ISP3010

Application note AN190702

Use of ISP3010 Development Kit



Introduction

Scope

This document gives details on hardware and software for using and testing Insight SiP Bluetooth Low Energy and UWB module ISP3010 (model ISP3010-UX).

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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*

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.
- SoftDevices for nRF52832.

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

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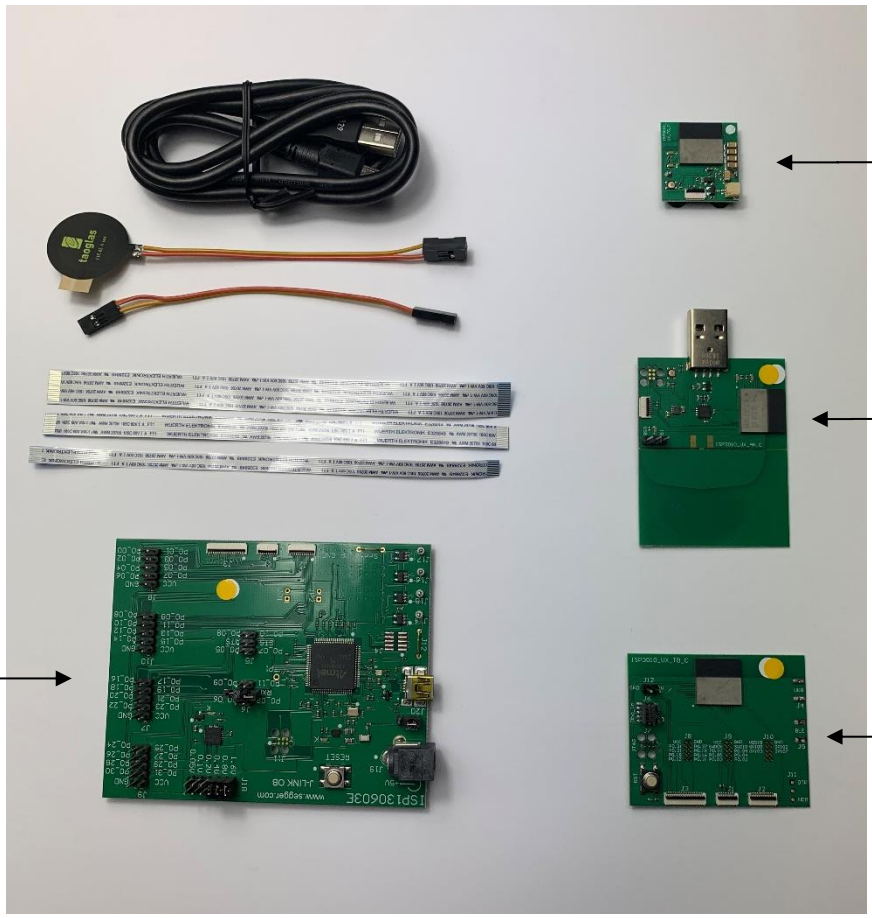
Other Insight SiP documents that complete the above

- AN1907 App Note – this document.
- DS3010 module data sheet.
- ISP3010-UX-TB Test Board schematic “Schematic_ISP3010-UX-TB”.
- ISP130603 Interface Board schematic “SC130604”.
- ISP3010 Tag Board schematic “Schematic_ISP3010-UX-TG”.
- ISP3010 Anchor Board schematic “Schematic_ISP3010-UX-AN”.

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2. Dev Kit Hardware Content

1 x USB cable
1 x NFC antenna
1 x 2-lead patch cable
1 x FPC 22 pin cable
1 x FPC 14 pin cable
1 x FPC 10 pin cable



1 x ISP1510-UX-TG
Tag Board

1 x ISP1510-UX-AN
Anchor Board

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

1 x ISP1510-UX-TB
Test Board

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3. Software Installation

This paragraph describes the steps to follow for software installation.

1. Download and install the IDE of your choice:

    a. 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, nRFDeviceFamilyPack, nRF examples…, etc …Note that the free Keil MDK-ARM IDE is limited to 30k file size. For large applications a paid license is required.

    b. Download and install Segger Embedded Studio (SES) from *https://www.segger.com/downloads*. Go to *https://license.segger.com/Nordic.cgi* and fill the form. A free license key will be emailed to you, start SES, go to Tools -> License Manager and activate your license. This option allows compilation and loading of large applications.

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

3. Go to www.nordicsemi.com. On the top menu go to "Products" then "Bluetooth Low Energy" then "nRF52832 mainstream SoC". Scroll down to find a menu:

    a. Compatible Downloads: You can download the nRF52 SDK and the appropriate Softdevice.

    b. Get started: Link to all the necessary documentation to work on nRF52832.

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). Alternatively nRF Connect for Desktop (with the programmer plug-in) can be used for programming. Go to *https://www.nordicsemi.com/Software-and-Tools/Development-Tools/nRF-Connect-for-desktop*, download and install the latest version, then install the "programmer" plugin.

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4. Hardware Description

4.1. ISP3010-UX Module



ISP3010-UX is a Bluetooth Low Energy and Ultra Wide Band module with integrated antennas.

Despite its small size of 14.0 x 14.0 x 1.5 mm, the ISP3010 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.

ISP3010 differentiates from other modules by integrating a multi band antenna in the package, to support both BLE frequency band at 2.4 GHz and UWB frequency band at 6.5 GHz. This is a new and unique concept developed by Insight SiP within a SIP package. In addition, this module also integrates all passives, crystals and DC/DC converters to optimize the power consumption for longer lifetime when operating on coin-cell batteries.

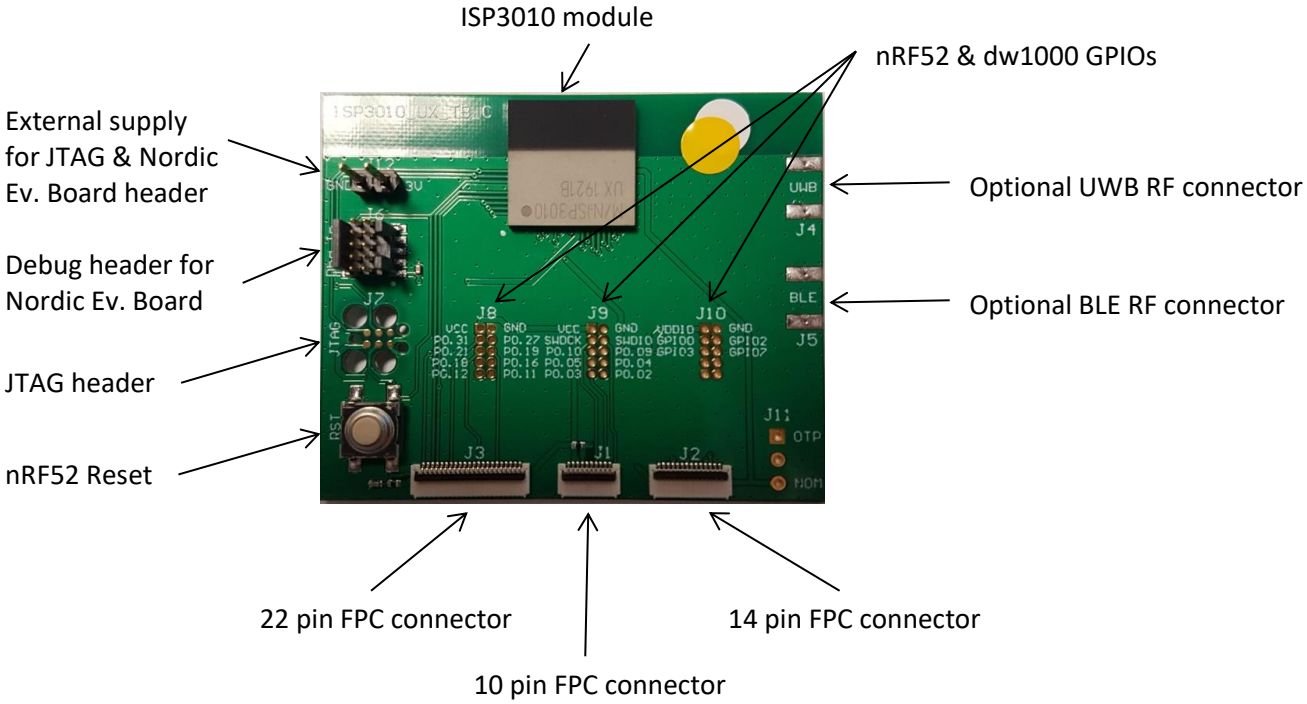
The ISP3010 module offers the perfect stand-alone ranging solution for short range security bubble applications, for standard location applications requiring typically 50 meters range from module to module, or even longer distances application when the ISP3010 is used in conjunction with optimized UWB anchor antennas.

