

LoRa[®] / LoRaWAN[®] Test Solutions

 **LoRa Alliance Certified™**
as an en-device for EU and KR



May 2023

Contents

- Summary of Key Features



- Product Comparison
- PC Application Software
- RF Shielding Enclosure
- Production Test Solution
- Stand-alone Operation of 5020B

End-device Test Solutions

Key Features



● Protocol Conformance Tests

○ LoRaWAN® Pre-Certification

- LW V1.0.2:

EU863-870, US/CA902-928, AS923, KR920-923, and IN865-867

- LW V1.0.4:

EU863-870, US/CA902-928, AS923-1/2/3/4, KR920-923, IN865-867, AU915-928, RU864-870, and EU433 Class B/C Certification

○ LoRaWAN® Protocol

- Compatible with LoRaWAN® version of V1.0.2, 1.0.3, 1.0.4 and V1.1.0

- Class A/B/C

- support 64(125kHz)+8(500kHz) channel, 96(125kHz) channel

○ Regional Parameters

- *EU 868, US 915, EU 433, AU 915, CN 470, AS 923(1/2/3/4), KR 920, IN 865, and RU 864*

○ Scenarios for MAC commands and application data

- *Multiple MAC commands and MAC command script*

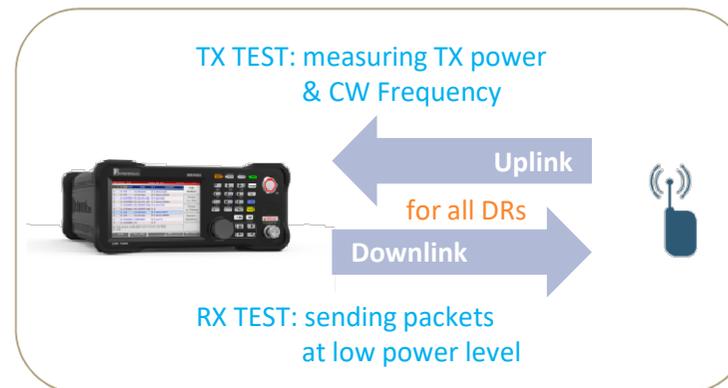
● RF Performance Tests

○ RX Sensitivity

- Class A/B/C

○ TX Power

○ TX CW Frequency



Gateway Test Solutions

● Protocol Conformance Tests

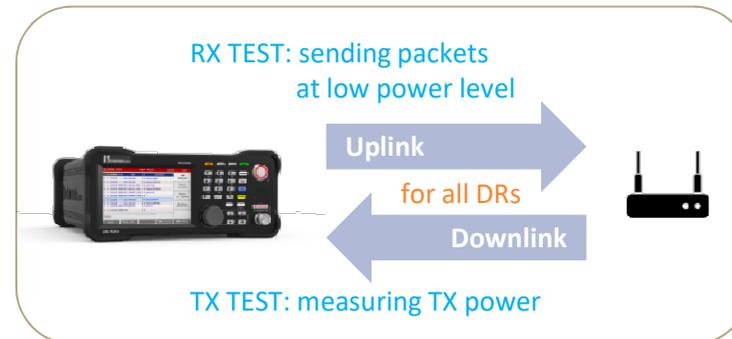
- LoRaWAN® Protocol
 - Compatible with LoRaWAN® version of V1.0.2, 1.0.3, 1.0.4 and V1.1.0
 - Class A/B/C
- Regional Parameters
 - EU 868, US 915, EU 433, AU 915, CN 470, AS 923, KR 920, IN 865, and RU 864
- Scenarios for MAC commands and application data
 - Multiple MAC commands and MAC command script

Key Features



● RF Performance Tests

- RX Sensitivity
- TX Power
- GW Non-regression Tests (Semtech)
 - TX Output Power Measurement
 - Sensitivity
 - PER / RSSI / SNR
 - Frequency Error Tolerance
 - CW Interferer / Blocker Immunity



LBT Test Solution

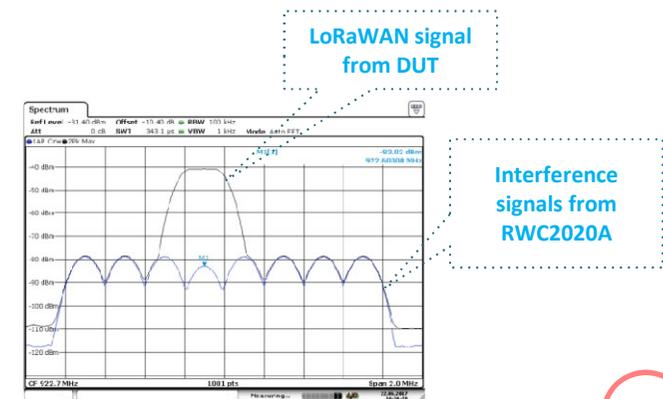
● What is LBT?

- Listen Before Talk; to prevent interference or collision between devices on common frequency channels

● How to test LBT?

- Use RWC2020A Interference Generator as an interferer
 - Automatically controlled by RWC5020x via a serial communication
- For details, refer to the Local Regulations of Japan and Korea

Key Features



Manufacturing Test Solutions

Key Features



● SOL #1: Separate TX/RX Test

- Non-signaling test (one-way test)
- Signal Analyzer function for TX Test
 - Measuring TX power and CW frequency
- Signal Generator function for RX Test
 - Measuring RX sensitivity with predefined test packets
- A wired control of DUT might be required

● SOL #2: Simultaneous TX/RX Test

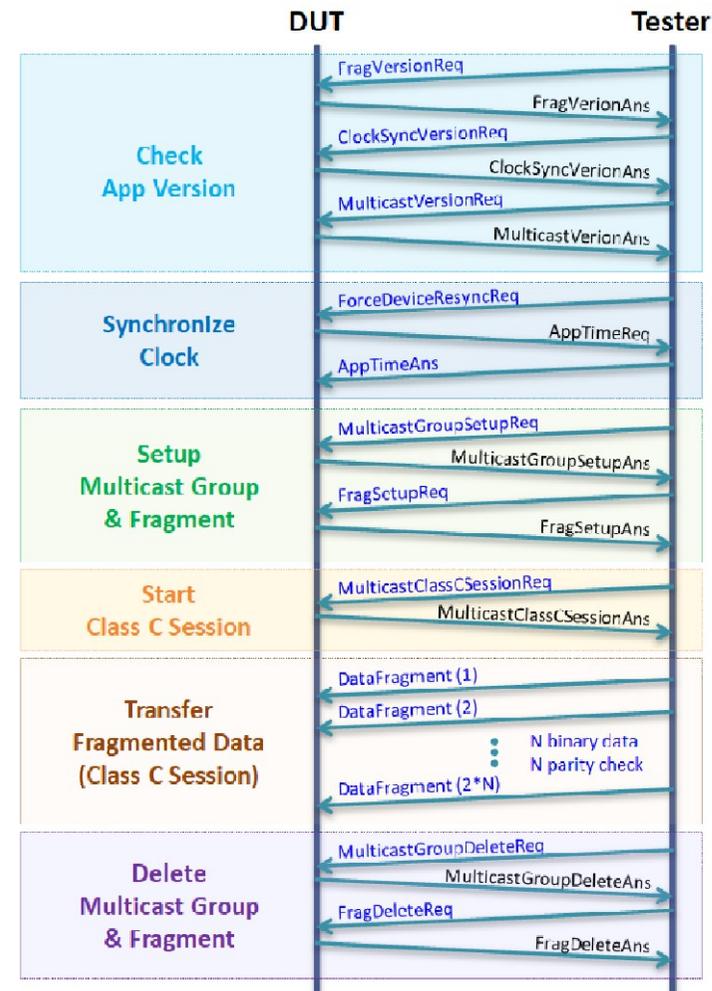
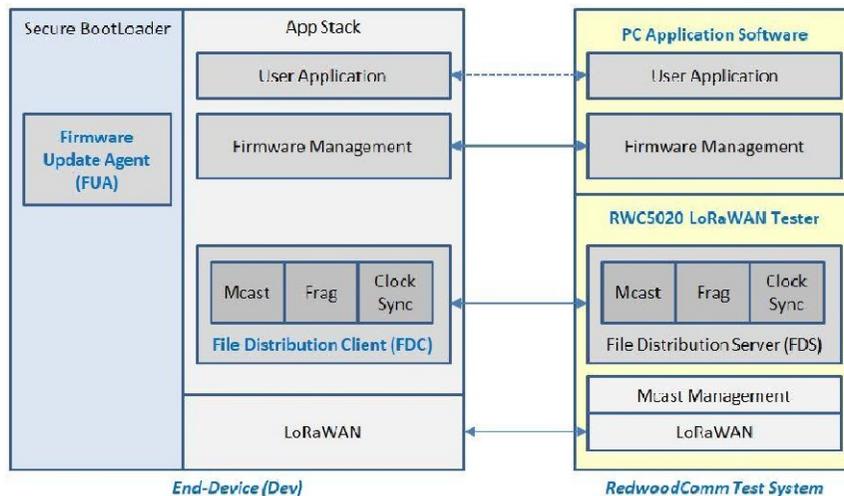
- Combining the advantages of signaling test and non-signaling test
- Simple test protocol is defined between DUT and the tester
- A wired control of DUT might not be necessary

FUOTA Test Solution

Key Features



- Fully Automated Test Scenario
 - Easy to use
- Users can use their own binary files for testing



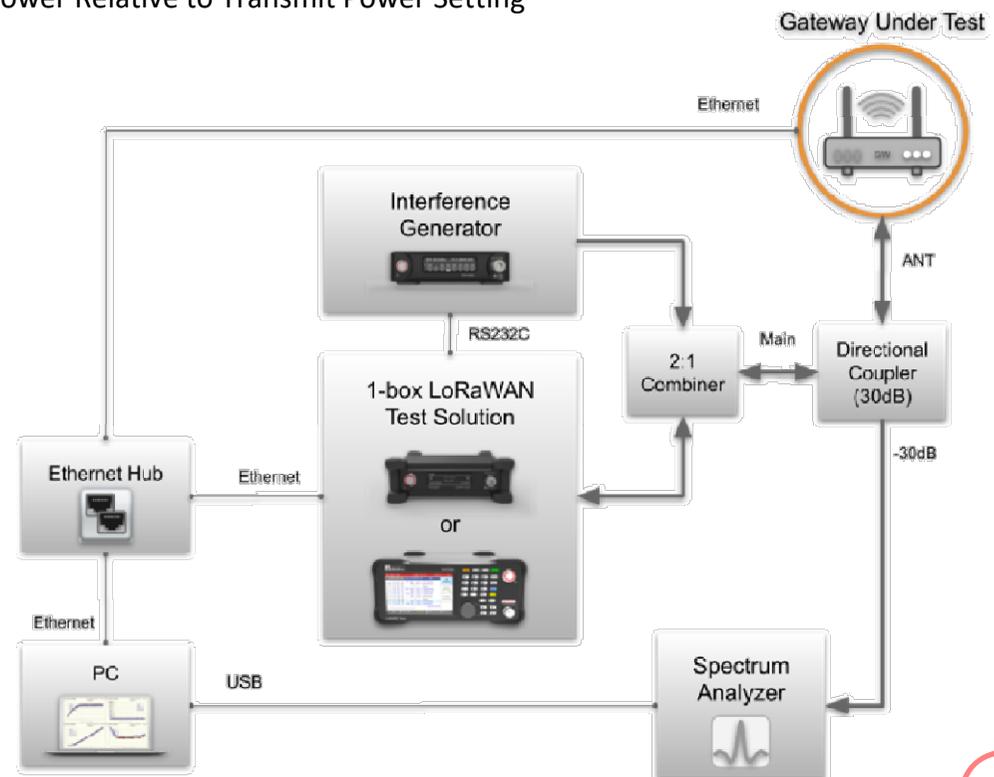
GW Test & Measurement Guidelines

● Related Document

○ [Download from the LoRa Alliance](#)

● Recommended instruments: RWC5020B (or M) and RWC2020A

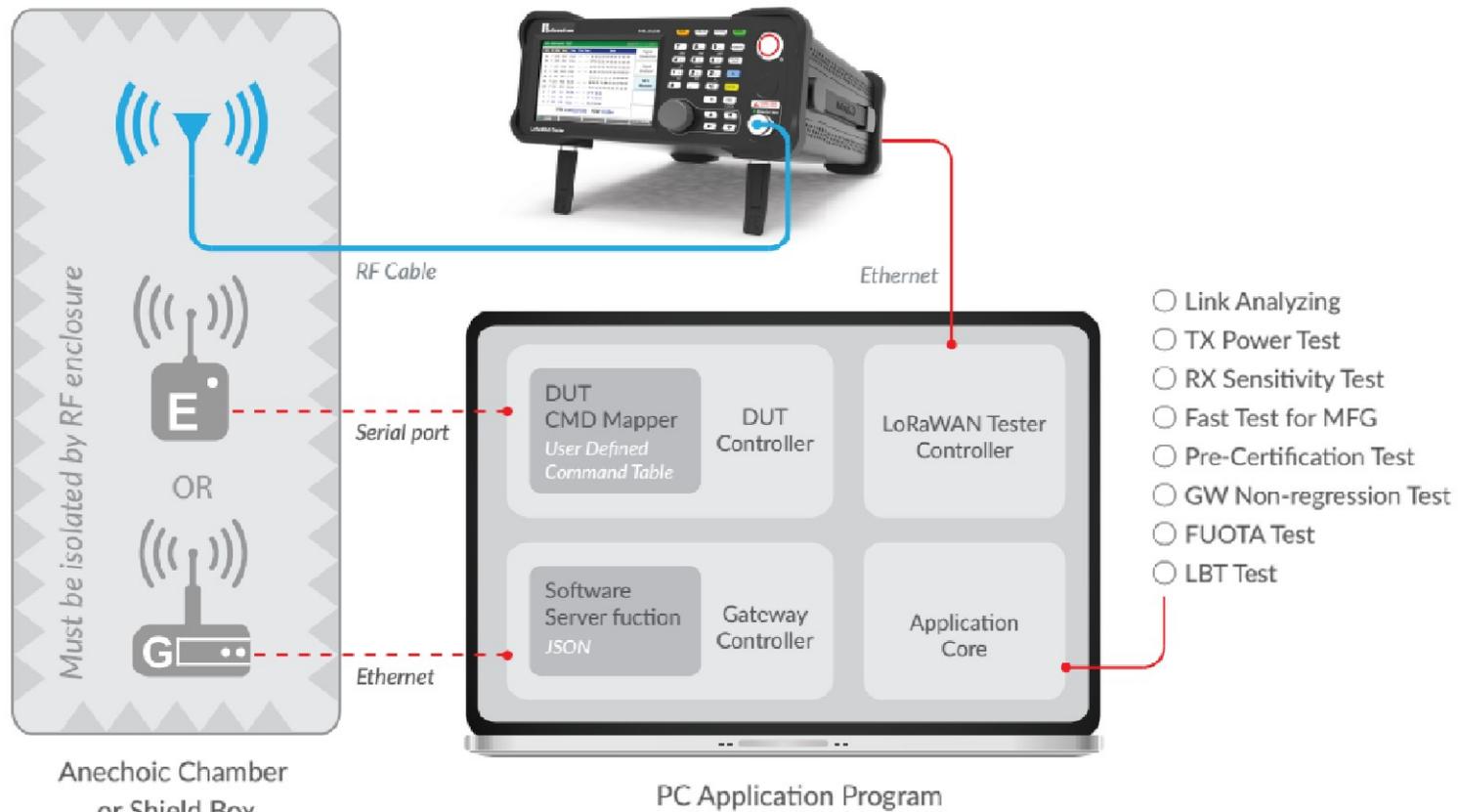
- Tx & Rx Operation and Survival with Open/Short Load
- Measured and Reported RF Transmit Power Relative to Transmit Power Setting
- Tx Conducted Emissions Out-of-Band
- Tx Intermodulation
- Tx Frequency Error
- Rx Sensitivity
- Rx Dynamic Range
- Rx In-Band Blocking/Selectivity
- Rx Out-of-Band Blocking/Selectivity
- Rx Intermodulation
- Cold Start
- Time Accuracy



