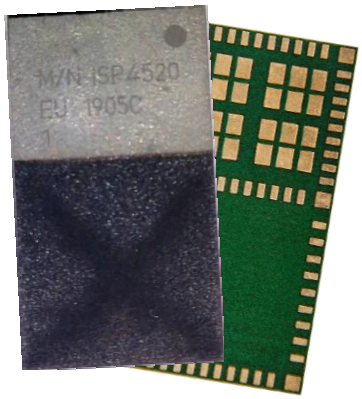
Use of ISP4520-EU Development Kit



Application Note AN190301

Introduction

Scope

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

Contents

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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, 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

- 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.

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”.

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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 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, 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 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, nRFgo studio, SDK … etc …

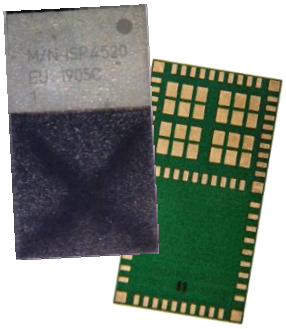
    b. nRF52 Development Tools: You can download the last nRF5 SDK.

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). 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.

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.

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.

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.

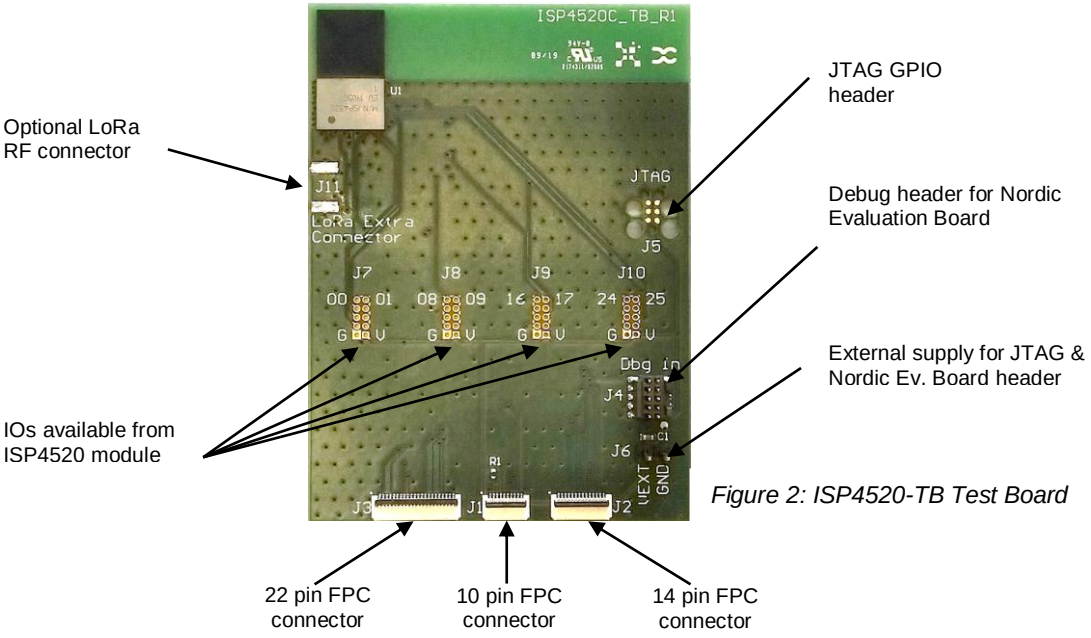


Figure 2: ISP4520-TB Test Board

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 document ISP4520C_TB_SCH.

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.

