Application Note AN170701

Use of ISP1510 Development Kit

Introduction

Scope

This document gives details on hardware and software for using and testing Insight SiP Bluetooth Low Energy module ISP1510 (model ISP1510-UX).

Contents

1. Recommended Documentation

The following documents and Dev Kits (software portion) are required to understand the complete setup and programming methods:

Nordic Semiconductor Documents:

- nRF52832 Development kit User Guide (hardware section should be partially ignored – Insight SiP development kit hardware replaces Nordic Semiconductor hardware).
- nRF52 Series Reference Manual.
- nRF52832 PS (data sheet).
- S132 nRF52832 SoftDevice Specification.
- nRF5 SDK (for software development on the nRF51 and nRF52 Series).

To access documentation, information, go to:

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

Nordic Semiconductor Dev kits (software portion):

- nRFgo Studio.
- nRF5 Software Development Kit (SDK):
  - Precompiled HEX files.
  - Source code.
  - Keil ARM project files.
- S132 nRF52832 SoftDevice.
- Master Control Panel.

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

DecaWave Documents:

- DW1000 Data Sheet
- DW1000 User Manual
- APS013: DW1000 and Two Way Ranging

To access documentation, information, go to:

- https://www.decawave.com/support (Official DecaWave website, registration required)

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Other ISP documents that complete the above:

- AN1606 App Note – this document.
- DS1510 module data sheet.
- ISP1510-UX-TB Test Board schematic “Schematic_ ISP1510-UX-TB”.
- ISP130603 Interface Board schematic “SC130604”.
- ISP1510 Tag Board schematic “Schematic_ ISP1510-UX-TG”.
- ISP1510 Anchor Board schematic “Schematic_ ISP1510-UX-AN”.

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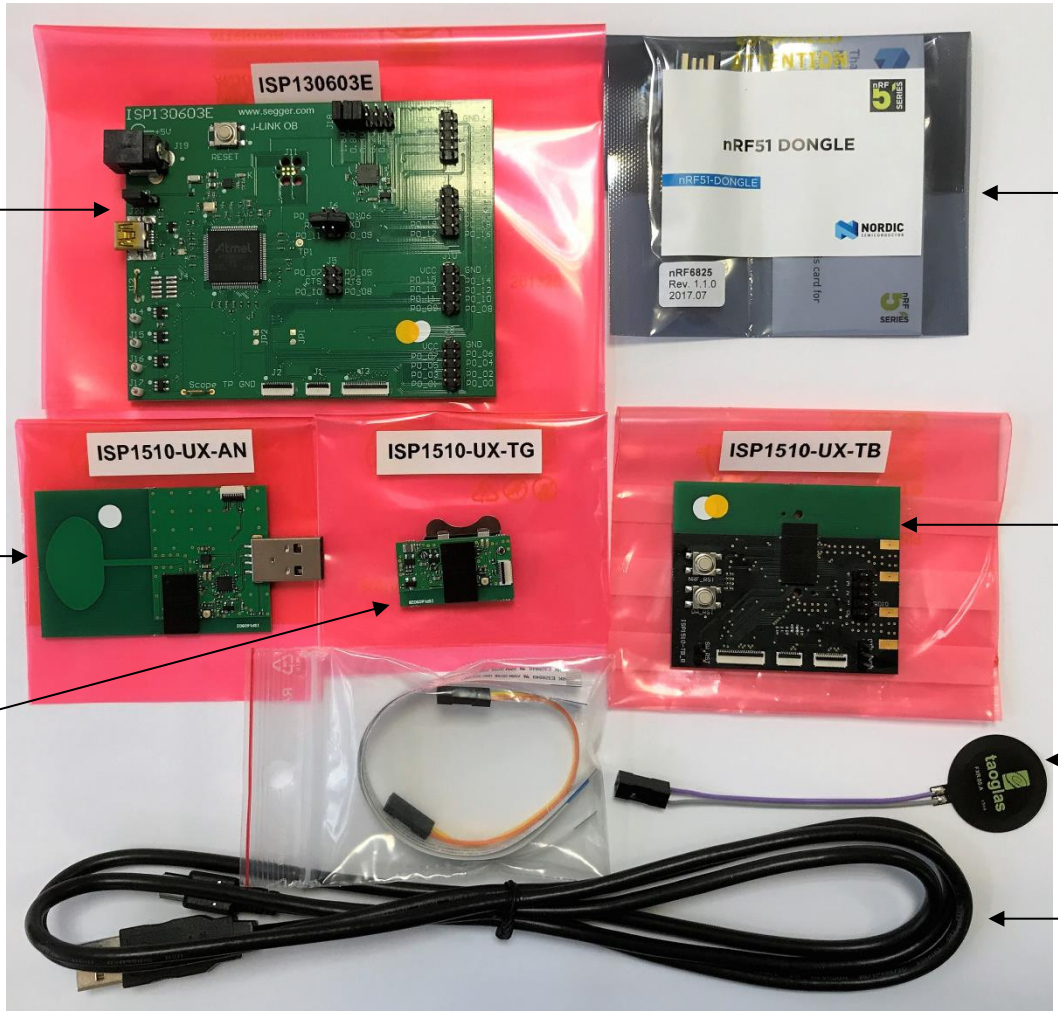
2. ISP1510 Dev Kit Hardware Content



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

1 x nRF5 series Development Dongle

1 x ISP1510-UX-TB Test Board

1 x ISP1510-UX-AN Anchor Board

1 x ISP1510-UX-TG Tag Board

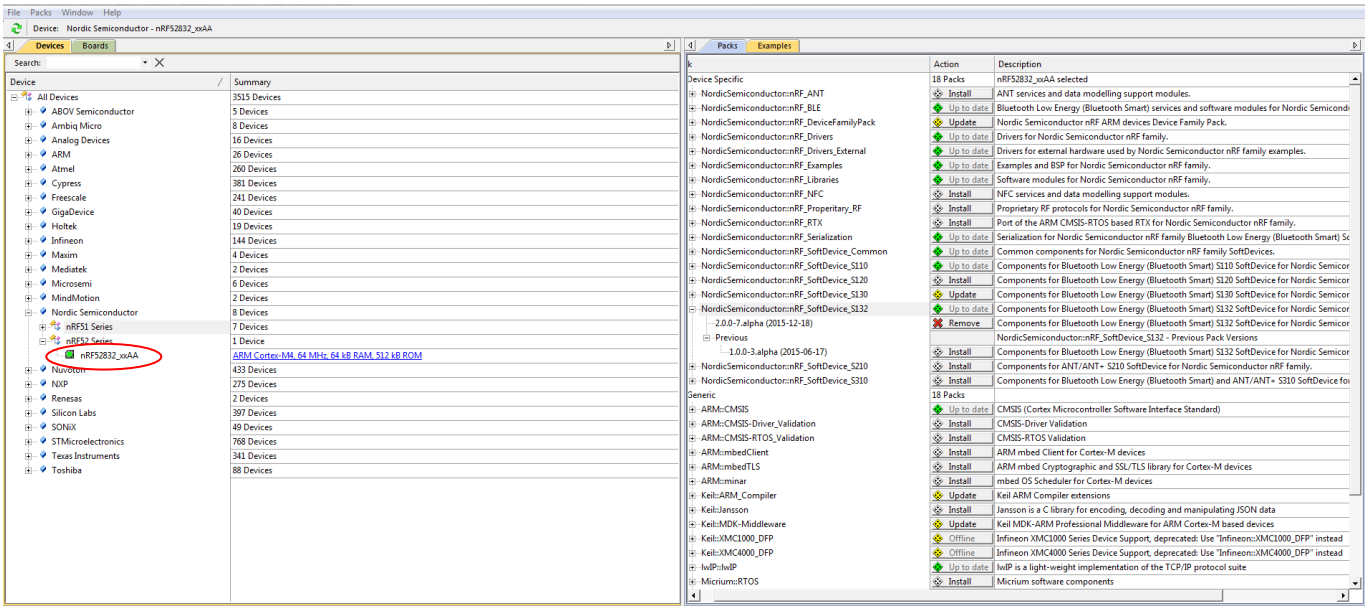
1 x NFC antenna

1 x USB cable
1 x FPC 22 pin cable
1 x FPC 14 pin cable
1 x FPC 10 pin cable
1 x 2-lead patch cable
1 x Lithium Battery CR2032

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, a Pack Installer window appears. 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, nRF DeviceFamilyPack, nRF examples…, etc …
All the Packs are installed on the following directory: C:\Keil_v5\ARM\Pack\NordicSemiconductor.

2. Download and run the J-Link Software and documentation pack for Windows from http://www.segger.com/jlink-software.html. The serial number from your SEGGER J-Link hardware is needed to identify your device and can be found printed on the chip on the J-Link Lite emulator board.

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

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

    a. nRF52 Series : Click on nRF52832 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.

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

6. Download and install nRFgo Studio (Make sure to download the last version updated).

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

4. Hardware Description

4.1. ISP1510-UX Module

ISP1510-UX is a Bluetooth Low Energy and UWB module with integrated antennas.

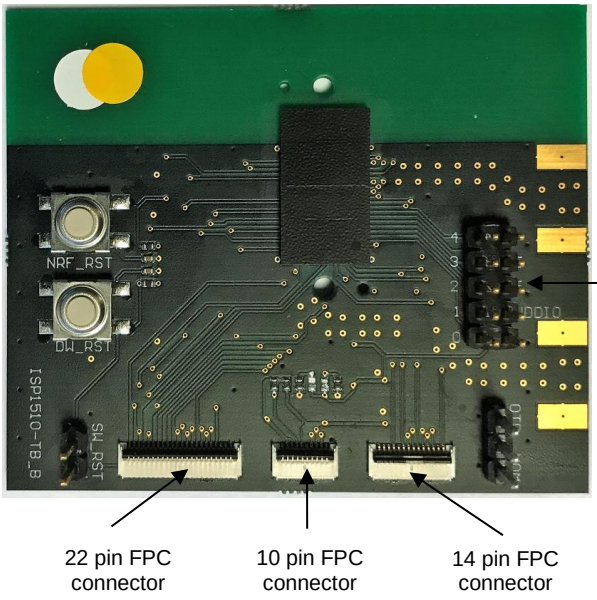
Despite its small size of 9.0 x 16.0 x 1.9 mm, the ISP1510 module integrates the DecaWave DW1000 chipset which is an Ultra Wide Band transceiver dedicated to indoor localization applications. This chipset needs an external processor to operate and Insight SiP decided to integrate the Nordic Semi nRF52 SoC. In addition to the powerful ARM Cortex M4F MCU, this chip also provides a BLE and NFC connectivity for wireless set up and control of the UWB chip.

ISP1510 also integrates all passives, crystals and DC/DC converters to optimize the power consumption. And last but not least, it integrates 2 antennas in the same package. This is a new and unique concept developed by Insight SiP within a SIP package. For BLE function, we keep using our usual PCB trace antenna design. For UWB function, the second antenna is printed directly on top of the molding.

For more details, see Insight SiP module data sheet (document DS1510).

4.2. ISP1510-UX-TB Test Board

ISP1510-UX-TB is the basic application test board that has dimensions of 50 x 60 mm².