Typical Test Setup

Key Features

● Automated PC Software and Example of Test Setup



NEW

Latest Updates

Key Features

● New Features for Next Version of RF Board

- 64(125kHz) + 8(500kHz) Channel Support
- SF5/SF6 Support
- Simultaneous emulation of End-device (ED) and Gateway (GW) for “Relay” test

● New Features Added

- Update of LoRaWAN Pre-Certification Test for Class B Devices
- Update of LoRaWAN Pre-Certification Test for Class C Devices
- Update of new version of FUOTA test procedures

Contents

- Summary of Key Features
- **Product Comparison**



- PC Application Software
- RF Shielding Enclosure
- Production Test Solution
- Stand-alone Operation of 5020B

RWC5020B

Product Comparison

- **Fully operable in both stand-alone and remote control mode**
 - User interface: 5" LCD and keypads
 - Remote control interface: Ethernet, RS-232C
- **Operation mode**
 - End-device Test / Gateway Test / Non-signaling Test
- **Target**
 - R&D, QC
- **Output Power**
 - 0 to -150dBm
- **Testing capability**
 - Protocol conformance
 - RF performance



RWC5020M

Product Comparison

- **Operable in remote control mode**
 - 2.8" OLED display for monitoring status
 - Remote control interface: Ethernet, RS-232C
- **Operation mode**
 - End-device Test / Gateway Test / Non-signaling Test
- **Target**
 - R&D, QC, production
- **Output Power**
 - 0 to -150dBm
- **Testing capability**
 - Protocol conformance
 - RF performance
- **Supply Power**
 - 12V/3A adapter provided



RWC5021P

Product Comparison

- **Operable in remote control mode**
 - 4 LED status indicators
 - Remote control interface: Ethernet, USB-C (VCOM)
- **Operation mode**
 - End-device Test
- **Target**
 - R&D, QC
- **Output Power**
 - 0 to -30dBm
- **Testing capability**
 - Protocol conformance
- **Supply Power**
 - 5V/0.5A USB-C powered



Comparison Table 1/2

Product Comparison

	5020B	5020M	5021P
Stand-alone Capability	YES	NO	NO
Exterior			
- Dimensions	250(w)x110(h)x348(d) mm	200(w)x70(h)x220(d) mm	100(w)x30(h)x140(d) mm
- Weight	5 kg	2.2 kg	0.5 kg
- Display	5", 800x480, 16M color, TFT LCD	2.8", 256x64, 16 gray, OLED	4 LED indicators
- Front Keypad	YES	NO	NO
- Power Input	100 to 240 VAC, 50/60Hz	12V/3A VDC (AC/DC adapter provided)	5V/0.5A (USB-C)
- Control Interface	Ethernet, RS-232C	Ethernet, RS-232C	Ethernet, USB-C (VCOM)
Frequency Bands			
- 400MHz to 510MHz	Included	Selectable by Band	Selectable by Region
- 862MHz to 960MHz	Included	Selectable by Band	Selectable by Region
RF Power Level			
- Output Power	0dBm to -150dBm	0dBm to -150dBm	0dBm to -30dBm
- Input for Power Measurement	+30dBm to -80dBm	+30dBm to -80dBm	+30dBm to -80dBm
- Input for Frequency Measurement	+30dBm to -50dBm	+30dBm to -50dBm	Not available
Operational Modes			
- End-device Test	Selectable	Selectable	Included
- Gateway Test	Selectable	Selectable	Not available
- Non-signaling Test	Included	Selectable	Not available

Comparison Table 2/2

Product Comparison

	5020B	5020M	5021P
Protocol Compliance Tests (end-device only)			
- LoRaWAN Pre-Certification Tests	Optional	Optional	Optional
- Operator Pre-Certification Tests	Optional	Optional	NO
RF Performance Tests			
- Receiver Sensitivity Test	YES	YES	NO
- Output Power Measurement	YES	YES	NO
- Carrier Frequency Measurement	YES	YES	NO
- LBT Test	YES (2020A required)	YES (2020A required)	NO
- Gateway Non-regression Test	YES (2020A required partly)	YES (2020A required partly)	NO
Link Analyzer			
- Message Logging and Analysis	YES	YES	YES
- MAC Commands Transmission	YES	YES	YES
- Application/User Data Transmission	YES	YES	YES
- User Script Generation	YES	YES	YES
Functionalities			
- FUOTA Test	YES	YES	NO
- Manufacturing Test (MFG/NST)	YES	YES	NO
Compatibility with 5020x PC Application Software			
- Pre-Certification Test	YES	YES	YES
- RF Performance Test	YES	YES	NO
- Link Analyzer	YES	YES	YES
- Functions: NST, MFG, FUOTA	YES	YES	NO

Hardware Specification 1/2

Product Comparison

	RWC5020B	RWC5020M
Frequency	<ul style="list-style-type: none"> • Range : 400MHz to 510MHz, 862MHz to 960MHz • Resolution : 100Hz • Stability vs. +25°C : ±0.5ppm standard • Stability vs. Aging : ±1ppm/1st year 	
Output Level	<ul style="list-style-type: none"> • Range : 0dBm to -150dBm • Resolution : 0.1dB • Accuracy : ±1dB • Impedance : 50Ω 	
Input Level	<ul style="list-style-type: none"> • +30dBm to -80dBm for Power Measurement • +30dBm to -50dBm for Frequency Measurement 	
Measurement Accuracy	<ul style="list-style-type: none"> • ±1dB for Power • ±1KHz for Frequency (Single Tone) 	
VSWR	<ul style="list-style-type: none"> • Better than 1:1.5 	
External Reference Frequency Input	<ul style="list-style-type: none"> • Frequency : 10MHz • Power Range : 0dBm to +20dBm 	
Remote Programming Ports	<ul style="list-style-type: none"> • RJ45(Ethernet) • RS-232C 	
Miscellaneous	<ul style="list-style-type: none"> • Operating temperature : 5 to 40°C • Line Voltage : 100 to 240 VAC, 50/60Hz • Dimension : 250(w) x 110(h) x 348(d) mm • Weight : 5kg 	<ul style="list-style-type: none"> • Operating temperature : 5 to 40°C • Input : 12V/3A VDC • Dimension : 200(w) x 70(h) x 220(d) mm • Weight : 2.2kg

Hardware Specification 2/2

Product Comparison

	RWC5021P	RWC2020A
Frequency	<ul style="list-style-type: none"> • Range : 400MHz to 510MHz, 862MHz to 960MHz • Resolution : 100Hz • Stability vs. +25°C : ±5 ppm • Stability vs. Aging : ±2.5ppm/year 	<ul style="list-style-type: none"> • Range : 400MHz to 1000MHz • Resolution : 100Hz • Accuracy : ±2ppm/year@operating temperature
Output Level	<ul style="list-style-type: none"> • Range : 0dBm to -30dBm • Resolution : 0.1dB • Accuracy : ±2dB • Impedance : 50Ω 	<ul style="list-style-type: none"> • Range : -10dBm to -100dBm • Resolution : 0.1dB • Accuracy : ±1dB • Impedance : 50Ω
Input Level	<ul style="list-style-type: none"> • +30dBm to -80dBm for Power Measurement 	N/A
Measurement Accuracy	<ul style="list-style-type: none"> • ±3dB for Power 	N/A
VSWR	<ul style="list-style-type: none"> • Better than 1:1.5 	<ul style="list-style-type: none"> • Better than 1:1.5
Phase Noise (Single tone mode)	N/A	<ul style="list-style-type: none"> • -103dBc @ 1kHz • -110dBc @ 10kHz • -110dBc @ 100kHz • -138dBc @ 1MHz
Remote Programming Ports	<ul style="list-style-type: none"> • RJ45 (Ethernet) • USB-C (VCOM) 	<ul style="list-style-type: none"> • RJ45 (Ethernet) • RS-232C
Miscellaneous	<ul style="list-style-type: none"> • Operating temperature : 5 to 40°C • Input : 5V/0.5A (USB-C) • Dimension : 100(w) x 30(h) x 140(d) mm • Weight : 0.5kg 	<ul style="list-style-type: none"> • Operating temperature : 5 to 40°C • Input : 12V/3A VDC • Dimension : 166(w) x 50(h) x 194(d) mm • Weight : 0.95kg

Ordering Information (5020B)

Product Comparison

Main Product

Order Code	Part Name
C5020B-00	EDT+GWT+NST
C5020B-01	EDT+GWT
C5020B-02	NST
C5020B-03	EDT
C5020B-04	GWT
C5020B-05	EDT+NST
C5020B-06	GWT+NST

Options

Order Code	Part Name
O5020B-01	LoRaWAN Pre-Cert EU868
O5020B-03	LoRaWAN Pre-Cert US915
O5020B-04	LoRaWAN Pre-Cert AS923
O5020B-05	LoRaWAN Pre-Cert KR920
O5020B-06	LoRaWAN Pre-Cert IN865
O5020B-09	LoRaWAN Pre-Cert AU915
O5020B-11	LoRaWAN Pre-Cert RU864
O5020B-12	LoRaWAN Pre-Cert EU433
O5020B-98	Calibration
O5020B-99	SW/FW Maintenance

* All regional parameters of the LoRaWAN® specification are provided in EDT or GWT.

* Pre-Certification Tests are add-on options for EDT only.

* The default PC software is provided with purchasing of C5020B-xx.

Ordering Information (5020M)

Product Comparison

Main Product

Order Code	Part Name
C5020M-X0	EDT+GWT+NST
C5020M-X1	EDT+GWT
C5020M-X2	NST
C5020M-X3	EDT
C5020M-X4	GWT
C5020M-X5	EDT+NST
C5020M-X6	GWT+NST
	X: H or L Select Freq Band: High or Low
O5020M-10	Multiple Freq Band Option

Options

Order Code	Part Name
O5020M-01	LoRaWAN Pre-Cert EU868
O5020M-03	LoRaWAN Pre-Cert US915
O5020M-04	LoRaWAN Pre-Cert AS923
O5020M-05	LoRaWAN Pre-Cert KR920
O5020M-06	LoRaWAN Pre-Cert IN865
O5020M-09	LoRaWAN Pre-Cert AU915
O5020M-11	LoRaWAN Pre-Cert RU864
O5020M-12	LoRaWAN Pre-Cert EU433
O5020M-98	Calibration
O5020M-99	SW/FW Maintenance

* All regional parameters of the LoRaWAN® specification are provided in EDT or GWT.

* Pre-Certification Tests are add-on options for EDT only.

* The default PC software is provided with purchasing of C5020M-xx.

Ordering Information (5021P)

Product Comparison

Main Product

Order Code	Part Name
C5021P-00	EDT

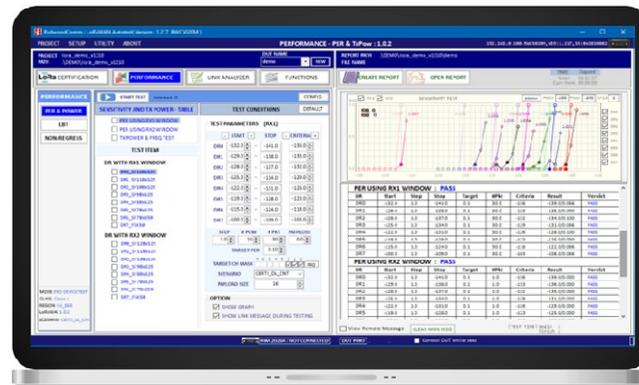
Options

Order Code	Part Name
O5021P-01	LoRaWAN Region EU868
O5021P-03	LoRaWAN Region US915
O5021P-04	LoRaWAN Region AS923
O5021P-05	LoRaWAN Region KR920
O5021P-06	LoRaWAN Region IN865
O5021P-09	LoRaWAN Region AU915
O5021P-11	LoRaWAN Region RU864
O5021P-12	LoRaWAN Region EU433
O5021P-99	SW/FW Maintenance

** The default PC software is provided with purchasing of C5021P-00.*

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- **PC Application Software**



- RF Shielding Enclosure
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Pre-Cert Test for LoRaWAN® V1.0.2

PC Application Software

The screenshot displays the 'PRE-CERTIFICATION - EU_868' window of the LoRaWAN Autotest software. The interface is divided into several sections:

- Top Bar:** Shows the project name 'DEMO_V1330', the DUT 'CERT_EDT_EU868_V102_ClassA', and the report path.
- Navigation:** Includes buttons for 'LoRa CERTIFICATION', 'PERFORMANCE', 'LINK ANALYZER', and 'FUNCTIONS'. There are also 'CREATE REPORT' and 'OPEN REPORT' buttons.
- Time Information:** A table showing 'Total' and 'Curr-Item' for both 'Elapsed' and 'Estimated' time, all currently at '00:00:00'.
- CERTIFICATION Section:**
 - Left sidebar: 'EU868'.
 - Center: 'START TEST EU Certification Test' with a 'CONFIG' button.
 - Tree view: 'Selected 0' with a 'SKIP' button. The tree shows a hierarchy of tests:
 - LoRa Alliance Conformance Test (EU)
 - 1 Activation and Deactivation Pre and Post test
 - 1.1 Certification Application Activation
 - 1.2 Certification Application Deactivation
 - 2 Over the Air Activation
 - 2.1 Pre-Join Behaviour
 - 2.2 Join Accept with DLSettings
 - 2.3 Join Accept with Delay Settings on RX2 window
 - 2.4 Join Accept with CFList
 - 2.5 DevNonce Verification for Join Request
 - 3 Activation by Personalization
 - 3.1 Activation by Personalization
 - 4 Certification Application Functionality
 - 4.1 Default Setting Test
 - 4.1.a Channel Plan and Usage
 - 4.1.b Cryptograph
 - 4.1.b.i AES Encryption
 - 4.1.b.ii Message Integrity Code
 - 4.1.c Downlink Error Rate
 - 4.1.d Receive Window Timing
 - 4.1.e Frame Sequence Number
- Bottom left: Checkboxes for 'Add raw data', 'Stop link after test', 'Test ADR', and 'Test Opt DR'.
- Bottom right: 'Test Parameters' section with 'PATHLOSS' set to '0.0' and 'DEFAULT'.

