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Sigfox RF & Protocol Test Procedure RSA-SDR-Dongle for RC5-UDL-ENC

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IMPORTANT NOTICE

The device proposed in Sigfox RF & Protocol Tests has to be representative of the ones present in the field.

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

- Read carefully the Radio_Signal_Analyzer User Guide (available on Build Website: <https://build.sigfox.com>).
- Have a Sigfox Checklist (available on Build Website: <https://build.sigfox.com>) properly filled in (all information in the checklist will be used all tests long).

Contents

1	Introduction	3
1.1	Scope	3
1.2	Acronyms and abbreviations	3
1.3	Radio_Signal_Analyzer	4
1.3.1	User guide	4
1.3.2	Verdict Type	4
1.3.3	Checklist Information	4
2	Sigfox RF & Protocol Tests	5
2.1	Test Setup	5
2.2	Tests Execution	6
2.2.1	Uplink Tests	7
2.2.1.a	Test UL-RF Analysis Nominal Voltage	7
2.2.1.b	Test UL-RF Analysis Minimum Voltage	7
2.2.1.c	Test UL-RF Analysis Maximum Voltage	8
2.2.1.d	Test UL-Protocol	9
2.2.1.e	Test UL-Protocol Encrypted Payload	10
2.2.1.f	Test UL-Non Volatile Memory	10
2.2.1.g	Test UL-Public Key	11
2.2.1.h	Test UL-Frequency Distribution	12
2.2.1.i	Test UL-Repeat Timeout	12
2.2.1.j	Test UL-Frequency Synthesis	13
2.2.2	Downlink Tests	13
2.2.2.a	Test DL-Protocol	13
2.2.2.b	Test DL-Protocol Encrypted Payload	14
2.2.2.c	Test DL-Start Of Listening Window	14
2.2.2.d	Test DL-End Of Listening Window	14
2.2.2.e	Test DL-GFSK Receiver	15
2.2.2.f	Test DL-Link Budget	15
3	Results	16
4	APPENDIX	17
4.1	How to configure RSA if you don't know the private key ?	17
4.2	LBT test with ADDON RF & Protocol VERSION < 0.4.0 ?	17

1 Introduction

This document describes the test procedure compliant with the Sigfox RF & Protocol Test Plan .

1.1 Scope

This document is delivered to Device Makers to help them execute Sigfox tests before the official Sigfox RF & Protocol Tests .

1.2 Acronyms and abbreviations

- **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

1.3 Radio_Signal_Analyzer

1.3.1 User guide

Before starting test, read carefully the Radio_Signal_Analyzer User guide (available on Build Website: <https://build.sigfox.com>), it will be easier to use Radio_Signal_Analyzer and to find all things after that.

1.3.2 Verdict Type

EVALUATION	All requirements are manual verdict and have to be updated by the operator. Check each "Covered requirement" table to know the manual verdict and the "Manual Verdict" explanation to know if this verdict is "FAILED" or "PASSED".
TOOL-ANALYSIS	All requirements are automatic verdict and will be updated automatically by Radio_Signal_Analyzer .
MEASUREMENT	All measurement are automatic and will be updated automatically by RSA.

1.3.3 Checklist Information

All information from the checklist have to be filled in properly before starting test.

Radio_Signal_Analyzer should be configured according to the *RF & Protocol Test Guide* (RCx, modem type, ID/KEY values, ...). Some information **will be needed all test long**.

2 Sigfox RF & Protocol Tests

All tests below are described to help to validate some requirements for the Sigfox RF & Protocol Tests . It could help during the development, but it's not a certification.

Some requirement cannot be validated with the SDR DONGLE as it is not calibrated in Power Level/Frequency. With this equipment do not forget to keep a safe margin for all tests. All verdicts "inconclusive" (due to SDR DONGLE) have to be tested following the Sigfox Test Plan (available on Build Website: <https://build.sigfox.com>).

