# Dual-Axis ±5 *g* Accelerometer with SPI Interface

Data Sheet

# ADIS16006

## FEATURES

**Dual-axis accelerometer**
**SPI digital output interface**
**Internal temperature sensor**
**Highly integrated; minimal external components**
**Bandwidth externally selectable**
**1.9 m*g* resolution at 60 Hz**
**Externally controlled electrostatic self-test**
**3.0 V to 5.25 V single-supply operation**
**Low power: <2 mA**
**3500 *g* shock survival**
**7.2 mm × 7.2 mm × 3.7 mm package**

## APPLICATIONS

**Industrial vibration/motion sensing**
**Platform stabilization**
**Dual-axis tilt sensing**
**Tracking, recording, analysis devices**
**Alarms and security devices**

## GENERAL DESCRIPTION

The ADIS16006 is a low cost, low power, complete dual-axis accelerometer with an integrated serial peripheral interface (SPI). An integrated temperature sensor is also available on the SPI interface. The ADIS16006 measures acceleration with a full-scale range of ±5 *g* (minimum). The ADIS16006 can measure both dynamic acceleration (vibration) and static acceleration (gravity).

The typical noise floor is 200 μg/√Hz, allowing signals below 1.9 m*g* (60 Hz bandwidth) to be resolved.

The bandwidth of the accelerometer is set with optional capacitors, $C_X$ and $C_Y$, at the XFILT pin and the YFILT pin. Digital output data for both axes is available via the serial interface.

An externally driven self-test pin (ST) allows the user to verify the accelerometer functionality.

The ADIS16006 is available in a 7.2 mm × 7.2 mm × 3.7 mm, 12-terminal LGA package.

## FUNCTIONAL BLOCK DIAGRAM

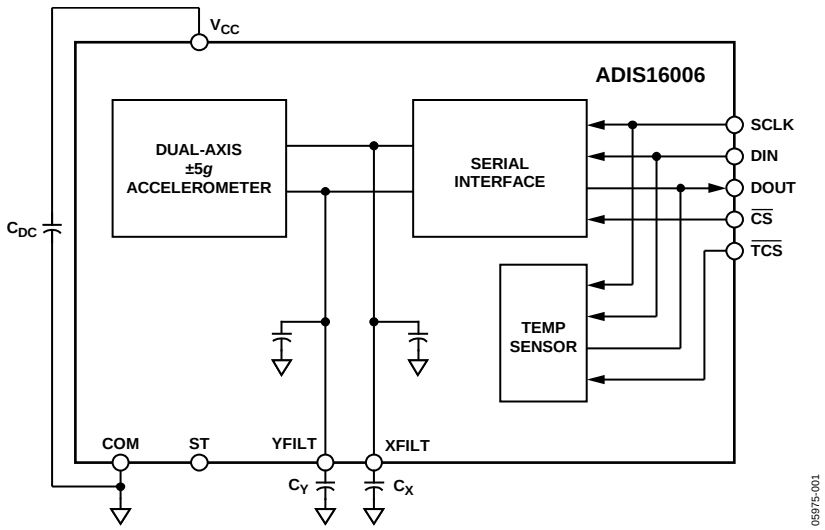


*Figure 1.*


Document Feedback


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**3/12—Rev. A to Rev. B**

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Added Table 6; Renumbered Sequentially ... 11

**10/07—Rev. 0 to Rev. A**

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**3/06—Revision 0: Initial Version**

# SPECIFICATIONS

$T_A$ = −40°C to +125°C, $V_{CC}$ = 5 V, $C_X$ = $C_Y$ = 0 µF, acceleration = 0 *g*, unless otherwise noted. All minimum and maximum specifications are guaranteed. Typical specifications are not guaranteed.

**Table 1.**

| Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| ACCELEROMETER SENSOR INPUT | Each axis | | | | |
| Measurement Range[1] | | ±5 | | | *g* |
| Nonlinearity | % of full scale | | ±0.5 | ±2.5 | % |
| Package Alignment Error | | | ±1.5 | | Degrees |
| Alignment Error | X sensor to Y sensor | | ±0.1 | | Degrees |
| Cross-Axis Sensitivity | | | ±1.5 | ±3 | % |
| ACCELEROMETER SENSITIVITY | Each axis | | | | |
| Sensitivity at XFILT, YFILT | | 242 | 256 | 272 | LSB/*g* |
| Sensitivity Change due to Temperature[2] | Delta from 25°C | | ±0.3 | | % |
| ZERO *g* BIAS LEVEL | Each axis | | | | |
| 0 *g* Voltage at XFILT, YFILT | | 1905 | 2048 | 2190 | LSB |
| 0 *g* Offset vs. Temperature | | | ±0.1 | | LSB/°C |
| ACCELEROMETER NOISE PERFORMANCE | | | | | |
| Noise Density | At 25°C | | 200 | | µ*g*/√Hz rms |
| ACCELEROMETER FREQUENCY RESPONSE[3, 4] | | | | | |
| $C_X$, $C_Y$ Range | | 0 | | 10 | µF |
| $R_{FILT}$ Tolerance | | 24 | 32 | 40 | kΩ |
| Sensor Bandwidth | $C_X$ = 0 µF, $C_Y$ = 0 µF | | 2.26 | | kHz |
| Sensor Resonant Frequency | | | 5.5 | | kHz |
| ACCELEROMETER SELF-TEST | | | | | |
| Logic Input Low | | | | 0.2 × $V_{CC}$ | V |
| Logic Input High | | 0.8 × $V_{CC}$ | | | V |
| ST Input Resistance to COM | | 30 | 50 | | kΩ |
| Output Change at $X_{OUT}$, $Y_{OUT}$[5] | Self-Test 0 to Self-Test 1 | 102 | 205 | 307 | LSB |
| TEMPERATURE SENSOR | | | | | |
| Accuracy | $V_{CC}$ = 3 V to 5.25 V | | ±2 | | °C |
| Resolution | | | 10 | | Bits |
| Update Rate | | | 400 | | µs |
| Temperature Conversion Time | | | 25 | | µs |
| DIGITAL INPUT | | | | | |
| Input High Voltage ($V_{INH}$) | $V_{CC}$ = 4.75 V to 5.25 V | 2.4 | | | V |
| | $V_{CC}$ = 3.0 V to 3.6 V | 2.1 | | | V |
| Input Low Voltage ($V_{INL}$) | $V_{CC}$ = 3.0 V to 5.25 V | | | 0.8 | V |
| Input Current | $V_{IN}$ = 0 V or $V_{CC}$ | −10 | +1 | +10 | µA |
| Input Capacitance | | | 10 | | pF |
| DIGITAL OUTPUT | | | | | |
| Output High Voltage ($V_{OH}$) | $I_{SOURCE}$ = 200 µA, $V_{CC}$ = 3.0 V to 5.25 V | $V_{CC}$ − 0.5 | | | V |
| Output Low Voltage ($V_{OL}$) | $I_{SINK}$ = 200 µA | | | 0.4 | V |

| Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| POWER SUPPLY | | | | | |
| Operating Voltage Range | | 3.0 | | 5.25 | V |
| Quiescent Supply Current | $f_{SCLK}$ = 50 kSPS | | 1.5 | 1.9 | mA |
| Power-Down Current | | | 1.0 | | mA |
| Turn-On Time[6] | $C_X$, $C_Y$ = 0.1 µF | | 20 | | ms |

