MSP430과 Sub 1Gh Transceiver을 이용한 SIGFOX Reference 디자인 솔루션 소개

LPWAN, SIGFOX and Texas Instruments

SIGFOX and Texas Instruments
SERIAL MICROLELECTRONICS KOREA LTD

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LPWAN, SIGFOX and Texas Instruments

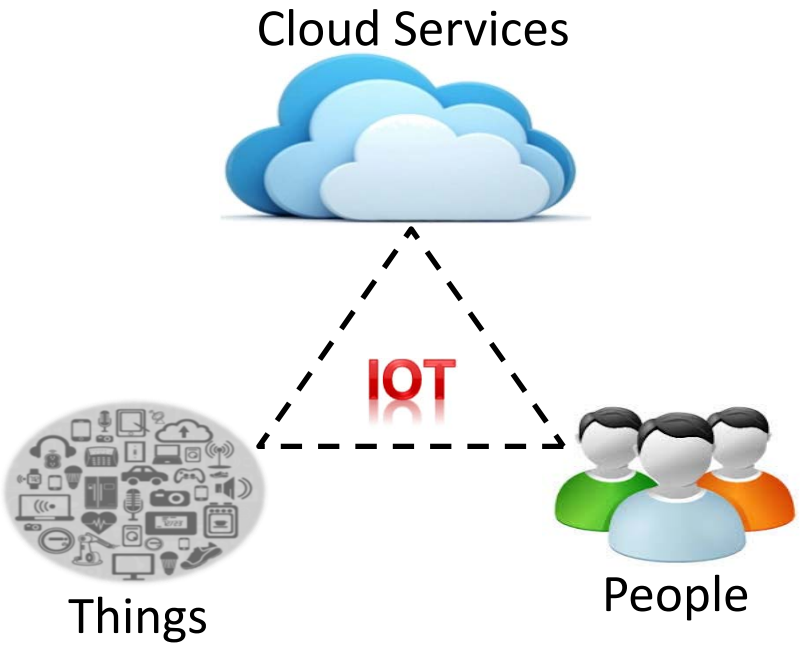
SIGFOX

SERIAL 新睿集團

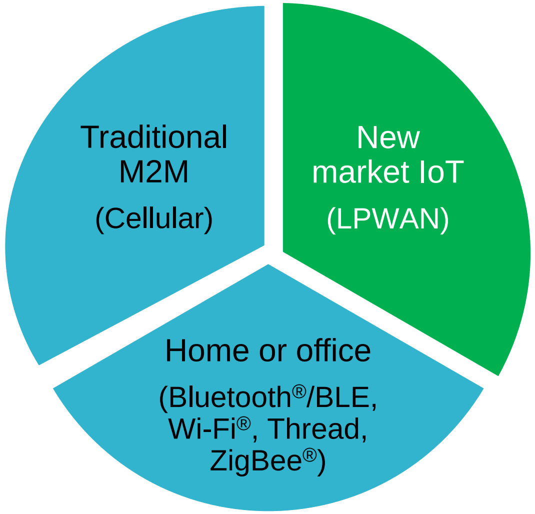
Texas Instruments

What is the IoT?

Things, People and Cloud services get connected using the Internet



Segmenting IoT communication



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Low Power Wide Area Network (LPWAN)

A type of wireless network designed to allow
wide area, long range communications
at a low bit rate
with great power efficiency
among things (connected objects such as sensors)

LPWAN Features

Long Range

- End-nodes can be up to 10 km from the basestation

Low Data Rate

- Less than 5 kbps
- Often only 10-256 bytes per message
- Message transmitted hundred's of times per day

Low Power

- Makes very long battery life time possible
- 5-10 years possible

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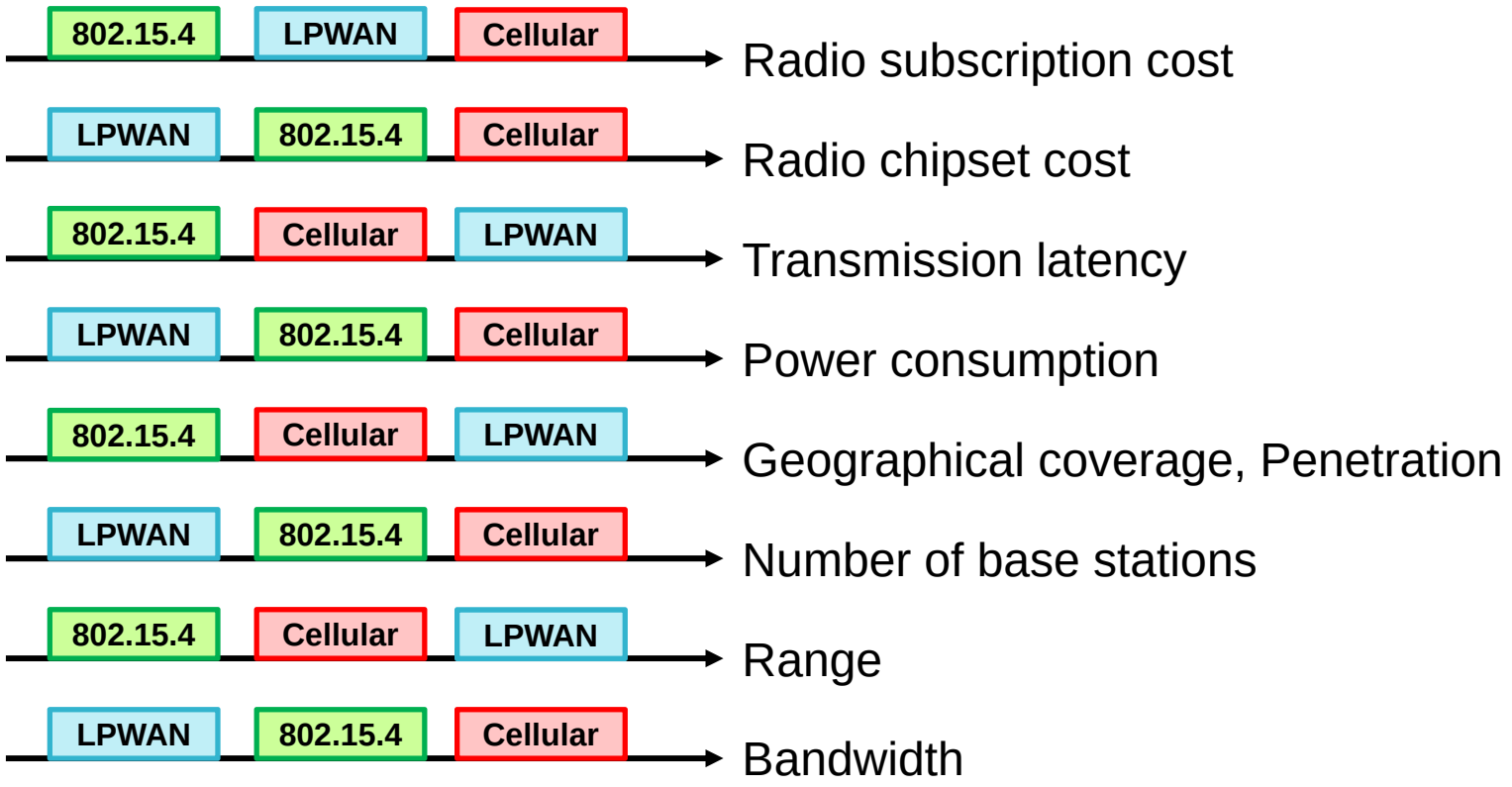
LPWAN Network Configuration

