



TESTING LABORATORY  
CERTIFICATE # 4821.01



## FCC PART 15.247

### TEST REPORT

For

### Shenzhen Rakwireless Technology Co., Ltd.

Room 506, Bldg B, New Compark, Pingshan First Road, Taoyuan Street, XiLi town,  
Nanshan District, Shenzhen, China

**FCC ID: 2AF6B-RAK4270H**

|   |   |
|---|---|
| <b>Report Type:</b><br>Original Report        | <b>Product Type:</b><br>LoRa Module   |
| <b>Report Number:</b> <u>RSZ200709005-00B</u> |   |
| <b>Report Date:</b>                           | <u>2020-08-17</u>   |
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## **TABLE OF CONTENTS**

|  |           |
|--|-----------|
| <b>GENERAL INFORMATION</b> .....   | <b>4</b>  |
| PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT).....                        | 4         |
| OBJECTIVE .....  | 4         |
| RELATED SUBMITTAL(S)/GRANT(S).....   | 4         |
| TEST METHODOLOGY .....   | 4         |
| MEASUREMENT UNCERTAINTY .....  | 5         |
| <b>SYSTEM TEST CONFIGURATION</b> .....   | <b>6</b>  |
| DESCRIPTION OF TEST CONFIGURATION .....  | 6         |
| EQUIPMENT MODIFICATIONS .....  | 6         |
| EUT EXERCISE SOFTWARE .....  | 6         |
| EQUIPMENT MODIFICATIONS .....  | 6         |
| DUTY CYCLE .....   | 7         |
| SUPPORT EQUIPMENT LIST AND DETAILS .....                                       | 7         |
| EXTERNAL I/O CABLE.....  | 7         |
| BLOCK DIAGRAM OF TEST SETUP .....  | 8         |
| <b>SUMMARY OF TEST RESULTS</b> .....   | <b>9</b>  |
| <b>TEST EQUIPMENT LIST</b> .....   | <b>10</b> |
| <b>FCC §15.247 (i) &amp; §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)</b> ..... | <b>11</b> |
| APPLICABLE STANDARD .....  | 11        |
| RESULT .....   | 11        |
| <b>FCC §15.203 - ANTENNA REQUIREMENT</b> .....                                 | <b>12</b> |
| APPLICABLE STANDARD .....  | 12        |
| ANTENNA CONNECTOR CONSTRUCTION .....   | 12        |
| <b>FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS</b> .....                     | <b>13</b> |
| APPLICABLE STANDARD .....  | 13        |
| EUT SETUP .....  | 13        |
| EMI TEST RECEIVER SETUP.....   | 13        |
| TEST PROCEDURE .....   | 13        |
| CORRECTED FACTOR & MARGIN CALCULATION .....                                    | 14        |
| TEST DATA .....  | 14        |
| <b>FCC §15.209, §15.205 &amp; §15.247(d) - SPURIOUS EMISSIONS</b> .....        | <b>17</b> |
| APPLICABLE STANDARD .....  | 17        |
| EUT SETUP .....  | 17        |
| EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP .....                              | 18        |
| TEST PROCEDURE .....   | 18        |
| CORRECTED AMPLITUDE & MARGIN CALCULATION .....                                 | 18        |
| TEST DATA .....  | 18        |
| <b>FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH</b> .....                      | <b>25</b> |
| APPLICABLE STANDARD .....  | 25        |
| TEST PROCEDURE .....   | 25        |
| TEST DATA .....  | 25        |
| <b>FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER</b> .....               | <b>28</b> |
| APPLICABLE STANDARD .....  | 28        |

|   |           |
|---|-----------|
| TEST PROCEDURE .....  | 28        |
| TEST DATA .....   | 28        |
| <b>FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE.....</b> | <b>29</b> |
| APPLICABLE STANDARD .....   | 29        |
| TEST PROCEDURE .....  | 29        |
| TEST DATA .....   | 29        |
| <b>FCC §15.247(e) - POWER SPECTRAL DENSITY .....</b>                  | <b>31</b> |
| APPLICABLE STANDARD .....   | 31        |
| TEST PROCEDURE .....  | 31        |
| TEST DATA .....   | 31        |

## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

|                                     |  |
|-------------------------------------|--|
| Product                             | LoRa Module                                      |
| Tested Model                        | RAK4270(H)                                       |
| Frequency Range                     | 903.0-914.2 MHz                                  |
| Maximum Conducted Peak Output Power | 11.41dBm   |
| Antenna Specification               | 2.3dBi (White Antenna)<br>2.0dBi (Black Antenna) |
| Voltage Range                       | DC 3.3V  |
| Date of Test                        | 2020-07-16 to 2020-07-27                         |
| Sample serial number                | RSZ200709005-RF-S1(Assigned by BACL, Shenzhen)   |
| Received date                       | 2020-07-09                                       |
| Sample/EUT Status                   | Good condition                                   |

### Objective

This report is prepared on behalf of *Shenzhen Rakwireless Technology Co., Ltd.* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

### Related Submittal(s)/Grant(s)

Part 15.247 DSS submissions with FCC ID: 2AF6B-RAK4270H.

### Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

And KDB 558074 D01 15.247 Meas Guidance v05r02.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

## Measurement Uncertainty

| Parameter                          | Uncertainty              |                    |
|------------------------------------|--------------------------|--------------------|
| Occupied Channel Bandwidth         | ±5%                      |                    |
| RF Output Power with Power meter   | ±0.73dB                  |                    |
| RF conducted test with spectrum    | ±1.6dB                   |                    |
| AC Power Lines Conducted Emissions | ±1.95dB                  |                    |
| Emissions,<br>Radiated             | Below 1GHz<br>Above 1GHz | ±4.75dB<br>±4.88dB |
| Temperature                        | ±1°C                     |                    |
| Humidity                           | ±6%                      |                    |
| Supply voltages                    | ±0.4%                    |                    |

*Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.*

## Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

The system was configured for testing in engineering mode.

#### Frequency List

| Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| 64      | 903             | 65      | 904.6           | 66      | 906.2           | 67      | 907.8           |
| 68      | 909.4           | 69      | 911             | 70      | 912.6           | 71      | 914.2           |

Test at channel 64, 67, 71.

### Equipment Modifications

No modification was made to the EUT tested.

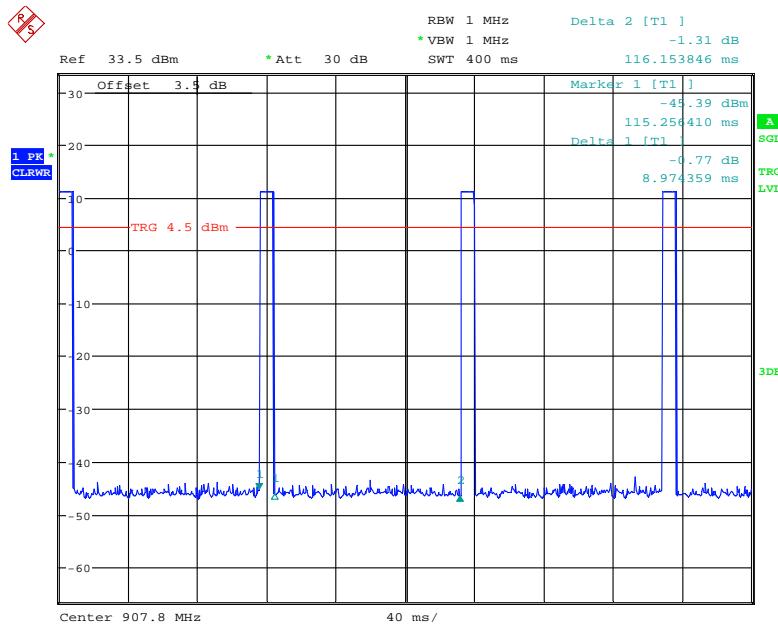
### EUT Exercise Software

“UartAssist.exe” was made to the EUT tested and the power level is 14.

### Equipment Modifications

No modification was made to the EUT tested.

