



Multilink-Multirole Demo User's Guide

Multilink_Multirole_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 Multilink-Multirole Demo Application	6
2.3. Build Multilink-Multirole Demo Application	7
3. Programming Multilink-Multirole Firmware	8
4. Running Multilink-Multirole Demo	11

Multilink_Multirole_Demo_User's_Guide

1. Overview

This document explains how to setup a Multilink-Multirole demo using SAML21 Xplained Pro, BM71-XPro, BNO055 Click board. This document briefly talks about setting up hardware, building application, programming application and running a demo.

This demo application showcases a Proof-of-Concept example of using **ble_host_sdk** to setup BM71 as a Multilink-Multirole device where it plays both GAP-Central and GAP-Peripheral roles, simultaneously. 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

Multilink_Multirole_Demo_User's_Guide

1.1. Hardware Setup

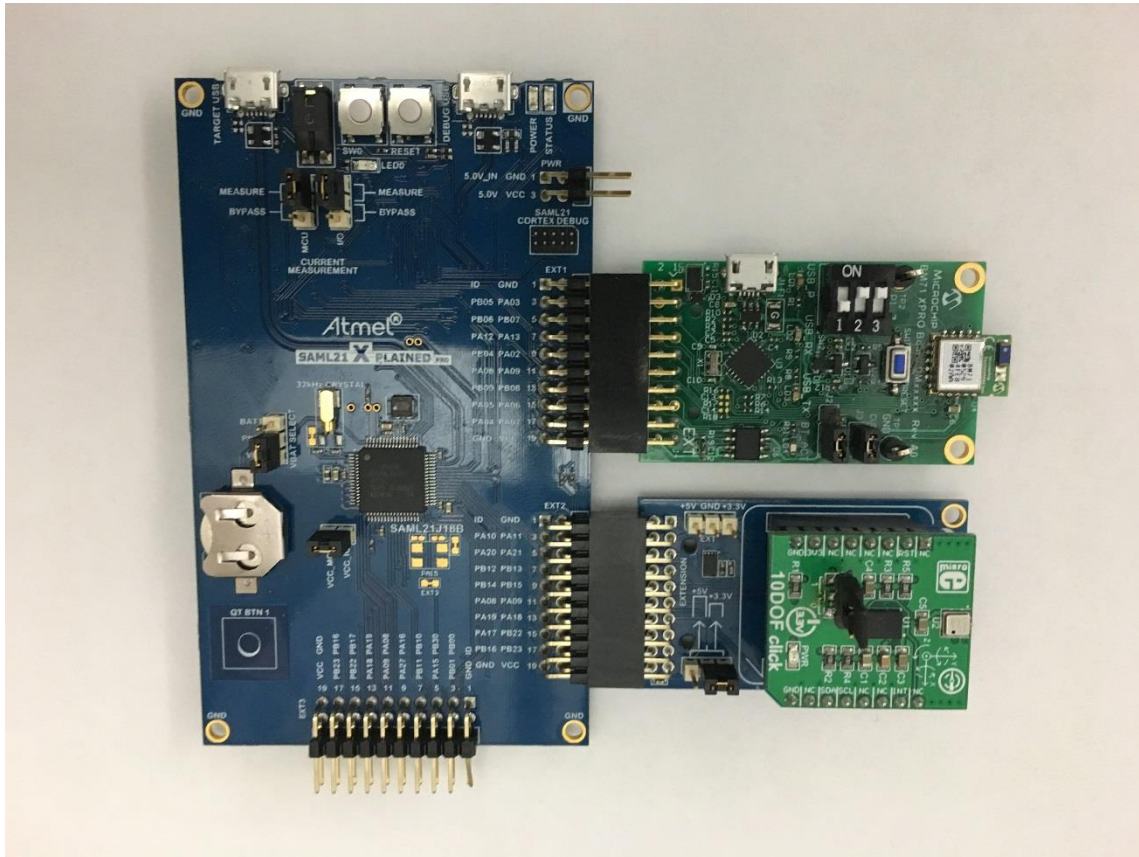


Figure 1: SAML21 Xplained Pro with BM71-XPro and MikroElektronika BNO055 Click Board

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 or iOS phones from the following link.



Android:

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

Multilink_Multirole_Demo_User's_Guide

1.3. Console

The Multilink-Multirole 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.

Use the following serial port configuration to interact with BM71.

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

Multilink_Multirole_Demo_User's_Guide

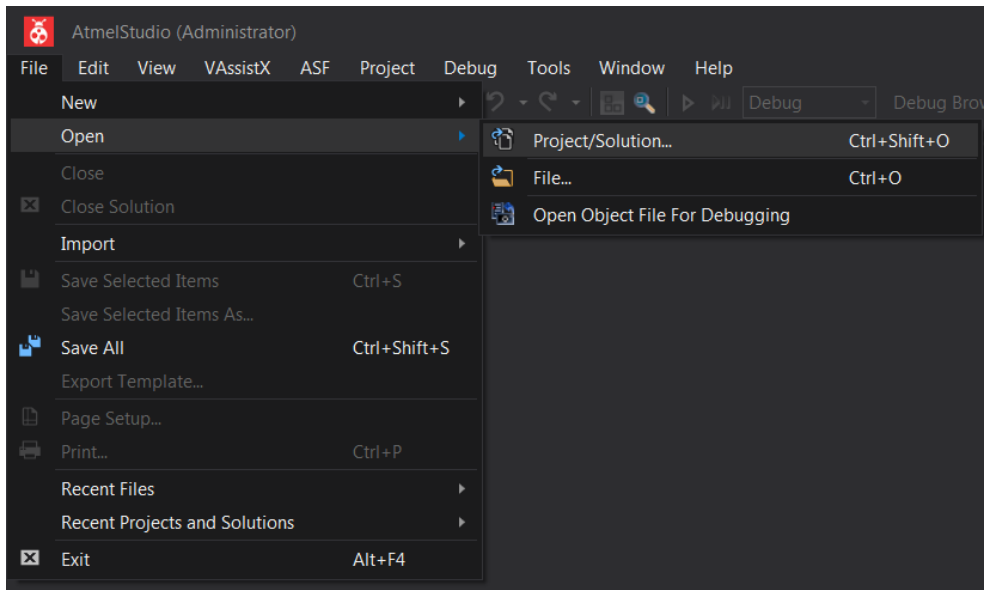
2. Build Procedure

This section describes the build procedure of Multilink-Multirole demo application on Atmel Studio 7.

