Application note AN200101

Use of ISP4580
BLE + LoRa
Multi Sensor Board

Introduction

Scope

This application note describes how to set up a Sensor demonstration with ISP4580 Sensor Board that will send data using LoRa radio. Two types of demonstrations are presented:

- In the first one the ISP4580 Sensors Board will send data to an ISP4520-GW through LoRa radio.
- The second demonstration requires the use of a LoRaWan gateway (not provided by Insight SiP), the ISP4580 sensors board being configured as a LoRaWan class A device.

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Document Revision History

Revision	Date	Ref	Change Description
R0	22/01/2020	jf pg	Preliminary release
R1	13/02/2020	jf pg	Addition of instructions for softdevice flashing and modulation changes with Android App
R2	09/05/2022	pd pg	Document layout update
R3	25/03/2025	cb pg	Updated firmware description and added document section

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1. Recommended Documentation

The following Nordic Semiconductor document and Software Dev Kits are required.

Nordic Semiconductor Document

- nRF52832 Product Specification – make sure you have the most recent version.
- nRF5 SDK (for software development on the nRF52 Series).
- SX1261/2 Product Specification from Semtech

To access documentation, go to:

- Official Nordic Semi website *http://www.nordicsemi.com*
- Documentation about nRF5 SDK
- *https://docs.nordicsemi.com/bundle/sdk_nrf5_v17.1.0/page/index.html*
- 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*
- Official Semtech website https://www.semtech.com/products/wireless-rf/lora-connect/sx1261

Software Dev kits

- nRF5 SDK which includes source code as well as SES project files.
- IDE Segger Embedded Studio version 5.42. This can be obtained from Segger with a free license for development of nRF52 devices.

To access these files, go to *www.nordicsemi.com* and download the files.

Insight SiP documents

- AN200101 App Note – this document.
- ISP4520 Module Data sheet – available on Insight SiP website.
- ISP4580 Sensor Module data sheet – available on Insight SiP website

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2. Hardware Description

ISP4580 Sensor Board has dimensions of 74.8 x 55.3 mm² and encloses:

- ISP4520LoRa and BLE module.
- ST Micro LPS22HB barometer sensor.
- ST Micro LSM9DS1accelerometer / magnetometer / gyroscope sensor.
- Sensirion Humidity / Temperature sensor
- LITEON LTR-303ALS
- JTAG footprint for the programming
- USB female connector
- CR2032 battery holder

This module is based on the Semtech SX126x single-chip LoRa transceiver series and the nRF52832 Nordic Semiconductor 2.4GHz wireless System on Chip (SoC). It integrates a 32-bit ARM Cortex™ M4F CPU, flash memory as well as analog and digital peripherals.

The ISP4520 can support LoRa connectivity compliant to LoRa Alliance standards. LoRa section can be used as a stand-alone transmitting module connected to a LoRaWAN network for long range communication; or in a private LoRa network. SX1261 chipset is used for EU and JP variants; SX1262 for US variant.

The ISP4520 also integrates BLE connectivity compliant to Bluetooth V4.2. It can be used either in Peripheral or Central roles for BLE. Fully qualified BLE stacks for nRF52832 are implemented in theS132 SoftDevice which can be freely downloaded.

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3. Firmware Package

Insight SiP provides source code for the ISP4580 demo. The code can be downloaded from Insight SiP github : https://github.com/insightsip

There are 2 demos that can be run using code from the github:

- A basic LoRa demo that uses the ISP4580 sensor board to send environmental and motion data to a ISP4520C_GW_R1 lora “gateway” via LoRa. The received data can be visualized either using a Terminal to read data from the gateway’s COM port or using the ISP4580 Android app that can be downloaded from the PlayStore.
- A LoRaWan demo that uses the ISP4580 sensor board to send data to a LoRaWan gateway.

For the basic lora demo the firmware is located in the “apps/lora” directory from ISP4520-examples on the github:

- isp4580-lora-tx-demo: Firmware to be flashed on an ISP4580 board. It reads sensor measurements and transmits them to an ISP4520-GW using raw LoRa radio.

- isp4580-lora-rx-demo: Firmware to be flashed on an ISP4520-GW board. It receives LoRa frames from the ISP4580 boards and displays sensor measurements on UART/BLE.

