

## Description

The ZXCT180Q is automotive AEC-Q qualified uni-directional current shunt monitor which is designed to be a cost-effective solution to deal with 26V common-mode in a smaller supply voltage range 2.7V to 5.5V powering the device.

The ZXCT180Q supports the small-signal bandwidths as high as 400kHz at 20V/V gain and fast large-signal slew rates of 2V/ $\mu$ s. This ability can be used to detect rapid changes in the sensed current and fast response to the output so that these features make the ZXCT180Q a good choice for applications such as low-side motor control and the system fault current detection.

OUT pin is a voltage proportional to the load current. Based on OUT pin configurations, ZXCT180 has Pinout A and B as a flexibility for users to choose a proper one for PCB layout. In addition, this device has four fixed voltage gain options in 20V/V, 50V/V, 100V/V, and 200V/V. It can measure voltage across shunts at common-mode voltages from -0.3V to 26V, independent of supply voltage with a maximum supply current of 370 $\mu$ A. All versions are AEC-Q100 grade 1 temperature range, -40°C to +125°C, and are offered in the SOT25 package.

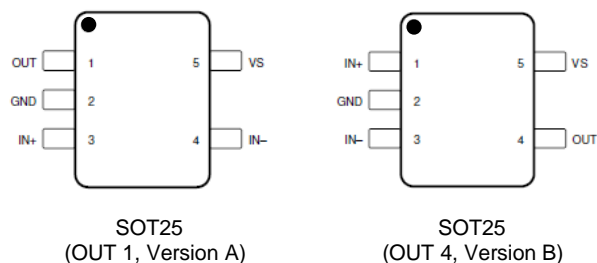
## Features

- Supply Voltage Range: 2.7V to 5.5V
- Wide Common-Mode Range: -0.3V to 26V
- Gain Error: (Maximum over Temperature):  $\pm$ 1%
- Choice of Gains:
  - Pinout A1 and B1: 20V/V
  - Pinout A2 and B2: 50V/V
  - Pinout A3 and B3: 100V/V
  - Pinout A4 and B4: 200V/V
- Low Offset Voltage: Typical  $\pm$ 100 $\mu$ V and 1- $\mu$ V/ $^{\circ}$ C Drift
- Rail-to-Rail Output Capability
- Low Quiescent Current: 370 $\mu$ A (max)
- Package: 5-Pin SOT25
- ESD Protection JESD 22, 5000V HBM (A114)
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **The ZXCT180Q is suitable for automotive applications requiring specific change control; this part is AEC-Q100 qualified, PPAP capable, and manufactured in IATF16949 certified facilities.**

<https://www.diodes.com/quality/product-definitions/>

- 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.

## Pin Assignments

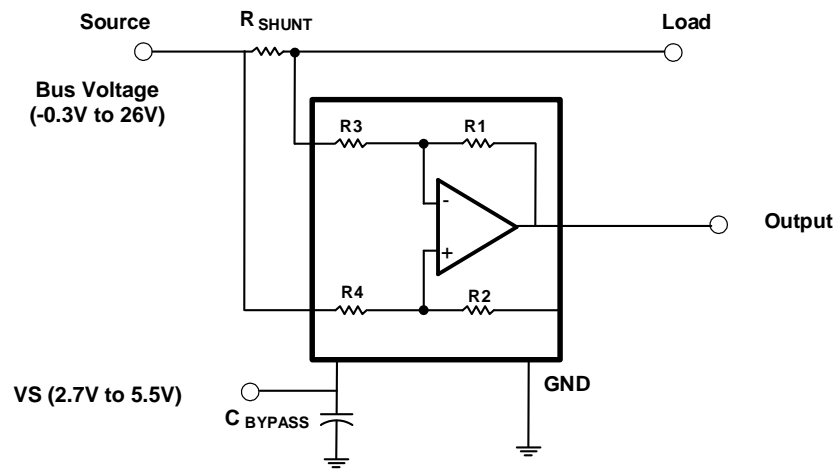


## Applications

- Vehicle valve controls
- Vehicle body control systems
- Vehicle motor controls, e-pumps
- Vehicle lighting controls
- Fault current detection
- Wireless charging
- Current sensing (high-side/low-side)
- Battery charging and discharging

