



GAP–Peripheral Demo User’s Guide

GAP_Peripheral_Demo_User's_Guide

Contents

1. Overview.....	3
1.1. Hardware Setup	4
1.2. Smart Phone Application	4
1.3. Console	5
2. Build Procedure	6
2.1. Open Atmel Studio 7	6
2.2. Open GAP-Peripheral Demo Application	6
2.3. Build GAP-Peripheral Demo Application	7
3. Programming Firmware	8
4. Running GAP-Peripheral Demo with BLESensorApp.....	11
5. Running GAP-Peripheral Demo with GAP-Central Device	15

GAP_Peripheral_Demo_User's_Guide

1. Overview

This document explains how to setup an GAP-Peripheral demo using SAML21 Xplained Pro, BM71-XPro, BNO055 Click board and Smart phone. 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-Peripheral. This demo application uses custom GATT service to share accelerometer and gyroscope sensor data with remote device.

The following table provides the list of supported 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

GAP_Peripheral_Demo_User's_Guide

1.1. Hardware Setup

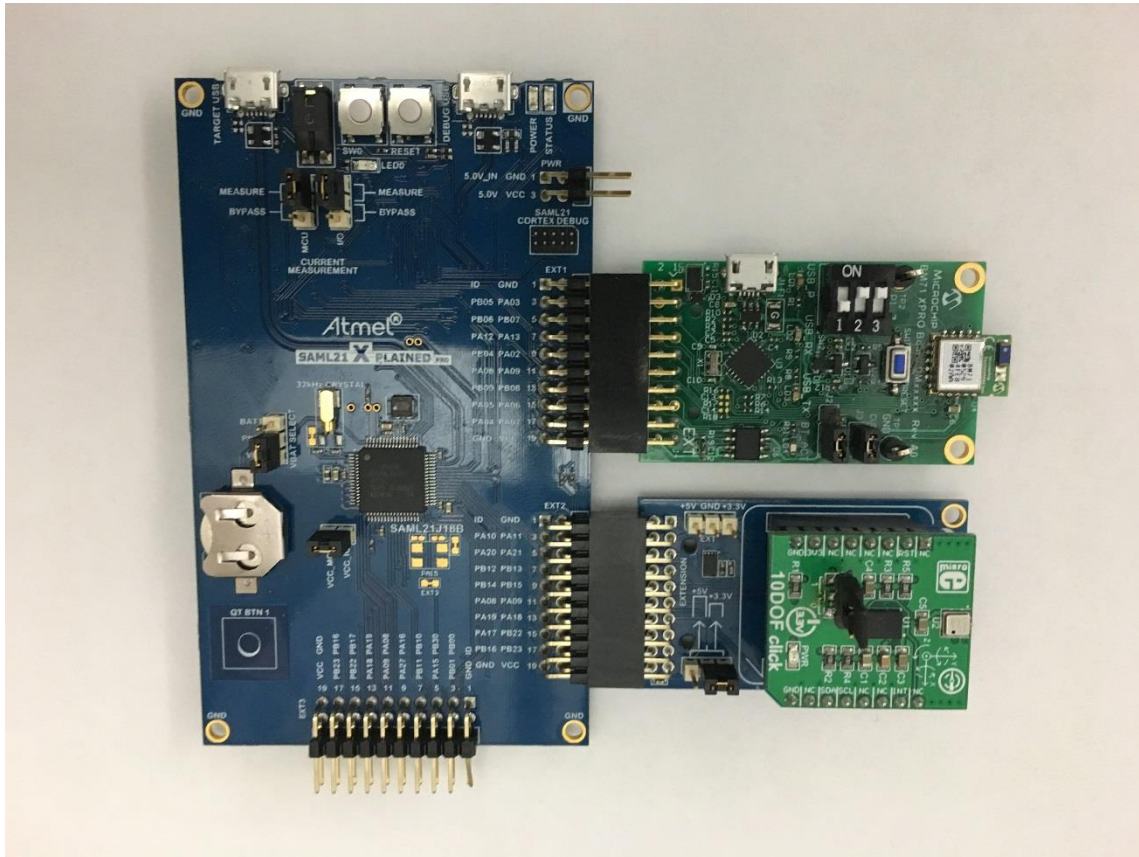


Figure 1: SAML21 Xplained Pro with BM71-XPro and MikroElektronika BNO055 Click Board

1. Plug-in the BM71-XPro board into EXT1 of SAML21 Xplained Pro board as shown in Figure 1.
2. MikroElektronika BNO055 Click Board is used in this demo.
 - a. You can find more details here, <http://www.mikroe.com/click/10dof/>
3. Plug-in the Click board adapter into the EXT2 of SAML21 Xplained Pro as shown in Figure 1.
4. Plug-in the Click board into the Click board adapter as shown in Figure 1.
5. Connect the SAML21 Xplained Pro board to the host PC using micro USB cable.

1.2. Smart Phone Application

You can download the BLESensorApp for Android phones from the following link.



Android:

<https://play.google.com/store/apps/details?id=com.microchip.bleSENSORAPP&hl=en>

GAP_Peripheral_Demo_User's_Guide

1.3. Console

The GAP-Peripheral demo application uses the Universal Asynchronous Receiver/Transmitter (UART) interface on SAML21 Xplained Pro to send the status messages like Advertising, Connected, Disconnected ... etc. Any serial application (ex: TeraTerm) can be used to interact with SAML21 Xplained Pro.

UART (COM port) settings,

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

GAP_Peripheral_Demo_User's_Guide

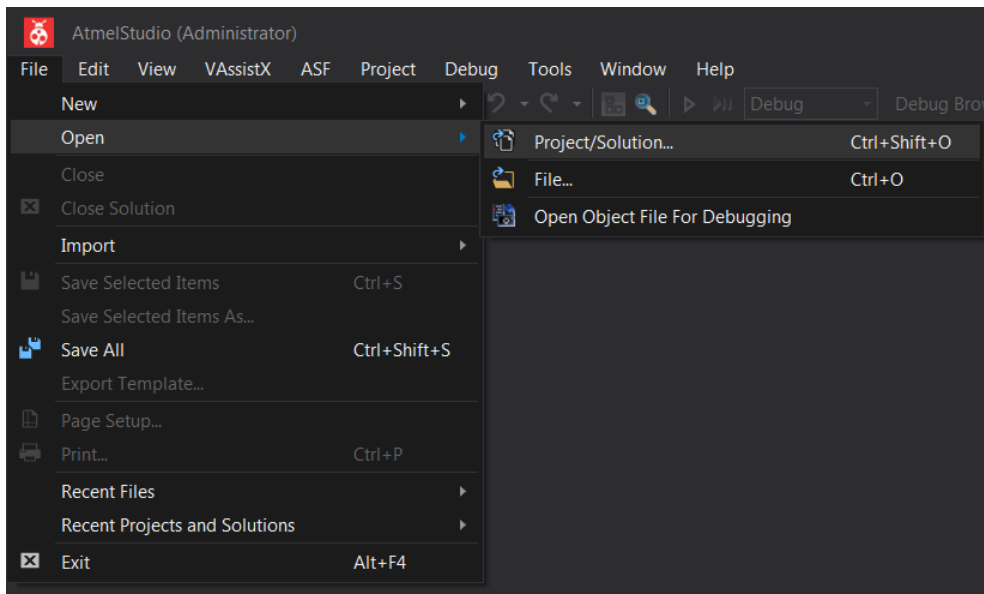
2. Build Procedure

This section describes the build procedure of GAP-Peripheral demo application on Atmel Studio 7.