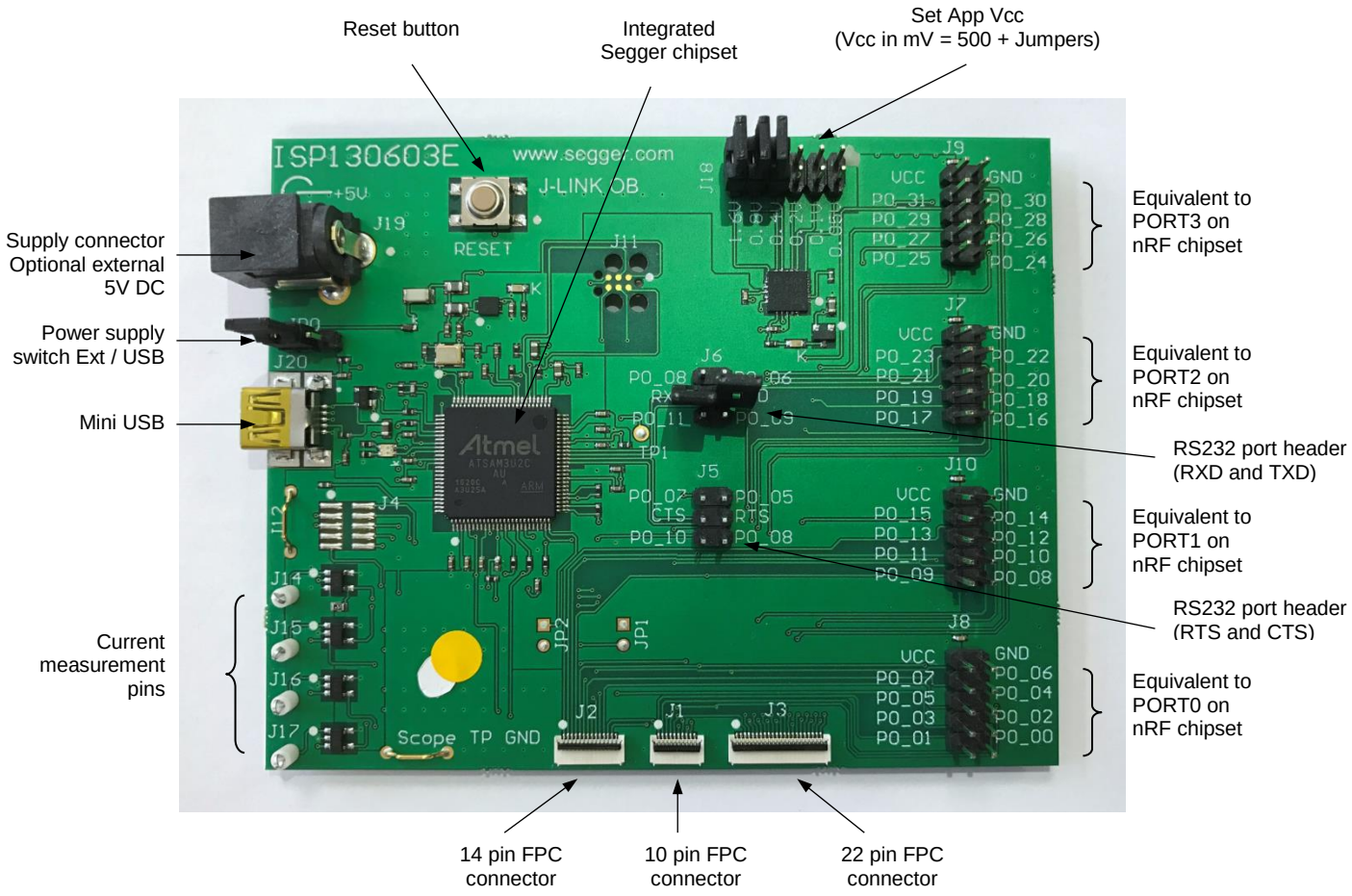
It encloses:

- ISP1510-UX UWB and BLE module
- 3 x FPC connectors in order to access the nRF52832 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.
- 1 x 10 pin header order to access the decaWave GPIOs

The ISP1510-UX-TB electrical schematic is presented in document Schematic_ ISP1510-UX-TB.

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.

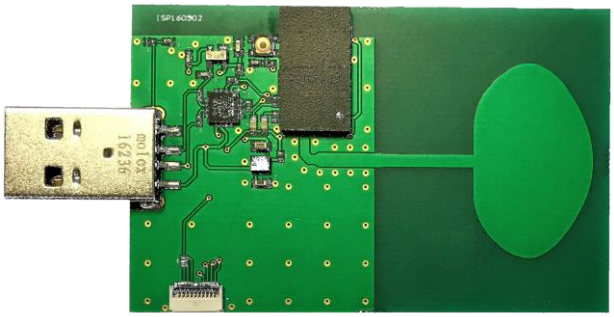


4.4. ISP1510-AN Anchor Board

ISP1510 Anchor Board is one of two the application boards that is used for the ranging demonstration.
It has dimensions of 62.5 x 40 mm².

It encloses:
- ISP1510-UX UWB and BLE module
- 2 x mini-LEDs
- USB connector
- Removable 10 pin FPC connector for software loading
- FTDI USB-to-Serial adapter
- UWB Antenna on PCB
- Ranging firmware

The ISP1510-AN Anchor Board electrical schematic is presented in the document Schematic_ ISP1510-UX-AN.



4.5. ISP1510-TG Tag Board

ISP1510 Tag Board is one of two the application boards that is used for the ranging demonstration.
It has dimensions of 31 x 18 mm².

It encloses:
- ISP1510-UX UWB and BLE module
- 2 x mini-LEDs
- Battery holder
- Removable 10 pin FPC connector for software loading
- Ranging firmware

The ISP1510-TG Tag Board electrical schematic is presented in the document Schematic_ ISP1510-UX-TG.

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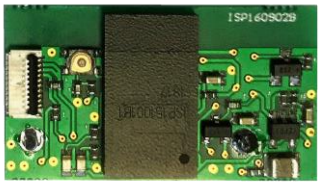


4.6. nRF5 series Development Dongle

The reader should refer to the corresponding paragraph in nRF52832 Development Kit User Guide document.

5. Basic Application using ISP1510-UX-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 ISP1510-UX-TB Test Board to the Master Emulator. In order to use Bluetooth Low Energy radio, the software is loaded in 2 parts:

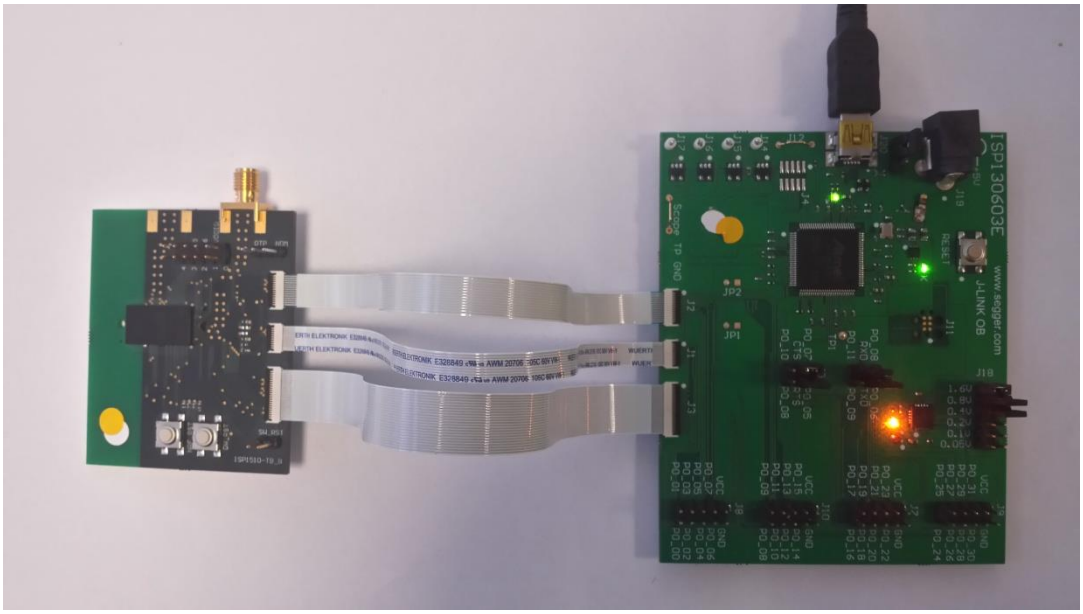
- S132 SoftDevice using nRFgo Studio (hex file, no source).
- Proximity Application using Keil uVision.

Then Master Emulator is connected and Proximity Application is launched.

S132 SoftDevice loading

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

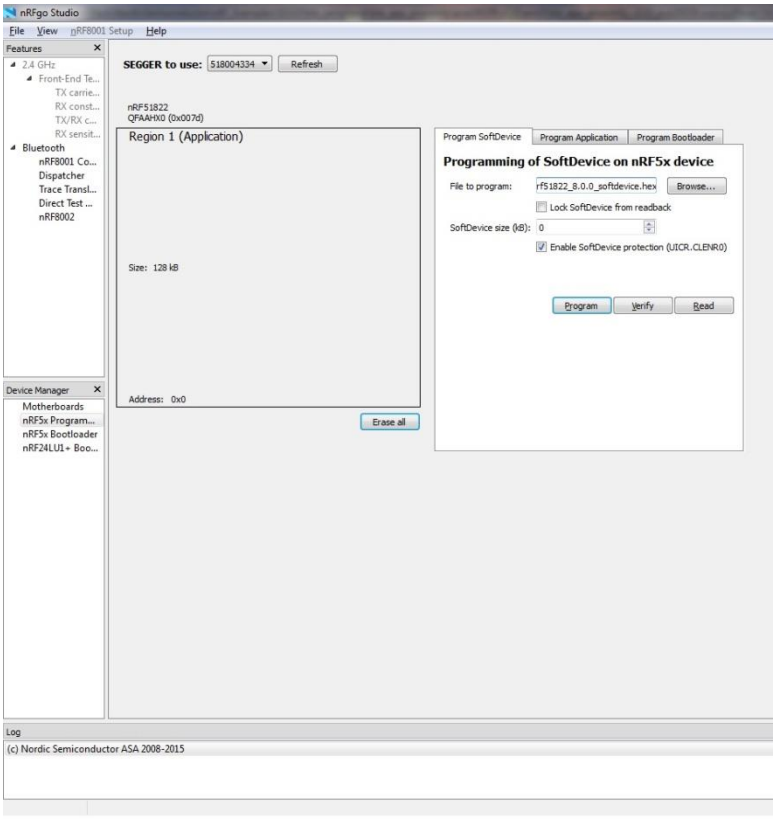
2. Connect the ISP1510-UX-TB Test Board to the ISP130603 Interface Board with the 10 pin, 14 pin and 22 pin FPC jumper cables (0.5 mm pitch, provided in the Development Kit).



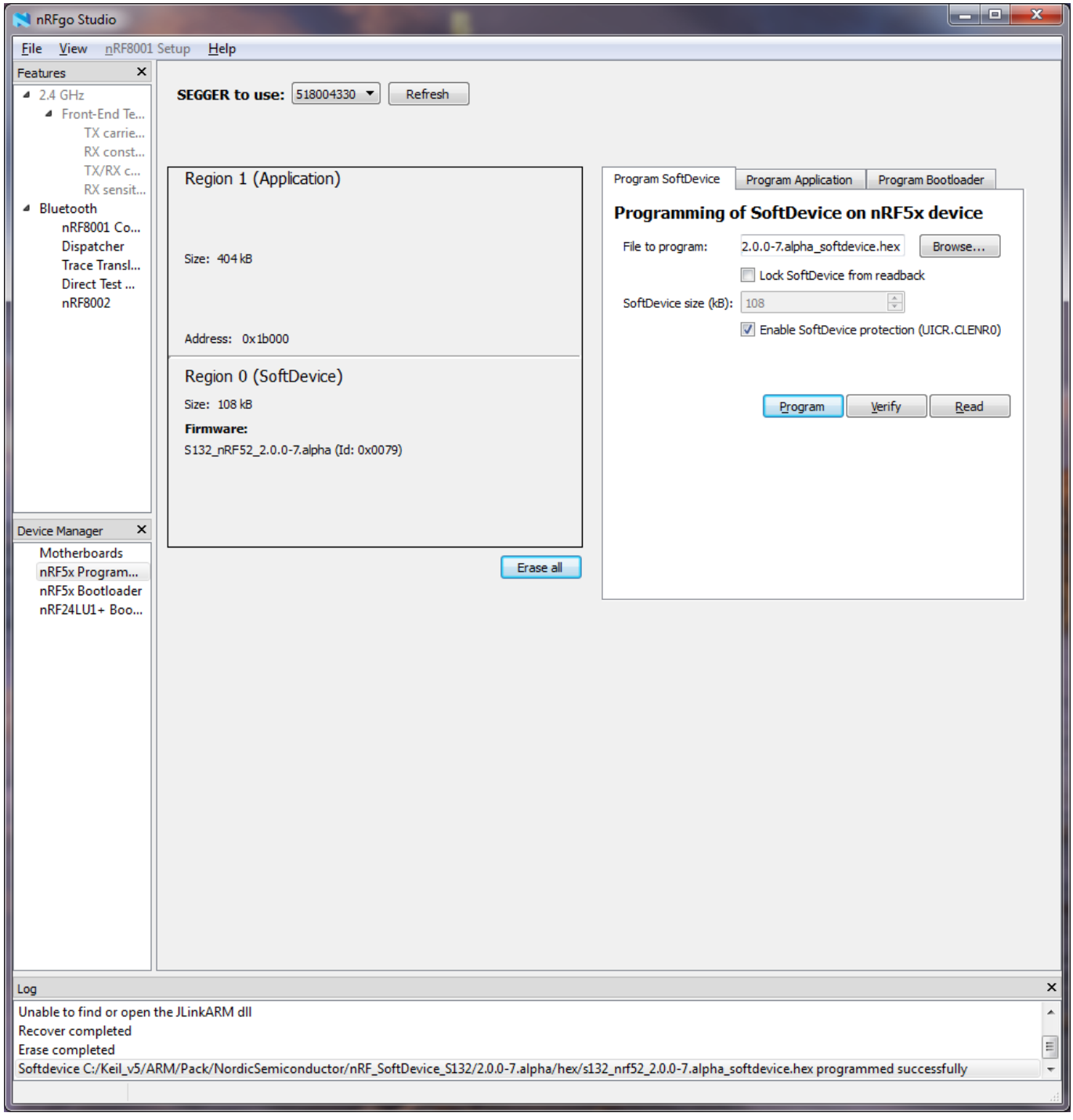
3. Start nRFgo Studio.