[1] Guaranteed by measurement of initial offset and sensitivity.
[2] Defined as the output change from ambient-to-maximum temperature or ambient-to-minimum temperature.
[3] Actual bandwidth response controlled by user-supplied external capacitor ($C_X$, $C_Y$).
[4] See the Setting the Bandwidth section for more information on how to reduce the bandwidth.
[5] Self-test response changes as the square of $V_{CC}$.
[6] Larger values of $C_X$ and $C_Y$ increase turn-on time. Turn-on time is approximately (160 × (0.0022 + $C_X$ or $C_Y$) + 4) in milliseconds, where $C_X$ and $C_Y$ are in µF.

## TIMING SPECIFICATIONS

$T_A$ = −40°C to +125°C, acceleration = 0 *g*, unless otherwise noted.

**Table 2.**

| Parameter[1, 2] | $V_{CC}$ = 3.3 V | $V_{CC}$ = 5 V | Unit | Description |
|---|---|---|---|---|
| $f_{SCLK}$[3] | 10 | 10 | kHz min | |
| | 2 | 2 | MHz max | |
| $t_{CONVERT}$ | 14.5 × $t_{SCLK}$ | 14.5 × $t_{SCLK}$ | | |
| $t_{ACQ}$ | 1.5 × $t_{SCLK}$ | 1.5 × $t_{SCLK}$ | | Throughput time = $t_{CONVERT}$ + $t_{ACQ}$ = 16 × $t_{SCLK}$ |
| $t_1$ | 10 | 10 | ns min | $\overline{TCS}$/$\overline{CS}$ to SCLK setup time |
| $t_2$[4] | 60 | 30 | ns max | Delay from $\overline{TCS}$/$\overline{CS}$ until DOUT three-state disabled |
| $t_3$[4] | 100 | 75 | ns max | Data access time after SCLK falling edge |
| $t_4$ | 20 | 20 | ns min | Data setup time prior to SCLK rising edge |
| $t_5$ | 20 | 20 | ns min | Data hold time after SCLK rising edge |
| $t_6$ | 0.4 × $t_{SCLK}$ | 0.4 × $t_{SCLK}$ | ns min | SCLK high pulse width |
| $t_7$ | 0.4 × $t_{SCLK}$ | 0.4 × $t_{SCLK}$ | ns min | SCLK low pulse width |
| $t_8$[5] | 80 | 80 | ns max | $\overline{TCS}$/$\overline{CS}$ rising edge to DOUT high impedance |
| $t_9$[6] | 5 | 5 | µs typ | Power-up time from shutdown |

[1] Guaranteed by design. All input signals are specified with $t_R$ and $t_F$ = 5 ns (10% to 90% of $V_{CC}$) and timed from a voltage level of 1.6 V. The 3.3 V operating range spans from 3.0 V to 3.6 V. The 5 V operating range spans from 4.75 V to 5.25 V.
[2] See Figure 3 and Figure 4.
[3] Mark/space ratio for the SCLK input is 40/60 to 60/40.
[4] Measured with the load circuit in Figure 2 and defined as the time required for the output to cross 0.4 V or 2.0 V with $V_{CC}$ = 3.3 V and time for an output to cross 0.8 V or 2.4 V with $V_{CC}$ = 5.0 V.
[5] $t_8$ is derived from the measured time taken by the data outputs to change 0.5 V when loaded with the circuit in Figure 2. The measured number is then extrapolated back to remove the effects of charging or discharging the 50 pF capacitor. This means that the time, $t_8$, quoted in the Timing Specifications is the true bus relinquish time of the part and is independent of the bus loading.
[6] Shutdown recovery time denotes the time it takes to start producing samples and does not account for the recovery time of the sensor, which is dependent on the overall bandwidth.

