Use of ISP4580
BLE + LoRa
Multi Sensor board

Application Note AN200101

Introduction

Scope

This application note describes how to set up a Sensor demonstration with ISP4580 Sensors 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.

Contents

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

1. 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.

2. Firmware package

Insight SiP provides a package containing source code for the ISP4580 demo. The package contains 3 projects:

+ demo_sensor_lora: Firmware to be flashed on an ISP4580 board. It reads sensor measurements and transmits them to an ISP4520-GWusing raw LoRa radio.
+ demo_receiver_lora: Firmware to be flashed on an ISP4520-GW board. It receives LoRa frames from the ISP4580 boards and displays sensor measurements on UART/BLE.
+ demo_sensor_classA: Firmware to be flashed on an ISP4580 board. It reads sensor measurements and transmits them to a LoRaWan gateway.

Detailed package directory tree shown below. The Nordic SDK is not included in the archive. Download *nRF5_SDK_14.2.0_17b948a.zip (Link)* and extract to <Your directory>\src\nordic_sdk.
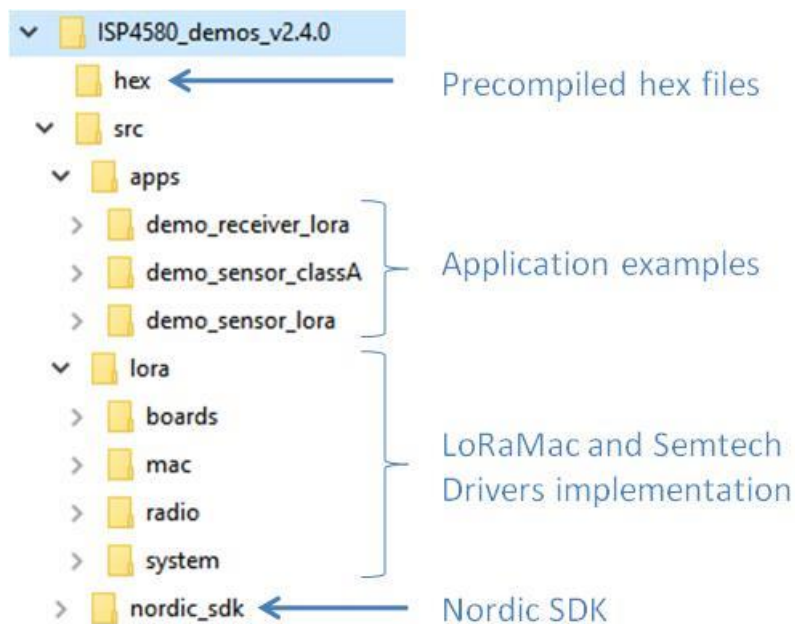

Figure 1: Firmware package directory

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3. Example demo_sensor_lora / demo_lora_receiver

