
Transferring Weather Data to a Smart Device BLE Client Using a Curiosity Development Board

Introduction

This application note demonstrates the use of a Bluetooth® Low Energy (BLE) module to transfer temperature, pressure, and relative humidity readings to an application running on a smart device. The host MCU (PIC32MZ2048EFM100 or PIC32MX470F512H) interfaces with a BLE2 click board over the UART, and the Weather click board over the I²C interface. The BLE2 click board uses the RN4020 module, and the Weather click board has a BME280 module. The weather data can be viewed using the Microchip Bluetooth Data Application on the Android™ platform.

This demonstration can be run either on a Curiosity PIC32MZ EF Development Board, or a Curiosity PIC32MX470 Development Board.

To examine the features of the Curiosity boards, refer to the following User's Guides:

- [PIC32MZ EF Curiosity Development Board User's Guide \(DS70005282\)](#)
- [PIC32MX470 Curiosity Development Board User's Guide \(DS70005283\)](#)

1. Required Tools and Applications

The following Microchip development tools are needed to run the BLE Weather Click board demonstration:

- The demonstration can be run either on the Curiosity PIC32MZ EF Development Board ([DM320104](#)), which is available from [Microchip Direct](#), or on the Curiosity PIC32MX470 Development Board ([DM320103](#)), which is available from [Microchip Direct](#)
- Download and install the latest version of the [MPLAB X Integrated Development Environment \(IDE\)](#)
- Download and install the latest version of the [MPLAB XC32 C/C++ Compiler](#)
- Optionally download and install the latest version of the [MPLAB Harmony Integrated Software Framework](#)

Note:

1. Using the MPLAB Harmony Integrated Software Framework will extend the functionality of this project by adding new modules, software frameworks, and libraries to the project.
2. This application project is developed on the following tools
 - MPLAB X IDE v4.05
 - MPLAB XC32 C Compiler v1.44
 - MPLAB Harmony v2.05
 - MPLAB X IDE plug-in: MPLAB Harmony Configurator (MHC) v2.0.5.2

The following click boards from Mikroelektronika are used:

- BLE2 click board ([MIKROE-1715](#))
- Weather click board ([MIKROE-1978](#))

The following applications are used for the smart device:

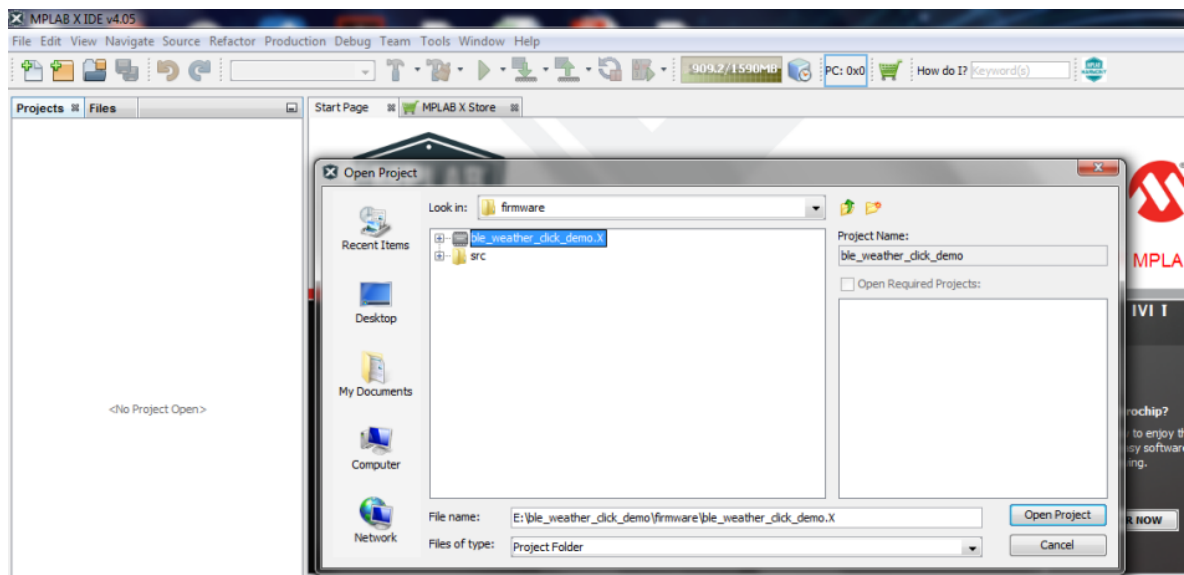
- For Android devices: [Microchip Bluetooth Data Application](#)

2. Building the Application

The following steps are used to build the application:

1. Download the ble_weather_click_demo project. These demonstrations along with their documentation will be available on the [Curiosity PIC32MZEF Development Board](#) and [Curiosity PIC32MX470 Development Board](#) web pages, under the *Curiosity Demo Examples* tab.
2. Using MPLAB X IDE, build the project by selecting *File > Open Project* and choosing the ble_weather_click_demo.X project, which is located in <project_path>/ble_weather_click_demo/firmware, as shown in the following figure.

Figure 2-1. Opening the Weather Demonstration Project



3. The project has two configurations. Depending on the selected development board, select the corresponding configuration, as shown in the following figure.

