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Be prepared for Sigfox RF & Protocol Tests

Public Use

IMPORTANT NOTICE

The *DUT* proposed in Sigfox RF & Protocol Tests has to be representative of all devices of the same model that will be deployed on the network, as defined on the terms and agreement signed when submitting to Sigfox RF & Protocol Tests.

To succeed in your Sigfox RF & Protocol Tests, you must :

- Read carefully this document and follow all the steps described within
- Answer the Checklist questions at the end of this document
- Provide the *RF & Protocol Test Guide* to the *Sigfox Accredited Test House*
- Execute RF & Protocol pre-test on your side before sending the *DUT* to the *Sigfox Accredited Test House* with : Radio_Signal_Analyzer + SDR DONGLE (available on Build Website: *https://build.sigfox.com*)

ADJUSTABLE OUTPUT POWER

If the *DUT* proposed in Sigfox RF & Protocol Tests has the capability to change its RF output power : Two separated Sigfox RF & Protocol Tests reports have to be provided (at minimum and maximum RF output power)

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1 Introduction

1.1 Scope

This document describes how to prepare the Sigfox RF & Protocol Tests and all pre-requisites the *DUT* and the *Partner* must respect to comply with Sigfox RF & Protocol Tests.
Partner has to fill out and provide the checklist to the *Sigfox Accredited Test House* . Sigfox RF & Protocol Tests are executed in conducted mode.

For mode details on Sigfox certification process, go to Build Website: *https://build.sigfox.com*.

1.2 Definitions and Acronyms

1.2.1 Definitions

Sigfox Accredited Test House: A test house accredited by Sigfox to execute Sigfox RF & Protocol Tests

Candidate Modular Design/Device: One unit of a Candidate Modular Design/Device model sent for RF & Protocol testing, also called *DUT* in this document. Can be a prototype but shall be representative to series

Device: Manufactured end-product that is intented for use by end-user customers on the Sigfox network

Modular Design: is defined as HW/SW design which must :

- be integrated into a *Device* to operate on Sigfox Network
- fulfill Sigfox Verified™ modular design requirements

Partner: Person/company developing a Sigfox product that can be either a Modular Design or Device, and intended to pass through Sigfox Certification process.

Sigfox Protocol Library: SW binary file for management of the protocol part of the Sigfox communication.

RF & Protocol Test Guide: Full Test Guide for testing only with all commands/way/information to go through Sigfox RF & Protocol Tests

Sigfox RF & Protocol Specifications: are the documents containing RF & Protocol requirements for Sigfox certification.

Sigfox RF & Protocol Tests: is the set of Sigfox RF & Protocol Tests required for Sigfox certification.

1.2.2 Acronyms

- **2GFSK**: 2-Level Gaussian Frequency Shift Keying
- **ACK**: Acknowledgement
- **AES**: Advanced Encryption Standard
- **Att**: Attenuator
- **CAB**: Client Application Board
- **CBC**: Cipher Block Chaining
- **CS**: Carrier Sense
- **Cold Test**: Test executed in initial condition (wait till the DUT come back to the initial system between two tests)
- **DBPSK**: Differential Binary Phase-Shift Keying
- **DUT**: Device Under Test
- **Duty Cycle**: part of a period in which a signal is active (high state/Period)
- **ENC**: Encrypted

- **Fd**: DUT Frequency
- **Fe**: Equipment Frequency
- **Legacy Uplink**: initial payload format of Sigfox Uplink without encryption
- **LBT**: Listen Before Talk
- **NVM**: Non Volatile Memory
- **OOB**: Out Of Band
- **PAC**: Porting Authorization Code
- **PER**: Packet Error Rate
- **PMR**: Private Mobile Radio
- **RC**: Radio Configuration
- **RF**: Radio Frequency
- **RSA**: Radio_Signal_Analyzer
- **RSSI_dut**: DUT RSSI
- **RSSI_eq**: Equipment RSSI
- **SMIQ**: Vector Signal Generator
- **SOC**: System On Chip
- **Sigfox Message**: Three frames with payload 303132333435363738393A3B
- **UNBT**: Ultra Narrow Band Transceiver

2 Be prepared for Sigfox RF & Protocol Tests

2.1 Get the Sigfox RF & Protocol Specifications

You can get the latest Sigfox RF & Protocol Specifications per Radio Configuration from Build Website: *https://build.sigfox.com*

- **Sigfox RF & Protocol Specifications**
- **Sigfox RF & Protocol Test Plan**

Ensure you read those documents properly to match all Sigfox Requirements on your device. Both software and hardware concerns need to be studied to verify that *DUT* will pass Sigfox RF & Protocol Tests.

