

## SPMB250-A1EVAL demonstration kit user manual and installation guide

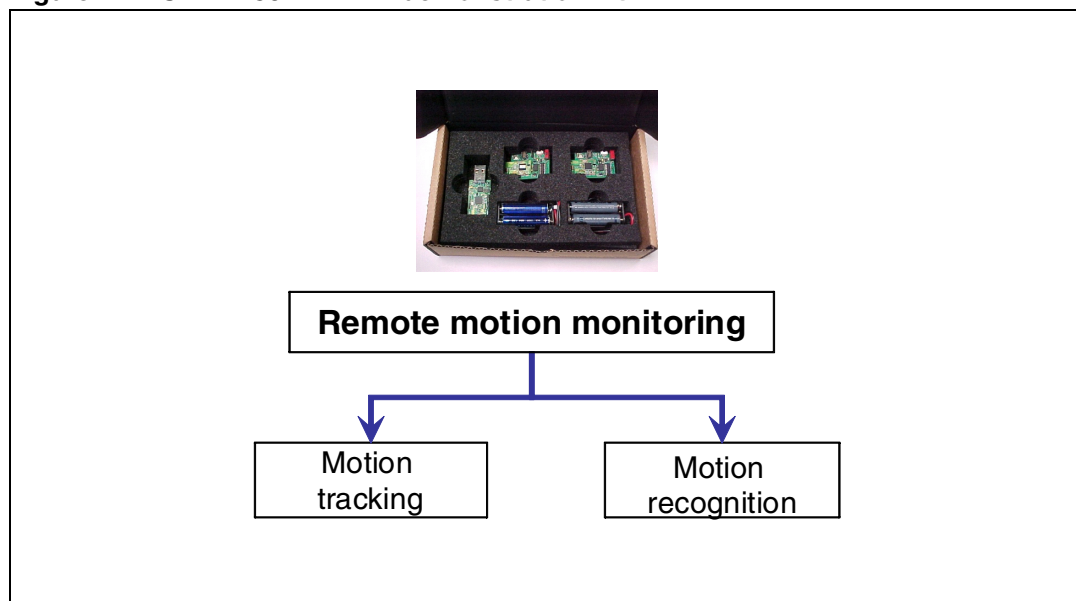
### Introduction

The SPMB250-A1 is a ready-to-use wireless acceleration sensor based on a 802.15.4-compliant radio transceiver.

The integration of two SPMB250-A1 modules together with an 802.15.4 ZigBee<sup>®</sup>-based dongle make the SPMB250-A1EVAL demonstration kit a complete tool for demonstrating the features and functions of the SPMB250-A1 in remote motion monitoring applications.

The modules in the kit are pre-programmed with an application based on the EmberZNet™ 3.0.0 ZigBee<sup>®</sup> protocol stack that allows the sending of data captured by the accelerometer to the dongle when plugged into a PC USB slot. The kit also includes a graphical application which provides an example of one of the possible uses of the acceleration data.

**Figure 1. SPMB250-A1EVAL demonstration kit**



# Contents

- 1      SPMB250-A1EVAL description ..... 3**
  - 1.1    Demonstration kit contents ..... 3
  - 1.2    CD contents ..... 4
  - 1.3    Related documents ..... 4
  - 1.4    PC system requirements ..... 4
  - 1.5    Target applications ..... 4
  
- 2      SPMB250-A1EVAL kit hardware ..... 5**
  - 2.1    SPMB250-A1 ..... 5
  - 2.2    ZigBee® dongle ..... 6
  
- 3      Installation procedures ..... 8**
  - 3.1    Installing the FTDI driver ..... 8
  - 3.2    Installing the Plane demo ..... 9
  
- 4      Firmware description ..... 10**
  - 4.1    Dongle firmware ..... 10
  - 4.2    MotionBee™ firmware ..... 11
  - 4.3    Forming a network ..... 11
  
- 5      Plane demo ..... 12**
  
- 6      Revision history ..... 14**

# 1 SPMB250-A1EVAL description

The SPMB250-A1EVAL (demonstration kit in the rest of the document) is a ready-to-use kit designed as a platform for evaluating the capabilities of the SPMB250-A1 wireless sensor in motion monitoring applications, where two sensor modules communicate with a remote device over an 802.15.4 channel.

