ANALOG DEVICES

AN-376
APPLICATION NOTE

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Using the ADXL50EM Accelerometer Evaluation Module

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IMPORTANT FEATURES

1. Complete Mechanically Assembled Acceleration Measuring System
2. Rugged, Nonresonant, Mechanical Mounting
3. Measures Accelerations Up to ±50 g
4. Operates on Single +5 V dc Supply
5. Precalibrated, Buffered Output
6. Nominal Sensitivity: 19 mV/g
7. Nominal 0 g Level: +1.8 V
8. Built-in Self-Test Feature
9. Wide Frequency Response: DC to 1 kHz

FUNCTIONAL DESCRIPTION

The ADXL50 evaluation module simplifies the evaluation, experimentation and testing of the ADXL50 accelerometer IC in a wide variety of accelerometer applications with a minimum of design effort.

Figure 1 shows the evaluation module's schematic (see the ADXL50 data sheet for more complete information regarding the ADXL50 IC). The module's output sensitivity, zero g offset level, and bandwidth may be easily modified by the user. The module has been carefully designed so that mechanical resonances are minimized.

CONSTRUCTION DETAILS

On the top side of the module's PC board is an ADXL50JH accelerometer and the board's ground plane. On the reverse side of the PC board are its surface-mount components, which are industry standard 0805 size capacitors and resistors.

Connection points for +5 V, ground, self-test, 3.4 V reference and V_{OUT} are shown in Figure 2. These are connected to the cable.

