

RWC5020x Application Program

Operating Manual

Version 1.20
(RWC5020x SW Version 1.20)

16. September 2019

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I. Getting Started

This chapter explains how to download and start RWC5020X application program.

- 1.1 Download and Installation
- 1.2 Start the Application
- 1.3 GUI Structure

1.1 Download and Installation

RWC5020X application program is provided by email or download link and the downloaded file can be unzipped into users' directory. After unzip the file you can be noticed there is an install program as the fig 1.1 Then, just run the install file and follow the instruction of Setup wizard and let it know installation options. Setup wizard will install the executive file RWC5020x_APP.exe, fonts, dlls, and demo project as fig 1.3

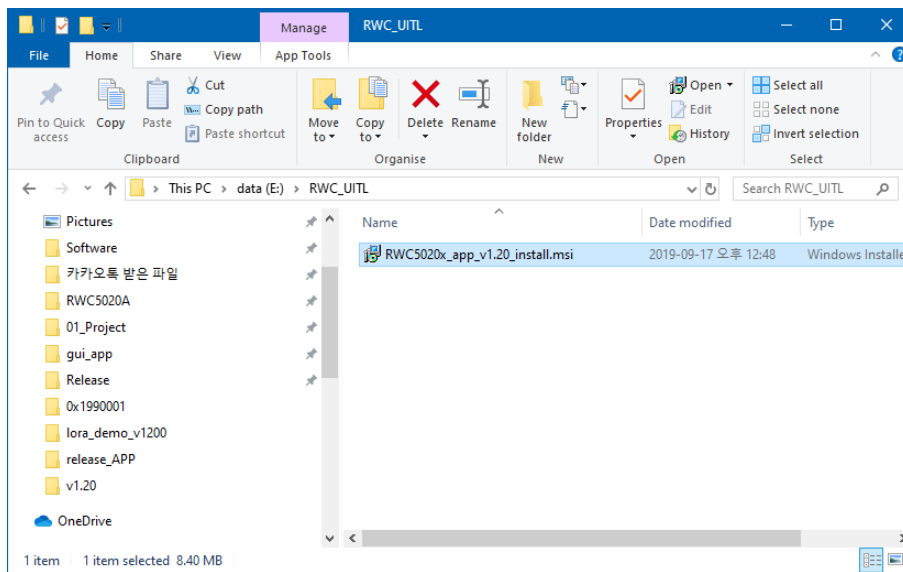


Fig 1.1 Download and unzip the zip file into user's directory

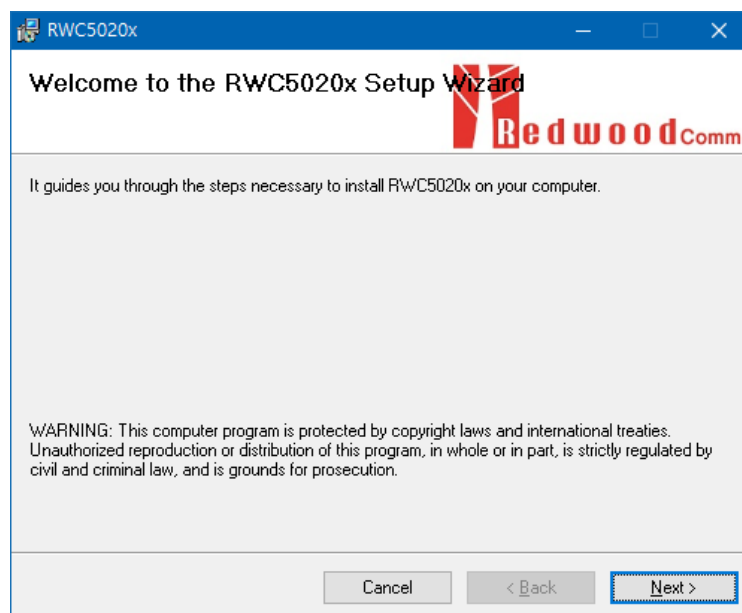


Fig 1.2 Setup wizard of RWC5020x application

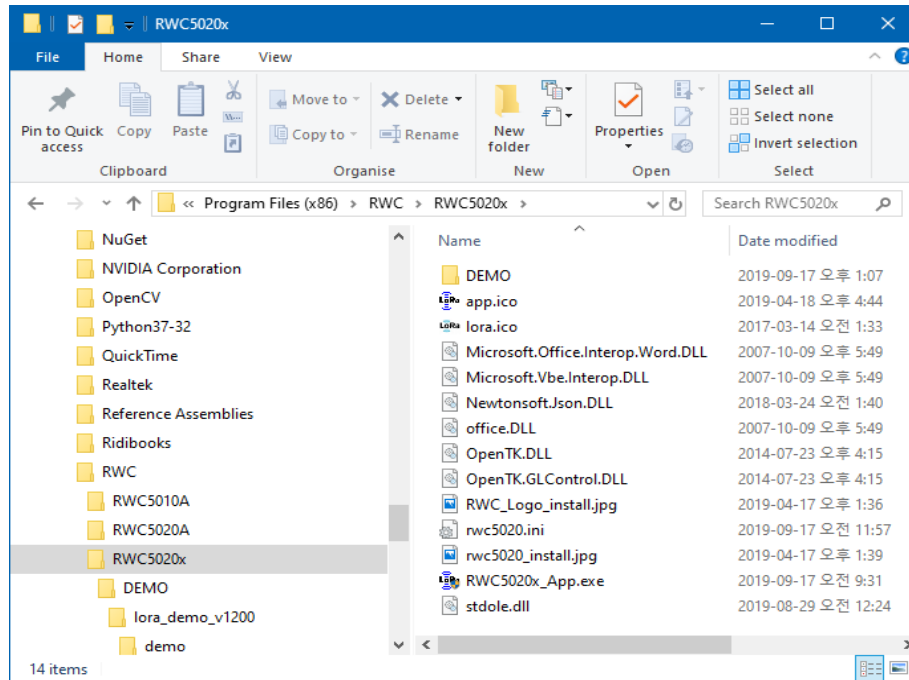


Fig 1.3 RWC5020x related directories and file after installation

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- Note:**
1. Recommended to use windows7 or later for OS of user's PC.
 2. Strongly recommended to use '.' than ',' for floating expression.
 3. Strongly recommended to use '.' than ',' for decimal expression.
 4. Strongly recommended to use English than other languages.
 5. If you want to avoid the authorization problem with your OS system, you'd better install application software on non-system disk, like 'D'.
-

1.2 Start the Application

To run the application program, just execute the application 'RWC5020X_App.exe'.

In order to use whole functions that the application has, connect your app and RWC5020x.

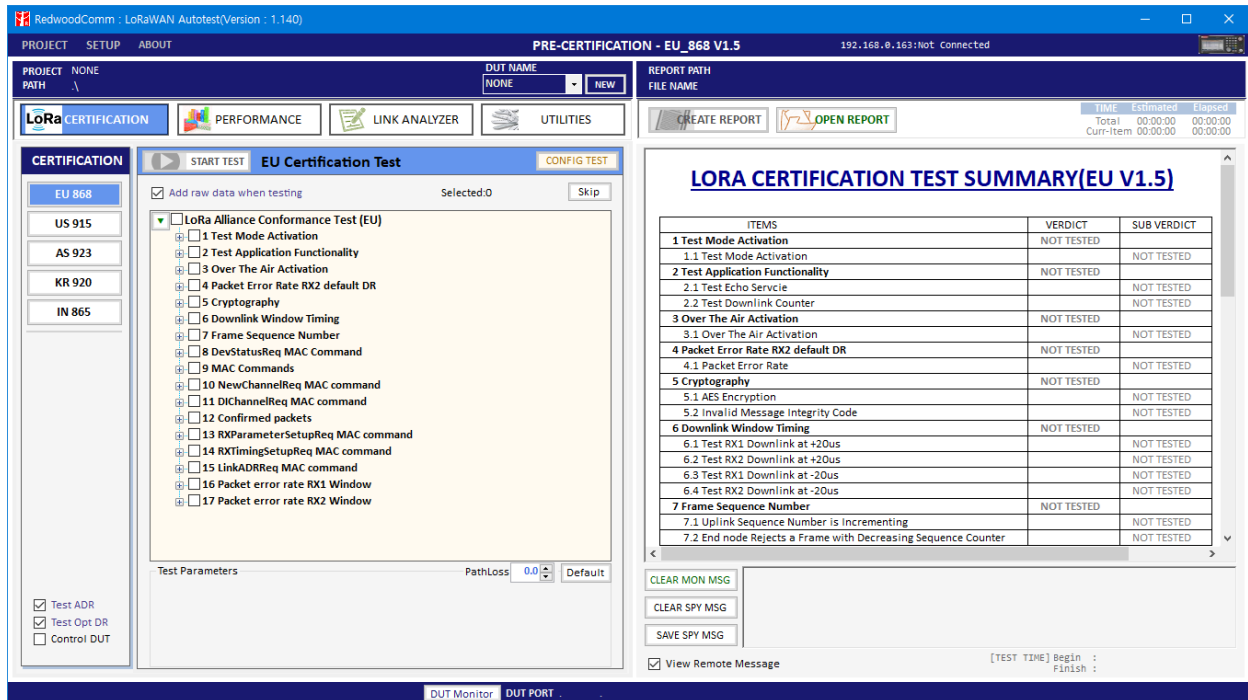


Fig 1.4 The Initial Screen of the Application

You can make a connection using connection menu. Refer the 2.2.1.

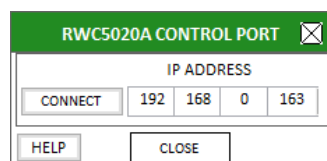


Fig 1.5 Popup window to Connect PC application and the equipment RWC5020x

1.3 GUI Structure

RWC5020X application program consists of three categories: Project Menus, Test Functions, and Report Functions. The next chapters will include the detail explanation about each category respectively. In the following figure, blue color boxed functions are project menu functions, and red color boxed functions are test related ones, and green color boxed functions are report related ones.

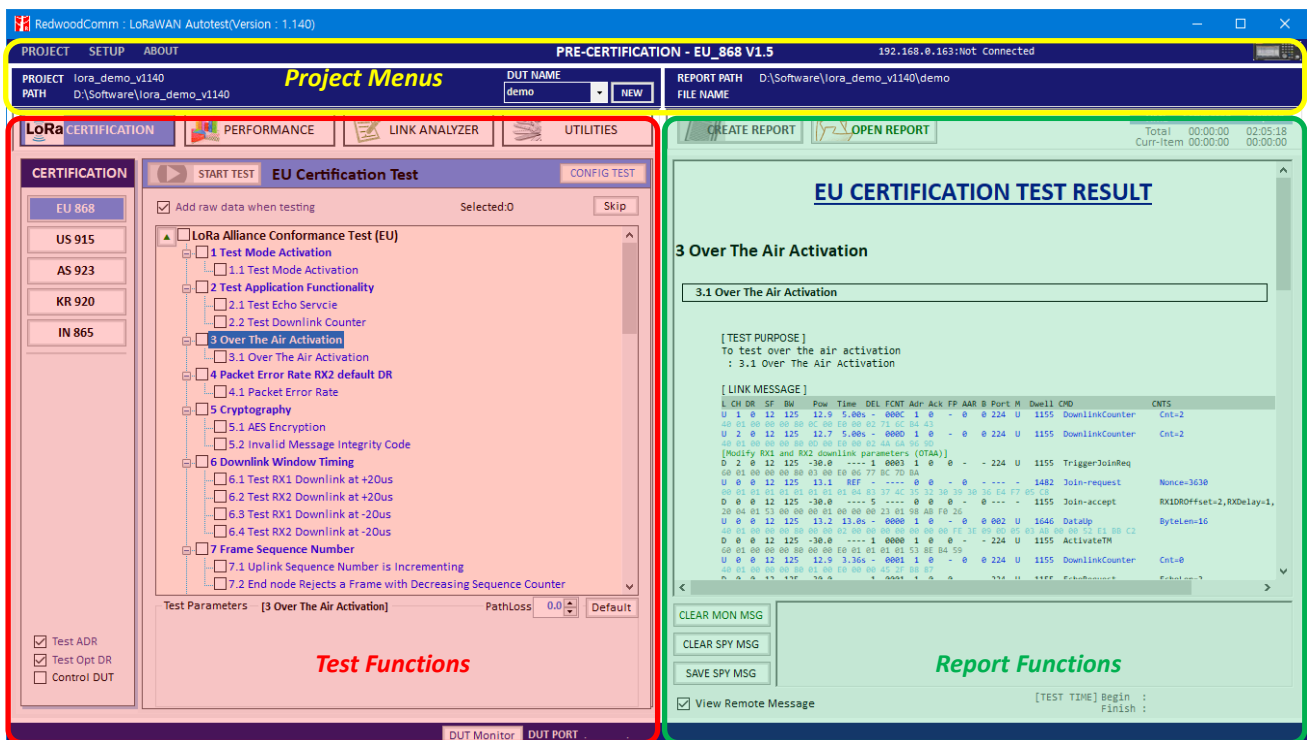


Fig 1.6 Categories of the Application

II. Project Menus

This chapter explains how to handle a project, DUT, test condition and test environment. With Top Menus, user can create or open a project file, or delete currently opened project, and manage DUT environment file. User can also access to User Manual file and optional information.

- 2.1 Project Menu
- 2.2 Setup Menu
- 2.3 About Menu

2.1 Project Menu

The application has three top menu; [PROJECT], [SETUP], and [ABOUT]. This section shows how to use and configure them before tests.

2.1.1 Project

Before starting use of the application, at least two basic works should be done; one is creating project and the other is creating a DUT. When a new project is created, a 'project_name.ini' file will be generated.

When a new DUT is created in the project, a 'DUT_name.ini' file will be generated.

[PROJECT] MENU consists of 5 sub menus such as [New Project], [Open Project], [Del Current Project], [Project List] and [Open Demo Project].

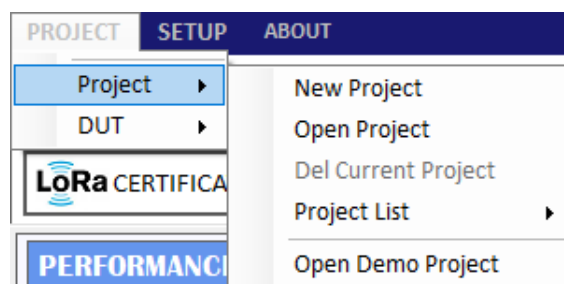


Fig 2.1 Project Menu

2.1.1.1 New Project

[New Project] creates a new project file. Before test, a project file and a DUT file must be created or opened. Project may have many DUTs.

2.1.1.2 Open Project

[Open project] opens an existing project file which the user selects. [Open project] also opens the last tested DUT file automatically when the application starts, if 'Load last project at start' is checked in [SETUP] -> [Utility Environment]..

2.1.1.3 Del Current Project

[Del Current Project] deletes currently opened project including all DUT files in project folder. The deleted project cannot be recovered. Be careful to delete a project.

2.1.1.4 Project List

[Project List] shows the list of projects in current directory. Just clicking one of the listed projects opens the project. Maximum 7 project names will be saved.

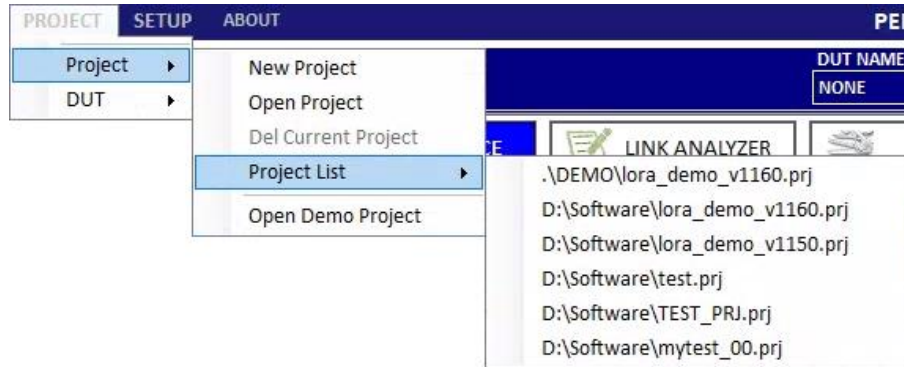


Fig 2.2 [Project List] Menu

2.1.1.5 Open Demo Project

[Open Demo Project] opens a demo project.

A demo project has been installed when RWC5020X application installed in the sub-directory, '.\DEMO\' of the application installed directory.

