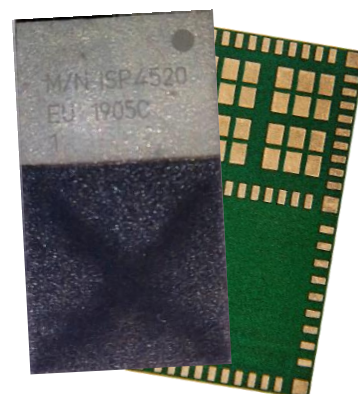


ISP4520

Application note AN190301



Use of ISP4520 Development Kit



Introduction

Scope

This document gives details on hardware and software for using and testing Insight SiP Combo LoRa - BLE module ISP4520

Contents

1.	Recommended Documentation.....	3
2.	ISP4520 Dev Kit Hardware Content.....	5
3.	Software Installation.....	6
4.	Hardware Description	7
4.1.	ISP4520 Module	7
4.2.	ISP4520-TB Test Board.....	7
4.3.	ISP4520-GW Gateway Board	8
4.4.	ISP130603 Interface Board.....	10
4.5.	ISP4520 Hardware setup.....	11
5.	LoRa Applications	12
5.1.	LoRa SDK.....	12
5.2.	Temperature transmission from ISP4520-TB to ISP4520-GW.....	13
5.3.	Ping-Pong	19
5.4.	End device	21
5.5.	Class A LoRaWAN node.....	22
6.	BLE Application	23
6.1.	Preliminary.....	23
6.2.	Firmware loading	23
6.3.	Testing on smartphone	25



Revision History

Revision	Date	Ref	Change Description
R0	04/04/2019	jf pg	Preliminary release
R1	17/07/2019	jf pg	Minor typo update
R2	10/03/2020	jf pg	Minor typo update
R3	18/02/2021	jf pg	Update linked to LoraWAN 1.0.4 spec evolution
R4	09/06/2022	pd pg	Document layout update

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, go to:

- ✚ Official Nordic Semi website <http://www.nordicsemi.com>
- ✚ 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

- ✚ nRF Connect for Desktop
- ✚ 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.






Semtech Documents

- ✚ SX1261-SX1262 Product Datasheet
- ✚ SX1261 Calculator Tools
- ✚ Semtech Application Notes concerning SX1261/SX1262 and LoRa

To access documentation, information, go to <https://www.semtech.com/products/wireless-rf/lora-transceivers/sx1261>

Other Insight SiP documents

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

-  AN190301 App Note – this document.
-  DS4520 module data sheet.
-  ISP4520-XX-GW Gateway Board schematic “ISP4520C_GW_SCH”.
-  ISP4520-XX-TB Test Board schematic “ISP4520C_TB_SCH”
-  ISP130603 Interface Board schematic “SC130604”.

2. ISP4520 Dev Kit Hardware Content



Figure 1: ISP4520 Dev Kit content

3. Software Installation

This paragraph describes the steps to follow for software installation.

1. Download and install the IDE:
 - 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, nRF DeviceFamilyPack, 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 and log in to your Nordic My Page account.

Go to Products and click on Low power short-range wireless. You will have access to the different product:

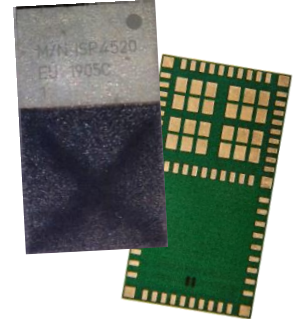
 - a. nRF52 Series: Click on nRF52832 SoC and on the download section you have access to the documentation, SoftDevice, nRFgo studio, SDK ... etc ...
 - b. nRF52 Development Tools: You can download the last nRF5 SDK.
4. You can also download the SDK in the following link: <https://developer.nordicsemi.com/>.
5. 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.

4. Hardware Description

4.1. ISP4520 Module

ISP4520 is a LoRa and Bluetooth Low Energy module with integrated antennas.

Despite its small size of 9.8 x 17.2 x 1.7 mm, the ISP4520 module integrates the Semtech SX1261-SX1262 chipset which is a LoRa transceiver dedicated to long range IoT applications. This chipset needs an external processor to operate and is coupled with the Nordic Semi nRF52832 SoC. In addition to the powerful ARM Cortex M4F MCU, this chip also provides BLE connectivity for wireless set up and control of the LoRa chip.



The ISP4520 also integrates all passives, crystals and DC/DC converters to optimize the power consumption. And last but not least, it integrates a LoRa-BLE dual band antenna in the same package. This is a new and unique concept developed by Insight SiP within a SiP package, it allows using a proprietary antenna located inside the SiP module.

The ISP4520 has 3 variants:

- ✚ ISP4520-EU: Integrates the Semtech SX1261 and the LoRa RF is optimized for 868 MHz.
- ✚ ISP4520-US: Integrates the Semtech SX1262 and the LoRa RF is optimized for 915 MHz.
- ✚ ISP4520-JP: Integrates the Semtech SX1261 and the LoRa RF is optimized for 923 MHz.

For more details, see Insight SiP module data sheet (document DS4520 module data sheet).

4.2. ISP4520-TB Test Board

The ISP4520-TB Test Board / Mote consists of a module mounted on a PCB for prototyping and testing purposes. It includes a connection to the ISP130603 Interface Board. ISP4520-TB has dimensions of 55 x 75 mm².

It includes:

- ✚ ISP4520 LoRa - BLE module
- ✚ 4 x footprint for optional 2x5 pin / 1.27mm pitch connector for access to the ISP4520 GPIOs.
- ✚ 10 pin FPC connector on top side of the board.
- ✚ 14 pin FPC connector on top side of the board.
- ✚ 22 pin FPC connector on top side of the board.
- ✚ 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/>
- ✚ 2 x 5pin 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 LoRa antenna.

The ISP4520C_TB electrical schematic is presented in the document ISP4520C_TB_SCH.

