Getting started with the Sigfox S2-LP kit

Introduction

The STSW-S2LP-SFX-DK is an evaluation SW package for Sigfox networking with the S2-LP high performance, ultra-low power RF transceiver. It is designed to operate in the majority of radio configuration zones (RCZ) described by Sigfox.

The STSW-S2LP-SFX-DK SW package supports the STEVAL-FKI868V1, STEVAL-FKI868V2, STEVAL-FKI915V1, X-NUCLEO-S2868A2 and X-NUCLEO-S2915A1 kit platforms.

In addition, the package includes the STDES-MONARCH, the STEVAL-FKI001V1 and support for the STEVAL-IDB007V2 and STEVAL-IDB008V2 (kits to be used in conjunction with the shields included in the above mentioned kits). The latter solution enables the support for BlueNRG1/2 System-on-Chip alternatively to the STM32 microcontroller.

It provides an S2-LP Sigfox library with a complete set of APIs to develop embedded applications.

The S2-LP - Sigfox Demo GUI PC application provides an interactive interface to transmit messages to the Sigfox network and program the STEVAL-FKI nodes with the Sigfox ID to set the node for network communication.

For details regarding the BlueNRG-1/-2 hardware and software development kit, refer to STSW-BLUENRG1/2-DK.

1 Sigfox S2-LP kit content

The package includes:

- the Sigfox Demo GUI and corresponding firmware to:
  - prepare the board with ID/PAC/Key from the pool assigned to ST devices (see Section 4 Demo description)
  - run a demo that transmits user defined messages to the Sigfox network (see Section 5 Push button demo description)
- a framework to develop embedded Sigfox-enabled applications, with examples in the source code.
- an application note which describes the Sigfox firmware framework based on the S2-LP transceiver and on both STM32 MCU and BlueNRG1/2 SoC, with guidelines on how to develop solutions that are optimized for power.
- the Sigfox Flasher, a tool and related software APIs to store Sigfox credentials and manufacturing calibration values (frequency offset and RSSI), in a secure way, into the MCU internal Flash.

2 Requirements

2.1 Hardware requirements

A Windows® PC with:

- 2 USB ports
- 135 MB free hard disk space

At least one of the following ST evaluation kits:

- STEVAL-FKI868V2 or X-NUCLEO-S2868A2 (for RC1, RC3, RC5 and RC6) kit with STM32 Nucleo-64 development board or STEVAL-IDB007V2/IDB008V2 board
- STEVAL-FKI915V1 or X-NUCLEO-S2915A1 (for RC2 and RC4) with STM32 Nucleo-64 development board or STEVAL-IDB007V2/IDB008V2 board
- STEVAL-FKI001V1 development kit

2.2 Software prerequisites

- Microsoft Windows 7 or later
- Adobe Acrobat Reader 6.0 or later
- BlueNRG-1 ST-LINK-Utility
- STM32CubeProgrammer

One of the following integrated development environments (to develop embedded Sigfox-enabled applications):

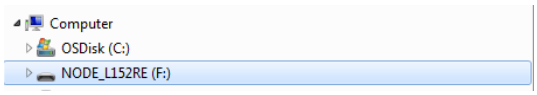
1. IAR EWARM 8.32.1 or later
2. Keil MDK-ARM µVision 5.17 or later

3 Board registration

3.1 ST-side registration

This registration procedure has to be performed only once via the ST GUI.

Step 1.

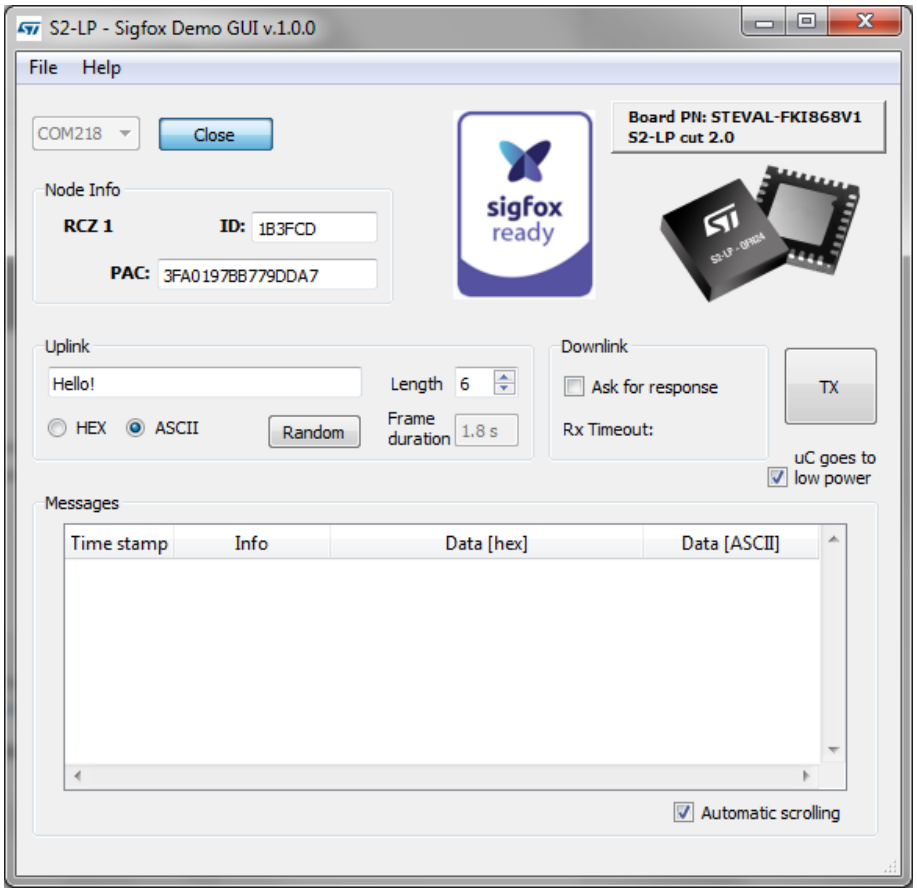
STM32	STEVAL-FKI001V1
Connect the STM32 Nucleo-64 development board to a PC via USB. Windows should automatically recognize the board as a hard drive **Figure 1. NUCLEO disk drive** 	Connect the STEVAL-FKI001V1 development board to a PC via USB and connect an ST-Link programmer to the JTAG/SWD connector.

Step 2.

STM32	STEVAL-FKI001V1
Flash the development board by simply dragging the appropriate bin file (in the Binaries/Sigfox_CLI_Demo_Project folder) to the NODE drive. Choose the bin file according to your STM32 Nucleo-64 development board: – SIGFOX_CLI_DEMO_NUCLEO_XX.bin	Open the BlueNRG-1 ST-LINK Utility and flash the development board by simply dragging the SIGFOX_CLI_DEMO_FKI001V1.hex file (in the Binaries/ Sigfox_CLI_Demo_Project folder) into the application window and select [**Target**]>[**Program**] and then press [**Start**].