- Star topology

LPWAN Compared



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TI Sub-1GHz Wireless Long Range Mode

http://processors.wiki.ti.com/index.php/Cc112x_cc120x_lrm

More than 100 km range with CC1120+CC1190
114 km range test with the transmitter at Table Mountain in Cape Town and the receiver along the coast.
CC1120+CC1190EM at 868 MHz in Long Range Mode
https://www.youtube.com/watch?v=wgqtEu5PfAw

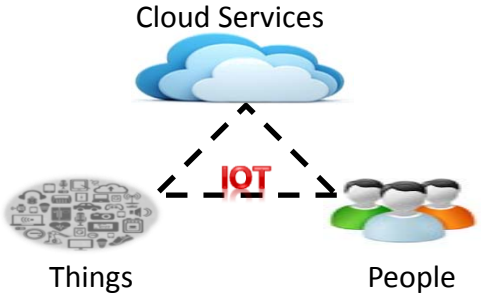
25 km Range Test in Cape Town, South Africa
25 km range test with the transmitter at Table Mountain in Cape Town and the receiver along the coast.
CC1120EM operating at 868 MHz, 1.2 kbps, +/-4 kHz deviation, +14 dBm output power…
https://www.youtube.com/watch?v=42HpV2E0ZI8

LPWAN, SIGFOX and Texas Instruments

What is SIGFOX™ ?

- SIGFOX is a Low Power Wide Area Network provider for IoT market

- SIGFOX is rolling out a world wide sub-1 GHz network targeting long range applications
  - 12 byte payload up to 140 messages per day
  - Data rate 100 bps (EU) or 600 bps (US)



- SIGFOX offers very low-cost internet connections (IoT) using ultra-narrowband solutions in the license free bands

SIGFOX Target Sectors

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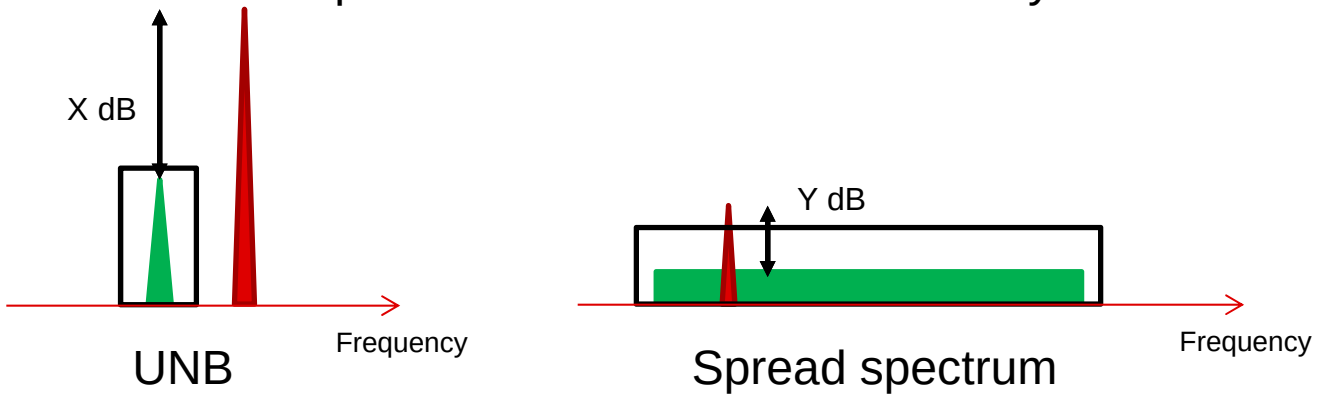
SIGFOX in a Nutshell

What SIGFOX provides	What SIGFOX does not provide
• Professionally managed public network • Easy out of the box connectivity • Long range • Low power connectivity • High capacity network • Low upfront cost • Low subscription cost • Resistance to jammers • Several use cases	• Real-time remote control use cases (<1 s) • Low latency (<1 s) • Frequent software update OTA

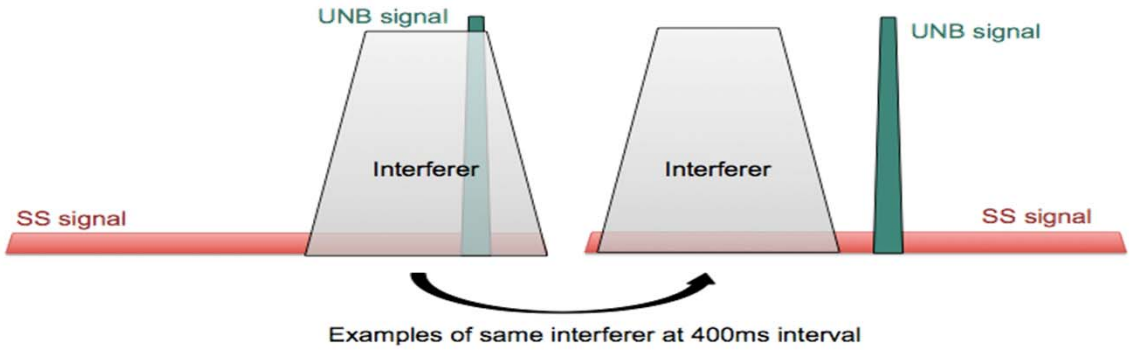
UNB Resistance to Interference (1)