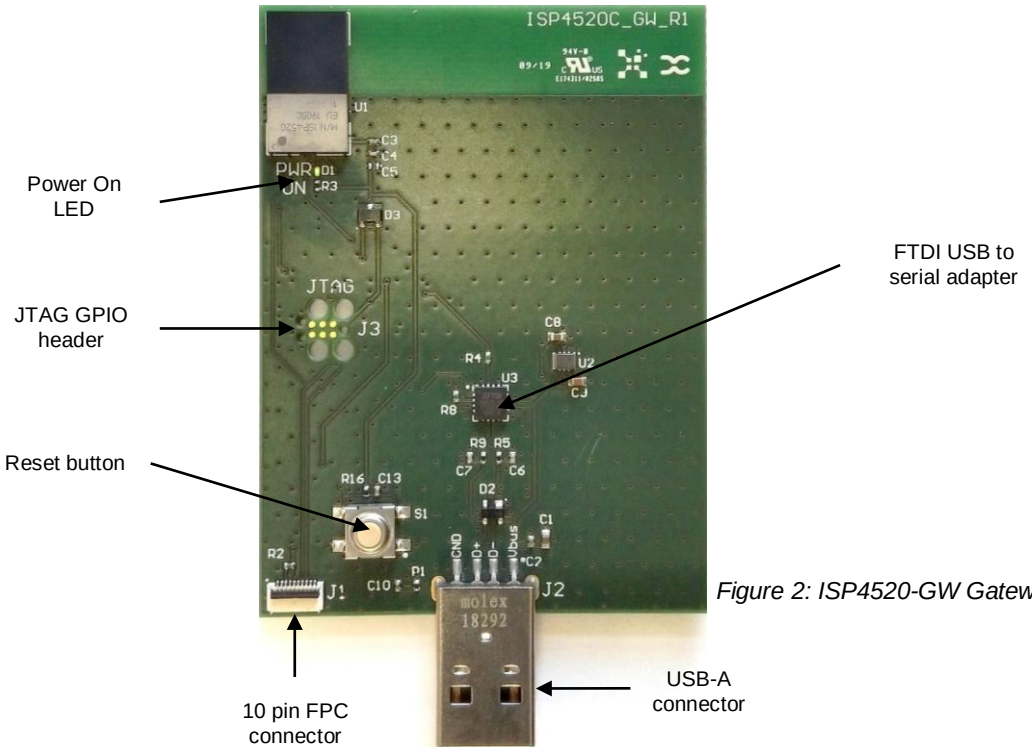


Figure 2: ISP4520-GW Gateway Board

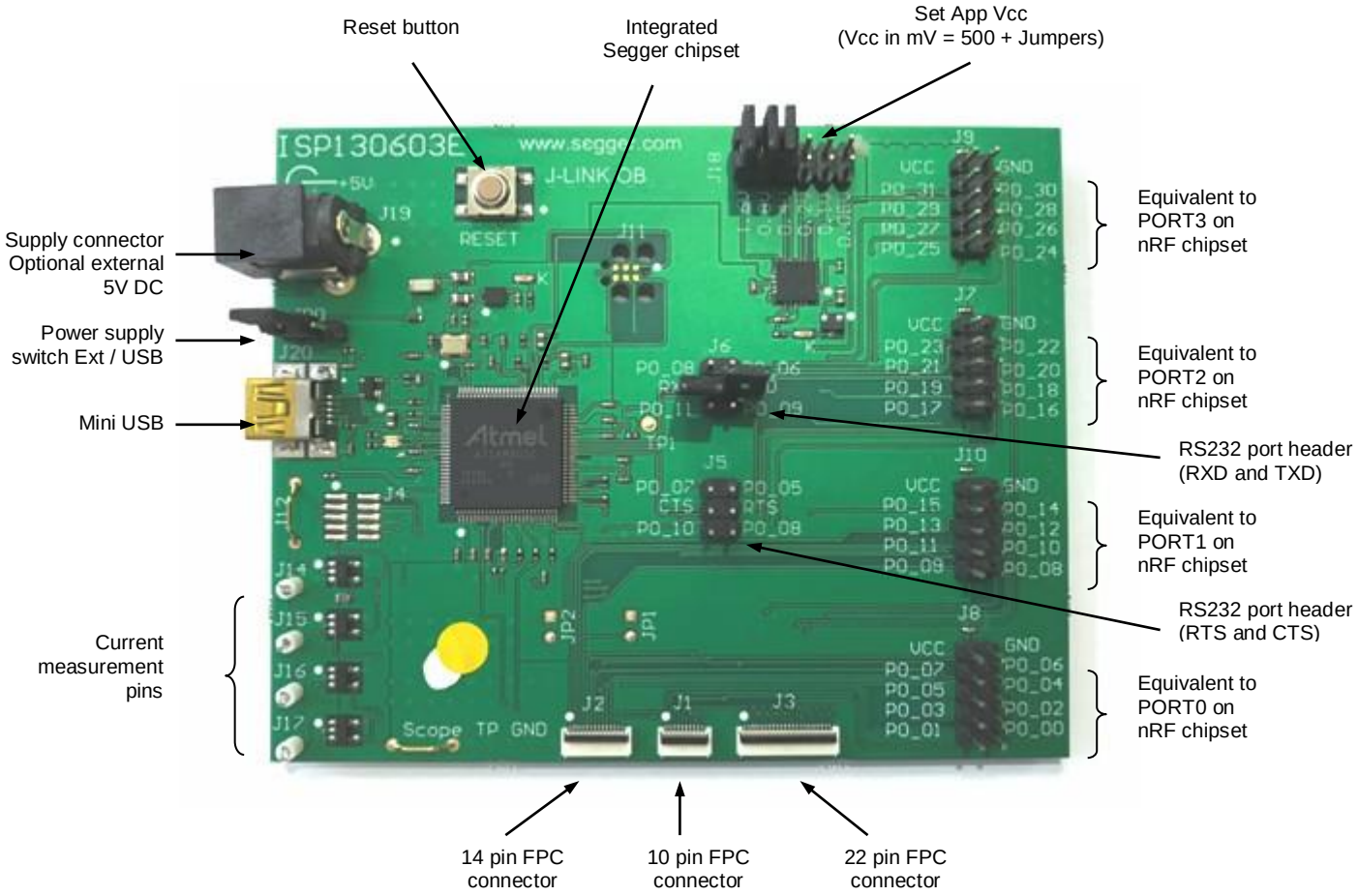
It includes:

- 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.



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.

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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
- Class A LoRaWAN: Example of Class A - LoRaWAN node (LoRaWAN gateway required).
- 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 develop branch (10-Oct-2017 commits, 4.4.1 release candidate) available at *https://github.com/Lora-net/LoRaMac-node/tree/ae0c9cc5d53ebbc11437dfe9711a1c3a1114dc5f*.

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

Detailed LoRa SDK directory tree shown below in Figure 4.

One project is available per application example and for each hardware platform and development environment.

The SDK will evolve to include other features and support for ISP4520_JP and ISP4520_US as the devices become available.

Keil v5 and Segger Embedded Studio are supported.

The Nordic SDK is not included in the archive. Download *nRF5_SDK_14.2.0_17b948a.zip* and extract to <Your directory>\src\nordic_sdk.

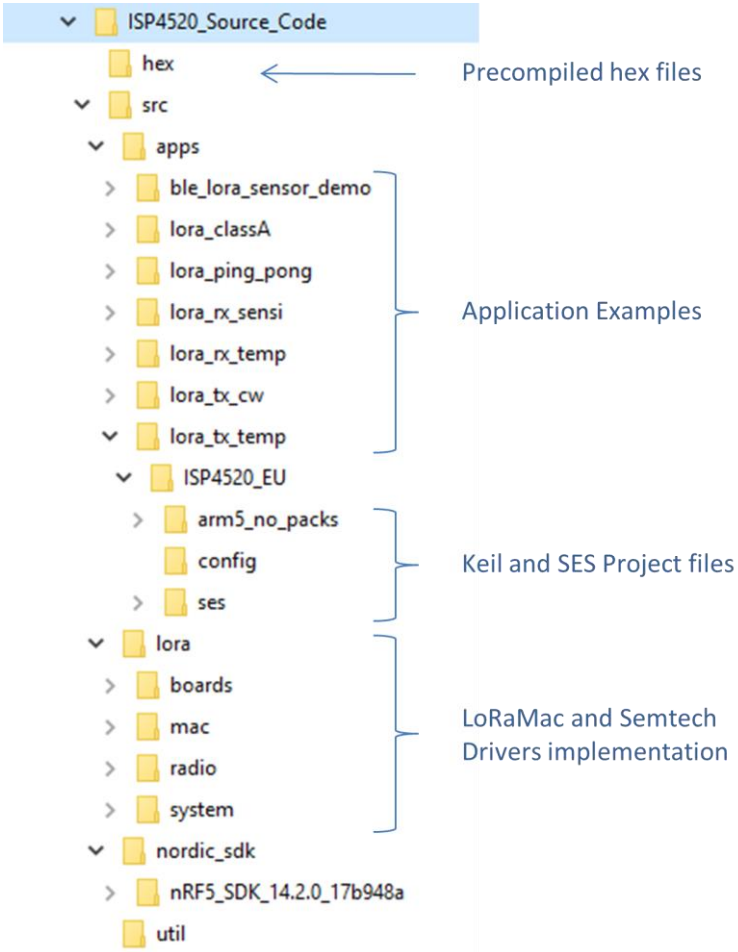

Figure 3: LoRa SDK directory tree

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*)

In the SDK, the “LoRa temperature transmitter” firmware is called “lora_tx_temp” and the “LoRa temperature receiver” is called “lora_rx_temp”

Note: By default, in the development kit, the ISP4520_TB is loaded with the “lora_tx_temp” firmware and the ISP4520_GW is loaded with the “lora_rx_temp” firmware.

