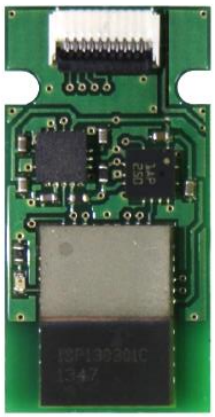
Application Note AN140802

Accelero-Magnetometer, Temperature and Barometer Sensor Demonstration



Introduction

Scope

This application note describes how to set up a Sensor application with ISP131001 Sensors Board that will send data via the Bluetooth link to the Master Emulator, an Apple Device or an Android Device.

Three types of demonstration are presented. The first one is directly executable with hardware and software provided in the Development Kit using Master Control Panel application.

The second demonstration requires the use of an iPhone or an iPad. The iOS application is available on the App Store.

The third demonstration requires the use of an Android Device. The Android application is available on the Google Play.

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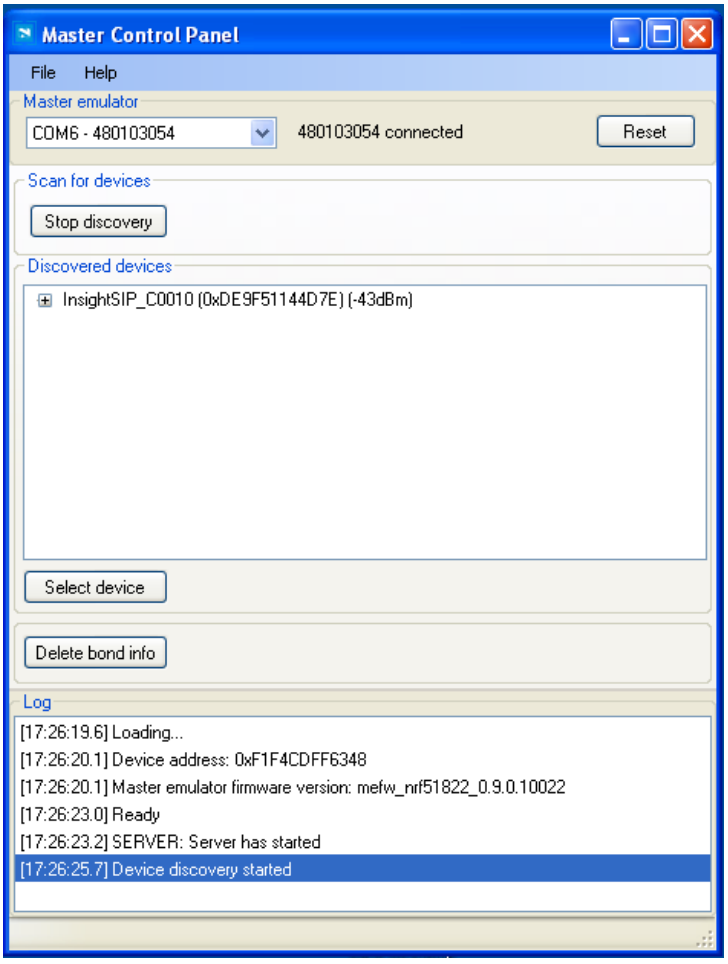
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1. Demonstration with Master Control Panel

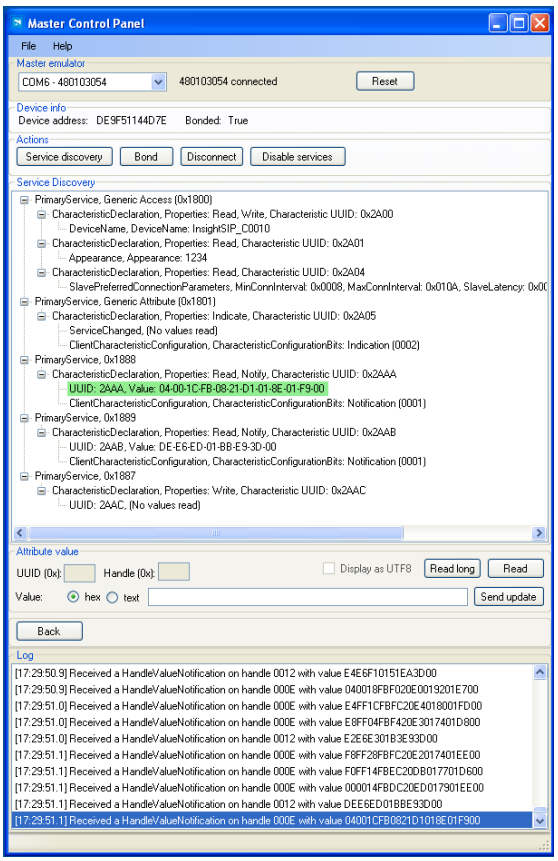
1. Place the CR2032 lithium battery into the battery holder.
2. Connect nRF51 Dongle (Master Emulator) into a USB port on your computer.
3. Start Master Control Panel.
4. Click Start Discovery.

