Application Note RAN502004R6

Tested Version : SW/FW V1.320

RWC5020x MFG Test Solution

General Description

This document describes the manufacturing test solution of LoRa products using RWC5020x. In this solution, DUT (Device Under Test) is required to operate in the test mode, which is described as 'DUT Requirement' in the following sections.

Test Procedure

Basically manufacturing tests of LoRa products should be performed in non-signaling mode because of two reasons; test time and a type of DUT. Testing in signaling mode requires much longer test time caused by the limitation of LoRa communication technology. Testing in non-signaling mode does not concern a type of DUT, in other words, either an End-device or a Gateway can be tested under the same test concept.

Although the test is performed in non-signaling mode, a simple protocol should be defined for test automation in production lines as communication between the tester and DUT. Fig 1 shows the test procedure for MFG test using RWC5020x and DUT can be an End-device or a Gateway. The procedure consists of 3 steps as follows.

Step 1

Upon starting the test, the tester waits for the first packet from DUT, which indicates DUT is ready to be tested. The first 2 bytes of payload in this packet shall be 0xFFFF which means it's the control packet to initiate the test (START_FLAG) and the rest of payload may contain user-defined data for application purpose, e.g., serial number of DUT. The maximum length of the user-defined data shall be 128 bytes. Then DUT should be ready to receive test packets from the tester and count them.

Step 2

Once the tester receives the first packet (START_FLAG) from DUT, it starts transmitting the test packets. The test packet is described in the Parameter Configuration section. The time interval between consecutive packets can be configured by users, which may depend on the receivability of DUT and may affect the resultant total test time. Test packets should be transmitted at the defined power level of the tester to evaluate the receiver performance of DUT, while DUT counts the number of successfully received packets, denoted as *K*. After packets are transmitted *N* times, the number of packets defined by users, the tester sends the control packet to inform the transmission ends (END_FLAG) and to force DUT to be ready to report the *K* value to the tester. The control packet should be transmitted at 20dB higher

power than the power of test packets for reliability of control.

Step 3

The tester waits for the report packet from DUT within the report timeout defined by users. DUT should wait at least 500ms after receiving END_FLAG, transmit the report packet containing K value of 2byte-long, and retransmit the same packet twice with a time interval (Δt) for reliability of test and power measurements. Then the tester calculates Packet Error Rate (PER) by *K* / *N* and measures the power to check whether the results meet the user criteria.

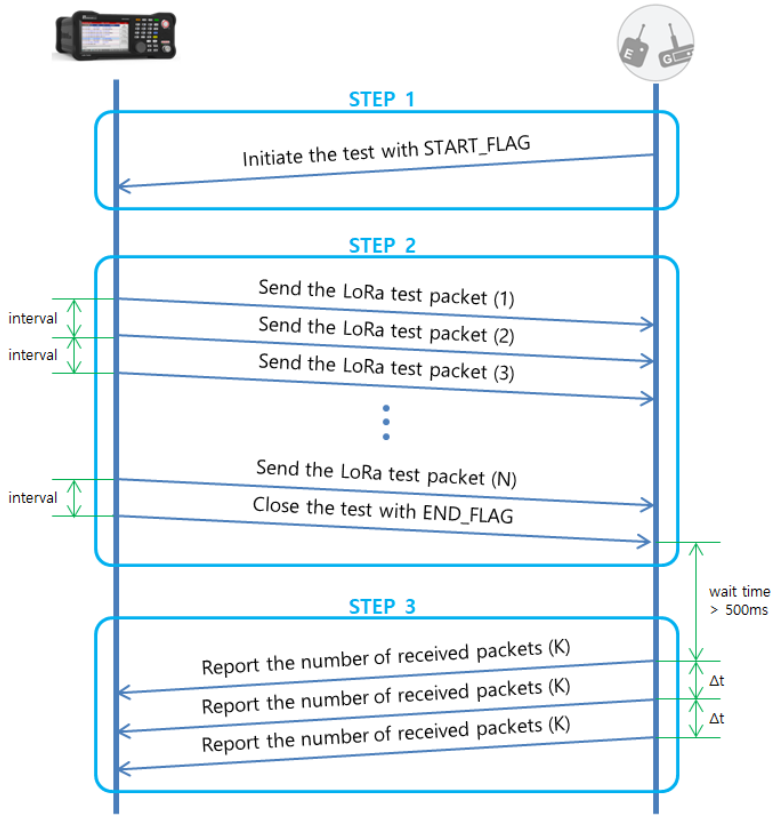

Fig 1. Test Procedure for MFG Test

Parameter Configuration

This section describes the configuration of test packets and other test parameters. Fig 2 shows the configuration screen of the PC software.