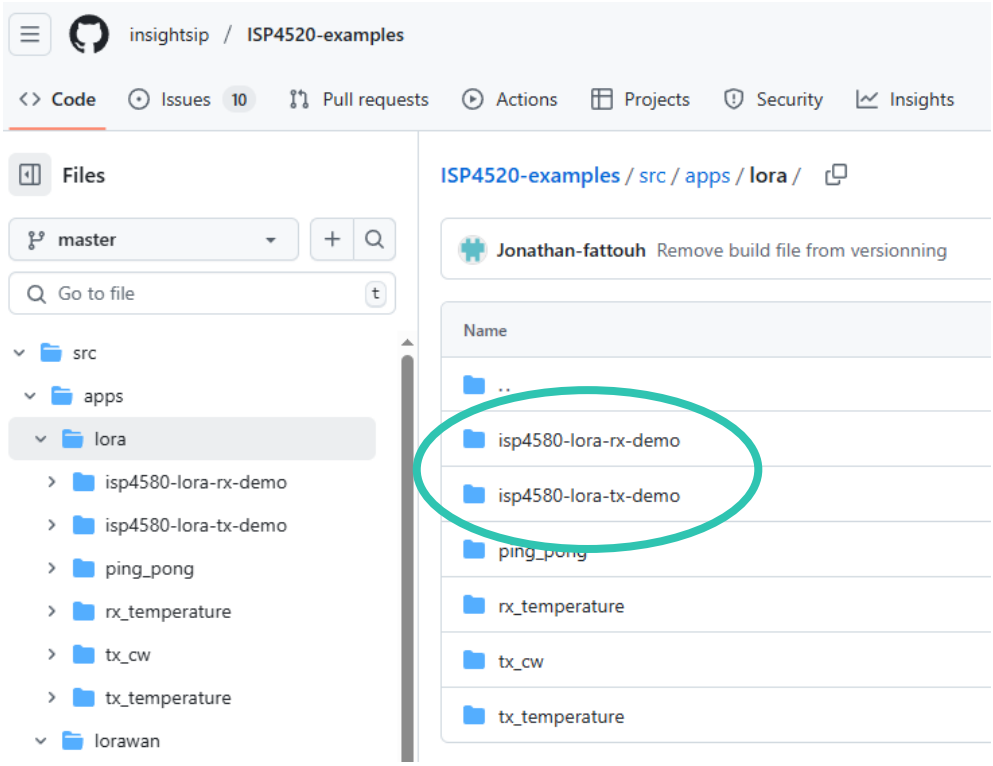


Figure 1 Insight SiP Github - ISP4520-examples basic lora

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For the LoraWan demo the firmware is located in the lorawan directory on the github:

- Isp4580-demo: Firmware to be flashed on an ISP4580 board. It reads sensor measurements and transmits them to a LoRaWan gateway.

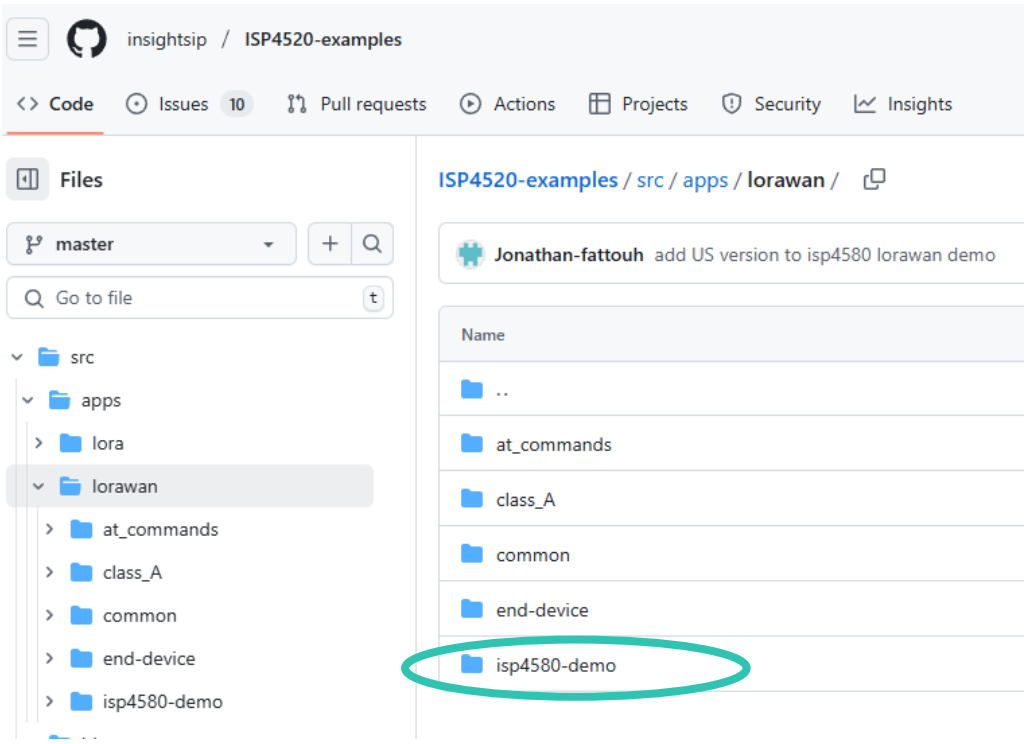


Figure 2 Insight SiP Github – ISP4520- examples lorawan

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4. Basic lora example – lora sensor to lora receiver

4.1. Description

In this example, an ISP4580 board is loaded with the “isp4580-lora-tx-demo” firmware and an ISP4520-GW board is loaded with the “isp4580-lora-rx-demo” firmware. The “isp4580-lora-tx-demo” will periodically fetch data from all sensors present on the ISP4580 board (Pressure, temperature, humidity, light, acceleration and magnetic flux) and transmit them using LoRa radio. The “isp4580-lora-rx-demo” will set the LoRa on the ISP4520-GW board in continuous reception, parse and display sensor data on a serial terminal such as RealTerm (https://sourceforge.net/projects/realterm).

