Description

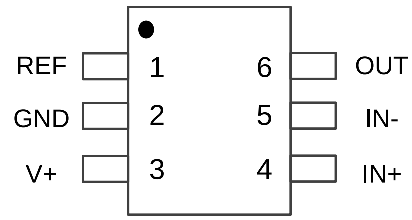
The DIODES™ ZXCT210 is a high precision current-shunt monitor with gain 200V/V to measure low voltage drop (10mV) across a small shunt resistor with minimal error. This enables high accuracy of large current measurement and reduces a power loss caused by the measurement. OUT pin is a voltage proportional to the load current. It can then be processed with an ADC.

This device is designed with zero-drift architecture and is manufactured by post trim technology to achieve low offset voltage (±30μV), low gain drift (10ppm/°C) and low gain error (±0.5%) among full temperature range for precise measurement.

The ZXCT210 operates from a single 2.7V to 26V power supply with a maximum of 100μA of supply current from -40°C to +125°C, and is offered in SOT363 package.

Pin Assignments

Top View



SOT363

Features

- Supply Voltage Range: 2.7V to 26V
- Temperature Range: -40°C to +125°C
- Wide Common-Mode Range: -0.1V to 26V
- Support Shunt Drops of 10mV Full-Scale
- Gain Error (Maximum Overtemperature)
  - A and B Version: ±0.8%
  - C Version: ±0.5%
- Offset Voltage (Maximum Overemperature)
  - A Version: ±35μV
  - B and C Version: ±30μV
- 0.5μV/°C Offset Drift (Maximum)
- 10ppm/°C Gain Drift (Maximum)
- Quiescent Current: 100μA (Maximum)
- Rail-to-Rail Output Capacity
- Gains: 200V/V
- Package: 6-Pin SOT363
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative.**
  https://www.diodes.com/quality/product-definitions/

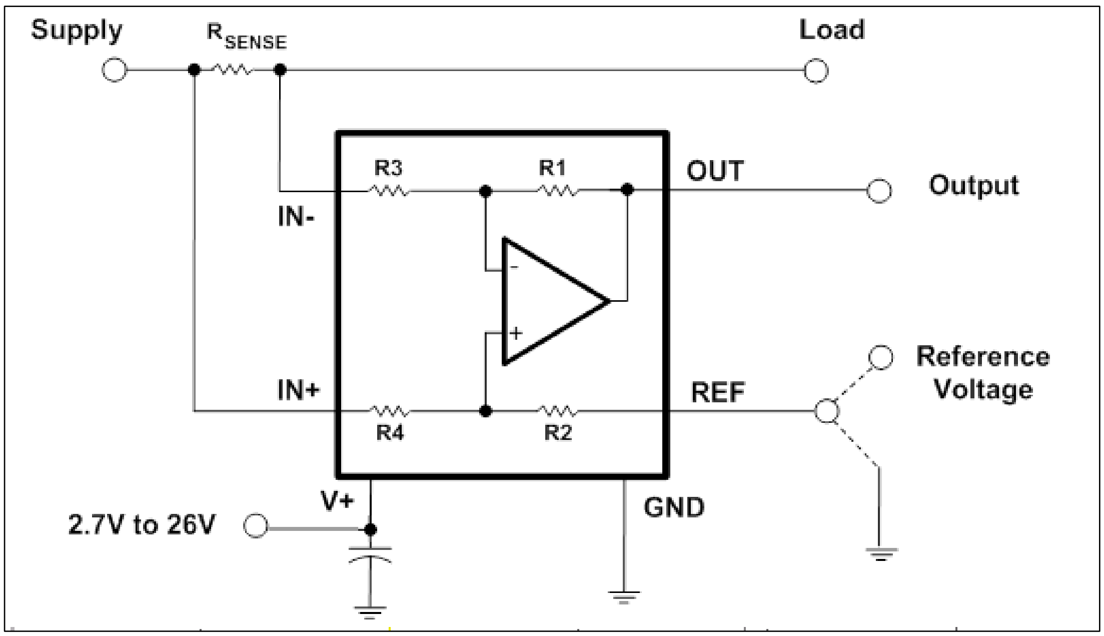
Applications

- Current sensing (high-side/low-side)
- Battery charging and discharging
- Computer racks
- High performance video cards
- Industrials
- Power supplies
- Instrumentation
- Control systems
- Metering