Figure 2-2. Selecting the Hardware Configuration

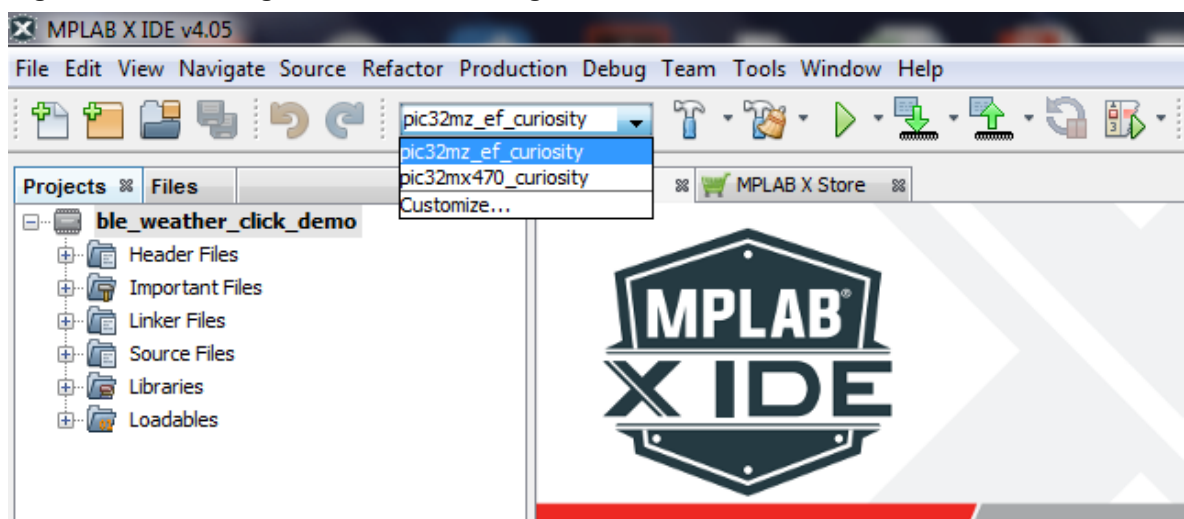


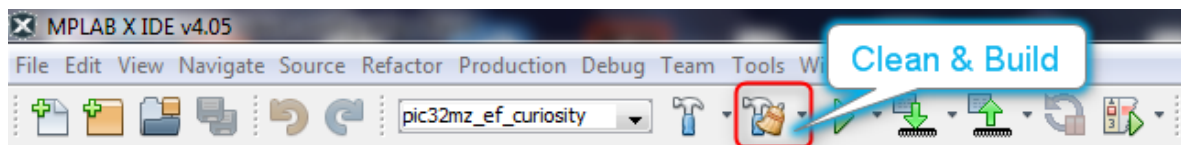
Table 2-1. Supported Configurations

Development Board	Configuration Name	Description
PIC32MZ2048EFM100	pic32mz_ef_curiosity	Sets up MPLAB X IDE to build and run the demonstration application on the PIC32MZ EF Curiosity Development Board, with the PIC32MZ2048EFM100 microcontroller. The UART driver is configured to use UART1 instance of the peripheral at 115200 baud, 8 bits, no parity and 1-stop bit. The I ² C driver is configured to use I ² C2 instance of the peripheral at 25 kHz clock.
PIC32MX470F512H	pic32mx470_curiosity	Sets up the MPLAB X IDE to build and run the demonstration application on the PIC32MX470 Curiosity Development Board, with the PIC32MX470F512H microcontroller. The UART driver is configured to use UART1 instance of the peripheral at 115200 baud, 8 bits, No parity and 1-stop bit. The I ² C driver is configured to use I ² C2 instance of the peripheral at 25 kHz clock.

Building the Project

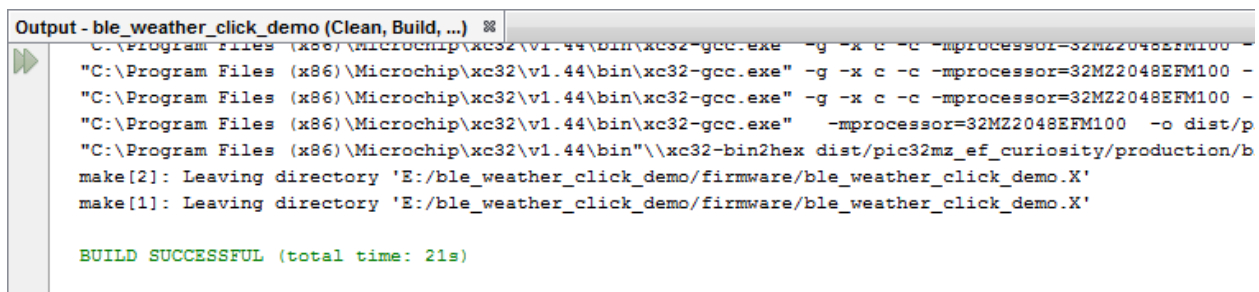
1. Clean and Build the project by clicking the *Clean and Build* icon, as shown in the following figure.

Figure 2-3. Clean and Build the Project



2. Check the Build log, which is located at the bottom of the MPLAB X IDE, as shown in the following figure.

Figure 2-4. Build Log



Note:

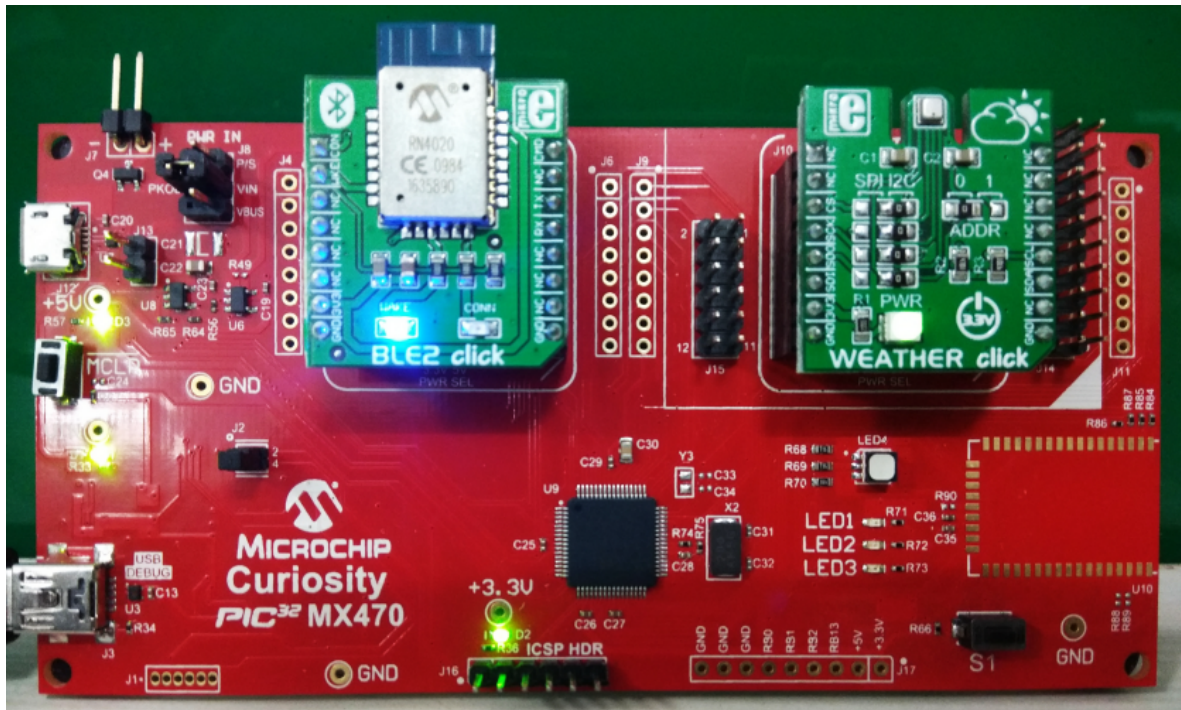
Frequently a project will not compile on a Windows™ computer due to a limitation in the path length. The Windows operating system has a maximum path length of 260 characters. This limitation causes file paths to be truncated when attempting to compile, which leads to files not being found by the compiler. Try placing the project in the top level directory, usually `C:/.` For more information, refer to the Maximum Path Length Limitation section of the Naming Files, Paths, and Namespaces, which is available on the [Microsoft Developer Network site](https://docs.microsoft.com/en-us/windows/win32/fileio/naming-a-file).

