

# **RF Performance Tests of LoRa Gateways without an External Network Server**

## **Application Note**

### **RWC5020A and PC Application Software**

RAN1940001-rev2

## Background

Generally a gateway acts a role as a bridge between end-devices and the network server in LoRaWAN network. Moreover, a gateway is close to a part of the physical layer of the network server. Therefore, there have been limited test methods in testing gateways; their performances had to be tested in non-signaling mode (so called ‘a test mode’) without connecting to their network server. Their software functions need be verified together with their network server as well.

In this document, we introduce a new test method to verify gateways’ RF performance without an external network server, which is a part of non-regression tests for gateways defined by Semtech. It consists of TX output power measurement, sensitivity, PER, RSSI, SNR, frequency error tolerance, and CW interferer/blocker immunity, while the spectral measurement is out of the scope of this document. Basically a gateway under test shall support the JSON interface defined by Semtech. The RWC5020A PC application software includes a simple network server function which controls the gateway under test via the JSON interface for all automatic RF performance tests. The conceptual block diagram of the new test method is as follows.

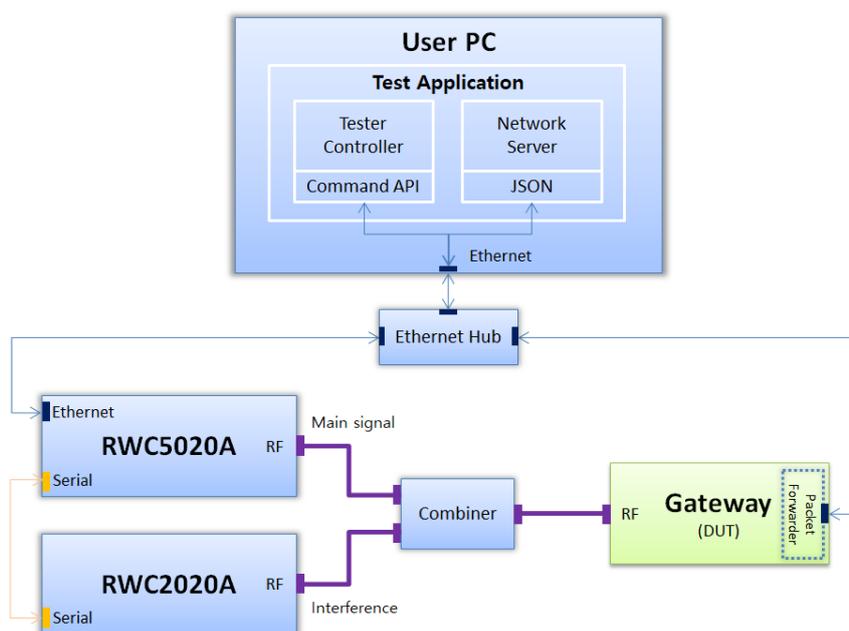


Fig 1. Conceptual Block Diagram

## Gateway Non-regression Tests

This section introduces the test items for gateway performance tests, called non-regression tests – introduced by Semtech, and shows the example results.

### TX Output Power Measurement

This measurement allows to verify the TX power calibration performance by checking whether to reach an expected output power.

## Sensitivity

This is a Packet Error Rate (PER) measurement versus the signal level, which will contribute to finding a sensitivity level as a result. It is required that the measurement step shall be fine as the PER decreases from 100% to 0% in less than 10 dB. It should be measured for each spreading factor.

## PER

This is a PER measurement over wide input signal level range. Here the coarse measurement step may be used.

## RSSI Channel and Signal

This is a functional test of power measurement in a gateway receiver. It consists of two parts; the RSSI channel and the RSSI signal. The RSSI channel corresponds to the power in the receive channel including the noise and potential interference, while the RSSI signal corresponds to the power of the LoRa packet only excluding the in-band noise.

The curve itself represents the mean value of the RSSI (channel or signal), computed with linear values rather than logarithmic ones. The error between the input signal and the returned value is also displayed. The bars below and above the curve represent the min and the max error versus the mean value.

The difference between the RSSI channel and RSSI signal is observable at low input signal power: the RSSI channel is equal to the noise floor whereas the RSSI signal is equal to the input signal. The RSSI signal stays linear over the range of the input signal, in contrary to the RSSI channel.