The Radio Configuration are set as below :

Parameter	RC1	RC2	RC3a/c	RC4	RC5	RC6	RC7
Uplink Central Frequency(MHz)	868.130	902.200	923.200	920.800	923.300	865.200	868.800
Downlink Central Frequency(MHz)	869.525	905.200	922.200	922.300	922.300	866.300	869.100
Spectrum Access Method	DC 1%	FH	LBT	FH	LBT	DC 1%	DC 1%

2.2 Integration of Sigfox Protocol Library

The *Device* must integrate the *Sigfox Protocol Library* for management of the protocol part of the Sigfox communication.

The *Partner* can find the way to get the latest Sigfox Protocol Library (binary file) on Build Website: *https://build.sigfox.com*.

2.3 Prepare your DUT for Sigfox RF & Protocol Tests

This section describes the pre-requisites the *DUT* (End Product and Modular Design) must respect and deliver to the *Sigfox Accredited Test House* for the test execution.
It also describes declarative information and documentation to be provided prior testing.

2.3.0.a DUT Declarative Pre-requisites

[PREREQUISITE-10] Device Configuration

Pre-Requisite Description:

The *Partner* must provide in the *RF & Protocol Test Guide* the *DUT* information about :

- Radio configuration
- Modem type (i.e. Uplink only or Uplink and Downlink)
- Encryption capability
- Repeater
- Monarch
- Secure Element

Example : RC1, Uplink and Downlink, No Encryption, Not a repeater, no SE

[PREREQUISITE-11] Device Identification

Pre-Requisite Description:

The *Partner* must provide the *DUT* in the *RF & Protocol Test Guide* information about:

- Commercial product name
- Product model name/number
- Certification type (i.e. *Device*, *Modular Design*)

Example : Product name : SigfoxV3, This is a Modular Design.

[PREREQUISITE-12] RF & Protocol Test Guide

Pre-Requisite Description:

The *Partner* must provide a *RF & Protocol Test Guide* with all the necessary information to execute Sigfox RF & Protocol Tests . This file should be a .pdf file.
This *RF & Protocol Test Guide* is not the final user manual, it must include how to handle the device, commands, information and ways to use the *DUT* described in this document, etc ...

Example : UART : Baudrate, Databits, Stopbits, Parity, etc .. External power supply picture, etc ...

[PREREQUISITE-13] Input Power Supply

Pre-Requisite Description:

The *Partner* has to provide in the *RF & Protocol Test Guide* the nominal value (give the value of your *DUT* datasheet, not the SOC or RF IC datasheet) and the range of input power supply voltage that is written is the datasheet of the device. Sigfox RF & Protocol Tests are executed on min, max and nominal values.
Partner has to provide in the *RF & Protocol Test Guide* the current limitation value of the *DUT* .

Min and Max values can be the same if the *DUT* is always supplied with the same voltage (datasheet indicates one supported value).

Example : 3.0V - 3.3V - 4.2V, 1A

[PREREQUISITE-14] Adjustable RF Output Power

Pre-Requisite Description:

The *Partner* has to provide in the *RF & Protocol Test Guide* the full range of the RF output power (give the value of your *DUT* datasheet, not the SOC or RF IC datasheet) that is written in the datasheet of the device in case of adjustable RF output power.
The *Partner* has to provide in the *RF & Protocol Test Guide* the way (give the command or else) to configure his *DUT* in minimum RF output power and in maximum RF output power. Sigfox RF & Protocol Tests are executed on min and max values (two full test reports).

