

# RADIO TEST REPORT

## FCC ID: 2ATPO-RA08

**Product:** LoRa Module

**Trade Mark:**  

**Model No.:** Ra-08

**Family Model:** N/A

**Report No.:** S22021800203001

**Issue Date:** Apr 02.2022

### Prepared for

Shenzhen Ai-Thinker Technology Co., Ltd  
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Community, Xixiang Street, Baoan District, Shenzhen, China

### Prepared by

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## 1. TEST RESULT CERTIFICATION

|                                   |                                                                                                                               |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Applicant's name .....            | Shenzhen Ai-Thinker Technology Co., Ltd                                                                                       |
| Address.....                      | 410, Block C, Huafeng Smart Innovation Port, Gushu 2nd Road, Gushu Community, Xixiang Street, Baoan District, Shenzhen, China |
| Manufacturer's Name .....         | Shenzhen Ai-Thinker Technology Co., Ltd                                                                                       |
| Address.....                      | 410, Block C, Huafeng Smart Innovation Port, Gushu 2nd Road, Gushu Community, Xixiang Street, Baoan District, Shenzhen, China |
| Product description               |                                                                                                                               |
| Product name .....                | LoRa Module                                                                                                                   |
| Model and/or type reference ..... | Ra-08                                                                                                                         |
| Family Model .....                | N/A                                                                                                                           |

Measurement Procedure Used:

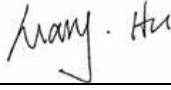
| APPLICABLE STANDARDS                              |             |
|---------------------------------------------------|-------------|
| APPLICABLE STANDARD/ TEST PROCEDURE               | TEST RESULT |
| FCC 47 CFR Part 15, Subpart C<br>ANSI C63.10-2013 | Complied    |

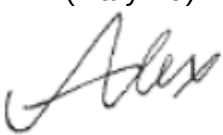
This device described above has been tested by Shenzhen NTEK Testing Technology Co., Ltd., and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.

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The test results of this report relate only to the tested sample identified in this report.

Date of Test : Feb 18, 2022 ~ Apr 02, 2022

Testing Engineer :   
(Mary Hu)

Authorized Signatory :   
(Alex Li)

## 2. SUMMARY OF TEST RESULTS

| FCC Part15 (15.231), Subpart C |                            |          |        |
|--------------------------------|----------------------------|----------|--------|
| Standard Section               | Test Item                  | Judgment | Remark |
| 15.207                         | Conducted Emission         | Pass     |        |
| 15.203                         | Antenna Requirement        | Pass     |        |
| 15.231(b)<br>15.209<br>15.205  | Radiated Spurious Emission | Pass     |        |
| 15.231(c)                      | Occupied Bandwidth         | Pass     |        |
| 15.231(a)(2)                   | Transmitter Timeout        | Pass     |        |

NOTE:

(1) "N/A" denotes test is not applicable in this Test Report.

### 3.FACILITIES AND ACCREDITATIONS

#### 3.1 FACILITIES

All measurement facilities used to collect the measurement data are located at

1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street, Bao'an District, Shenzhen 518126 P.R. China

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.10 and CISPR Publication 22.

#### 3.2 LABORATORY ACCREDITATIONS AND LISTINGS

##### Site Description

CNAS-Lab. : The Laboratory has been assessed and proved to be in compliance with CNAS-CL01:2006 (identical to ISO/IEC 17025:2005)

The Certificate Registration Number is L5516.

IC-Registration The Certificate Registration Number is 9270A.

CAB identifier:CN0074

FCC- Accredited Test Firm Registration Number: 463705.

Designation Number: CN1184

A2LA-Lab. The Certificate Registration Number is 4298.01

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories.

This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Name of Firm : Shenzhen NTEK Testing Technology Co., Ltd.

Site Location : 1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street, Bao'an District, Shenzhen 518126 P.R. China.

#### 3.3 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement  $y \pm U$ , where expanded uncertainty  $U$  is based on a standard uncertainty multiplied by a coverage factor of  $k=2$ , providing a level of confidence of approximately 95 %.

| No. | Item                                | Uncertainty             |
|-----|-------------------------------------|-------------------------|
| 1   | Conducted Emission Test             | $\pm 2.80\text{dB}$     |
| 2   | RF power, conducted                 | $\pm 0.16\text{dB}$     |
| 3   | Spurious emissions, conducted       | $\pm 0.21\text{dB}$     |
| 4   | All emissions, radiated(30MHz~1GHz) | $\pm 2.64\text{dB}$     |
| 5   | All emissions, radiated(1GHz~6GHz)  | $\pm 2.40\text{dB}$     |
| 6   | All emissions, radiated(> 6GHz)     | $\pm 2.52\text{dB}$     |
| 7   | Temperature                         | $\pm 0.5^\circ\text{C}$ |
| 8   | Humidity                            | $\pm 2\%$               |

#### 4. GENERAL DESCRIPTION OF EUT

|                     |                                                                                                                                                                                                                    |                |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Equipment           | LoRa Module                                                                                                                                                                                                        |                |
| Trade Name          |                                                  |                |
| Model Name          | Ra-08                                                                                                                                                                                                              |                |
| Family Model        | N/A                                                                                                                                                                                                                |                |
| Model Difference    | N/A                                                                                                                                                                                                                |                |
| Sample no.          | S220218002008                                                                                                                                                                                                      |                |
| Product Description | The EUT is a LoRa Module                                                                                                                                                                                           |                |
|                     | Operation Frequency:                                                                                                                                                                                               | 411-525MHz     |
|                     | Modulation Type:                                                                                                                                                                                                   | LoRa/FSK/OOK   |
|                     | Number Of Channel                                                                                                                                                                                                  | 115CH          |
|                     | Antenna Designation:                                                                                                                                                                                               | Spring Antenna |
|                     | Antenna Gain:                                                                                                                                                                                                      | 2dBi           |
|                     | Based on the application, features, or specification exhibited in User's Manual, the EUT is considered as an ITE/Computing Device. More details of EUT technical specification, please refer to the User's Manual. |                |
| Channel List        | Refer to below                                                                                                                                                                                                     |                |
| Power supply        | DC 3.3V form Uart                                                                                                                                                                                                  |                |
| Adapter             | N/A                                                                                                                                                                                                                |                |
| Battery             | N/A                                                                                                                                                                                                                |                |
| HW Version          | V1.1                                                                                                                                                                                                               |                |
| FW Version          | V1.1.0                                                                                                                                                                                                             |                |

Note:

- For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.
- Channel List:

| Channel | Frequency (MHz) |
|---------|-----------------|
| 01      | 411MHz          |
| 02      | 412MHz          |
| --      | --              |
| 57      | 467 MHz         |
| 58      | 468 MHz         |
| --      | --              |
| 114     | 524 MHz         |
| 115     | 525 MHz         |

3. Test Channel:

| Channel | Frequency<br>(MHz) |
|---------|--------------------|
| 01      | 411 MHz            |
| 58      | 468 MHz            |
| 115     | 525 MHz            |

[illegible]

## 5. DESCRIPTION OF TEST MODES

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

Note: ETU supports three modulation modes of LoRa/FSK/OOK, but only records worst mode FSK

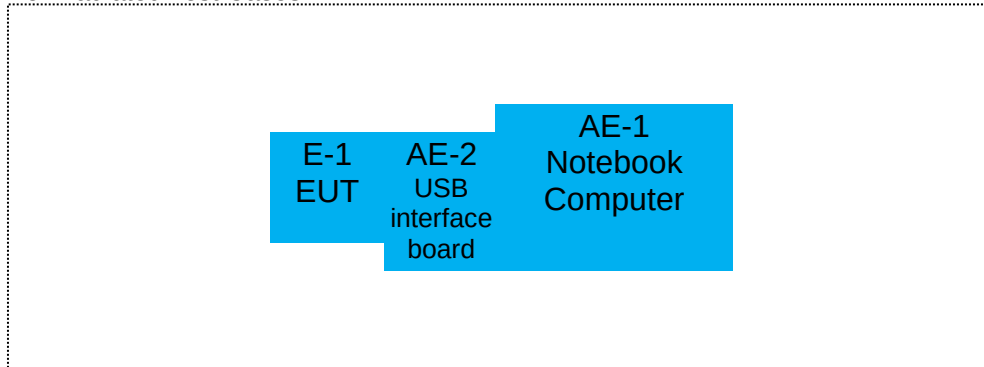
| Pretest Mode | Description        |
|--------------|--------------------|
| Mode 1       | Channel 01 FSK TX  |
| Mode 2       | Channel 58 FSK TX  |
| Mode 3       | Channel 115 FSK TX |

| For Radiated Emission |                    |
|-----------------------|--------------------|
| Final Test Mode       | Description        |
| Mode 1                | Channel 01 FSK TX  |
| Mode 2                | Channel 58 FSK TX  |
| Mode 3                | Channel 115 FSK TX |

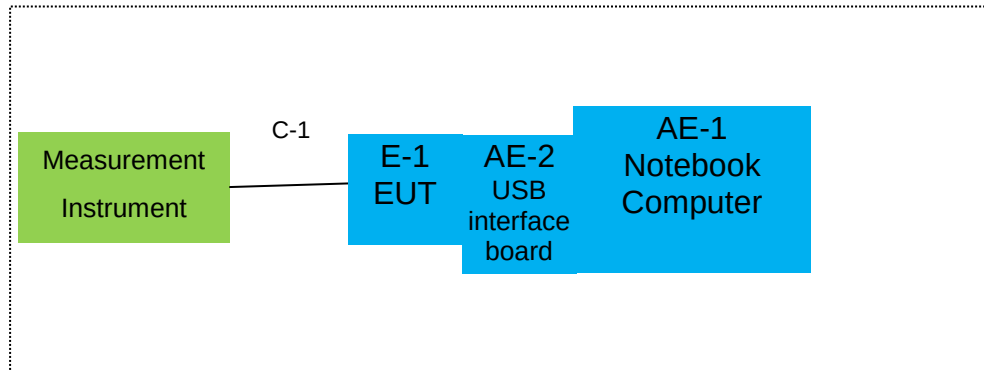
## 6. SETUP OF EQUIPMENT UNDER TEST

### 6.1 BLOCK DIAGRAM CONFIGURATION OF TEST SYSTEM

For Radiated Test Cases



For Conducted Test Cases



Note: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

## 6.2 DESCRIPTION OF SUPPORT UNITS(CONDUCTED MODE)

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

| Item | Equipment           | Mfr/Brand                                                                                                                                                             | Model/Type No. | Series No. | Note        |
|------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------------|-------------|
| E-1  | LoRa Module         |  ,  | Ra-08          | N/A        | EUT         |
| AE-1 | Notebook Computer   | Dell                                                                                                                                                                  | 1816           | N/A        | Peripherals |
| AE-2 | USB interface board | N/A                                                                                                                                                                   | N/A            | N/A        | Peripherals |
|      |                     |                                                                                                                                                                       |                |            |             |
|      |                     |                                                                                                                                                                       |                |            |             |

| Item | Cable Type | Shielded Type | Ferrite Core | Length |
|------|------------|---------------|--------------|--------|
| C-1  | RF Cable   | Yes           | NO           | 0.1m   |
|      |            |               |              |        |
|      |            |               |              |        |
|      |            |               |              |        |
|      |            |               |              |        |
|      |            |               |              |        |
|      |            |               |              |        |

Note:

- (1) The support equipment was authorized by Declaration of Confirmation.
- (2) For detachable type I/O cable should be specified the length in cm in 『Length』 column.
- (3) “YES” is means “shielded” “with core”; “NO” is means “unshielded” “without core”.