3. Configuring the Hardware

The following steps are used to configure the hardware for the Demonstration:

1. Mount the BLE2 click board on the mikroBUS socket J5.
2. Mount the Weather click board on the mikroBUS socket J10.

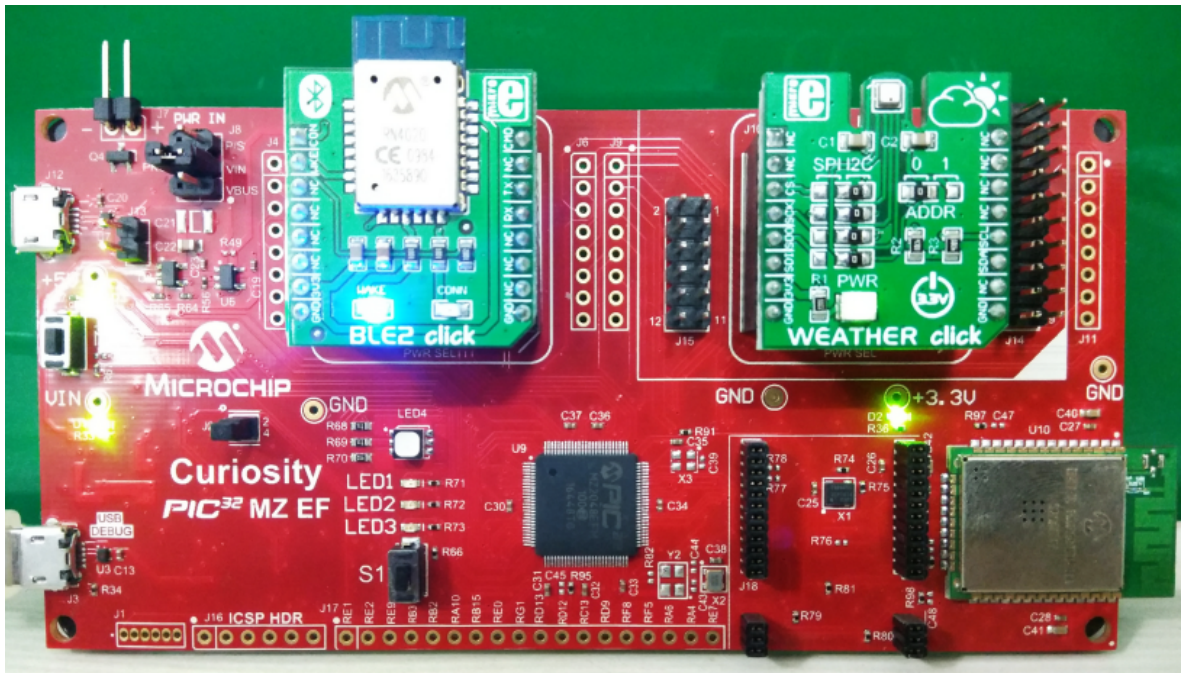
Figure 3-1. Curiosity PIC32MX470 Development Board



3. Power the Curiosity PIC32MX470 Development Board from the host computer through a Type-A male to Mini-B USB cable connected to the Mini-B port (J3). The cable is not included with the kit. Ensure that the jumper is placed in the J8 header, which is between 4 and 3, to select the supply from the debug USB connector.

Note: For the Curiosity PIC32MX470 Development Board, verify that the value of the series resistors (R61 and R63) mounted on the SCL2 and SDA2 lines of the mikroBUS socket J10 are set to zero Ohms. If not, replace the resistors R61 and R63 with zero Ohm resistors.

Figure 3-2. Curiosity PIC32MZ EF Development Board

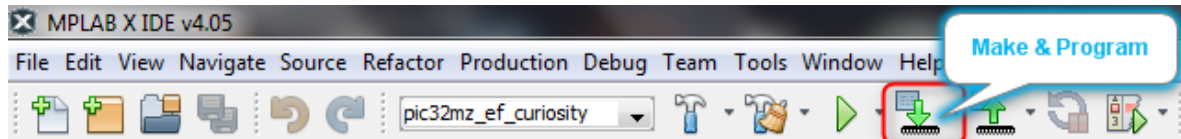


4. Running the Demonstration

This application demonstrates the use of the BLE module to transfer weather data to a BLE client application running on a smart device. The following steps are used for running the demonstration:

1. Open the project in MPLAB X IDE and select the pic32mx470_curiosity, or pic32mz_ef_curiosity configuration depending on the development board in use.
2. Build the code and program the device by clicking the Make and Program icon as shown in the following figure.

Figure 4-1. Building the Code and Programming the Device



3. After power up, the BLE module is in Active mode and starts advertising, which is indicated by the WAKE LED turning blue, as shown in the following figure.

