CC112x TI-SIGFOX SDK Demo

Getting Started Guide

Literature Number: SWRU487
June 2016

Introduction

This user's guide is intended to help users set up and get started with the CC112x SIGFOX Demo application. This document explains how to acquire the hardware and software for the development kit. It also contains instructions on how to get the kit to communicate with the SIGFOX network.

1.1 Get a SIGFOX Device ID With Temporary Access

Send an email to: tech-p1-team@sigfox.com to request the activation-code extraction firmware. For this initial request, SIGFOX requires the following information:

- Full legal company name
- First and last name of employee being granted access to the SIGFOX network
- Country and state, or region where development work will occur
- Country, or countries of target product deployment

SIGFOX responds with a binary file called TI_SIGFOX_activation_code_application.txt. Follow the instructions in Section 1.2.

1.2 Get the Hardware

The hardware is slightly different for the Americas and Europe.

To make a development kit for the Americas, order one of each of the following:

- MSP430F5529 LaunchPad™
  - http://www.ti.com/tool/msp-exp430f5529lp
- CC1120 CC1190 BoosterPack™
  - http://www.ti.com/tool/TIDC-SIGFOX-CC1120-CC1190-BP

To make a development kit for Europe, order one of each of the following:

- MSP430F5529 LaunchPad
  - http://www.ti.com/tool/msp-exp430f5529lp
- CC1125 BoosterPack
  - http://www.ti.com/tool/boostxl-cc1125

To make a development kit for Japan, order one of each of the following:

- MSP430F5529 LaunchPad
  - http://www.ti.com/tool/msp-exp430f5529lp
- CC1125 BoosterPack
  - http://www.ti.com/tool/boostxl-cc1125

1.3 Setup the Hardware

To assemble the kits for either FCC or ETSI/ARIB, simply connect the BoosterPack to the LaunchPad as shown in Figure 1-1 and Figure 1-2.

Figure 1-1. LaunchPad and BoosterPack Assemble for FCC SIGFOX Applications

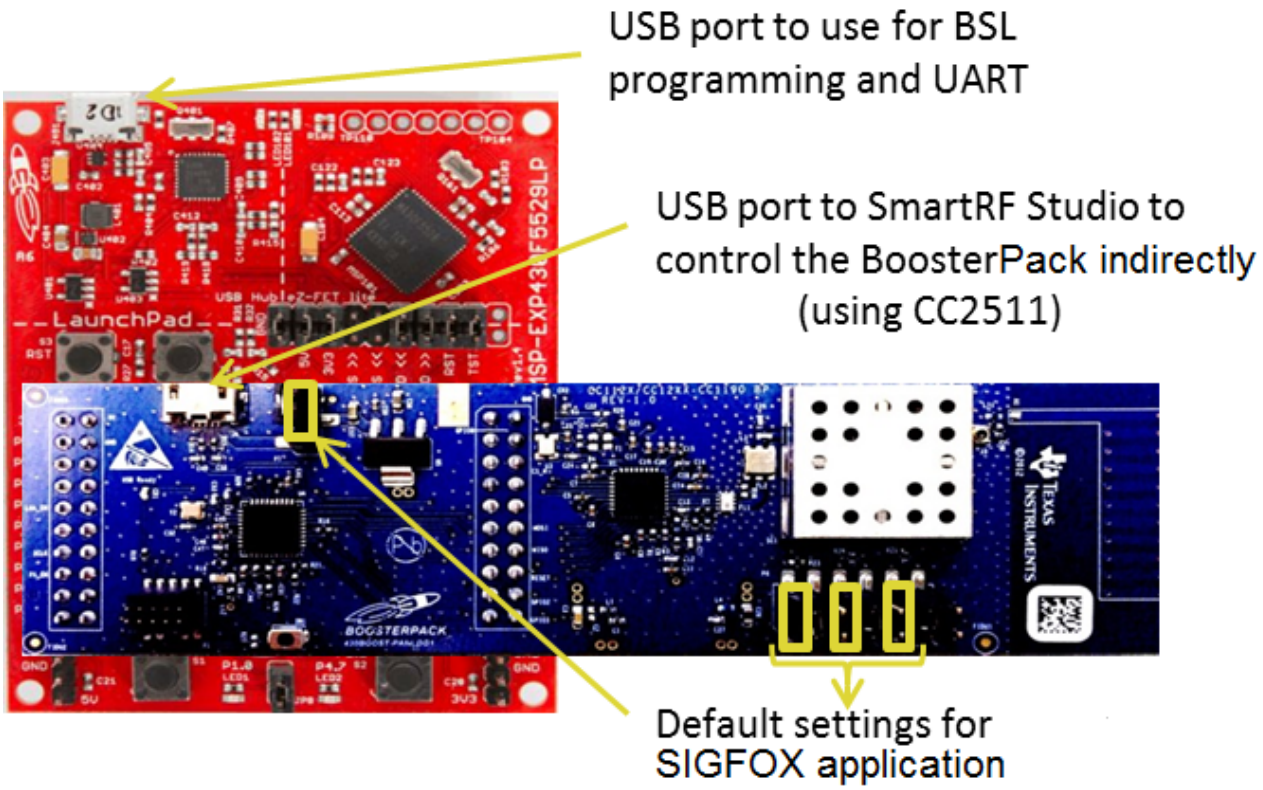
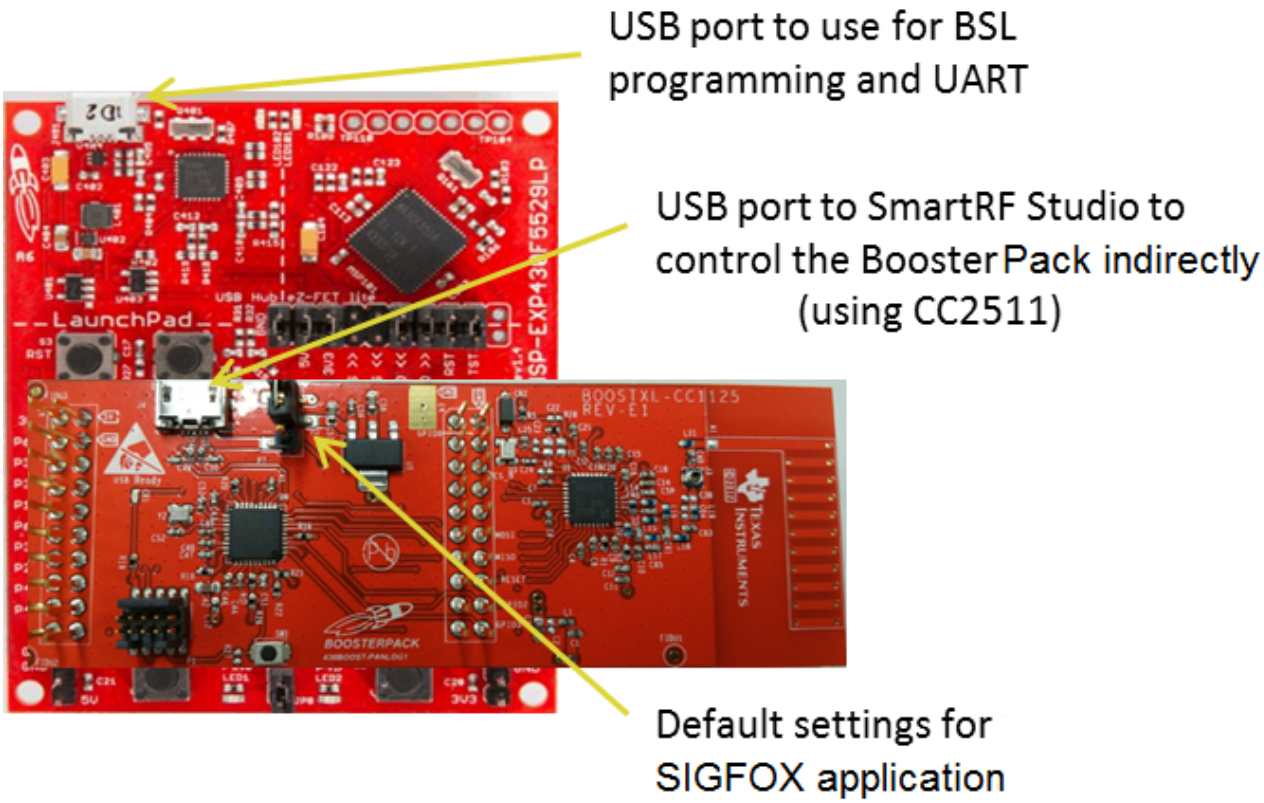