For more details, see Insight SiP module data sheet (document DS3010).

4.2. ISP3010-UX-TB Test Board

The ISP3010-TB Test Board consists of a module mounted on a PCB for prototyping and testing purposes. It includes a connection to the ISP130603 Interface Board. ISP3010-UX-TB has dimensions of 45 x 55 mm².

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It encloses:

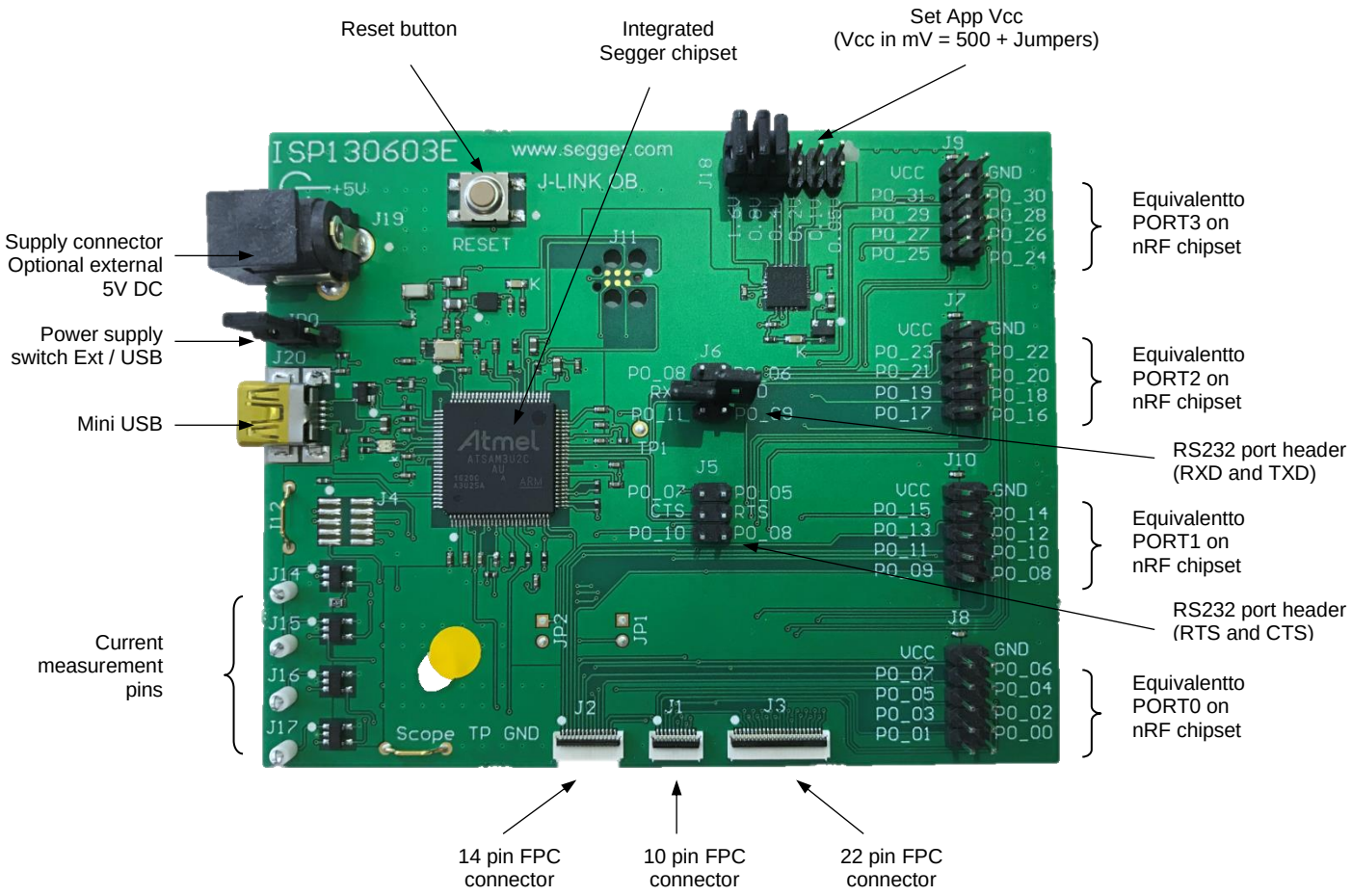
- ISP3010-UX UWB and BLE module
- 3 x FPC connectors in order to access the nRF52832 GPIOs with the interface board:
  - 1 x 10 pin FPC connector on top side of the board.
  - 1 x 14 pin FPC connector on top side of the board.
  - 1 x 22 pin FPC connector on top side of the board.
- 2 x footprints for optional 2x6 pin/1.27mm pitch connector for access to the nRF52 GPIOs.
- Footprints for 2x6 pin/1.27mm pitch connector for access to the dw1000 GPIOs.
- JTAG footprint for programming using 6 pin Segger Jlink Adapter.
  https://www.segger.com/products/debug-probes/j-link/accessories/adapters/6-pin-needle-adapter/
- 2x5 pin header for programming using Segger Jlink interface contained in Nordic Evaluation Board.
- 2-pin header for power supply when using 6 pin JTAG or Nordic JTAG programming options.
- Footprint for optional external UWB and BLE antenna.
- Reset button for the nRF52.

The ISP3010-UX-TB electrical schematic is presented in document Schematic_ISP3010-UX-TB.

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4.3. ISP130603 Interface Board