Figure 4-2. BLE Module in Active Mode on the PIC32MZ EF

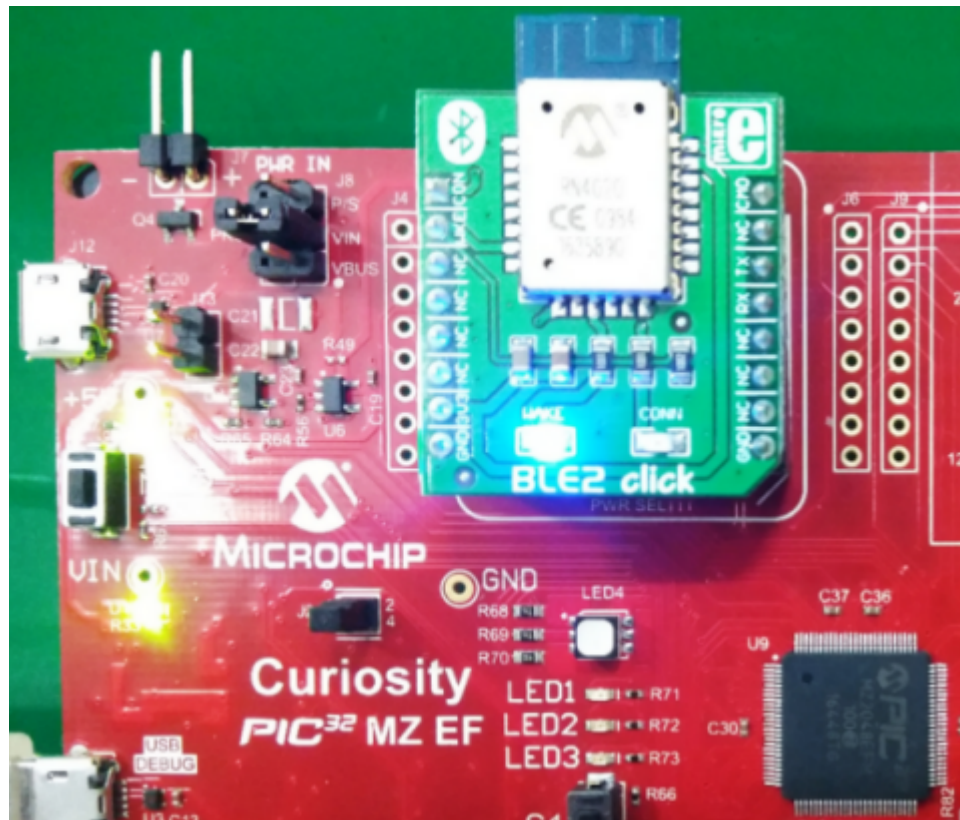
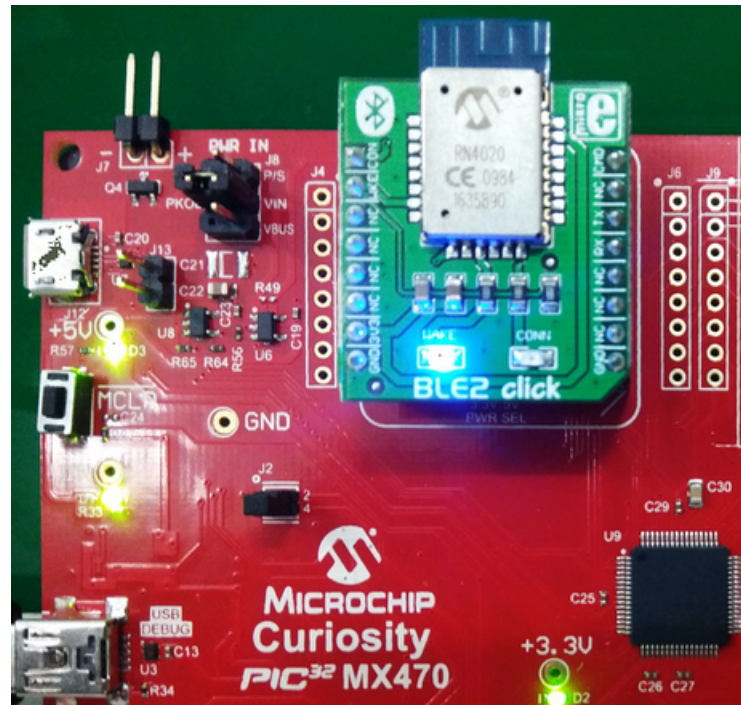
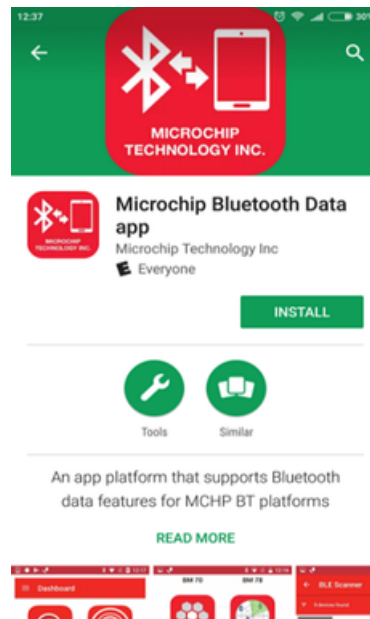


Figure 4-3. BLE Module in Active Mode on a PIC32MX470



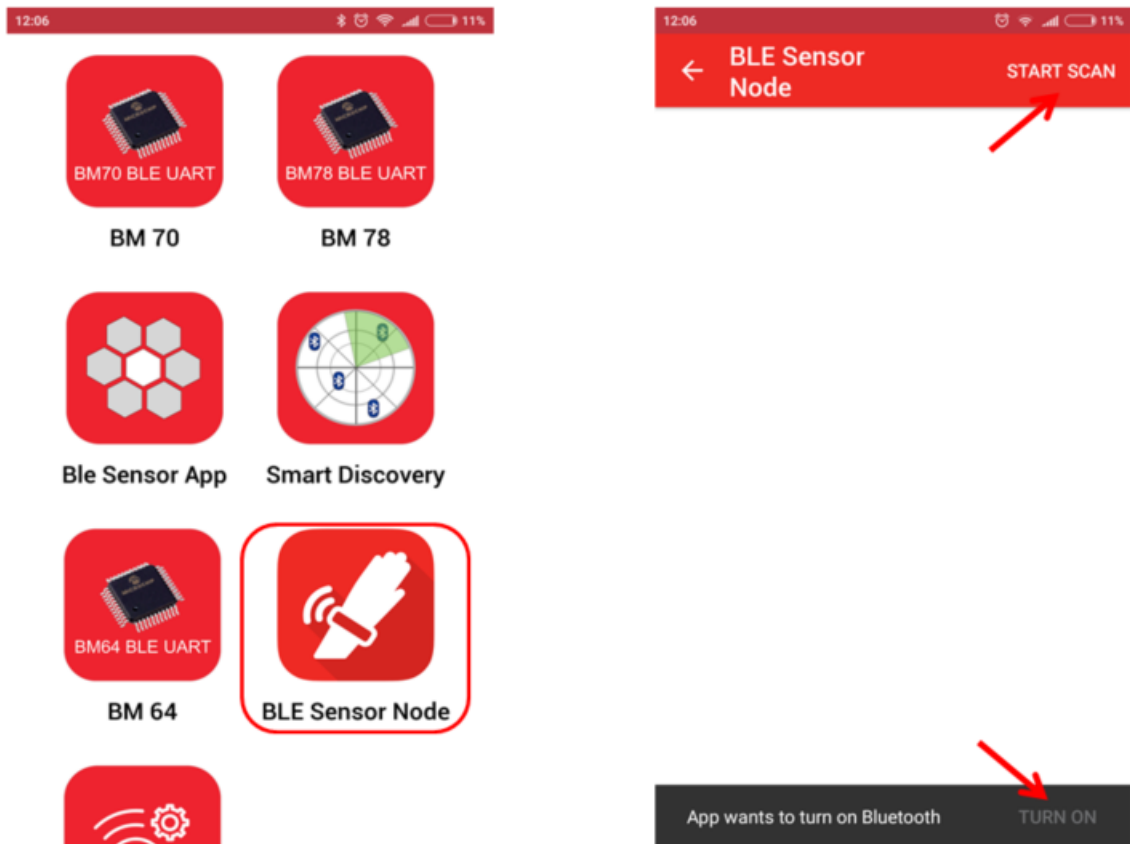
- Download and install the *Microchip Bluetooth Data App* from the Android™ Play Store on your Android-based smart device, as shown in the following figure.