4. Select nRF5x Programming.

5. Click Erase all.



6. Browse to SoftDevice hex file and click Program. The SoftDevice is available on the Nordic Website or by installing the SoftDevice S132 with the Pack Installer, for example : C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_SoftDevice_S132\2.0.0-7.alpha\hex



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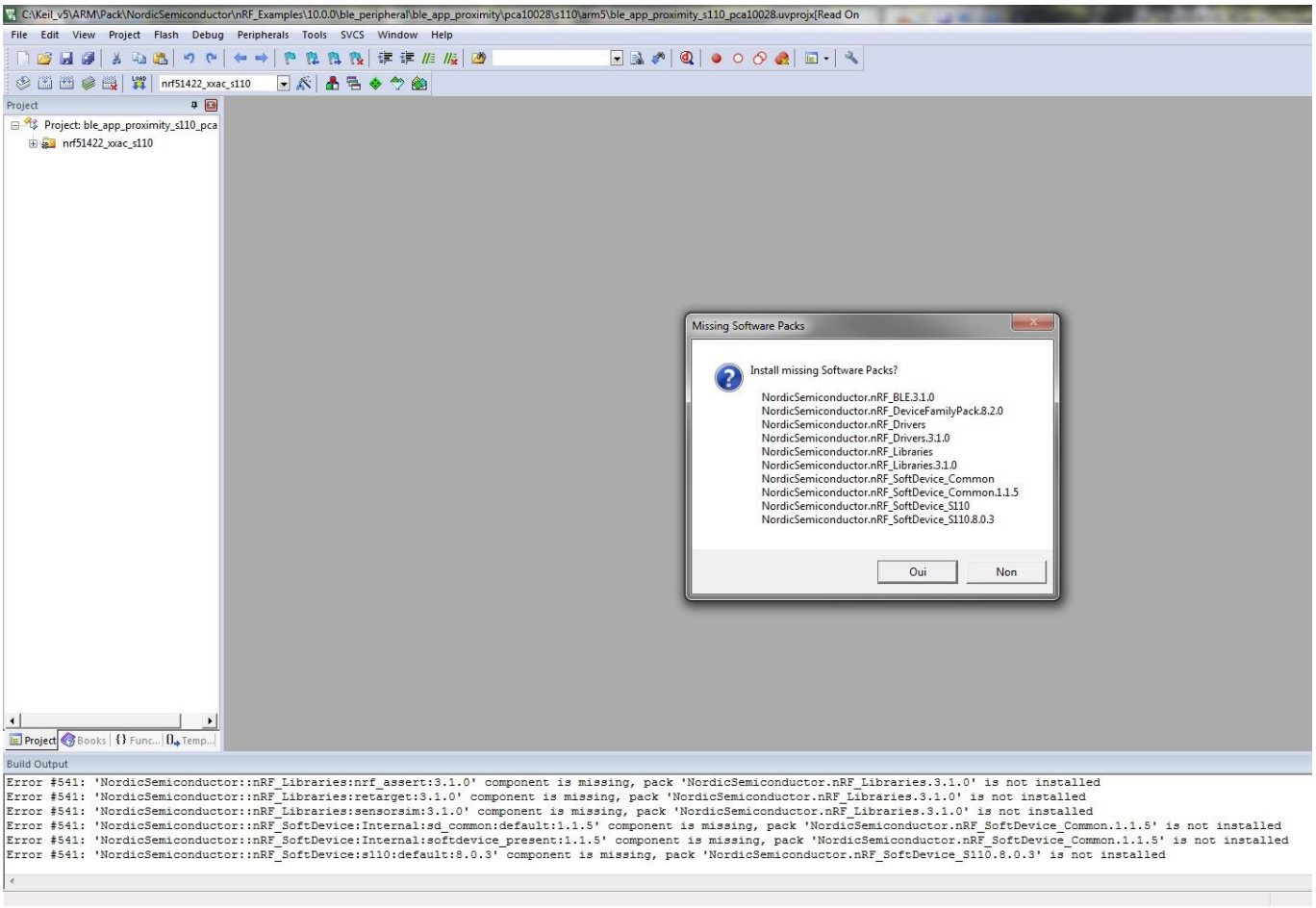
Proximity Application loading

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.

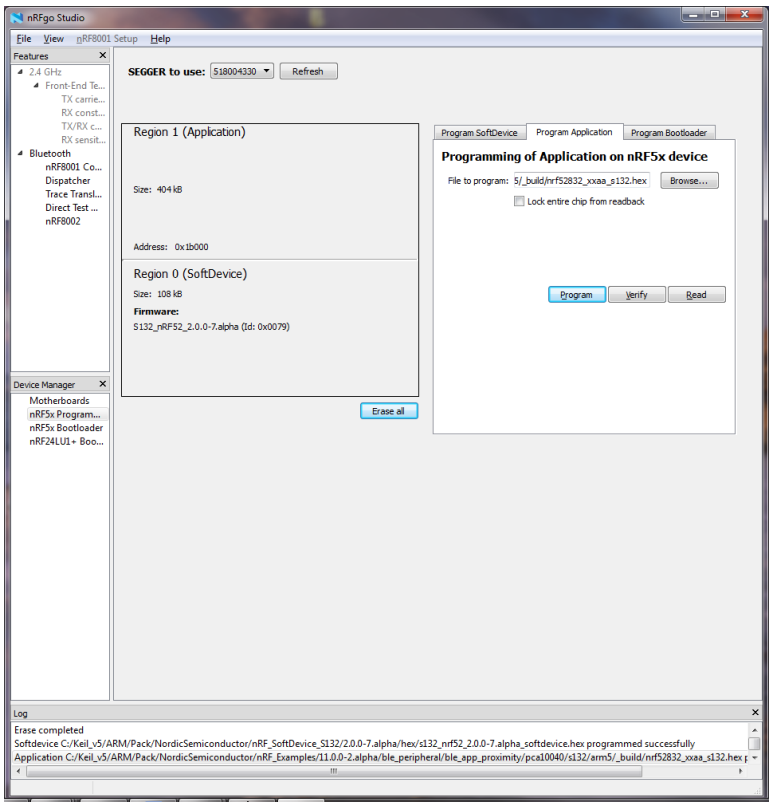
   (Ex: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha\ble_peripheral\ble_app_proximity\pca10040\s132\arm5 \ ble_app_proximity_s132_pca10040.uvprojx).



If some Install Softwares Packs is missing, a window appears, and you can install it.

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.

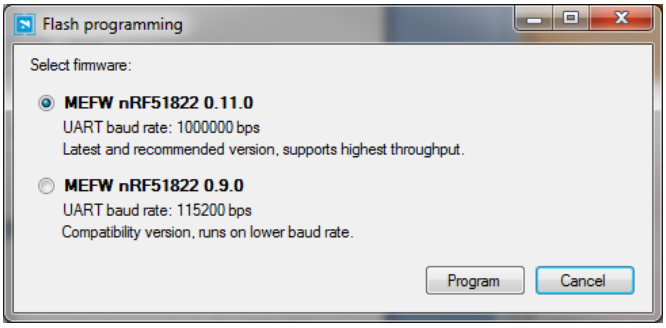


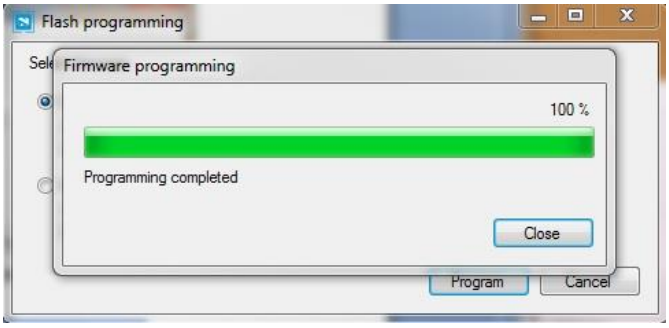
The file project is located for example:
C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha\ble_peripheral\ble_app_proximity\pca10040\s132\arm5_build _build\ nrf52832_xxaa_s132.hex).

Master Emulator and Proximity Application

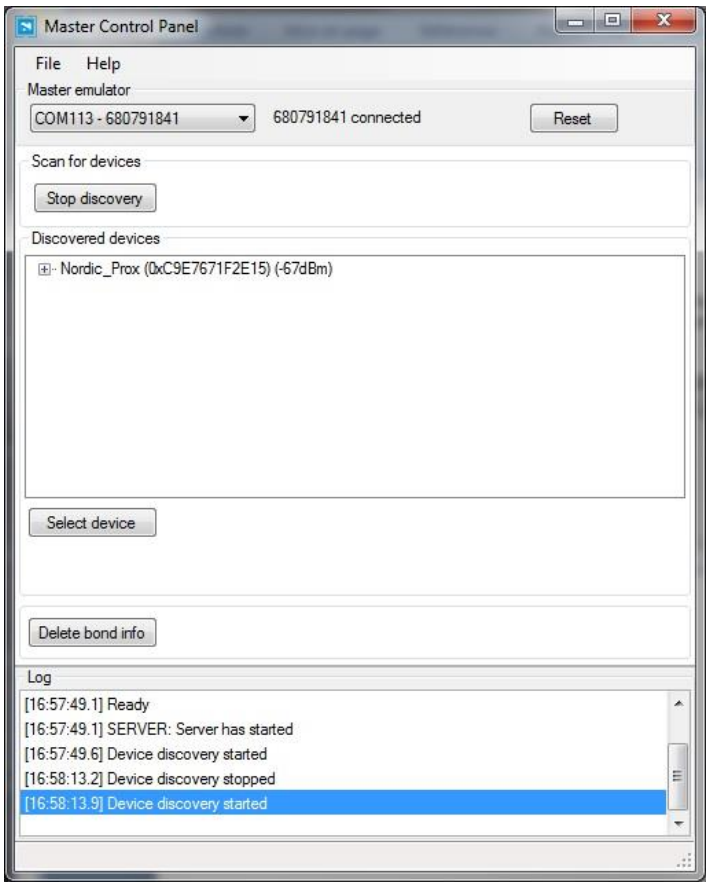
1. Connect nRF51 Dongle (Master Emulator) into a USB port on your computer.

