

Accelerometer Demonstration

With the 13213-SRB (Sensor Reference Board)

1 Introduction

This application note describes how Freescale's accelerometer technology is used in conjunction with the Freescale MC13213 device. The MC13213 is Freescale's second-generation ZigBee platform which incorporates a low power 2.4 GHz radio frequency transceiver and an 8-bit microcontroller into a single 9x9x1 mm 71-pin LGA package. The MC13213 RF transceiver is an IEEE[®] 802.15.4-compliant radio that operates in the 2.4 GHz ISM frequency band. The MC13213 microcontroller is based on the HCS08 Family of Microcontroller Units (MCU) and provides 60K of flash and 4KB of RAM and is also intended for use with the Freescale fully compliant 802.15.4 MAC where larger memory is required. In addition, the MC13213 can support ZigBee applications that use a stack from 3rd party vendors. For more details about the MC13213, refer to the MC13211/212/213/214 ZigBee[™]- Compliant Platform - 2.4 GHz Low Power Transceiver for the IEEE[®] 802.15.4 Standard plus Microcontroller Data Sheet, document number MC1321x.

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Using micro machining and integrated circuit technology, Freescale produces highly reliable, capacitive, acceleration sensors. Freescale's sensor technology can be used in a number of applications including medical, appliance, consumer, and industrial areas such as washing machines, gaming, LCD projectors, tracking boards, and robotics. This application note outlines how the Triax demonstration application is written and configured. Basic demonstration program operating instructions can be found in AN3230, *MC1321x Accelerometer Demonstration Program Quick Start Guide*.

2 SRB Hardware Overview

The SRB introduces users to the MC13213 2.4 GHz wireless data transceiver and low power, low cost 8-bit MCU integrated into a single package. The SRB includes a USB port configured as a virtual communications port, background debug module (BDM) for in-circuit hardware debug and programming, switches, LEDs, 3-axis accelerometers and a buzzer. This provides users with a small, low-cost development platform for establishing wireless data networks.

The SRB is a 2 inch by 3 inch reference board that can be configured as a network node that contains the MC13213 transceiver/MCU System in a Package (SiP), a 16 MHz crystal, and a printed circuit antenna. Also included is a Freescale MMA7260QR2 3-axis accelerometer that has four g-force settings:

- +/- 1.5
- +/- 2.0
- +/- 4.0
- +/- 6.0

The accelerometer also has a power saving enable pin. See the MMA7260Q Data Sheet for more details.

Four switches and four LEDs are available for application and user interaction. The SRB derives its power from either the USB port or a 2.1 mm power connector that allows an input supply voltage range of 5 to 9 VDC.

For a more in-depth description of the SRB, refer to the *MC13213-EVK User's Guide* (MC13213EVKUG).

3 Triax Demonstration Overview

The Triax demonstration is a collection of hardware and software that contains the following:

- Two SRBs (one SRB used as a PC_Radio Board and the other used as an Accelerometer Board)
- A USB cable to provide serial communication between the PC and the PC_Radio application running on the PC_Radio Board
- A power supply for the Accelerometer application running on the Accelerometer Board
- The standalone Triax Software PC application
- The embedded application that runs on both the PC_Radio Board and the Accelerometer Board
- A Serial Command Protocol that is implemented on both the Triax Software PC application and the PC_Radio Board
- An RF command set that communicates between the Accelerometer Board and the PC_Radio Board over-the-air using the Simplified Media Access Controller (SMAC)

NOTE

ANSI C Source code is provided for the embedded applications so users are able to see how a basic SMAC application is written and debugged.

Figure 1 shows the basic functional blocks of the Accelerometer Demonstration and serves as a guide that describes how all of the blocks communicate to build a working Accelerometer Demonstration application.

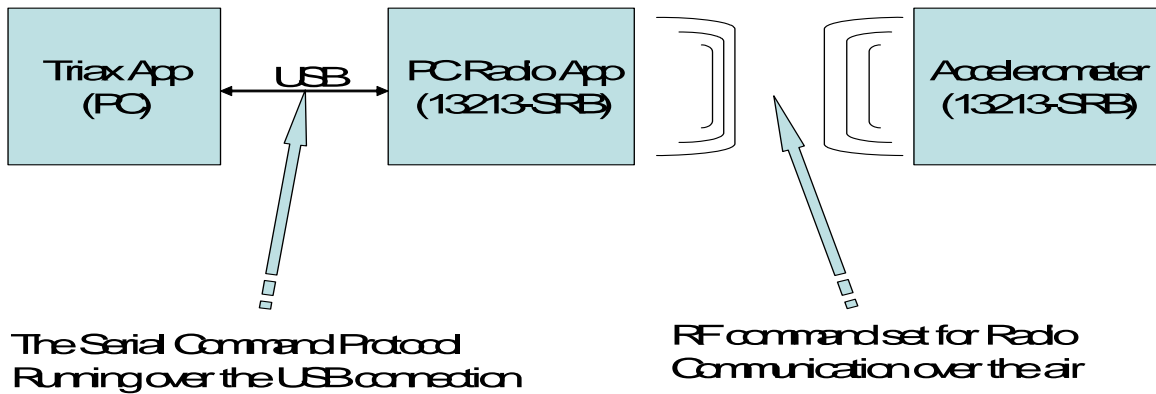


Figure 1. General Triax Demonstration System Overview

NOTE

It is important to understand the names and functions of all the devices shown in Figure 1 because applications and demonstration described later in this note refer to their meaning.

4 Triax Graphical User Interface (GUI)

The Triax demonstration GUI shown in Figure 2 was built to show wireless sensor examples that use the on-board accelerometer on the SRBs. The Triax GUI is a collection of applets that show some basic accelerometer applications. Two different types of applets are available:

- [Table 1](#) lists a set of applets that are PC-based and require the PC_Radio board to be connected to the PC for graphical output
- [Table 2](#) lists a set of applets that are embedded, standalone applications that do not require connection to a PC

Table 1. Accelerometer Applications That Require a PC Connection

Applet Name	Description
Tilt	Shows analogue gauges for X, Y, and Z axes applications.
PDA Scrolling	Provides a virtual PDA that shows menu scrolling via X axis tilting.
Digitally Filtered Tilt	Shows X and Y axis, XY line plots as well as a scrolling histogram of the X and Y axis data.
Shipping and Handling	Provides a log of X, Y, and Z axes movement over a specified accelerometer threshold in the X, Y, and Z axes. Also provides an indicator that shows if the SRB has been turned upside down. The Shipping and Handling applet simulates a shipping acceleration monitor for tracking sensitive packages.

