Use of ISP1807-LR Evaluation Boards

Application Note AN181104

Introduction

Scope

This document gives details on hardware and software for using and testing Insight SiP Bluetooth Low Energy module ISP1807-LR, version with 1MB flash and 256kB RAM memories.

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1. Recommended Documentation

The following Nordic Semiconductor documents and Software Dev Kits are required to understand the complete setup and programming methods.

Nordic Semiconductor Documents

- nRF52840 Development kit User Guide, hardware section should be partially ignored – Insight SiP development kit hardware replaces Nordic Semiconductor hardware.
- nRF52 Series Reference Manual.
- nRF52840 Product Specification V.x.x – make sure you have the last document version updated.
- S100 series SoftDevice Specification.
- nRF5 SDK for software development on nRF52 Series.

To access documentation, information, go to:

- Official Nordic Semi website *http://www.nordicsemi.com*
- The Nordic Semiconductor Infocenter is a “comprehensive library” containing technical documentation for current and legacy solutions and technologies *http://infocenter.nordicsemi.com/index.jsp*
- The Nordic Semiconductor Documentation library *https://www.nordicsemi.com/DocLib*
- Ask any Nordic related question and get help *https://devzone.nordicsemi.com/questions*
- For any question, you can also open a case on the *http://www.nordicsemi.com*

Software Dev kits

- nRFgo Studio.
- nRF5 Software Development Kit (SDK) which includes precompiled HEX files, source code as well as SES and Keil ARM project files.
- S100 series SoftDevice, namely S140.
- Master Control Panel and/or nRF Connect application for Smartphone.

To access these files, go to *www.nordicsemi.com* and download the files. Instructions can be found in Section 3.

Other Insight SiP documents

To complete the above, following documents are available on Insight SIP website or/and on request:

- AN181104 App Note – this document.
- DS1807 module data sheet.
- ISP1807-LR-TB Test Board schematic.
- ISP130603 Interface Board schematic.
- ISP1880 Sensors Board schematic.

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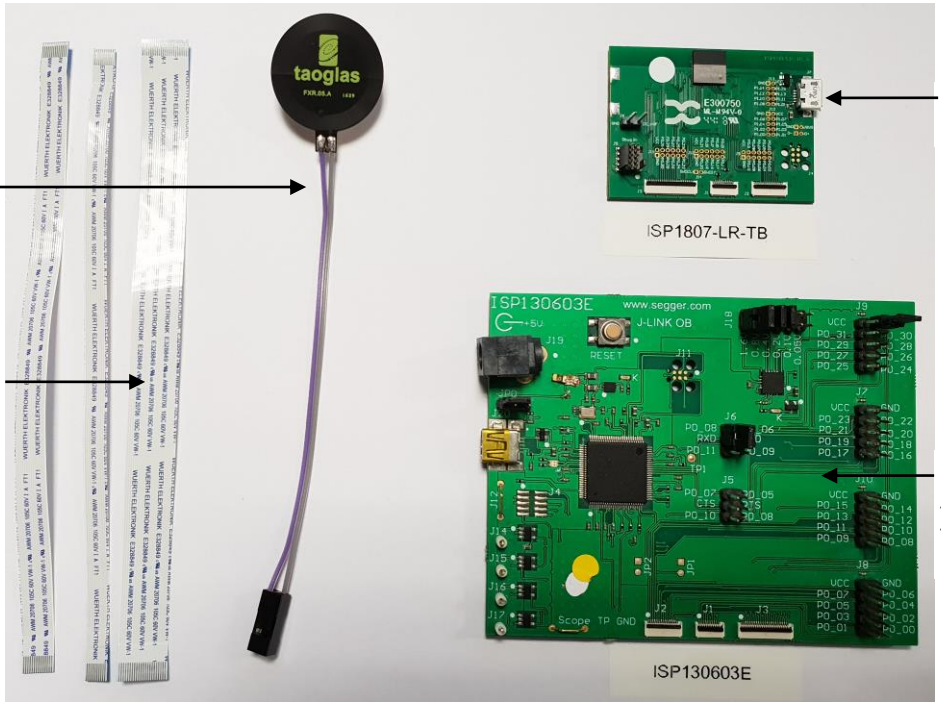
2. ISP1807-LR Evaluation Board Hardware Content



1 x NFC antenna

1 x FPC jumper cable 22 pin
1 x FPC jumper cable 14 pin
1 x FPC jumper cable 10 pin

1 x ISP1807-LR-TB Test Board

1 x ISP130603 Interface Board with J-Link Lite CortexM-9 JTAG/SWD Emulator

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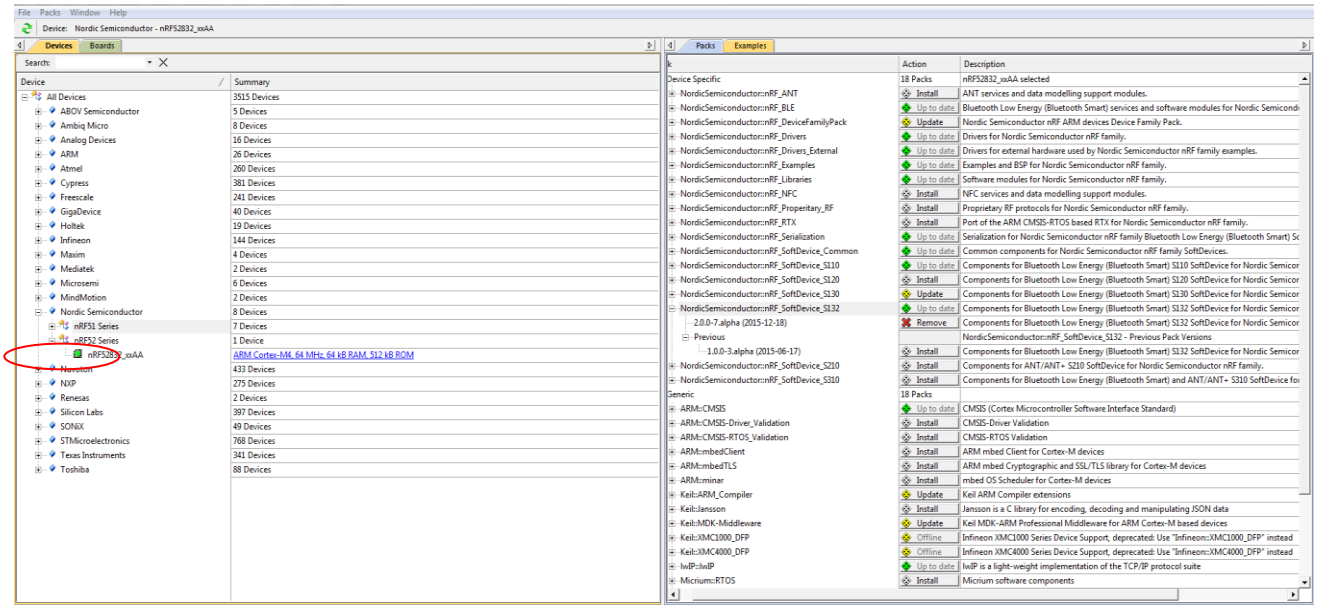
3. Software Installation

This paragraph describes the steps to follow for software installation.

1. Download and install Keil MDK-ARM from *https://www.keil.com/demo/eval/arm.htm* to your hard drive. After installation, you have two ways to launch a uVision project:

   a. Open Keil uVision and click on the “Packs” section and “Check for updates”. After you can show in the Device section “Nordic Semiconductor” on the left side of the screen and different Packs available on the right side of the screen.



   On the “Packs” section, you can download and update Nordic example, nRF SoftDevice, nRFDeviceFamilyPack, nRF examples…, etc …

   All the Packs are installed on the following directory:
   C:\Keil_v5\ARM\Pack\NordicSemiconductor.

   b. Or download the nRF5-SDK.zip (latest version) on the Nordic website and install it on your hard disk drive (see section 4). Once you open a uVision project, an alert message invites you to install DeviceFamilyPack. Download the latest version of the pack on the Nordic Semi website, install it and then you can open your uVision project with success.

2. Download the latest version and run the J-Link Software and documentation pack for Windows from *http://www.segger.com/jlink-software.html*.

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3. Go to www.nordicsemi.com and log in to your Nordic My Page account.

   Go to Products and click on Bluetooth Smart/Bluetooth Energy. You will have access to the different product:

   a. nRF52 Series: Click on nRF52840 and on the download section you have access to the documentation, SoftDevice, Master control panel, nRFgo studio, SDK … etc …
   b. nRF52 Development Tools: You can download the last nRF5 SDK.

4. You can also download the SDK in the following link: *https://developer.nordicsemi.com/*.

5. Download and install nRFgo Studio, make sure to download the last version updated. During the installation, windows will appear and propose you to install a version of Jlink driver (not the last one) and also a version of nRF5x-Command-Line-Tools (not the last one). We recommend downloading and install the last version of Jlink (see section 2 above) and to download and install the last version of "nRF5x-Command-Line-Tools"available on the Nordic web site on the download section, for example: *https://www.nordicsemi.com/eng/Products/nRF52840*

6. Download and install Master Control Panel (x86 is for 32 bits windows and x64 is for 64 bits windows).

   You can also download the Smartphone application "nRF Connect" available on the Play Store (Android version) and on the App Store (IOS version).

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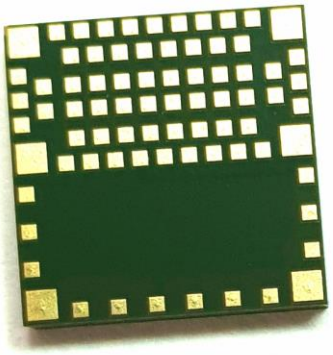
4. Hardware Description

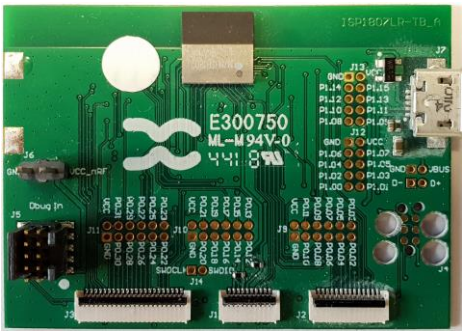
4.1. Information about ISP1807-LR Module

ISP1807-LR is a Bluetooth Low Energy module with integrated antenna.



This module is based on Nordic Semiconductor nRF52840 2.4 GHz wireless SoC. nRF52840 integrates nRF52series 2.4 GHz transceiver, a 32bit ARM Cortex™- M4F CPU, flash memory, and analogue and digital peripherals. nRF52840 can support Bluetooth low energy and a range of proprietary 2.4 GHz protocols. The ISP1807-LR module measures 8 x 8 x 0.95 mm3. The module integrates all the decoupling capacitors, the 32 MHz and 32 kHz crystals, their load capacitors, the DC-DC converter component, the RF matching circuit and the antenna in addition to the wireless SoC. For more details, see Insight SiP module data sheet (document DS1807).