**Typical Applications Circuit**

Device	OUT (Pin 1)	OUT (Pin 4)	Gain Option	Gain	Gain Error	V <sub>OS (MAX.)</sub>	Gain Drift
				V/V	%	μV	μV/°C
ZXCT180Q	A	B	1	20	1.0	±400	1
	A	B	2	50	1.0	±400	1
	A	B	3	100	1.0	±400	1
	A	B	4	200	1.0	±400	1



Recommendation of C<sub>BYPASS</sub> 0.1μF

$$V_{OUT} = (I_{LOAD} \times R_{SHUNT}) \times GAIN$$

**Pin Descriptions**

Pin Name	Pin Number		I/O	Description
	Pinout A	Pinout B		
GND	2	2	—	Ground
VS	5	5	Power	Power supply, 2.7V to 5.5V
IN+	3	1	Analog input	Connect to supply side of shunt resistor.
IN-	4	3	Analog input	Connect to load side of shunt resistor.
OUT	1	4	Analog output	Output voltage

**Absolute Maximum Ratings** (@  $T_A = +25^\circ\text{C}$ , unless otherwise specified.) (Note 4)

Parameter		Rating	Unit
Supply Voltage ( $V_S$ )		+6	V
Analog Inputs IN+, IN-	Differential (IN+)-(IN-)	-28 to 28	V
	Common Mode	GND -0.3 to 26	V
REF Pin Input Voltage		GND- 0.3 to ( $V_S$ ) + 0.3	V
OUT Pin Output Voltage		GND- 0.3 to ( $V_S$ ) + 0.3	V
Max. Output Current (Note 5)		8	mA
ESD Human Body ESD Protection (HBM)		5	kV
ESD Charged Device Model ESD Protection (CDM)		1.5	kV
$R_{\theta JA}$ (Junction-to-Ambient Thermal Resistance) (Note 6)		128	$^\circ\text{C/W}$
$R_{\theta JC}$ (Junction-to-Case Thermal Resistance) (Note 6)		37	$^\circ\text{C/W}$
Operating Temperature, $T_A$		-40 to +125	$^\circ\text{C}$
Storage Temperature		-65 to +150	$^\circ\text{C}$

- Notes:
- 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.
  - Input voltage at any pin can exceed the voltage shown if the current at that pin is limited to 5mA.
  - $R_{\theta JA}$  and  $R_{\theta JC}$  are measured at  $T_A = +25^\circ\text{C}$  on a high effective thermal conductivity minimum recommended pad (MRP) FR-4 PC board.

**Recommended Operating Conditions** (Note 7)

Symbol	Parameter	Min	Typ	Max	Unit
$V_{CM}$	Common-Mode Input Voltage	-0.3	12	26	V
$V_S$	Operating Supply Voltage (applied to $V_S$ )	2.7	5	5.5	V
$T_A$	Operating Ambient Temperature	-40	—	+125	$^\circ\text{C}$

- Note: 7. Refer to the *Typical Applications Circuit*.