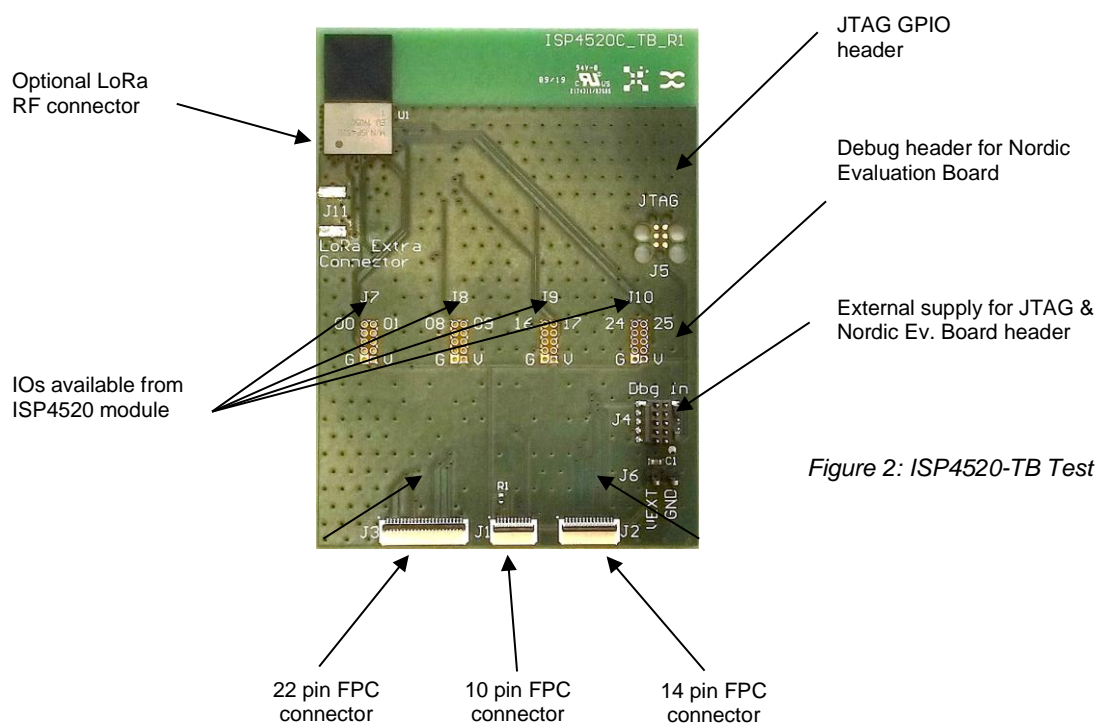
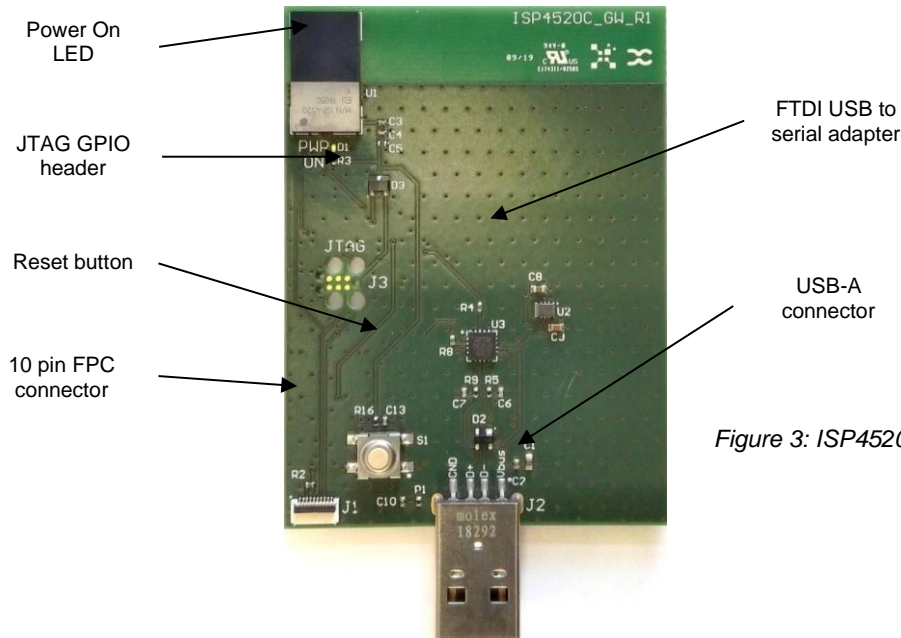


Figure 2: ISP4520-TB Test Board

4.3. ISP4520-GW Gateway Board



The RX Test Board / Gateway consists of a PCB integrating an ISP4520 module and a USB plug for connection to a PC port com. It enables the communication with a TX Test Board / Mote in a point to point connectivity mode through LoRa standards. ISP4520-GW Gateway Board has dimensions of 55 x 75 mm².

It includes:

- ISP4520 LoRa-BLE module
- 1 x mini-LED for Power ON indication
- USB-A connector
- 10 pin FPC connector for software loading via ISP130603 Interface board
- FTDI USB-to-Serial adapter
- Switch button for ISP4520 reset sequence

The ISP4520C_GW electrical schematic is presented in document ISP4520C_GW_SCH.

4.4. 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.