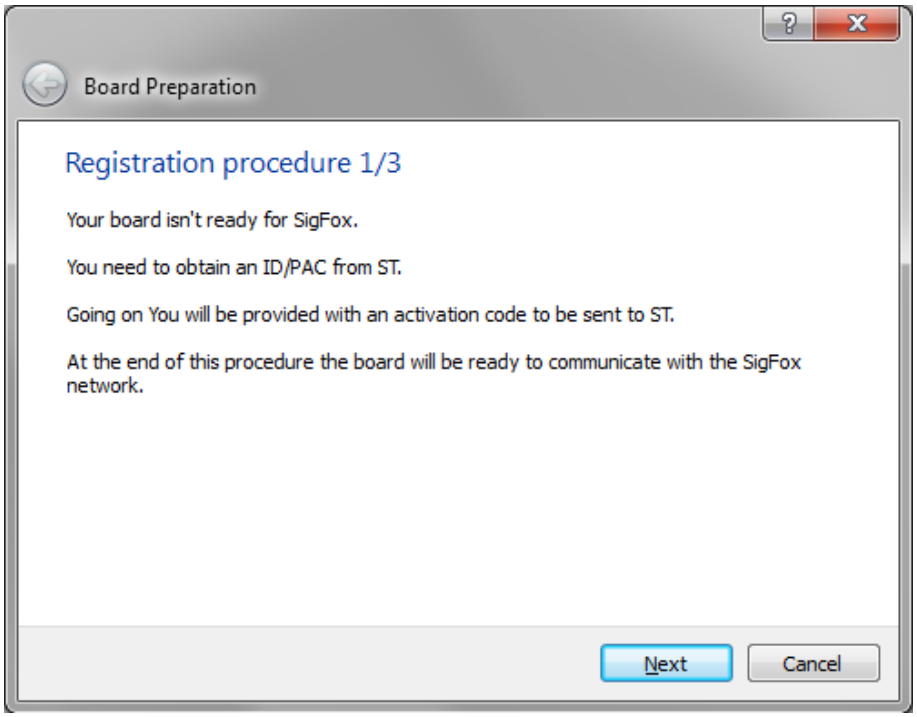
Step 3. Open the ST Sigfox GUI and the COM port associated with the development board.

Figure 2. Sigfox Demo GUI main window



Step 4. Click on the [**Open**] button.
If the board does not contain Sigfox data, a Board Preparation wizard appears.

Figure 3. ST Registration procedure 1/3



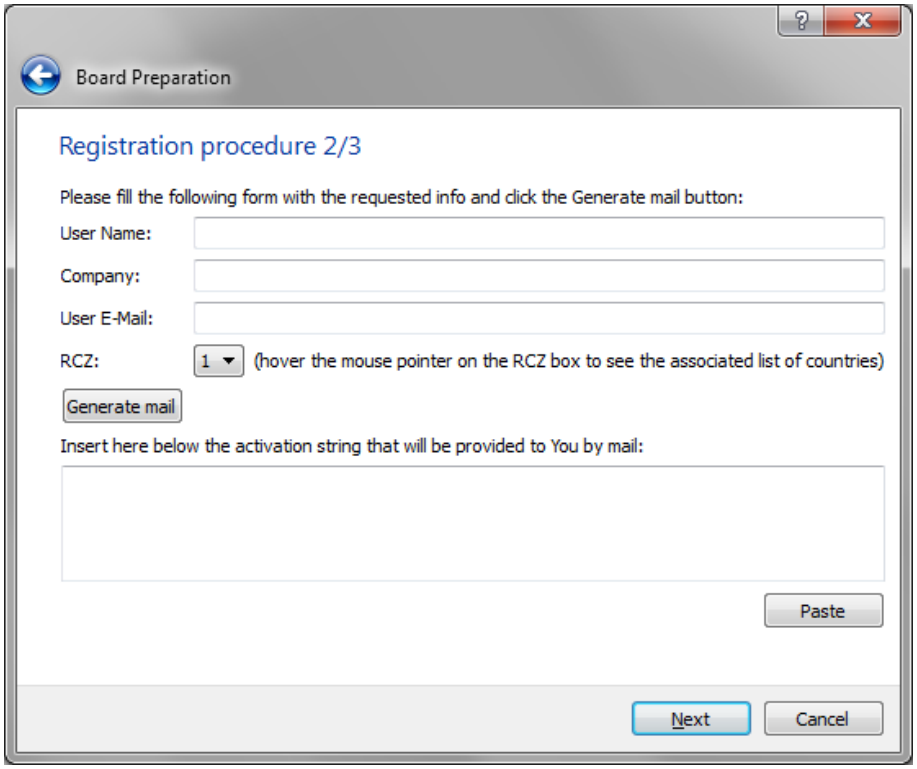
Step 5. Click the [**Next**] button

You will be prompted to complete a short form with your:

- name
- company name
- e-mail address
- radio configuration zone (RCZ) number

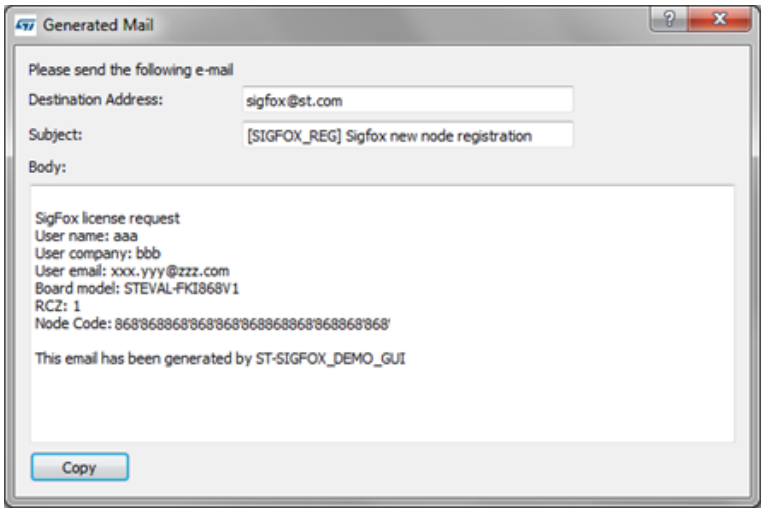
Note: You must specify the correct RC zone to avoid generating an incorrect ID. Please refer to https://build.sigfox.com/sigfox-radio-configurations-rc for the updated list of Sigfox Radio Configuration (RC) zones.

Figure 4. ST Registration procedure 2/3



Step 6. Click on the [**Generate mail**] button
A window appears with the e-mail data you need to send.