Additionally, both firmwares implement custom BLE services to allow configuration of the LoRa link and retrieval of the sensor measurement values. The ISP4520 Android app, available on PlayStore is available.

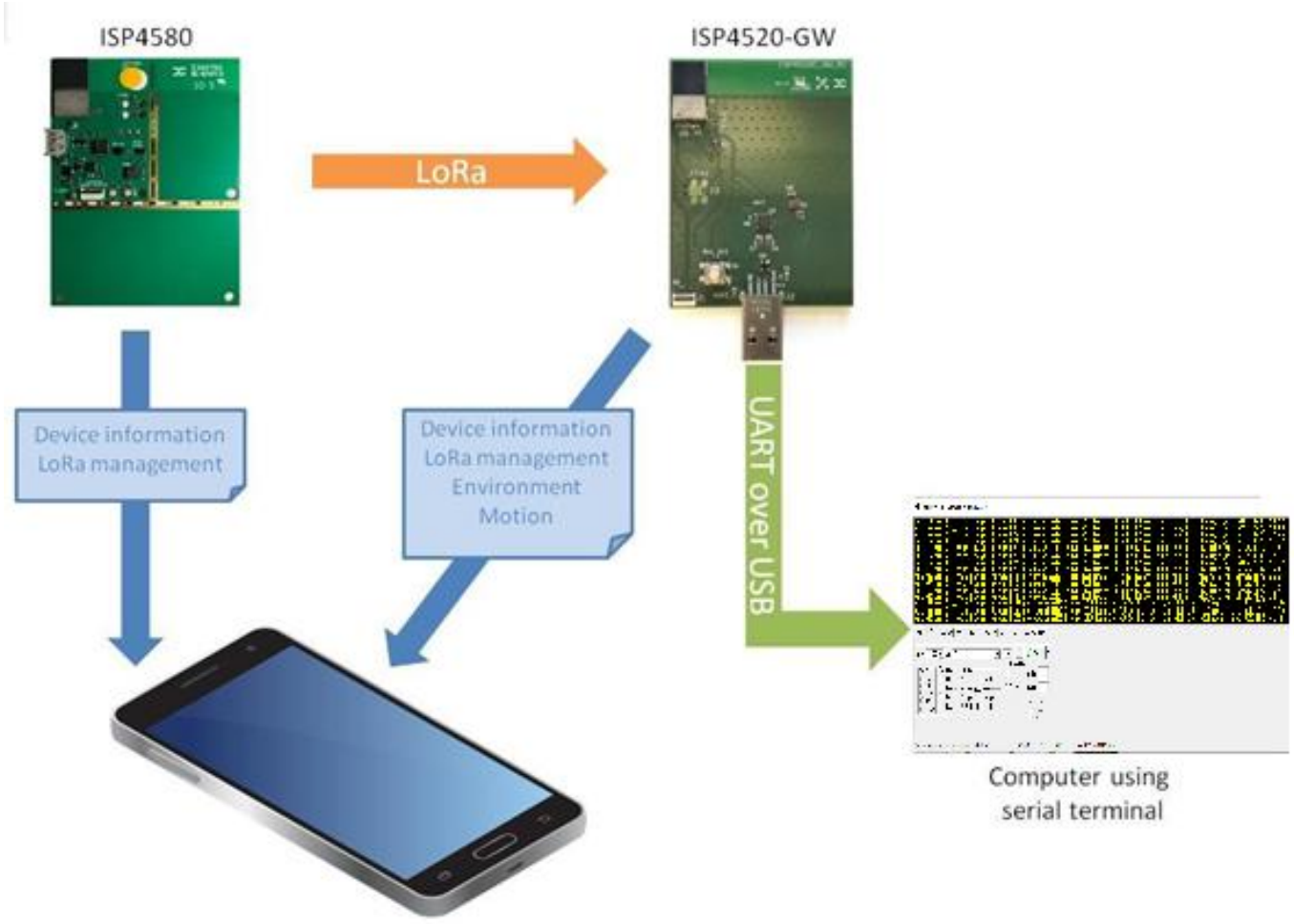


Figure 3 Demo Overview

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BLE services

LoRa Management Service UUID: 1000
Base UUID: 7ed3xxxx-c005-11e8-a355-529269fb1459

Name	UUID	Type	Size	Description
Configuration	1101	Write/Read	5 bytes	Configure LoRa: uint8_t -data rate uint8_t -tx power uint16_t -tx interval in ms uint8_t - ADR enable
RX diagnostic	1102	Notify	4 bytes	uint8_t – frame number int16_t - rssi uint8_t - snr

Environment Service UUID: 1200
Base UUID: b8c7XXXX-dd70-4c5a-b872-184eac50d00b

Name	UUID	Type	Size	Description
Configuration	1201	Write/Read	8 bytes	Configure sensor timings: uint16_t - Temperature interval in ms (100 ms - 5000 ms). uint16_t - Pressure interval in ms (50 ms - 5000 ms). uint16_t - Humidity interval in ms (100 ms - 5000 ms) uint16_t - Light interval in ms (100 ms - 5000 ms)
Temperature	1202	Notify	4 bytes	Temperature in Celsius. Single Precision Floating-Point format
Pressure	1203	Notify	4 bytes	Pressure in hPa. Single Precision Floating-Point format
Humidity	1204	Notify	4 bytes	Relative humidity in %. Single Precision Floating-Point format
Light	1205	Notify	4 bytes	Light in lx. Single Precision Floating-Point format

