



GAP–Central Demo User’s Guide

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1. Overview

This document explains how to setup a GAP-Central demo using SAML21 Xplained Pro, BM71-XPro. This document briefly talks about setting up hardware, building application, programming firmware, and running a demo.

This demo application showcases a Proof-of-Concept example of using **ble_host_sdk** to setup BM71 as GAP-Central. This demo application scan for suitable GAP-Peripheral device and connects with it. Once connected it discovers device orientation service and characteristics in remote device and enable notifications to get accelerometer and gyroscope sensor data from remote device. Upon receiving data from remote GAP-Peripheral device, the Central demo prints them on serial console.

The following table provides the list of expected BLE services and Characteristics in this application.

Name	UUID	Properties	Size (bytes)
Device Orientation Service (Custom)	0xF05ABAC1393611E587A60002A5D5C51B	-	-
Accelerometer Position Characteristic	0x1BC5D5A50200A687E5113639D7BA5AF0	Notify, Read	6
Gyroscope Position Characteristic	0x1BC5D5A50200A687E5113639D4BA5AF0	Notify, Read	6

2. Configuring the BM71 XPRO board

It is necessary to configure the BM71 XPRO board by making changes to the configuration file and flash the modified changes to BM71 XPRO board. The configuration changes demand the module to configure in Manual mode.

By default, the BM71 XPro board is configured to operate in Auto mode. The Microchip Studio project, however, requires the module to set up in Manual mode.

The following instructions show how to setup and configure the module to add configuration changes.

1. Connect the BM71 XPro directly to the PC using the MicroUSB on the board. The BM71 XPro board should enumerate a COM port. If not, check if the necessary MCP2200 drivers have been installed.

2. Set up the module to programming mode by configuring the Switch 1 in 3-pin DIP switch to ON state. The switch#1 sets the mode of operation on the module (between application mode and flash write mode). Refer to details on pin P2_0 in the BM70 datasheet for more details. The Blue LED (labeled BT_ACT, LD4) should be solid BLUE now. If not, check the following: a. Press 'Reset' button on the board.

NOTE: Make sure the jumper on J2 is set to USB.

3. Make sure that the BM71 module does have the correct BM71 firmware installed. By default, they should be. However, if you have programmed the module to be RN4871, change the firmware back to BM71. If the module has RN871 firmware, the module will not operate as expected and the Studio project will fail.

4. Open the UI tool for the BM70/71 modules. This tool is available for download from the BM70/71 webpage under the 'Software libraries/firmware' section.

5. Open the UI tool:



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- a. In the example below, the 'BM71 default table' is being used as the base file.
Click on 'Edit' to start editing the memory parameters.
- b. The following changes are made in the first 'System Setup' tab:
 - i. Disable the low power operation.
 - ii. Change the operation mode to 'Manual pattern.'

The screenshot displays the 'System Setup' configuration window. The 'Device Information' section shows 'Name Fragment' set to 'BM71_BLE'. The 'UART Setting' section includes 'HCI Baud Rate Index' (0x03 : 115200), 'H/W Flow Control' (Disable), 'Rx Notify Length' (0x05), 'UART RX_IND' (Disable), 'UART Parity' (Disable), 'Parity Mode' (0x00: Odd Parity), and 'Stop Bit' (1 stop bit). The 'Operation Mode Setting' section shows 'Operation Pattern' set to 'Manual Pattern' and 'Configure Mode Timeout' (0x00). Red boxes highlight the 'Disable' option for 'UART RX_IND' and the 'Manual Pattern' option for 'Operation Pattern'. Navigation buttons at the bottom include 'Previous', 'Next', and 'Finish'.

Section	Parameter	Value
Device Information	Name Fragment	BM71_BLE [32 characters]
	Help	
UART Setting	HCI Baud Rate Index	0x03 : 115200
	H/W Flow Control	Disable
	Rx Notify Length	0x05 (0x00~0xFF)
	UART RX_IND	Disable
	UART Parity	Disable
	Parity Mode	0x00: Odd Parity
	Stop Bit	1 stop bit
Operation Mode Setting	Operation Pattern	Manual Pattern
	Configure Mode Timeout	0x00
Help		
Previous Next Finish		

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3. Hardware Setup

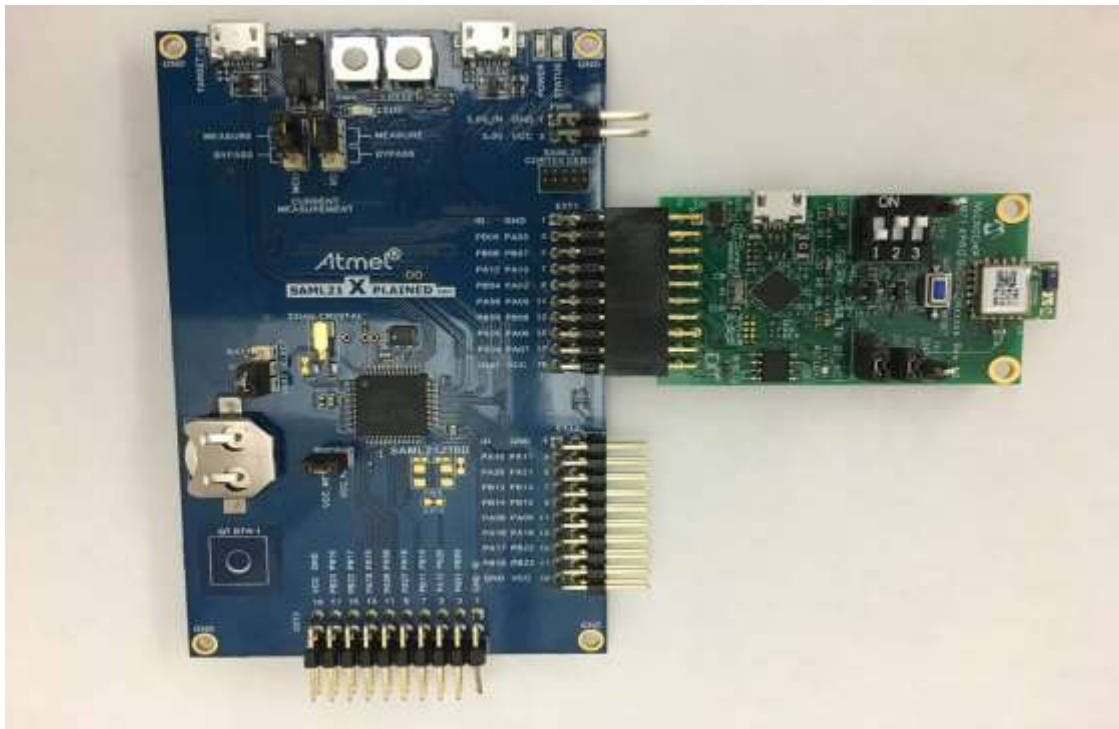


Figure 1: SAML21 Xplained Pro with BM71-XPro

1. Plug in the BM71-XPro board into EXT1 of SAML21 Xplained Pro board as shown in Figure 1.
2. Connect the SAML21 Xplained Pro board to the host PC using micro USB cable.