## CIRCUIT AND TIMING DIAGRAMS

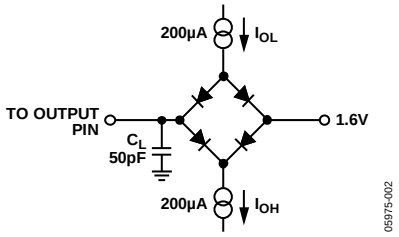


*Figure 2. Load Circuit for Digital Output Timing Specifications*

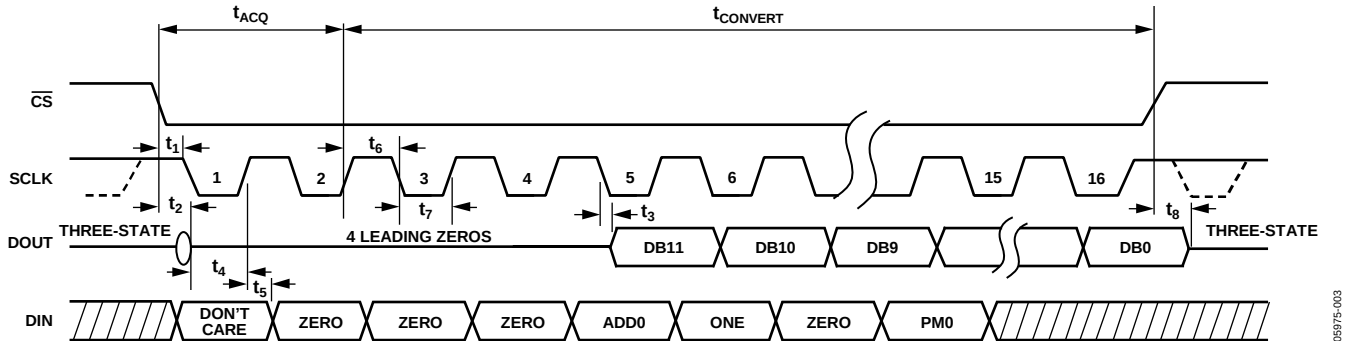


*Figure 3. Accelerometer Serial Interface Timing Diagram*

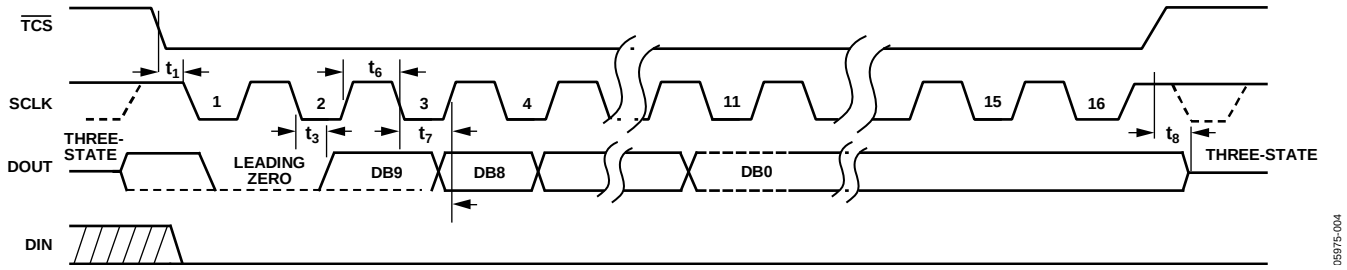


*Figure 4. Temperature Serial Interface Timing Diagram*

# ABSOLUTE MAXIMUM RATINGS

**Table 3.**

| Parameter | Rating |
|---|---|
| Acceleration (Any Axis, Unpowered) | 3500 *g* |
| Acceleration (Any Axis, Powered) | 3500 *g* |
| $V_{CC}$ | −0.3 V to +7.0 V |
| All Other Pins | (COM − 0.3 V) to ($V_{CC}$ + 0.3 V) |
| Output Short-Circuit Duration (Any Pin to Common) | Indefinite |
| Operating Temperature Range | −40°C to +125°C |
| Storage Temperature Range | −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 indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Table 4. Package Characteristics**

| Package Type | $\theta_{JA}$ | $\theta_{JC}$ | Device Weight |
|---|---|---|---|
| 12-Terminal LGA | 200°C/W | 25°C/W | 0.3 grams |

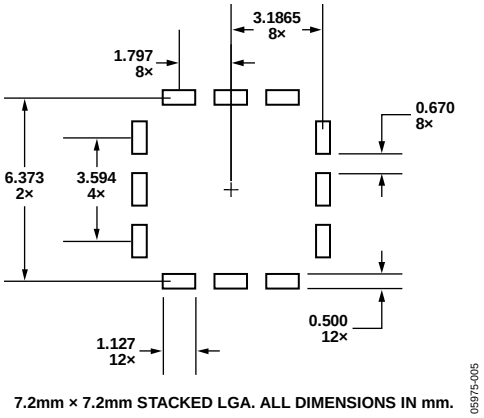


*Figure 5. Second-Level Assembly Pad Layout*

## ESD CAUTION

**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

# PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

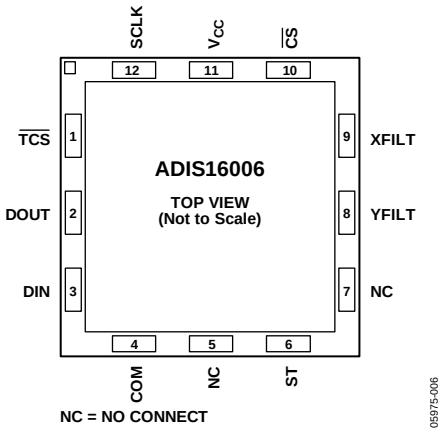


*Figure 6. Pin Configuration*

**Table 5. Pin Function Descriptions**

| Pin No. | Mnemonic | Description |
|---|---|---|
| 1 | $\overline{TCS}$ | Temperature Chip Select. Active low logic input. This input frames the serial data transfer for the temperature sensor output. |
| 2 | DOUT | Data Out, Logic Output. The conversion of the ADIS16006 is provided on this output as a serial data stream. The bits are clocked out on the falling edge of the SCLK input. |
| 3 | DIN | Data In, Logic Input. Data to be written into the control register of the ADIS16006 is provided on this input and is clocked into the register on the rising edge of SCLK. |
| 4 | COM | Common. Reference point for all circuitry on the ADIS16006. |
| 5, 7 | NC | No Connect. |
| 6 | ST | Self-Test Input. Active high logic input. Simulates a nominal 0.75 *g* test input for diagnostic purpose. |
| 8 | YFILT | Y-Channel Filter Node. Used in conjunction with an optional external capacitor to band limit the noise contribution from the accelerometer. |
| 9 | XFILT | X-Channel Filter Node. Used in conjunction with an optional external capacitor to band limit the noise contribution from the accelerometer. |
| 10 | $\overline{CS}$ | Chip Select. Active low logic input. This input provides the dual function of initiating the accelerometer conversions on the ADIS16006 and framing the serial data transfer for the accelerometer output. |
| 11 | $V_{CC}$ | Power Supply Input. The $V_{CC}$ range for the ADIS16006 is 3.0 V to 5.25 V. |
| 12 | SCLK | Serial Clock, Logic Input. SCLK provides the serial clock for accessing data from the part and writing serial data to the control register. This clock input is also used as the clock source for the conversion process of the ADIS16006. |

