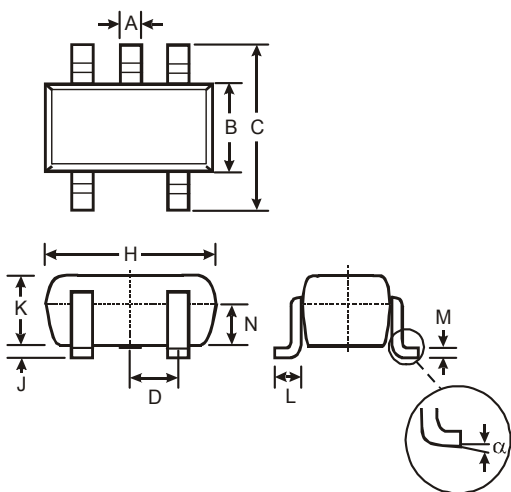
| Order Reference | Package | Package Code | Identification Code | Packing: 7" Tape and Reel | | | Qualification Grade |
|-----------------|---------|--------------|---------------------|---------------------------|------------|--------------------|---------------------|
| | | | | Quantity | Tape Width | Part Number Suffix | |
| ZXCT1080QE5TA | SOT25 | E5 | 1080 | 3000 | 8 | TA | Automotive Grade |
| ZXCT1081QE5TA | SOT25 | E5 | 1081 | 3000 | 8 | TA | Automotive Grade |

Marking Information



Package Outline Dimensions (All Dimensions in mm)

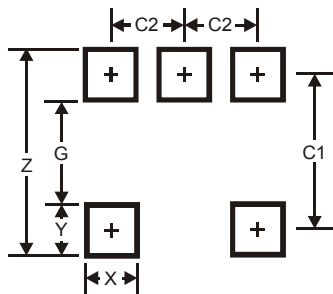
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.



| 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 (All Dimensions in mm)

Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for latest version.



| 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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