Figure 1-2. LaunchPad and BoosterPack Board Settings for ETSI/ARIB SIGFOX Applications

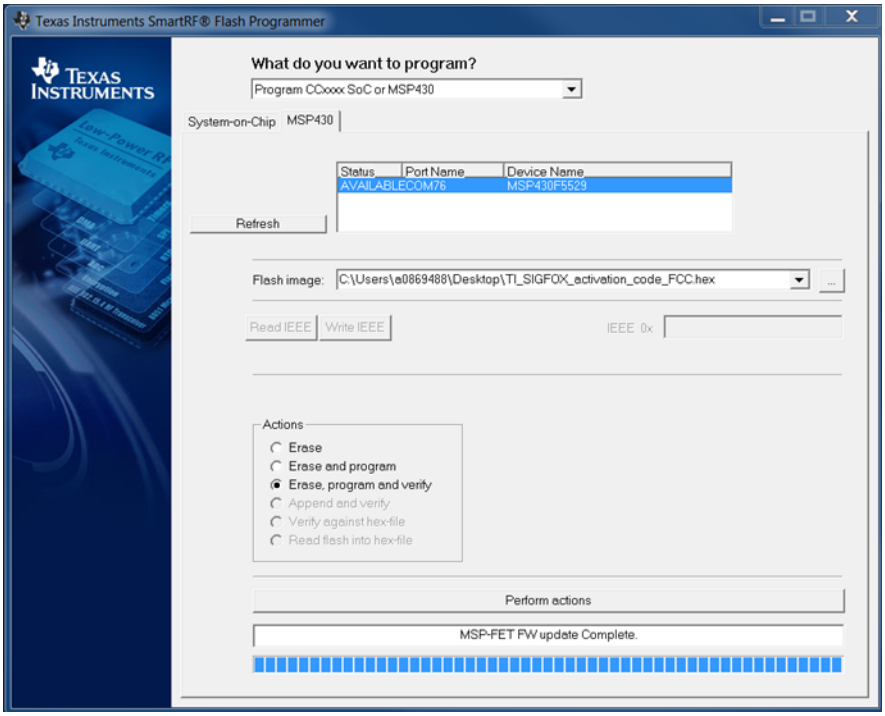


1.4 Extract Activation ID from LaunchPad

Download the image that reads the activation code from the LaunchPad and BoosterPack combo. The file is called TI_SIGFOX_activation_code_application.txt and is provided by SIGFOX as described in Section 1.1. Then, flash the file to the LaunchPad. Each activation code is specific for a specific region of the world, which is why it is important to provide the location information to SIGFOX in the initial request.