Table 1. Accelerometer Applications That Require a PC Connection

Applet Name	Description
Raw Data	Shows the X,Y, and Z axes raw A/D data, the interpolated voltage, as well as the associated acceleration reading measured in g's.
XYZ	Shows either a 2-dimensional projection of the current X and Y axis readings or a 3-dimensional projection of the X, Y, and Z axes.
Scope	A running chart of the X, Y, and Z axes readings on a traditional scope background.
Load Imbalance	Load imbalance shows the lateral movement in the X and Y plane and determines if an unbalanced condition exists in a simulated washing machine application.

Table 2. Standalone Accelerometer Applications

Application Name	Application Number	Description
PC_Radio	1	The application that communicates with the PC GUI.
Accel	2	The remote application that communicates to the PC_Radio.
Freefall	3	Detects when the Z axis accelerometer is measuring approximately 0g's. If a freefall is detected, the accelerometer packet buzzer is turned on and a packet is sent from the Accelerometer application on the Accelerometer board to the PC_Radio application on the PC_Radio board. When the PC_Radio board receives the freefall indication from the Accelerometer Board, the PC_Radio board's buzzer and LED4 are turned on.
Shock Detection	4	Detects movement in any of the X, Y, or Z axes. On movement, the following occurs on the Accelerometer Board: <ul style="list-style-type: none"> • For movement detected in the X axis, LED1 blinks once and the buzzer chirps once. • For movement detected in the Y axis LED1 blinks twice and the buzzer chirps twice. • For movement detected in the Z axis, LED1 blinks three times and the buzzer chirps three times. On movement in any axis, the Accelerometer Board sends a data packet to the PC_Radio Board and the following occurs on the PC_Radio Board: <ul style="list-style-type: none"> • LED4 blinks once and the buzzer chirps once to indicate X axis movement. • LED4 blinks twice and the buzzer chirps twice to indicate Y axis movement. • LED4 blinks three times and the buzzer chirps three times to indicate Z axis movement.
Anti-Theft	5	If the Accelerometer Board is tilted more than 15 degrees off of the default center position, the buzzer is turned on and a data packet is sent to the PC_Radio Board which will then turn on its buzzer and LED4.
Battery Save	6	The Battery Saver application shows how an application can take advantage of an accelerometer being used as a power saving component on a battery operated board. The Accelerometer Board simulates a board that is powered up by turning on its buzzer. When the Accelerometer Board is not moved for at least 5 seconds, the board simulates powering down by turning off its buzzer. Once the Accelerometer Board detects movement, the board simulates a power up and the buzzer is again turned on. This is a good demonstration for a remote control board.



Figure 2. Triax Main Window

NOTE

For optimal viewing, the display settings should be set to 96 DPI and the resolution set to 1280x1024.

4.1 Sensor Data View

To accurately map the output of the MMA7260QR2 accelerometer to the “Raw Data” applet in the Triax application while the SRB is laying flat, the raw values should read approximately 0,0 for the X and Y axes. This is because the SRB is not moving in either axis. However, the Z axis should read approximately 1 because gravity is pushing down on the device at approximately 1g. If a user were to stand still while holding the SRB flat (component side up) gravity would be pushing down on the accelerometer and the user should see the Z axis value at approximately 1g. Users can turn the SRB upside down (component side down) and the accelerometer Z axis value should be approximately -1g. [Figure 3](#) shows the axes orientations.

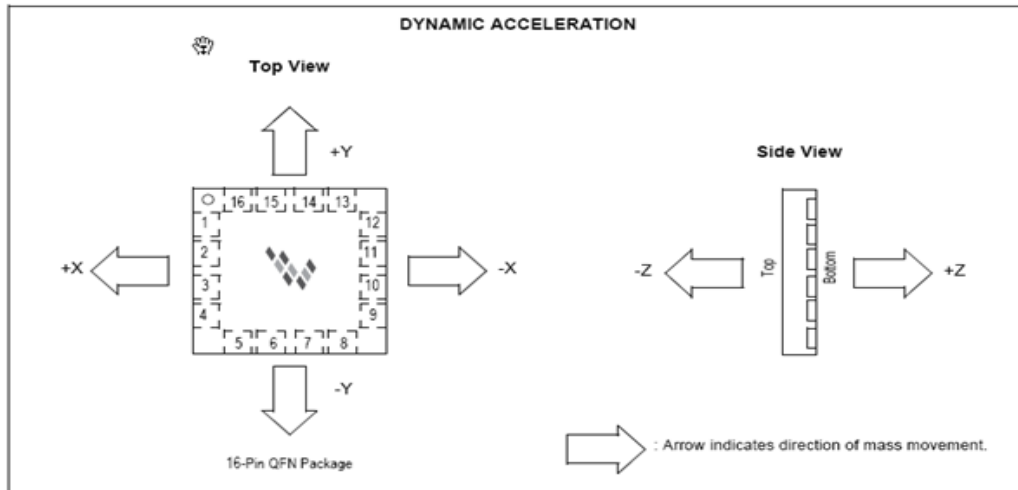


Figure 3. SRB X, Y, and Z Axes Orientation

The sensor data view displays the raw data being sent from the accelerometers after the analog data from each accelerometer has been sampled by the 10-bit A/D converter in the MCU and converted to the corresponding digital value. The application then displays the X, Y, and Z accelerometer outputs in the following three formats:

- Volts
- 10-bit A/D readings (0-255)
- Each axis value converted into g's

This data is displayed as shown in [Figure 4](#).