The kit includes two SPMB250-A1 modules and one ZigBee<sup>®</sup>-based dongle module.

This document describes:

- the modules contained in the demonstration kit
- the features of the software loaded in the demonstration kit modules
- the format of the packets at the serial output of the dongle when the software is used

The three different classes of demonstration kit users are:

- Demo users - The kit runs the demo using a simple tilt monitoring application. In this case, the document provides guidelines on how to:
  - network the modules together
  - install the FTDI driver
  - install and run the demo
- Developers of new PC applications - The software loaded in the sensors and dongle is meant to be used without modifications and allows the development of PC applications that can use up to 4 SPMB250-A1 modules together. In this case the document provides guidelines on how to:
  - network the modules together
  - install the FTDI driver
- Developers of new application firmware - The new firmware must be loaded on the modules by means of integrated SIF connectors. Instructions on application development with the EmberZNet<sup>™</sup> protocol stack and the use of Ember development tools for the SN250 is beyond the scope of this document. The reader should refer to the Ember documentation for details.

## 1.1 Demonstration kit contents

- 2 SPMB250-A1 acceleration sensor modules
- 1 ZigBee<sup>®</sup>-based dongle
- 2 battery holders
- 8 AA batteries
- 1 CD

## 1.2 CD contents

- SPMB250-A1 datasheet
- SPMB250-A1EVAL demonstration kit user manual and installation guide (this document)
- Plane demo software files
- javacomm20-win32
- java3d-1\_4\_0-windows-i586-1

## 1.3 Related documents

- SPMB250-A1 datasheet
- SPZB250 datasheet
- Ember documentation library
- LIS3LV02DL datasheet and application note AN2381

## 1.4 PC system requirements

- Microsoft® Windows® XP
- Intel® Pentium® III or higher
- 512 MB of RAM
- 50 MB of available hard disk space
- An Internet connection to download the Java environment and FTDI driver (download files and follow installation instructions on the relevant web sites)

To run the demonstration, the PC requires the installation of the Java SE Runtime Environment (JRE). The demo successfully runs with JRE 6.5, which is available from the Sun Microsystems web site.

## 1.5 Target applications

Accelerometer sensors can be generally used to measure both dynamic and static acceleration data. The SPMB250-A1 provides a small, portable solution with the capability to accommodate various accelerometer applications requiring data transmission over a wireless channel. The radio is 802.15.4 compliant and is integrated with a processor in a single-chip solution for use with the EmberZNet™ ZigBee® protocol stacks. The accelerometer is a three-axis digital output linear MEMS sensor.

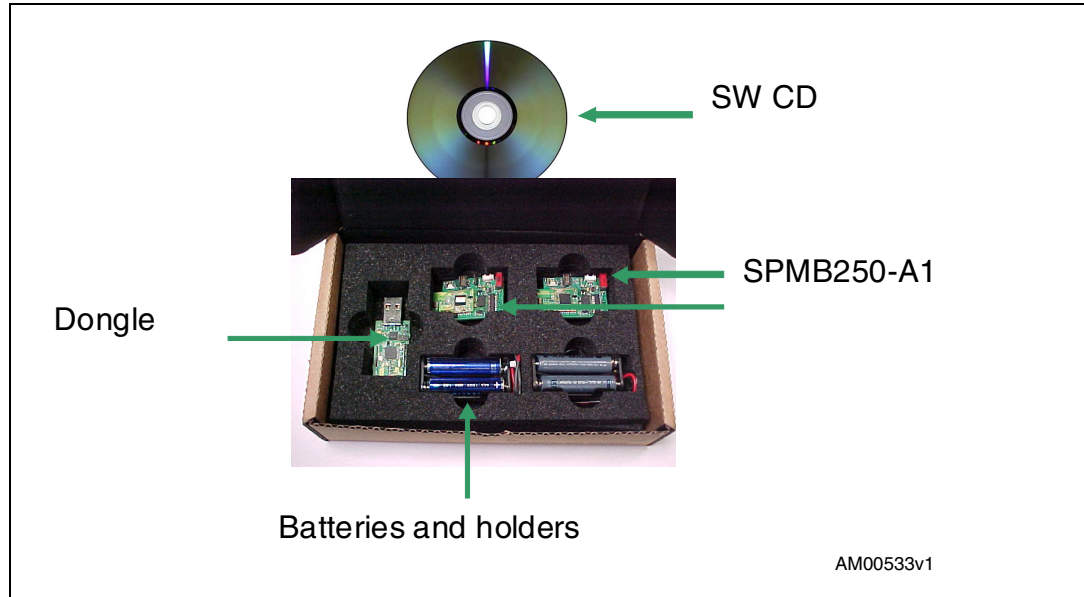
Possible target application are:

- Medical devices
- Sport equipment
- Games
- Environmental monitoring
- Industrial control
- Security

## 2 SPMB250-A1EVAL kit hardware

The demonstration kit is ready-to-use and is designed as a platform to evaluate the capabilities of SPMB250-A1 wireless sensor in remote motion monitoring applications. The kit is securely packaged in a padded box, as shown in [Figure 2](#).

**Figure 2. Demonstration kit box**

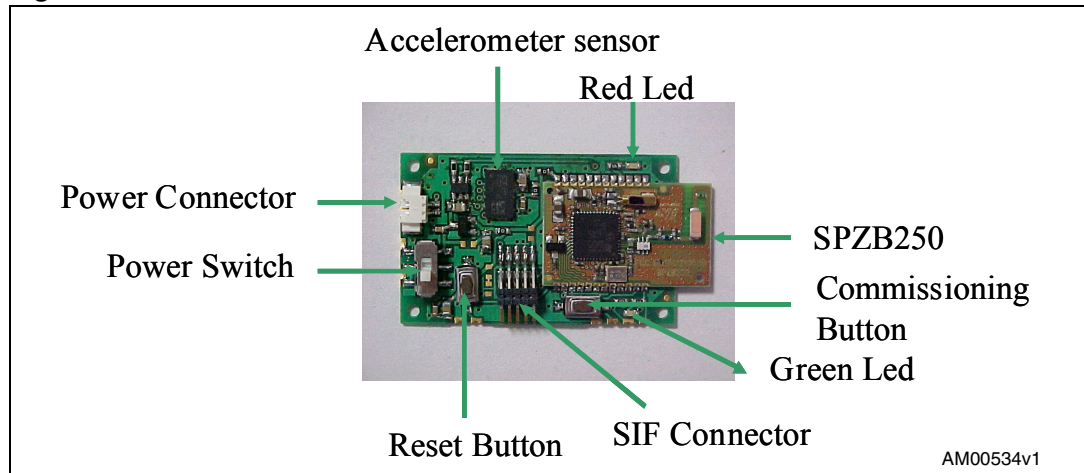


### 2.1 SPMB250-A1

The SPMB250-A1 (referred to as MotionBee™ in the remainder of the document) belongs to the STMicroelectronics MotionBee™ sensor family and is designed to enable the development of applications for remote motion monitoring. This version of the MotionBee™ sensor integrates an SPZB250 ZigBee® wireless module together with an LIS3LV02DL 3-axis MEMS accelerometer and represents a ready-to-use battery-powered wireless sensor. The compact size of the MotionBee™ makes it ideal for use in many different remote motion monitoring applications. When the EmberZNet™ protocol stack is loaded, MotionBee™ can play the role of end-device or router in a ZigBee® network.

The main components integrated in the MotionBee™ modules are represented in [Figure 3](#).

Figure 3. SPMB250-A1 MotionBee™ module



The accelerometer is a 3-axis digital-output linear MEMS sensor that includes a sensing element and an IC interface capable of taking information from the sensing element and providing the measured acceleration signals to external applications through an I<sup>2</sup>C/SPI serial interface. The LIS3LV02DL has a user-selectable full scale of  $\pm 2 g$ ,  $\pm 6 g$  and is capable of measuring acceleration data over a bandwidth of 640 Hz for all axes. The device bandwidth may be selected according to application requirements.

The SPZB250 is a ready-to-use ZigBee® module for OEM use. It integrates the SN250 ZigBee® system-on-chip (SoC) with an external oscillator, a balun filter and an antenna.