3.1. Description

In this example, an ISP4580 board is loaded with the "demo_sensor_lora" firmware and an ISP4520-GW board is loaded with the "demo_receiver_lora" firmware. The "demo_sensor_lora" will periodically fetch data from all sensor present on the ISP4580 board (Pressure, temperature, humidity, light and acceleration) and transmit them using LoRa radio. The "demo_receiver_lora" will set the LoRa on the ISP4520-GW board in continuous reception, parse and display 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.
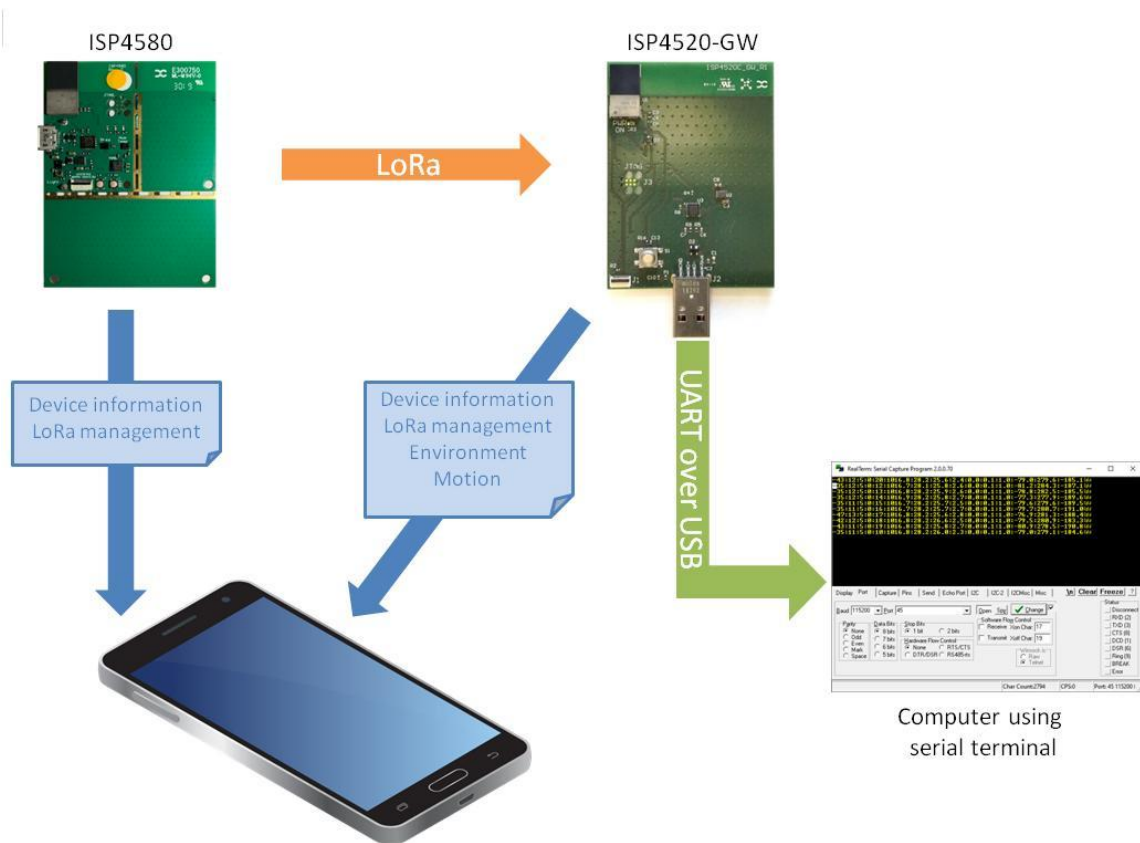

Figure 2: Demo overview

3.2. 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

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

3.3. LoRa Frame

The LoRa frame is organized as follow:

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

3.4. 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 the picture of the hardware configuration below.
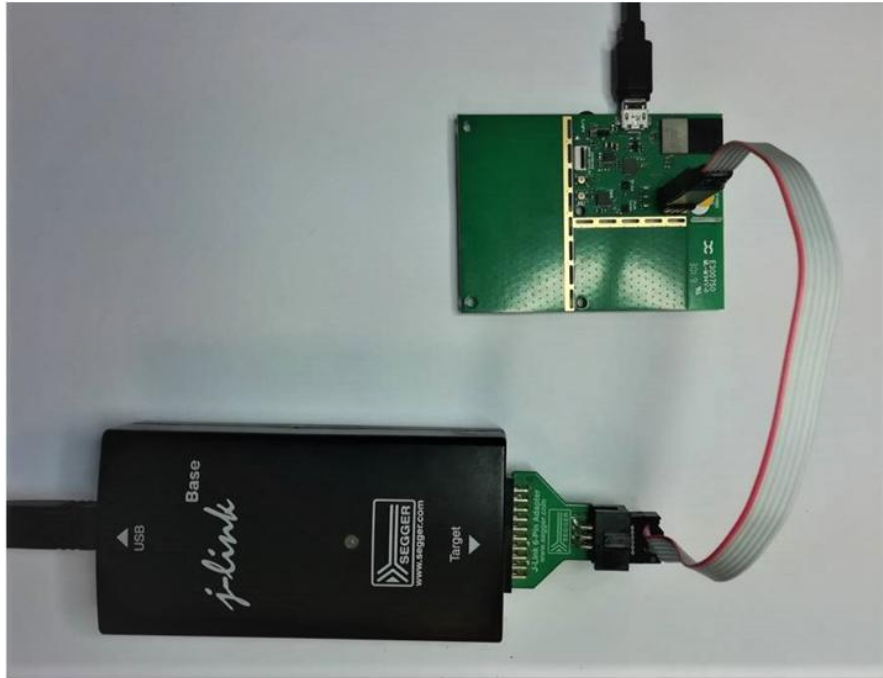
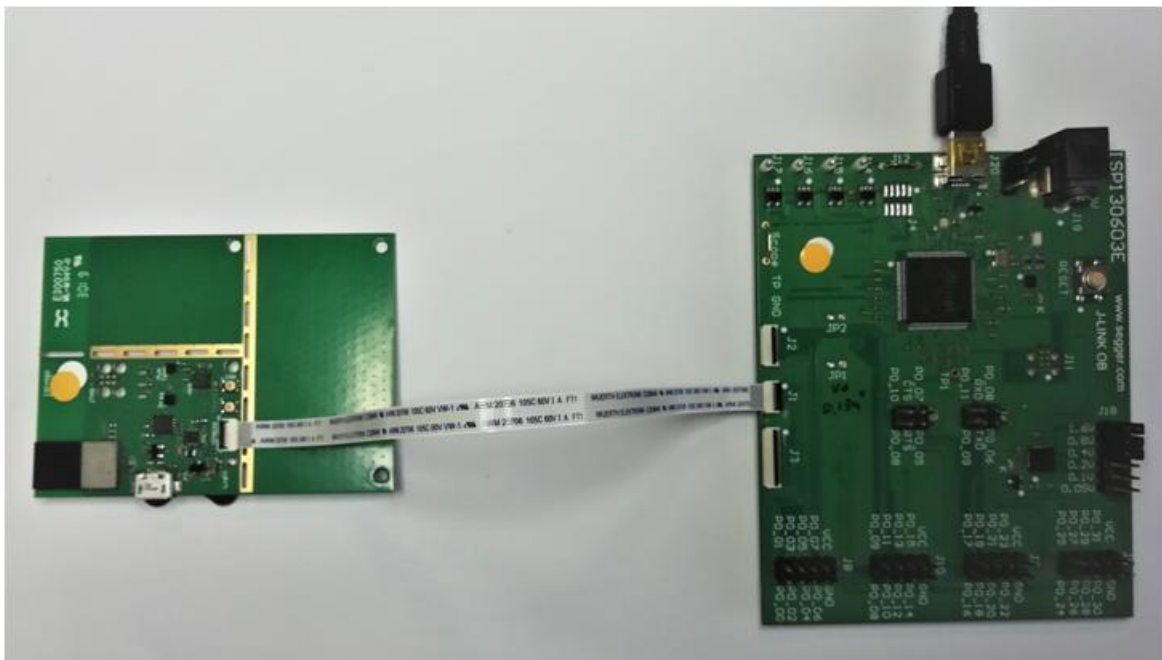*Figure 3: ISP4580 firmware loading via external JTAG*

Figure 4: ISP4580 firmware loading via embedded JTAG in Interface Board

2. Start nRF Connect Programmer, drag and drop the following files in the "File Memory Layout" box:
   - Softdevice named s132_nrf52_5.0.0_softdevice.hex
   - Application file. Depending on the module variant the app file can be demo_sensor_lora_EU.hex for Europe, demo_sensor_lora_JP.hex for Japan or demo_sensor_lora_US.hex for US.