## Duty cycle



Date: 20.JUL.2020 22:39:08

| T <sub>on</sub> (ms) | T <sub>on+off</sub> (ms) | Duty Cycle (%) |
|----------------------|--------------------------|----------------|
| 8.97                 | 116.15                   | 7.72           |

## Support Equipment List and Details

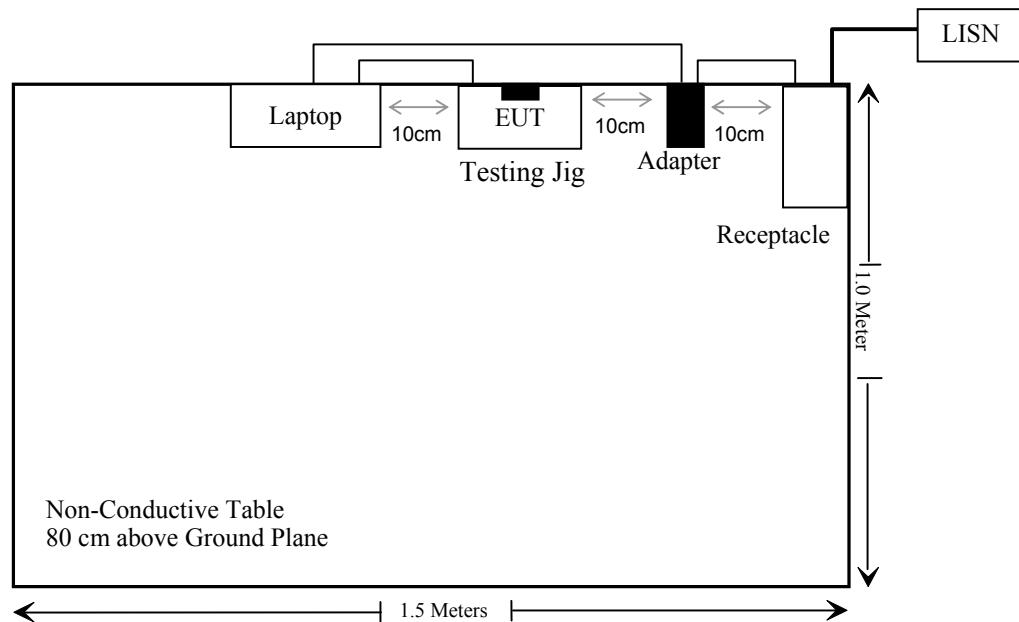
| Manufacturer | Description   | Model          | Serial Number    |
|--------------|---------------|----------------|------------------|
| Rakwireless  | Testing Jig   | Unknown        | Testing Jig      |
| Toshiba      | Laptop        | Satellite C600 | PSCZNQ-00G006    |
| Toshiba      | AC/DC Adapter | PA3715E-1AC3   | T0311043001798DA |

## External I/O Cable

| Cable Description                  | Length (m) | From Port  | To          |
|------------------------------------|------------|------------|-------------|
| Un-shielded Detachable AC Cable    | 1.6        | Receptacle | Adapter     |
| Un-shielded Un-Detachable DC Cable | 1.6        | Adapter    | Laptop      |
| Un-shielded Detachable USB Cable   | 0.6        | Laptop     | Testing Jig |

**Block Diagram of Test Setup**

For Conducted Emission:



## SUMMARY OF TEST RESULTS

| FCC Rules                       | Description of Test                      | Result     |
|---------------------------------|--|------------|
| §15.247 (i), §2.1091            | Maximum Permissible Exposure(MPE)        | Compliance |
| §15.203                         | Antenna Requirement                      | Compliance |
| §15.207 (a)                     | AC Line Conducted Emissions              | Compliance |
| §15.205, §15.209,<br>§15.247(d) | Spurious Emissions                       | Compliance |
| §15.247 (a)(2)                  | 6 dB Emission Bandwidth                  | Compliance |
| §15.247(b)(3)                   | Maximum Conducted Output Power           | Compliance |
| §15.247(d)                      | 100 kHz Bandwidth of Frequency Band Edge | Compliance |
| §15.247(e)                      | Power Spectral Density                   | Compliance |

## TEST EQUIPMENT LIST

| Manufacturer                    | Description               | Model           | Serial Number          | Calibration Date | Calibration Due Date |
|---------------------------------|---------------------------|-----------------|------------------------|------------------|----------------------|
| <b>Conducted Emissions Test</b> |                           |                 |                        |                  |                      |
| Rohde & Schwarz                 | EMI Test Receiver         | ESCI            | 101120                 | 2019/08/04       | 2020/08/03           |
| Rohde & Schwarz                 | LISN                      | ENV216          | 101613                 | 2019/08/04       | 2020/08/03           |
| Rohde & Schwarz                 | Transient Limitor         | ESH3Z2          | DE25985                | 2019/11/29       | 2020/11/28           |
| Unknown                         | CE Cable                  | CE Cable        | UF A210B-1-0720-504504 | 2019/11/29       | 2020/11/28           |
| Rohde & Schwarz                 | CE Test software          | EMC 32          | V8.53.0                | NCR              | NCR                  |
| <b>Radiated Emission Test</b>   |                           |                 |                        |                  |                      |
| R&S                             | EMI Test Receiver         | ESR3            | 102455                 | 2019/08/04       | 2020/08/03           |
| Sonoma instrument               | Pre-amplifier             | 310 N           | 186238                 | 2019/08/04       | 2020/08/03           |
| Sunol Sciences                  | Broadband Antenna         | JB1             | A040904-1              | 2017/12/22       | 2020/12/21           |
| Unknown                         | Cable 2                   | RF Cable 2      | F-03-EM197             | 2019/11/29       | 2020/11/28           |
| Unknown                         | Cable                     | Chamber Cable 1 | F-03-EM236             | 2019/11/29       | 2020/11/28           |
| Rohde & Schwarz                 | Auto test software        | EMC 32          | V9.10                  | NCR              | NCR                  |
| Rohde & Schwarz                 | Spectrum Analyzer         | FSV40-N         | 102259                 | 2019/08/04       | 2020/08/03           |
| COM-POWER                       | Pre-amplifier             | PA-122          | 181919                 | 2019/11/29       | 2020/11/28           |
| Sunol Sciences                  | Horn Antenna              | DRH-118         | A052604                | 2017/12/22       | 2020/12/21           |
| Insulted Wire Inc.              | RF Cable                  | SPS-2503-3150   | 02222010               | 2019/11/29       | 2020/11/28           |
| Unknown                         | RF Cable                  | W1101-EQ1 OUT   | F-19-EM005             | 2019/11/29       | 2020/11/28           |
| <b>RF Conducted Test</b>        |                           |                 |                        |                  |                      |
| Rohde & Schwarz                 | SPECTRUM ANALYZER         | FSU26           | 200120                 | 2020/04/03       | 2021/04/02           |
| Agilent                         | USB Wideband Power Sensor | U2021XA         | MY54250003             | 2019/08/04       | 2020/08/03           |
| WEINSCHEL                       | 3dB Attenuator            | Unknown         | F-03-EM230             | 2019/11/29       | 2020/11/28           |
| Unknown                         | RF Cable                  | Unknown         | 2301 276               | 2019/11/29       | 2020/11/28           |

**\* Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

## FCC §15.247 (i) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

### Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

#### Limits for General Population/Uncontrolled Exposure

| Limits for General Population/Uncontrolled Exposure |                               |                               |                                     |                          |
|---|-------------------------------|-------------------------------|-------------------------------------|--------------------------|
| Frequency Range (MHz)                               | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density (mW/cm <sup>2</sup> ) | Averaging Time (Minutes) |
| 0.3-1.34  | 614                           | 1.63                          | *(100)                              | 30                       |
| 1.34-30   | 824/f                         | 2.19/f                        | *(180/f <sup>2</sup> )              | 30                       |
| 30-300  | 27.5                          | 0.073                         | 0.2                                 | 30                       |
| 300-1500  | /                             | /                             | f/1500                              | 30                       |
| 1500-100,000  | /                             | /                             | 1.0                                 | 30                       |

f = frequency in MHz

\* = Plane-wave equivalent power density

### Result

#### Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm<sup>2</sup>)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

| Frequency (MHz) | Maximum Antenna Gain |           | Tune up conducted power |       | Evaluation Distance (cm) | Power Density (mW/cm <sup>2</sup> ) | MPE Limit (mW/cm <sup>2</sup> ) |
|-----------------|----------------------|-----------|-------------------------|-------|--------------------------|-------------------------------------|---------------------------------|
|                 | (dBi)                | (numeric) | (dBm)                   | (mW)  |                          |                                     |                                 |
| 903.0-914.2     | 2.3                  | 1.7       | 12.0                    | 15.85 | 20                       | 0.005                               | 0.602                           |

Note: To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

#### Result: Compliance

## FCC §15.203 - ANTENNA REQUIREMENT

---

### Applicable Standard

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

- a. Antenna must be permanently attached to the unit.
- b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### Antenna Connector Construction

The EUT has a unique antenna connector, fulfill the requirement of this section. Please refer to the EUT photos.

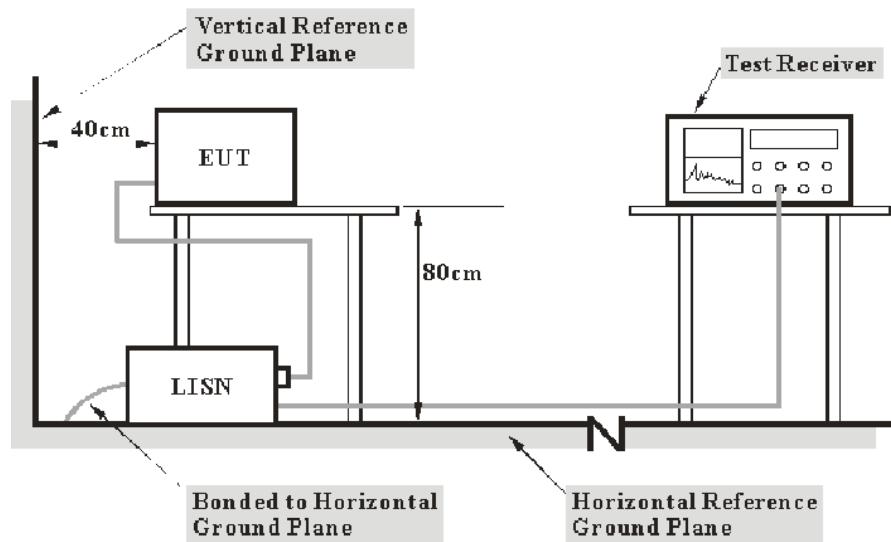
**Result:** Compliance.

## FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

### Applicable Standard

FCC §15.207(a)

### EUT Setup



**Note:** 1. Support units were connected to second LISN.  
 2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

### EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

| Frequency Range  | IF B/W |
|------------------|--------|
| 150 kHz – 30 MHz | 9 kHz  |

### Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

## Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Data

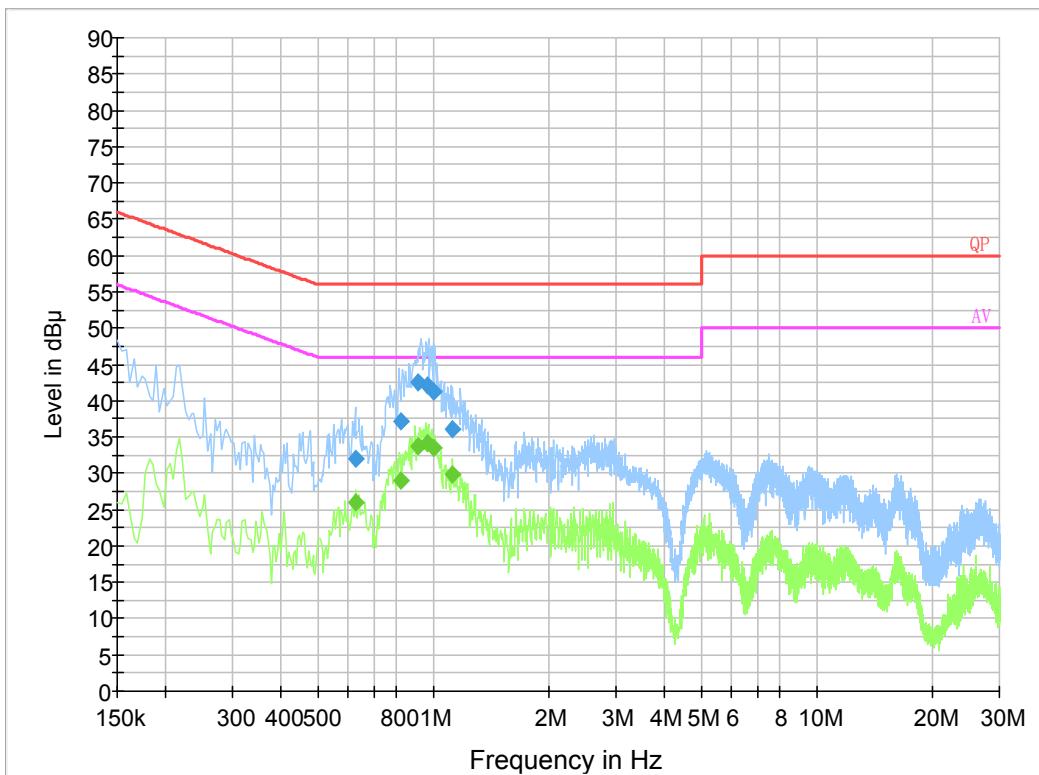
### Environmental Conditions

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25 °C     |
| <b>Relative Humidity:</b> | 65 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

*The testing was performed by Haiguo Li on 2020-07-18.*

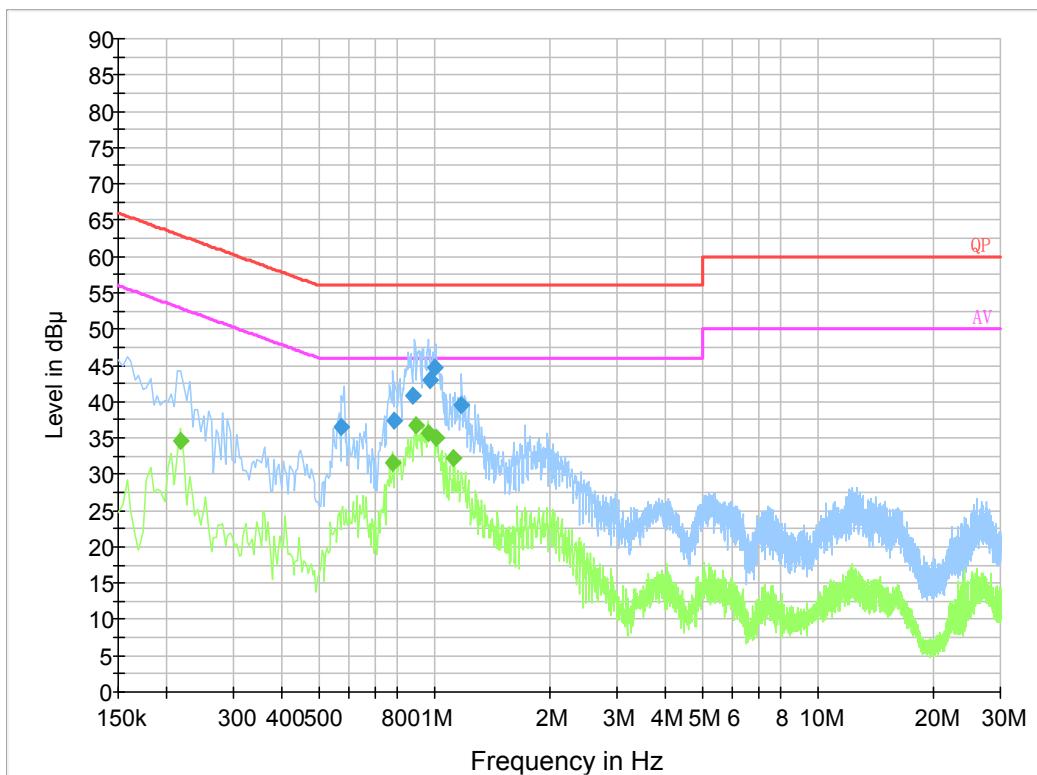
*EUT operation mode: Transmitting (the worst case is Low channel)*

## AC 120V/60 Hz, Line



| Frequency (MHz) | Corrected Amplitude (dB $\mu$ V) | Correction Factor (dB) | Limit (dB $\mu$ V) | Margin (dB) | Detector (PK/Ave./QP) |
|-----------------|----------------------------------|------------------------|--------------------|-------------|-----------------------|
| 0.628610        | 32.0                             | 19.8                   | 56.0               | 24.0        | QP                    |
| 0.826210        | 37.2                             | 19.8                   | 56.0               | 18.8        | QP                    |
| 0.916410        | 42.5                             | 19.8                   | 56.0               | 13.5        | QP                    |
| 0.967390        | 42.1                             | 19.8                   | 56.0               | 13.9        | QP                    |
| 1.002790        | 41.2                             | 19.9                   | 56.0               | 14.8        | QP                    |
| 1.121110        | 36.1                             | 19.8                   | 56.0               | 19.9        | QP                    |
| 0.628610        | 26.0                             | 19.8                   | 46.0               | 20.0        | Ave.                  |
| 0.826210        | 29.0                             | 19.8                   | 46.0               | 17.0        | Ave.                  |
| 0.916410        | 33.8                             | 19.8                   | 46.0               | 12.2        | Ave.                  |
| 0.967390        | 34.2                             | 19.8                   | 46.0               | 11.8        | Ave.                  |
| 1.002790        | 33.6                             | 19.9                   | 46.0               | 12.4        | Ave.                  |
| 1.121110        | 29.9                             | 19.8                   | 46.0               | 16.1        | Ave.                  |

## AC 120V/60 Hz, Neutral



| Frequency (MHz) | Corrected Amplitude (dB $\mu$ V) | Correction Factor (dB) | Limit (dB $\mu$ V) | Margin (dB) | Detector (PK/Ave./QP) |
|-----------------|----------------------------------|------------------------|--------------------|-------------|-----------------------|
| 0.573270        | 36.5                             | 19.8                   | 56.0               | 19.5        | QP                    |
| 0.786270        | 37.3                             | 19.8                   | 56.0               | 18.7        | QP                    |
| 0.876650        | 40.8                             | 19.7                   | 56.0               | 15.2        | QP                    |
| 0.979510        | 43.0                             | 19.8                   | 56.0               | 13.0        | QP                    |
| 0.998790        | 44.7                             | 19.8                   | 56.0               | 11.3        | QP                    |
| 1.176330        | 39.5                             | 19.8                   | 56.0               | 16.5        | QP                    |
| 0.218000        | 34.6                             | 19.8                   | 52.9               | 18.3        | Ave.                  |
| 0.782000        | 31.6                             | 19.8                   | 46.0               | 14.4        | Ave.                  |
| 0.894000        | 36.7                             | 19.7                   | 46.0               | 9.3         | Ave.                  |
| 0.962000        | 35.7                             | 19.8                   | 46.0               | 10.3        | Ave.                  |
| 1.014000        | 35.0                             | 19.8                   | 46.0               | 11.0        | Ave.                  |
| 1.126000        | 32.2                             | 19.8                   | 46.0               | 13.8        | Ave.                  |