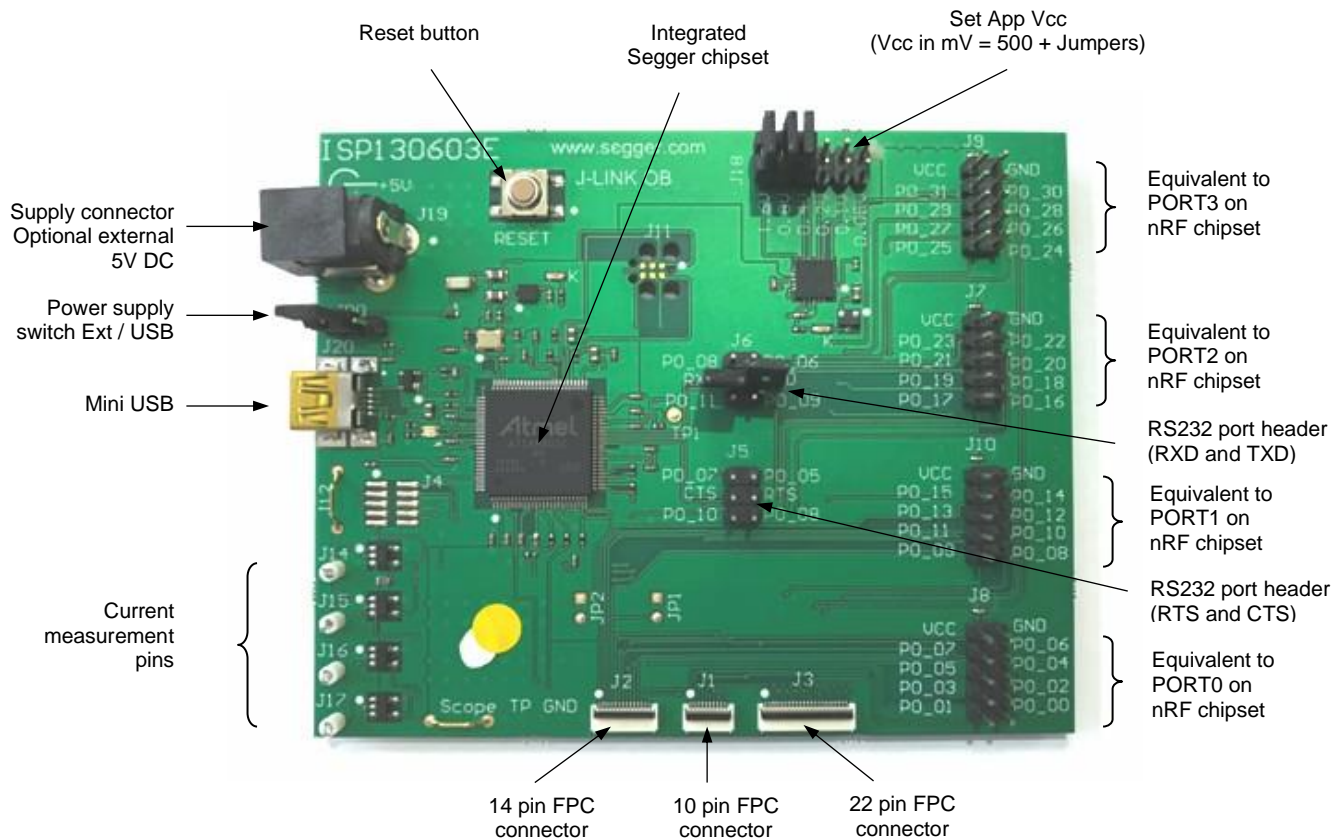


Figure 4: ISP130603 Interface Board

4.5. ISP4520 Hardware setup

For normal operation, supply voltage is set either by the Interface board or by external supply. It can be set between 2.2V and 3.6V max.







Warning

It is imperative to avoid powering the test boards from more than one power source at a time. This applies to both IS4520-TB and ISP4520-GW. This could lead to permanent damage to the ISP4520 module.

5. LoRa Applications

5.1. LoRa SDK





Insight SiP provides an SDK package containing source code for different LoRa applications. The package will be supplied to ISP4520 module and Dev Kit customers on demand:

-  Continuous waveform transmission: Transmit a constant frequency signal, used for debugging purpose.
-  Ping-Pong: Exchange simple LoRa packets between 2 devices
-  Temperature: Transmit LoRa packets containing temperature data from the ISP4520-TB to the ISP4520-GW
-  A “Hello world” type LoRaWAN example (LoRaWAN gateway required)
-  An example of implementation of LoRaWan AT commands
-  These applications are written to be run on ISP4520 (nRF52832 target).

The nRF52 part is based on Nordic SDK v14.2.0 available at https://developer.nordicsemi.com/nRF5_SDK/nRF5_SDK_v14.x.x

The LoRa part is based on Semtech/StackForce implementation from the master branch (4.4.1 release). It is available at: <https://github.com/Lora-net/LoRaMac-node/tree/master>

The following nRF52832 hardware is used by the LoRa part and therefore shouldn't be used for other applications:

-  RTC2
-  SPI0 on pins P0.23, P0.25 and P0.26
-  GPIO on pins P0.11, P0.19, P0.24 and P0.27
-  GPIOTE on pin P0.11

The LoRa examples can be download at <https://github.com/insightsip/ISP4520-examples>. The directory tree is shown below in Figure 5.

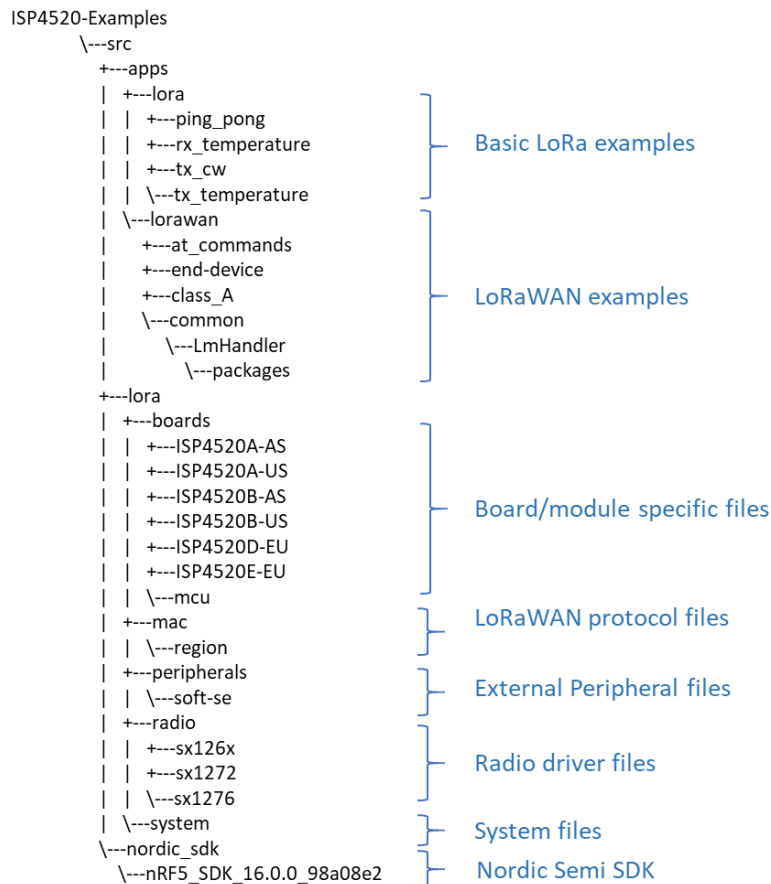


Figure 5: LoRa SDK directory tree

A LoRa RX/TX switch is integrated in the ISP4520. The state of this switch is controlled by the DIO2 pin of the SX126x. The SX126xdriver provides a function called `SX126xSetDio2AsRfSwitchCtrl()` that allows to do it automatically.