Figure 4-4. Microchip Bluetooth Data App



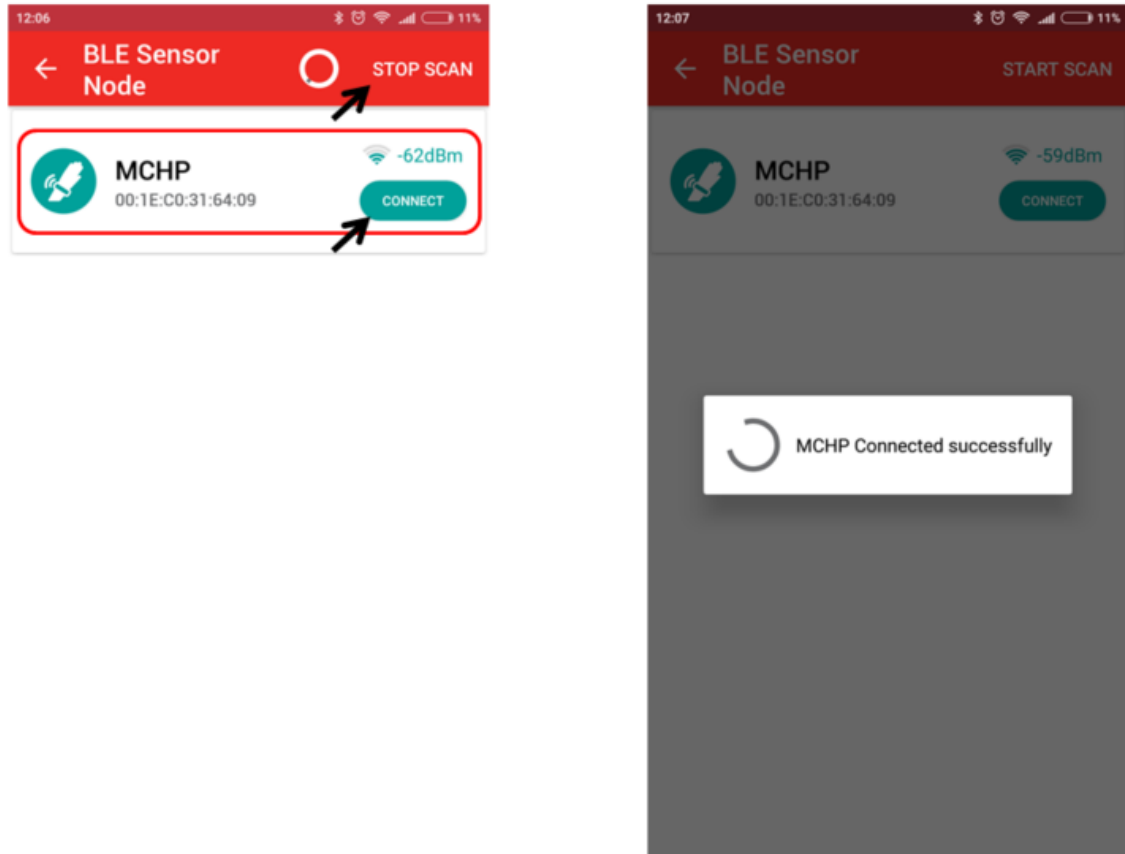
- Open the Microchip Bluetooth Data (MBD) application on your smart device and tap the *BLE Sensor Node* icon on the dashboard, as shown in the following figure. If prompted, allow the application to turn on Bluetooth for the smart device.

Figure 4-5. Starting BLE Sensor Node and Scanning BLE Devices



- Scan for Bluetooth devices by tapping *START SCAN* (refer to the previous figure). The RN4020 device should appear as *MCHP* in the list of Bluetooth devices found. Stop the scan and connect using the the *MCHP* BLE device, as shown in the following figure. This will establish a connection between the MBD BLE application (acting as the BLE client) and the RN4020 BLE device (acting as the BLE server).

Figure 4-6. Select the Microchip BLE Device



7. When the device is connected, the *CONN* LED on the BLE2 click board will turn green, as shown in the following figure.

