BE PREPARED FOR SIGFOX RF & PROTOCOL TESTS

Version 5.0.2

PUBLIC

1. Warning

IMPORTANTE NOTICE

The UUT 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 Sigfox certification Terms & Conditions (signed when submitting for Sigfox certification).

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
- Execute RF & Protocol pre-test on your side before sending the UUT to the Sigfox Accredited Test
- Provide the RF & Protocol Test Guide to the Sigfox Accredited Test House

ADJUSTABLE OUTPUT POWER

If the RF output power of the UUT being certified can be modified : Two separated Sigfox RF & Protocol Tests reports have to be provided (at minimum and maximum RF output power)

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2. Introduction

2.1. Scope

This document describes how to prepare the Sigfox RF & Protocol Tests and all pre-requisites the UUT and the Partner must respect to comply with Sigfox RF & Protocol Tests. The 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.

2.2. Definitions and Acronyms

2.2.1. Definitions

- **Sigfox Accredited Test House**: A test house accredited by Sigfox to execute Sigfox RF & Protocol Tests
- **Candidate Modular Design/Device/Development Solution**: One unit of a Candidate Modular Design/Device/Development Solution model sent for RF & Protocol testing, also called UUT 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 TM modular design requirements
- **Partner**: Person/company developing a Sigfox product that can be either a Modular Design, a Device, or a Development Solution, 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.
- **Product** : term used in this document covering Devices and modular designs.
- **Development Solution** : Engineering board, technology evaluation board or prototyping tool that is not used to operate on Sigfox network for commercial service delivery. It can be a development kit, breakout, shield board, expansion/extension board...

2.2.2. Accronyms

- **CS**: Carrier Sense
- **Cold Test**: Test executed in initial condition (wait till the UUT come back to the initial system between two tests)
- **DC :** Duty Cycle: part of a period in which a signal is active (high state/Period)
- **UUT** : Unit Under Test (Device, Modular Design or Development Solution)
- **FH** : Frequency Hopping

- **LBT**: Listen Before Talk
- **PAC**: Porting Authorization Code
- **RC**: Radio Configuration
- **RF**: Radio Frequency
- **RSA**: Radio_Signal_Analyzer
- **Sigfox Message**: Three frames with payload 303132333435363738393A3B
- **Roc**: Rollover Counter

3. Be prepared for Sigfox RF & Protocol Tests

3.1. Get the Sigfox RF & Protocol Specifications

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

Ensure you read this document properly to match all Sigfox Requirements on your UUT. Both software and hardware concerns need to be studied to verify that UUT will pass Sigfox RF & Protocol Tests.

3.2. Radio Configurations overview

Radio Configuration	Uplink Frequency (Hz)	Downlink Frequency (Hz)	Baudrate (bps)	Spectrum Access	Monarch Beacon Frequency (Hz)
RC1	868130000	869525000	100	DC	869505000
RC2	902200000	905200000	600	FH	905180000
RC3c	923200000	922200000	100	LBT	922250000
RC4	920800000	922300000	600	FH	922250000
RC5	923300000	922300000	100	LBT	922250000
RC6	865200000	866300000	100	DC	866250000
RC7	868800000	869100000	100	DC	869160000

3.3. Integration of Sigfox Protocol Library

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

3.4. Prepare your UUT for Sigfox RF & Protocol Tests

This section describes the pre-requisites the Unit Under Test (UUT) must prepare and respect before being delivered to the Sigfox Accredited Test House for the test execution.

It also describes declarative information and documentation to be provided prior testing.

3.4.1. UUT Declarative Pre-requisites

[PREREQUISITE-10] UUT Configuration

Prerequisite Description

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

- Radio configuration
- Modem type (i.e. Uplink only or Uplink and Downlink)
- Encryption capability
- Repeater
- Monarch
- Public Key
- Single/multi frame capability
- One or several Message counter maximum value (128, 256, 512, 1024, 2048, 4096)

In case of ENCRYPTION, there is a single message counter maximum value: 4096.

Example : RC1, Uplink and Downlink, No Encryption, Not a repeater, public key supported, multi frame capable, message counter 4096.

[PREREQUISITE-11] UUT Identification

Prerequisite Description

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

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

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

[PREREQUISITE-12] RF & Protocol Test Guide

Prerequisite 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 only include how to handle the UUT, commands, information and ways to use the UUT described in this document, etc ...