4. Console

The GAP-Central demo application uses the Universal Asynchronous Receiver/Transmitter (UART) interface on SAML21 Xplained Pro to send the status messages like Scanning, Connected, Disconnected and the sensor data from remote device. Any serial application (ex: TeraTerm) can be used to interact with SAML21 Xplained Pro.

Use the following serial port configuration to interact with BM70.

Baud rate	115200
Data	8 bits
Parity	none
Stop	1 bit
Flow control	none

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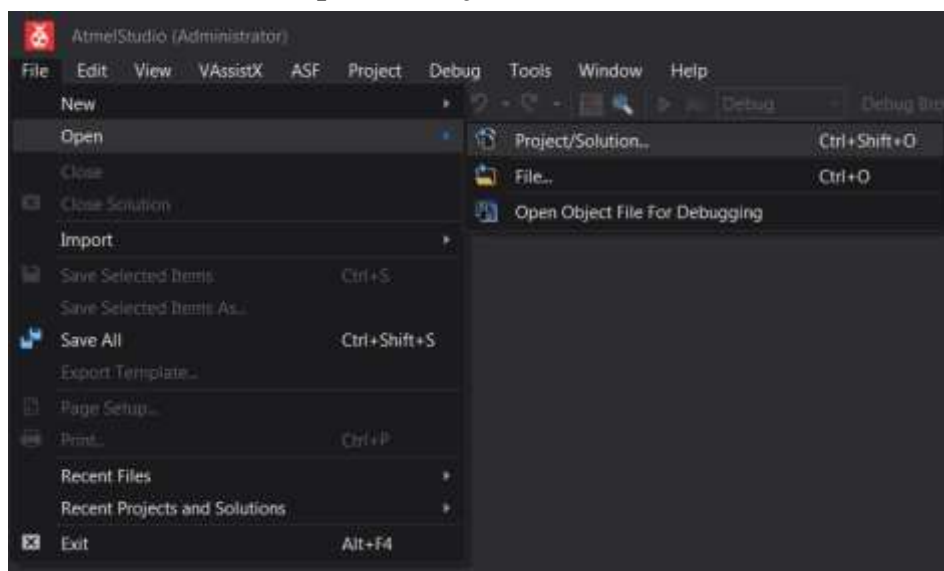
5. Build Procedure

This section describes build procedure of GAP-Central demo application on Microchip Studio 7.