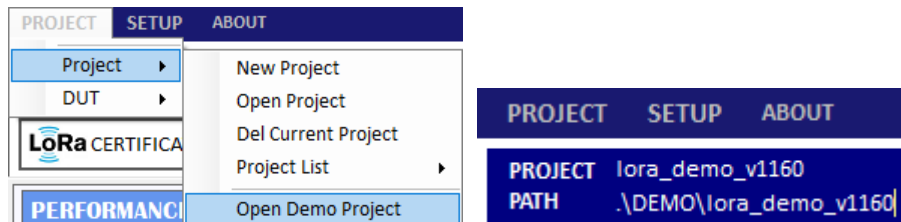


Fig 2.3 [Open Demo Project] menu and directory information

2.1.2 DUT

In this application, DUT means device name to be tested. DUT is a member of a project. You can create many DUTs. If a new DUT is created, a 'DUT_name.ini' file will be generated. It includes information of DUT's test environment. If you want to test a new DUT, you'd better create a new DUT file and test.

2.1.2.1 New DUT

When [New DUT] of DUT Menu or NEW button clicked, the 'NEW DUT CREATION' window which helps you create a new DUT will be shown. Type a DUT name and click [CREATE] button.

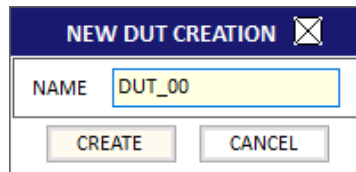


Fig 2.4 Creation of a new DUT

The list of DUT names that you created will be shown in DUT list box as the following figure.

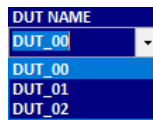


Fig 2.5 List of DUT names

2.1.2.2 DEL Current DUT


[DEL Current DUT] deletes currently opened DUT file. The deleted DUT file cannot be recovered.

2.2 Setup Menu

2.2.1 Connection between APP and RWC5020x

RWC5020X Application works under Ethernet connection between user's PC and RWC5020x.

2.2.1.1 Open RWC5020X CONTROL PORT window

Clicking [Connect RWC5020X] of SETUP Menu or clicking  icon shows the 'RWC5020x CONTROL PORT' window which helps you setup RWC5020X's IP.

2.2.1.2 Setup IP

Setup the IP address same as the RWC5020x's connected to the PC and click [CONNECT] button. If PC recognizes a RWC5020X, the [CONNECT] will be changed to [CONNECTED].

After connection, the application's title bar shows the version, device type(RWC5020A or B), and local PC's network IP. Some of the functionality or parameters will be limited with RWC5020A.

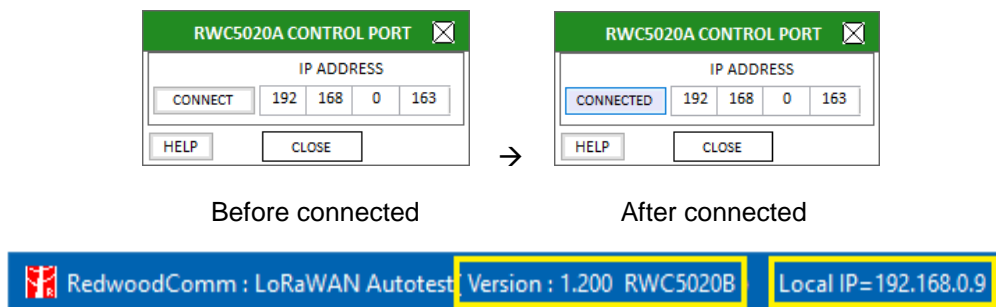


Fig 2.6 IP Setup for connection

2.2.2 Control DUT

Control DUT menu consists of five sub menus : Open Port, Load User Cmds, Show User Cmds, Show DUT Monitor, and Make Cmds Template.

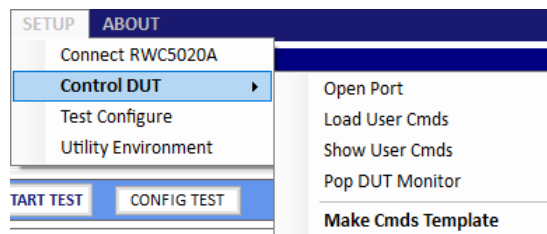


Fig 2.7 Control DUT Menu

2.2.2.1 Open PORT

[Open PORT] shows a 'DUT CONTROL PORT' window to setup and open UART port for DUT control. After configuring its port number and baud rate, click [OPEN PORT] button.

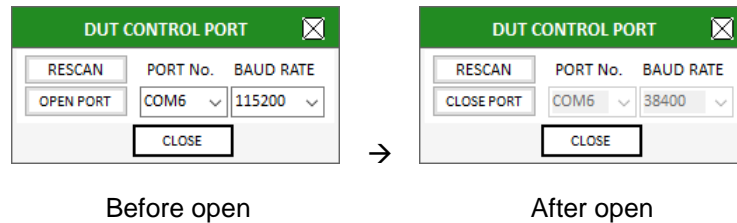


Fig 2.8 DUT Control Port Setup

2.2.2.2 Load User Cmds

[Load User Cmds] pops up a 'OpenFile Window' for opening a DUT control file(.txt) which describes configuration and user commands. If you want to create your own command file, use [Make Cmds Template] function which helps you create a template file.

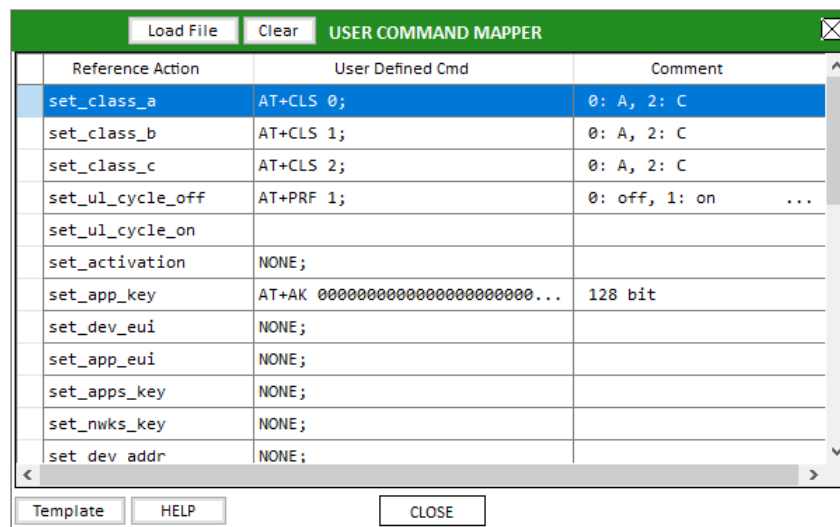
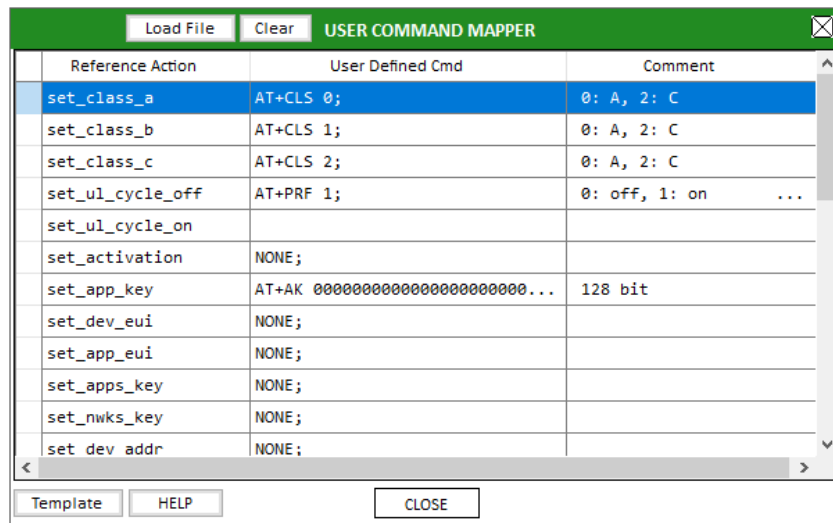


Fig 2.9 Example of Load User Cmds

2.2.2.3 Show User Cmds

[Show User Cmds] pops up the 'COMMAND LIST for DUT CONTROL' window and shows user-defined commands which are loaded currently. To see user's own commands with this window, user has to load a ready-made DUT control file(.txt).



Reference Action	User Defined Cmd	Comment
set_class_a	AT+CLS 0;	0: A, 2: C
set_class_b	AT+CLS 1;	0: A, 2: C
set_class_c	AT+CLS 2;	0: A, 2: C
set_ul_cycle_off	AT+PRF 1;	0: off, 1: on ...
set_ul_cycle_on		
set_activation	NONE;	
set_app_key	AT+AK 00000000000000000000...	128 bit
set_dev_eui	NONE;	
set_app_eui	NONE;	
set_apps_key	NONE;	
set_nwks_key	NONE;	
set dev addr	NONE;	

Buttons: Template, HELP, CLOSE

Fig 2.10 Example of Show User Cmds

2.2.2.4 Show DUT Monitor

[Show DUT Monitor] shows a popup window which shows the DUT's response. User may send control commands using the popup window.

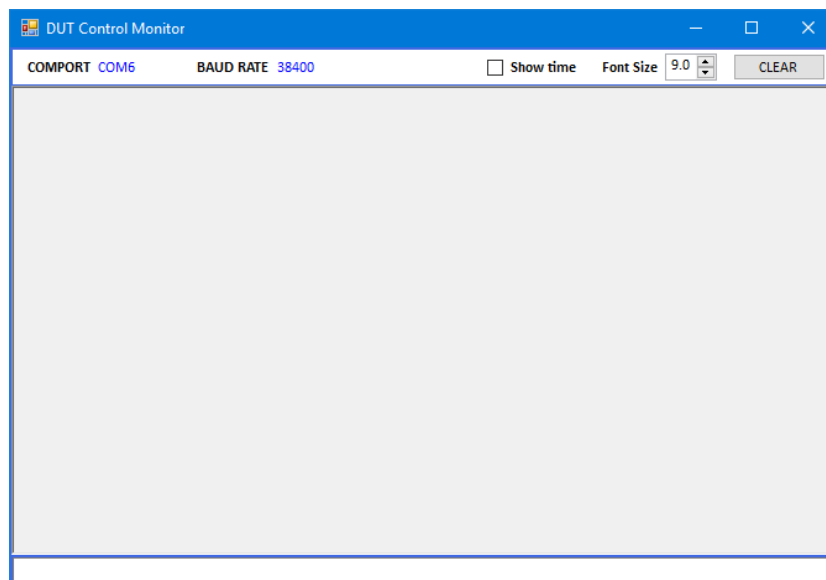
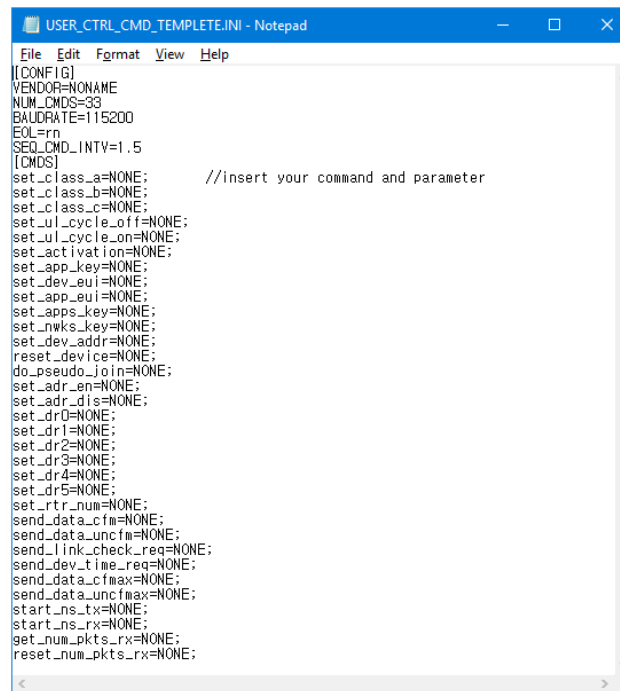


Fig 2.11 DUT Monitor screen

2.2.2.5 Make Cmds Template

[Make Cmds Template] creates a template file function which can help user create user's own control file by showing a template file. User can fill it up and save it as a text file (.txt).



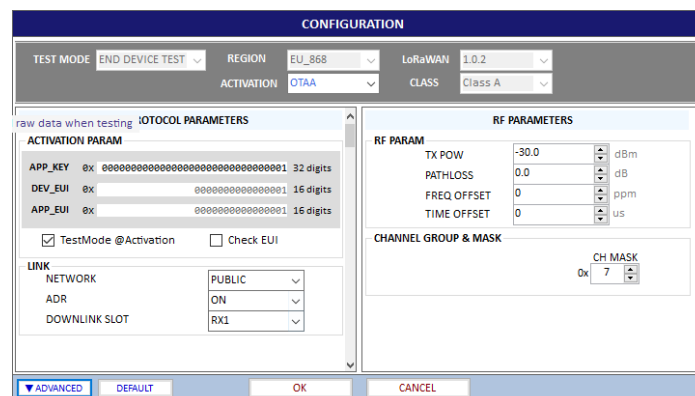
```

File Edit Format View Help
[[CONFIG]]
VENDOR=NONAME
NUM_CMDS=33
BAUDRATE=115200
EOL=rn
SEQ_CMD_INTV=1.5
[[CMDS]]
set_class_a=NONE;           //insert your command and parameter
set_class_b=NONE;
set_class_c=NONE;
set_ul_cycle_off=NONE;
set_ul_cycle_on=NONE;
set_activation=NONE;
set_app_key=NONE;
set_dev_eui=NONE;
set_app_eui=NONE;
set_apps_key=NONE;
set_nwks_key=NONE;
set_dev_addr=NONE;
reset_device=NONE;
do_pseudo_join=NONE;
set_addr_en=NONE;
set_addr_dis=NONE;
set_dr0=NONE;
set_dr1=NONE;
set_dr2=NONE;
set_dr3=NONE;
set_dr4=NONE;
set_dr5=NONE;
set_rtr_num=NONE;
send_data_cfm=NONE;
send_data_uncfm=NONE;
send_link_check_req=NONE;
send_dev_tme_req=NONE;
send_data_cfm_max=NONE;
send_data_uncfm_max=NONE;
start_ns_tx=NONE;
start_ns_rx=NONE;
get_num_pkts_rx=NONE;
reset_num_pkts_rx=NONE;
  
```

Fig 2.12 Template of User Control Commands

2.2.3 Test Configuration

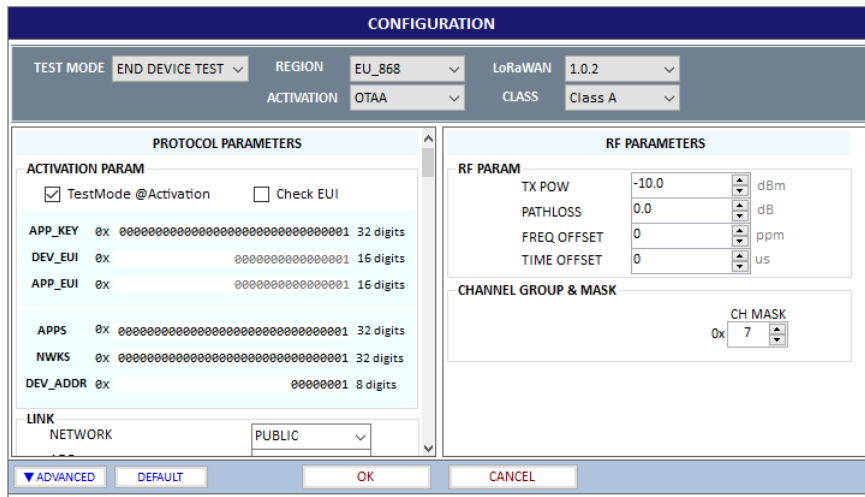
[Test Configure] or **CONFIG TEST** shows a window in which user can setup the basic properties of DUT. This configuration is applied to all test functions of the application.