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Motion Service UUID: 1300
Base UUID: b8c7XXXX-dd70-4c5a-b872-184eac50d00b

Name	UUID	Type	Size	Description
Configuration	1301	Write/Read	2 bytes	uint16_t - interval in ms (50 ms - 5 s)

Name	UUID	Type	Size	Description
Gravity vector	1302	Notify	12 bytes	Attitude represented by a gravity vector: float - x float - y float– z
Angular rotation vector	1303	Notify	12 bytes	Attitude represented by an angular rotation vector: float - x float - y float - z
Magnetization vector	1304	Notify	12 bytes	Attitude represented by a magnetization vector: float - x float - y float - z

LoRa Frame

The LoRa frame is organized as follows:

Position	Bit 0	Bit 1	Bit 3	Bit 5	Bit 7	Bit 9	Bit 11	Bit 13
Type	Frame counter	Press	Temp	Humidity	Light	Acc	Mag	Gyro
Format	uint8_t	uint16_t	int16_t	uint16_t	uint16_t	int16_t x3	int16_t x3	int16_t x3
Unit	N/A	hPa	°C	%	lx	g	uT	dps
Scale	N/A	x10	x100	x100	x100	x100	x100	x100

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4.2. Firmware compilation and download

The firmware supplied on the github is source code. In order to use the code it must be compiled and linked with Segger Embedded Studio. For each firmware find the appropriate SES solution and open it in the IDE (example – “isp4580-lora-tx-demo.emProject”). Choose the appropriate project within the complete solution for the EU or US option. The firmware can be built with “Build” command and loaded with “Build and Run” command. The IDE can also be used in debug mode.

4.3. Jlink connection to ISP4580

1. Select one of the methods:
   a. Connect the ISP4580 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 ISP4580 to your computer using an USB cable. Connect an external JLINK probe with 6-pin connector (not provided in the kit) to the ISP4580 JTAG connector.
   Refer to the picture of the hardware configuration below.

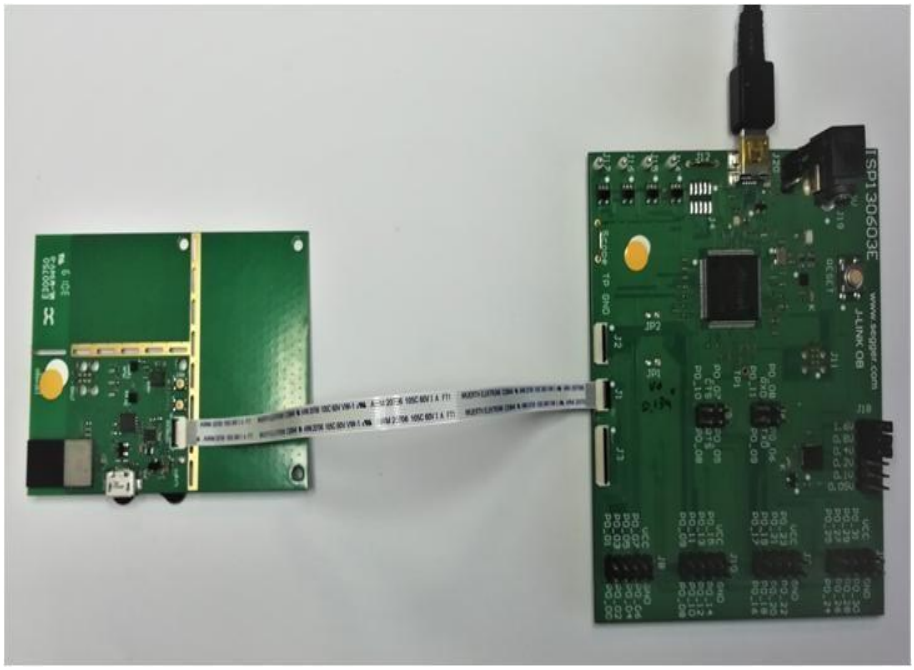


Figure 4 ISP4580 firmware loading via embedded JTAG in Interface Board

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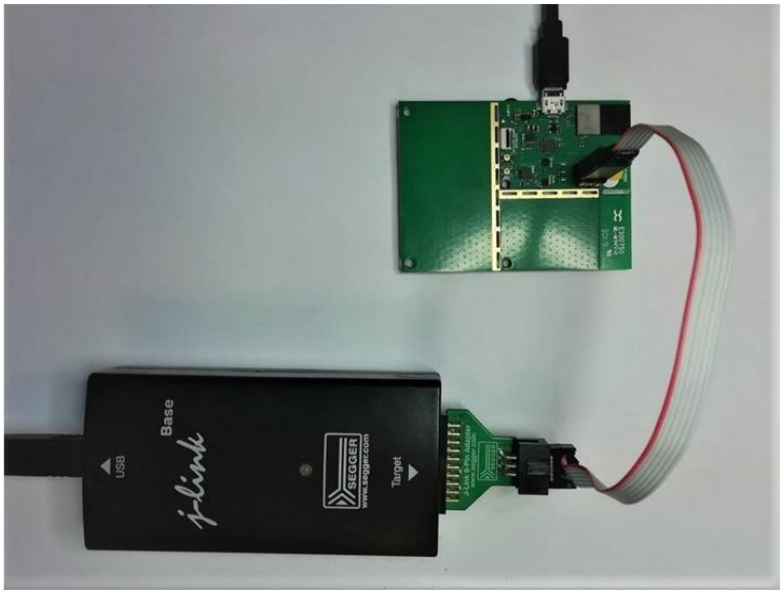


