

# MC1321x Accelerometer Demonstration Program

## Quick Start Guide

### 1 Introduction

This application note describes the basic procedures necessary to run the MC1321x Accelerometer Demonstration Program. The Accelerometer Demonstration application is programmed into the Flash of the 13213-Sensor Reference Board (SRB) from the factory. The output power of the transmitter on the SRB is set to MAX\_POWER to provide maximum range.

The Accelerometer Demonstration highlights various wireless accelerometer use cases. For more details on running the other Simple Media Access Controller (SMAC) based demonstration applications, refer to AN3231.

For more details about the MC1321x, refer to the appropriate MC1321x, ZigBee™ - Compliant Platform - 2.4 GHz Low Power Transceiver for the IEEE® 802.15.4 Standard plus Microcontroller Data Sheet.

For more details about the SRB, refer to the *13213EVK Evaluation Kits User's Guide* (13213EVGUG).

A complete Accelerometer Demonstration consists of the embedded Accelerometer Demonstration code

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running on two SRBs. One SRB runs the PC\_Radio application (PC\_Radio Board) and the other SRB runs the Accelerometer application (Accelerometer Board). A PC with the Triax software installed and running is connected to the PC\_Radio Board through a USB connection.

## 2 Board Setup

To setup both boards for operation (transmit and receive), perform the steps shown in this section. [Figure 1](#) shows the SRB removed from its plastic case.