The SN250 SoC design integrates a full-featured 802.15.4 radio with a 16-bit processor. It is designed to run the EmberZNet ZigBee® protocol stack from Ember Corp., and can be fully reprogrammed to run custom applications.

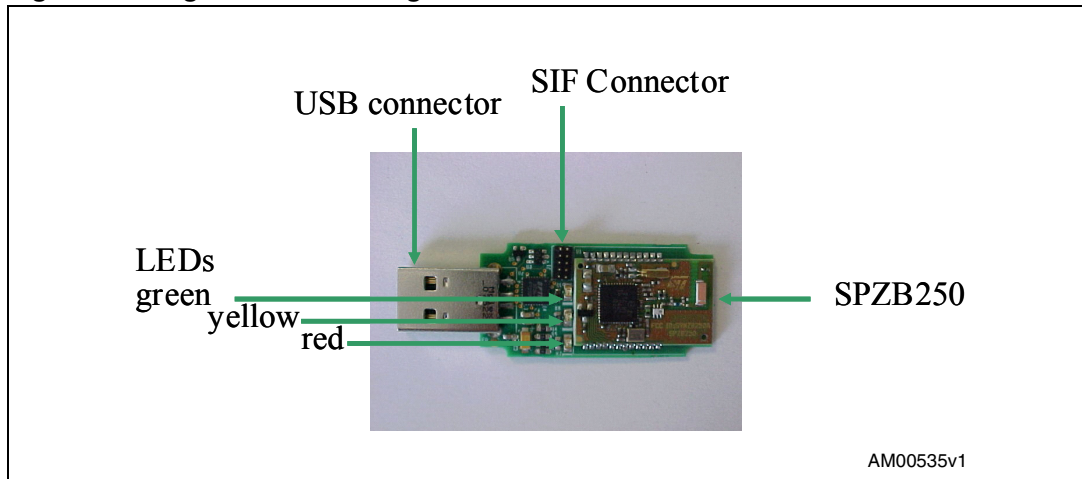
The MotionBee™ modules also integrate a SIF connector, allowing interfacing with the Ember development kit for firmware loading and debugging. Finally, the module integrates two LEDs, 1 power connector, 1 power switch, a reset button and a commissioning button.

## 2.2 ZigBee® dongle

Based on the SPZB250, the ZigBee® dongle (“dongle” in the rest of the document) is a module with a USB stick form-factor. It provides a cost-effective method of adding ZigBee® wireless connectivity to any device which employs USB. The dongle can be programmed using the SIF connector integrated in the board. When connected, the dongle is powered through the USB and it can be used to transfer data to the connected operator for data analysis, storage and computation. The dongle uses a USB controller from FTDI Ltd. to communicate with the host computer.

The main components of the dongle are represented in [Figure 4](#).