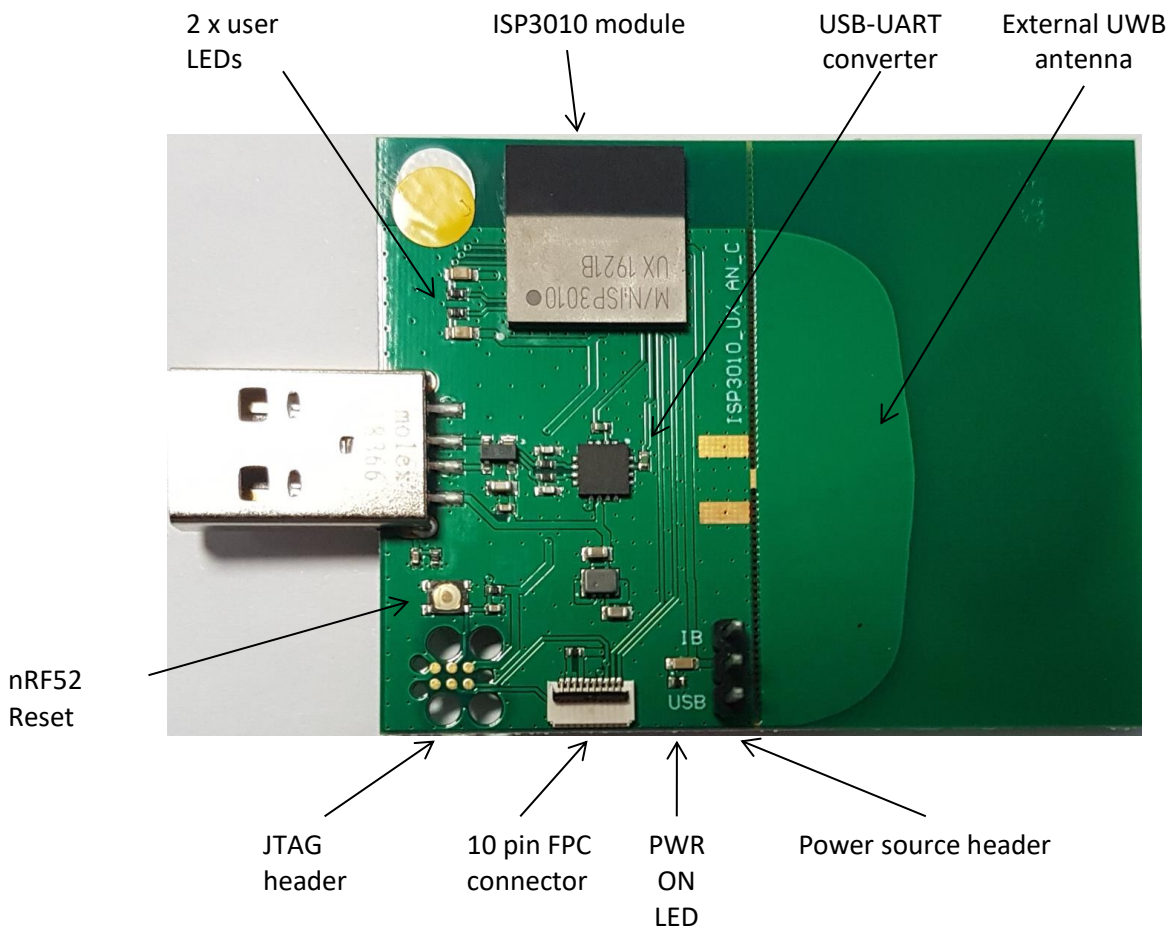
ISP130603 is the application type interface board that has dimensions of 100 x 80 mm².
The ISP130603 electrical schematic is presented in document SC130604.



4.4. ISP3010-AN Anchor Board

The ISP3010 Anchor board consists of a PCB integrating an ISP3010 module and a USB plug for connection to a PC port com. It enables the communication with a TAG through UWB standards. The ISP3010-AN Anchor board Gateway Board has dimensions of 60 x 47 mm².

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It encloses:

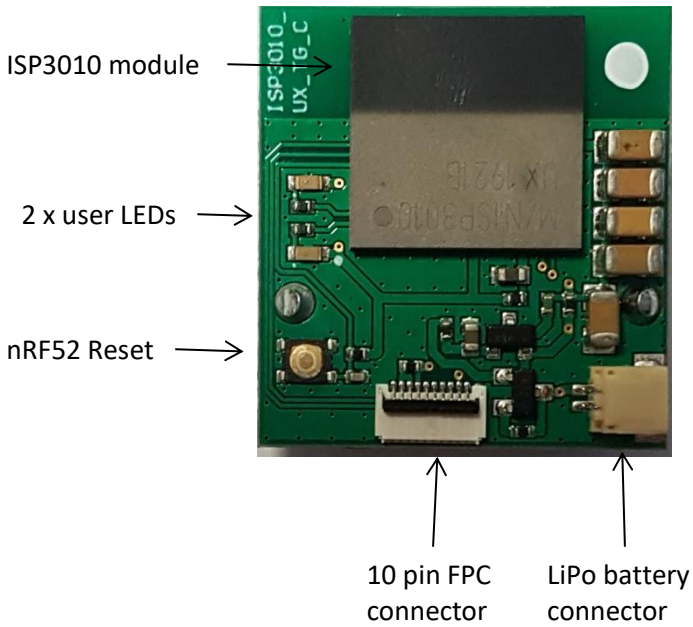
- ISP3010-UX UWB and BLE module
- 2 x user programmable mini-LEDs
- USB connector
- Removable 10 pin FPC connector for software loading
- JTAG footprint for programming using 6 pin Segger Jlink Adapter.
  https://www.segger.com/products/debug-probes/j-link/accessories/adapters/6-pin-needle-adapter/
- FTDI USB-to-Serial adapter
- UWB Antenna on PCB
- Power source header: put a jumper between the middle pin and
  - IB pin to power the board using the interface board (FPC connector).
  - USB pin to power the board using the USB connector

The ISP13010-AN Anchor Board electrical schematic is presented in the document Schematic_ISP3010-UX-AN.

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4.5. ISP3010-TG Tag Board

ISP3010 Tag Board consists of a small PCB integrating an ISP3010 module powered by a coin cell.
It has dimensions of 27 x 25 mm².



It encloses:

- ISP3010-UX UWB and BLE module
- 2 x user programmable mini-LEDs
- Battery holder on bottom side
- Removable 10 pin FPC connector for software loading
- LiPo battery connector

The ISP3010-TG Tag Board electrical schematic is presented in the document Schematic_ISP3010-UX-TG.

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5. UWB Applications

5.1. UWB source code

Insight SiP provides a package containing source code for different UWB applications. The package is available at our website at: https://www.insightsip.com/products/combo-smart-modules/isp3010.

Provided code examples are:
- Simple UWB transmission
- Simple UWB reception
- UWB continuous waveform generation
- Simple TWR application
- Two-way ranging demo (a complete ready to run BLE/UWB application that is configured to operate with our Smart Phone demo)

These applications are written to be run on ISP3010 (nRF52832 target).

The nRF52 part is based on Nordic SDK v15.3 available at *http://developer.nordicsemi.com/nRF5_SDK*.
The DW1000 part is based on Device Driver Version 05.01.

The following nRF52832's GPIO are used to communicate with the DW1000, therefore shouldn't be used for another purpose:
- P0.06: SPI Clock
- P0.07: Interrupt from DW1000
- P0.25: Active low Reset (Warning: Do not drive this GPIO high)
- P0.26: SPI Mosi
- P0.28: Wake up
- P0.29: SPI Chip Select
- P0.30: SPI Miso

The examples are made using Segger Embedded Studio.

Detailed ISP3010 source code directory tree shown below:

```
ISP3010_source_code
    ├─ hex                          // Precompiled examples
    └─ src
        ├─ apps
        │   ├─ ranging_demo         // Ranging demo project files
        │   ├─ simple_twr_initiator // Simple UWB two-ranging example
        │   ├─ simple_twr_responder // Simple UWB two-ranging example
        │   ├─ simple_uwb_rx        // Simple UWB reception example
        │   ├─ simple_uwb_tx        // Simple UWB transmission example
        │   └─ uwb_cw               // Continuous waveform transmission example
        ├─ boards                   // Board and  module specific files
        └─ nRF5_SDK_15.3.0_59ac345  // Nordic SDK v15.3.0
```


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The Nordic SDK is not included in the archive. Download nRF5_SDK_15.3.0_59ac345.zip and extract to <Your directory>\src.

5.2. Range demo

Description

This paragraph shows you how to set up the Insight SiP's Range application between the Anchor board and the Tag Board. The range is calculated using UWB and results are sent via the Bluetooth link 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.

The demonstration requires the use of an Android device. The Android application is available on Google Play.

An App is 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 module capabilities.

Firmware loading on ISP3010-UX-TG

1. Connect the ISP3010-UX-TG to the ISP130603 Interface Board with the 10 pin FPC jumper cable (0.5 mm pitch, provided in the Development Kit). Connect the provided USB cable from the Interface Board ISP130603 to your computer.
   Refer to picture of the hardware configuration below.