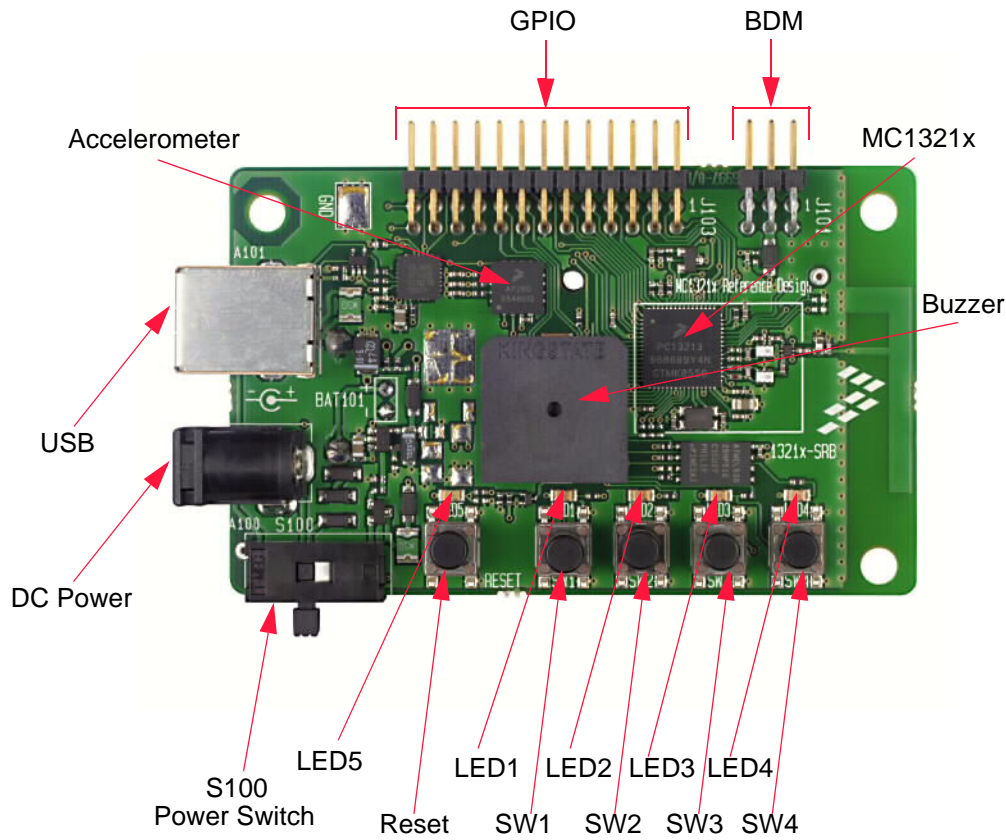


Figure 1. SRB Component Location

### 2.1 Board One Setup (PC\_Radio Board)

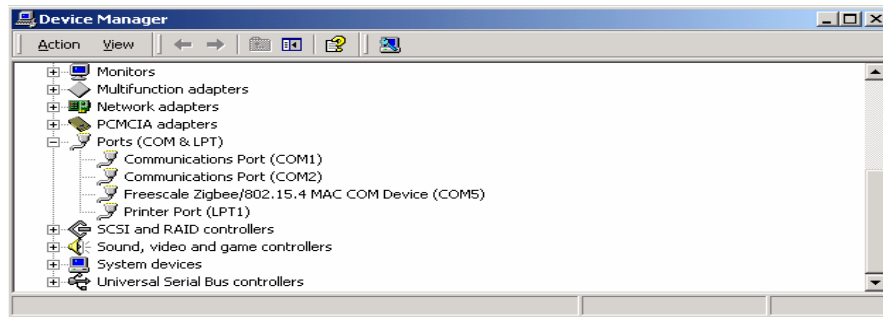
1. Connect a SRB to the PC using the USB cable included in the kit.
2. Connect the USB bus to the USB hub. This provides power to the board through the USB bus. Power on the board by setting the Power Switch (S100) to the ON position.
3. Press the Reset Button once. The LEDs are off, but the PC\_Radio application is running and in receive mode.

## 2.2 Board Two Setup (Accelerometer Board)

1. Connect 9 VDC power to DC power connector with the 9 VDC wall transformer included in the kit. Power on the board by setting the Power Switch (S100) to the ON position. Another board power option is to use the batteries which provides the advantage of true wireless operation (no cables) and allows users to easily move and manipulate the SRB.
2. Press the Reset Button once.
3. Press button SW1 once and LED3 will momentarily flash to indicate Application Two is running (Accelerometer Mode).
4. The Accelerometer application sends a ping packet to the PC\_Radio every two seconds. This is indicated on the Accelerometer Board by a blinking LED2.
5. The Accelerometer application detects when the Accelerometer Board is moved and quickly toggles LED1, then sends a packet to the PC\_Radio Board with an updated reading.

## 2.3 PC Setup

1. If the Evaluation Kit tools are already installed, then users can run the Triax software by navigating to the link using the Start menu.
2. From Windows, select Start->Programs->Freescale ZigBee->Test Tool->Triax.
  - a) If the Triax application does not exist, go to [Step 3](#) to install it.
  - b) If the application is in the Start Menu, go to [Step 8](#).
3. To run only the Triax application, insert the CD supplied with the kit into the PC CD-ROM drive.
4. If autorun is not enabled on the PC, locate the Autorun directory on the CD and run the `CDBrowser.exe` file.
5. After launching the Evaluation Kit CD Browser, select Install/Uninstall.
6. Select the SMAC packet under Additional.
7. Run the installation and select the appropriate install folder.
8. Run the `Triax.exe` file from the selected install location on the PC hard drive.
9. The Triax application is set up to run on COM ports 1-10. To check which COM port is being used by the USB, perform the following tasks:
  - a) Open the System Properties window by clicking on Start->Settings->Control Panel->System.
  - b) Select the “Hardware” tab, and click the “Device Manager” button. The Device Manager window appears as shown in [Figure 2](#).
  - c) Scroll to the “Ports” label and expand the tree by clicking the “+” sign to show the COM ports in the system.
  - d) The COM Port selected by the system is titled “Freescale ZigBee/802.15.4 MAC COM Device (COM5)” as shown in [Figure 2](#).

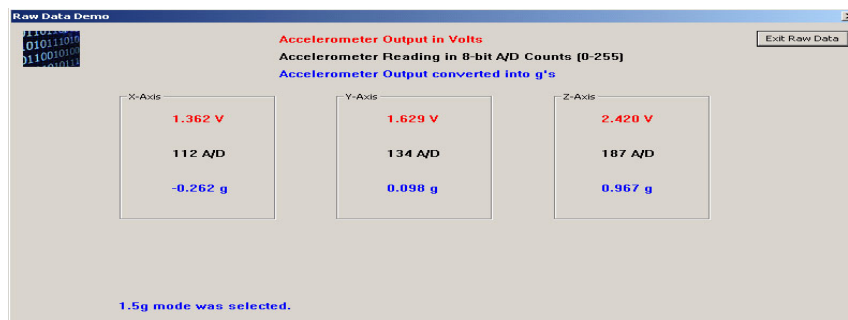


**Figure 2. COM Port Determination in Device Manager**

10. If the COM port chosen for “Freescale Zigbee/802.15.4 MAC COM Device” is not a port within Ports 1-10, then perform the following tasks:
  - a) Double click on “Freescale Zigbee/802.15.4 MAC COM Device” in the Device Manager window and the “Properties” window will appear.
  - b) Select the “Port Settings” tab and then click the “Advanced” button.
  - c) Go to the “Com Port Number” drop down menu and select a COM port between 1-10 that is not in use.

