



# TEST REPORT

Product Name: Animal Activity Sensor  
FCC ID: 2BHFL-MR1  
Trademark: MCCI  
Model Number: MR-1  
Prepared For: MCCI Corporation  
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Manufacturer: MCCI Corporation  
Address: 3520 Krums Corners Road, Ithaca, NY 14850-9169, USA  
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Sample Received Date: Feb. 13, 2025  
Sample tested Date: Feb. 13, 2025 to Mar. 20, 2025  
Issue Date: Mar. 20, 2025  
Report No.: CTB25021300601RF01  
Test Standards: FCC CFR Title 47 Part 15 Subpart C Section 15.247  
ANSI C63.10:2013  
Test Results: PASS  
Remark: This is LoRa radio test report.

Compiled by:

Reviewed by:

Approved by:

Zhou kui

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Bin Mei / Director

Note: If there is any objection to the inspection results in this report, please submit a written report to the company within 15 days from the date of receiving the report. The test report is effective only with both signature and specialized stamp. This result(s) shown in this report refer only to the sample(s) tested. Without written approval of Shenzhen CTB Testing Technology Co., Ltd. this report can't be reproduced except in full. The tested sample(s) and the sample information are provided by the client. "\*" indicates the testing items were fulfilled by subcontracted lab. "#" indicates the items are not in CNAS accreditation scope.

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(Note: N/A means not applicable)



1. VERSION

| Report No.         | Issue Date    | Description | Approved |
|--------------------|---------------|-------------|----------|
| CTB25021300601RF01 | Mar. 20, 2025 | Original    | Valid    |

## 2. TEST SUMMARY

The Product has been tested according to the following specifications:

| Test Item                                            | Test Requirement                                                            | Test method      | Result |
|------------------------------------------------------|-----------------------------------------------------------------------------|------------------|--------|
| <b>AC Power Line Conducted Emission</b>              | 47 CFR Part 15 Subpart C Section 15.207                                     | ANSI C63.10-2013 | PASS   |
| <b>Radiated Spurious emissions</b>                   | 47 CFR Part 15 Subpart C Section 15.205/15.209                              | ANSI C63.10-2013 | PASS   |
| <b>Band edge and RF Conducted Spurious Emissions</b> | 47 CFR Part 15 Subpart C Section 15.247(d)/15.205(a)                        | ANSI C63.10-2013 | PASS   |
| <b>Conducted Peak Output Power</b>                   | 47 CFR Part 15 Subpart C Section 15.247 (b)(1)                              | ANSI C63.10-2013 | PASS   |
| <b>20dB Occupied Bandwidth</b>                       | 47 CFR Part 15 Subpart C Section 15.247 (a)(1)                              | ANSI C63.10-2013 | PASS   |
| <b>Carrier Frequencies Separation</b>                | 47 CFR Part 15 Subpart C Section 15.247 (a)(1)                              | ANSI C63.10-2013 | PASS   |
| <b>Hopping Channel Number</b>                        | 47 CFR Part 15 Subpart C Section 15.247 (b)                                 | ANSI C63.10-2013 | PASS   |
| <b>Dwell Time</b>                                    | 47 CFR Part 15 Subpart C Section 15.247 (a)(1)                              | ANSI C63.10-2013 | PASS   |
| <b>Pseudorandom Frequency Hopping Sequence</b>       | 47 CFR Part 15 Subpart C Section 15.247(a)&TCB Exclusion List (7 July 2002) | ANSI C63.10-2013 | PASS   |
| <b>Antenna Requirement</b>                           | 47 CFR Part 15 Subpart C Section 15.203/15.247 (b)                          | /                | PASS   |
| <b>RF Exposure Evaluation</b>                        | 47 CFR Part 15 Subpart C Section 15.247 (i)/1.1310/2.1093                   | KDB447498D01v06  | PASS   |

Remark:

Test according to ANSI C63.10-2013.

### 3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

| Item                                               | Uncertainty        |
|----------------------------------------------------|--------------------|
| Occupancy bandwidth                                | 54.3kHz            |
| Conducted output power Above 1G                    | 0.9dB              |
| Conducted output power below 1G                    | 0.9dB              |
| Power Spectral Density , Conduction                | 0.9dB              |
| Conduction spurious emissions                      | 2.0dB              |
| Out of band emission                               | 2.0dB              |
| 3m chamber Radiated spurious emission(9KHz-30MHz)  | 4.8dB              |
| 3m chamber Radiated spurious emission(30MHz-1GHz)  | 4.6dB              |
| 3m chamber Radiated spurious emission(1GHz-18GHz)  | 5.1dB              |
| 3m chamber Radiated spurious emission(18GHz-40GHz) | 3.4dB              |
| humidity uncertainty                               | 5.5%               |
| Temperature uncertainty                            | 0.63℃              |
| frequency                                          | 1×10 <sup>-7</sup> |
| Conducted Emission (150KHz-30MHz)                  | 3.2 dB             |
| Radiated Emission(30MHz ~ 1000MHz)                 | 4.8 dB             |
| Radiated Emission(1GHz ~6GHz)                      | 4.9 dB             |