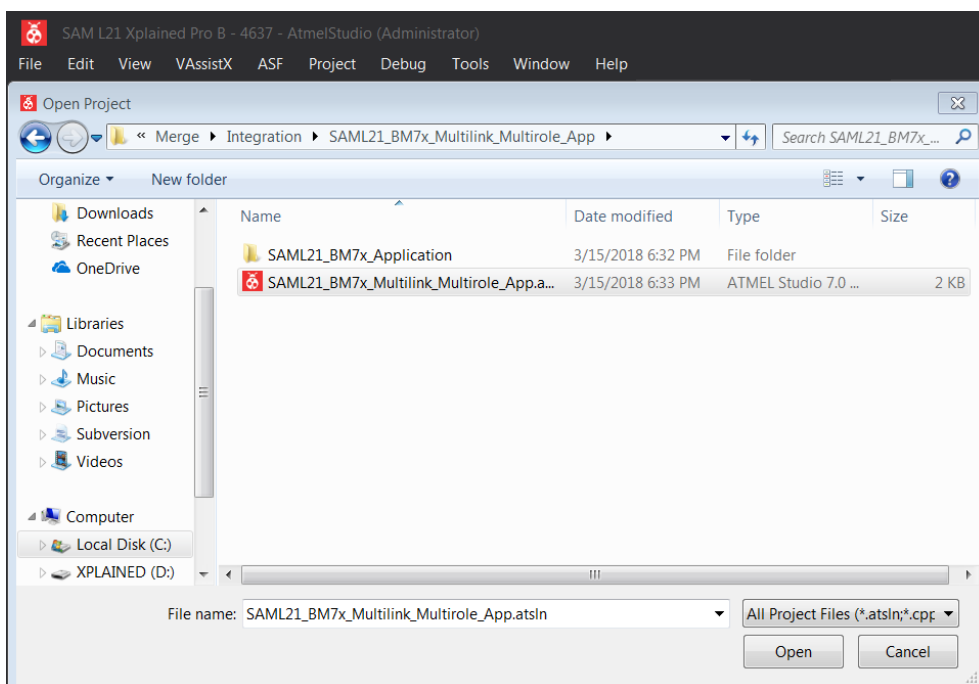
2.1. Open Atmel Studio 7

2.2. Open Multilink-Multirole Demo Application

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



2. Select “SAML21_BM7x_Multilink_Multirole_App.atsln” and press **Open**.

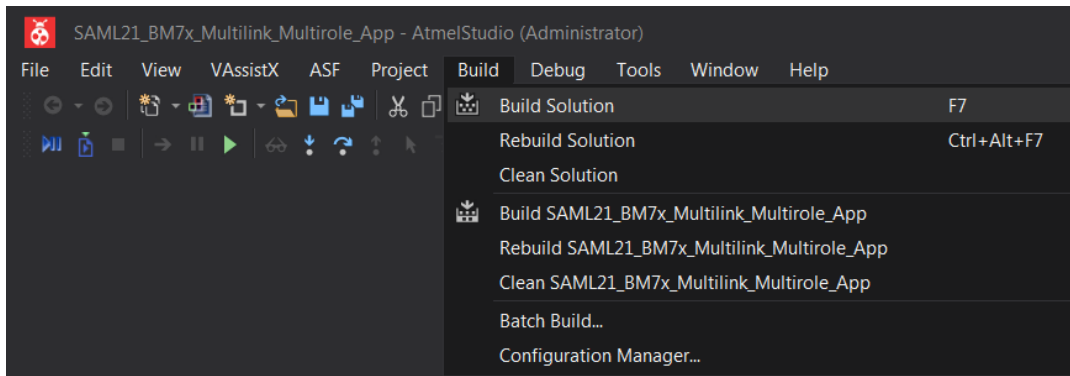


3. Once the project is opened, you can see the files attached to this project in Solution Explorer Window

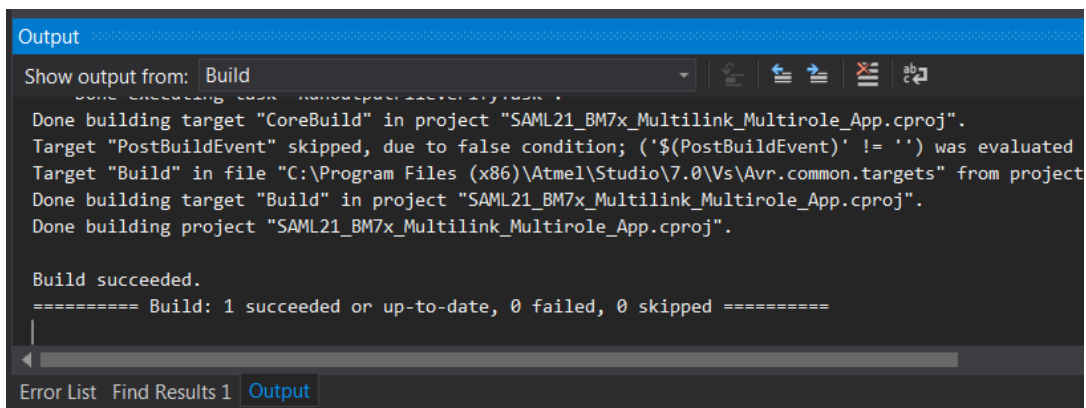
Multilink_Multirole_Demo_User's_Guide

2.3. Build Multilink-Multirole Demo Application

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



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



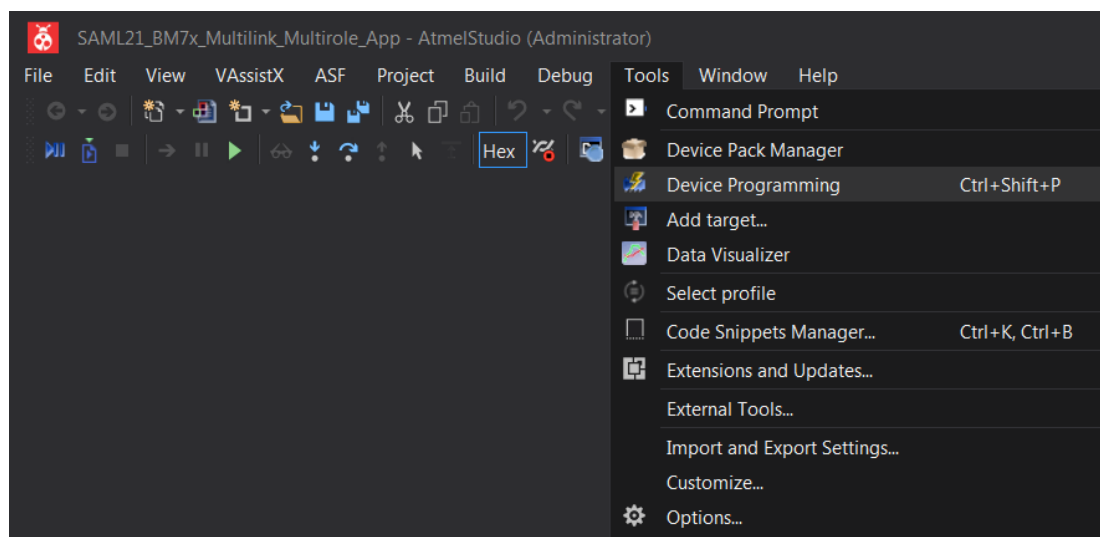
3. You can find the Hex images in “..\SAML21_BM7x_Application\Debug”.

Multilink_Multirole_Demo_User's_Guide

3. Programming Multilink-Multirole Firmware

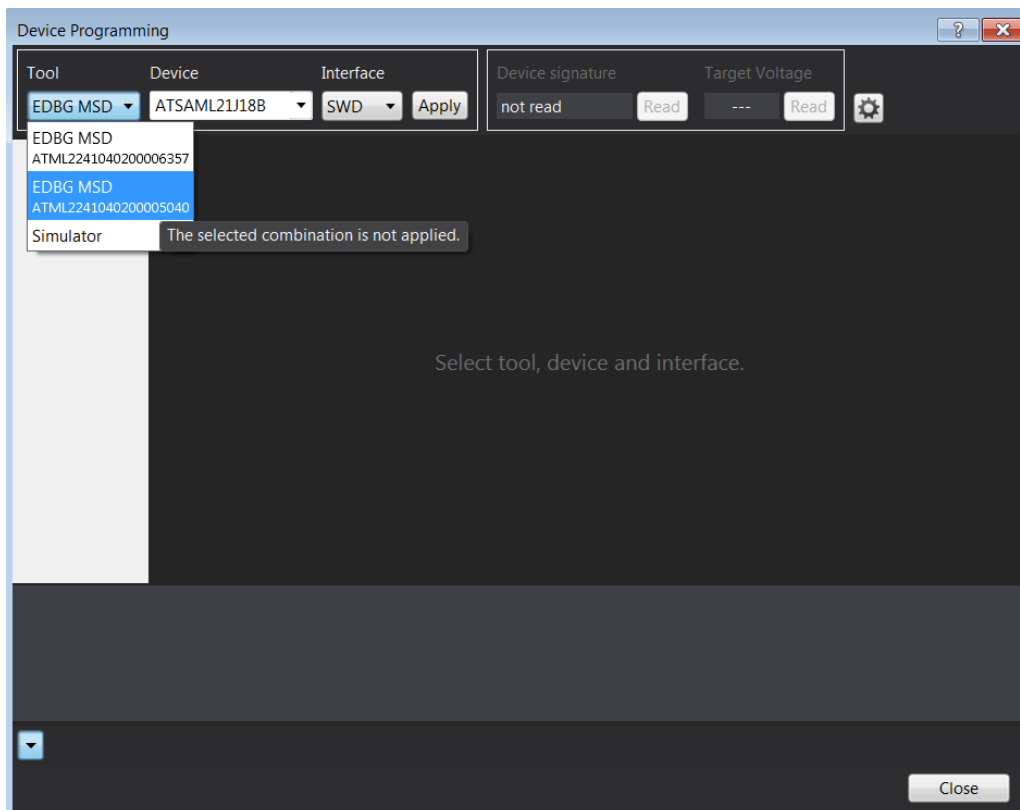
This section describes the procedure to program Multilink-Multirole demo firmware on SAML21 Xplained Pro board.