4.2. ISP1807-LR-TB Test Board



Board dimensions are 50 x 37 mm². It includes:

- ISP1807-LR BLE module
- 3 x FPC connectors in order to access the nRF52840 GPIOs:
  - 1 x 10 pin FPC connector on top side of the board.
  - 1 x 14 pin FPC connector on top side of the board.
  - 1 x 22 pin FPC connector on top side of the board.
- 2 x 5 pin header for the Debug using Nordic Evaluation Board
- JTAG footprint for the programming
- USB female connector

The ISP1807LR-TB electrical schematic is presented in document Schematic_ISP1807-LR-TB.

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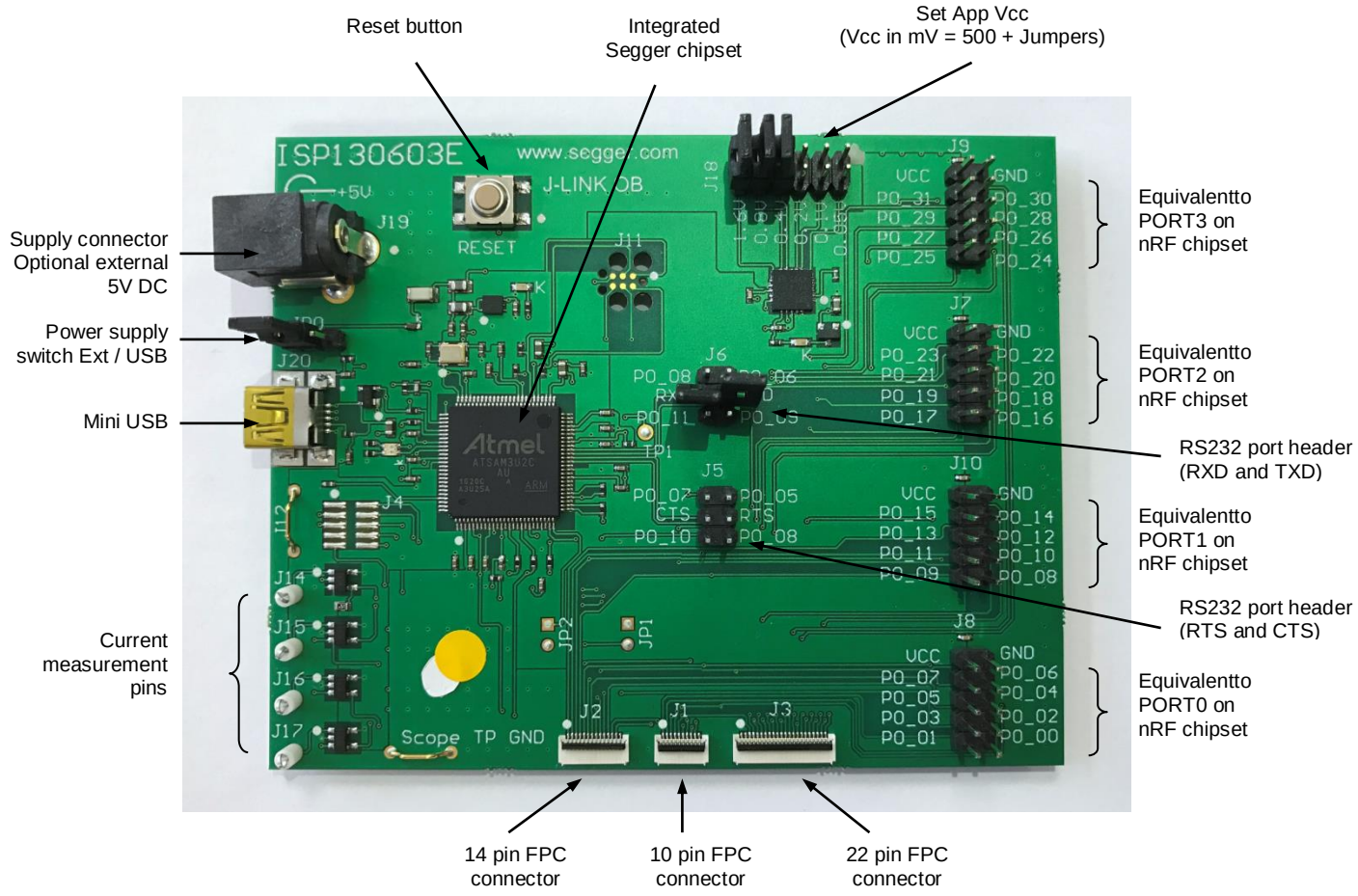
4.3. ISP130603 Interface Board

ISP130603 is the application type interface board that has dimensions of 100 x 80 mm². The ISP130603 electrical schematic is presented in document SC130604.



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4.4. ISP1880 Sensors Board

ISP1880 Sensor Board is not included in the Evaluation Board and can be purchased separately. It has dimensions of 32 x 26.5 mm² and encloses:

- ISP1807-LR BLE module.
- ST Micro LPS22HB barometer sensor.
- ST Micro LSM9DS1 accelerometer / magnetometer / gyroscope sensor.
- Sensirion SHTC3 Humidity / Temperature sensor
- Jtag footprint for the programming
- USB female connector
- CR2032 battery holder
- Software to read/drive the sensors.

4.5. nRF5 series Development Dongle

nRF5 Development Dongle is not included in the Evaluation Board and can be purchased separately. The reader should refer to the corresponding paragraph in nRF52840 Development Kit User Guide document.

Dongle/Master can also refer to your Smartphone by downloading the Smartphone application “nRF Connect” available on the Play Store (Android version) and on the App Store (IOS version).

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5. Basic Application using ISP1807-LR-TB Test Board

5.1. Basic BLE Proximity Application

This paragraph shows you how to set up and program a BLE proximity application on top of a SoftDevice that will send data on a Bluetooth link from the ISP1807-LR-TB Test Board to the Master Emulator. In order to use Bluetooth Low Energy radio, the software is loaded in 2 parts:

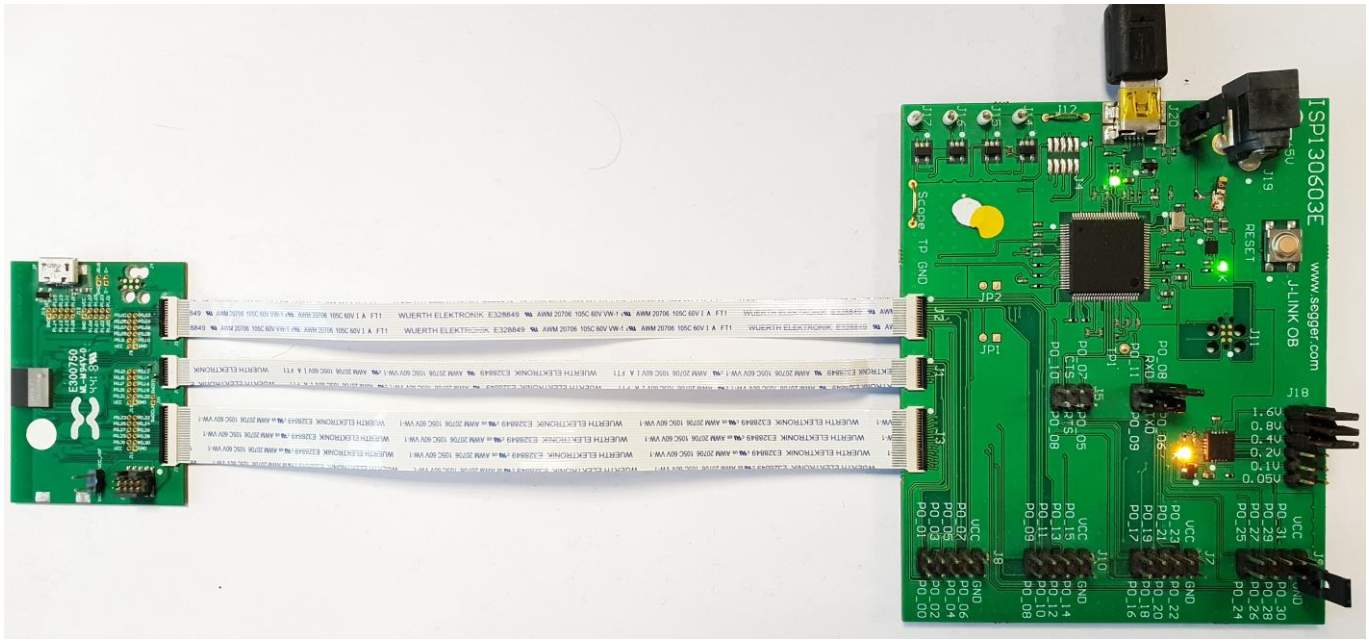
- S140 SoftDevice using nRFgo Studio (hex file, no source).
- Proximity Application using Keil uVision.

Then Master Emulator is connected and Proximity Application is launched.

S140 SoftDevice loading

1. Connect the provided USB cable from the Interface Board ISP130603 to your computer.

2. Connect the ISP1807-LR-TB Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit).



3. Start nRFgo Studio.

4. Select nRF5x Programming.

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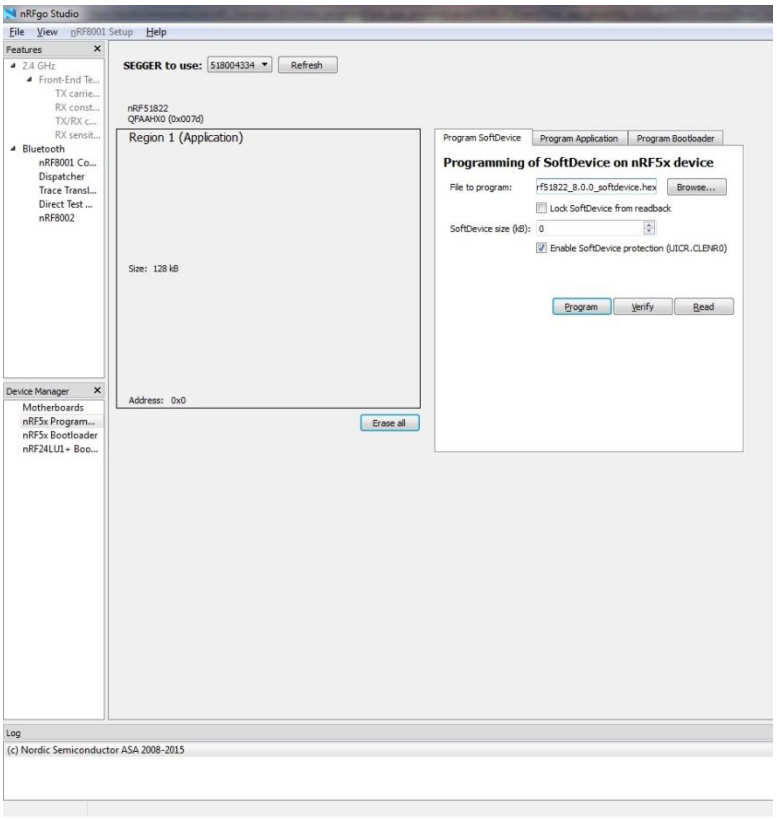
5. Click Erase all.