- Ultra Narrowband (UNB) vs Spread Spectrum (SS)
  - At equal power UNB concentrates energy in a smaller bandwidth
  - On the RX side there is a filter which needs to be wide enough to capture the transmitted signal
  - Smaller RX bandwidth reduces probability of collision with high power interferer
  - Smaller RX bandwidth provides better close-in selectivity



UNB Resistance to Interference (2)

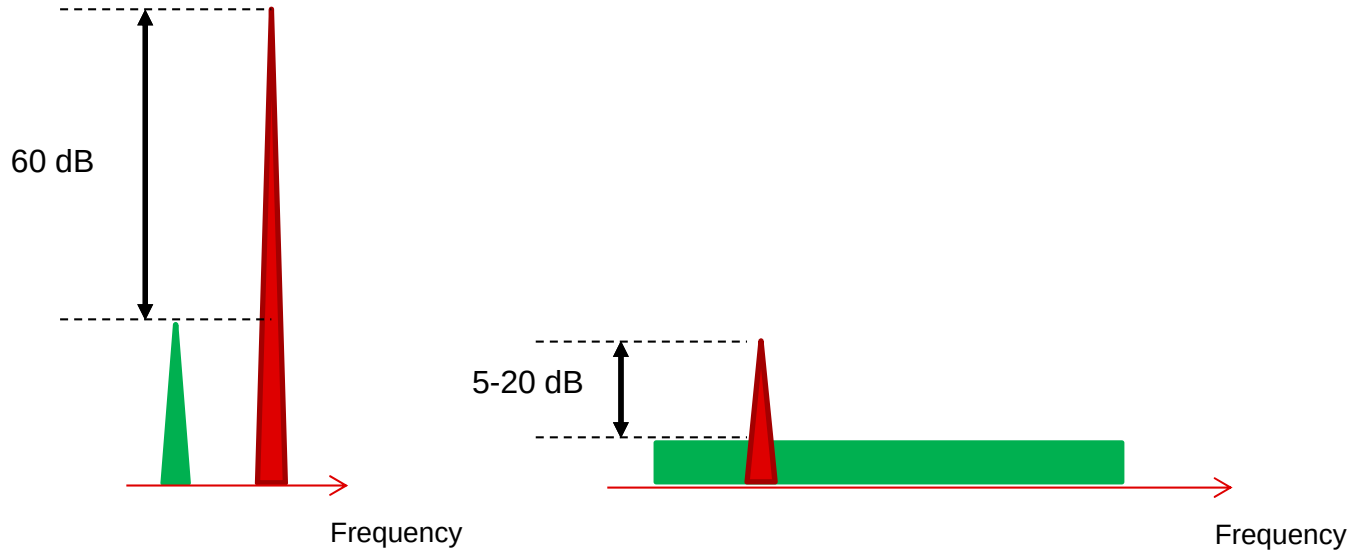
- **Example 1:** One frequency hopping jammer
  - Jammer can be very high power – FCC requirement is < 4 W
  - Jammer is hopping fast – FCC requirement is less than 400 ms
  - Probability of having a blocking interferer in SS is higher than UNB



- Ultra Narrowband will have better resistance to interferer than spread spectrum

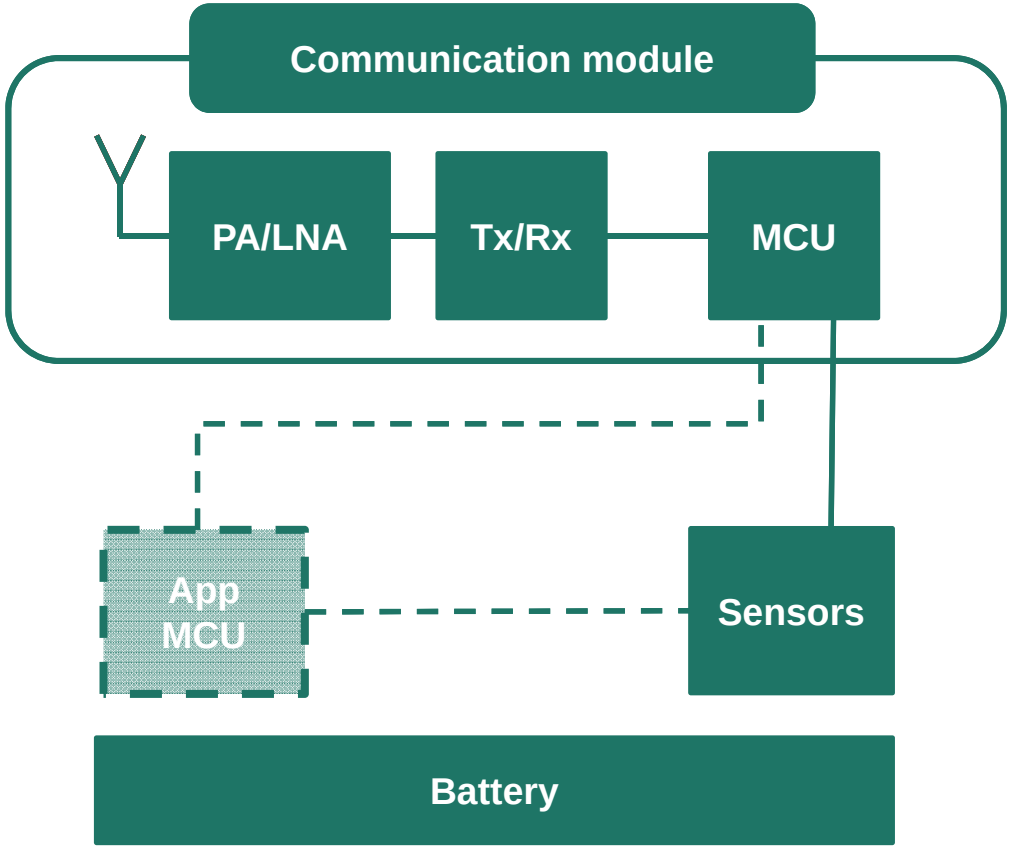
UNB Resistance to Interference (3)