CONFIGURATION	
TEST MODE: END DEVICE TEST	REGION: EU_868
LoRaWAN: 1.0.2	ACTIVATION: OTAA
CLASS: Class A	
RF PARAMETERS TX POW: -30.0 dBm PATHLOSS: 0.0 dB FREQ OFFSET: 0 ppm TIME OFFSET: 0 us	
CHANNEL GROUP & MASK CH MASK: 0x 7	

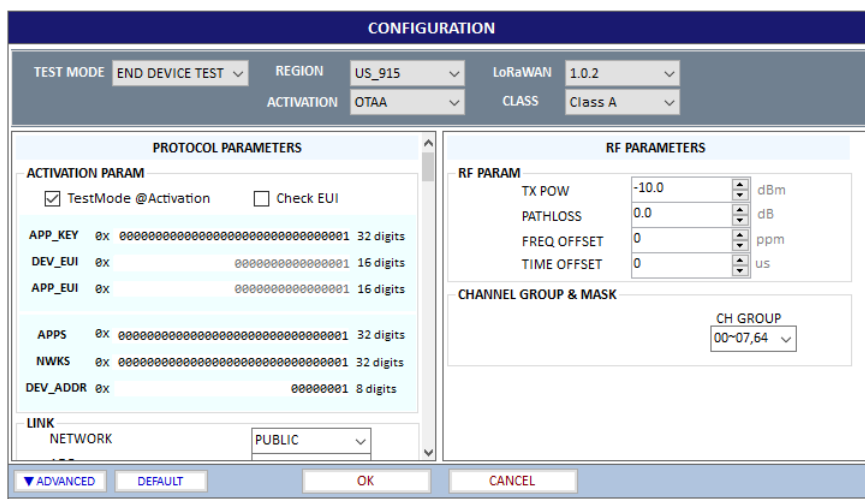
Fig 2.13 Basic Configuration window for Certification Test

Clicking the value of 'KEY/CTRL' shows a popup window for protocol key values configuration in which user can setup keys and switch DUT between OTAA and ABP mode. In case of regions that the number of channels is greater than 8, the window also shows the selection of channel group. This configuration is applied to all test functions of the application.



The screenshot shows the 'CONFIGURATION' window for the 'EU_868' region. The 'TEST MODE' is set to 'END DEVICE TEST', 'REGION' is 'EU_868', 'LoRaWAN' is '1.0.2', 'ACTIVATION' is 'OTAA', and 'CLASS' is 'Class A'. The 'PROTOCOL PARAMETERS' section includes 'ACTIVATION PARAM' with checkboxes for 'TestMode @Activation' (checked) and 'Check EUI'. Below are fields for 'APP_KEY' (32 digits), 'DEV_EUI' (16 digits), 'APP_EUI' (16 digits), 'APPS' (32 digits), 'NWKS' (32 digits), and 'DEV_ADDR' (8 digits). The 'LINK' section shows 'NETWORK' set to 'PUBLIC'. The 'RF PARAMETERS' section includes 'TX POW' (-10.0 dBm), 'PATHLOSS' (0.0 dB), 'FREQ OFFSET' (0 ppm), and 'TIME OFFSET' (0 us). The 'CHANNEL GROUP & MASK' section shows 'CH MASK' set to '0x 7'. At the bottom are buttons for 'ADVANCED', 'DEFAULT', 'OK', and 'CANCEL'.

Fig 2.14 Protocol Keys Configuration window



The screenshot shows the 'CONFIGURATION' window for the 'US_915' region. The 'TEST MODE' is set to 'END DEVICE TEST', 'REGION' is 'US_915', 'LoRaWAN' is '1.0.2', 'ACTIVATION' is 'OTAA', and 'CLASS' is 'Class A'. The 'PROTOCOL PARAMETERS' section is identical to the previous window. The 'RF PARAMETERS' section is also identical. The 'CHANNEL GROUP & MASK' section shows 'CH GROUP' set to '00~07,64'. At the bottom are buttons for 'ADVANCED', 'DEFAULT', 'OK', and 'CANCEL'.

Fig 2.15 Protocol Keys Configuration window for US/CA Region

Clicking 'SETUP' for CH MASK in Test Configuration window shows a popup window for modification of one of channel frequencies.

Click the [ADVANCED](#) button in order to see detail channel information as the following configuration parameter window.

CONFIGURATION

TEST MODE END DEVICE TEST

REGION KR_920

LoRaWAN 1.0.2

ACTIVATION OTAA

CLASS Class A

PROTOCOL PARAMETERS

ACTIVATION PARAM
☒ TestMode @Activation ☐ Check EUI

APP_KEY 0x 00000000000000000000000000000000 32 digits
DEV_EUI 0x 0000000000000000 16 digits
APP_EUI 0x 0000000000000000 16 digits

APPS 0x 00000000000000000000000000000000 32 digits
NWKS 0x 00000000000000000000000000000000 32 digits
DEV_ADDR 0x 00000001 8 digits

LINK

NETWORK

PUBLIC

ADR

ON

DOWNLINK SLOT

RX1

MAC_RSP : JOIN_ACCEPT

NET ID

0x 1

DEV_ADDR

0x 1

RF PARAM

TX POW

-10.0

dBm

PATHLOSS

0.0

dB

FREQ OFFSET

0

ppm

TIME OFFSET

0

us

CHANNEL GROUP & MASK

OPERATOR LoRaWAN

CH MASK 0x FF

CHANNEL INFO.

RX2 FREQ

921.900

MHz

RX2 DR

DR_0

UpLink Channel List		DownLink Channel List	
UL_CH_00	922.100000	DL_CH_00	922.100000
UL_CH_01	922.300000	DL_CH_01	922.300000
UL_CH_02	922.500000	DL_CH_02	922.500000
UL_CH_03	921.900000	DL_CH_03	921.900000
UL_CH_04	922.700000	DL_CH_04	922.700000
UL_CH_05	922.900000	DL_CH_05	922.900000
UL_CH_06	923.100000	DL_CH_06	923.100000
UL_CH_07	923.300000	DL_CH_07	923.300000

▲ BASIC
DEFAULT
OK
CANCEL

Fig 2.16 Modification of Channel Frequency

III. Test Functions

This chapter explains how to use pre-certification tests, RF performance tests, Link Analyzer, and other utilities. With test functions, user can select test mode of test items, handle test operation, and setup test environment.

- 3.1 Certification Test
- 3.2 Performance Test
- 3.3 Link Analyzer
- 3.4 Utilities

3.1 Certification Test

3.1.1 LoRaWAN Certification

There are five regional LoRaWAN Certification functions such as EU, US/CA, AS, KR, and IN. Other regional certification functions will be added as soon as they are published. If you select one of the certification functions, regional parameters will be configured automatically according to the certification.

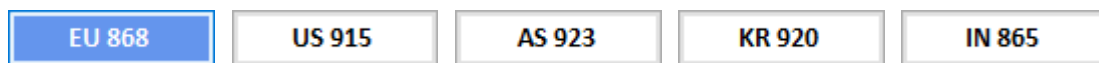


Fig 3.1 Selection of Region for LoRaWAN Certification Test

3.1.2 Operator Certification

There are two Operator Certification option, SKT and ICA. Other private certifications could be added according to further requests.



Fig 3.2 Selection of Region for Operator Certification Test

3.1.3 Certification Test Items

All regional certification test items are according to the LoRaWan regional specification version 1.02 including optional test items. All test items are tree structures and selectable one by one.

3.1.3.1 Meaning of colored text

Each color has the meaning of verdict; the blue-colored is PASSED, the red-colored is FAILED, the black colored is NOT_TESTED, and the Gray is not-selected OPTIONAL item.

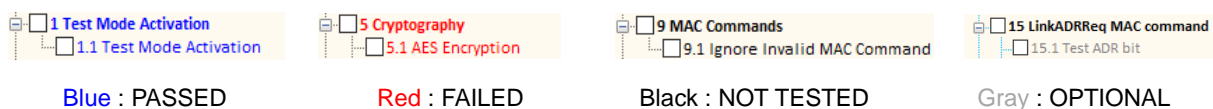


Fig 3.3 Meaning of Text Color

3.1.3.2 Selection and Test Parameter Configuration

Select the test items to be tested by clicking the check boxes in front of the subtitles. If user click a test

item, its test parameters will be shown at the bottom of test items if it has been tested

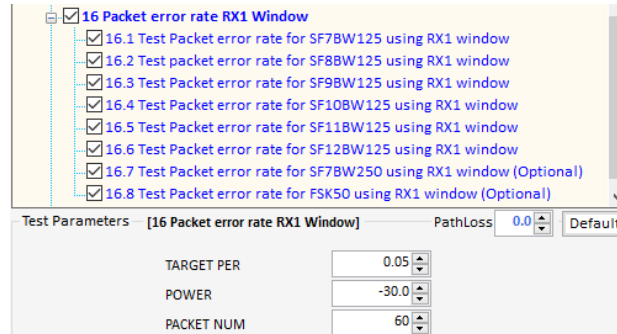




Fig 3.4 Configuration of Test Parameters

3.1.3.3 Start Test

Just click  button and all selected items will be tested sequentially. Keep in mind RWC5020X application program will automatically overwrite the result after each item is tested. Only at the beginning of the test, program warns it will overwrite the previous test result. In other words, the application always keeps the recent test results.

3.1.3.4 Control DUT

If you want to control DUT while test, check the ☒ **Control DUT** check box, then PC application will send control command according to the loaded user control command file. Refer to 2.2.2 for DUT control. You can see the transmitted commands and received responses to/from DUT respectively on DUT control monitor window. Click the  button and a large DUT control monitor will be pop up.

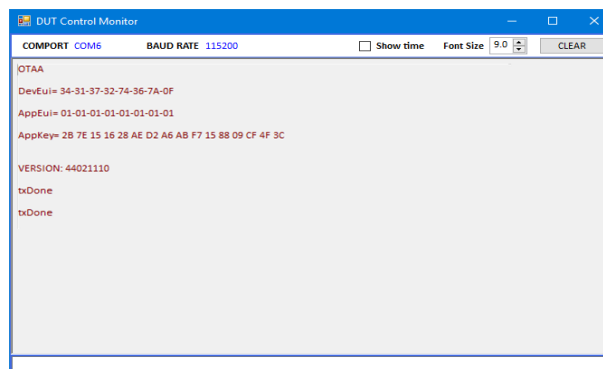


Fig 3.5 DUT Control Monitor

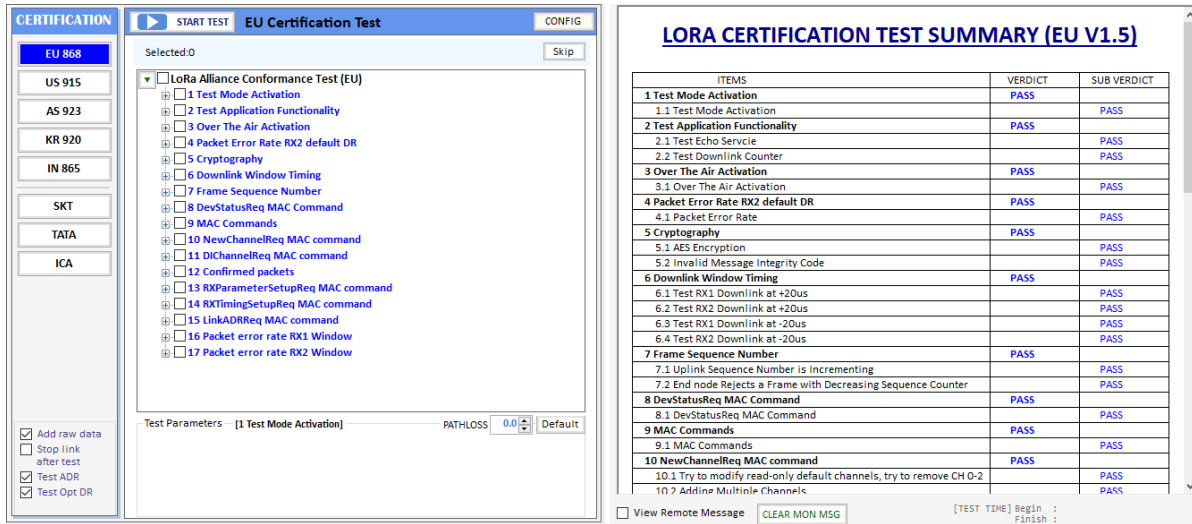
COMPORT and BAUDRATE information of the current control port will be displayed as follows.



Fig 3.6 COMPORT and BAUDRATE after connection.

3.1.3.5 Test Result – Summary Table

When click the certification title, the test summary table will be shown on result window.

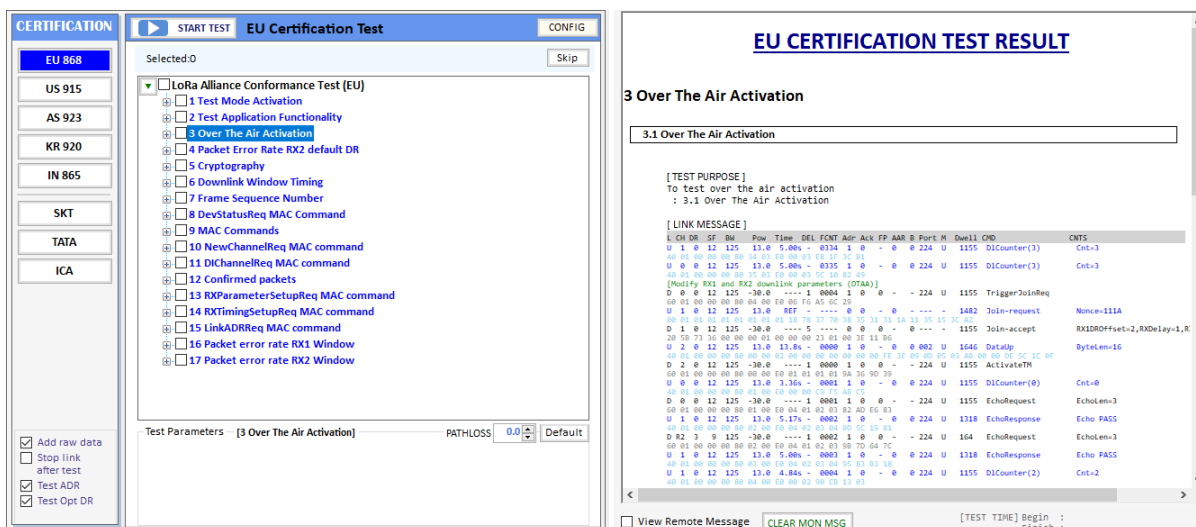


ITEMS	VERDICT	SUB VERDICT
1 Test Mode Activation	PASS	
1.1 Test Mode Activation		PASS
2 Test Application Functionality	PASS	
2.1 Test Echo Service		PASS
2.2 Test Downlink Counter		PASS
3 Over The Air Activation	PASS	
3.1 Over The Air Activation		PASS
4 Packet Error Rate RX2 default DR	PASS	
4.1 Packet Error Rate		PASS
5 Cryptography	PASS	
5.1 AES Encryption		PASS
5.2 Invalid Message Integrity Code		PASS
6 Downlink Window Timing	PASS	
6.1 Test RX1 Downlink at +20us		PASS
6.2 Test RX2 Downlink at +20us		PASS
6.3 Test RX1 Downlink at -20us		PASS
6.4 Test RX2 Downlink at -20us		PASS
7 Frame Sequence Number	PASS	
7.1 Uplink Sequence Number is incrementing		PASS
7.2 End node Rejects a Frame with Decreasing Sequence Counter		PASS
8 DevStatusReq MAC Command	PASS	
8.1 DevStatusReq MAC Command		PASS
9 MAC Commands	PASS	
9.1 MAC Commands		PASS
10 NewChannelReq MAC command	PASS	
10.1 Try to modify read-only default channels, try to remove CH 0-2		PASS
10.2 Add Multiple Channels		PASS

Fig 3.7 Test Result – Summary Table

3.1.3.6 Test Result – Detail Report

Clicking the sub title, detail test result will be shown on result window



EU CERTIFICATION TEST RESULT

3 Over The Air Activation

3.1 Over The Air Activation

[TEST PURPOSE]
To test over the air activation
: 3.1 Over The Air Activation

[LINK MESSAGE]

