

FEATURES

- Ultralow power: as low as 23 μA in measurement mode and 0.1 μA in standby mode at $V_S = 2.5\text{ V}$ (typical)**
- Power consumption scales automatically with bandwidth**
- User-selectable resolution**
 - Fixed 10-bit resolution
 - Full resolution, where resolution increases with g range, up to 13-bit resolution at $\pm 16\text{ g}$ (maintaining 4 mg/LSB scale factor in all g ranges)
- Patent pending, embedded memory management system with FIFO technology minimizes host processor load**
- Single tap/double tap detection**
- Activity/inactivity monitoring**
- Free-fall detection**
- Supply voltage range: 2.0 V to 3.6 V**
- I/O voltage range: 1.7 V to V_S**
- SPI (3- and 4-wire) and I²C digital interfaces**
- Flexible interrupt modes mappable to either interrupt pin**
- Measurement ranges selectable via serial command**
- Bandwidth selectable via serial command**
- Wide temperature range (-40°C to $+85^\circ\text{C}$)**
- 10,000 g shock survival**
- Pb free/RoHS compliant**
- Small and thin: 3 mm \times 5 mm \times 1 mm LGA package**

APPLICATIONS

- Handsets
- Medical instrumentation
- Gaming and pointing devices
- Industrial instrumentation
- Personal navigation devices
- Hard disk drive (HDD) protection

GENERAL DESCRIPTION

The ADXL345 is a small, thin, ultralow power, 3-axis accelerometer with high resolution (13-bit) measurement at up to $\pm 16\text{ g}$. Digital output data is formatted as 16-bit two's complement and is accessible through either a SPI (3- or 4-wire) or I²C digital interface.

The ADXL345 is well suited for mobile device applications. It measures the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion or shock. Its high resolution (3.9 mg/LSB) enables measurement of inclination changes less than 1.0° .

Several special sensing functions are provided. Activity and inactivity sensing detect the presence or lack of motion by comparing the acceleration on any axis with user-set thresholds. Tap sensing detects single and double taps in any direction. Free-fall sensing detects if the device is falling. These functions can be mapped individually to either of two interrupt output pins. An integrated, patent pending memory management system with a 32-level first in, first out (FIFO) buffer can be used to store data to minimize host processor activity and lower overall system power consumption.

Low power modes enable intelligent motion-based power management with threshold sensing and active acceleration measurement at extremely low power dissipation.

The ADXL345 is supplied in a small, thin, 3 mm \times 5 mm \times 1 mm, 14-lead, plastic package.

FUNCTIONAL BLOCK DIAGRAM

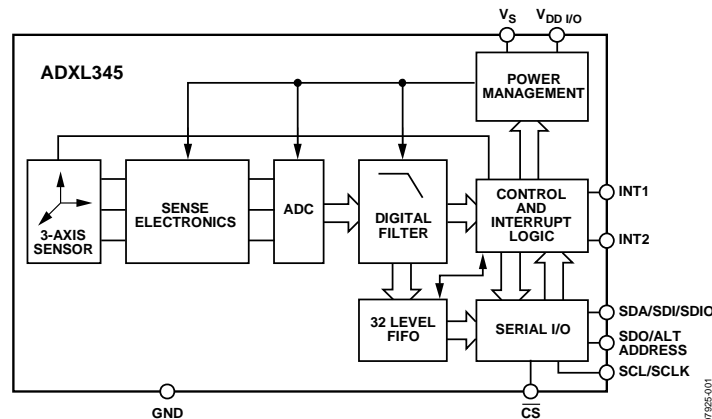


Figure 1.

Rev. C

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6/09—Revision 0: Initial Version

ADXL345

SPECIFICATIONS

T_A = 25°C, V_S = 2.5 V, V_{DD I/O} = 1.8 V, acceleration = 0 g, C_S = 10 μF tantalum, C_{I/O} = 0.1 μF, output data rate (ODR) = 800 Hz, unless otherwise noted. All minimum and maximum specifications are guaranteed. Typical specifications are not guaranteed.

Table 1.