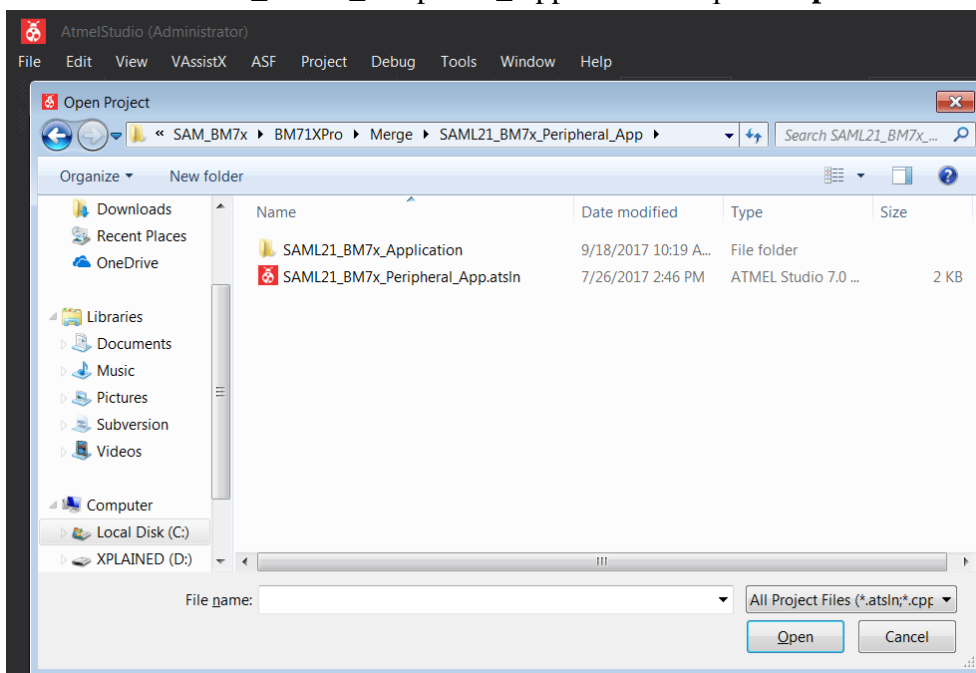
2.1. Open Atmel Studio 7

2.2. Open GAP-Peripheral Demo Application

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



2. Select “SAML21_BM7x_Peripheral_App.atsln” and press **Open**.

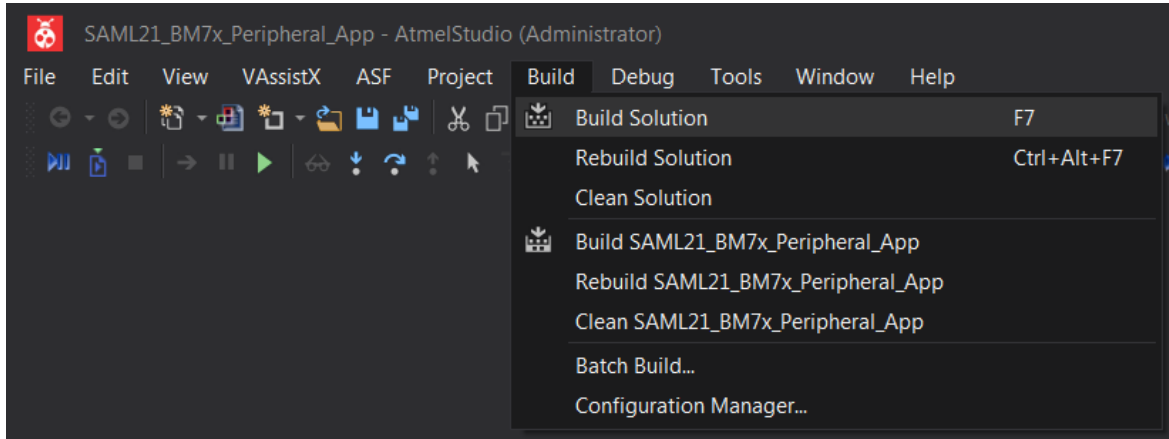


3. Once the project is opened, you can see the files attached to this project in Solution Explorer Window

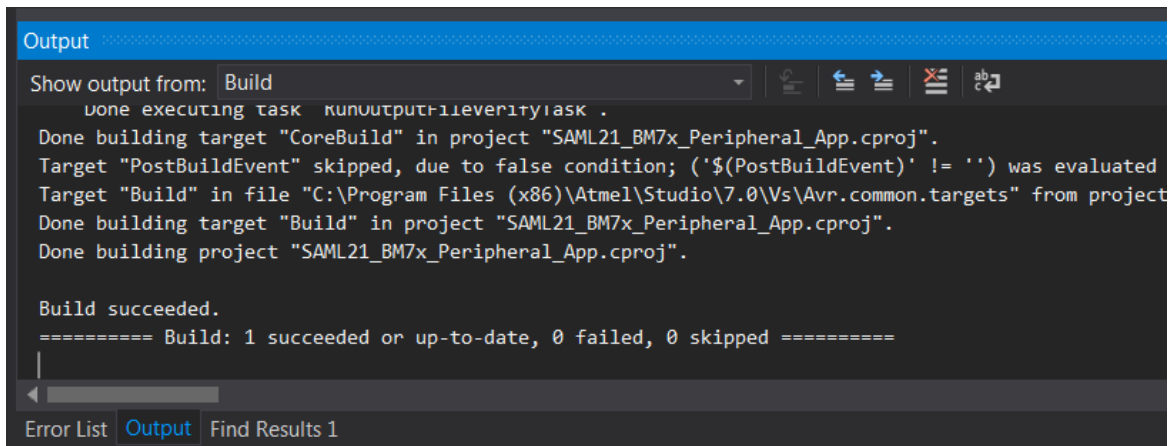
GAP_Peripheral_Demo_User's_Guide

2.3. Build GAP-Peripheral Demo Application

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



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



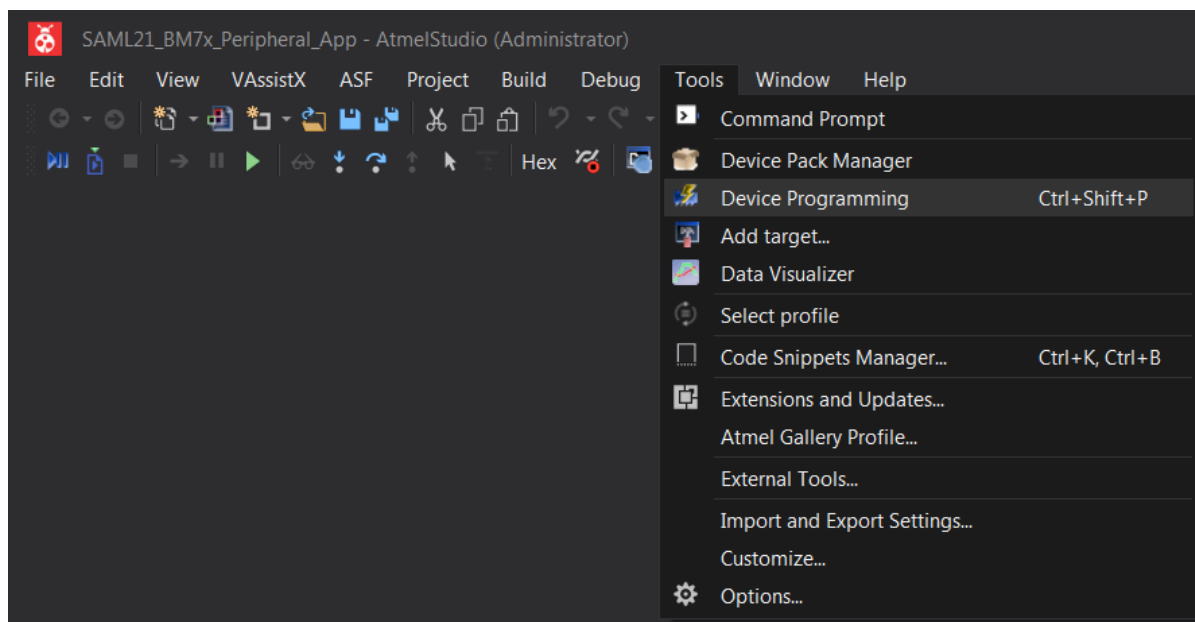
3. You can find the Hex images in “..\SAML21_BM7x_Application\Debug”.