Figure 4. ZigBee®-based dongle module



### 3 Installation procedures

#### 3.1 Installing the FTDI driver

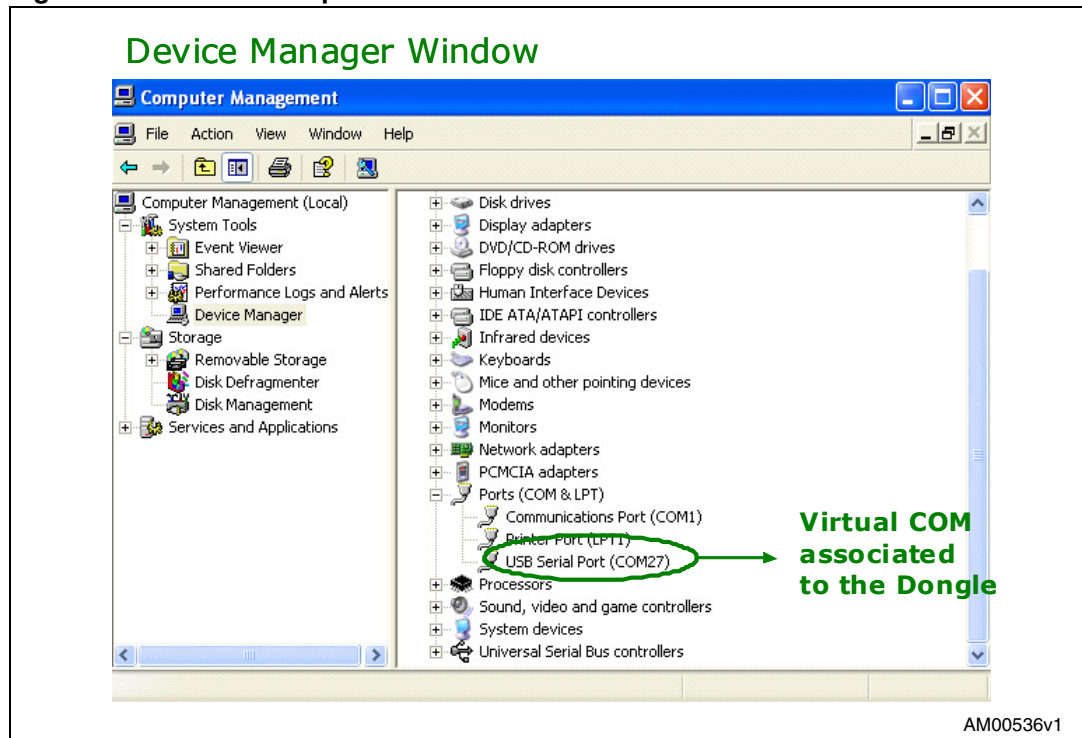
The dongle integrates a USB controller from FTDI to communicate with the host computer. To communicate with the dongle, the FTDI drivers must be installed on the host. FTDI provides drivers for Windows, Linux, BSD, Macintosh, and Windows CE. Windows users require the virtual COM port (VCP) drivers.

If the necessary drivers are not already installed on the PC, they can be downloaded from the driver section of the FTDI Chip web site. After the file has completed downloading to a folder on the PC, unzip the file.

Plug the dongle into an available USB slot on the PC. The operating system detects the new hardware and prompts for the location where the driver files can be found. With the browser, select the root of the driver directory that was unzipped previously and follow the on-screen instructions.

After installing the driver, the dongle appears as a COM port in the Windows device manager. Multiple dongles may be connected to the USB ports of the same computer simultaneously. In this case each dongle will be assigned a different COM port identifier. The example in *Figure 5* shows one dongle connected to the PC and assigned COM27 as its “USB Serial Port”.

Figure 5. Virtual COM port number





## 3.2 Installing the Plane demo

In order to properly run the Plane demo, the following steps must be carefully followed:

1. **Install the Java Runtime Environment (JRE)** - the Plane demo has been developed in Java and requires the JRE installation on the PC. The demo has been successfully tested with JRE 6.5.
2. **Install the Java3D package** - Java 3D is an additional Java package that enables the creation of three-dimensional graphics applications and Internet-based applets. The Java3D install file is included in the demonstration kit CD. To install the package, double-click on the file: java3d-1\_4\_0-windows-i586-1, and follow the installation wizard.
3. **Install the Javacomm package** - Javacomm is an additional Java package that provides access to a serial port. It has been developed by Sun Microsystems and can be downloaded from the Sun web site. Javacomm is also included in the demonstration kit CD. To install the package:
  - a) unzip javacomm20-win32.zip
  - b) copy the file commapi/win32com.dll to <your\_jdkroot\_folder>/<your\_jre\_folder>/bin
  - c) copy the file commapi/comm.jar to <your\_jdkroot\_folder>/<your\_jre\_folder>/lib/ext
  - d) copy the file commapi/javax.comm.properties to <your\_jdkroot\_folder>/<your\_jre\_folder>/lib/
4. **Install the Java binary files** - Copy "Plane.zip" from the demonstration kit CD into one of your personal folders (<your\_folder> in the rest of the document) and unzip it. The folder "Plane" will be created that contains the Java binary files needed to run the demo.
5. **Set the virtual COM port** - The virtual COM port associated with the dongle (see the previous paragraph to detect this number) must be edited in the following file:  
<your\_folder>/Plane/configfiles/configuration.xml

For example, if the virtual COM port is COM27, the content of "configuration" file must become:

```
<?xml version="1.0"?>
<config>
<port>27</port>
<start>i</start>
<stop>f</stop>
<length>10</length>
</config>
```

where the number of the port is specified in line 3.