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 Applications Circuit

Part Number	Version	Gain	Gain Error	V_{OS}	Gain Drift
		V/V	%	µV	ppm/°C
ZXCT210A	A	200	0.8	±35	10
ZXCT210B	B	200	0.8	±30	10
ZXCT210C	C	200	0.5	±30	10



$$V_{OUT} = (I_{LOAD} \times R_{SENSE})\ GAIN + V_{REF}$$

Pin Descriptions

Pin Name	Pin Number	I/O	Description
	SOT363		
REF	1	Analog input	Reference voltage, 0V to V+
GND	2	—	Ground
V+	3	Power	Power supply, 2.7V to 26V
IN+	4	Analog input	Connect to supply side of shunt resistor.
IN-	5	Analog input	Connect to load side of shunt resistor.
OUT	6	Analog output	Output voltage

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

Description		Rating	Unit
Supply Volatge (V+)		+26	V
Analog Inputs IN+, IN-	Differential (IN+)-(IN-)	-26 to 26	V
	Common Mode	GND - 0.3 to 26	V
REF Input Voltage		GND - 0.3 to (V+) + 0.3	V
Output		GND - 0.3 to (V+) + 0.3	V
Input Current into All Pins (Note 5)		5	mA
ESD Human Body ESD Protection (HBM)		±5	kV
ESD Charged-Device Model ESD Protection (CDM)		±1.5	kV

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.
5. Input voltage at any pin can exceed the voltage shown if the current at that pin is limited to 5mA.

Thermal Information (Note 6)

Symbol	Parameter	Value	Unit
$R_{\theta JA}$	Junction-to-Ambient Thermal Resistance	228	°C/W
$R_{\theta JC}$	Junction-to-Case Thermal Resistance	64	

Note: 6. $R_{\theta JA}$ and $R_{\theta JC}$ are measured at T_A = +25°C on a high effective thermal conductivity four-layer test board per JEDEC 51-7.

Recommended Operating Conditions (Note 7)

Symbol	Parameter	Min	Typ	Max	Unit
V_{CM}	Common-Mode Input Voltage	-0.1	12	26	V
V_S	Operating Supply Voltage (Applied to V+)	2.7	5	26	V
T_A	Operating Ambient Temperature	-40	—	+125	°C

Note: 7. Refer to the *Typical Application Circuit*.

Electrical Characteristics (T_A = +25°C, V_S = 5V, V_{IN+} = 12V, 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°C to +125°C	-0.3	—	26	VV
CMRR	Common-Mode Rejection		ZXCT210, V_{IN+} = 0V to 26V V_{SENSE} = 0mV T_A = -40°C to +125°C	100	120	—	dB
V_{OS}	Offset Voltage, RTI (Note 8)		ZXCT210A, V_{SENSE} = 0mV	—	±0.55	±35	μV
			ZXCT210B, ZXCT210C V_{SENSE} = 0mV	—	±0.55	±30	μV
dV_{OS}/dT	V_{OS} vs. Temperature		T_A = -40°C to +125°C	—	0.1	0.5	μV/°C
—	Long-Term Stability (Note 9)		—	—	—	100	μV
PSRR	Power Supply Rejection		V_S = 2.7V to 18V V_{IN+} = 18V, V_{SENSE} = 0mV	—	±0.1	—	μV/V
I_B	Input Bias Current		V_{SENSE} = 0mV	—	28	—	μA
I_{OS}	Input Offset Current		V_{SENSE} = 0mV	—	±0.02	—	μA
G	Gain	ZXCT210	—	—	—	—	V/V
E_G	Gain Error		A and B Version, V_{SENSE} = -5mV to 5mV T_A = -40°C to +125°C	—	±0.03%	±0.8%	—
			C Version, V_{SENSE} = -5mV to 5mV T_A = -40°C to +125°C	—	±0.03%	±0.5%	—
—	Gain Drift vs. Temperature		T_A = -40°C to +125°C	—	3	10	ppm/°C
—	Nonlinearity Error		V_{SENSE} = -5mV to 5mV	—	±0.01%	—	—
V_{OH}	Swing to V+ Power-Supply Rail		R_L = 10kΩ to GND, T_A = -40°C to +125°C	—	(V+) – 0.05	(V+) – 0.2	V
V_{OL}	Swing to GND		R_L = 10kΩ to GND, T_A = -40°C to +125°C	—	(V_{GND}) + 0.005	(V_{GND}) + 0.05	V
—	Maximum Capacitive Load		No Sustained Oscillation	—	1	—	nF
GBW	Band Width		C_{LOAD} = 10pF, ZXCT210	—	14	—	kHz
SR	Slew Rate		—	—	0.4	—	V/μs
—	Voltage Noise Density		—	—	25	—	$nV/\sqrt{Hz}$
V_S	Operating Voltage Range		T_A = -40°C to +125°C	2.7	—	26	V
			-20°C to +85°C	2.5	—	26	
I_Q	Quiescent Current		V_{SENSE} = 0mV	—	65	100	μA
			T_A = -40°C to +125°C	—	—	115	μA
T_J	Operating Junction Temperature		—	-40	—	+150	°C
T_{STG}	Storage Temperature Range		—	-65	—	+150	°C