Figure 4. Raw Data Demonstration Application

NOTE

To improve accuracy of the accelerometer readings, refer to [Section 4.9](#), “Setting Up the Calibration Application”.

4.2 XYZ Demonstration Application

The XYZ Demonstration application can be used for a gaming board application such as a race car game. Instead of using buttons and joysticks, the application uses the sensors and relative location to move the car based on the motion of the controller. The only buttons required for the board are the accelerator and the brake. The XYZ Demonstration application displays the location of the PC_Radio board based on the movement of the Accelerometer board. The boxes on the display represent the X, Y, and Z axes. The XYZ Demonstration application uses the raw data sent from the accelerometers and processed by the MCU. It uses the converted data to move to the corresponding location on the display as shown in [Figure 5 \(2-D\)](#) and [Figure 6 \(3-D\)](#).

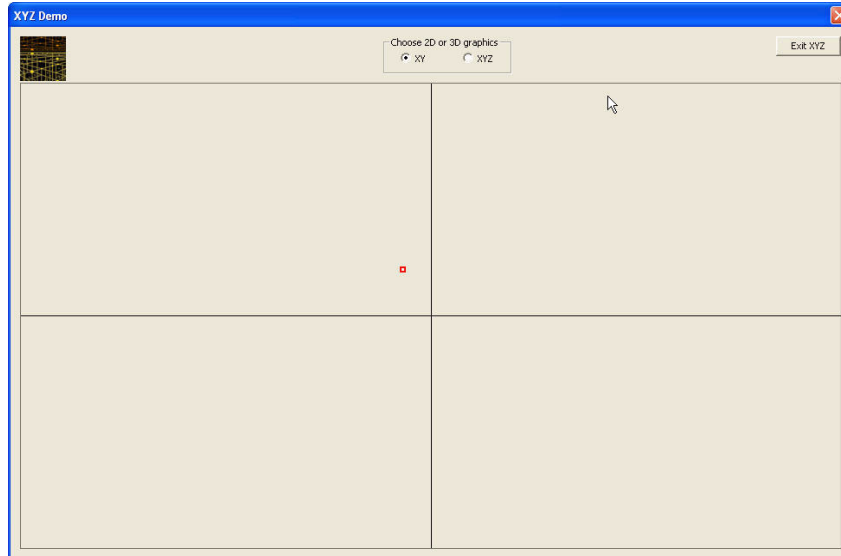


Figure 5. XYZ Application (2-D)

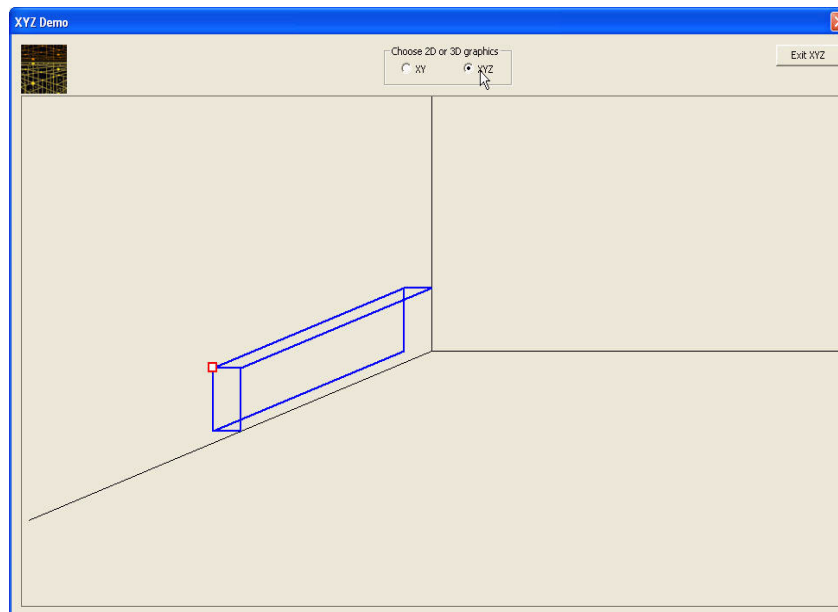


Figure 6. XYZ Application (3-D)

4.3 Tilt Module

The Tilt Module translates the g readings of each axis to an angle of rotation. It displays the current physical angle of the transmitter board on the X, Y, and Z axes as shown in Figure 7.

Use cases could include medical applications that incorporate a tilt range in physical therapy boards or medical equipment monitoring. In these cases, the accelerometers could be used to ensure that the equipment is used properly. For example, wrist mounted heartbeat monitors will obtain the most accurate measurement if the blood pressure sensing board is at the same elevation as the heart. By using an accelerometer to measure the angle of the arm, the monitor can guide users to the correct arm position before taking the measurement. The accuracy and repeatability of the blood pressure measurement is greatly increased by using the tilt information to tell users exactly where to position their arm. In addition, the accelerometer would be constantly sensing motion and position and be able to stop a measurement if a user's arm shifts out of the proper position. Through software, the monitor would be able to monitor the patient's arm for movement, identify the angle of the patient's arm, and determine if the angle of the patient's arm has changed.