6. Browse to SoftDevice hex file and click Program. The SoftDevice is available on the Nordic Website or on the SDK folder by installing the nRF5-SDK and go to for example: *\nRF5_SDK_15.0.0 \components\softdevice\s140\hex\s140_nrf52_6.0.0_softdevice.hex*

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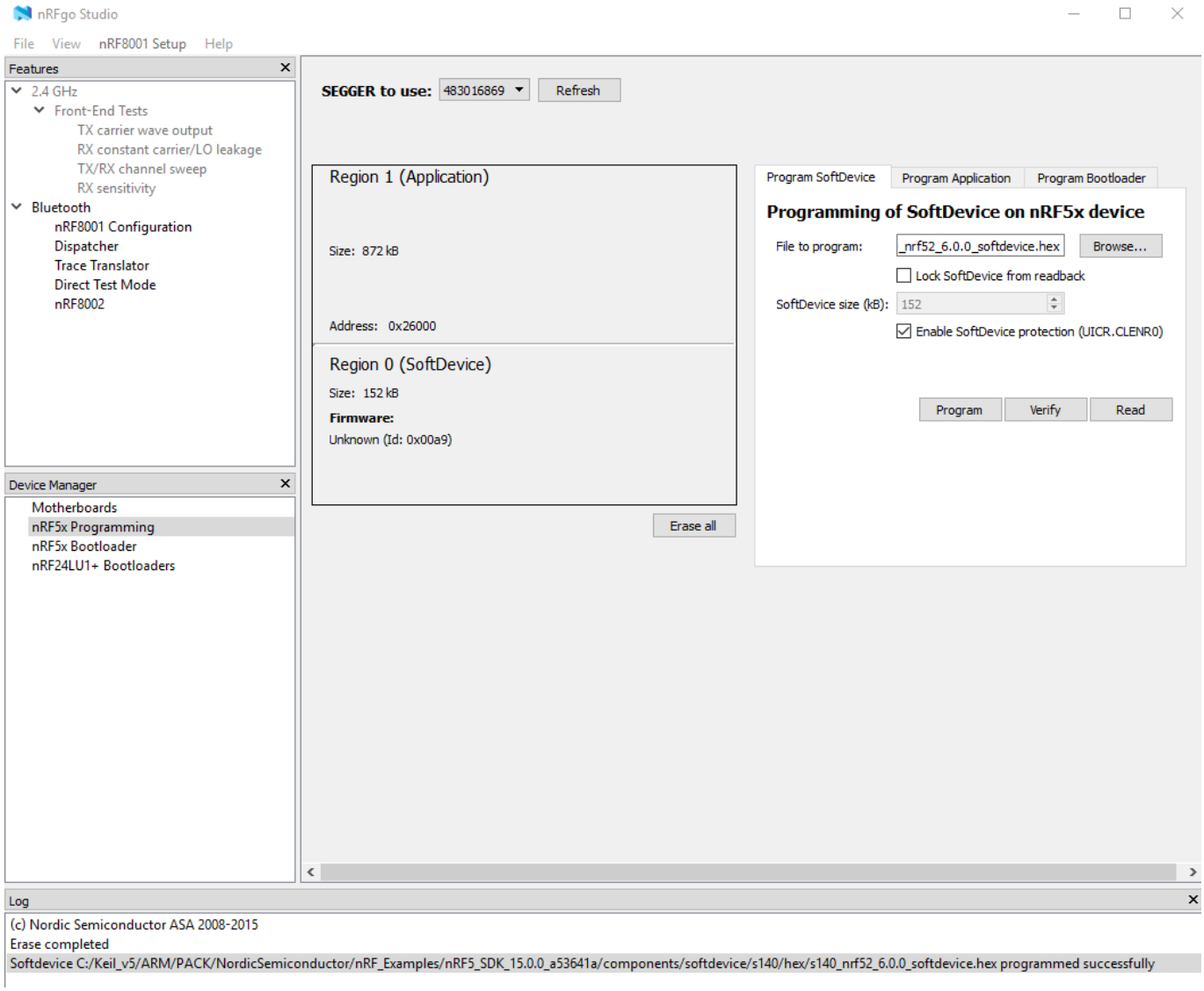

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Proximity Application loading

You can directly load the program application (hex file) through nRFgo Studio. Nordic have already compiled file and it is available on the followed path, for example:
…\nRF5_SDK_15.0.0\examples\ble_peripheral\ble_app_proximity\hex\ble_app_proximity_pca10056_s140.hex

Be careful, this hex file is including SoftDevice (SoftDevice 6.0.0) and proximity app. Please make sure there is no SoftDevice pre-programmed before. If this is the case, erase all and load *ble_app_proximity_pca10056_s140.hex*.

If you want to modify the application software example, you can use Keil uVision and follow recommendation below:

1. Start Keil uVision.

2. Select Project then Open Project in order to open Proximity app. Make sure it is the right file project. The project is locked, it is read only, if you want to modify it, you have to change the right in the file App directory properties, for example:
   …\nRF5_SDK_15.0.0\examples\ble_peripheral\ble_app_proximity\pca10056\s140\arm5_no_packs\ble_app_proximity_pca10056_s140.uvprojx.

3. Click Build Target and Load. If you have this message after click Load, it means that the power is not enough and you have to increase the voltage by adding jumpers on the interface board.

   You can also load the hex file (generated after building target with keil uVision) by nRFgo studio in the program application.

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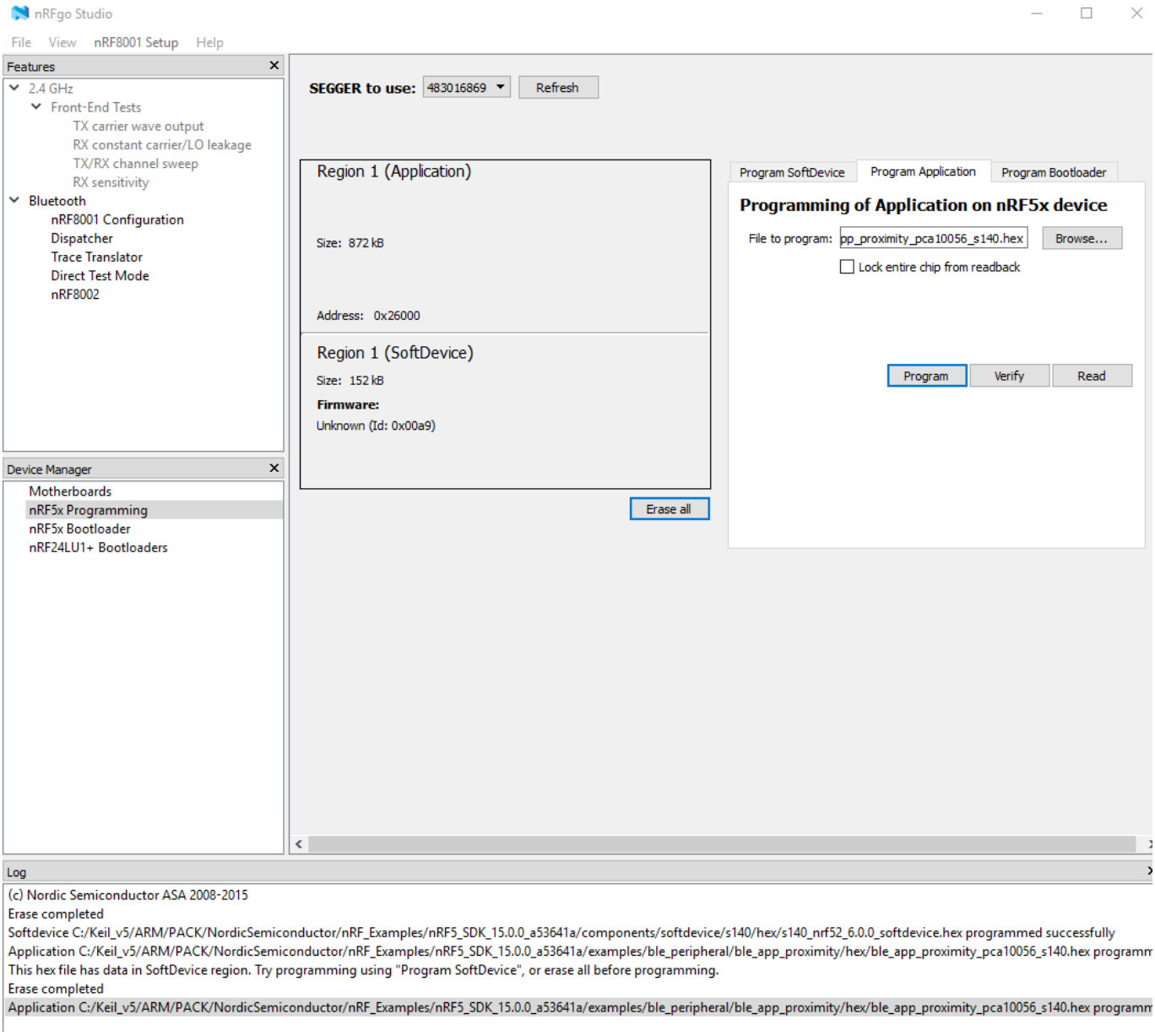

The file project is located for example:
…\nRF5_SDK_15.0.0\examples\ble_peripheral\ble_app_proximity\pca10056\s140\arm5_no_packs_build\nrf52840_xxaa.hex

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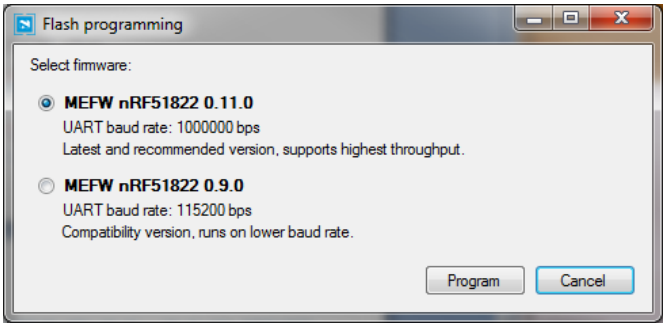
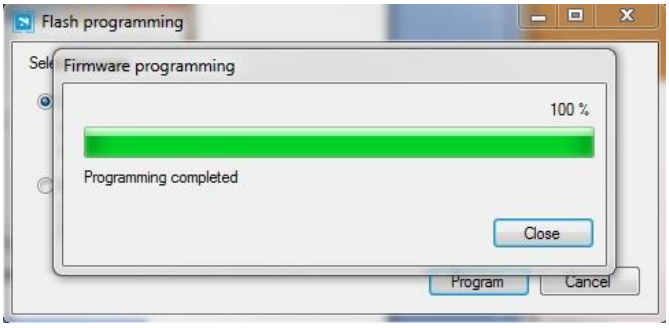
Master Emulator and Proximity Application