GAP_Peripheral_Demo_User's_Guide

3. Programming Firmware

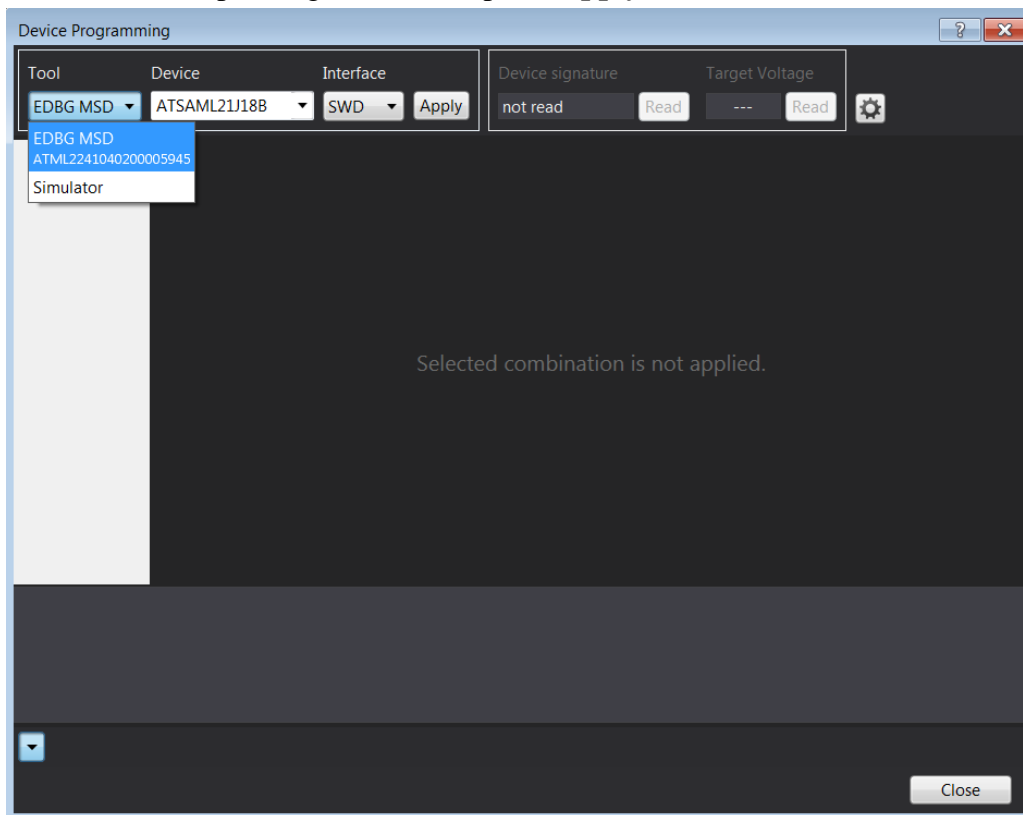
This section describes the procedure to program GAP-Peripheral demo firmware on SAML21 Xplained Pro board.