Figure 5: ISP4580 firmware loading via external JTAG

4.4. Jlink Connection to 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. Note that the interface board may differ from the photo below.
   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.
   c. Refer to picture of the hardware configuration below.

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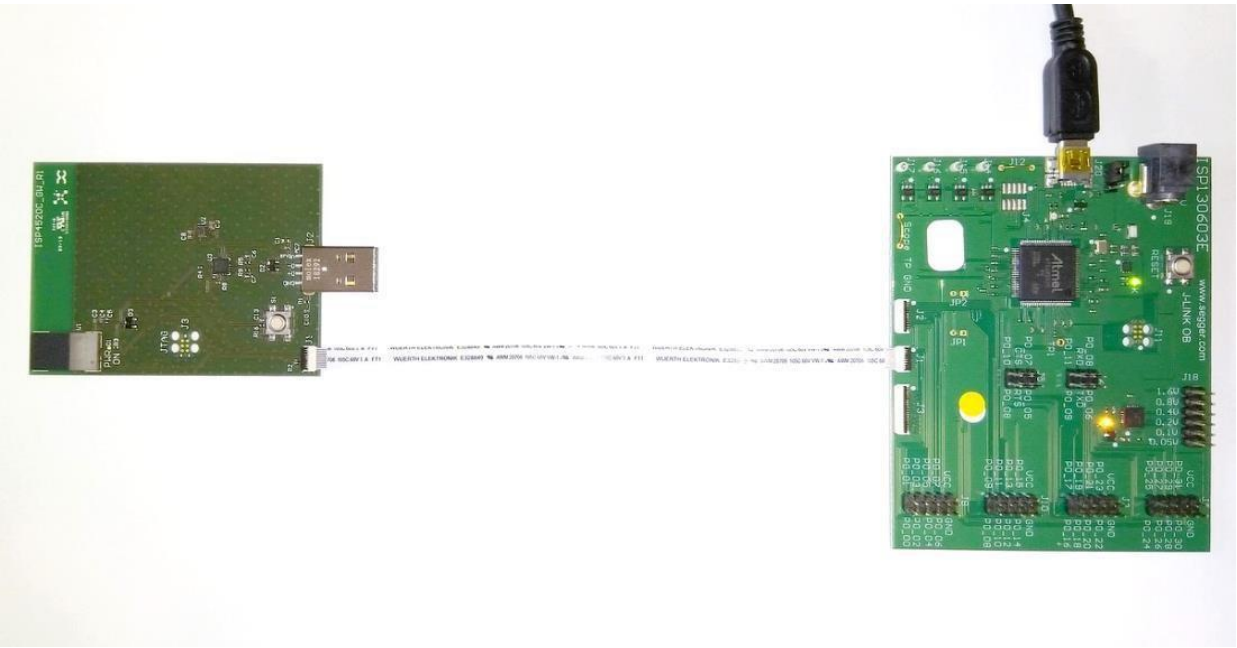