- **Example 2:** One jammer at 25 kHz offset
  - UNB: jammer can be up to 60 dB stronger than the wanted signal
  - SS: jammer can be up to 5-20 dB stronger than the wanted signal

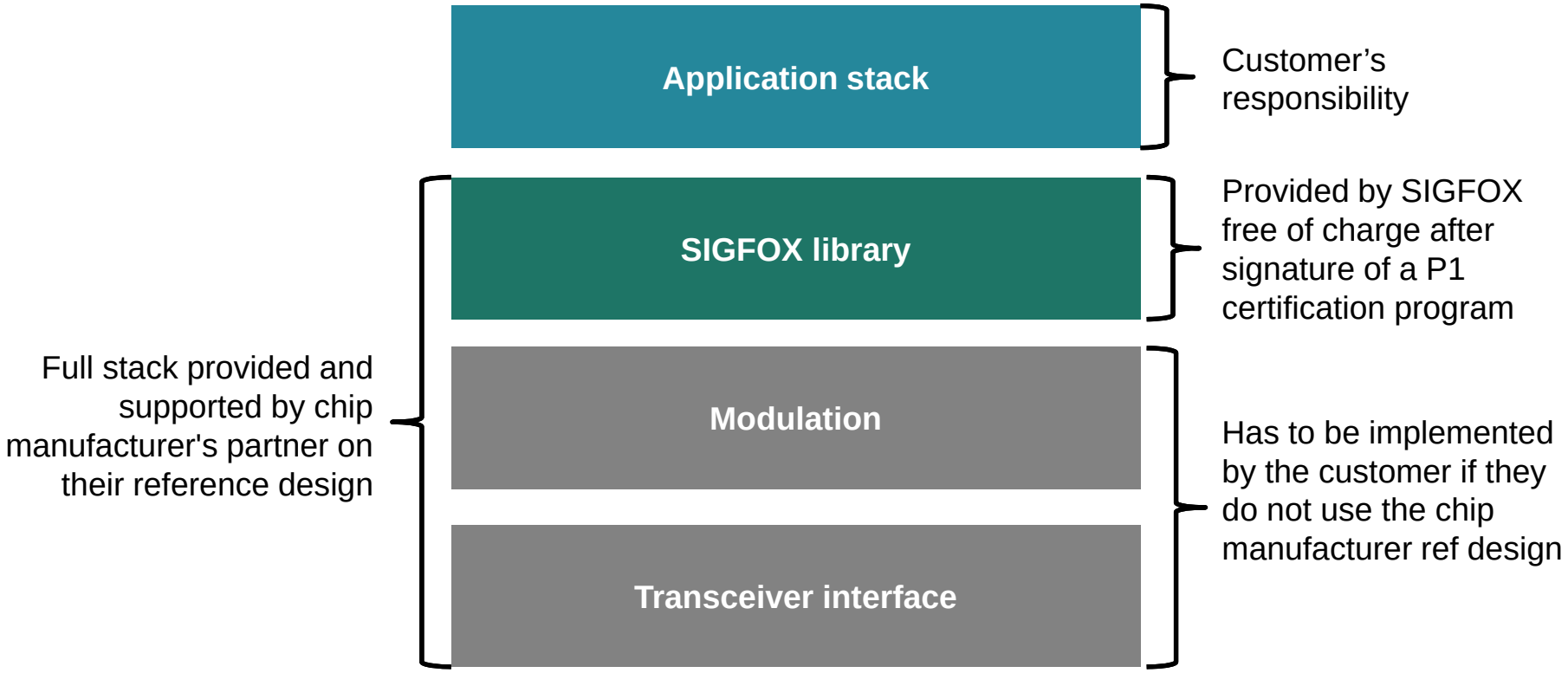


- Ultra Narrowband will have better resistance to interferer than spread spectrum

HW Architecture



SW Architecture



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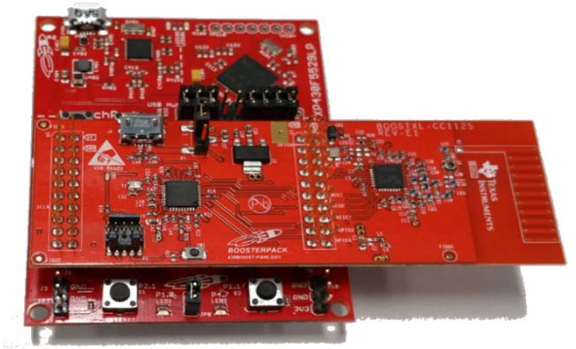
TI SIGFOX Reference Design Solution

	Europe	US
Radio	CC1125	CC1120
Range extender	None	CC1190
MCU	MSP430F5529	MSP430F5529

- The MSP can handle both the RF protocol and the application **or** can be configured as a network controller alongside an application MCU
- SIGFOX SW solution requires 24K Flash and 2K RAM

How to Get Started

Hardware Ref Design	Software
Order SIGFOX BoosterPack • **US**: BOOSTXL-CC1120-90 • **Europe**: BOOSTXL-CC1125 (Preview)	All SW provided by SIGFOX • tech-p1-team@sigfox.com
Order MSP-EXP430F5529LP LaunchPad	**Step1**: Provide contact info to receive Activation software
	Step 2: Extract Activation ID from Launchpad
	Step 3: Provide activation ID to SIGFOX
	Step 4: SIGFOX provides SIGFOX CCS SDK
	Step 5: Log-in SIGFOX back-end