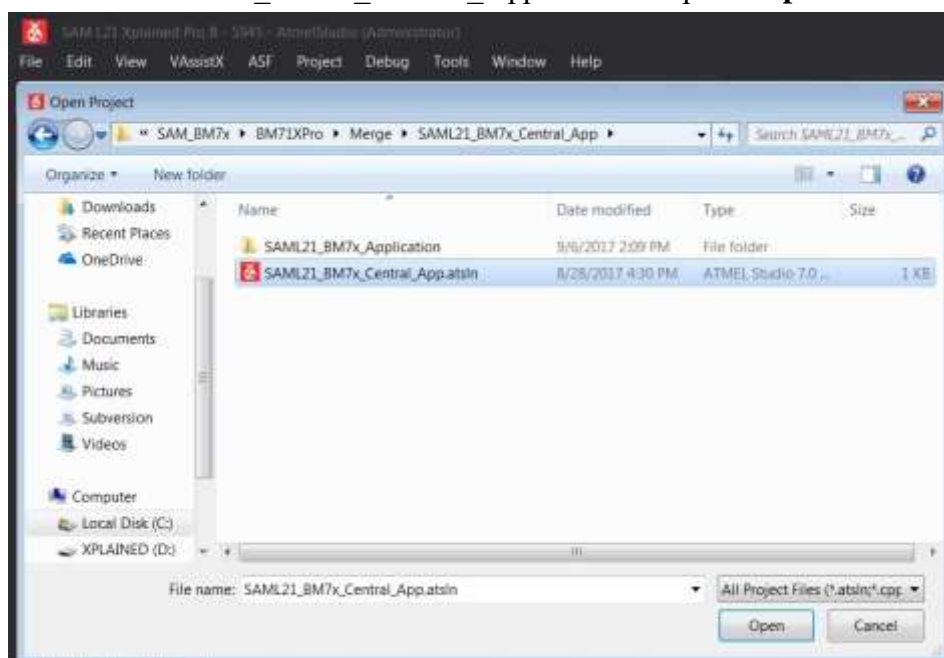
5.1. Open Microchip Studio 7

5.2. Open GAP-Central Demo Application

1. Go to menu **File** → **Open** → **Project/Solution**.



2. Select “SAML21_BM7x_Central_App.atsln” and press **Open**.

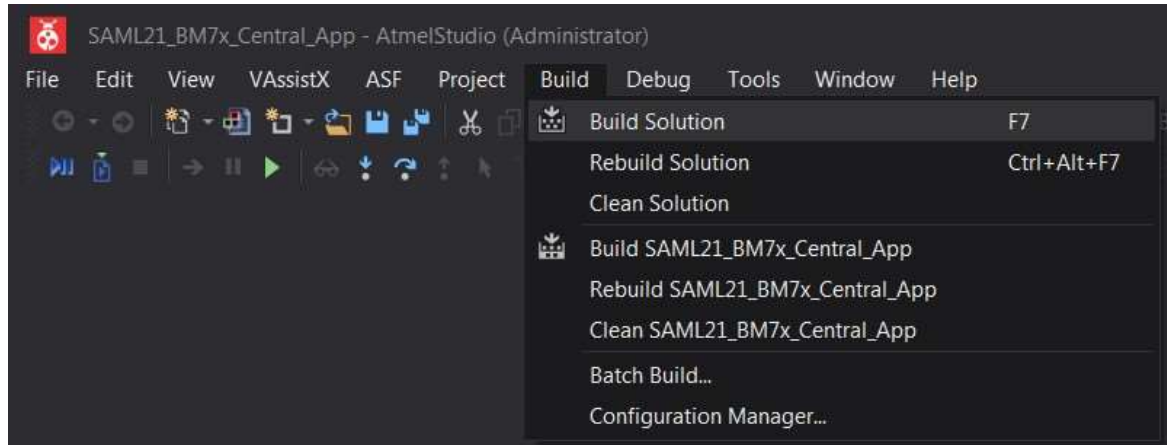


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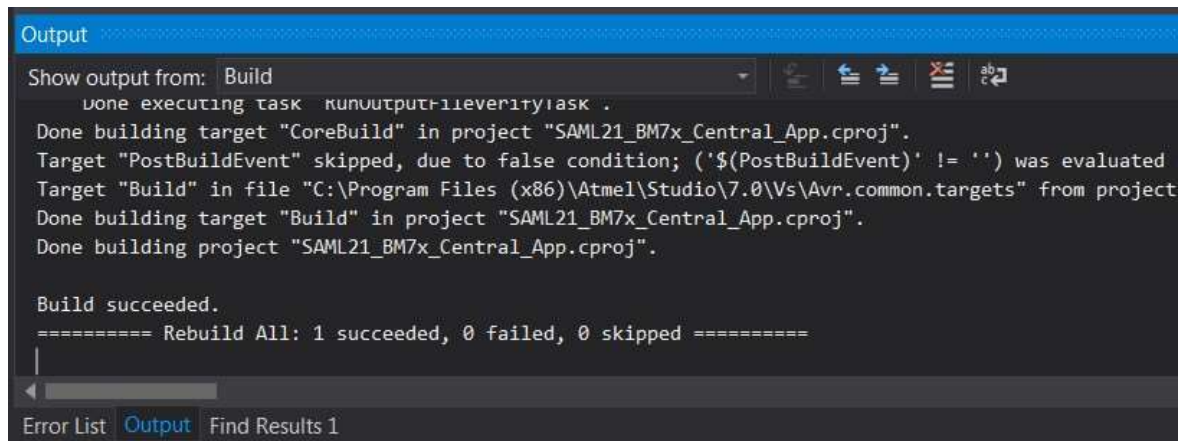
3. Once the project is opened, you can see the files attached to this project in Solution Explorer Window

5.3. Build GAP-Central Demo Application

1. Go to menu **Build** → **Build Solution** or Press **F7**



2. Build status can be checked in **Output** window.



3. You can find the Hex images in "..\SAML21_BM7x_Application\Debug".

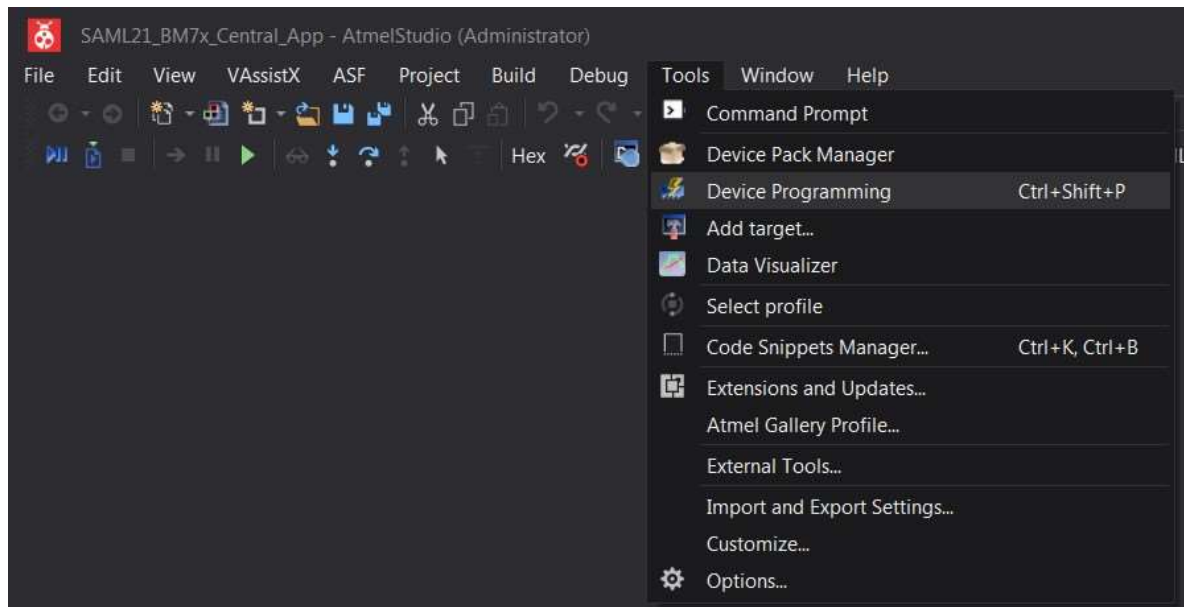
6. Programming Firmware

This section describes the procedure to program GAP-Central demo firmware on SAML21 Xplained Pro board.

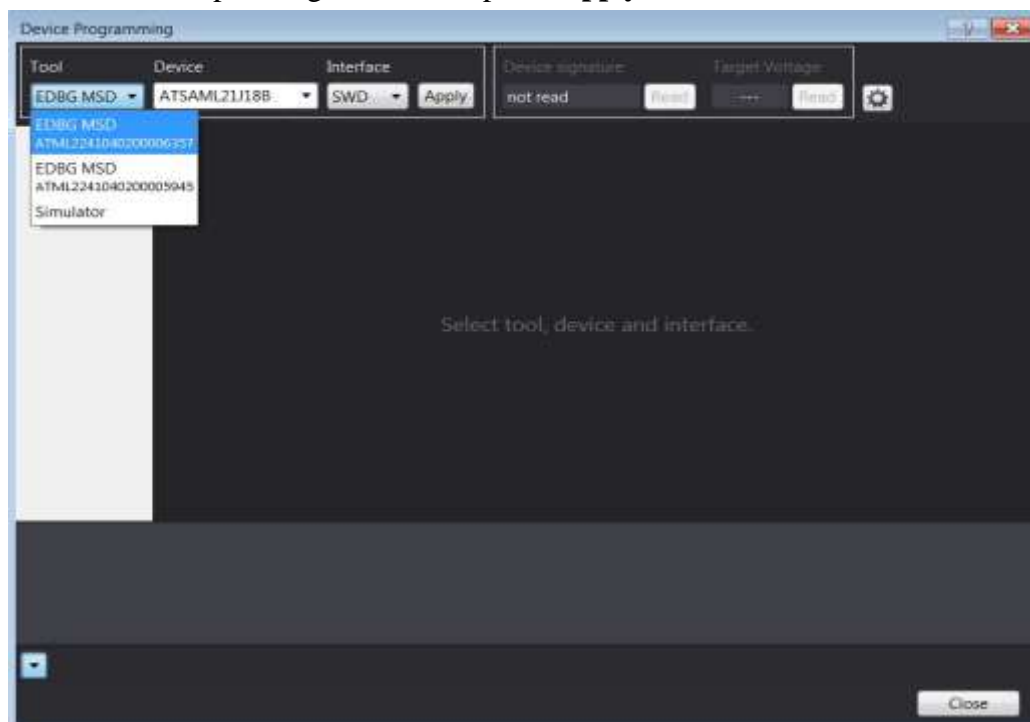
1. Connect the SAML21 Xplained Pro board to the host PC using micro-USB cable. Perform the following steps:

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- a. Verify that the virtual COM port is enumerated on the host PC.
 - b. Make sure that POWER LED (green) is solid ON.
2. To program the HEX files into the SAML21, go to menu **Tools** → **Device Programming** or Press **Ctrl + Shift + P**.