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

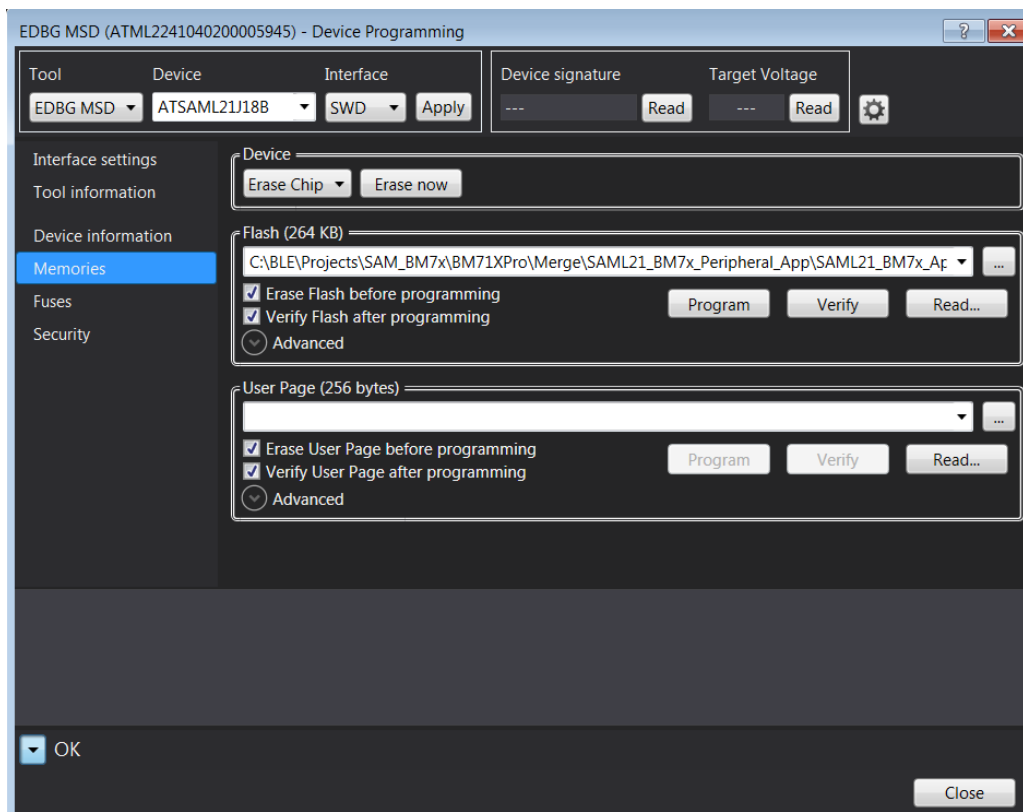


GAP_Peripheral_Demo_User's_Guide

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

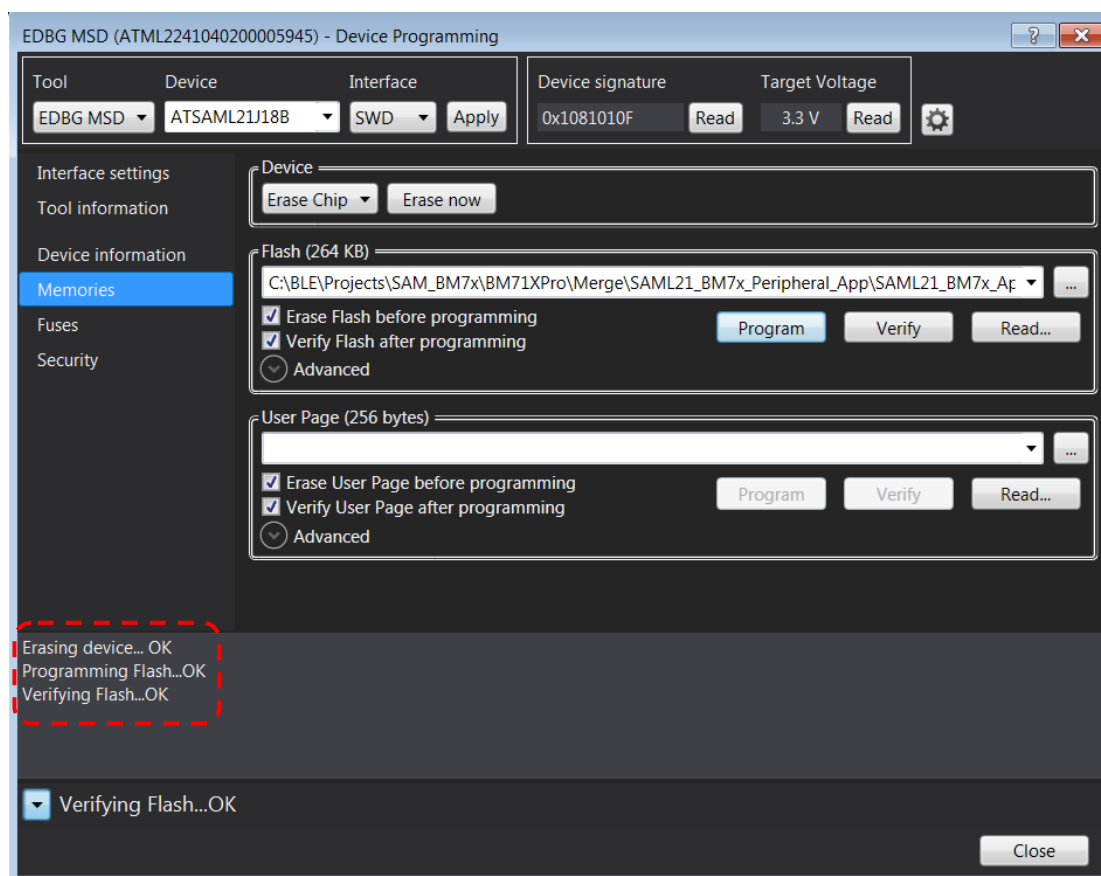


4. Go to **Memories** Tab and select Hex file.



GAP_Peripheral_Demo_User's_Guide

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.

GAP_Peripheral_Demo_User's_Guide

4. Running GAP-Peripheral Demo with BLESensorApp

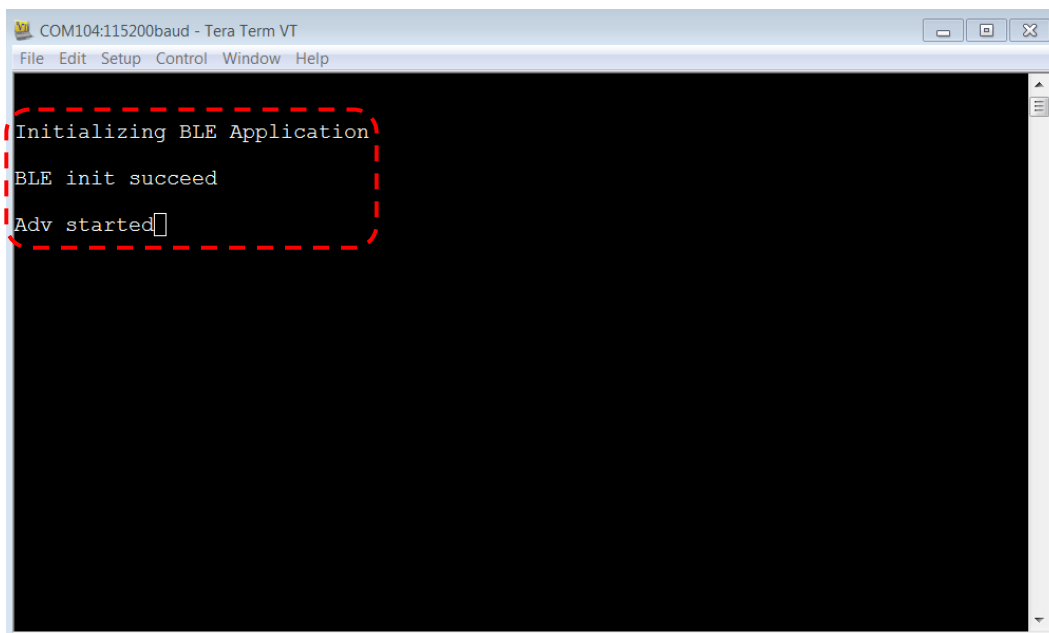
This section describes the GAP-Peripheral Demo procedures to work with Android BLESensorApp.

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 terminal 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 advertising by checking the TeraTerm window for a message “Adv started”.



4. Download and install the BLESensorApp on Android device using the links below:

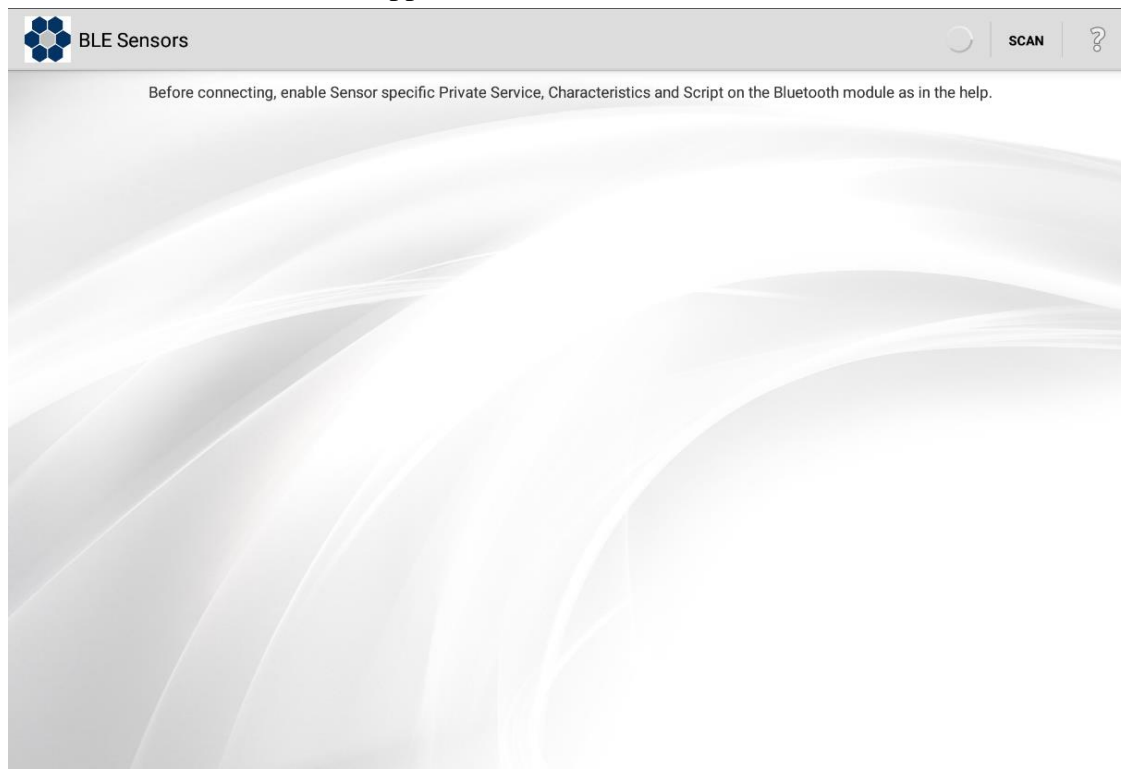


Android:

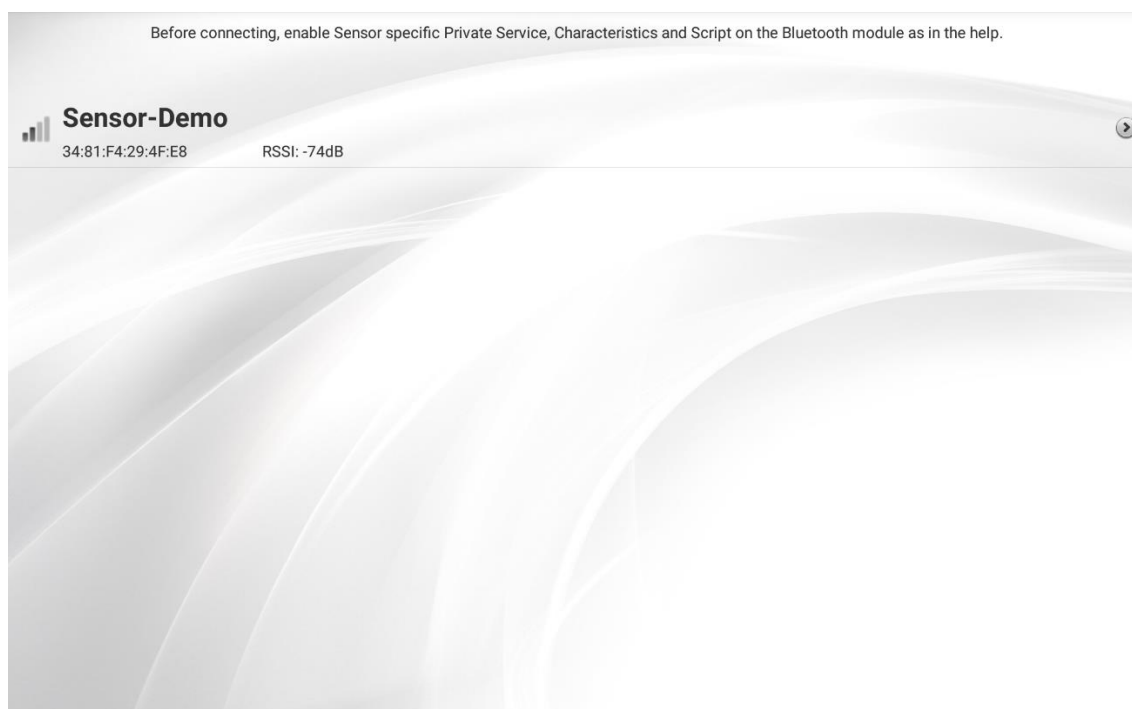
<https://play.google.com/store/apps/details?id=com.microchip.bleensorapp&hl=en>

GAP_Peripheral_Demo_User's_Guide

5. Open **BLESensorApp** on Smart phone
6. Press **SCAN** on BLESensorApp

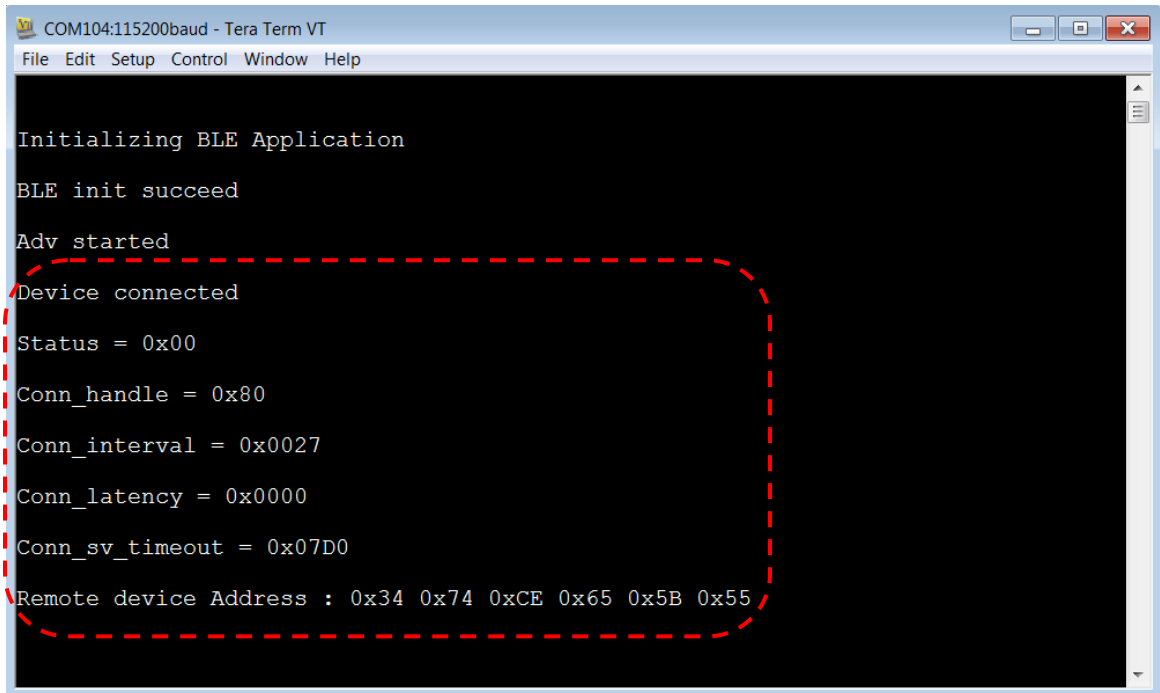


7. Click on **Sensor-Demo** in the BLESensorApp scan list to connect to the BM71



GAP_Peripheral_Demo_User's_Guide

8. After successful connection, GAP-Peripheral device prints the connection details in console.

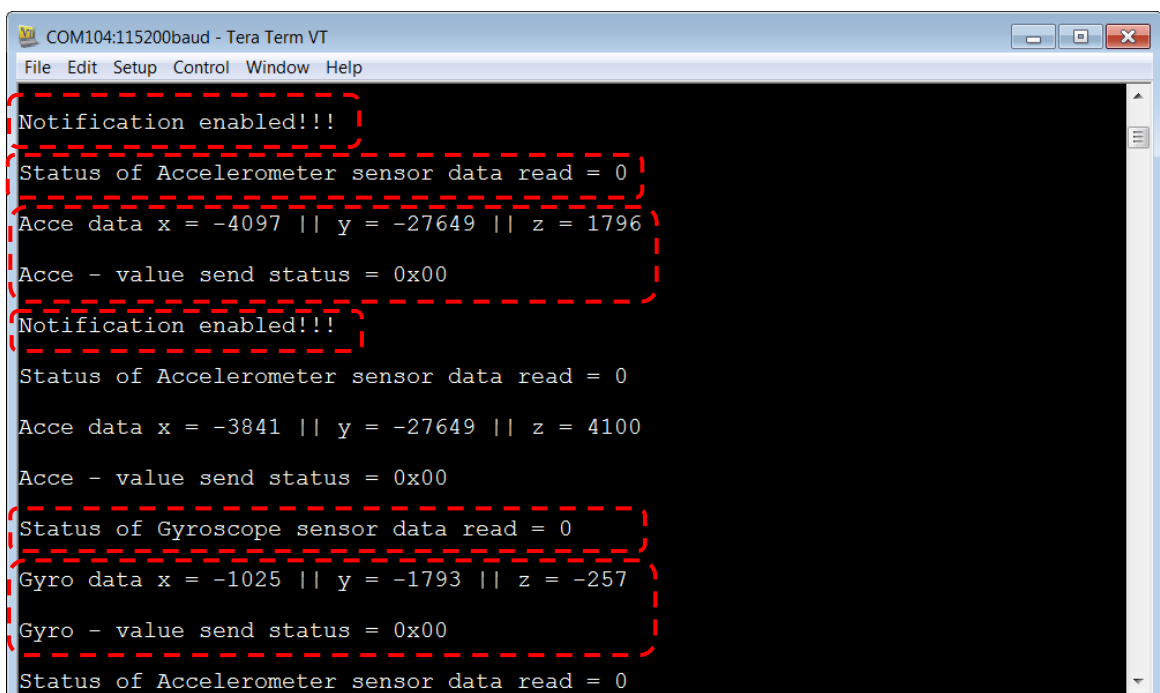


The screenshot shows a Tera Term VT window titled 'COM104:115200baud - Tera Term VT'. The window contains the following text:

```
Initializing BLE Application
BLE init succeed
Adv started
Device connected
Status = 0x00
Conn_handle = 0x80
Conn_interval = 0x0027
Conn_latency = 0x0000
Conn_sv_timeout = 0x07D0
Remote device Address : 0x34 0x74 0xCE 0x65 0x5B 0x55
```

A red dashed box highlights the connection details from 'Device connected' to 'Remote device Address'.

9. Once connected, the BLESensorApp discovers the accelerometer and gyroscope sensor characteristics and enable notifications.
10. Once notification enabled by BLESensorApp, GAP-Peripheral prints the accelerometer and gyroscope sensor read operation status and data on console.