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**.

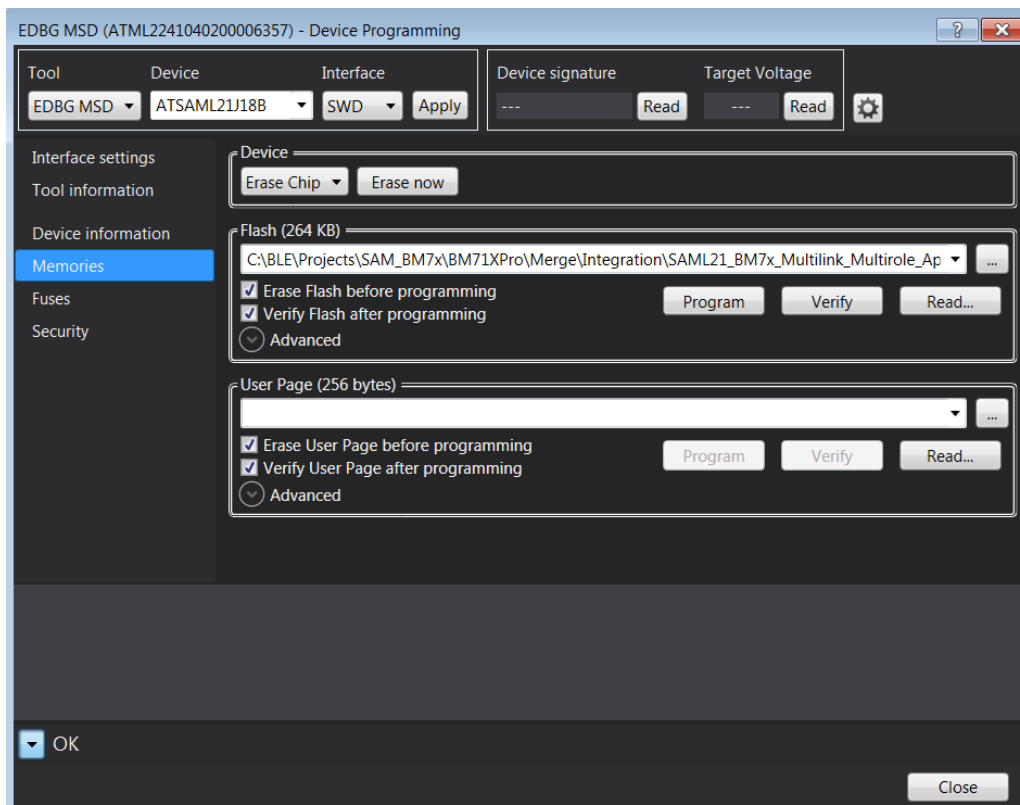


Multilink_Multirole_Demo_User's_Guide

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

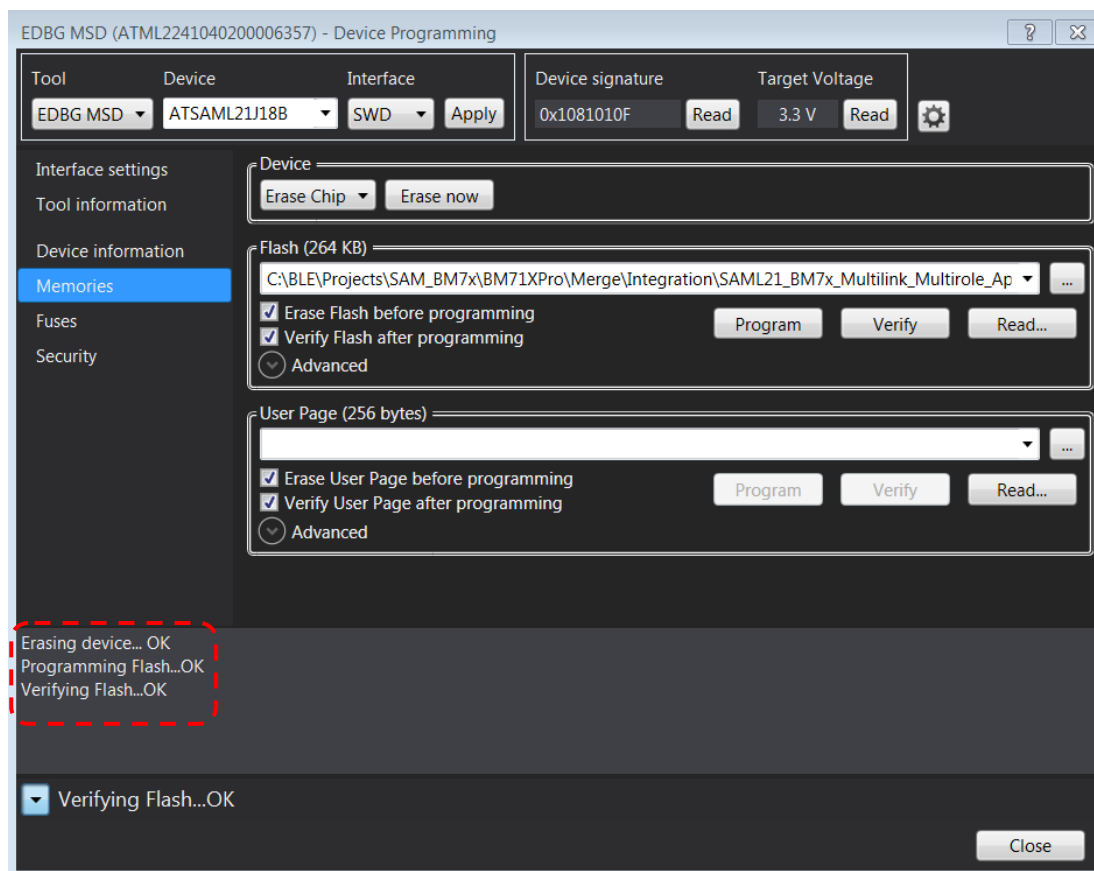


4. Go to **Memories** Tab and select Hex file.



Multilink_Multirole_Demo_User's_Guide

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



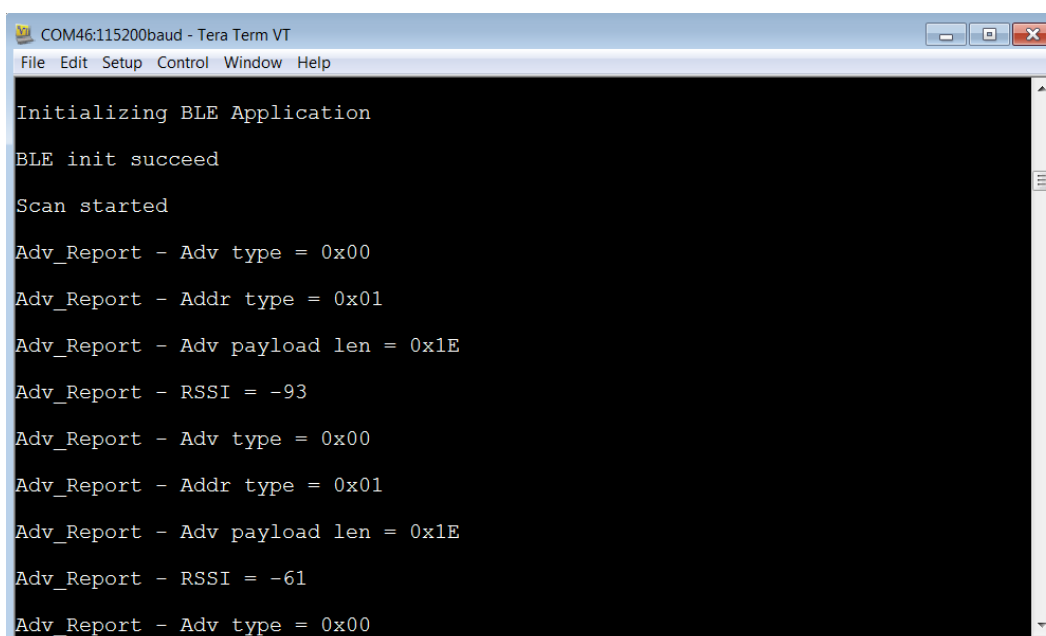
6. Once programming is done, close the Device Programming window.