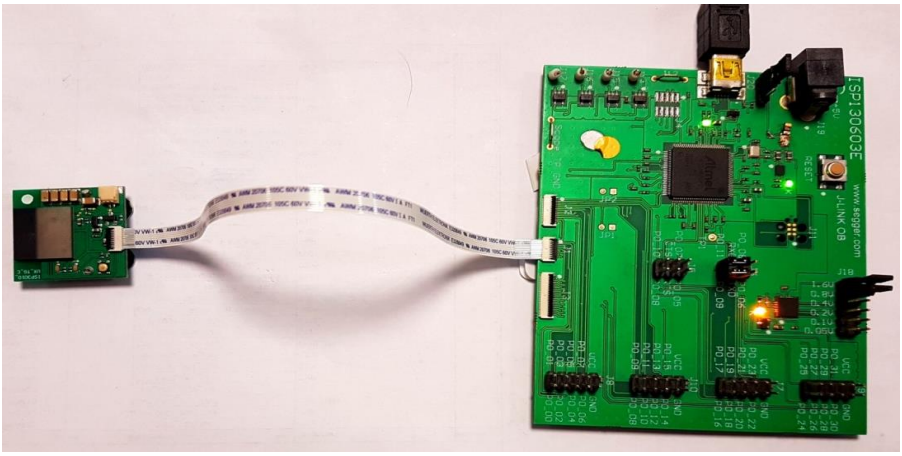


Figure1: ISP3010-UX-TG firmware loading via embedded JTAG in Interface Board

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2. Start nRF Connect Programmer, drag and drop s132_nrf52_6.1.1_softdevice.hex and TWR_Demo_Initiator.hex files in the “File Memory Layout” box, and click “Erase & write”.

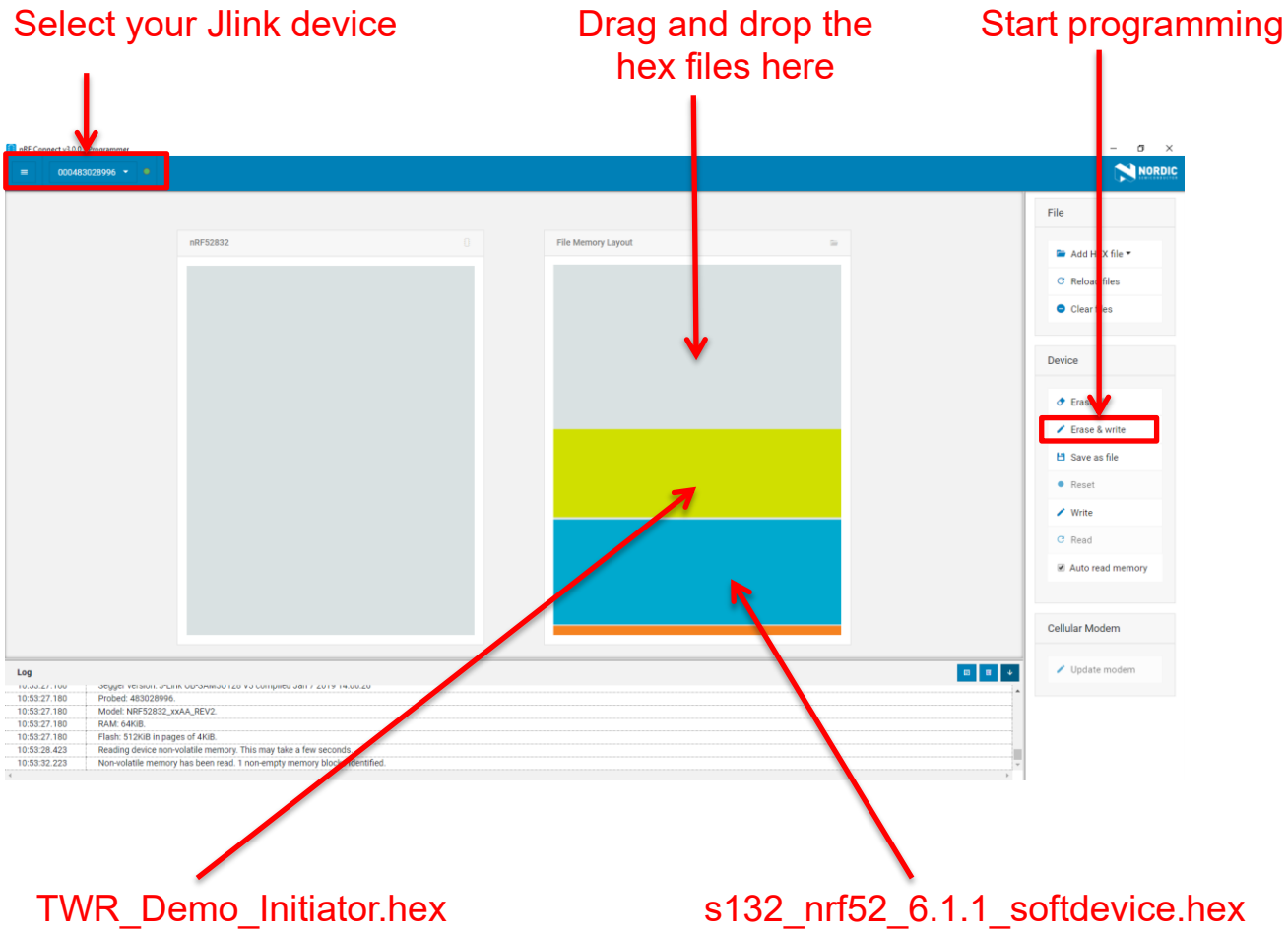


Figure 2: Loading ranging demo in tag with nRF Connect

Firmware loading on ISP3010-UX-AN

1. Select one of the methods:

   a. Connect the ISP3010-UX-AN to the ISP130603 Interface Board with the 10 pin FPC jumper cable (0.5 mm pitch, provided in the Development Kit). Connect the provided USB cable from the Interface Board ISP130603 to your computer. Set the power source to IB.

   b. Plug the ISP3010-UX-AN USB to your computer. Connect an external JLINK probe with 6-pin connector (not provided in the kit) to the ISP4520-GW JTAG connector. Set the power source to USB.

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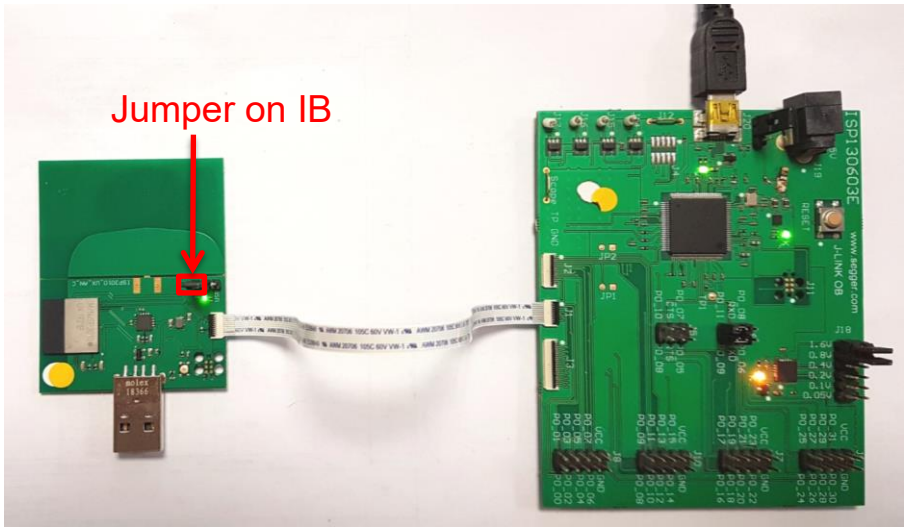