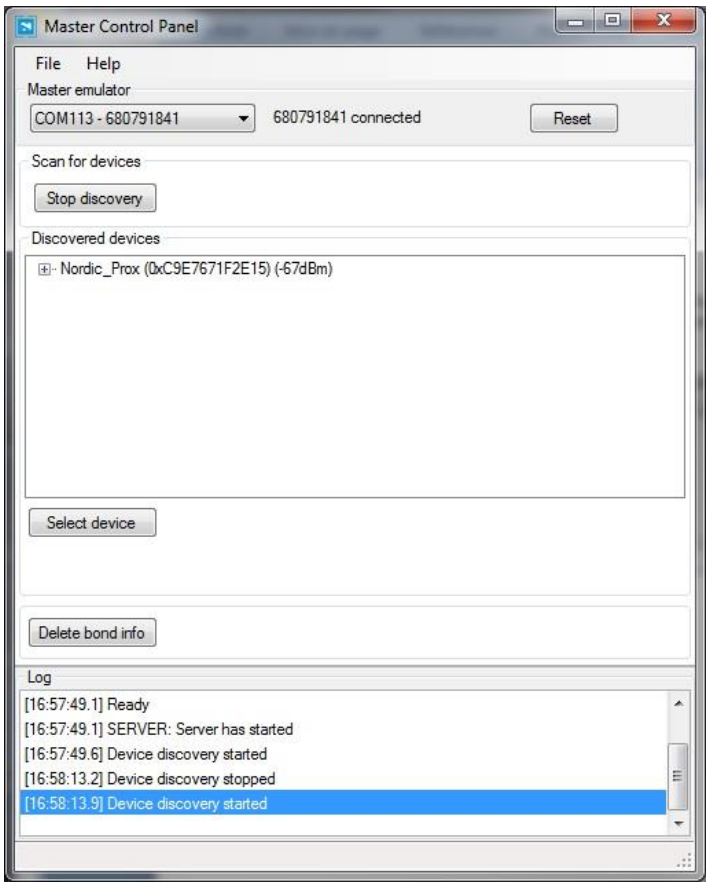
1. Connect nRF5 Dongle (Master Emulator) into a USB port on your computer.

2. Start Master Control Panel. If you have no master emulator found, you have to flash the dongle in Flash programming section.





3. Click Start Discovery.



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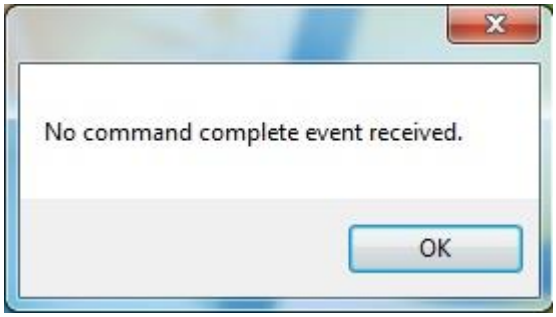
4. After starting discovery, if no device appearing, disconnect and connect again the interface board power supply.

5. If you have an error message as indicated in the photo, it means that the nRF5 Dongle is not programmed.



For your information, please refer to the nRF51822 Development Kit User Guide document as indicated in our application note ISP130301-DK1 part 4.5 on page 14-7. You can find this user guide on the Nordicsemi website. The procedure to program the nRF51Dongle is described on page 13. I enclose a copy of the user guide for your convenience.

a. Open the Master Control Panel from the Start menu (Start > All Programs > Nordic Semiconductor > Master Control Panel).
b. Make sure the Development Dongle is detected. The Master Emulator item list should show COMnn-xxxxxxxxx (nn gives the COM port number; xxxxxxxxx is the SEGGER serial number printed on the dongle). Restart the application if it doesn't appear in the item list. Before continuing, make sure you have selected the correct device by verifying the serial number in the item list with the serial number printed on the Development Dongle.
c. When you use the Development Dongle for the first time, you must first program it with the Master Emulator Firmware.
    i. In the Master Control Panel menu click File and select Flash Programming.
    ii. Click Browse. This opens a browser that automatically points to the location of themefw_nrf51822_<version>_firmware.hex (<version> will be replaced by a number giving the version of the actual firmware).
    iii. The Master Control Panel Firmware file is located in: C:\Program Files (x86) \ Nordic Semiconductor \ Master Control Panel \<version>\firmware\pca10000\MEFW_nRF51822_<version>_firmware.hex.
    iv. Select the Master Emulator Firmware file and click Open.
    v. Click Program to start programming the selected device.
    vi. When the programming is finished click Exit to go back to the main window.

6. Click Select Device.

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

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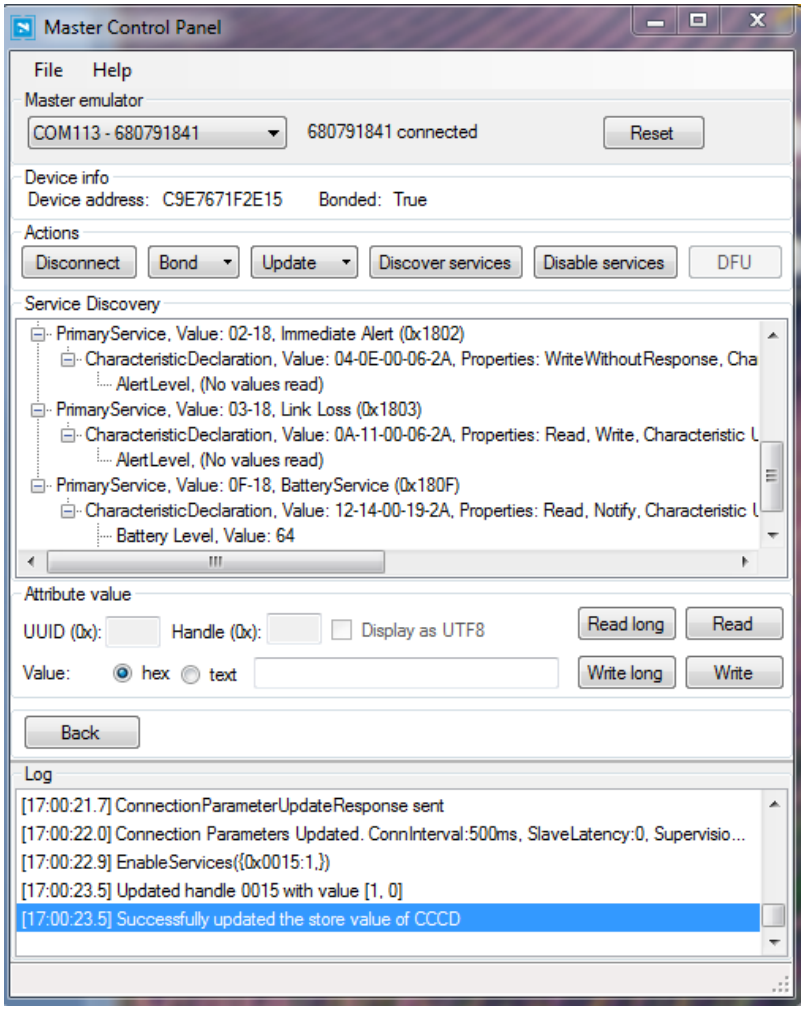

8. You can note Battery voltage is sent by the ISP1807-LR-TB Test Board to the Master Emulator via the Bluetooth link. The application is written to send a value that changes cyclically.

9. You can also use the “nRFConnect” application which is available for iOS from App Store and for Android from Play Store. Download, install and run the application, click to SCAN and select the device: Nordic_PROX.

Notice

Please pay attention to the compatibility between the IC revision, the SoftDevice, the nRF5 SDK, etc, ... Please read the compatibility matrix available on the “infocenter” website from Nordic: *http://infocenter.nordicsemi.com/index.jsp*

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5.2. Direct Test Mode (UART)

This paragraph shows you how to set up and program the Direct Test Mode through the UART on ISP1807-LR-TB Test Board.

Direct Test Mode Set-up

1. Connect the USB cable from the Interface Board ISP130603 to your computer.

2. Connect the ISP1807-LR-TB Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit)

3. On the ISP130603 Interface Board, connect the 2-lead patch cable in order to connect:
   - RXD to P0_08 (by default on the source code)
   - TXD to P0_06 (by default on the source code)

   Make sure the RXD/TXD labels match for each wire. This matches the default setting if you are using the Nordic Board PCA10056 in the SDK project (be careful: depending on the Nordic Board version you are using, the ports used could be different,see next part: Direct Test Mode loading).

Direct Test Mode Loading

1. Start Keil uVision.

2. Select Project then Open Project in order to open Direct Test Mode application:
   …\nRF5_SDK_15.0.0\examples\dtm\direct_test_mode\pca10056\blank\arm5_no_packs\direct_test_mode_pca10056.uvprojx

Warning

Regarding the Nordic Board you are using, the RX and TX pin number could be different. In the following pictures, the Nordic board PCA10056 is used (you can modify the Nordic Board model in: Flash → Configure Flash Tools → C/C++, by writing the correct Board name in the “Define” area with the name indicated in the boards.h).

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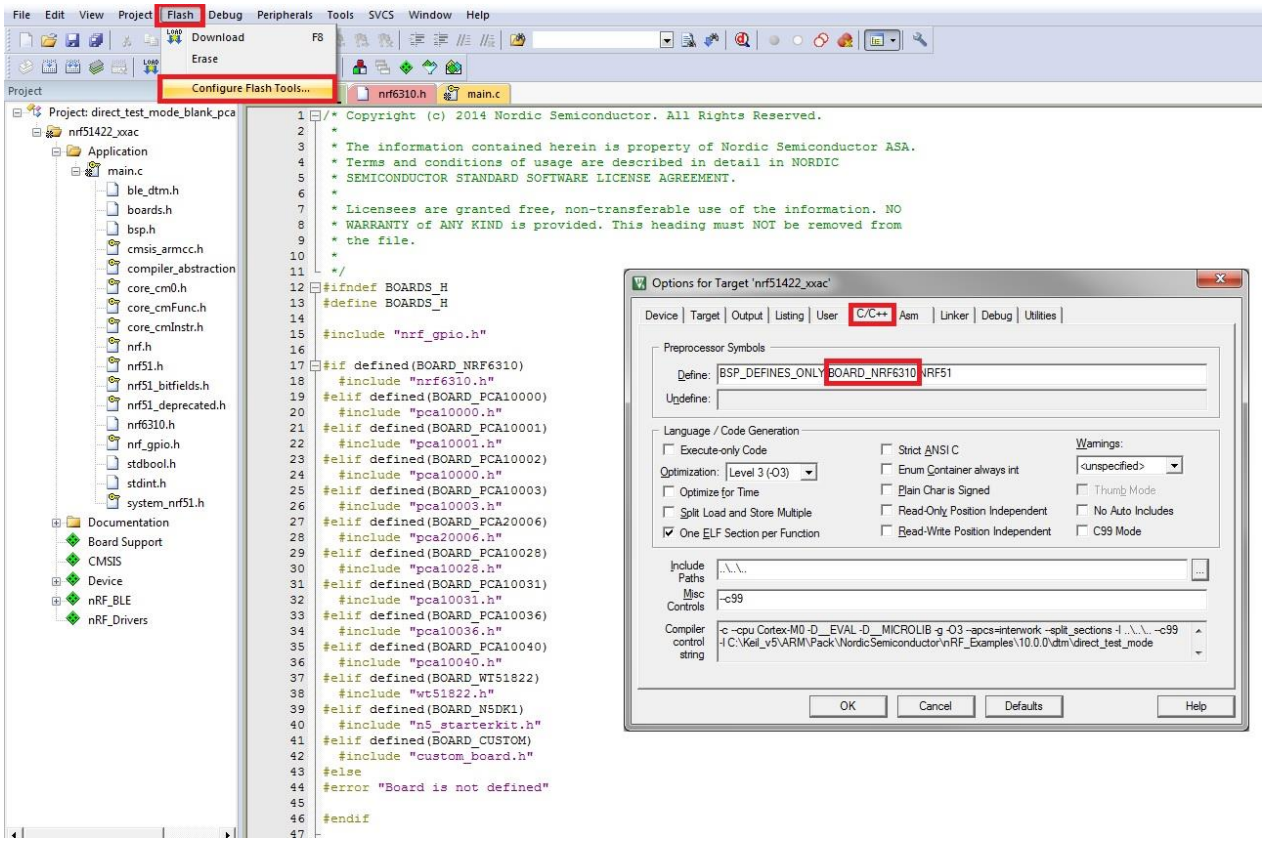

In the following picture, the Nordic board PCA10040 is used by default and the RX and TX pin number are 08 and 06.