Figure 6 ISP4520-GW firmware loading via embedded JTAG in Interface Board

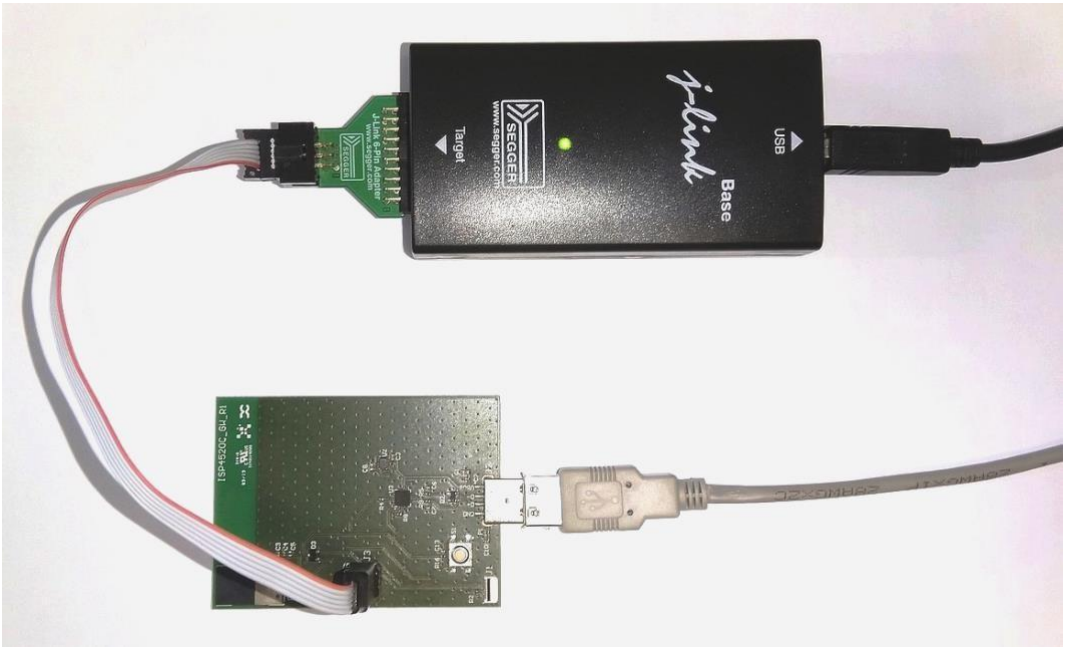


Figure 7 ISP4520-GW firmware loading via JTAG using Segger JLink with 6 pin adapter

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4.5. Demonstration using Android smartphone

An App is available for Android Devices. The android App is a demonstration App that is provided “as is” in order to demonstrate the ISP4580 capabilities.

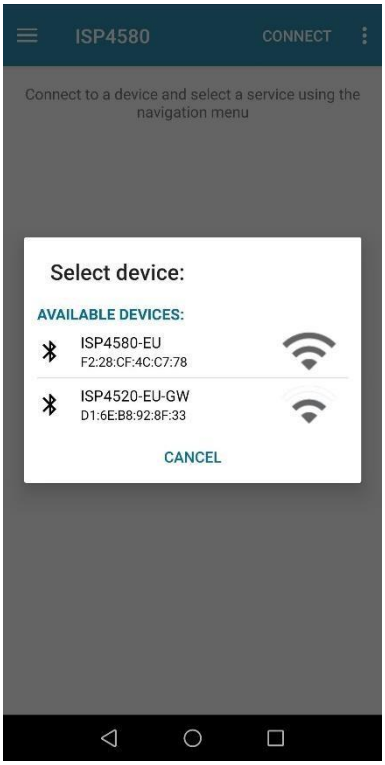
Make sure your Android device is compatible with Bluetooth 4.0 (Android v4.3 at least).
Download the ISP4580 demo on Google Play:
https://play.google.com/store/apps/details?id=com.insightsip.isp4580_configuration

After the application is downloaded and installed you will be able to set up the application demonstration as follow:

1. Connect the ISP4580 to a power supply with the USB cable. This can either be a battery pack or a PC. Note that a CR2032 battery does not supply sufficient current for the LoRa transmissions over any period of time.

2. Plug the ISP4520-GW to a PC USB port.

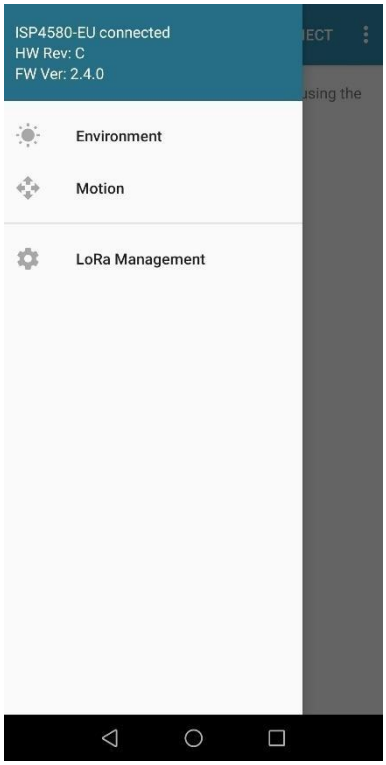
3. Start the ISP4580_Demo application on your Android, click Connect and select the board you want to connect to. Depending on which board the application is connected to, the navigation menu will give access to different services.

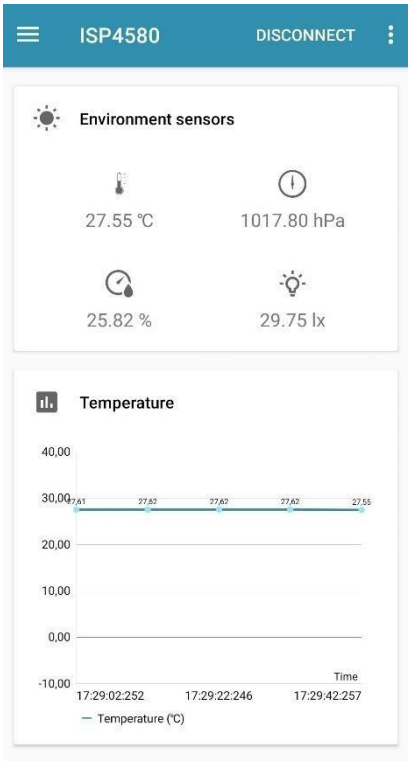


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4. Clicking on “Environment” will open the environment screen.

   On this screen: instant values and graphs for temperature, pressure, humidity and light are displayed.
   These values are coming from the ISP4580’s onboard sensors.