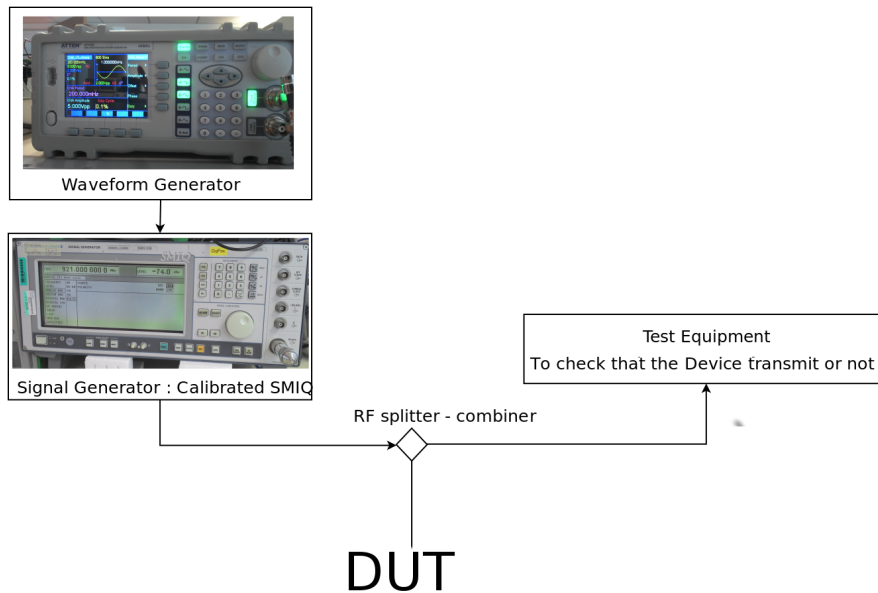
2.1 Test Setup

Computer with Radio_Signal_Analyser



Test Setup :

- Measure cable path losses of the setup
- Launch Radio_Signal_Analyzer
- Configure the "Device Configuration" window, (**This Configuration should not be modified after starting Sigfox RF & Protocol Tests otherwise all Radio_Signal_Analyser results will be reset**)
 - ID/KEY : **if you have operational ID/KEY and don't know the private KEY value refer to the Appendix explanations**
 - Radio_Signal_Analyzer will automatically update the test list. If a test mentioned in the following Sigfox RF & Protocol Test Procedure is not in the Radio_Signal_Analyzer test list, continue with the next test.
- Select "SDR DONGLE" in the "Tester" part
- Click "Open"
- Click "Start"



LBT Test Setup : This test setup has to be used only for LBT tests

- Configure the signal generator at -40dBm at 923.3000 MHz
- Configure the Waveform Generator (with fixed high state = 10.2s) according to the Carrier Sense value :
 - Period = (10.2s + (CS_value_in_s + 0.001)) s
 - Duty Cycle = (10.2 / Period) * 100 %
- Connect the signal generator, the Waveform Generator and the SDR-DONGLE to the DUT through a Combiner

Fill in all following information :

- Fill in all DUT information in "Info / Equipment / Verdicts" window ("Information" subwindow)
- Fill in all equipment information according to your setup in "Info / Equipment / Verdicts" window ("Equipment" subwindow), or load your equipment information file (if already saved)

2.2 Tests Execution

ADJUSTABLE RF OUTPUT POWER :

If the device proposed in Sigfox RF & Protocol Tests has the option to change the RF output power the Sigfox RF & Protocol Tests has to be done twice :

- Once at minimum RF output power configured in the *DUT* (the whole Sigfox RF & Protocol Test Procedure has to be followed with this configuration) .
- Second time at maximum RF output power configured in the *DUT* (the whole Sigfox RF & Protocol Test Procedure has to be followed with this configuration) .

Two Sigfox RF & Protocol Tests reports will be provided for this *DUT* .



2.2.1 Uplink Tests

2.2.1.a Test UL-RF Analysis Nominal Voltage

TEST CONDITION

Cold tests have to be done to validate all RF requirements, the goal is to validate the device in worst condition (before established system) .

Test execution :

- Ensure that your DUT is in **cold test condition (Remove all USB cables and power supply)**
 - Select "UL - RF Analysis Nominal Voltage" in "Test" drop-down menu
 - **Power up** the DUT in Nominal Voltage
 - Click "Raw IQ File" to start the record in the "Configuration" part and choose a folder
1. **If NO ADDON RF & PROTOCOL :**
 - Run the Sigfox Test Mode TX-BPSK with config 3 with your DUT
 - Wait for the end of the Test mode on the DUT
 2. **If ADDON RF & PROTOCOL VERSION \geq V0.1.0 :**
 - Run the Sigfox Test Mode TX-BPSK with your DUT
 - Wait for the end of the Test mode on the DUT
- Click "Raw IQ File" again to stop the record
 - Check the record size (value should be different from 0 MB)

Manual Verdict :

- **DBPSK Modulation envelope** : This test is PASSED only if the signal is modulated with amplitude level when a 0 occurs (Check the "envelope" window) .