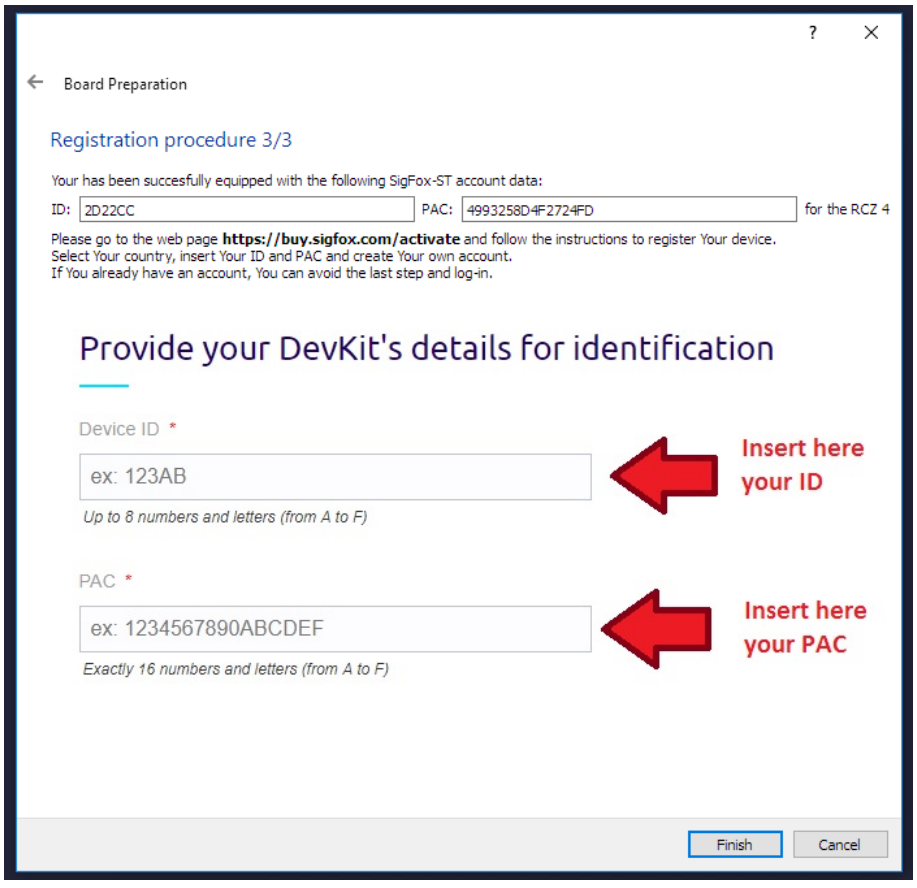
Figure 5. Generated mail pop-up



Step 7. Send an email with the Destination Address, Subject and e-mail text shown in the popup window
You will receive an answer (at the e-mail address you specified previously) with an activation string

Step 8. Paste the activation string you receive in the text box and click Next

Figure 6. ST Registration procedure 3/3



Step 9. If the activation string is correct, the board is programmed with the Sigfox account data and the ID and PAC is shown on the final page

The board is now ready and you can register the board in its own Sigfox backend

3.2 Sigfox side registration

Visit https://buy.sigfox.com/activate for ST development kit registration.

Step 1. Insert the country where the board should operate the ID and PAC of the board.

Step 2. Then fill a form to obtain an account on the sigfox backend.

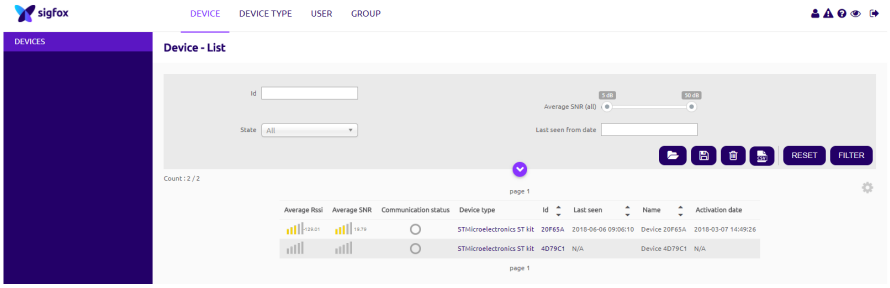
An e-mail will be sent to the specified e-mail address.

Step 3. Choose a password and sign in to its own backend from https://backend.sigfox.com.

Step 4. Go to the DEVICE section.

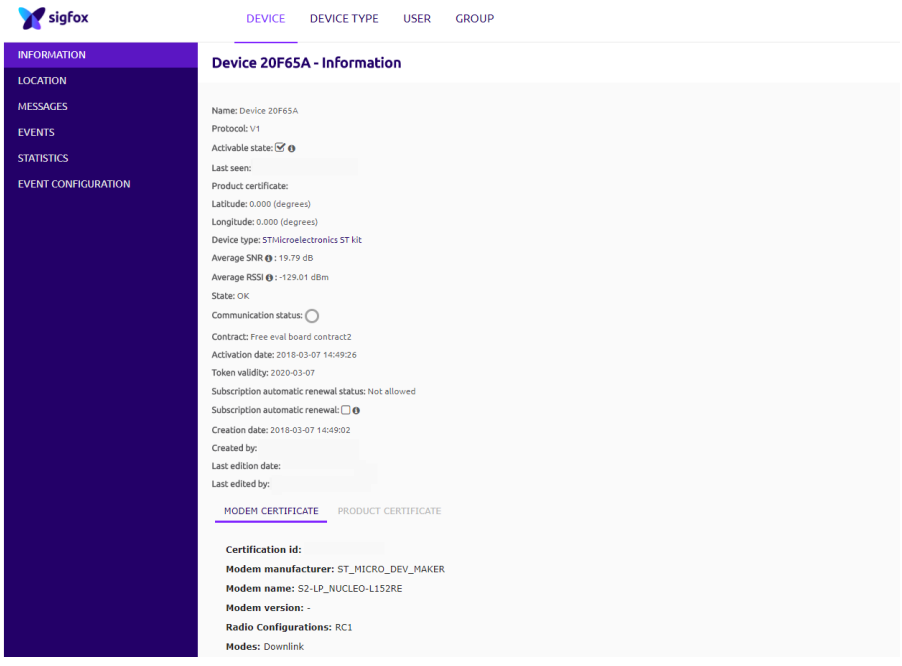
This section provides a list of registered devices and other data.

Figure 7. Sigfox device page



Step 5. Click on the device ID to access a node summary page:

Figure 8. Sigfox device information

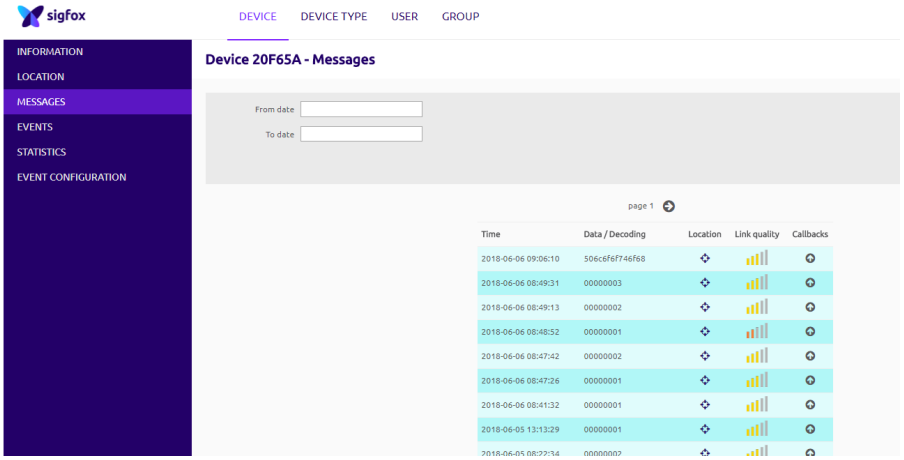


Step 6. Click on messages to show a list of all sent messages.

For each message, the following information is shown:

– the date and time
– the data in hex (so if the transmission occurred with the S2-LP Sigfox GUI, the data should be the transmitted message in hex)
– the location of the node (link to a map)
– a link quality indicator (SNR bar)

Figure 9. Sigfox device messages



4 Demo description

The demo can run either on a kit connected to a PC running the Sigfox Demo GUI (Section 4.1 Sigfox Demo GUI), or on a kit supplied via USB in standalone mode (Section 4.2 Demo without connection to a PC).

4.1 Sigfox Demo GUI

After board registration, you can transmit messages using the GUI.