Notes: 8. RTI = Referred to input.
9. The long-term stability is defined as MAX. V_{OS} shift during high temperature life test 1000 hours with T_A = +125°C. This V_{OS} drift with time is not a linear function of time, and the shift is greater initially and diminishes over time. This parameter is guaranteed by design.

Typical Performance Characteristics

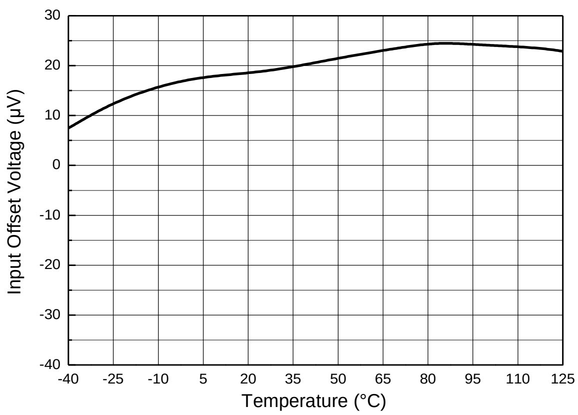


Figure 1. Offset Voltage vs. Temperature

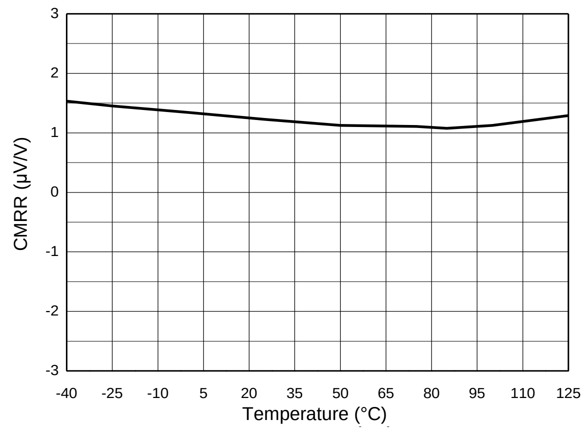