- Summary Report:** A window titled 'LORA CERTIFICATION TEST SUMMARY (EU V1.6)' displays a table of test results:

ITEMS	VERDICT	SUB VERDICT
1 Activation and Deactivation Pre and Post test	PASS	
1.1 Certification Application Activation		PASS
1.2 Certification Application Deactivation		PASS
2 Over the Air Activation	PASS	
2.1 Pre-Join Behaviour		PASS
2.2 Join Accept with DLSettings		PASS
2.3 Join Accept with Delay Settings on RX2 window		PASS
2.4 Join Accept with CFList		PASS
2.5 DevNonce Verification for Join Request		PASS
3 Activation by Personalization	PASS	
3.1 Activation by Personalization		PASS
4 Certification Application Functionality	PASS	
4.1 Default Setting Test	PASS	
4.1.a Channel Plan and Usage		PASS
4.1.b Cryptograph	PASS	
4.1.b.i AES Encryption		PASS
4.1.b.ii Message Integrity Code		PASS
4.1.c Downlink Error Rate		PASS
4.1.d Receive Window Timing		PASS
4.1.e Frame Sequence Number	PASS	

* **LoRaWAN V1.0.2:**
EU863-870, US/CA902-928, AS923, KR920-923,
and IN865-867

* Test summary and report generation
* Estimated and elapsed time information

Pre-Cert Test for LoRaWAN® V1.0.4

PC Application Software

The screenshot displays the 'PRE-CERTIFICATION - EU_868' window. The interface includes a menu bar (PROJECT, SETUP, UTILITY, ABOUT), a status bar (192.168.0.121 - RWC5020B, VER:1.336, SW:0x1870014), and a main workspace. The workspace is divided into several sections:

- PROJECT:** DEMO_V1330, PATH: \DEMO\DEMO_V1330
- DUT:** NEW, CERT_EDT_EU868_V104_ClassA
- REPORT PATH:** \DEMO\DEMO_V1330\CERT_EDT_EU868_V104_ClassA
- FILE NAME:** (empty)
- Buttons:** LoRa CERTIFICATION, PERFORMANCE, LINK ANALYZER, FUNCTIONS, CREATE REPORT, OPEN REPORT
- TIME:** Total 00:00:00, Elapsed 00:00:00, Estimated 00:00:00
- CERTIFICATION:** All Region Certification (START TEST, CONFIG)
- Selected 0:**
 - LoRa Alliance Conformance Test (EU_868)
 - 1 Activation Pre-test
 - 1.1 DUT Pre-condition Activation
 - 2 Over the Air Activation
 - 2.1 Pre-Join Behaviour
 - 2.2 Join-Accept with DLSettings
 - 2.3 Join-Accept with Delay Settings
 - 2.4 Join-Accept with CFList
 - 3 Activation by Personalization
 - 3.1 Dynamic channel plan devices
 - 3.2 Fixed channel plan devices
 - 4 Device Functionality Tests
 - 4.1 Default Setting Tests
 - 4.2 Confirmed Frames
 - 5 MAC Command Tests
 - 5.1 DevStatusReq
 - 5.2 NewChannelReq
 - 5.3 DLChannelReq
 - 5.4 RXParamSetupReq
 - 5.5 RXTimingSetupReq
 - 5.6 TXParamSetupReq
- PATH LOSS:** 0.0
- Checkboxes:** Add raw data, Stop link after test, Test ADR, Test Opt DR
- Summary Table:**

LORA CERTIFICATION TEST SUMMARY (ALL V1.0.0)

REGION : EU_868

ITEMS	VERDICT	SUB VERDICT
1 Activation Pre-test	PASS	
1.1 DUT Pre-condition Activation		PASS
2 Over the Air Activation	PASS	
2.1 Pre-Join Behaviour	PASS	
2.1.a For Dynamic Channel (DC) plan devices		PASS
2.1.b For Fixed Channel (FC) plan devices		NOT TESTED
2.2 Join-Accept with DLSettings		PASS
2.3 Join-Accept with Delay Settings		PASS
2.4 Join-Accept with CFList	PASS	
2.4.a For Dynamic Channel (DC) plan devices		PASS
2.4.b For Fixed Channel (FC) plan devices		NOT TESTED
3 Activation by Personalization	NOT TESTED	
3.1 Dynamic channel plan devices	NOT TESTED	
3.1.a All regions		NOT TESTED
3.1.b For regions with dwell time limitation only		NOT TESTED
3.2 Fixed channel plan devices	NOT TESTED	
3.2.a All regions		NOT TESTED
3.2.b For regions with dwell time limitation only		NOT TESTED
4 Device Functionality Tests	PASS	
- SCALE:** 1.0
- CLEAR MSG** button
- SPY MESSAGE:** CLEAR, SAVE
- View SPY MSG (Max 300 lines)** checkbox
- [TEST TIME] Begin:** (empty), **Finish:** (empty)
- Status Bar:** END DEVICE/EU_868/1.0.4/CLASS A/OTAA, RWC2020A: NOT CONNECTED, REFCLK INT, RGAIN:MEDIUM

* **LoRaWAN V1.0.4:**
 EU863-870, US/CA902-928, AS923-1/2/3/4, KR920-923,
 IN865-867, AU915-928, RU864-870, and EU433
 Class B/C Certification

* Test summary and report generation
 * Estimated and elapsed time information

RF Performance Test (EDT Class A)

PC Application Software

The screenshot displays the 'PERFORMANCE - PER & TxPow : 1.0.2' software interface. The main window is divided into several sections:

- Project Information:** PROJECT DEMO_V1330, PATH .\DEMO\DEMO_V1330, DUT NEW PERF_EDT_EU868_V102_ClassA.
- Navigation:** LoRa CERTIFICATION, PERFORMANCE (selected), LINK ANALYZER, FUNCTIONS.
- Performance Configuration:**
 - START TEST:** Selected: D
 - SENSITIVITY AND TX POWER - TABLE:** Includes checkboxes for 'PER USING RX1 WINDOW', 'PER USING RX2 WINDOW', and 'TX POWER & FREQ TEST'.
 - TEST CONDITIONS:** DEFAULT. Includes 'TEST PARAMETERS' with 'POWER(dBm)' and '10dB Scale' options, and 'TEST ITEM' lists for 'DR WITH RX1 WINDOW' and 'DR WITH RX2 WINDOW'.
 - TEST PARAMETERS:** A table with columns for DR, START, STOP, and CRITERIA.
 - STEP(dB), # POW, # PKT, PATHLOSS(dB):** Configuration fields for the test.
 - TARGET PER:** Set to 0.100.
 - TARGET CH MASK:** Includes checkboxes for 'FRQ'.
 - SCENARIO:** CERTI_ECHO.
 - PAYLOAD SIZE:** 16 Byte.
 - OPTION:** Includes checkboxes for 'SHOW GRAPH' and 'SHOW LINK MESSAGE DURING TESTING'.
- Sensitivity Test Graph:** A plot showing power levels for RX1 and RX2 across various DR values (DR0 to DR7).
- Test Results Summary:**
 - PER USING RX1 WINDOW : PASS**

DR	Start	Step	Stop	Target	#Pkt	Criteria	Result	Verdict
DR0	-129.0	1.0	-138.0	0.100	1	-131	-134.0/0.000	PASS
DR1	-126.0	1.0	-135.0	0.100	1	-128	-130.0/0.000	PASS
DR2	-125.0	1.0	-134.0	0.100	1	-127	-128.0/0.000	PASS
DR3	-122.0	1.0	-131.0	0.100	1	-124	-125.0/0.000	PASS
DR4	-119.0	1.0	-128.0	0.100	1	-121	-122.0/0.000	PASS
DR5	-116.0	1.0	-125.0	0.100	1	-118	-120.0/0.000	PASS
DR6	-112.0	1.0	-121.0	0.100	1	-113	-117.0/0.000	PASS
DR7	-97.0	1.0	-106.0	0.100	1	-98	-101.0/0.000	PASS
 - PER USING RX2 WINDOW : PASS**

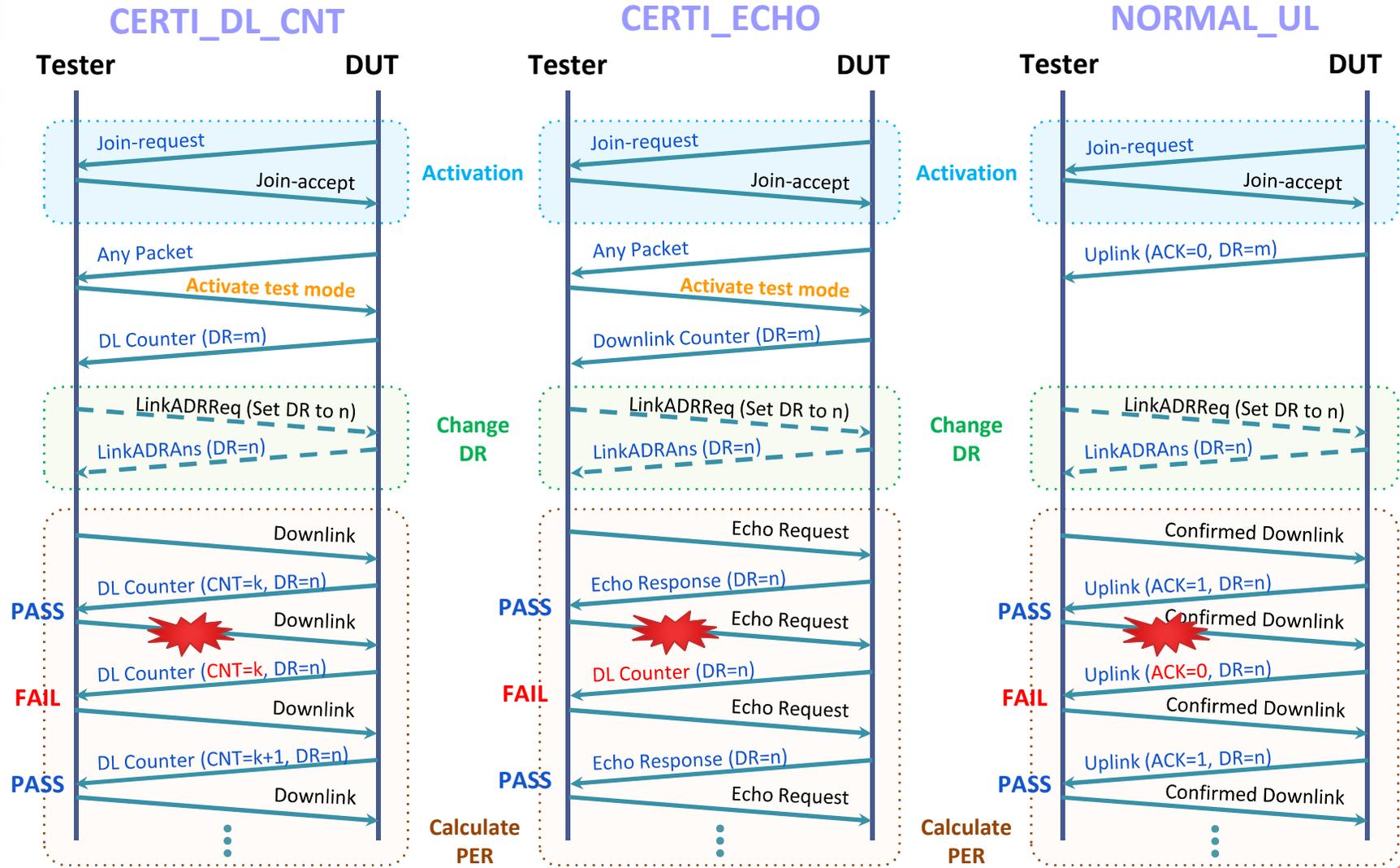
DR	Start	Step	Stop	Target	#Pkt	Criteria	Result	Verdict
DR0	-129.0	1.0	-138.0	0.100	1	-131	-134.0/0.000	PASS
DR1	-126.0	1.0	-135.0	0.100	1	-128	-131.0/0.000	PASS
DR2	-125.0	1.0	-134.0	0.100	1	-127	-130.0/0.000	PASS
- Status Bar:** END DEVICE/EU_868/1.0.2/CLASS A/OTAA, RWC2020A: NOT CONNECTED, REFCLK INT, RXGAIN:MEDIUM.

- * PER measurement for **downlink – RX1/RX2 for Class A**
- Scenario: **CERTI_ECHO, CERTI_DL_CNT, NORMAL_UL**
- * TX power and CW frequency measurement

- * Test summary and report generation
- * Estimated and elapsed time information

Sensitivity Test Scenario (Class A)

PC Application Software



RF Performance Test (EDT Class B)

PC Application Software

The screenshot displays the RedwoodComm LoRaWAN Autotest software interface. The main window is titled "PERFORMANCE - PER & TxPow : 1.0.2". The interface is divided into several sections:

- Project Information:** PROJECT: DEMO_V1330, PATH: \DEMO\DEMO_V1330, DUT: NEW PERF_EDT_EU868_V102_ClassB.
- Navigation:** LoRa CERTIFICATION, PERFORMANCE (selected), LINK ANALYZER, FUNCTIONS.
- Performance Configuration:**
 - PER & POWER:** LBT, NON-REGRESS.
 - SENSITIVITY AND TX POWER - TABLE:** Includes checkboxes for "PER USING PING" and "STOP LINK AFTER TEST".
 - TEST CONDITIONS:** TEST PARAMETERS (PING) with fields for START, STOP, and CRITERIA for DR0 through DR7. Includes "STEP (dB)", "# POW", "# PKT", and "PATHLOSS (dB)" settings.
 - TEST ITEM:** "DR WITH PING SLOT" with checkboxes for DR0 through DR7.
 - OPTION:** "SHOW GRAPH" and "SHOW LINK MESSAGE DURING TESTING" are checked.
- Graphs:** A "SENSITIVITY TEST" graph showing PER vs. Frequency (MHz) for various DRs. The graph shows a sharp increase in PER at specific frequencies for each DR.
- PERFORMANCE TEST SUMMARY:**
 - DUTNAME: PERF_EDT_EU868_V102_ClassB
 - REGION: EU_868
 - PER USING PING: PASS
 - Table with columns: DR, Start, Step, Stop, Target, #Pkt, Criteria, Result, Verdict.
- Status Bar:** END DEVICE / EU_868 / 1.0.2 / CLASS B / OTAA, RWC2020A: NOT CONNECTED, REFCLK, INT, RGAIN: MEDIUM.