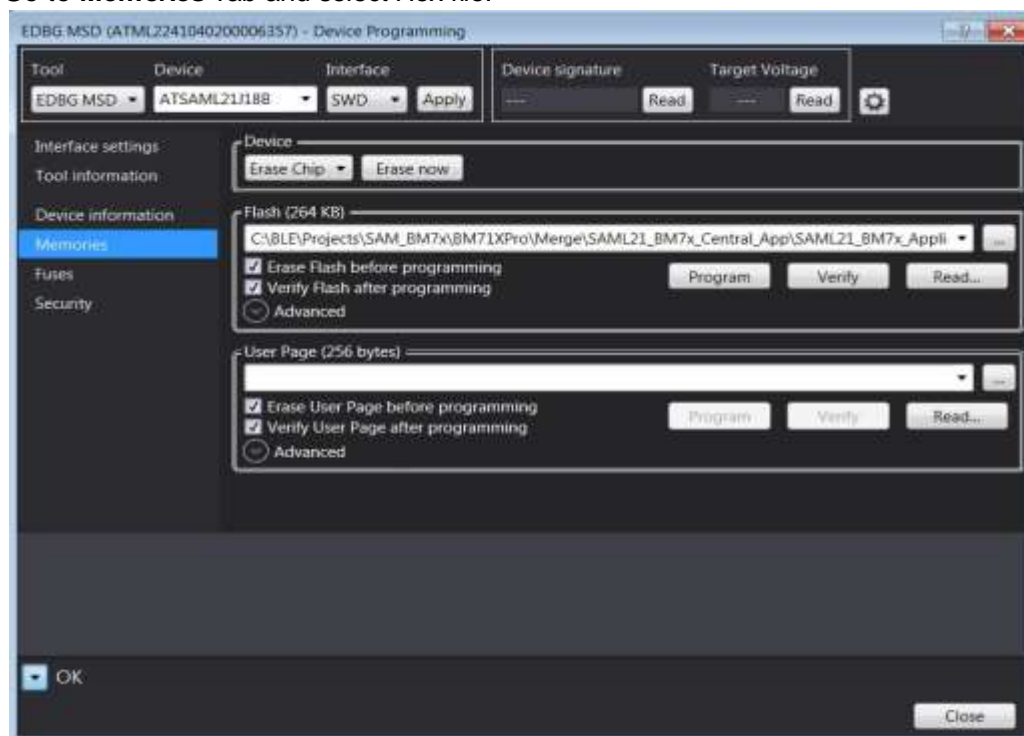


3. Select the corresponding **EDBG** and press **Apply**.

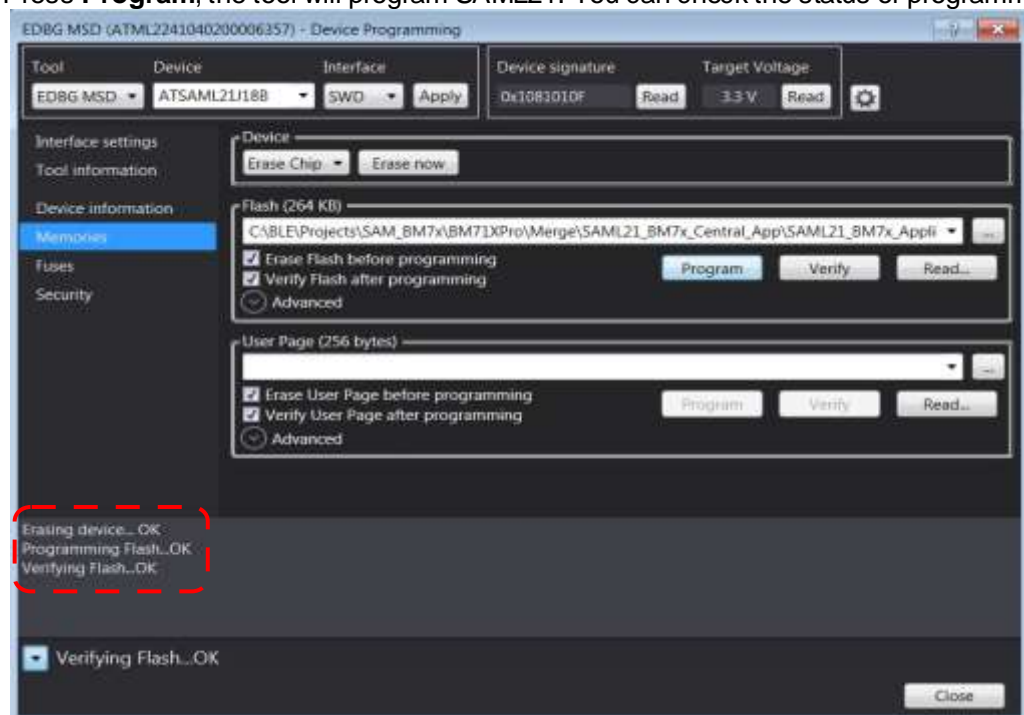


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4. Go to **Memories** Tab and select Hex file.