Figure 3: ISP3010-UX-AN firmware loading via embedded JTAG in Interface Board

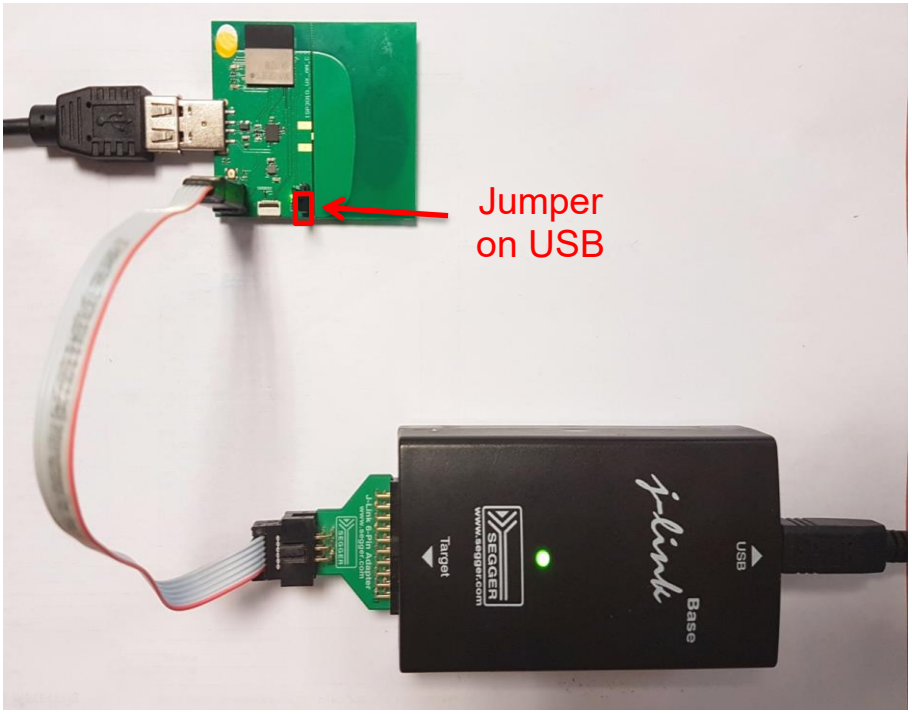


Figure 4: ISP3010-UX-AN firmware loading via JTAG using Segger JLink with 6 pin adapter- the USB cable is required to power the board

2. Start nRF Connect Programmer, drag and drop s132_nrf52_6.1.1_softdevice.hex and TWR_Demo_Responder.hex files in the “File Memory Layout” box, and click “Erase & write

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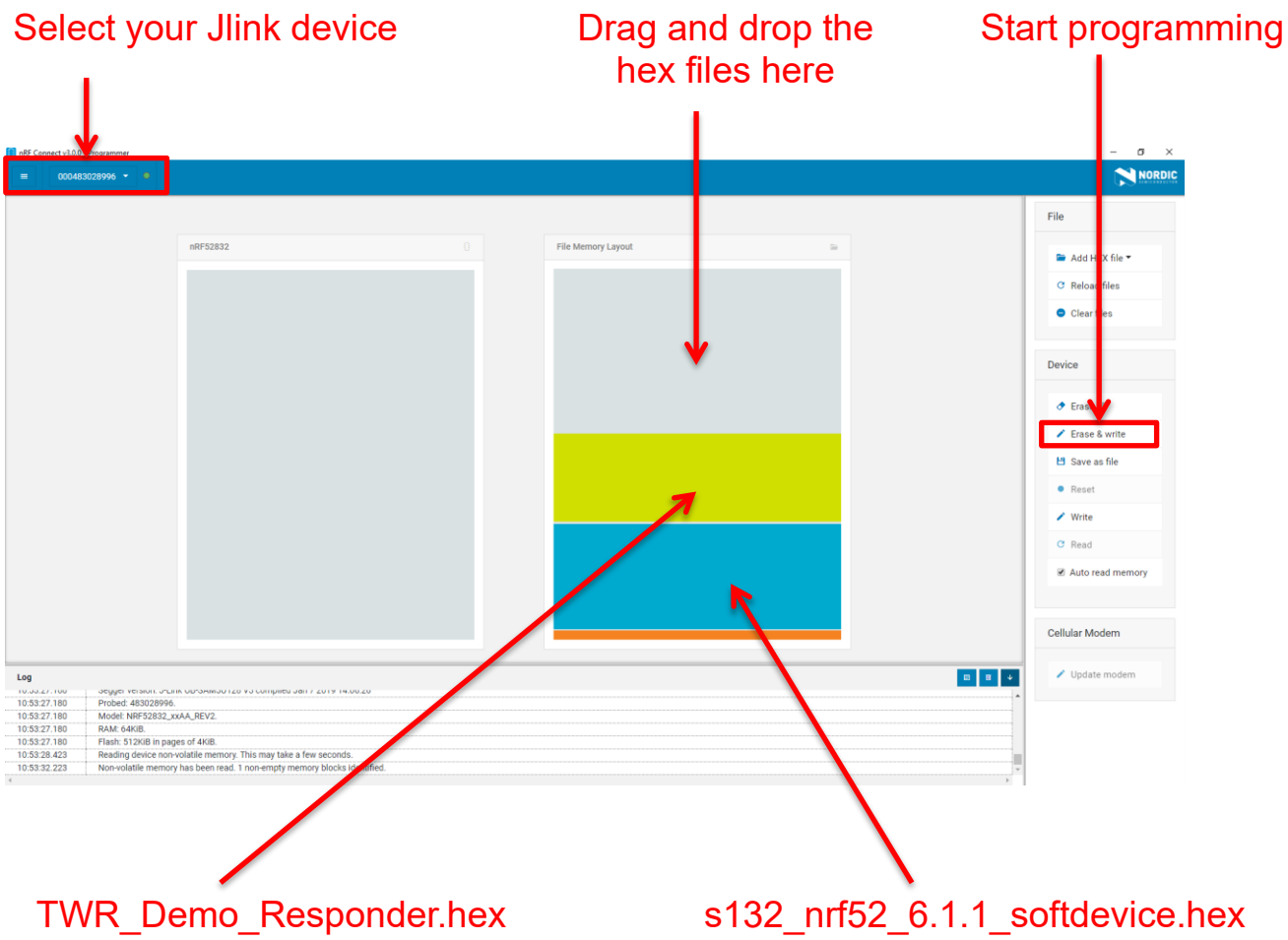


Figure 5: Loading ranging demo in anchor with nRF Connect

Testing

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

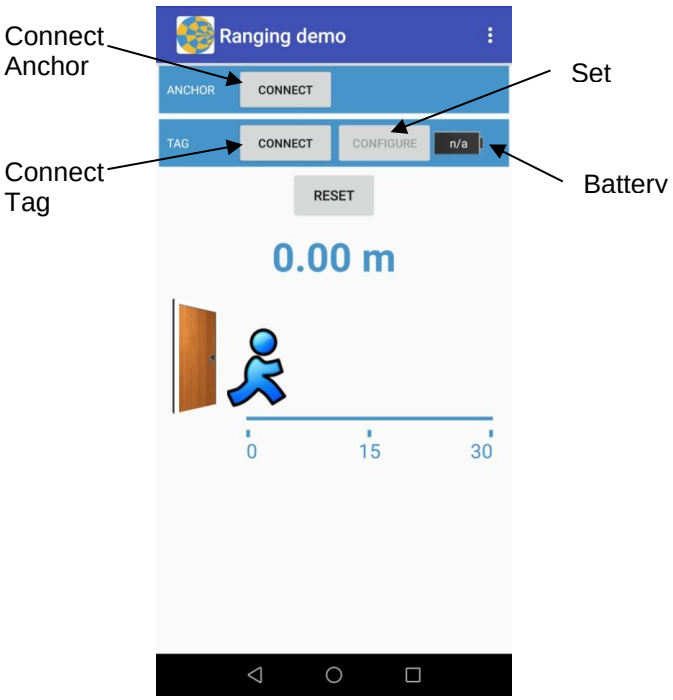
After the application is downloaded and installed you should see the application on your Android device. Then you will be able to set up the application demonstration as follows:

1. 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).