The power of the switch is supplied by the DIO3 pin of the SX126x. This allows to power down the switch and the TCXO when they are not needed. The SX126x driver provides a function called `SX126xSetDio3AsTcxoCtrl()` that allows to do it automatically.

5.2. Temperature transmission from ISP4520-TB to ISP4520-GW

Description

In this example, one of the modules is configured as “LoRa temperature transmitter”; it measures the local temperature using its embedded temperature sensor and then transmits the result via LoRa packets to another module configured as “LoRa temperature receiver”. The receiver displays the remote temperature on a serial terminal such as RealTerm (<https://sourceforge.net/projects/realterm>)

The “LoRa temperature transmitter” firmware is located in:

ISP4520-Examples\src\apps\lora\tx_temperature

The “LoRa temperature receiver” firmware is located in:

ISP4520-Examples\src\apps\lora\rx_temperature

Note: By default, in the development kit, the ISP4520_TB is loaded with the “LoRa temperature transmitter” firmware and the ISP4520_GW is loaded with the “LoRa temperature receiver” firmware.

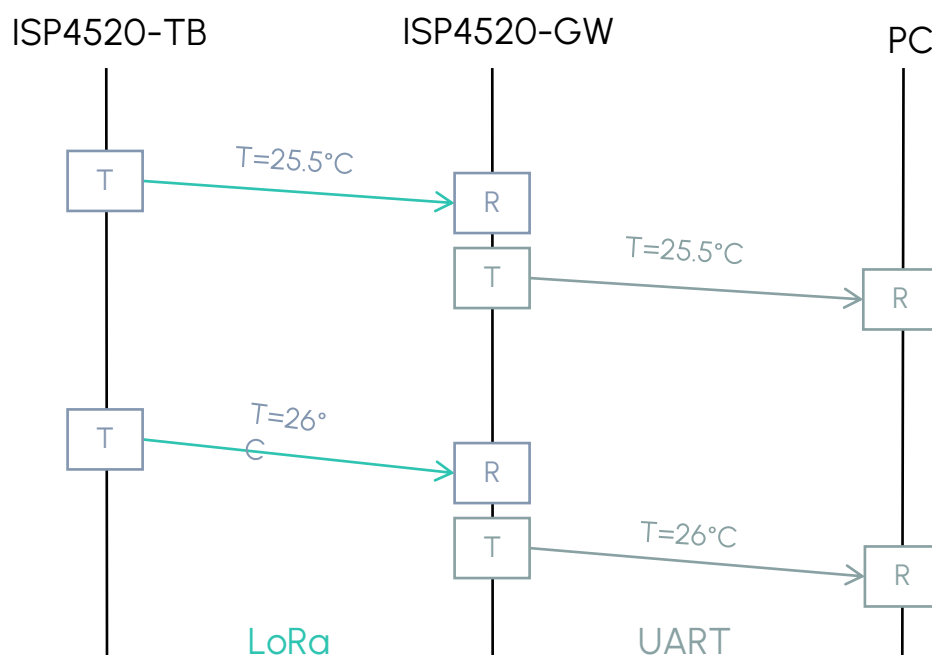


Figure 6: Temperature example

Firmware loading on ISP4520-TB

1. 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.

Refer to picture of the hardware configuration below.

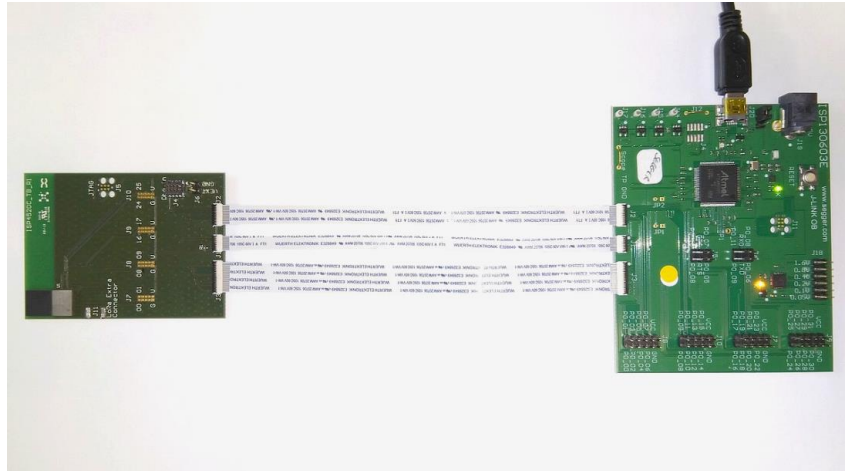


Figure 7: ISP4520-TB firmware loading via embedded JTAG in Interface Board

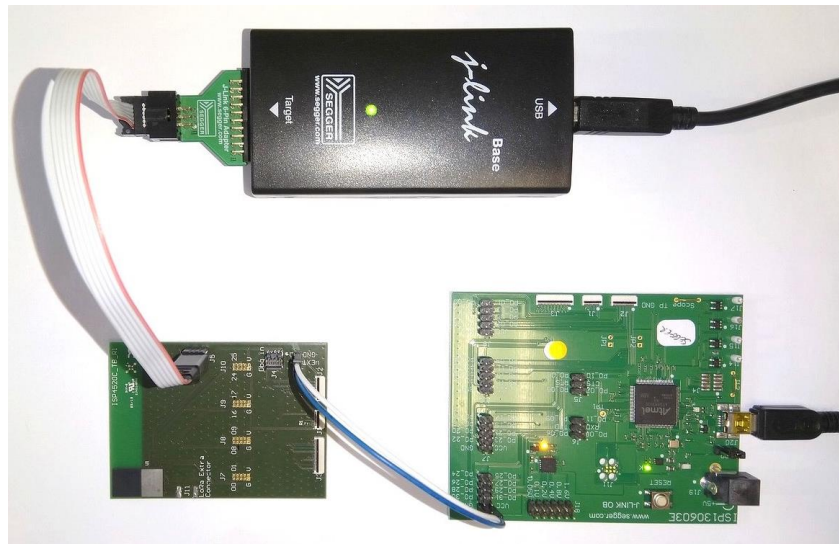


Figure 8: ISP4520-TB firmware loading via JTAG using Segger JLink with 6 pin adapter

2. Using Segger Embedded Studio, open the solution named “tx-temperature.emProject” in <Root directory>\ISP4520-Examples\s\r\apps\lora\tx_temperature\ses.
3. The solution contains 3 projects, one for each region EU, AS and US. Select project corresponding to the module variant, right click on it and click “Set as active project”.
4. Go to Build -> Select “Build and Run”

Firmware loading on ISP4520-GW

1. Select one of the methods:
 - a. Connect the ISP4520-GW 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-GW USB to your computer. Connect an external JLINK probe with 6-pin connector (not provided in the kit) to the ISP4520-GW JTAG connector.