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

[PREREQUISITE-13] Input Power Supply

Prerequisite Description

The Partner has to provide in the RF & Protocol Test Guide the nominal value (give the value of your UUT datasheet, not the SOC or RF IC datasheet) and the range of input power supply voltage that is written is the datasheet of the UUT. 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 UUT

Min and Max values can be the same if the UUT 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

Prerequisite 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 UUT datasheet, not the SOC or RF IC datasheet) that is written in the datasheet of the UUT 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 UUT 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 UUT has a fixed RF output power value.

Example : To configure the UUT 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] RF Oscillator properties

Prerequisite Description

The Partner has to provide the following rf oscillator properties values : (This will be used to check the global frequency accuracy of the UUT)

- Aging value (**for 5 years**)
- Temperature tolerance (**taking into account the operating temperature range**)
- Operationnal Static frequency accuracy (**without production calibration** : refert oscillator datasheet and provide the worst inaccuracy value, **with production calibration** : taking into account your calibration and provide the worst inaccuracy value)

All values should be in the RF & Protocol Test Guide.

Warning: Temperature Frequency tolerance added to Aging frequency tolerance and Static Frequency Tolerance must be less or equal to +/- 20 ppm during all the product life.

Example : Aging : +/- 2ppm (for 5 years) and temperature +/- 3ppm (-40 to +60 degree Celsius) and operationnal static frequency accuracy +/-2.5ppm.

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

Prerequisite Description

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

Example : No wrapped wires

3.4.2. UUT Hardware Pre-requisites

[PREREQUISITE-20] RF connector

Prerequisite Description

UUT 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

Prerequisite Description

As the UUT has to be tested on the full range of its power supply, the Partner has to provide a UUT 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 UUT.

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

Example : Picture with cables

[PREREQUISITE-22] Modem version

Prerequisite Description

The UUT must have a general product version, candidate for the Sigfox RF & Protocol Tests , this version should be reported in the RF & Protocol Test Guide.

The UUT must have all hardware version reported in the RF & Protocol Test Guide :

- Schematic version
- PCB version
- BOM version

Example : Product version : V4, Hardware part : schematic V2.1, PCB V1, BOM V3

3.4.3. UUT Software Pre-requisites

[PREREQUISITE-30] All Firmware versions flashed

Prerequisite Description

The UUT 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 UUT .

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] UUT Firmware

Prerequisite Description

The UUT must provide in the RF & Protocol Test Guide a way to check and display the UUT Firmware version

If the UUT 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=3 (for final software version), version V3.0

[PREREQUISITE-32] Sigfox Library

Prerequisite Description

The UUT must provide in the RF & Protocol Test Guide a way to check and display all the Sigfox Library versions :

- MCU_API version
- RF_API version
- Sigfox LIBRARY
- ADDON RF & PROTOCOL version numbers present in the UUT.

This pre-requisite is only mandatory for UUT integrating Sigfox Library.

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

[PREREQUISITE-33] LBT Carrier Sense duration

Prerequisite Description

The Partner has to provide in the RF & Protocol Test Guide the duration of the Carrier Sense of the UUT.

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-34] RX RSSI Calibrated

Prerequisite Description

The UUT must be calibrated in RX RSSI level +/- 2 dB (use Test Mode D to calibrate)

[PREREQUISITE-35] RX GFSK Reporting

Prerequisite 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 test mode D. During the test mode, the UUT 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 D : the RSSI value will be returned in the terminal with "TEST-PASSED" if the frame has been received properly

[PREREQUISITE-36] Test Procedure Commands availability

Prerequisite Description

The Partner must provide an interface to activate all device 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 :

- Device Test Mode C : 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-37] Specific Credentials

Prerequisite Description

The UUT 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 UUT , the Secure Element provider has to deliver the Partner with Test Samples flashed with these values.

[PREREQUISITE-38] Access to ID and PAC

Prerequisite Description

The UUT 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 UUT registering on SIGFOX network (8 bytes length) : mandatory to give to customer for registering

Example : AT$ID? and AT$PAC?

[PREREQUISITE-39] Current Rollover Counter (Roc) values FEATURE ENCRYPTION

Prerequisite Description

The Partner has to provide current rollover counter value (Roc) for RF & Protocol tests in the RF & Protocol Test Guide .

Roc description: In case of encryption, message counter maximun value is 4096. Rollover counter (Roc) is incremented every time the message counter reach the limit.