Figure 2 Common-Mode Rejection Ratio vs. Temperature

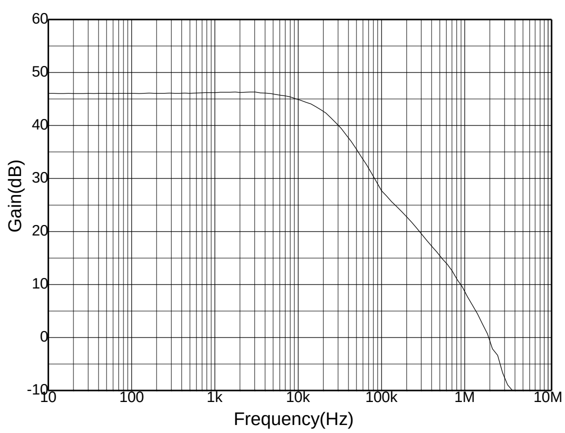


Figure 3. Gain vs. Frequency

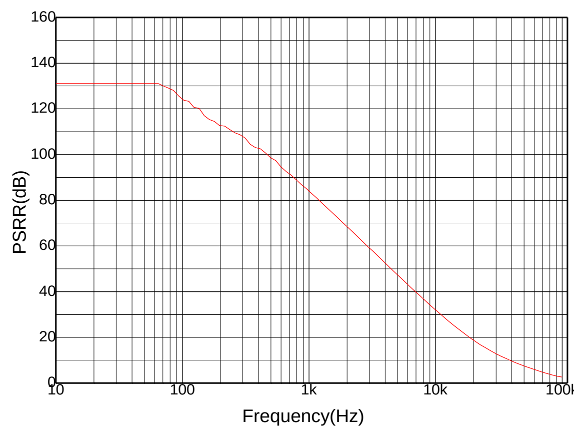


Figure 4. Power-Supply Rejection Ratio vs. Frequency

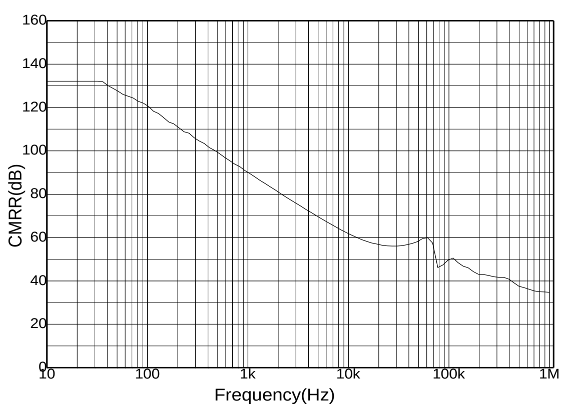


Figure 5. Common-Mode Rejection Ratio vs. Frequency

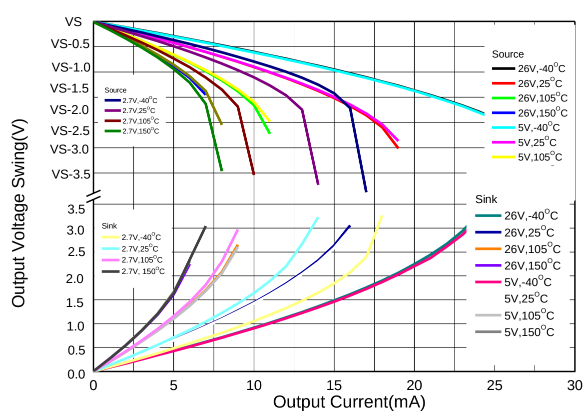


Figure 6. Output Voltage Swing vs. Output Current

Typical Performance Characteristics (continued)