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



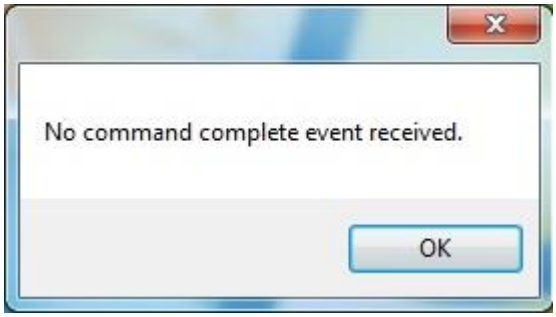


3. Click Start Discovery.



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 :

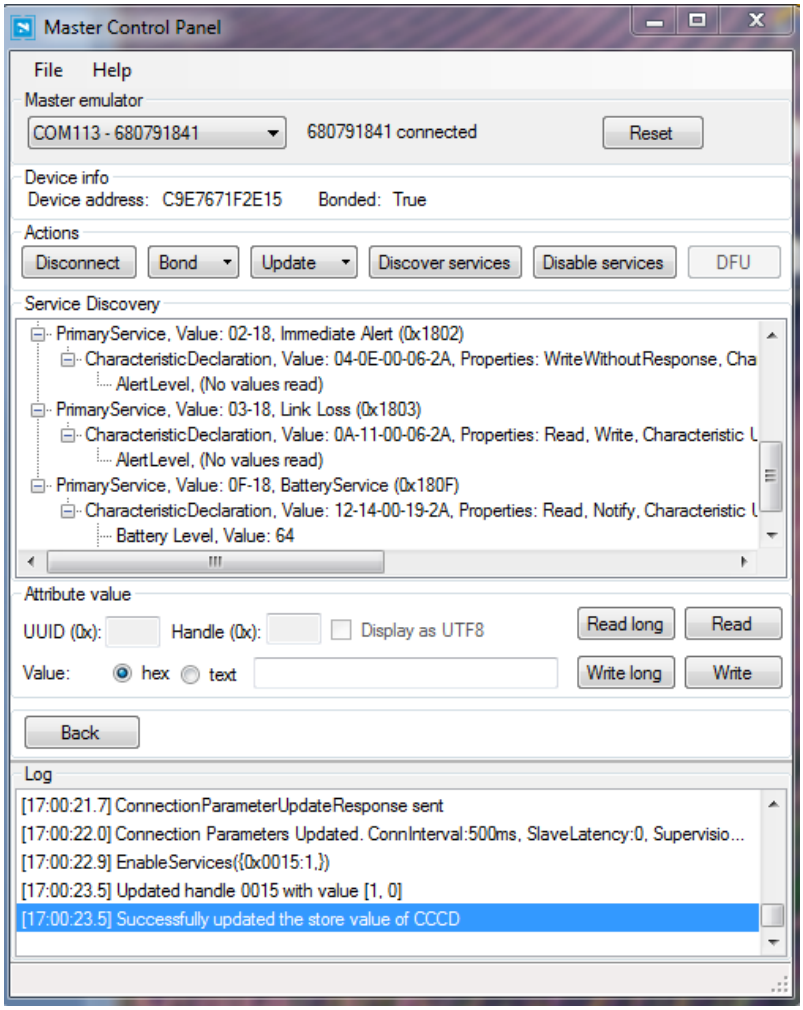


It means that the nRF5 Dongle is not programmed. For your information, please refer to the nRF51822 Development Kit User Guide document as indicated in our application note ISP130301-DK1 part 4.5 on page 14-7. You can find this user guide on the Nordicsemi website. The procedure to program the nRF51 Dongle is described on page 13. I enclose a copy of the user guide for your convenience.

1) Open the Master Control Panel from the Start menu (Start > All Programs > Nordic Semiconductor > Master Control Panel).
2) 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.
3) When you use the Development Dongle for the first time, you must first program it with the Master Emulator Firmware.
   a. In the Master Control Panel menu click File and select Flash Programming.
   b. Click Browse. This opens a browser that automatically points to the location of the
   c. mefw_nrf51822_<version>_firmware.hex (<version> will be replaced by a number
   d. giving the version of the actual firmware).
   e. The Master Control Panel Firmware file is located in:
   f. C:\Program Files (x86) \ Nordic Semiconductor \ Master Control Panel \<version>\firmware
   g. pca10000\MEFW_nRF51822_<version>_firmware.hex.
   h. Select the Master Emulator Firmware file and click Open.
   i. Click Program to start programming the selected device.
   j. 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.



8. You can note Battery voltage is sent by the ISP1510-UX-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 “nRF Master Control Panel” application which is available for iOS from Apple Store and for Android from Play Store. Download, install and run the application, click to SCAN and select the device: Nordic_PROX.

Important notification: 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

5.2. Direct Test Mode (UART)

This paragraph shows you how to set up and program the Direct Test Mode through the UART on ISP1510-UX-TB Test Board.

Direct Test Mode Set-up

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

2. Connect the ISP1510-UX-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

   Make sure the RXD/TXD labels match for each wire. This matches the default setting if you are using the Nordic Board PCA10040 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: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha\ dtm\direct_test_mode\ pca10040\blank\arm5\direct_test_mode_blank_pca10040.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 PCA10040 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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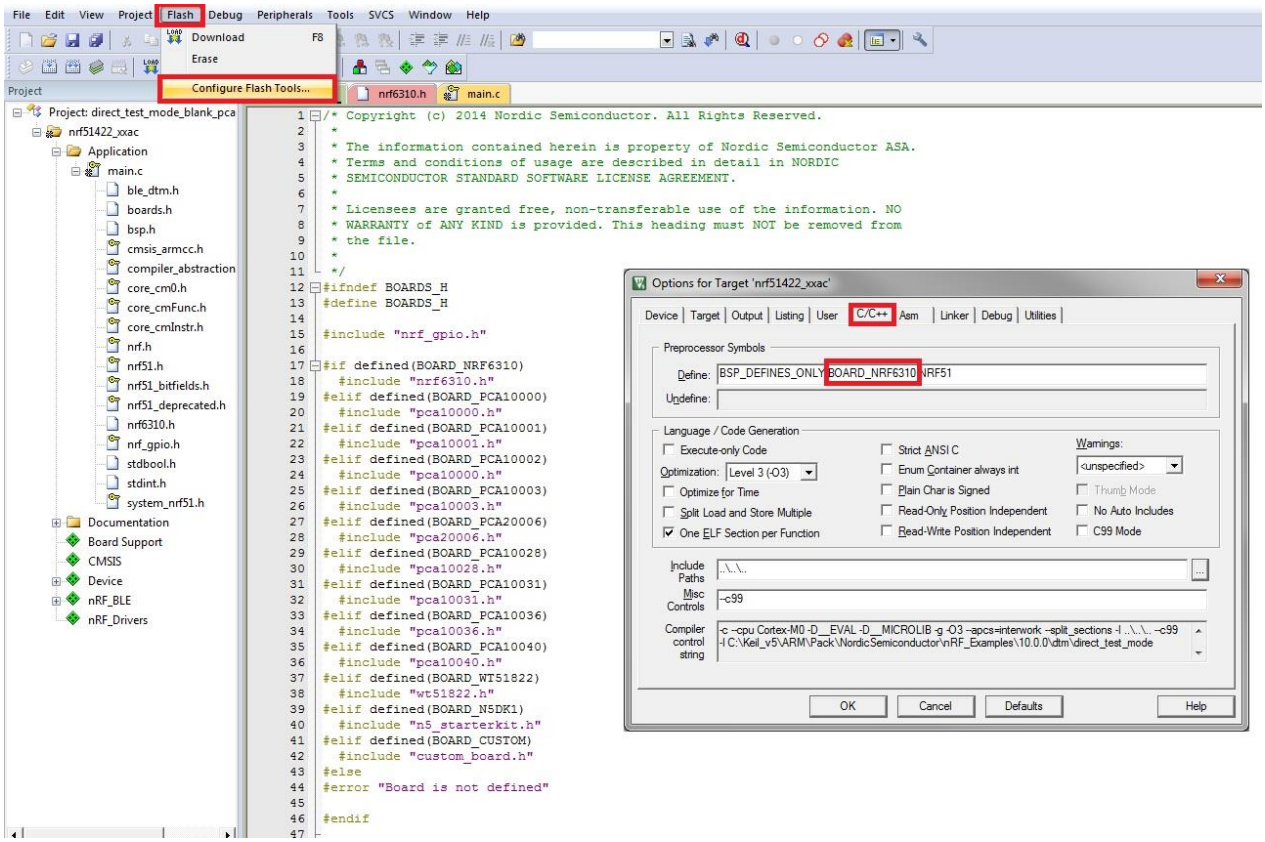
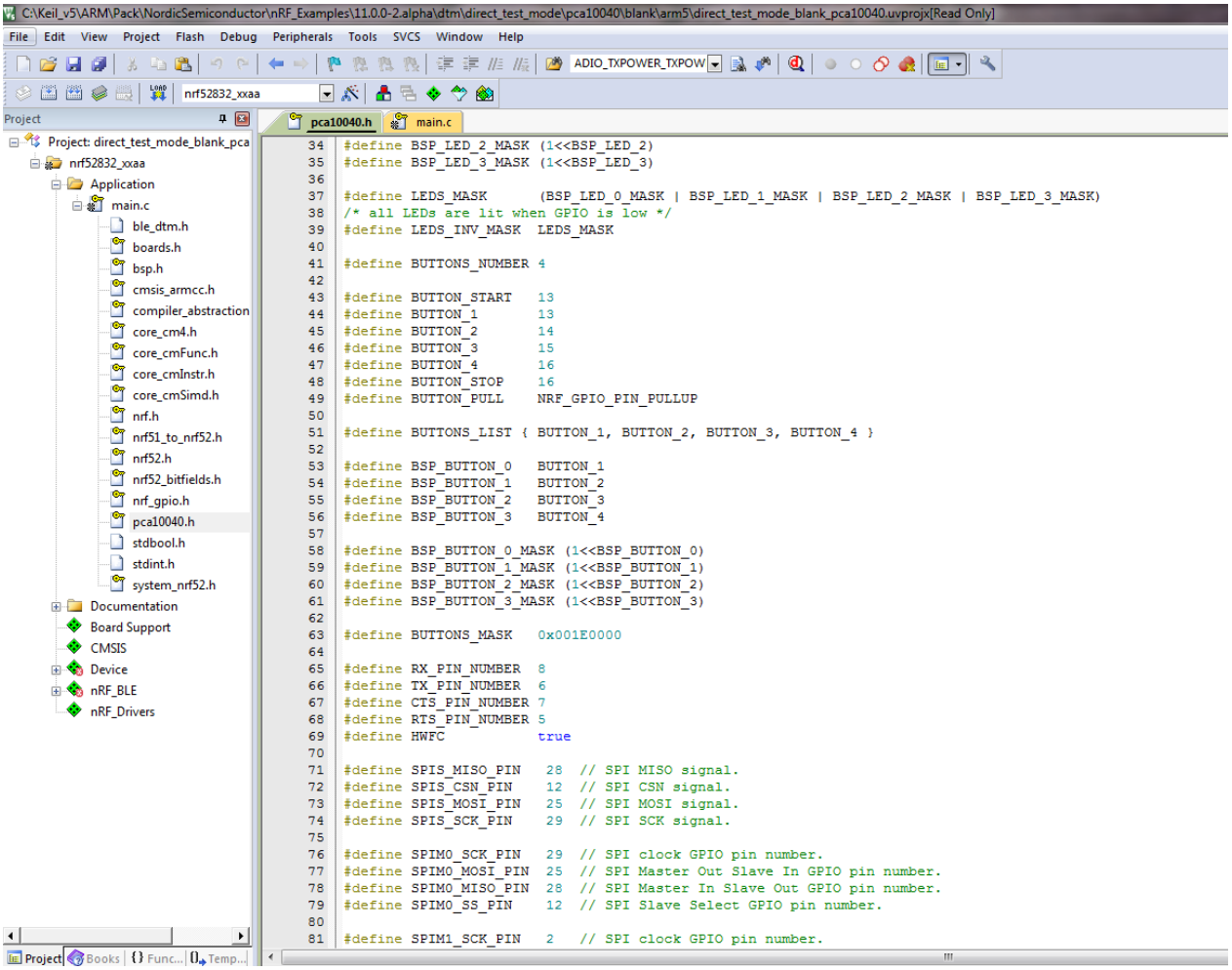
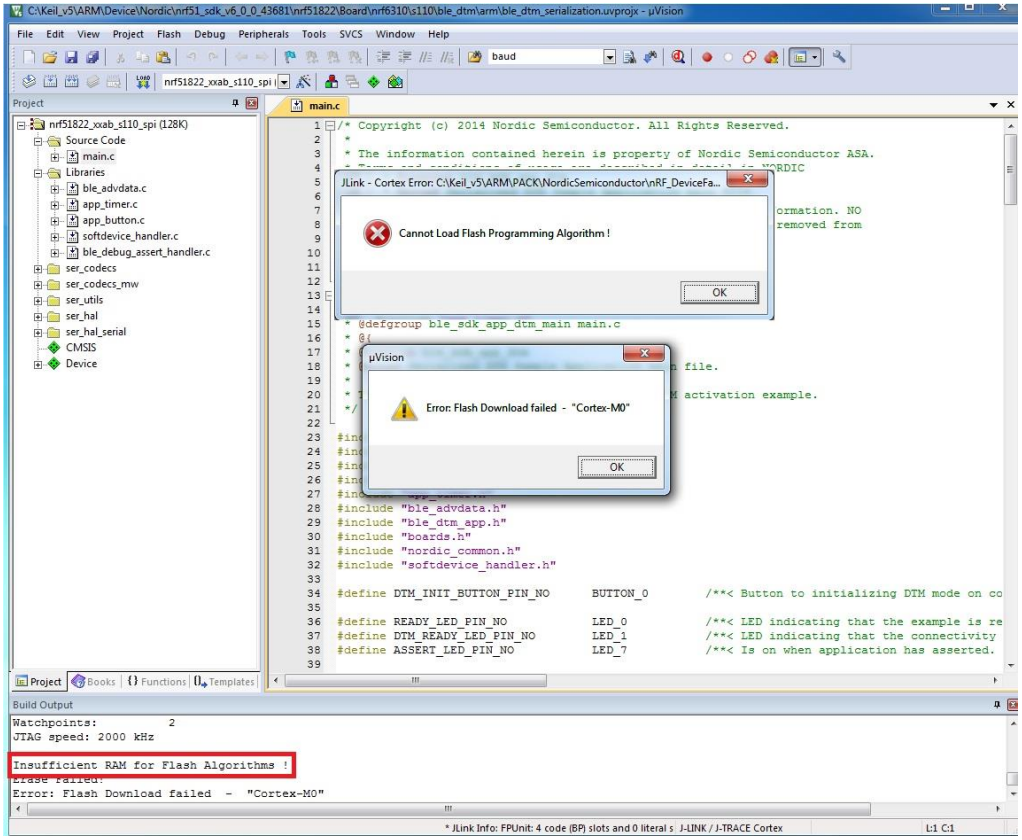


In the following picture, the Nordic board PCA10040 is used by default and the RX and TX pin number are 08 and 06.