## Note:

- 1) Correction Factor =LISN VDF (Voltage Division Factor) + Cable Loss + Transient Limiter Attenuation
- 2) Corrected Amplitude = Reading + Correction Factor
- 3) Margin = Limit – Corrected Amplitude

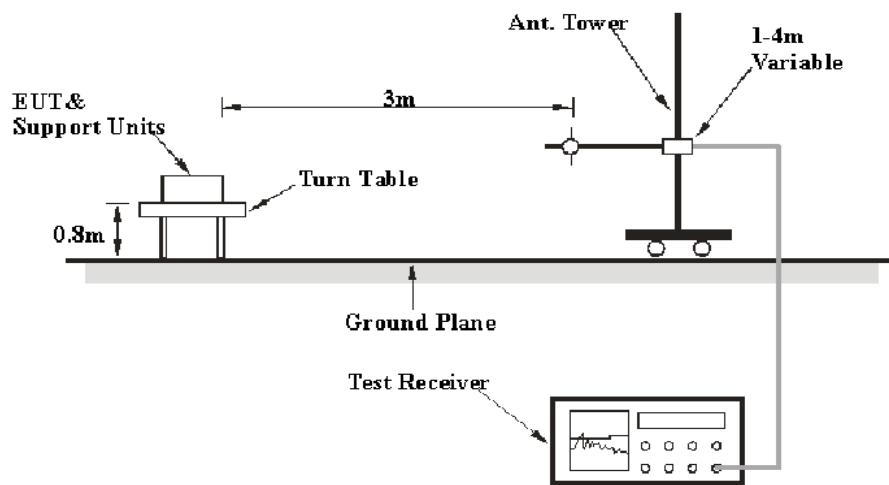
## FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

### Applicable Standard

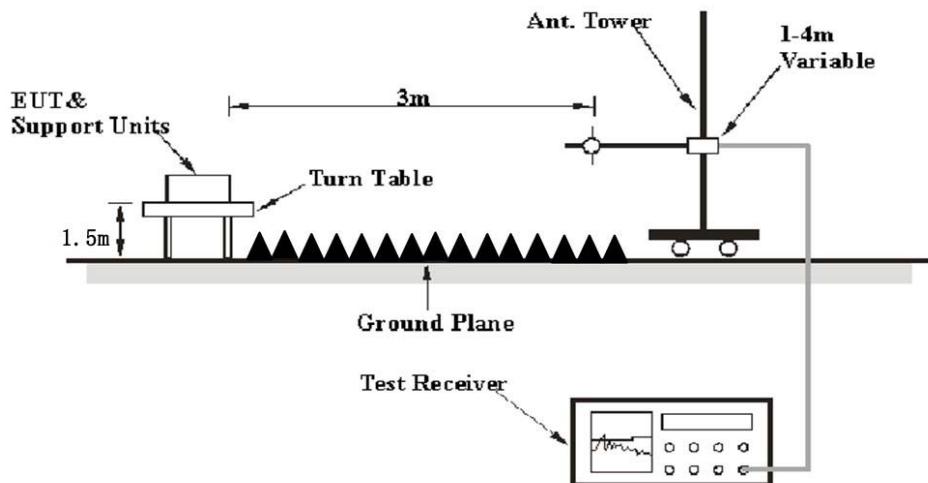
FCC §15.247 (d); §15.209; §15.205;

### EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

## EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 10GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

| Frequency Range   | RBW     | Video B/W               | IF B/W  | Measurement |
|-------------------|---------|-------------------------|---------|-------------|
| 30 MHz – 1000 MHz | 100 kHz | 300 kHz                 | 120 kHz | QP          |
| Above 1 GHz       | 1MHz    | 3 MHz                   | /       | PK          |
|                   | 1MHz    | 10 Hz <sup>Note 1</sup> | /       | Average     |
|                   | 1MHz    | >1/T <sup>Note 2</sup>  | /       | Average     |

Note 1: when duty cycle is no less than 98%

Note 2: when duty cycle is less than 98%

## Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection modes for frequencies above 1 GHz.

## Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Data

### Environmental Conditions

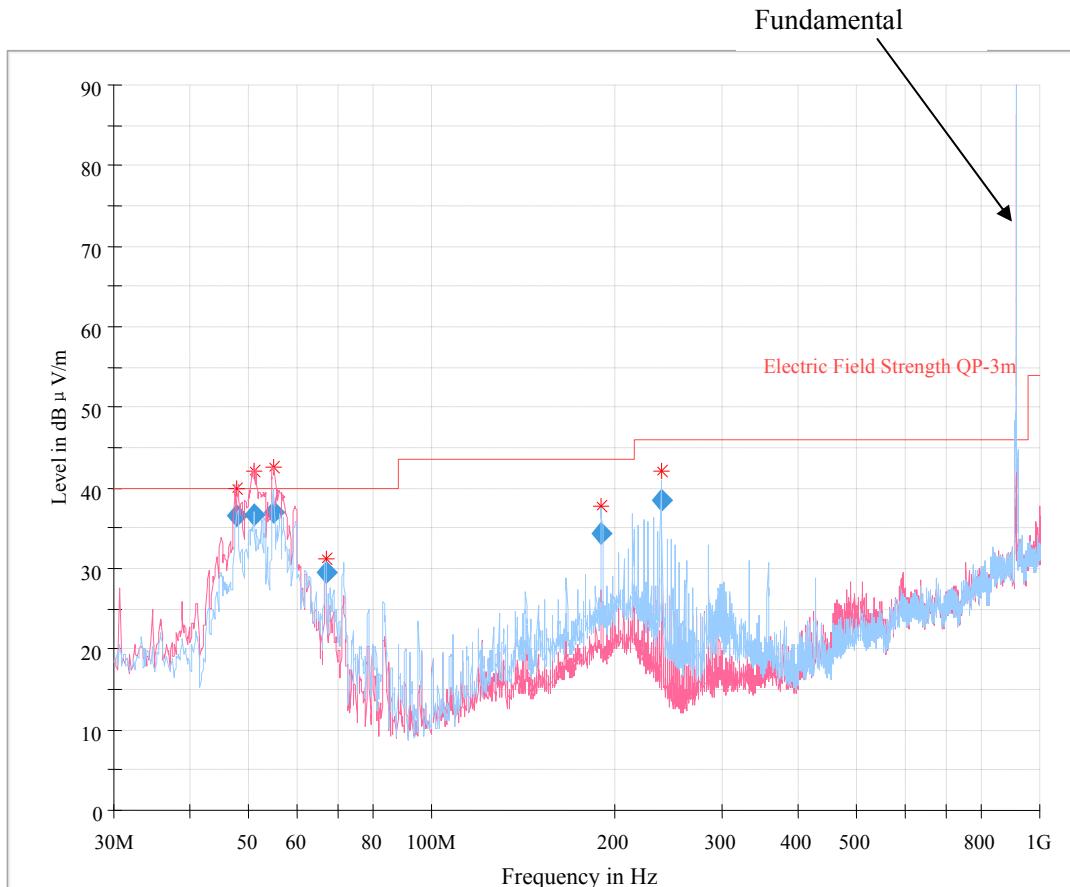
|                    |           |
|--------------------|-----------|
| Temperature:       | 29 °C     |
| Relative Humidity: | 56 %      |
| ATM Pressure:      | 101.0 kPa |

*The testing was performed by Holland Yang on 2020-07-27 for below 1GHz and Leo Huang on 2020-07-21 for above 1GHz.*

EUT operation mode: Transmitting (Low channel)