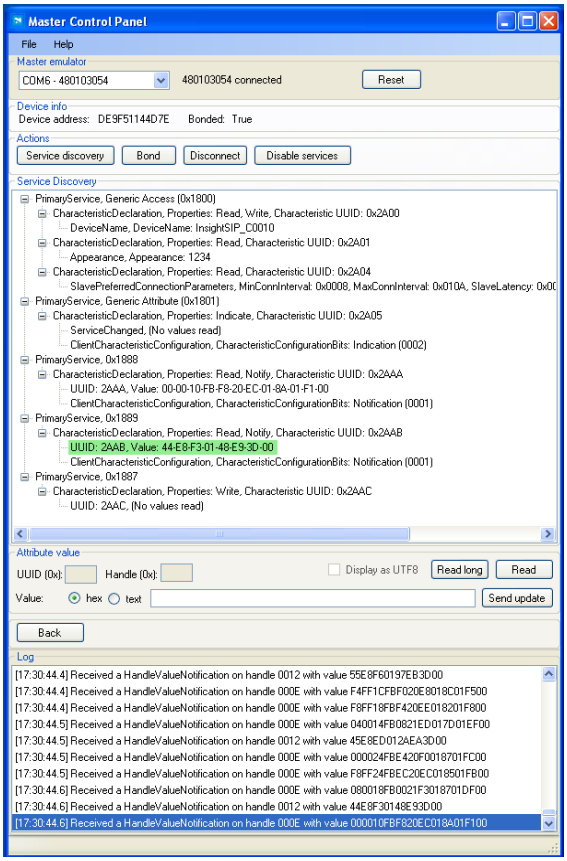


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5. Click Select Device.

6. On the following display, click successively on Bond, Discover Services and Enable Services.





7. You can note data that transit between the ISP131001 Sensors Board and the Master Emulator via the Bluetooth link:
   - Data of the accelerometer/magnetometer on the above left figure
   - Data of the temperature/pressure on the above right figure

8. To switch off ISP131001 Sensors Board, remove battery.

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2. Demonstration with iPhone or iPad Device

The Sensor application is only available on iOS device. On the App Store, search “sip sensor” or “insight sip” and download the App. The iOS App is a demonstration App that is provided "as is" in order to demonstrate the Smart Bluetooth sensor node. Only one iPhone or iPad is allowed per development kit.

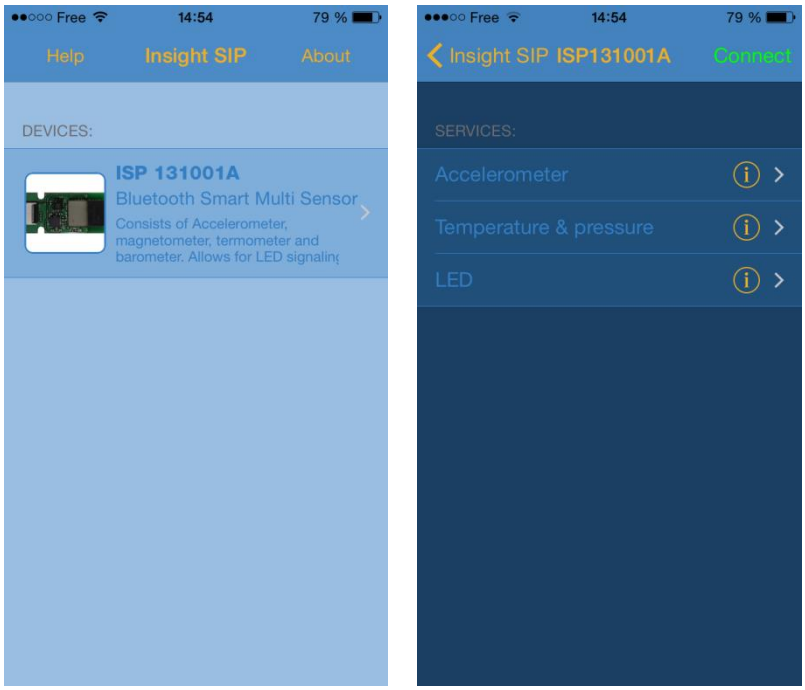
Make sure you iOS device is compatible with Bluetooth 4.0 (iPhone 4S or higher, iPad Air, Mini, 3rd generation and above).