RF PARAMETERS

TX POW

Output power of RWC5020x, i.e. target power level to evaluate the receiver performance of DUT

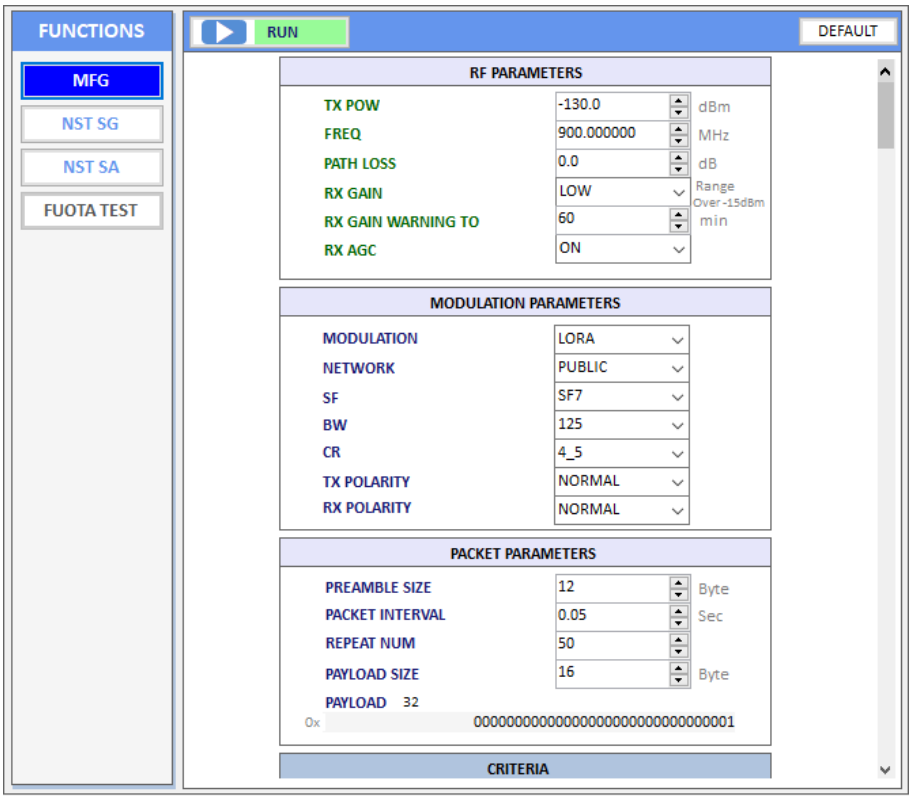

Fig 2. Parameter Configuration for MFG Test

FREQ

RF frequency of RWC5020x

PATH LOSS

RF path loss between RF port of RWC5020x and RF port of DUT; The measured power will be compensated with the defined path loss.

RX GAIN

Initial gain of the RX Automatic Gain Control (AGC) function of RWC5020x; it is very important to set this parameter correctly to get proper test results quickly. The recommended initial value for RX GAIN depending on the expected input level to RWC5020x (INPUT) is:

- LOWER, if INPUT is higher than +15dBm
- LOW, if INPUT is between +15dBm and -15dBm
- MEDIUM, if INPUT is between -15dBm and -40dBm
- HIGH, otherwise

RX GAIN WARNING TO

If RWC5020x does not receive any packets for a while, RWC5020x assumes that RX_GAIN may be incorrect and displays a notification. This parameter defines the timeout period for this notification.

RX AGC

This parameter determines whether RX GAIN is automatically adjusted or not; ON or OFF.

MODULATION PARAMETERS

MODULATION

the modulation type; LORA or FSK

NETWORK

the type of LoRa network (synchronization word) to be used in LoRa modulation; PUBLIC or PRIVATE

SF

the spreading factor of a LoRa test packet; SF7 to SF12, or ANY. When this value is set to ANY, RWC5020x receives packets of any kind of SF and applies the same SF value for TX packets.