# TYPICAL PERFORMANCE CHARACTERISTICS

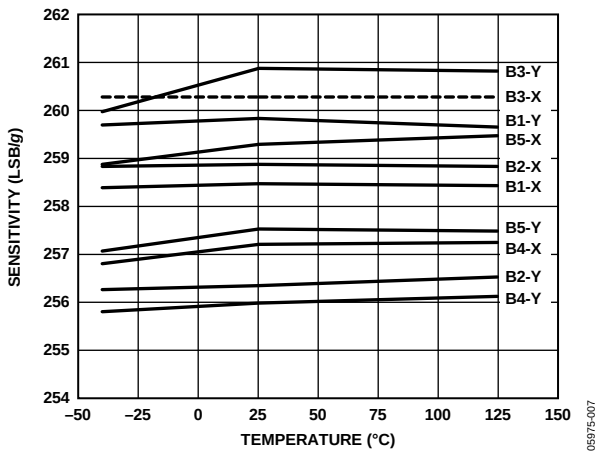


*Figure 7. Sensitivity vs. Temperature (±1 g Stimulus)*

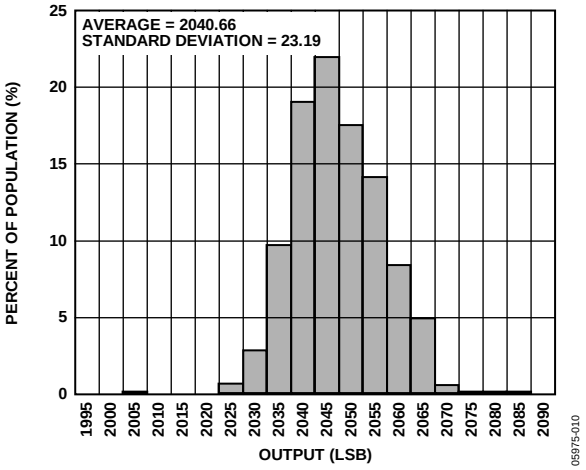


*Figure 10. X-Axis 0 g Bias at 25°C*

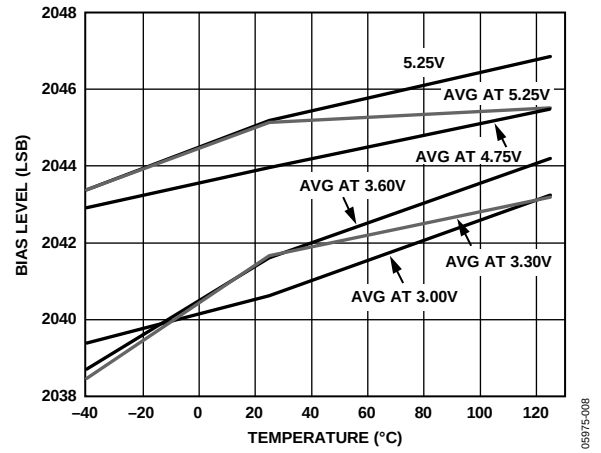


*Figure 8. X-Axis 0 g Bias vs. Temperature*

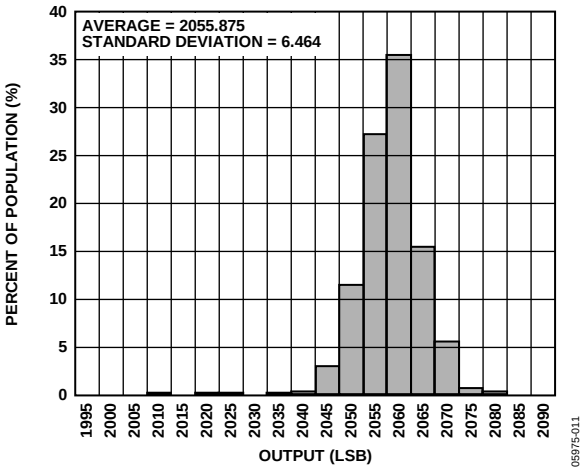


*Figure 11. Y-Axis 0 g Bias at 25°C*

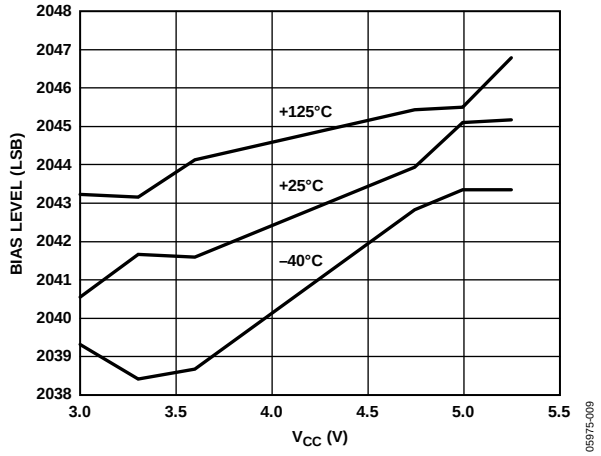


*Figure 9. X-Axis 0 g Bias vs. Supply Voltage*

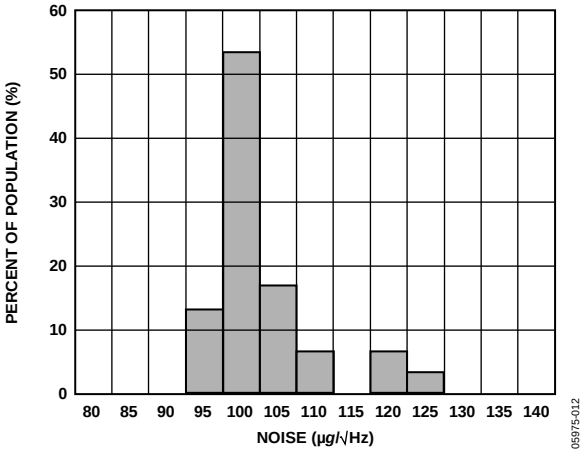


*Figure 12. Noise (X-Axis) at $V_{CC}$ = 5 V, 25°C*

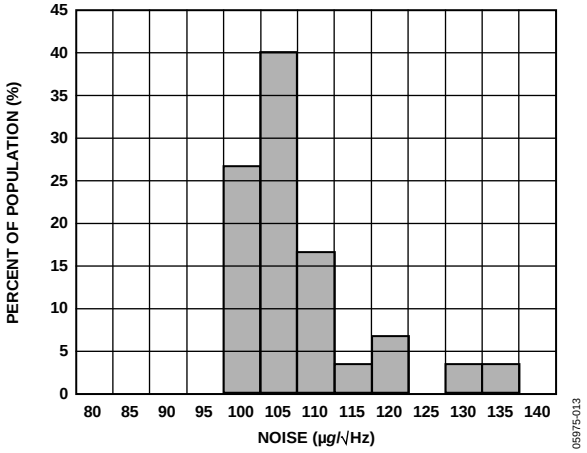


Figure 13. Noise (Y-Axis) at $V_{CC}$ = 5 V, 25°C

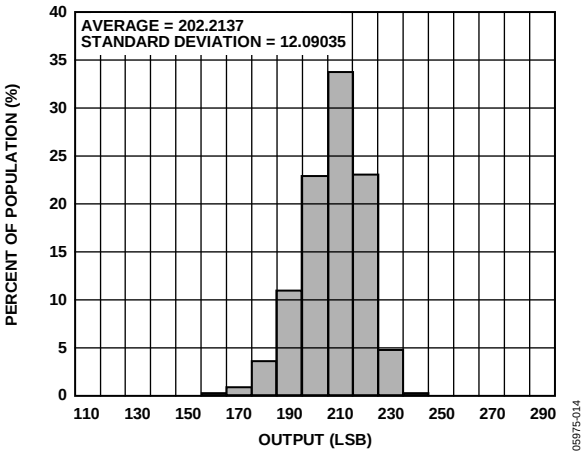


Figure 14. X-Axis Self-Test at $V_{CC}$ = 5 V, 25°C

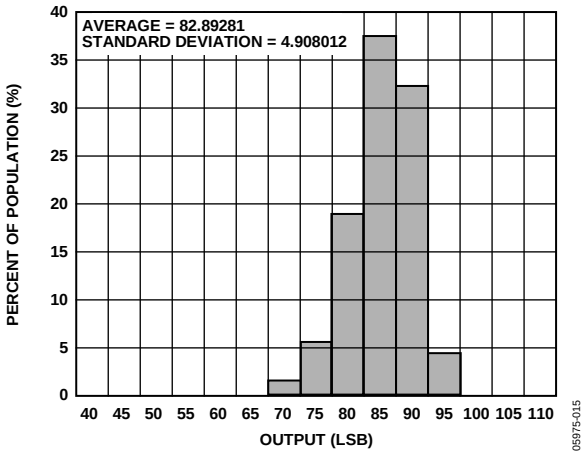


Figure 15. X-Axis Self-Test at $V_{CC}$ = 3.3 V, 25°C

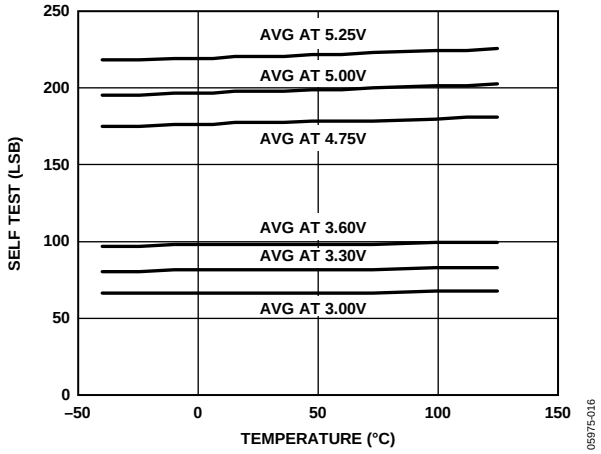


Figure 16. Self-Test X-Axis vs. Temperature

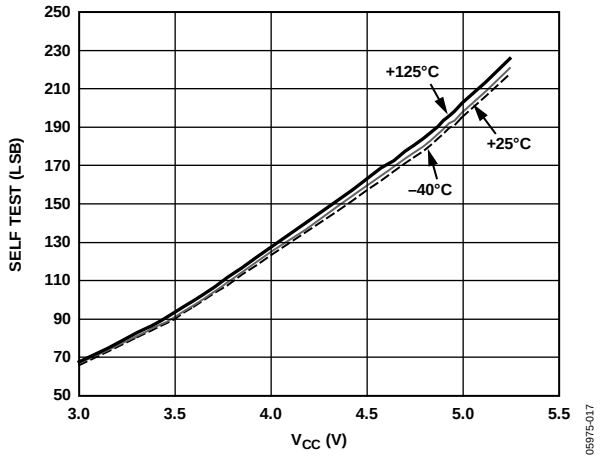


Figure 17. Self-Test X-Axis vs. Supply Voltage

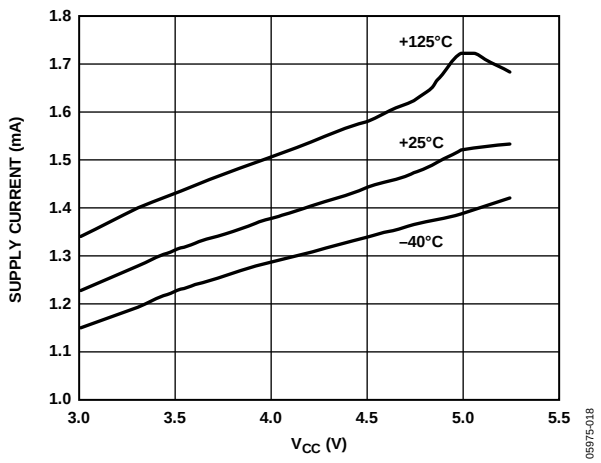


Figure 18. Supply Current vs. Supply Voltage

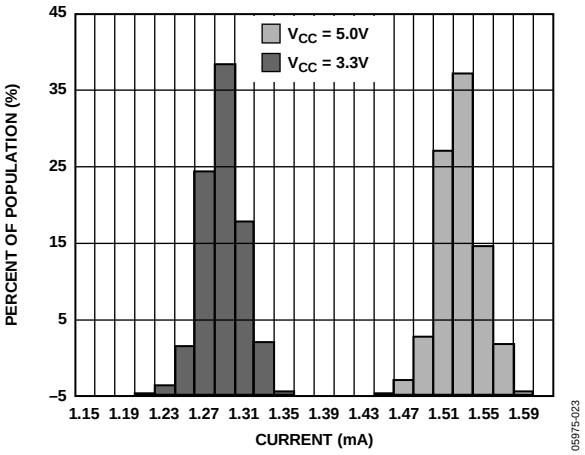


*Figure 19. Supply Current at 25°C*

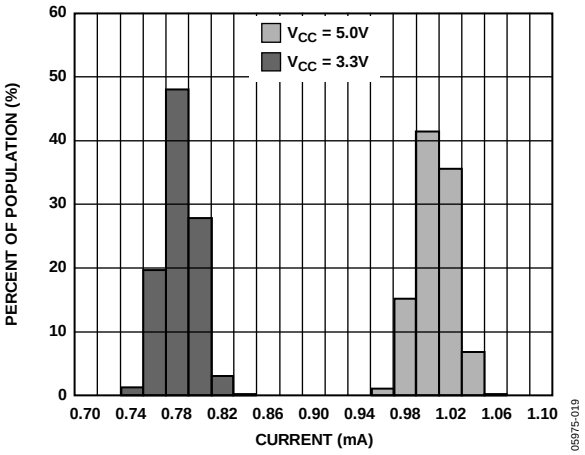


*Figure 20. Power-Down Supply Current*

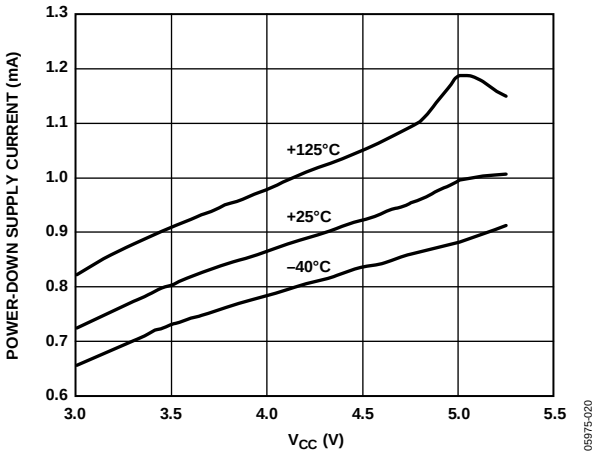


*Figure 21. Power-Down Supply Current vs. Supply Voltage*

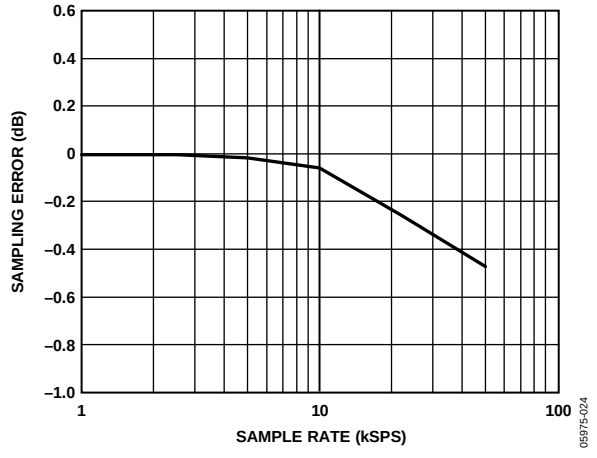


*Figure 22. Sampling Error vs. Sampling Frequency*

# THEORY OF OPERATION

The ADIS16006 is a low cost, low power, complete dual-axis accelerometer with an integrated serial peripheral interface (SPI) and an integrated temperature sensor whose output is also available on the SPI interface. The ADIS16006 is capable of measuring acceleration with a full-scale range of ±5 *g* (minimum). The ADIS16006 can measure both dynamic acceleration (vibration) and static acceleration (gravity).

## ACCELEROMETER DATA FORMAT

The accelerometer data is in a 12-bit, offset binary format. See Table 6 for examples of this data format.

**Table 6. Acceleration Data Format Examples**

| Acceleration (*g*) | Decimal | Hex | Binary |