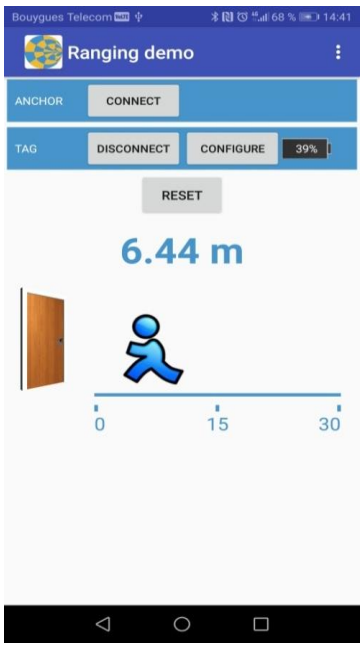
2. Power up both boards: Place the CR2032 lithium battery into the battery holder of the Tag Board and plug the Anchor Board into an USB port or USB battery power supply.

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3. Start “Ranging Demo” application on your Android, you can establish a BLE connection with the Tag, the Anchor or both by clicking the “connect” buttons.



4. Ranging should automatically start at power up. Range should be updating.



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5. By pressing the “Configure” button you can set the Range measurement interval (default 300ms). This setting is only relevant for the Tag as it is the one which initiates the ranging operation.

5.3. Simple UWB transmission & reception

Description

The uwb_tx and uwb_tx examples show an easy implementation of transmitting and receiving uwb frames. The uwb_tx firmware will configure the ISP3010 to transmit a “Hello world” every second.
The uwb_rx firmware will configure the ISP3010 to set its uwb receiver on. Any received uwb frames will be retransmit as RTT logs. RTT logs can be displayed using Segger embedded Studio or using the standalone JLinkRTTViewer.exe.

Firmware loading

See chapter Range demo chapter.

Testing

Connect the receiver to the interface board or a JLink probe. Start JLinkRTTViewer.exe. Fill the JLink configuration as shown in Figure 6: Link RTT configuration.

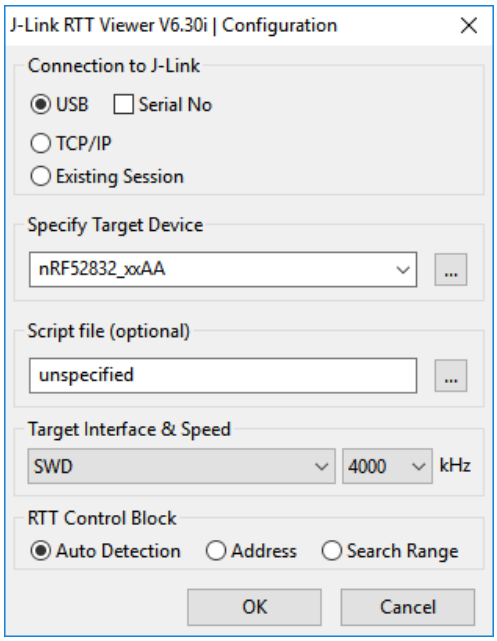


Figure 6: Link RTT configuration

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The following logs should appear:

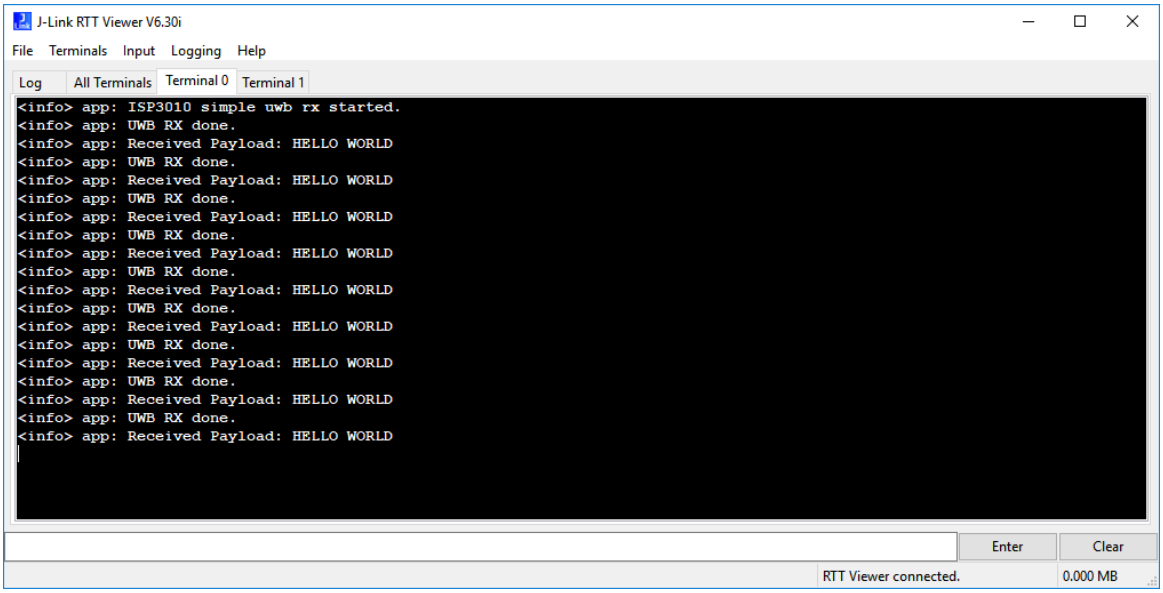


Figure 7: uwb_rx example logs

5.4. Simple UWB two way ranging

Description

The simple_twr_initiator and simple_twr_responder examples show an easy implementation of two way ranging. Here, the initiator (loaded with simple_twr_initiator firmware) transmits an “init” frame every 500ms. The responder (loaded with simple_twr_responder firmware) is in RX mode all the time. When it receives an “init” frame, it responds with a “resp” frame containing all the necessary for the initiator to compute the range between these 2 devices.

Both ‘init” and ‘resp” message follow the 802.15.4 frame structure.

Type	Frame Control	Sequence Number	PAN ID	Destination Address	Source Address	Payload	CRC
Bits	2	1	2	2	2	Variable	2
Init	0x4188	0 to 255	0xdeca	“d2”	“d1”	Bit 0: 0x51	-
Resp	0x4188	0 to 255	0xdeca	“d1”	“d2”	Bit 0: 0x52 Bits 1-4: init_rx timestamp Bits 5-8: resp_tx timestamp	-

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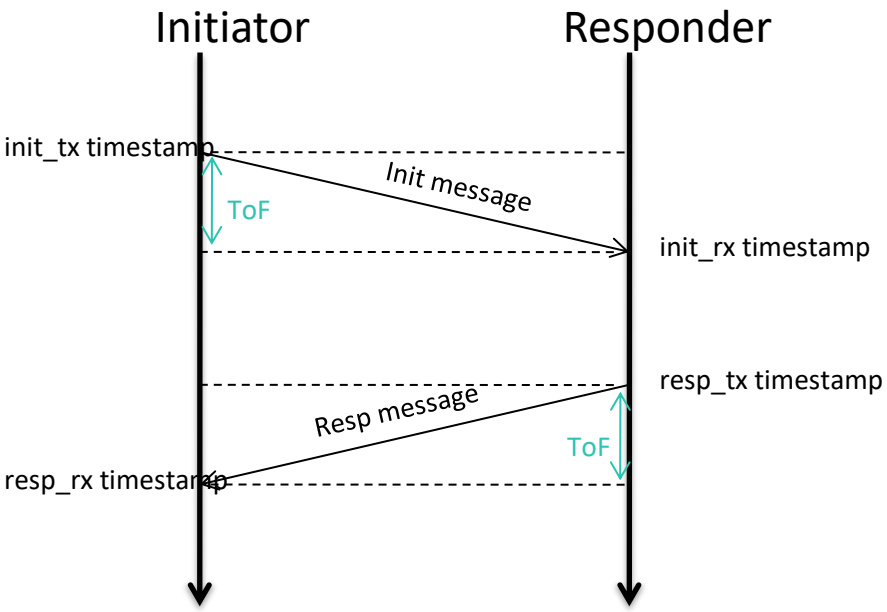


Figure 8: Two way ranging

The initiator can calculate the time of flight (ToF) using the formula:

$$ToF = \frac{(resp_{rx} - init_{tx} - resp_{tx} + init_{rx})}{2}$$

Where:

- Resp_rx is the timestamp of the “resp” message reception.
- Init_tx is the timestamp of the “init” message transmission.
- Resp_tx is the timestamp of the “resp” message transmission.
- Init_rx is the timestamp of the “init” message reception.