The two ways to flash the LaunchPad follow. Flashing can be done using the SmartRF Flash programmer (http://www.ti.com/tool/flash-programmer, version 1 only). Rename the .txt file to a .hex file, and flash it using the SmartRF Flash programmer, as shown in Figure 1-3.

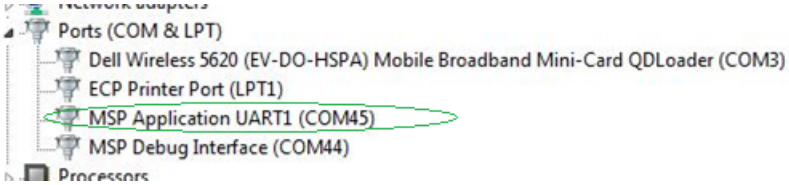
Figure 1-3. SmartRF Flash Programmer Configuration Page Settings



The alternative way to flash is by using the MSP430™ Flasher application.

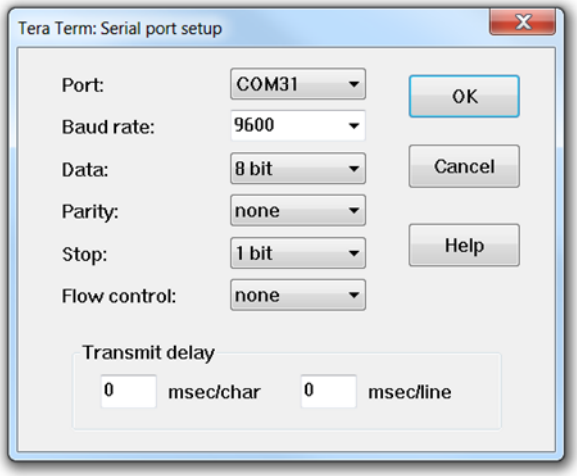
1. Download and install the application from http://www.ti.com/tool/msp430-flasher.
2. Using the command prompt, execute the following commands from the correct folder.
   ```
   > MSP430Flasher -w ".\TI_SIGFOX_activation_code_FCC.txt" -v -g -z [VCC]
   ```
3. If using a Linux® computer, set the path for the executable before executing the flash command.
   ```
   > export LD_LIBRARY_PATH=~/MSP430Flasher_1.3.7/
   ```
4. Connect to the LaunchPad using a terminal program.
5. Download and install your favorite terminal program. We have tested Coolterm (http://freeware.the-meiers.org/) and TeraTerm (http://logmett.com/tera-term-the-latest-version).
6. Identify the UART port number using the device manager, as shown in Figure 1-4.

Figure 1-4. Identifying Applications UART Port Number



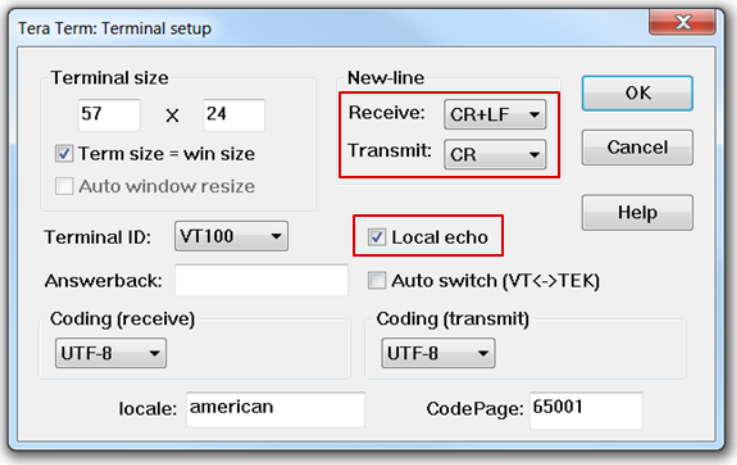
7. Set up the serial port that is identified by MSP Application UART1 (see Figure 1-5).

Figure 1-5. UART Serial Port Setup



8. Enable local echo on the terminal to see the characters that are typed on the terminal (see Figure 1-6).

Figure 1-6. UART Terminal Setup



9. Once the terminal set up is complete, connect the LaunchPad to the PC using the USB connector. The BoosterPack remains unconnected to PC.
10. Once the connection with the device is established, press ENTER. Then, the following message should appear:

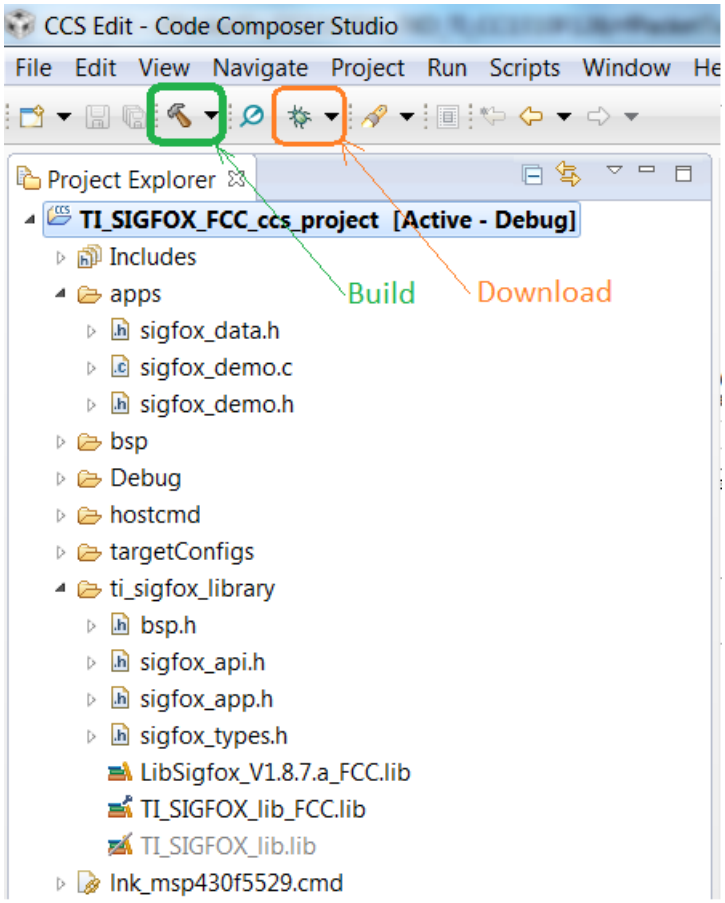
```
!!! Launchpad and Boosterpack boards must be fit together!!!
Press Enter to get your device's numbers:
```

11. Press ENTER again to retrieve the 20-digit activation code in this format: 6BAE144709AA12004823.
12. If the HEX identifies that you are trying to extract an ID from an incorrect combination of devices it returns: “Not a VALID Board for TI-SIGFOX project”. In this case, check the hardware setup and try again.
13. Send a second email to: tech-p1-team@sigfox.com to request access to the full project by supplying the activation code that was extracted from the hardware. SIGFOX responds to the request by creating a unique development project that has been targeted for the unique MSP430 and CC112x device combination. This process can take up to 24 hours.
14. If not already installed, then install Code Composer 6, by going to this link. The installation must be Version 6.1.0.00104 or later, and ensure to select the MSP Ultra Low Power MCUs option for processor support.

1.5 CCS Project

Open the TI_SIGFOX_project into the CCS application; this is a MSP430 application using the radio on the BoosterPack. Compile the project, load it onto the LaunchPad, and run it. Once the project is running, the device is ready to send and receive packets to the SIGFOX network. The device is expected to be within range of a SIGFOX base station. The device accepts instructions from the user using AT commands. Figure 1-7 shows the Code Composer build and download buttons.

Figure 1-7. Code Composer Build and Download Buttons



SIGFOX Backend

2.1 What is Backend?

SIGFOX backend is a web portal that gives users access to manage devices and data on the SIGFOX network. Users can log in to the backend to add and access their devices. https://backend.sigfox.com/.

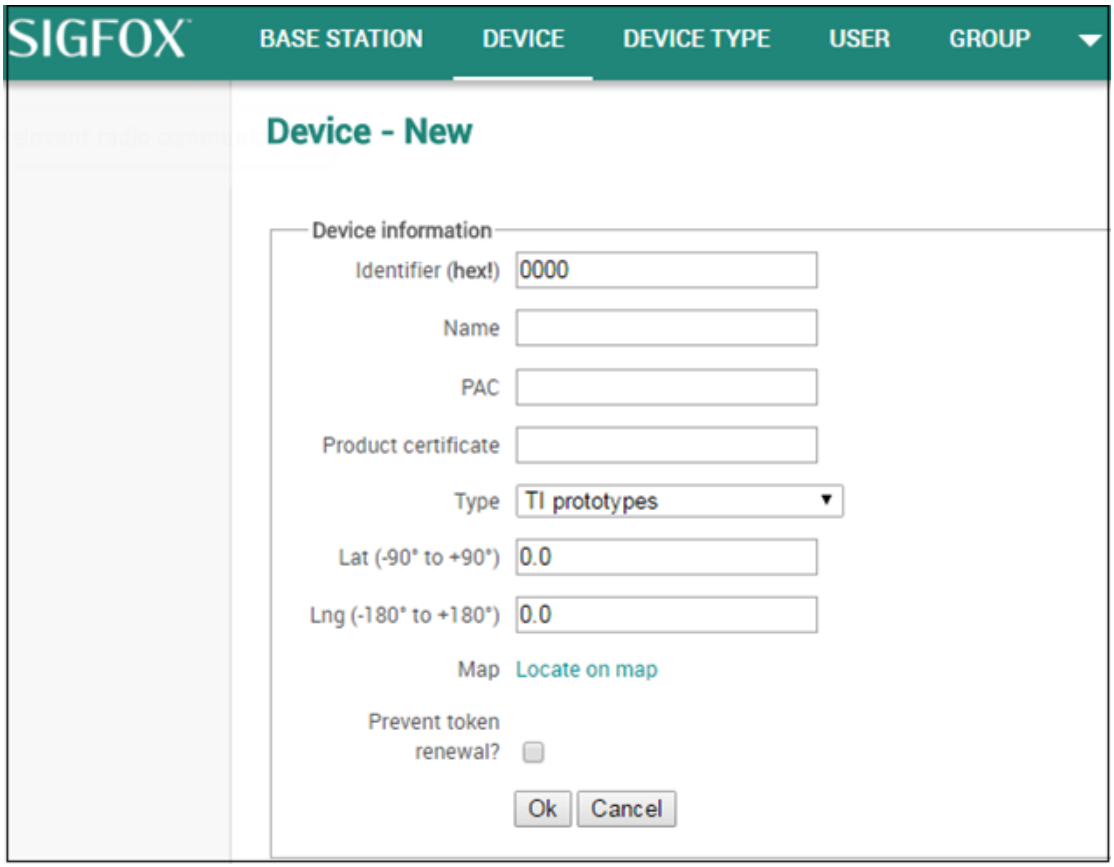
2.2 Adding a User Device to Backend

The device ID and PAC number are required to add a device to the backend. This information can be obtained using AT commands through the terminal. Press ENTER after every command.