The “sip sensor” application is downloaded and installed. You should see the application on your iOS device.
Then you will be able to set up the application demonstration as follows:

1. Place the CR2032 lithium battery into the battery holder.

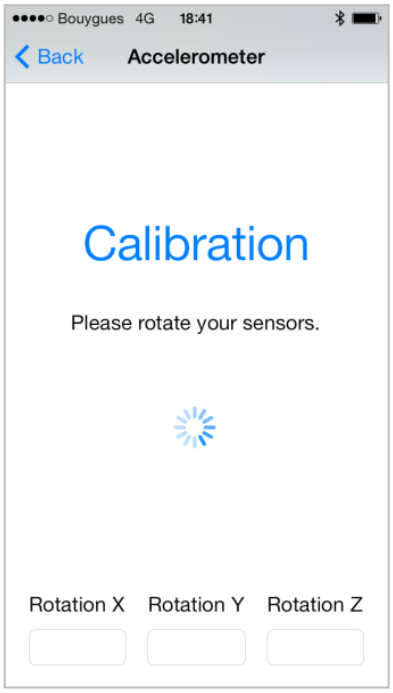
2. Connect the battery holder to the Sensors Board ISP131001.

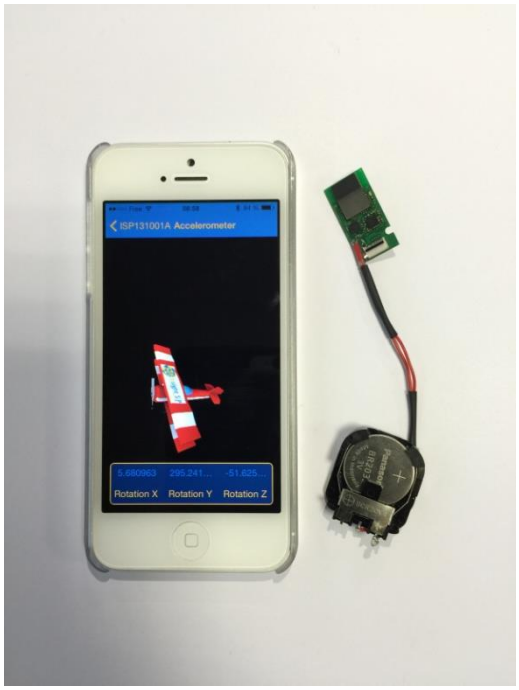
3. Start “isp sensor” application on your iOS, click Connect and select your Sensors Board.



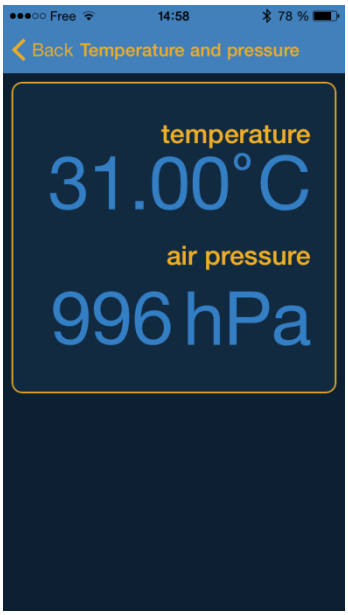
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4. Click Accelerometer. A Calibration phase invites you to rotate the ISP131001 Sensors Board. Then, a starship on your iPhone screen follows the Sensors board movement.



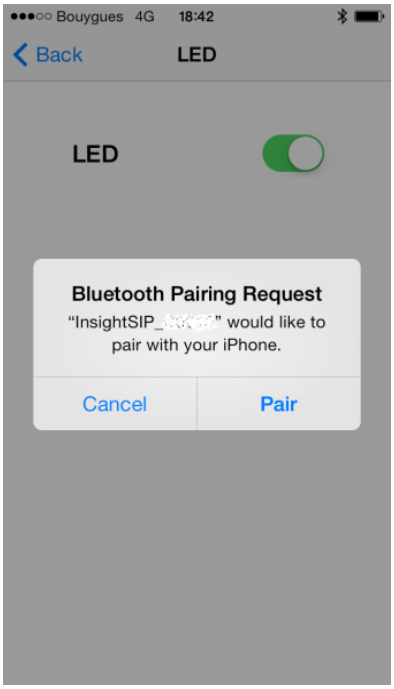


5. Click Back and Temperature to start temperature and pressure demonstration.



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6. Click Back and LED. A prompt will invite you to pair the Sensors Board with the iPhone. Click Pair. The LED lights up.



To switch off ISP131001 Sensors Board, remove battery

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3. Demonstration with Android Device

An App is also available for Android Devices. On Google Play, search “sip sensor” or “insight sip” and download the App. The android App is a demonstration App that is provided “as is” in order to demonstrate the Smart Bluetooth sensor node.