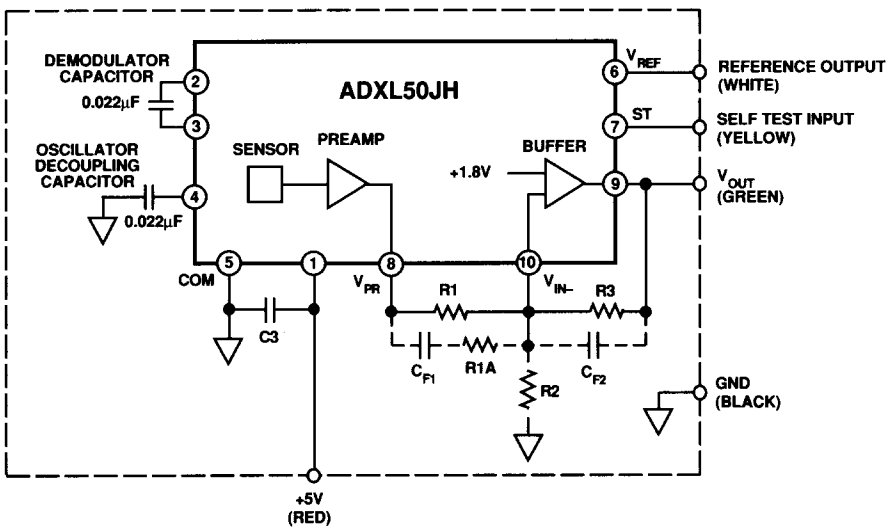


Figure 1. ADXL50EM Evaluation Module Schematic

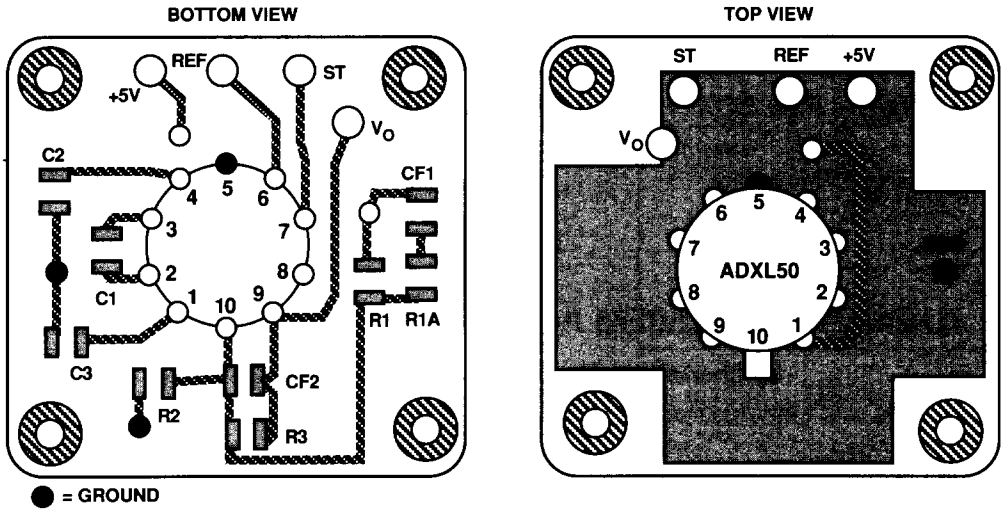


Figure 2. ADXL50EM Module Printed Circuit Board Layout

ADXL50EM MODULE SPECIFICATIONS

The ADXL50EM module is configured to provide a nominal output sensitivity of 19 mV/g with a 0 g level of +1.8 V. Except for variations due to the ±1% tolerance of the two 0.5% resistors used in the module, it has the same specifications as the ADXL50JH grade devices. For all other specifications, refer to the ADXL50 data sheet. Note that both sensitivity and 0 g offset can be user trimmed—see "modifying the ADXL50EM module."

Output Sensitivity & Polarity: In the ADXL50EM module the preamplifier output of the ADXL50 (V_{PR}) is internally connected to the ADXL50's buffer amplifier's input ($-V_{IN}$) terminal. Therefore, the output voltage polarity will be opposite that occurring at the V_{PR} terminal of the ADXL50.

Modifying the ADXL50EM Module: The output sensitivity, 0 g offset level, and circuit bandwidth can each be modified by removing the printed circuit board from the module and replacing or adding surface mount components. Nonsurface mount resistors or capacitors should not be used because they can resonate. Figure 2 shows the layout of the module's printed circuit board. Access to the board is provided by removing the four screws on the bottom of the module.

Standard Modifications Using the On-Chip Buffer Amplifier:

1. To add a one pole low pass filter, connect a chip capacitor of the desired value across resistor R3 (see the "one pole post filtering" section of the ADXL50 data sheet for details on component selection).
2. To modify for ac coupling (i.e., high pass filtering), remove resistor R1 and solder capacitor CF1 and resistor R1a to the footprints adjacent to R1.
3. To add bandpass filtering, perform Steps 1 and 2 above.
4. To perform a 0 g offset trim, temporarily connect a 500 kΩ trim potentiometer across the footprints labeled R2 and adjust the trim potentiometer for the desired 0 g level (above +1.8 V). Remember to orient the cube so that its axis of sensitivity is horizontal. Remove the trim potentiometer, measure its value with an ohmmeter, and then use the closest standard resistor value for R2.
5. To perform a sensitivity (scale factor) trim, remove resistor R1, temporarily insert a 100 kΩ trim potentiometer in its place and adjust for ±1 g using the earth's gravity (see the ADXL50 data sheet for more details). Remove the trim potentiometer and insert the closest standard value resistor onto the footprints.

When reinstalling the board, carefully hand tighten the board's mounting screws. If the board is to be removed and used outside the module, it should be attached to a rigid surface using four mounting screws with standoffs to provide clearance below the board.

MECHANICAL CHARACTERISTICS

In many accelerometer applications, proper mounting techniques are crucial in order to eliminate unwanted mechanical resonances (see the application note AN-372 for more details). Mechanical resonances produce vibrations which, to the accelerometer, are indistinguishable from an actual acceleration. The ADXL50EM module was specifically designed to minimize the majority of these resonances.

Resonances were minimized by making the board size as small as possible, by using only surface mount components, and by using a very flexible interconnection cable. The circuit board is attached to the module's shell using 4/40 screws in all four corners of the board providing the proper mechanical seating for vibration and shock testing.

Figure 3 shows the output amplitude vs. frequency of the ADXL50 accelerometer under ideal conditions. Although steps were taken to reduce resonances, the evaluation module demonstrates how the ADXL50 will actually behave when mounted on a typical printed circuit board. The graphs of Figures 4, 5, and 6 show the relative output amplitude vs. frequency of the ADXL50EM module when mounted in a mechanical