Multilink_Multirole_Demo_User's_Guide

4. Running Multilink-Multirole Demo

In this demo the Multilink-Multirole device plays both GAP-Central and GAP-Peripheral roles. First the device will play a GAP-Central role and it scans and connects with remote GAP-Peripheral device. Once connected Multilink-Multirole device will play a GAP-Peripheral role and it starts advertising and further accept connection from remote GAP-Central device.

1. After programming the demo, press a reset button on Multilink-Multirole device (Reset button on SAML21 Xplained Pro board).
 - a. Make sure that POWER LED (green) on SAML21 Xplained Pro board is solid ON and the LD4 (blue) on BM71-XPro is blinking at a regular interval.
2. Ensure that the Multilink-Multirole device is scanning by checking the TeraTerm window for a message “Scan started”.



The screenshot shows a TeraTerm window titled 'COM46:115200baud - Tera Term VT'. The window contains the following text:

```
Initializing BLE Application
BLE init succeed
Scan started
Adv_Report - Adv type = 0x00
Adv_Report - Addr type = 0x01
Adv_Report - Adv payload len = 0x1E
Adv_Report - RSSI = -93
Adv_Report - Adv type = 0x00
Adv_Report - Addr type = 0x01
Adv_Report - Adv payload len = 0x1E
Adv_Report - RSSI = -61
Adv_Report - Adv type = 0x00
```

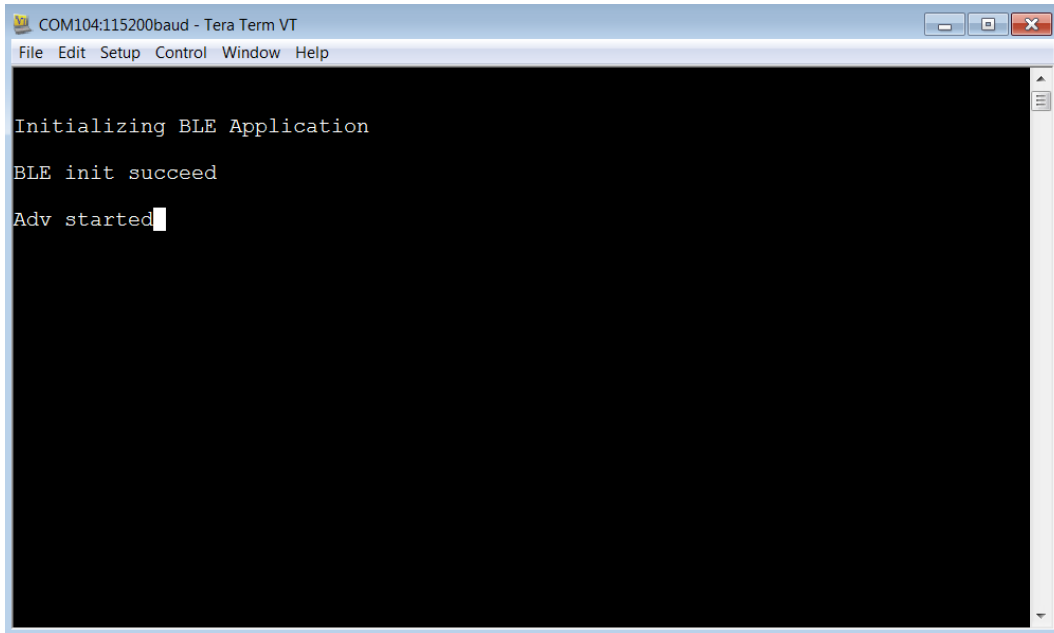
3. Prepare a GAP-Peripheral device (Refer: GAP_Peripheral_Demo_Getting_Started_Guide.doc)
4. Connect the GAP-Peripheral device to the host PC using micro USB cable. Perform the following steps:
 - a. Verify that the virtual COM port is enumerated on the host PC.
 - b. Open the enumerated COM port on a serial terminal application like TeraTerm with the following settings:

Baudrate	115200
Data	8 bits
Parity	none
Stop	1 bit

Multilink_Multirole_Demo_User's_Guide

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.
5. Ensure that the GAP-Peripheral device is advertising by checking the TeraTerm window for a message “Adv started”.

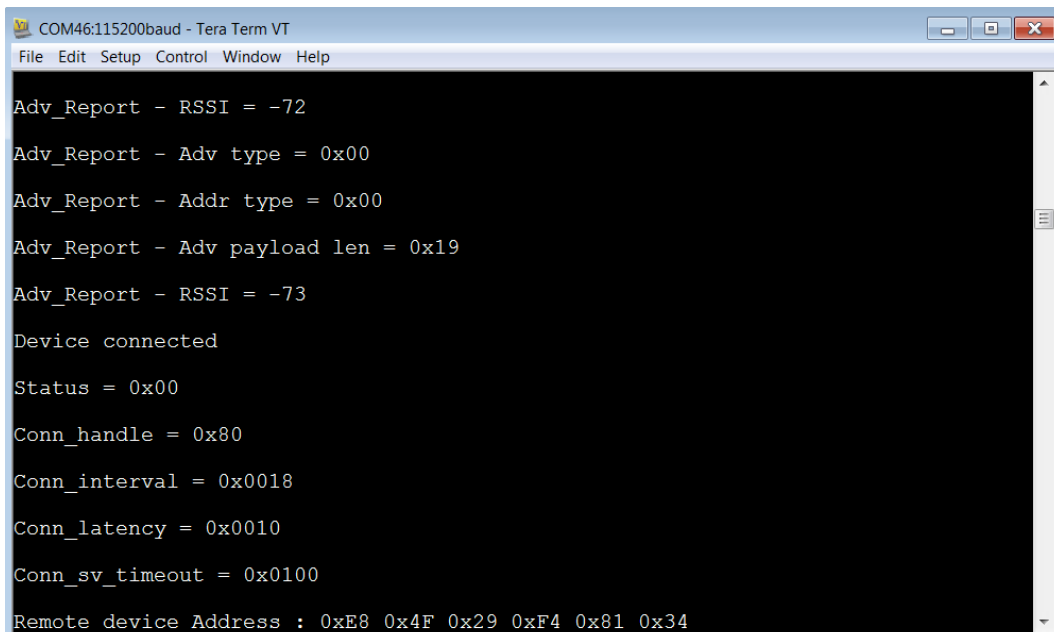


A screenshot of a TeraTerm window titled "COM104:115200baud - Tera Term VT". The window has a menu bar with "File", "Edit", "Setup", "Control", "Window", and "Help". The main text area is black with white text. The text displayed is: "Initializing BLE Application", "BLE init succeed", and "Adv started" followed by a cursor. A vertical scrollbar is visible on the right side of the text area.