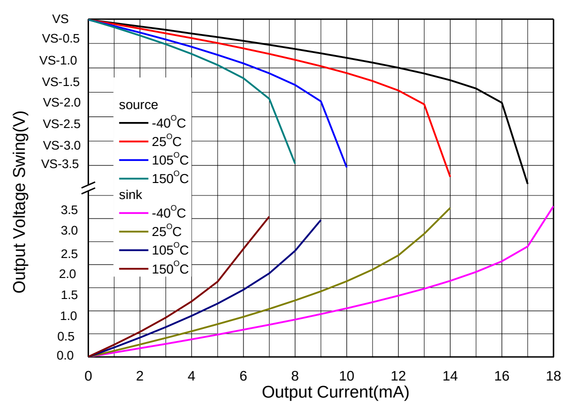


Figure 7. Output Voltage Swing vs. Output Current

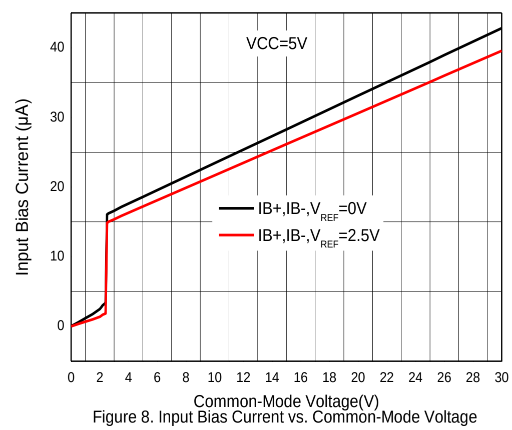


Figure 8. Input Bias Current vs. Common-Mode Voltage

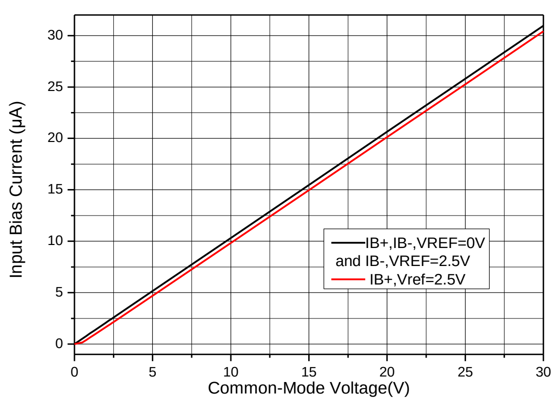


Figure 9. Input Bias Current vs. Common-Mode Voltage With Supply Voltage=0V(Shutdown)

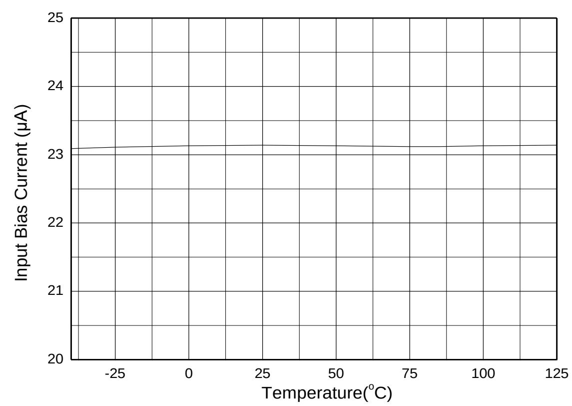


Figure 10. Input Bias Current vs. Temperature

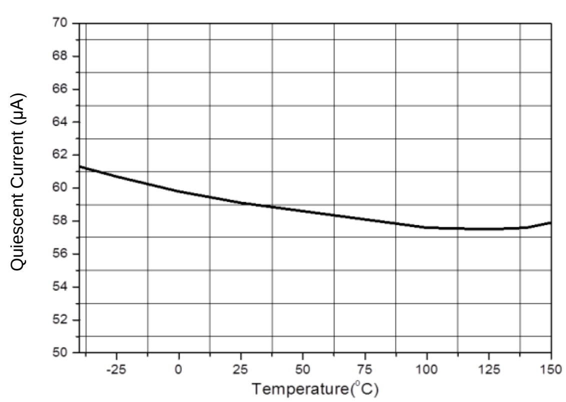


Figure 11. Quiescent Current vs. Temperature

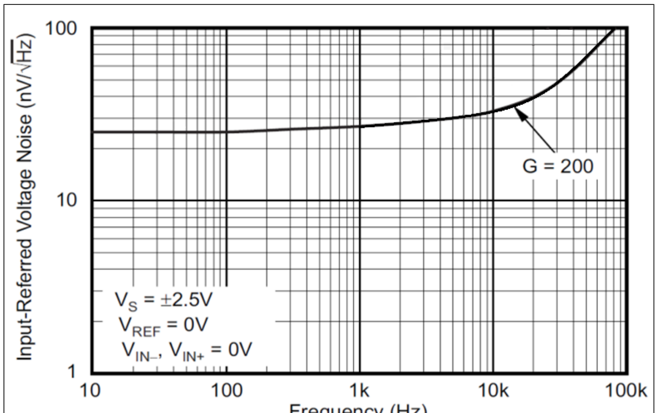


Figure 12. Input-Referred Voltage Noise vs. Frequency

Typical Performance Characteristics (continued)