5. Press **Program**, the tool will program SAML21. You can check the status of programming.



6. Once programming is done, close the Device Programming window.

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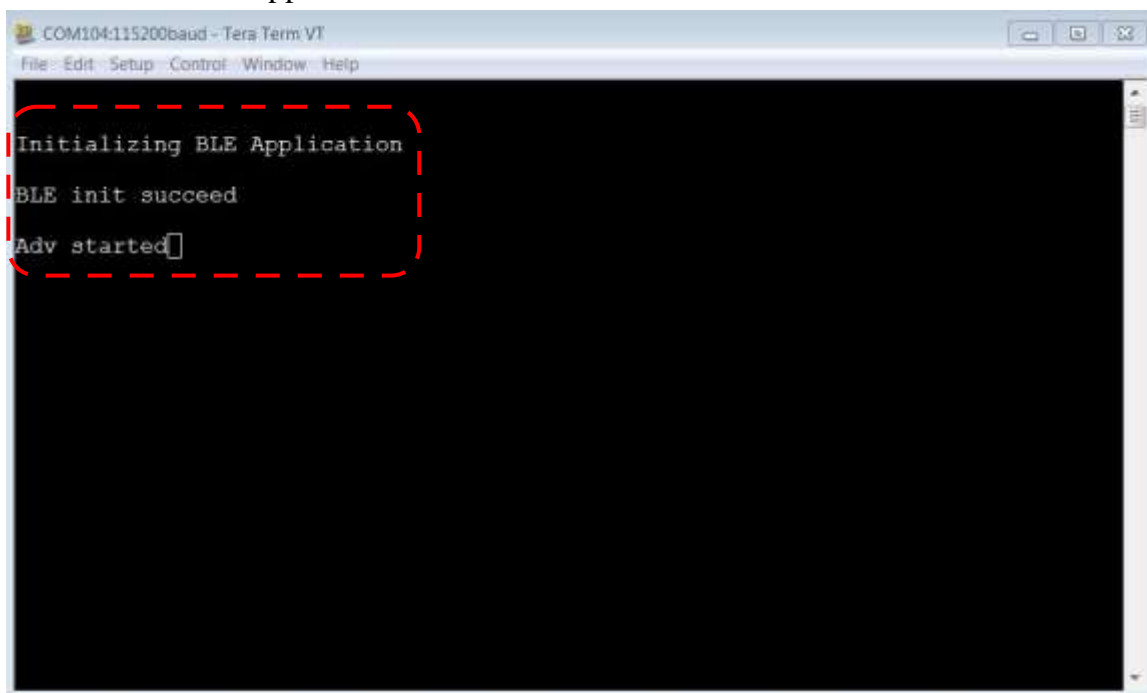
7. Running GAP-Central Demo with GAP-Peripheral Device

This section describes the GAP-Central Demo procedures to work with GAP-Peripheral device.

1. Connect BM71-XPro on EXT1 of SAML21 Xplained Pro board (GAP-Peripheral device).
2. Connect the GAP-Peripheral device to the host PC using micro-USB cable. Perform the following steps:
 - a. Verify that the virtual COM port is enumerated on the host PC.
 - b. Open the enumerated COM port on a serial console application like TeraTerm with the following settings:

Baudrate	115200
Data	8 bits
Parity	none
Stop	1 bit
Flow control	none

- c. Make sure that POWER LED (green) on SAML21 Xplained Pro board is solid ON.
 - d. Press Reset button on SAML21 Xplained Pro board and verify that LD4 (blue) on BM71-XPro is blinking at a regular interval.
3. Ensure that the GAP-Peripheral device is up and running and start advertising. Check status on a serial console application.



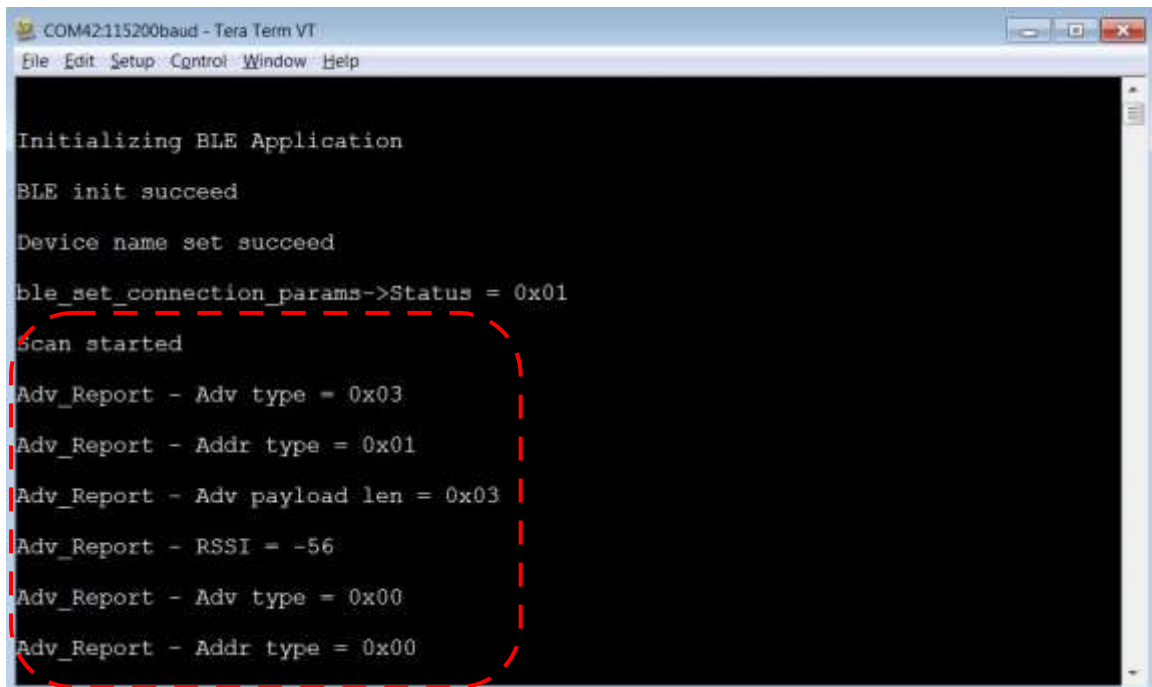
- -
 -
 4. Connect BM71-XPro on EXT1 of SAML21 Xplained Pro board (GAP-Central device).

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5. Connect the GAP-Central device to the host PC using micro USB cable. Perform the following steps:
 - a. Verify that the virtual COM port is enumerated on the host PC.
 - b. Open the enumerated COM port on a serial console application like TeraTerm with the following settings:

Baudrate	115200
Data	8 bits
Parity	none
Stop	1 bit
Flow control	none

- c. Make sure that POWER LED (green) on SAML21 Xplained Pro board is solid ON.
 - d. Press Reset button on SAML21 Xplained Pro board and verify that LD4 (blue) on BM71-XPro is blinking at a regular interval.
6. Ensure GAP-Central device is up and running and start scanning. Check status on a serial console application.