|---|---|---|---|
| +5 | 3328 | 0xD00 | 1101 0000 0000 |
| +2/256 | 2050 | 0x802 | 1000 0000 0010 |
| +1/256 | 2049 | 0x801 | 1000 0000 0001 |
| 0 | 2048 | 0x800 | 1000 0000 0000 |
| −1/256 | 2047 | 0x7FF | 0111 1111 1111 |
| −2/256 | 2046 | 0x7FE | 0111 1111 1110 |
| −5 | 768 | 0x300 | 0011 0000 0000 |

## SELF-TEST

The ST pin controls the self-test feature. When this pin is set to $V_{CC}$, an electrostatic force is exerted on the beam of the accelerometer. The resulting movement of the beam allows the user to test if the accelerometer is functional. The typical change in output is 801 m*g* (corresponding to 205 LSB) for $V_{CC}$ = 5.0 V. This pin can be left open-circuit or connected to common in normal use. The ST pin should never be exposed to voltage greater than $V_{CC}$ + 0.3 V. If the system design is such that this condition cannot be guaranteed (for example, multiple supply voltages are present), a low $V_F$ clamping diode between ST and $V_{CC}$ is recommended.

## SERIAL INTERFACE

The serial interface on the ADIS16006 consists of five wires: $\overline{CS}$, $\overline{TCS}$, SCLK, DIN, and DOUT. Both accelerometer axes and the temperature sensor data are available on the serial interface. The $\overline{CS}$ and $\overline{TCS}$ are used to select the accelerometer or temperature sensor outputs, respectively. $\overline{CS}$ and $\overline{TCS}$ cannot be active at the same time.

The SCLK input accesses data from the internal data registers.

## ACCELEROMETER SERIAL INTERFACE

Figure 3 shows the detailed timing diagram for serial interfacing to the accelerometer in the ADIS16006. The serial clock provides the conversion clock. $\overline{CS}$ initiates the conversion process and data transfer and frames the serial data transfer for the accelerometer output. The accelerometer output is sampled on the second rising edge of the SCLK input after the falling edge of $\overline{CS}$. The conversion requires 16 SCLK cycles to complete. The rising edge of $\overline{CS}$ puts the bus back into three-state. If $\overline{CS}$ remains low, the next digital conversion is initiated. The details for the control register bit functions are shown in Table 7.