#### 4. PRODUCT INFORMATION AND TEST SETUP

##### 4.1 Product Information

|                       |                          |
|-----------------------|--------------------------|
| Model(s):             | MR-1                     |
| Model Description:    | N/A                      |
| Hardware Version:     | V1.0                     |
| Software Version:     | V1.0                     |
| Operation Frequency:  | 902.3-914.9MHz           |
| Max. RF output power: | 13.698dBm                |
| Type of Modulation:   | LoRa                     |
| Antenna installation: | Internal antenna         |
| Antenna Gain:         | 902.3-914.9MHz: -1.96dBi |
| Ratings:              | 5VDC USB Power           |

##### 4.2 Test Setup Configuration

See test photographs attached in EUT TEST SETUP PHOTOGRAPHS for the actual connections between Product and support equipment.

##### 4.3 Support Equipment

| Item | Equipment | Mfr/Brand | Model/Type No. | Series No. | Note |
|------|-----------|-----------|----------------|------------|------|
| 1    | Adapter   | JIYIN     | JY-05100C      | /          | /    |

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

#### 4.4 Channel List

902.3-914.9MHz

| CH No. | Frequency (MHz) | CH No. | Frequency (MHz) | CH No. | Frequency (MHz) | CH No. | Frequency (MHz) |
|--------|-----------------|--------|-----------------|--------|-----------------|--------|-----------------|
| 0      | 902.3           | 16     | 905.5           | 32     | 908.7           | 48     | 911.9           |
| 1      | 902.5           | 17     | 905.7           | 33     | 908.9           | 49     | 912.1           |
| 2      | 902.7           | 18     | 905.9           | 34     | 909.1           | 50     | 912.3           |
| 3      | 902.9           | 19     | 906.1           | 35     | 909.3           | 51     | 912.5           |
| 4      | 903.1           | 20     | 906.3           | 36     | 909.5           | 52     | 912.7           |
| 5      | 903.3           | 21     | 906.5           | 37     | 909.7           | 53     | 912.9           |
| 6      | 903.5           | 22     | 906.7           | 38     | 909.9           | 54     | 913.1           |
| 7      | 903.7           | 23     | 906.9           | 39     | 910.1           | 55     | 913.3           |
| 8      | 903.9           | 24     | 907.1           | 40     | 910.3           | 56     | 913.5           |
| 9      | 904.1           | 25     | 907.3           | 41     | 910.5           | 57     | 913.7           |
| 10     | 904.3           | 26     | 907.5           | 42     | 910.7           | 58     | 913.9           |
| 11     | 904.5           | 27     | 907.7           | 43     | 910.9           | 59     | 914.1           |
| 12     | 904.7           | 28     | 907.9           | 44     | 911.1           | 60     | 914.3           |
| 13     | 904.9           | 29     | 908.1           | 45     | 911.3           | 61     | 914.5           |
| 14     | 905.1           | 30     | 908.3           | 46     | 911.5           | 62     | 914.7           |
| 15     | 905.3           | 31     | 908.5           | 47     | 911.7           | 63     | 914.9           |

#### 4.5 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

| Test mode              | Low channel | Middle channel | High channel |
|------------------------|-------------|----------------|--------------|
| Transmitting<br>(LoRa) | 902.3MHz    | 908.7MHz       | 914.9MHz     |
| Receiving<br>(LoRa)    | 902.3MHz    | 908.7MHz       | 914.9MHz     |

#### 4.6 Test Environment

|                            |     |
|----------------------------|-----|
| Humidity(%):               | 54  |
| Atmospheric Pressure(kPa): | 101 |
| Normal Voltage(DC):        | 5V  |
| Normal Temperature(°C)     | 23  |
| Low Temperature(°C)        | 0   |
| High Temperature(°C)       | 40  |

## 5. TEST FACILITY AND TEST INSTRUMENT USED

### 5.1 Test Facility

All measurement facilities used to collect the measurement data are located at 1&2F., Building A, No. 26, Xinghe Road, Xinqiao, Xinqiao Street, Bao'an District, Shenzhen, Guangdong, China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-1 other equivalent standards.