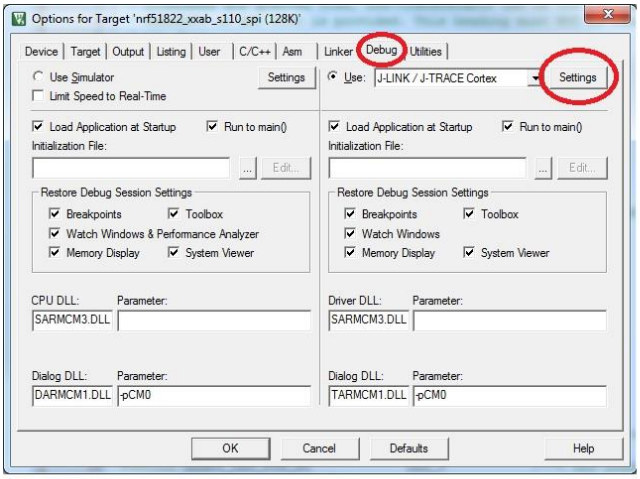


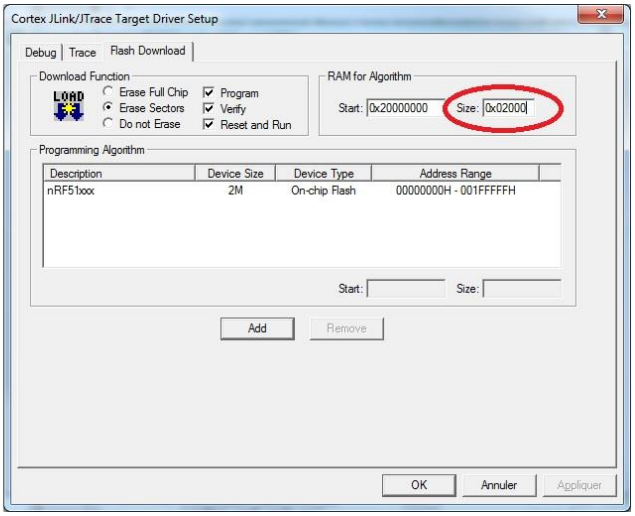
3. Click Build Target and Load.

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



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).



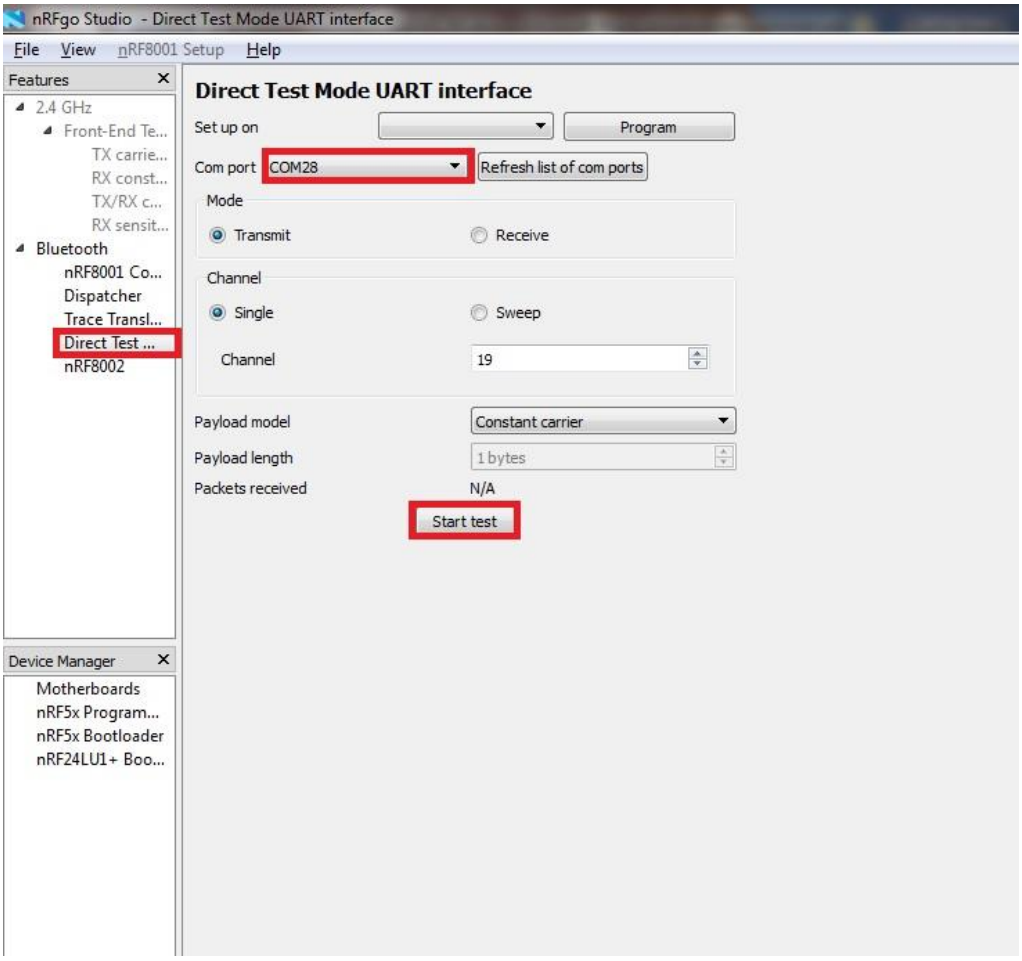


6. Click OK and load again the project.

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.

Important notification: 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).

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 ISP1510-UX-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 ISP1510-UX-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_11
   - 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 pca10040 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 data (CTS) and vice versa.

UART Mode Loading

1. Start Keil uVision.

2. Select Project then Open Project in order to open UART_example application: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha\peripheral\uart \pca10040\arm5\uart_pca10040.uvprojx.

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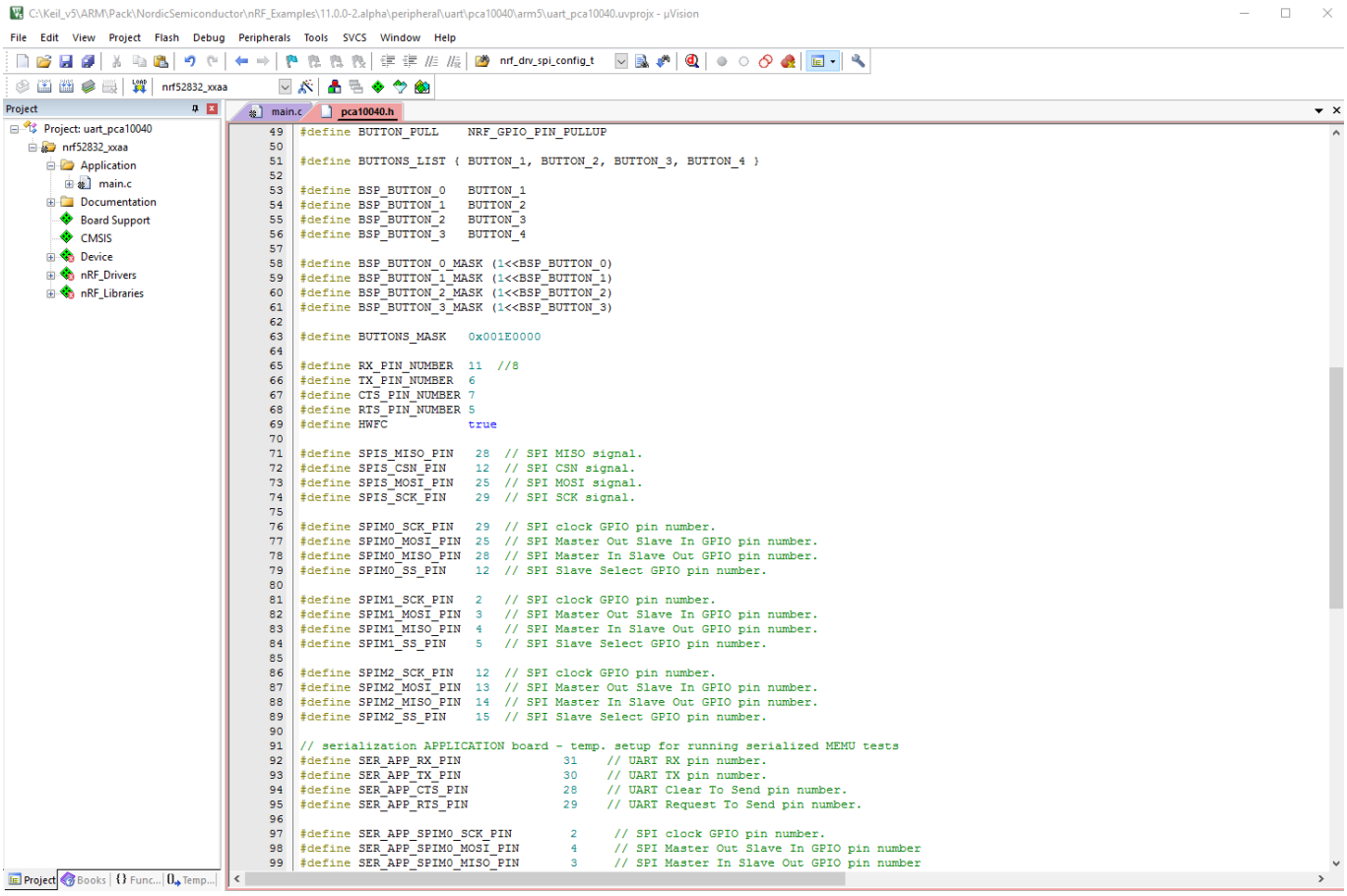
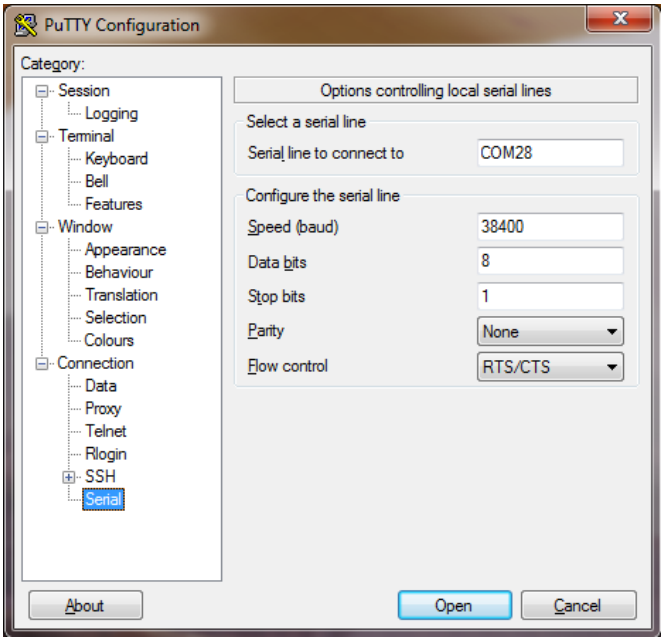


3. Click Build Target and Load.

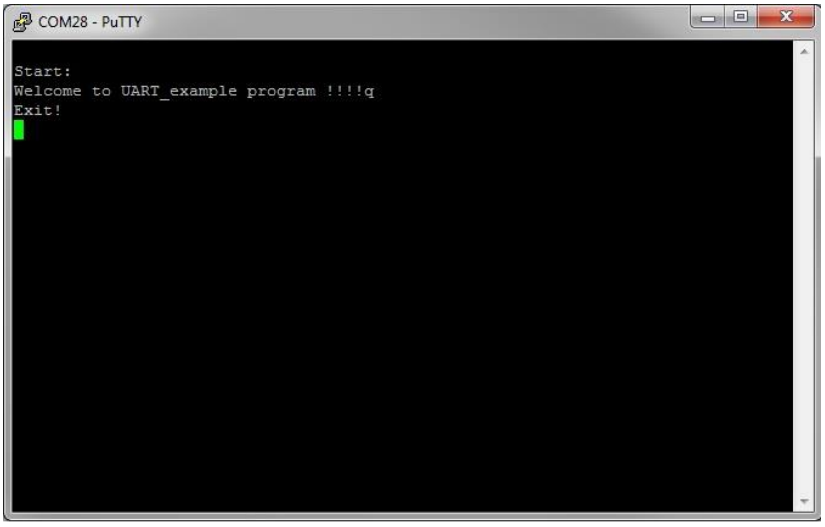
UART Mode Testing

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: **S132**.
- 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 ISP1510-UX-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_11
   - 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 data (CTS) and vice versa.