Refer to picture of the hardware configuration below.

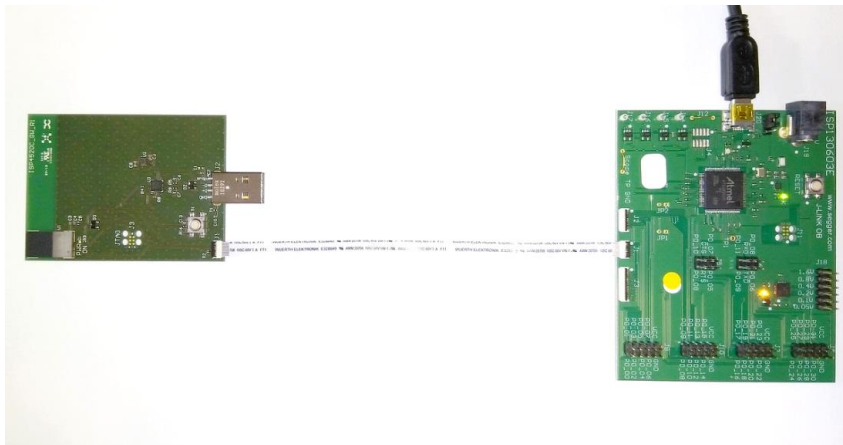


Figure 10: ISP4520-GW firmware loading via embedded JTAG in Interface Board

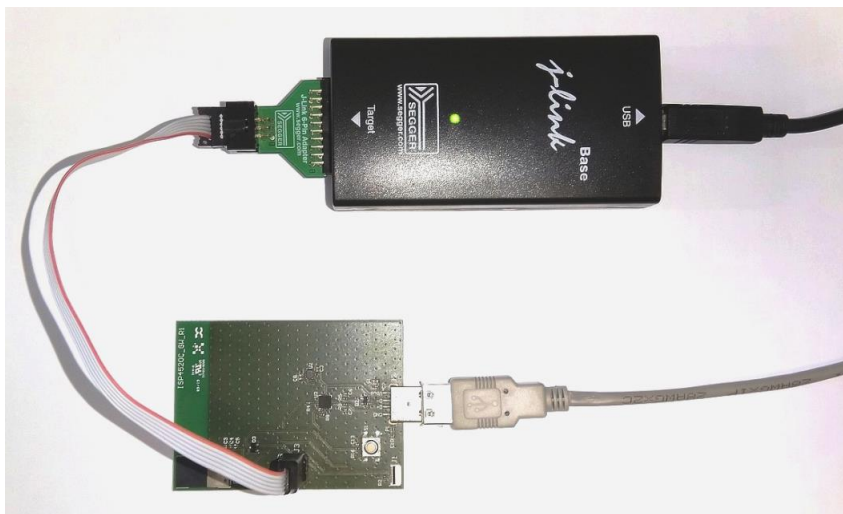


Figure 11: ISP4520-GW firmware loading via JTAG using Segger JLink with 6 pin adapter

2. Using Segger Embedded Studio, open the solution named “rx-temperature.emProject” in <Root directory>\ISP4520-Examples\src\apps\lora\rx_temperature\ses.
3. The solution contains 3 projects, one for each region EU, AS and US. Select project corresponding to the module variant, right click on it and click “Set as active project”.
4. Go to Build -> Select “Build and Run”
5. If not done already, plug the ISP4520-GW USB to your computer. Download and install a serial terminal software (RealTerm, putty, etc ...)
6. Select the port number associated with the ISP4520-GW. Configure the Port with Baudrate:115200, Parity: None, Data bits:8, Stop bits: 1, Hardware Flow control: None