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

Initializing BLE Application
BLE init succeed
Adv started
```

6. Multilink-Multirole device which is currently scanning will initiate a connection with GAP-Peripheral device, if it discovers GAP-Peripheral device and the advertising parameter matches its requirement.



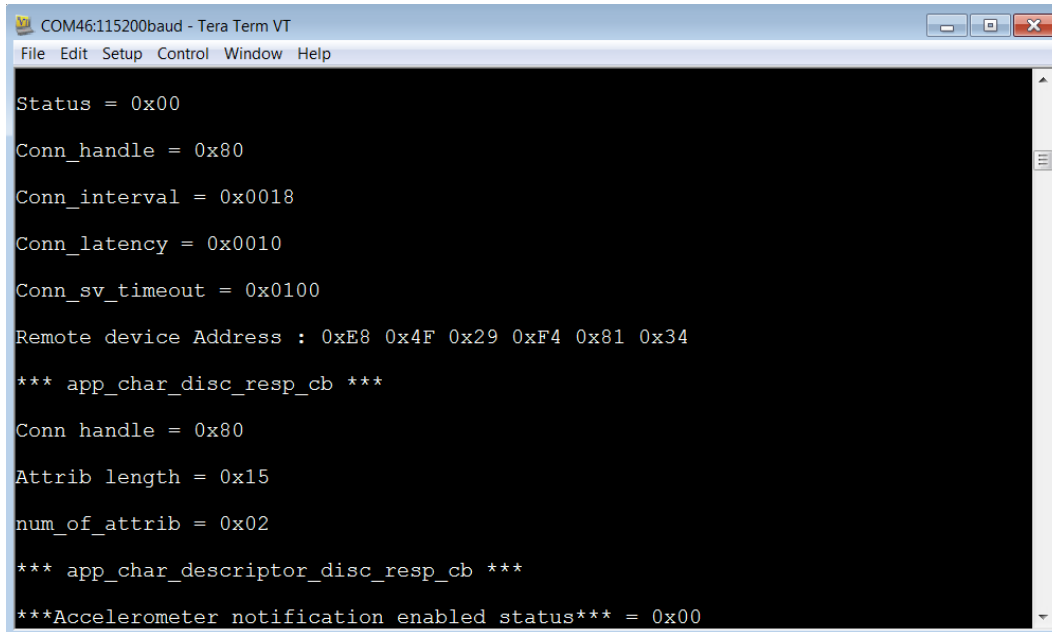
A screenshot of a TeraTerm window titled "COM46:115200baud - Tera Term VT". The window has a menu bar with "File", "Edit", "Setup", "Control", "Window", and "Help". The main text area is black with white text. The text displayed is: "Adv_Report - RSSI = -72", "Adv_Report - Adv type = 0x00", "Adv_Report - Addr type = 0x00", "Adv_Report - Adv payload len = 0x19", "Adv_Report - RSSI = -73", "Device connected", "Status = 0x00", "Conn_handle = 0x80", "Conn_interval = 0x0018", "Conn_latency = 0x0010", "Conn_sv_timeout = 0x0100", and "Remote device Address : 0xE8 0x4F 0x29 0xF4 0x81 0x34". A vertical scrollbar is visible on the right side of the text area.

```
COM46:115200baud - Tera Term VT
File Edit Setup Control Window Help

Adv_Report - RSSI = -72
Adv_Report - Adv type = 0x00
Adv_Report - Addr type = 0x00
Adv_Report - Adv payload len = 0x19
Adv_Report - RSSI = -73
Device connected
Status = 0x00
Conn_handle = 0x80
Conn_interval = 0x0018
Conn_latency = 0x0010
Conn_sv_timeout = 0x0100
Remote device Address : 0xE8 0x4F 0x29 0xF4 0x81 0x34
```

Multilink_Multirole_Demo_User's_Guide

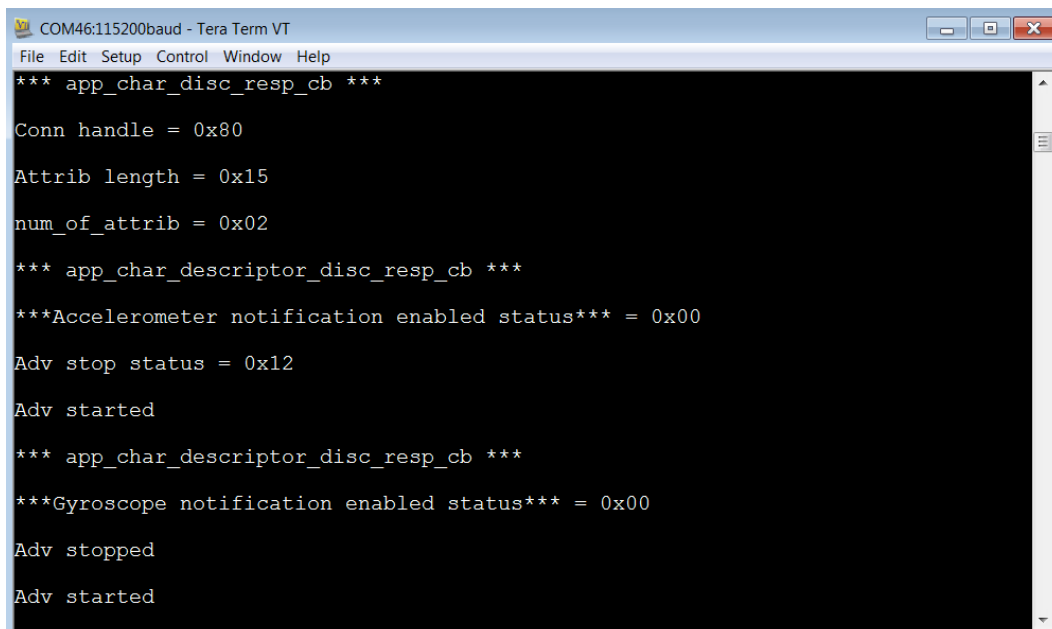
7. Once connected, the Multilink-Multirole device initiates service discovery and look for device orientation service.



```
COM46:115200baud - Tera Term VT
File Edit Setup Control Window Help

Status = 0x00
Conn_handle = 0x80
Conn_interval = 0x0018
Conn_latency = 0x0010
Conn_sv_timeout = 0x0100
Remote device Address : 0xE8 0x4F 0x29 0xF4 0x81 0x34
*** app_char_disc_resp_cb ***
Conn handle = 0x80
Attrib length = 0x15
num_of_attrib = 0x02
*** app_char_descriptor_disc_resp_cb ***
***Accelerometer notification enabled status*** = 0x00
```

8. When the Multilink-Multirole device discovers the device orientation service and its characteristics, it enables notifications on the accelerometer and gyroscope sensor characteristics.

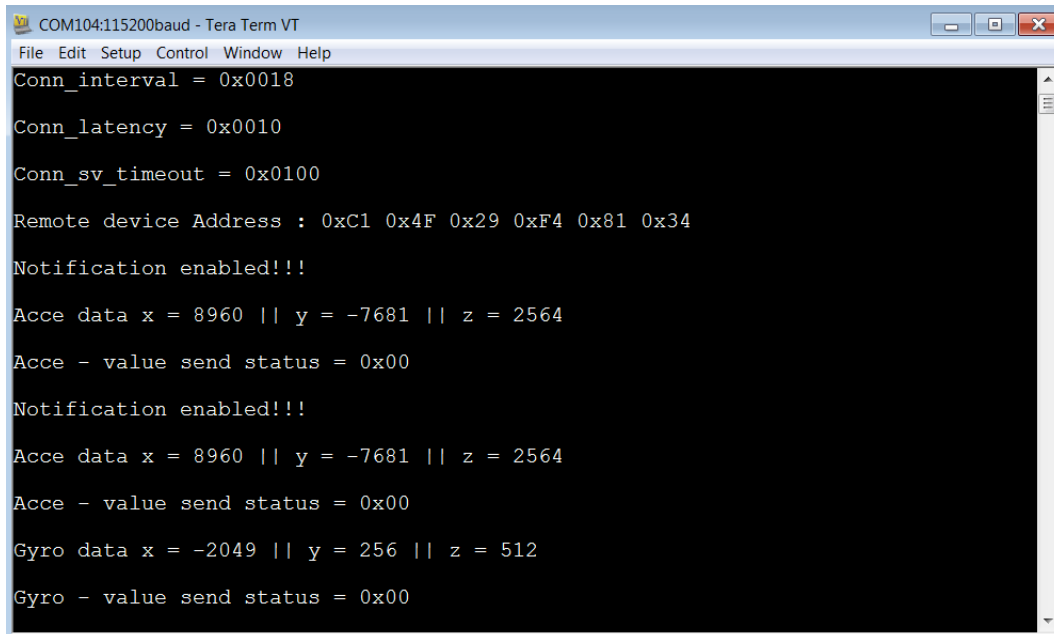