### *Accelerometer Control Register*

| MSB | | | | | | | LSB |
|---|---|---|---|---|---|---|---|
| DONTC | ZERO | ZERO | ZERO | ADD0 | ONE | ZERO | PM0 |

**Table 7. Accelerometer Control Register Bit Functions**

| Bit | Mnemonic | Comments |
|---|---|---|
| 7 | DONTC | Don't care. Can be 1 or 0. |
| 6, 5, 4 | ZERO | These bits should be held low. |
| 3 | ADD0 | This address bit selects the x-axis or y-axis outputs. A 0 selects the x-axis; a 1 selects the y-axis. |
| 2 | ONE | This bit should be held high. |
| 1 | ZERO | This bit should be held low. |
| 0 | PM0 | This bit selects the operation mode for the accelerometer; set to 0 for normal operation and 1 for power-down mode. |

### *Power-Down*

By setting PM0 to 1 when updating the accelerometer control register, the ADIS16006 goes into shutdown mode. The information stored in the control register is maintained during shutdown. The ADIS16006 changes modes as soon as the control register is updated. If the part is in shutdown mode and PM0 is changed to 0, the part powers up on the 16th SCLK rising edge.

### *ADD0*

By setting ADD0 to 0 when updating the accelerometer control register, the x-axis output is selected. By setting ADD0 to 1, the y-axis output is selected.

### *ZERO*

ZERO is defined as the Logic low level.

### *ONE*

ONE is defined as the Logic high level.

### *DONTC*

DONTC is defined as don't care and can be a low or high logic level.

### *Accelerometer Conversion Details*

Every time the accelerometer is sampled, the sampling function discharges the internal $C_X$ or $C_Y$ filtering capacitors by up to 2% of their initial values (assuming no additional external filtering capacitors are added). The recovery time for the filter capacitor to recharge is approximately 10 µs. Therefore, sampling the accelerometer at a rate of 10 kSPS or less does not induce a sampling error. However, as sampling frequencies increase above 10 kSPS, one can expect sampling errors to attenuate the actual acceleration levels.