For additional support please see Wiki
SIGFOX SDK Demo User's Guide

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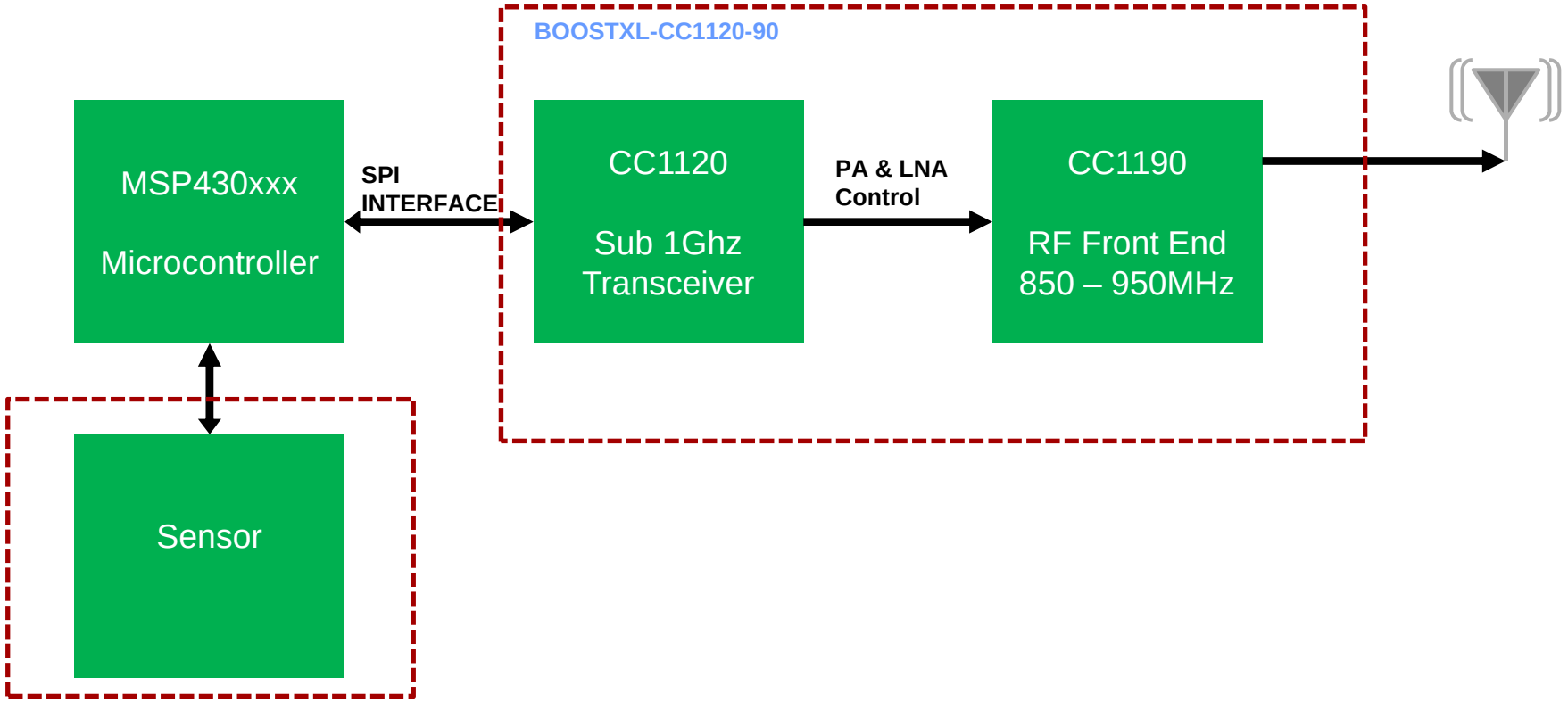
SIGFOX HW Block Diagram - US



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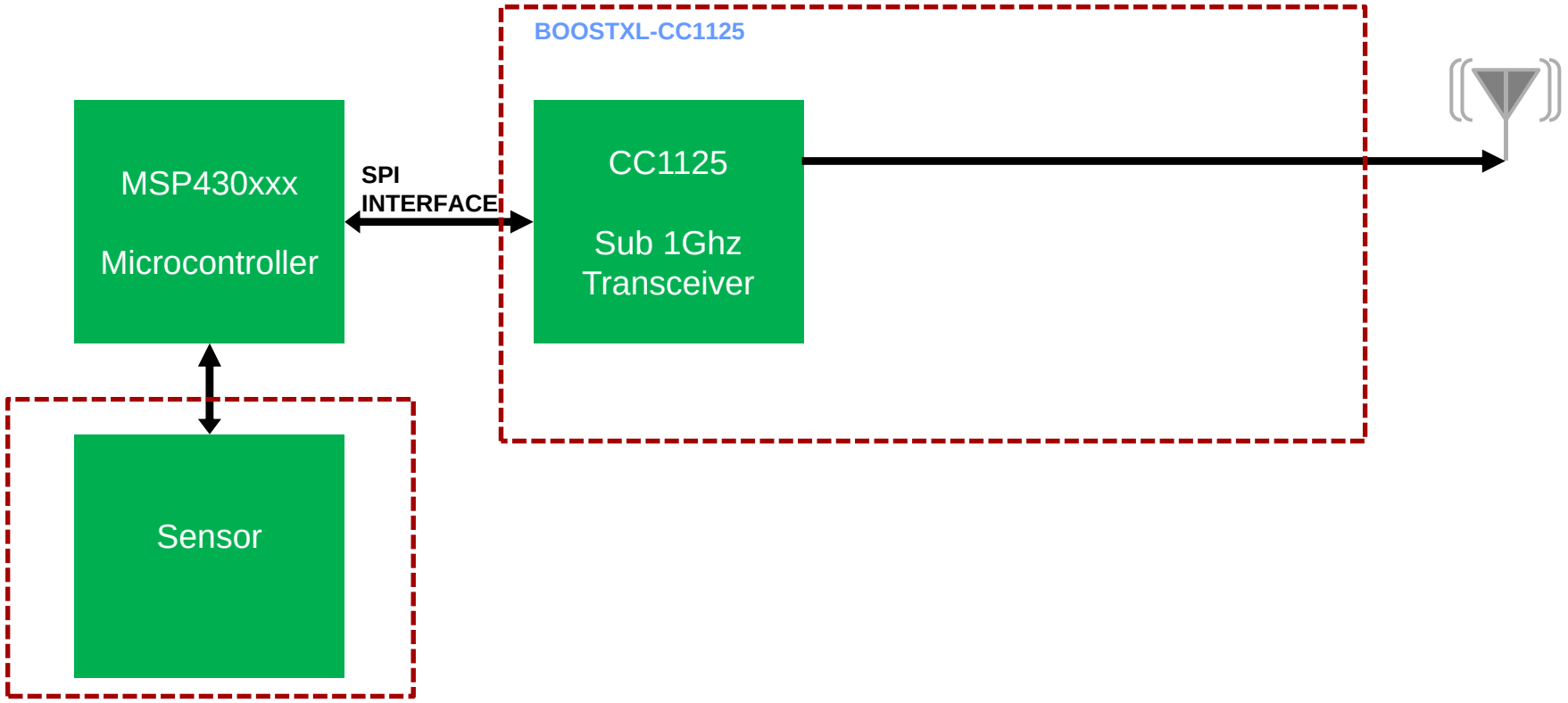
SIGFOX HW Block Diagram - Europe