*Note:* The names of folders contained in the folder path **MUST NOT** contain blank spaces.

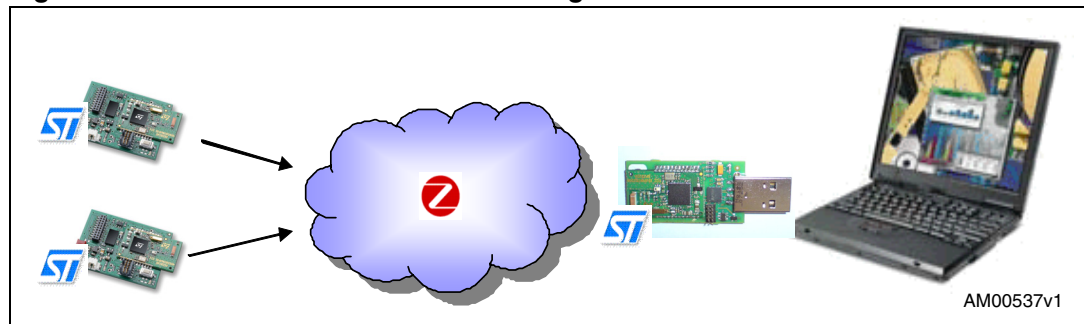
## 4 Firmware description

The demonstration kit is released with a simple application already loaded in the MotionBee™ and dongle modules.

This application integrates the functionalities of a ZigBee®-based protocol (EmberZNet™ 3.0.0), which allows the networking of the modules in a star configuration, as represented in Figure 6. Specifically:

- When acting as end device/router, each MotionBee™ collects data from the integrated accelerometer, encapsulates this data within the payload and transmits the packet over the wireless channel.
- When acting as network coordinator and sink device, the dongle receives the packets from the MotionBee™ and transfers their payload to the serial port to make them available on the PC through the COM port.

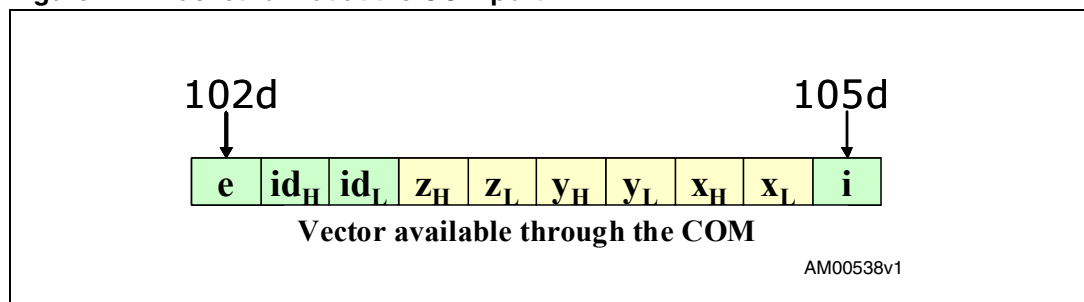
Figure 6. Demonstration kit network configuration



### 4.1 Dongle firmware

The dongle firmware integrates the EmberZNet™ 3.0.0 protocol stack with a simple application that allows the transfer of the data payload to the UART port of the SN250 SoC together with the NodeID of the sender. The main purpose of this is to allow PC access to the accelerometer data through the COM port. The firmware is not compliant with application profiles defined within the ZigBee® Alliance and has been written only for demonstration purposes.

Figure 7. Packet format at the COM port



*Figure 7* shows the format of the packet as available at the COM port.

- The “i” and “e” bytes are fixed at 105d and 102d respectively and function as a packet delimiter.
- NodeID corresponds to the network address of the MotionBee™ modules assigned during the network joining procedure. In an application running on the PC, this field makes it possible to distinguish the sender of each packet.
- X, Y, Z are the acceleration values as detected by the sensors in each MotionBee™.

## 4.2 MotionBee™ firmware

The firmware loaded on the MotionBee™ modules includes the EmberZNet™ 3.0.0 protocol stack together with a simple application that samples the accelerometer with a fixed frequency of 33 Hz. The accelerometer data are composed within the packet payload and then sent to the radio for transmission. On each axis the scale of measured values is set to  $\pm 2 g$ .