| Parameter | Test Conditions | Min | Typ ¹ | Max | Unit |
|--|---|-------|------------------|----------------|---------|
| SENSOR INPUT | | | | | |
| Measurement Range | Each axis User selectable | | ±2, ±4, ±8, ±16 | | g |
| Nonlinearity | Percentage of full scale | | ±0.5 | | % |
| Inter-Axis Alignment Error | | | ±0.1 | | Degrees |
| Cross-Axis Sensitivity ² | | | ±1 | | % |
| OUTPUT RESOLUTION | | | | | |
| All g Ranges | Each axis 10-bit resolution | | 10 | | Bits |
| ±2 g Range | Full resolution | | 10 | | Bits |
| ±4 g Range | Full resolution | | 11 | | Bits |
| ±8 g Range | Full resolution | | 12 | | Bits |
| ±16 g Range | Full resolution | | 13 | | Bits |
| SENSITIVITY | | | | | |
| Sensitivity at X _{OUT} , Y _{OUT} , Z _{OUT} | All g-ranges, full resolution | 230 | 256 | 282 | LSB/g |
| | ±2 g, 10-bit resolution | 230 | 256 | 282 | LSB/g |
| | ±4 g, 10-bit resolution | 115 | 128 | 141 | LSB/g |
| | ±8 g, 10-bit resolution | 57 | 64 | 71 | LSB/g |
| | ±16 g, 10-bit resolution | 29 | 32 | 35 | LSB/g |
| Sensitivity Deviation from Ideal | All g-ranges | | ±1.0 | | % |
| Scale Factor at X _{OUT} , Y _{OUT} , Z _{OUT} | All g-ranges, full resolution | 3.5 | 3.9 | 4.3 | mg/LSB |
| | ±2 g, 10-bit resolution | 3.5 | 3.9 | 4.3 | mg/LSB |
| | ±4 g, 10-bit resolution | 7.1 | 7.8 | 8.7 | mg/LSB |
| | ±8 g, 10-bit resolution | 14.1 | 15.6 | 17.5 | mg/LSB |
| | ±16 g, 10-bit resolution | 28.6 | 31.2 | 34.5 | mg/LSB |
| Sensitivity Change Due to Temperature | | | ±0.01 | | %/°C |
| 0 g OFFSET | | | | | |
| 0 g Output for X _{OUT} , Y _{OUT} | Each axis | -150 | 0 | +150 | mg |
| 0 g Output for Z _{OUT} | | -250 | 0 | +250 | mg |
| 0 g Output Deviation from Ideal, X _{OUT} , Y _{OUT} | | | ±35 | | mg |
| 0 g Output Deviation from Ideal, Z _{OUT} | | | ±40 | | mg |
| 0 g Offset vs. Temperature for X-, Y-Axes | | | ±0.4 | | mg/°C |
| 0 g Offset vs. Temperature for Z-Axis | | | ±1.2 | | mg/°C |
| NOISE | | | | | |
| X-, Y-Axes | ODR = 100 Hz for ±2 g, 10-bit resolution or all g-ranges, full resolution | | 0.75 | | LSB rms |
| Z-Axis | ODR = 100 Hz for ±2 g, 10-bit resolution or all g-ranges, full resolution | | 1.1 | | LSB rms |
| OUTPUT DATA RATE AND BANDWIDTH | | | | | |
| Output Data Rate (ODR) ^{3, 4, 5} | User selectable | 0.1 | | 3200 | Hz |
| SELF-TEST⁶ | | | | | |
| Output Change in X-Axis | | 0.20 | | 2.10 | g |
| Output Change in Y-Axis | | -2.10 | | -0.20 | g |
| Output Change in Z-Axis | | 0.30 | | 3.40 | g |
| POWER SUPPLY | | | | | |
| Operating Voltage Range (V _S) | | 2.0 | 2.5 | 3.6 | V |
| Interface Voltage Range (V _{DD I/O}) | | 1.7 | 1.8 | V _S | V |
| Supply Current | ODR ≥ 100 Hz | | 140 | | μA |
| | ODR < 10 Hz | | 30 | | μA |
| Standby Mode Leakage Current | | | 0.1 | | μA |

ADXL345

| Parameter | Test Conditions | Min | Typ ¹ | Max | Unit |
|--|-----------------|-----|------------------|-----|------|
| TEMPERATURE Operating Temperature Range | | -40 | | +85 | °C |
| WEIGHT Device Weight | | | 30 | | mg |

¹ The typical specifications shown are for at least 68% of the population of parts and are based on the worst case of mean $\pm 1 \sigma$, except for 0 g output and sensitivity, which represents the target value. For 0 g offset and sensitivity, the deviation from the ideal describes the worst case of mean $\pm 1 \sigma$.

² Cross-axis sensitivity is defined as coupling between any two axes.

³ Bandwidth is the -3 dB frequency and is half the output data rate, bandwidth = ODR/2.

⁴ The output format for the 3200 Hz and 1600 Hz ODRs is different than the output format for the remaining ODRs. This difference is described in the Data Formatting of Upper Data Rates section.

⁵ Output data rates below 6.25 Hz exhibit additional offset shift with increased temperature, depending on selected output data rate. Refer to the Offset Performance at Lowest Data Rates section for details.

⁶ Self-test change is defined as the output (g) when the SELF_TEST bit = 1 (in the DATA_FORMAT register, Address 0x31) minus the output (g) when the SELF_TEST bit = 0. Due to device filtering, the output reaches its final value after $4 \times \tau$ when enabling or disabling self-test, where $\tau = 1/(\text{data rate})$. The part must be in normal power operation (LOW_POWER bit = 0 in the BW_RATE register, Address 0x2C) for self-test to operate correctly.

⁷ Turn-on and wake-up times are determined by the user-defined bandwidth. At a 100 Hz data rate, the turn-on and wake-up times are each approximately 11.1 ms. For other data rates, the turn-on and wake-up times are each approximately $\tau + 1.1$ in milliseconds, where $\tau = 1/(\text{data rate})$.

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