## 2.4 Verifying Operation

1. Check for the ping packet. The Accelerometer application sends a ping packet to the PC\_Radio every two (2) seconds as indicated by LED2. The Accelerometer Board quickly blinks LED2 indicating that the ping packet is sent. The PC\_Radio receives the ping and toggles LED2 upon reception. Once connectivity between the PC\_Radio and the Accelerometer Board is verified, go to [Step 2](#).
2. To check if the Accelerometer Board is working, move the Accelerometer Board. LED1 blinks, which indicates that the Accelerometer Board has detected movement.
3. With the default application, data that represents movement of the Accelerometer Board is sent to the PC\_Radio. When the PC\_Radio receives this data, LED2 toggles.
4. Select the “Raw Data” applet from the Triax application. The Raw Data applet shows the X, Y, and Z axes A/D values as reported by the Accelerometer Board. When the board is laying flat, the raw values should read approximately 0g for both the X and Y axes. However, the Z axis should read approximately 1g. As shown in [Figure 3](#), when the Accelerometer Board is moved, the values of the X, Y, and Z axes are updated on the Raw Data applet.



**Figure 3. Raw Data Demonstration**

## NOTE

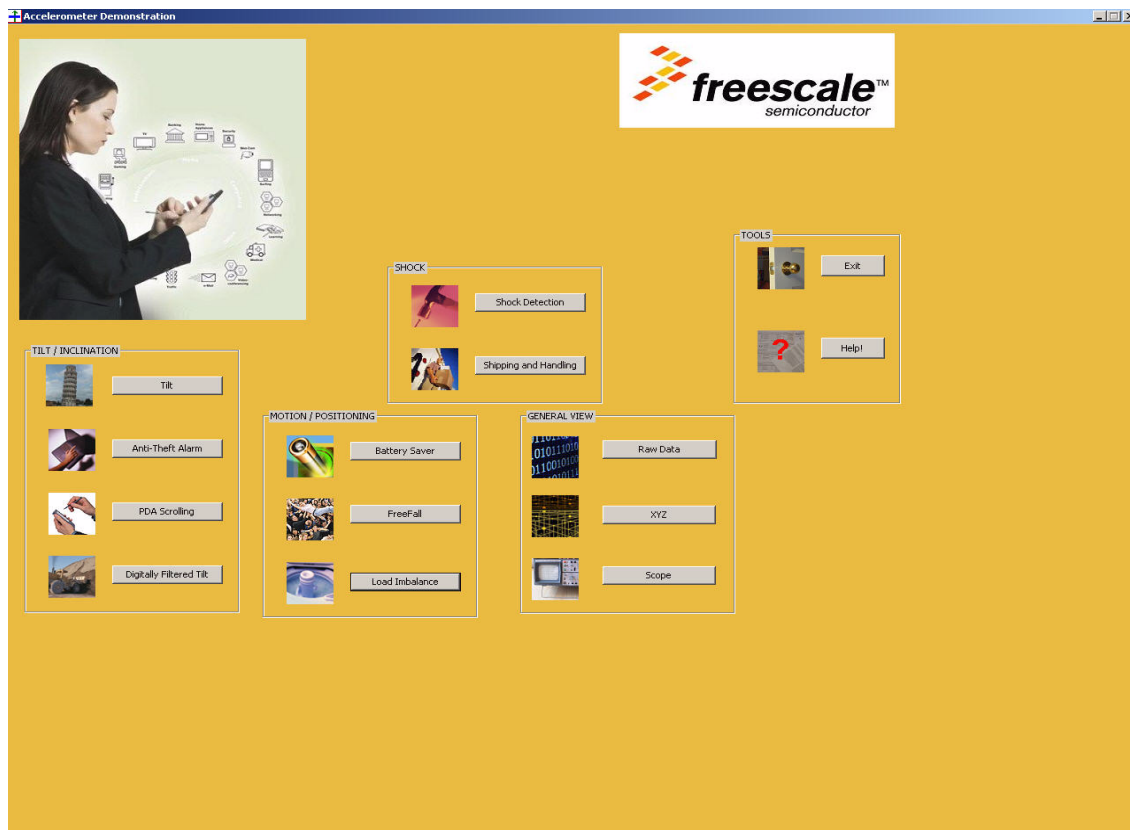
To improve accuracy of the accelerometer reading, refer to [Section 3.1.5](#), “Setting Up the Calibration Procedure”.

# 3 Customizing the Demonstration

This section describes how to customize the Accelerometer Demonstration program.