- To obtain the device ID, type command: AT$ID?
- To obtain the device PAC, type command: AT$PAC?

To add a device to the backend, login to the SIGFOX backend, click on Device, and then click New, in the top right corner of the browser. Now add the new device by filling out the form. Figure 2-1 shows how to add a new device to the SIGFOX backend.

Figure 2-1. Add New Device to SIGFOX Backend

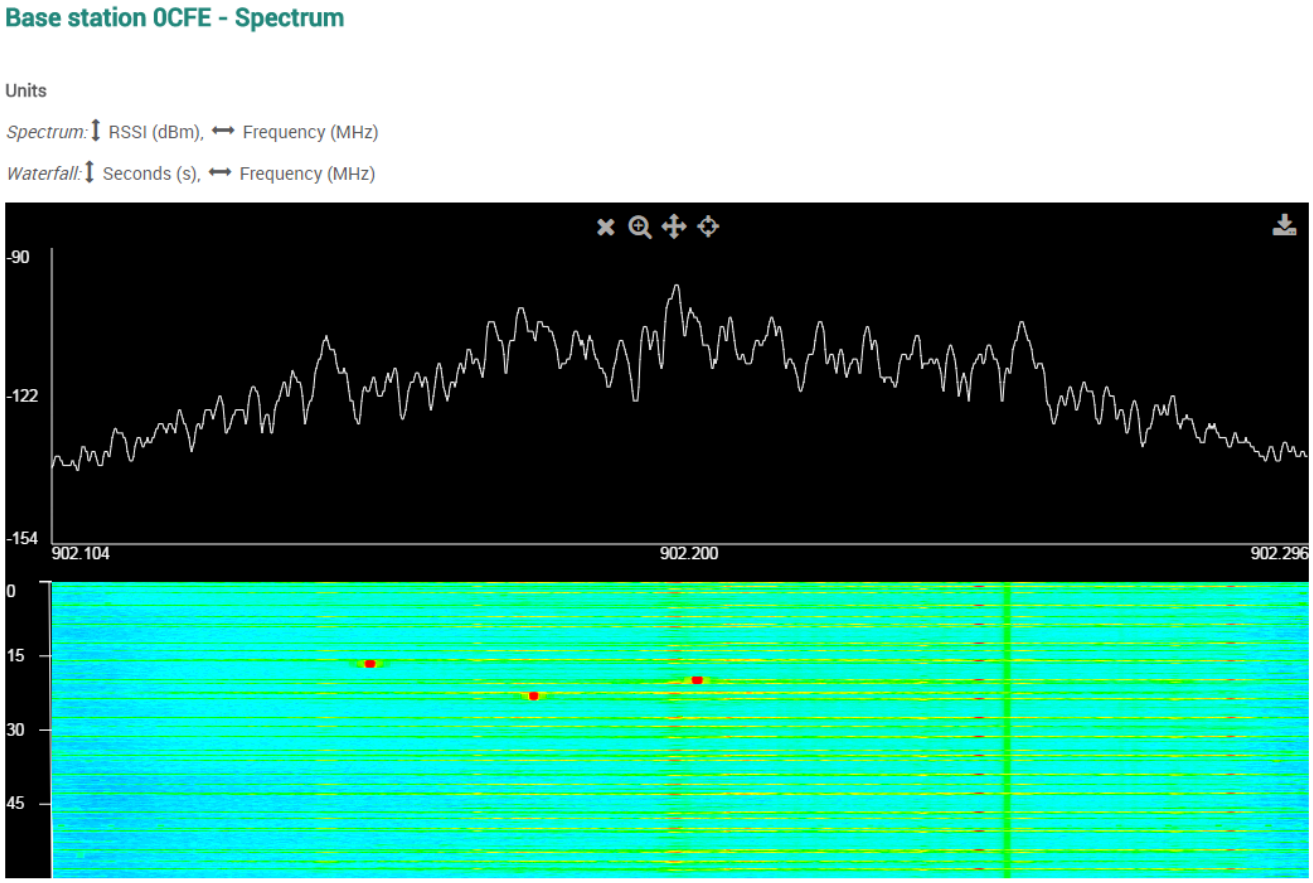


2.3 Communicating With the SIGFOX Base Station

Data can be sent and received from the closest SIGFOX base station using AT commands. To send one bit of data, use command AT$SB=0/1. To send a frame of data, use command AT$SF=<payload data>. Payload data is a hexadecimal number with even bytes. Example: 123abc.

Once the command is issued, a packet is transmitted three times at three different frequencies, to increase the chances of reception. Figure 2-2 shows the spectrum at the base station.

Figure 2-2. Spectrum at the Base Station



NOTE: After flashing or resetting any device connected to the SIGFOX network, users must press Disengage Sequence Number button, on the Device or Device Type page, in the SIGFOX backend. The sequence number is a security measure, which prevents device spoofing by verifying that an incremental sequence number is generated by the device each time it transmits to the network. This number is reset each time the device is flashed. Without disengaging the sequence number on the backend, no messages can be received.