This pre-requisite could be NOT-APPLICABLE if the device has a fixed RF output power value.

Example : To configure the device in minimum RF output power send : AT$302=10 for 10dBm, in maximum RF output power send AT$302=14 for 14dBm. This command has to be sent before any other command after reset

[PREREQUISITE-15] Oscillator datasheet

Pre-Requisite Description:

The *Partner* has to provide the datasheet of the radio oscillator with both values. This will be used to check the global frequency accuracy of the device. This datasheet must include

- Aging value (for 5 years)
- Temperature tolerance (with the temperature range)

Both values should be in the *RF & Protocol Test Guide*.

Example : Aging : +/- 2ppm (for 5 years) and temperature +/- 3ppm (-40 to +60 degree Celsius).

[PREREQUISITE-16] DUT representative to mass-production product

Pre-Requisite Description:

Except for RF output connector, the *DUT* must be as close as possible to the mass-production product (in terms of Hardware and Firmware).

Example : No wrapped wires

2.3.0.b DUT Hardware Pre-requisites

[PREREQUISITE-20] RF connector

Pre-Requisite Description:

DUT must have an RF connector to perform measurements in conducted mode on SMA termination. Take care about the matching on this RF connector.
If this is not an SMA termination connector, please provide the associated cable.

[PREREQUISITE-21] Input Power Supply Testability

Pre-Requisite Description:

As the *DUT* has to be tested on the full range of its power supply, the *Partner* has to provide a *DUT* with wired access to the source power supply in order to allow the use of an external variable power supply.
If external wires are needed, they must be already soldered on the *DUT*.

Partner has to give instruction in the *RF & Protocol Test Guide* to power up the *DUT*.

Example : Picture with cables

[PREREQUISITE-22] Hardware version

Pre-Requisite Description:

The *DUT* must have a general hardware version, candidate for the Sigfox RF & Protocol Tests, this version should be reported *RF & Protocol Test Guide* .

Example : Hardware version : V4

2.3.0.c DUT Software Pre-requisites

[PREREQUISITE-30] All Firmware versions flashed

Pre-Requisite Description:

The *DUT* must have the firmware version, candidate for the Sigfox RF & Protocol Tests, flashed within.

If possible, flash only the sub-Firmware managing Sigfox function, without application code (avoid new execution of RF & Protocol tests for any change on the application code).

If your Firmware depends on external source libs (coming from RF IC Maker), please list the different versions used to compose the final modem software version impacting Sigfox requirements. *Sigfox Accredited Test House* won't flash any release in the *DUT* .

List all versions (RF_API, MCU_API, Software version, Library version, etc...) in the *RF & Protocol Test Guide*.

Example : Final software version : V3.4 , Library version V2.5.0, Addon version V0.4.0, RF_API version 1.2, MCU_API version 1.3

[PREREQUISITE-31] DUT Firmware and Sigfox Lib version check

Pre-Requisite Description:

The *DUT* must provide in the *RF & Protocol Test Guide* a way to check and display the *DUT* Firmware version, MCU_API version, RF_API version , Sigfox LIBRARY and ADDON RF & PROTOCOL version numbers present in the device.

If the *DUT* contains both applicative Firmware, Sigfox Modulation/Demodulation and Protocol Firmware, a specific sub-Firmware version must be reported for Sigfox part (Modulation/Demodulation and Protocol).

Example : AT$V=1 (for RF_API version), AT$V=2 (for MCU_API version), AT$V=3 (for final software version), AT$LIB? , AT$ADDON?

[PREREQUISITE-32] LBT Carrier Sense duration

Pre-Requisite Description:

The *Partner* has to provide in the *RF & Protocol Test Guide* the duration of the Carrier Sense of the *DUT*. This will be used to configure the blocker in LBT related test.

This pre-requisite is APPLICABLE only for RC3 and RC5.