3. Click "Erase & write".

3.5. 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.
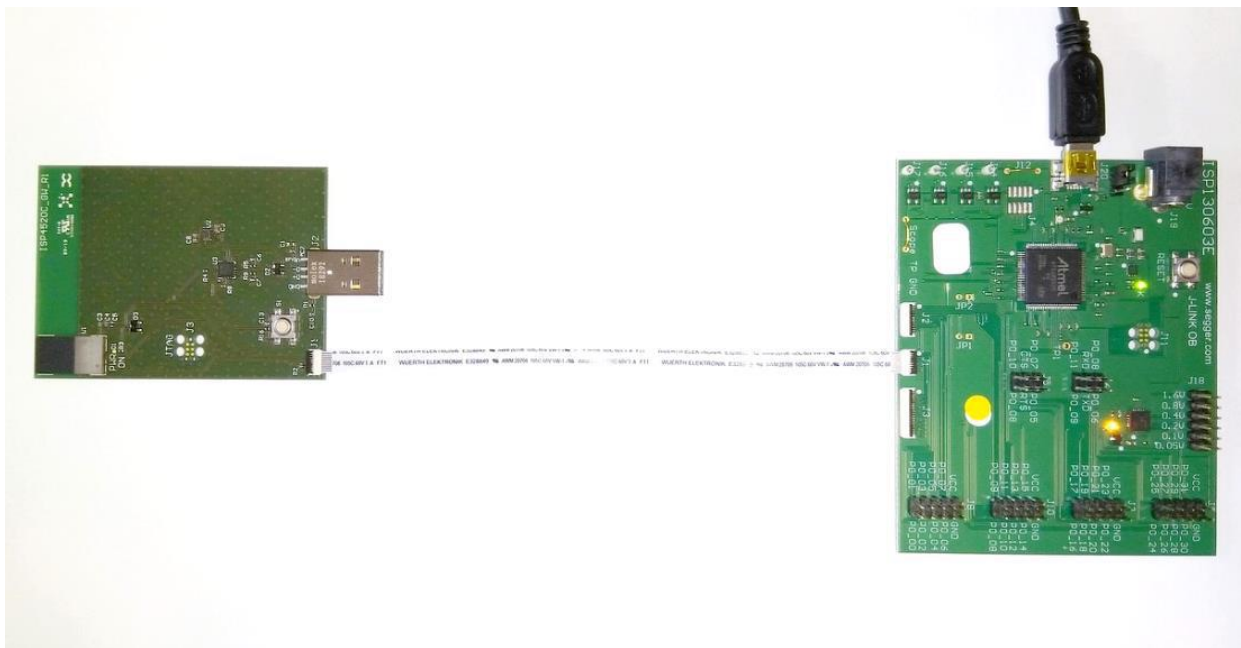   c. Refer to picture of the hardware configuration below.

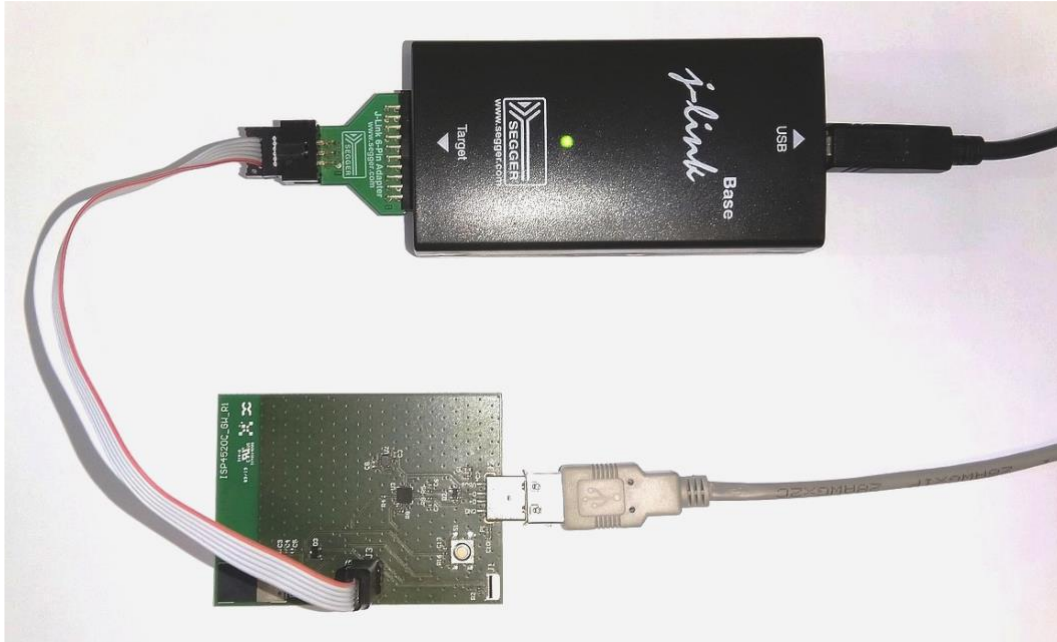*Figure 5: ISP4520-GW firmware loading via embedded JTAG in Interface Board*

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

1. Start nRF Connect Programmer, drag and drop the following files in the "File Memory Layout" box:
    *   Softdevice. Named s132_nrf52_5.0.0_softdevice.hex
    *   Application file. Depending on the module variant the app file can be demo_receiver_lora_EU.hex for Europe, demo_receiver_lora_JP.hex for Japan or demo_receiver_lora_US.hex for US.