**Electrical Characteristics** ( $T_A = +25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $V_{IN+} = 12\text{V}$ ,  $V_{SENSE} = V_{IN+} - V_{IN-}$ , and  $V_{REF} = V_S / 2$ , unless otherwise noted.)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{CM}$	Common-Mode Input	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	-0.3	—	26	V
CMRR	Common-Mode Rejection	$V_{IN+} = 0\text{V}$ to $26\text{V}$ , $V_{SENSE} = 10\text{mV}$	84	110	—	dB
$V_{OS}$	Offset Voltage, RTI (Note 8)	$V_{SENSE} = 0\text{mV}$ , $V_{CM} = 0\text{V}$	—	$\pm 50$	$\pm 150$	$\mu\text{V}$
		$V_{SENSE} = 0\text{mV}$ , $V_{CM} = 12\text{V}$	—	$\pm 100$	$\pm 400$	$\mu\text{V}$
$dV_{OS}/dT$	$V_{OS}$ vs. Temperature	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	—	—	1.0	$\mu\text{V}/^\circ\text{C}$
—	Long-Term Stability	Life test 1000 hours with $T_A = +125^\circ\text{C}$ (Note 9)	—	—	$\pm 400$	$\mu\text{V}$
PSRR	Power Supply Rejection	$V_S = 2.7\text{V}$ to $5.5\text{V}$ $V_{IN+} = 12\text{V}$ , $V_{SENSE} = 10\text{mV}$	—	$\pm 8$	$\pm 40$	$\mu\text{V}/\text{V}$
$I_B$	Input Bias Current	$V_{SENSE} = 0\text{mV}$ , $I_{N+} = 0\text{V}$ , $I_{N-} = 0\text{V}$	—	-6	—	$\mu\text{A}$
		$V_{SENSE} = 0\text{mV}$ , $I_{N+} = 12\text{V}$ , $I_{N-} = 12\text{V}$	—	75	—	$\mu\text{A}$
$I_{OS}$	Input Offset Current	$V_{SENSE} = 0\text{mV}$	—	$\pm 0.05$	—	$\mu\text{A}$
G	Gain	ZXCT180QA1 / B1	—	20	—	V/V
		ZXCT180QA2 / B2	—	50	—	
		ZXCT180QA3 / B3	—	100	—	
		ZXCT180QA4 / B4	—	200	—	
$E_G$	Gain Error	$V_{OUT} = 0.5\text{V}$ to Supply Voltage – $0.5\text{V}$ $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	—	$\pm 0.1\%$	$\pm 1\%$	—
—	Gain Error vs. Temperature	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	—	1.5	20	ppm/ $^\circ\text{C}$
—	Nonlinearity Error	$V_{OUT} = 0.5\text{V}$ to Supply Voltage – $0.5\text{V}$	—	$\pm 0.01\%$	—	—
$V_{OH}$	Swing to $V_S$ Power-Supply Rail	$R_L = 10\text{k}\Omega$ to GND, $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	—	$(V_S) - 0.02$	$(V_S) - 0.03$	V
$V_{OL}$	Swing to GND	$R_L = 10\text{k}\Omega$ to GND, $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	—	$(V_{GND}) + 0.0005$	$(V_{GND}) + 0.005$	V
—	Maximum Capacitive Load	No sustained oscillation	—	1	—	nF
GBW	Bandwidth	$C_{LOAD} = 10\text{pF}$ , ZXCT180QA1 / B1	—	400	—	kHz
		$C_{LOAD} = 10\text{pF}$ , ZXCT180QA2 / B2	—	300	—	
		$C_{LOAD} = 10\text{pF}$ , ZXCT180QA3 / B3	—	150	—	
		$C_{LOAD} = 10\text{pF}$ , ZXCT180QA4 / B4	—	85	—	
SR	Slew Rate	—	—	2	—	V/ $\mu\text{s}$
—	Voltage Noise Density	—	—	40	—	nV/ $\sqrt{\text{Hz}}$
$V_S$	Operating Voltage Range	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	2.7	—	5.5	V
$I_Q$	Quiescent Current	$V_{SENSE} = 10\text{mV}$	—	250	355	$\mu\text{A}$
		$V_{SENSE} = 10\text{mV}$ , $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	—	—	370	$\mu\text{A}$
—	Specified Range	—	-40	—	+125	$^\circ\text{C}$
—	Operating Range	—	-40	—	+125	$^\circ\text{C}$

Notes: 8. RTI = Referred to input

9. For the long-term stability, the maximum  $V_{OS}$  shift with time has been calculated during life test 1000 hours with  $T_A = +125^\circ\text{C}$ .

This  $V_{OS}$  drift with time is not a linear function of time, and the shift is great initially and slows down (becomes linear) over time. This parameter is guaranteed by design.