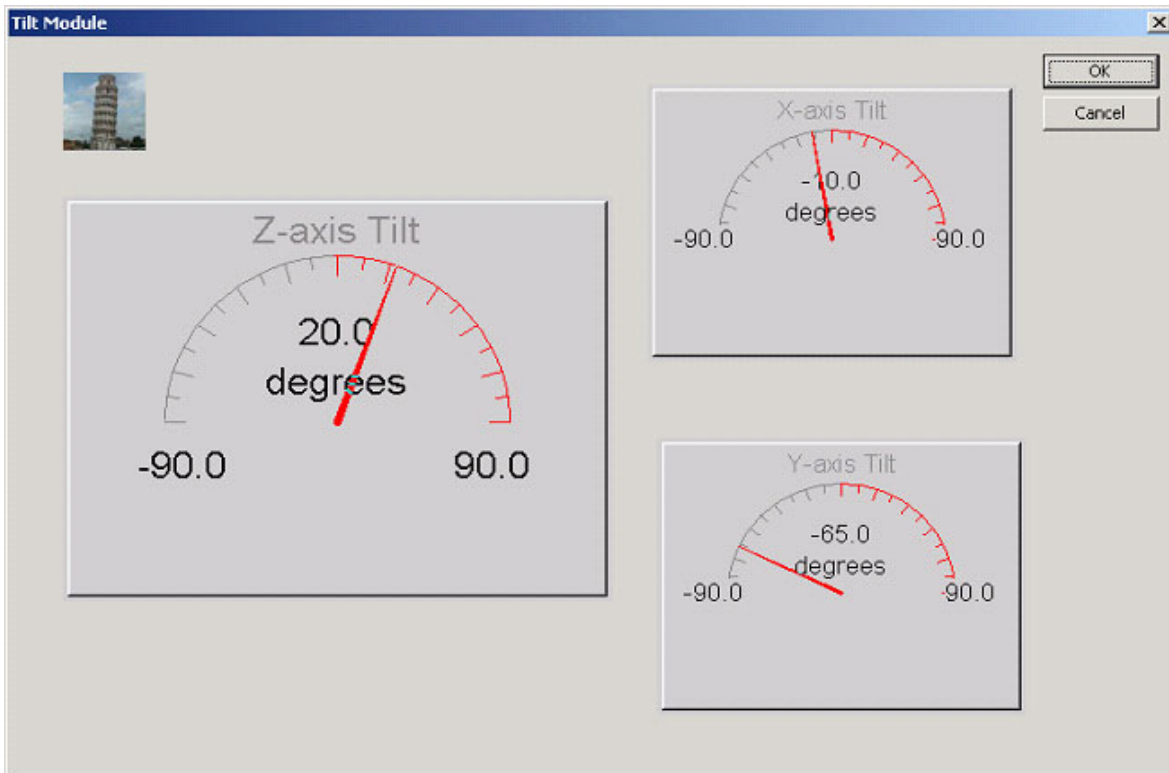


Figure 7. Tilt Module

4.4 Shipping and Handling Application

The Shipping and Handling application can record shock levels experienced during the transportation of fragile products. This information would allow shipping and handling companies to track incidents during package shipment. If the company were accused of mistreating a package, the company can view the log of the Shipping and Handling Application to verify if the product was mistreated or not.

The Shipping and Handling application uses the low-g accelerometers to detect shock and on which axis the shock occurred. As shown in [Figure 8](#), this application time stamps every time a predetermined shock threshold is violated or when the accelerometer is turned upside down.

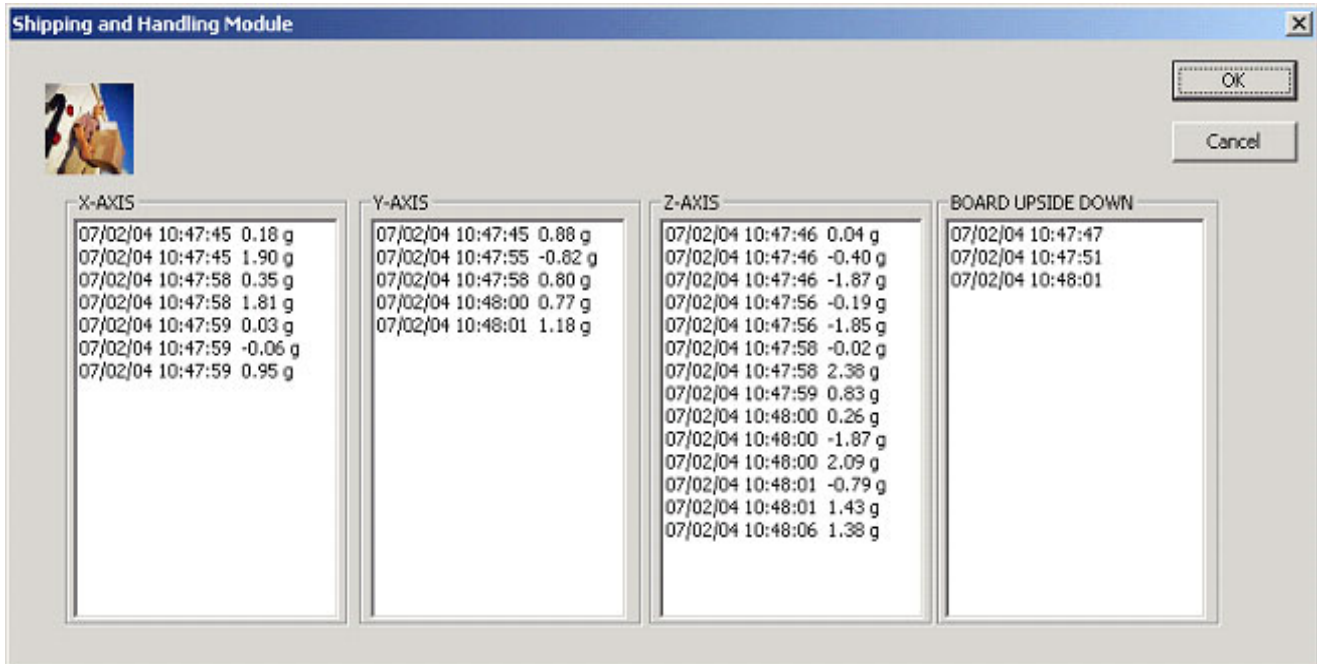


Figure 8. Shipping and Handling Application

4.5 Load Imbalance Application

The Load Imbalance application simulates the imbalance that can occur in a washing machine. The Load Imbalance application displays the movement of the washing machine and calculates the Rotations Per Minute (RPM) and deflection of the washing machine. The graph displays the X and Y axes accelerometer data and shows the center of the orbit denoted by a green '+' symbol as shown in Figure 9. The application then calculates the RPM and the diameter of the deflection. If the diameter of the deflection is greater than 0.5 inches, then a simulated unbalanced condition is present and the data points are drawn in red. If a simulated unbalanced condition is not present, then the data points are drawn in blue.