S132 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 by installing the SoftDevice with the Pack Installer, for example: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_SoftDevice_S132\2.0.0-7.alpha\hex

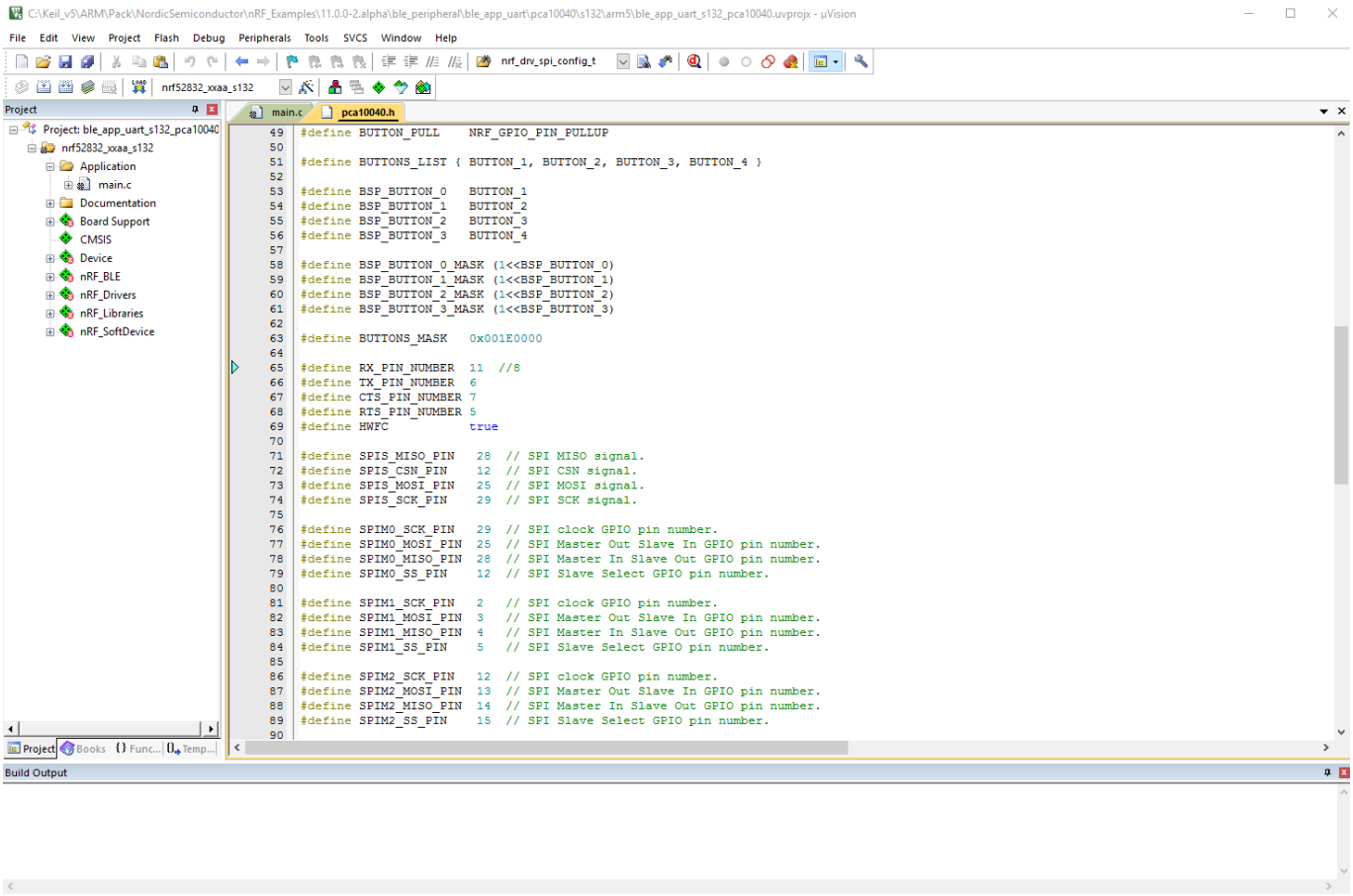
UART Mode Loading

1. Start Keil uVision.

2. Select Project then Open Project in order to open ble_app_uart application: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha\ble_peripheral\ble_app_uart\pca10040\s132\arm5 \ble_app_uart_s132_pca10040.

3. Click Build Target and Load.

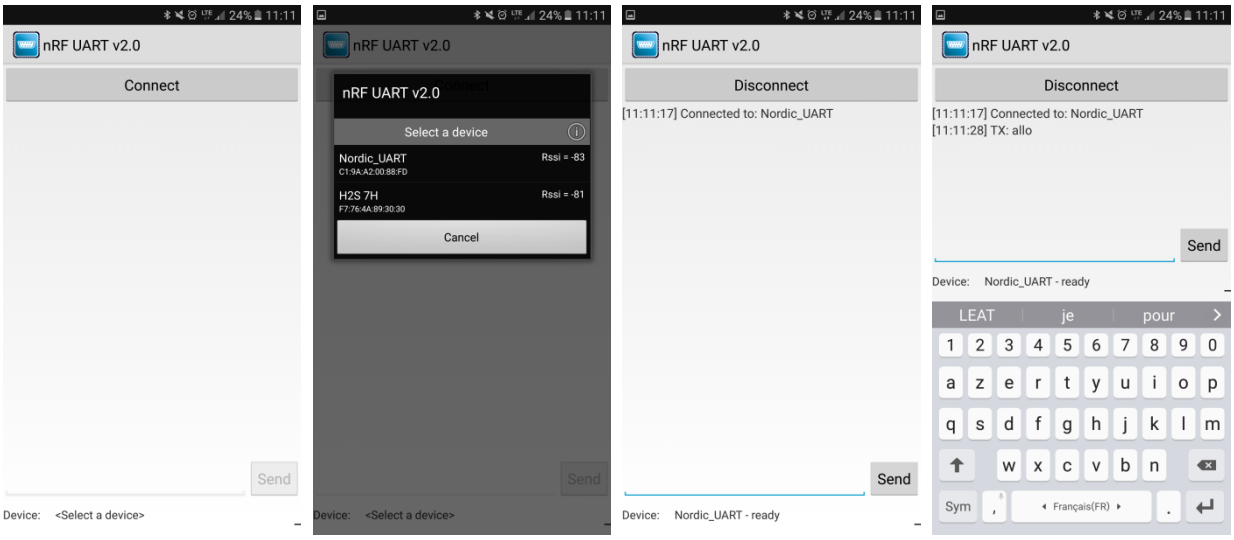
Insight SiP can provide the Hex files on demand at contact@insightsip.com



BLE Mode Testing

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

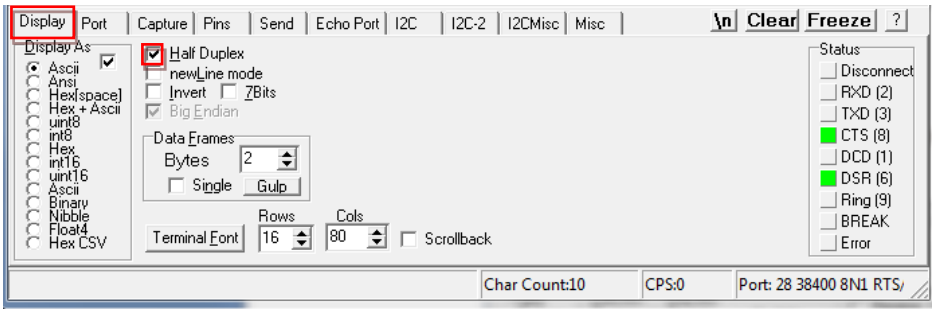
2. Run the App, click to Connect and select the device: Nordic_UART.

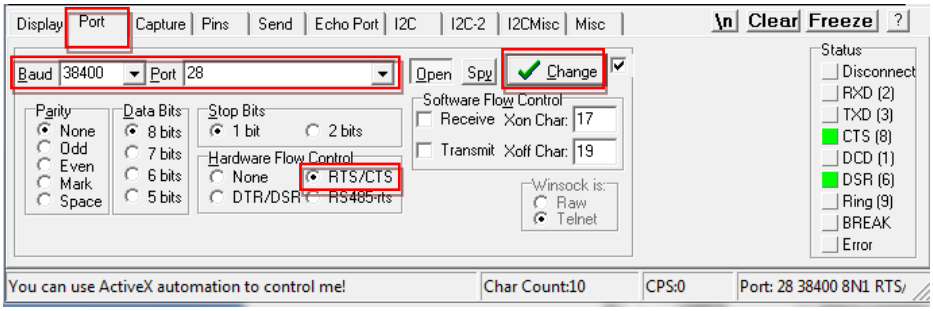


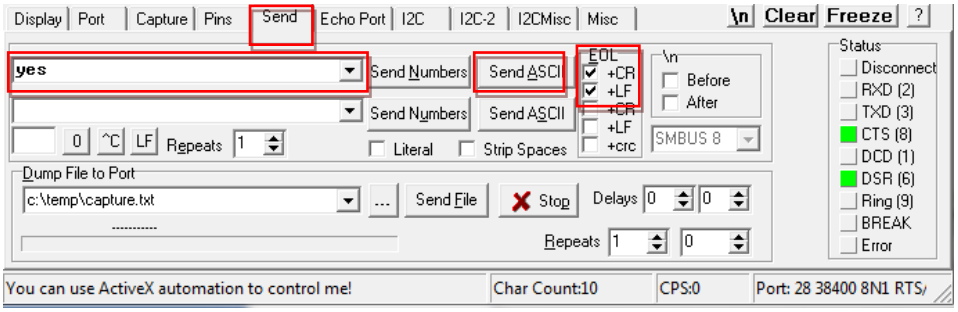
3. You are now able to send and receive data through the BLE. Next step is to establish the communication with the UART interface.