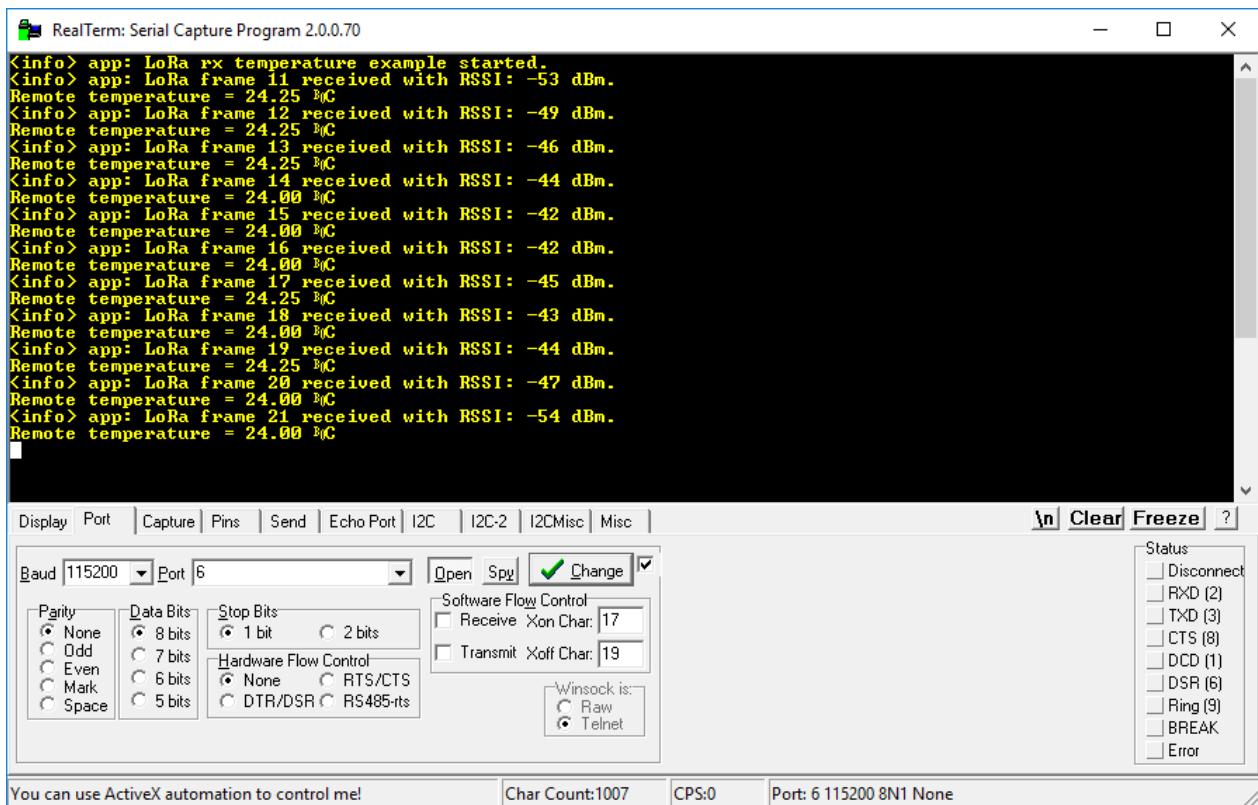


Figure 12: Serial terminal with temperature

Note: If the port COM is not found and you get a “USB device not recognized”, try installing the Virtual port COM drivers at <https://www.ftdichip.com/Drivers/VCP.htm>.

LoRa settings

The default LoRa settings used in this example are:

- Bandwidth: 125 kHz
- Spreading factor: 7
- Coding Rate: 4/5
- Frequency: 868 MHz

To change these settings, the source code needs to be modified on both ends.

1. Using Segger Embedded Studio, open the solution named “tx-temperature.emProject”.
2. The solution contains 3 projects, one for each region EU, AS and US. Select project corresponding to the module variant, right click on it and click “Set as active project”.
3. Open main.c file and edit the following #define:
RF_FREQUENCY
TX_OUTPUT_POWER
LORA_BANDWIDTH
LORA_SPREADING_FACTOR
LORA_CODINGRATE

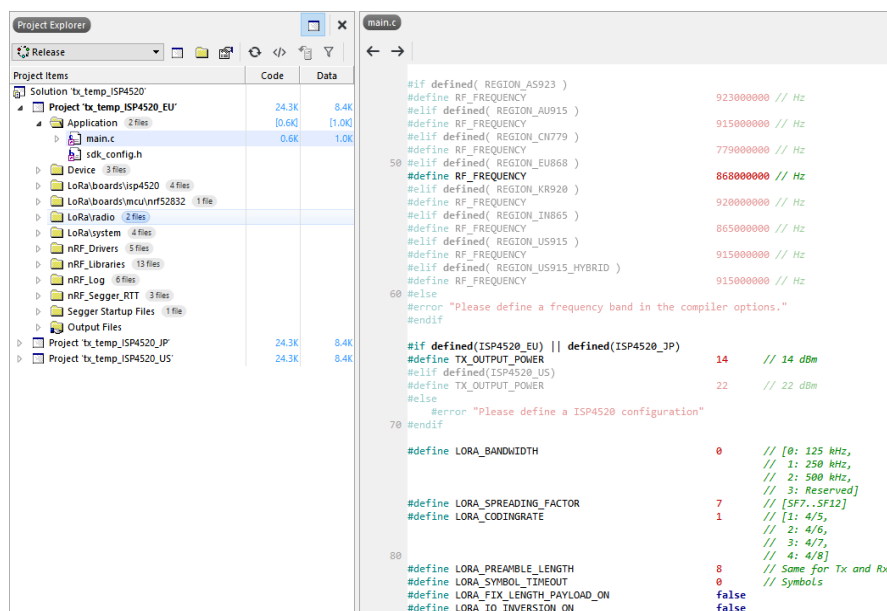


Figure 13: LoRa settings in main.c

4. Go to Build -> Select “Build and Run”
5. Repeat with the ISP4520-GW using the rx_temperature project. All LoRa parameters (except TX_OUTPUT_POWER) must be the same for both devices.

5.3. Ping-Pong

Description

This example is a direct adaptation of ping-pong example provided with the SX126x drivers. Both devices will exchange LoRa packets in a TX/RX point-to-point link. When one of the devices receives a valid LoRa packet (Ping or Pong), it will notify the user the RSSI and the SNR of the packet and then will transmit the other valid LoRa packet back to the other device.

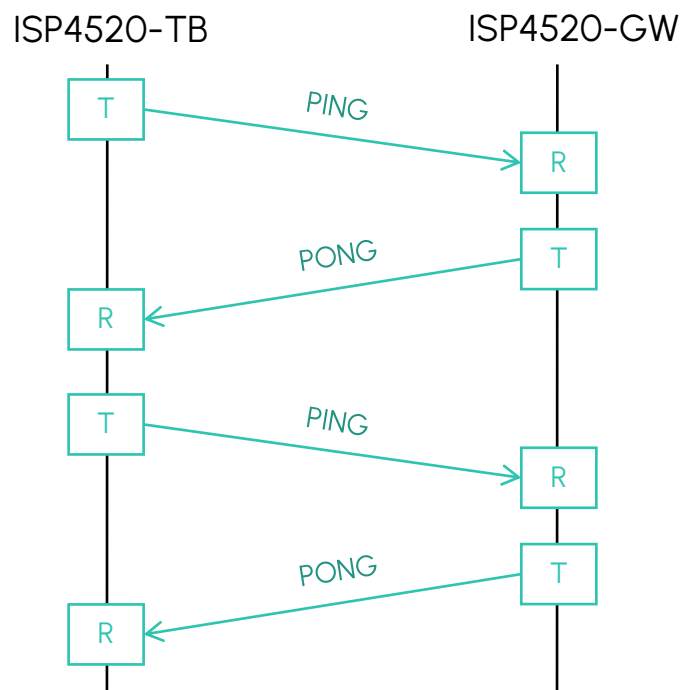


Figure 14: Ping-Pong example

Notifications of received packets are printed on the debug terminal. Open the JLink viewer "JLinkRTTViewer.exe". By default it is located in "C:\Program Files (x86)\SEGGER\<Your Jlink version>\". Specify the target Device: NRF52832_XXA and the interface: SWD.