TI MCU Options

- SIGFOX SW solution requires 24K Flash and 2K RAM
- SIGFOX solution also requires a 24 MHz system clock and 8 MHz SPI clock frequency
- SIGFOX solution can be ported to any MSP430F5xxx family meeting the memory and clocking requirements
- Supported MSP430 families include:
  - MSP430F51xx
  - MSP430F54xx
  - MSP430F55xx

More Helpful Resources

Wiki : SIGFOX SDK Demo User's Guide

(http://processors.wiki.ti.com/index.php/Sigfox_SDK_Demo_User's_Guide)

SIGFOX Certified Ref Design:

- CC1120-CC1190 BoosterPack
  (http://www.ti.com/tool/TIDC-SIGFOX-CC1120-CC1190-BP)
- CC1125 BoosterPack
  (http://www.ti.com/tool/BOOSTXL-CC1125)

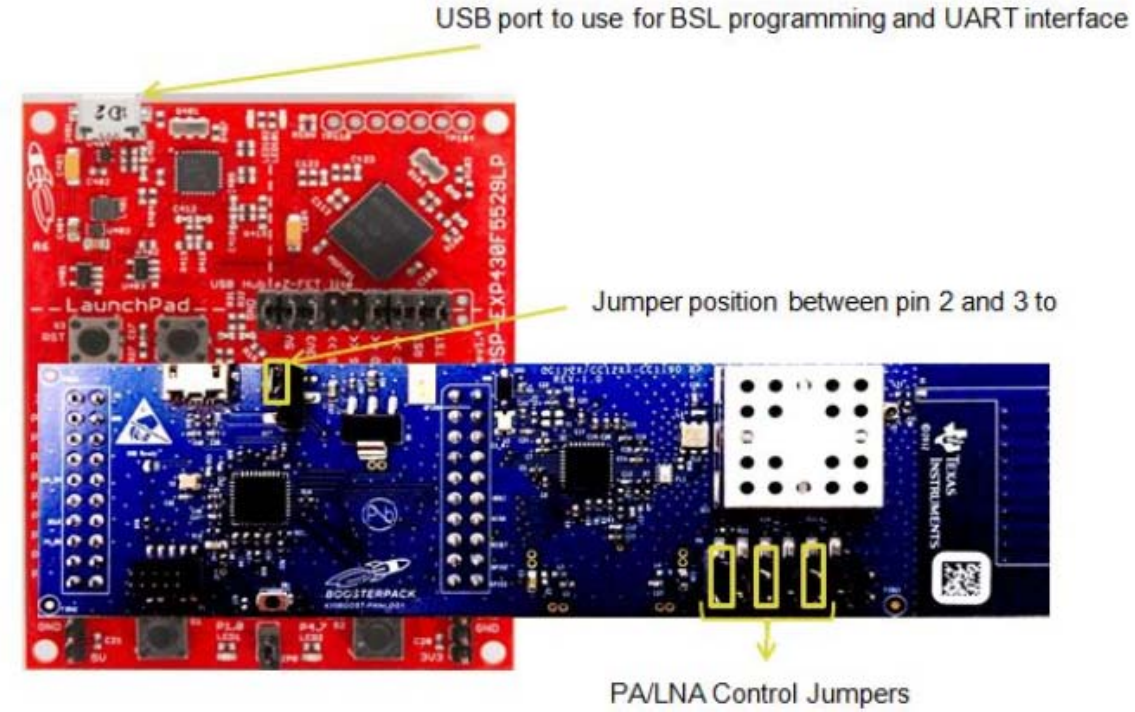
SIGFOX SDK Demo

Get the Hardware (US)