**Typical Performance Characteristics**

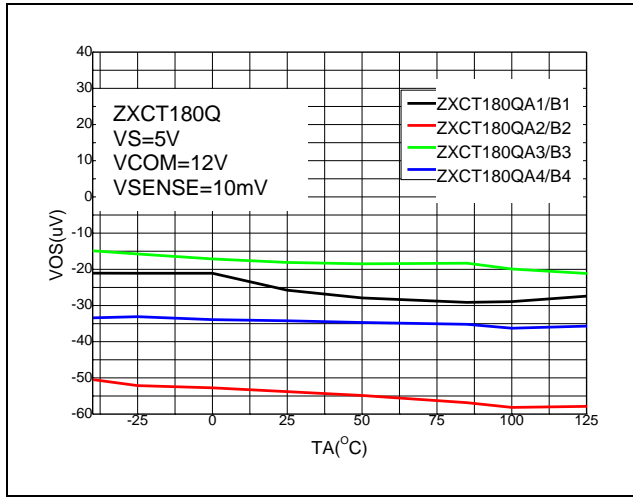


Figure 1. Offset Voltage vs. Temperature

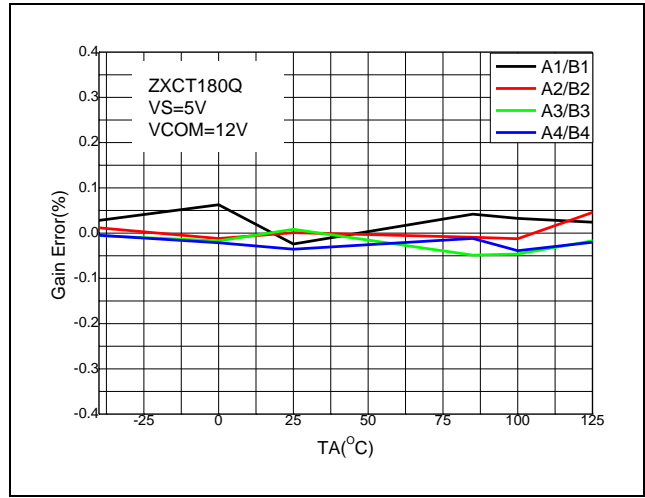


Figure 2. Gain Error vs. Temperature

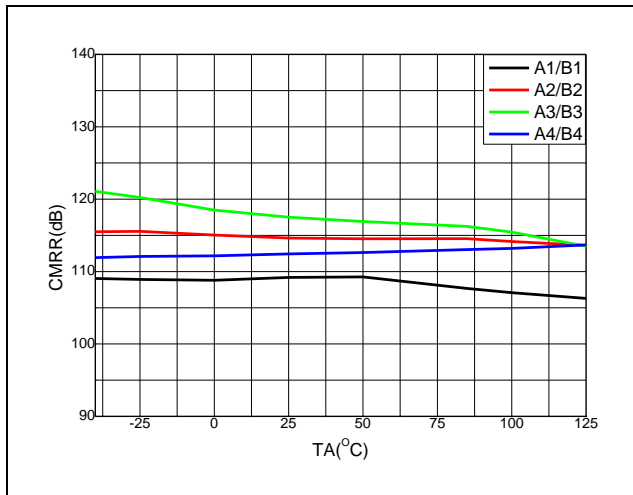


Figure 3. CMRR vs. Temperature

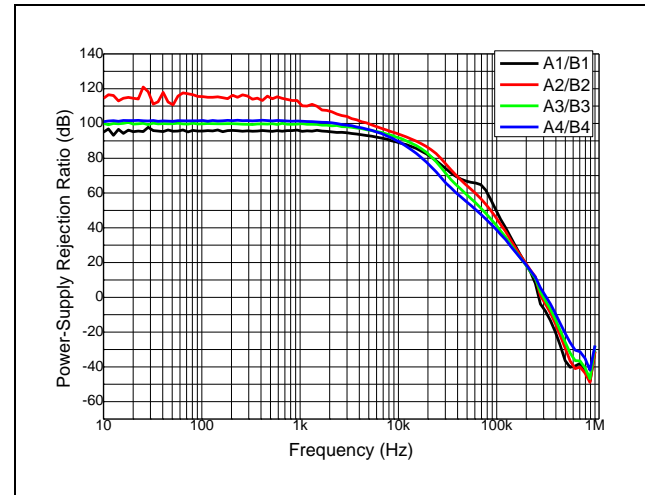


Figure 4. PSRR vs. Frequency

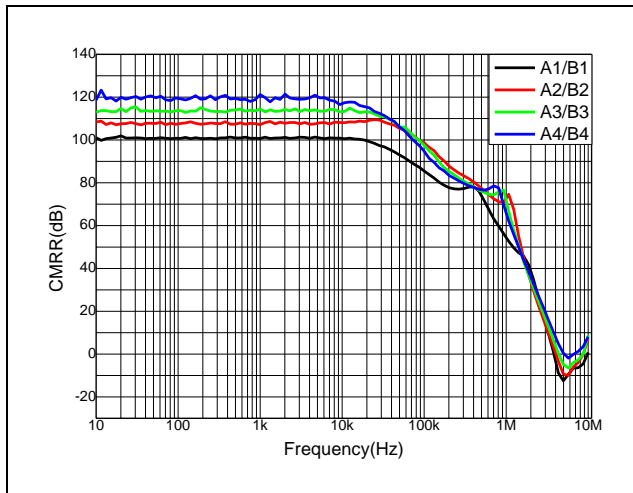


Figure 5. CMRR vs. Frequency

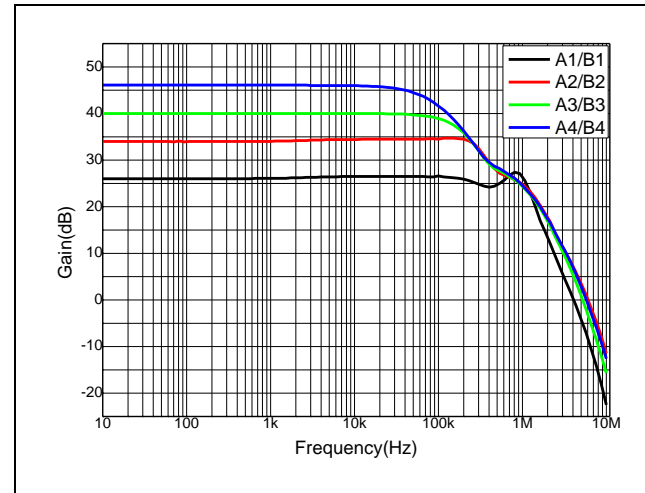


Figure 6. Gain vs. Frequency

**Typical Performance Characteristics** (continued)

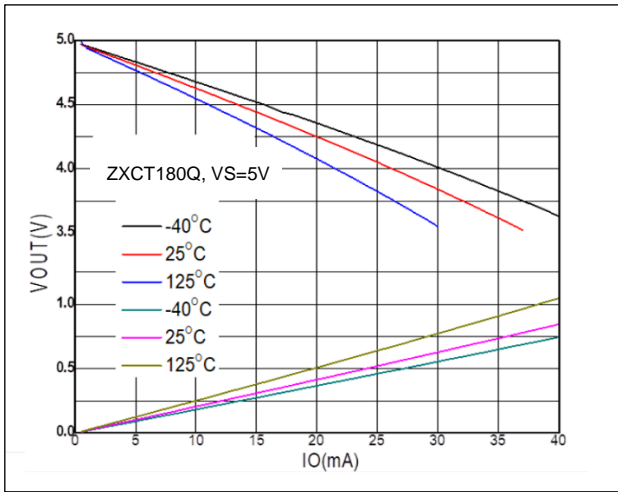