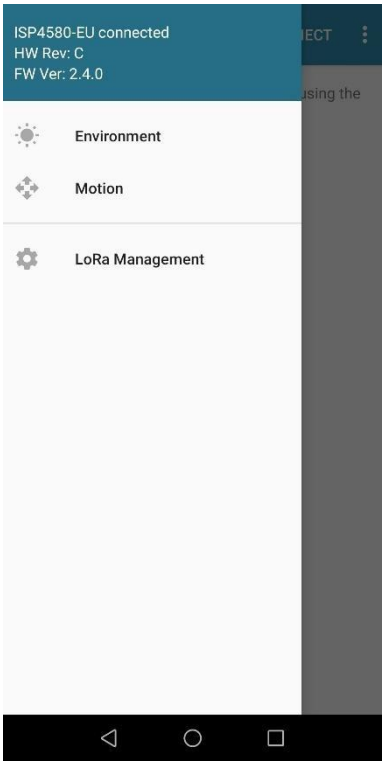


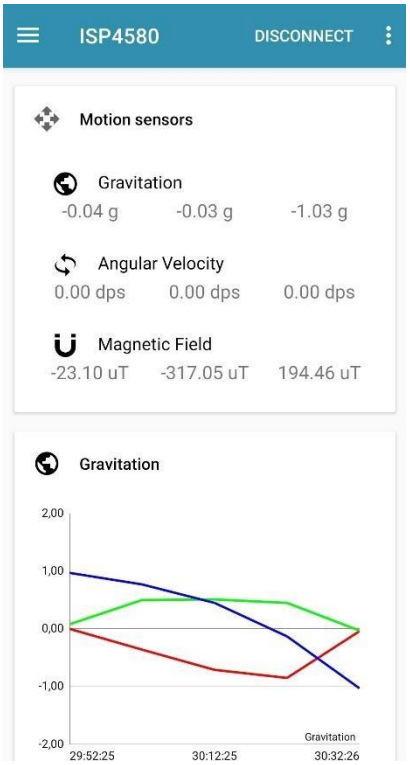


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5. Clicking on “Motion” will open the motion screen.

   On this screen: instant values and graphs for Gravity, magnetic field are displayed. These values are coming from the ISP4580’s onboard sensors





6. Clicking on “LoRa Management” will open the LoRa management screen.

   On this screen, the following parameters can be configured:
   - Data rate: Change the spreading factor of LoRa radio. Both ISP4580 and ISP4520-GW must be configured with the same data rate.
   - Tx power: Change transmit power of the LoRa signal.

   This parameter in only used by the ISP4580.
   - Adaptative data rate: Not used on this demo.
   - Interval: Interval between each LoRa transmission

   This parameter in only used by the ISP4580.



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This screen also displays RSSI and SNR of received LoRa frames.
This is only used on the ISP4520-GW.

7. If no data is displayed on the Environment and Motion screens, check that the same LoRa modulation is configured on both ISP4580 and ISP4520-GW boards. Connect to each device, go to “LoRa Management” screen, set the same data rate (for ex SF7) and click on “Apply”. Note also that it is important to have 2 compatible boards (both EU, both US or both AS). The firmware for the sensor board and the gateway should also be selected for the same region (US, EU or AS).

4.6. Using Serial port

The ISP4520-GW also transmits sensor data through a serial port.
Configure the serial port using a serial port terminal such as RealTerm:

- Baudrate: 115200
- Parity: None
- Data bits: 8
- Stop bits: 1
- Hardware control: OFF

RealTerm can be downloaded at https://sourceforge.net/projects/realterm.

When the the ISP4520-GW receives a LoRa packet from the ISP4580, it will parse and transmit it through the serial port.