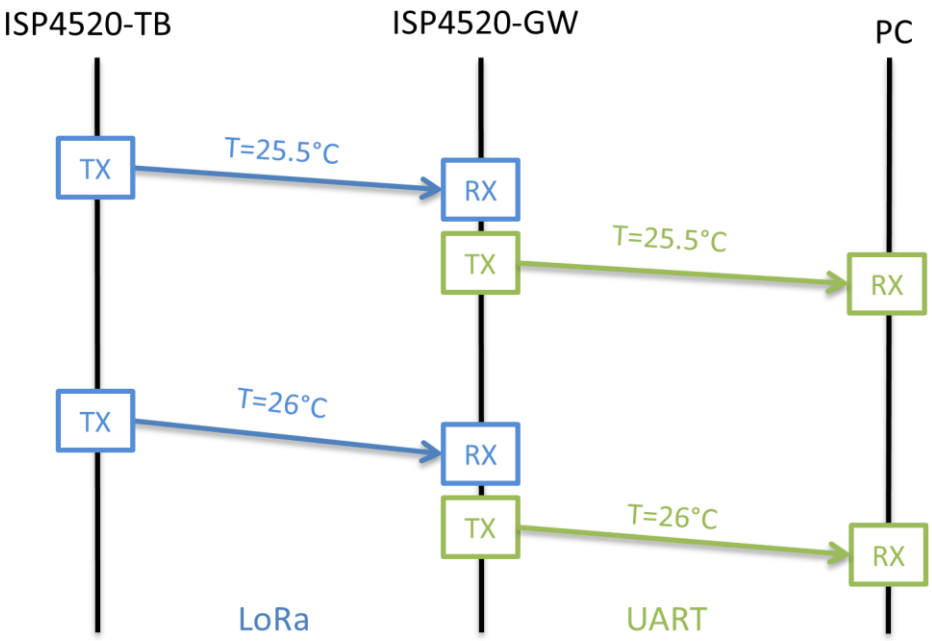

Figure 4: Temperature example

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.

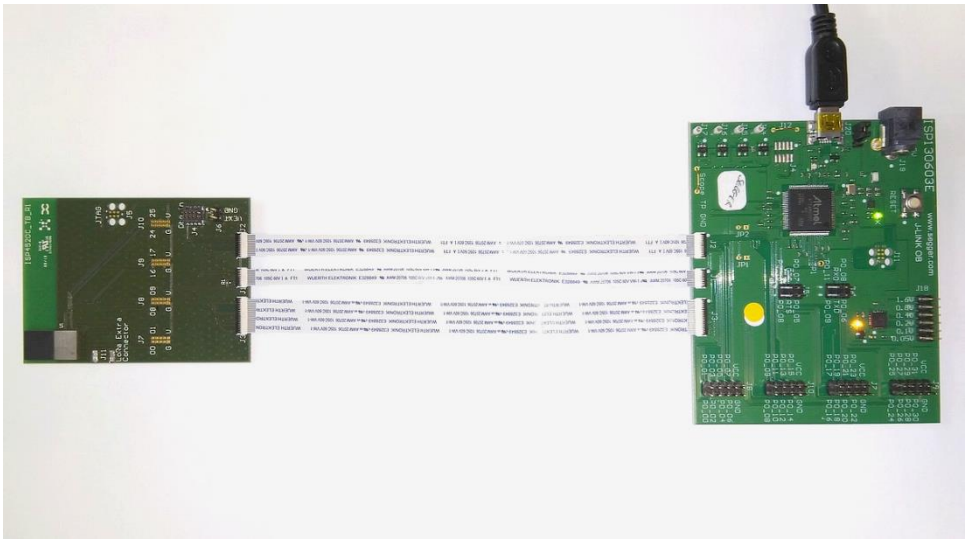

Figure 5: ISP4520-TB firmware loading via embedded JTAG in Interface Board

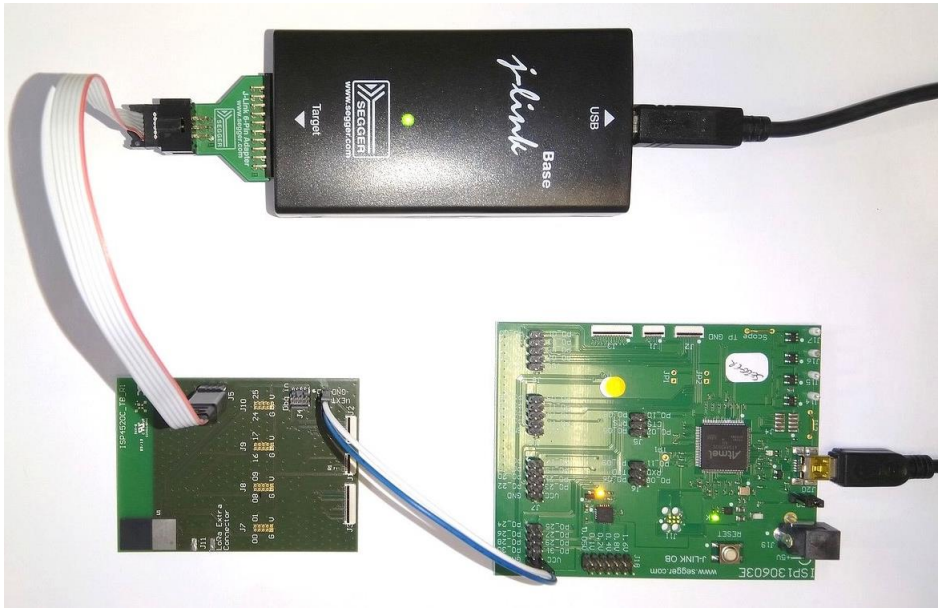

Figure 6: ISP4520-TB firmware loading via JTAG using Segger JLink with 6 pin adapter

2. Start nRF Connect Programmer, drag and drop the lora_tx_temp_isp4520.hex in the “File Memory Layout” box, and click “Erase & write”.