## 3.1 Accelerometer Demonstration

As shown in [Figure 4](#), all of the Accelerometer Demonstration applications are available from this window. Coming out of reset, the application defaults to Application One described later in this section. Application One sends X, Y, and Z axes data to the PC\_Radio when the Accelerometer Board is moved. The Triax software requests the data from the PC\_Radio and uses that information as needed. The majority of applets in the Triax software use this mode. However, some applets are stand alone and do not directly require a PC. Refer to AN3232 for more information on these stand alone applications.



**Figure 4. Accelerometer Demonstration Main Window**

The embedded applications described in this section do not require a PC and run on both the PC\_Radio Board and Accelerometer Board. The status and functionality are monitored using the LEDs on the boards.

### 3.1.1 Setting Up the Freefall Application

1. Press the Reset button once on the PC\_Radio Board. (Out of reset the PC Application is running.)
2. Press the Reset button once on the Accelerometer Board.
3. Press SW1 twice on the Accelerometer Board, pausing between each button press until LED3 and LED4 are lit. LED3 and LED4 indicate that Application Three (Freefall) is running.

Pick up the Accelerometer Board and while holding on to the board, perform a dropping motion to simulate a freefall. A buzzer sounds on the Accelerometer Board and sends a packet to the PC\_Radio Board to indicate a freefall. The PC\_Radio Board then sounds its buzzer and sets LED4.

### 3.1.2 Setting Up the Shock Detection Application

1. Press the Reset button once on the PC\_Radio Board. (Out of reset the PC application is running.)
2. Press the Reset button once on the Accelerometer Board.
3. Press SW1 three times on the Accelerometer Board, pausing between each button press until LED2 is lit. LED2 indicates that Application Four (Shock Detection) is running.
4. When moved in the X direction, the following occurs:
  - a) Accelerometer Board blinks LED1 once, sounds its buzzer once, then sends a packet to the PC\_Radio Board.
  - b) The PC\_Radio Board blinks LED4 once and sounds its buzzer once.
5. When moved in the Y direction, the following occurs:
  - a) Accelerometer Board blinks LED1 twice, sounds its buzzer twice, then sends a packet to the PC\_Radio Board.
  - b) The PC\_Radio Board blinks LED4 twice and sounds its buzzer twice.
6. When moved in the Z direction, the following occurs:
  - c) Accelerometer Board blinks LED1 three times, sounds its buzzer three times, then sends a packet to the PC\_Radio Board.
  - d) The PC\_Radio Board blinks LED4 three times and sounds its buzzer three times.

### 3.1.3 Setting Up the Anti Theft Alarm Application

1. Press the Reset button once on the PC\_Radio Board. (Out of reset the PC application is running.)
2. Press the Reset button once on the Accelerometer Board.
3. Press SW1 four times on the Accelerometer Board, pausing between each button press until LED2 and LED4 are lit. LED2 and LED4 indicate that Application Five (Anti Theft Alarm) is running.
4. If the Accelerometer Board is tilted 15 degrees past nominal, the buzzer sounds on both the PC\_Radio and the Accelerometer Board.

### 3.1.4 Setting Up the Battery Saver Application

1. Press the Reset button once on the PC\_Radio Board. (Out of reset the PC application is running.)
2. Press the Reset button once on the Accelerometer Board.
3. Press SW1 five times on the Accelerometer Board, pausing between each button press until LED2 and LED3 are lit. LED2 and LED3 indicate that Application Six (Battery Saver) is running.
4. If the Accelerometer Board is not moved for more than 5 seconds, a packet is sent to the PC\_Radio Board and its buzzer and LED4 are turned off. Once the Accelerometer Board is moved again, the PC\_Radio Board turns on its buzzer and sets LED4.

### 3.1.5 Setting Up the Calibration Procedure

In order to verify and visualize the calibration procedure, the `Triax.exe` PC GUI must be running, but it is not required.

1. Press the Reset button once on the PC\_Radio Board. (Out of reset, the PC application is running.)
2. Press the Reset button once on the Accelerometer Board.
3. Place the Accelerometer Board on a flat surface (component side up).
4. Press SW1 once on the Accelerometer Board to advance the application to the Accelerometer Mode (Application Two). LED3 momentarily lights to indicate that Application Two is running. The Accelerometer Board sends out a ping packet every two (2) seconds and updates the data on the XYZ Demo PC application each time the board is moved.
5. If the data points for the X, Y, and Z axes shown on the PC GUI are not near the origin of the graph, then continue to [Step 6](#).
6. Press SW4 once on the Accelerometer Board until all LEDs are lit. This shows that the calibration is being performed.
7. Verify that the Accelerometer Board is calibrated by viewing the X, Y, and Z axes on the PC GUI. The squares on the display should be approximately at axis point 0,0. If the calibration is still incorrect, repeat the calibration process until the data points are nominally at axis point 0,0.
8. Exit the application in the GUI and press the Reset button once on both boards. Press SW1 once on the Accelerometer Board to return to main application functionality.