2. Click "Erase & write".

3.6. 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 yourAndroid 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. Place the CR2032 lithium battery into the battery holder of the ISP4580.

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

3. Start the ISP4580_Demo application on your Android, click Connect and select theboard you want to connect to. Depending on which board the application is connected to, the navigation menu will give access to different services.
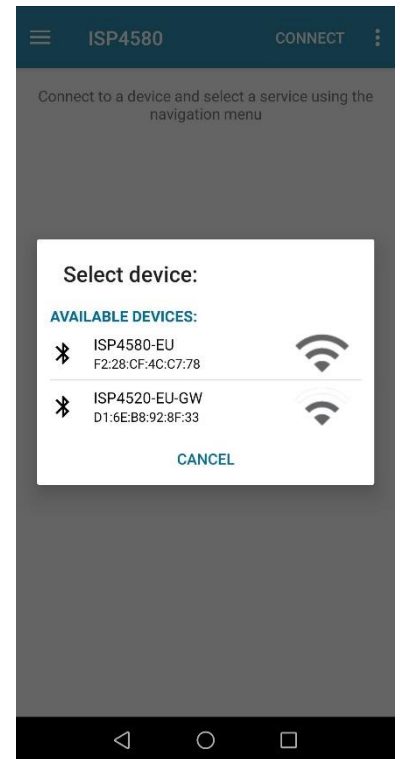
4. Clicking on "Environment" will open the environment screen.

   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.

   This display is only available for on ISP4520-GW board loaded with the "demo_receiver_lora" firmware as it is the only one configured with the BLE environment service.
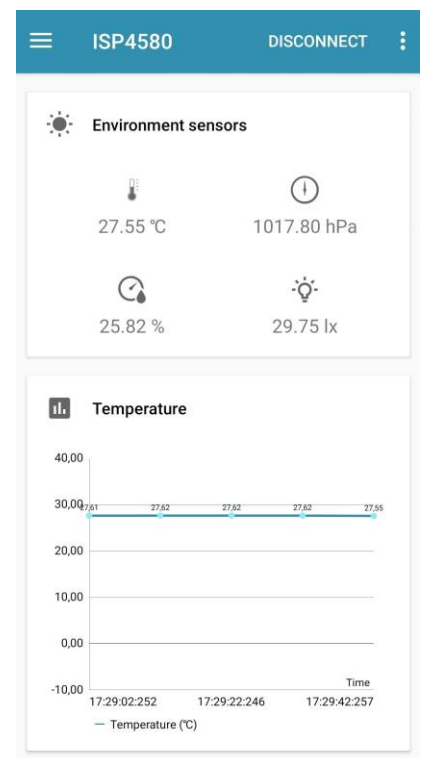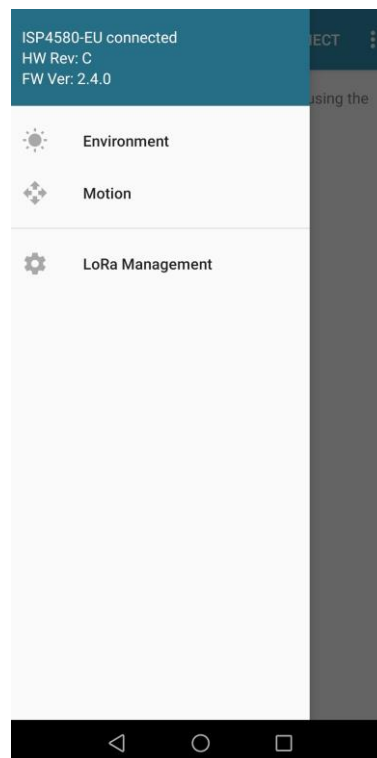
5. Clicking on "Motion" will open the motion screen.