### Antenna 1

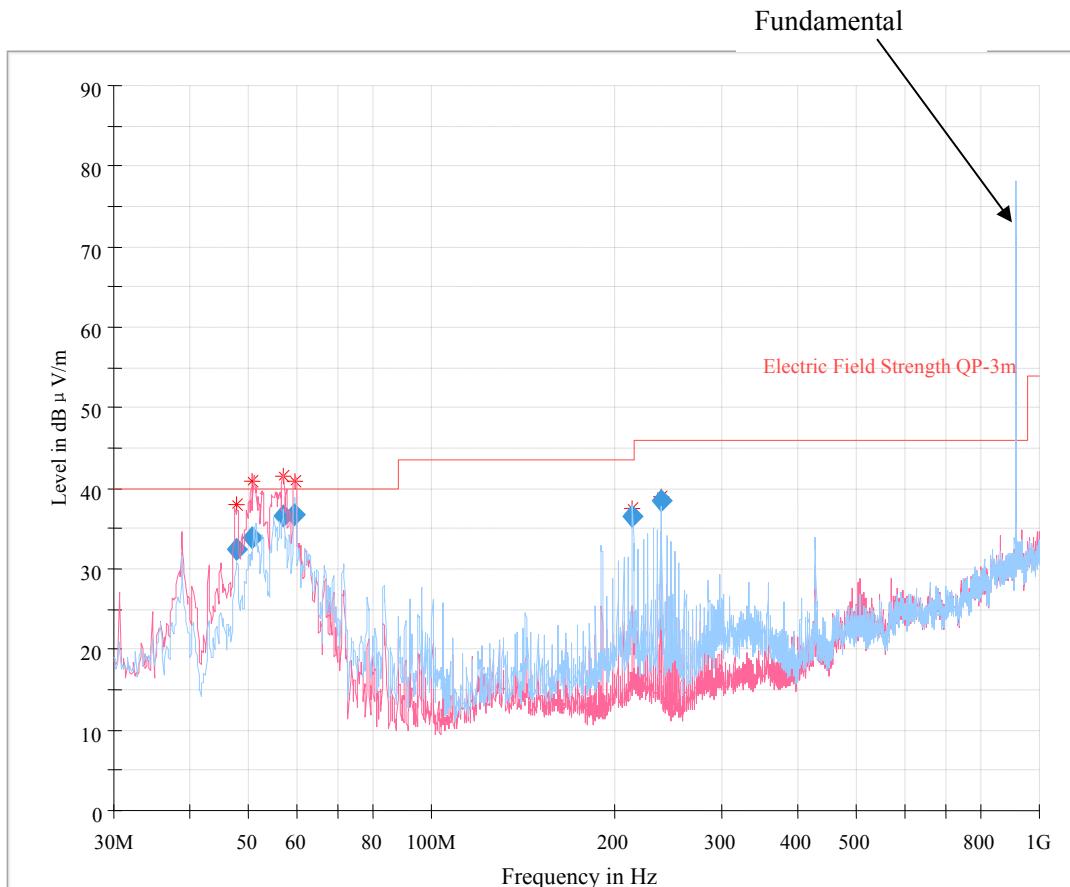
30 MHz~1 GHz:



| Frequency (MHz) | Corrected Amplitude (dB $\mu$ V/m) | Antenna height (cm) | Antenna Polarity | Turntable position (degree) | Correction Factor (dB/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
|-----------------|------------------------------------|---------------------|------------------|-----------------------------|--------------------------|----------------------|-------------|
| 47.862500       | 36.23                              | 103.0               | V                | 306.0                       | -18.6                    | 40.00                | 3.77        |
| 51.084125       | 36.55                              | 104.0               | V                | 304.0                       | -19.7                    | 40.00                | 3.45        |
| 54.961875       | 36.74                              | 103.0               | V                | 289.0                       | -19.9                    | 40.00                | 3.26        |
| 66.848625       | 29.57                              | 346.0               | H                | 175.0                       | -20.5                    | 40.00                | 10.43       |
| 190.649250      | 34.35                              | 173.0               | H                | 298.0                       | -15.1                    | 43.50                | 9.15        |
| 238.358625      | 38.42                              | 118.0               | H                | 106.0                       | -14.1                    | 46.00                | 7.58        |

**1 GHz - 10 GHz:**

| Frequency<br>(MHz) | Receiver                |                          | Turntable<br>Degree | Rx Antenna    |                | Corrected<br>Factor<br>(dB) | Corrected<br>Amplitude<br>(dB $\mu$ V/m) | FCC Part<br>15.247/205/209 |                |
|--------------------|-------------------------|--------------------------|---------------------|---------------|----------------|-----------------------------|--|----------------------------|----------------|
|                    | Reading<br>(dB $\mu$ V) | Detector<br>(PK/QP/Ave.) |                     | Height<br>(m) | Polar<br>(H/V) |                             |  | Limit<br>(dB $\mu$ V/m)    | Margin<br>(dB) |
| 903 MHz            |                         |                          |                     |               |                |                             |  |                            |                |
| 1806.00            | 62.43                   | PK                       | 344                 | 2.2           | V              | -1.65                       | 60.78                                    | 74                         | 13.22          |
| 1806.00            | 46.38                   | Ave.                     | 344                 | 2.2           | V              | -1.65                       | 44.73                                    | 54                         | 9.27           |
| 2709.00            | 51.97                   | PK                       | 143                 | 1.8           | V              | 1.09                        | 53.06                                    | 74                         | 20.94          |
| 2709.00            | 38.79                   | Ave.                     | 143                 | 1.8           | V              | 1.09                        | 39.88                                    | 54                         | 14.12          |
| 907.8 MHz          |                         |                          |                     |               |                |                             |  |                            |                |
| 1815.60            | 60.60                   | PK                       | 267                 | 2.2           | V              | -1.55                       | 59.05                                    | 74                         | 14.95          |
| 1815.60            | 46.21                   | Ave.                     | 267                 | 2.2           | V              | -1.55                       | 44.66                                    | 54                         | 9.34           |
| 2723.40            | 50.86                   | PK                       | 256                 | 2.2           | V              | 1.19                        | 52.05                                    | 74                         | 21.95          |
| 2723.40            | 39.87                   | Ave.                     | 256                 | 2.2           | V              | 1.19                        | 41.06                                    | 54                         | 12.94          |
| 914.2 MHz          |                         |                          |                     |               |                |                             |  |                            |                |
| 1828.40            | 61.60                   | PK                       | 338                 | 1.9           | V              | -1.55                       | 60.05                                    | 74                         | 13.95          |
| 1828.40            | 46.03                   | Ave.                     | 338                 | 1.9           | V              | -1.55                       | 44.48                                    | 54                         | 9.52           |
| 2742.60            | 52.09                   | PK                       | 242                 | 1.0           | V              | 1.19                        | 53.28                                    | 74                         | 20.72          |
| 2742.60            | 43.35                   | Ave.                     | 242                 | 1.0           | V              | 1.19                        | 44.54                                    | 54                         | 9.46           |

**Antenna 2****30 MHz~1 GHz:**

| Frequency (MHz) | Corrected Amplitude (dB $\mu$ V/m) | Antenna height (cm) | Antenna Polarity | Turntable position (degree) | Correction Factor (dB/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
|-----------------|------------------------------------|---------------------|------------------|-----------------------------|--------------------------|----------------------|-------------|
| 47.866000       | 32.42                              | 109.0               | V                | 132.0                       | -18.6                    | 40.00                | 7.58        |
| 50.551375       | 33.83                              | 101.0               | V                | 285.0                       | -19.7                    | 40.00                | 6.17        |
| 57.134625       | 36.23                              | 111.0               | V                | 288.0                       | -20.0                    | 40.00                | 3.77        |
| 59.556875       | 36.39                              | 103.0               | V                | 284.0                       | -20.1                    | 40.00                | 3.61        |
| 214.335250      | 36.57                              | 145.0               | H                | 99.0                        | -13.9                    | 43.50                | 6.93        |
| 238.317500      | 38.55                              | 128.0               | H                | 95.0                        | -14.1                    | 46.00                | 7.45        |

**1 GHz - 10 GHz:**

| Frequency<br>(MHz) | Receiver                |                          | Turntable<br>Degree | Rx Antenna    |                | Corrected<br>Factor<br>(dB) | Corrected<br>Amplitude<br>(dB $\mu$ V/m) | FCC Part<br>15.247/205/209 |                |
|--------------------|-------------------------|--------------------------|---------------------|---------------|----------------|-----------------------------|--|----------------------------|----------------|
|                    | Reading<br>(dB $\mu$ V) | Detector<br>(PK/QP/Ave.) |                     | Height<br>(m) | Polar<br>(H/V) |                             |  | Limit<br>(dB $\mu$ V/m)    | Margin<br>(dB) |
| 903 MHz            |                         |                          |                     |               |                |                             |  |                            |                |
| 1806.00            | 47.89                   | PK                       | 89                  | 2.1           | V              | -1.65                       | 46.24                                    | 74                         | 27.76          |
| 1806.00            | 28.09                   | Ave.                     | 89                  | 2.1           | V              | -1.65                       | 26.44                                    | 54                         | 27.56          |
| 2709.00            | 47.93                   | PK                       | 258                 | 1.1           | V              | 1.09                        | 49.02                                    | 74                         | 24.98          |
| 2709.00            | 28.57                   | Ave.                     | 258                 | 1.1           | V              | 1.09                        | 29.66                                    | 54                         | 24.34          |
| 907.8 MHz          |                         |                          |                     |               |                |                             |  |                            |                |
| 1815.60            | 47.88                   | PK                       | 2                   | 2.3           | V              | -1.55                       | 46.33                                    | 74                         | 27.67          |
| 1815.60            | 28.16                   | Ave.                     | 2                   | 2.3           | V              | -1.55                       | 26.61                                    | 54                         | 27.39          |
| 2723.40            | 47.70                   | PK                       | 220                 | 2.1           | V              | 1.19                        | 48.89                                    | 74                         | 25.11          |
| 2723.40            | 28.65                   | Ave.                     | 220                 | 2.1           | V              | 1.19                        | 29.84                                    | 54                         | 24.16          |
| 914.2 MHz          |                         |                          |                     |               |                |                             |  |                            |                |
| 1828.40            | 48.25                   | PK                       | 291                 | 1.3           | V              | -1.55                       | 46.70                                    | 74                         | 27.30          |
| 1828.40            | 28.16                   | Ave.                     | 291                 | 1.3           | V              | -1.55                       | 26.61                                    | 54                         | 27.39          |
| 2742.60            | 46.35                   | PK                       | 122                 | 1.3           | V              | 1.19                        | 47.54                                    | 74                         | 26.46          |
| 2742.60            | 28.43                   | Ave.                     | 122                 | 1.3           | V              | 1.19                        | 29.62                                    | 54                         | 24.38          |