## 3.2 Changing the RF Channel

In there is an interference issue, the RF channel can be changed by pressing SW2 on both the PC\_Radio and the Accelerometer Board. Only four (4) frequencies are available:

- 2405 GHz
- 2430 GHz
- 2455 GHz
- 2480 GHz

For example, out of reset, LED4 is set to indicate that the first channel (2.405 GHz) is being used. To change channels, press SW2 on the Accelerometer Board. The buzzer chirps and LED3 is set to indicate



that the second channel (2.430 GHz) is now being used. Press SW2 on the PC\_Radio board which will set LED3 and thus match channels with the Accelerometer Board.

The PC\_Radio Board and the Accelerometer Board are required to be on the same channel to work correctly. If communication problems exist, it is possible that one of the boards is on a different channel. Reset both boards to ensure that both are on the first channel (2.405 GHz), or push button SW2 until both boards LEDs match.

### NOTE

There is no reason to change channels unless the system encounters an interference issue or users want to simultaneously run multiple demonstrations.

## 3.3 PC Triax Applets

Users can run the following applets using Application One settings.

1. Raw Data — As shown in Figure 5, the Raw Data application shows the raw data sent from the accelerometers and processed by the MCU. The following data is provided:
  - X, Y, and Z accelerometer output in volts
  - 8-bit A/D readings (0-255)
  - The output of each axis is converted into g's.

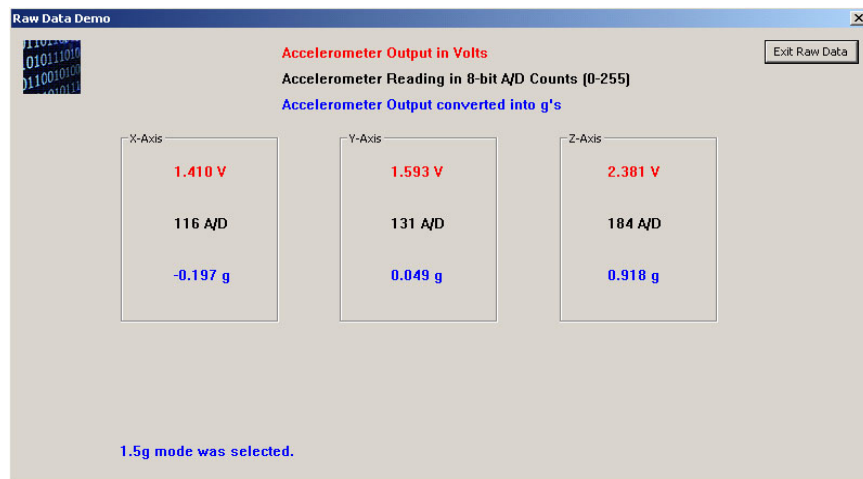
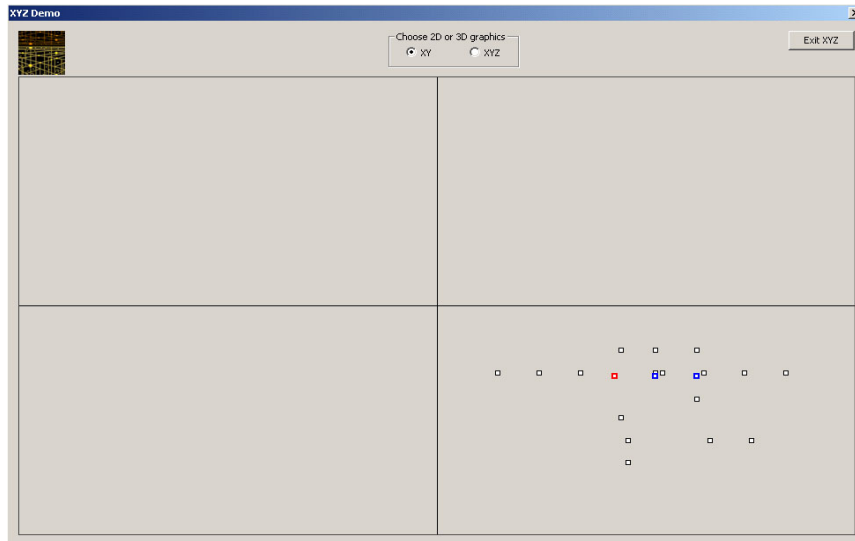