### 6.3 EQUIPMENTS LIST FOR ALL TEST ITEMS

#### Radiation Test equipment

| Item | Kind of Equipment                  | Manufacturer | Type No.      | Serial No.    | Last calibration         | Calibrated until         | Calibration period |
|------|------------------------------------|--------------|---------------|---------------|--------------------------|--------------------------|--------------------|
| 1    | Spectrum Analyzer                  | Agilent      | E4407B        | MY45108040    | 2021.04.27               | 2022.04.26               | 1 year             |
| 2    | Spectrum Analyzer                  | Agilent      | N9020A        | MY49100060    | 2021.07.01               | 2022.06.30               | 1 year             |
| 3    | EMI Test Receiver                  | Agilent      | N9038A        | MY53227146    | 2021.07.01               | 2022.06.30               | 1 year             |
| 4    | Test Receiver                      | R&S          | ESPI          | 101318        | 2021.04.27               | 2022.04.26               | 1 year             |
| 5    | Bilog Antenna                      | TESEQ        | CBL6111D      | 31216         | 2021.03.29<br>2021.07.01 | 2022.03.28<br>2022.06.30 | 1 year             |
| 6    | 50Ω Coaxial Switch                 | Anritsu      | MP59B         | 6200983705    | 2020.05.11               | 2023.05.10               | 3 year             |
| 7    | Horn Antenna                       | EM           | EM-AH-10180   | 2011071402    | 2021.03.29<br>2021.07.01 | 2022.03.28<br>2022.06.30 | 1 year             |
| 8    | Horn Ant                           | Schwarzbeck  | BBHA 9170     | 9170-181      | 2021.11.07               | 2022.11.06               | 1 year             |
| 9    | Amplifier                          | EMC          | EMC051835SE   | 980246        | 2021.07.01               | 2022.06.30               | 1 year             |
| 10   | Amplifier                          | MITEQ        | TTA1840-35-HG | 177156        | 2021.11.07               | 2022.11.06               | 1 year             |
| 11   | Loop Antenna                       | ARA          | PLA-1030/B    | 1029          | 2021.07.01               | 2022.06.30               | 1 year             |
| 12   | Power Meter                        | DARE         | RPR3006W      | 15I00041SN084 | 2019.08.06               | 2022.08.05               | 3 year             |
| 13   | Test Cable (9KHz-30MHz)            | N/A          | R-01          | N/A           | 2019.08.06               | 2022.08.05               | 3 year             |
| 14   | Test Cable (30MHz-1GHz)            | N/A          | R-02          | N/A           | 2019.06.28               | 2022.06.27               | 3 year             |
| 15   | High Test Cable(1G-40G Hz)         | N/A          | R-03          | N/A           | 2019.08.06               | 2022.08.05               | 3 year             |
| 16   | High Test Cable(1G-40G Hz)         | N/A          | R-04          | N/A           | 2021.07.01               | 2022.06.30               | 1 year             |
| 17   | temporary antenna connector (Note) | NTS          | R001          | N/A           | N/A                      | N/A                      | N/A                |

**Note:**

We will use the temporary antenna connector (soldered on the PCB board) When conducted test  
And this temporary antenna connector is listed within the instrument list

AC Conduction Test equipment

| Item | Kind of Equipment       | Manufacturer | Type No.  | Serial No. | Last calibration | Calibrated until | Calibration period |
|------|-------------------------|--------------|-----------|------------|------------------|------------------|--------------------|
| 1    | Test Receiver           | R&S          | ESCI      | 101160     | 2021.04.27       | 2022.04.26       | 1 year             |
| 2    | LISN                    | R&S          | ENV216    | 101313     | 2021.04.27       | 2022.04.26       | 1 year             |
| 3    | LISN                    | SCHWARZBECK  | NNLK 8129 | 8129245    | 2021.04.27       | 2022.04.26       | 1 year             |
| 4    | 50Ω Coaxial Switch      | ANRITSU CORP | MP59B     | 6200983704 | 2020.05.11       | 2023.05.10       | 3 year             |
| 5    | Test Cable (9KHz-30MHz) | N/A          | C01       | N/A        | 2020.05.11       | 2023.05.10       | 3 year             |
| 6    | Test Cable (9KHz-30MHz) | N/A          | C02       | N/A        | 2020.05.11       | 2023.05.10       | 3 year             |
| 7    | Test Cable (9KHz-30MHz) | N/A          | C03       | N/A        | 2020.05.11       | 2023.05.10       | 3 year             |

Note: Each piece of equipment is scheduled for calibration once a year except the Aux Equipment & Test Cable which is scheduled for calibration every 1 or 3 years.

## **7. ANTENNA REQUIREMENT**

### **7.1 STANDARD REQUIREMENT**

15.203 requirement: For intentional device, 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.

### **7.2 EUT ANTENNA**

The EUT antenna is permanent attached Spring Antenna (Gain: 2dBi). It comply with the standard requirement.

## 8. CONDUCTED EMISSION MEASUREMENT

### 8.1 Applicable Standard

According to FCC Part 15.207(a) and KDB 174176 D01 Line Conducted FAQ v01r01

### 8.2 Conformance Limit

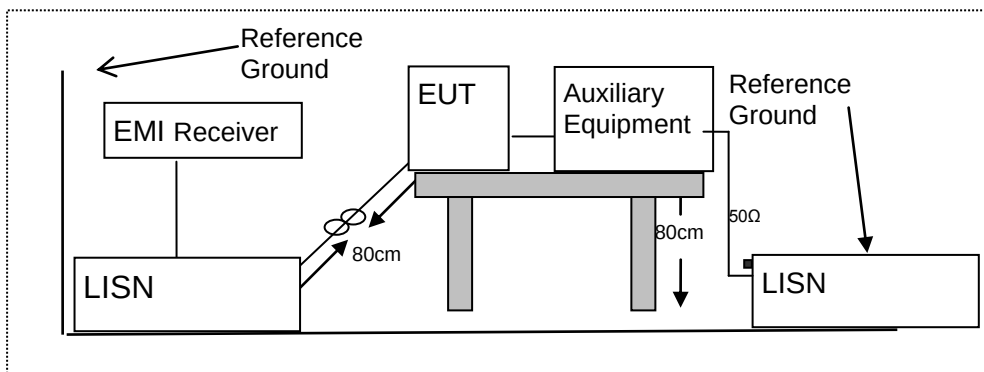
| Frequency(MHz) | Conducted Emission Limit |         |
|----------------|--------------------------|---------|
|                | Quasi-peak               | Average |
| 0.15-0.5       | 66-56*                   | 56-46*  |
| 0.5-5.0        | 56                       | 46      |
| 5.0-30.0       | 60                       | 50      |

Note: 1. \*Decreases with the logarithm of the frequency  
 2. The lower limit shall apply at the transition frequencies  
 3. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

### 8.3 Measuring Instruments

The Measuring equipment is listed in the section 6.3 of this test report.

### 8.4 Test Configuration



### 8.5 Test Procedure

According to the requirements in Section 13.1.4.1 of ANSI C63.10-2013 Conducted emissions the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-Peak and average detector mode.

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room.
2. The EUT was placed on a table which is 0.8m above ground plane.
3. Connect EUT to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
4. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40cm long.
5. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
6. LISN at least 80 cm from nearest part of EUT chassis.
7. The frequency range from 150KHz to 30MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth(IF bandwidth=9KHz) with Maximum Hold Mode
9. For the actual test configuration, please refer to the related Item –EUT Test Photos.

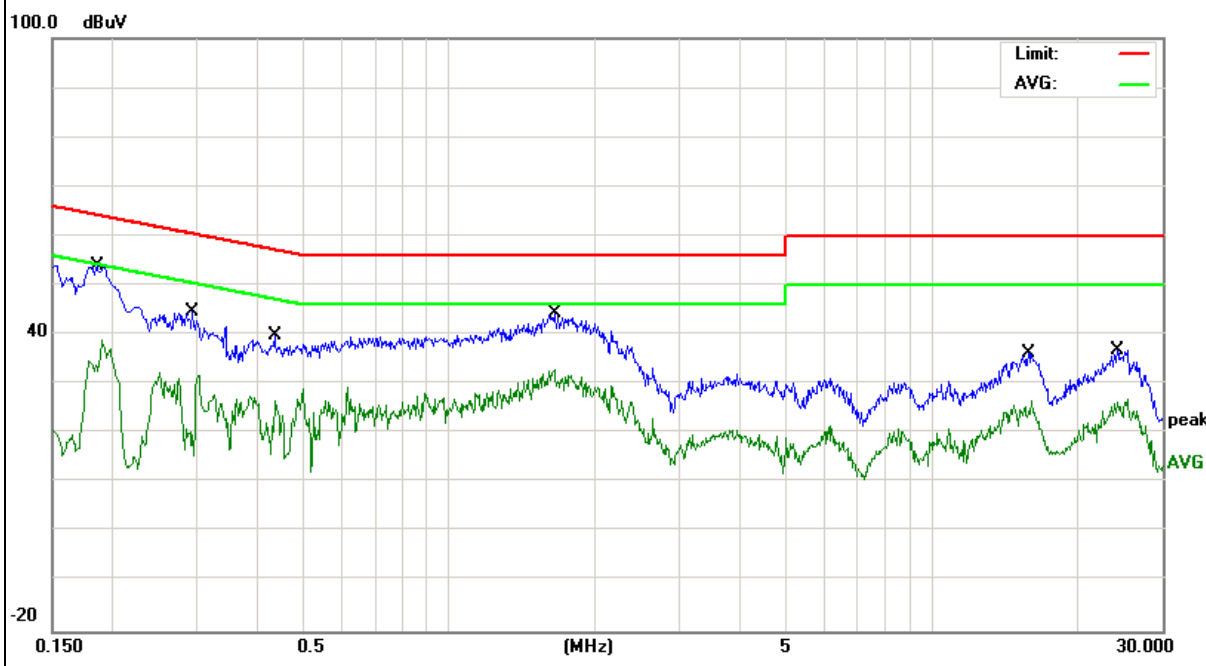
## 8.6 Test Results

|                |                                                   |                     |        |
|----------------|---------------------------------------------------|---------------------|--------|
| EUT :          | LoRa Module                                       | Model Name :        | Ra-08  |
| Temperature :  | 26 °C                                             | Relative Humidity : | 54%    |
| Pressure :     | 1010hPa                                           | Phase :             | L      |
| Test Voltage : | DC 3.3V by Control panel and Adapter AC 120V/60Hz | Test Mode :         | Mode 1 |

| Frequency<br>(MHz) | Reading Level<br>(dBμV) | Correct Factor<br>(dB) | Measure-ment<br>(dBμV) | Limits<br>(dBμV) | Margin<br>(dB) | Remark |
|--------------------|-------------------------|------------------------|------------------------|------------------|----------------|--------|
| 0.1859             | 44.55                   | 9.55                   | 54.10                  | 64.21            | -10.11         | QP     |
| 0.1859             | 29.26                   | 9.55                   | 38.81                  | 54.21            | -15.40         | AVG    |
| 0.2923             | 35.16                   | 9.54                   | 44.70                  | 60.46            | -15.76         | QP     |
| 0.2923             | 22.34                   | 9.54                   | 31.88                  | 50.46            | -18.58         | AVG    |
| 0.4339             | 30.36                   | 9.55                   | 39.91                  | 57.18            | -17.27         | QP     |
| 0.4339             | 17.19                   | 9.55                   | 26.74                  | 47.18            | -20.44         | AVG    |
| 1.6497             | 34.72                   | 9.58                   | 44.30                  | 56.00            | -11.70         | QP     |
| 1.6497             | 23.27                   | 9.58                   | 32.85                  | 46.00            | -13.15         | AVG    |
| 15.8619            | 26.50                   | 9.80                   | 36.30                  | 60.00            | -23.70         | QP     |
| 15.8619            | 16.73                   | 9.80                   | 26.53                  | 50.00            | -23.47         | AVG    |
| 24.1580            | 26.96                   | 9.94                   | 36.90                  | 60.00            | -23.10         | QP     |
| 24.1580            | 16.28                   | 9.94                   | 26.22                  | 50.00            | -23.78         | AVG    |

Remark:

1. All readings are Quasi-Peak and Average values.
2. Factor = Insertion Loss + Cable Loss.

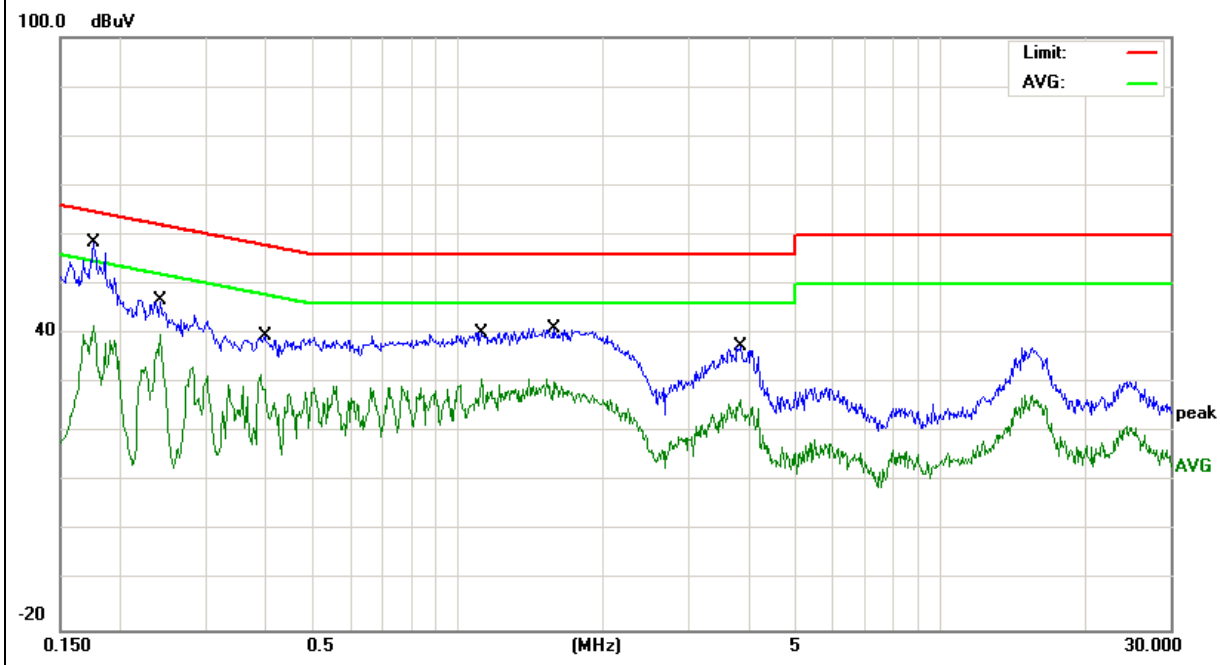


|                |                                                   |                     |        |
|----------------|---------------------------------------------------|---------------------|--------|
| EUT :          | LoRa Module                                       | Model Name :        | Ra-08  |
| Temperature :  | 26 °C                                             | Relative Humidity : | 54%    |
| Pressure :     | 1010hPa                                           | Phase :             | N      |
| Test Voltage : | DC 3.3V by Control panel and Adapter AC 120V/60Hz | Test Mode :         | Mode 1 |

| Frequency<br>(MHz) | Reading Level<br>(dBμV) | Correct Factor<br>(dB) | Measure-ment<br>(dBμV) | Limits<br>(dBμV) | Margin<br>(dB) | Remark |
|--------------------|-------------------------|------------------------|------------------------|------------------|----------------|--------|
| 0.1758             | 48.86                   | 9.54                   | 58.40                  | 64.68            | -6.28          | QP     |
| 0.1758             | 32.18                   | 9.54                   | 41.72                  | 54.68            | -12.96         | AVG    |
| 0.2419             | 37.06                   | 9.54                   | 46.60                  | 62.03            | -15.43         | QP     |
| 0.2419             | 30.20                   | 9.54                   | 39.74                  | 52.03            | -12.29         | AVG    |
| 0.3980             | 29.97                   | 9.54                   | 39.51                  | 57.89            | -18.38         | QP     |
| 0.3980             | 22.08                   | 9.54                   | 31.62                  | 47.89            | -16.27         | AVG    |
| 1.1180             | 30.75                   | 9.55                   | 40.30                  | 56.00            | -15.70         | QP     |
| 1.1180             | 21.27                   | 9.55                   | 30.82                  | 46.00            | -15.18         | AVG    |
| 1.5780             | 31.43                   | 9.57                   | 41.00                  | 56.00            | -15.00         | QP     |
| 1.5780             | 21.24                   | 9.57                   | 30.81                  | 46.00            | -15.19         | AVG    |
| 3.8620             | 27.91                   | 9.59                   | 37.50                  | 56.00            | -18.50         | QP     |
| 3.8620             | 16.91                   | 9.59                   | 26.50                  | 46.00            | -19.50         | AVG    |

Remark:

1. All readings are Quasi-Peak and Average values.
2. Factor = Insertion Loss + Cable Loss.



## 9. RADIATED EMISSION MEASUREMENT

### 9.1 Applicable Standard

According to 15.209& 15.205 and ANSI C63.10-2013

### 9.2 Radiated Emission Limits (FCC 15.209)

| Frequencies (MHz) | Field Strength (micorvolts/meter) | Measurement Distance (meters) |
|-------------------|-----------------------------------|-------------------------------|
| 0.009~0.490       | 2400/F(KHz)                       | 300                           |
| 0.490~1.705       | 24000/F(KHz)                      | 30                            |
| 1.705~30.0        | 30                                | 30                            |
| 30~88             | 100                               | 3                             |
| 88~216            | 150                               | 3                             |
| 216~960           | 200                               | 3                             |
| Above 960         | 500                               | 3                             |

Note:

- (1) The tighter limit applies at the band edges.
- (2) Emission level (dBuV/m)=20log Emission level (uV/m).
- (3) Measurement was performed at an antenna to the closed point of EUT distance of meters.
- (4) For Frequency 9kHz~30MHz:  
Distance extrapolation factor =40log(Specific distance/ test distance)(dB);  
Limit line=Specific limits(dBuV) + distance extrapolation factor.  
For Frequency above 30MHz:  
Distance extrapolation factor =20log(Specific distance/ test distance)(dB);  
Limit line=Specific limits(dBuV) + distance extrapolation factor.

According to FCC Part 15.205, Restricted bands:

| MHz               | MHz                 | MHz           | GHz         |
|-------------------|---------------------|---------------|-------------|
| 0.090-0.110       | 16.42-16.423        | 399.9-410     | 4.5-5.15    |
| 0.495-0.505       | 16.69475-16.69525   | 608-614       | 5.35-5.46   |
| 2.1735-2.1905     | 16.80425-16.80475   | 960-1240      | 7.25-7.75   |
| 4.125-4.128       | 25.5-25.67          | 1300-1427     | 8.025-8.5   |
| 4.17725-4.17775   | 37.5-38.25          | 1435-1626.5   | 9.0-9.2     |
| 4.20725-4.20775   | 73-74.6             | 1645.5-1646.5 | 9.3-9.5     |
| 6.215-6.218       | 74.8-75.2           | 1660-1710     | 10.6-12.7   |
| 6.26775-6.26825   | 123-138             | 2200-2300     | 14.47-14.5  |
| 8.291-8.294       | 149.9-150.05        | 2310-2390     | 15.35-16.2  |
| 8.362-8.366       | 156.52475-156.52525 | 2483.5-2500   | 17.7-21.4   |
| 8.37625-8.38675   | 156.7-156.9         | 2690-2900     | 22.01-23.12 |
| 8.41425-8.41475   | 162.0125-167.17     | 3260-3267     | 23.6-24.0   |
| 12.29-12.293      | 167.72-173.2        | 3332-3339     | 31.2-31.8   |
| 12.51975-12.52025 | 240-285             | 3345.8-3358   | 36.43-36.5  |
| 12.57675-12.57725 | 322-335.4           | 3600-4400     | (2)         |
| 13.36-13.41       |                     |               |             |

## LIMITS OF RADIATED EMISSION MEASUREMENT ( FCC 15.231)

| Fundamental Frequency<br>(MHz) | Field Strength of<br>fundamental<br>(microvolts/meter) | Field Strength of Unwanted<br>Emissions<br>(microvolts/meter) |
|--------------------------------|--------------------------------------------------------|---------------------------------------------------------------|
| 40.66 - 40.70                  | 2250.00                                                | 225.00                                                        |
| 70 - 130                       | 950.00                                                 | 95.00                                                         |
| 130 - 174                      | 1,250 to 3,750 **                                      | 95 to 375 **                                                  |
| 174 - 260                      | 3750.00                                                | 375.00                                                        |
| 260 - 470                      | 3,750 to 9,500 **                                      | 375 to 1,250 **                                               |
| Above 470                      | 9500.00                                                | 950.00                                                        |

Notes:

(1) \*\* linear interpolations

[Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130-174 MHz, uV/m at 3 meters = 56.81818(F) - 6136.3636; for the band 260-470 MHz, uV/m at 3 meters = 41.6667(F) - 7083.3333. The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.]

The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in 93 Section 15.209, whichever limit permits a higher field strength.

| Spectrum Parameter                    | Setting               |
|---------------------------------------|-----------------------|
| Attenuation                           | Auto                  |
| Start Frequency                       | 1000 MHz              |
| Stop Frequency                        | 10th carrier harmonic |
| RB / VB (emission in restricted band) | 1MHz / 1MHz for Peak  |

| Receiver Parameter     | Setting                         |
|------------------------|---------------------------------|
| Attenuation            | Auto                            |
| Start ~ Stop Frequency | 9kHz~150kHz / RB 200Hz for QP   |
| Start ~ Stop Frequency | 150kHz~30MHz / RB 9kHz for QP   |
| Start ~ Stop Frequency | 30MHz~1000MHz / RB 90kHz for QP |

### 9.3 TEST PROCEDURE

The test site semi-anechoic chamber has met the requirement of NSA tolerance 4 dB according to the standards: ANSI C63.10-2013. The test distance is 3m. The setup is according to the requirements in Section 13.1.4.1 of ANSI C63.10-2013 and CAN/CSA-CEI/IEC CISPR 22.

This test is required for any spurious emission that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT.

Use the following spectrum analyzer settings:

| Spectrum Parameter                    | Setting                                          |
|---------------------------------------|--------------------------------------------------|
| Attenuation                           | Auto                                             |
| Start Frequency                       | 1000 MHz                                         |
| Stop Frequency                        | 10th carrier harmonic                            |
| RB / VB (emission in restricted band) | 1 MHz / 1 MHz for Peak, 1 MHz / 10Hz for Average |

| Receiver Parameter     | Setting                          |
|------------------------|----------------------------------|
| Attenuation            | Auto                             |
| Start ~ Stop Frequency | 9kHz~150kHz / RB 200Hz for QP    |
| Start ~ Stop Frequency | 150kHz~30MHz / RB 9kHz for QP    |
| Start ~ Stop Frequency | 30MHz~1000MHz / RB 120kHz for QP |

- The measuring distance of at 3 m shall be used for measurements at frequency up to 1GHz. For frequencies above 1GHz, any suitable measuring distance may be used.
- The EUT was placed on the top of a rotating table 0.8 m for below 1GHz and 1.5m for above 1GHz the ground at a 3 meter. The table was rotated 360 degrees to determine the position of the highest radiation.
- The height of the equipment or of the substitution antenna shall be 0.8 m for below 1GHz and 1.5m for above 1GHz; the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For the radiated emission test above 1GHz:  
Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.
- The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
- If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP Limits and then no additional QP Mode measurement performed.
- For the actual test configuration, please refer to the related Item –EUT Test Photos.