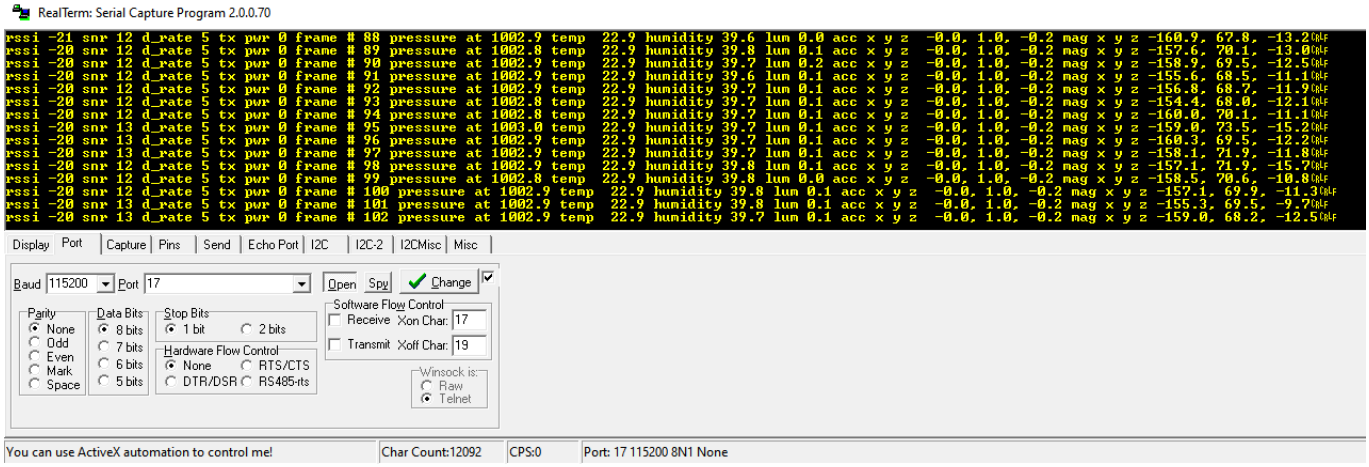


Figure 8 Serial port output on Real Term

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Format: RSSI:SNR:DR:TxP:FN:Pr:Temp:Humi:Light:AccX:AccY:AccZ:MagX:MagY:MagZ\r\n

Frame %d, rssi= %d dBm, pressure= %.1f hPa, temp= %.1f degC, humidity= %.1f %%, light= %.1f lux, acc= %.1f %.1f %.1f g, mag=%.1f %.1f %.1f uT\r\n

With parameter in order:

1. Frame counter
2. RSSI in dBm
3. Pressure measurement in hPA
4. Temperature measurement in °C
5. Relative Humidity measurement in %
6. Light measurement in lux
7. X, Y and Z accelerometer measurement in g
8. X, Y and Z magnetometer measurement in uT

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5. Example for LoRaWan - isp4580-demo

5.1. Description

In this example, an ISP4580 board is loaded with the “isp4580-demo” firmware. The “isp4580-demo” will periodically fetch data from all sensors present on the ISP4580 board (Pressure, temperature, humidity, light, acceleration, magnetic flux density) and transmit them to a LoRaWan network.

Additionally, the firmware implements a custom BLE service to allow configuration of the LoRa link.

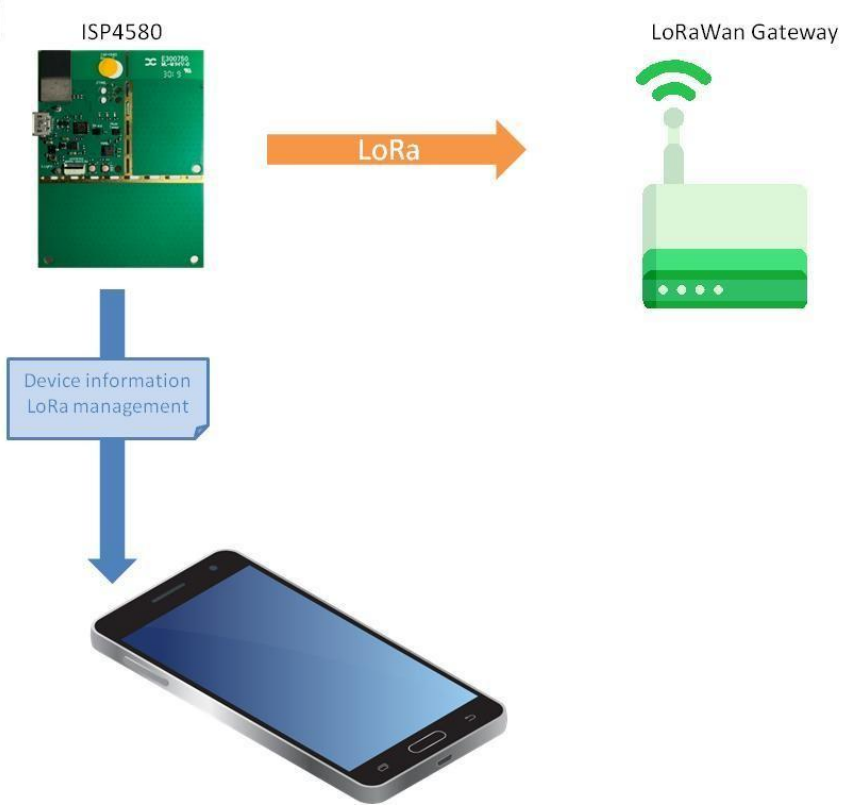


Figure 9 Global demo overview

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5.2. BLE services

The LoRa Management Service is implemented.
See Chapter 3.2 for more detail.

5.3. Firmware loading on ISP4580

1. Select one of the methods:
   a. Connect the ISP4580 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 ISP4580 to your computer using an USB cable. Connect an external JLINK probe with 6-pin connector (not provided in the kit) to the ISP4580 JTAG connector.
   Refer to picture of the hardware configuration in chapter Firmware loading on ISP4580.

2. Open the solution “isp4580-demo“ using Segger Embedded Studio in <your_directory>\src\apps\lorawan\isp4580-demo\ses

3. Select the project variant (ISP480-demo_ISP4520E-EU or ISP480-demo_ISP4520B-US) by right-clicking the project and then “Set as Active Project”.

4. Edit the commissioning.h file to select the activation method:
   - OTAA
   - ABP

Edit the se-identity.h file in order to give the device access to the your LoRaWan network
- Device eui
- Join EUI
- Application Key
- etc

5. Build the project and flash the board. The board should automatically join the network and then periodically transmit data.

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