Some requirements cannot be validated as the SDR DONGLE is not calibrated in frequency as Static Frequency Drift. We recommend to keep a safe margin for the Dynamic Drift for example. Test DL-GFSK Receiver has to be executed just after this test (due to static frequency measurement).

2.2.1.b Test UL-RF Analysis Minimum Voltage

TEST CONDITION

Cold tests have to be done to validate all RF requirements, the goal is to validate the device in worst condition (before established system) .

Test execution :

- Ensure that your DUT is in **cold test condition (Remove all USB cables and power supply)**
 - Select "UL - RF Analysis Minimum Voltage" in "Test" drop-down menu
 - **Power up** the DUT in Minimum Voltage
1. **If NO ADDON RF & PROTOCOL :**
 - Run the Sigfox Test Mode TX-BPSK with config 3 with your DUT
 - Wait for the end of the Test mode on the DUT

2. If ADDON RF & PROTOCOL VERSION \geq V0.1.0 :

- Run the Sigfox Test Mode TX-BPSK with your DUT
- Wait for the end of the Test mode on the DUT

Manual Verdict :

- **DBPSK Modulation envelope** : This test is PASSED only if the signal is modulated with amplitude level when a 0 occurs (Check the "envelope" window) .

Some requirements cannot be validated as the SDR DONGLE is not calibrated in frequency as Static Frequency Drift. We recommend to keep a safe margin for the Dynamic Drift for example.

2.2.1.c Test UL-RF Analysis Maximum Voltage

TEST CONDITION

Cold tests have to be done to validate all RF requirements, the goal is to validate the device in worst condition (before established system) .

Test execution :

- Ensure that your DUT is in **cold test condition (Remove all USB cables and power supply)**
- Select "UL - RF Analysis Maximum Voltage" in "Test" drop-down menu
- **Power up** the DUT in Maximum Voltage

1. If NO ADDON RF & PROTOCOL :

- Run the Sigfox Test Mode TX-BPSK with config 3 with your DUT
- Wait for the end of the Test mode on the DUT

2. If ADDON RF & PROTOCOL VERSION \geq V0.1.0 :

- Run the Sigfox Test Mode TX-BPSK with your DUT
- Wait for the end of the Test mode on the DUT

Manual Verdict :

- **DBPSK Modulation envelope** : This test is PASSED only if the signal is modulated with amplitude level when a 0 occurs (Check the "envelope" window) .

Some requirements cannot be validated as the SDR DONGLE is not calibrated in frequency as Static Frequency Drift. We recommend to keep a safe margin for the Dynamic Drift for example.

RF Analysis Covered Requirements :

Reference	Requirement	Verdict Type
PRS-RF-PROTOCOL-13	Static Frequency Tolerance	TOOL-ANALYSIS
PRS-RF-PROTOCOL-20	DBPSK Modulation envelope	EVALUATION
PRS-RF-PROTOCOL-21	Phase Measurement	TOOL-ANALYSIS
PRS-RF-PROTOCOL-22	Extra symbols before the first Sigfox bit of the frame	TOOL-ANALYSIS
PRS-RF-PROTOCOL-23	Extra symbols after the last Sigfox bit of the frame	TOOL-ANALYSIS
PRS-RF-PROTOCOL-30	TX Max Symbol duration	TOOL-ANALYSIS
PRS-RF-PROTOCOL-31	Max TX Baudrate Cumulated Error	TOOL-ANALYSIS
PRS-RF-PROTOCOL-40	Power Spectral Density	TOOL-ANALYSIS
PRS-RF-PROTOCOL-50	Transitional Frequency Dynamic Drift	TOOL-ANALYSIS
PRS-RF-PROTOCOL-51	Established Frequency Dynamic Drift	TOOL-ANALYSIS
PRS-RF-PROTOCOL-110	Modulated Conducted Output Power	MEASUREMENT
PRS-RF-PROTOCOL-130	I/Q Wave record	TOOL-ANALYSIS

The I/Q Wave record requirement is only checked during UL-RF Analysis Nominal Voltage test.