## TEMPERATURE SENSOR SERIAL INTERFACE

### *Read Operation*

Figure 4 shows the timing diagram for a serial read from the temperature sensor. The $\overline{TCS}$ line enables the SCLK input. Ten bits of data and a leading zero are transferred during a read operation. Read operations occur during streams of 16 clock pulses. The serial data can be received into two bytes to accommodate the entire 10-bit data stream. If only eight bits of resolution are required, the data can be received into a single byte. At the end of the read operation, the DOUT line remains in the state of the last bit of data clocked out until $\overline{TCS}$ goes high, at which time the DOUT line from the temperature sensor goes three-state.

### *Write Operation*

Figure 4 also shows the timing diagram for the serial write to the temperature sensor. The write operation takes place at the same time as the read operation. Data is clocked into the control register on the rising edge of SCLK. DIN should remain low for the entire cycle.

### *Temperature Sensor Control Register*

| MSB | | | | | | | LSB |
|---|---|---|---|---|---|---|---|
| ZERO | ZERO | ZERO | ZERO | ZERO | ZERO | ZERO | ZERO |

**Table 8. Temperature Sensor Control Register Bit Functions**

| Bit | Mnemonic | Comments |
|---|---|---|
| 7 to 0 | ZERO | All bits should be held low. |

### *ZERO*

ZERO is defined as the Logic low level.

### *Output Data Format*

The output data format for the temperature sensor is twos complement. Table 9 shows the relationship between the temperature and the digital output.

**Table 9. Temperature Sensor Data Format**

| Temperature | Digital Output (DB9 … DB0) |
|---|---|
| −40°C | 11 0110 0000 |
| −25°C | 11 1001 1100 |
| −0.25°C | 11 1111 1111 |
| 0°C | 00 0000 0000 |
| +0.25°C | 00 0000 0001 |
| +10°C | 00 0010 1000 |
| +25°C | 00 0110 0100 |
| +50°C | 00 1100 1000 |
| +75°C | 01 0010 1100 |
| +100°C | 01 1001 0000 |
| +125°C | 01 1111 0100 |

### *Temperature Sensor Conversion Details*

The ADIS16006 features a 10-bit digital temperature sensor that allows an accurate measurement of the ambient device temperature to be made.

The conversion clock for the temperature sensor is internally generated; therefore, no external clock is required except when reading from and writing to the serial port. In normal mode, an internal clock oscillator runs the automatic conversion sequence. A conversion is initiated approximately every 350 µs. At this time, the temperature sensor wakes up and performs a temperature conversion. This temperature conversion typically takes 25 µs, at which time the temperature sensor automatically shuts down. The result of the most recent temperature conversion is available in the serial output register at any time. Once the conversion is finished, an internal oscillator starts counting and is designed to time out every 350 µs. The temperature sensor then powers up and does a conversion.

If the $\overline{TCS}$ is brought low every 350 µs (±30%) or less, the same temperature value is output onto the DOUT line every time without changing. It is recommended that the $\overline{TCS}$ line not be brought low every 350 µs (±30%) or less. The ±30% covers process variation. The $\overline{TCS}$ should become active (high to low) outside this range.

The device is designed to autoconvert every 350 µs. If the temperature sensor is accessed during the conversion process, an internal signal is generated to prevent any update of the temperature value register during the conversion. This prevents the user from reading back spurious data. The design of this feature results in this internal lockout signal being reset only at the start of the next autoconversion. Therefore, if the $\overline{TCS}$ line goes active before the internal lockout signal is reset to its inactive mode, the internal lockout signal is not reset. To ensure that no lockout signal is set, bring $\overline{TCS}$ low at a greater time than 350 µs (±30%). As a result, the temperature sensor is not interrupted during a conversion process.

In the automatic conversion mode, every time a read or write operation takes place, the internal clock oscillator is restarted at the end of the read or write operation. The result of the conversion is typically available 25 µs later. Reading from the device before conversion is complete provides the same set of data.

## POWER SUPPLY DECOUPLING

The ADIS16006 integrates two decoupling capacitors that are 0.047 µF in value. For local operation of the ADIS16006, no additional power supply decoupling capacitance is required. However, if the system power supply presents a substantial amount of noise, additional filtering can be required. If additional capacitors are required, connect the ground terminal of each of these capacitors directly to the underlying ground plane. Finally, note that all analog and digital grounds should be referenced to the same system ground reference point.

## SETTING THE BANDWIDTH

The ADIS16006 has provisions for band limiting the accelerometer. Capacitors can be added at the XFILT pin and the YFILT pin to implement further low-pass filtering for antialiasing and noise reduction. The equation for the 3 dB bandwidth is

$$f_{-3dB} = 1/(2\pi(32\ k\Omega) \times (C_{(XFILT,\ YFILT)} + 2200\ pF))$$

or more simply,

$$f_{-3dB} = 5\ \mu F/(C_{(XFILT,\ YFILT)} + 2200\ pF)$$

The tolerance of the internal resistor ($R_{FILT}$) can vary typically as much as ±25% of its nominal value (32 kΩ); thus, the bandwidth varies accordingly.

A minimum capacitance of 0 pF for $C_{XFILT}$ and $C_{YFILT}$ is allowable.

**Table 10. Filter Capacitor Selection, $C_{XFILT}$ and $C_{YFILT}$**

| Bandwidth (Hz) | Capacitor (µF) |
|---|---|
| 1 | 4.7 |
| 10 | 0.47 |
| 50 | 0.10 |
| 100 | 0.047 |
| 200 | 0.022 |
| 400 | 0.01 |
| 2250 | 0 |

## SELECTING FILTER CHARACTERISTICS: THE NOISE/BANDWIDTH TRADE-OFF

The accelerometer bandwidth selected ultimately determines the measurement resolution (smallest detectable acceleration). Filtering can be used to lower the noise floor, which improves the resolution of the accelerometer. Resolution is dependent on the analog filter bandwidth at XFILT and YFILT.

The ADIS16006 has a typical bandwidth of 2.25 kHz with no external filtering. The analog bandwidth can be further decreased to reduce noise and improve resolution.

The ADIS16006 noise has the characteristics of white Gaussian noise, which contributes equally at all frequencies and is described in terms of µg/√Hz (that is, the noise is proportional to the square root of the bandwidth of the accelerometer). The user should limit bandwidth to the lowest frequency needed by the application to maximize the resolution and dynamic range of the accelerometer.