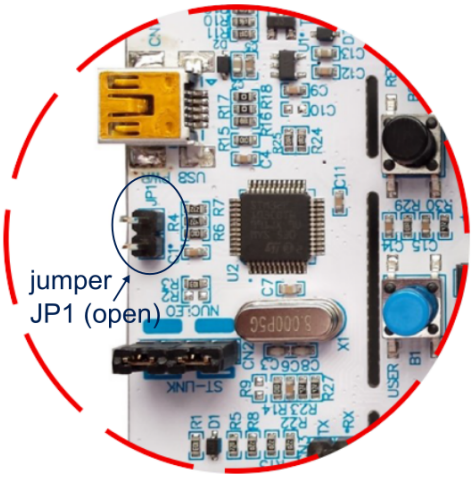
Step 1. Flash the board with the appropriate Sigfox_CLI_Demo firmware, located in the Binaries/Sigfox_CLI_Demo_Project folder

Step 2. Connect the STM32 Nucleo-64 or STEVAL-FKI001V1 development board to a PC via USB.

Step 3. (For STM32 only) Ensure jumper JP1 (near the USB connector) is open so the PC to assign a COM port to it.

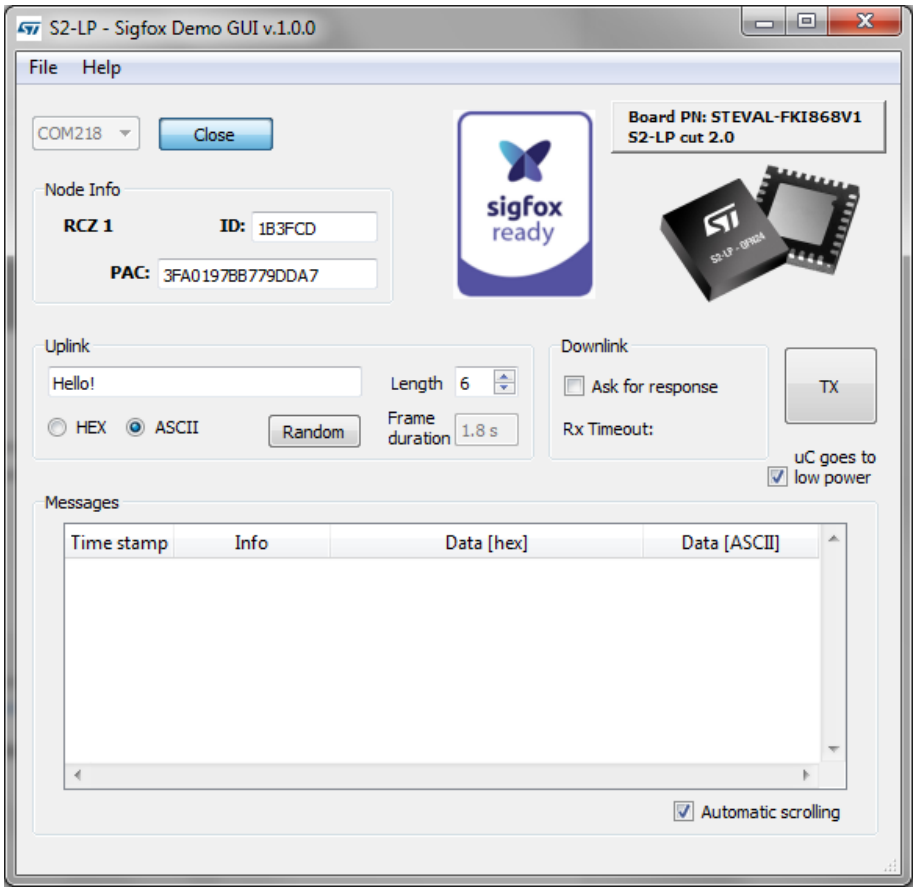
LEDs LD1 and LD3 on the board should both be lit.

Figure 10. JP1 position on STM32 Nucleo board



Step 4. Launch the Sigfox Demo GUI on your PC

Figure 11. Sigfox Demo GUI main window



Step 5. Click on the TX button to transmit data.

In adherence with protocol, the frame is repeated three times with a 500 ms interval; the duration of each frame is shown in the Frame duration box.

The frames received by the base-stations are shown in the DEVICE > Messages section of the sigfox backend.

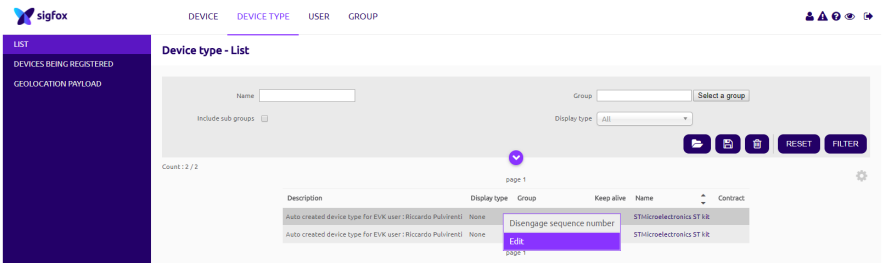
Note: The maximum length of a message is 12 bytes, as per the sigfox protocol.

Step 6. Check the Ask for response checkbox and then click TX again.

The message is sent with a response request and the transmission is followed by a reception phase of up to 50 s. The received message is shown in the Messages section of the GUI.

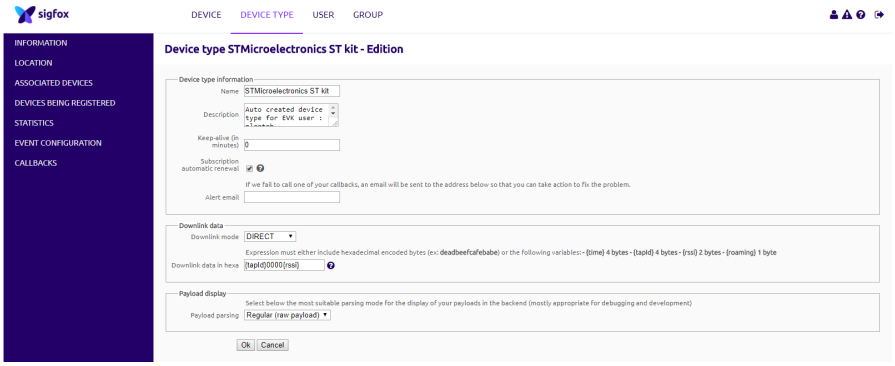
Step 7. To set the response for each device from the sigfox backend, log-in, go to the DEVICE TYPE tab and click on the device type description.

Figure 12. Sigfox DEVICE TYPE tab



Step 8. Click Edit to change the Downlink data parameters.

Figure 13. Sigfox DEVICE TYPE parameters



Step 9. Check the uC goes to low power checkbox to set the microcontroller in low power mode during radio transactions.

4.1.1 Sigfox Demo GUI menu items

The File menu can be used to access the Demo firmware and Sigfox library version information.

For radio configuration zones 2 and 4, there is also the Set Std Configuration option described in Section 4.3.3 node_set_std_config command description.

The Help menu provides GUI version information.

4.2 Demo without connection to a PC

In this mode, the board is not connected to a PC

Step 1. (For STM32 only) Close jumper JP1 in Figure 10. JP1 position on STM32 Nucleo board.

This allows the STM32 to execute the firmware program without being enumerated to a USB host device.

LED LD1 will blink and LD3 will remain lit.

Step 2. Press the blue button (on STM32 Nucleo boards) or the SW1 button (on STEVAL-FKI001V1).

The node transmits a 32-bit counter to the network representing the number of times this button has been pressed since the last reset.

4.3 Using the command line

The SIGFOX_CLI_DEMO_NUCLEO firmware lets send simple commands using a serial terminal.