The screenshot shows a Tera Term VT window titled 'COM104:115200baud - Tera Term VT'. The window contains the following text:

```
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
```

Red dashed boxes highlight the notification status and sensor data for both the accelerometer and gyroscope.

GAP_Peripheral_Demo_User's_Guide

11. Once connected with GAP-Peripheral (Sensor-Demo) and notifications are enabled, BLESensorApp shows the Accelerometer and Gyroscope sensor data in graph view.



GAP_Peripheral_Demo_User's_Guide

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

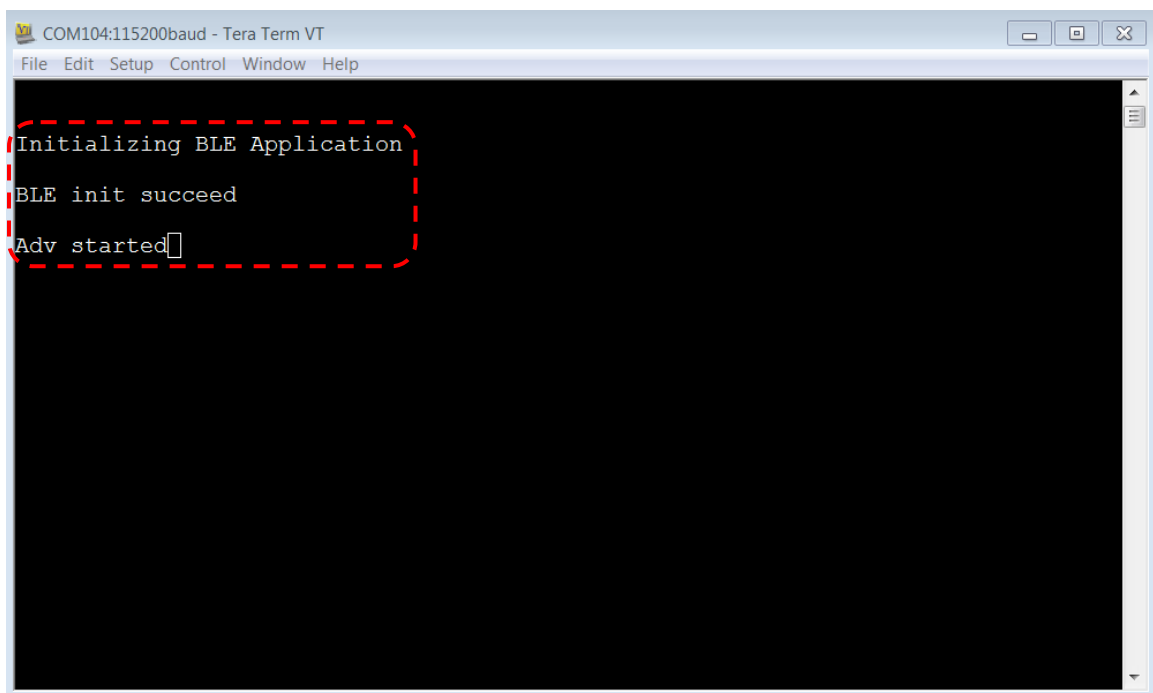
This section describes the GAP-Peripheral Demo procedures to work with GAP-Central device.

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.



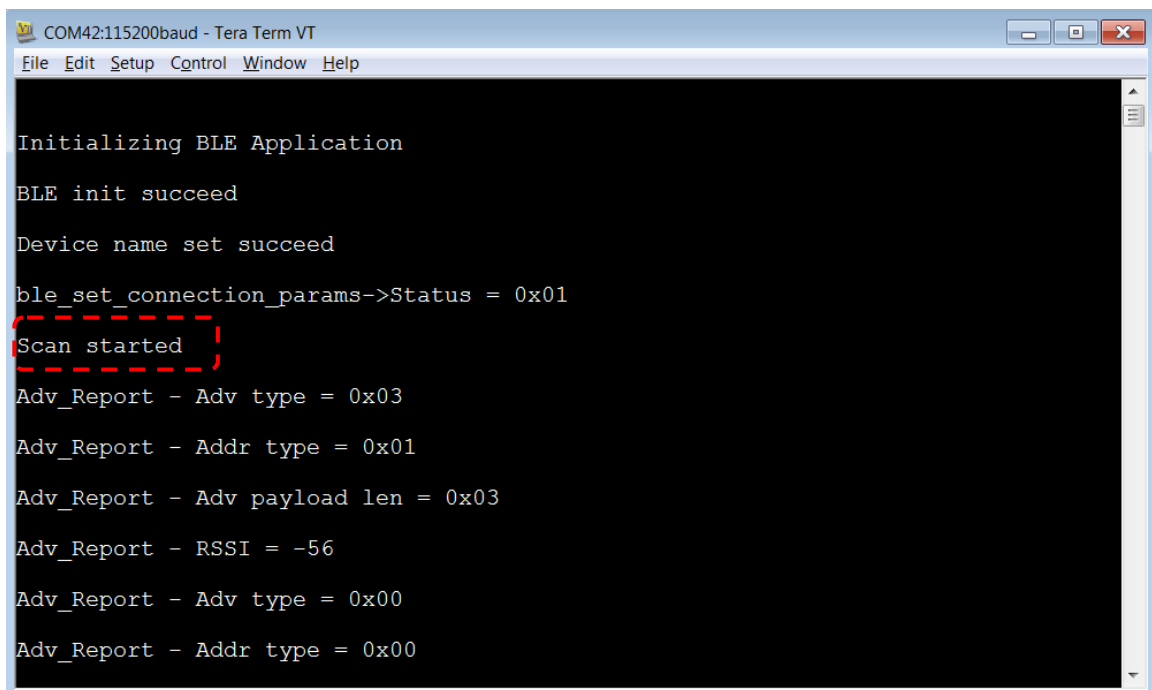
4. Connect BM71-XPro on EXT1 of SAML21 Xplained Pro board (GAP-Central device).
5. Connect the GAP-Central device to the host PC using micro USB cable. Perform the following steps:

GAP_Peripheral_Demo_User's_Guide

- 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.



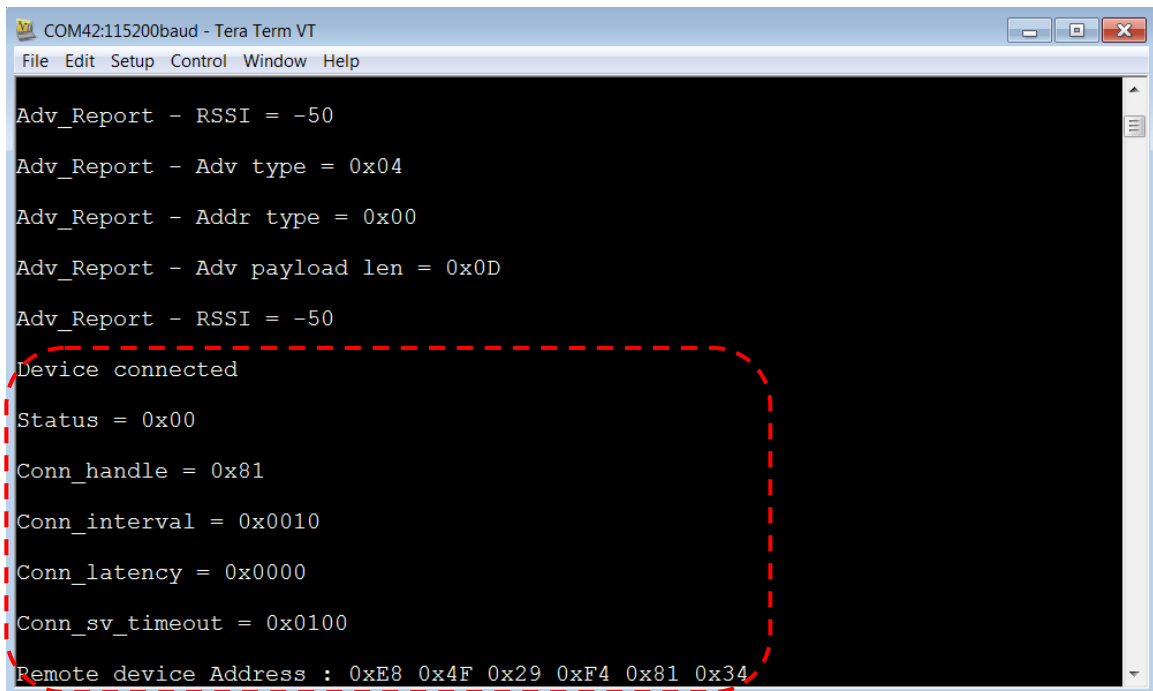
The screenshot shows a TeraTerm window titled 'COM42:115200baud - Tera Term VT'. The menu bar includes File, Edit, Setup, Control, Window, and Help. The terminal output displays the following text:

```
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
```