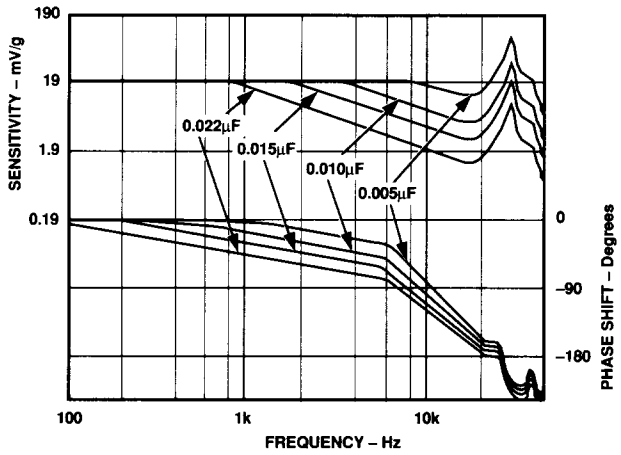


Figure 3. ADXL50EM Frequency Response for Various Demodulator Capacitors

shaker and accelerated along the X, Y or Z axis. Note that the scale of Figure 4 is 3 dB per division and 10 dB per division for the other two figures. Figure 4 shows a resonance at approximately 7 kHz due to the ADXL50 IC's package flexing on its leads as the PC board moves below it. Since the X axis amplitude includes the signal, its resonant peak appears small compared with the Y and Z axis amplitudes which contain virtually no signal and are normalized to the system noise. The resonance can vary in both amplitude and frequency depending on how securely the device is attached to the PC board.

Note that there are several easy ways to reduce these resonances. The most obvious is to simply low pass filter the ADXL50's output above its 1 kHz typical bandwidth, by adding a capacitor across resistor R3, the ADXL50 buffer's feedback resistor. Several mechanical cures may also be employed, such as potting the entire cavity of the module with a suitable material. Paraffin wax will allow removal of the circuit board while harder substances such as epoxy make a permanent bond. Potting the cavity will dramatically reduce the resonance amplitude. Alternatively, the header package of the ADXL50 can be epoxied to the board at the seating plane (the center of its pin circle) which will cause the resonant peak to shift higher in frequency to approximately 12 kHz.

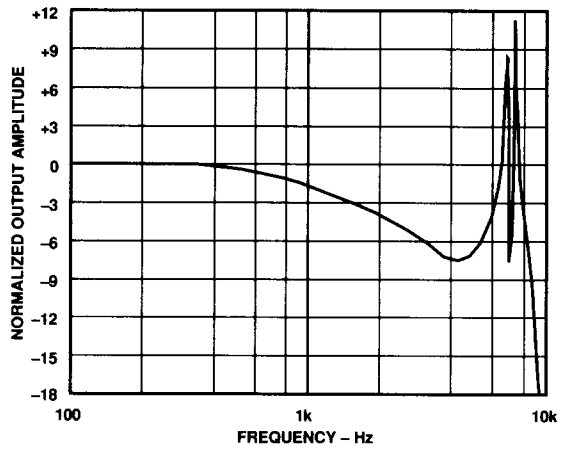


Figure 4. Normalized Amplitude vs. Frequency of the ADXL50EM Module When Accelerated Along the Sensitive "X" Axis

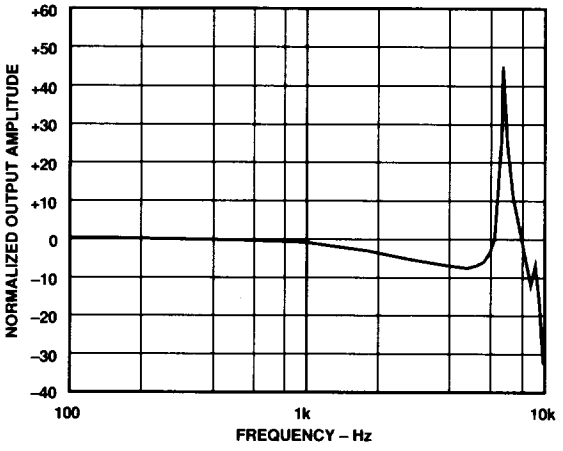


Figure 5. Normalized Amplitude vs. Frequency of the ADXL50EM Module When Accelerated Along Its Transverse "Y" Axis

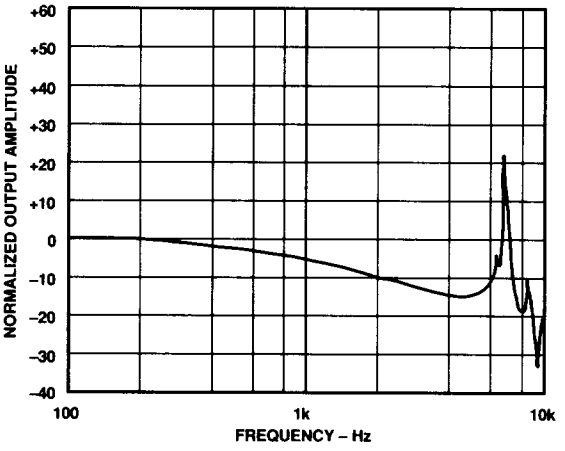


Figure 6. Normalized Amplitude vs. Frequency of the ADXL50EM Module When Accelerated Along Its Transverse "Z" Axis