**Note:**

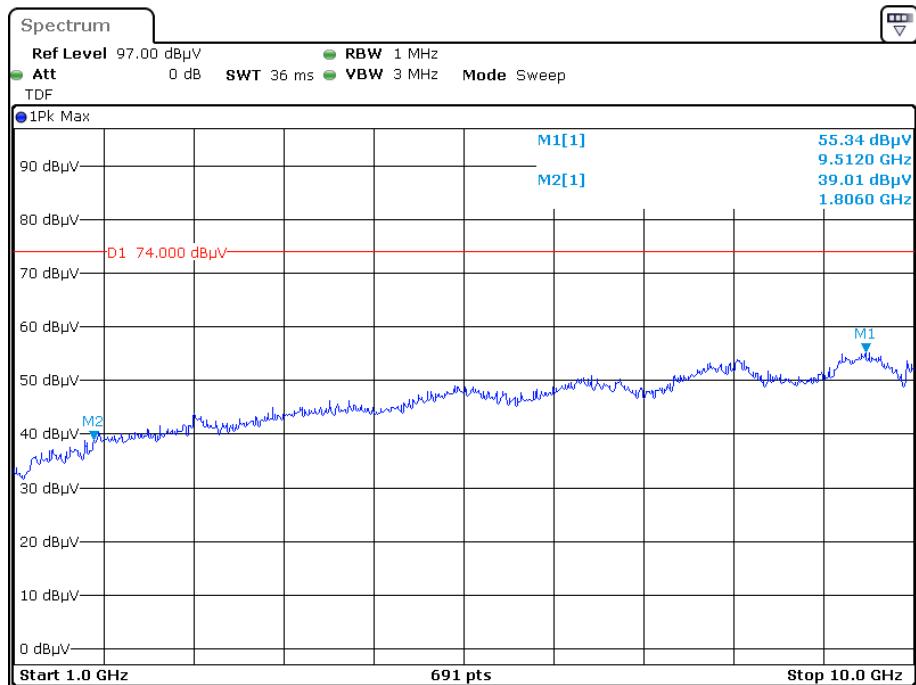
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

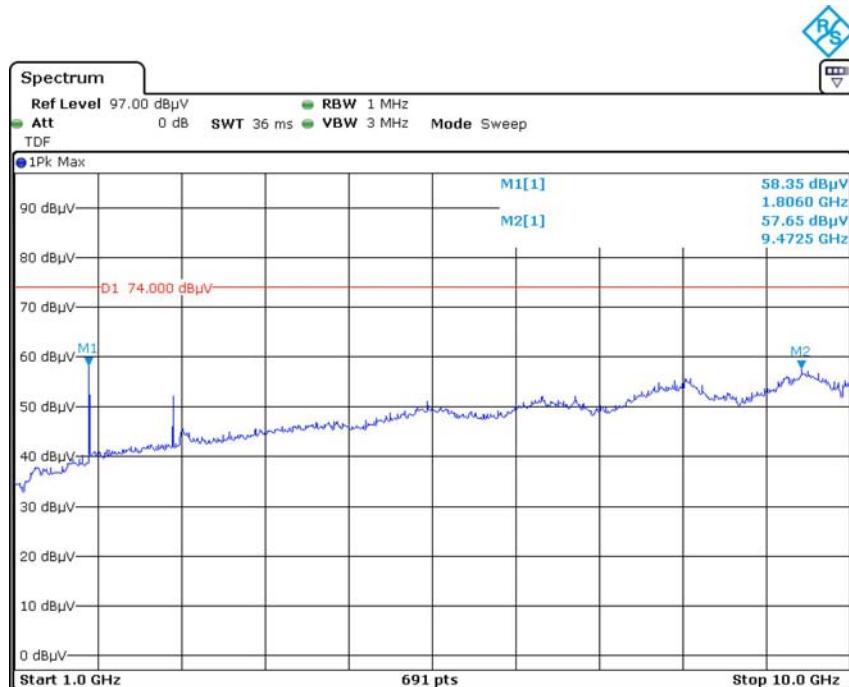
The other spurious emission which is 20dB to the limit was not recorded.

**Antenna 1, Low Channel  
Pre-scan for Peak value  
Horizontal**

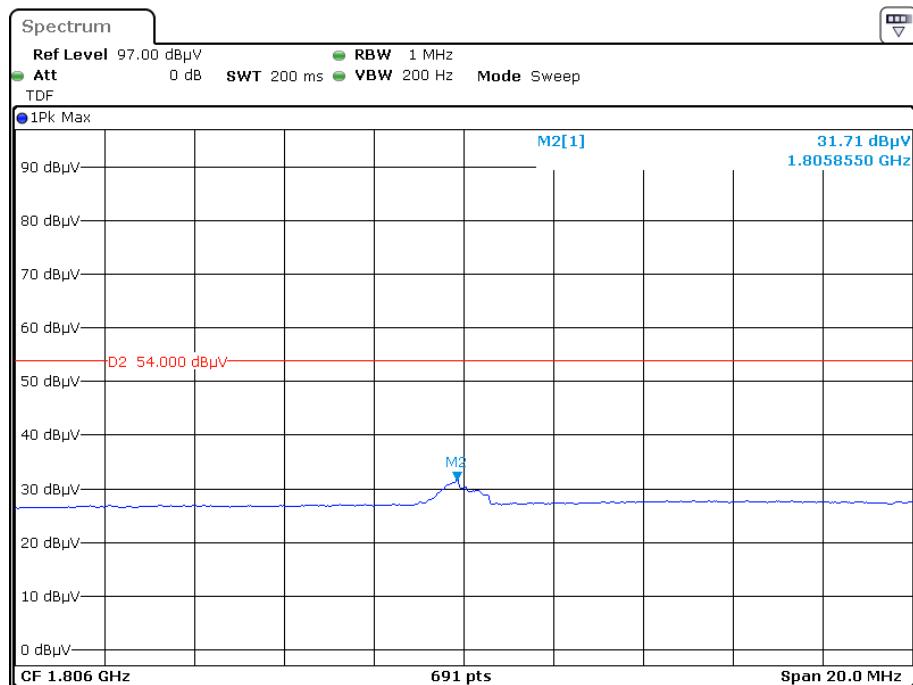
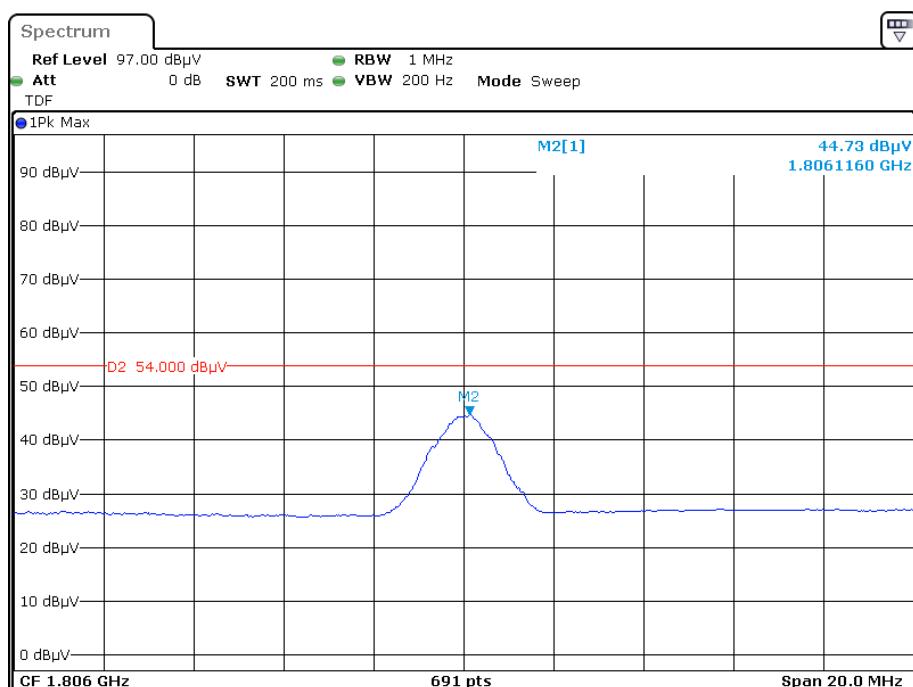


Date: 21.JUL.2020 17:59:10

**Vertical**



Date: 21.JUL.2020 17:49:18

**Average  
Horizontal****Vertical**

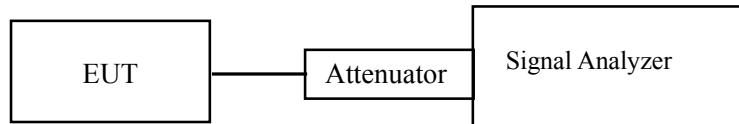
## FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH

### Applicable Standard

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.