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

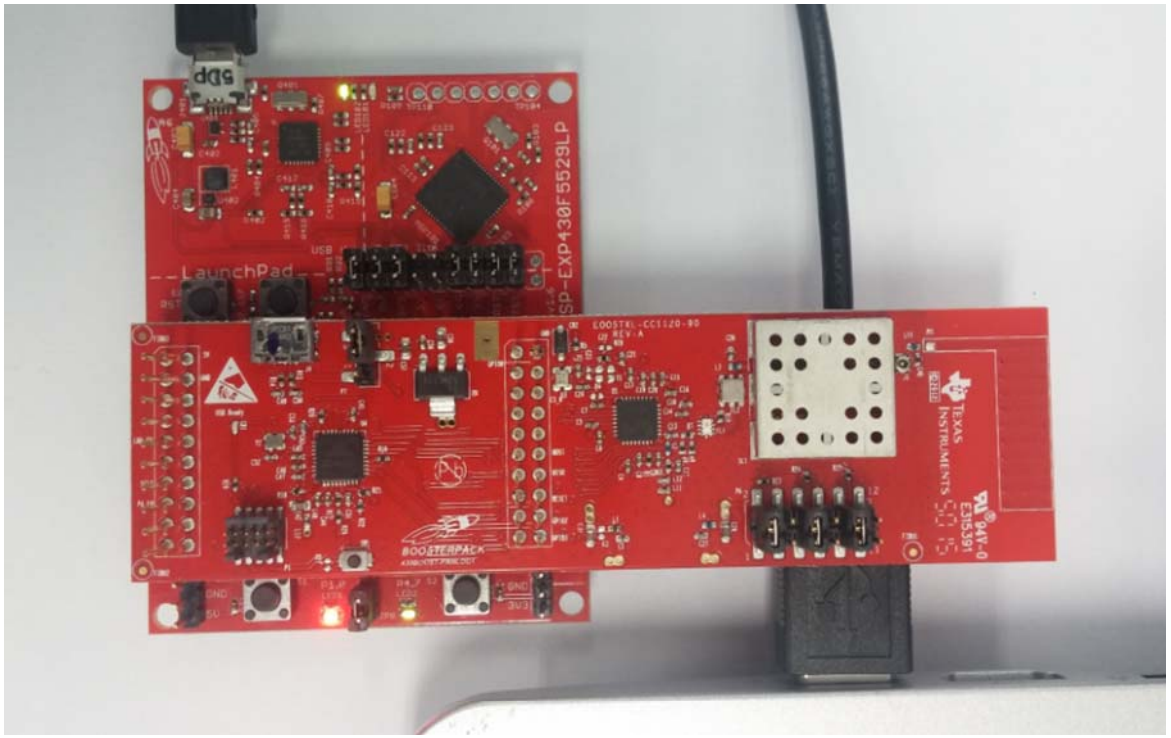
SIGFOX SDK Demo

Setup the Hardware



SIGFOX SDK Demo

Setup the Hardware



SIGFOX SDK Demo

- **Step 1**: Provide contact info to receive Activation software

  - Send an email to: tech-p1-team@sigfox.com to request the activation-code extraction firmware.

  - 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.

SIGFOX SDK Demo

- **Step 2**: Extract Activation ID from Launchpad

  - Download the image that reads the activation code from the LaunchPad and BoosterPack combo.

    - SmartRF Flash programmer

      (http://www.ti.com/tool/flash-programmer)

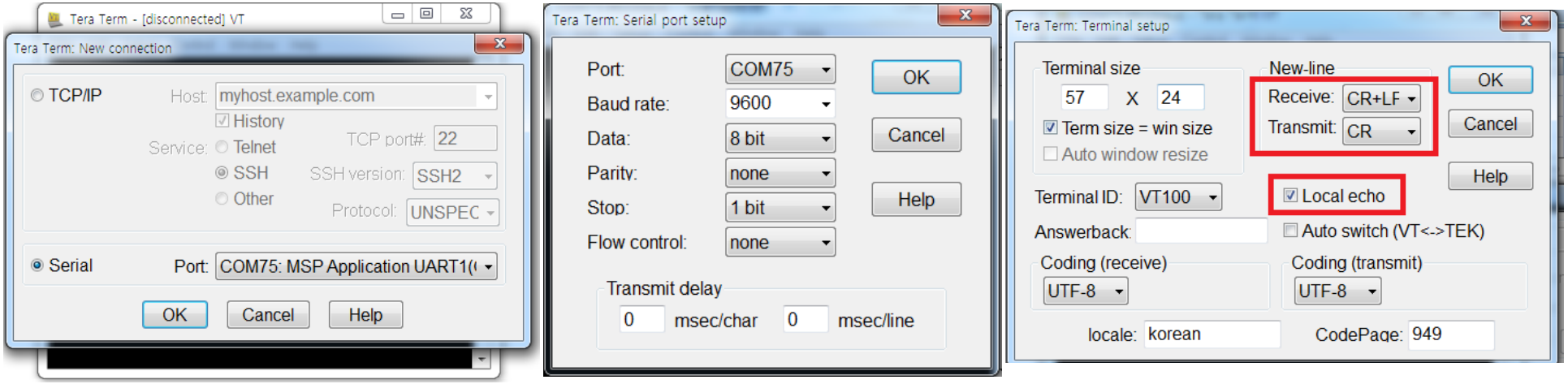
    - MSP430™ Flasher application

      (http://www.ti.com/tool/msp430-flasher)

SIGFOX SDK Demo

- **Step 3**: Provide activation ID to SIGFOX

  - Connect to the LaunchPad using a terminal program (TeraTerm)

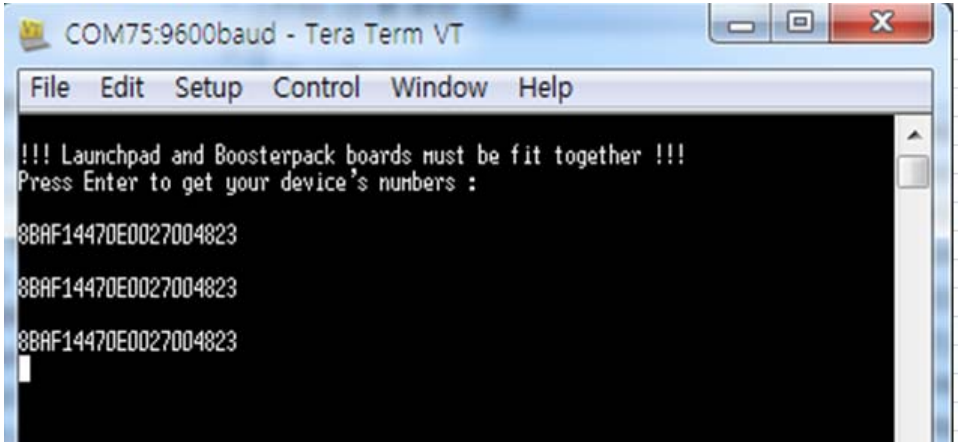


SIGFOX SDK Demo

- **Step 3**: Provide activation ID to SIGFOX

  - Once the connection with the device is established, press ENTER.

  - 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.

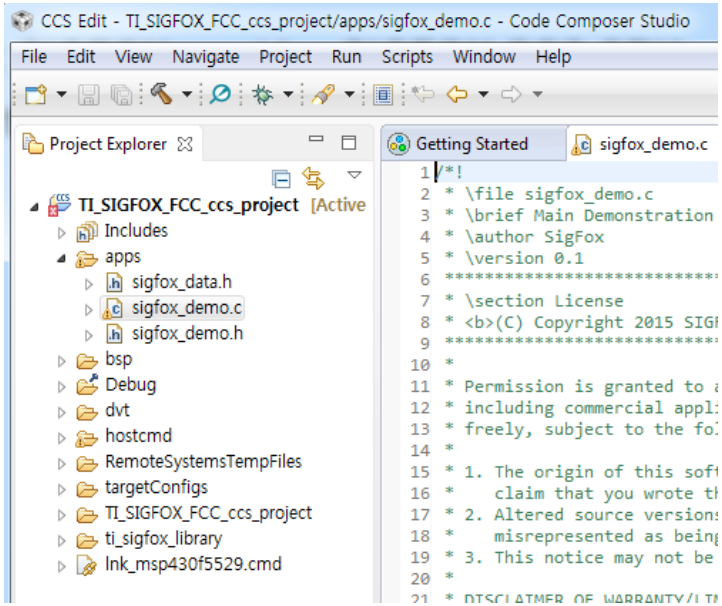


SIGFOX SDK Demo

- **Step 4**: SIGFOX provides SIGFOX CCS SDK

  - Open the TI_SIGFOX_project into the CCS application.