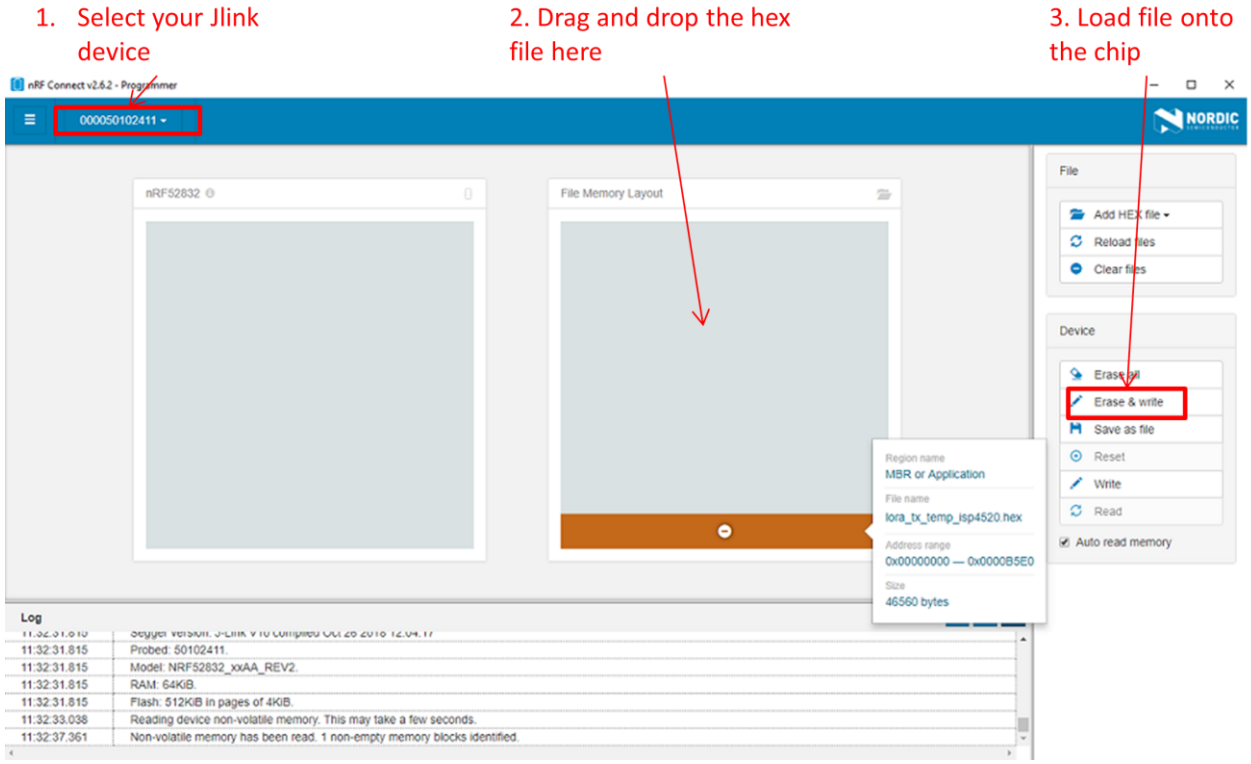

Figure 7: Loading "lora_tx_temp" with nRF Connect

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.

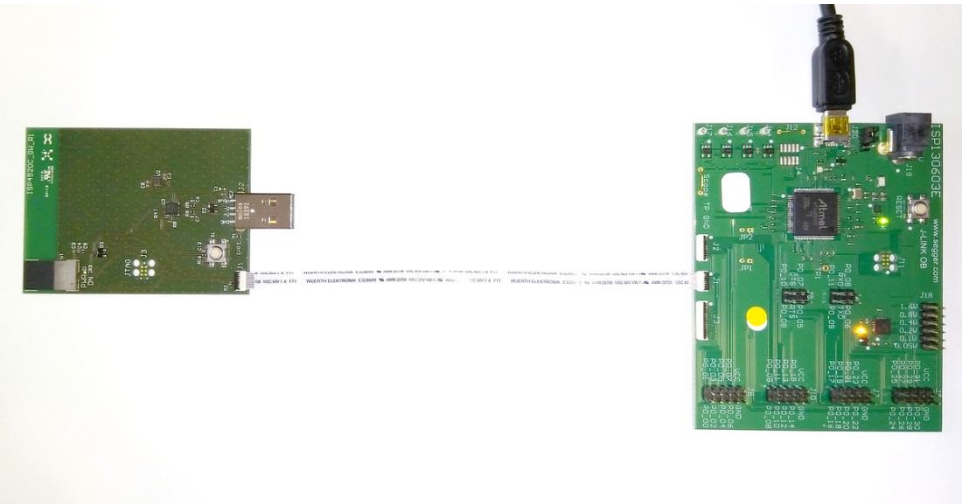

Figure 8: ISP4520-TB firmware loading via embedded JTAG in Interface Board

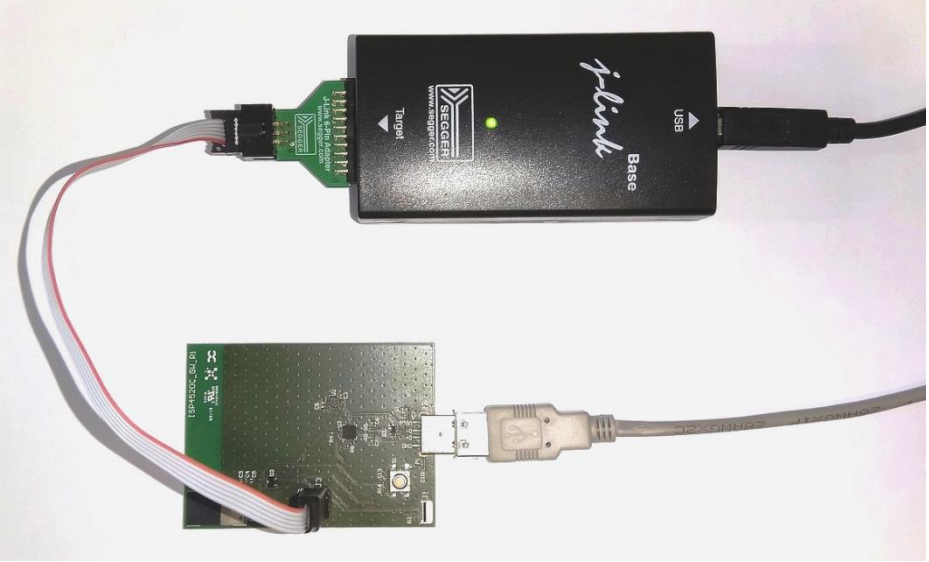

Figure 9: ISP4520-TB firmware loading via JTAG using Segger JLink with 6 pin adapter

2. Start nRF Connect Programmer, drag and drop the lora_rx_temp_isp4520.hex in the “File Memory Layout” box, and click “Erase & write”.