### Test Data

#### Environmental Conditions

|                    |           |
|--------------------|-----------|
| Temperature:       | 24 °C     |
| Relative Humidity: | 53 %      |
| ATM Pressure:      | 101.0 kPa |

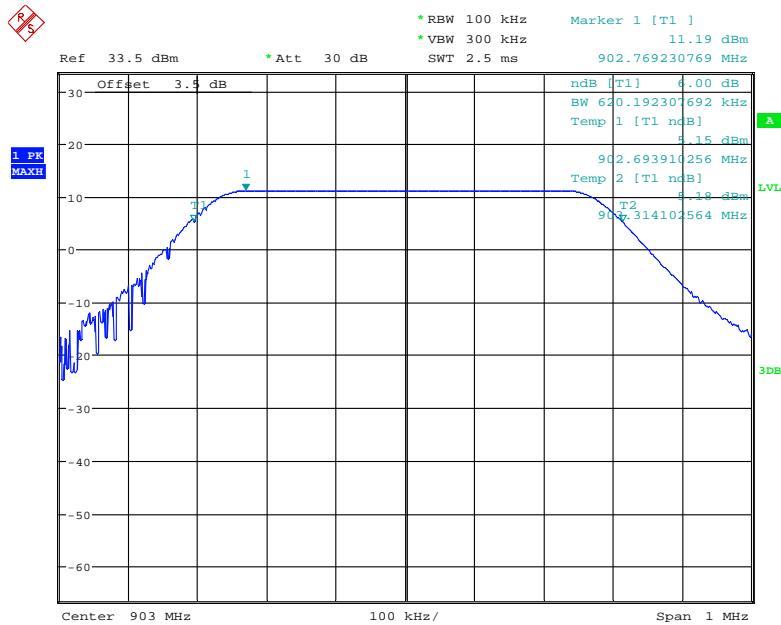
The testing was performed by George Zhong on 2020-07-16.

**Test Result:** Pass.

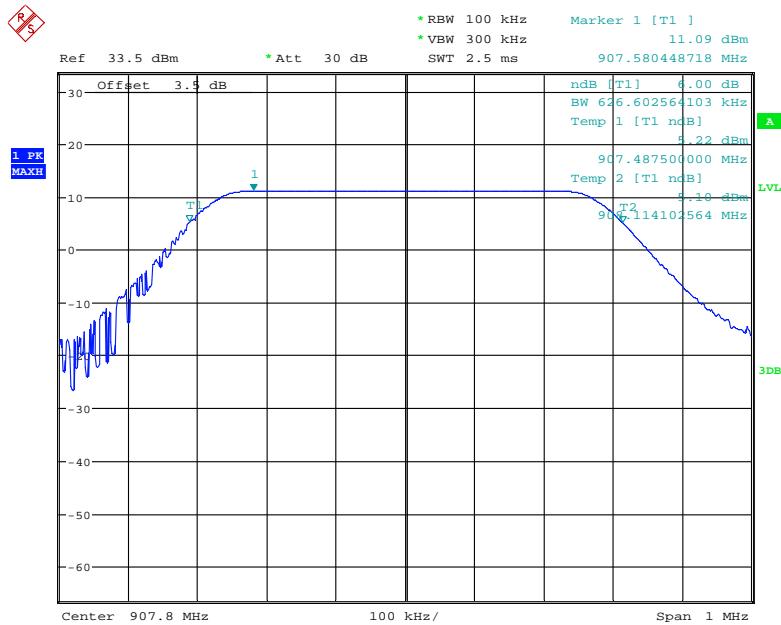
Please refer to the following table and plots.

*EUT operation mode: Transmitting*

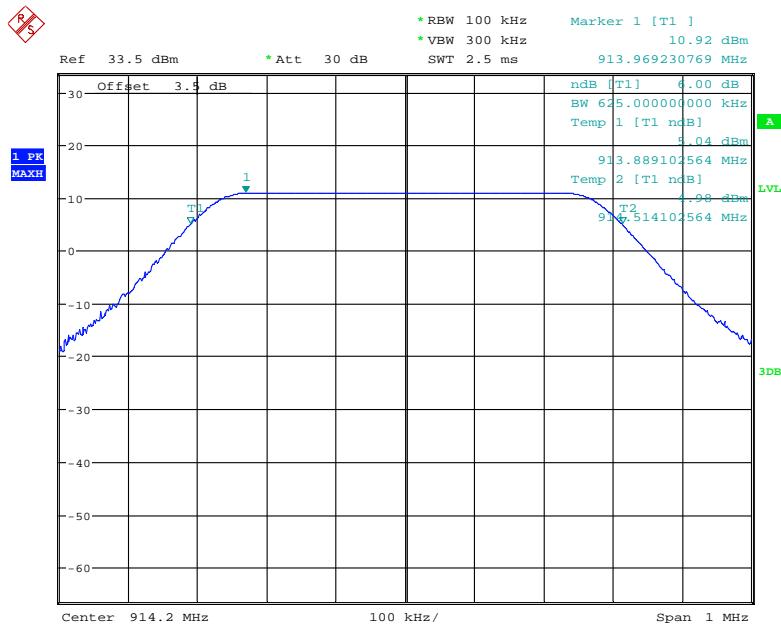
| Channel | Frequency (MHz) | 6 dB Emission Bandwidth (MHz) | Limit (MHz) |
|---------|-----------------|-------------------------------|-------------|
| Low     | 903.0           | 0.620                         | ≥0.5        |
| Middle  | 907.8           | 0.627                         | ≥0.5        |
| High    | 914.2           | 0.625                         | ≥0.5        |

**Low Channel**

Date: 16.JUL.2020 23:14:53

**Middle Channel**

Date: 16.JUL.2020 23:11:41

**High Channel**

Date: 16.JUL.2020 23:08:41

## FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

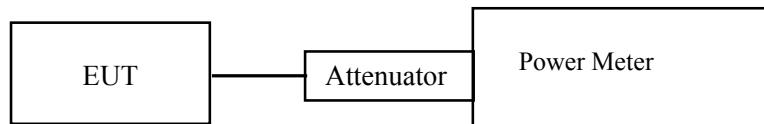
### Applicable Standard

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power.

Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

### Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.



### Test Data

#### Environmental Conditions

|                    |           |
|--------------------|-----------|
| Temperature:       | 23 °C     |
| Relative Humidity: | 54 %      |
| ATM Pressure:      | 101.0 kPa |

The testing was performed by George Zhong on 2020-07-16.

EUT operation mode: Transmitting

| Channel | Frequency (MHz) | Max Conducted Peak Output Power (dBm) | Limit (dBm) | Result |
|---------|-----------------|---------------------------------------|-------------|--------|
| Low     | 903.0           | 11.41                                 | ≤30         | Pass   |
| Middle  | 907.8           | 11.33                                 | ≤30         | Pass   |
| High    | 914.2           | 11.24                                 | ≤30         | Pass   |

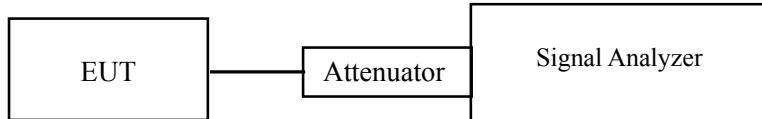
## FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

### Applicable Standard

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.