* PER measurement for downlink – Ping-slot for Class B

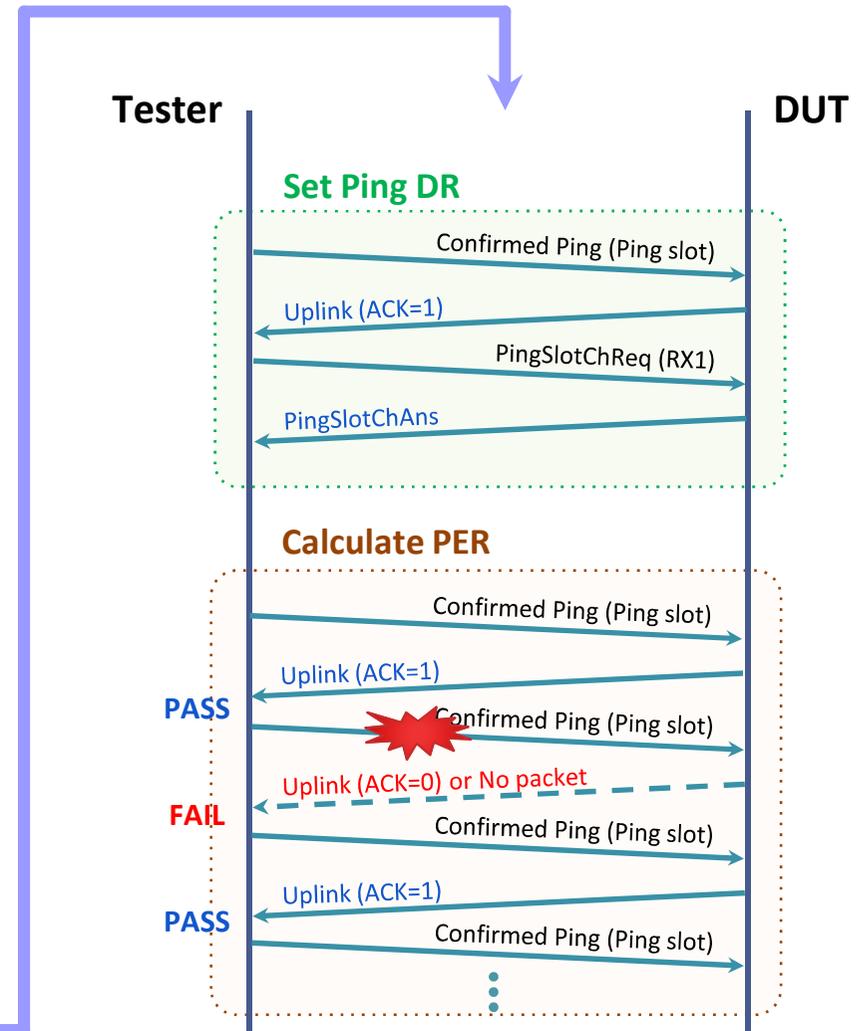
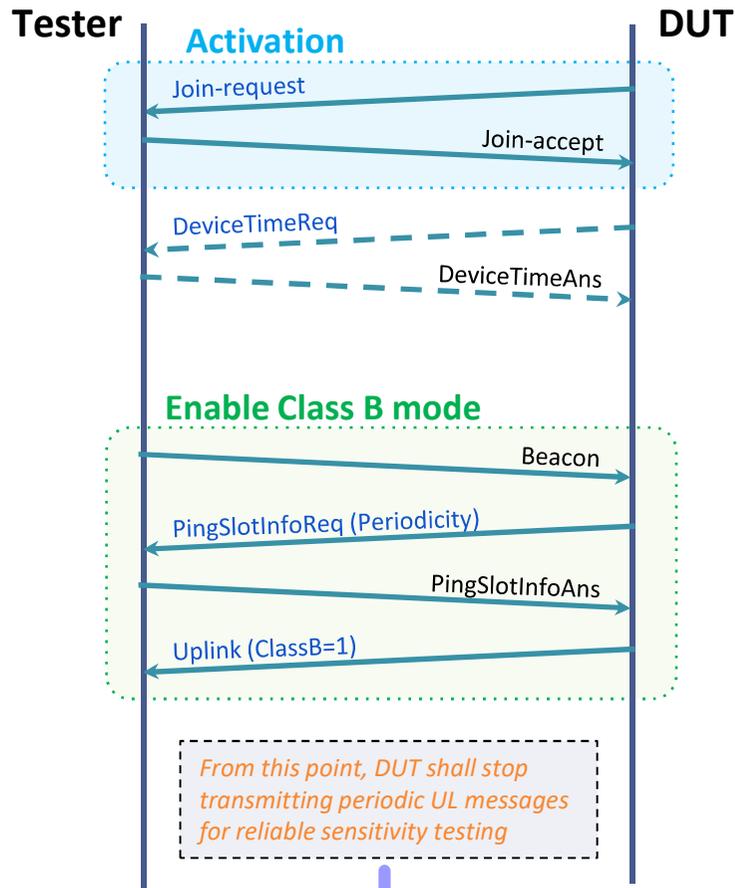
* Test summary and report generation

* Estimated and elapsed time information

Sensitivity Test Scenario (Class B)

PC Application Software

Ping-slot for Class B



RF Performance Test (GWT)

PC Application Software

The screenshot displays the RedwoodComm LoRaWAN Autotest software interface. The title bar indicates the version is 1.334 (RWC5020B). The main window is titled "PERFORMANCE - PER & TxPow : 1.0.2".

Configuration Panel:

- PROJECT:** DEMO_V1330
- PATH:** \DEMO\DEMO_V1330
- DUT:** NEW PERF_GWT_EU868_V102_ClassA
- REPORT PATH:** \DEMO\DEMO_V1330\PERF_GWT_EU868_V102_ClassA
- FILE NAME:** (empty)

Performance Test Configuration:

- TEST CONDITIONS:** DEFAULT
- TEST PARAMETERS (UL):** POWER(dBm) [10dB Scale]
- TEST ITEM:** DR (DR0_5F12BW125, DR1_5F11BW125, DR2_5F10BW125, DR3_5F9BW125, DR4_5F8BW125, DR5_5F7BW125)
- TEST PARAMETERS (UL) Table:**

DR	START	STOP	CRITERIA
DR0	-129.0	-138.0	-129.0
DR1	-126.0	-135.0	-126.0
DR2	-125.0	-134.0	-125.0
DR3	-122.0	-131.0	-122.0
DR4	-119.0	-128.0	-119.0
DR5	-116.0	-125.0	-116.0
- STEP(dB):** 1.0, **# POW:** 10, **# PKT:** 1, **PATHLOSS(dB):** 0.0
- TARGET PER:** 0.100
- SCENARIO:** NORMAL_UL
- PAYLOAD SIZE:** 16 Byte
- OPTION:** SHOW GRAPH, SHOW LINK MESSAGE DURING TESTING

Sensitivity Test Graph: A plot showing PER (0.0 to 1.0) vs. Frequency (97 to 150 MHz). It displays several narrowband signals labeled DR0 through DR5.

PERFORMANCE TEST SUMMARY:

DUTNAME: PERF_GWT_EU868_V102_ClassA
REGION: EU_868

PER OF GATEWAY : PASS

DR	Start	Step	Stop	Target	#Pkt	Criteria	Result	Verdict
DR0	-129.0	1.0	-138.0	0.1	1.0	-129	-129.0/0.000	PASS
DR1	-126.0	1.0	-135.0	0.1	1.0	-126	-132.0/0.000	PASS
DR2	-125.0	1.0	-134.0	0.1	1.0	-125	-128.0/0.000	PASS
DR3	-122.0	1.0	-131.0	0.1	1.0	-122	-126.0/0.000	PASS
DR4	-119.0	1.0	-128.0	0.1	1.0	-119	-123.0/0.000	PASS
DR5	-116.0	1.0	-125.0	0.1	1.0	-116	-119.0/0.000	PASS

TX POWER TEST : PASS

POW	CH0	CH1	CH2	CH3	CH4	CH5	CH6	CH7	Verdict
0	-11.7	-11.6	-11.6						PASS

Status Bar: GATEWAY / EU_868 / 1.0.2 / CLASS A / OTAA | RWC2020A : NOT CONNECTED | REFCLK INT | RXGAIN:MEDIUM

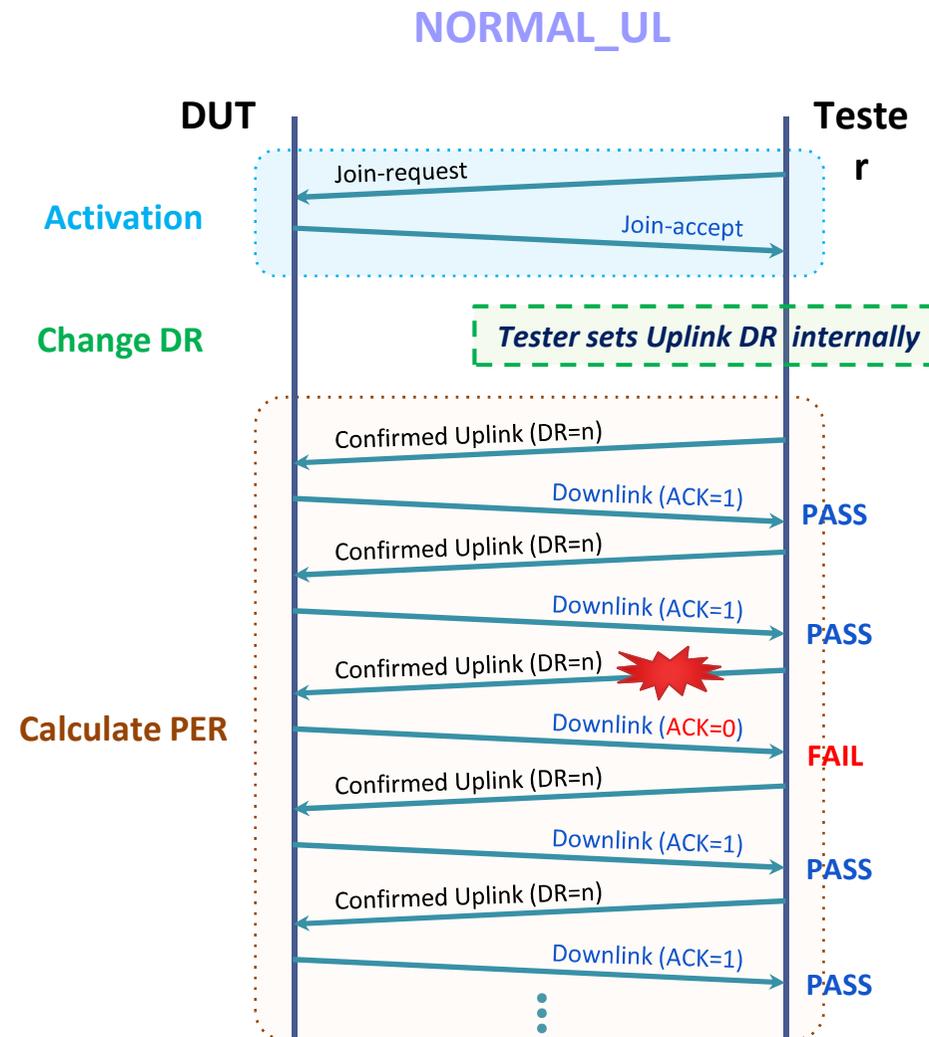
* PER measurement for uplink (GWT)

* Test summary and report generation

* Estimated and elapsed time information

Sensitivity Test Scenario (GWT)

PC Application Software



LBT Test (EDT, GWT)

PC Application Software

The screenshot displays the 'PERFORMANCE - LBT' window of the RedwoodComm LoRaWAN Autotest software. The interface is divided into several sections:

- Header:** PROJECT: RT_V1220_2_kevin, DUT NAME: 25_01, REPORT PATH: D:\RWC5020A\Software\RT_V1220_2_kevin\25_01
- Navigation:** LoRa CERTIFICATION, PERFORMANCE (selected), LINK ANALYZER, FUNCTIONS, CREATE REPORT, OPEN REPORT
- Configuration (Left Panel):**
 - TEST ITEM: CHANNEL MODE TEST, BURST MODE TEST
 - Wanted Signal Pathloss (dB): 4.1, Unwanted Signal Pathloss (dB): 4.1
 - CHANNEL MODE PARAMETER: TEST TIME: 1 Min, RFF POW: 80 dBm, CH00-CH07: +1, +1, -3, +1, +1, +1, +1, +1
 - BURST MODE PARAMETERS: TEST ITERATION: 10 Iteration
 - Diagram showing POWER NORMAL and POWER BURST durations.
- Results (Right Panel):**
 - PROJECT NAME: RT_V1220_2_kevin, DUT NAME: 25_01, TESTER SERIAL: 0x2003000, TEST DATE & TIME: 4/19/2020 9:37:04 PM
 - LBT TEST (CHANNEL MODE): TEST DURATION: 1 Min, REFERENCE POWER: -80 dBm, RELATIVE POWER: CH00: +1, CH01: +1, CH02: -3, CH03: +1, CH04: +1, CH05: +1, CH06: +1, CH07: +1
 - [LINK MESSAGE] Table with columns: L, CH, DR, SF, BW, Pow, Time, DEL, FONT, ADR, ACK, FP, AAR, B, Port, M, Dwell, CMD, CNT
 - [RESULT] Table with columns: RECEIVED #PKT, CH00, CH01, CH02, CH03, CH04, CH05, CH06, CH07
- Footer:** RWC2020A: CONNECTED, DUT PORT, Control DUT while test

- * Integration with RWC2020A
- * Channel mode test
- * Burst mode test

- * Test summary and report generation
- * Elapsed time information

GW Non-regression Test (Semtech)

PC Application Software

The screenshot displays the 'PERFORMANCE - NON-REGRESSION OF GW' software interface. The top menu includes PROJECT, SETUP, UTILITY, and ABOUT. The main window is divided into several sections:

- Project Information:** PROJECT: DEMO_V1330, DUT: NEW PERF_GWT_NRT_EU868_V103_ClassA, REPORT PATH: \DEMO\DEMO_V1330\PERF_GWT_NRT_EU868_V103_ClassA, FILE NAME: [empty].
- Navigation:** LoRa CERTIFICATION, PERFORMANCE (selected), LINK ANALYZER, FUNCTIONS.
- Performance Test Configuration:**
 - Buttons: RUN, SKIP, Default, GW IP.
 - TEST ITEM TX: TX OUT POWER MEASUREMENT, PER/RSSI/SNR, SENSITIVITY, FREQUENCY ERROR TOLERANCE, CW INTERFERER IMMUNITY.
 - TEST START TIME: 2019-01-31 11:30:55.
 - FREQ(MHz): F1: 868.1000, F2: 868.3000, F3: 868.5000, F4: 867.1000.
 - BW: 125, SF: 8, 9, 10, 11, 12.
 - PATHLOSS(dB): RWC502x: 4.0, RWC2020A: 4.0.
 - TX INTERVAL(Sec): 0.2.
 - PER/RSSI/SNR TEST PARAMETERS: # PACKET: 10, POW STEP: 1 dB.
 - Hardware diagram showing RWC5020A, RWC2020A, and a laptop connected via Ethernet (LAN) and Network.
- MONITOR ...:**
 - Buttons: SHOW RESULT VALUE, JSON PKT Monitor, SAVE, CLEAR.
 - TEST CONDITION table:

TEST NAME	:	PER/RSSI/SNR
DUT NAME	:	PERF_GWT_NRT_EU868_V103_ClassA
TEST EQUIPMENT	:	RWC5020B
PATHLOSS	:	0.0 dB
POWER START	:	-140 dBm
POWER STOP	:	-10 dBm
POWER STEP	:	1.0 dB
NUMBER OF PACKETS	:	30
- RESULTS:**
 - RESULT INFO: PER/RSSI/SNR.
 - FREQUENCY: F1:864.3000, F2:864.5000, F3:864.7000, F4:864.7000.
 - SF: SF7, SF8, SF9, SF10, SF11, SF12.
 - Legend: LEGEND, SHOW DOT, THICK LINE.
 - Graphs: SNR vs. POWER, PER vs. POWER, RSSI CH MEAN, RSSI CH ERROR.
 - Time: Total 00:00:00, Curr-Item 00:00:00.
- Status Bar:** GATEWAY / EU 868 / 1.0.2 / CLASS A / OTAA, RWC2020A: NOT CONNECTED, REFCLK INT, RXGAIN:MEDIUM.