L	CH	DR	SF	BI	Power	Time	DEL	FONT	ACK	FP	AAR	B	Port	M	Dwell	CHD	CNTS
U	1	0	12	125	13.0	5.00s	-	0334	1	0	-	0	224	U	1155	Dcounter(1)	Cnt=3
U	0	0	12	125	13.0	5.00s	-	0335	1	0	-	0	224	U	1155	Dcounter(1)	Cnt=3
[Modify RX1 and RX2 downlink parameters (OTAA)]																	
U	0	0	12	125	-30.0	----	1	0004	1	0	-	0	224	U	1155	TriggerJoinReq	
GO	01	00	00	00	00	04	00	00	00	00	00	00	00	00	00	00	00
U	1	0	12	125	13.0	REF	----	0	0	-	0	0	224	U	1155	Join-request	Nonce=111A
GO	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01
U	1	0	12	125	-30.0	----	5	0000	1	0	-	0	224	U	1155	Join-accept	RXIDROffset=2,RXDelay=1,R
GO	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
U	2	0	12	125	13.0	13.8s	-	0000	1	0	-	0	062	U	1046	DataUp	ByteLen=16
GO	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
D	2	0	12	125	-30.0	----	1	0000	1	0	-	0	224	U	1155	ActivateTM	
GO	01	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
U	0	0	12	125	13.0	3.36s	-	0001	1	0	-	0	224	U	1155	Dcounter(0)	Cnt=0
GO	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01
U	0	0	12	125	-30.0	----	1	0001	1	0	-	0	224	U	1155	EchoRequest	EchoLen=3
GO	01	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
U	1	0	12	125	13.0	5.17s	-	0002	1	0	-	0	224	U	1118	EchoResponse	Echo PASS
GO	01	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
U	0	0	12	125	-30.0	----	1	0002	1	0	-	0	224	U	1118	EchoRequest	EchoLen=3
GO	01	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
U	1	0	12	125	13.0	5.00s	-	0003	1	0	-	0	224	U	1118	EchoResponse	Echo PASS
GO	01	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
U	1	0	12	125	13.0	4.84s	-	0004	1	0	-	0	224	U	1155	Dcounter(2)	Cnt=2
GO	01	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

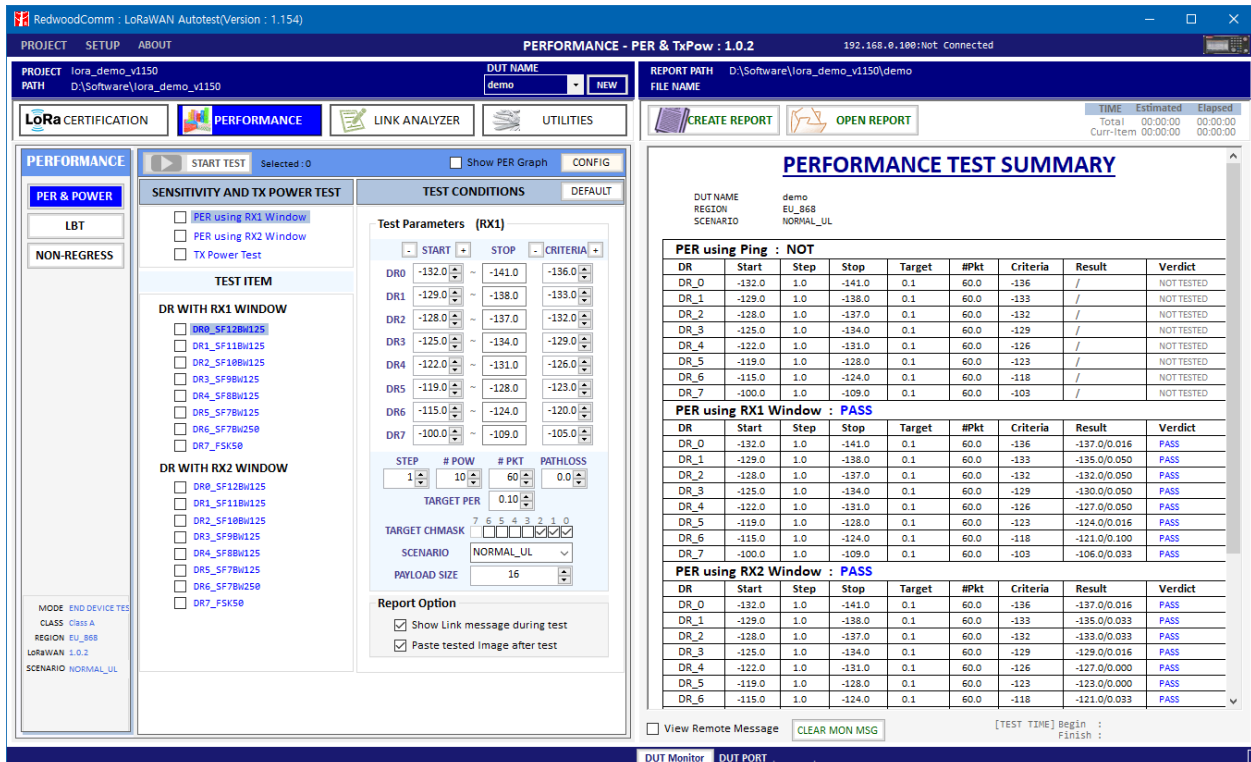
Fig 3.8 Test Result – Detail Report

3.2 Performance Test

Performance test function consists in PER & POWER, LBT, and NON-REGRESS test.

3.2.1 PER & POWER

This function makes RWC5020X search the sensitivity level by measuring the PER (Packet Error Rate) and measure TX power of DUT according to the test configuration and conditions.



The screenshot displays the 'PERFORMANCE - PER & TxPow : 1.0.2' window. The left sidebar shows 'PER & POWER' selected. The main area is divided into 'SENSITIVITY AND TX POWER TEST' and 'TEST CONDITIONS'. The 'TEST CONDITIONS' section includes 'Test Parameters (RX1)' with a table of DR values, 'STEP', '# POW', '# PKT', and 'PATHLOSS'. The 'TEST ITEM' section lists various DR configurations. The 'REPORT PATH' and 'FILE NAME' fields are visible. The right panel shows the 'PERFORMANCE TEST SUMMARY' with three tables: 'PER using Ping : NOT', 'PER using RX1 Window : PASS', and 'PER using RX2 Window : PASS'. Each table lists DR, Start, Step, Stop, Target, #Pkt, Criteria, Result, and Verdict.

DR	Start	Step	Stop	Target	#Pkt	Criteria	Result	Verdict
DR_0	-132.0	1.0	-141.0	0.1	60.0	-136	/	NOT TESTED
DR_1	-129.0	1.0	-138.0	0.1	60.0	-133	/	NOT TESTED
DR_2	-128.0	1.0	-137.0	0.1	60.0	-132	/	NOT TESTED
DR_3	-125.0	1.0	-134.0	0.1	60.0	-129	/	NOT TESTED
DR_4	-122.0	1.0	-131.0	0.1	60.0	-126	/	NOT TESTED
DR_5	-119.0	1.0	-128.0	0.1	60.0	-123	/	NOT TESTED
DR_6	-115.0	1.0	-124.0	0.1	60.0	-118	/	NOT TESTED
DR_7	-100.0	1.0	-109.0	0.1	60.0	-103	/	NOT TESTED

DR	Start	Step	Stop	Target	#Pkt	Criteria	Result	Verdict
DR_0	-132.0	1.0	-141.0	0.1	60.0	-136	-137.0/0.016	PASS
DR_1	-129.0	1.0	-138.0	0.1	60.0	-133	-135.0/0.050	PASS
DR_2	-128.0	1.0	-137.0	0.1	60.0	-132	-132.0/0.050	PASS
DR_3	-125.0	1.0	-134.0	0.1	60.0	-129	-130.0/0.050	PASS
DR_4	-122.0	1.0	-131.0	0.1	60.0	-126	-127.0/0.050	PASS
DR_5	-119.0	1.0	-128.0	0.1	60.0	-123	-124.0/0.016	PASS
DR_6	-115.0	1.0	-124.0	0.1	60.0	-118	-121.0/0.100	PASS
DR_7	-100.0	1.0	-109.0	0.1	60.0	-103	-106.0/0.033	PASS

DR	Start	Step	Stop	Target	#Pkt	Criteria	Result	Verdict
DR_0	-132.0	1.0	-141.0	0.1	60.0	-136	-137.0/0.016	PASS
DR_1	-129.0	1.0	-138.0	0.1	60.0	-133	-135.0/0.033	PASS
DR_2	-128.0	1.0	-137.0	0.1	60.0	-132	-133.0/0.033	PASS
DR_3	-125.0	1.0	-134.0	0.1	60.0	-129	-129.0/0.016	PASS
DR_4	-122.0	1.0	-131.0	0.1	60.0	-126	-127.0/0.000	PASS
DR_5	-119.0	1.0	-128.0	0.1	60.0	-123	-123.0/0.000	PASS
DR_6	-115.0	1.0	-124.0	0.1	60.0	-118	-121.0/0.033	PASS

Fig 3.9 Performance Test

3.2.2.1 Test Configuration

Click **CONFIG TEST** to set up the test configuration: Region, DUT Type, Class, test scenario, channels, and so on. There are three types of DUT; END DEVICE, GATEWAY, and NON-SIGNAL. Available test items may be different according to the selection of Region and DUT Type parameters. There are two types of test scenario to measure PER; NORMAL_UL and CERTI_ECHO. The CERTI_ECHO requires DUT to support Certification test mode and applicable only to END DEVICE test. The NORMAL_UL uses confirmed signaling to check packet loss.

3.2.2.2 Selection and Test Condition Configuration

Select the test items to be tested by clicking the check boxes in front of the subtitles. If you click a test item, its test conditions will be shown at the right side of test items.

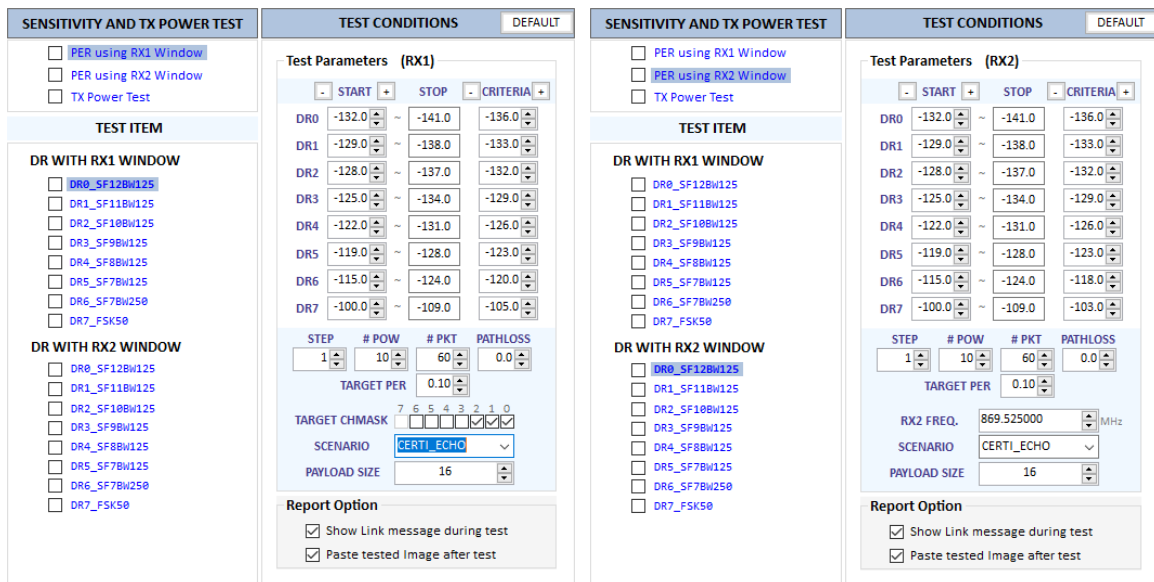


Fig 3.10 Test Conditions for PER using RX1 and RX2 Window

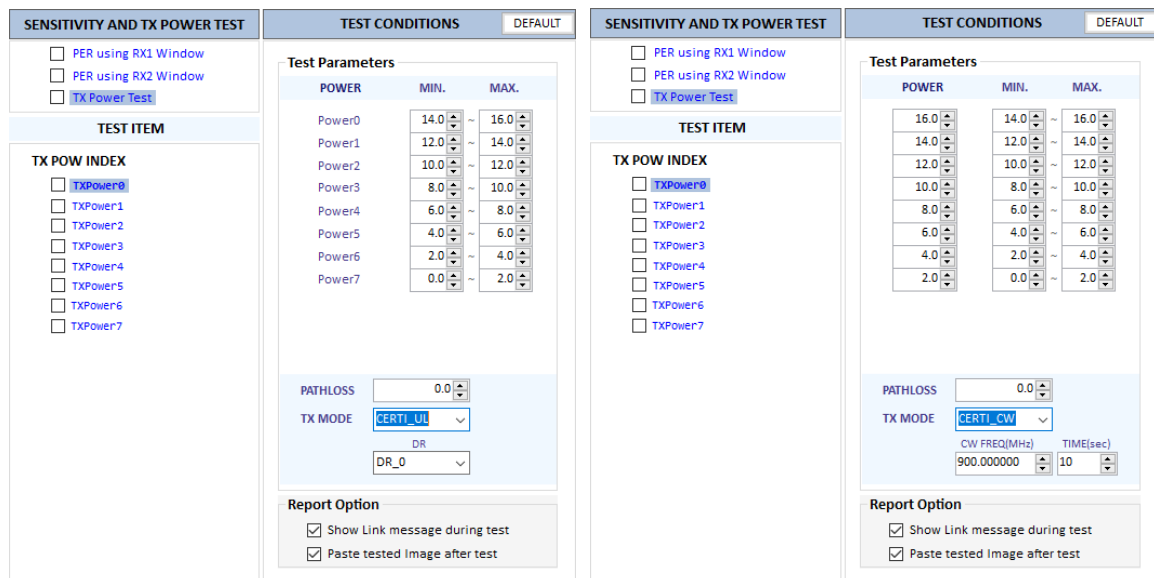


Fig 3.11 Test Conditions for TX Power Test using Lora Signal or CW

3.2.2.3 Start Test

If  button is clicked, the selected test items will be tested sequentially.

3.2.2.4 Test Result – Summary Table

When the tile **SENSITIVITY AND TX POWER TEST** is clicked, the test result summary table will be shown on the result window

PERFORMANCE TEST SUMMARY (demo)

DUT NAME
REGION
SCENARIO

demo
EU_868
CERTI_ECHO

PER using RX1 Window : PASS									
DR	Start	Step	Stop	Target	#Pkt	Criteria	Result	Verdict	
DR_0	-132.0	1.0	-141.0	0.1	60.0	-136	-137.0/0.016	PASS	
DR_1	-129.0	1.0	-138.0	0.1	60.0	-133	-135.0/0.016	PASS	
DR_2	-128.0	1.0	-137.0	0.1	60.0	-132	-133.0/0.083	PASS	
DR_3	-125.0	1.0	-134.0	0.1	60.0	-129	-129.0/0.033	PASS	
DR_4	-122.0	1.0	-131.0	0.1	60.0	-126	-127.0/0.016	PASS	
DR_5	-119.0	1.0	-128.0	0.1	60.0	-123	-124.0/0.066	PASS	
DR_6	-115.0	1.0	-124.0	0.1	60.0	-118	-121.0/0.100	PASS	
DR_7	-100.0	1.0	-109.0	0.1	60.0	-103	-107.0/0.083	PASS	
PER using RX2 Window : PASS									
DR	Start	Step	Stop	Target	#Pkt	Criteria	Result	Verdict	
DR_0	-132.0	1.0	-141.0	0.1	60.0	-136	-138.0/0.083	PASS	
DR_1	-129.0	1.0	-138.0	0.1	60.0	-133	-135.0/0.033	PASS	
DR_2	-128.0	1.0	-137.0	0.1	60.0	-132	-132.0/0.083	PASS	
DR_3	-125.0	1.0	-134.0	0.1	60.0	-129	-129.0/0.000	PASS	
DR_4	-122.0	1.0	-131.0	0.1	60.0	-126	-127.0/0.000	PASS	
DR_5	-119.0	1.0	-128.0	0.1	60.0	-123	-124.0/0.050	PASS	
DR_6	-115.0	1.0	-124.0	0.1	60.0	-118	-120.0/0.000	PASS	
DR_7	-100.0	1.0	-109.0	0.1	60.0	-103	-106.0/0.050	PASS	
TX Power Test : PASS									
POW	CH0	CH1	CH2	CH3	CH4	CH5	CH6	CH7	Verdict
0	12.6	12.5	12.6						PASS
1	11.0	10.8	10.9						PASS
2	8.0	8.3	8.3						PASS
3	5.4	5.3	5.5						PASS
4	3.1	3.1	3.3						PASS
5	0.8	0.8	0.8						PASS
6	-1.1	-1.0	-1.4						PASS
7	1.2	1.0	1.4						PASS

Fig 3.12 Test Result – Summary Table

3.2.2.5 Test Result – Detail Report

When the subtitle **PER using RX1 Window** is clicked, all tested results will be shown on the result window from SF12 to SF7 at the same time. When the test item title is clicked, the selected item's test result will be shown on the result window.