Example : Current rollover counter (Roc) value of the product sent to perform RF & protocol tests : 11

[PREREQUISITE-40] Supported Frame Types

Prerequisite Description

The Partner has to provide all types of frame supported by the UUT in the RF & Protocol Test Guide .

Example : No Payload, Bit(False), Bit(True), Keep Alive, 1 Byte, 2 Bytes, 3 Bytes, 4 Bytes, 5 Bytes, 6 Bytes, 7 Bytes, 8 Bytes, 9 Bytes, 10 Bytes, 11 Bytes, 12 Bytes

3.5. Pre-test your UUT

Pre-testing is strongly recommended by Sigfox to ensure that the UUT 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** which allows to execute the tests (available on Build Website: https://build.sigfox.com)

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 UUT performance before formal Sigfox RF & Protocol Tests .

3.6. Send UUT to Sigfox Accredited Test House

The Partner has to ensure he based his UUT on the latest Sigfox Specification.

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

- Pre-test the UUT as described in Pre-test your UUT Section
- Check that all test control commands (or other) documented in the RF & Protocol Test Guide are functional
- Ensure that your UUT is calibrated (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 UUT .

4. 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 UUT and the RF & Protocol Test Guide.

The UUT must be **calibrated (Level [RX RSSI and LBT RSSI])**.

Prerequisite	Response
[PREREQUISITE-10] Do you attest that the full UUT 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 UUT and the current limitation are documented in the RF & Protocol Test Guide ? (Yes/No).	
[PREREQUISITE-14] Do you attest the way to configure your UUT 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 aging (5 years), temperature and operationnal static frequency accuracy of the rf oscillator are documented in the RF & Protocol Test Guide ? (Yes /No).	
[PREREQUISITE-16] Do you attest the UUT 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 UUT 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 UUT modem version and all hardware versions are available in the RF & Protocol Test Guide ? (Yes/No)	
[PREREQUISITE-23] Do you attest the targetted power class of the UUT is in the RF & Protocol Test Guide ? (Yes/No)	
[PREREQUISITE-30] Do you attest the UUT has been flashed and that all versions required are available in the RF & Protocol Test Guide ? (Yes/No)	
[PREREQUISITE-31] Do you attest the way to retrieve the Software version is documented in the RF & Protocol Test Guide ? (Yes/No)	
[PREREQUISITE-32] Do you attest all ways to retrieve the Sigfox LIBRARY and ADDON RF & PROTOCOL versions are documented in the RF & Protocol Test Guide ? *(only mandatory for devices integrating Sigfox Library)* (Yes/No)	
[PREREQUISITE-33] Do you attest the duration of your Carrier Sense in ms is documented in the RF & Protocol Test Guide (Yes/No) ?	
[PREREQUISITE-34] Do you attest the UUT RSSI has been calibrated with +/- 2 dB ? (Yes/No)	

[PREREQUISITE-35] 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-36] 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-37] Do you attest you are using test credential values ? (Yes/No)	
[PREREQUISITE-38] Do you attest the way to get ID and Initial PAC are documented in the RF & Protocol Test Guide ? (Yes/No)	
[PREREQUISITE-39] Do you attest all rollover counter supported values and the current rollover counter value are documented in the RF & Protocol Test Guide ? (Yes/No)	
[PREREQUISITE-39] Do you attest all Kinds of frame supported by the UUT are documented in the RF & Protocol Test Guide ? (Yes/No)	

5. Document history

Date	Version	Description
February 2020	V5.0.0	▪ Remove some Accronyms - add Product defintion ▪ Add Publick Key, Multiframe / Single frame feature declaration and remove Secure Element (all supported frames are defined in another prerequisite) ▪ Rename « Hardware version » to « Modem version » ▪ Rename « Oscillator datasheet » to « Oscillator properties » ▪ Add a pre-requisite to ask for the supported MC rollover and the one of the DUT (candidate for test) ▪ Add a pre-requisites on the supported frames ▪ Remove the request for DUT calibration of Frequency (in ‘Send DUT’ section and appendix) ▪ Remove the « addon » information in the ‘Send DUT’ section. ▪ Split the "DUT Firmware and SIgfox Library version check" in 2 pre-requisites (the second one is only mandatory if the DUT integrates the Sigfox Library). ▪ Replace DUT into UUT in the whole document