The line 'Scan started' is highlighted with a red dashed rectangular box.

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

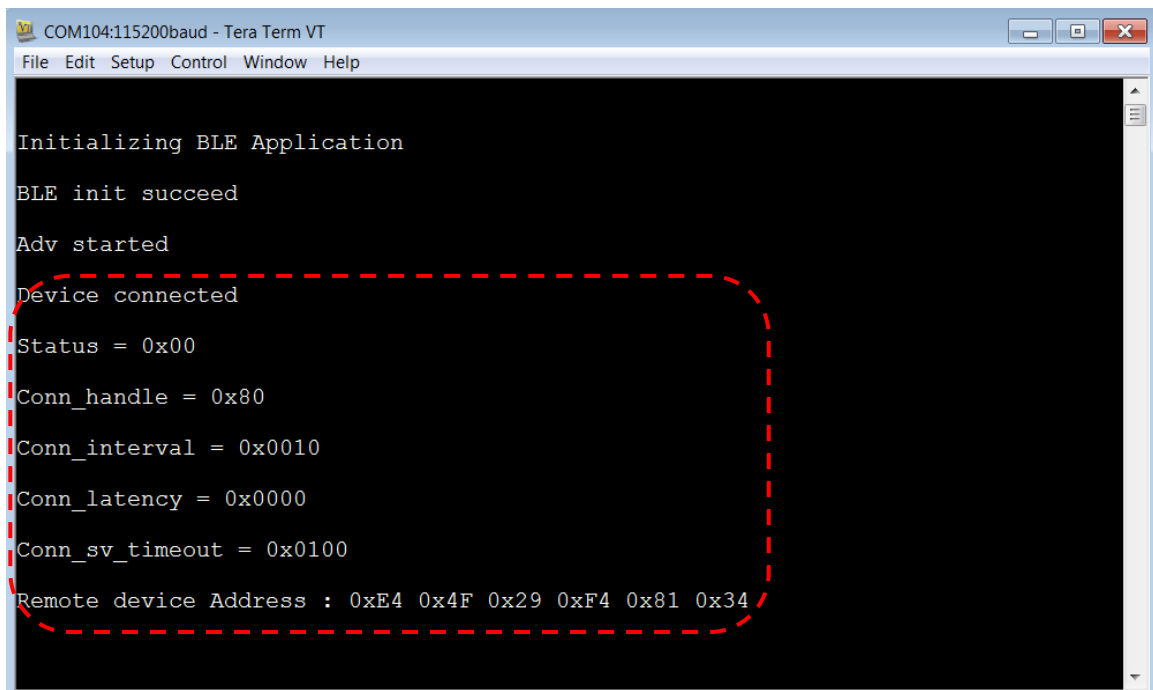
GAP_Peripheral_Demo_User's_Guide



```
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.

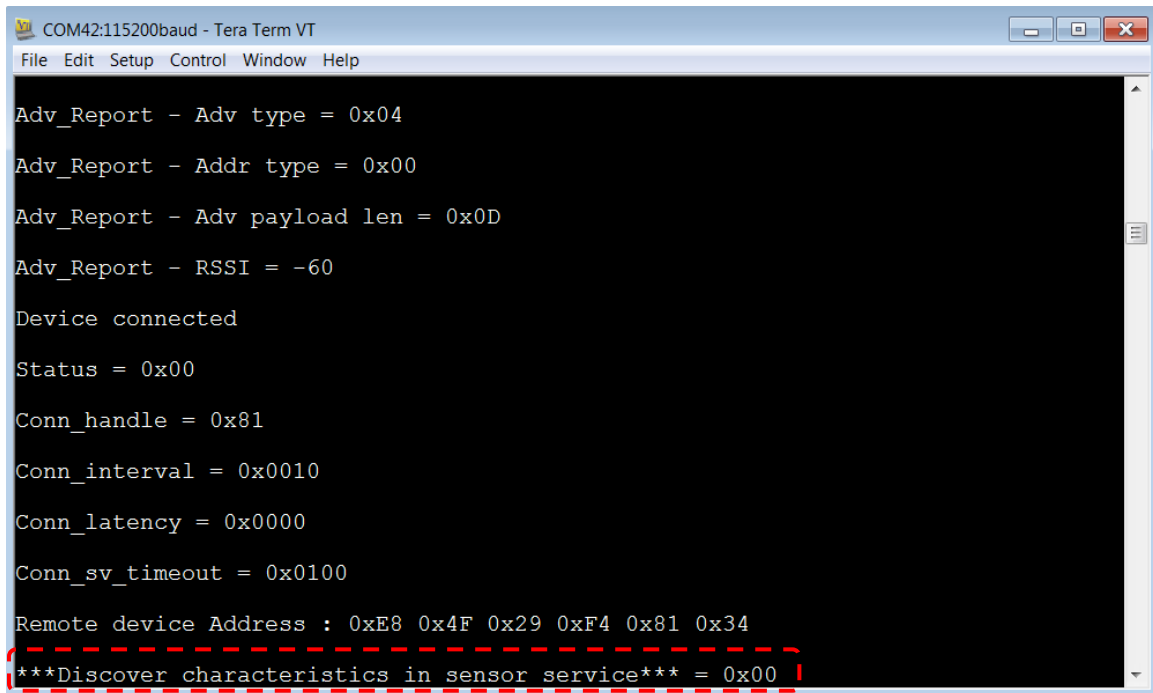