UART Mode Testing

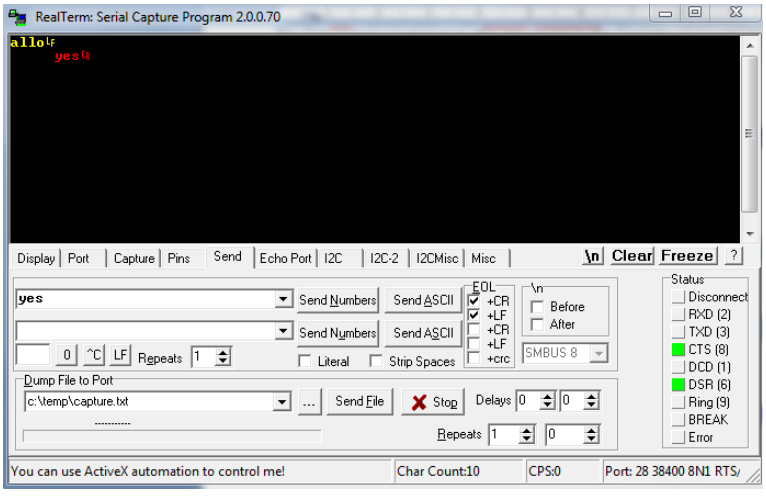
1. Download and install the program “RealTerm” (or equivalent like Putty, TTERM for example) in order to configure the baudrate, the port COM, .. etc …

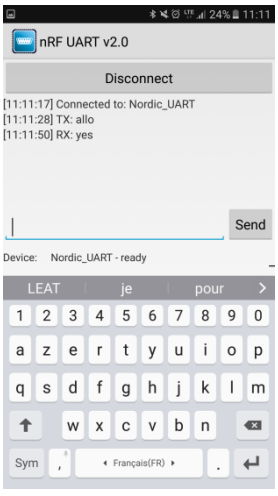






2. Click to Send, write some characters and click to “Send ASCII”.





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

5.5. NFC Launch App Example

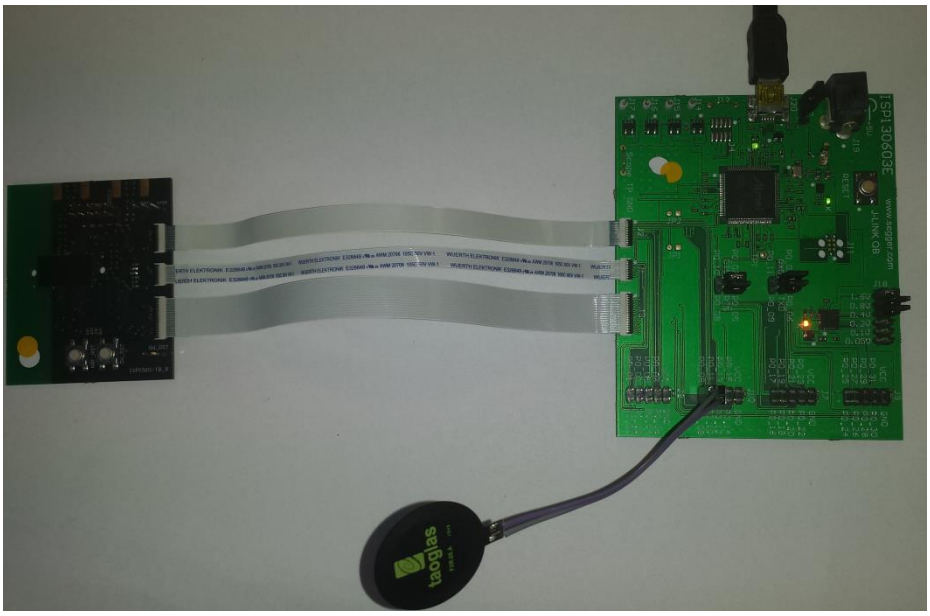
The Launch App Example shows how to use the NFC tag to launch an app on a device that supports NFC and runs Android (4.0 or later) or Windows Phone (8.0 or later).

NFC Mode Set-up

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

2. Connect the ISP1510-UX-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



NFC Mode Loading

1. Start Keil uVision.

2. Select Project then Open Project in order to open UART_example application: C:\Keil_v5\ARM\Pack\NordicSemiconductor\nRF_Examples\11.0.0-2.alpha \nfc\experimental_record_launch_app\pca10040\arm5\ nfc_launchapp_record_pca10040.uvprojx.

3. Click Build Target and Load.

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.

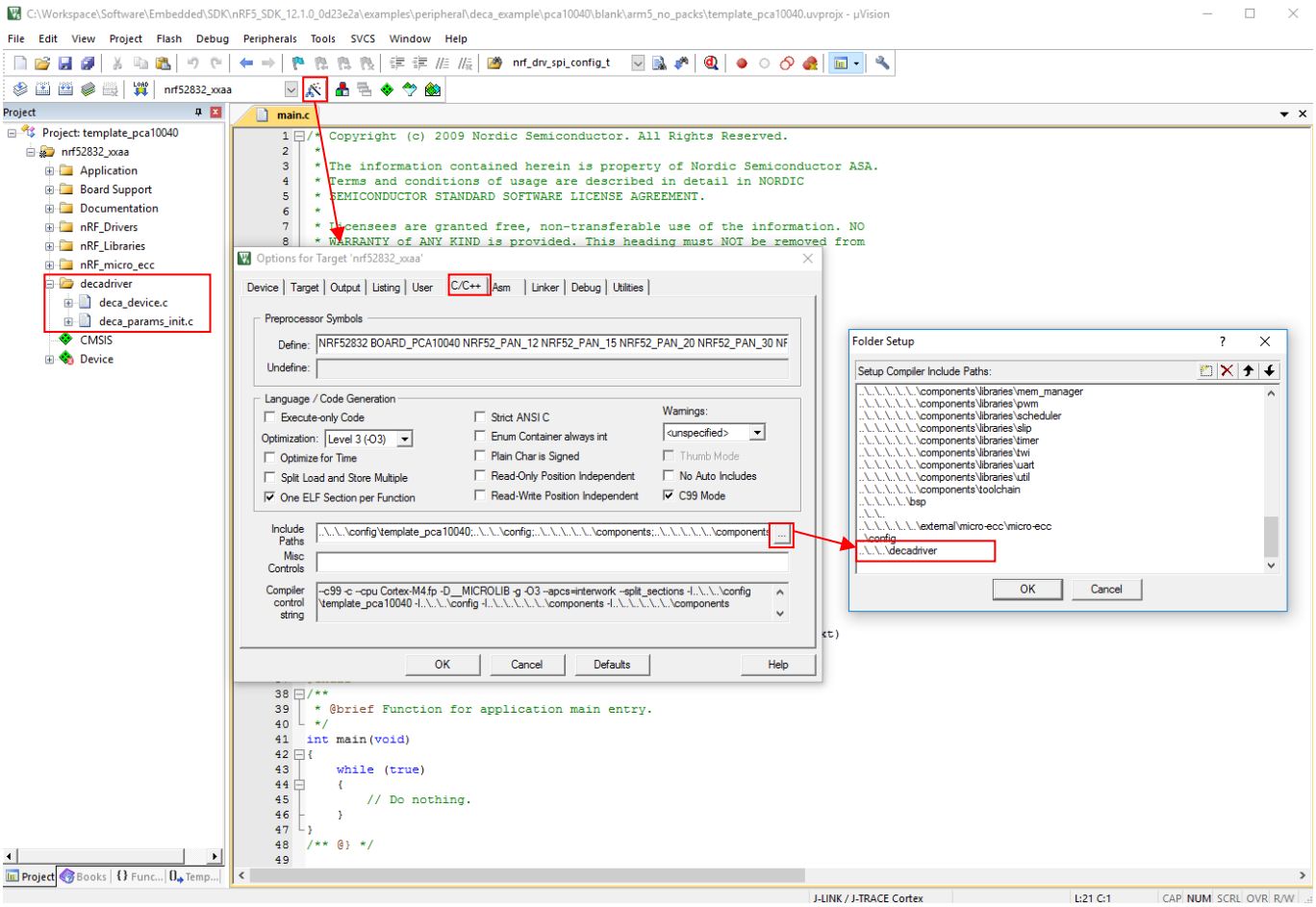
5.6. Simple UWB transmissions using Decawave

DecaWave provides various example codes in C language: simple transmission, simple reception, ranging etc.
However, these examples are made to be used by the IDE CooCox with an STM32 target. This chapter will explain how to use decaWave driver and example code in an nRF52 Keil project.

1. Download "**DW1000 Application Programming Interface with application examples"** from decawave website: https://www.decawave.com/support/software. This package contains drivers and example codes for the DW1000.

2. Create a Keil project. In this chapter we will start from the Nordic's template_project provided in their SDK. Open project in \pca10040\blank\arm5_no_packs.

3. Copy the decadriver directory of the decawave package into your project directory. Add deca_device.c and deca_param_init.c to your project. Add the decadriver directory to your Include Paths.



4. Copy the content of examples/ex_01a_simple_tx main.c of the decawave package into your main.c.
   Modify the “config” static variable which holds the decawave’s signal parameters. We will be using channel 5.
   Remove the following lines of code we don’t need:
   - #include "lcd.h", #include "sleep.h" and #include "port.h"
   - #define APP_NAME "SIMPLE TX v1.2"
   - lcd_display_str(APP_NAME);
   - reset_DW1000();
   - lcd_display_str("INIT FAILED");

   Building the project now will result in the following errors:

```
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol peripherals_init (referred from main.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol sleep_ms (referred from main.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol spi_set_rate_high (referred from main.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol spi_set_rate_low (referred from main.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol deca_sleep (referred from deca_device.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol decamutexoff (referred from deca_device.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol decamutexon (referred from deca_device.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol readfromspi (referred from deca_device.o).
.\_build\nrf52832_xxaa.axf: Error: L6218E: Undefined symbol writetospi (referred from deca_device.o).
```

   Now we need to implement these 9 missing functions.

5. Implement the peripherals_init function; this is where the SPI peripheral will be initialized. Don’t forget to add "nrf_drv_spi.h" in your include list.

```
#define SPI_INSTANCE  0 /**< SPI instance index. */
static const nrf_drv_spi_t spi = NRF_DRV_SPI_INSTANCE(SPI_INSTANCE);  /**< SPI instance. */

static void peripherals_init ()
{
        nrf_drv_spi_config_t spi_config = NRF_DRV_SPI_DEFAULT_CONFIG;
        spi_config.frequency  =     NRF_DRV_SPI_FREQ_1M;
        spi_config.mode  =          NRF_DRV_SPI_MODE_0;
        spi_config.bit_order =      NRF_DRV_SPI_BIT_ORDER_MSB_FIRST;
        spi_config.miso_pin  =      24;
        spi_config.mosi_pin =       17;
        spi_config.sck_pin  =       8;
        spi_config.orc      =       0x00;
        APP_ERROR_CHECK(nrf_drv_spi_init(&spi, &spi_config, NULL));
        // Set chip select high
        nrf_gpio_cfg_output (23);
        nrf_gpio_pin_write(23, 1);
}
```

6. Implement readfromspi function.

```
int readfromspi(uint16 headerLength, const uint8 *headerBuffer, uint32 readlength, uint8 *readBuffer)
{
	uint8 rxBodyBuff[readlength+headerLength];
	// Drive CS Low
	nrf_gpio_pin_write (23, 0);
	// Send/read data
	nrf_drv_spi_transfer (&spi, headerBuffer, headerLength, rxBodyBuff, readlength+headerLength);
	// Drive CS High
	nrf_gpio_pin_write (23, 1);
	// get "read part" of rxBodyBuff
	for(uint8 i=0;i<readlength;i++) readBuffer[i] = rxBodyBuff[headerLength+i];
	return 0;
}
```

7. Implement writetospi function.

```
int writetospi(uint16 headerLength, const uint8 *headerBuffer, uint32 bodylength, const uint8 *bodyBuffer)
{
	// prepare TX buffer
	uint8_t txBuff[headerLength+bodylength];
	for(uint8_t i=0;i<headerLength;i++) txBuff[i] = headerBuffer[i];
	for(uint8_t i=0;i<bodylength;i++) txBuff[headerLength+i] = bodyBuffer[i];
	// Drive CS Low
	nrf_gpio_pin_write (23, 0);
	// send data
	nrf_drv_spi_transfer (&spi, txBuff, headerLength+bodylength, NULL, 0);
	// Drive CS High
	nrf_gpio_pin_write (23, 1);
	 return 0;
}
```

8. Implement spi_set_rate_high and spi_set_rate_low functions.

```
static void spi_set_rate_low()
{
	NRF_SPIM_Type * p_spim = spi.p_registers;
	nrf_spim_frequency_set (p_spim, (nrf_spim_frequency_t)NRF_DRV_SPI_FREQ_1M);
}

static void spi_set_rate_high()
{
	NRF_SPIM_Type * p_spim = spi.p_registers;
	nrf_spim_frequency_set (p_spim, (nrf_spim_frequency_t)NRF_DRV_SPI_FREQ_8M);
}
```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9. Implement deca_sleep and sleep_ms functions.

```
void sleep_ms(unsigned int time_ms)
{
	nrf_delay_ms (time_ms);
}

void deca_sleep(unsigned int time_ms)
{
	nrf_delay_ms (time_ms);
}
```

10. Implement decamutexon and decamutexoff functions.

```
decaIrqStatus_t decamutexon(void)
{
	// To be implemented if needed
	return 1 ;
}

void decamutexoff(decaIrqStatus_t s)
{
	// To be implemented if needed
}
```

11. Build the project (This should now succeed). Load the firmware to the ISP1510. The module is now emitting an UWB packet every second. The UWB signal can be observed using a Signal Analyzer at 6.5GHz.