Figure 5. Raw Data Demonstration

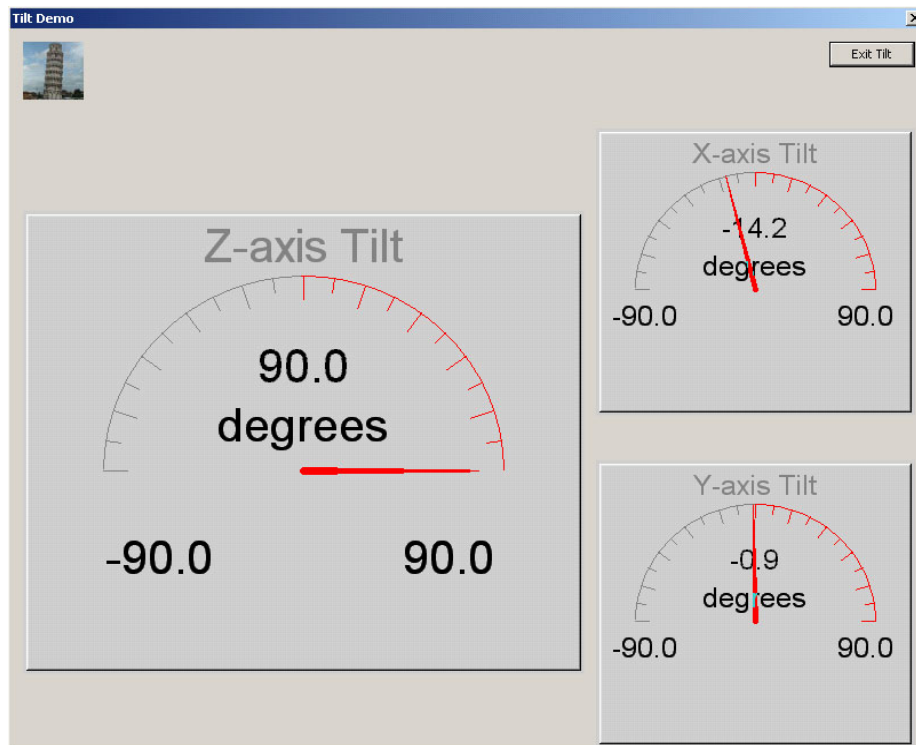


- XYZ Demo — As shown in [Figure 6](#), the XYZ Demo application displays the location of the board on two different dimensions (2D and 3D) based on movement of the board. To move the boxes on the display that represent the X, Y, and Z axes, pick up the PC\_Radio and move it to different angles.



**Figure 6. XYZ Demonstration**

- Tilt — The Tilt application translates the g's experienced in each axis to an angle of rotation. To view different angles, rotate the PC\_Radio Board.



**Figure 7. Tilt Module Application**

- Shipping and Handling — The Shipping and Handling application time stamps when a pre-determined threshold is violated or when a board is turned upside down.