```
COM46:115200baud - Tera Term VT
File Edit Setup Control Window Help

*** app_char_disc_resp_cb ***
Conn handle = 0x80
Attrib length = 0x15
num_of_attrib = 0x02
*** app_char_descriptor_disc_resp_cb ***
***Accelerometer notification enabled status*** = 0x00
Adv stop status = 0x12
Adv started
*** app_char_descriptor_disc_resp_cb ***
***Gyroscope notification enabled status*** = 0x00
Adv stopped
Adv started
```

9. At this stage, Multilink-Multirole device will start advertising. So that the remote GAP-Central device can connect with Multilink-Multirole device.
10. Once the accelerometer and gyroscope sensor characteristics notifications enabled, the GAP-Peripheral device start sending accelerometer and gyroscope sensor data.

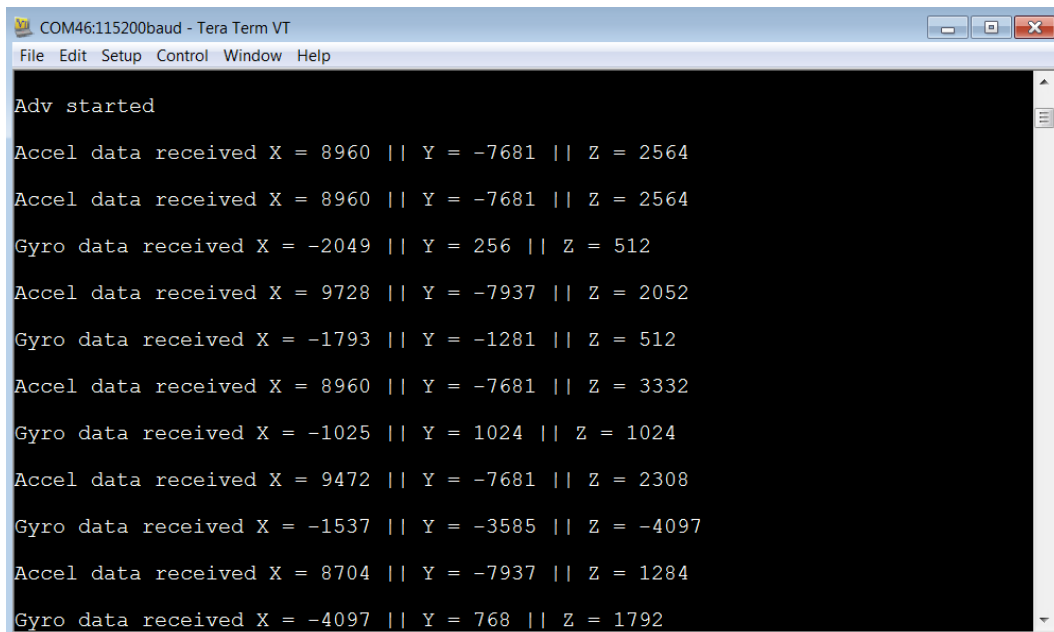
Multilink_Multirole_Demo_User's_Guide



A screenshot of a Tera Term VT window titled 'COM104:115200baud'. The window displays the following text:

```
File Edit Setup Control Window Help
Conn_interval = 0x0018
Conn_latency = 0x0010
Conn_sv_timeout = 0x0100
Remote device Address : 0xC1 0x4F 0x29 0xF4 0x81 0x34
Notification enabled!!!
Acce data x = 8960 || y = -7681 || z = 2564
Acce - value send status = 0x00
Notification enabled!!!
Acce data x = 8960 || y = -7681 || z = 2564
Acce - value send status = 0x00
Gyro data x = -2049 || y = 256 || z = 512
Gyro - value send status = 0x00
```

11. Upon receiving sensor data notifications, the Multilink-Multirole device print them on serial console.



A screenshot of a Tera Term VT window titled 'COM46:115200baud'. The window displays the following text:

```
File Edit Setup Control Window Help
Adv started
Accel data received X = 8960 || Y = -7681 || Z = 2564
Accel data received X = 8960 || Y = -7681 || Z = 2564
Gyro data received X = -2049 || Y = 256 || Z = 512
Accel data received X = 9728 || Y = -7937 || Z = 2052
Gyro data received X = -1793 || Y = -1281 || Z = 512
Accel data received X = 8960 || Y = -7681 || Z = 3332
Gyro data received X = -1025 || Y = 1024 || Z = 1024
Accel data received X = 9472 || Y = -7681 || Z = 2308
Gyro data received X = -1537 || Y = -3585 || Z = -4097
Accel data received X = 8704 || Y = -7937 || Z = 1284
Gyro data received X = -4097 || Y = 768 || Z = 1792
```

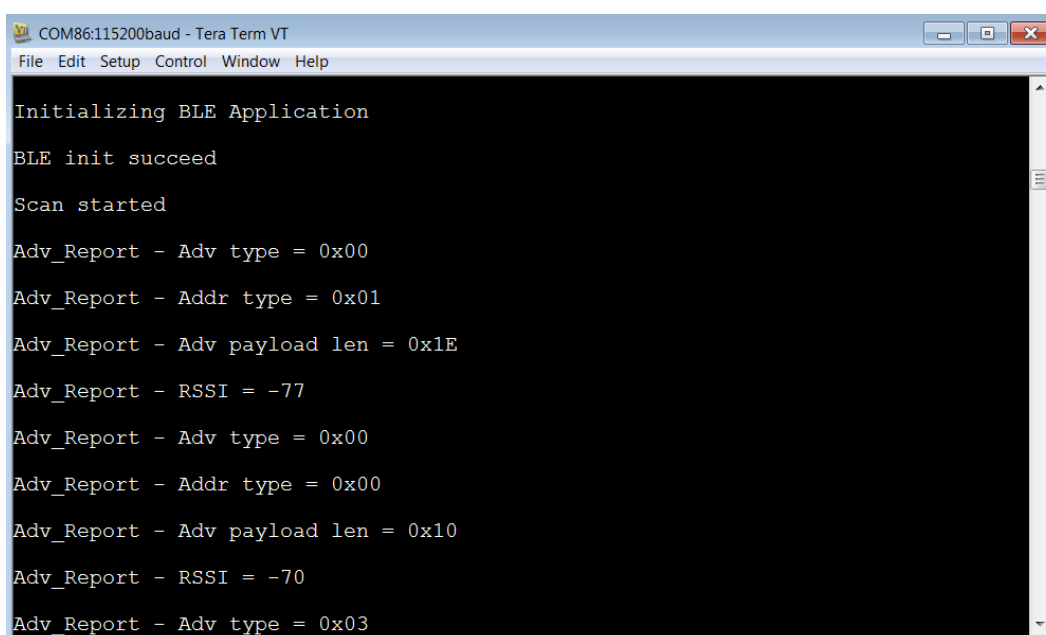
12. Prepare a GAP-Central device (Refer: GAP_Central_Demo_Getting_Started_Guide.doc)
13. Connect the GAP-Central device to the host PC using micro USB cable. Perform the following steps:
- Verify that the virtual COM port is enumerated on the host PC.
 - Open the enumerated COM port on a serial terminal application like TeraTerm with the following settings:

Baudrate	115200
-----------------	--------

Multilink_Multirole_Demo_User's_Guide

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.
14. Ensure that the GAP-Central device is scanning by checking the TeraTerm window for a message “Scan started”.



The screenshot shows a TeraTerm window titled "COM86:115200baud - Tera Term VT". The window contains the following text:

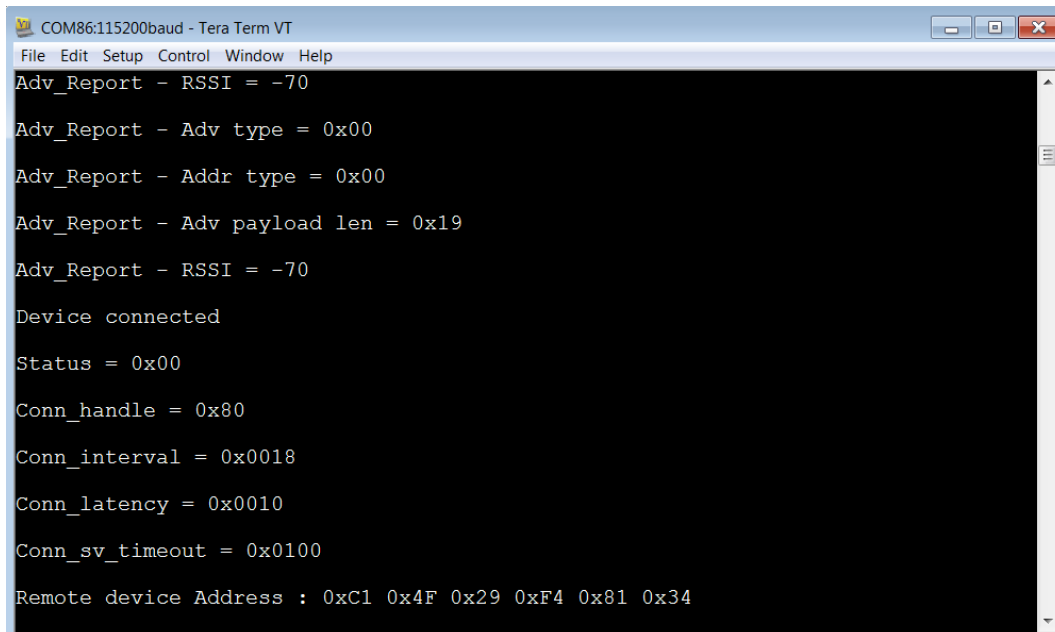
```
File Edit Setup Control Window Help