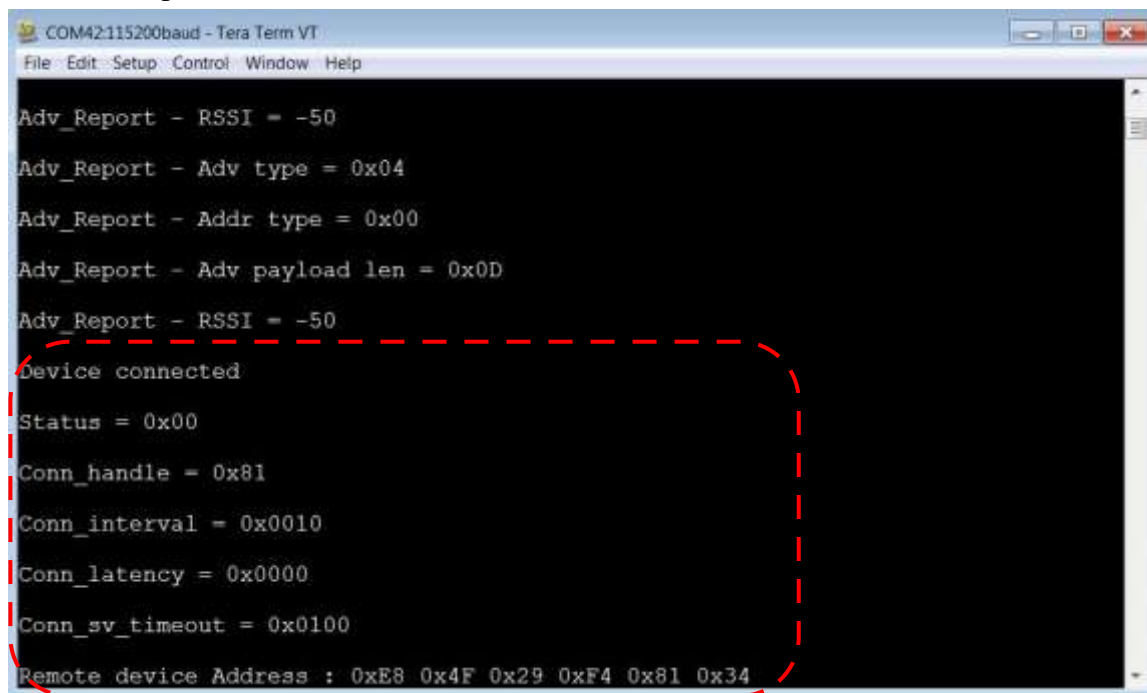
```
COM42:115200baud - Tera Term VT
File Edit Setup Control Window Help

Initializing BLE Application
BLE init succeed
Device name set succeed
ble_set_connection_params->Status = 0x01
Scan started
Adv_Report - Adv type = 0x03
Adv_Report - Addr type = 0x01
Adv_Report - Adv payload len = 0x03
Adv_Report - RSSI = -56
Adv_Report - Adv type = 0x00
Adv_Report - Addr type = 0x00
```

7. As GAP-Central device receives advertisements from devices in vicinity, it prints the advertisement report in serial console.
8. GAP-Central device finds the suitable GAP-Peripheral device based on the advertisement payload and initiates a connection.

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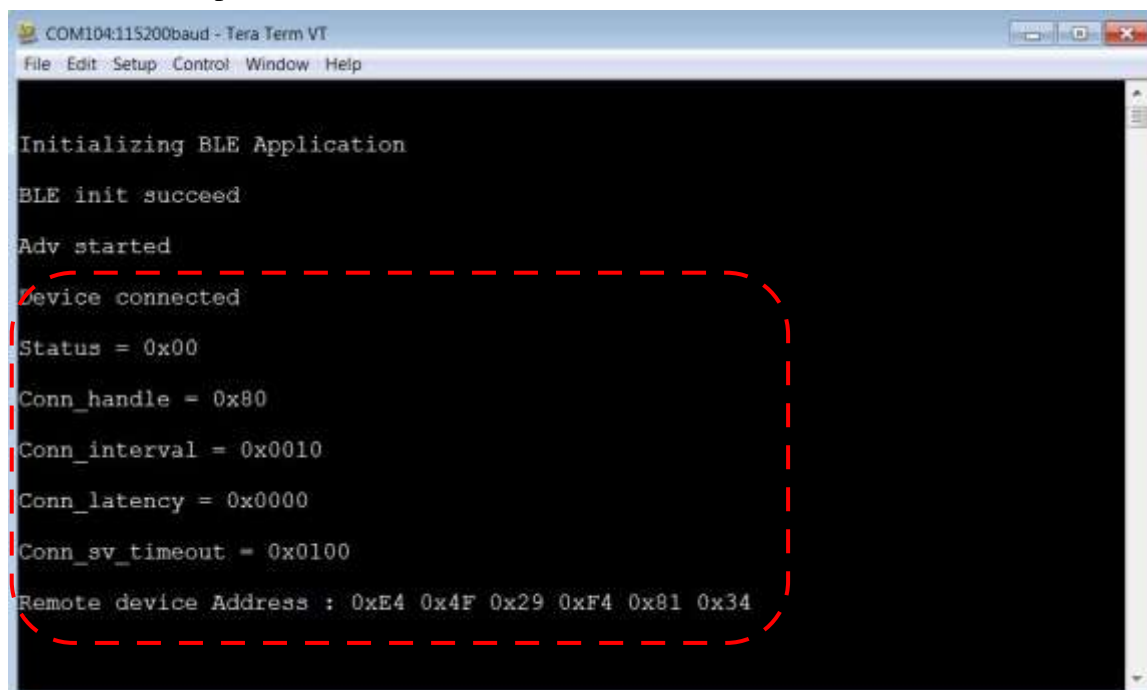
9. Once connected the GAP-Central device prints the GAP-Peripheral device address and connection parameters in serial console.



```
COM42:115200baud - Tera Term VT
File Edit Setup Control Window Help

Adv_Report - RSSI = -50
Adv_Report - Adv type = 0x04
Adv_Report - Addr type = 0x00
Adv_Report - Adv payload len = 0x0D
Adv_Report - RSSI = -50
Device connected
Status = 0x00
Conn_handle = 0x81
Conn_interval = 0x0010
Conn_latency = 0x0000
Conn_sv_timeout = 0x0100
Remote device Address : 0xE8 0x4F 0x29 0xF4 0x81 0x34
```

10. Similarly, once connected GAP-Peripheral device prints the GAP-Central device address and connection parameters in serial console.