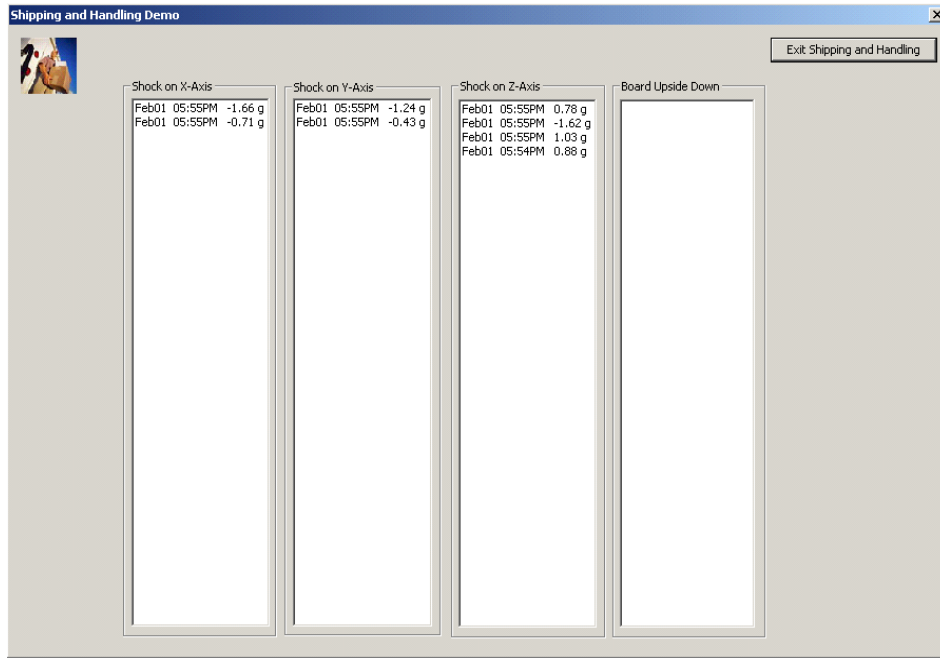


Figure 8. Shipping and Handling Demonstration

- PDA Scroll - The PDA application allows PDA menu selection by tilting.

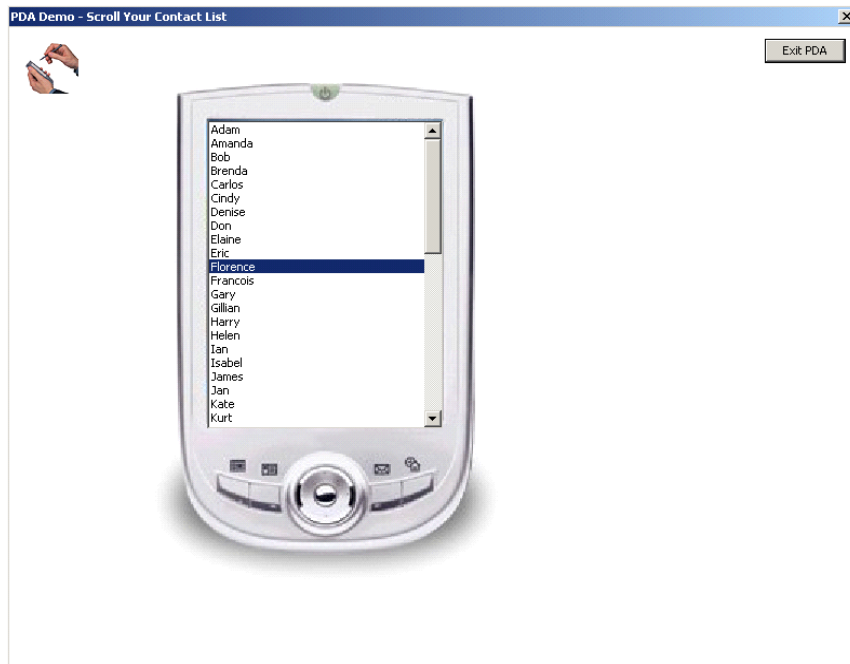
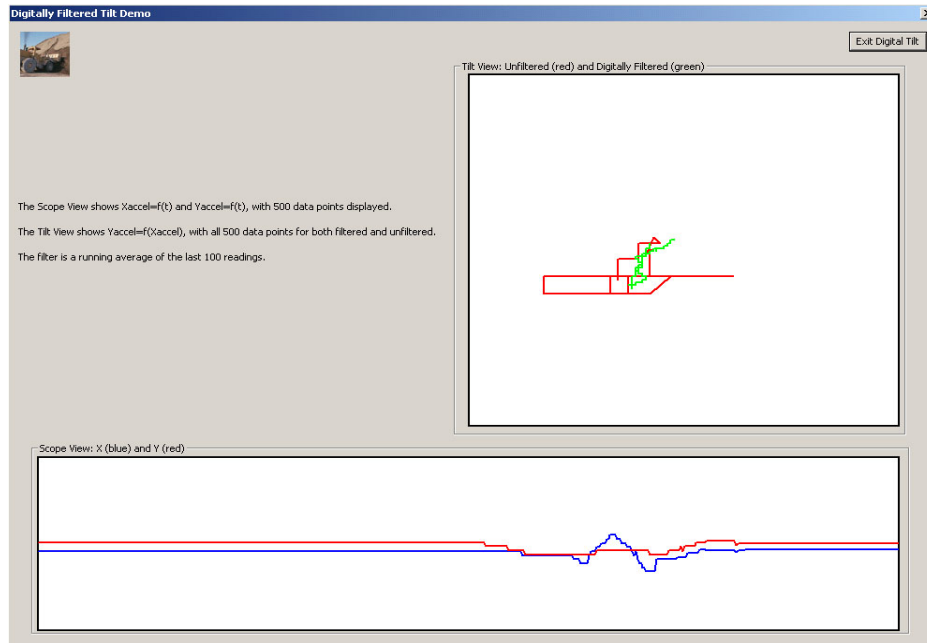