PERFORMANCE TEST RESULT	
PER using RX1 Window : DR0_SF12BW125	
[TEST CONDITION]	
[PROTOCOL CONFIGURATION]	
REGION	EU_868
CHANNEL	0x7
DUT TYPE	END DEVICE TEST
CLASS	Class A
SCENARIO	CERT_ECHO
PAYLOAD LENGTH	16
[SENSITIVITY]	
START POWER	-132.0 dBm
STEP POWER	1.0 dB
NUMBER OF POWER	10
STOP POWER	-141.0 dBm
PATH LOSS	0.0
RX Window	RX1
RX SPREADINGFACTOR	DR0_SF12BW125
NUMBER OF PACKET	60
Target PER	0.1
SENSITIVITY CRITERIA : -136 dBm	
[TEST RESULT]	
[SENSITIVITY RESULT]	
Measured PER	0.0
Measured Sensitivity	-137.0 dBm
[VERDICT]	
PASS	
[Elapsed Time] 00:48:03	

Fig 3.13 Test Result – Detail Report

3.2.2.6 Report Option

There are two options for reporting the test results as the following figure.

Report Option

☐ Show Link message during test

☐ Paste tested Image after test

Fig 3.14 Report Option

If “Show Link Message during test” is checked, Link messages during test will be attached in the test report.

[LINK MESSAGE]												
L	CH	SF	BW	POW	TIME	FCNT	Adr	Ack	B	FP	M	CMD
U	0	7	125	11.6	REF	----	0	0	-	---	-	Join-request
D	0	7	125	-30.0	----	----	0	0	-	---	-	Join-accept
U	2	12	125	11.8	7.80s	0000	0	0	-	002	U	DataUp
D	2	12	125	-30.0	----	0001	0	0	-	224	U	ActivateTM
U	1	12	125	11.9	8.44s	0001	0	0	-	224	U	DownlinkCounter
D	1	12	125	-30.0	----	0002	0	0	-	000	U	LinkADRReq
U	1	12	125	11.8	5.18s	0002	0	0	-	224	U	LinkADRAns
D	1	12	125	-30.0	----	0003	0	0	-	224	U	EchoRequest
U	0	12	125	11.8	5.35s	0003	0	0	-	224	U	EchoResponse
D	0	12	125	-132.0	----	0004	0	0	-	224	U	EchoRequest
U	2	12	125	11.8	5.02s	0004	0	0	-	224	U	EchoResponse

Fig 3.15 Link Messages attached in Test Report

If “Paste tested Image after test” is checked, the result figure will be attached in the test report.

[SENSITIVITY RESULT]

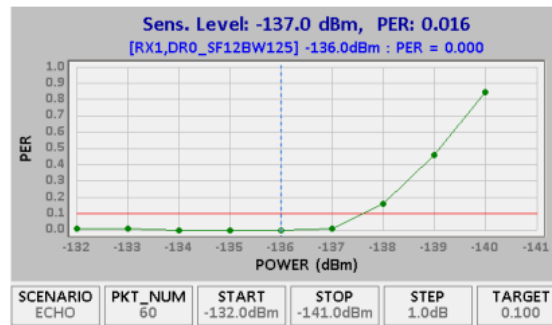


Fig 3.16 Result Figure attached in Test Report

3.2.2.7 Change SF during test

If “Change SF during test” is checked, it makes RWC5020X send commands to make DUT change spreading factor according to the test item.

3.2.2.8 Show Result Graph

If “Show Result Graph” is checked, it shows PER curve or TX power graph while or after test as the following figure.

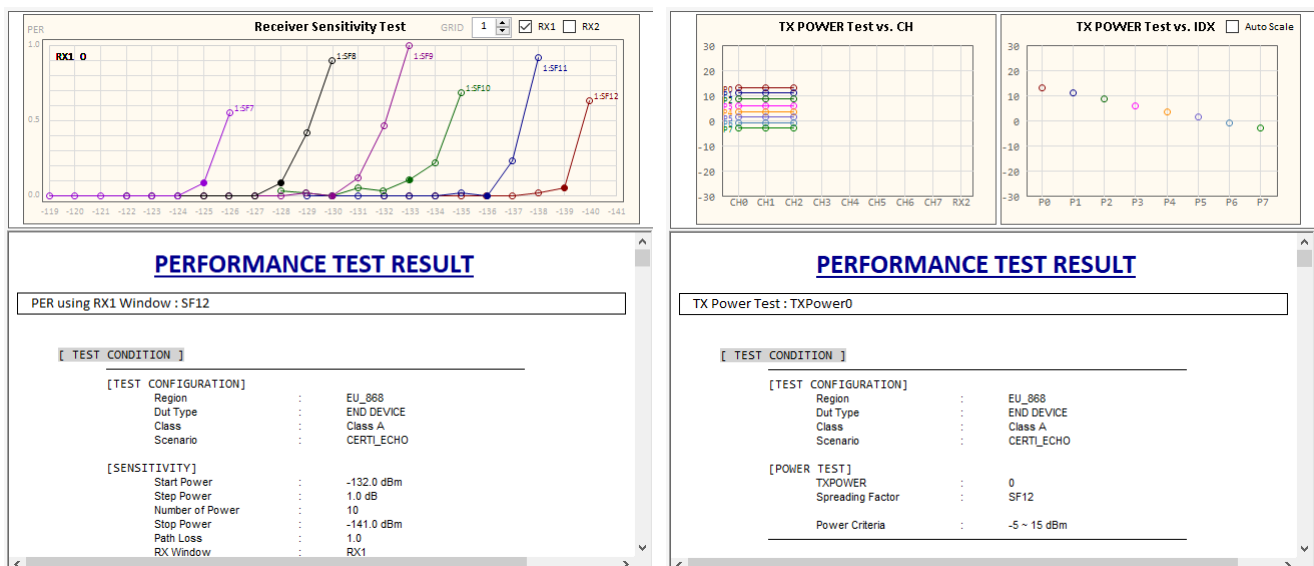


Fig 3.17 Show Result Graph of PER and TX Power

3.2.2.9 View Remote Message

If “View Remote Message” is checked, it shows remote control commands and responses between the application and RWC5020X.



Fig 3.18 Remote Message

3.2.3 LBT Test

RWC5020X application provides LBT(listen before talk) test function.

User has to prepare RWC2020A LBT interferer for this function. Connect RWC5020X and RWC2010A with RS232 cable. RWC2020A will be controlled by RWC5020X through RS232 cable while LBT testing. RWC2020A will transmit interference signals as you set up in this application program. RWC5020X supports 8 channel interferer signals at the same time. RWC2020A is mandatory for this test.

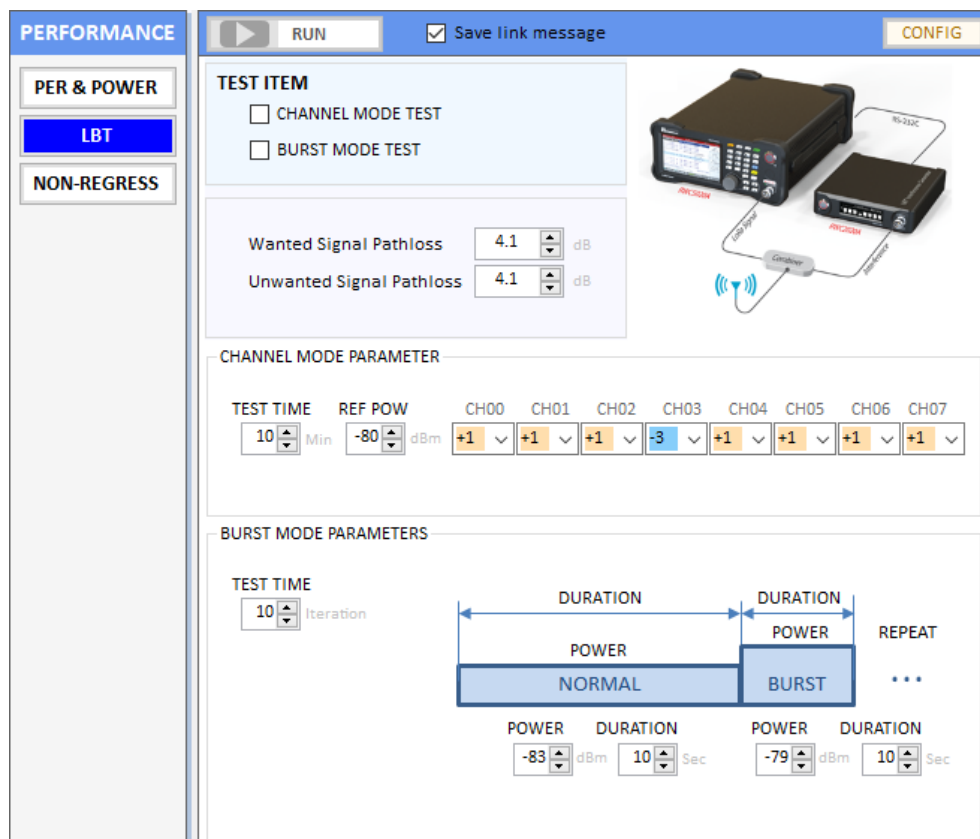



Fig 3.19 LBT Scenario configuration window

3.2.3.1 Checking the connection to RWC2020A

User must check whether RWC2020A is connected or not by clicking  before LBT test. LBT test will not be run without RWC2020A LBT interferer.

3.2.3.2 Test Scenarios

The application provides two scenarios, channel and burst mode test.

In the channel mode test, RWC2020A transmit signal as a multi-tones in multi-channel that user selected simultaneously. User can set the test duration, reference power, and relative sub-channel power of RWC2020A interfering signal.

In the burst mode test, RWC2020A alternatively transmits multi-tones according to the time schedule. User can setup the time duration of each signal burst.

RWC5020X will make RWC2020A set the reference power, relative sub-channel powers before test.

3.2.3.3 Channel mode test

User can configure the reference power and relative sub channel power of RWC2020A interfering signal. If you set the same as fig 3.20, RWC2020A generates eight interfering tones and each channel power will be set as the table.

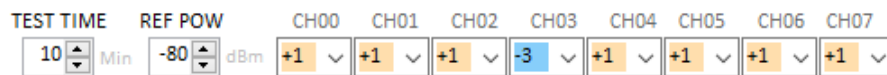


Fig 3.20 LBT Channel mode configuration

CH	0	1	2	3	4	5	6	7
Power (dBm)	-79	-79	-79	-83	-79	-79	-79	-84

3.2.3.4 Burst mode test

In burst mode test, user can configure the power and the duration of each burst signal as well as test iteration. RWC2020A alternatively transmits two burst signals according to the power and duration.

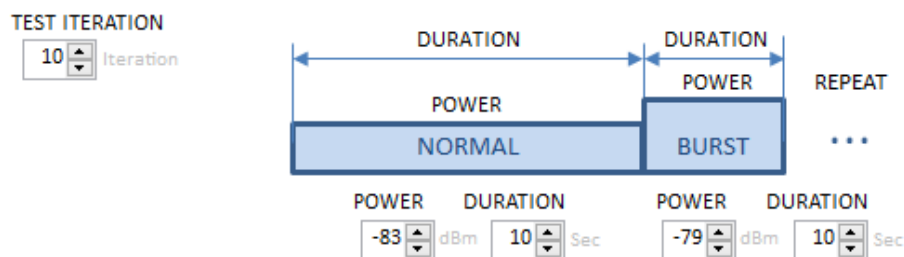



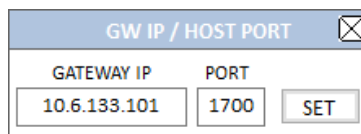
Fig 3.21 LBT Burst mode configuration

3.2.3.4 Starting LBT test and result

Clicking  make RWC5020X start communication with DUT and RWC2020A generate interference signal. While testing, RWC5020X counts up received packets per channel and display the result. The DUT shall not use channels whose interference signal is above the reference value as a normal operation.

3.2.4 NON-REGRESSION

Non-regression test consists in 5 automated test function such as TX output power calibration, PER/RSSI/SNR, sensitivity, frequency error tolerance, and CW interferer immunity test. RWC5020X Application software provides minimal amount of server functionality to respond to the request from a gateway. In order to let RWC5020X know the IP and the port of gateway, user has to set them manually.



GW IP / HOST PORT	
GATEWAY IP	PORT
10.6.133.101	1700
SET	

Fig 3.22 The IP and PORT setup window

3.2.4.1 TX output power calibration

This function measures TX output power of the DUT(gateway) and shows the power properties and make property table.

In this test, the RWC5020X application program makes DUT transmit signal according to the setup power through LAN with JSON and RWC5020X equipment measures the TX power of the gateway. User can use this function a calibrator for gateway.

User can setup power start, power step, number of powers, and number of packets.



TX POWER CALIBRATION PARAMETERS				
POW START	POW STEP	# POW	POW STOP	# PACKET
13 dBm	1 dB	8	10 dBm	10

Fig 3.23 Parameters for TX PWER CALIBRATION

User cannot change stop power. It will be calculated according to the power start and power step values automatically.

3.2.4.2 PER/RSSI/SNR

This function measures the PER(packet error rate) and read and show the RSSI(Rx Signal Strength Indication) and SNR(Signal to Noise Ratio) information from the gateway using JSON.

In this test, RWC5020X transmits LoRa signal and RWC5020X application program asks the gateway for RSSI, SNR and the number of packet it received. RWC5020X application programs will calculate PER with the number of packet received and show the result graphically.

Power step is fixed at 1dB and Power range is also fixed.

PER/RSSI/SNR TEST PARAMETERS

PACKET

10

POW STEP 1 dB

Fig 3.24 Parameters for PER/RSSI/SNR

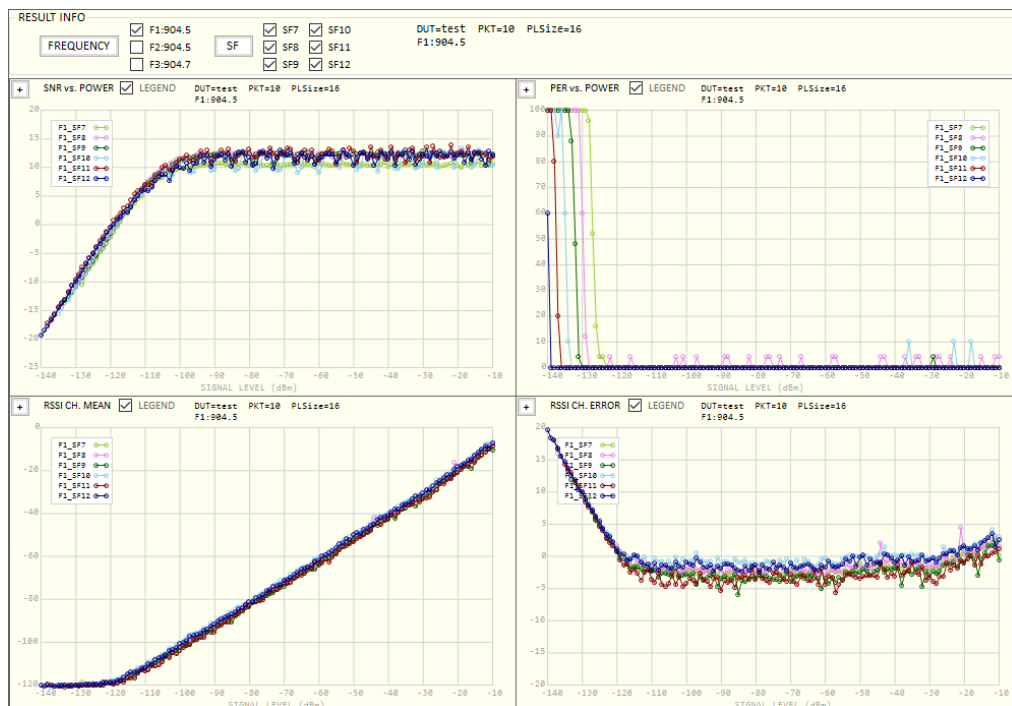


Fig 3.25 The test result of PER/RSSI/SNR

3.2.4.3 SENSITIVITY

This function measures the PER(packet error rate) with respect to the power and search the sensitivity using the PER result.

In this test, RWC5020X transmits LoRa signal and RWC5020X application program asks the gateway the number of packet it received. RWC5020X application programs will calculate PER using the

number of packet which it received and show the result graphically.

Power step is fixed at 1dB and Power range is also fixed.

More transmit packets will make more reliable result.