In the JSON protocol for gateway V1, only the *rssi* field is present as the SX1301 only provides the RSSI channel value, not the RSSI signal one. In the gateway V2, the RSSI signal is provided by the DSP present on board. The JSON protocol includes an additional field *rsig* which contains both fields; *rssic* (RSSI channel) and *rssis* (RSSI Signal).

## SNR

Similar to the RSSI values, the curve itself represents the mean value of the SNR computed with linear values rather than logarithmic ones. The bars below and above the curve represent the min and the max error versus the mean value.

## Frequency Error Tolerance

This is a PER measurement over center frequency offsets in ppm. The amount of frequency offset in ppm shall be applied to both analog and digital clocks of the test system.

## CW Interferer/Blocker Immunity

This is a PER measurement in the presence of the interference signal, depending on the

frequency offset between the main signal and the interference signal.

## How to test using RWC5020A software

RWC5020A gets the capability of running the Semtech’s Non-regression tests for Gateway since V1.16x release. Its application software will manage RWC5020A and RWC2020A, and will internally run a simple network server which can communicate with a gateway under test via the JSON interface. Eventually, it can perform all the tests sequentially and automatically without any other external controls. The test results can be generated with various report formats with respect to frequencies, spreading factors, or both.

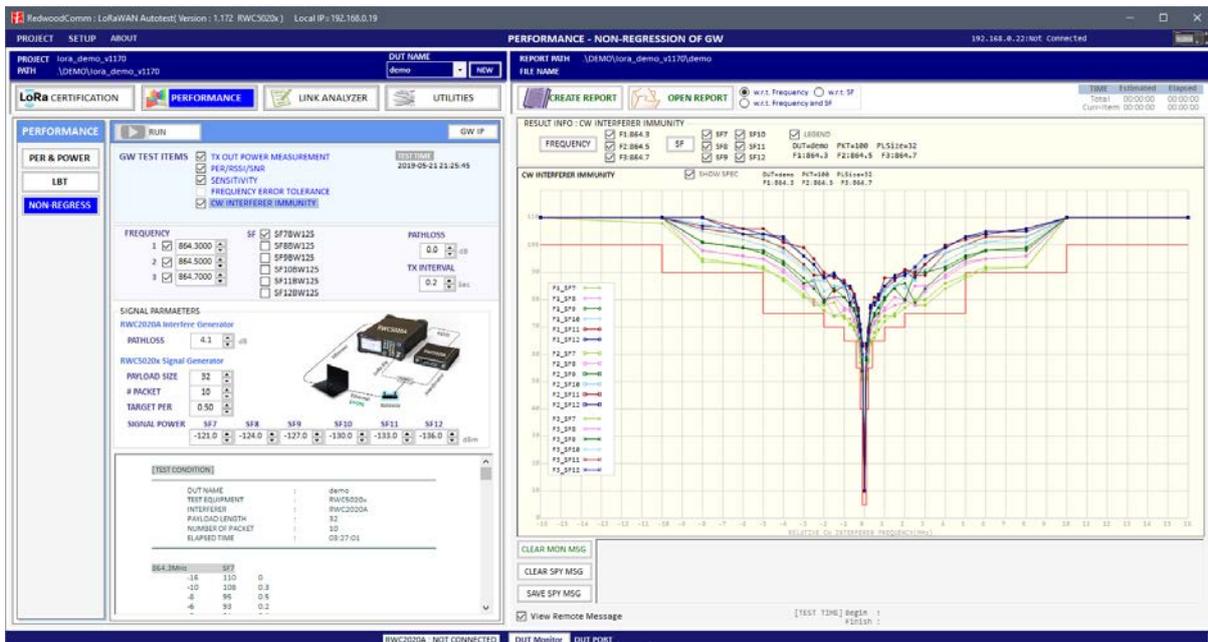


Fig 2. Example of Non-regression Tests

### Basic operation

Refer to the user manual for basic operation of RWC5020A PC Application software.