3. If not done already, plug the ISP4520-GW USB to your computer. Download and install a serial terminal software (RealTerm, putty, etc …)

4. 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

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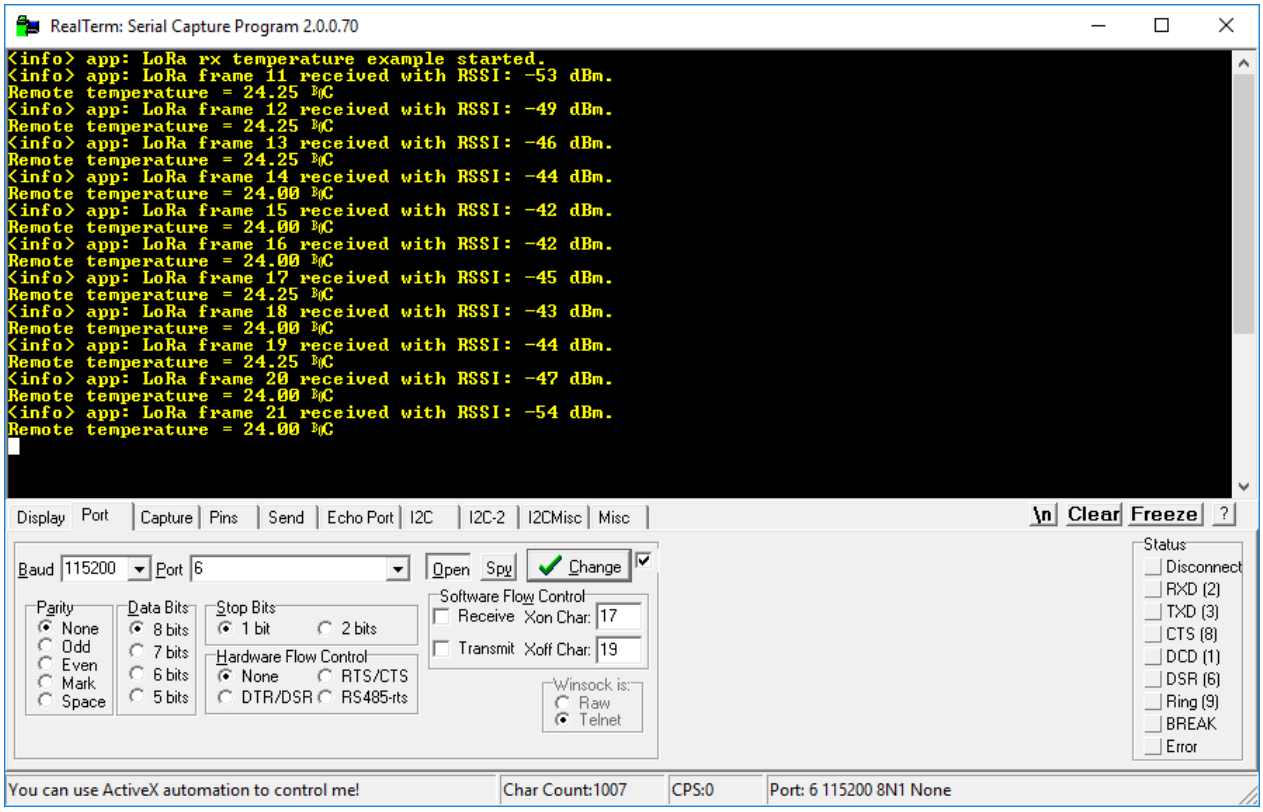

Figure 10: Serial terminal with temperature

Note: If the port COM is not found and you get a “USB device not recognized”, try installing the Vitual 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 project named “tx_temp_ISP4520_EU.emProject” in <Your directory>\src\apps\ lora_tx_temp \ISP4520_EU\ses

2. Open main.c file and edit the following #define:
   RF_FREQUENCY
   TX_OUTPUT_POWER
   LORA_BANDWIDTH
   LORA_SPREADING_FACTOR
   LORA_CODINGRATE