Initializing BLE Application
BLE init succeed
Scan started

Adv_Report - Adv type = 0x00
Adv_Report - Addr type = 0x01
Adv_Report - Adv payload len = 0x1E
Adv_Report - RSSI = -77
Adv_Report - Adv type = 0x00
Adv_Report - Addr type = 0x00
Adv_Report - Adv payload len = 0x10
Adv_Report - RSSI = -70
Adv_Report - Adv type = 0x03
```

15. GAP-Central device which is currently scanning will initiate a connection with Multilink-Multirole device, if it discovers Multilink-Multirole device and the advertising parameter matches its requirement.

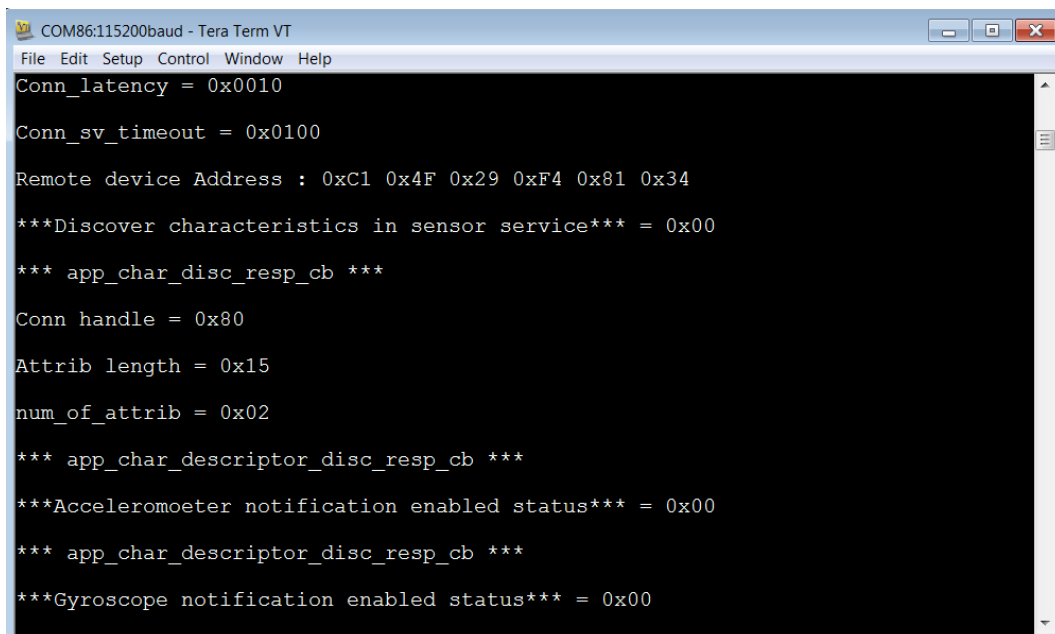
Multilink_Multirole_Demo_User's_Guide



A screenshot of a Tera Term VT window titled 'COM86:115200baud - Tera Term VT'. The window displays a series of text-based status reports. The reports include RSSI values, ADV report details (type, address type, payload length), connection status, and various connection parameters like handle, interval, latency, and timeout. At the bottom, the remote device address is listed as a 6-byte hexadecimal string.

```
COM86:115200baud - Tera Term VT
File Edit Setup Control Window Help
Adv_Report - RSSI = -70
Adv_Report - Adv type = 0x00
Adv_Report - Addr type = 0x00
Adv_Report - Adv payload len = 0x19
Adv_Report - RSSI = -70
Device connected
Status = 0x00
Conn_handle = 0x80
Conn_interval = 0x0018
Conn_latency = 0x0010
Conn_sv_timeout = 0x0100
Remote device Address : 0xC1 0x4F 0x29 0xF4 0x81 0x34
```

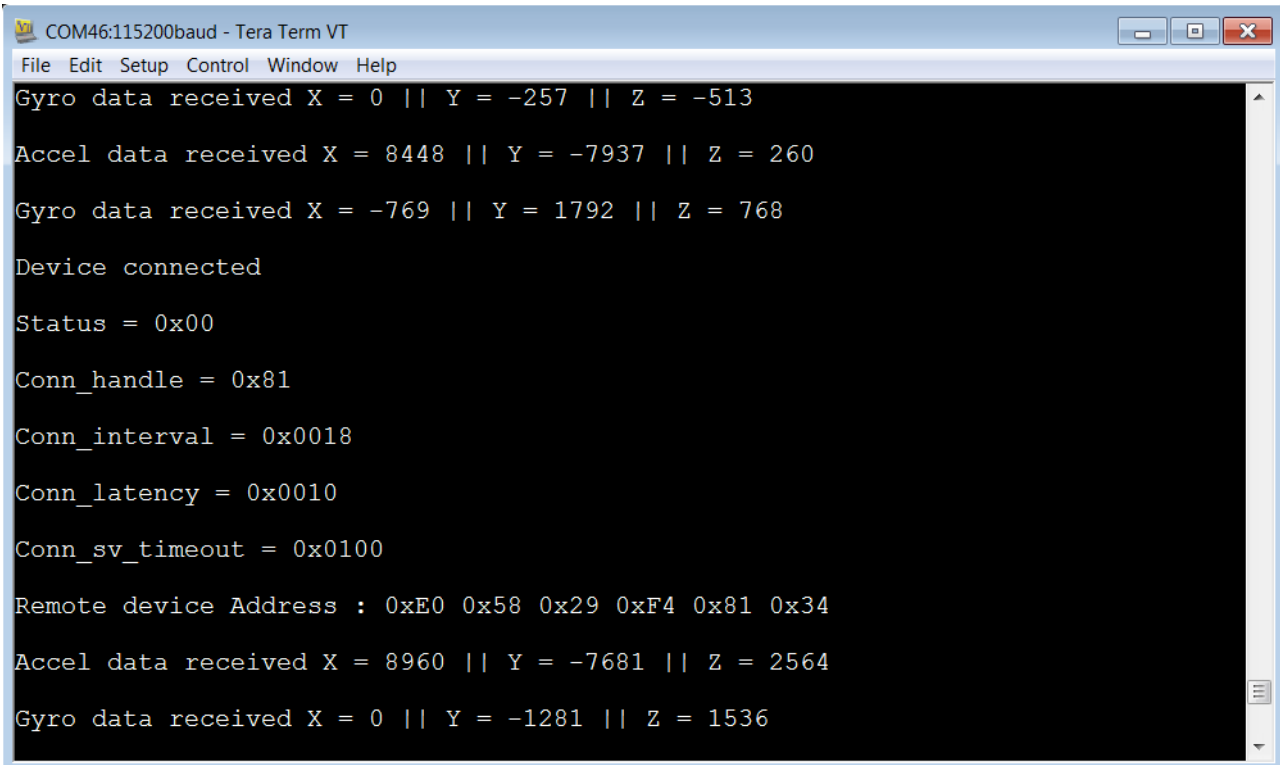
16. Once connected, the GAP-Central device initiates service discovery and look for device orientation service.



A screenshot of a Tera Term VT window titled 'COM86:115200baud - Tera Term VT'. The window displays the continuation of the connection process, showing service discovery results. It includes the remote device address, a status for discovering characteristics in the sensor service, and two specific discovery responses for accelerometer and gyroscope notifications, both with a status of 0x00.