SENSITIVITY and PER TEST PARAMETERS

PACKET

10

POW STEP

1 dB

Fig 3.26 Parameters for SENSITIVITY

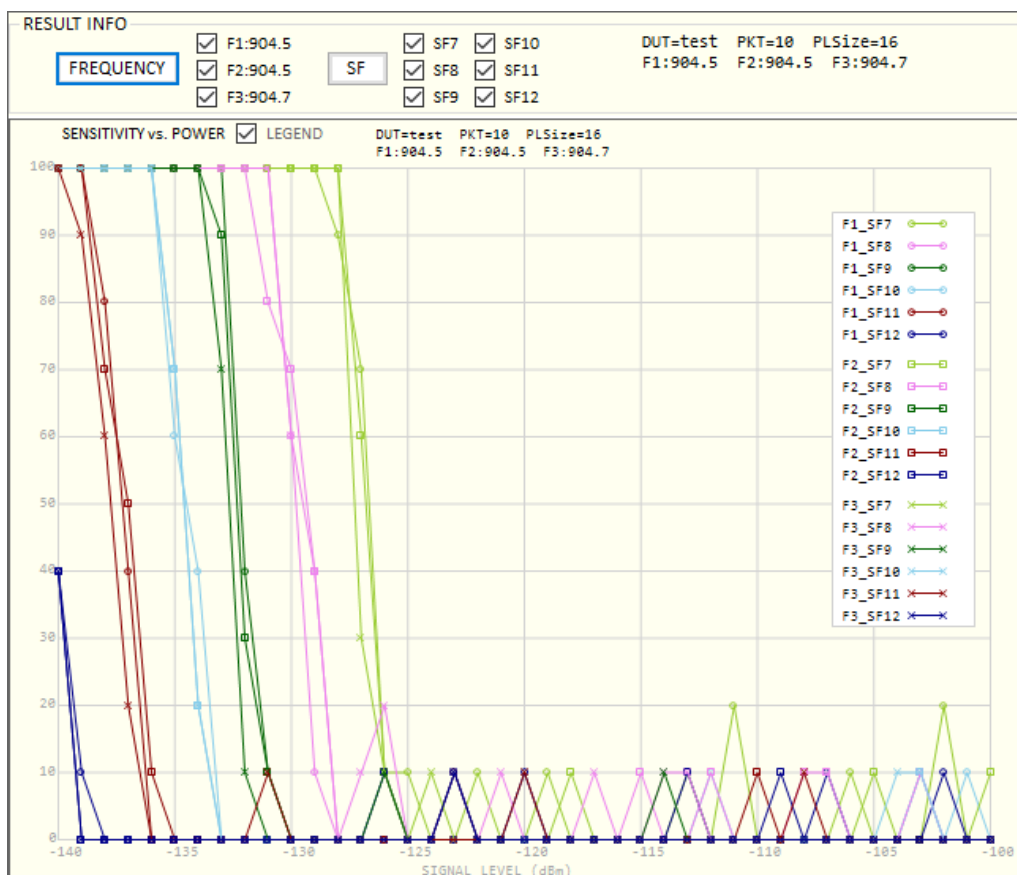


Fig 3.27 The test result of SENSITIVITY

3.2.4.4 Frequency error tolerance

This function measures the immunity properties against frequency error of the DUT(gateway) using the packet error rate.

In this test, RWC5020X transmits LoRa signal with frequency offset and RWC5020X application program asks the gateway for the number of packet which it received. RWC5020X application programs will calculate PER using the number of packet received.

TX Power of RWC5020X is fixed at -100dBm and frequency offset step is fixed at 1.0ppm.
User may change the number of packets to be tested.

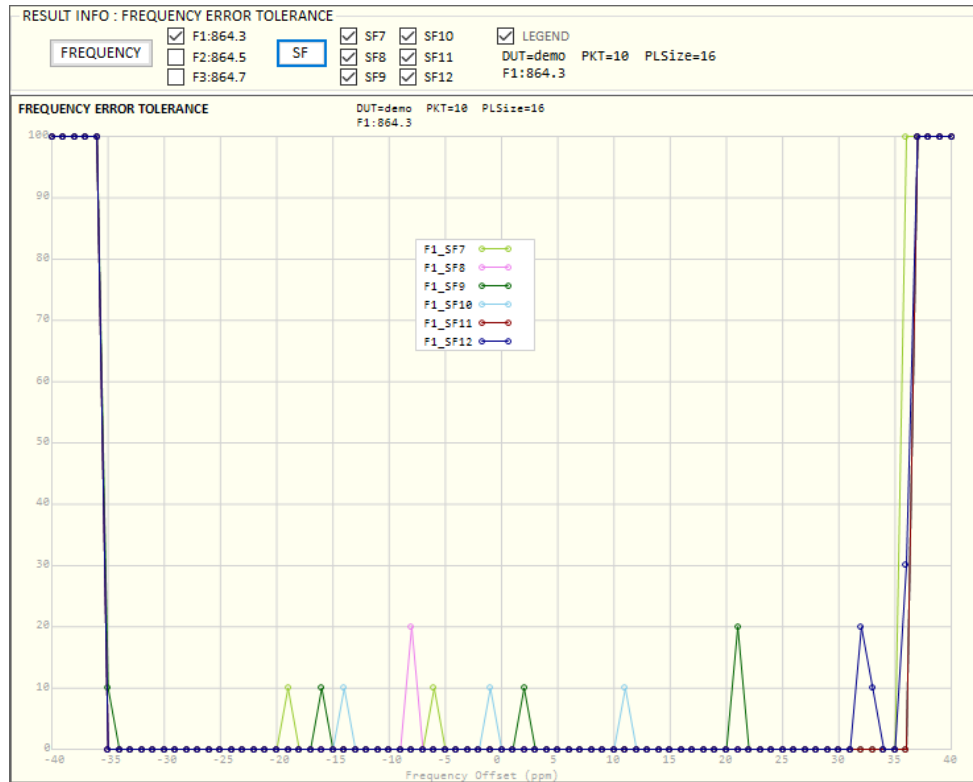


Fig 3.28 A test result Example of FREQUENCY ERROR TOLERANCE

3.2.4.5 CW immunity against the interferences with frequency offset.

This function measures the immunity properties of the gateway against interference signal.

In this test, RWC5020X transmits LoRa signal as a wanted signal, RWC2020A transmits CW as an interferer and RWC5020X application program asks the gateway for the number of packet received while testing. RWC5020X application programs search the power of which PER meets the target while PER calculating current PER using the number of packet gateway received. User can set interference frequencies and each power for the each spreading factor respectively.

RWC2020A interferer generator is mandatory for this test.

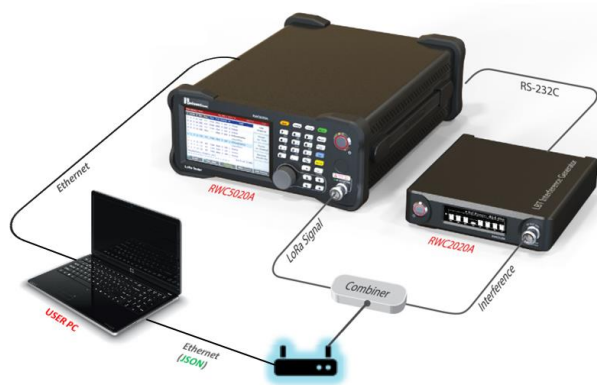


Fig 3.29 CW Interferer test environment

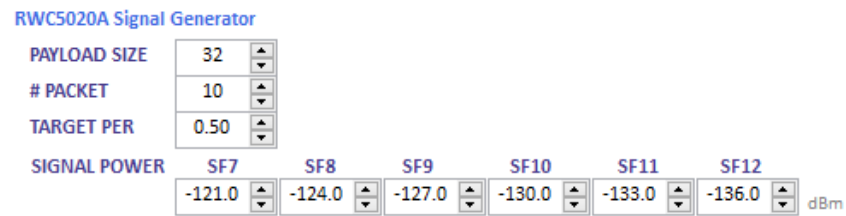


Fig 3.30 CW Interferer test parameters

The following figure is a test result with a frequency and SFs.

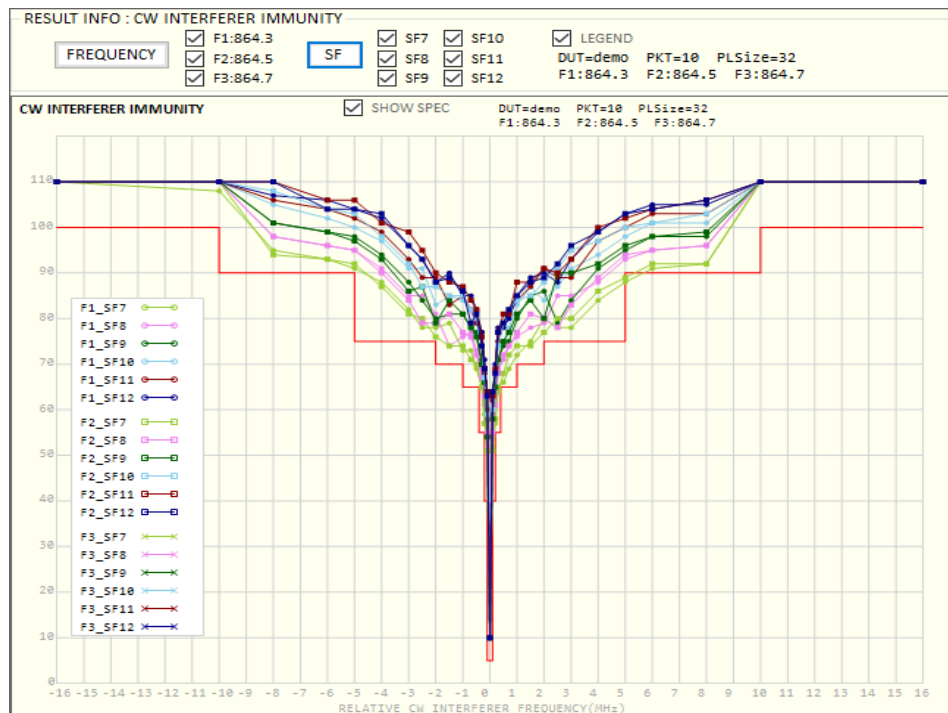


Fig 3.31 The test result of CW Interferer Immunity

3.3 Link Analyzer

Link Analyzer helps to dump all link messages from RWC5020X while communicating with DUT. In addition, users can make script and play it using 'script editor'. Users can add or remove a command group called action which includes single or multiple MAC command.

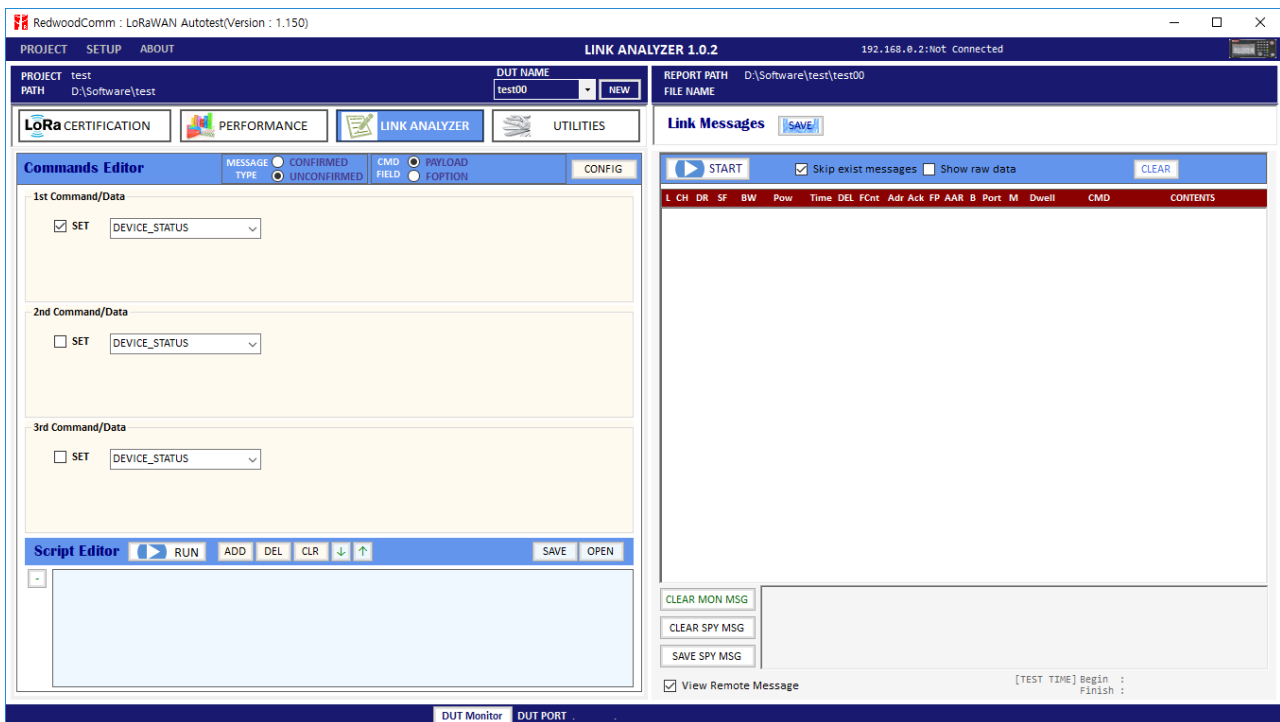




Fig 3.32 Link Analyzer

3.3.1 Dumping link message

Clicking  button of link message window makes RWC5020X start dumping link messages between RWC5020X and DUT line by line. Clicking  button makes RWC5020X stop dumping.

3.3.2 Commands editor

With or without dumping, you can edit MAC commands into link script editor window. We named a script component which include a single or multiple commands, information, and sleep time as an action.

In order to add an action, you have to make ☒ SET checked which you want to add. Clicking add button you can add commands and information automatically as you set. If you want to select multiple MAC commands in a single frame, click multiple set check box for each MAC CMD. The maximum number of multiple MAC commands in a frame is three with RWC5020X.

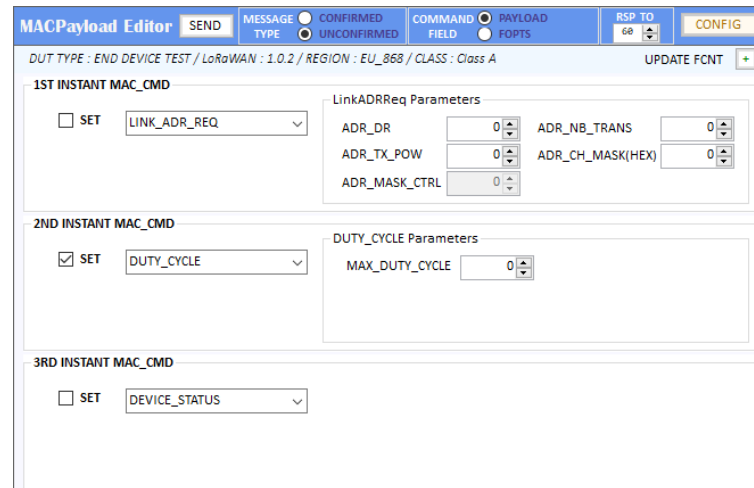


Fig 3.33 Commands Editor

3.3.3.2 MESSAGE TYPE

You can select the message type using MESSAGE TYPE option.
 CONFIRMED or UNCONFIRMED

3.3.3.3 COMMAND FIELD

If you select COMMAND FIELD as the PAYLOAD, you can send a single or multiple commands in PAYLOAD.

If you select COMMAND FIELD as the FOPTS, you can send a single or multiple commands in FOPTS field and user data in PAYLOAD field. When you select FOPTS, you can set PAYLOAD data as you wish.

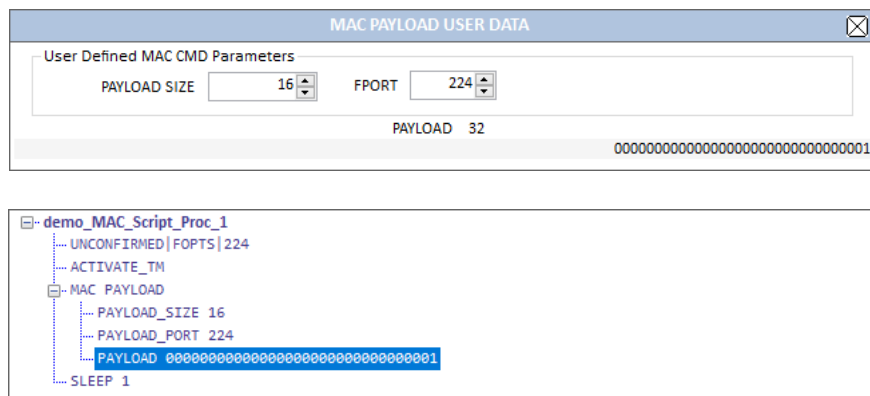


Fig 3.34 MAC PAYLOAD USER DATA Editor and script

3.3.3.4 RESPONSE TIME OUT

RWC5020X will wait the DUT's response according to the RSP_TO value.