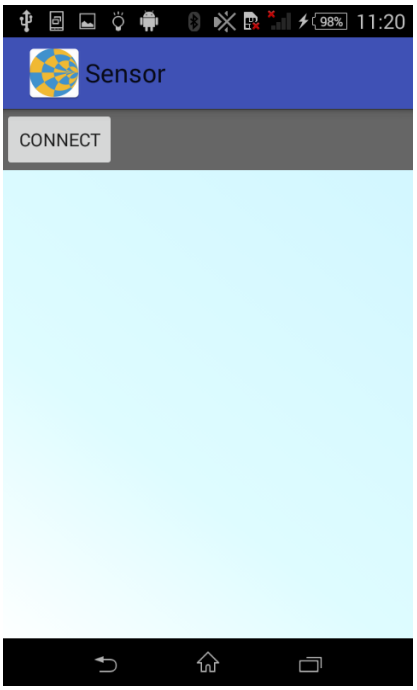
Make sure your Android device is compatible with Bluetooth 4.0 (Android v4.3 at least).

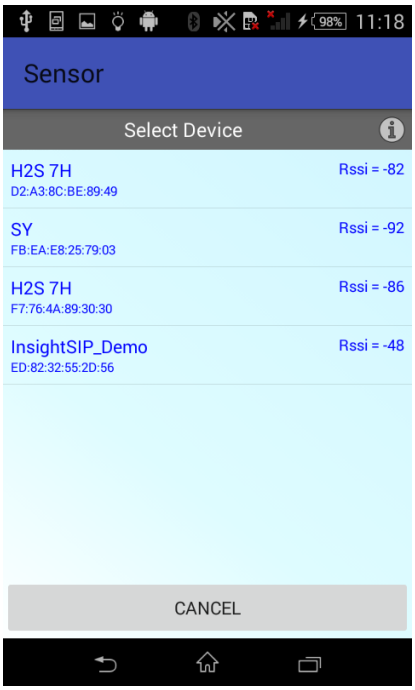
After the “sip sensor” application is downloaded and installed you should see the application on your Android device. Then you will be able to set up the application demonstration as follows:

1. (For Android v6 or earlier) In order to be able to scan for BLE devices, the application needs to have “Location” permission. You have to enable “Location” service in the settings and give permission to the Sensor App to use Location (Settings -> Application Manager -> Sensor -> Permission).

2. Place the CR2032 lithium battery into the battery holder.

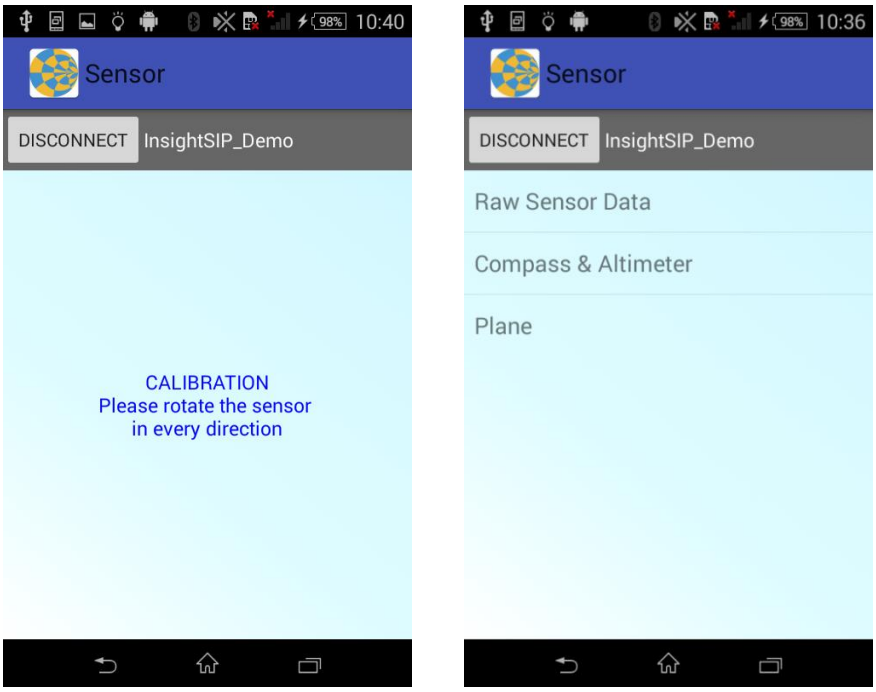
3. Start “Sensor” application on your Android, click Connect and select your Sensor Board (InsightSIP_DEMO)