### 5.2 Test Instrument Used

| No. | Equipment                                 | Manufacturer | Type No.                  | Serial No.   | Firmware Version           | Calibrated until |
|-----|-------------------------------------------|--------------|---------------------------|--------------|----------------------------|------------------|
| 1   | Spectrum Analyzer                         | Agilent      | N9020A                    | MY52090073   | A.14.16                    | 2024.07.05       |
| 2   | Power Sensor                              | Agilent      | U2021XA                   | MY56120032   | /                          | 2024.07.05       |
| 3   | Power Sensor                              | Agilent      | U2021XA                   | MY56120034   | /                          | 2024.07.05       |
| 4   | Communication test set                    | R&S          | CMW500                    | 108058       | V3.5.80                    | 2024.07.05       |
| 5   | Spectrum Analyzer                         | KEYSIGHT     | N9020A                    | MY51289897   | A.14.16                    | 2024.07.05       |
| 6   | Signal Generator                          | Agilent      | N5181A                    | MY50140365   | A.01.60                    | 2024.07.05       |
| 7   | Vector signal generator                   | Agilent      | N5182A                    | MY47420195   | A.01.87                    | 2024.07.05       |
| 8   | Communication test set                    | Agilent      | E5515C                    | MY50102567   | B.19.07<br>(E1962B)        | 2024.07.06       |
| 9   | 2.4 GHz Filter                            | Shenxiang    | MSF2400-24<br>83.5MS-1154 | 20181015001  | /                          | 2024.07.05       |
| 10  | 5 GHz Filter                              | Shenxiang    | MSF5150-58<br>50MS-1155   | 20181015001  | /                          | 2024.07.06       |
| 11  | Filter                                    | Xingbo       | XBLBQ-DZA<br>120          | 190821-1-1   | /                          | 2024.07.06       |
| 12  | BT&WI-FI Automatic test software          | Microwave    | MTS8000                   | Ver. 2.0.0.0 | /                          | /                |
| 13  | Rohde & Schwarz SFU Broadcast Test System | R&S          | SFU                       | 101017       | /                          | 2024.10.30       |
| 14  | Temperature humidity chamber              | Hongjing     | TH-80CH                   | DG-15174     | /                          | 2024.07.05       |
| 15  | 234G Automatic test software              | Microwave    | MTS8200                   | Ver. 2.0.0.0 | /                          | /                |
| 16  | 966 chamber                               | C.R.T.       | 966                       | /            | /                          | 2024.08.11       |
| 17  | Receiver                                  | R&S          | ESPI                      | 100362       | RF_ATTEN_7<br>(104489/003) | 2024.07.05       |
| 18  | Amplifier                                 | HP           | 8447E                     | 2945A02747   | /                          | 2024.07.05       |
| 19  | Amplifier                                 | Agilent      | 8449B                     | 3008A01838   | /                          | 2024.07.05       |
| 20  | TRILOG Broadband Antenna                  | Schwarzbeck  | VULB 9168                 | 00869        | /                          | 2024.07.08       |

|    |                                      |             |            |            |   |            |
|----|--------------------------------------|-------------|------------|------------|---|------------|
| 21 | Double Ridged Broadband Horn Antenna | Schwarzbeck | BBHA9120D  | 01911      | / | 2024.07.08 |
| 22 | EMI test software                    | Fala        | EZ-EMC     | FA-03A2 RE | / | /          |
| 23 | Loop Antenna                         | Schwarzbeck | FMZB 1519B | 1519B-224  | / | 2024.07.08 |
| 24 | loop antenna                         | ZHINAN      | ZN30900A   | GTS534     | / | /          |
| 25 | 40G Horn antenna                     | A/H/System  | SAS-574    | 588        | / | 2024.10.30 |
| 26 | Amplifier                            | AEROFLEX    | Aeroflex   | 097        | / | 2024.07.05 |