- * Recommended by Semtech
- * Evaluation of a gateway hardware performances
- * JSON interface to control a gateway

- * Test summary and report generation
- * Elapsed time information

Link Analyzer & Script Editor

PC Application Software

RedwoodComm : LoRaWAN Autotest(Version : 1.217 RWC5020M)

PROJECT SETUP UTILITY ABOUT LINK ANALYZER 1.0.2 192.168.0.109-RWC5020M,VER:1.217,SM:0x2030002

PROJECT lora_demo_v1210 DUT NAME demo NEW
PATH .\DEMO\lora_demo_v1210 REPORT PATH .\DEMO\lora_demo_v1210\demo FILE NAME

LoRa CERTIFICATION PERFORMANCE LINK ANALYZER FUNCTIONS

PAYLOAD EDITOR SEND DL SLOT RX1 MSG CONFIRMED CMD PAYLOAD RESP 60 CONFIG
TYPE UNCONFIRMED FIELD FOPTS TIMEOUT

END DEVICE TEST / LoRaWAN : 1.0.2 / EU_868 / CLASS A /
MAC COMMAND (PAYLOAD) USER DEFINED

SET DEVICE_STATUS

SET LINK_ADDR_REQ LinkADDRReq Parameters
DR DR3_SF9BW125 TX_POW 1 NB_TRANS 1
MASK_CTL 0 CH_MASK 0x7

SET RX_PARAM_SETUP RX_PARAM_SETUP Parameters
RX1_DR_OFF 0 RX2_FREQ 869.525
RX2_DR DR0_SF12BW125

SCRIPT EDITOR RUN SKIP COMMAND ADD DEL CLR DOWN UP SAVE LOAD

demo_MAC_Script_Proc_1
UNCONFIRMED PAYLOAD 60
DEVICE_STATUS
LINK_ADDR_REQ
ADR_DR DR3_SF9BW125
ADR_TX_POW 1
ADR_NB_TRANS 1
ADR_CH_MASK 0x7
RX_PARAM_SETUP
RX1_DR_OFFSET 0
RX2_FREQUENCY 869.525
RX2_DR DR0_SF12BW125

LINK MESSAGE Clear Before Dump Show raw data SAVE MSG

START FCNT DutyCycle

L	CH	DR	SF	BW	Pow	Time	DEL	FCnt	ADR	Ack	FP	AAR	B	Port	M	Dwell	CMD	CONTENTS
U	1	0	12	125	13.0	150s	-	0000	1	0	-	0	0	002	U	1646	DataUp	BytLen=16
D	1	0	12	125	-30.0	----	1	0000	1	0	-	-	-	224	U	1155	ActLiveLcTM	
U	0	0	12	125	12.0	1.00s	-	0001	1	0	-	0	0	224	U	1155	D1Counter(0)	Cnt=0
D	0	0	12	125	-30.0	----	1	0001	1	0	-	-	-	000	U	1482	DevStatusReq	
D	0	0	12	125	-30.0	----	1	0001	1	0	-	-	-	000	U	1482	LinkADRReq	Pow=1,DR=0,Mask
U	1	0	12	125	13.8	5.33s	-	0002	1	0	-	0	0	224	U	1482	RXParamSetReq	RXIDROffset=0,R
U	1	0	12	125	13.8	5.33s	-	0002	1	0	-	0	0	224	U	1482	{DevStatusAns}	Battery=254,SN
U	1	0	12	125	13.8	5.33s	-	0002	1	0	-	0	0	224	U	1482	{LinkADRAns}	Pow=1, DR=1, Ma
U	1	0	12	125	13.8	5.33s	-	0002	1	0	-	0	0	224	U	1482	{RXParamSetAns}	RXIDROffset=1,
D	0	0	12	125	-30.0	----	1	0002	1	0	-	-	-	000	U	991	NoPayload	
U	2	0	12	125	13.8	4.68s	-	0003	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	1	0	12	125	13.8	5.00s	-	0004	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	0	0	12	125	13.8	5.00s	-	0005	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	1	0	12	125	13.8	5.00s	-	0006	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	0	0	12	125	13.8	5.00s	-	0007	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	2	0	12	125	13.8	5.00s	-	0008	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	2	0	12	125	13.8	5.00s	-	0009	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	1	0	12	125	13.8	5.00s	-	000A	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	2	0	12	125	13.8	5.00s	-	000B	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	1	0	12	125	13.8	5.00s	-	000C	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	2	0	12	125	13.8	5.00s	-	000D	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	0	0	12	125	13.8	5.00s	-	000E	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	2	0	12	125	13.0	5.00s	-	000F	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	1	0	12	125	13.8	5.00s	-	0010	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	2	0	12	125	13.8	5.00s	-	0011	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	1	0	12	125	13.8	5.00s	-	0012	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	2	0	12	125	13.0	5.00s	-	0013	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2
U	0	0	12	125	13.8	5.00s	-	0014	1	0	-	0	0	224	U	1155	D1Counter(2)	Cnt=2

View Remote Message CLEAR MON MSG [TEST TIME] Begin : Finish :

RWC2020A: NOT CONNECTED DUT PORT

- * Link creation and analysis
- * MAC command and user data transmission
- * Multiple MAC commands
- * Script editor for user scenarios

- * Recording link messages
- * Raw data available in hexadecimal format

FUOTA Test

PC Application Software

The screenshot displays the 'FUNCTIONAL TEST - FUOTA TEST' window. The interface includes a menu bar (PROJECT, SETUP, UTILITY, ABOUT), a status bar (192.168.0.103: Not Connected), and a main workspace divided into configuration and results sections.

Configuration Section (FUOTA PARAMETERS):

- CONFIG FRAGMENTATION:** INDEX: 0, SIZE: 16, NB_FRAG: 16, ALGO: LDPC, DtsCR: 0x FFFFFFFF. Includes an 'OPEN BIN' button.
- CONFIG MULTICAST:** Mc GroupID: 0, Mc Addr: 0x FFFFFFFF, Mc Interval: 0.1, Mc DR: DR3_SF9BW125, Mc Freq: 859.5250, Mc Key: 0x 12345678901234567890123456789012 (32 digits).

Results Section: A log window showing test execution details, including data fragments and session management. Key entries include:

```

-->DataFragment: N=46 over 26, Frag_size=16
D R2 3 9 125 -10.0 ---- 1 0020 1 0 0 - - 201 U 226 DataDown ByteL
60 FF FF FF FF 80 20 00 C9 08 2E 00 B4 25 52 DC 03 15 7F 05 20 85 E2 63 D1 28 E0 12 71 20 23 9C
-->DataFragment: N=47 over 26, Frag_size=16
D R2 3 9 125 -10.0 ---- 1 002E 1 0 0 - - 201 U 226 DataDown ByteL
60 FF FF FF FF 80 2E 00 C9 08 2F 00 4E 5A EC EE 56 D4 34 1A 78 03 99 41 47 9C F7 45 96 10 13 34
-->DataFragment: N=40 over 26, Frag_size=16
D R2 3 9 125 -10.0 ---- 1 002F 1 0 0 - - 201 U 226 DataDown ByteL
60 FF FF FF FF 80 2F 00 C9 08 30 00 E0 60 77 04 27 1F 02 F9 C8 DA 1A 6C 36 34 21 EA 95 3F 3A 14
-->DataFragment: N=49 over 26, Frag_size=16
D R2 3 9 125 -10.0 ---- 1 0030 1 0 0 - - 201 U 226 DataDown ByteL
60 FF FF FF FF 80 30 00 C9 08 31 00 BB AA 13 F3 08 5A 95 40 9C FD 30 A6 CB D5 4F A7 2E A3 72 0F
-->DataFragment: N=50 over 26, Frag_size=16
D R2 3 9 125 -10.0 ---- 1 0031 1 0 0 - - 201 U 226 DataDown ByteL
60 FF FF FF FF 80 31 00 C9 08 32 00 04 35 F8 B6 9C C5 1C A0 B3 42 38 7A 1E 16 7A 0E F8 7E 08 59
-->DataFragment: N=51 over 26, Frag_size=16
D R2 3 9 125 -10.0 ---- 1 0032 1 0 0 - - 201 U 226 DataDown ByteL
60 FF FF FF FF 80 32 00 C9 08 33 00 44 5A 68 5C 51 D1 E1 C6 C1 3F 20 DE 08 D9 C9 0A 26 41 3F C1
-->DataFragment: N=52 over 26, Frag_size=16
D R2 3 9 125 -10.0 ---- 1 0033 1 0 0 - - 201 U 226 DataDown ByteL
60 FF FF FF FF 80 33 00 C9 08 34 00 D8 90 96 20 08 B0 C5 AC 30 EC 76 AC 40 34 58 44 D8 13 57 C4
U 1 0 12 125 -29.2 1305 - 000A 1 0 - 0 0 099 U 1646 UDataUp ByteL
40 01 00 00 00 0A 00 63 8E C8 13 68 68 55 E0 E3 CF 8A E0 DF 0F A0 3B 57 CE 5E D3 82
U 0 0 12 125 -28.9 5.00s - 0000 1 0 - 0 0 099 U 1646 DataUp ByteL
40 01 00 00 00 0B 00 63 89 75 45 A3 DC 00 F6 13 D0 33 04 85 F3 30 71 05 1A 8D 34 D6
-->FragSessionDeleteReq: FragIndex=0
D 0 0 12 125 -10.0 ---- 1 0000 1 0 0 - - 201 U 1155 DataDown DyteL
60 01 00 00 00 08 08 C9 03 00 CE FC 9C 18
-->FragSessionDeleteAns: FragIndex=0, Status=0
U 0 0 12 125 -29.0 4.51s - 000C 1 0 - 0 0 201 U 1155 DataUp ByteL
40 01 00 00 00 0C 00 C0 03 00 D7 30 DD 01
    
```

Summary and Status:

- Buttons: CLEAR MON MSG (PASS), CLEAR SPY MSG (FUOTA finished successfully), SAVE SPY MSG (EXEC:LINK:STOP).
- View Remote Message: [TEST TIME] Begin : 9/10/2019 AM 9:25:58, Finish : 9/10/2019 AM 9:29:39.
- Status: RWC2020A: NOT CONNECTED, DUT PORT.

- * Clock synchronization
- * Multicast / Unicast
- * Fragmentation and data transport
- * User binary file

- * Test summary and report generation
- * Elapsed time information

Contents

- Summary of Key Features
- Product Comparison
- PC Application Software
- **RF Shielding Enclosure**

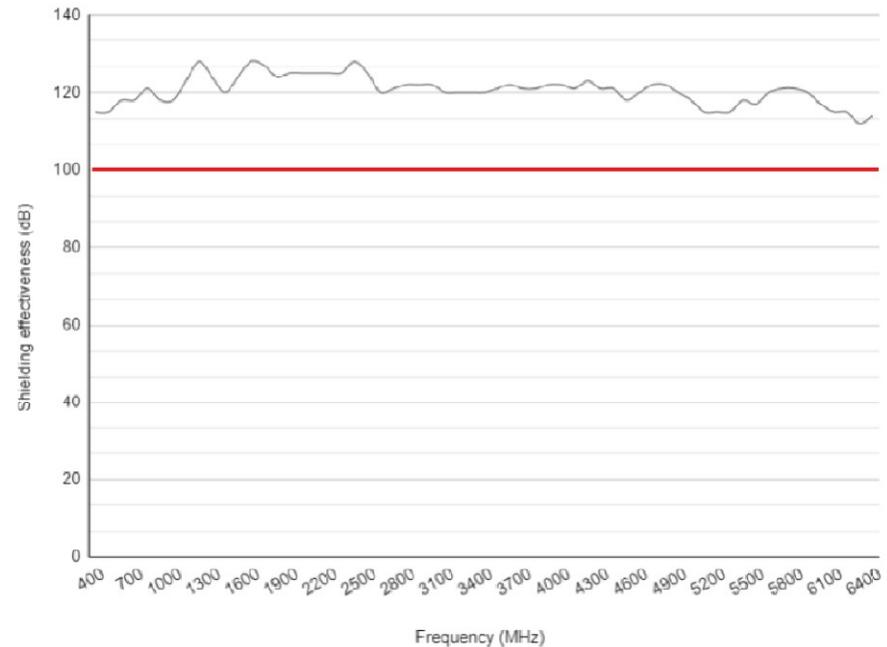


- Production Test Solution
- Stand-alone Operation of 5020B

RWC7100A

RF Shielding Enclosure

- Very High Shielding Effectiveness (dB)



- Applications

- LTE, NB-IoT devices (700MHz, 2-6GHz)
- LoRa, Sigfox devices (400MHz, 900MHz, 2.4GHz)
- WiFi devices (2.4GHz, 5.8-6.2GHz)
- BT/BLE devices (2.4GHz)
- GNSS devices (1.2-1.6GHz)

Add-on Modules

● IO Modules

- USB 3.0 Fiber Interface Module
- USB 3.0 to 2.0 HUB Module
- N to SMA Module
- SMA to SMA Module
- DB9 Module



RF Shielding Enclosure

● Antenna Modules

- Wide-band Right-hand Circular Polarized (RHCP) Antenna Set
- Wide-band Left-hand Circular Polarized (LHCP) Antenna Set



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- Stand-alone Operation of 5020B

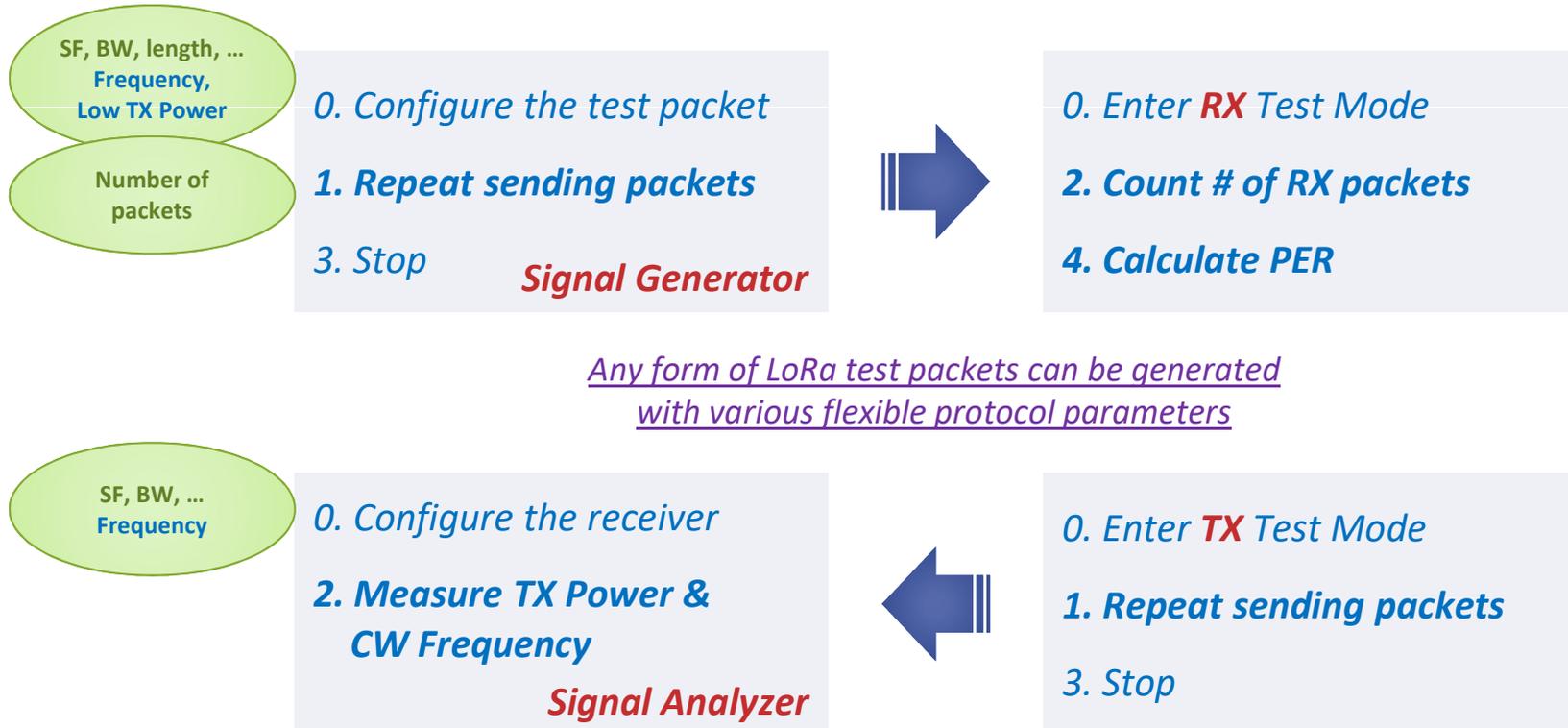
Manufacturing Solution 1

Production Test Solution

● Separate TX/RX Test with SG/SA (NST)