Note:

Both horizontal and vertical antenna polarities were tested and performed pretest at three orthogonal axis. The worst case emissions were reported

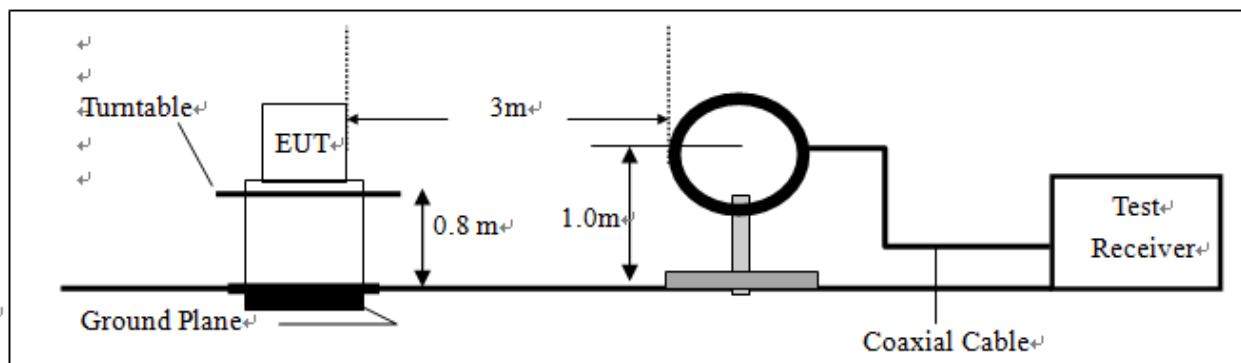
During the radiated emission test, the Spectrum Analyzer was set with the following configurations:

| Frequency Band (MHz) | Function | Resolution bandwidth | Video Bandwidth |
|----------------------|----------|----------------------|-----------------|
| 30 to 1000           | QP       | 120 kHz              | 300 kHz         |
| Above 1000           | Peak     | 1 MHz                | 1 MHz           |
|                      | Average  | 1 MHz                | 10 Hz           |

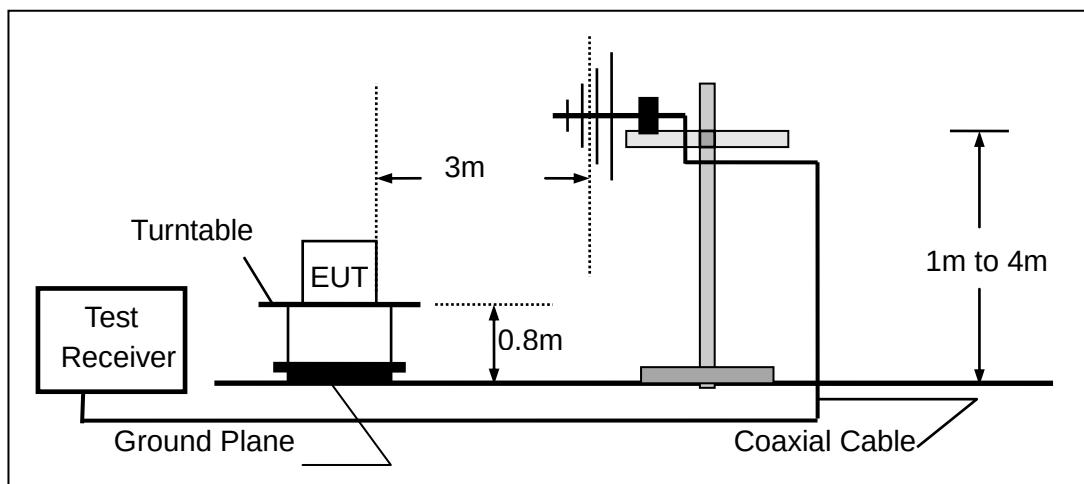
Note: for the frequency ranges below 30 MHz, a narrower RBW is used for these ranges but the measured value should add a RBW correction factor (RBWCF) where  $RBWCF [dB] = 10 \cdot \lg(100 [kHz] / \text{narrower RBW} [kHz])$ . , the narrower RBW is 1 kHz and RBWCF is 20 dB for the frequency 9 kHz to 150 kHz, and the narrower RBW is 10 kHz and RBWCF is 10 dB for the frequency 150 kHz to 30 MHz.

## 9.4 TEST SETUP

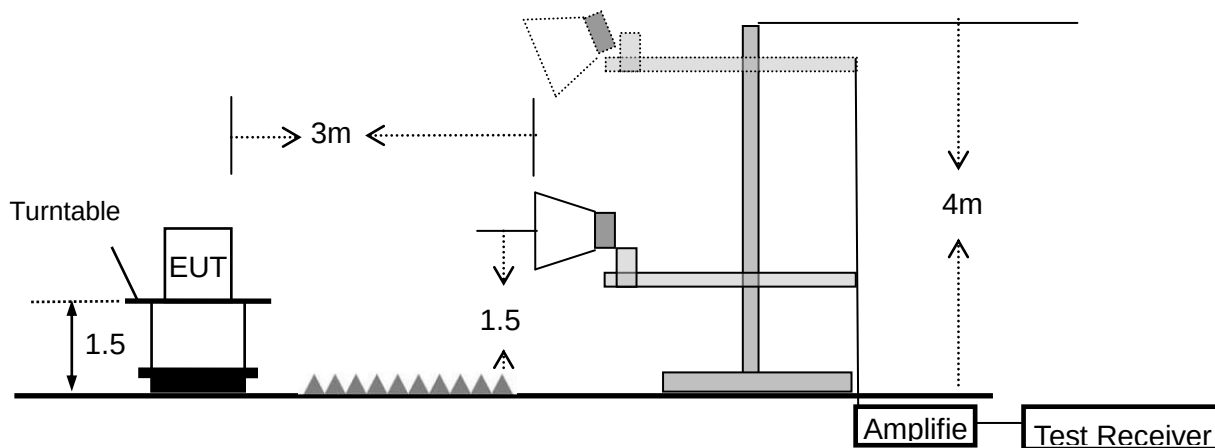
(A) For radiated emissions below 30MHz



(B) For radiated emissions from 30MHz to 1000MHz



(C) For radiated emissions above 1000MHz



## 9.5 TEST RESULTS

## ■ Emission below 30MHz (9KHz to 30MHz)

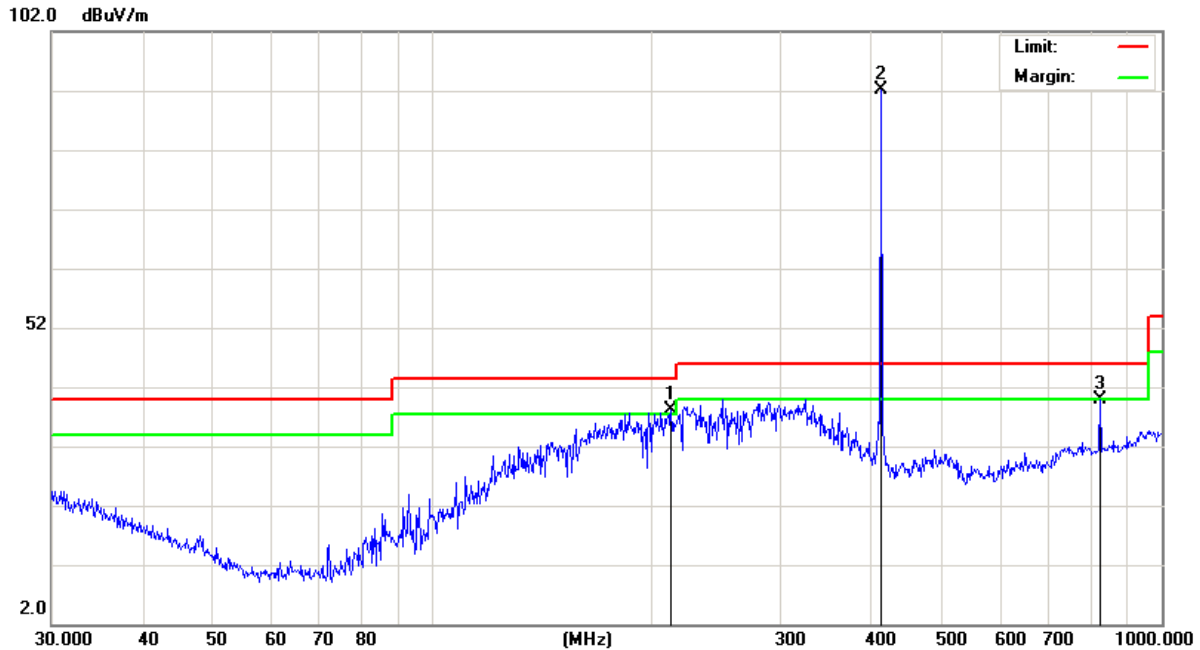
|              |             |                    |         |
|--------------|-------------|--------------------|---------|
| EUT:         | LoRa Module | Model Name :       | Ra-08   |
| Temperature: | 20 °C       | Relative Humidity: | 48%     |
| Test Mode:   | Mode 1      | Test By:           | Mary Hu |

| Freq.<br>(MHz) | Ant.Pol.<br>H/V | Emission Level(dBuV/m) |    | Limit 3m(dBuV/m) |    | Over(dB) |    |
|----------------|-----------------|------------------------|----|------------------|----|----------|----|
|                |                 | PK                     | AV | PK               | AV | PK       | AV |
| --             | --              | --                     | -- | --               | -- | --       | -- |

Note: the amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.

■ Emission below 1GHz (30MHz to 1GHz)

|                |                   |                     |        |
|----------------|-------------------|---------------------|--------|
| EUT :          | LoRa Module       | Model Name :        | Ra-08  |
| Temperature :  | 20 °C             | Relative Humidity : | 48%    |
| Pressure :     | 1010hPa           | Test Mode :         | Mode 1 |
| Test Voltage : | DC 3.3V form Uart |                     |        |

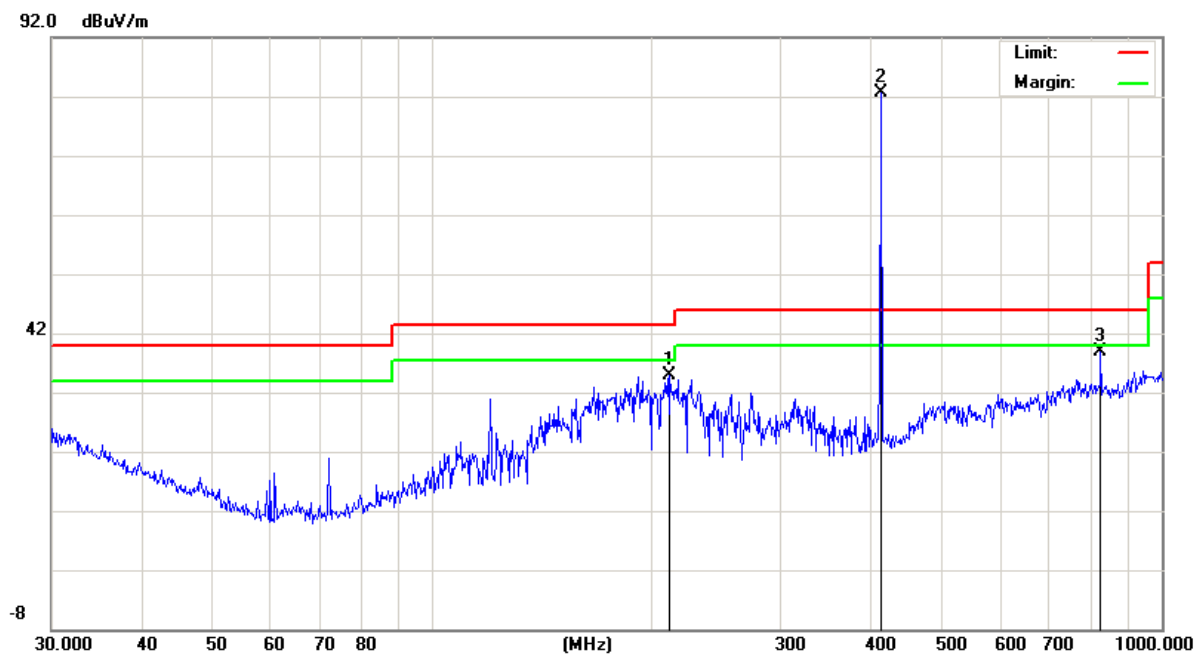


| Polar (H/V) | Frequency (MHz) | Reading (dBuV/m) | Correct dB/m | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Remark |
|-------------|-----------------|------------------|--------------|-----------------|----------------|-----------------|--------|
| H           | 212.2692        | 28.19            | 9.89         | 38.08           | 43.5           | -5.42           | QP     |
| H           | 411             | 74.15            | 18           | 92.15           | 100.04         | -7.89           | Peak   |
| H           | 411             | -                | -            | 75.50           | 80.04          | -4.54           | AVG    |
| H           | 822             | 14.52            | 25.31        | 39.83           | 80.04          | -40.21          | Peak   |
| H           | 822             | -                | -            | 23.18           | 60.04          | -36.86          | AVG    |