2.4 Retrieving Messages From the Base Station

To check the message received at the base station from your device, perform the following steps.

1. Click on the Device tab.
2. Select your Device ID.
3. Select the Messages button.

Figure 2-3 shows examples of messages on the base station.

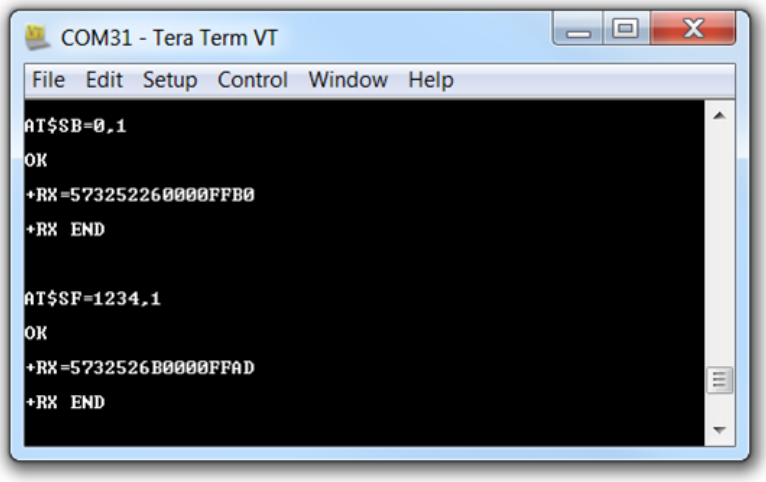
Figure 2-3. Messages on the Base Station

Time	Delay (s)	Header	Data / Decoding	Location	Base station	RSSI (dBm)	SNR (dB)	Freq (MHz)	Rep	Callbacks
2016-05-10 21:28:14	3.4	0010	09e40c1c0cfa0013 Temp: 25.0 °C VDD idle: 3.300 V VDD tx: 3.100 V RSSI: -81.0		0CFE	-88.00	23.06	902.2590	1	
2016-05-10 21:27:39	3.2	0000 ack required	1234		0CFE	-83.00	23.80	902.2186	3	
2016-05-10 21:27:05	2.8	0010	09e40c1c0cfa000f Temp: 25.0 °C VDD idle: 3.300 V VDD tx: 3.100 V RSSI: -85.0		0CFE	-84.00	27.02	902.1738	1	
2016-05-10 21:26:30	2.1	0000 ack required	00		0CFE	-80.00	29.11	902.1739	3	

2.5 Sending Bidirectional Messages

Using AT$SB or AT$SF with a second argument set to 1 initiates a bidirectional message. The response from the base station is printed on the terminal. Figure 2-4 shows the bidirectional message.

Figure 2-4. Bidirectional Message

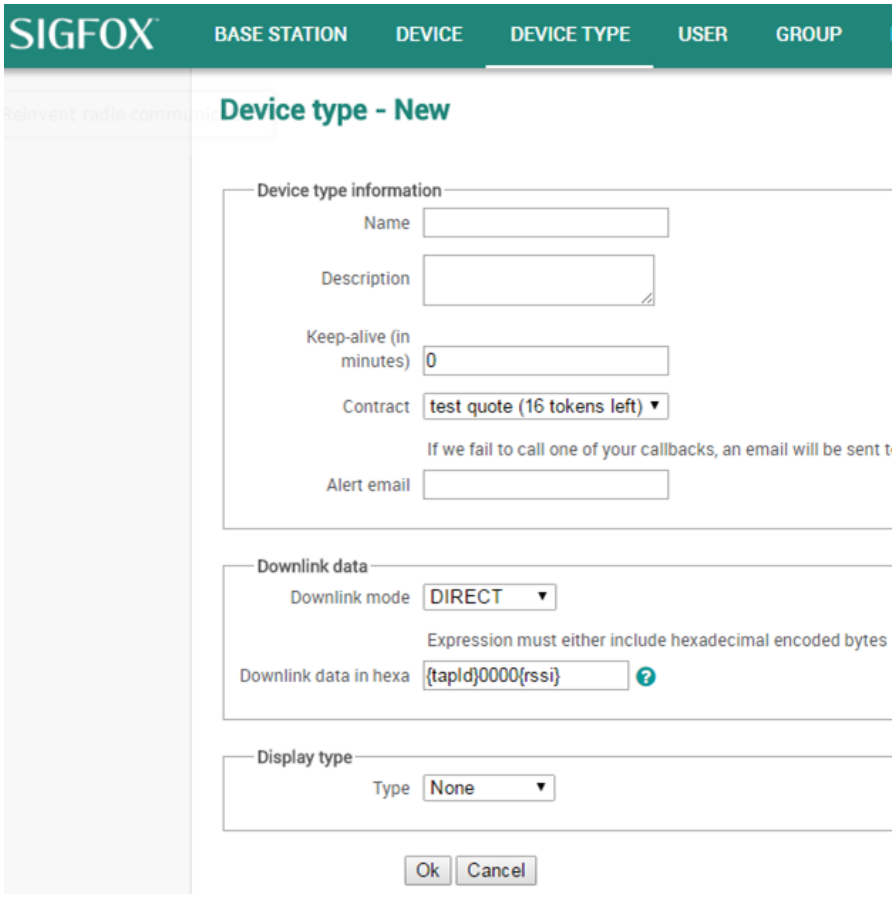


2.6 Creating Device Type

Creating a device type in the backend lets users to group a set of devices, and manage the base station as desired. To add a new device type, perform the following steps.

