



Low-Cost $\pm 2 g$ Dual-Axis Accelerometer with Duty Cycle Output

ADXL202E*

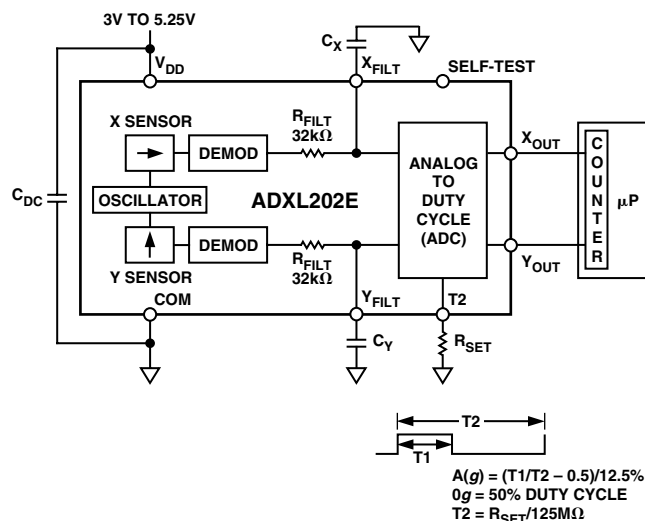
FEATURES

- 2-Axis Acceleration Sensor on a Single IC Chip
- 5 mm $\times$ 5 mm $\times$ 2 mm Ultrasmall Chip Scale Package
- 2 mg Resolution at 60 Hz
- Low-Power < 0.6 mA
- Direct Interface to Low-Cost Microcontrollers via Duty Cycle Output
- BW Adjustment with a Single Capacitor
- 3 V to 5.25 V Single Supply Operation
- 1000 g Shock Survival

APPLICATIONS

- 2-Axis Tilt Sensing with Faster Response than Electrolytic, Mercury, or Thermal Sensors
- Computer Peripherals
- Information Appliances
- Alarms and Motion Detectors
- Disk Drives
- Vehicle Security

FUNCTIONAL BLOCK DIAGRAM



GENERAL DESCRIPTION

The ADXL202E is a low-cost, low-power, complete 2-axis accelerometer with a digital output, all on a single monolithic IC. It is an improved version of the ADXL202AQC/JQC. The ADXL202E will measure accelerations with a full-scale range of $\pm 2 g$. The ADXL202E can measure both dynamic acceleration (e.g., vibration) and static acceleration (e.g., gravity).

The outputs are analog voltage or digital signals whose duty cycles (ratio of pulsewidth to period) are proportional to acceleration. The duty cycle outputs can be directly measured by a microprocessor counter, without an A/D converter or glue logic. The duty cycle period is adjustable from 0.5 ms to 10 ms via a single resistor (R_{SET}).

The typical noise floor is $200 \mu g \sqrt{Hz}$, allowing signals below 2 mg (at 60 Hz bandwidth) to be resolved.

The bandwidth of the accelerometer is set with capacitors C_X and C_Y at the X_{FILT} and Y_{FILT} pins. An analog output can be reconstructed by filtering the duty cycle output.

The ADXL202E is available in 5 mm $\times$ 5 mm $\times$ 2 mm 8-lead hermetic LCC package.

*Patents Pending

REV. A

Information furnished by Analog Devices is believed to be accurate and reliable. However, no responsibility is assumed by Analog Devices for its use, nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Analog Devices.

One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
Tel: 781/329-4700 World Wide Web Site: <http://www.analog.com>
Fax: 781/326-8703 © Analog Devices, Inc., 2000

ADXL202E—SPECIFICATIONS ($T_A = T_{MIN}$ to T_{MAX} , $T_A = 25^{\circ}\text{C}$ for J Grade only, $V_{DD} = 5\text{ V}$, $R_{SET} = 125\text{ k}\Omega$, Acceleration = 0 g , unless otherwise noted.)