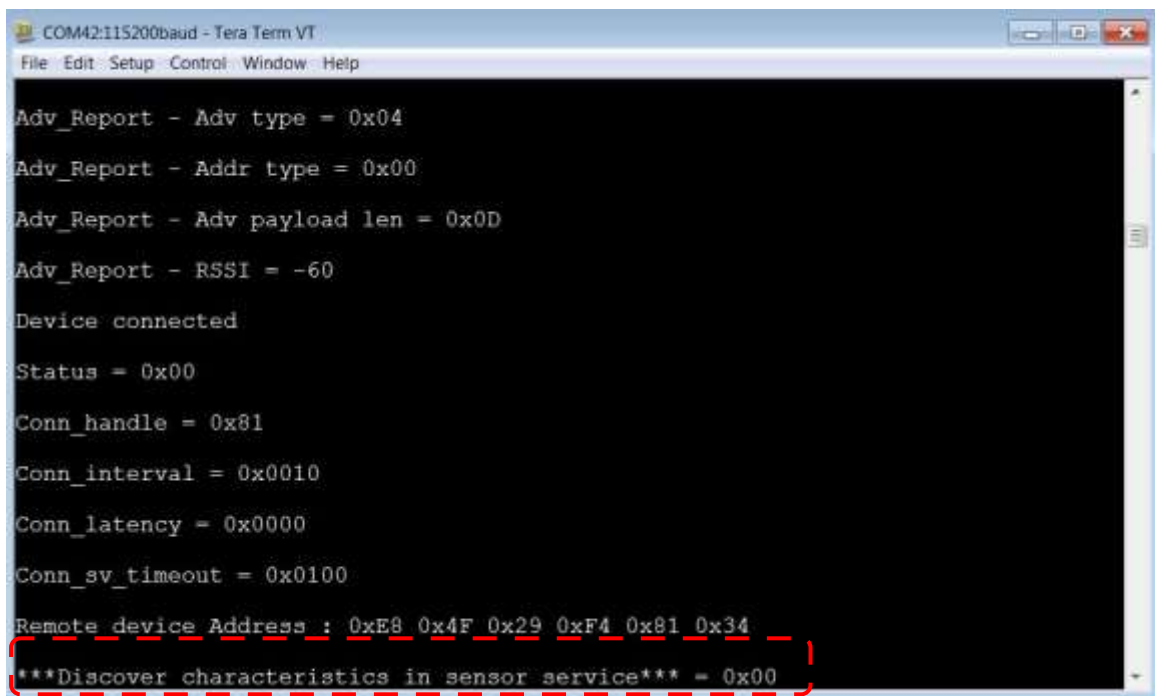


```
COM104:115200baud - Tera Term VT
File Edit Setup Control Window Help

Initializing BLE Application
BLE init succeed
Adv started
Device connected
Status = 0x00
Conn_handle = 0x80
Conn_interval = 0x0010
Conn_latency = 0x0000
Conn_sv_timeout = 0x0100
Remote device Address : 0xE4 0x4F 0x29 0xF4 0x81 0x34
```

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11. Once connected, Multilink-Central discovers the device orientation service and characteristics in remote device based on the UUID.

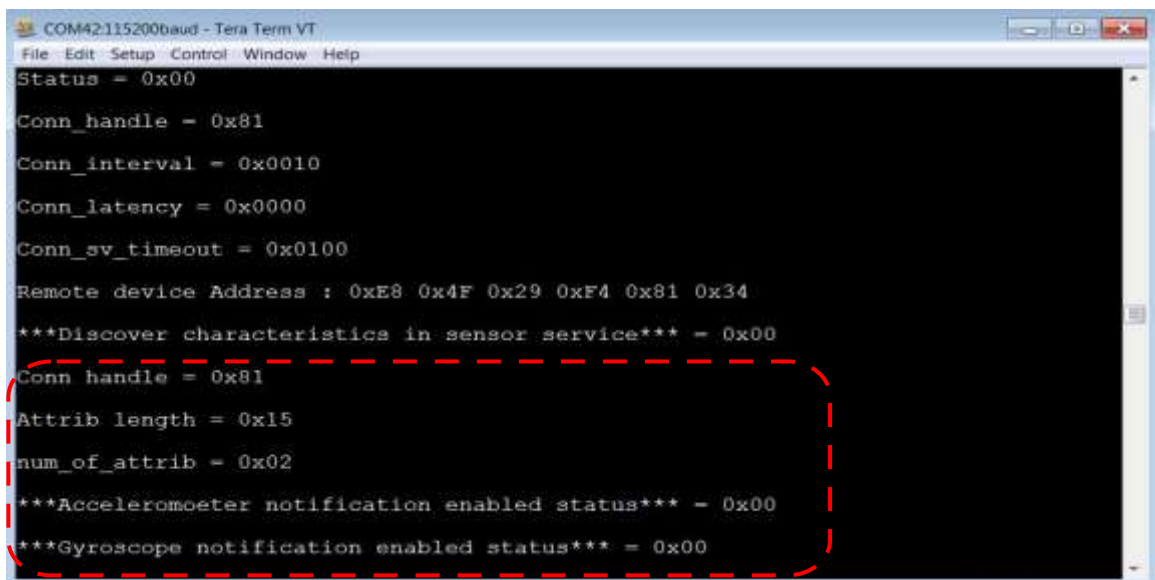


A screenshot of a Tera Term VT window titled 'COM42:115200baud - Tera Term VT'. The window displays a series of text messages from a Bluetooth device. The messages include: 'Adv_Report - Adv type = 0x04', 'Adv_Report - Addr type = 0x00', 'Adv_Report - Adv payload len = 0x0D', 'Adv_Report - RSSI = -60', 'Device connected', 'Status = 0x00', 'Conn_handle = 0x81', 'Conn_interval = 0x0010', 'Conn_latency = 0x0000', and 'Conn_sv_timeout = 0x0100'. Below these, the 'Remote device Address' is listed as '0xE8 0x4F 0x29 0xF4 0x81 0x34'. The final line, '***Discover characteristics in sensor service*** = 0x00', is enclosed in a red dashed rectangular box.

```
COM42:115200baud - Tera Term VT
File Edit Setup Control Window Help

Adv_Report - Adv type = 0x04
Adv_Report - Addr type = 0x00
Adv_Report - Adv payload len = 0x0D
Adv_Report - RSSI = -60
Device connected
Status = 0x00
Conn_handle = 0x81
Conn_interval = 0x0010
Conn_latency = 0x0000
Conn_sv_timeout = 0x0100
Remote device Address : 0xE8 0x4F 0x29 0xF4 0x81 0x34
***Discover characteristics in sensor service*** = 0x00
```

12. It also discovers the Client Characteristic Configuration Descriptors (CCCD) of accelerometer and gyroscope sensor characteristics and enabled them to receive notifications.