### Test Data

#### Environmental Conditions

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 24 °C     |
| <b>Relative Humidity:</b> | 55 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

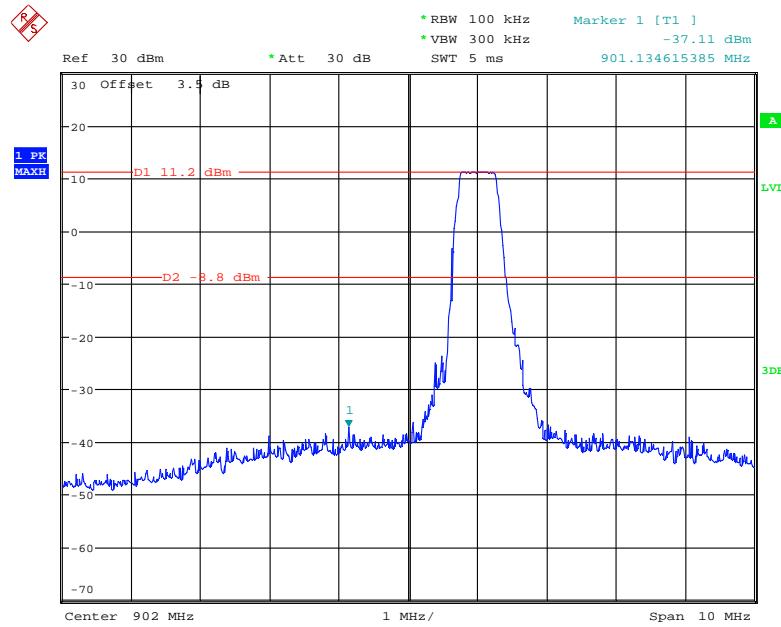
*The testing was performed by George Zhong on 2020-07-16.*

*EUT operation mode: Transmitting*

**Test Result:** Compliance

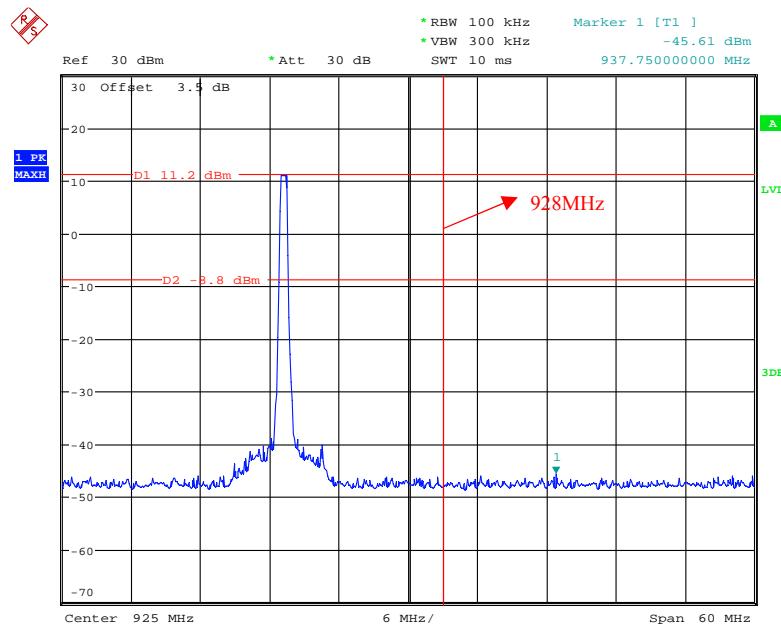
Please refer to the following plots.

## Left Side



Date: 16.JUL.2020 23:36:04

## Right Side



Date: 16.JUL.2020 23:33:39

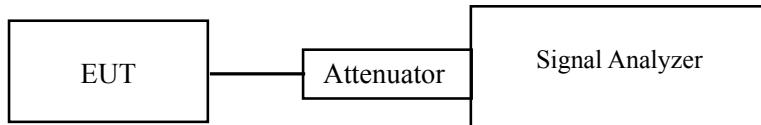
## FCC §15.247(e) - POWER SPECTRAL DENSITY

### Applicable Standard

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

### Test Procedure

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW to:  $3\text{kHz} \leq \text{RBW} \leq 100\text{ kHz}$ .
3. Set the VBW  $\geq 3 \times \text{RBW}$ .
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



### Test Data

#### Environmental Conditions

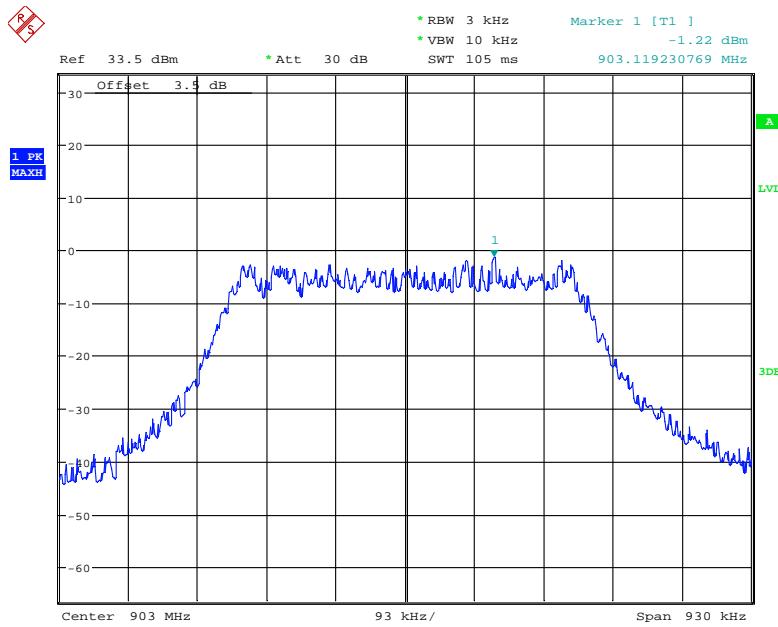
|                    |           |
|--------------------|-----------|
| Temperature:       | 23 °C     |
| Relative Humidity: | 54 %      |
| ATM Pressure:      | 101.0 kPa |

The testing was performed by George Zhong on 2020-07-16.

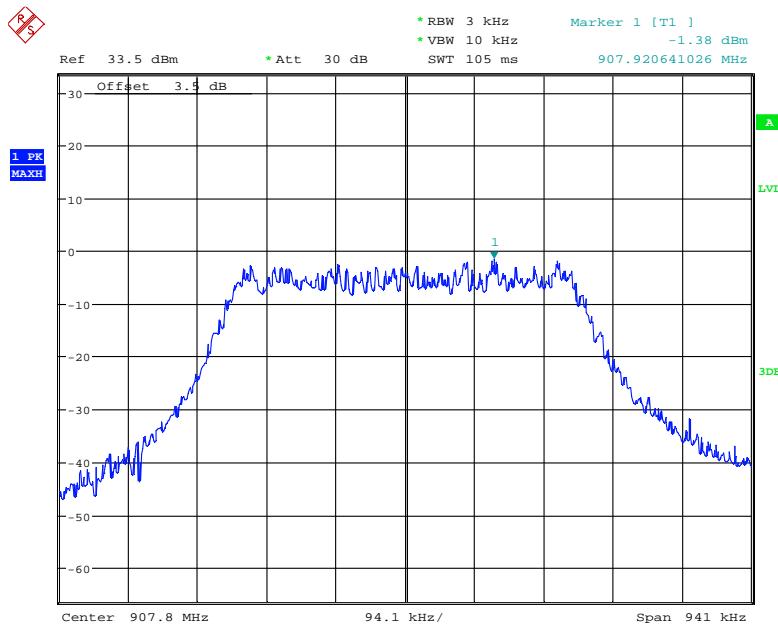
EUT operation mode: Transmitting

Test Result: Pass

| Channel | Frequency (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) |
|---------|-----------------|----------------|------------------|
| Low     | 903.0           | -1.22          | ≤8               |
| Middle  | 907.8           | -1.38          | ≤8               |
| High    | 914.2           | -1.54          | ≤8               |

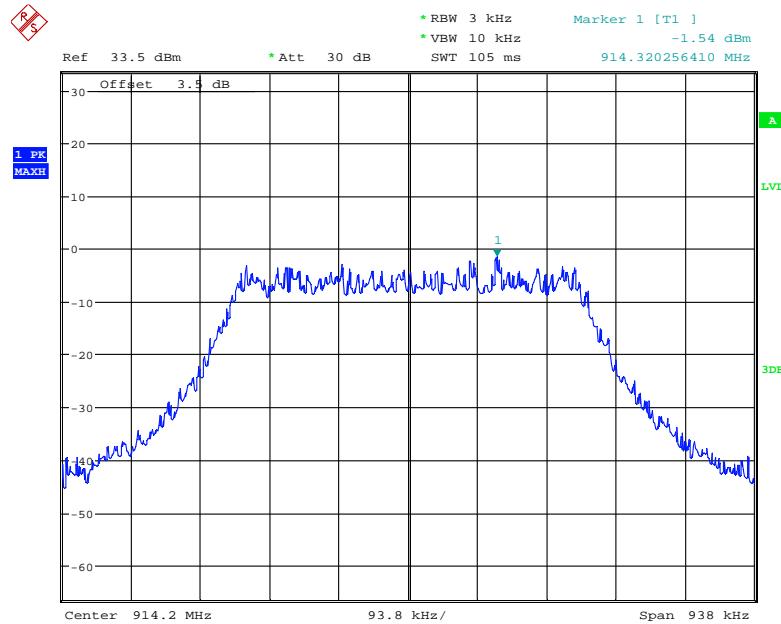
**Power Spectral Density, Low Channel**

Date: 16.JUL.2020 23:20:23

**Power Spectral Density, Middle Channel**

Date: 16.JUL.2020 23:21:56

## Power Spectral Density, High Channel



Date: 16.JUL.2020 23:22:47

\*\*\*\*\* END OF REPORT \*\*\*\*\*