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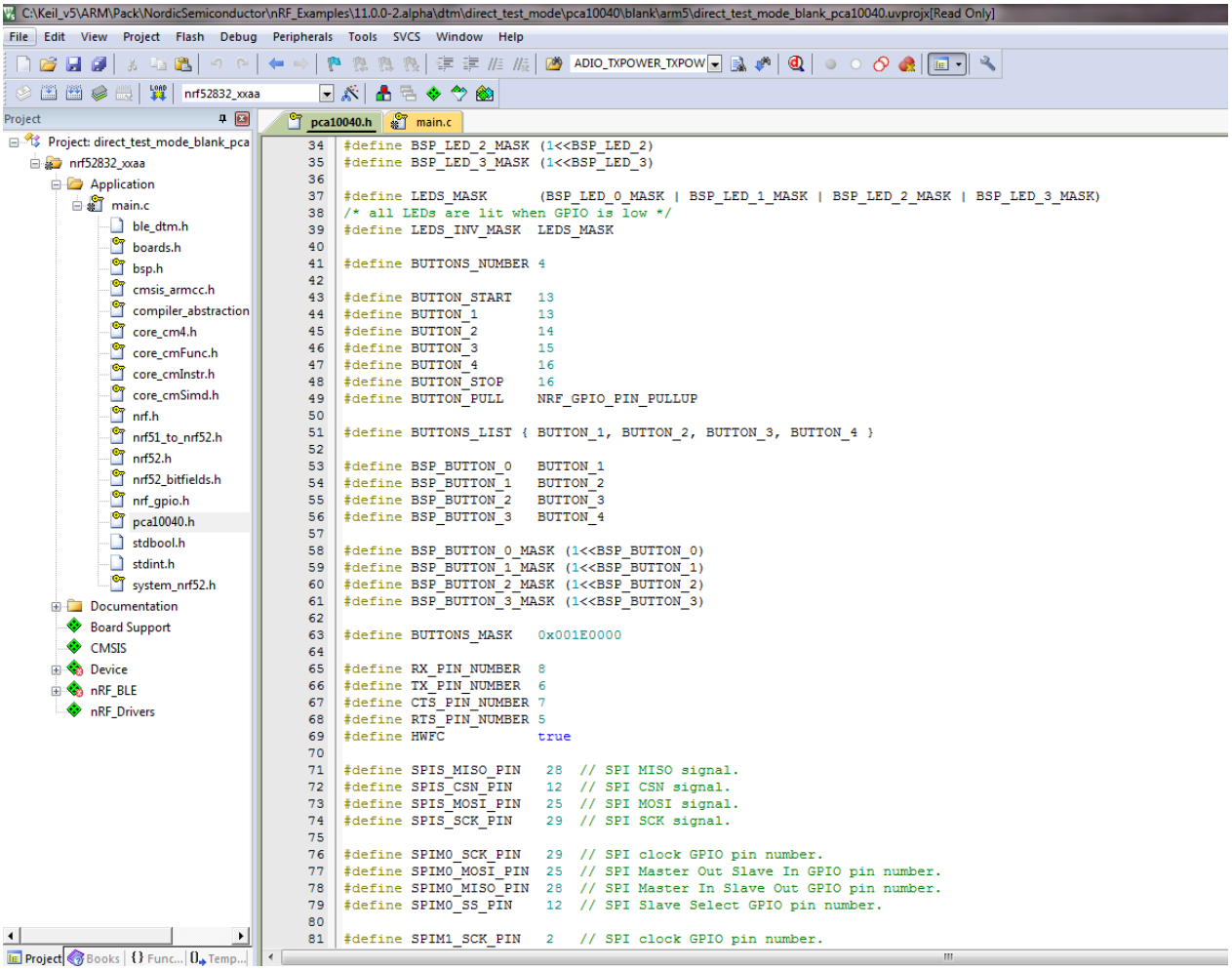

3. Click Build Target and Load.

4. If you have the next error message, it means that you have not enough RAM to flash algorithm.

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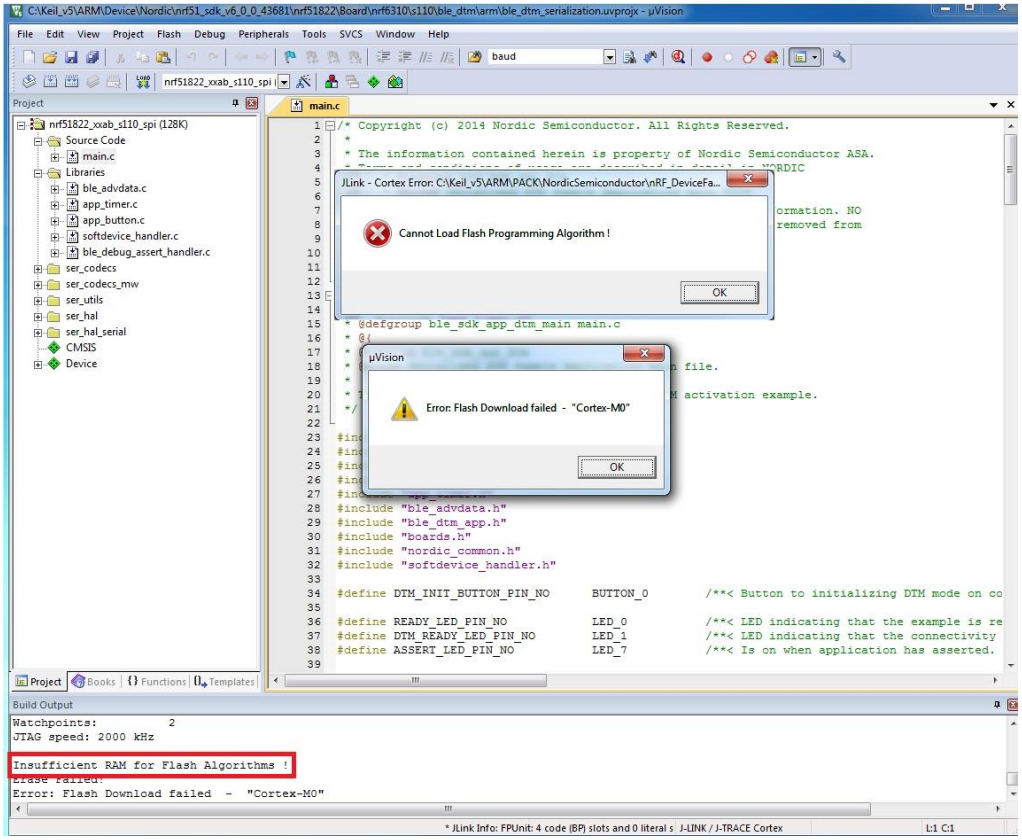
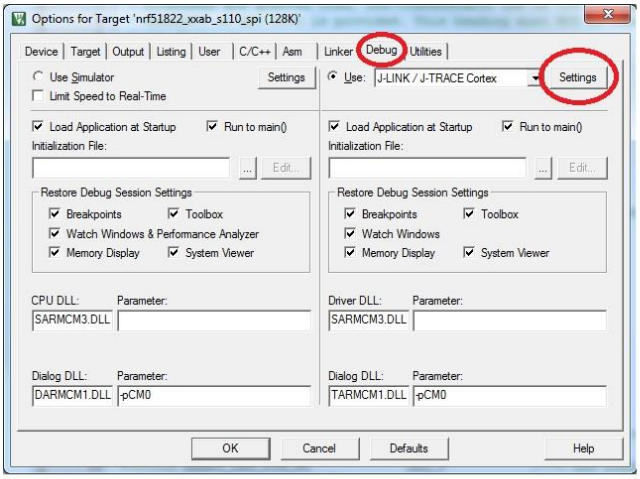
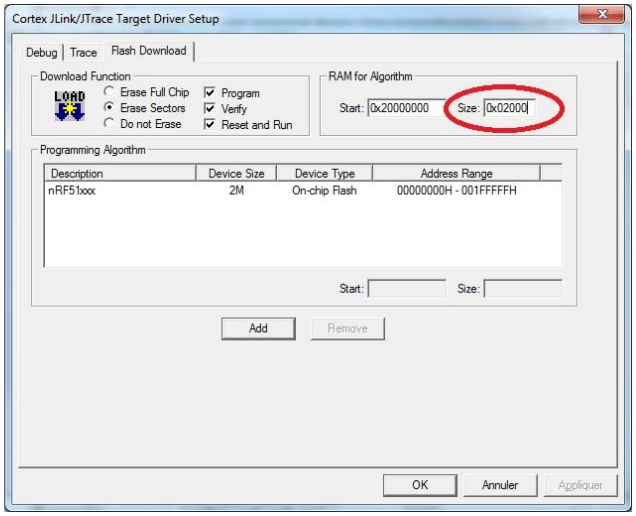


5. You can modify the size of the RAM Algorithm in:
Flash → Configure Flash Tools… and on the windows click on *Debug → Settings*
Click on *Flash Download* and modify the size (put 0x02000).