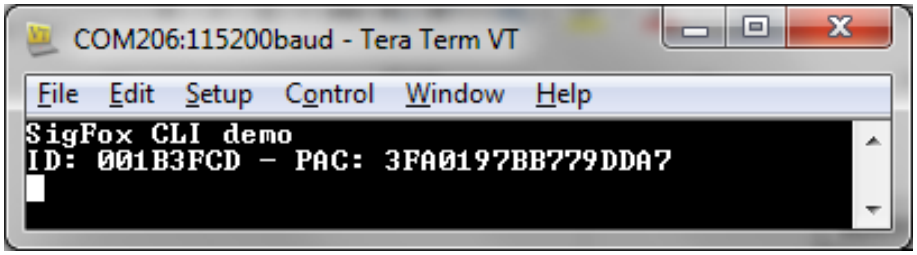
Step 1. Open the COM port with a baudrate of 115200

A simple command shell opens.

Step 2. Press the reset button.

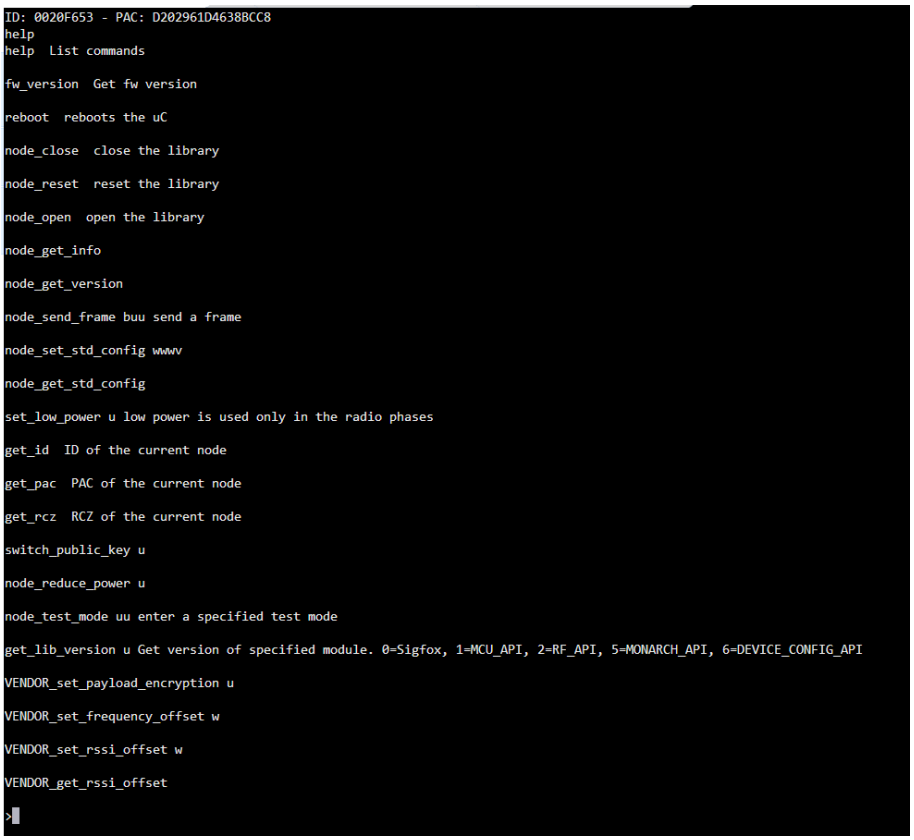
The board resets and a string containing ID and PAC in hex format is printed.

Figure 14. Command line terminal box



Step 3. Type help.
A list of all commands is shown.

Figure 15. Command line function list



4.3.1 Command line function description

Table 1. Available command line functions

NAME	ARGUMENTS	DESCRIPTION
fw_version	None	Returns the firmware version
node_send_oob	None	Sends OOB frame
node_set_rc_sync_period	Period	Sets the RC SYNC period
set_payload_encryption	0: no 1: yes	Sets the encryption of the payload
get_id	None	Returns the Sigfox ID of the board
get_pac	None	Returns the Sigfox PAC of the board
get_rcz	None	Returns the RCZ
node_open	None	Opens the Sigfox library Must be called before performing any send operation
node_close	None	Closes the Sigfox library

NAME	ARGUMENTS	DESCRIPTION
node_send_frame	list-of-bytes: must be enclosed between { } brackets and represented in hex without spaces. tx_repetitions: integer require_downlink: integer	See Section 4.3.2 node_send_frame command description
node_set_std_config	conf_word0,conf_word1, conf_word2 : 3 conf words of 32bits each default_sigfox_channel can be from 1 to 82	Sets the standard channel configuration. This function is only for RCZ2 and 4. See Section 4.3.3 node_set_std_config command description
node_reset	None	Resets the Sigfox library state
node_get_info	None	Returns info on send frame depending on the mode you're using
node_execute_monarch_scan	rc_capabilities_bit_mask: Bit Mask of the RCx on which the scan has to be executed (see Table 2. Sigfox Monarch RC Capabilities bitmask) timer: Scan duration value unit: Unit to be considered for the scan time computation	This function executes a scan to detect a Sigfox Beacon
node_stop_monarch_scan	None	Stops a RC scan which is on going
node_monarch_test_mode	rc: rc zone test_mode: the type of test to perform rc_capabilities	Performs Sigfox tests for Monarch
start_continuous_transmission	Frequency: the frequency of the continuous wave Mode: Type of modulation to use in continuous mode (see Table 3. Continuous transmission types of modulation)	Executes a continuous wave or modulation
stop_continuous_transmission	None	Stops a continuous wave or modulation
switch_pa	0: no 1: yes	Sets or unsets the presence of the PA
set_lbt_thr_offset	lbt_thr: the LBT threshold	Sets the LBT threshold value to use during Sigfox certification
get_lbt_thr_offset	None	Returns the value of the LBT threshold
set_smps_voltage	voltage_level: the desired output voltage (see Table 4. set_smps_voltage argument values)	This allows changing the SMPS output voltage in order to change the maximum output power. The function accepts the codes in table xx3
set_xtal_frequency_offset	Crystal compensation value (Hz)	Aligns the crystal frequency adding the compensation value
reduce_output_power	reduction: the reduction factor in 0.5 dB (approx)	Reduces the output power of the transmitted signal by a factor. = reduction argument * 0.5 dB
set_low_power	1: enable_low_power (default) 0: disable_low_power	Enables or disables microcontroller low power mode during transmission and reception operations

NAME	ARGUMENTS	DESCRIPTION
switch_public_key	1: switch to the public key 0: use the key of this specific node.	The public key is [00, 11, 22, … , FF]
reboot	None	Reboots the device
node_get_version	None	Returns the version of the Sigfox library
node_get_std_config	None	Returns the standard channel configuration in memory
node_test_mode	RCZ: integer Test_Mode: integer	Executes a specified test mode
get_lib_version	Lib_ID: Integer 0=Sigfox 1=MCU_API 2=RF_API 5=MONARCH_API 6=DEVICE_CONFIG_API	Gets version of specified module.
set_payload_encription	1: enable payload encryption 0: disable payload encryption	Enables payload encryption
set_frequency_offset - **DEPRECATED**(1)	Offset (Hz): real	Overrides default offset calibration
set_rssi_offset	Offset: real	Sets RSSI calibration value
get_rssi_offset	None	Returns the last RSSI offset in memory
node_send_bit	Bit to send: 1 or 0 Number of repetition: integer	Sends a single bit n times
node_open_with_zone	RCZ: integer	Opens Sigfox library with a specified RC zone (see Table 9. Supported Sigfox RC zones)
switch_test_credentials	1: Enable test credentials 0: Disable test credentials	Enables credentials to be used during Sigfox verified tests

1. *Only for backward compatibility. Please, now refer to the set_xtal_frequency_offset command*

Table 2. Sigfox Monarch RC Capabilities bitmask

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
-	-	RC6	RC5	RC4	RC3	RC2	RC1

Table 3. Continuous transmission types of modulation

Modulation mode	Value
No modulation	0
DBPSK 100bps	1
DBPSK 600bps	2

Table 4. **set_smps_voltage argument values**

Argument	SMPS value
7	1.8 V
6	1.7 V
5	1.6 V
4	1.5 V
3	1.4 V
2	1.3 V

4.3.2 node_send_frame command description

To send a frame, call the `node_open command` and then the `node_send_frame` command specifying the following parameters:

1. The list of bytes to be transmitted: given as a hexadecimal string (12 bytes max.).
2. tx_repetitions:
   - If `require_downlink` is set, the frame is sent tx_repetitions + 1 times (tx_repetitions ≤ 2)
   - If `initiate_downlink_flag` is not set, tx_repetitions is forced to 2.
3. require_downlink: Request a downlink frame from the base-station and wait for reception.