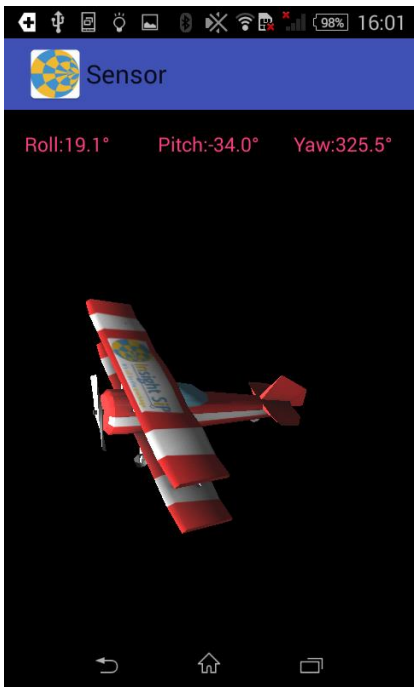


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4. A Calibration phase invites you to rotate the ISP131001 Sensors Board. Then, a menu will appear.

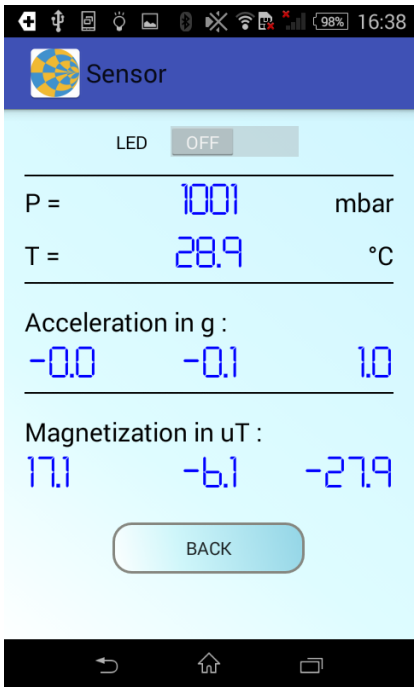


5. Select “Plane” and a plane will appear on the screen and it will follow the board movement.

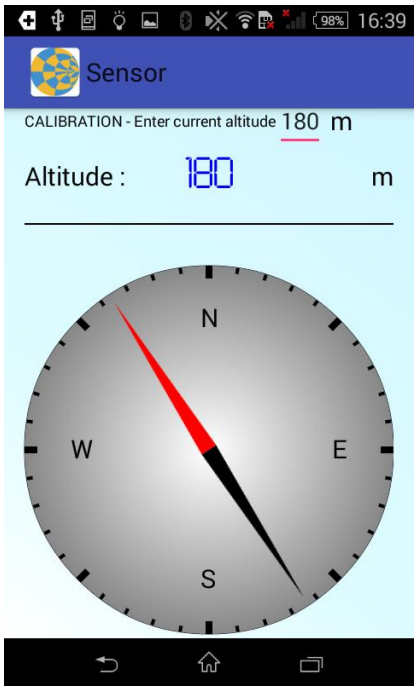


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6. Press Back and Select “Raw Sensor Data” to monitor all sensor data. On this screen, LED can also be turned ON/OFF.



7. Press Back and Select “Compass & Altimeter”. The top part is the altimeter, it has to be calibrated by entering your current altitude once. The bottom part is the compass and it doesn’t need to be calibrated (it has already been done in step 4).