### Test setup

For gateway test, the test configuration using RWC5020A and RWC2020A is required as shown as the following figure. RWC2020A is required only for generation of interference signal in 'CW Interferer/Blocker Immunity' test.



Fig 3. Gateway Test Setup

### GW connection setup / JSON interface

A simple network server works in the RedwoodComm application software on a user PC and it can communicate with gateway under test via JSON interface over Ethernet. For detail information about JSON interface, please refer to the Semtech's website. To setup IP, click 'GW IP' on the application to pop up the IP configuration screen. Then set the gateway's IP address and a port number as shown in Fig 4. In addition, the server IP shall be configured in gateway setup, which must be the IP address of a user PC. It is displayed on the title bar of the application software for users' convenience as shown in Fig 5.



Fig 4. IP Configuration for Interfacing with Gateway



Fig 5. Local IP address displayed on the title bar

### Parameter setup

There are two sorts of parameters; common ones for all tests and dedicated ones for each test.

#### Common parameters

##### FREQUENCY

The target frequencies to be tested.

### SF

The spreading factor to be tested.

### TX INTERVAL

The time interval between consecutive packets that RWC5020A will transmit. Its default value is 0.2sec.

### PATHLOSS

The path loss between the RF port of RWC5020A and the one of a gateway under test for the compensation of TX power of RWC5020A; it should be measured accurately prior to the test.

## **Parameters for TX Output Power Measurement**

### POW START

The start value of the power for the measurement.

### POW STEP

The step value of the power for the measurement.

### # POW

The number of the power values for the measurement.

### POW STOP

The stop value of the power, calculated by POW\_START, POW\_STEP and # POW (display only).

### # PACKET

The number of packets to be used for the measurement.

## **Parameters for PER/RSSI/SNR and Sensitivity**

### # PACKET

The number of packets to be used for the test.

### POW STEP

The step value of the power (display only).

## **Parameters for Frequency Error Tolerance**

### # PACKET

The number of packets to be used for the test.

### POWER

The transmitting power of RWC5020A (display only).

### OFFSET STEP

The step value of the frequency offsets (display only).

## Parameters for CW Interferer Immunity

[RWC2020A Interference Generator]

### PATHLOSS

The path loss between the RF port of RWC2020A and the one of a gateway under test for the compensation of TX power of RWC2020A; it should be measured accurately prior to the test.

### SET FREQ

The frequency table of the interference signal; the number of frequencies to be tested, relative frequencies and the start power are required to be defined.

[RWC5020A Signal Generator]

### PAYLOAD SIZE

The size of the payload to be used for the test in bytes. Its default value is 32.

### # PACKET

The number of the packets to be used for the test. Its default value is 10.

### TARGET PER

The target PER value for the PER measurement during the test. Its default value is 0.5.

### SIGNAL POWER

The reference LoRa signal power for each SF during the test.

## Selection and execution

Select the items to execute by clicking checkboxes to be tested and click RUN. To stop the test in the middle of running, click STOP.

## Test results

The example test results are shown below.