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

   This display is only available for on ISP4520-GW board loaded with the "demo_receiver_lora" firmware as it is the only one configured with the BLE environment service
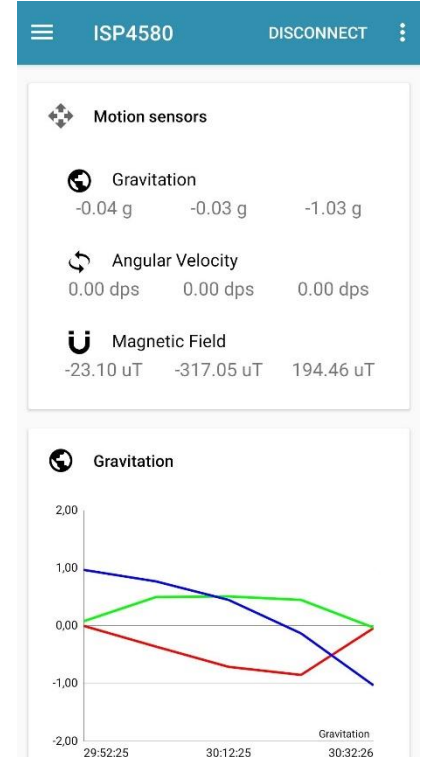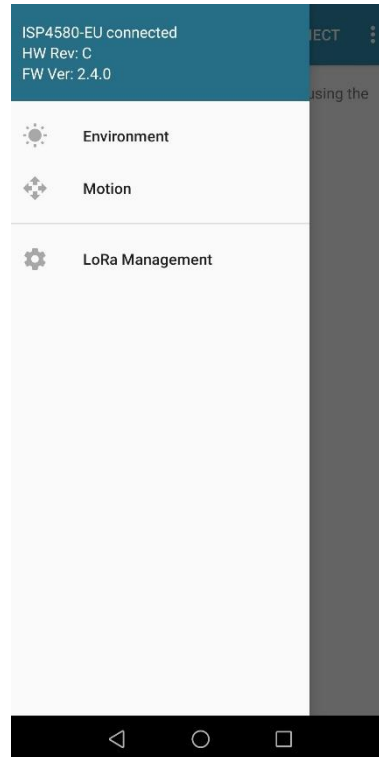
6. Clicking on "LoRa Management" will open the LoRa management screen.

   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.

   This screen also displays RSSI and SNR of received LoRa frames. This is only used on the ISP4520-GW.
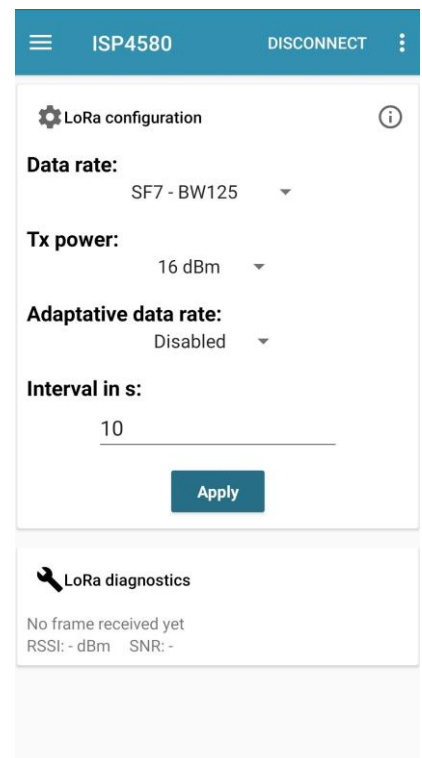
7. If no data is displayed on the Environment and Motion screens, check that the same LoRa modulation is configured on both ISP4580 and ISP4520-GW boards. Connect to each device, go to "LoRa Management" screen, set the same data rate (for ex SF7) and click on "Apply".

3.7. Using Serial port

The ISP4520-GW also transmits sensors data through 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.
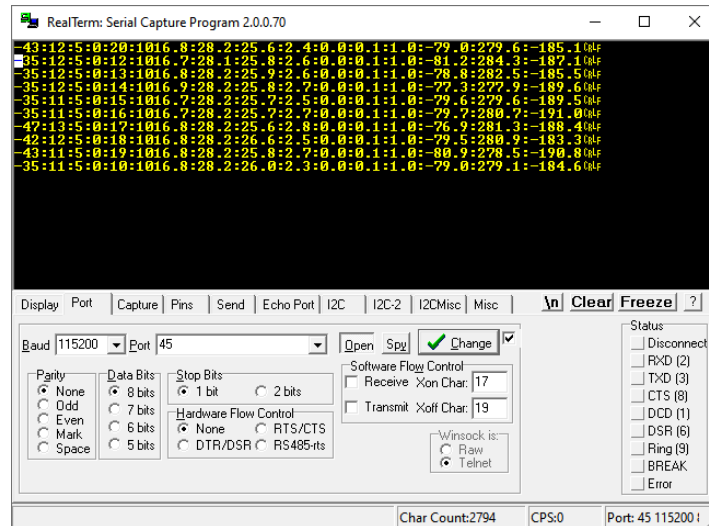