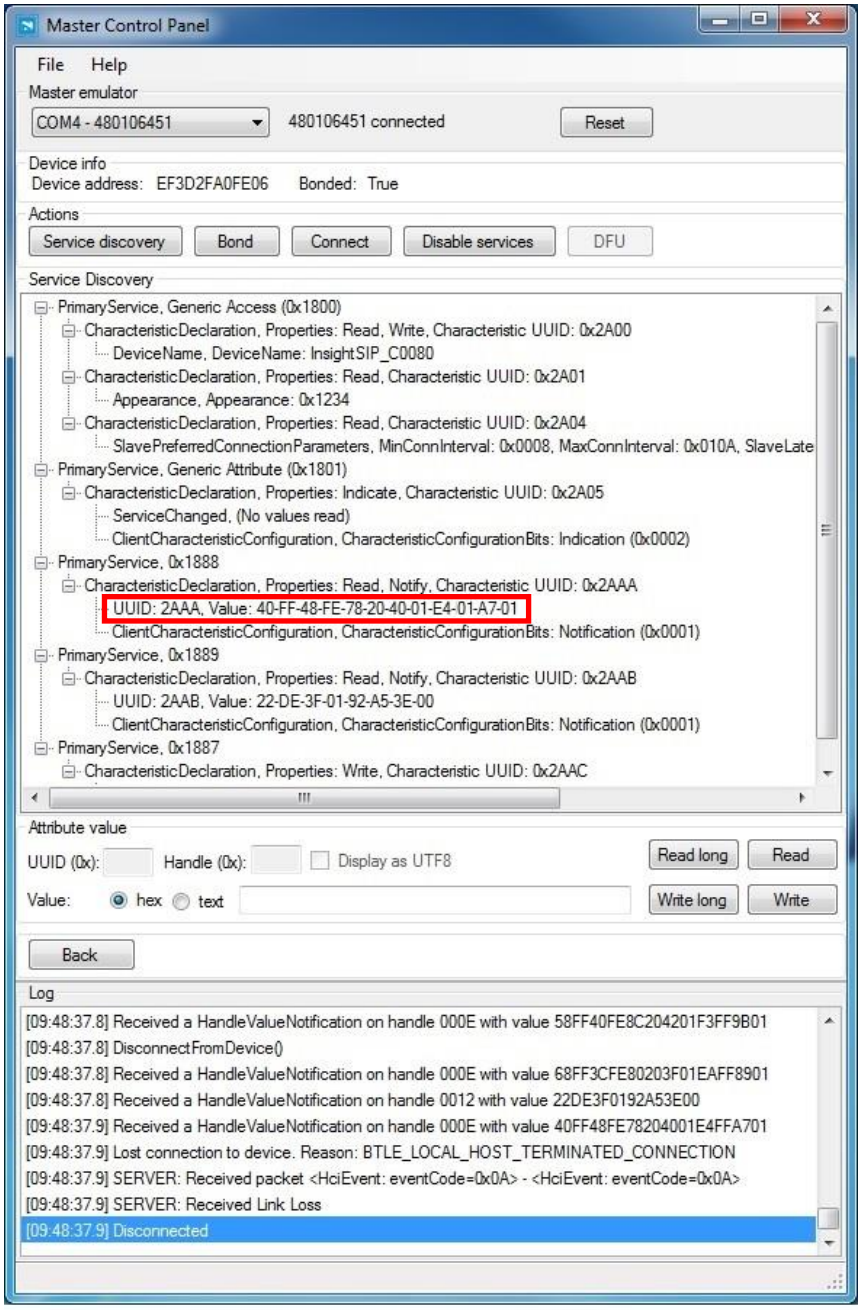


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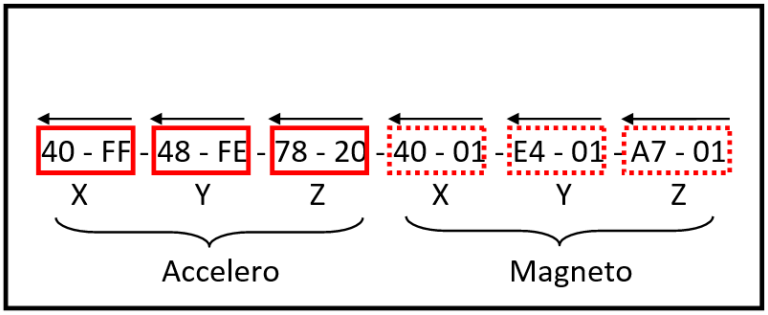
4. Data Sensor Analysis

4.1. Accelerometer Data

Display the Master Control Panel as explain in Section 1 and refer to the UUID: 2AAA Value.



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To calculate the Accelero Sensor data (SEN_{ACC}), data must be read in the opposite way:

X: FF - 40 | Y: FE - 48 | Z: 20 - 78

(2 bytes = 16 bits)

According to the formula in the Freescale FXOS8700CQ datasheet:
(http://cache.freescale.com/files/sensors/doc/data_sheet/FXOS8700CQ.pdf)

- Accelero data sensibility in test conditions (±2 *g* mode) are expressed as ACC_OUT as 2's complement numbers.

$$2^{14} = 16384 \quad \rightarrow \quad \frac{16384}{4} = 4096\ LSB/g \ \rightarrow \quad \frac{1}{4096} = 2.44 \times 10^{-4}\ g/LSB$$

Accelero output data:

$$SEN_{ACC} = ACC_{OUT}(dec) \times 0.244 = (mg/LSB)$$

Warning: In the source program, we use ±4 g mode (not ±2 g mode). We have to divide by 2048 (instead of 4096). Therefore, the final result must be divided by 2.