Note: The average value of fundamental frequency is:

Average= Peak Value+ 20log(Duty cycle), Final Average=Peak -16.65

|                |                   |                     |        |
|----------------|-------------------|---------------------|--------|
| EUT :          | LoRa Module       | Model Name :        | Ra-08  |
| Temperature :  | 20 °C             | Relative Humidity : | 48%    |
| Pressure :     | 1010hPa           | Test Mode :         | Mode 1 |
| Test Voltage : | DC 3.3V form Uart |                     |        |



| Polar (H/V) | Frequency (MHz) | Reading (dBuV/m) | Correct dB/m | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Remark |
|-------------|-----------------|------------------|--------------|-----------------|----------------|-----------------|--------|
| V           | 211.5261        | 24.89            | 9.91         | 34.8            | 43.5           | -8.7            | QP     |
| V           | 411             | 64.65            | 18           | 82.65           | 100.04         | -17.39          | Peak   |
| V           | 411             | -                | -            | 66.00           | 80.04          | -14.04          | AVG    |
| V           | 822             | 13.54            | 25.31        | 38.85           | 80.04          | -41.19          | Peak   |
| V           | 822             | -                | -            | 22.20           | 60.04          | -37.84          | AVG    |

Note: The average value of fundamental frequency is:

Average= Peak Value+ 20log(Duty cycle), Final Average= Peak-16.65

■ Emission Above 1GHz (1GHz to 6GHz)

|               |             |                     |            |
|---------------|-------------|---------------------|------------|
| EUT :         | LoRa Module | Model Name :        | Ra-08      |
| Temperature : | 20 °C       | Relative Humidity : | 48%        |
| Pressure :    | 1010 hPa    | Test Voltage :      | DC 3.3V    |
| Test Mode :   | Mode 1      | Polarization :      | Horizontal |

| No. | Frequency | Reading  | Correct Factor | Dutycycle Factor | Result   | Limit    | Over Limit | Remark |
|-----|-----------|----------|----------------|------------------|----------|----------|------------|--------|
|     | (MHz)     | (dBuV/m) | (dB)           | (dB)             | (dBuV/m) | (dBuV/m) | (dB)       |        |
| 1   | 1233.000  | 65.57    | -26.98         | -                | 38.59    | 80.04    | -41.45     | Peak   |
| 2   | 1644.000  | 65.02    | -25.77         | -                | 39.25    | 80.04    | -40.79     | Peak   |
| 3   | 2055.000  | 63.45    | -22.65         | -                | 40.80    | 80.04    | -39.24     | Peak   |
| 4   | 1233.000  | -        | -              | -16.65           | 21.94    | 60.04    | -38.10     | AVG    |
| 5   | 1644.000  | -        | -              | -16.65           | 22.60    | 60.04    | -37.44     | AVG    |
| 6   | 2055.000  | -        | -              | -16.65           | 24.15    | 60.04    | -35.89     | AVG    |

|               |             |                     |          |
|---------------|-------------|---------------------|----------|
| EUT :         | LoRa Module | Model Name :        | Ra-08    |
| Temperature : | 20 °C       | Relative Humidity : | 48%      |
| Pressure :    | 1010 hPa    | Test Voltage :      | DC 3.3V  |
| Test Mode :   | Mode 1      | Polarization :      | Vertical |

| No. | Frequency | Reading  | Correct Factor | Dutycycle Factor | Result   | Limit    | Over Limit | Remark |
|-----|-----------|----------|----------------|------------------|----------|----------|------------|--------|
|     | (MHz)     | (dBuV/m) | (dB)           | (dB)             | (dBuV/m) | (dBuV/m) | (dB)       |        |
| 1   | 1233.000  | 65.28    | -26.98         | -                | 38.30    | 80.04    | -41.74     | Peak   |
| 2   | 1644.000  | 66.22    | -25.77         | -                | 40.45    | 80.04    | -39.59     | Peak   |
| 3   | 2055.000  | 63.75    | -22.65         | -                | 41.10    | 80.04    | -38.94     | Peak   |
| 4   | 1233.000  | -        | -              | -16.65           | 21.65    | 60.04    | -38.39     | AVG    |
| 5   | 1644.000  | -        | -              | -16.65           | 23.80    | 60.04    | -36.24     | AVG    |
| 6   | 2055.000  | -        | -              | -16.65           | 24.45    | 60.04    | -35.59     | AVG    |

**Note: 1.** EUT Pre-scan X/Y/Z orientation, only worst case is presented in the report(Y orientation).

**2.** \*Calculate Average value based on Duty Cycle correction factor:

Duty Cycle=Ton/(Ton+Toff) =0.147=14.7%

Duty Cycle factor= 20log (Duty Cycle) =20log (0.147) = -16.65

Average=Peak+ Duty Cycle factor

2. FCC Limit for Average Measurement = 41.6667(411)-7083.3333=10029.18uV/m  
=80.04dBuV/m

3. Pulse Desensitization Correction Factor

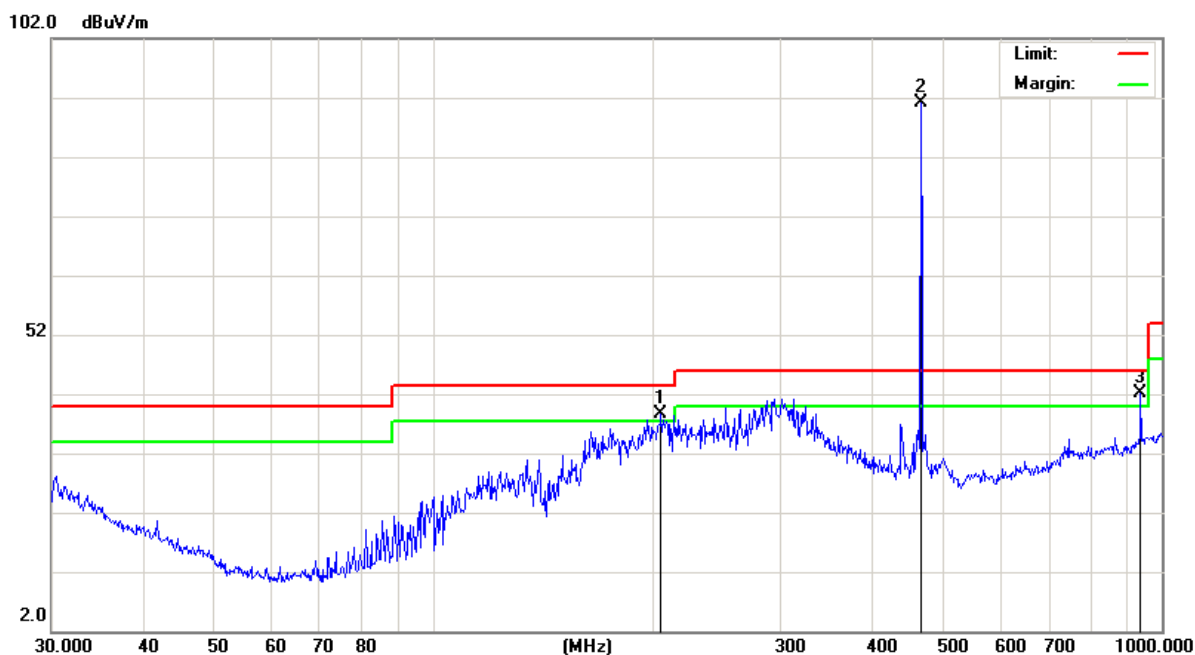
Pulse Width(PW)= 100ms

2/PW=2/100ms=0.02kHz

RBW(100kHz)>2/PW (0.02kHz),

■ Emission below 1GHz (30MHz to 1GHz)

|                |                   |                     |        |
|----------------|-------------------|---------------------|--------|
| EUT :          | LoRa Module       | Model Name :        | Ra-08  |
| Temperature :  | 20 °C             | Relative Humidity : | 48%    |
| Pressure :     | 1010hPa           | Test Mode :         | Mode 2 |
| Test Voltage : | DC 3.3V form Uart |                     |        |

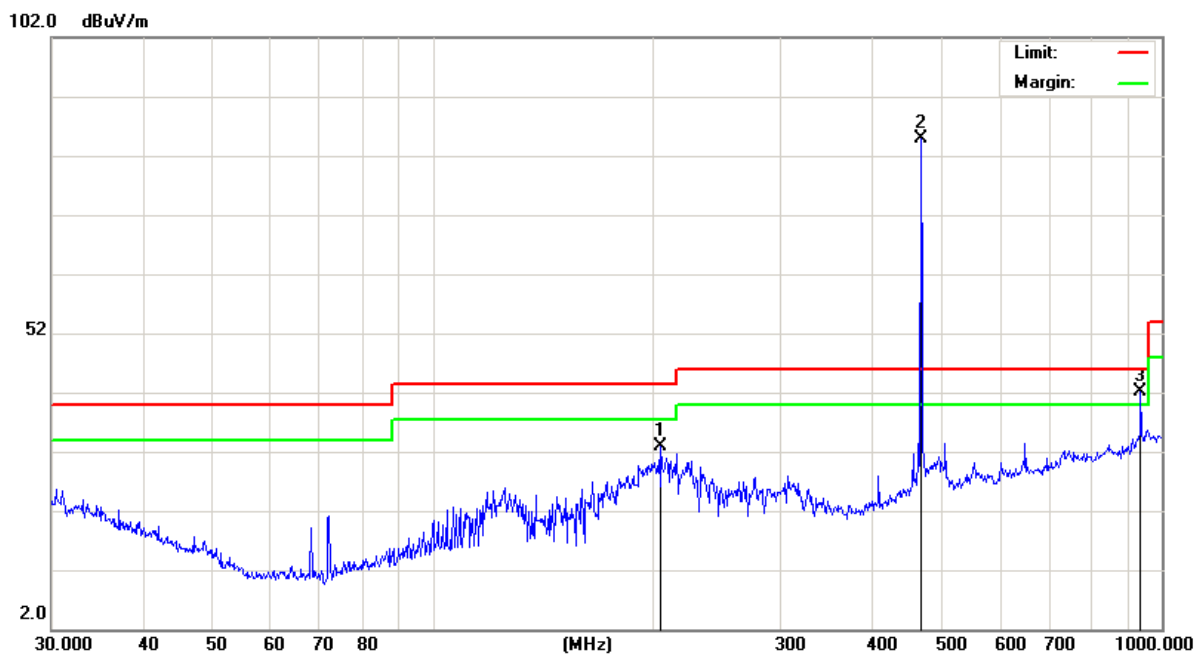


| Polar (H/V) | Frequency (MHz) | Reading (dBuV/m) | Correct dB/m | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Remark |
|-------------|-----------------|------------------|--------------|-----------------|----------------|-----------------|--------|
| H           | 205.6750        | 28.87            | 9.83         | 38.70           | 43.50          | -4.80           | QP     |
| H           | 468             | 72.1             | 19.1         | 91.20           | 101.85         | -10.65          | Peak   |
| H           | 468             | -                | -            | 74.51           | 81.85          | -7.34           | AVG    |
| H           | 936             | 14.22            | 27.88        | 42.10           | 81.85          | -39.75          | Peak   |
| H           | 936             | -                | -            | 25.41           | 61.85          | -36.44          | AVG    |

Note: The average value of fundamental frequency is:

Average= Peak Value+ 20log(Duty cycle), Final Average=Peak-16.69

|                |                   |                     |        |
|----------------|-------------------|---------------------|--------|
| EUT :          | LoRa Module       | Model Name :        | Ra-08  |
| Temperature :  | 20 °C             | Relative Humidity : | 48%    |
| Pressure :     | 1010hPa           | Test Mode :         | Mode 2 |
| Test Voltage : | DC 3.3V form Uart |                     |        |



| Polar (H/V) | Frequency (MHz) | Reading (dBuV/m) | Correct dB/m | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Remark |
|-------------|-----------------|------------------|--------------|-----------------|----------------|-----------------|--------|
| V           | 205.6750        | 23.02            | 9.83         | 32.85           | 43.50          | -10.65          | QP     |
| V           | 468             | 65.9             | 19.1         | 85.00           | 101.85         | -16.85          | Peak   |
| V           | 468             | -                | -            | 68.31           | 81.85          | -13.54          | AVG    |
| V           | 936             | 6.49             | 27.88        | 34.37           | 81.85          | -47.48          | Peak   |
| V           | 936             | -                | -            | 17.68           | 61.85          | -44.17          | AVG    |

Note: The average value of fundamental frequency is:

Average= Peak Value+ 20log(Duty cycle), Final Average= Peak-16.69

■ Emission Above 1GHz (1GHz to 6GHz)

|               |             |                     |            |
|---------------|-------------|---------------------|------------|
| EUT :         | LoRa Module | Model Name :        | Ra-08      |
| Temperature : | 20 °C       | Relative Humidity : | 48%        |
| Pressure :    | 1010 hPa    | Test Voltage :      | DC 3.3V    |
| Test Mode :   | Mode 2      | Polarization :      | Horizontal |

| No. | Frequency | Reading  | Correct Factor | Dutycycle Factor | Result   | Limit    | Over Limit | Remark |
|-----|-----------|----------|----------------|------------------|----------|----------|------------|--------|
|     | (MHz)     | (dBuV/m) | (dB)           | (dB)             | (dBuV/m) | (dBuV/m) | (dB)       |        |
| 1   | 1401.000  | 65.01    | -26.76         | -                | 38.25    | 81.85    | -43.60     | Peak   |
| 2   | 1868.000  | 63.92    | -24.44         | -                | 39.48    | 81.85    | -42.37     | Peak   |
| 3   | 2335.000  | 63.69    | -23.3          | -                | 40.39    | 81.85    | -41.46     | Peak   |
| 4   | 1401.000  | -        | -              | -16.69           | 21.56    | 61.85    | -40.29     | AVG    |
| 5   | 1868.000  | -        | -              | -16.69           | 22.79    | 61.85    | -39.06     | AVG    |
| 6   | 2335.000  | -        | -              | -16.69           | 23.70    | 61.85    | -38.15     | AVG    |

|               |             |                     |          |
|---------------|-------------|---------------------|----------|
| EUT :         | LoRa Module | Model Name :        | Ra-08    |
| Temperature : | 20 °C       | Relative Humidity : | 48%      |
| Pressure :    | 1010 hPa    | Test Voltage :      | DC 3.3V  |
| Test Mode :   | Mode 2      | Polarization :      | Vertical |

| No. | Frequency | Reading  | Correct Factor | Dutycycle Factor | Result   | Limit    | Over Limit | Remark |
|-----|-----------|----------|----------------|------------------|----------|----------|------------|--------|
|     | (MHz)     | (dBuV/m) | (dB)           | (dB)             | (dBuV/m) | (dBuV/m) | (dB)       |        |
| 1   | 1401.000  | 65.01    | -26.76         | -                | 38.25    | 81.85    | -43.60     | Peak   |
| 2   | 1868.000  | 63.92    | -24.44         | -                | 39.48    | 81.85    | -42.37     | Peak   |
| 3   | 2335.000  | 63.69    | -23.3          | -                | 40.39    | 81.85    | -41.46     | Peak   |
| 4   | 1401.000  | -        | -              | -16.69           | 21.56    | 61.85    | -40.29     | AVG    |
| 5   | 1868.000  | -        | -              | -16.69           | 22.79    | 61.85    | -39.06     | AVG    |
| 6   | 2335.000  | -        | -              | -16.69           | 23.70    | 61.85    | -38.15     | AVG    |

**Note: 1.** EUT Pre-scan X/Y/Z orientation, only worst case is presented in the report(Y orientation).

**2.** \*Calculate Average value based on Duty Cycle correction factor:

$$\text{Duty Cycle} = \text{Ton} / (\text{Ton} + \text{Toff}) = 0.1469 = 14.69\%$$

$$\text{Duty Cycle factor} = 20 \log (\text{Duty Cycle}) = 20 \log (0.1469) = -16.69$$

$$\text{Average} = \text{Peak} + \text{Duty Cycle factor}$$

$$\begin{aligned} \text{3. FCC Limit for Average Measurement} &= 41.6667(467) - 7083.3333 = 12375 \mu\text{V/m} \\ &= 81.85 \text{ dBuV/m} \end{aligned}$$

4. Pulse Desensitization Correction Factor

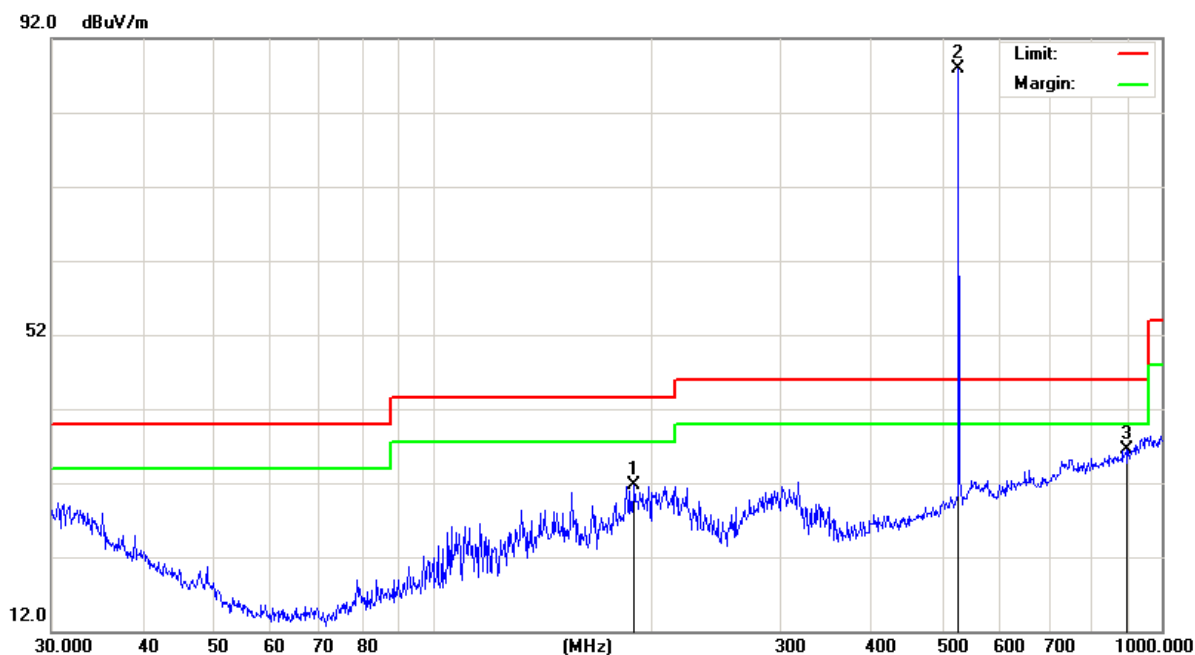
$$\text{Pulse Width(PW)} = 100 \text{ ms} \quad 2/\text{PW} = 2/1024 \text{ ms} = 0.02 \text{ kHz}$$

$$\text{RBW}(100 \text{ kHz}) > 2/\text{PW} (0.02 \text{ kHz}),$$

Therefore PDCF is not needed.

■ Emission below 1GHz (30MHz to 1GHz)

|                |                   |                     |        |
|----------------|-------------------|---------------------|--------|
| EUT :          | LoRa Module       | Model Name :        | Ra-08  |
| Temperature :  | 20 °C             | Relative Humidity : | 48%    |
| Pressure :     | 1010hPa           | Test Mode :         | Mode 3 |
| Test Voltage : | DC 3.3V form Uart |                     |        |

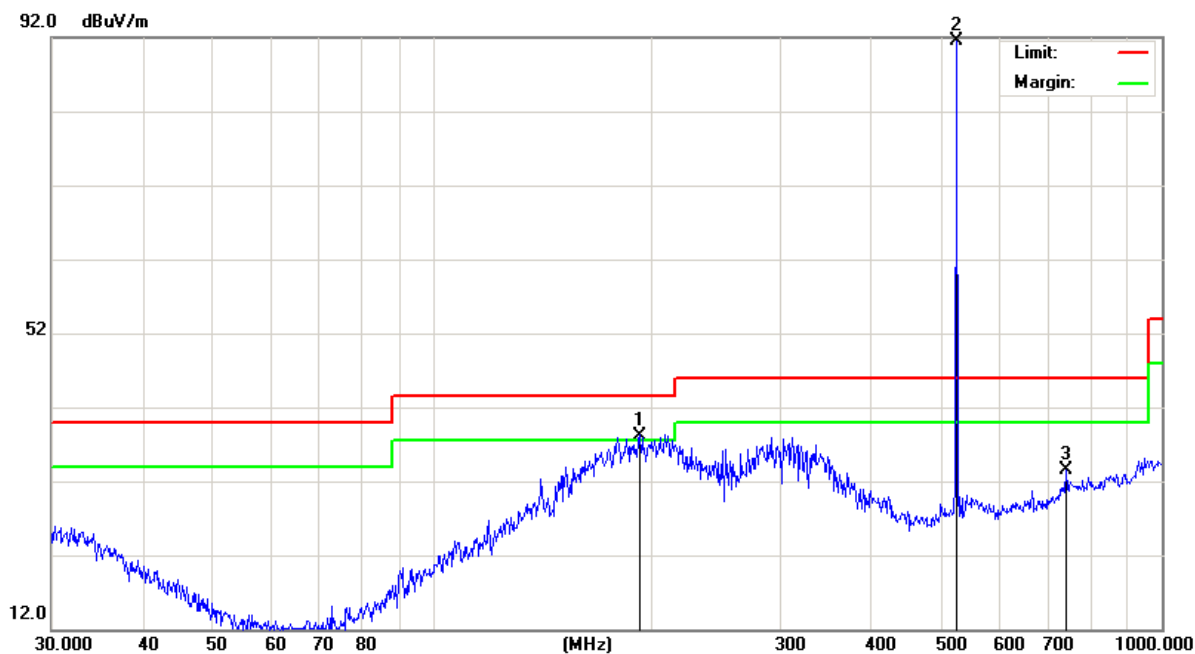


| Polar (H/V) | Frequency (MHz) | Reading (dBuV/m) | Correct dB/m | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Remark |
|-------------|-----------------|------------------|--------------|-----------------|----------------|-----------------|--------|
| V           | 189.074         | 22.49            | 9.28         | 31.77           | 43.5           | -11.73          | QP     |
| V           | 525             | 67.19            | 20.71        | 87.90           | 103.4          | -15.50          | Peak   |
| V           | 525             | -                | -            | 71.21           | 83.4           | -12.19          | AVG    |
| V           | 893.8567        | 10.21            | 26.28        | 36.49           | 46             | -9.51           | QP     |

Note: The average value of fundamental frequency is:

Average= Peak Value+ 20log(Duty cycle), Final Average=Peak -16.69

|                |                   |                     |        |
|----------------|-------------------|---------------------|--------|
| EUT :          | LoRa Module       | Model Name :        | Ra-08  |
| Temperature :  | 20 °C             | Relative Humidity : | 48%    |
| Pressure :     | 1010hPa           | Test Mode :         | Mode 3 |
| Test Voltage : | DC 3.3V form Uart |                     |        |



| Polar (H/V) | Frequency (MHz) | Reading (dBuV/m) | Correct dB/m | Result (dBuV/m) | Limit (dBuV/m) | Over Limit (dB) | Remark |
|-------------|-----------------|------------------|--------------|-----------------|----------------|-----------------|--------|
| H           | 192.4182        | 29.22            | 8.98         | 38.2            | 43.5           | -5.3            | QP     |
| H           | 525             | 71.08            | 20.52        | 91.60           | 103.4          | -11.80          | Peak   |
| H           | 525             | -                | -            | 74.91           | 83.4           | -8.49           | AVG    |
| H           | 739.6603        | 8.32             | 25.11        | 33.43           | 46             | -12.57          | QP     |