Note: The behavior of the node is different in uplink (`require_downlink=0`) and downlink (`require_downlink=1`).

The following procedures are initiated in the different cases:

- uplink :
  - Send uplink frames (3)

```
Command example: node_send_frame {012345} 0 0
```

```
Command response: {{(node_send_frame)} API call...{sfx_error:00}}
```

- downlink :
  - Send uplink frames (1 to 3)
  - Receive downlink frame
  - Send out of band frame (Voltage, temperature and RSSI)

```
Command example: node_send_frame {012345} 2 1
```

```
Command response: {{(node_send_frame)} API call...{sfx_error:00}
```

```
{customer_resp: 0x00,0x00,0x00,0x50,0x6C,0x75,0x74,0x6F}}
```

4.3.3 node_set_std_config command description

FCC allows the transmitters to choose different macro channels to implement a frequency hopping pattern allowed by the standard. These macro channels can be chosen through three 32-bit configuration words.

Each bit of the `config_words[0,1,2]` array represents a macro channel according to the following mapping:

Table 5. **Macro channel mapping - config_words[0]**

Macro Ch.	1	2	3	4	5	6	7	…	32
Frequency (MHz)	902.2	902.5	902.8	903.1	903.4	903.7	904.0	…	911.5
config_words[0] bit	0	1	2	3	4	5	6	…	31

Table 6. Macro channel mapping - config_words[1]

Macro Ch.	33	34	35	36	37	38	39	…	64
Frequency (MHz)	911.8	912.1	912.4	912.7	913.0	913.3	913.6	…	921.1
config_words[1] bit	0	1	2	3	4	5	6	…	31

Table 7. Macro channel mapping - config_words[2]

Macro Ch.	65	66	67	68	69	70	71	…	86
Frequency (MHz)	921.4	921.7	922.0	922.3	922.6	922.9	923.2	…	927.7
config_words[2] bit	0	1	2	3	4	5	6	…	21

A macro channel is only enabled when the corresponding `config_words[]` bit is set to 1. At least 9 macro channels must be enabled to meet the FCC specifications.

The last argument is an integer representing the `sigfox_default_channel`. It should be set as follows:

- For RCZ2, the operational frequency should be 902.2MHz and the default channel is 1.
- For RCZ4, it is necessary to keep the 902.2 MHz frequency in the open function but, since the sigfox operational channel is at 920.8MHz, we need to set the default channel to 63.

By default the GUI uses the following `std_config`:

Table 8. Default STD config

Parameter	RCZ2	RCZ4
config_words[0]	0x000001FF	0x00000000
config_words[1]	0x00000000	0xF0000000
config_words[2]	0x00000000	0x00001F
sigfox_default_channel	1	63

Note: This command is ineffective for RCZ1.

5 Push button demo description

This is an ST-Sigfox demo showing how to use the Sigfox protocol to send a message to a base station each time the blue button on the STM32 Nucleo board, the button 2 of the STEVAL-IDB007V2/STEVAL-IDB008V2 board, or the SW1 button on the STEVAL-FKI001V1 is pressed. The payload of the message is a number representing the number of times the button has been pressed since the last boot sequence.

If something goes wrong during initialization, the green LED on the STM32 Nucleo board or the red lLED on the STEVAL-IDB007V2/STEVAL-IDB008V2 board will blink continuously.

The root folder of the project is Projects/Projects_Cube/Sigfox_Applications/Sigfox_PushButton_Demo_Project.

The same example is provided both for MDK-ARM Keil and IAR Embedded Workbench integrated development environments.

5.1 KEIL project

To use the project with KEIL µVision 5 for ARM®:

Step 1. Open the KEIL µVision 5 for ARM and select Project→Open Project.

Step 2. Open the KEIL project
Projects/Projects_Cube/S2-LP_Sigfox_DK/SigFox_PushButton_Project

Step 3. Select the desired platoform (STM32 or BlueNRG) and open the project in the MDK-ARM folder

Step 4. Select the configuration and go to Project→Rebuild all target files.
This will recompile and link the entire application

Step 5. Select Project→Download to download the corresponding binary image.

5.2 IAR project

To use the project with IAR Embedded Workbench for ARM®:

Step 1. Open the Embedded Workbench for ARM and select File→Open→Workspace.

Step 2. Open the IAR project
Projects\Projects_Cube\S2-LP_SigFox_DK\SigFox_PushButton_Project

Step 3. Select the desired platoform (STM32 or BlueNRG) and open the project in the EWARM folder

Step 4. Select Project→Rebuild All.
This will recompile and link the entire application

Step 5. Select Project→Download and Debug to download the corresponding binary image.

6 Sigfox CLI demo description

This ST-Sigfox demo shows how to use a command line interface (CLI) to send commands which use the Sigfox protocol to send messages and perform pre-certification tests (for the available commands refer to Section 4.3 Using the command line).

6.1 STEVAL-IDB007V2/STEVAL-IDB008V2 limitations

As described in Section 6.5 BlueNRG-1/2 support, the STEVAL-IDB007V2/STEVAL-IDB008V2 evaluation boards cannot use the UART and the external EEPROM at the same time, so the EEPROM cannot be used in this project.

For this reason, in the CLI Project, you should use the define `USE_FLASH` for the MCU Flash to store credentials and any other Sigfox nonvolatile data.

6.2 Sigfox pre-certification tests

The CLI project includes the SIGFOX ADDON library that allows performing the entire test suite before the official certification.

The test procedure requires the RSA-SDR-Dongle kit from Sigfox.

Test can be performed calling the node_test_mode command specifying RCZ and Test ID.