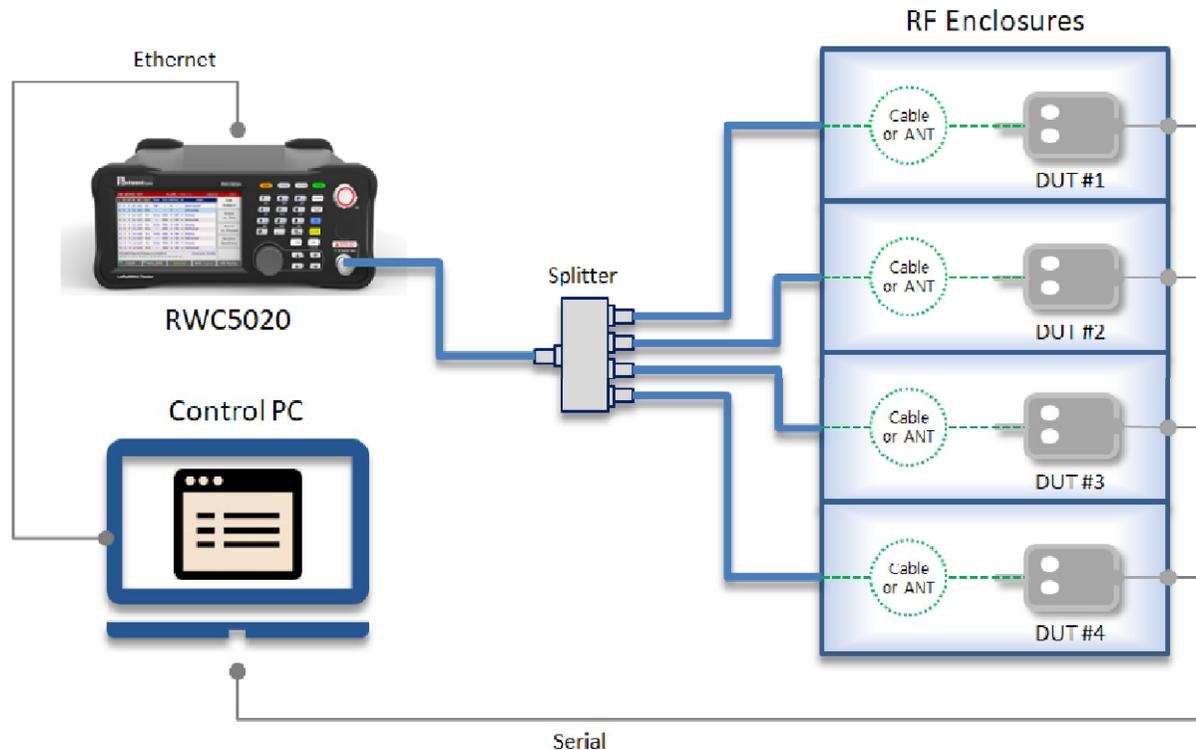
DUT
End-device or Gateway



Test Example of Multiple DUTs

Production Test Solution

Using NST SG/SA



[RX TEST]

- The test packets sent by the tester as specified are transferred to each DUT by a splitter at the same time.
- Each DUT counts the number of packets it receives, which is read by the user application software.

[TX TEST]

- A DUT is forced to transmit CW signal.
- The tester measures the power and the frequency* of the CW signal.
- A DUT is forced to send the LoRa test packets.
- The tester measures the power of the test packets.
- The rest of DUTs are tested in turns.

- The tester shall be controlled by the user application software via Ethernet.
- This software may also control the DUTs if necessary.

- The DUTs should be put into RF enclosure(s) to minimize the effect of interferences.
- Any available or efficient method can be adopted for RF connection; either radiated or conducted.

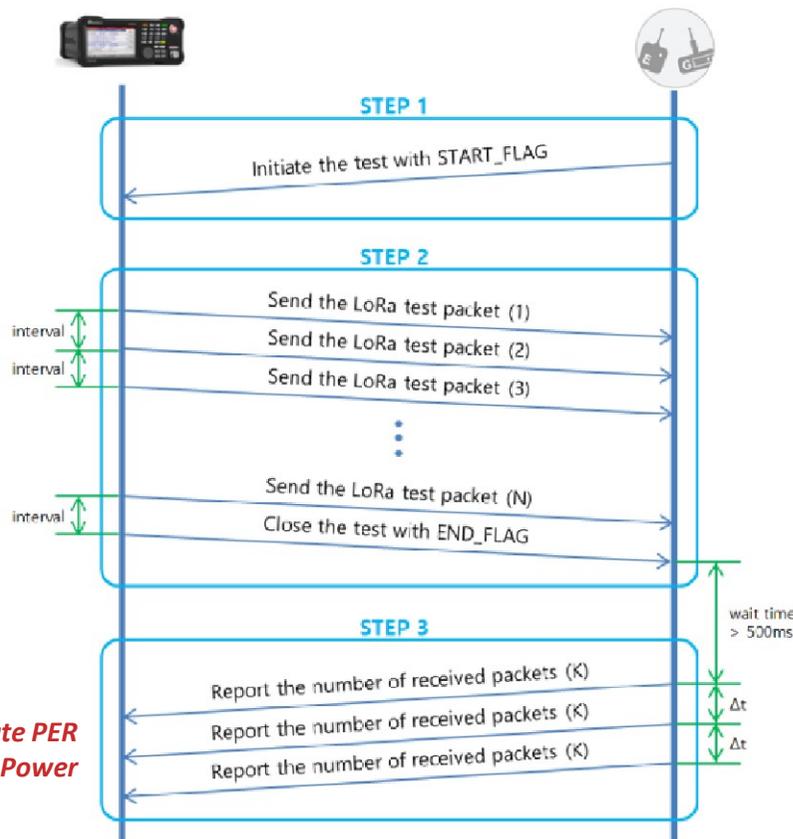
* Frequency measurement is available only in RWC5020B/M.

Manufacturing Solution 2

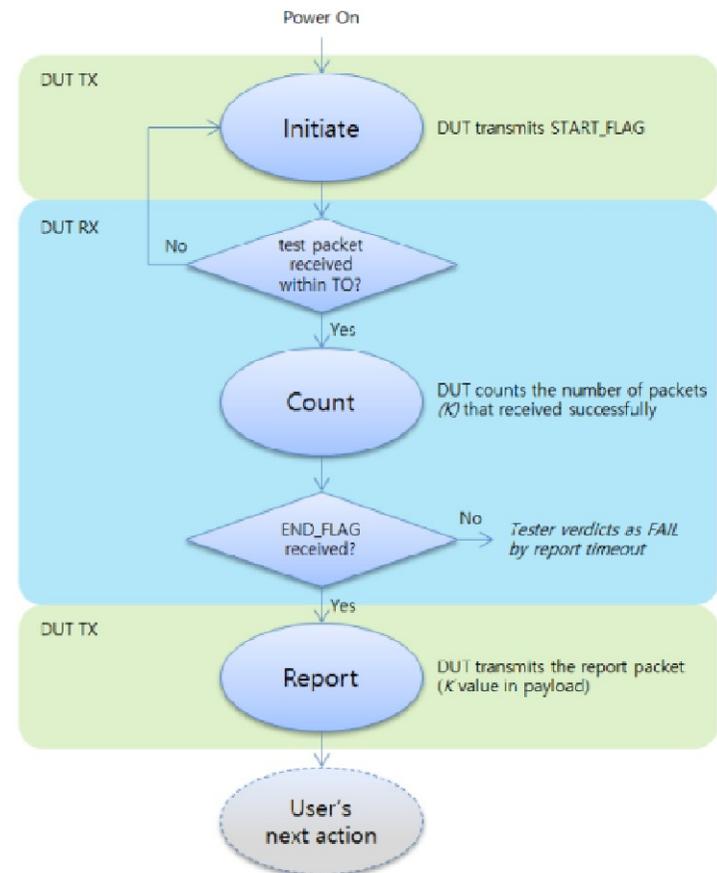
Production Test Solution

● Simultaneous TX/RX Test with MFG

Applicable to all LoRa products (end-devices & gateways)



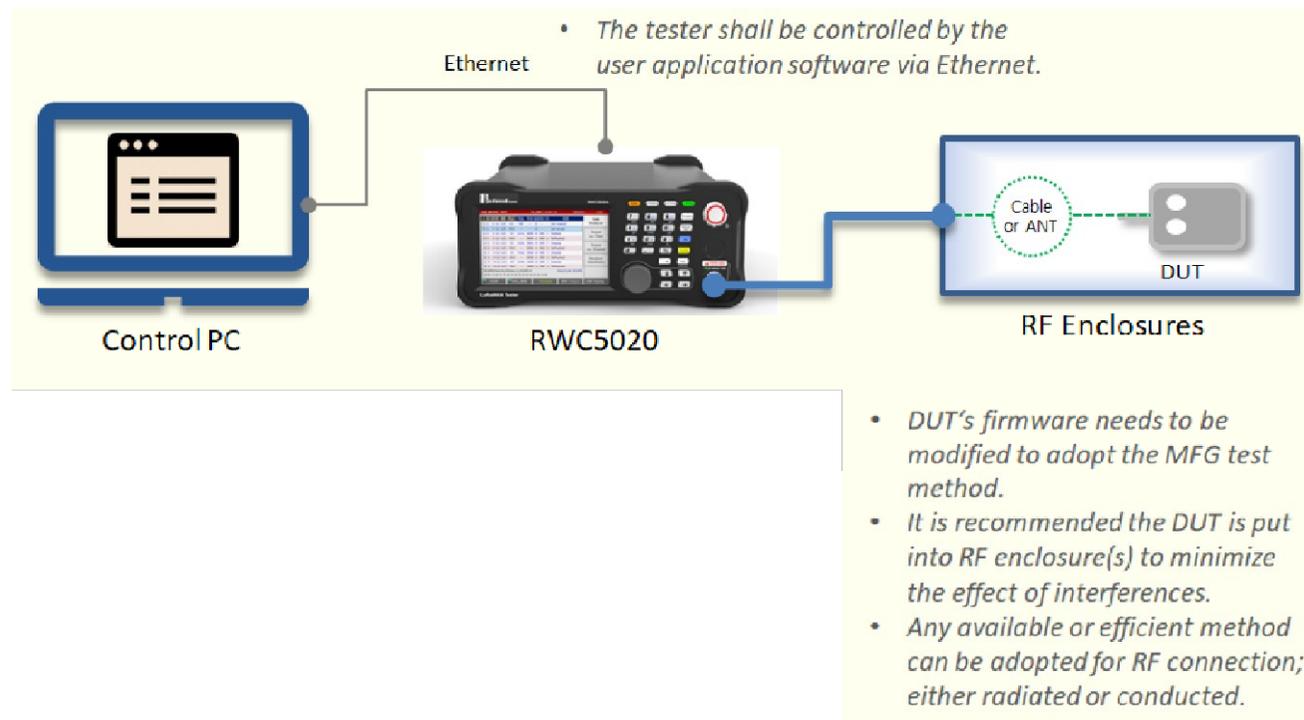
Calculate PER
Measure TX Power



Test Example of a Single DUT

Production Test Solution

Using MFG Function



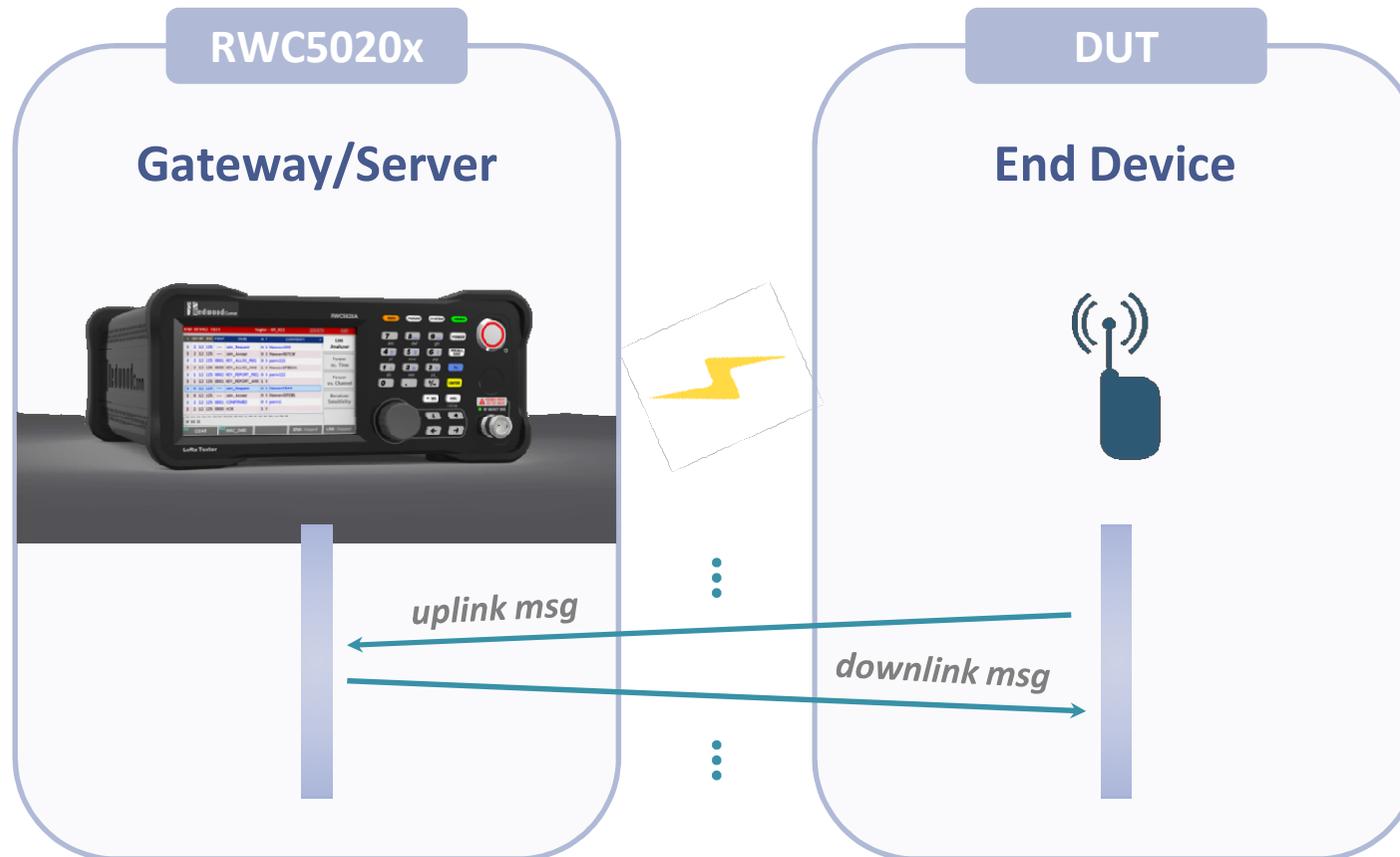
Contents

- Summary of Key Features
- Product Comparison
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- RF Shielding Enclosure
- Production Test Solution
- **Stand-alone Operation of 5020B**



End Device Test

Stand-alone Operation



Link Analyzer

Stand-alone Operation

- Create a LoRaWAN link between a DUT and the tester
- Analyze the MAC and application messages

The screenshot displays the 'END DEVICE TEST' interface for 'EU_868 / V1.0.2 / A'. The main table lists messages with columns for direction (L/D), channel (CH), data rate (DR), spreading factor (SF), bandwidth (BW), power (Pow), time, frame count (FCnt), acknowledgment port (AckPort), modulation (M), dwell time, and command (CMD). Annotations point to an uplink message (Join-request), a downlink message (Join-accept), and the raw data in hexa-decimal format at the bottom. On the right, there are panels for 'Link Analyzer', 'Power Measure' (with CH and TIME sub-panels), and 'Receiver Sensitivity'. A 'Calculated Duty Cycle' of 23.44% is shown at the bottom right. The interface also includes function keys like 'CLEAR', 'MAC_SEND', and 'Activated', along with a 'LINK: Running' status indicator.