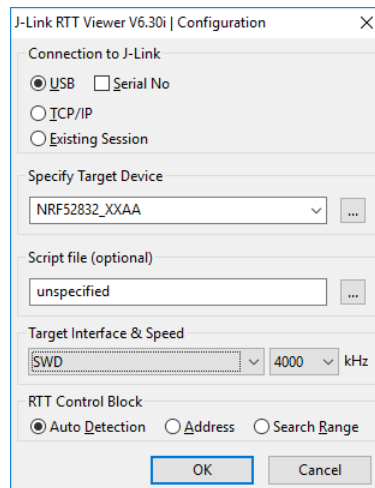


Figure 15: JLink RTT Viewer configuration

A window with the log should appear:

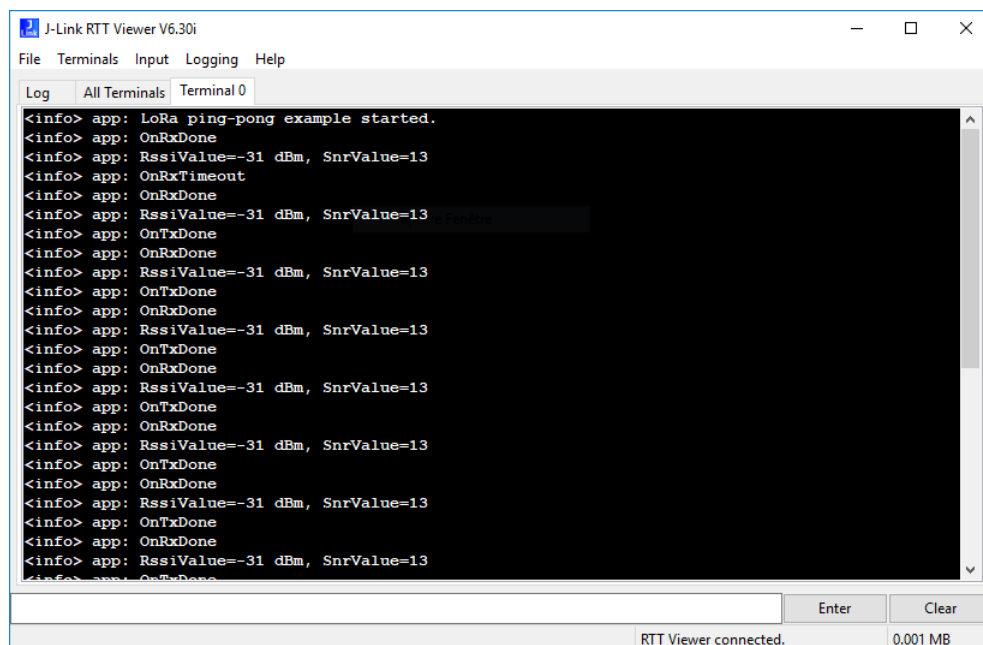


Figure 16: Ping-Pong logs

Firmware loading

See Section 5.2 above for details about how to load firmware on the ISP4520.

LoRa settings

See Section 5.2 above for details about how to edit the LoRa settings in the firmware.



5.4. End device

Description

This is an example of LoRaWAN end node implementation. It periodically tries to send a “Hello world!” unconfirmed message every ~5sec to a LoRaWAN network.

The example supports both join procedures: Activation by personalization (ABP) and Over-The-Air-Activation (OTAA). The selection of the join procedure is hardcoded in a configuration file.

LoRaWAN settings

In order to make it work with a LoRaWAN network, the user needs to edit the “commissioning.h” and the “se-identity.h” files.

The “commissioning.h” is in <Root directory>ISP4520-Examples\src\apps\lorawan\common and provides configuration for:

- Selection of join procedure (OTAA or ABP)
- Public or private network selection

The “se-identity.h” is in <Root directory>ISP4520-Examples\src\lora\peripherals\soft-se and provides configuration for:

- LORAWAN_DEVICE_EUI
- LORAWAN_JOIN_EUI
- APP_KEY
- NWK_KEY

The others key needs to be filled out if the ABP join procedure is used.

1. Using Segger Embedded Studio, open the project named “end-device.emProject” in <Your directory>\ISP4520-Examples\src\apps\lorawan\end-device.
2. The solution contains 3 projects, one for each region EU, AS and US. Select the project corresponding to the module variant, right click on it and click “Set as active project”.
3. Edit the se-identity file (located in ISP4520-Examples\src\lora\peripherals\soft-se) to your needs.
4. Go to Build -> Select “Build and Run”

5.5. Class A LoRaWAN node

Description

This is an example of LoRaWAN end node implementation. It periodically sends a “Hello world!” unconfirmed message to a LoRaWAN network.

The example supports both join procedures: Activation by personalization (ABP) and Over-The-Air-Activation (OTAA). The selection of the join procedure is hardcoded in a configuration file.

Note: This is deprecated implementation. Please use the “End-device” solution instead.

LoRaWAN settings

Refer to End device section.

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.