For X axis, we convert FF - 40 (hex) in decimal:

$$SEN_{ACC}(X)(\text{mg}) = -192 \times 0.244 = -46.848\ \text{mg}$$

The final result must be divided by 2.

$$SEN_{ACC}(X)(\text{mg}) = -\frac{46.848}{2} = -23.42\ \text{mg}$$

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For Y axis, we convert FE - 48 (hex) in decimal

$$SEN_{ACC}(Y)(\text{mg}) = -440 \times 0.244 = -107.36 \text{ mg}$$

The final result must be divided by 2.

$$SEN_{ACC}(Y)(\text{mg}) = -\frac{107.36}{2} = -53.68 \text{ mg}$$

For Z axis, we convert 20 - 78 (hex) in decimal

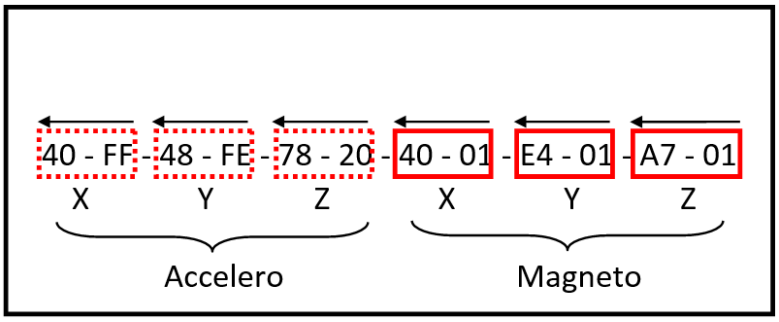
$$SEN_{ACC}(Z)(\text{mg}) = 8312 \times 0.244 = 2028 \text{ mg}$$

The final result must be divided by 2.

$$SEN_{ACC}(Z)(\text{mg}) = \frac{2028}{2} = 1014 \text{ mg}$$

4.2.Magnetometer Data

Refer again to the UUID: 2AAA Value from the Master Control Panel.



To calculate the Accelero Sensor data (SEN_{MAG}), data must be read in the opposite way:

X: 01 - 40 Y: 01 - E4 Z: 01 - A7

(2 bytes = 16 bits)

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According to the formula in the Freescale FXOS8700CQ datasheet:
(http://cache.freescale.com/files/sensors/doc/data_sheet/FXOS8700CQ.pdf)

- Magneto data sensibility are expressed as MAG_OUT as 2's complement numbers.

  Magneto output data :

$$SEN_{MAG} = MAG_{OUT}(dec) \times 0.1 = (\mu T/LSB)$$

For X axis, we convert 01 - 40 (hex) in decimal:

$$SEN_{MAG}(X)(\mu T) = 320 \times 0.1 = 32\ \mu T$$

For Y axis, we convert 01 - E4 (hex) in decimal:

$$SEN_{MAG}(Y)(\mu T) = 484 \times 0.1 = 48.4\ \mu T$$

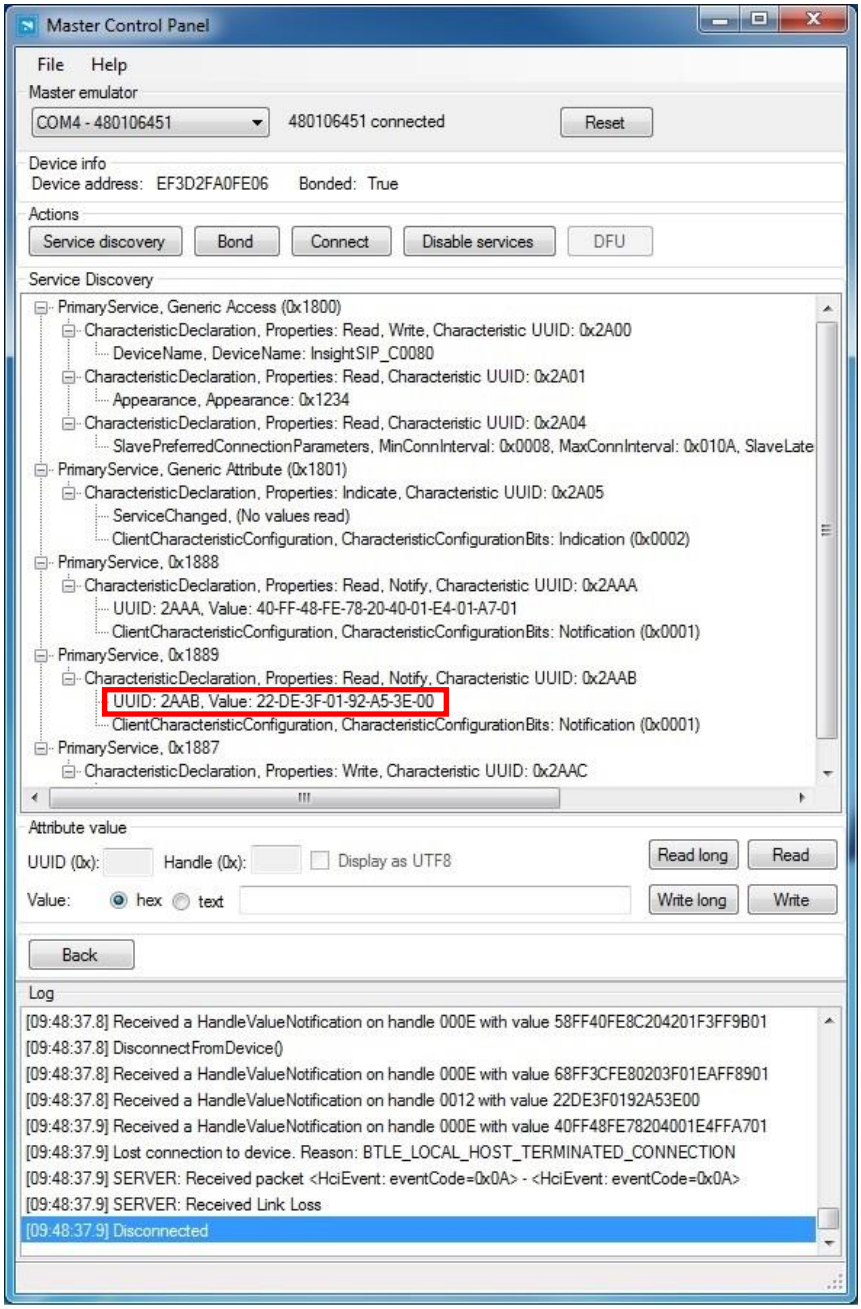
For Z axis, we convert 01 - A7 (hex) in decimal:

$$SEN_{MAG}(Z)(\mu T) = 423 \times 0.1 = 42.3\ \mu T$$

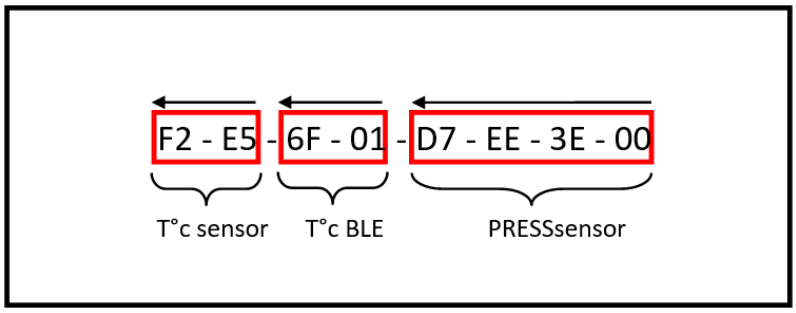
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4.3. Temperature and Barometer Data

Display the Master Control Panel as explain in Section 1 and refer to the UUID: 2AAB Value.



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- To calculate the Temperature Sensor data (T_{Sensor}), data must be read in the opposite way:

E5 - F2

(2 bytes = 16 bits)

According to the formula in the LPS331AP datasheet:
(http://www.pololu.com/file/download/LPS331AP.pdf?file_id=0J622)

- Temperature data are expressed as TEMP_OUT_H & TEMP_OUT_L as 2's complement numbers.

Temperature output data:

$$T_{sensor}(°c) = 42.5 + \frac{TEMP_OUT(dec)}{480}$$

We convert E5 - F2 (hex) in decimal:

$$T_{sensor}(°c) = 42.5 + \frac{-6670}{480} = 28.60°c$$

- To calculate the Temperature BLE data (T_{BLE}), data must be read in the opposite way:

01 - 6F

(2 bytes = 16 bits)

We convert 6F (hex) in decimal (See Nordic documentation for the formula):

$$T_{BLE}(°c) = \frac{111}{4} = 27.75°c$$

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- To calculate the Pressure Sensor data (P_{Sensor}), data must be read in the opposite way:

00 - 3E - EE - D7

(4 bytes = 32 bits)

According to the formula in the LPS331AP datasheet:
(http://www.pololu.com/file/download/LPS331AP.pdf?file_id=0J622)

- Pressure data are expressed as PRESS_OUT_H & PRESS_OUT_L & PRESS_OUT_XL in 2's complement. Values exceeding the operating pressure Range are clipped.

Pressure output data:

$$P_{sensor}(\text{mbar}) = \frac{\text{PRESS_OUT(dec)}}{4096}$$

We convert 3E - EE - D7 (hex) in decimal:

$$P_{sensor}(\text{mbar}) = \frac{4124375}{4096} = 1007 \text{ mbar}$$

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