With the single-pole, roll-off characteristic, the typical noise of the ADIS16006 is determined by

$$rmsNoise = (200\ \mu g/\sqrt{Hz}) \times (\sqrt{(BW \times 1.57)})$$

At 100 Hz, the noise is

$$rmsNoise = (200\ \mu g/\sqrt{Hz}) \times (\sqrt{(100 \times 1.57)}) = 2.5\ mg$$

Often, the peak value of the noise is desired. Peak-to-peak noise can only be estimated by statistical methods. Table 11 is useful for estimating the probabilities of exceeding various peak values, given the rms value.

**Table 11. Estimation of Peak-to-Peak Noise**

| Peak-to-Peak Value | Percentage of Time Noise Exceeds Nominal Peak-to-Peak Value (%) |
|---|---|
| 2 × rms | 32 |
| 4 × rms | 4.6 |
| 6 × rms | 0.27 |
| 8 × rms | 0.006 |

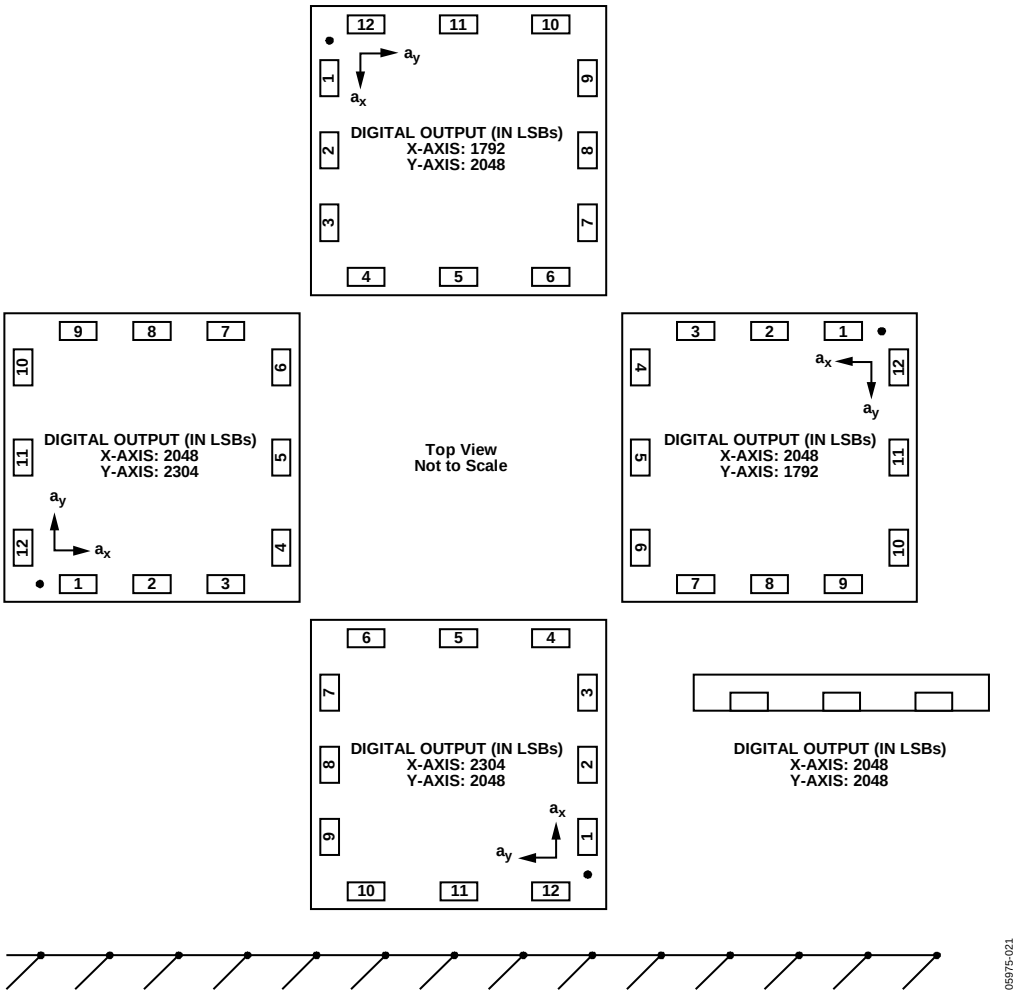


*Figure 23. Output Response vs. Orientation*

# APPLICATIONS

## SECOND LEVEL ASSEMBLY

The ADIS16006 can be attached to the second level assembly board using SN63 (or equivalent) or lead-free solder. IPC/JEDEC J-STD-020 and J-STD-033 provide standard handling procedures for these types of packages.

# OUTLINE DIMENSIONS

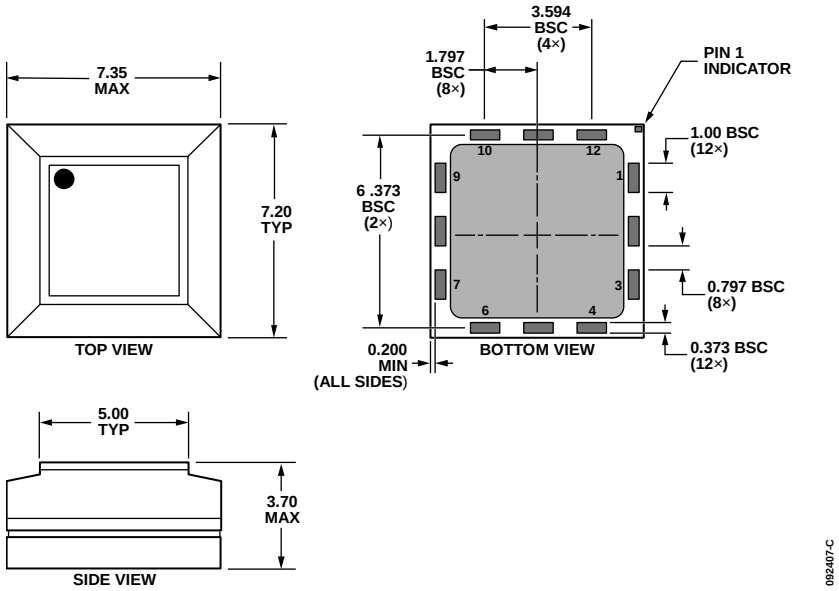


*Figure 24. 12-Terminal Land Grid Array [LGA]*
*(CC-12-1)*
*Dimensions shown in millimeters*

## ORDERING GUIDE

| Model[1] | Temperature Range | Package Description | Package Option |
|---|---|---|---|
| ADIS16006CCCZ | −40°C to +125°C | 12-Terminal Land Grid Array (LGA) | CC-12-1 |
| ADIS16006/PCBZ | | Evaluation Board | |

[1] Z = RoHS Compliant Part.


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