Figure 4-7. *CONN* LED on the BLE2 for the Curiosity PIC32MZ EF Development Board

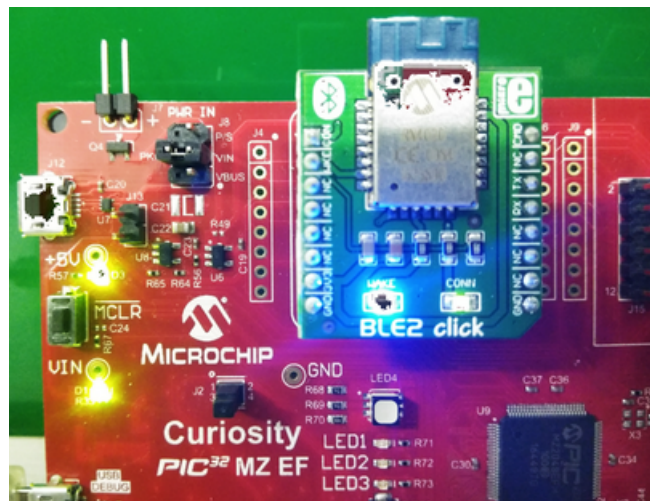
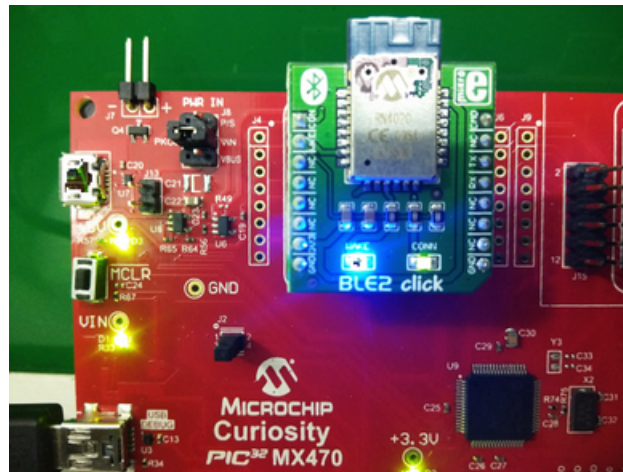


Figure 4-8. CONN LED on the BLE2 for the Curiosity PIC32MX470 Development Board



8. The RN4020 module will define private or custom services, and their associated characteristics. All private services or characteristics have a 128-bit UUID. The following table lists the private or custom services, and the associated characteristics enabled by the host MCU in the RN4020 module (BLE server).

The Environment Data Characteristic sends temperature, pressure and relative humidity data. The Output Data Rate (ODR) characteristic controls the rate at which the weather data is read and updated by the host MCU to the BLE server. The following ODR settings are allowed:

- 1Hz
- 2Hz
- 4Hz
- 8Hz
- 10Hz

Table 4-1. User Defined Custom Services and Characteristics

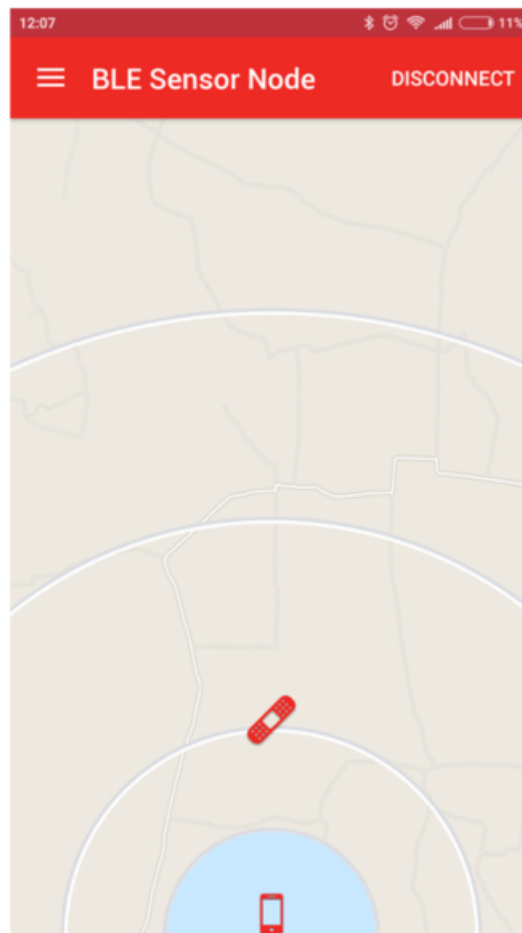
Custom Service or Characteristic	UUID	Property	Data
Environment Service	F05A- BAC0 -3936-11E5-87A6-0002-A5D5-C51B	NA	NA
Environment Data Characteristic (Temperature/Pressure/Humidity)	F05A- BAD0 -3936-11E5-87A6-0002-A5D5-C51B	Read/Notify	Byte0 = Temp LSB Byte1 = Temp MSB Byte2 = Pressure LSB Byte3 = Pressure MSB Byte4 = UV LSB0 Byte5 = UV LSB1 Byte6 = UV MSB0 Byte7 = UV MSB1

Custom Service or Characteristic	UUID	Property	Data
			Byte8 = Humidity
Output Data Rate Characteristic	F05A-BAD1-3936-11E5-87A6-0002-A5D5-C51B	Read/Write	1 Byte

Note: There is no light sensor on the PIC32 board, therefore bytes 4-7 corresponding to the UV data are set to 0 by the BLE server.

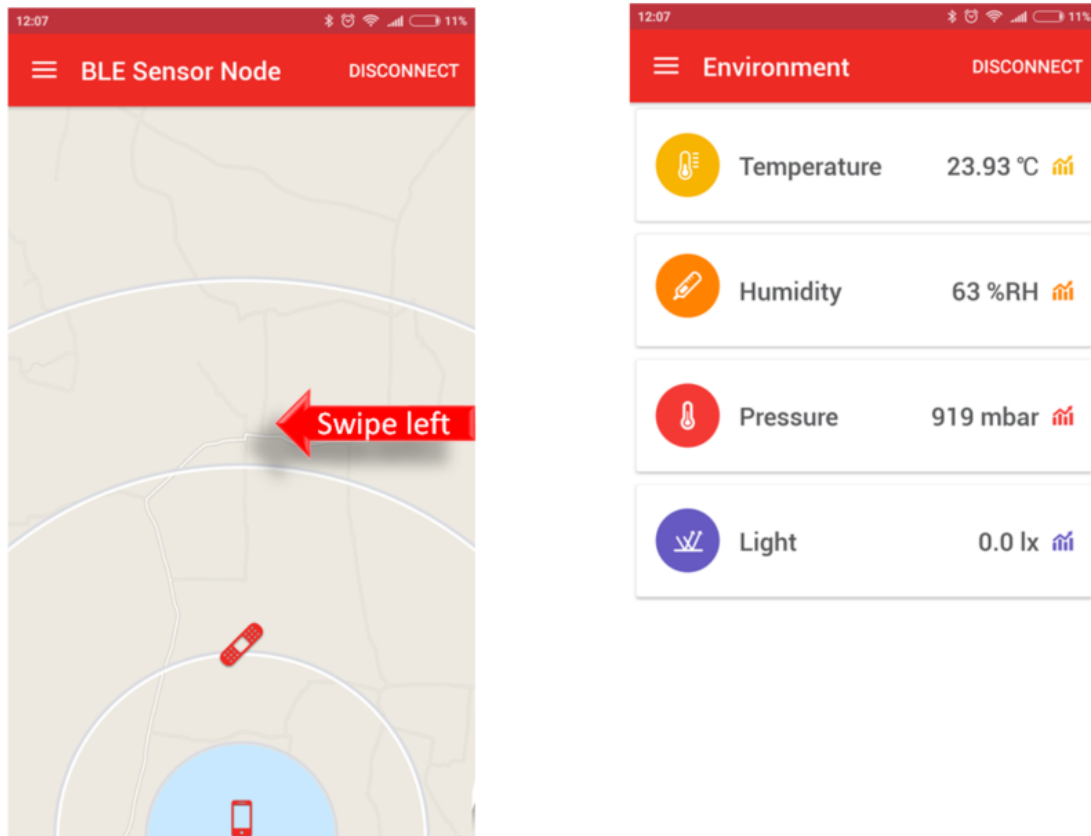
- Once connected, the application shows the proximity screen as shown in the following figure. The page displays the Status of the Bluetooth link, and using RSSI, the approximate range between the Android host device and the Curiosity PIC32 Development Board. There is a *Navigation Drawer* button on the top left of the screen and a *DISCONNECT* button on the top right of the screen.