6.2.1 Sigfox RCZ values

Table 9. Supported Sigfox RC zones

RCZ ID	RCZ Name	Description
0	SFX_RC1	Radio Configuration 1
1	SFX_RC2	Radio Configuration 2
2	SFX_RC3A	Radio Configuration 3A
3	SFX_RC3C	Radio Configuration 3C
4	SFX_RC4	Radio Configuration 4
5	SFX_RC5	Radio Configuration 5
6	SFX_RC6	Radio Configuration 6
8	SFX_RC101	Radio Configuration 101

6.2.2 Sigfox test ID values

Table 10. Sigfox suitable test ID values

Test ID	Test name
0	SFX_TEST_MODE_TX_BPSK
1	SFX_TEST_MODE_TX_PROTOCOL
2	SFX_TEST_MODE_RX_PROTOCOL
3	SFX_TEST_MODE_RX_GFSK
4	SFX_TEST_MODE_RX_SENSI
5	SFX_TEST_MODE_TX_SYNTH
6	SFX_TEST_MODE_TX_FREQ_DISTRIBUTION
7	SFX_TEST_MODE_RX_MONARCH_PATTERN_LISTENING_SWEEP
8	SFX_TEST_MODE_RX_MONARCH_PATTERN_LISTENING_WINDOW

Test ID	Test name
9	SFX_TEST_MODE_RX_MONARCH_BEACON
10	SFX_TEST_MODE_RX_MONARCH_SENSI
11	SFX_TEST_MODE_TX_BIT
12	SFX_TEST_MODE_PUBLIC_KEY
13	SFX_TEST_MODE_NVM

6.3 KEIL project

To use the project with KEIL µVision 5 for ARM®:

- Open the KEIL µVision 5 for ARM and select Project→Open Project
- Open the Keil project in
  - Projects\Projects_Cube\S2-LP_SigFox_DK\SigFox_CLI_Demo_Project
- Select the desired platform (STM32 or BlueNRG) and open the project in the MDK-ARM folder
- Select the configuration and go to Project→Rebuild all target files
  - This will recompile and link the entire application
- Select Project→Download to download the corresponding binary image

6.4 IAR project

To use the project with IAR Embedded Workbench for ARM©:

Step 1. Open the Embedded Workbench for ARM©.

Step 2. Select [**File**]>[**Open**]>[**Workspace**].

Step 3. Open the IAR project
Projects\Projects_Cube\S2-LP_SigFox_DK\SigFox_CLI_Demo_Project

Step 4. Select the desired platform (STM32 or BlueNRG) and open the project in the EWARM folder.

Step 5. Select [**Project**]>[**Rebuild All**]

Step 6. Select [**Project**]>[**Download and Debug**] to download the corresponding binary image.

6.5 BlueNRG-1/2 support

The STSW-S2LP-SFX-DK SW package supports the STEVAL-FKI001V1, the Monarch Reference Design and the STEVAL-IDB007V2/STEVAL-IDB008V2 platforms.

To use them, you have to download and install the latest STSW-BLUENRG1-DK software package from www.st.com to install the USB-to-serial driver needed for the applications requiring the serial port.

For the STEVAL-IBD007V2 and the STEVAL-IDB008V2 some hardware modifications are also needed to ensure compatibility with S2-LP evaluation kits.

6.5.1 Changes to the STEVAL-IDB007V2 and STEVAL-IDB008V2 boards

To make the STEVAL-IDB007V2 or STEVAL-IDB008V2 boards compatible with the STEVAL-FKI868V2/STEVAL-FKI915V1 boards, you have to apply some changes to the board, on the bottom layer:

Step 1. Remove R12 resistor.

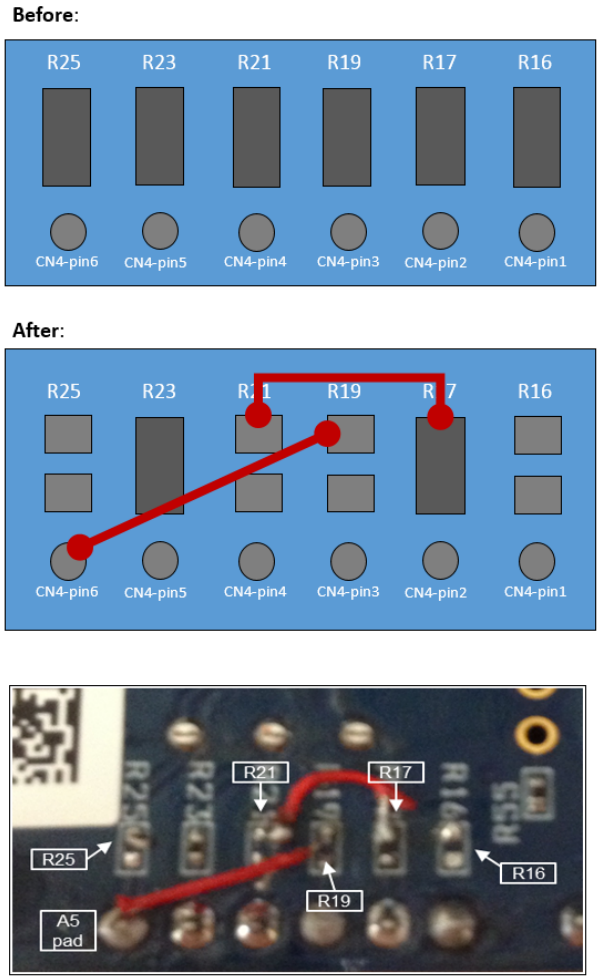
Step 2. Create a short-circuit between pin 8 and pin 7 of CN3 connector.

Step 3. Remove R25, R21, R19, R16 resistors.

Step 4. Set a short between the internal pad of R21 and R17 resistors.

Step 5. Set a short between pin 6 of CN4 connector and the internal pad of R19 resistor.

Figure 16. STEVAL-IDB007V1/2 or STEVAL-IDB008V2 hardware modifications



6.5.2 BlueNRG-1/2 SoC connections for STEVAL-IDB007V2 and STEVAL-IDB008V2

After applying the modifications, the STEVAL-IDB007V2 and STEVAL-IDB008V2 platform pin connection is as described the following table.

Table 11. STEVAL-IDB007V2 platform pin description with board function

Pin name	Pin num.	Function										
		LEDs	S2-LP	Buttons	FKI_E2PROM	Pressure sensor	3D accelerometer and gyroscope	JTAG	Arduino connectors			
									CN1	CN2	CN3	C4
DIO10	1							JTMS-SWTDIO				
DIO9	2							JTCK-SWTCK				
DIO8	3				SPI_CS				pin 1 (IO8)		pin 2 (TX)	
DIO7	4	DL2							pin 2 (IO9)			pin 6 (SCL)

Pin name	Pin num.	Function										
		LEDs	S2-LP	Buttons	FKI_E2PROM	Pressure sensor	3D accelerometer and gyroscope	JTAG	Arduino connectors			
									CN1	CN2	CN3	C4
DIO6	5	DL1	SDN								pin 7 (IO6)	pin 5 (SDA)
DIO5	7			PUSH2		SDA (PUSH2 button)			pin 9 (SDA)			
DIO4	8					SCL			pin 10 (SCL)			
DIO3	9		SPI_SDO		SPI_SDO		SPI_SDO		pin 5 (MISO)		pin 6 (IO5)	
DIO2	10		SPI_SDA		SPI_SDA		SPI_SDA		pin 4 (MOSI)		pin 5 (IO4)	
DIO1	11						SPI_CS	JTAG-TDO	pin 3 (CS)			
DIO0	12		SPI_SCL		SPI_SCL		SPI_SCL	JTAG-TDI	pin 6 (SCK)		pin 4 (IO3)	
DIO14	13	DL3	SPI_CS									pin 4 (AD3)
RESET	25		RESET	RESET				RESET		pin 3 (NRST)	pin 8 (IO7)	
DIO13	29		GPIO3	PUSH1								pin 3 (AD2)
DIO12	30						INT1					pin 1 (AD0)
DIO11	32										pin 1 (RX) pin 3 (IO2)	pin 2 (AD1)

6.5.3 S2-LP

The S2-LP is placed in the STEVAL-FKI868V2 and STEVAL-FKI915V1 boards connected to the STEVAL-IDB007V2 and STEVAL-IDB008V2 through the Arduino connectors (CN1-4) and can be driven by the BlueNRG-1/2 via SPI.