6. Basic Range Application with ISP1510

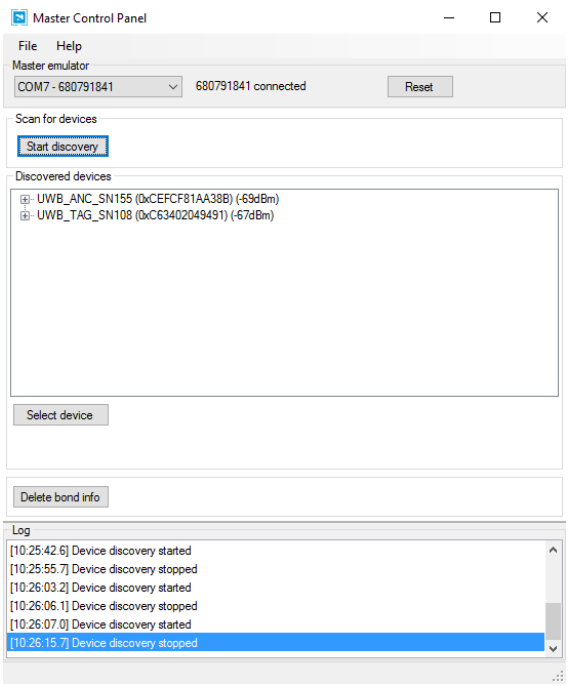
This paragraph shows you how to set up the Insight SiP's Range application between ISP1510 Anchor and Tag Board. The range is calculated using UWB and results are sent via the Bluetooth link to the Master Emulator or to a smartphone / tablet.

In this demo, the Anchor and the Tag operate as a pair. The Tag is the one initiating the ranging exchange and the "Anchor" is listening for the tag messages and responding to it. At the end of the ranging exchange the Anchor can then calculate the time of flight thus the range between the Tag and the Anchor.

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 device. The Android application is available on the Google Play.

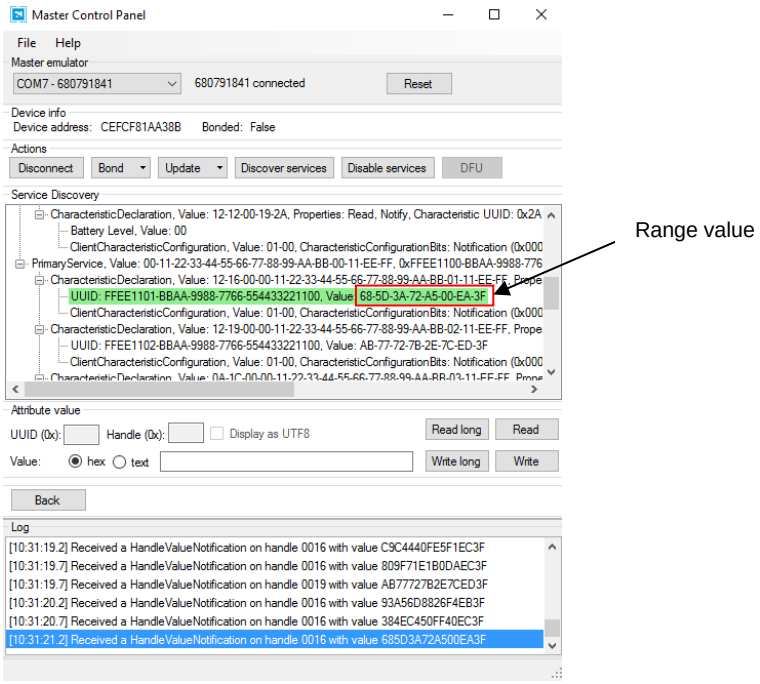
6.1. On Master Control Panel

1. Place the CR2032 lithium battery into the battery holder of the Tag Board.
2. Plug the Anchor Board into an USB port.
3. Connect nRF51 Dongle (Master Emulator) into a USB port on your computer.
4. Start Master Control Panel.
5. Click Start Discovery.



6. Two devices should appear: UWB_TAG_SNXXX and UWB_ANC_SNXXX. Select UWB_ANC_SNXXX and click on “Select Device”.

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



8. You can see data that transit between the ISP1510 Anchor Board and the Master Emulator via the Bluetooth link.
   The distance range is located in the service 0xFFEE1100BBAA99887766554433221100. In this example data is 0x3FEA00A5723A5D68 which is the 64bit floating point representation of 0.81 m.

9. To switch off the ISP1510 Tag Board, remove battery from the Tag Board, unplug the Anchor Board from the USB port.

6.2. On Android Device

An App is also available for Android Devices. On Google Play, search “sip sensor” or “insight sip” and download the App. The android App is a demonstration App that is provided “as is” in order to demonstrate the Smart Bluetooth sensor node.

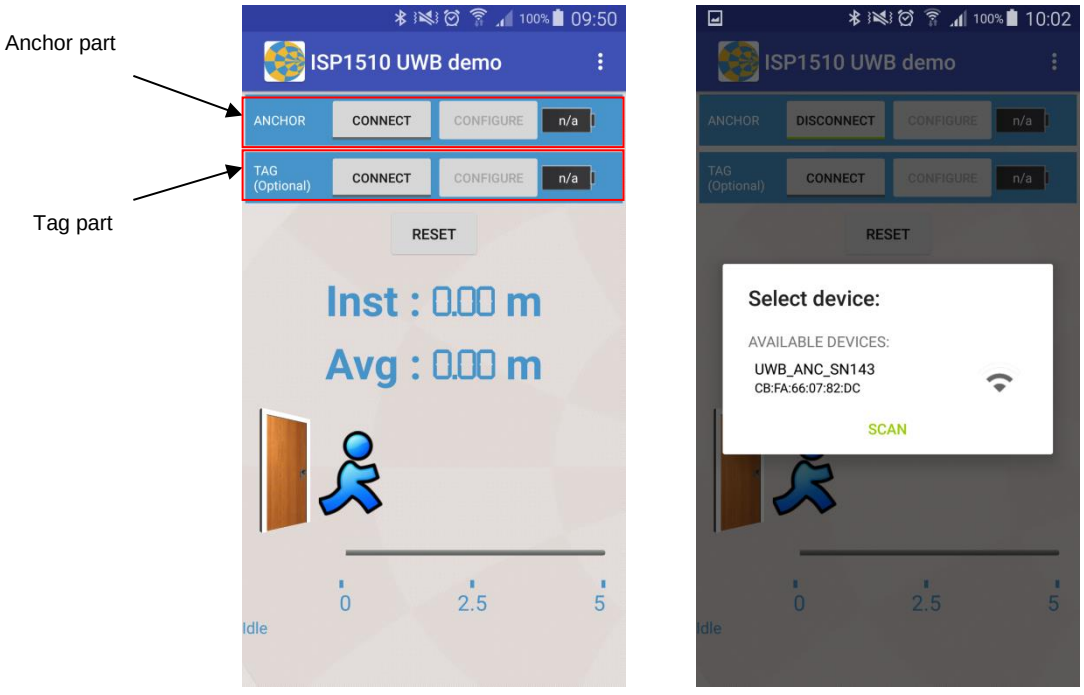
Make sure your Android device is compatible with Bluetooth 4.0 (Android v4.3 at least).

After the application is downloaded and installed you should see the application on your Android device. Then you will be able to set up the application demonstration as follows:

1. (For Android v6 or older) In order to be able to scan for BLE devices, the application needs to have “Location” permission. You have to enable “Location” service in the settings and give permission to the Sensor App to use Location (Settings -> Application Manager -> Sensor -> Permission).

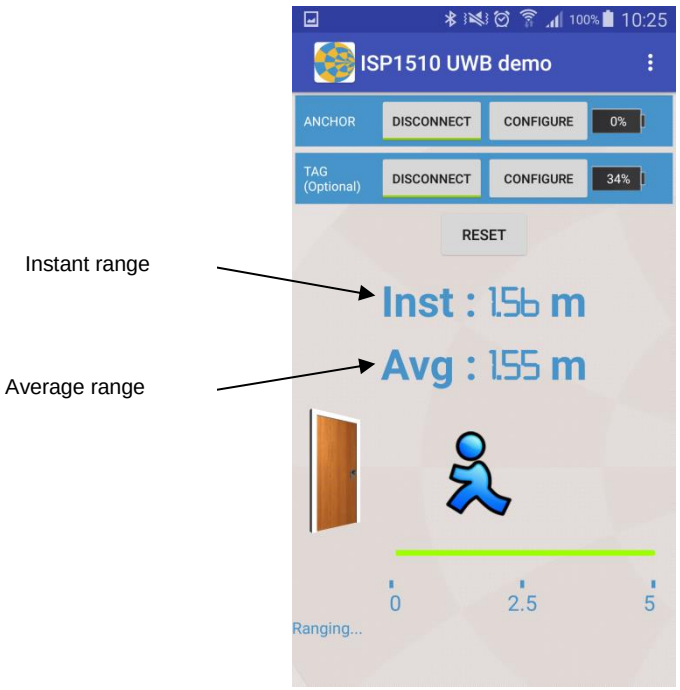
2. Power up both boards: Place the CR2032 lithium battery into the battery holder of the Tag Board and plug the Anchor Board into an USB port.

3. Start “ISP1510 UWB Demo” application on your Android, In the “Anchor part” click Connect and select your Anchor Board (UWB_ANC_SNxxx). Do the same for the Tag Board.

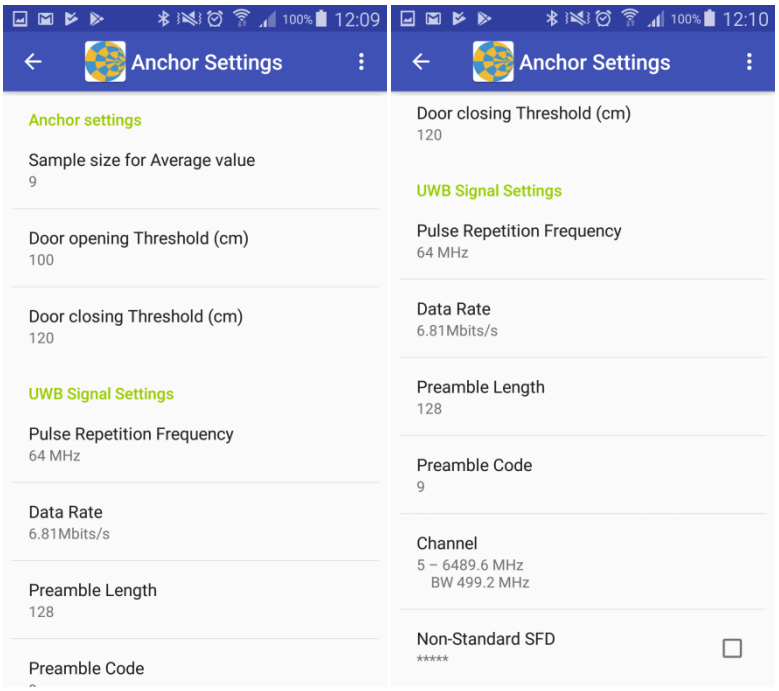


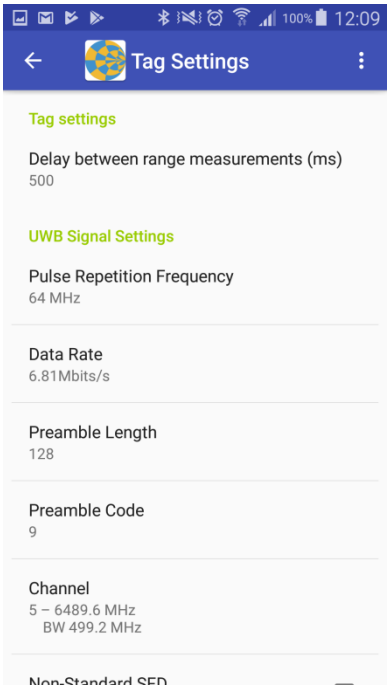
NB: Ranging data is only provided by the Anchor Board, thus only BLE connection to the Anchor Board is necessary.

4. Ranging should automatically starts at power up. Instant and average range should be updating.



5. By pressing the “Configure” buttons you have access to a number of settings of the Tag/Anchor.





The list of Anchor parameters is :

- Average : set the number of sample used to calculte the average range value
- Door opening Threshold : set distance which trigger the opening of the door in cm
- Door ClosingThreshold : set distance which trigger the the closing of the door in cm

The list of Tag parameters is:

- Delay : set the delay in ms between each range update in

The list of Decawave specific parameters is:

- Pulse Repetition Frequency : 16 MHz or 64 MHz
- Data Rate : 110 Kbit/s, 850 Kbits/s or 6.81 Mbits/s
- Preamble Length : 64, 128, 256, 512, 1024, 1536, 2048 or 4096 symbols
- Preamble Code : Preamble pattern selection
- Channel : Frequency channel selection
- Non-Standard SFD : Enable to use the DecaWave defined non-standard SFD

It is not recommanded to change this parameters.

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