  - Compile the project, load it onto the LaunchPad, and run it.



SIGFOX SDK Demo

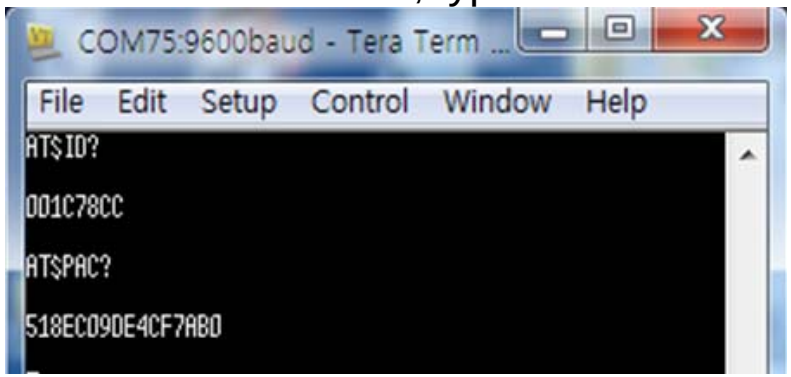
- **Step 5**: Log-in SIGFOX back-end

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

  - The device ID and PAC number are required to add a device to the backend

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

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



SIGFOX SDK Demo

- **Step 5**: Log-in SIGFOX back-end

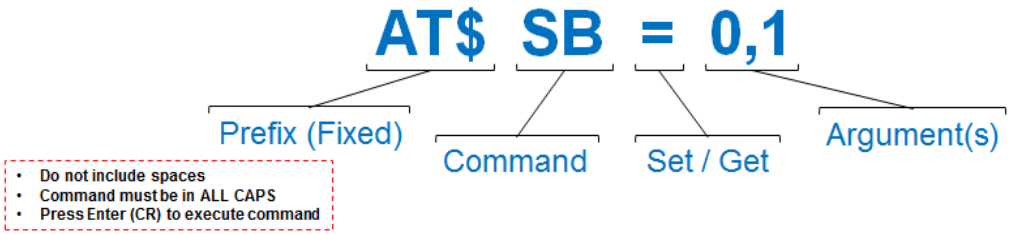
  Below figure shows examples of messages on the base station.

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	

SIGFOX SDK Demo

- ***AT Commands***

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



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

SIGFOX SDK Demo

- ***AT Commands***

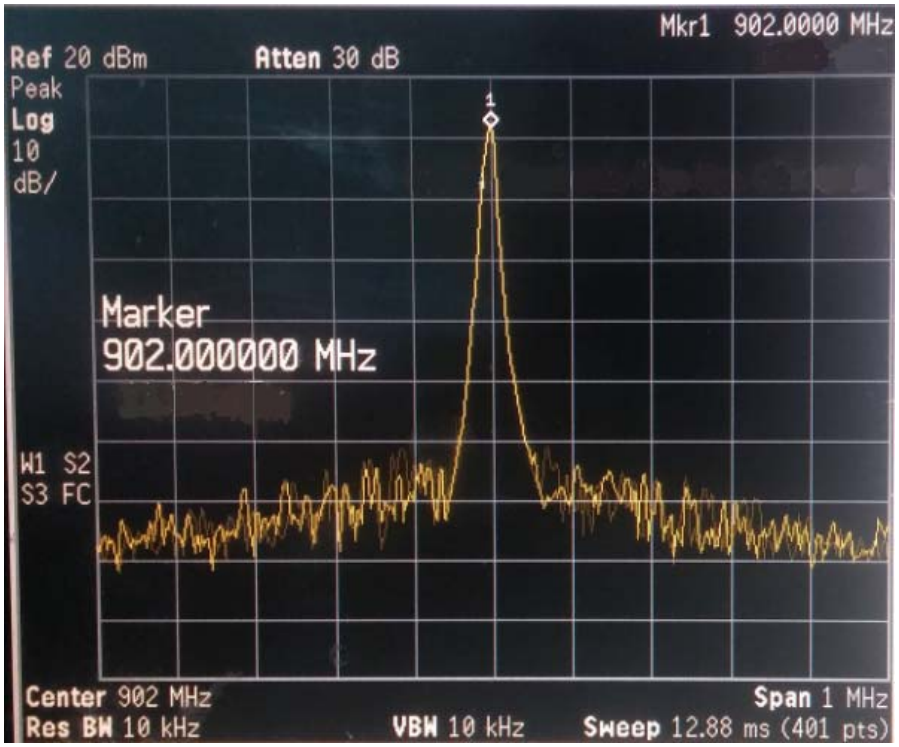
```
AT$ID?

001C78CC

AT$PAC?

518EC09DE4CF7AB0

AT$IF?

902200000

AT$DR?

905200000

AT$SF=313233343536373839404142

Wait 20 seconds before sending Frames

OK
```

```
AT$SF=5464737420fD657373616765,1

OK

Wait 20 seconds before sending Frames

Error with this command :3E

AT$SB=1

Wait 20 seconds before sending Frames

OK

AT$SB=0,1

OK

Wait 20 seconds before sending Frames

Error with this command :4E
```

SIGFOX SDK Demo

- ***AT Commands***

```
AT$CH=902000000,1

OK
```



Get More Information

To learn more information about the **industry's broadest wireless portfolio**,

Wireless Connectivity solution overview

Wireless on ti.com: www.ti.com/wireless

E2E Forum: www.ti.com/wiconforum

TI Connectivity Wiki: www.ti.com/connectivitywiki

eBook on Wireless for Industrial: Connectivity in the Industrial IoT

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Q & A

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