6. Click OK and load again the project.

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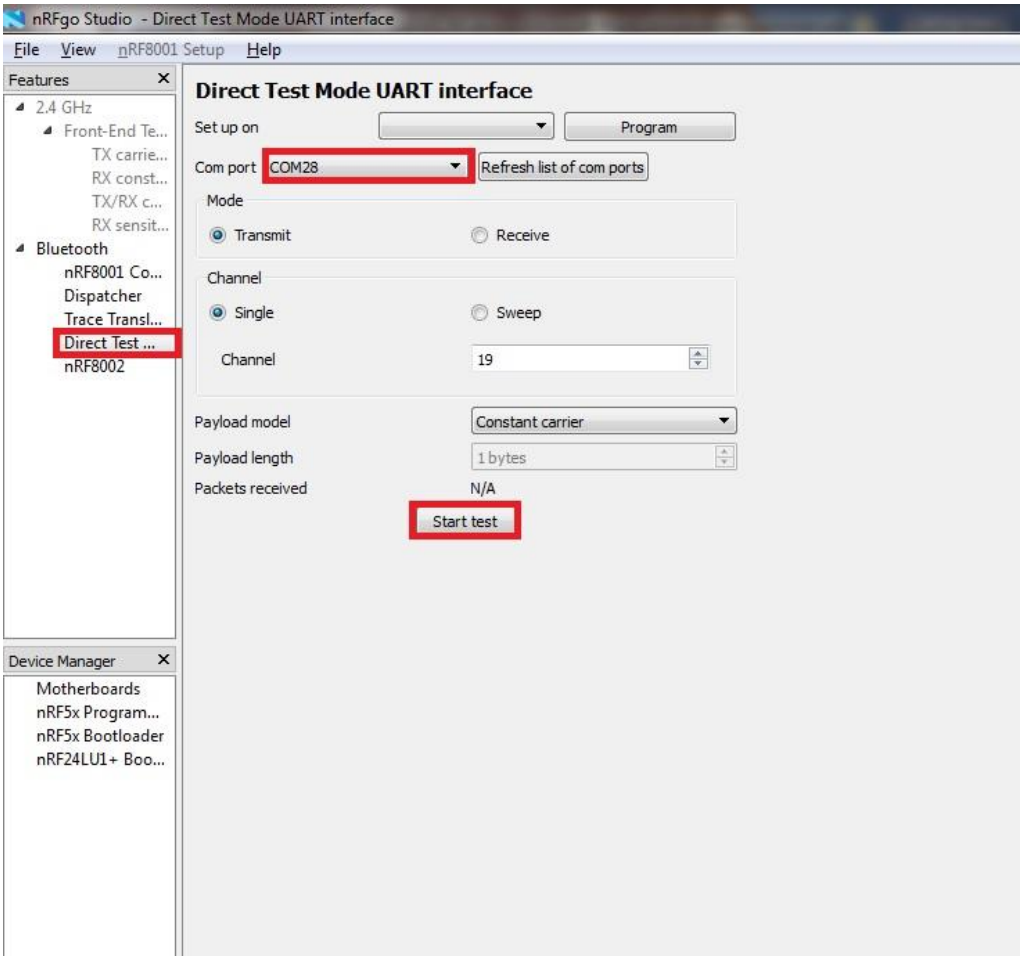
Direct Test Mode Testing

1. Start nRFgo Studio.

2. Select Direct Test Mode.



3. For details on how to use the Direct Test Mode, press F1 to open the nRFgo Studio help.

Notice

Erase all before loading Direct Test Mode program. The SoftDevice must not be loaded, only the Program Application with uVision or with nRFgo studio in “Program Application” (load the .hex generated by uVision).

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5.3. UART Mode Example

This paragraph shows you how to set up and program a communication by sending some characters through the UART interface on ISP1807-LR-TB Test Board. This example just echoes input characters from the PC terminal.

UART Mode Set-up

1. Connect the USB cable from the Interface Board ISP130603 to your computer.

2. Connect the ISP1807-LR-TB Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit)

3. On the ISP130603 Interface Board, connect the 2-lead patch cable in order to connect:
   - RXD to P0_08
   - TXD to P0_06
   - CTS to P0_07
   - RTS to P0_05

   Make sure the RXD/TXD and CTS/RTS labels match for each wire. This matches the default setting if you are using the Nordic Board pca10056 in the SDK project (be careful: depending on the Nordic Board version you are using, the ports used could be different, see next part: UART Mode loading). CTS and RTS are needed because in the UART process when the TX is ready to send (RTS), the RX needs to allow the TX send datas (CTS) and vice versa.

UART Mode Loading

1. Start Keil uVision.

2. Select Project then Open Project in order to open UART_example application: *…\nRF5_SDK_15.0.0\examples\peripheral\uart\pca10056\arm5_no_packs\uart_pca10056.uvprojx*

3. Click Build Target and Load.

Note

Nordic have already generated the hex file “uart_pca10056.hex” available on the SDK folder, for example:
…\nRF5_SDK_15.0.0\examples\peripheral\uart\hex\uart_pca10056.hex

Insight SiP can provide also the Hex files on demand at *contact@insightsip.com*

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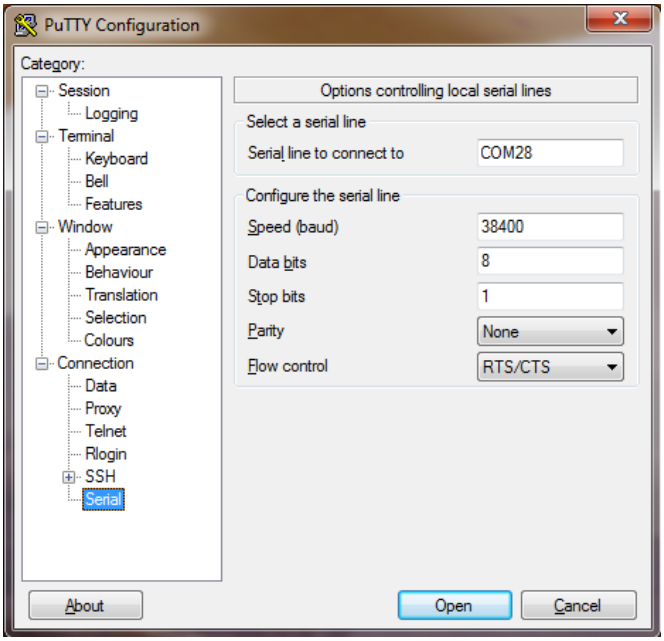
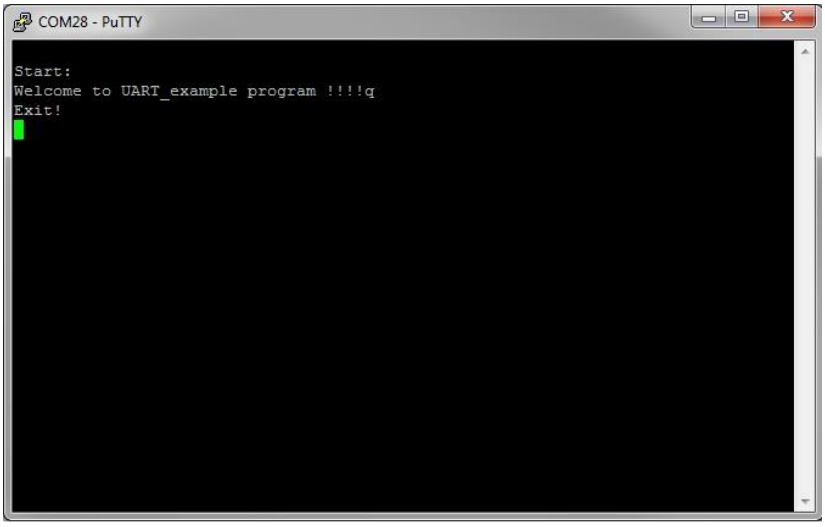
UART Mode Testing

1. Download and install the program “Putty.exe” (or equivalent like TTERM for example) in order to configure the baudrate, the port COM, ..etc …



2. Click to Open.

3. You can write and/or delete some characters. Sometimes you have to reset the ISP130603 Interface Board in case if it is not working.



4. Press ‘q’ to exit

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5.4. BLE UART Mode Example

This paragraph shows you how to set up and program an example that emulates a serial port over BLE. In the example, Nordic Semiconductor's development board serves as a peer to the phone application "nRF UART", which is available for iOS from Apple Store and for Android from Play Store. In addition, the example demonstrates how to use a proprietary (vendor-specific) service and characteristics with the SoftDevice. In order to use Bluetooth Low Energy and UART interface, the software is loaded in 2 parts:

- The SoftDevice: **S140**.
- ble_app_uart using Keil uVision.

UART Mode Set-up

1. Connect the USB cable from the Interface Board ISP130603 to your computer.

2. Connect the ISP1807-LR-TB Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit)

3. On the ISP130603 Interface Board, connect the 2-lead patch cable in order to connect:
   - RXD to P0_08
   - TXD to P0_06
   - CTS to P0_07
   - RTS to P0_05

   Make sure the RXD/TXD and CTS/RTS labels match for each wire (be careful: depending on the Nordic Board version you are using, the ports used could be different, see next part: UART Mode loading).

   CTS and RTS are needed because in the UART process when the TX is ready to send (RTS), the RX needs to allow the TX send datas (CTS) and vice versa.

S140 SoftDevice loading

1. Start nRFgo Studio

2. Select nRF5x Programming

3. Click Erase all

4. Browse to SoftDevice hex file and click Program. The SoftDevice is available on the Nordic Website or on the SDK folder by installing the nRF5-SDK and go to,for example: *\nRF5_SDK_15.0.0 \components\softdevice\s140\hex\s140_nrf52_6.0.0_softdevice.hex*

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UART Mode Loading

1. Start Keil uVision.

2. Select Project then Open Project in order to open ble_app_uart application:
   …\nRF5_SDK_15.0.0\examples\ble_peripheral\ble_app_uart\pca10056\s140\arm5_no_packs\ble_app_uart_pca10056_s140.uvprojx

3. Click Build Target and Load.

Note

You can directly load the program application (hex file) through nRFgo Studio. Nordic have already compiled file and it is available on the followed path, for example:
…\nRF5_SDK_15.0.0\examples\ble_peripheral\ble_app_uart\hex\ble_app_uart_pca10056_s140.hex

Be careful, this hex file is including SoftDevice (SoftDevice 6.0.0) and “ble app uart” application. Please make sure there is no SoftDevice pre-programmed before. If this is the case, erase all and load *ble_app_uart_pca10056_s140.hex*.