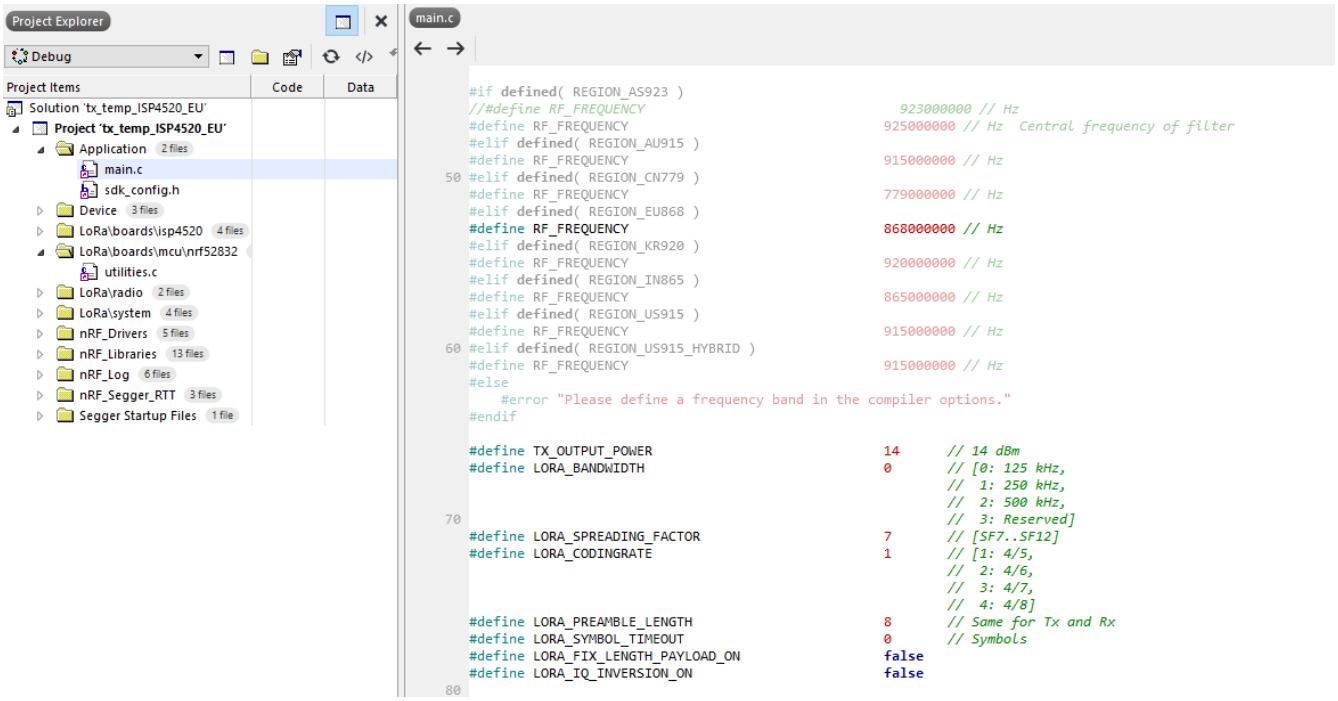

Figure 11: LoRa settings in main.c

3. Go to Build -> Build tx_temp_ISP4520_EU and then go to Target -> Download tx_temp_ISP4520_EU

4. Repeat with the ISP4520-GW using the lora_rx_temp 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.

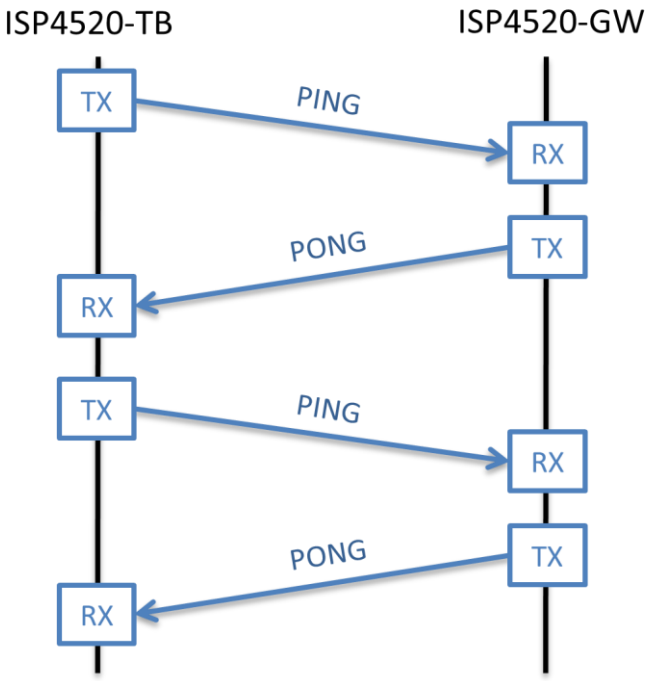

Figure 12: Ping-Pong example

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.

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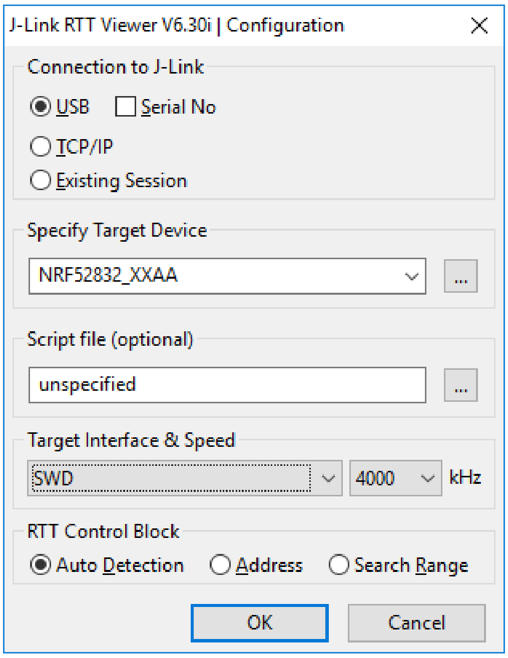

Figure 13: JLink RTT Viewer configuration

A window with the log should appear:

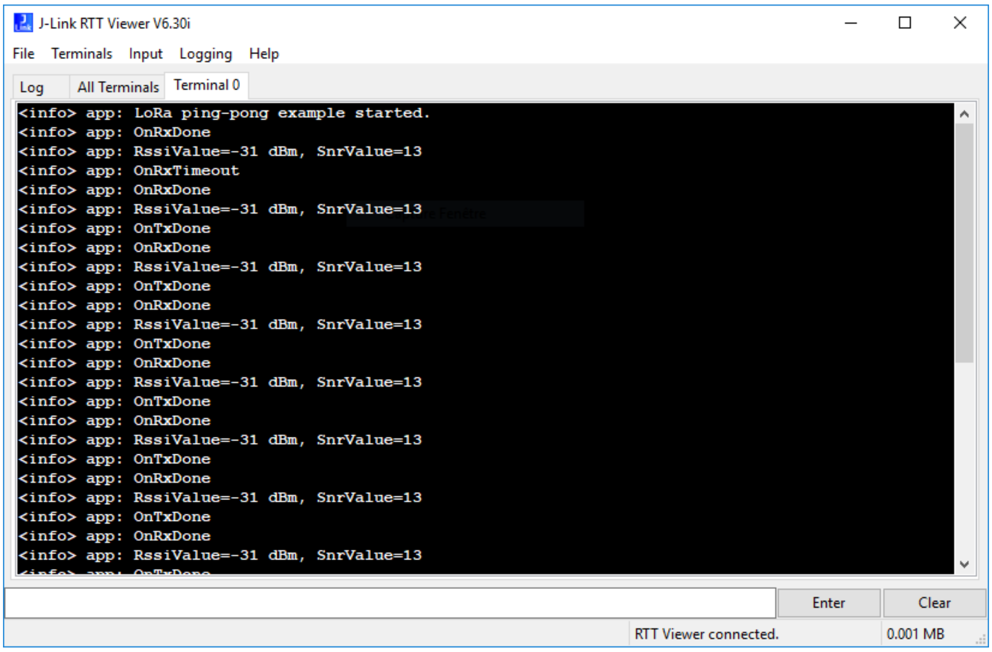

Figure 14 : Ping-Pong logs

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. 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.

LoRaWAN settings

In order to make it work with a LoRaWAN network, the user needs to edit the “commissioning.h” file with all the necessary information such as:

- OTAA or ABP Join procedure
- Device EUI: identifies the device, it can be manually set in the code or automatically generated using nRF52832 device identifier.
- Application EUI: identifies the application.
- Application Key. Used to generate session keys (OTAA only).
- Network Session Key: Encrypt the packets protocol data (ABP only).
- Application Session Key: Encrypt the packet user payload (ABP only).
- Device Address: indentifies a device on a particular network (ABP only). It can be manually set in the code or automatically generating using nRF52832 device identifier.

1. Using Segger Embedded Studio, open the project named “loramac_classA_ISP4520_EU.emProject” in <Your directory>\src\apps\lora_classA\ISP4520_EU\ses.