1. Click the Device Type tab.
2. Click the New button in the top right corner.
3. Choose the group, and fill out the form that appears (see Figure 2-5).

Figure 2-5. New Device Type Setup



2.7 Associate a Device to a Device Type

To associate the device to a device type, perform the following steps.

1. Click on the Device tab.
2. Click on the ID of the device.
3. Click the Edit button, and select the device type from the drop-down list, then click OK (see Figure 2-6).

Figure 2-6. Add a Device to a Device Type

2.8 Changing the Downlink Message

Once the device is associated with a device type, users can modify the downlink message for a device type. Perform the following steps.

1. Click on the Device Type tab.
2. Select the device type.
3. Click the Edit button in the top right corner.
4. Modify the downlink data in hexa to change the downlink message.
5. Send a bidirectional message using the command AT$SF=<payload data>,1.

Figure 2-7 shows the field where downlink data can be modified.

Figure 2-7. Downlink Data

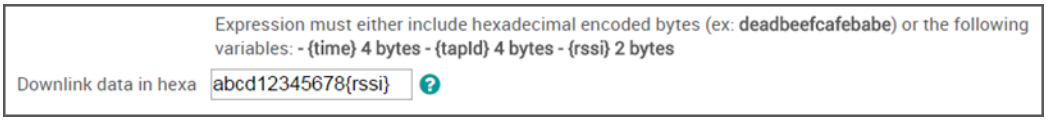
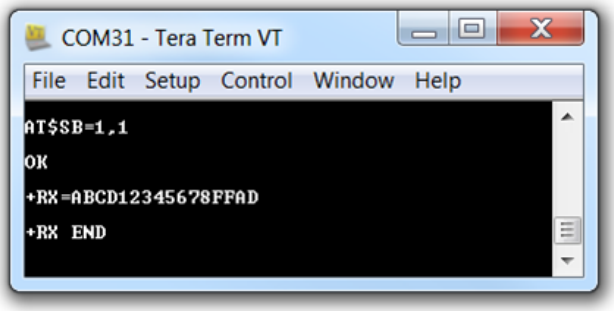


Figure 2-8 shows the modified downlink received data.

Figure 2-8. Downlink Received Data



2.9 Adding Custom Callbacks

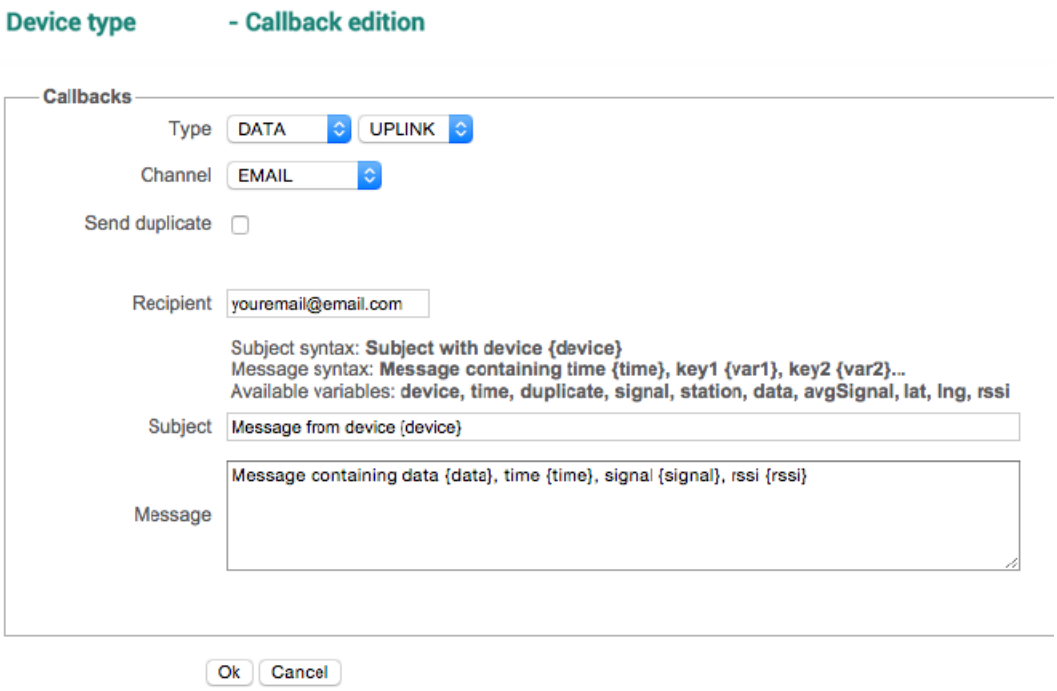
Users can create a callback for a device type. A callback defines how the base station should respond to devices from a device type. Callbacks are triggered when a new device message is received, or device communication loss is detected. A set of available variables are replaced by their value when a callback is called. More information can be found here: https://backend.sigfox.com/apidocs/callback.

To add a new callback, perform the following steps.

1. Click the Device Type tab.
2. Select the Device type.
3. Click the Callbacks button.
4. Click the New button.
5. Click the Custom Callbacks button.

Figure 2-9 shows adding a callback that sends out an email when an uplink message is received from a device.