The range is then:

$$Range = ToF * SpeedOfLight$$

Firmware loading

See chapter Range demo chapter.

Testing

Connect the initiator to the interface board or a JLink probe. Start JLinkRTTViewer.exe. Fill the JLink configuration as shown in Figure 6: Link RTT configuration.

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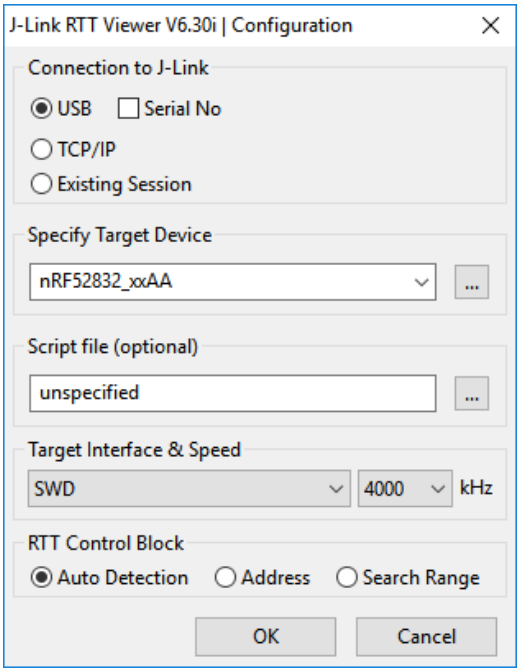


Figure 9: JLink RTT configuration

The following logs should appear:

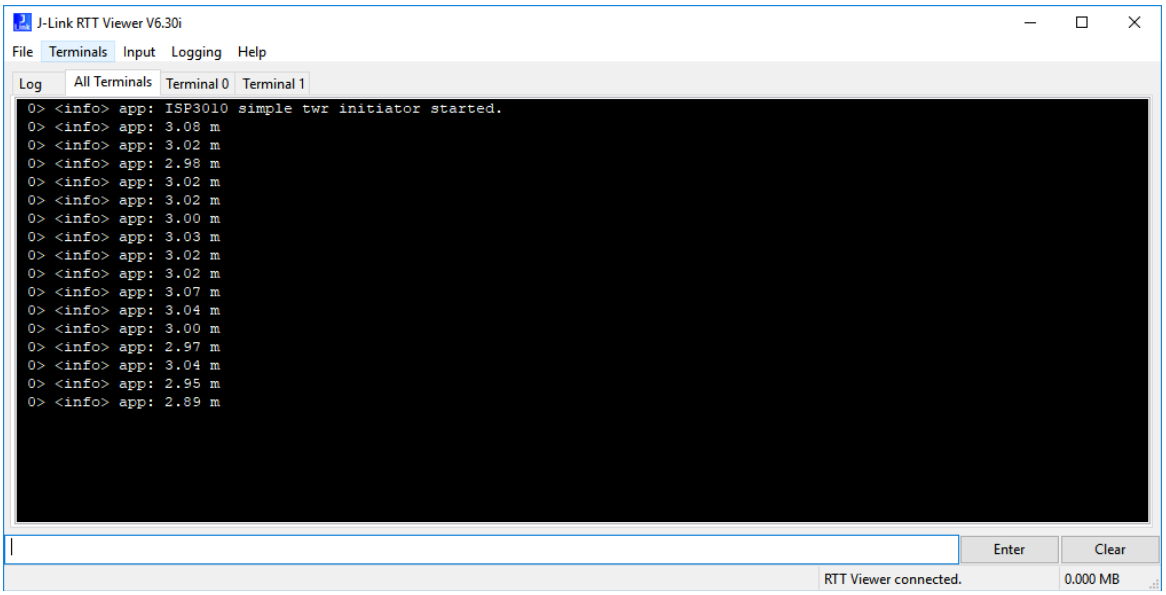


Figure 10: simple_twr example logs

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6. BLE Application

6.1. Preliminary

This paragraph shows you how to set up and program a simple BLE application. The example shown in this chapter is the proximity application. This application alerts the user when connected devices are too far apart.

For information about other BLE applications please refer to the ISP1507 application note available at https://www.insightsip.com/products/bluetooth-smart-modules/isp1507.

6.2. Firmware loading

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

2. Select one of the methods:

   a. Connect the ISP4520-TB to the ISP130603 Interface Board with the 10 pin FPC jumper cable (0.5 mm pitch, provided in the Development Kit). Connect the provided USB cable from the Interface Board ISP130603 to your computer.

   b. Plug the ISP4520-TB USB to your computer. Connect an external JLINK probe with 6-pin connector (not provided in the kit) to the ISP4520-TB JTAG connector.

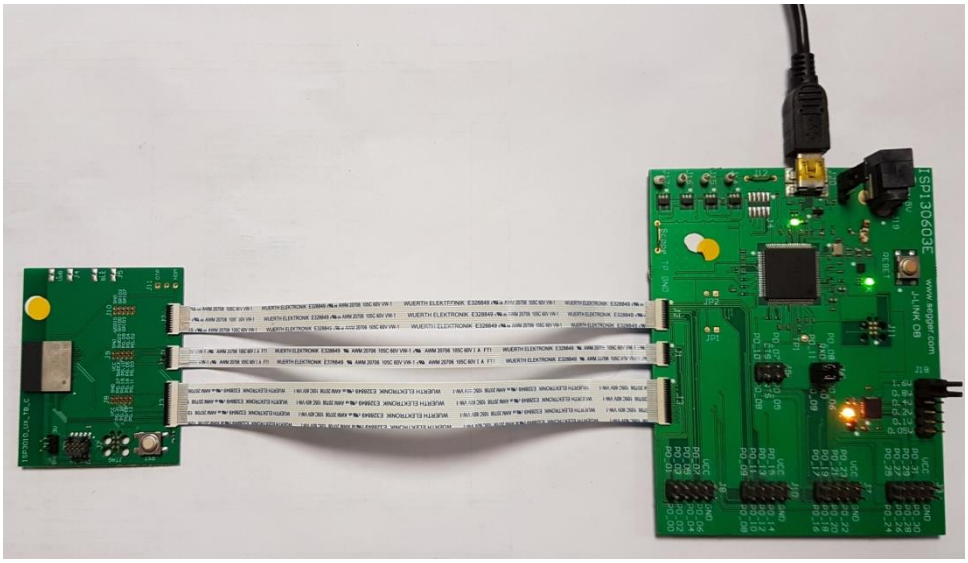


Figure 11: ISP3010-UX-TB firmware loading via embedded JTAG in Interface Board

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Specification subject to change without notice.