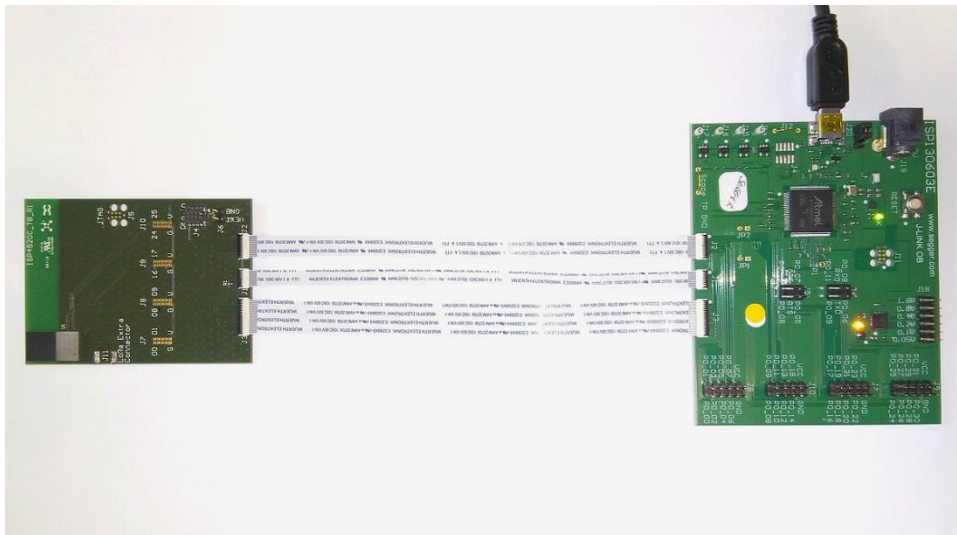


Figure 19: ISP4520-TB firmware loading via embedded JTAG in Interface Board

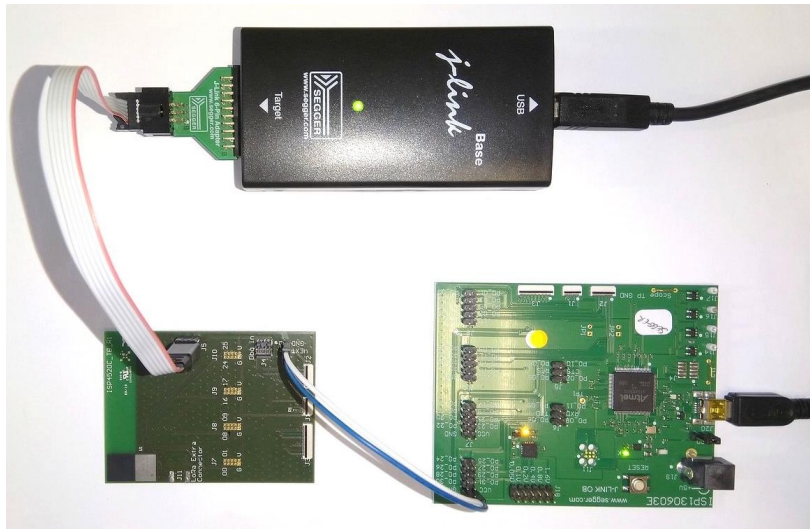


Figure 20: ISP4520-TB firmware loading via JTAG using Segger JLink with 6 pin adapter

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.

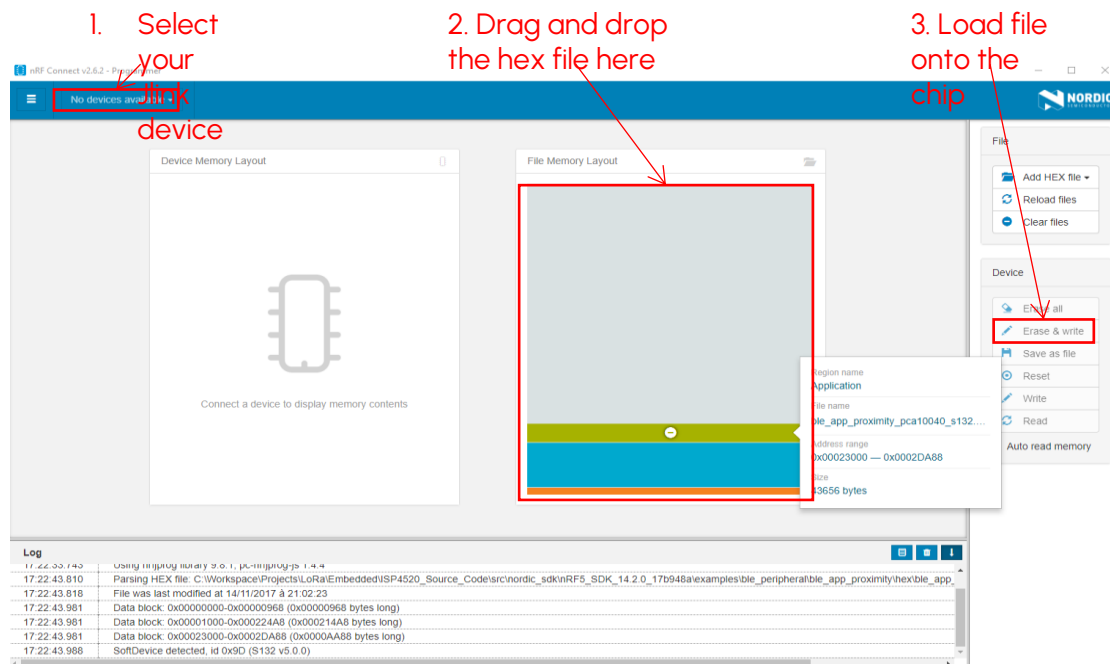


Figure 21: Loading "ble_app_proximity_pca10040_s132" with nRF Connect

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

Smartphone window examples shown below.

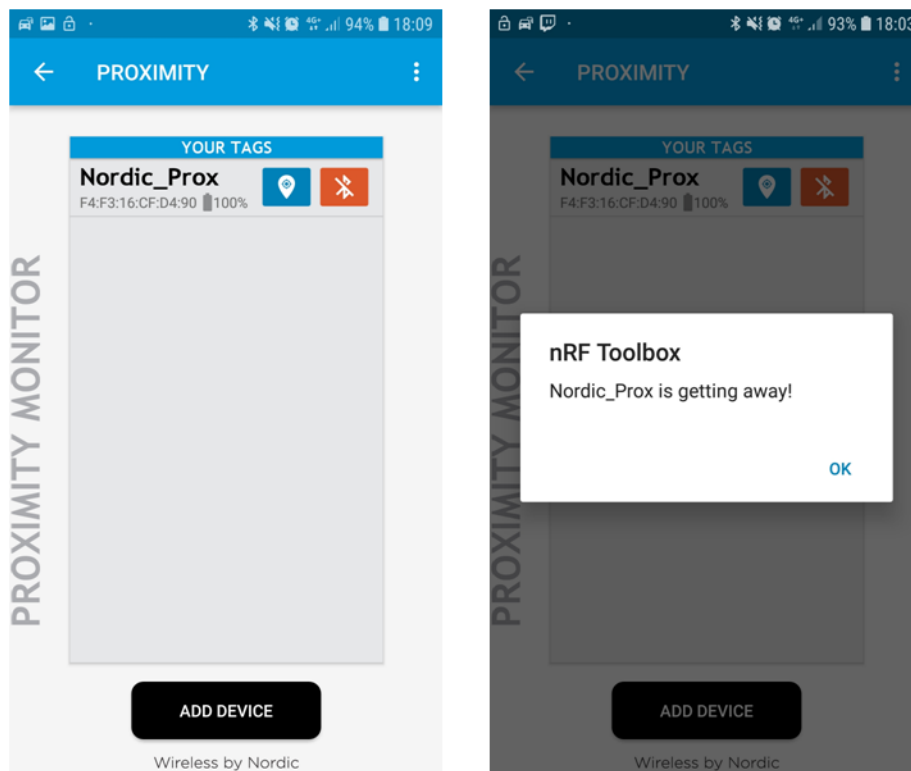


Figure 22: Proximity application