Unit : second.

Range : 10~ 600 second



Fig 3.35 Response time out value

3.3.3 Script editor

3.3.3.1 Adding actions

You can edit MAC commands into link script editor window using      buttons.

Script editor does not check that the commands are same or not. It means same commands can be added single action. You must check whether it is intended or not by yourself.

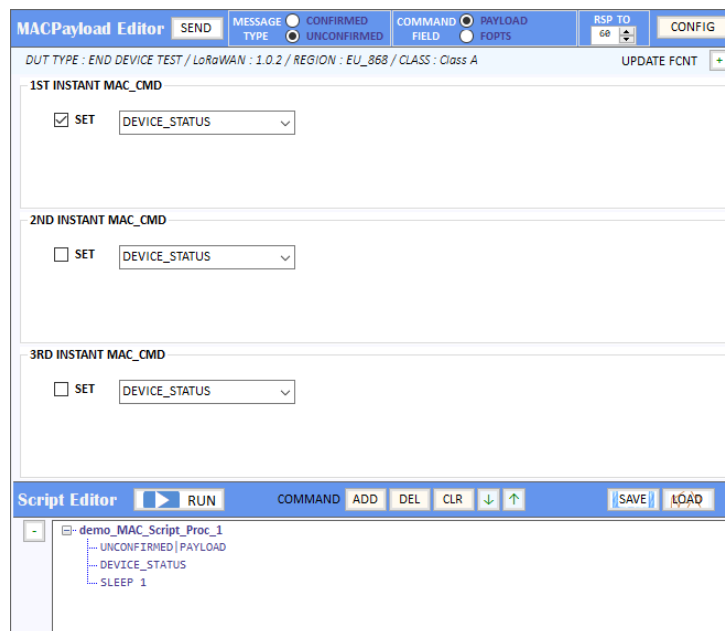


Fig 3.36 Adding an actor into Script Editor

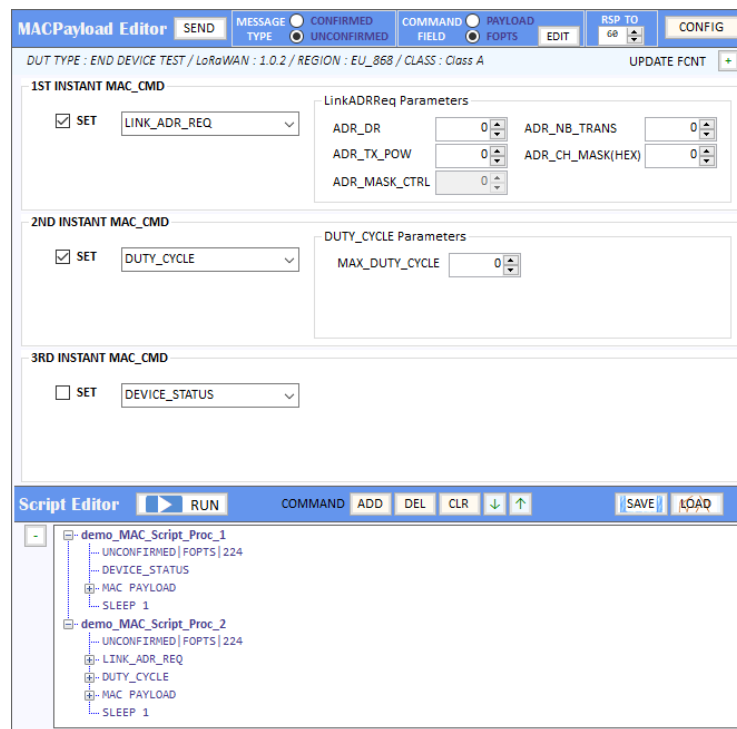


Fig 3.37 Adding an actor that includes a 2 commands

SLEEP makes RWC5020X be waited until the noticed time is expired in second unit before sending the next command. You can edit the time values.

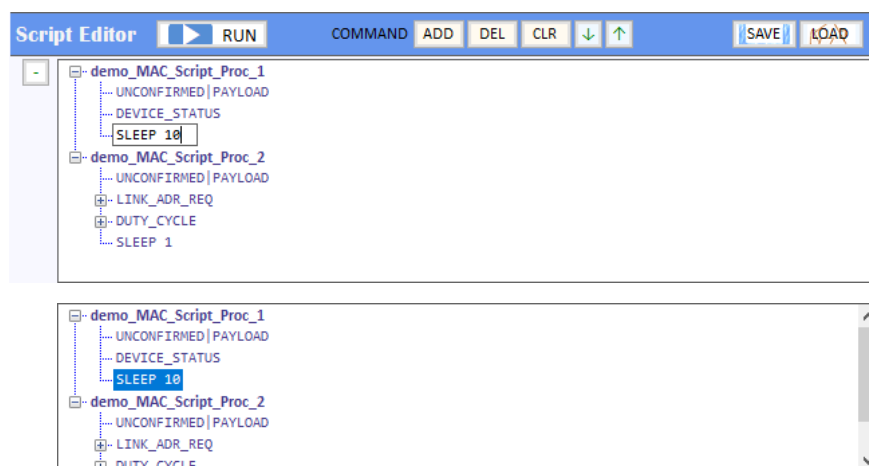



Fig 3.38 Editing SLEEP time between actions

3.3.3.2 Moving actions

You can move actions up or down using   buttons. At first select action and move it.

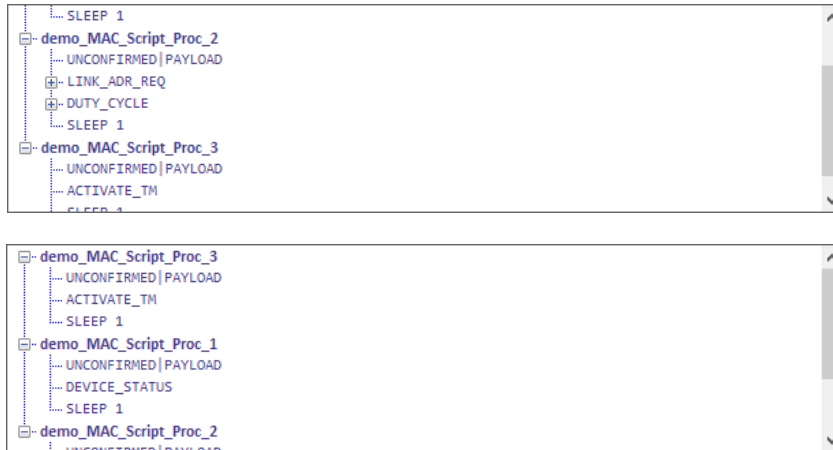


Fig 3.39 Moving action.

3.3.3.3 Deleting actions

You can delete action by clicking [DEL] button. Script editor dose not ask whether you delete it or not.

Delete actions carefully. You may not delete commands but an actions.

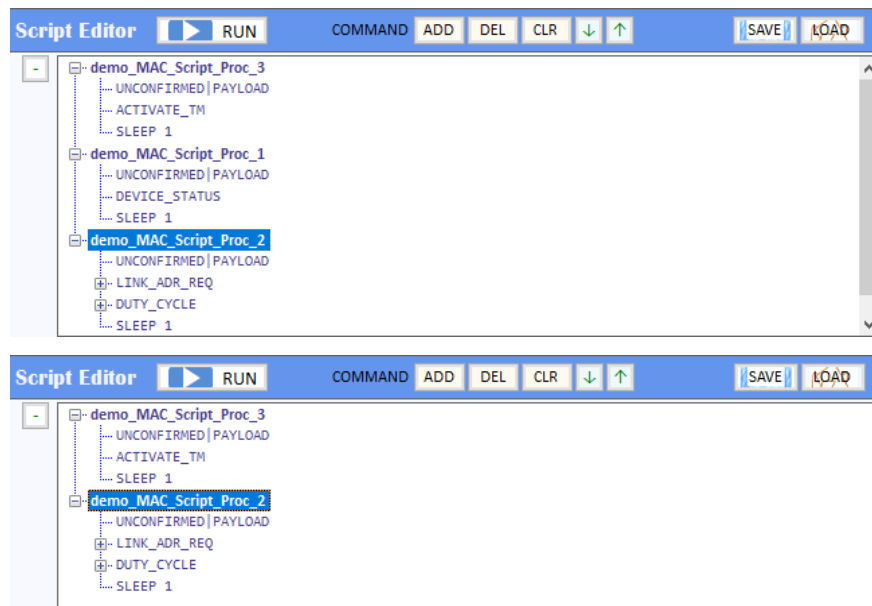


Fig 3.40 Deleting action.

3.3.3.4 Renaming actions

You can edit the name of action or parameters even command by yourself.

Just click left mouse button and edit as you want to. Application does not verify the commands and

parameters. Rename very carefully.

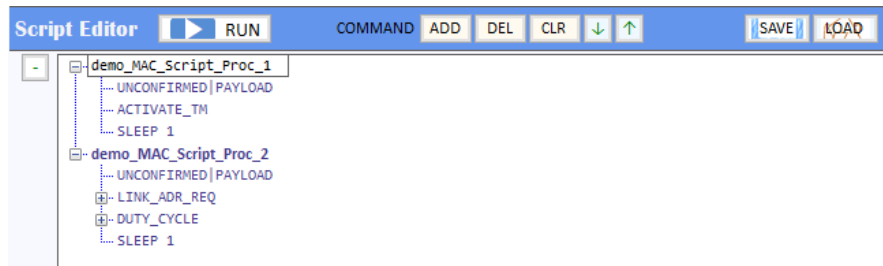



Fig 3.41 Renaming action title.


Define the PAYLOAD TYPE as UNCONFIRMED or CONFIRMED and define the CMD FIELD as PAYLOAD or FOPTION. You can verify what you selected from action's information

UNCONFIRMED|FOPTION|224

3.3.3.5 Running actions

Clicking **Script Editor**  makes RWC5020X send MAC commands to DUT according to the script. Before run script, RWC5020X must be in running link analyzer. If it is not in running link analyzer, application will let RWC5020X run link analyzer automatically while running script.

3.3.3.6 Saving Script

You can save the script what you have edited for next time using. After modifying your script, click  and select folder where you want to save it.

3.3.3.7 Opening Script

You can recall the script what you have saved before. Just click  and select saved script file.


3.4 Utilities

It consists of 5 functions: DUT Control, Tester(RWC5020X) Control, Screen capture, and manufacturing test function.

3.4.1 DUT Control

This function is a simple terminal tool. It helps user control DUTs through RS232 using string command. User can transmit DUT control commands all by one click or line-by-line.

3.4.1.1 How to Use

Just typing user own remote control commands and clicking  transmits commands to RWC5020X sequentially. User can use a special command SLEEP which just lets PC wait transmitting for described time. The parameter of SLEEP is time in millisecond unit, e.g., SLEEP 1000 makes PC wait for 1000ms.

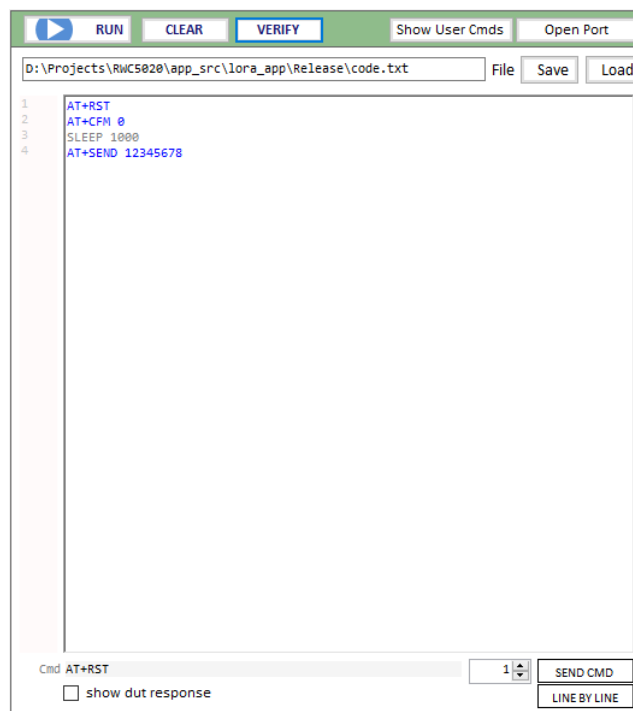



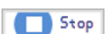
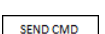
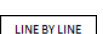
Fig 3.42 DUT Control

3.4.1.2 Verify Commands

Clicking  verifies the commands on editor. Verifying criteria is based on the loaded user

commands. Verified commands will be colored. The blue colored commands are user commands, and the grey colored ones are not user commands.


3.4.1.3 Transmit Methods

Clicking  starts transmitting commands. Transmitting commands will be stopped if you click  or all commands are transmitted. Clicking  transmits the selected command. Clicking  transmits listed commands line by line.

3.4.2 Tester (RWC5020X) Control

This function is a simple terminal tool. It helps user control RWC5020X through LAN using string command. User can transmit RWC5020X remote commands all by one click or line-by-line.

3.4.2.1 How to Use

Clicking  starts transmitting commands on command window sequentially. User can use a special command SLEEP. It makes PC wait for transmitting the next command. The parameter of SLEEP is time in millisecond unit, e.g., SLEEP 1000 makes PC wait for 1000ms.

3.4.2.2 Template

Template functions will fill the commands window with ready-made commands sequence as an example.

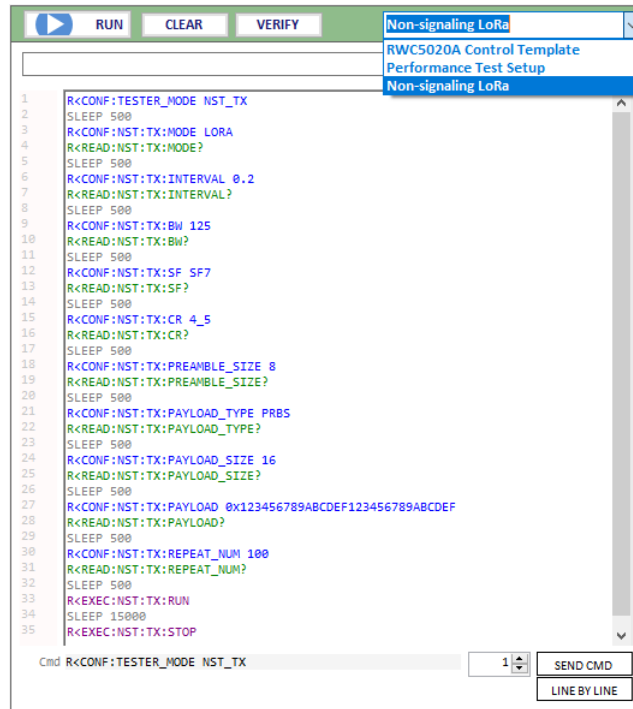

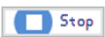
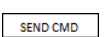
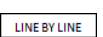
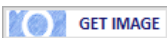


Fig 3.43 Tester Control

3.4.2.3 Transmit Methods

Clicking  starts transmitting commands. Transmitting commands will be stopped if you click  or all commands are transmitted. Clicking  transmits the selected command. Clicking  transmits listed commands line by line increasing the command number.

3.4.3 Screen Capture

Clicking  captures and shows the current screen of the connected RWC5020X and save it as a bmp file. If you click one of listed up file on list window, the selected bmp file will be shown on image window.

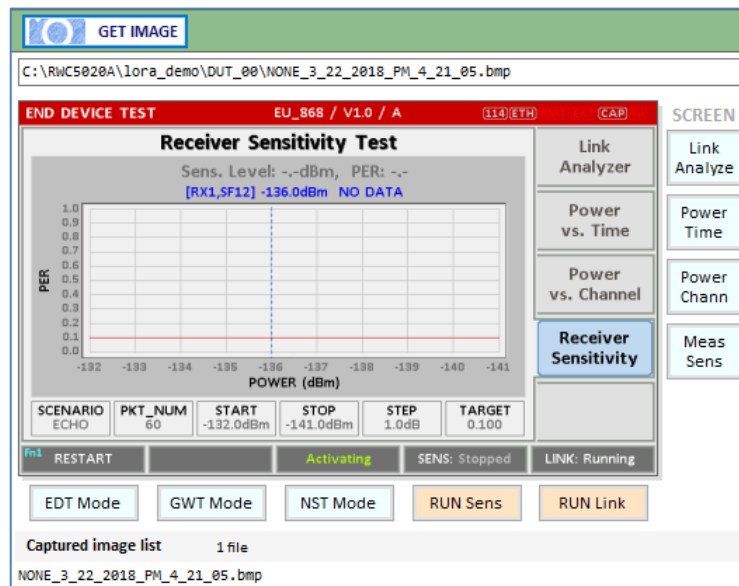


Fig 3.44 Screen Capture

3.4.4 Function for Manufacturing

This function is for quick test for manufacturing. It helps user measure PER and the TX power of DUT very fast and easily.