2. Edit the commissioning file to your needs.

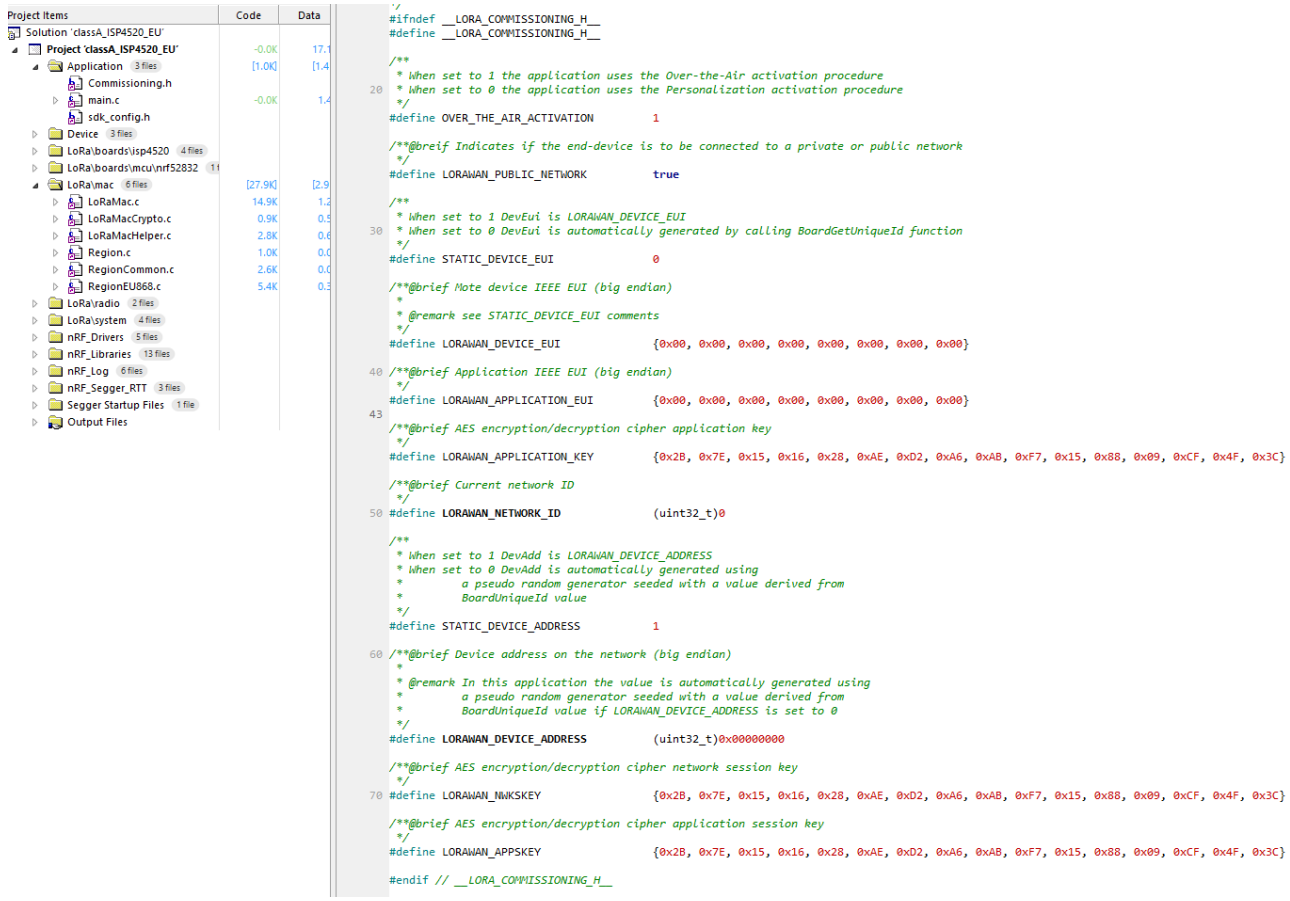

Figure 15: Commissioning.h file

3. Press “Start execution” (Green arrow at the top right of the IDE). An RTT debug terminal will open and display the Join parameters. If using OTAA method a message will be displayed to confirm that the device successfully joined the network.

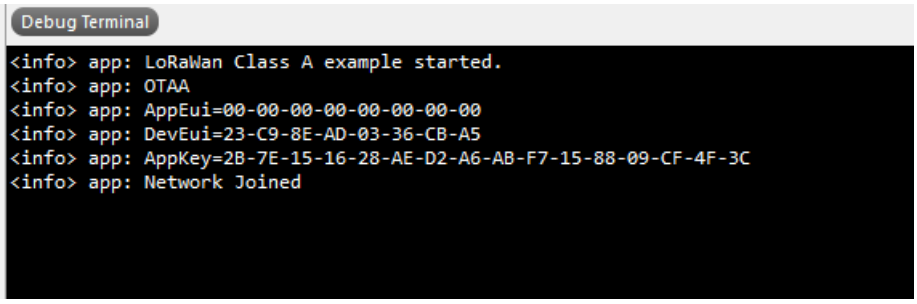

Figure 16: Network joined using OTAA

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.

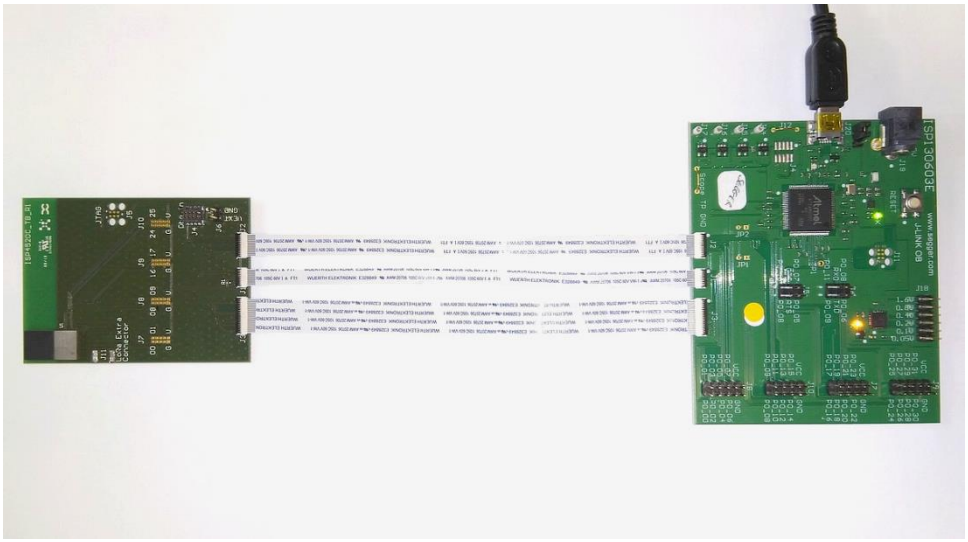

Figure 17: ISP4520-TB firmware loading via embedded JTAG in Interface Board

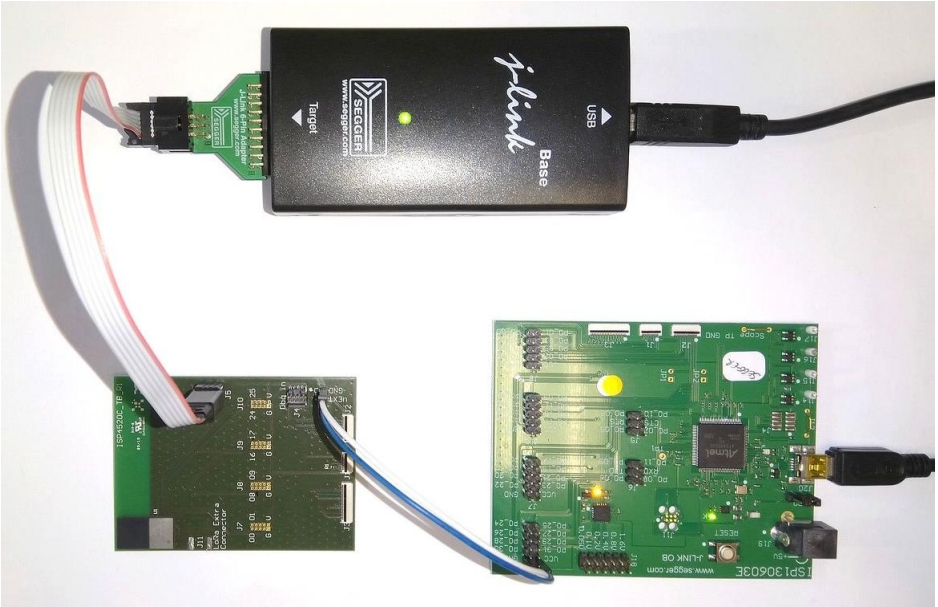

Figure 18: ISP4520-TB firmware loading via JTAG using Segger JLink with 6 pin adapter

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.