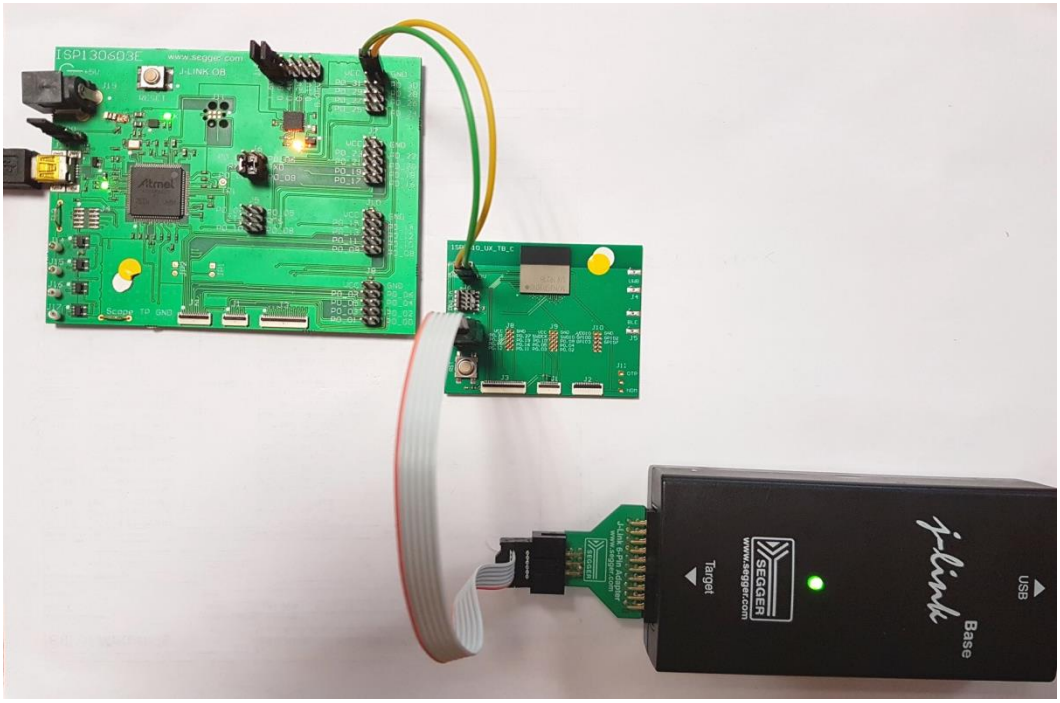


Figure 12: ISP3010-UX-TB firmware loading via JTAG using Segger JLink with 6 pin adapter- the board is powered by3V from the interface board or other 3V power supply

Start nRF Connect Programmer, drag and drop the ble_app_proximity_pca10040_s132.hex in the “File Memory Layout” box, and click “Erase & write”.The .hex is located in <your Nordic SDK> \examples\ble_peripheral\ble_app_proximity\hex

Software window shown below.

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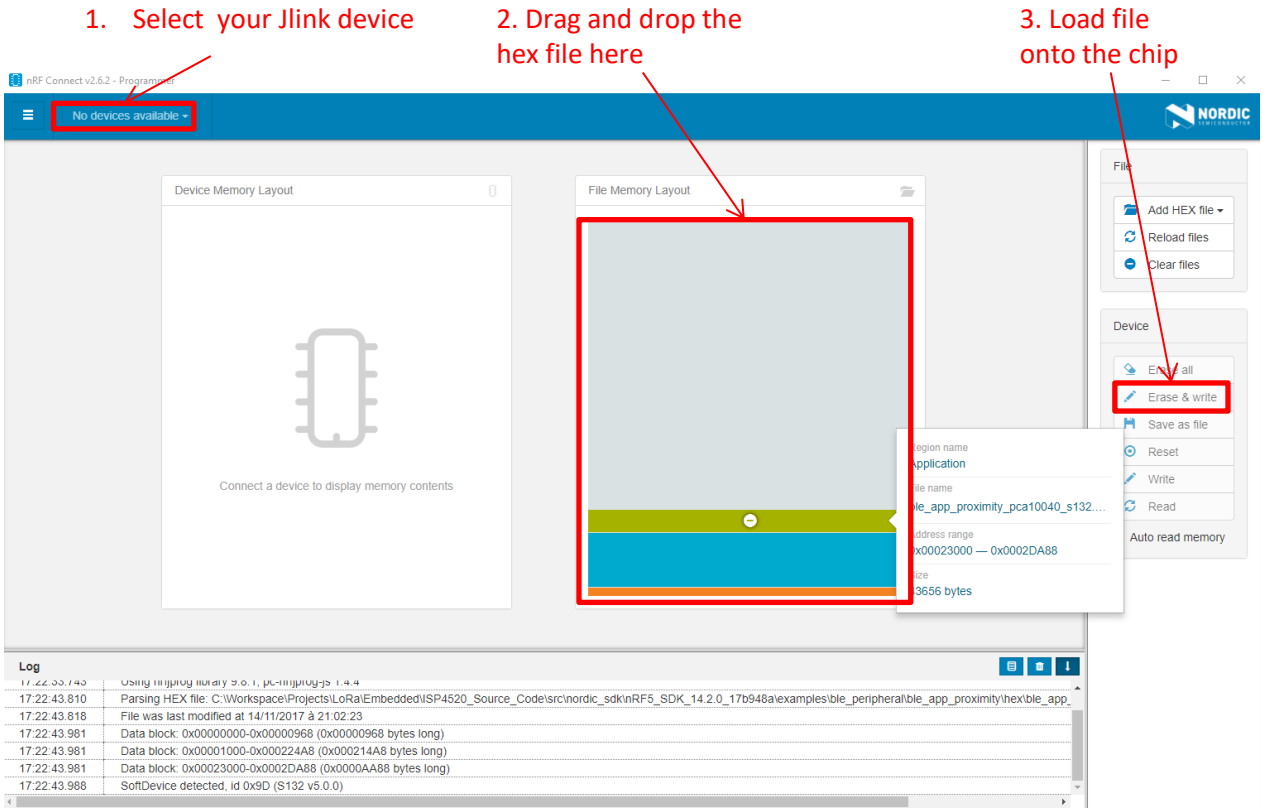


Figure 13: Loading "ble_app_proximity_pca10040_s132" with nRF Connect

6.3. Testing on smartphone

1. On a smartphone download and install the nRF Toolbox application. The application is available on both iOS and Android.

2. Start nRF Toolbox and select PROXIMITY.

3. Click ADD DEVICE to start scanning for suitable BLE devices. The proximity application advertises as “Nordic_prox”. Select the device you want to connect to.

1. Now the user should be notified when both devices are getting far away.

   Smartphone window examples shown below.

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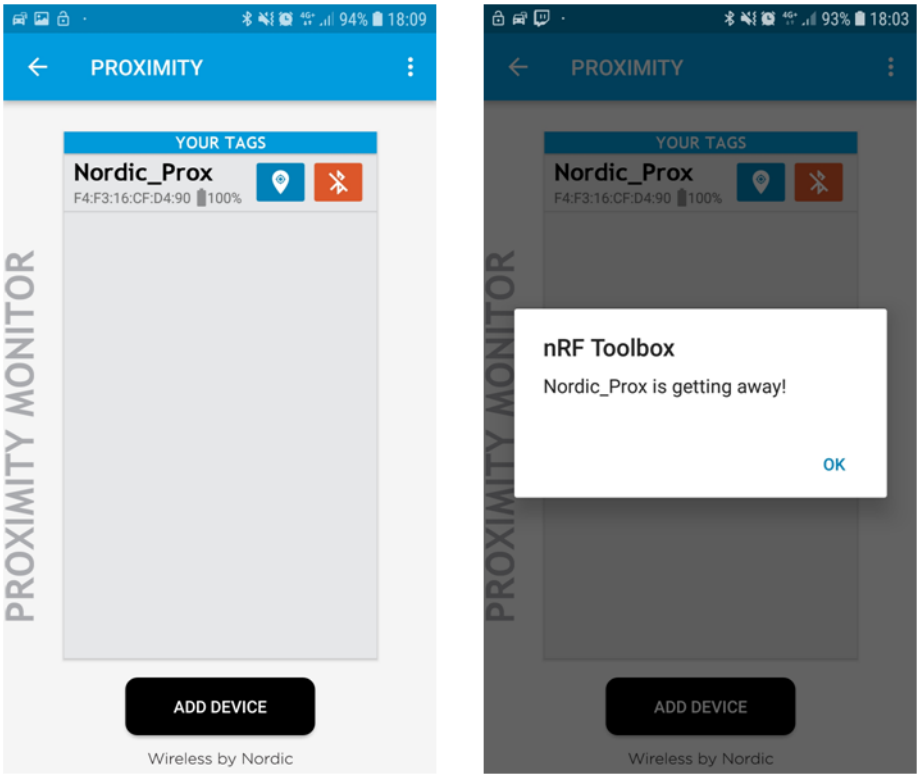


Figure 14: Proximity application

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