For this function, a special function has to be prepared in DUT.

In the special mode of DUT, transmitting MEAS_START_FLAG, counting packets, recognizing MEAS_STOP_FLAG, and transmitting 3 same report frames functions should be prepared.

For the DUT information, "user data" such as serial number can be added In the MEAS_START_FLAG packet

3.4.4.1 Test concept

MEAS_START_FLAG packet transmitted from DUT makes RWC5020X start transmitting packets to DUT at the power specified by user. After transmitting the MEAS_START_FLAG, DUT must switch to RX mode to receive packets from RWC5020X and count the number of the packets received.

After transmitting all packets, RWC5020X transmits MEAS_END_FLAG packet that makes DUT stop counting and report the number of received packets.

After receiving the MESA_END_FLAG from RWC5020X, DUT must transmit report frame including the number of received frames 3 times within TIMEOUT time.

RWC5020X calculated PER with the reported information. Whenever DUT transmits any frame

RWC5020X measures the TX power of DUT and show the averaged value after receiving report packets.

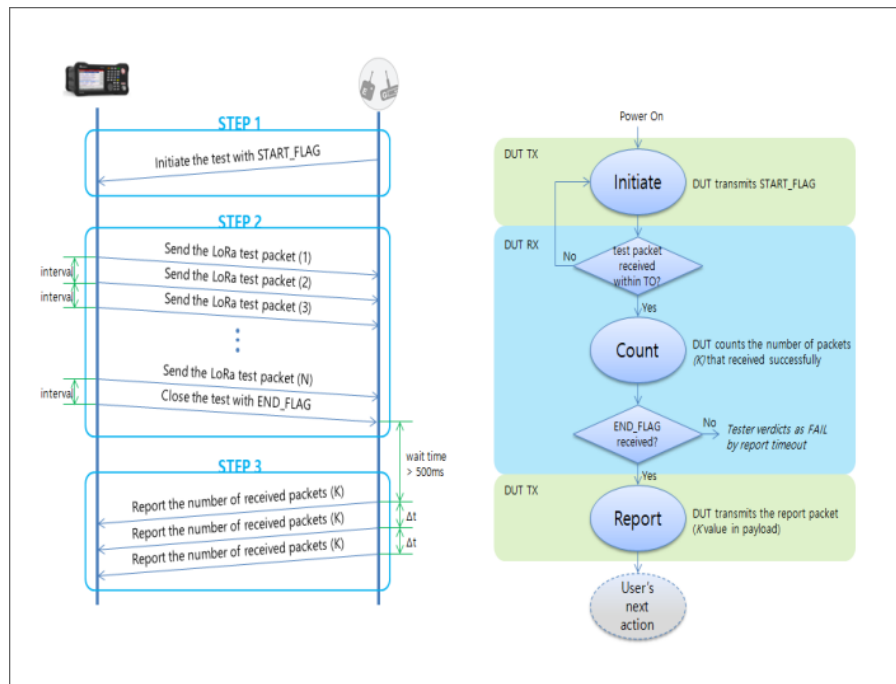


Fig 3.45 Test scenario for manufacturing

3.4.4.2 Test configuration

Click **CONFIG** to set up the MFG configuration

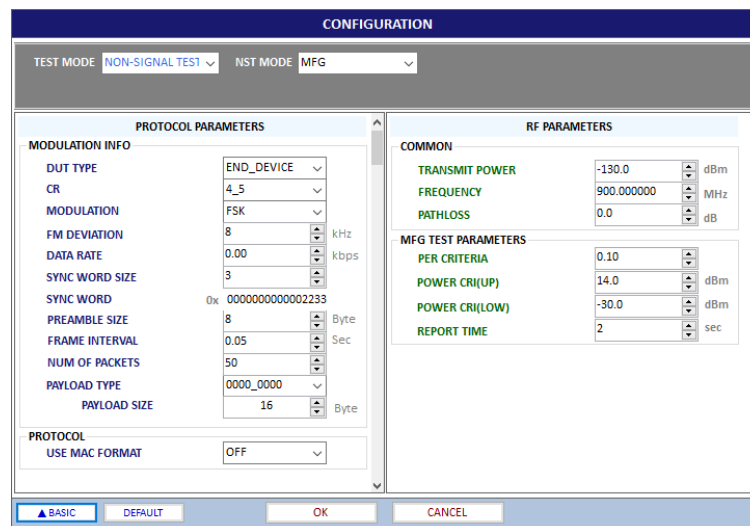


Fig 3.46 Configuration window for MFG

3.4.4.2 Operation example

Clicking **RUN** makes RWC5020X wait the MEAS_START_FLAG MFG from DUT.

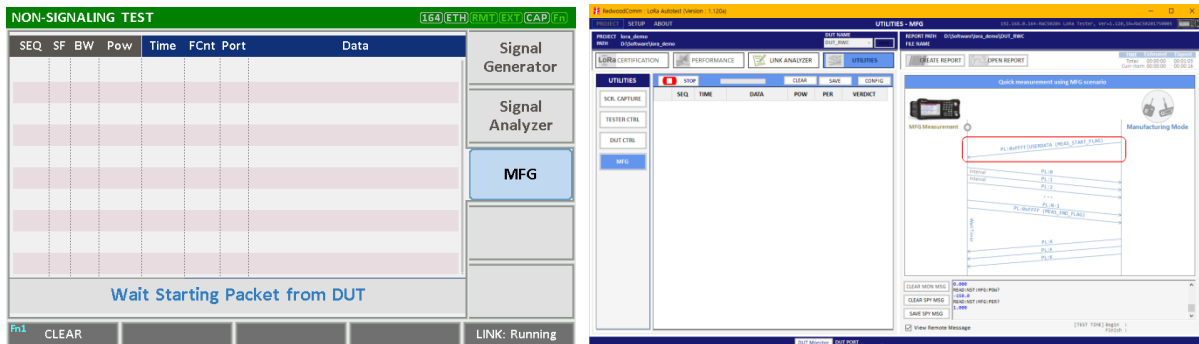


Fig 3.47 The screen of MFG of RWC5020X and PC Application waiting for MEAS_START_FLAG from DUT

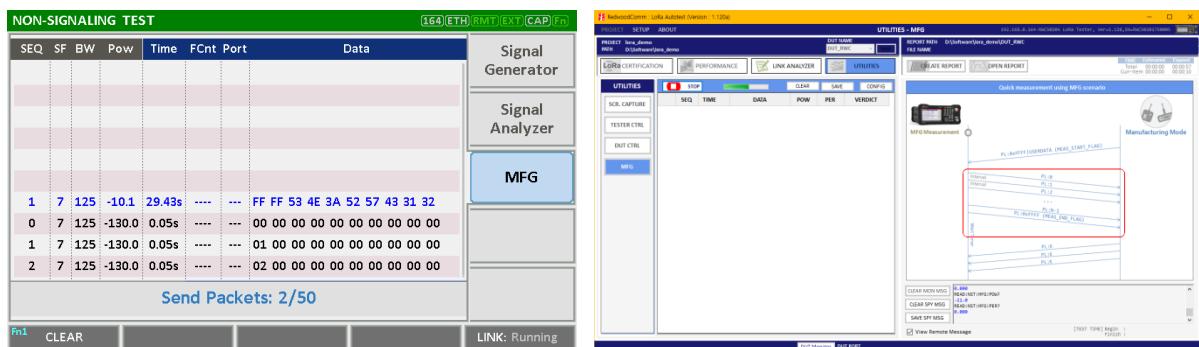


Fig 3.48 The screen of MFG of RWC5020X and PC application while transmitting packets

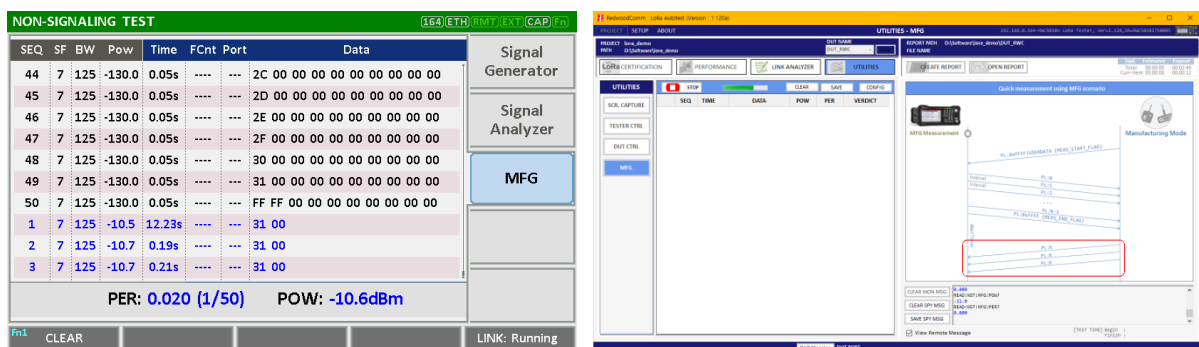


Fig 3.49 The screen of MFG of RWC5020X and PC application waiting for report frames from DUT

3.4.4.3 Getting the result

User can take measured result PER and TX Power of DUT using remote commands.

Commands for

Reading the measured power of DUT :

READ:NST:MFG:POW?

Reading the measured PER of DUT :

READ:NST:MFG:PER?

Reading the user data in MEAS_START_FLAG frame :

READ:NST:MFG:DUT_INFO?

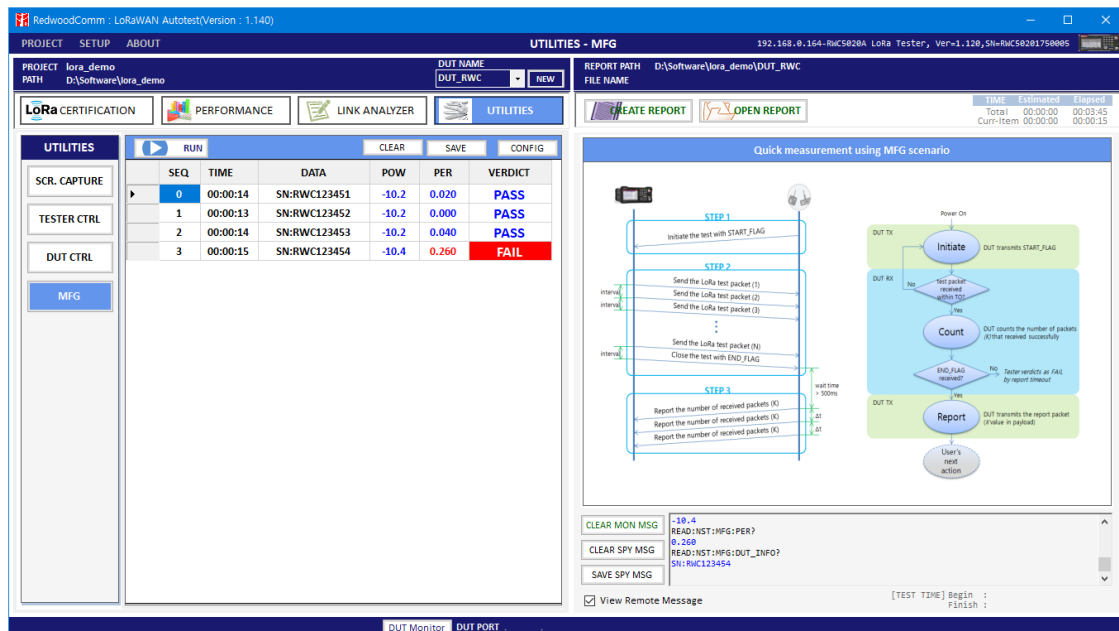


Fig 3.50 Example test using 4 DUTs(N=50, Target PER=0.1)



Refer the application note for more detail guide.

III. Report Functions

This chapter explains how to handle test reports for various kinds of test results. With report functions, user can see a report messages while test, and create a report file after test finished and open it whenever user want to.

4.1 Report File Manager

4.1.1 Create Report

Clicking  pops up the save file window. You can change file name and save the result document. The result file will be saved as a word document.  will be enabled on Certification and Performance tab.

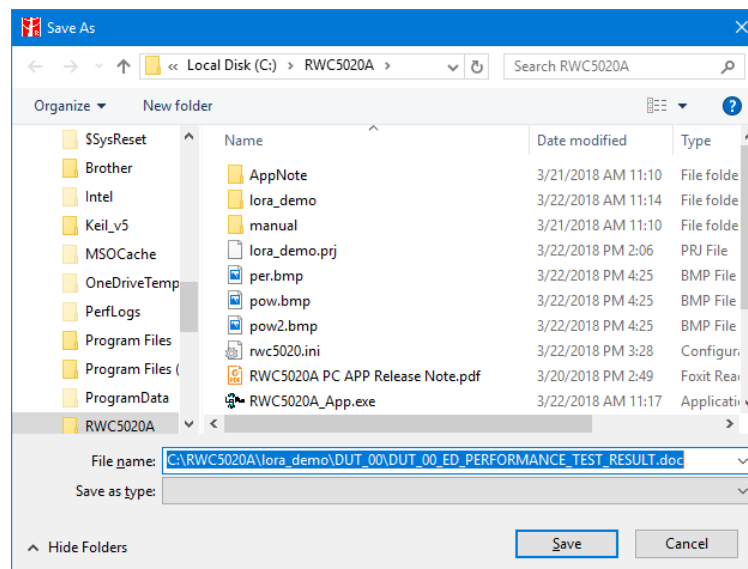


Fig 4.1 Save file window for creating a report file

A report option will be appeared when NON-REGRESS test is selected as Fig 4.2.

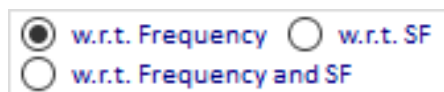



Fig 4.2 Report option menu for NON-REGRESS test

- ☒ **w.r.t. Frequency** All NON-REGRESS test report will be created with respect to the tested frequency
- ☐ **w.r.t. SF** All NON-REGRESS test report will be created with respect to the tested Spreading Factor
- ☐ **w.r.t. Frequency and SF** All NON-REGRESS test report will be created with respect to both tested frequency and SF

4.1.2 How to Open the Saved Report File

Clicking  pops up a REPORT LIST window. Double clicking on a file name opens the selected file. The reading tool is Microsoft Word installed on your PC. This result file viewer shows current DUT directory.

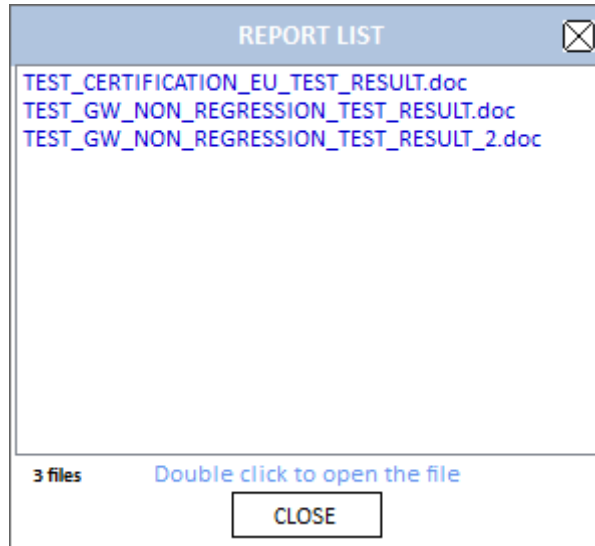


Fig 4.3 List of Test Report File

V. Revision History

Version	Date(YYYYMMDD)	Description
V1.11	2018.03.22	- Created for Firmware version: V1.11
V1.12	2018.04.25	- Modified for Firmware version: V1.12
V1.13	2018.07.19	- Modified for Firmware version: V1.13
V1.14	2018.10.10	- Modified for Firmware version: V1.14
V1.15	2018.12.15	- Modified for Firmware version: V1.15
V1.16	2019.04.16	- Modified for Firmware version: V1.16
V1.17	2019.06.18	- Modified for Firmware version: V1.17
V1.20	2019.09.16	- Modified for Firmware version: V1.20