2.2.1.d Test UL-Protocol

Test execution :

- Select "UL-Protocol" in "Test" drop-down menu
- **Power up** the DUT in Nominal Voltage
 1. **If NO ADDON RF & PROTOCOL :**
 - Configure the configWord : CW[0]=0x00000001 CW[1]=0x00002EE0 CW[2]=0x00000000
 - Send a Sigfox Message with your DUT (payload 1 bit only : "0")
 - Wait for the end of the Test mode on the DUT
 - Send a Sigfox Message with your DUT (payload 1 bit only : "1")
 - Wait for the end of the Test mode on the DUT
 - Send a OOB Sigfox Message with your DUT
 - Wait for the end of the Test mode on the DUT
 - Send a Sigfox Message with your DUT (payload 1 byte only : "40")
 - Wait for the end of the Test mode on the DUT
 - Send a Sigfox Message with your DUT (payload 2 bytes only : "4041")
 - Wait for the end of the Test mode on the DUT
 - Send a Sigfox Message with your DUT (payload 3 bytes only : "404142")
 - Wait for the end of the Test mode on the DUT
 - Send a Sigfox Message with your DUT (payload 4 bytes only : "40414243")
 - Wait for the end of the Test mode on the DUT
 - Send a Sigfox Message with your DUT (payload 5 bytes only : "4041424344")
 - Wait for the end of the Test mode on the DUT
 - Send a Sigfox Message with your DUT (payload 6 bytes only : "404142434445")
 - Wait for the end of the Test mode on the DUT
 - Send a Sigfox Message with your DUT (payload 7 bytes only : "40414243444546")
 - Wait for the end of the Test mode on the DUT
 - Send a Sigfox Message with your DUT (payload 8 bytes only : "4041424344454647")
 - Wait for the end of the Test mode on the DUT
 - Send a Sigfox Message with your DUT (payload 9 bytes only : "404142434445464748")
 - Wait for the end of the Test mode on the DUT



- Send a Sigfox Message with your DUT (payload 10 bytes only : "40414243444546474849")
- Wait for the end of the Test mode on the DUT
- Send a Sigfox Message with your DUT (payload 11 bytes only : "404142434445464748494A")
- Wait for the end of the Test mode on the DUT
- Send a Sigfox Message with your DUT (payload 12 bytes only : "404142434445464748494A4B")
- Wait for the end of the Test mode on the DUT

2. If ADDON RF & PROTOCOL VERSION \geq V0.1.0 :

- Run the Sigfox Test Mode TX-PROTOCOL with your DUT
- Wait for the end of the Test mode on the DUT

2.2.1.e Test UL-Protocol Encrypted Payload

Test execution :

- Select "UL - Protocol Encrypted Payload" in "Test" drop-down menu
- Switch your device in encrypted mode
- Run the Sigfox Test Mode TX-PROTOCOL with your DUT
- Wait for the end of the Test mode on the DUT
- **Switch your device in not-encrypted mode**

2.2.1.f Test UL-Non Volatile Memory

Test execution :

- Select "UL - Non Volatile Memory" in "Test" drop-down menu

1. If NO ADDON RF & PROTOCOL :

- Configure the configWord : CW[0]=0x00000001 CW[1]=0x00002EE0 CW[2]=0x00000000
- Send a Sigfox Message with your DUT (payload 1 byte only). As seen in the picture, identify the FIRST MESSAGE with Freq1 for frame 1, freq2 for frame 2 and freq3 for frame 3 in the "demodulation window" in RSA.
- **Power down (remove all USB cables and power supply) the DUT**
- **Power up** the DUT in Nominal Voltage
- Configure the configWord : CW[0]=0x00000001 CW[1]=0x00002EE0 CW[2]=0x00000000
- Send a Sigfox Message with your DUT (payload 1 byte only). As seen in the picture, identify the SECOND MESSAGE with Freq4 for frame 1, freq5 for frame 2 and freq6 for frame 3 in the "demodulation window" in RSA
- Wait for the end of the Test mode on the DUT

2. If ADDON RF & PROTOCOL VERSION $<$ V0.4.0 :

- Send a Sigfox Message with your DUT (payload 1 byte only). As seen in the picture, identify the FIRST MESSAGE with Freq1 for frame 1, freq2 for frame 2 and freq3 for frame 3 in the "demodulation window" in RSA
- **Power down (remove all USB cables and power supply) the DUT**
- **Power up** the DUT in Nominal Voltage
- Send a Sigfox Message with your DUT (payload 1 byte only). As seen in the picture, identify the SECOND MESSAGE with Freq4 for frame 1, freq5 for frame 2 and freq6 for frame 3 in the "demodulation window" in RSA
- Wait for the end of the Test mode on the DUT