```
COM104:115200baud - Tera Term VT
File Edit Setup Control Window Help

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
```

11. GAP-Central discovers the characteristics in remote device based on the service UUID.

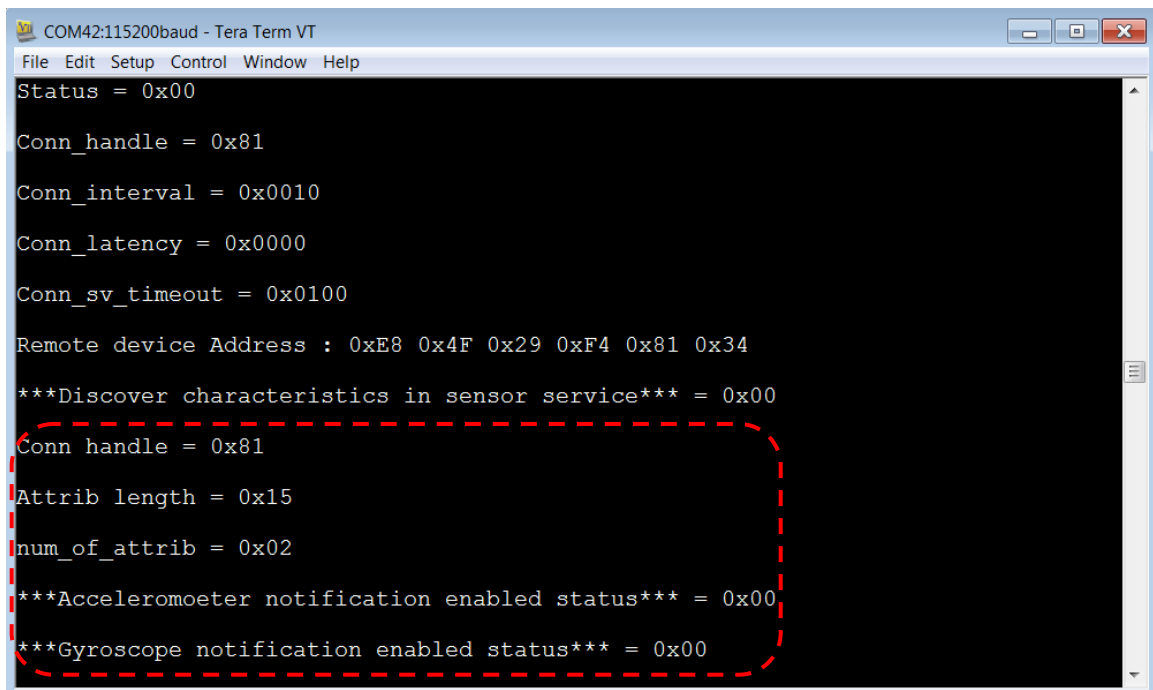
GAP_Peripheral_Demo_User's_Guide



```
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.



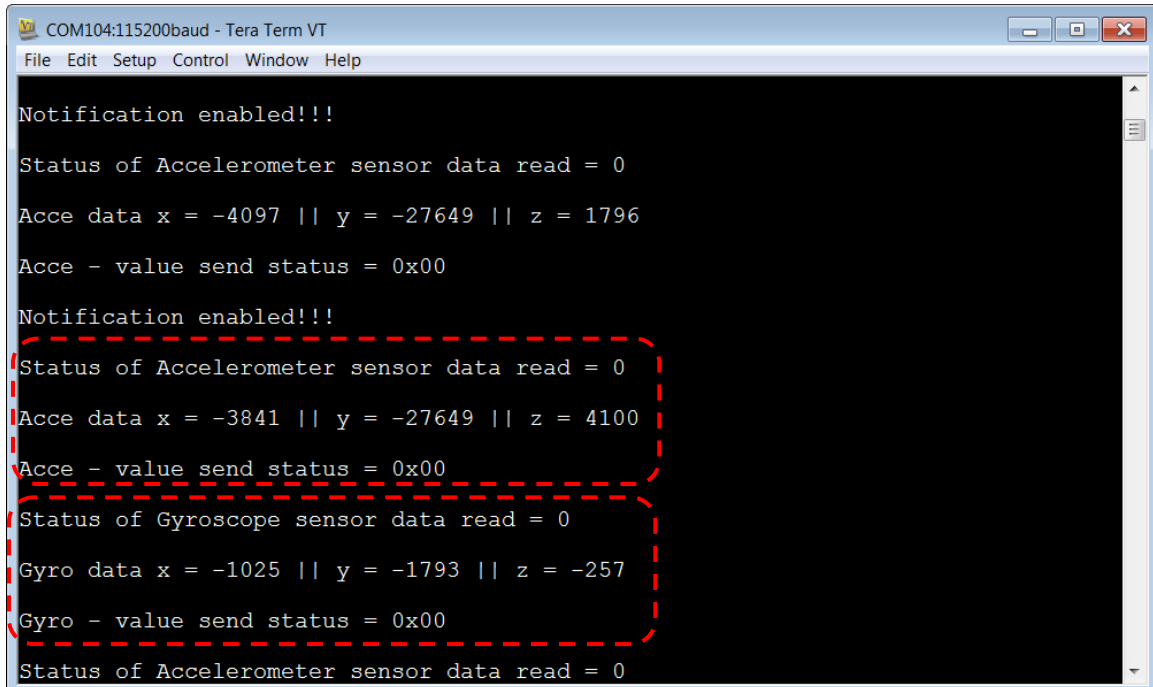
```
COM42:115200baud - Tera Term VT
File Edit Setup Control Window Help

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
```

13. Upon notification enabled by GAP-Central device, GAP-Peripheral device start reading accelerometer and gyroscope sensor data and notifies it to GAP-Central device.
14. GAP-Peripheral prints the following in serial console,
- a. Accelerometer and gyroscope sensor read operation status

GAP_Peripheral_Demo_User's_Guide

- b. Accelerometer and gyroscope sensor data
- c. Status of notification send to GAP-Central.



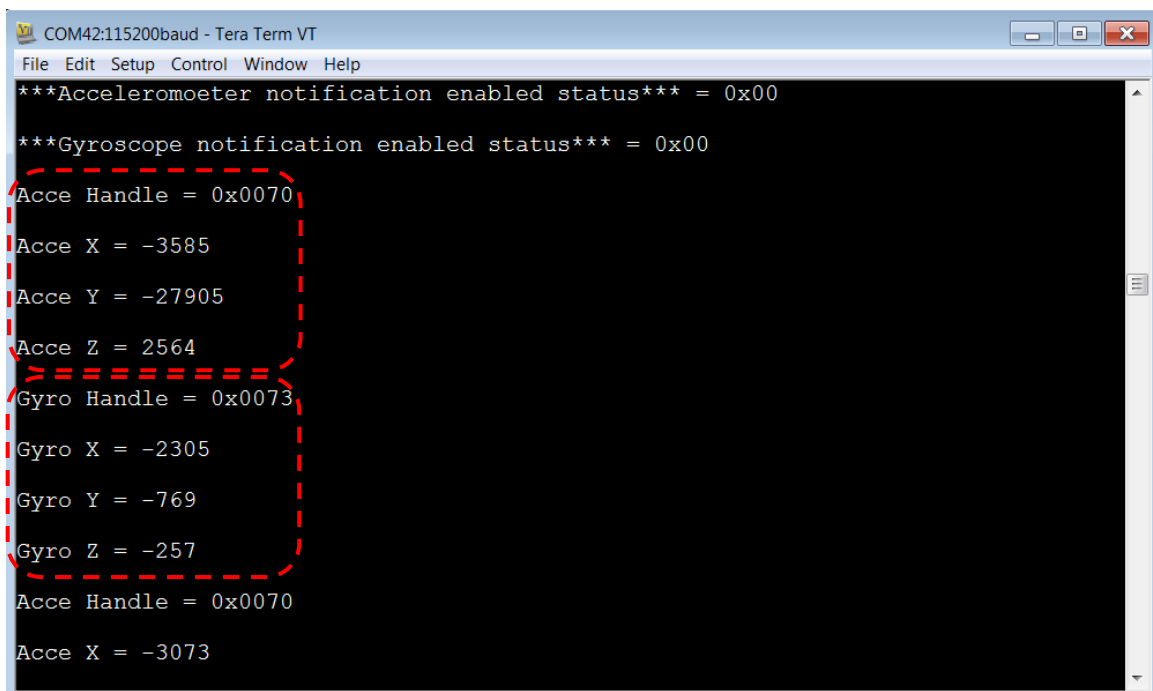
The screenshot shows a Tera Term VT window titled 'COM104:115200baud - Tera Term VT'. The window contains the following text:

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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
```

A red dashed box highlights the following lines:

```
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
```

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



The screenshot shows a Tera Term VT window titled 'COM42:115200baud - Tera Term VT'. The window contains the following text:

```
***Acceleromoeter 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
```

A red dashed box highlights the following lines:

```
Acce Handle = 0x0070  
Acce X = -3585  
Acce Y = -27905  
Acce Z = 2564  
===== > =====  
Gyro Handle = 0x0073  
Gyro X = -2305  
Gyro Y = -769  
Gyro Z = -257
```

GAP_Peripheral_Demo_User's_Guide

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