Figure 7. Output Voltage Swing vs. Output Current

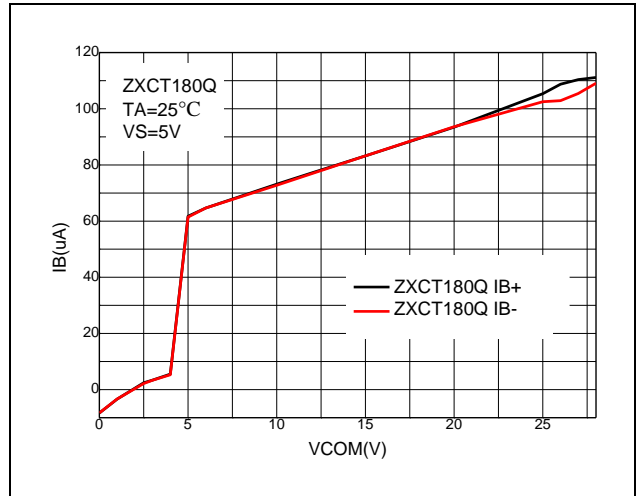


Figure 8. Input Bias Current vs. Common-Mode Voltage

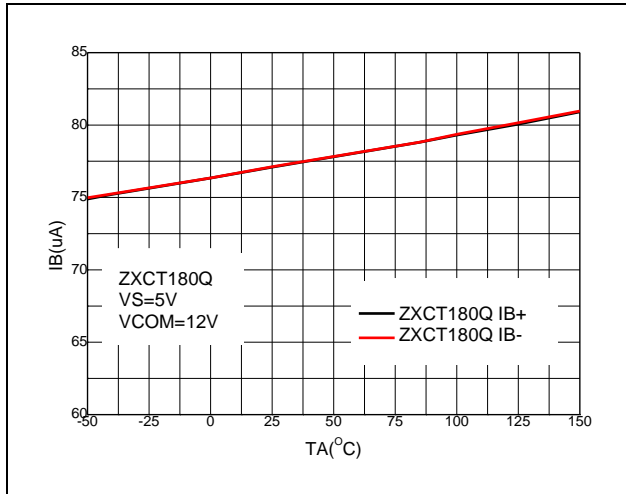


Figure 9. Input Bias Current vs. Temperature

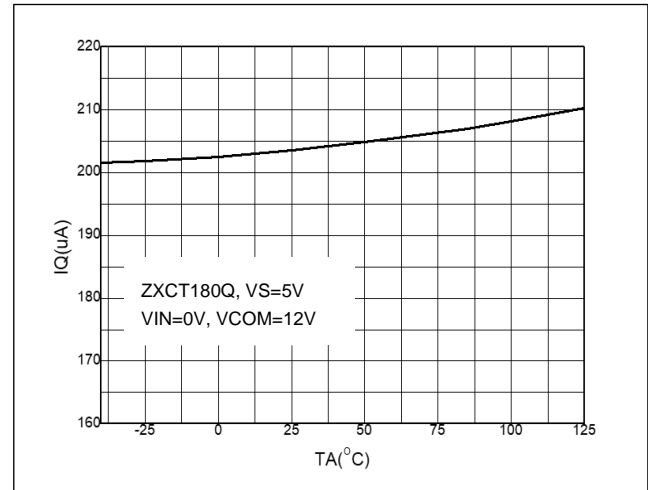


Figure 10. Quiescent Current vs. Temperature

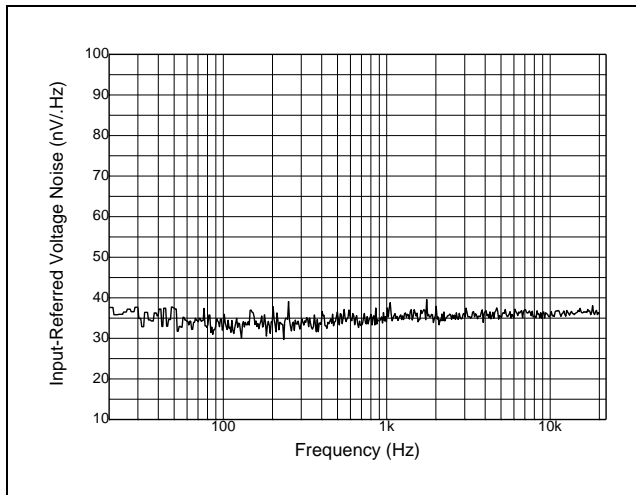


Figure 11. Input Noise Voltage vs. Frequency

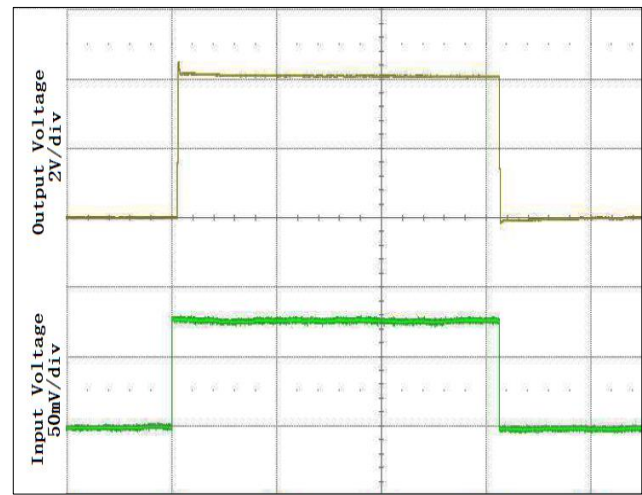


Figure 12. Step Response for A2 (G=50), Input 80mV vs. Output 2V

## Application Information

### General Information

The ZXCT180Q has a wide common mode of -0.3V to 26V and it can be used in low-side and high-side current sensing. The device is a specially designed, current-sensing amplifier able to accurately measure voltages developed across a current-sensing resistor on common-mode voltages that far exceed the supply voltage powering the device. The chip topology enables high-precision measurements with maximum input offset voltages as low as 400 $\mu$ V, with a maximum temperature contribution of 1.0 $\mu$ V/ $^{\circ}$ C over the full temperature range of -40 $^{\circ}$ C to +125 $^{\circ}$ C.