3. If ADDON RF & PROTOCOL VERSION \geq V0.4.0 :

- Run the Sigfox Test Mode NVM with your DUT
- **Power down (remove all USB cables and power supply) the DUT**

- **Power up** the DUT in Nominal Voltage
- Run the Sigfox Test Mode NVM with your DUT
- Wait for the end of the Test mode on the DUT

Manual Verdict : If **NO ADDON RF & PROTOCOL** or if **ADDON RF & PROTOCOL VERSION < V0.4.0**

- **NVM Frequency Storage** : After Power down/up, in the "demodulation window", the verdict should be :

"PASSED" if freq1 is not equal to freq4 +/-100Hz, freq2 is not equal to freq5 +/-100Hz, freq3 is not equal to freq6 +/-100Hz. ("PASSED Verdict" example below).

In "Demodulation" window, after power down/up, the Device (picture below) had not the same Sequence Number and same Frequencies as before. NVM requirements should be "passed" in the "Info / Equipment / Verdicts" window ("verdicts" subwindow).

Example : "PASSED Verdict"

Modulation	Type	Repeat	Frequency (Hz)	Rssi (dBm)	Start (s)	Stop (s)	Length (s)	Id	Sequence	Downlink ?	Data	Hmac Status	Crc Status	Raw Frame
AM	Data	1	-10749	54	206.385	208.463	2.077	FEDCBA98	3	No	40 41 42 43 44 45 46 47 48 49 4A 4B	OK	OK	AA AA A0 4C 00 03 98 BA DC FE 40 41 42 43 44 45 46 47 48 49 4A 4B 86 47 5D 30
AM	Data	2	-4337	31	208.991	211.068	2.077	FEDCBA98	3	No	40 41 42 43 44 45 46 47 48 49 4A 4B	OK	OK	AA AA A0 71 00 02 B2 C9 05 BE F0 71 B3 F2 37 76 B4 F5 3E 7F BD FC A4 F5 24 E4
AM	Data	3	8471	44	211.594	213.672	2.077	FEDCBA98	3	No	40 41 42 43 44 45 46 47 48 49 4A 4B	OK	OK	AA AA A0 97 00 05 BE 94 6B C1 D0 51 12 D3 95 54 17 D6 9A 5B 18 D9 B5 E4 9F B8
AM	Data	1	-9143	74	238.154	240.231	2.077	FEDCBA98	4	No	40 41 42 43 44 45 46 47 48 49 4A 4B	OK	OK	AA AA A0 4C 00 04 98 BA DC FE 40 41 42 43 44 45 46 47 48 49 4A 4B 6E 7A 19 CA
AM	Data	2	-1134	32	240.758	242.835	2.077	FEDCBA98	4	No	40 41 42 43 44 45 46 47 48 49 4A 4B	OK	OK	AA AA A0 71 00 07 F2 C9 05 BE F0 71 B3 F2 37 76 B4 F5 3E 7F BD FC 02 D9 93 5D
AM	Data	3	-10329	57	243.361	245.439	2.077	FEDCBA98	4	No	40 41 42 43 44 45 46 47 48 49 4A 4B	OK	OK	AA AA A0 97 00 05 BE 94 6B C1 D0 51 12 D3 95 54 17 D6 9A 5B 18 D9 B5 E4 9F B8

"FAILED" if freq1=freq4 +/-100Hz, freq2=freq5 +/-100Hz, freq3=freq6 +/-100Hz.

2.2.1.g Test UL-Public Key

If the DUT contains a Secure Element (SE) this requirement is "Not Applicable" : add "Device contains a Secure Element" in the comment part for the requirement "Public Key" in "Info / Equipment / Verdicts" window ("verdicts" subwindow).

This test is mandatory only for Modular Design and Development Solution and not mandatory for Device, in this case do not run the following test and add a comment in the comment part for the requirement "Public Key" in "Info / Equipment / Verdicts" window .