CONNECTIONS & ORIENTATION

Figure 7 shows the connector pinout and wire color code for the ADXL50EM module. To avoid ground loop currents, the connector's "ground" or common lead should be a separate wire from that connecting the cable's shield to ground. Figure 8 provides mechanical dimensions of the ADXL50EM module.

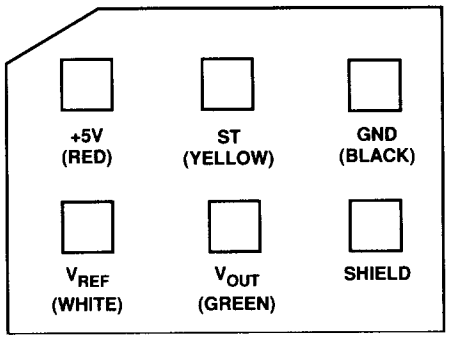
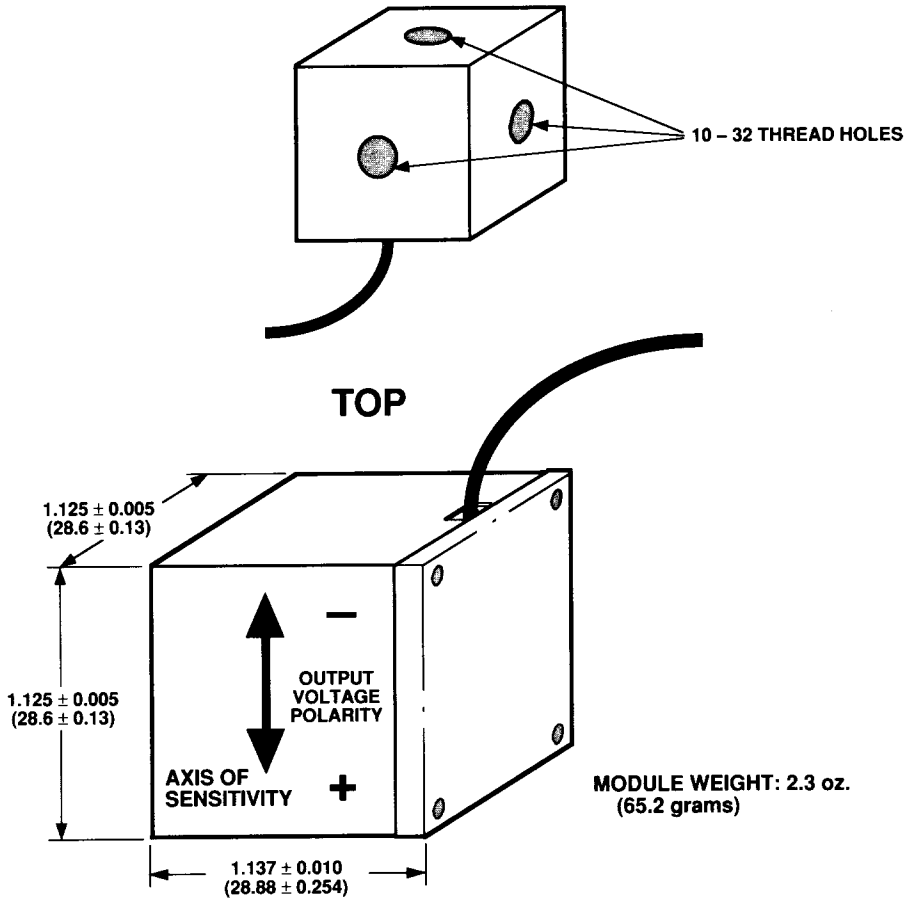


Figure 7. ADXL50EM Module Connector Pinout (As Seen Looking Down on Connector Pins)



DIMEMSIONS SHOWN ARE IN INCHES AND (mm).
NOTE: THE METAL CASE OF THE EVALUATION MODULE IS ISOLATED.

Figure 8. ADXL50EM Module Mechanical Dimensions

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