### Input and Output Pin Voltage Ranges

The ZXCT180Q can withstand the full input signal range of up to 26V at the input sense pins, regardless of whether the device has power applied or has the VS pin at zero volts. The input circuitry of the ZXCT180Q can accurately measure beyond its power-supply voltage. For example, the VS power supply is 5V, whereas the voltage applied to the analog input pins IN+ or IN- can be as high as 26V. At the moment, the output voltage range of the OUT pin is limited by the voltage on the power supply and a consideration of the maximum  $V_{OH}$ .

### Power Supply Recommendations

The ZXCT180Q can operate on as low as 2.7V. In some applications the power supply may be selected to limit the output range that is compatible with parts using this signal such as an analog converter or an analog input pin on a microcontroller. The power supply has been set at 5V. This will limit the output voltage of the current monitor. The ground connections for the ADC and current monitor should be wired as a star configuration to minimize error. A power-supply bypass capacitor connected closely to the device pins is required for stability with a suggested value of 0.1 $\mu$ F. Please place the power-supply bypass capacitor as close as possible to the device power supply and ground pins. Additional decoupling capacitance can be added to compensate for noisy or high-impedance power supplies.

Figure 13 shows the basic connections of the ZXCT180Q. Connect the input pins (IN+ and IN-) as closely as possible to the shunt resistor to minimize any resistance in series with the shunt resistor.

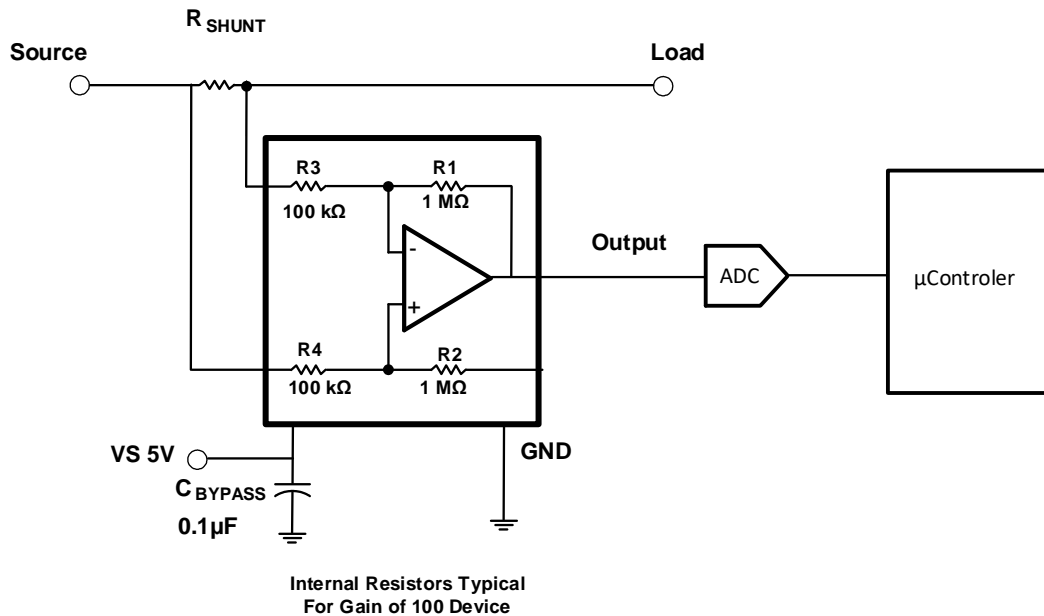
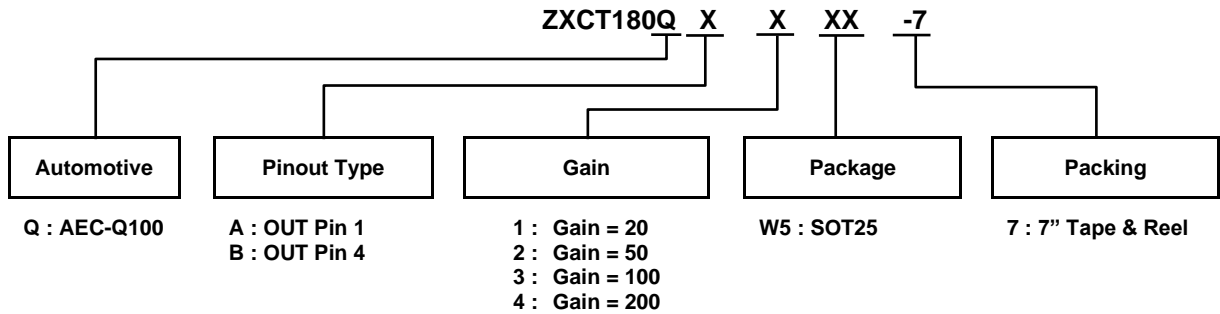