L	CH	DR	SF	BW	Pow	Time	FCnt	AckPort	M	dwell	CMD
U	2	0	12	125	-28.2	REF	----	0	---	-	1482 Join-request
D	2	0	12	125	0.0	----	----	0	---	-	1155 Join-accept
U	0	0	12	125	-29.2	11.9s	0000	0	099	C	1646 DataUp
D	0	0	12	125	0.0	----	0000	1	000	U	991 NoPayload
U	1	0	12	125	-29.3	5.00s	0001	0	099	C	1646 DataUp
D	1	0	12	125	0.0	----	0001	1	000	U	991 NoPayload
U	2	0	12	125	-29.5	5.00s	0002	0	099	C	1646 DataUp
D	2	0	12	125	0.0	----	0002	1	000	U	991 NoPayload
U	2	0	12	125	-29.5	5.00s	0003	0	099	C	1646 DataUp
D	2	0	12	125	0.0	----	0003	1	000	U	991 NoPayload

RX1DROffset=0,RXDelay=1,RX2DR=0
 20 71 B0 B0 00 00 00 01 00 00 00 00 01 E8 32 4B 3F
 DutyCycle: 23.44%

Link Analyzer

Stand-alone Operation

- Transmission of MAC Command or Application Data
 - To check how a DUT responds to MAC commands
 - Supporting all LoRaWAN MAC commands with user configuration
 - Field selection: frame payload or frame options
 - Message type selection: confirmed or unconfirmed
 - User defined message: editable payload data and port field

END DEVICE TEST EU_868 / V1.0.2 / A (012) ETH (MD) (CAP)

LINK	PROTOCOL	RF
REGION	INSTANT_MAC_CMD1	EU_868
MAC_PAYLOAD	DEV_STATUS	
MAC_CMD_T	LINK_ADR	CONFIRMED
MAC_CMD_F	DUTY_CYCLE	PAYLOAD
NUM_OF_CMI	RX_PARAM_SETUP	1
INSTANT_MA	TX_PARAM_SETUP	LINK_ADR
ADR_DR		MF12BW125

POP-UP EXIT

Fn1 CLEAR Fn2 MAC_SEND Activating LINK: Running

END DEVICE TEST EU_868 / V1.0.2 / A (012) ETH (MD) (CAP)

L	CH	DR	SF	BW	Pow	Time	FCnt	AckPort	M	dwell	CMD	Link Analyzer
U	0	0	12	125	-29.2	5.00s	003A	0	099	U 1646	DataUp	
U	2	0	12	125	-29.5	5.00s	003B	0	099	U 1646	DataUp	
U	1	0	12	125	-29.2	5.01s	003C	0	099	U 1646	DataUp	
U	1	0	12	125	-29.3	5.00s	003D	0	099	U 1646	DataUp	
D	1	0	12	125	0.0	----	0031	0	000	U 1318	LinkADRReq	Power Measure
U	0	0	12	125	-29.2	4.51s	003E	0	000	U 1155	LinkADRAns	Receiver Sensitivity
U	2	0	12	125	-29.5	5.50s	003F	0	099	U 1646	DataUp	
U	1	0	12	125	-29.2	5.01s	0040	0	099	U 1646	DataUp	
U	0	0	12	125	-29.3	5.00s	0041	0	099	U 1646	DataUp	
U	2	0	12	125	-29.5	5.00s	0042	0	099	U 1646	DataUp	

Pow=1, DR=1, Mask=1
40 01 00 00 00 80 3E 00 00 03 07 5A 35 77 FE

Fn1 CLEAR Fn2 MAC_SEND Activated LINK: Running

EDT

Link Analyzer

Stand-alone Operation

- Transmission of Multiple MAC commands in a single frame
 - To check how a DUT responds to multiple MAC commands
 - Up to 3 MAC commands

END DEVICE TEST EU_858 / V1.0.2 / A 022(ETH) (CAP) RS

LINK	PROTOCOL	RF
NUM_OF_CMD		2 ✓
INSTANT_MAC_CMD1	RX_PARAM_SETUP	✓
RX1_DR_OFFSET		0
RX2_FREQ		869.525000 MHz
RX2_DR	DRO_SF12BW125	
INSTANT_MAC_CMD2	LINK_ADR	✓
ADR_DR	DRO_SF12BW125	

1 ~ 3

Fn1 CLEAR Fn2 MAC_SEND Activated LINK: Running

END DEVICE TEST EU_868 / V1.0.2 / A 022(ETH) (CAP) RS

L	CH	DR	SF	BW	Pow	Time	FCnt	AckPort	M	dwell	CMD
U	2	0	12	125	-29.6	5.00s	0004	0 099	U	1646	DataUp
U	1	0	12	125	-29.6	10.1s	0006	0 099	U	1646	DataUp
U	0	0	12	125	-29.6	5.00s	0007	0 099	U	1646	DataUp
D	0	0	12	125	-10.0	----	0000	0 000	U	1482	RXParamSetReq
D											LinkADRReq
U	1	0	12	125	-29.6	4.68s	0008	0 000	U	1318	RXParamSetAns
U											LinkADRAns
D	1	0	12	125	-10.0	----	0001	0 000	U	991	NoPayload
U	0	0	12	125	-29.6	5.33s	0009	0 099	U	1646	DataUp
U	1	0	12	125	-29.6	5.00s	000A	0 099	U	1646	DataUp

RX1DROffset=1, RX2DR=1, CH=1

Fn1 CLEAR Fn2 MAC_SEND Activated LINK: Running

Link Analyzer

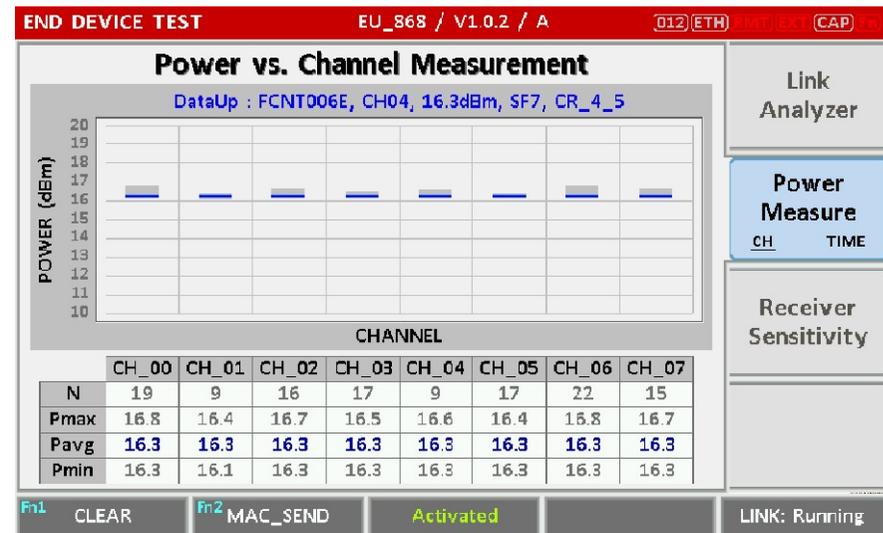
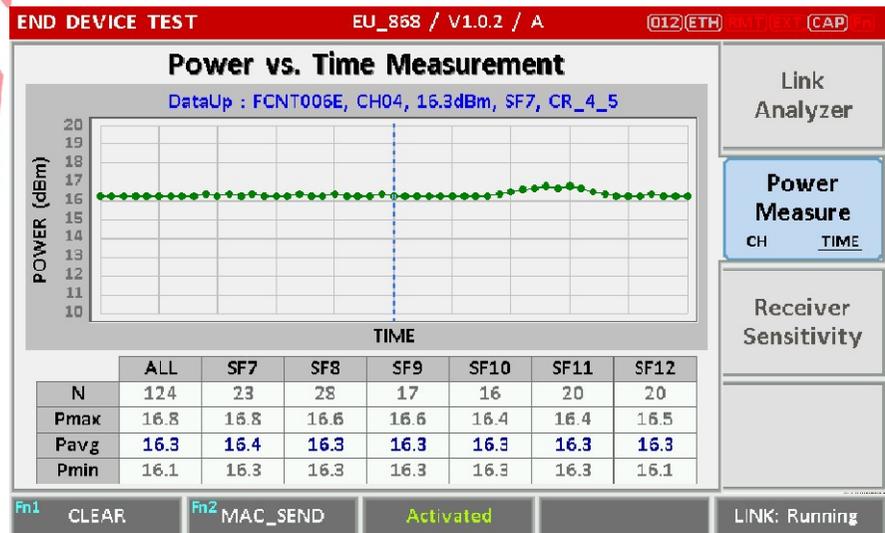
Power Measure
CH TIME

Receiver Sensitivity

Power Measurement

Stand-alone Operation

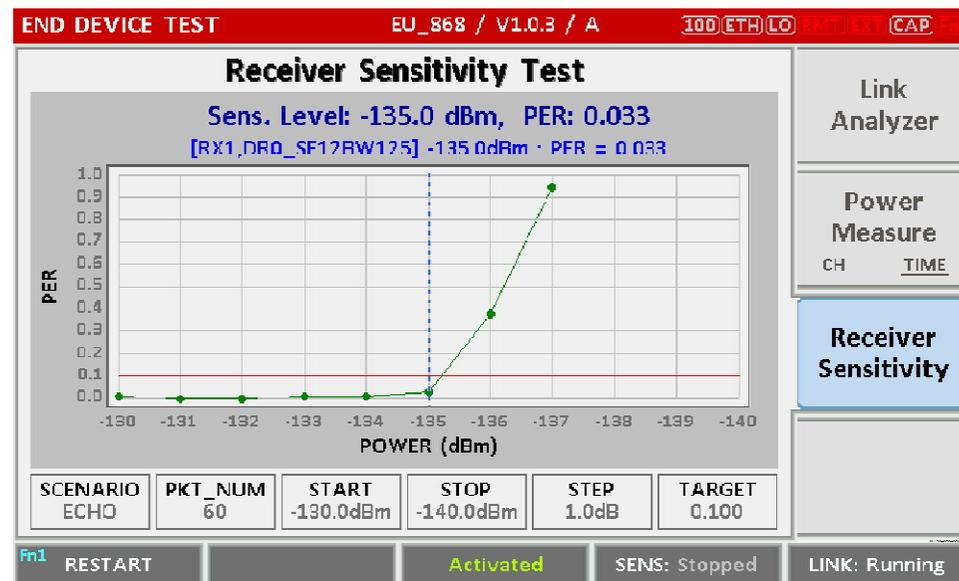
- Power vs. Time
 - Continuous monitoring of DUT's TX Power w.r.t. SF
- Power vs. Channel
 - Continuous monitoring of DUT's TX Power w.r.t. Channel
- Calculating the maximum/average/minimum values



RX Sensitivity Test

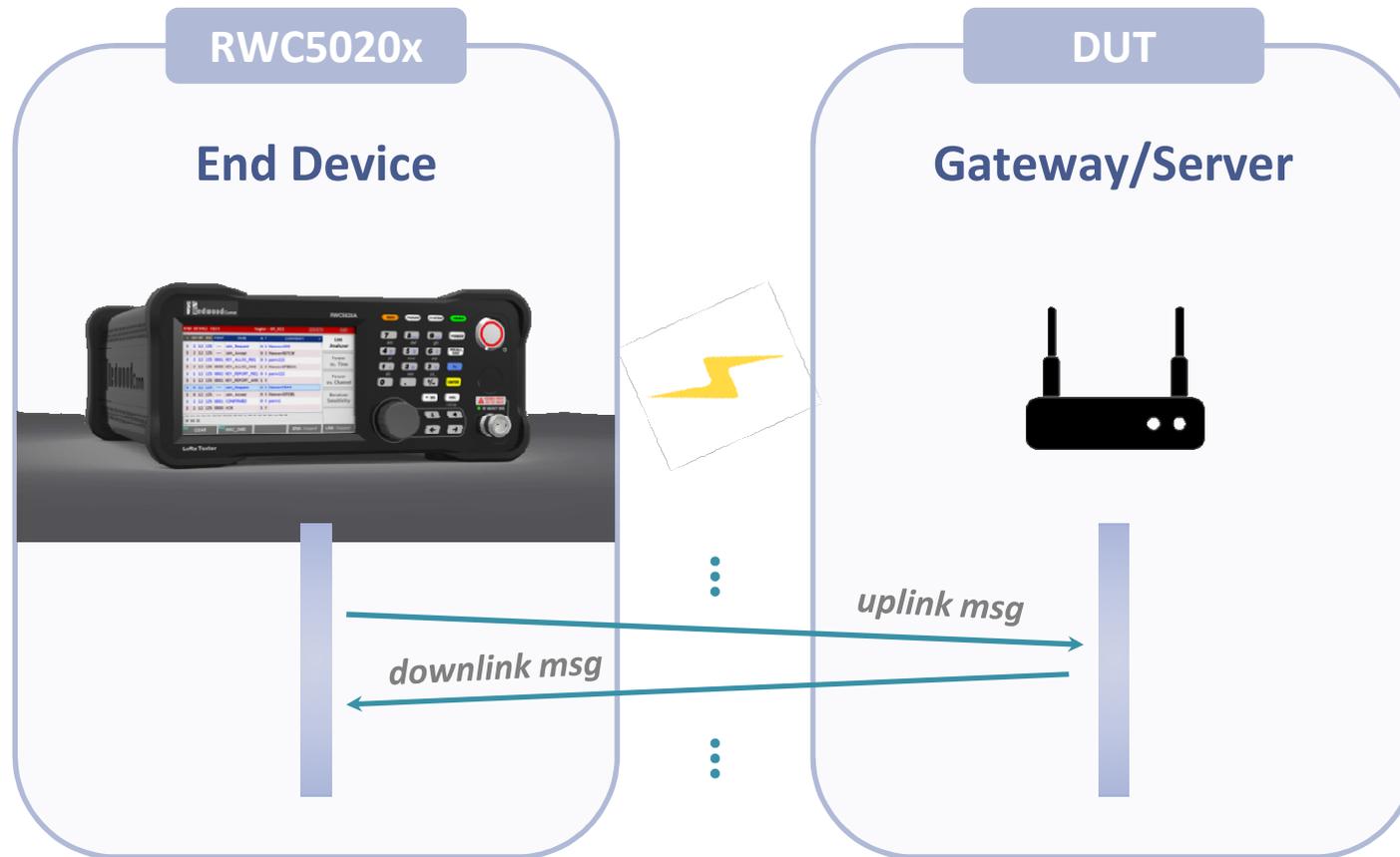
Stand-alone Operation

- Automatic Search of the Minimum Sensitivity Level
 - Determine range and step for the power sweep
 - Select the class of device and the target receive window
 - RX1 and RX2 for Class A, Ping-slot for Class B, RXC for Class C
 - The result value is the minimum power level at which the measured PER does not exceed the limit (TARGET_PER)



Gateway Test

Stand-alone Operation



Link Analyzer

Stand-alone Operation

- Create a LoRaWAN link between a DUT and the tester
- Analyze the MAC and application messages

GATEWAY TEST												EU_868 / V1.0.2 / A		022 ETH RMT EXT CAP Fn	
L	CH	DR	SF	BW	Pow	Time	FCnt	AckPort	M	dwell	CMD	Link Analyzer			
U	1	0	12	125	-10.0	REF	----	0	---	-	1482	Join-request	Power Measure CH TIME Receiver Sensitivity		
D	1	0	12	125	-28.4	----	----	0	---	-	1155	Join-accept			
U	0	0	12	125	-10.0	11.7s	0000	0	099	C	1646	DataUp			
D	0	0	12	125	-29.3	----	0000	1	---	U	991	NoPayload			
U	2	0	12	125	-10.0	5.00s	0001	0	099	C	1646	DataUp			
D	2	0	12	125	-29.3	----	0001	1	---	U	991	NoPayload			
U	1	0	12	125	-10.0	5.00s	0002	0	099	C	1646	DataUp			
D	1	0	12	125	-29.3	----	0002	1	---	U	991	NoPayload			
U	2	0	12	125	-10.0	5.00s	0003	0	099	C	1646	DataUp			
D	2	0	12	125	-29.2	----	0003	1	---	U	991	NoPayload			
RX1DROffset=0,RXDelay=1,RX2DR=0															
20 39 84 02 00 00 00 01 00 00 00 00 01 DE 46 E4 21															
Fn1 CLEAR			Fn2 MAC_SEND			Activated			LINK: Running						