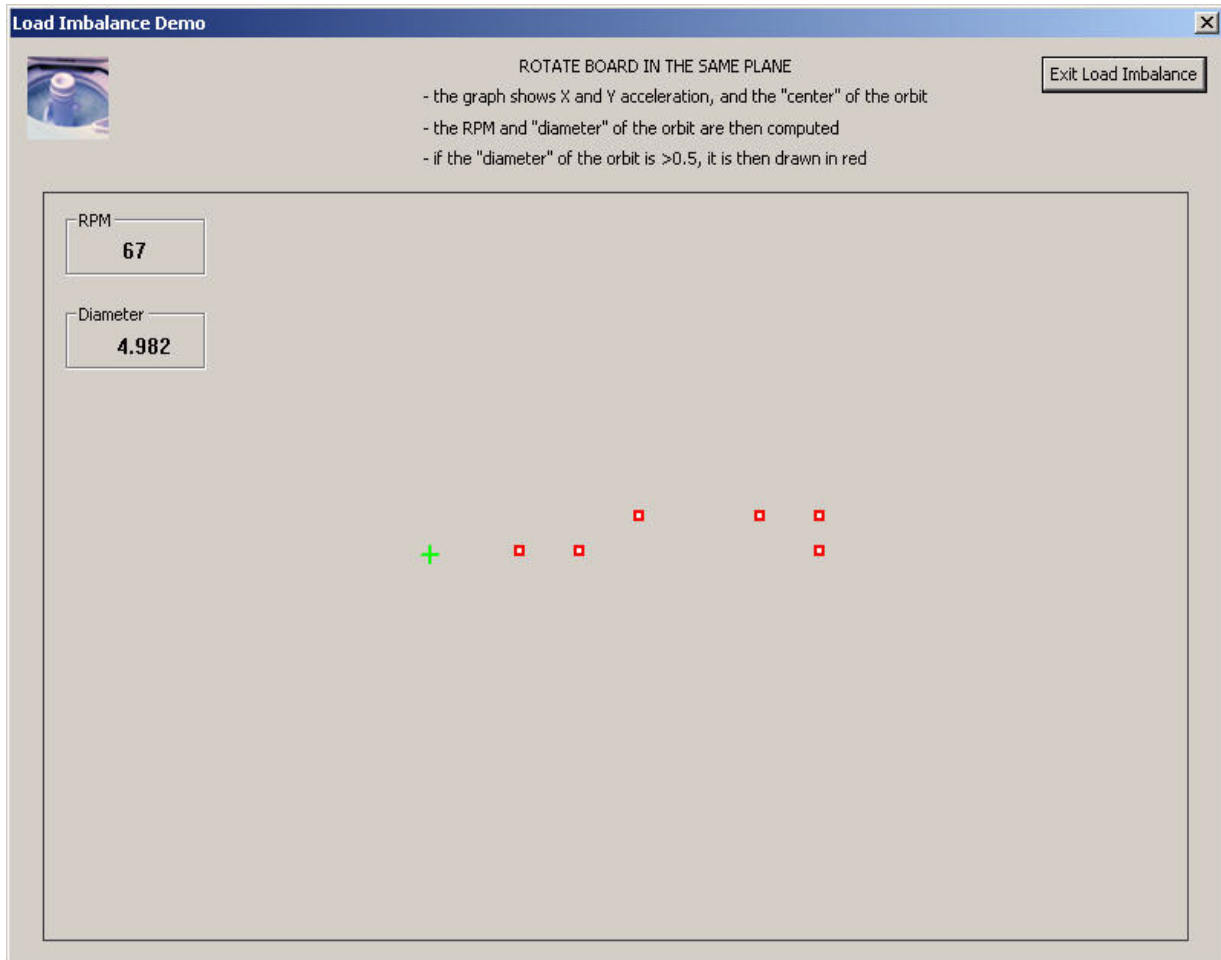


Figure 9. Load Imbalance Application

4.6 PDA Scrolling Application

The PDA Scrolling application provides users a unique method of selecting menu items in a PDA. An accelerometer can be integrated into a hand-held device, such as a PDA with a GUI interface, that can be controlled by the angle of the hand-held device itself. By tilting the hand-held device front to back or back to front, users could make menu selections and operate their device with only one hand. PDA menu item selection item is in the X axis direction. By tilting the SRB front to back or back to front, users can change the highlighted item in the PDA menu as shown in [Figure 10](#).