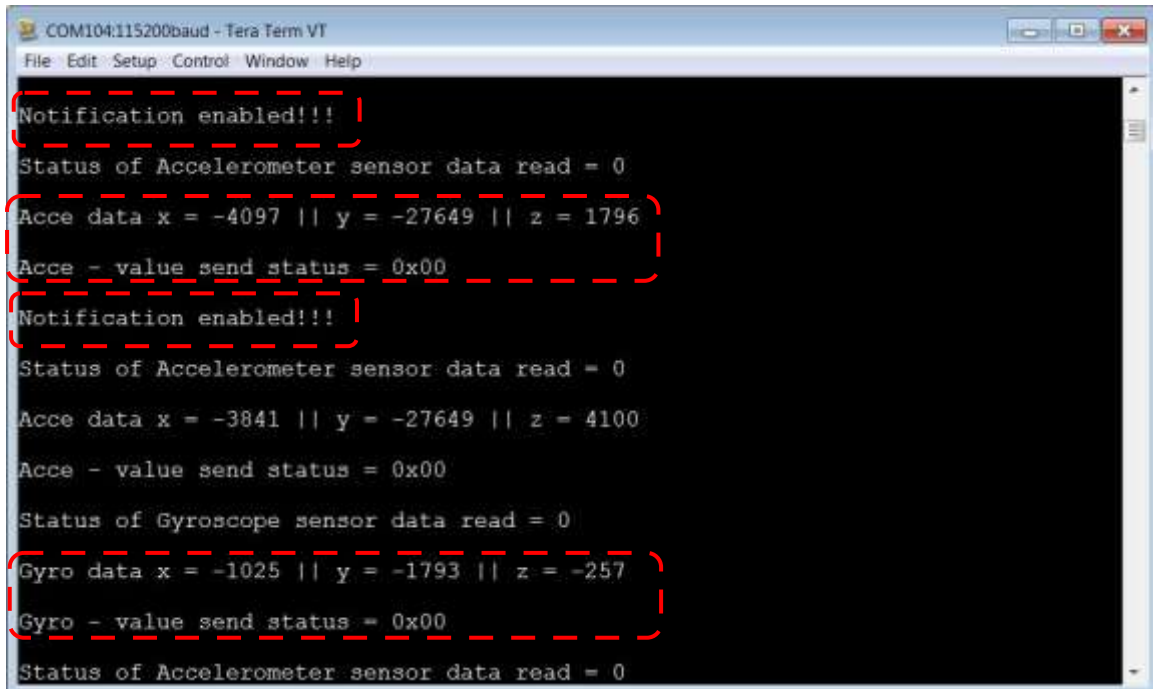
A screenshot of a Tera Term VT window titled 'COM42:115200baud - Tera Term VT'. The window displays text messages from a Bluetooth device. The messages include: 'Status = 0x00', 'Conn_handle = 0x81', 'Conn_interval = 0x0010', 'Conn_latency = 0x0000', 'Conn_sv_timeout = 0x0100', and 'Remote device Address : 0xE8 0x4F 0x29 0xF4 0x81 0x34'. Below these, the line '***Discover characteristics in sensor service*** = 0x00' is shown. The following three lines are enclosed in a red dashed rectangular box: 'Conn handle = 0x81', 'Attrib length = 0x15', and 'num_of_attrib = 0x02'. Below the box, the messages '***Accelerometer notification enabled status*** = 0x00' and '***Gyroscope notification enabled status*** = 0x00' are displayed.

```
COM42:115200baud - Tera Term VT
File Edit Setup Control Window Help

Status = 0x00
Conn_handle = 0x81
Conn_interval = 0x0010
Conn_latency = 0x0000
Conn_sv_timeout = 0x0100
Remote device Address : 0xE8 0x4F 0x29 0xF4 0x81 0x34
***Discover characteristics in sensor service*** = 0x00
Conn handle = 0x81
Attrib length = 0x15
num_of_attrib = 0x02
***Accelerometer notification enabled status*** = 0x00
***Gyroscope notification enabled status*** = 0x00
```

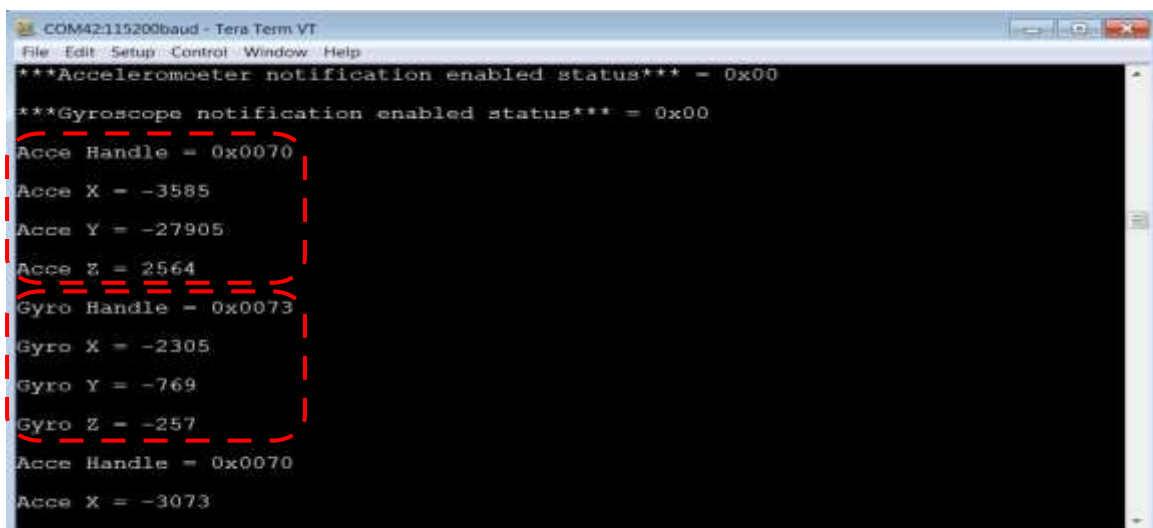
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13. Upon notification enabled by GAP-Central device, GAP-Peripheral device start notifies the accelerometer and gyroscope sensor data to GAP-Central device.
14. GAP-Peripheral prints the accelerometer and gyroscope sensor data on serial console. It also prints notification status on serial console.



```
COM104:115200baud - Tera Term VT
File Edit Setup Control Window Help
Notification enabled!!!
Status of Accelerometer sensor data read = 0
Acce data x = -4097 || y = -27649 || z = 1796
Acce - value send status = 0x00
Notification enabled!!!
Status of Accelerometer sensor data read = 0
Acce data x = -3841 || y = -27649 || z = 4100
Acce - value send status = 0x00
Status of Gyroscope sensor data read = 0
Gyro data x = -1025 || y = -1793 || z = -257
Gyro - value send status = 0x00
Status of Accelerometer sensor data read = 0
```

15. GAP-Central devices receive sensor data notifications and print them on serial console.



```
COM42:115200baud - Tera Term VT
File Edit Setup Control Window Help
***Accelerometer notification enabled status*** = 0x00
***Gyroscope notification enabled status*** = 0x00
Acce Handle = 0x0070
Acce X = -3585
Acce Y = -27905
Acce Z = 2564
Gyro Handle = 0x0073
Gyro X = -2305
Gyro Y = -769
Gyro Z = -257
Acce Handle = 0x0070
Acce X = -3073
```

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