Example : CS : 6ms

[PREREQUISITE-33] RX RSSI Calibrated

Pre-Requisite Description:

The *DUT* must be calibrated in RX RSSI level +/- 2 dB (use the RX-GFSK Test Mode to calibrate)

[PREREQUISITE-34] RX GFSK Reporting

Pre-Requisite Description:

The *Partner* must provide in the *RF & Protocol Test Guide* a way to know (print, GPIO or else...) if the frame is received successfully with its RSSI level, through the RX-GFSK test mode. During the test mode, the *DUT* must output (UART or else) the report status (FAILED or PASSED through report test result) and RSSI level of each GFSK pattern received.

Example : During the Test Mode RX-GFSK : the RSSI value will be returned in the terminal with "TEST-PASSED" if the frame has been received properly

[PREREQUISITE-35] Test Procedure Commands availability

Pre-Requisite Description:

The *Partner* must provide an interface to activate all SIGFOX ADDONS Library test modes, Sigfox Messages and other command (Public Key, config Words, etc ...) mentionned in the Sigfox RF & Protocol Test Procedure.
This can be done through AT commands or any command/ways (give all commands), Built-in tests (hardcoded functions), GPIOs, ...

Without these commands documented in the *RF & Protocol Test Guide*, the *Sigfox Accredited Test House* will not be able to follow the Sigfox RF & Protocol Test Procedure.

Example : Test Mode TX-BPSK : command AT$TM=0
Sigfox Message (payload 1 bit only) : command AT$SB=1
Switch Public Key : command AT$PUB=1
ConfigWord : command AT$CW=00000001,00000000,00000000,0

[PREREQUISITE-36] Specific Credentials

Pre-Requisite Description:

The *DUT* must be flashed with a specific private test Key, test ID and test PAC for the Sigfox RF & Protocol Tests .

- ID = 0xFEDCBA98 *(ID[0]=0x98, ID[3]=0xFE)* (Warning : Be careful on the ID endianess for Backend end CRA ID manipulation.)
- KEY = 0x0123456789ABCDEF0123456789ABCDEF *(KEY[0]=0x01, KEY[15]=0xEF)*
- PAC = 0x5445535420504143 *(PAC[0]=0x54, PAC[7]=0x43)*

Test equipment tools are designed to decode by default these credentials.

In case Secure Element is used for the *DUT* , the Secure Element provider has to deliver the *Partner* with Test Samples flashed with these values.

[PREREQUISITE-37] Access to ID and PAC

Pre-Requisite Description:

The *DUT* must provide in the *RF & Protocol Test Guide* a way (give the command or else) to get ID and initial PAC.

- ID = Unique ID (4 bytes length)
- PAC = Initial PAC used for Device registering on SIGFOX network (8 bytes length) : mandatory to give to customer for registering

Example : AT$ID? and AT$PAC?

2.4 Pre-test your DUT

Pre-testing is strongly recommended by Sigfox to ensure that the *DUT* meets requirements before submitting for formal Sigfox RF & Protocol Tests .

Sigfox RF & Protocol Tests are made in some of device's operational conditions but not all of them.

- Partner has to ensure its validation process covers the compliance of Sigfox RF & Protocol specification in all operational conditions (full temperature range for example)
- According to your application, Sigfox advises you to plan temperature testing with the *Sigfox Accredited Test House* to match your device operation

To validate almost all those requirements and prevent the Partner to be out of specification, Sigfox proposes :

- A small RF USB dongle (SDR DONGLE) combined with the Radio_Signal_Analyzer tool (RSA) that runs on a computer
- A **Sigfox RF & Protocol Test procedure RSA-SDR Dongle** which allows to execute the tests (available on Build Website: *https://build.sigfox.com*)
- A Sigfox RF & Protocol Test Plan for all the tests that cannot be executed with RSA-SDR Dongle

Note :This tool allows execution of most of Sigfox RF & Protocol tests in conducted mode. However, results can vary from a *Sigfox Accredited Test House* ones as SDR DONGLE are low cost tools that do not meet performances of RF laboratory equipment.
Sigfox Accredited Test House can propose pre-testing offers to assess a *DUT* performance before formal Sigfox RF & Protocol Tests .