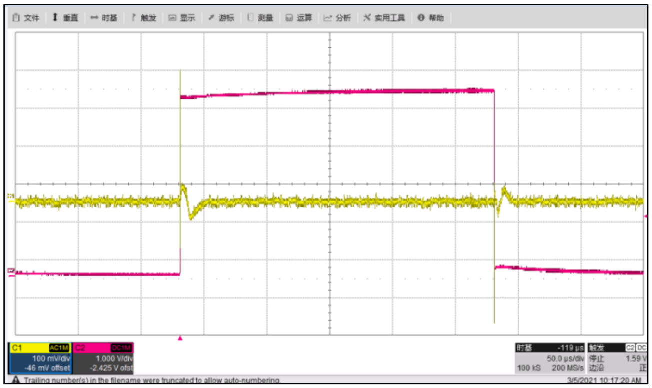


Figure 13. Common-Mode Voltage vs. Transient Response

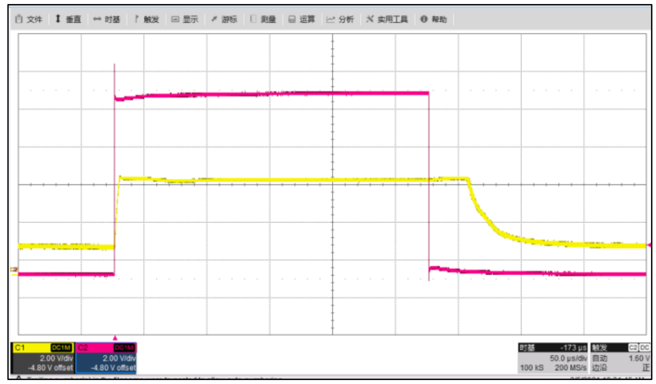


Figure 14. Noninverting Differential Input Overload

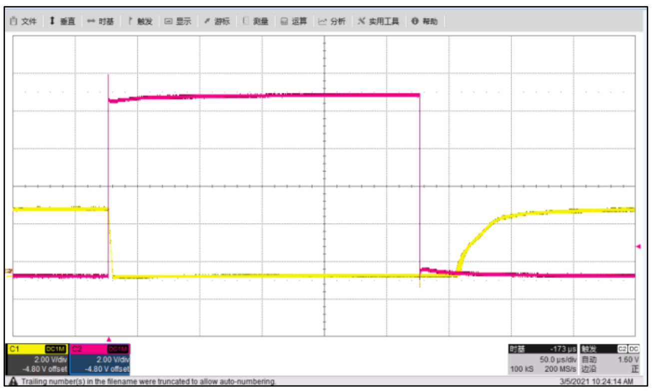


Figure 15. Inverting Differential Input Overload

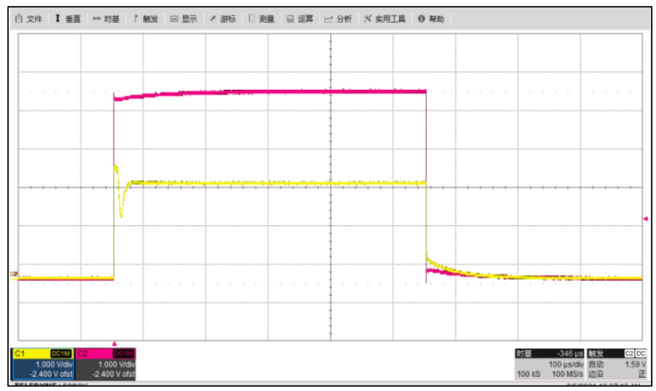


Figure 16. Start-up Response

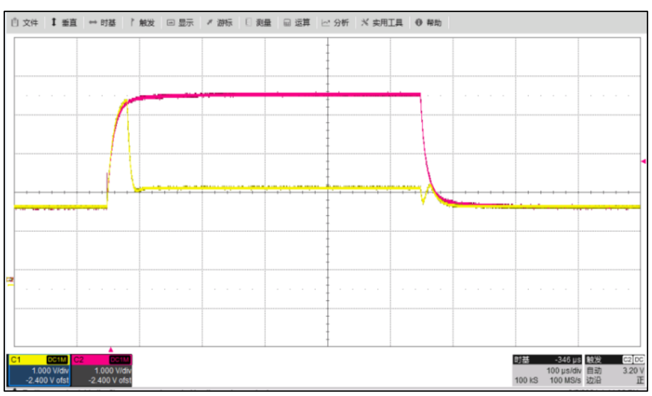


Figure 17. Brownout Recovery

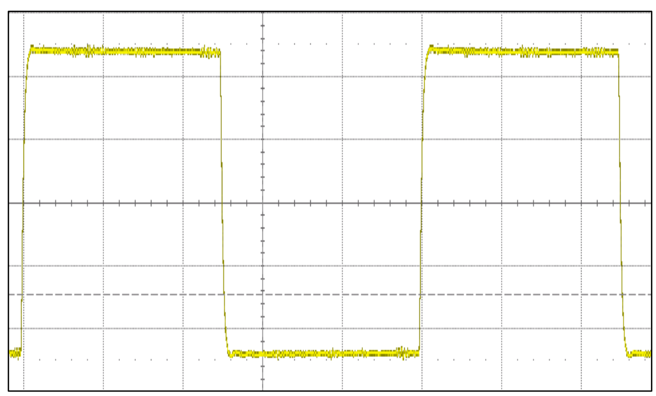


Figure 18. Output Stability with Load 2.2nF

Application Information

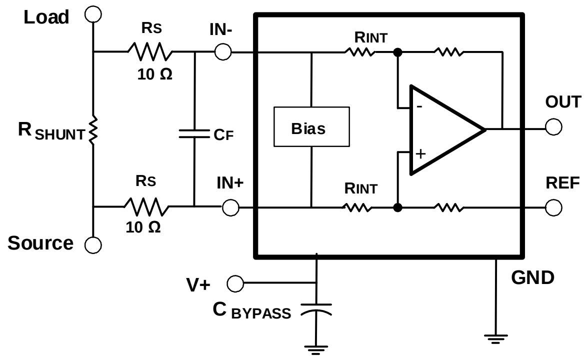


Figure 19. Filter at Input Pins

Input Filtering

Input filtering may be needed to limit the bandwidth of signals or to add protection against transients that may be generated as the result of shunt inductance. If the added source resistors are not closely matched there is an adverse impact on gain error, CMRR and V_{OS}. Figure 19 shows a filter placed at the inputs pins. It is recommended the added input resistors (R_S) should be 10Ω or less.

As a consideration to mitigate the impact of shunt inductance in a high current, high transient environment the RC time constant of the added R_S and C_F should be greater than the time constant implied by the inductance and resistance implied by R_{SHUNT}.