Note: The average value of fundamental frequency is:

Average= Peak Value+ 20log(Duty cycle), Final Average= Peak-16.69

■ Emission Above 1GHz (1GHz to 6GHz)

|               |             |                     |            |
|---------------|-------------|---------------------|------------|
| EUT :         | LoRa Module | Model Name :        | Ra-08      |
| Temperature : | 20 °C       | Relative Humidity : | 48%        |
| Pressure :    | 1010 hPa    | Test Voltage :      | DC 3.3V    |
| Test Mode :   | Mode 3      | Polarization :      | Horizontal |

| No. | Frequency | Reading  | Correct Factor | Dutycycle Factor | Result   | Limit    | Over Limit | Remark |
|-----|-----------|----------|----------------|------------------|----------|----------|------------|--------|
|     | (MHz)     | (dBuV/m) | (dB)           | (dB)             | (dBuV/m) | (dBuV/m) | (dB)       |        |
| 1   | 1050.000  | 64.59    | -28.40         | -                | 36.19    | 83.4     | -47.21     | Peak   |
| 2   | 1575.000  | 64.73    | -26.19         | -                | 38.54    | 83.4     | -44.86     | Peak   |
| 3   | 2100.000  | 63.86    | -22.02         | -                | 41.84    | 83.4     | -41.56     | Peak   |
| 4   | 1050.000  | -        | -              | -16.69           | 19.50    | 63.4     | -43.90     | AVG    |
| 5   | 1575.000  | -        | -              | -16.69           | 21.85    | 63.4     | -41.55     | AVG    |
| 6   | 2100.000  | -        | -              | -16.69           | 25.15    | 63.4     | -38.25     | AVG    |

|               |             |                     |          |
|---------------|-------------|---------------------|----------|
| EUT :         | LoRa Module | Model Name :        | Ra-08    |
| Temperature : | 20 °C       | Relative Humidity : | 48%      |
| Pressure :    | 1010 hPa    | Test Voltage :      | DC 3.3V  |
| Test Mode :   | Mode 3      | Polarization :      | Vertical |

| No. | Frequency | Reading  | Correct Factor | Dutycycle Factor | Result   | Limit    | Over Limit | Remark |
|-----|-----------|----------|----------------|------------------|----------|----------|------------|--------|
|     | (MHz)     | (dBuV/m) | (dB)           | (dB)             | (dBuV/m) | (dBuV/m) | (dB)       |        |
| 1   | 1050.000  | 64.75    | -28.4          | -                | 36.35    | 83.4     | -47.05     | Peak   |
| 2   | 1575.000  | 64.44    | -26.19         | -                | 38.25    | 83.4     | -45.15     | Peak   |
| 3   | 2100.000  | 63.17    | -22.02         | -                | 41.15    | 83.4     | -42.25     | Peak   |
| 4   | 1050.000  | -        | -              | -16.69           | 19.66    | 63.4     | -43.74     | AVG    |
| 5   | 1575.000  | -        | -              | -16.69           | 21.56    | 63.4     | -41.84     | AVG    |
| 6   | 2100.000  | -        | -              | -16.69           | 24.46    | 63.4     | -38.94     | AVG    |

**Note: 1.** EUT Pre-scan X/Y/Z orientation, only worst case is presented in the report(Y orientation).

**2.** \*Calculate Average value based on Duty Cycle correction factor:

Duty Cycle=Ton/(Ton+Toff) =0.1469=14.69%

Duty Cycle factor= 20log (Duty Cycle) =20log (0.1469) = -16.69

Average=Peak+ Duty Cycle factor

3. FCC Limit for Average Measurement = 41.6667(467)-7083.3333=12375uV/m  
=81.85dBuV/m

4. Pulse Desensitization Correction Factor

Pulse Width(PW)= 100ms

2/PW=2/1024ms=0.02kHz

RBW(100kHz)>2/PW (0.02kHz),

Therefore PDCF is not needed.

Duty Cycle:

411MHz:

The duty cycle is simply the on time divided by the period:

The duration of one cycle = 100ms

Effective period of the cycle =14.7ms,

Duty Cycle =14.7ms/100ms= 0.147=14.7%

468MHz:

The duty cycle is simply the on time divided by the period:

The duration of one cycle = 100ms

Effective period of the cycle =14.64ms,

Duty Cycle =14.64ms/100ms= 0.1464=14.64%

525MHz:

The duty cycle is simply the on time divided by the period:

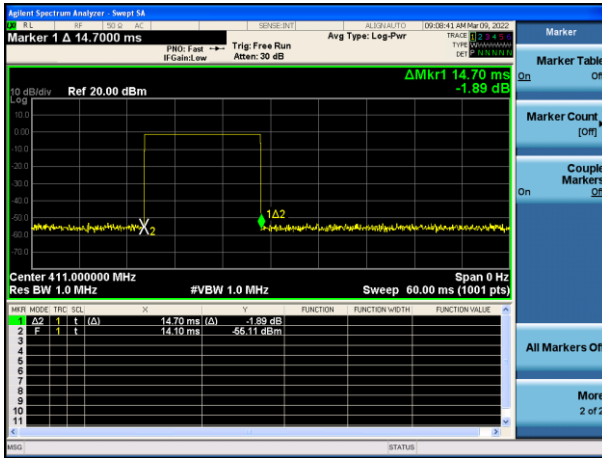
The duration of one cycle = 100ms

Effective period of the cycle =14.64ms,

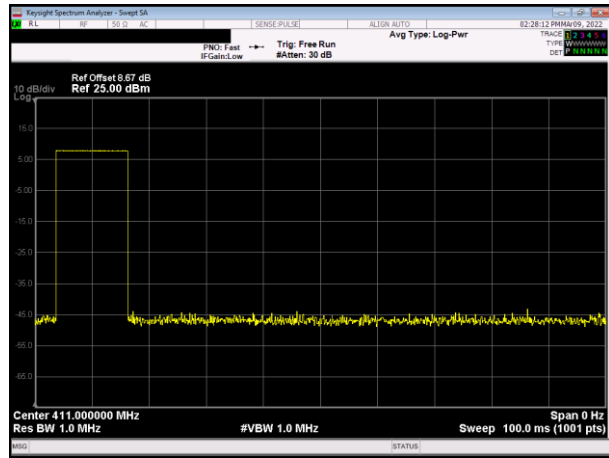
Duty Cycle =14.64ms/100ms= 0.1464=14.64%

### Channel 01

(Duty cycle)  $T_{ON}(\text{one hop})$

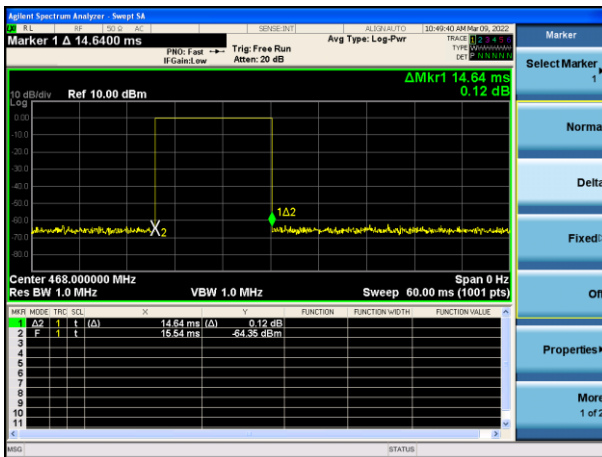


(Duty cycle) The duration of one cycle

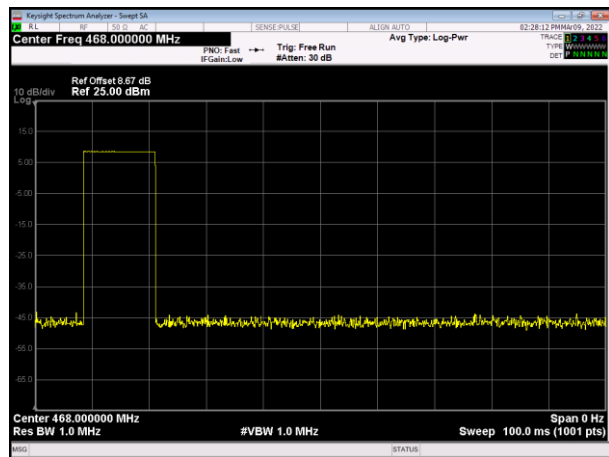


### Channel 58

(Duty cycle)  $T_{ON}(\text{one hop})$

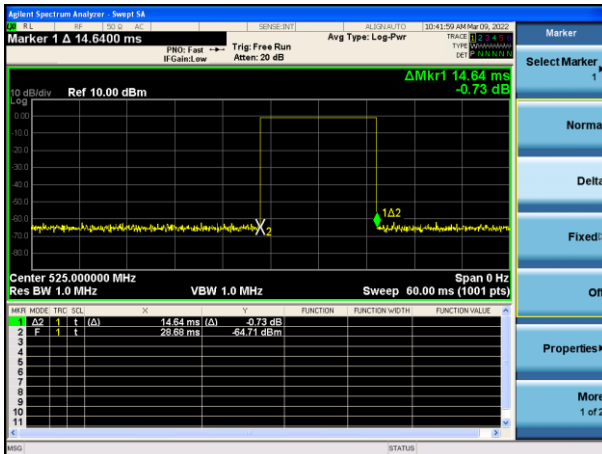


(Duty cycle) The duration of one cycle

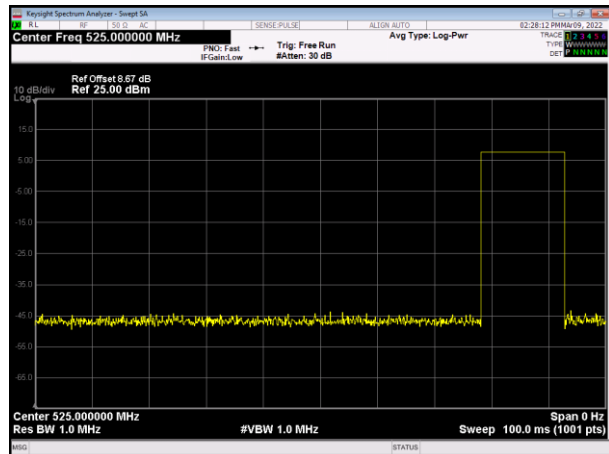


### Channel 115

(Duty cycle)  $T_{ON}(\text{one hop})$



(Duty cycle) The duration of one cycle



## 10. BANDWIDTH TEST

### 10.1 TEST PROCEDURE

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

Limit:  $411\text{MHz} \times 0.25\% = 1027.5\text{KHz}$

$468\text{MHz} \times 0.25\% = 1170.0\text{KHz}$

$525\text{MHz} \times 0.25\% = 1312.5\text{KHz}$

### 10.2 DEVIATION FROM STANDARD

No deviation.