Test execution :

- Select "UL - Public Key" in "Test" drop-down menu
- If NO ADDON RF & PROTOCOL :**
 - Configure the DUT in public Key
 - Configure the configWord : CW[0]=0x00000001 CW[1]=0x00002EE0 CW[2]=0x00000000
 - Send a Sigfox Message with your DUT (payload 1 byte only)
 - Wait for the end of the Sigfox message
 - Configure the DUT in private Key
 - If ADDON RF & PROTOCOL VERSION < V0.4.0 :**
 - Configure the DUT in public Key



- Send a Sigfox Message with your DUT (payload 1 byte only)
- Wait for the end of the Sigfox message
- Configure the DUT in private Key

3. If ADDON RF & PROTOCOL VERSION \geq V0.4.0 :

- Run the Sigfox Test Mode PUBLIC-KEY with your DUT
- Wait for the end of the Sigfox message

2.2.1.h Test UL-Frequency Distribution

Test execution :

- Select "UL - Frequency Distribution" in "Test" drop-down menu

1. If NO ADDON RF & PROTOCOL :

- Configure the configWord : CW[0]=0x00000001 CW[1]=0x00002EE0 CW[2]=0x00000000
- Run the Sigfox Test Mode TX-PROTOCOL with config 14 with your DUT
- Wait for the final verdict in "Info / Equipment / Verdicts" window ("verdicts" subwindow) (should be PASSED / FAILED / INCONCLUSIVE) and stop the DUT test mode.

2. If ADDON RF & PROTOCOL VERSION \geq V0.1.0 :

- Run the Sigfox Test Mode TX-FREQ-DISTRIBUTION with your DUT

2.2.1.i Test UL-Repeat Timeout

Read the following procedure carefully before starting your test.

Test execution :

1. If NO ADDON RF & PROTOCOL :

- **Connect the LBT test setup (with blocker)**
- **Start the blocker**
- Select "UL - Repeat Timeout" in "Test" drop-down menu
- Configure the configWord : CW[0]=0x00000001 CW[1]=0x00002EE0 CW[2]=0x00000000
- Run the Sigfox Test Mode TX-PROTOCOL with config 1 with your DUT
- Stop the Test Mode after the first 2 Sigfox Messages
- **Connect the test setup (without blocker) again**

2. If ADDON RF & PROTOCOL VERSION $<$ 0.4.0 :

- **This test is not possible with this ADDON RF & PROTOCOL VERSION**
- *Partner* : Refer to the Appendix explanations to implement a solution and call the new test mode : TX-BIT
- *Test House* : Refer to **If ADDON RF & PROTOCOL VERSION \geq V0.4.0** : for LBT testing

3. If ADDON RF & PROTOCOL VERSION \geq V0.4.0 :

- **Connect the LBT test setup (with blocker)**
- **Start the blocker**
- Select "UL - Repeat Timeout" in "Test" drop-down menu
- Run the Sigfox Test Mode TX-BIT with your DUT
- Wait for the end of the Test mode on the DUT
- **Connect the test setup (without blocker) again**

2.2.1.j Test UL-Frequency Synthesis

Test execution :

- Select "UL - Frequency Synthesis" in "Test" drop-down menu
1. **If NO ADDON RF & PROTOCOL :**
 - Configure the configWord : CW[0]=0x00000001 CW[1]=0x00002EE0 CW[2]=0x00000000
 - Run the Sigfox Test Mode TX-SYNTH with config 0 with your DUT
 - Wait for the final verdict in "Info / Equipment / Verdicts" window ("verdicts" subwindow) (should be PASSED / FAILED / INCONCLUSIVE) and stop the DUT test mode.
 2. **If ADDON RF & PROTOCOL VERSION ≥ V0.1.0 :**
 - Run the Sigfox Test Mode TX-SYNTH with your DUT
 - Wait for the end of the Test mode on the DUT

Uplink Covered Requirements :

Reference	Requirement	Verdict Type
PRS-RF-PROTOCOL-10	Frequency Steps	TOOL-ANALYSIS
PRS-RF-PROTOCOL-11	Operational Frequencies Range	TOOL-ANALYSIS
PRS-RF-PROTOCOL-12	Operational Frequencies Distribution	TOOL-ANALYSIS
PRS-RF-PROTOCOL-80	AES	TOOL-ANALYSIS
PRS-RF-PROTOCOL-81	NVM Frequency Storage	TOOL-ANALYSIS
PRS-RF-PROTOCOL-82	NVM Sequence Number Storage	TOOL-ANALYSIS
PRS-RF-PROTOCOL-83	Public Key switch	TOOL-ANALYSIS
PRS-RF-PROTOCOL-84	Number of frames per message in Uplink mode	TOOL-ANALYSIS
PRS-RF-PROTOCOL-85	Legacy Uplink	TOOL-ANALYSIS
PRS-RF-PROTOCOL-86	Uplink Encrypted payload	TOOL-ANALYSIS
PRS-RF-PROTOCOL-101	TX repeat timeout	TOOL-ANALYSIS
PRS-RF-PROTOCOL-120	DUT Temperature level	MEASUREMENT
PRS-RF-PROTOCOL-121	DUT Voltage level	MEASUREMENT