$$2 \cdot R_S \cdot C_F \geq \frac{L_{SHUNT}}{R_{SHUNT}}$$

Due to additional current used in the bias circuit the voltage between the IN- and IN+ pins will differ from voltage across the sense resistor. This will appear as a gain error at the output. These internal bias currents from the inputs are not equal in magnitude and change depending on common mode conditions. This is the motivation of keeping the added resistor below 10Ω. The chart below has the equations for calculating the gain errors based on adding well matched source resistors. The equations include a provision for the additional 20µA current used by the bias circuit block that is depicted as bias in Figure 19.

Product	Gain	R_{INT} R3 and R4	Gain Error Factor Equations	Gain Error % *		
				R_S = 10Ω	R_S = 20Ω	R_S = 30Ω
ZXCT210	200	5kΩ	$\frac{1,000}{R_S + 1000}$	0.9901%	1.9608%	2.9220%

*The percentages shown should be rounded to 2 significant figures. The excess can be used to check calculations. This is for a typical semiconductor process.

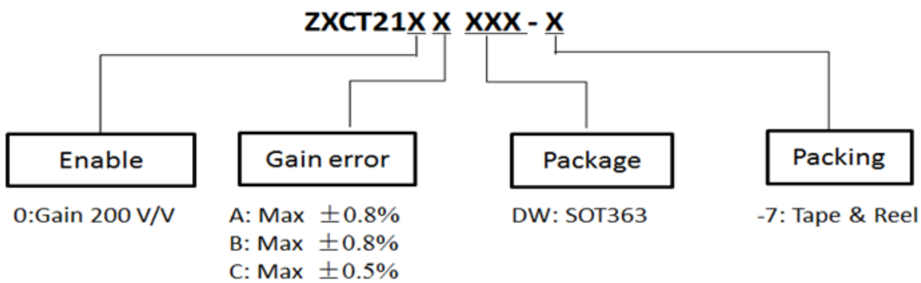
$$Gain\ Error\ (\%) = 100 \cdot (1 - Gain\ Error\ Factor)$$

Where

R_{INT} is the internal resistors R3 and R4 used to set the gain and differs per device type.