Parameter	Conditions	TPC ¹ Graph	ADXL202JE			ADXL202AE			Unit
			Min	Typ	Max	Min	Typ	Max	
SENSOR INPUT	Each Axis								
Measurement Range ²			± 2			± 2			g
Nonlinearity	Best Fit Straight Line			0.2			0.2		% of FS
Alignment Error ³		X		± 1			± 1		Degrees
Alignment Error	X Sensor to Y Sensor			0.01			0.01		Degrees
Cross-Axis Sensitivity ⁴		X		± 2			± 2		%
SENSITIVITY	Each Axis								
Duty Cycle per g	$T1/T2$, $V_{DD} = 5\text{ V}$	X	10.5	12.5	14.5	10	12.5	15	%/ g
Duty Cycle per g	$T1/T2$, $V_{DD} = 3\text{ V}$	X	9.0	11	13.0	8.5	11	13.5	%/ g
Sensitivity X_{FILT} , Y_{FILT}	$V_{DD} = 5\text{ V}$	X	265	312	360	250	312	375	mV/ g
Sensitivity X_{FILT} , Y_{FILT}	$V_{DD} = 3\text{ V}$	X	140	167	195	140	167	200	mV/ g
Temperature Drift ⁵	Delta from 25°C	X		± 0.5			± 0.5		%
ZERO g BIAS LEVEL	Each Axis								
0 g Duty Cycle	$T1/T2$, $V_{DD} = 5\text{ V}$	X	34	50	66	30	50	70	%
0 g Duty Cycle	$T1/T2$, $V_{DD} = 3\text{ V}$	X	31	50	69	31	50	69	%
0 g Voltage X_{FILT} , Y_{FILT}	$V_{DD} = 5\text{ V}$	X	2.1	2.5	2.9	2.0	2.5	3.0	V
0 g Voltage X_{FILT} , Y_{FILT}	$V_{DD} = 3\text{ V}$	X	1.2	1.5	1.8	1.2	1.5	1.8	V
0 g Duty Cycle vs. Supply		X		1.0	4.0		1.0	4.0	%/V
0 g Offset vs. Temperature ⁵	Delta from 25°C	X		2.0			2.0		mg/ $^{\circ}\text{C}$
NOISE PERFORMANCE									
Noise Density	@ 25°C	X		200			200	1000	$\mu\text{g}/\sqrt{\text{Hz}}$ rms
FREQUENCY RESPONSE									
3 dB Bandwidth	At Pins X_{FILT} , Y_{FILT}			6			6		kHz
Sensor Resonant Frequency				10			10		kHz
FILTER									
R_{FILT} Tolerance	32 k Ω Nominal			± 15			± 15		%
Minimum Capacitance	At Pins X_{FILT} , Y_{FILT}		1000			1000			pF
SELF-TEST									
Duty Cycle Change	Self-Test “0” to “1”			10			10		%
DUTY CYCLE OUTPUT STAGE									
F_{SET}	$R_{SET} = 125\text{ k}\Omega$		0.7		1.3	0.7		1.3	kHz
Output High Voltage	$I = 25\text{ }\mu\text{A}$		$V_S - 200\text{ mV}$			$V_S - 200\text{ mV}$			V
Output Low Voltage	$I = 25\text{ }\mu\text{A}$			200			200		mV
T2 Drift vs. Temperature			50			50			ppm/ $^{\circ}\text{C}$
Rise/Fall Time			200			200			ns
POWER SUPPLY									
Operating Voltage Range			3		5.25	3.0		5.25	V
Quiescent Supply Current				0.6	1.0		0.6	1.0	mA
Turn-On Time	C_{FILT} in μF		$160 \times C_{FILT} + 0.3$			$160 \times C_{FILT} + 0.3$			ms
TEMPERATURE RANGE									
Specified Performance AE						-40		+85	$^{\circ}\text{C}$
Operating Range			0		70	-40		+85	$^{\circ}\text{C}$

NOTES

¹Typical Performance Characteristics.

²Guaranteed by measurement of initial offset and sensitivity.

³Alignment error is specified as the angle between the true and indicated axis of sensitivity (see TPC 15).

⁴Cross-axis sensitivity is the algebraic sum of the alignment and the inherent sensitivity errors.

⁵Defined as the output change from ambient to maximum temperature or ambient to minimum temperature.

Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS*

Acceleration (Any Axis, Unpowered for 0.5 ms) 1000 *g*
 Acceleration (Any Axis, Powered for 0.5 ms) 500 *g*
 +V_S –0.3 V to +6.0 V
 Output Short Circuit Duration, (Any Pin to Common)

. Indefinite

Operating Temperature –55°C to +125°C

Storage Temperature –65°C to +150°C

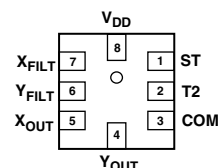
*Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicate in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Drops onto hard surfaces can cause shocks of greater than 1000 *g* and exceed the absolute maximum rating of the device. Care should be exercised in handling to avoid damage.

Package Characteristics

Package Weight	θ_{JA}	θ_{JC}	Device
8-Lead LCC	120°C/W	tbd°C/W	<1.0 grams

PIN CONFIGURATION



BOTTOM VIEW

PIN FUNCTION DESCRIPTIONS

Pin No.	Mnemonic	Description
1	ST	Self-Test
2	T2	Connect R _{SET} to Set T2 Period
3	COM	Common
4	Y _{OUT}	Y-Channel Duty Cycle Output
5	X _{OUT}	X-Channel Duty Cycle Output
6	Y _{FILT}	Y-Channel Filter Pin
7	X _{FILT}	X-Channel Filter Pin
8	V _{DD}	3 V to 5.25 V

ORDERING GUIDE

Model	No. of Axes	Specified Voltage	Temperature Range	Package Description	Package Option
ADXL202JE	2	3 V to 5 V	0 to 70°C	8-Lead LCC	E-8
ADXL202AE	2	3 V to 5 V	–40°C to +85°C	8-Lead LCC	E-8

CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the ADXL202E features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high-energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