2.2.2 Downlink Tests

2.2.2.a Test DL-Protocol

Test execution :

- Select "DL-Protocol" in "Test" drop-down menu
1. **If NO ADDON RF & PROTOCOL :**
 - Configure the configWord : CW[0]=0x00000001 CW[1]=0x00002EE0 CW[2]=0x00000000
 - Run the Sigfox Test Mode RX-PROTOCOL with config 1 with your DUT
 - Wait for the end of the Test mode on the DUT
 2. **If ADDON RF & PROTOCOL VERSION ≥ V0.1.0 :**
 - Run the Sigfox Test Mode RX-PROTOCOL with your DUT

- Wait for the end of the Test mode on the DUT

We recommend to keep a margin (middle of the allowed timings : between 1.4 and 4 s) as the measurement with the SDR-DONGLE is not really accurate. Some requirements cannot be validated as the SDR DONGLE is not calibrated in power level (as RSSI level). Both results need to be passed for final verdict. RSA displays the final verdict but only the last measurement is reported in RSA result column.

Example : If the first measurement is failed and the second passed, the final verdict will be failed with only the second measurement displays in RSA.

2.2.2.b Test DL-Protocol Encrypted Payload

Test execution :

- Select "DL-Protocol Encrypted Payload" in "Test" drop-down menu
- Switch your device in encrypted mode
- Run the Sigfox Test Mode RX-PROTOCOL with your DUT
- Wait for the end of the Test mode on the DUT
- **Switch your device in not-encrypted mode**

2.2.2.c Test DL-Start Of Listening Window

Test execution :

- Select "DL-Start Of Listening Window" in "Test" drop-down menu
1. **If NO ADDON RF & PROTOCOL :**
 - Configure the configWord : CW[0]=0x00000001 CW[1]=0x00002EE0 CW[2]=0x00000000
 - Run the Sigfox Test Mode RX-PROTOCOL with config 1 with your DUT
 - Wait for the end of the Test mode on the DUT
 2. **If ADDON RF & PROTOCOL VERSION \geq V0.1.0 :**
 - Run the Sigfox Test Mode RX-PROTOCOL with your DUT
 - Wait for the end of the Test mode on the DUT

2.2.2.d Test DL-End Of Listening Window

Test execution :

- Select "DL-End Of Listening Window" in "Test" drop-down menu
1. **If NO ADDON RF & PROTOCOL :**
 - Configure the configWord : CW[0]=0x00000001 CW[1]=0x00002EE0 CW[2]=0x00000000
 - Run the Sigfox Test Mode RX-PROTOCOL with config 1 with your DUT
 - Wait for the end of the Test mode on the DUT
 2. **If ADDON RF & PROTOCOL VERSION \geq V0.1.0 :**
 - Run the Sigfox Test Mode RX-PROTOCOL with your DUT
 - Wait for the end of the Test mode on the DUT

2.2.2.e Test DL-GFSK Receiver

The Sigfox Test Mode TX-BPSK has to be executed just before this test. The "static Drift (Hz)" will be updated automatically by RSA according to the Sigfox Test Mode TX-BPSK static drift result.

Test execution :

- Select "DL-GFSK Receiver" in "Test" drop-down menu
 - Click "Start Send GFSK" in "Configuration" part
1. **If NO ADDON RF & PROTOCOL :**
 - Run the Sigfox Test Mode RX-GFSK with config 30 with your DUT
 - Check the GFSK reporting
 - Wait for the end of the Test mode on the DUT
 - Click "Stop Send GFSK" in "Configuration" part
 2. **If ADDON RF & PROTOCOL VERSION \geq V0.1.0 :**
 - Run the Sigfox Test Mode RX-GFSK with your DUT
 - Check the GFSK reporting
 - Wait for the end of the Test mode on the DUT
 - Click "Stop Send GFSK" in "Configuration" part

The RX-GFSK level cannot be validated with the SDR-DONGLE (fixed level) but this test allows to validate the test mode RX-GFSK functionality.

Manual Verdict :

- **2GFSK 600bps :** This test is PASSED only if the DUT receives GFSK sent by Radio_Signal_Analyzer and reports the test result.