Figure 13. Typical Application

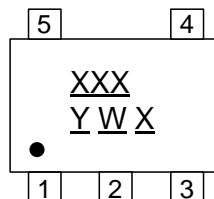
## Ordering Information



Orderable Part Number	Output	Package Code	Package	Packing	
				Qty.	Carrier
ZXCT180QA1W5-7	Pin 1	W5	SOT25	3000	7" Tape & Reel
ZXCT180QA2W5-7	Pin 1	W5	SOT25	3000	7" Tape & Reel
ZXCT180QA3W5-7	Pin 1	W5	SOT25	3000	7" Tape & Reel
ZXCT180QA4W5-7	Pin 1	W5	SOT25	3000	7" Tape & Reel
ZXCT180QB1W5-7	Pin 4	W5	SOT25	3000	7" Tape & Reel
ZXCT180QB2W5-7	Pin 4	W5	SOT25	3000	7" Tape & Reel
ZXCT180QB3W5-7	Pin 4	W5	SOT25	3000	7" Tape & Reel
ZXCT180QB4W5-7	Pin 4	W5	SOT25	3000	7" Tape & Reel

## Marking Information

(Top View)



**XXX** : Identification Code  
**Y** : Year 0 to 9 (ex: 4 = 2024)  
**W** : Week : A to Z : week 1 to 26;  
a to z : week 27 to 52; z represents  
Week 52 and 53  
**X** : Internal Code

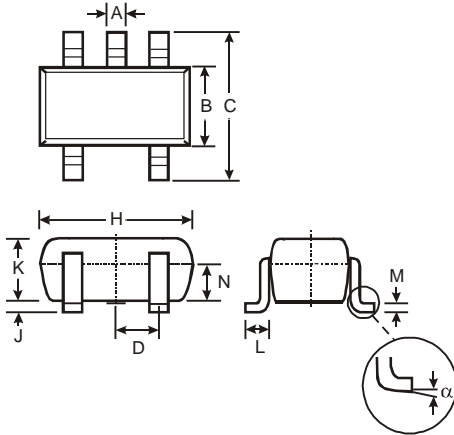
Orderable Part Number	Package	Identification Code
ZXCT180QA1W5-7	SOT25	MAQ
ZXCT180QA2W5-7	SOT25	MBQ
ZXCT180QA3W5-7	SOT25	MCQ
ZXCT180QA4W5-7	SOT25	MDQ
ZXCT180QB1W5-7	SOT25	MEQ
ZXCT180QB2W5-7	SOT25	MFQ
ZXCT180QB3W5-7	SOT25	MGQ
ZXCT180QB4W5-7	SOT25	MHQ



## Package Outline Dimensions

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

### SOT25

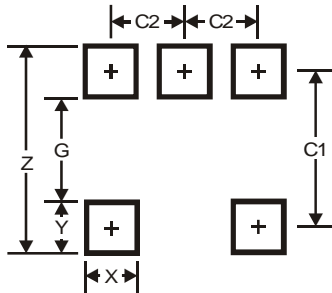


SOT25			
Dim	Min	Max	Typ
A	0.35	0.50	0.38
B	1.50	1.70	1.60
C	2.70	3.00	2.80
D	-	-	0.95
H	2.90	3.10	3.00
J	0.013	0.10	0.05
K	1.00	1.30	1.10
L	0.35	0.55	0.40
M	0.10	0.20	0.15
N	0.70	0.80	0.75
α	0°	8°	-
All Dimensions in mm			

## Suggested Pad Layout

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

### SOT25



Dimensions	Value
Z	3.20
G	1.60
X	0.55
Y	0.80
C1	2.40
C2	0.95

## Mechanical Data

### SOT25

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 <sup>(e3)</sup>
- Weight: 0.012 grams (Approximate)
- Max Soldering Temperature +260°C for 30 secs as per JEDEC J-STD-020

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