This application has been written only for demonstration purposes and it uses the accelerometer sensor in a specific configuration. Custom firmware can be developed and loaded on the modules through the SIF connector, in order to fully exploit all of the sensor configuration capabilities (please refer to the LIS3LV02DL datasheet and application note AN2381).

## 4.3 Forming a network

The procedure to network the dongle and the MotionBee™ is described below. The network uses channel 26 and PANID 0x01FF fixed values.

1. Connect the dongle to one of the USB slots on the PC. The dongle is powered through the USB port. Both green and red LEDs turn on. After creating the network, the dongle starts sending advertisement packets.
2. To connect a MotionBee™ within the network:
  - a) Turn on the power switch.
  - b) Push the commissioning button. The green LED turns on.
  - c) The MotionBee™ initiates the joining procedure and when the association step is completed, the red LED turns on.
  - d) The MotionBee™ starts sending packets (every 33 ms) and the green LED blinks at each transmission.
  - e) The dongle collects packets sent by the MotionBee™, making them available through the COM port with the format described above. The red LED blinks each time it receives a packet.

Up to 4 MotionBee™ modules can be connected to the same dongle without significant loss of performance.

## 5 Plane demo

The demonstration kit includes a demonstration program which provides an example of a possible use of the data on the PC to which the dongle is connected. The program demonstrates the tilt measurement capabilities of accelerometers using a simulated aircraft, referred to as “Plane” throughout this document.

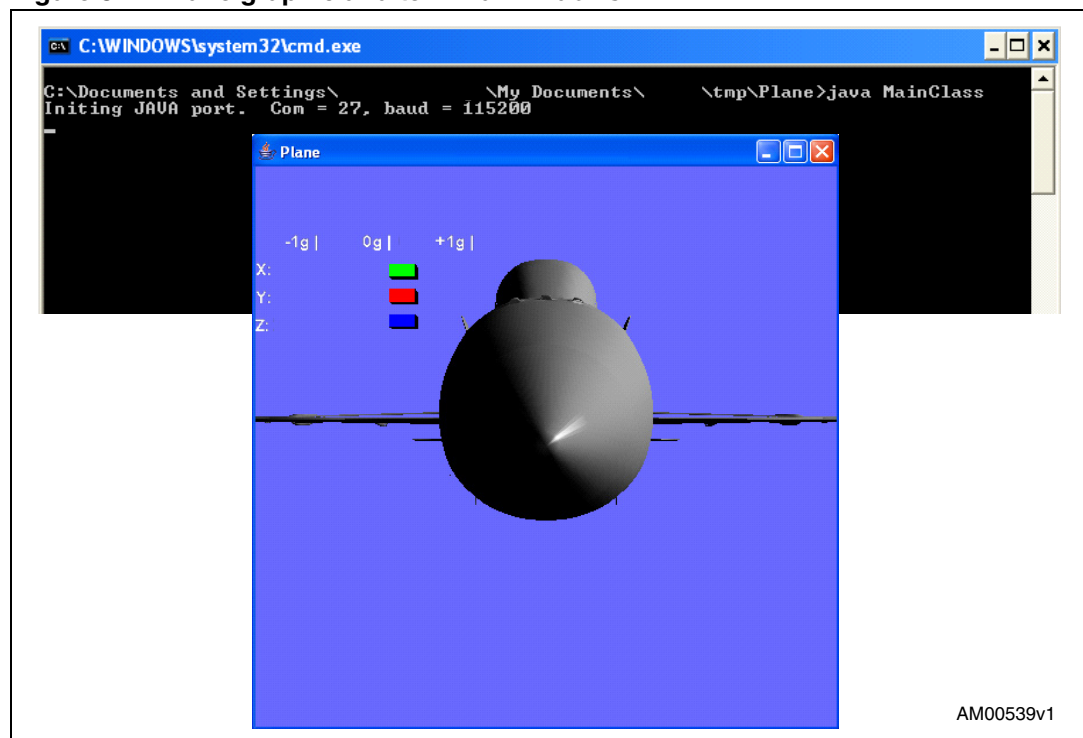
By creating a connection with the COM port, several kinds of applications running on the host computer can be used or developed to store, visualize or elaborate sensor data that are available in the format described in [Section 4.1: Dongle firmware](#). The sender of each packet can be recognized thanks to the NodeID field that is assigned to each MotionBee™ during the process of joining the network.