BW

the bandwidth of a LoRa test packet; 125kHz, 250kHz, or 500kHz

FM DEVIATION

the FM deviation value for FSK modulation

DATA RATE

the data rate value for FSK modulation

SYNC WORD SIZE

the Sync word size for FSK modulation

SYNC WORD

the Sync word for FSK modulation

CR

the coding rate of a LoRa test packet; 4_5, 4_6, 4_7, 4_8, or NO_CRC

TX POLARITY

the TX signal polarity; NORMAL or INVERSE

RX POLARITY

the RX signal polarity; NORMAL or INVERSE

PACKET PARAMETERS

PREAMBLE SIZE

the length of preamble in a test packet

PACKET INTERVAL
: the time interval between consecutive test packets

REPEAT NUM
: the number of transmission of test packets

PAYLOAD SIZE
: the size of payload of a test packet

PAYLOAD
: the content of payload in hexadecimal format

CRITERIA

PER Criteria
: the user's criteria of the result value of PER measurement

POWER CRITERIA UPPER
: the user's upper criteria of the result value of Power measurement

POWER CRITERIA LOWER
: the user's lower criteria of the result value of Power measurement

TIMEOUT
: the timeout that RWC5020x waits for report packets from DUT

Test Environment

Test environment may depend on users. RF enclosures, e.g. shield boxes, should be used in production lines to isolate DUT test environments from interferences. In this case, a positioning fixture is required for reliable tests, and RF path loss between antennas of the tester and DUT should be measured and applied to configuration.

DUT Requirement

DUT firmware should be modified or created to meet the following requirements for the manufacturing test described in the above.

Requirement for Step 1
After power-on, DUT shall transmit START_FLAG (the first 2 bytes should be 0xFFFF). Users can load any useful data into payload such as the serial number of DUT with the maximum length of 128bytes. After transmission, DUT should be ready to receive test packets from the tester

and count them. If there is no test packet from the tester within its own timeout, DUT shall retransmit the same START_FLAG.

Requirement for Step 2

DUT shall count the number of packets (*K*), received successfully. Upon receiving END_FLAG, DUT shall prepare to send the report packet containing the *K* value of 2byte-long.

Requirement for Step 3

DUT shall wait at least 500ms and transmit the report packet including *K* value in payload 3 times. Each transmission must be done every time interval (Δt) within the report timeout defined by the user. Then DUT may switch to normal firmware or the final firmware may be downloaded to DUT at the next stage in the production line.

DUT's State Transition Diagram

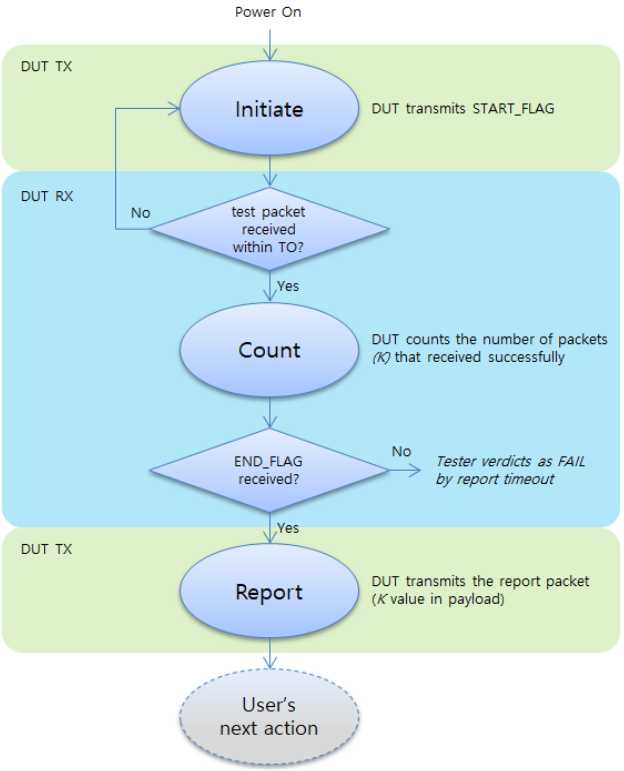

Fig 3. State Transition Diagram during MFG Test

Test Time

The test time may depend on various test parameters and conditions such as SF, payload length, the number of packets, frame interval, and so on. Table 1 shows the examples of elapsed test time measured under various combinations of the number of packets and SF.