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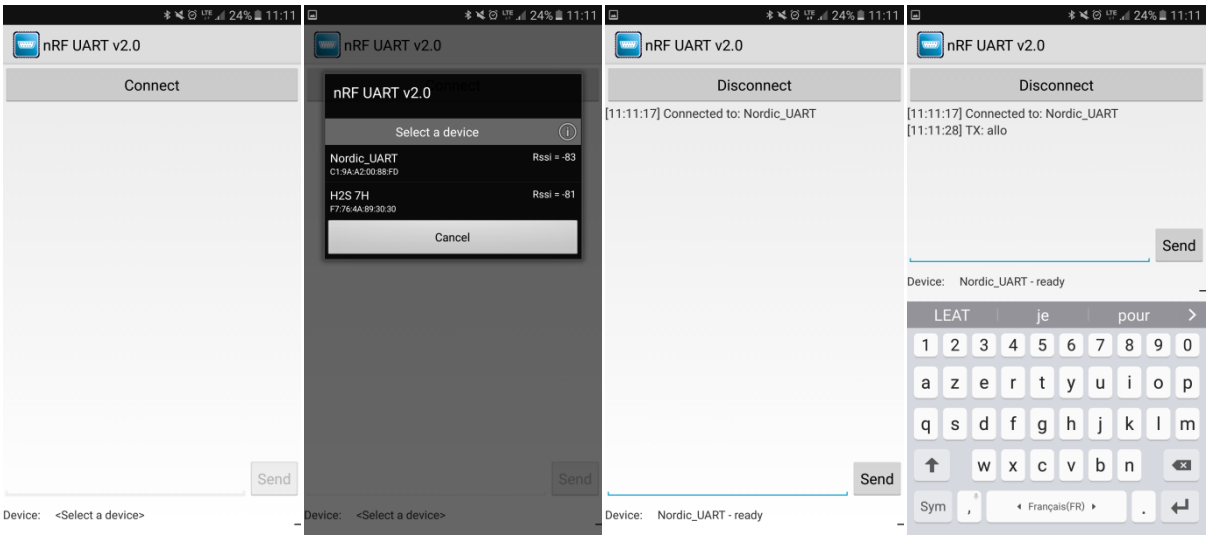
BLE ModeTesting

1. Download and install "nRF UART 2.0" on your iOS or Android device, which is available for iOS from App Store and for Android from Play Store.

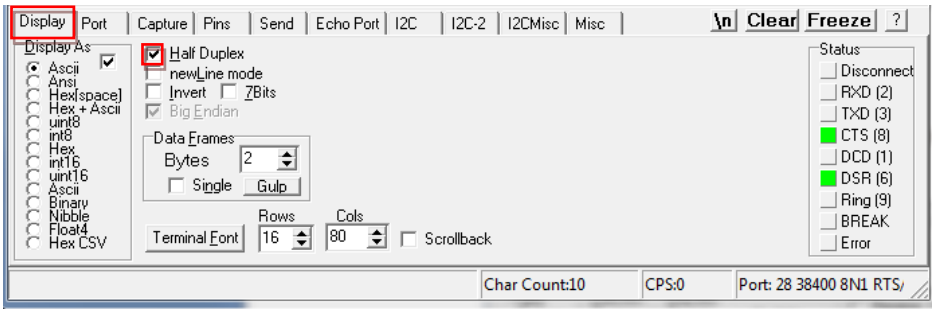
2. Run the App, click to Connect and select the device: Nordic_UART.



3. You are now able to send and receive data through the BLE. Next step is to establish the communication with the UART interface.

UART Mode Testing

1. Download and install the program “RealTerm” (or equivalent like Putty, TTERM for example) in order to configure the baudrate, the port COM, ..etc …



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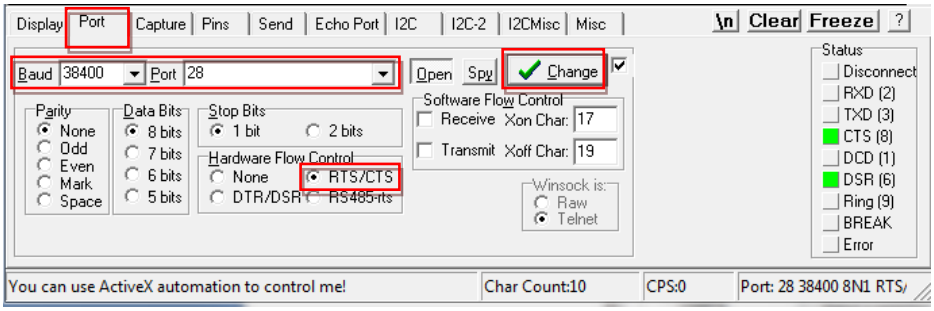
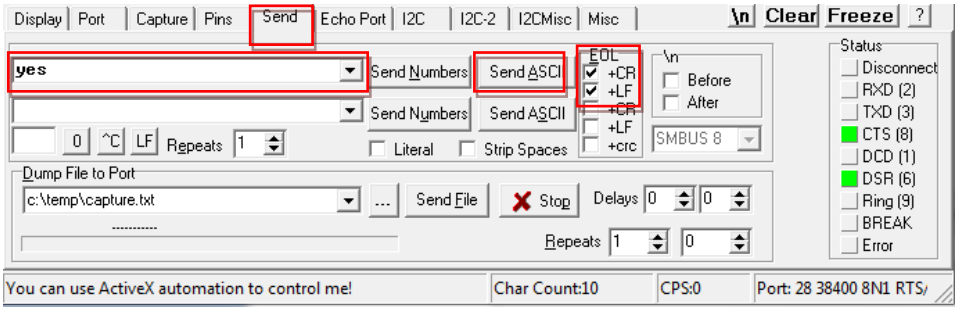
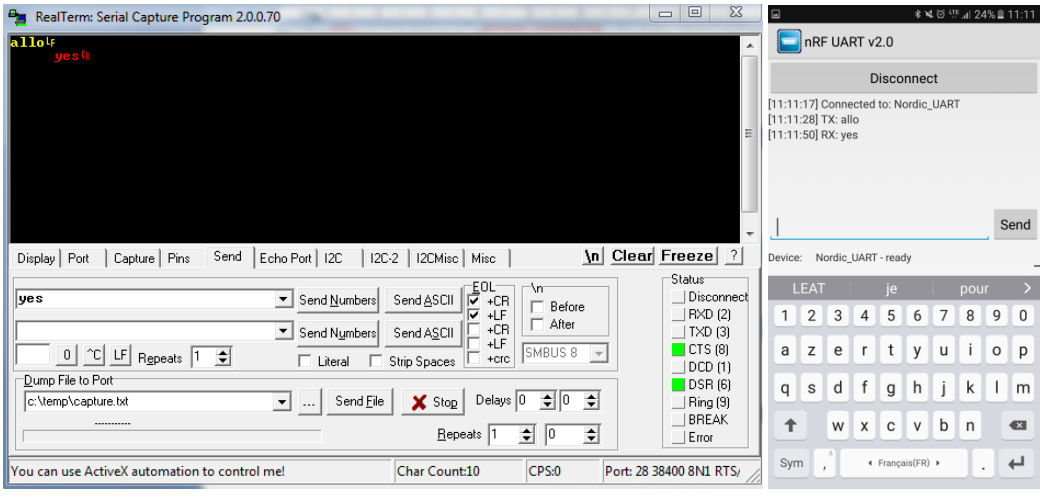




2. Click to Send, write some characters and click to “Send ASCII”.



3. The communication is established, you are now able to emulate a serial port over BLE.

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5.5. NFC Launch App Example

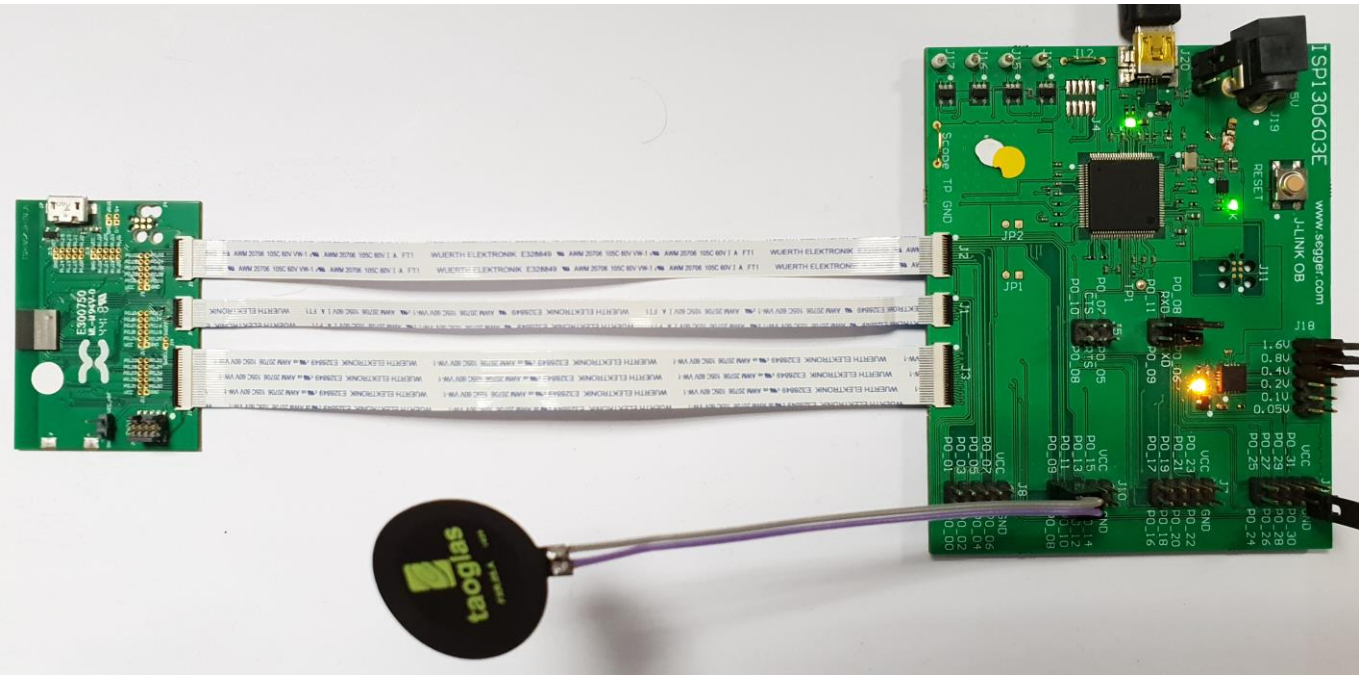
The Launch App Example shows how to use the NFC tag to launch an app on a device that supports NFC and runs Android (4.0 or later) or Windows Phone (8.0 or later).

NFC Mode Set-up

1. Connect the USB cable from the Interface Board ISP130603 to your computer.

2. Connect the ISP1807-LR-TB Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit)

3. On the ISP130603 Interface Board, connect the 2-lead patch cable in order to connect:
   - NFC_1 to P0_09
   - NFC_2 to P0_10



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NFC Mode Loading

1. Start Keil uVision.

2. Select Project then Open Project in order to open nfc_launchapp_record: *…\nRF5_SDK_15.0.0\examples\nfc\record_launch_app\pca10056\blank\arm5_no_packs\nfc_launch app_record_pca10056.*

3. Click Build Target and Load.

Note

Nordic have already generated the hex file “nfc_launchapp_record_pca10056.hex” available on the SDK folder, for example:
…\nRF5_SDK_15.0.0\examples\nfc\record_launch_app\hex\nfc_launchapp_record_pca10056.hex

NFC Mode Testing

Test the Launch App Example with a Smartphone or a tablet with NFC support by performing the following steps:

1. After programming the application, touch the NFC antenna with the Smartphone or tablet
2. Observe that the Smartphone/tablet tries to:
   - Launch the nRF Toolbox app if it is installed.
   - Download the nRF Toolbox app from the store if it is not installed.

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6. Basic Sensor Application with ISP1880

This paragraph shows you how to set up a Sensor application with ISP1880 Sensors Board that will send data via the Bluetooth link to the Master Emulator or to an Apple Device.