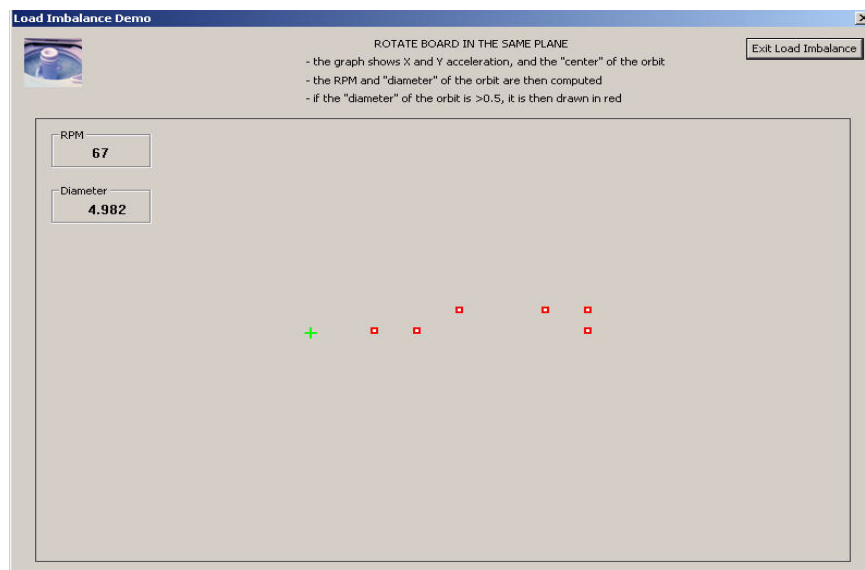
Figure 9. PDA Scroll Demonstration

- Digitally Filtered Tilt — The Digitally Filtered Tilt application provides a scope view of the X and Y axes. The scope view shows the X axis in blue and the Y axis in red. The tilt view shows two different data types of the X axis (unfiltered and filtered, average of 100 readings). The unfiltered data is in red and the filtered data is in green.



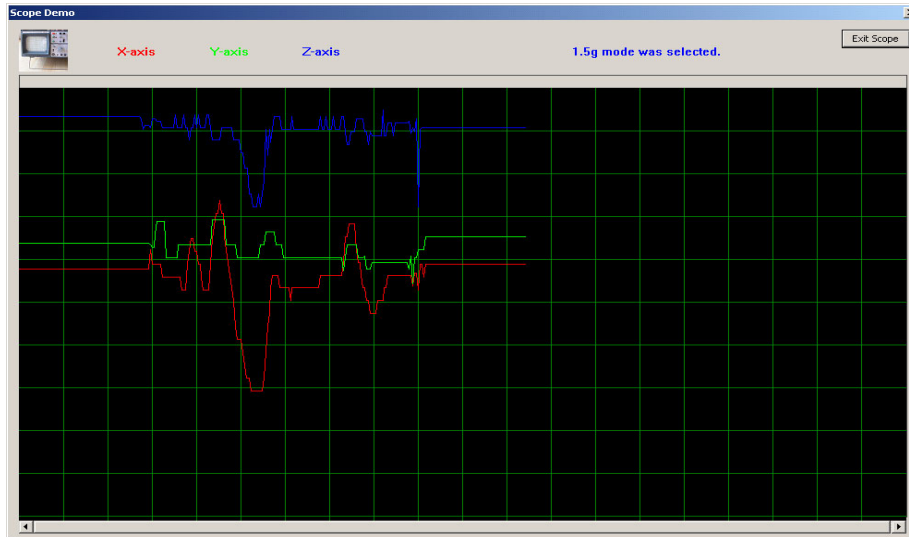
**Figure 10. Digitally Filtered Tilt**

- Load Imbalance Demonstration — The Load Imbalance Demonstration application shows a graph of the X and Y acceleration and the center of the orbit. The Rotations Per Minute (RPM) and the diameter are calculated using the X and Y values. If the diameter of the orbit is more than 0.5 inches, it is drawn in red.



**Figure 11. Load Imbalance Demonstration**

8. Scope Demonstration - The Scope Demonstration application displays the X, Y, and Z axes based on the movement of the board. The X axis is displayed in red, the Y axis is displayed in green, and the Z axis is displayed in blue.



**Figure 12. Scope Demonstration**

**NOTE**

If the Accelerometer Demonstration behavior becomes erratic when using batteries as the SRB power source, replace the batteries.

## NOTES

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