GPIO3 is connected to the BlueNRG-1/2 wake-up pin used to notify some events.

The BlueNRG-1/2 SoC acts as a SPI master and can be used to configure the device through registers and to send/receive data to/from the sub-1GHz channels.

6.5.4 E2PROM

The E2PROM containing the manufacturing data of the S2-LP board can be accessed by the BlueNRG-1/2 using the SPI bus.

Important:
Since the EEPROM CS signal is shared with the TX signal of the BlueNRG UART port (IO8), UART and EEPROM should be used in an exclusive way.

6.5.5 Hardware setup

Step 1. Connect a 2.4 GHz antenna to the STEVAL-IDB007V2 SMA connector.

Step 2. Connect an 868/915MHz antenna to the STEVAL-FKI868V2 and STEVAL-FKI915V1 SMA connector.

Step 3. Ensure the jumper configuration on the board is as described in Section 6.5.1 Changes to the STEVAL-IDB007V2 and STEVAL-IDB008V2 boards.

Step 4. Connect the motherboard to the PC via a USB cable.

Step 5. Verify the PWR LED DL4 light is on.

6.6 Sigfox Flasher

Sigfox board information (ID, PAC and KEY) can be stored in the device Flash memory using the SIGFOX_FLASHER tool included with the STSW-S2LP-SFX-DK package.

Before proceeding, you need to obtain valid credentials from Sigfox (for further details, contact your local reference for Sigfox).

However, you can use the test credentials for test purposes:

- **ID** = 0xFEDCBA98
- **KEY** = 0x0123456789ABCDEF0123456789ABCDEF

The SIGFOX_FLASHER is a tool to setup Sigfox credentials and board information related to Sigfox operations. The output of this tool is a binary file and, optionally, the information stored in the file can be directly flashed to the device.

All the examples included in this package can be programmed to read Sigfox credentials from Flash by simply declaring the USE_FLASH define in the pre-processor defined symbols.

Together with ID, PAC and KEY, other information stored in the Flash memory is related to:

- RCZ
- frequency offset
- RSSI offset
- LBT offset

6.6.1 Prerequisites

To save credentials in your device using the tool, ensure you have installed the right version of ST-LINK utility (for BlueNRG-1/BlueNRG-2 boards) or STM32CubeProg (for STM32 boards) as shown in the table below.

Table 12. ST-LINK utility and related devices

Device	Software required
STM32	STM32CubeProg
BlueNRG1/2	STSW-BNRG1STLINK

Once installed, check the application path with the one listed in the app.cfg file.

Default values for app.cfg are:

```
STM_32=C:/Program Files/STMicroelectronics/STM32Cube/STM32CubeProgrammer/bin/
STM32_Programmer_CLI.exe
BLNRG1=C:\Program Files (x86)\STMicroelectronics\BlueNRG-1_2 ST-Link Utility V 2.0.0\ST-
LINK_Utility\BlueNRG-1_ST-LINK_CLI.exe
```

6.6.2 Usage

After receiving your valid credentials, go to the SfxFlasher folder and open a Windows command window.

The SIGFOX_FLASHER tool supports a series of options as listed in the following table.

Table 13. **SIGFOX_FLASHER parameters**

Parameter	Description
Data	A string in the form of `ID;PAC;KEY;RCZ;FrequencyOffset;RSSIOffset;LBTOffset`
-e	Encryption mode: none, fixed, variable
-k key	16-byte long encryption key when fixed mode selected
-f [file name]	Output file name
-w [address]	Write directly in the Flash memory
-sn serial number	A specific ST-LINK serial number

Example:

```
> SIGFOX_FLASHER
"FEDCBA98;0102030405060708;0123456789ABCDEF0123456789ABCDEF;1;1740;21;0" -e fixed
-k 995511775533664400AABBCCDDEEFF00 -f myCredentials.bin -sn 31FF72064D43373017240843 -w
```

Note: The values for RC Zone field are:

- *1 = RC1*
- *2 = RC2*
- *3 = RC3c*
- *4 = RC4*
- *5 = RC5*

The command in the example generates the *myCredentials.bin* file which, through the –w option, is automatically flashed at the default location according to the table below.

Table 14. **Devices and related default Sigfox board data address**

Device	Default Sigfox board data address
STM32L0	0x0800FF00
STM32L1	0x08000200
STM32F0	0x0801F000
STM32F4	0x08004000
BlueNRG-1	0x10066000
BlueNRG-2	0x1007E000

6.6.3 Encryption

The Sigfox key can be optionally encrypted using an AES 128 bit encoding algorithm, with a 16-byte long key.

There are three ways of handling key encryption:

- no encryption
- fixed encryption
- variable encryption

6.6.3.1 *No encryption*

With the *-e none* option, the key provided as input will be stored as is, without any encryption or elaboration.

6.6.3.2 *Fixed encryption*

The term fixed identifies an encryption key used always as is for each board.

When fixed encryption is selected, using the *-e fixed* option, the custom key has to be provided with the *-k* option as in the example above.

6.6.3.3 *Variable encryption*

The term variable identifies a different encryption key for every board based on its own unique ID.
To enable this type of encryption, type the option *-e variable*.

Revision history

Table 15. **Document revision history**

Date	Version	Changes
01-Feb-2017	1	Initial release.
07-Sep-2018	2	Updated Introduction, Section 1 Sigfox S2-LP kit content, Section 2.1 Hardware requirements, Table 1. Sigfox radio configuration zone, Figure 6. ST Registration procedure 3/3, Figure 7. Sigfox device page, Figure 8. Sigfox device information, Figure 9. Sigfox device messages, Figure 12. Sigfox DEVICE TYPE tab, Figure 13. Sigfox DEVICE TYPE parameters, Figure 15. Command line function list, Table 2. Available command line functions and Table 3. Macro channel mapping - config_words[0]. Added Section 6.1 STEVAL-IDB007V2/STEVAL-IDB008V2 limitations, Section 6 Sigfox CLI demo description, Section 6.2 Sigfox pre-certification tests, Section 6.2.1 Sigfox RCZ values, Section 6.2.2 Sigfox test ID values, Section 6.3 IAR project, Section 6.4 BlueNRG-1/2 support, Section 6.5 Hardware requirements, Section 6.6 Changes to the STEVAL-IDB007V1/2 and STEVALIDB008V1/2 boards, Section 6.7 BlueNRG-1 SoC connections, Section 6.8 S2-LP, Section 6.9 E2PROM, Section 6.10 Hardware setup, Section 6.11 Sigfox credentials, Section 6.12 Prerequisites, Section 6.13 Usage, Section 6.14 Encryption, Section 6.14.1 No encryption, Section 6.14.2 Fixed encryption and Section 6.14.3 Variable encryption. Minor text edits.
11-Mar-2019	3	Updated Table 11. Sigfox suitable test ID values. Updated Section 3.1 ST-side registration and STEVAL-FKI001V1. Minor text changes.
02-Sep-2019	4	Updated Section 6.6 Sigfox credentials and Section 6.6.1 Prerequisites.
13-Sep-2019	5	Updated Table 2. Available command line functions.
27-Mar-2020	6	Updated Introduction, Section 1 Sigfox S2-LP kit content, Section 2.1 Hardware requirements, Section 2.2 Software prerequisites, Section 3.1 ST-side registration, Section 6.2 Sigfox precertification tests and Section 6.2.1 Sigfox RCZ values.
17-Sep-2020	7	Updated Section 6.6.2 Usage.

Contents

List of tables

List of figures