Two 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 android or an iOS device.

6.1. On Master Control Panel and/or with nRF connect app

1. Place the CR2032 lithium battery into the battery holder.
2. Connect nRF51 Dongle (Master Emulator) into a USB port on your computer, or use your Smartphone and launch “nRF connect” application.
3. Start Master Control Panel or launch “nRF Connect” app.
4. Scan and search the ISP1880 sensor.
5. Connect to the device
6. Once you are connected to the sensor, you can read the information related to the sensors by selecting the UUID corresponding, for example:
    a. UUID starting by *b8c71100 …* is related to the BLE configuration (connection interval, name of the device …)
    b. UUID starting by *b8c71200* …is related to the environmental sensors: humidity, pressure and temperature
    c. UUID starting by *b8c71300* …is related to the motion sensor: accelerometer

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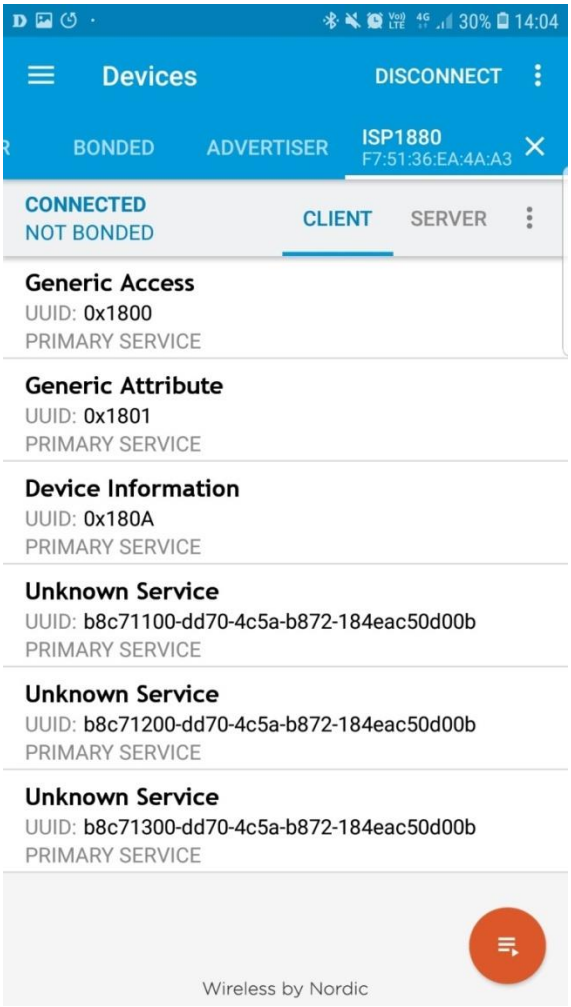

7. To switch off ISP1880 Sensor Board, remove battery.

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6.2. On Android Device

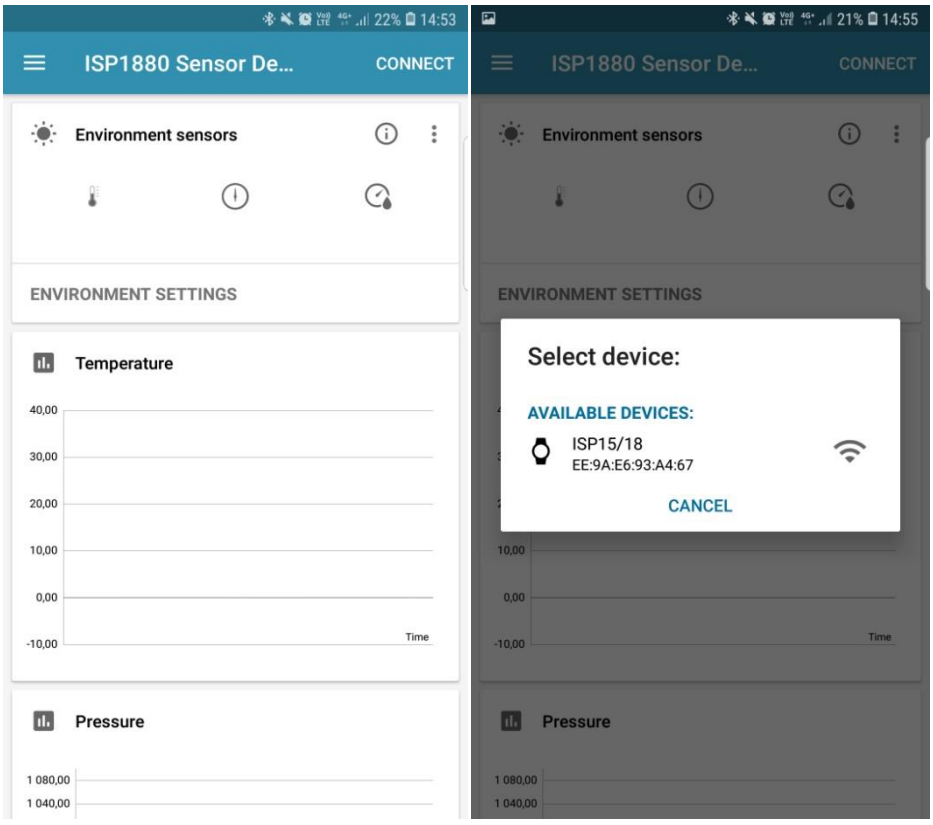
An App is also available for Android Devices. The app is still on development … and will be uploaded to the Play Store soon. The android App is a demonstration App that is provided “as is” in order to demonstrate the Smart Bluetooth sensor node.

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 need to validate the permission during the installation) you should see the application on your Android 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. Start “Sensor” application on your Android, click Connect and select your Sensor Board (ISP1880)



3. For the environmental sensors, you have the information on the main screen of the app.

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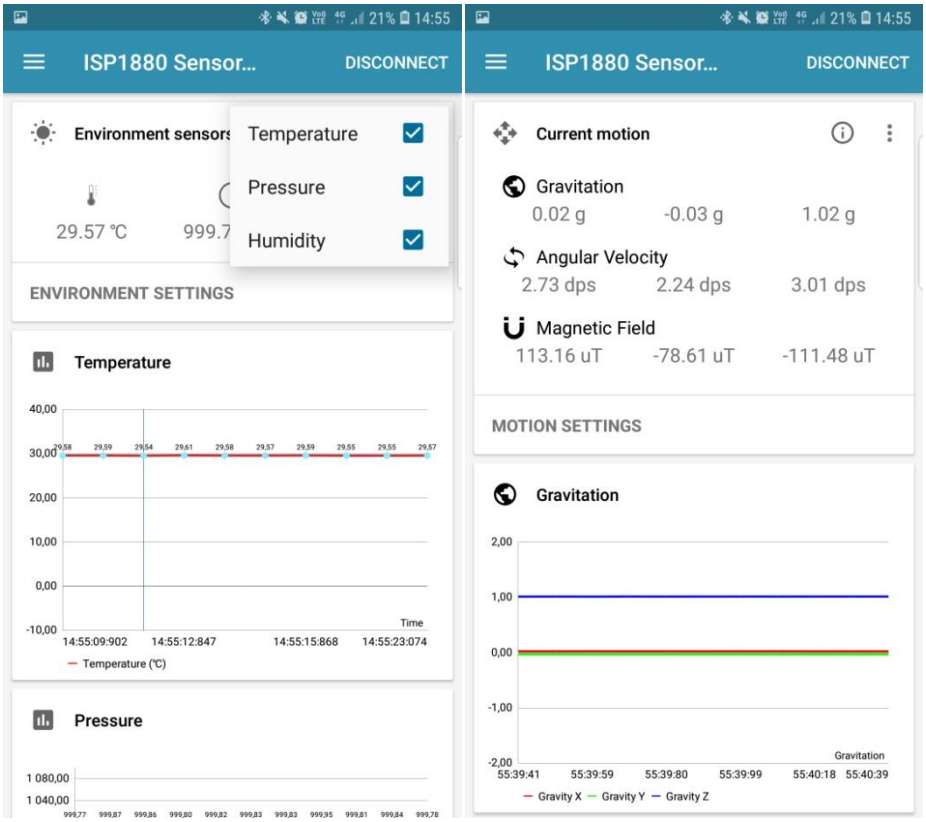

4. For the motion sensor, click on the top left part of the screen to move to the motion sensor. A calibration phase is needed to ensure a good motion . We invite you to rotate the ISP1880 Sensor Board. Then you can move the sensor on all the direction you want to see the plane moving in real time.

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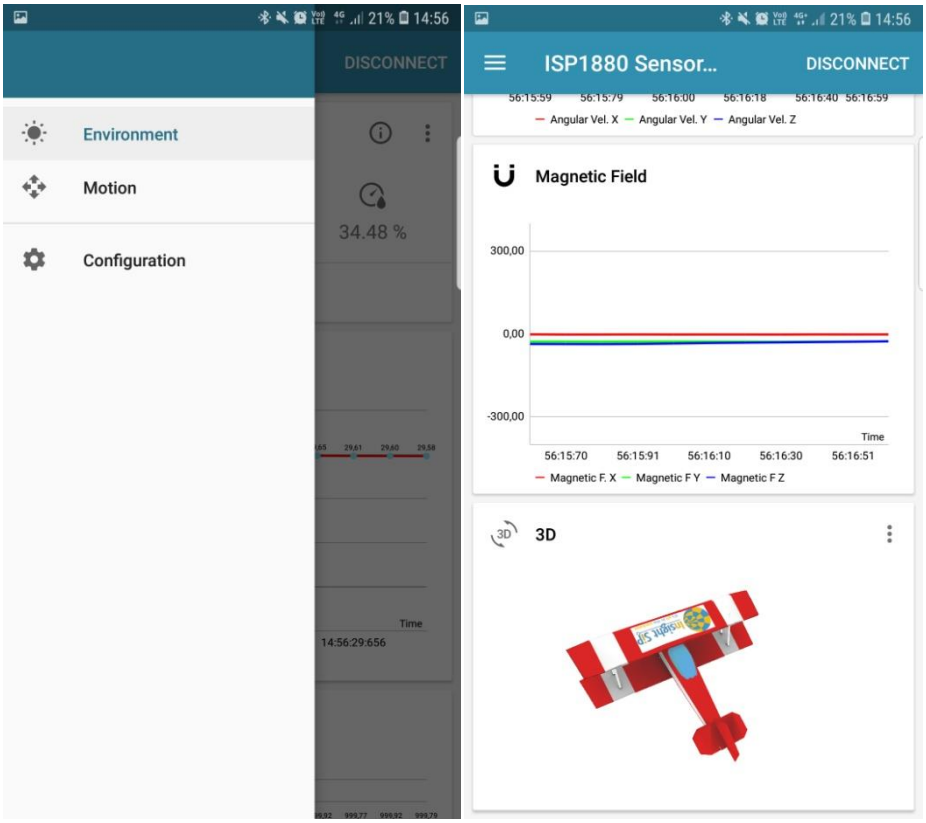

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