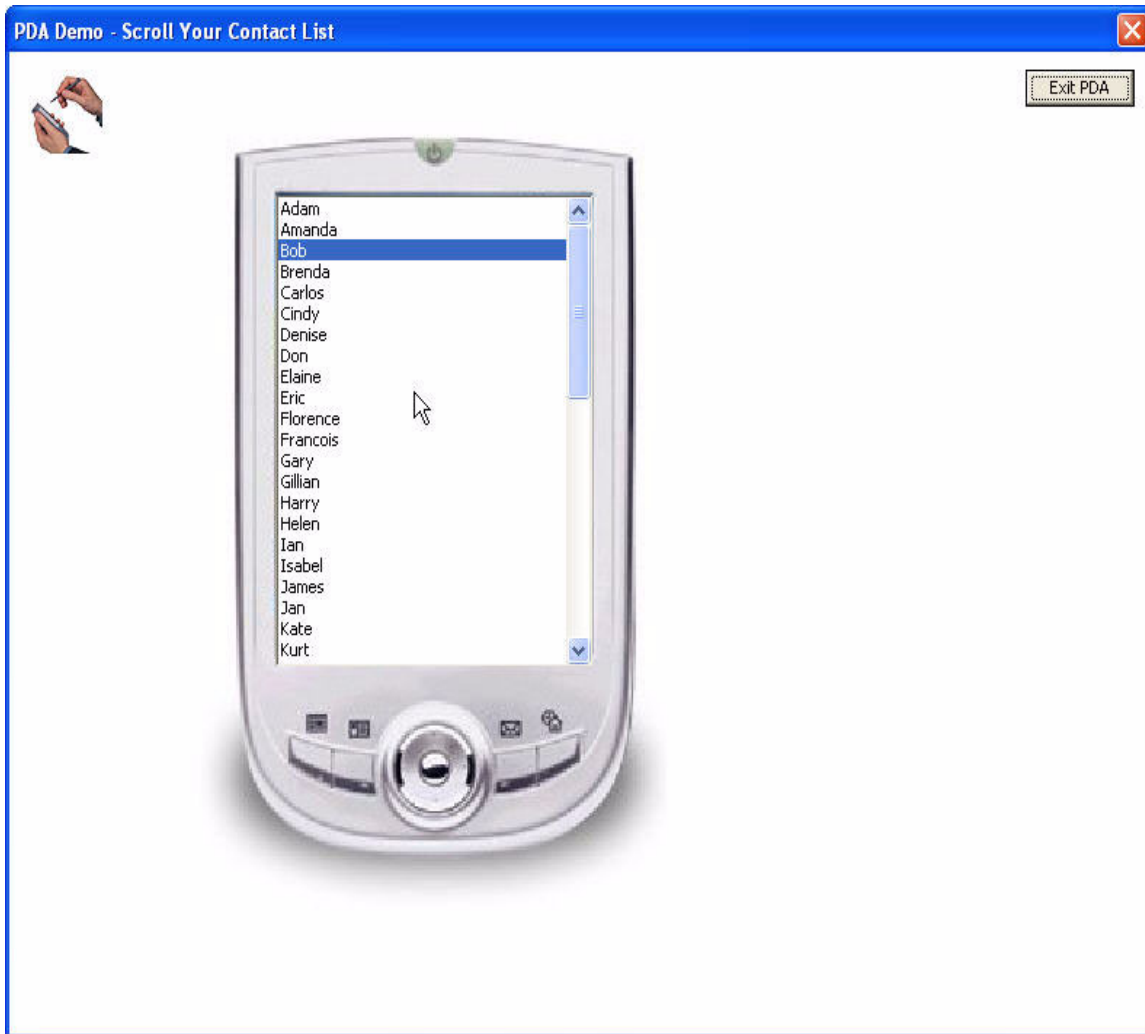


Figure 10. Triax PDA Scroll Application

4.7 Digitally Filtered Tilt

The Digitally Filtered Tilt application operates in the X and Y axes and has two views within the applet. [Figure 11](#) shows the scope view which shows the X and Y axes readings over the last 500 samples in raw format.

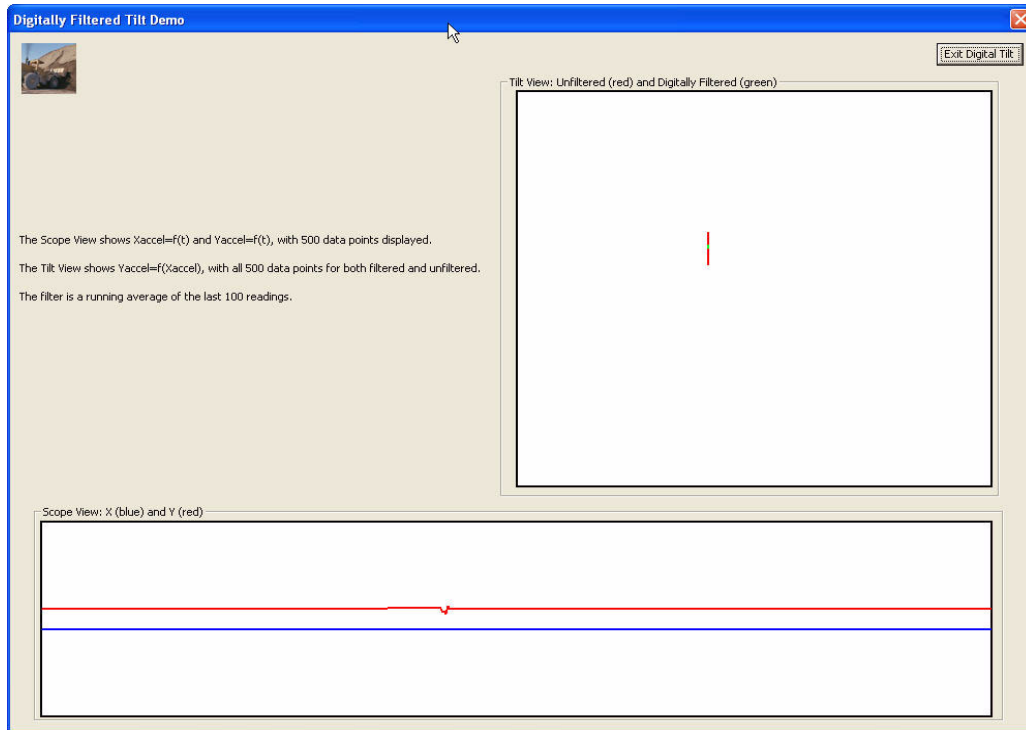


Figure 11. Triax Digitally Filtered Tilt (Raw Format)

[Figure 12](#) displays the moving average over the last 100 samples in the X and Y axes. Where appropriate, it may be advantageous for an application to do post processing on a PC rather than an embedded device. However, PC post processing can make the over-the-air packets larger and more frequent which uses more power and renders the channel active if the application is busy.

If more preprocessing is done at the sensor, then the network may be less impacted to allow better node density, throughput, and more efficient power usage. To reduce RF traffic from the accelerometer to the PC_Radio embedded applications, the Accelerometer application only updates the PC_Radio when the X, Y, and Z axes readings have deviated from the previous values. Application choices can affect the way a wireless system performs.