Figure 7: ISP4520-GW with RealTerm

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

With:
+ DR: data rate
+ TxP: Transmit Power (EIRP – 2*TxP)
+ FN: Frame number
+ Pr: Pressure in hPa
+ Temp: Temperature in °C
+ Humi: Relative Humidity in %
+ Light in lx
+ AccX: Acceleration X-axis
+ MagX: Magnetic field X-axis

4. Example sensor_demo_classA

4.1. Description

In this example, an ISP4580 board is loaded with the "demo_sensor_classA" firmware. The "demo_sensor_classA" will periodically fetch data from all sensors present on the ISP4580 board (Pressure, temperature, humidity, light and acceleration) and transmit them to a LoRaWan network.

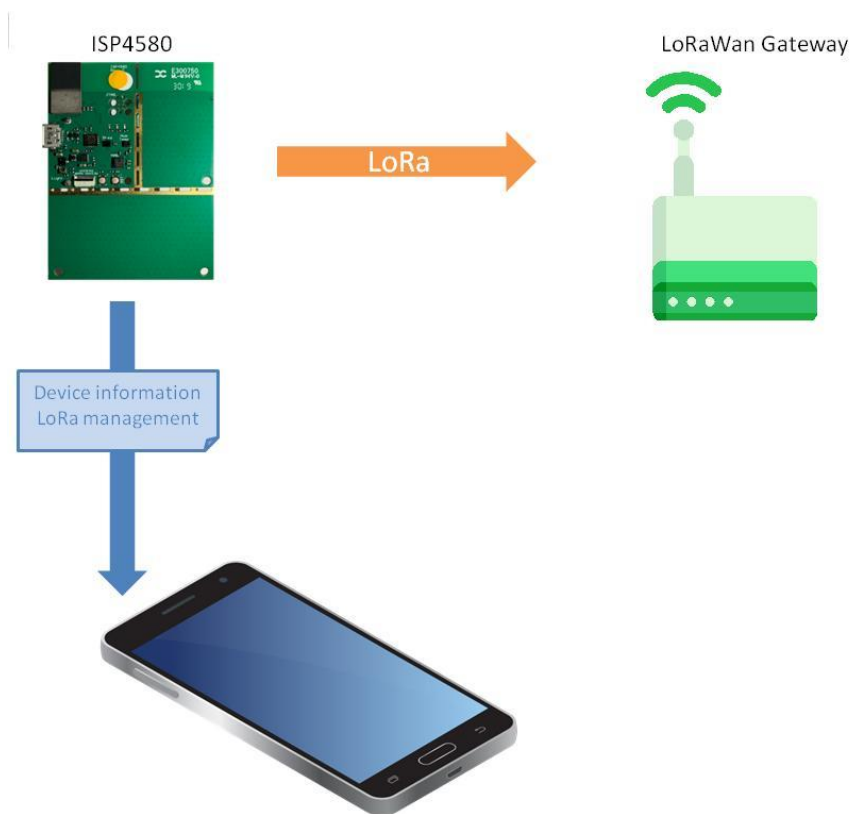Additionally,the firmware implementsa custom BLE service to allow configuration of the LoRa link.

Figure 8: Global demo overview

4.2. BLE services

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

4.3. 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 "demo_sensor_classA" using Segger Embedded Studio in <your_directory>\src\apps\demo_sensor_classA\project\ses

3. Select the project variant (demo_sensor_classA_EU, demo_sensor_classA_US or demo_sensor_classA_JP) by right-clicking the project and then "Set as Active Project".

4. Edit the commissionng.h file in order to give the device access to the your LoRaWan network:
   - Selection of the activation method: OTAA or ABP
   - Device EUI
   - Application EUI
   - Application Key
   - Etc

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