The demonstration kit is equipped with a simple graphical application (Plane) that uses acceleration data to measure the tilt of an object. In order to properly run the demo, the installation procedures described in the [Section 3](#) must be complete.

To run the demo:

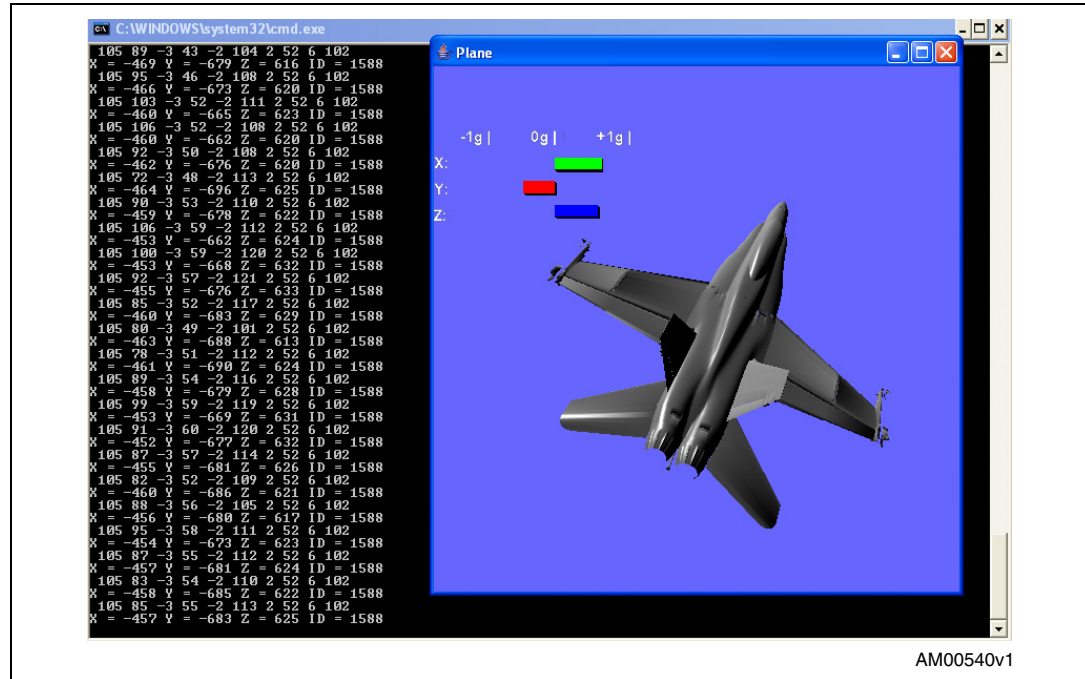
1. Plug the dongle into an empty USB slot on your PC.
2. Double click on the “Run Plane” batch file in <your\_folder>/Plane. The windows shown in [Figure 8](#) appear on the screen.
3. Switch on a MotionBee™ module and then press the commissioning button. After a few seconds the MotionBee™ starts to send packets to the dongle. The aircraft object on the screen starts to move by continuously tracking the tilt impressed on the MotionBee™. The packets read by the application through the COM port are visualized in the terminal window (See [Figure 9](#)).

**Figure 8. Plane graphic and terminal windows**



The goal of the application is to show how accelerometers can be used to measure the tilt of an object, where the tilt is a static measurement and where gravity is the acceleration being measured. The force of gravity is used as an input to determine the orientation of an object, calculating its degree of tilt. The x, y, z acceleration values are elaborated on the PC application to evaluate the rotation angles of a graphical object (Plane). The behavior of the demo is intuitive, as the graphical object on the PC monitor moves according to the movements impressed on the MotionBee™ module.

Figure 9. Plane demo while running



## 6 Revision history

Table 1. Document revision history

Date	Revision	Changes
10-Feb-2009	1	Initial release.
24-Nov-2009	2	Updated <a href="#">Chapter 3.2 on page 9</a>

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