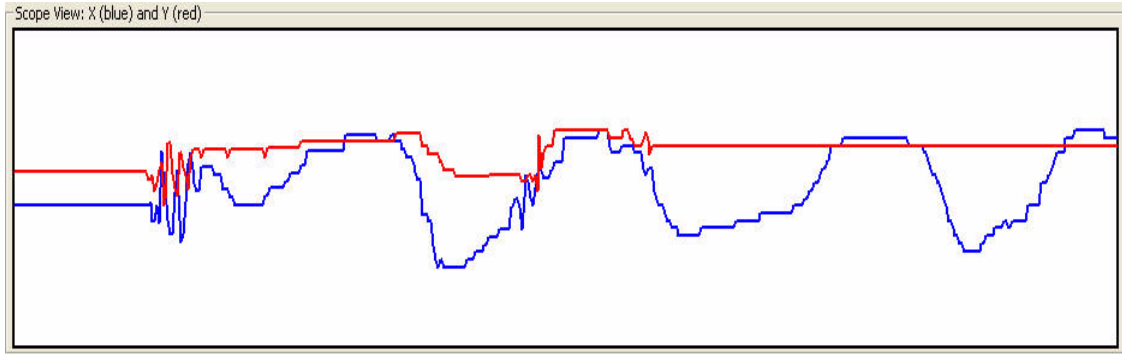


Figure 12. Triax Digitally Filtered Tilt (XY Scope View)

Figure 13 displays the Digitally Filtered Tilt XY Filtered view with a 100 point moving average of the X and Y axes readings.



Figure 13. Triax Digitally Filtered Tilt (Moving Average)

4.8 Standalone Applications

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.

4.8.1 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.

4.8.2 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.

4.8.3 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.

4.8.4 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.

4.9 Setting Up the Calibration Application

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.

4.10 Changing the 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 and the Accelerometer Boards 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.

4.11 Changing the Application Number

To switch between applications, press SW1 once on the Accelerometer Board. The buzzer chirps and the LEDs momentarily display the current application number on the LEDs.

For example, if the Accelerometer Board is running Application One (default) and SW1 is pressed, the buzzer on the Accelerometer Board chirps and the LEDs show that Application Two is running by setting the LEDs as follows:

- LED1 OFF
- LED2 OFF
- LED3 ON
- LED4 OFF

To switch from Application Two to Application Three press SW1 again. The buzzer on the Accelerometer Board chirps and the LEDs are set as follows:

- LED1 OFF
- LED2 OFF
- LED3 ON
- LED4 ON

This process continues until users reach Application Six. The application then rolls back over to Application 1 and the process continues.

No changes are required to the PC_Radio to switch between applications.

5 Accelerometer Quick Start Guide

AN3230, *Accelerometer Demonstration Quick Start Guide*, contains the start up procedures and assumes that one SRB has been programmed with the appropriate PC_Radio code and another SRB has been Flashed with the Accelerometer code. AN3230 also contains the default start up procedures for the Triax Demonstration software.

NOTE

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

6 Loading Embedded Applications to New Hardware

When using the procedure described in this section, it is assumed that either no code was Flashed to the SRBs or that the code was altered and then Flashed to the SRBs.

6.1 Setting Up the SRBs for Programming

1. To program the SRB, users must have a P&E Background Debug Module (BDM) Multilink cable. The P&E BDM Multilink cable is used with CodeWarrior™ Development Studio for the HCS08 to program the MCU and is available from Freescale. The red lead of the BDM cable must align to pin 1 of J101.

If using the parallel port version of the BDM cable, the BDM pod should be powered with a 2-5 VDC, negative center contact power supply or the SRB should be powered by a power supply through J106. The battery is not capable of sourcing the current required by the parallel BDM pod during programming.

2. Connect a 5 - 9 VDC power supply to the SRB power supply connector. If using the P&E BDM-Multilink cable the following should occur:

The blue LED on the P&E Multilink turns on if the connection to the PC is functioning.

The yellow LED on the P&E Multilink turns on if the cable is properly connected to the target.

6.2 Programming the SRBs

1. Select “CodeWarrior” and open the Accelerometer V3.mcp file.
2. Select “SRB” from the drop down menu in the project.

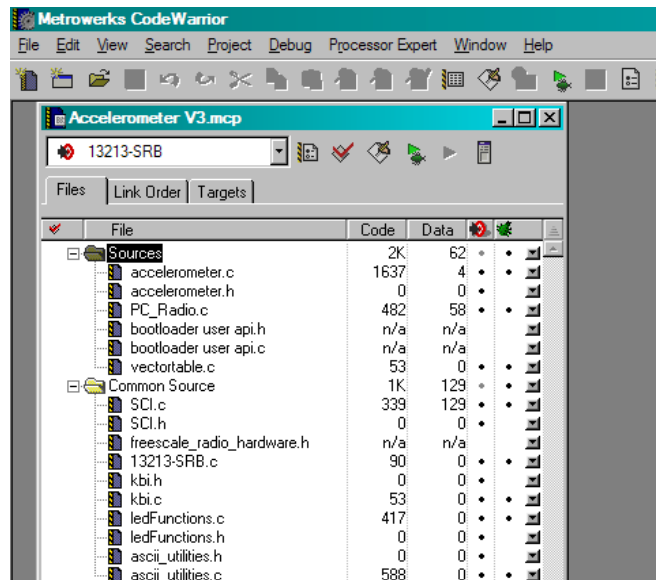



Figure 14. Loading the SRB Accelerometer Embedded Application from CodeWarrior

3. To choose debug, select one these two options:
 - a) Select the “Project/Debug” button.
 - b) Press Ctrl + F5.
4. If the debug window is unable to make a connection, ensure that the following options are set:
 - a) LPT1 — Parallel Port 1(Address \$0378) is selected in the drop down menu of the Connection Port of the personal computer.
 - b) HCS08 Processor — Autodetect is selected in the drop down menu of the CPU type.
 - c) Then click on the “Reset” and “Retry” buttons.
5. To run the program on the SRB, click on the green arrow on the toolbar.
6. Close the Debug window and detach the P&E BDM Multilink cable from the SRB.
7. To program the next SRB, repeat the steps shown in [Section 6.1, “Setting Up the SRBs for Programming”](#).