R_S is the added input resistors.

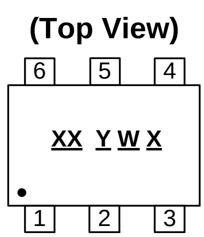
Ordering Information



Part Number	Suffix	Package Code	Package	Packing	
				Qty.	Carrier
ZXCT210ADW-7	-7	DW	SOT363	3000	7" Tape and Reel
ZXCT210BDW-7	-7	DW	SOT363	3000	7" Tape and Reel
ZXCT210CDW-7	-7	DW	SOT363	3000	7" Tape and Reel

Marking Information

SOT363



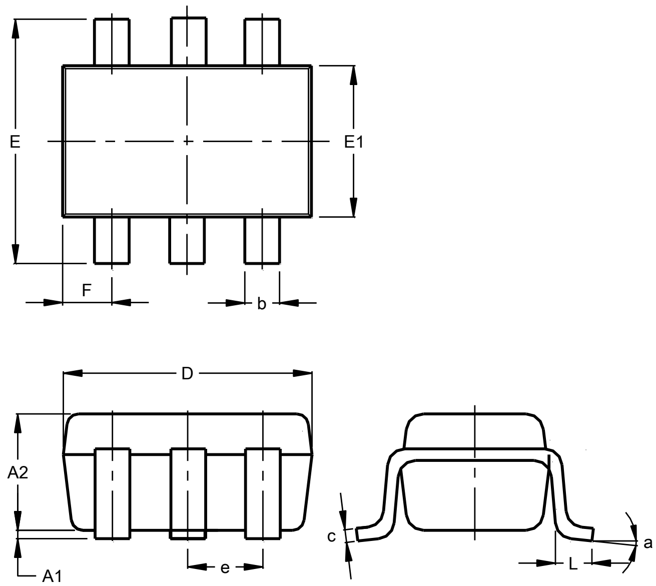
XX : Identification Code
Y : Year (ex: 2 = 2022)
W : Week : A to Z : week 1 to 26;
a to z : week 27 to 52; z represents
week 52 and 53
X : Internal Code

Part Number	Package	Identification Code
ZXCT210ADW-7	SOT363	YC
ZXCT210BDW-7	SOT363	YD
ZXCT210CDW-7	SOT363	YE

Package Outline Dimensions

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

SOT363

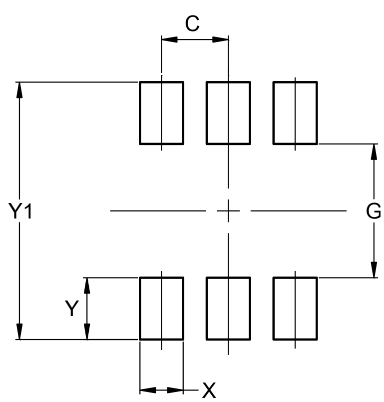


SOT363			
Dim	**Min**	**Max**	**Typ**
A1	0.00	0.10	0.05
A2	0.90	1.00	0.95
b	0.10	0.30	0.25
c	0.10	0.22	0.11
D	1.80	2.20	2.15
E	2.00	2.20	2.10
E1	1.15	1.35	1.30
e	0.650 BSC		
F	0.40	0.45	0.425
L	0.25	0.40	0.30
a	0°	8°	--
All Dimensions in mm			

Suggested PAD Layout

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

SOT363



Dimensions	Value (in mm)
C	0.650
G	1.300
X	0.420
Y	0.600
Y1	2.500

Mechanical Data

SOT363

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 (e3)
- Weight: 0.006 grams (Approximate)
- Max Soldering Temperature +260°C for 30 secs as per JEDEC J-STD-020

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