Figure 4-9. Proximity Screen



- Navigate to the Environment Sensor screen by swiping left on the proximity screen.

Figure 4-10. Environment Sensor Screen



Note:

1. Other features on the application like the Step Count, Accelerometer, Gyroscope etc. are not supported by this demo. Navigating to these screens may lead to an undefined behavior.
 2. There is no light sensor on the PIC32 board, therefore the demo will always show the light sensor readings as 0.
11. The user is re-directed to the corresponding graph, when the user taps on the Graph button as shown in the following figures.

Figure 4-11. Graph Buttons

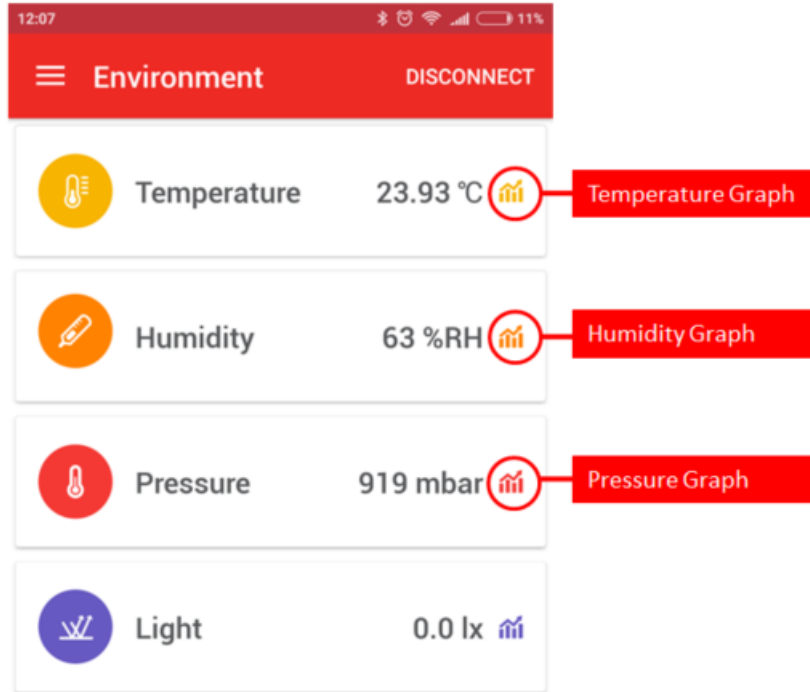


Figure 4-12. Temperature Plot

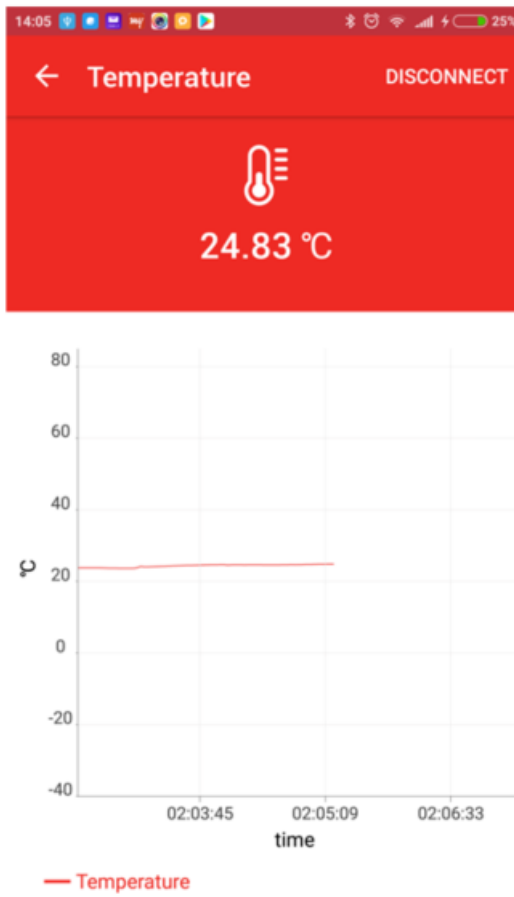


Figure 4-13. Humidity Plot

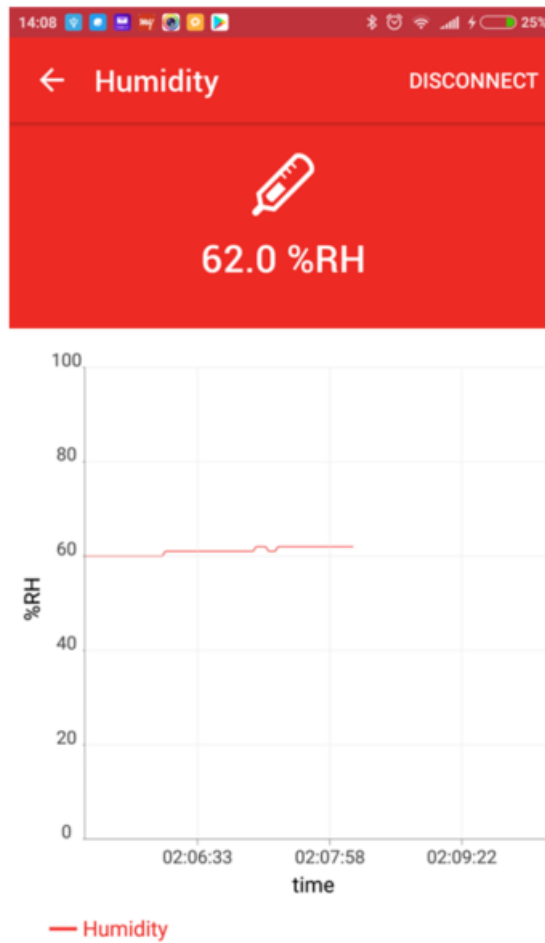