Link Analyzer

Stand-alone Operation

- Transmission of MAC Command or Application Data
 - To check how a DUT responds to MAC commands
 - Supporting all LoRaWAN MAC commands with user configuration
 - Multiple MAC commands in a single frame (Up to 3 commands)

GATEWAY TEST EU_858 / V1.0.2 / A [022] ETH [MD] [RMT] [EXT] [CAP] [Fn]

LINK	PROTOCOL	RF
MAC_PAYLOAD	INSTANT_MAC_CMD1	
MAC_CMD_T		CONFIRMED
MAC_CMD_F		PAYLOAD
NUM_OF_CMI		1
INSTANT_MA		LINK_CHECK
MAC_ANS_TO		60 sec
PERIODIC_UPLINK		NONE

POP-UP [EXIT]

Fn1 CLEAR Fn2 MAC_SEND Activating LINK: Running

GATEWAY TEST EU_868 / V1.0.2 / A [022] ETH [RMT] [EXT] [CAP] [Fn]

L	CH	DR	SF	BW	Pow	Time	FCnt	AckPort	M	dwell	CMD	Link Analyzer
U	1	0	12	125	-10.0	5.00s	0014	0	099	C	1646	DataUp
D	1	0	12	125	-29.3	----	0014	1	---	U	991	NoPayload
U	2	0	12	125	-10.0	5.00s	0015	0	099	C	1646	DataUp
D	2	0	12	125	-29.3	----	0015	1	---	U	991	NoPayload
U	0	0	12	125	-10.0	5.00s	0016	0	000	U	1155	LinkCheckReq
D	0	0	12	125	-29.3	----	0016	0	000	U	1155	LinkCheckAns
U	2	0	12	125	-10.0	5.00s	0017	0	099	C	1646	DataUp
D	2	0	12	125	-29.3	----	0017	1	---	U	991	NoPayload
U	0	0	12	125	-10.0	5.00s	0018	0	099	C	1646	DataUp
D	0	0	12	125	-29.3	----	0018	1	---	U	991	NoPayload

Margin=20, GwCnt=1
60 01 00 00 00 80 16 00 00 02 14 01 D5 ED E8 F4

Fn1 CLEAR Fn2 MAC_SEND Activated LINK: Running

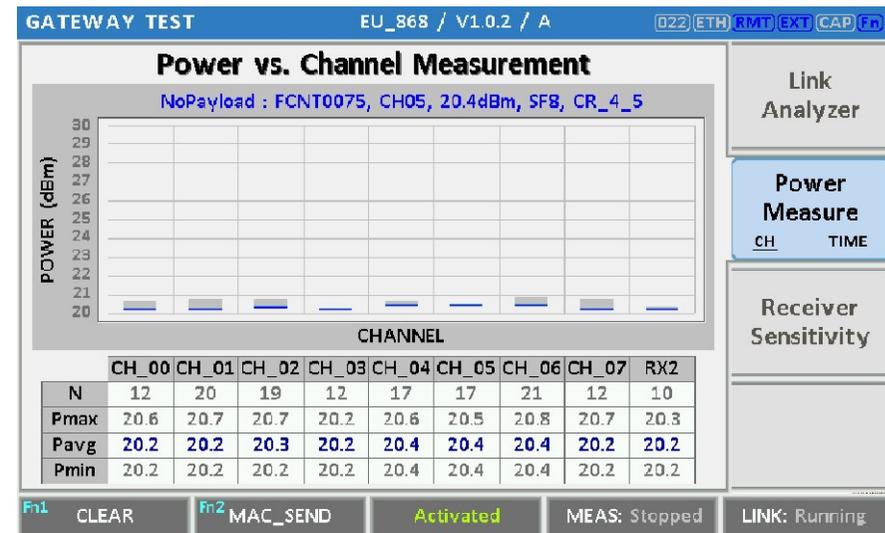
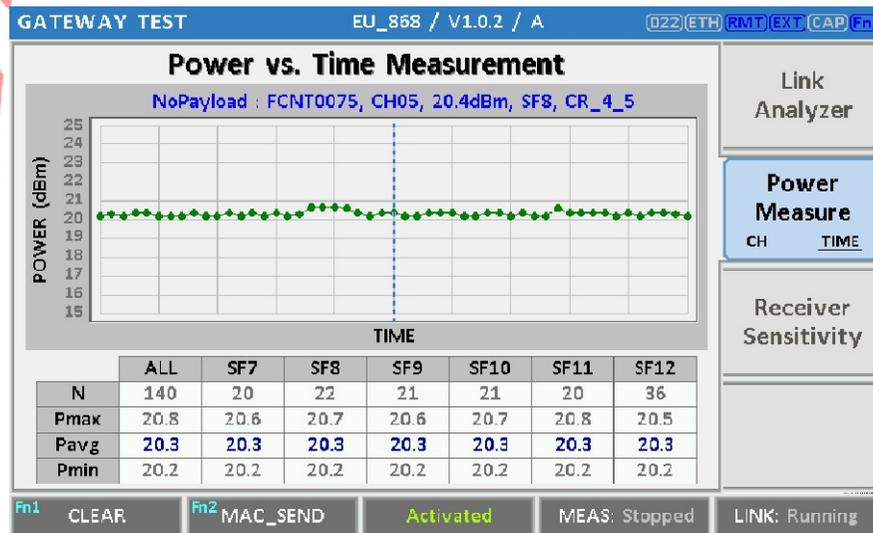
Power Measure CH TIME

Receiver Sensitivity

Power Measurement

Stand-alone Operation

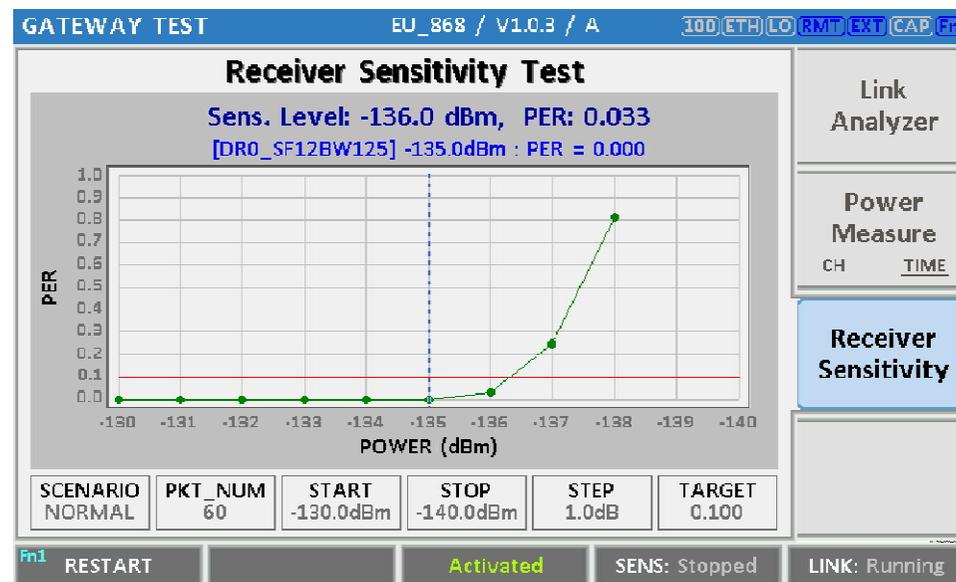
- Power vs. Time
 - Continuous monitoring of DUT's TX Power w.r.t. SF
- Power vs. Channel
 - Continuous monitoring of DUT's TX Power w.r.t. Channel
- Calculating the maximum/average/minimum values



RX Sensitivity Test

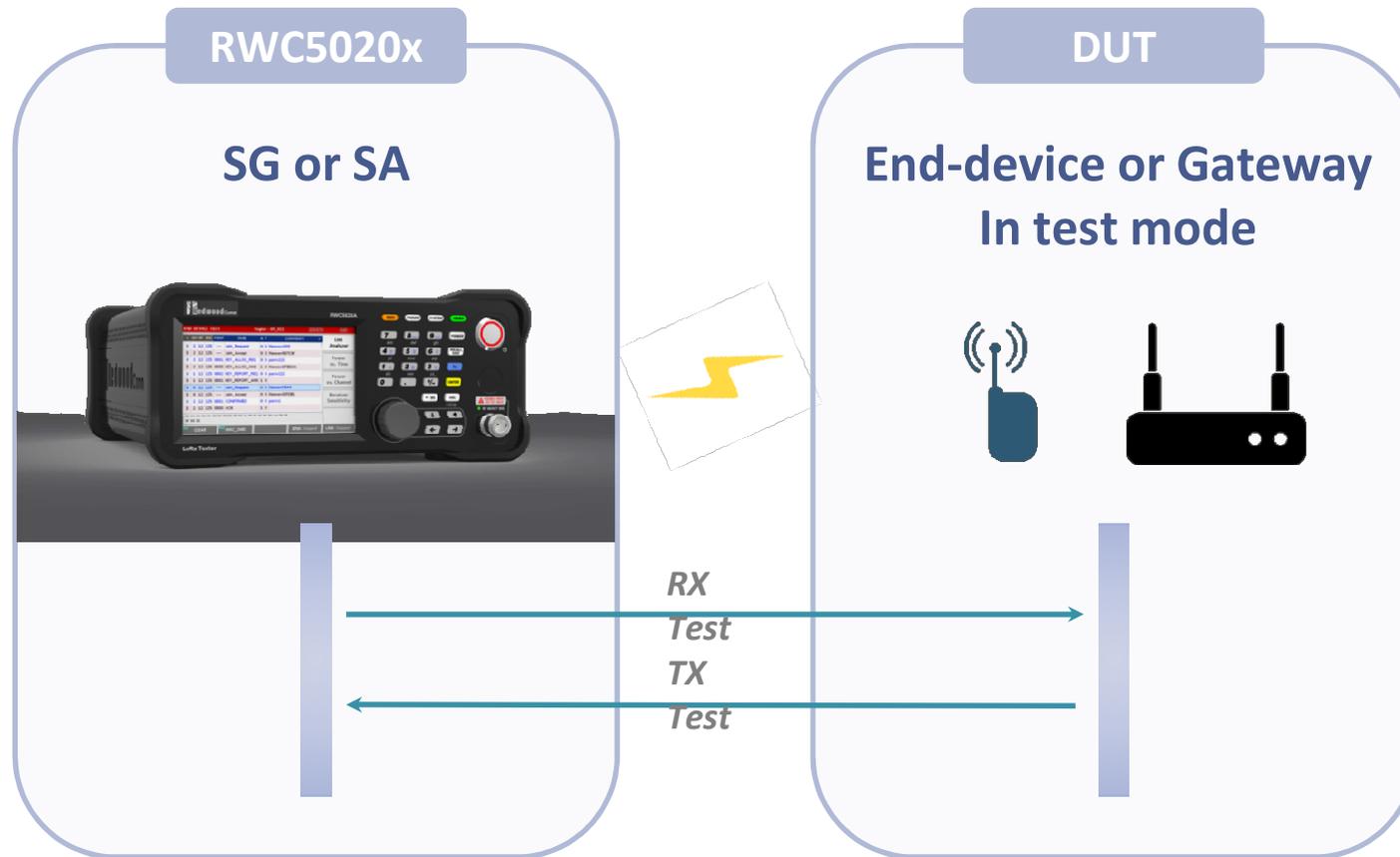
Stand-alone Operation

- Automatic Search of the Minimum Sensitivity Level
 - Determine range and step for the power sweep
 - The result value is the minimum power level at which the measured PER does not exceed the limit (TARGET_PER)



Non-signaling Test

Stand-alone Operation



NST TX

Stand-alone Operation

● Signal Generator

- Modulation - LoRa, FSK, CW
- LoRa Modulation - Network, Polarity, SF, BW, CR
- LoRa Packet - Preamble, Payload
- Repeat number, Packet interval

NON-SIGNALING TEST											[Z1] [ETH] [MD] [RMT] [EXT] [CAP] [Fn]										
SEQ	SF	BW	Pow	Time	dwel	Data															
0030	7	125	0.0	0.100s	51	00	01	02	03	04	05	06	07	08	09	Signal Generator					
0040	8	125	0.0	0.100s	92	00	01	02	03	04	05	06	07	08	09	Signal Analyzer					
0050	9	125	0.0	0.100s	164	00	01	02	03	04	05	06	07	08	09	MFG					
0060	10	125	0.0	0.100s	329	00	01	02	03	04	05	06	07	08	09	LINK: Stopped					
0070	11	125	0.0	0.100s	659	00	01	02	03	04	05	06	07	08	09	Fn1 CLEAR					
0080	12	125	0.0	0.100s	1318	00	01	02	03	04	05	06	07	08	09	Status : OFF					

NST

NST RX

Stand-alone Operation

- Signal Analyzer
 - Power Measurement - LoRa / FSK / CW
 - Frequency Measurement - CW

NON-SIGNALING TEST											(121) (ETH) (LO) (RMT) (EXT) (CAP) (FR)					
SEQ	SF	BW	Pow	Time	dwell	Data					Signal Generator					
0000	7	125	-----	-----	51	00	01	02	03	04	05	06	07	08	09	
0001	7	125	-10.8	0.15s	51	00	01	02	03	04	05	06	07	08	09	Signal Analyzer
0002	7	125	-10.8	0.15s	51	00	01	02	03	04	05	06	07	08	09	
0003	7	125	-10.8	0.15s	51	00	01	02	03	04	05	06	07	08	09	
0004	7	125	-10.8	0.15s	51	00	01	02	03	04	05	06	07	08	09	
0005	7	125	-10.8	0.15s	51	00	01	02	03	04	05	06	07	08	09	
0006	7	125	-10.8	0.15s	51	00	01	02	03	04	05	06	07	08	09	
0007	7	125	-10.8	0.15s	51	00	01	02	03	04	05	06	07	08	09	
0008	7	125	-10.8	0.15s	51	00	01	02	03	04	05	06	07	08	09	
0009	7	125	-10.8	0.15s	51	00	01	02	03	04	05	06	07	08	09	
POW(dBm) MAX: -10.8			AVG: -10.8			MIN: -10.8						MFG				
Fn1 CLEAR											LINK: Running					

NON-SIGNALING TEST											(121) (ETH) (LO) (RMT) (EXT) (CAP) (FR)					
SEQ	SF	BW	Pow	Time	dwell	Data					Signal Generator					
0006	--	--	-10.5	-----	----	CW Freq=868.299927MHz										
0007	--	--	-10.5	-----	----	CW Freq=868.299988MHz										
0008	--	--	-10.5	-----	----	CW Freq=868.299988MHz					Signal Analyzer					
0009	--	--	-10.5	-----	----	CW Freq=868.299927MHz										
0010	--	--	-10.5	-----	----	CW Freq=868.299927MHz										
0011	--	--	-10.5	-----	----	CW Freq=868.299927MHz										
0012	--	--	-10.5	-----	----	CW Freq=868.299927MHz										
0013	--	--	-10.5	-----	----	CW Freq=868.299988MHz										
0014	--	--	-10.5	-----	----	CW Freq=868.299988MHz										
0015	--	--	-10.5	-----	----	CW Freq=868.299988MHz										
POW(dBm) MAX: -10.5			AVG: -10.5			MIN: -10.6			FREQ(MHz) MAX: 868.299988			AVG: 868.299959		MIN: 868.299927		MFG
Fn1 CLEAR											LINK: Running					

Feedback

If you have any questions,
contact us at sales@redwoodcomm.com or
visit www.redwoodcomm.com.