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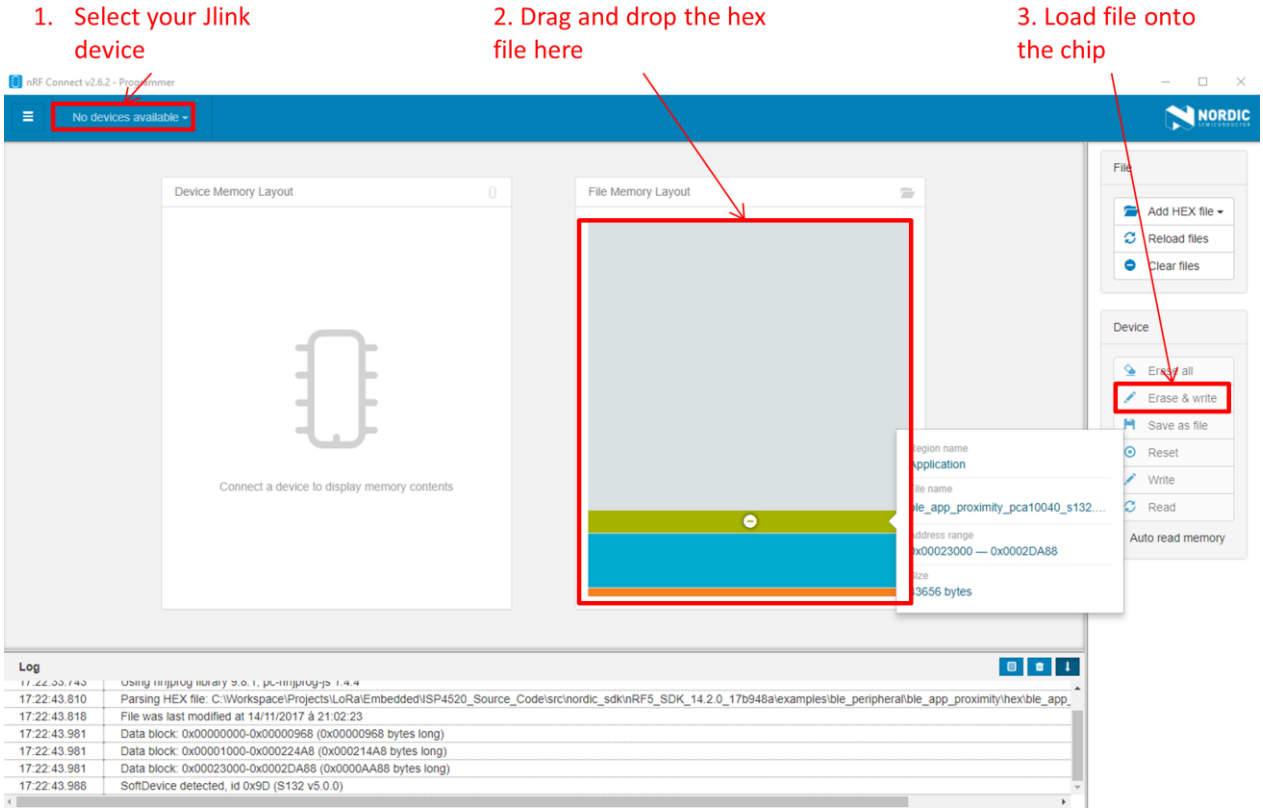

Figure 19: Loading "ble_app_proximity_pca10040_s132" with nRF Connect

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.

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

   Smartphone window examples shown below.

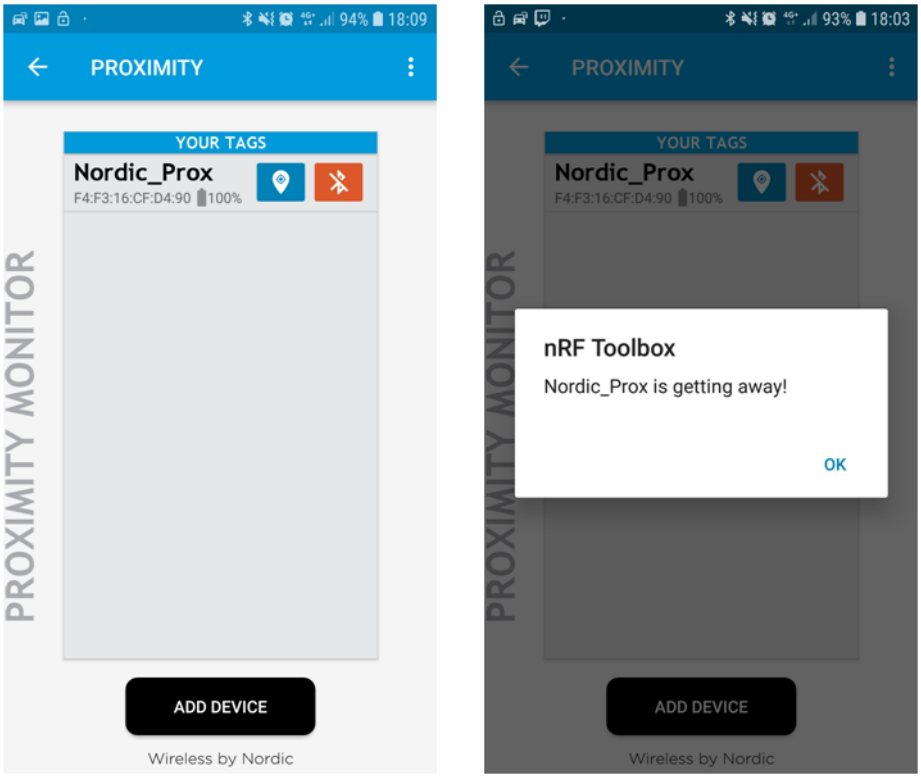

Figure 20: Proximity application