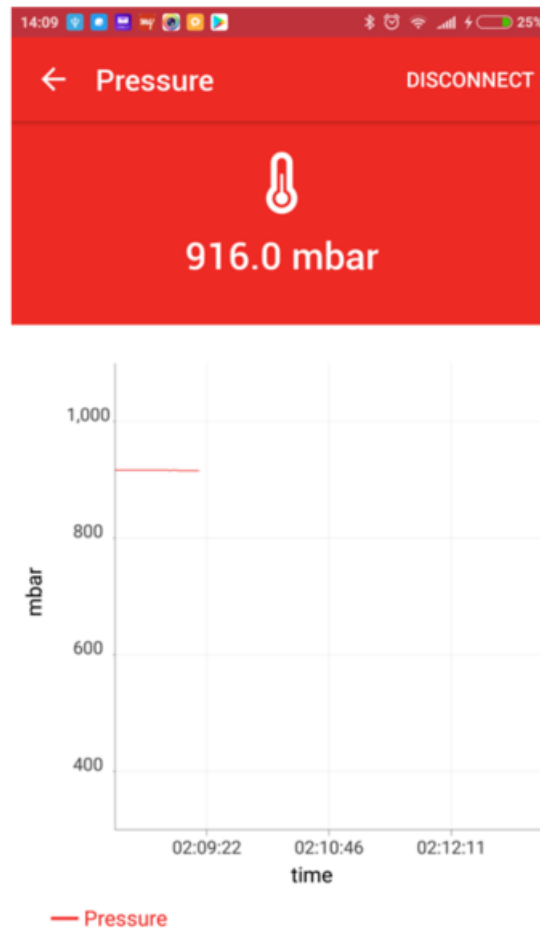
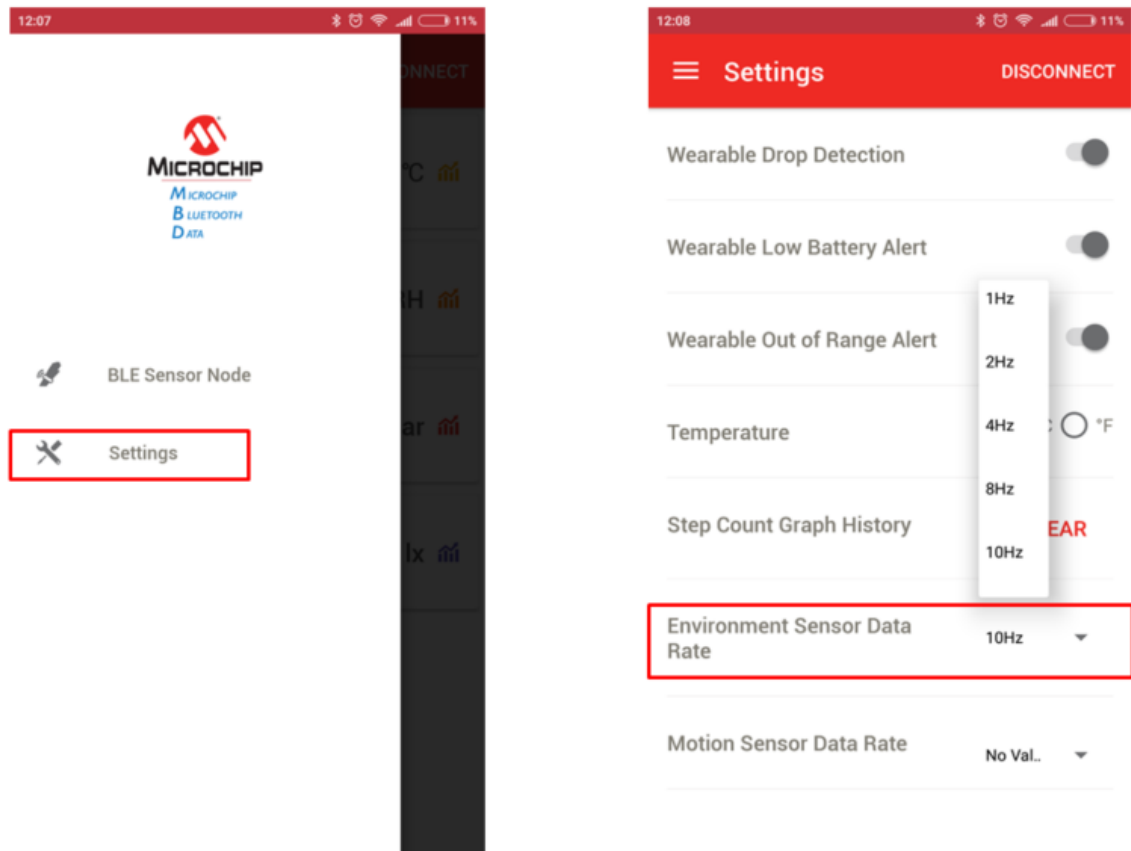


Figure 4-14. Pressure Plot



12. The ODR characteristic with UUID F05A-**BAD1**-3936-11E5- 87A6-0002-A5D5-C51B can be used to change the rate at which the environment data is read from the sensor and updated by the host MCU to the BLE server. The default rate is set to 1Hz (Output data rate value = 0x01). To change the ODR, tap on the *Navigation Drawer* button on the top left corner of the screen and then tap on Settings. The ODR can be changed to 1Hz, 2Hz, 4Hz, 8Hz or 10Hz by tapping on the *Environment Sensor Data Rate* in the Settings screen, as shown in the following figure.

Figure 4-15. Changing Output Data Rate



13. After changing the ODR, disconnect the BLE device and then reconnect it.

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