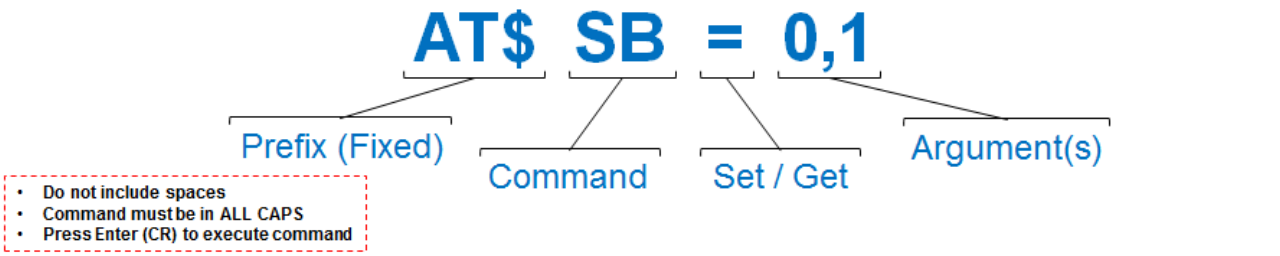
Figure 2-9. Add a Callback for a Device Type



AT Commands

ATtention (AT) commands are instructions used to control a modem. Every command starts with AT, and is case sensitive. Figure 3-1 lists the structure of the AT commands.

Figure 3-1. AT Command Structure



Description	Command	Set / Get	Arg 0	Arg 1
Device ID	ID	?**	*n/a*	*n/a*
Send Bit	SB	=	Payload (0 or 1)	*empty* = no downlink (DL), *1*: request DL
Send Frame	SF	=	Payload (bytes)	*empty* = no DL, *1*: request DL
Uplink Frequency	IF	= / ?	Frequency (Hz)	*n/a*
Test Mode	TM	=	0	# of frames
Continuous Wave	CW	=	Frequency (Hz)	*0*: stop, *1*: start

** Get commands do not take arguments

Table 3-1 lists the available AT commands and their usage.

Table 3-1. List of AT Commands

Task	Command and Response	Parameter Description
Send bit status	CMD: AT$SB=<stat_val><CR>	<stat_val>: status value 1/0 <dl_data>: 8 bytes of downlink message (1)
	RESP: OK<CR>	
Send bit status with downlink request	CMD: AT$SB=<stat_val>,1<CR>	
	RESP: OK<CR>	
	+RX=<dl_data><CR>	
	+RX END<CR>	
Send payload (in bytes)	CMD: AT$SF=<ul_data><CR>	<ul_data>: 0 to 12 bytes of uplink message (1) <dl_data>: 8 bytes of downlink message (1)
	RESP: OK<CR>	
Send payload with downlink request	CMD: AT$SF=<ul_data>,1<CR>	
	RESP: OK<CR>	
	+RX=<dl_data><CR>	
	+RX END<CR>	
Get device id	CMD: AT$ID?<CR>	<dev_id>: device ID
	RESP: <dev_id><CR>	

(1) ASCII coded HEX value

Table 3-1. List of AT Commands (continued)

Task	Command and Response	Parameter Description
Get uplink frequency	CMD: AT$IF?<CR>	<ul_freq>: central uplink frequency (Hz)
	RESP: <ul_freq><CR>	
Set uplink frequency (2)	CMD: AT$IF=<ul_freq><CR>	
	RESP: OK<CR>	
Get downlink frequency	CMD: AT$DR?<CR>	<dl_freq>: central downlink frequency (Hz)
	RESP: <dl_freq><CR>	
Set downlink frequency (2)	CMD: AT$DR=<dl_freq><CR>	
	RESP: OK<CR>	
TX test mode (3)	CMD: AT$ST=<count>,<ch><CR>	<count>: number of random 12-byte messages to send in test mode. 0 to 32767, or –1 for infinite packet TX. <ch>: channel for uplink. 0 to 480 or –1 for channel hopping
	RESP: OK<CR>	
RX test mode (3), (4)	CMD: AT$SR=<seq_num>,<ch>,<rxtout><CR>	<seq_num>: downlink message sequence number. <ch>: channel for downlink message. 0 to 480. <rxtout>: number seconds for RX time window. Automatically time out RX after this. for X count, <msgX>: 8 bytes of downlink data. (1) <rssi_valX>: rssi value
	RESP: RX=<msg1><CR>	
	RSSI=<rssi_val1><CR>	
	…	
	RX=<msgN><CR>	
	RSSI=<rssi_valN><CR>	
TX continuous wave mode (3)	CMD: AT$CW=<freq>,<mode><CR>	<freq>: frequency for CW mode (Hz)
	RESP: OK<CR>	<mode>: 1 to start CW mode and 0 to stop CW mode

(2) If the uplink or downlink frequency value is not set to the correct value, use this function to set the correct frequency value.
(3) Test mode function.
(4) A special tool is required to emulate a downlink message from a base station.

Each AT command and response is terminated with a carriage return <CR>. All the commands are case sensitive. There are no spaces between the characters or fields of these commands.

Acronyms

- ADMIN - Administrator
- CCS - Code Composer Studio
- CMD - Command
- CR - Carriage Return (0x0D)
- HEX - Hexadecimal Value
- LNA - Low-Noise Amplifier
- OOB - Out of Band
- PA - Power Amplifier
- RESP - Response
- RX - Receive
- TCXO - Temperature Controlled crystal (XTAL) Oscillator
- TX - Transmit
- XTAL - Crystal Oscillator

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