2.5 Send DUT to *Sigfox Accredited Test House*

The *Partner* has to ensure he based his device on :

- the latest Sigfox Specification
- the latest ADDON RF & Protocol

Prior sending the *DUT* to the *Sigfox Accredited Test House* , it's recommended to :

- Pre-test the *DUT* as described in Pre-test your DUT Section
- Check that all test control commands (or other) documented in the *RF & Protocol Test Guide* are functional

Ensure that your device is calibrated (Frequency, RX RSSI and LBT RSSI).
Fill out carefully the checklist and provide it with the RF & Protocol Test Guide to the *Sigfox Accredited Test House* with the *DUT* .

3 Appendix

Sigfox RF & PROTOCOL Checklist

Print this checklist, fill it in with the appropriate information and provide it to the Sigfox Accredited Test House along with your DUT and the RF & Protocol Test Guide .

*The DUT must be **calibrated** (Frequency / Level [RX RSSI and LBT RSSI]). Each Sigfox RF & Protocol Tests may be invoiced by Sigfox Accredited Test House , even with a FAIL verdict in test report.*

Prerequisite	Response
[PREREQUISITE-10] Do you attest that the full *DUT* configuration (Radio configuration, ...) is documented in the *RF & Protocol Test Guide* ? (Yes/No)	
[PREREQUISITE-11] Do you attest that the commercial product and model name and the certification type are documented in the *RF & Protocol Test Guide* ? (Yes/No)	
[PREREQUISITE-12] Do you attest all the needed information to execute Sigfox RF & Protocol Tests and pre-requisite information have been provided in the *RF & Protocol Test Guide* ? (Yes/No)	
[PREREQUISITE-13] Do you attest the Minimum Nominal and Maximum input voltage of the DUT and the current limitation are documented in the *RF & Protocol Test Guide* ? (Yes/No).	
[PREREQUISITE-14] Do you attest the way to configure your *DUT* in minimum and maximum RF output power is documented in the *RF & Protocol Test Guide* ? (Yes/No) (ONLY for adjustable RF output power devices)	
[PREREQUISITE-15] Do you attest both aging and temperature oscillator frequency accuracy values are documented in the *RF & Protocol Test Guide* ? (Yes/No).	
[PREREQUISITE-16] Do you attest the DUT used for Sigfox RF & Protocol Tests is representative of your mass production ? (Yes/No)	
[PREREQUISITE-20] Do you attest a wired RF connector is available on your *DUT* with SMA termination ? (yes/no)	
[PREREQUISITE-21] Do you explain the way to test on Nominal Minimum and Maximum voltage in the *RF & Protocol Test Guide* and provide cables if necessary ? (yes/no)	
[PREREQUISITE-22] Do you attest the *DUT* hardware version is available in the *RF & Protocol Test Guide* ? (yes/no)	
[PREREQUISITE-30] Do you attest the *DUT* has been flashed and that all versions required are available in the *RF & Protocol Test Guide* ? (yes/no)	
[PREREQUISITE-31] Do you attest all ways to retrieve the Software, Sigfox LIBRARY and ADDON RF & PROTOCOL versions are documented in the *RF & Protocol Test Guide* ? (Yes/No)	
[PREREQUISITE-32] Do you attest the duration of your Carrier Sense in ms is documented in the *RF & Protocol Test Guide* (Yes/No) ?	
[PREREQUISITE-33] Do you attest the *DUT* RSSI has been calibrated with +/- 2 dB ? (yes/no)	
[PREREQUISITE-34] Do you attest there is a way to report the received frame and RSSI information which is documented in the *RF & Protocol Test Guide* ? (yes/no)	
[PREREQUISITE-35] Do you attest, following the Sigfox RF & Protocol Test Procedure , the way to activate all test mode, Sigfox Messages and other commands or ways necessary for testing are documented in the *RF & Protocol Test Guide* ? (Yes/No)	
[PREREQUISITE-36] Do you attest you are using test credential values ? (Yes/No)	
[PREREQUISITE-37] Do you attest the way to get ID and Initial PAC are documented in the *RF & Protocol Test Guide* ? (Yes/No)	

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Prerequisite	Response