Number of packets	10	50	100	200
SF7	1.4	3.8	6.9	13.0
SF8	2.0	6.1	11.2	21.4
SF9	3.1	10.1	18.8	36.2
SF10	5.6	19.1	36.1	70.0
SF11	10.5	37.3	70.7	137.6
SF12	20.4	73.5	139.9	272.7

[Table 1] Elapsed Test Time in sec

Parameters Setup for Communication in Non-signaling mode

The following figure shows how users should configure parameters of their DUTs depending on the type of DUT. In case when DUT is an end-device, users need to configure parameters of their DUTs referring to the right green box below. In case when DUT is a gateway, users need to configure parameters of their DUTs referring to the left blue box below.

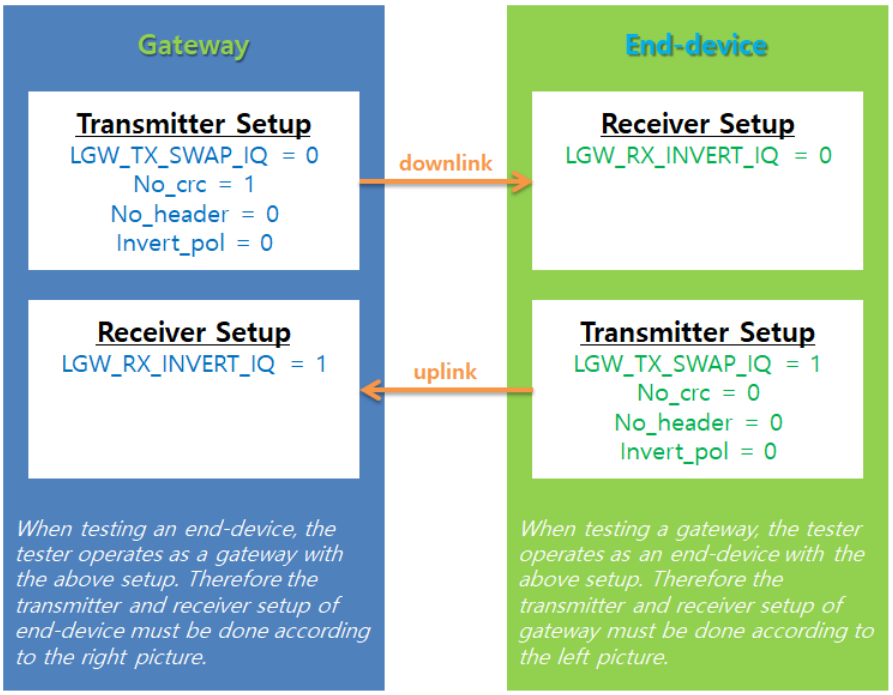

Fig 4. Parameter Configuration

Payload Example for MFG Test

Test Condition

USER_DATA // for example, a serial number for each DUT
N = 20 // Number of packets to be sent in PER test
Payload Size = 16 // the size of payload in RWC5020x

Test Result

K = 19 // Number of packets that DUT received

```
// End Device's START_FLAG packet
//      RWC5020x    <--    End Device
// 534E3A5257313233343531(="SN:RW123451")

FF FF 53 4E 3A 52 57 31 32 33 34 35 31

// [RWC5020x's packets (N=20, 16Byte)]
//      RWC5020x   -->    End Device
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
02 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
03 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
05 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
06 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
07 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
09 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0A 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0B 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0C 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0E 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
11 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
12 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
13 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

// RWC5020x's END_FLAG packet
//      RWC5020x   -->    End Device
FF FF 00 00 00 00 00 00 00 00 00 00 00 00 00 00

// DUT should wait at least 500ms

// End Device's Report packet (K=19)
//      RWC5020x    <--    End Device
13 00
// Add the time interval (Δt)
13 00
// Add the time interval (Δt)
13 00
```