```
COM86:115200baud - Tera Term VT
File Edit Setup Control Window Help
Conn_latency = 0x0010
Conn_sv_timeout = 0x0100
Remote device Address : 0xC1 0x4F 0x29 0xF4 0x81 0x34
***Discover characteristics in sensor service*** = 0x00
*** app_char_disc_resp_cb ***
Conn handle = 0x80
Attrib length = 0x15
num_of_attrib = 0x02
*** app_char_descriptor_disc_resp_cb ***
***Accelerometer notification enabled status*** = 0x00
*** app_char_descriptor_disc_resp_cb ***
***Gyroscope notification enabled status*** = 0x00
```

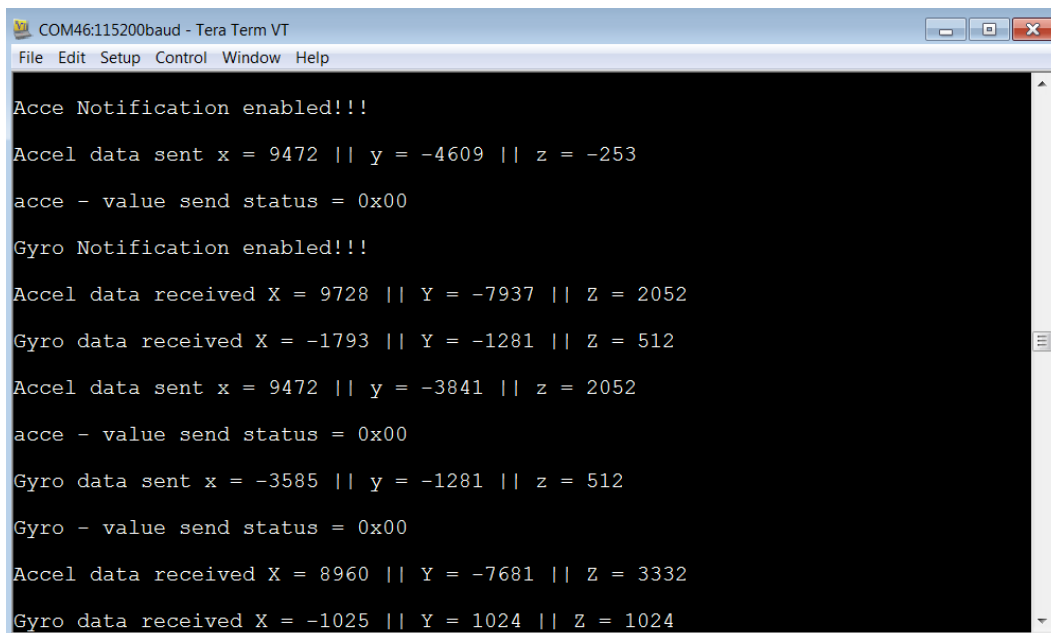

Multilink_Multirole_Demo_User's_Guide



A screenshot of a Tera Term VT window titled "COM46:115200baud - Tera Term VT". The window has a menu bar with "File", "Edit", "Setup", "Control", "Window", and "Help". The main text area displays the following output:

```
Gyro data received X = 0 || Y = -257 || Z = -513
Accel data received X = 8448 || Y = -7937 || Z = 260
Gyro data received X = -769 || Y = 1792 || Z = 768
Device connected
Status = 0x00
Conn_handle = 0x81
Conn_interval = 0x0018
Conn_latency = 0x0010
Conn_sv_timeout = 0x0100
Remote device Address : 0xE0 0x58 0x29 0xF4 0x81 0x34
Accel data received X = 8960 || Y = -7681 || Z = 2564
Gyro data received X = 0 || Y = -1281 || Z = 1536
```

17. When the GAP-Central device discovers the device orientation service and its characteristics in Multilink-Multirole device, it enables notifications on the accelerometer and gyroscope sensor characteristics.
18. Once the accelerometer and gyroscope notifications enabled, the Multilink-Multirole device start sending accelerometer and gyroscope sensor data.

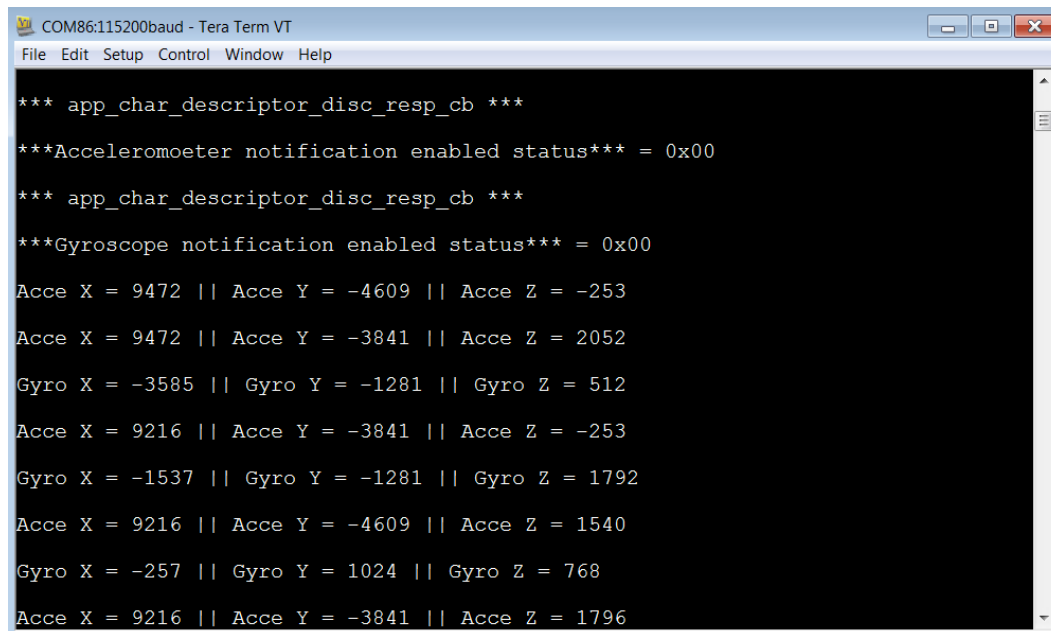


A screenshot of a Tera Term VT window titled "COM46:115200baud - Tera Term VT". The window has a menu bar with "File", "Edit", "Setup", "Control", "Window", and "Help". The main text area displays the following output:

```
Acce Notification enabled!!!
Accel data sent x = 9472 || y = -4609 || z = -253
acce - value send status = 0x00
Gyro Notification enabled!!!
Accel data received X = 9728 || Y = -7937 || Z = 2052
Gyro data received X = -1793 || Y = -1281 || Z = 512
Accel data sent x = 9472 || y = -3841 || z = 2052
acce - value send status = 0x00
Gyro data sent x = -3585 || y = -1281 || z = 512
Gyro - value send status = 0x00
Accel data received X = 8960 || Y = -7681 || Z = 3332
Gyro data received X = -1025 || Y = 1024 || Z = 1024
```

Multilink_Multirole_Demo_User's_Guide

19. Upon receiving sensor data notifications, the GAP-Central device prints them on serial console.

A screenshot of a Tera Term VT window titled 'COM86:115200baud - Tera Term VT'. The window displays a series of sensor data notifications. The text is as follows:

```
*** app_char_descriptor_disc_resp_cb ***  
***Acceleromoeter notification enabled status*** = 0x00  
*** app_char_descriptor_disc_resp_cb ***  
***Gyroscope notification enabled status*** = 0x00  
Acce X = 9472 || Acce Y = -4609 || Acce Z = -253  
Acce X = 9472 || Acce Y = -3841 || Acce Z = 2052  
Gyro X = -3585 || Gyro Y = -1281 || Gyro Z = 512  
Acce X = 9216 || Acce Y = -3841 || Acce Z = -253  
Gyro X = -1537 || Gyro Y = -1281 || Gyro Z = 1792  
Acce X = 9216 || Acce Y = -4609 || Acce Z = 1540  
Gyro X = -257 || Gyro Y = 1024 || Gyro Z = 768  
Acce X = 9216 || Acce Y = -3841 || Acce Z = 1796
```

20. In this demo, the GAP-Central device can be replaced by BLESensorApp (iOS)

Multilink_Multirole_Demo_User's_Guide

Trademarks:

The Microchip name and logo, the Microchip logo, MPLAB, and PIC are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.