2.2.2.f Test DL-Link Budget

The Test UL-RF Analysis Nominal Voltage has to be executed before this test.

Test execution :

- Select "DL - Link Budget" in "Test" drop-down menu
1. **If NO ADDON RF & PROTOCOL :**
 - Configure the configWord : CW[0]=0x00000001 CW[1]=0x00002EE0 CW[2]=0x00000000
 - Run the Sigfox Test Mode RX-SENSI with config 31 with your DUT
 - Wait for the final verdict in "Info / Equipment / Verdicts" window ("verdicts" subwindow) (should be PASSED / FAILED / INCONCLUSIVE) and stop the DUT test mode.
 2. **If ADDON RF & PROTOCOL VERSION \geq V0.1.0 :**
 - Run the Sigfox Test Mode RX-SENSI with your DUT
 - Wait for the final verdict in "Info / Equipment / Verdicts" window ("verdicts" subwindow) (should be PASSED / FAILED / INCONCLUSIVE) and stop the DUT test mode.

The sensitivity cannot be validated with the SDR-DONGLE (fixed level) but this test allows to validate the test mode RX-SENSITIVITY functionality.

Downlink Covered Requirements :

Reference	Requirement	Verdict Type
PRS-RF-PROTOCOL-60	2GFSK 600bps	EVALUATION
PRS-RF-PROTOCOL-70	Sigfox Link Budget	TOOL-ANALYSIS
PRS-RF-PROTOCOL-87	Downlink Legacy	TOOL-ANALYSIS
PRS-RF-PROTOCOL-88	Downlink Encrypted Payload	TOOL-ANALYSIS
PRS-RF-PROTOCOL-89	RSSI level	TOOL-ANALYSIS
PRS-RF-PROTOCOL-90	Number of Uplink frame in bi-directional mode	TOOL-ANALYSIS
PRS-RF-PROTOCOL-100	TX Interframe Timing in Uplink mode	TOOL-ANALYSIS
PRS-RF-PROTOCOL-102	TX Interframe Timing in Bi-directional mode	TOOL-ANALYSIS
PRS-RF-PROTOCOL-103	RX Start Of Listening	TOOL-ANALYSIS
PRS-RF-PROTOCOL-104	RX End Of Listening	TOOL-ANALYSIS
PRS-RF-PROTOCOL-105	RX to OOB(ack) Timing	TOOL-ANALYSIS

3 Results

Be careful, when saving the measurement, the result folder will be cleared.

For all manual verdicts, **add a note and/or a value** in the comment part.

If the manual verdict is fail, **add a note** in the comment part **to explain why** (for example : The command doesn't work).

Export results **when all requirements have been tested** (all verdicts should be "FAIL" , "INFO" or "PASS") :

- In "Info / Equipment / Verdicts" window, Choose "Export Results"
- Open the result folder
- Select your DUT picture
- Select the I/Q record
- Select the *RF & Protocol Test Guide*

The sigfoxrfandprotocol.tar.gz will contain all information (verdicts, comments, information) and **shouldn't be modified in any way**. All verdicts : "INCONCLUSIVE" , cannot be validate with this equipment (due to the equipment's limitation).

4 APPENDIX

4.1 How to configure RSA if you don't know the private key ?

This specific test setup is applicable only in case of old library and is not recommended as operational mode cannot be fully validated.

Configure RSA without Private KEY value if operational ID/KEY

The device proposed in Sigfox RF & Protocol Tests must have ID/KEY test values. However if the device is based on old library version it's possible to test in public KEY :

- Switch the DUT in public KEY
- In "Device Configuration" Replace the default ID value by your operational ID value
- In "Device Configuration" Replace the default KEY value by 0x00112233445566778899AABBCCDDEEFF
- Do not change this configuration during the whole procedure except for the specific Public Key test part

4.2 LBT test with ADDON RF & Protocol VERSION < 0.4.0 ?

This specific test is not possible with ADDON RF & Protocol VERSION < 0.4.0.
Partner has to provide a way to test it :

- If SIGFOX LIBRARY VERSION > 2.3.0 : update your ADDON RF & Protocol VERSION (contact Sigfox)
- Implement the test mode following Sigfox RF & Protocol Test Plan explanations (Build Website: <https://build.sigfox.com>)
- If SIGFOX LIBRARY VERSION < 2.3.1 : update your SIGFOX LIBRARY VERSION and your ADDON RF & Protocol VERSION (contact Sigfox)