### 10.3 TEST SETUP

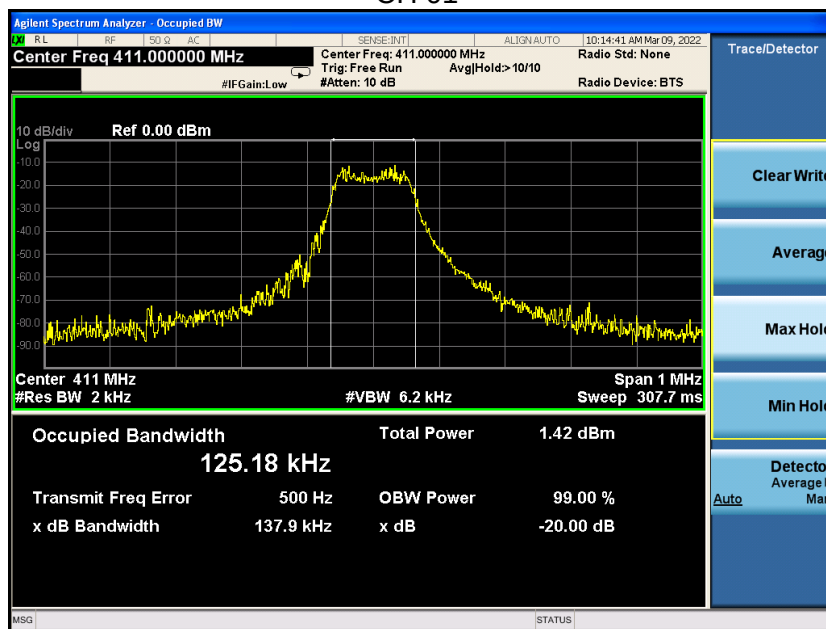


## 10.4 TEST RESULTS

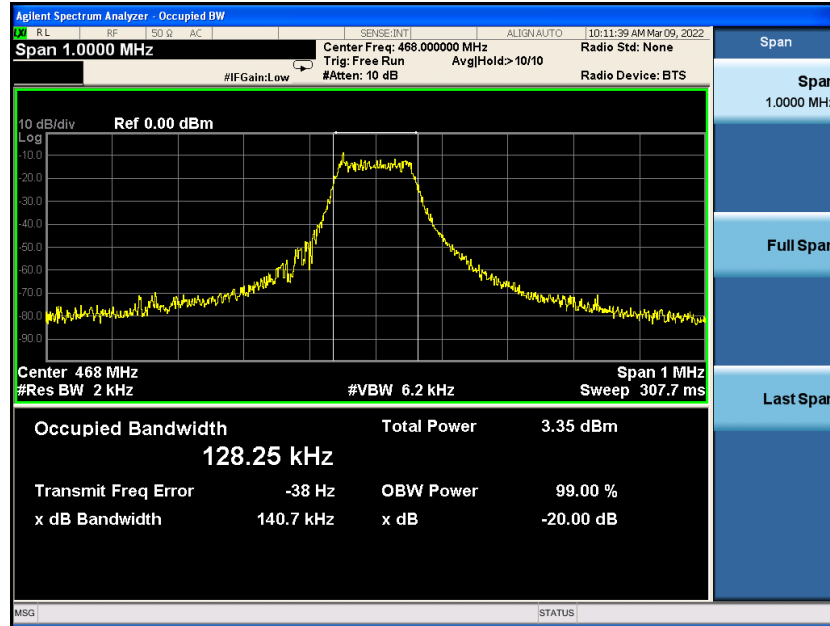
|               |                 |                     |                   |
|---------------|-----------------|---------------------|-------------------|
| EUT :         | LoRa Module     | Model Name :        | Ra-08             |
| Temperature : | 26 °C           | Relative Humidity : | 53%               |
| Pressure :    | 1020 hPa        | Test Power :        | DC 3.3V form Uart |
| Test Mode :   | TX CH 01/57/115 |                     |                   |

| Test Channel | Frequency (MHz) | 20 dB Bandwidth (kHz) | <Limit (kHz) |
|--------------|-----------------|-----------------------|--------------|
| CH01         | 411             | 137.9                 | 1027.5       |
| CH58         | 468             | 140.7                 | 1170.0       |
| CH115        | 525             | 143.1                 | 1312.5       |

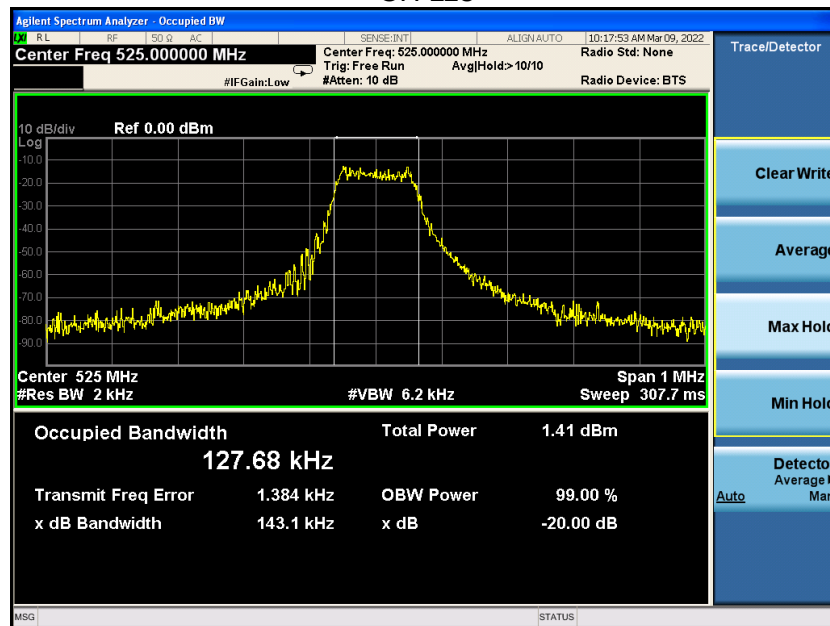
CH 01



### CH 58



### CH 115



## 11. TRANSMITTER TIMEOUT

### 11.1 REQUIREMENTS

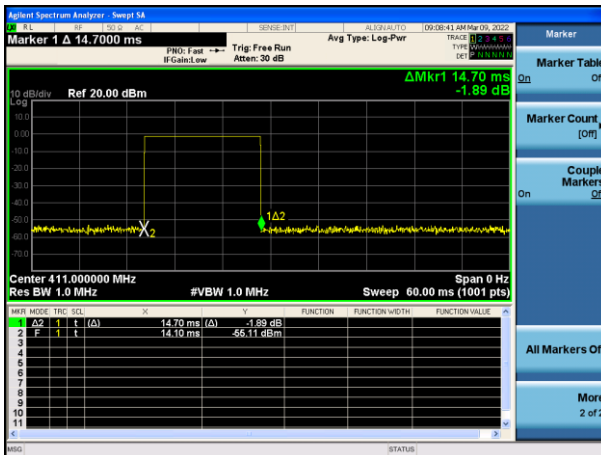
|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <p>A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.</p> <p><b>Result:</b> The EUT is a manually activated transmitter, press 5 seconds will automatically stop working</p>                                                                                                                                                                                                                                                                                                                             |
| 2 | <p>A transmitter activated automatically shall cease transmission within 5 seconds after activation.</p> <p><b>Result:</b> The EUT is a manually activated transmitter, press 5 seconds will automatically stop working</p>                                                                                                                                                                                                                                                                                                                                                                                      |
| 3 | <p>Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour</p> <p><b>Result:</b> The EUT does not support periodic transmission at regular predetermined intervals.</p> |
| 4 | <p>Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.</p> <p><b>Result:</b> The section is not applicable to EUT.</p>                                                                                                                                                                                                                                                                                                               |

| CHANNEL | THE DURATION OF EACH TRANSMISSION           | LIMIT | RESULT |
|---------|---------------------------------------------|-------|--------|
| CH 01   | $14.70\text{ms} \times 7 = 102.90\text{ms}$ | <5s   | PASS   |
| CH 58   | $14.64\text{ms} \times 7 = 102.48\text{ms}$ | <5s   | PASS   |
| CH 115  | $14.64\text{ms} \times 7 = 102.48\text{ms}$ | <5s   | PASS   |

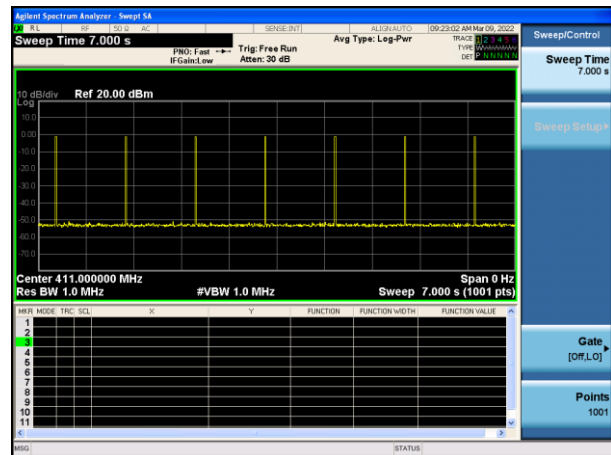
## Test data

### Channel 01

(Duty cycle)  $T_{ON}(\text{one hop})$

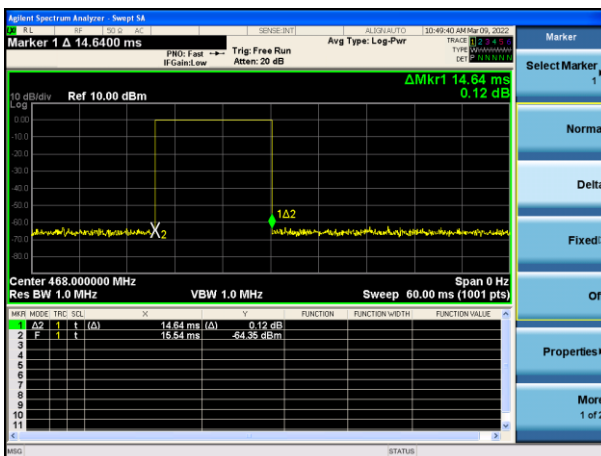


(Duty cycle) The duration of one cycle

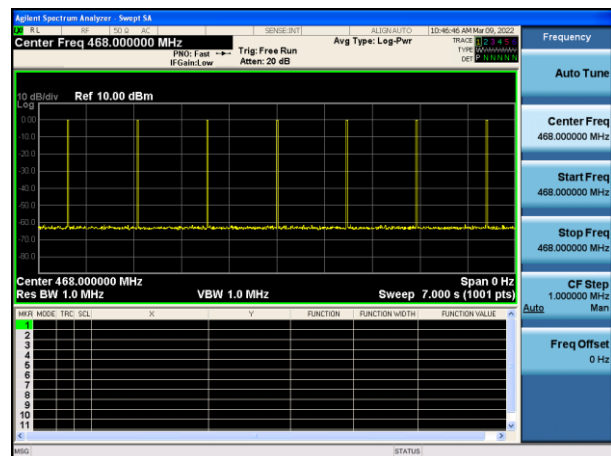


### Channel 57

(Duty cycle)  $T_{ON}(\text{one hop})$

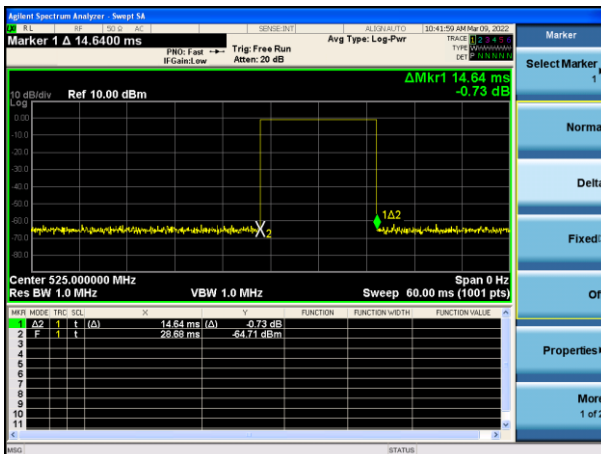


(Duty cycle) The duration of one cycle

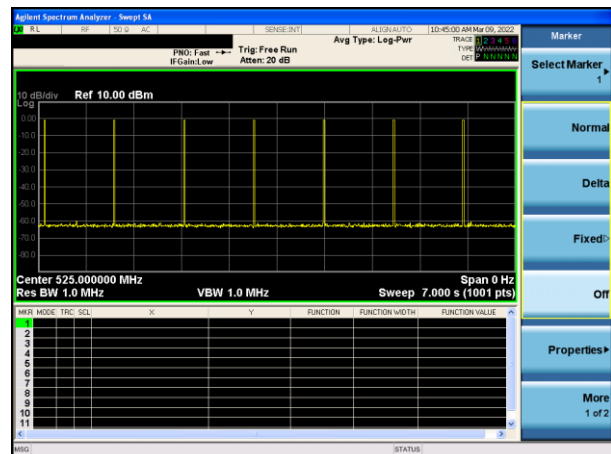


### Channel 115

(Duty cycle)  $T_{ON}(\text{one hop})$



(Duty cycle) The duration of one cycle



END OF REPORT