6.2.1 PC_Radio Application

1. Apply power to the SRB being used as the PC_Radio Board.
This can be accomplished by either connecting the included 9 VDC power supply to the 2.1mm power supply connector, the USB cable from the PC to the PC-Radio Board, or by inserting batteries in the PC_Radio Board. The following list shows the advantages of each connection:
 - Batteries are truly portable, but without a USB connection only the standalone applications can run.
 - Using the USB connection means that both the DC power supply and the UART connection are in one cable so all of the applications can run.
 - Using the DC power supply along with the USB connection means no current draw through the USB bus. Not drawing current through the USB bus is beneficial if the system is running on a non-powered USB hub.
2. After connecting power to the PC_Radio Board with either the batteries, USB cable, or the DC power supply, set the Power Switch (S100) to the ON position.
3. Press the Reset button once on the PC_Radio Board. The PC_Radio Board is now in receive mode.

6.2.2 Accelerometer Application

1. Connect power to the SRB being used as the Accelerometer Board. The same power options exist for the Accelerometer Board as the PC_Radio board.
2. After connecting power to the Accelerometer Board with either the batteries, USB cable, or the DC power supply, set the Power Switch (S100) to the ON position.
3. Press the Reset and SW1 buttons once. LED3 momentarily lights to indicate that the Accelerometer Application is now running on the Accelerometer Board.
4. The Accelerometer Board sends a ping packet to the PC_Radio Board every two (2) seconds as indicated by LED2.
5. The Accelerometer Board detects when the SRB is moved and quickly toggles LED1 and sends a packet to the PC_Radio Board with an updated reading.

6.2.3 Verifying Accelerometer Application Operation

To verify if the Accelerometer application is running on the Accelerometer Board, monitor the LEDs as follows:

- Watch LED2 on the Accelerometer Board. LED2 will blink every two (2) seconds to indicate each time it sends a ping packet to the PC_Radio Board
- Watch LED1 on the Accelerometer Board. LED1 will blink every time the Accelerometer Board is moved. Each time the Accelerometer Board is moved, it sends a data packet to the PC_Radio Board that tells the PC_Radio Board that the position and or orientation of the Accelerometer Board has changed

6.2.4 Verifying PC_Radio Application Operation

To verify if the PC_Radio Application is running on the PC_Radio Board, monitor the LEDs as follows:

- Watch LED1 on the PC_Radio Board. LED1 activity indicates physical movement of the Accelerometer Board
- Watch LED2 on the PC_Radio Board. LED2 activity indicates ping packets sent from the Accelerometer Board

6.2.5 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 BeeKit->Triax->Triax.
 - a) If the Triax application does not exist, go to [Step 3](#) to install it. If users do not have a CD, download the BeeKit installer from www.freescale.com/zigbee
 - b) If the application is in the Start Menu, go to [Step 6](#).
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, browse to the CD-Drive and execute the `BeeKitSetup.exe` file.
5. Once the BeeKit installer launches, follow the steps as directed to install the Triax PC application.
6. 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 15](#).
 - 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 15](#).

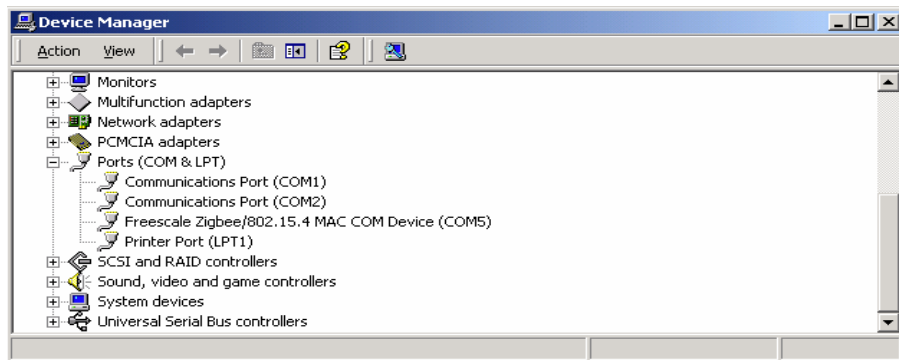


Figure 15. COM Port Determination in Device Manager

7. 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.

6.3 Viewing Data

The data being sent from the Accelerometer Board can be viewed in three formats using the Raw Data application. See AN3231, *MC1320x/MC1321x Demonstration Operation, Running the Basic Packet Error Rate, Wireless UART, Accelerometer, Range, Test Mode, and Lighting Demonstration Applications* for more information about the Raw Data application. The Raw Data application presents the raw data sent from the accelerometers and processed by the MCU as follows:

- X, Y, and Z axes accelerometer output in volts
- 8-bit A/D readings (0-255)
- The output of each axes converted to g's.

NOTE

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

7 Triax Demonstration Theory and Implementation

7.1 Serial Command Protocol

This section highlights the basic serial commands sent between the Triax application and the embedded PC_Radio application.

Table 3. Serial Interface Between PC_Radio and Triax Applications

PC Generates	Accelerometer Response	Description
R	N	Starts the handshake to show a valid serial connection
V	xNyNzN	PC asks for the current accelerometer reading
K		PC sends cal string (Not Yet Implemented)
k	rsp with “k” + 6 cal bytes	PC asks for current cal values (Not Yet Implemented)
C	c	PC asks PC_Radio for current Channel (Not Yet Implemented)

7.2 RF Command Interface

Table 4 shows the over-the-air packet format for all of the embedded applications. Currently, the PC_Radio Board is always listening and does not perform direct communication back to the Accelerometer Board, but this feature may be added at a later time.

Table 4. RF commands sent by the Accelerometer App to the PC_Radio

Name	Length	Format	Description
Ping Packet	11	'P' gi8AppStatus options; gu16msTimer (high byte); gu16msTimer(low byte); sCalValues.NxOff; sCalValues.NxMax; sCalValues.NyOff; sCalValues.NyMax; sCalValues.NzOff; sCalValues.NzMax;	The Accelerometer application sends a periodic ping to ensure that communication between the Accelerometer application and the PC_Radio application is still present. P — ping gi8App Status — Current Application number Options — For example, allows the accelerometer to turn the buzzer on and off. gu16msTimers — Makes the PC_Radio application aware of the Accelerometer application's timebase Cal Values are sent periodically in the event that they have to change.
Event Packet	2	gi8AppStatus; options	The Event Packet is Application Number Specific. The gi8AppStatus tells the PC_Radio which application number is sending the event. The options format defines which event is occurring.



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