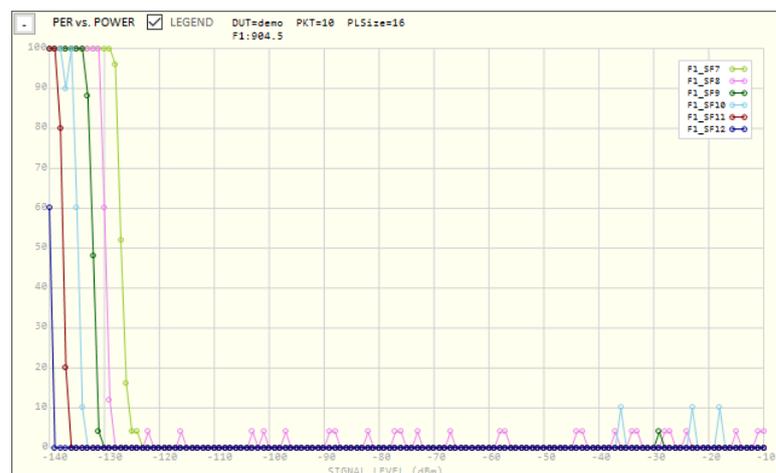


Fig 6. PER vs. Power @ Freq 1

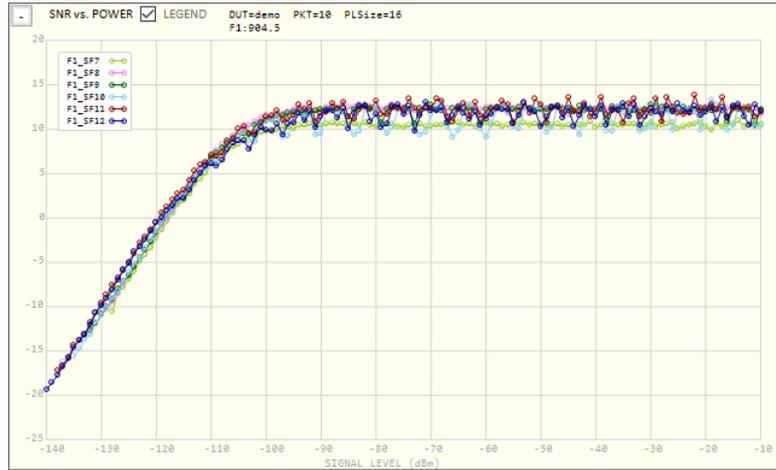


Fig 7. SNR vs. Power @ Freq 1

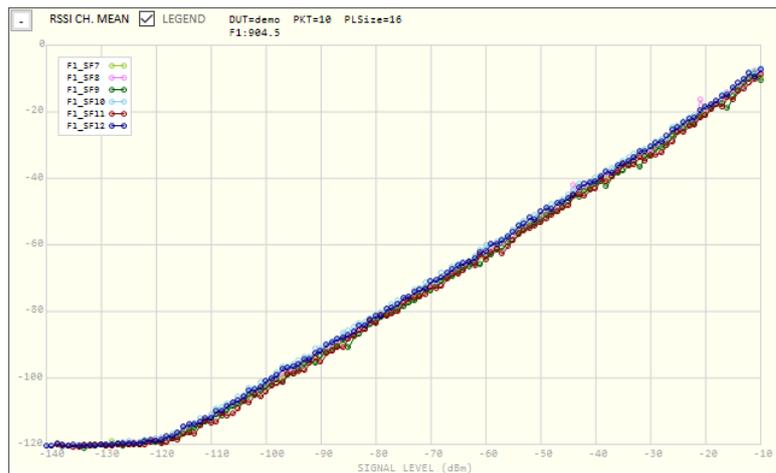


Fig 8. RSSI CH Mean vs. Power @ Freq 1

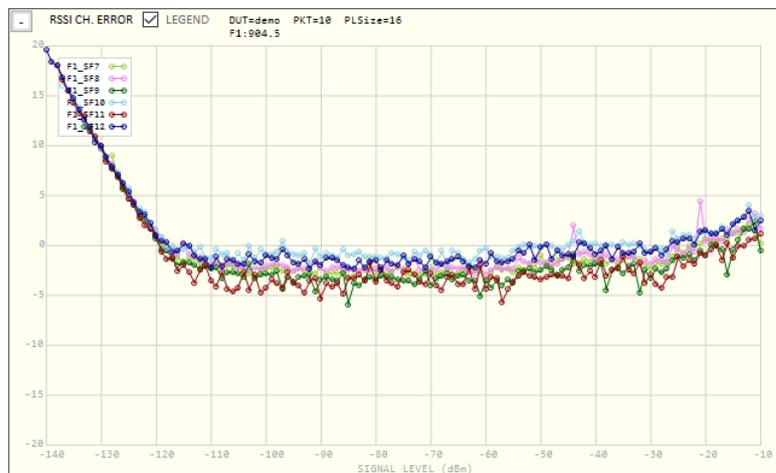
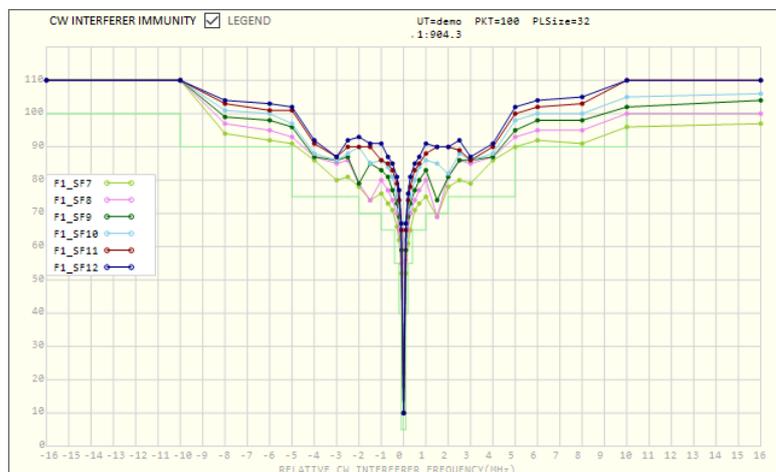
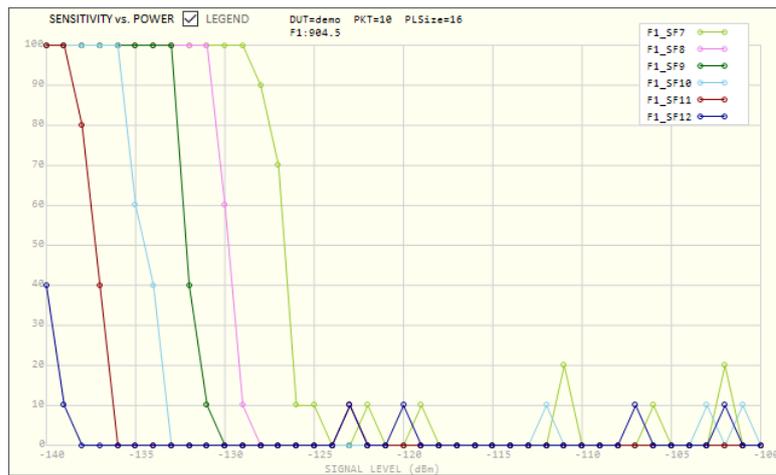
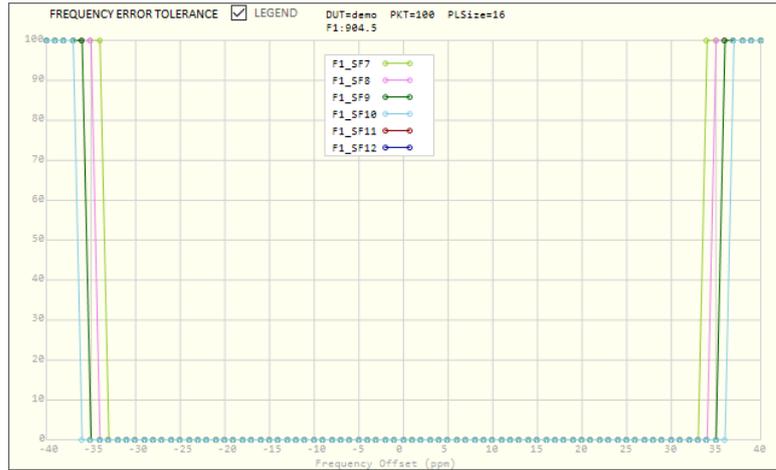


Fig 9. RSSI CH Error vs. Power @ Freq 1



### Generation of a report file

A report file can be generated with pictures of the test results in several formats. The report option enables to attach pictures in the report file separately with respect to frequency, SF, or

both. Click 'CREATE REPORT' to generate a report file from the existing test results. 'OPEN REPORT' can be used for browsing the existing test reports.

## Further Discussion

Non-regression tests of gateways are very important and essential to verify gateways' performances when a new firmware is released. The RWC5020A PC application software helps users execute those tests automatically and manage the test results. Users can apply their own test conditions with configurable test parameters. We're going to investigate and research for upgrades of test methodologies of gateways and release a new firmware and software whenever ready.

## References

[1] Semtech ANNWS.01.2.1.W.SYS, *LoRaWAN Network Server Demonstration: Gateway to Server Interface Definition* [↓](#)

[2] Semtech, *User Guide to the LoRa® PicoCell Gateway V1.0* [↓](#)