#### Continuous disturbance

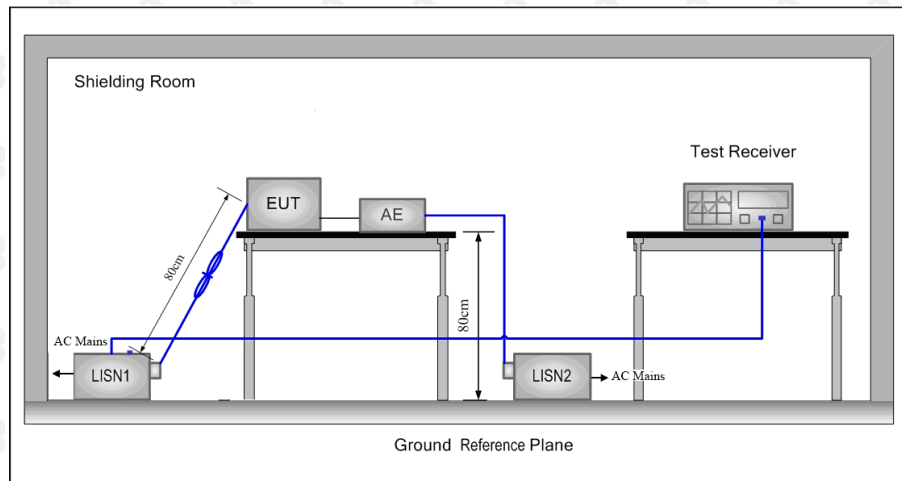
| No. | Equipment              | Manufacturer  | Model No.          | Serial No. | Firmware Version | Calibrated until |
|-----|------------------------|---------------|--------------------|------------|------------------|------------------|
| 1   | LISN                   | ROHDE&SCHWARZ | ESH3-Z5            | 100318     | /                | 2024.07.05       |
| 2   | Pulse limiter          | ROHDE&SCHWARZ | ESH3Z2             | 357881052  | /                | 2024.07.05       |
| 3   | EMI TEST RECEIVER      | ROHDE&SCHWARZ | ESCI               | 100428/003 | V4.42.SP3        | 2024.07.05       |
| 4   | Coaxial cable          | ZDECL         | Z302S-NJ-SM AJ-12M | 18091905   | /                | 2024.07.05       |
| 5   | ISN                    | Schwarzbeck   | NTFM8158           | 183        | /                | 2024.07.05       |
| 6   | Communication test set | Agilent       | E5515C             | MY50102567 | B.19.07 (E1962B) | 2024.07.05       |
| 7   | Communication test set | R&S           | CMW500             | 108058     | V3.5.80          | 2024.07.05       |
| 8   | EZ-EMC                 | Frad          | EMC-con3A1.1       | /          | /                | /                |

#### Radiated emission

| No. | Equipment                            | Manufacturer  | Model No.              | Serial No. | Firmware Version | Calibrated until |
|-----|--------------------------------------|---------------|------------------------|------------|------------------|------------------|
| 1   | Double Ridged Broadband Horn Antenna | Schwarzbeck   | BBHA 9120 D            | 01911      | /                | 2024.07.08       |
| 2   | TRILOG Broadband Antenna             | Schwarzbeck   | VULB 9168              | 00869      | /                | 2024.07.08       |
| 3   | Amplifier                            | Agilent       | 8449B                  | 3008A01838 | /                | 2024.07.05       |
| 4   | Amplifier                            | HP            | 8447E                  | 2945A02747 | /                | 2024.07.05       |
| 5   | EMI TEST RECEIVER                    | ROHDE&SCHWARZ | ESCI                   | 100428/003 | V4.42.SP3        | 2024.07.05       |
| 6   | Coaxial cable                        | ETS           | RFC-SNS-100-N MS-80 NI | /          | /                | 2024.07.05       |
| 7   | Coaxial cable                        | ETS           | RFC-SNS-100-N MS-20 NI | /          | /                | 2024.07.05       |
| 8   | Coaxial cable                        | ETS           | RFC-SNS-100-S MS-20 NI | /          | /                | 2024.07.05       |
| 9   | Coaxial cable                        | ETS           | RFC-NNS-100-NMS-300 NI | /          | /                | 2024.07.05       |
| 10  | Communication test set               | Agilent       | E5515C                 | MY50102567 | B.19.07 (E1962B) | 2024.07.05       |
| 11  | Communication test set               | R&S           | CMW500                 | 108058     | V3.5.80          | 2024.07.05       |
| 12  | EZ-EMC                               | Frad          | EMC-con3A1.1           | /          | /                | /                |

## 6. AC POWER LINE CONDUCTED EMISSION

### 6.1 Block Diagram Of Test Setup



### 6.2 Limit

Table 4 – AC power-line conducted emissions limits

| Frequency (MHz) | Conducted limit (dB $\mu$ V) |                            |
|-----------------|------------------------------|----------------------------|
|                 | Quasi-peak                   | Average                    |
| 0.15 - 0.5      | 66 to 56 <sup>Note 1</sup>   | 56 to 46 <sup>Note 1</sup> |
| 0.5 - 5         | 56                           | 46                         |
| 5 - 30          | 60                           | 50                         |

**Note 1:** The level decreases linearly with the logarithm of the frequency.

\* Decreasing linearly with the logarithm of the frequency

### 6.3 Test procedure

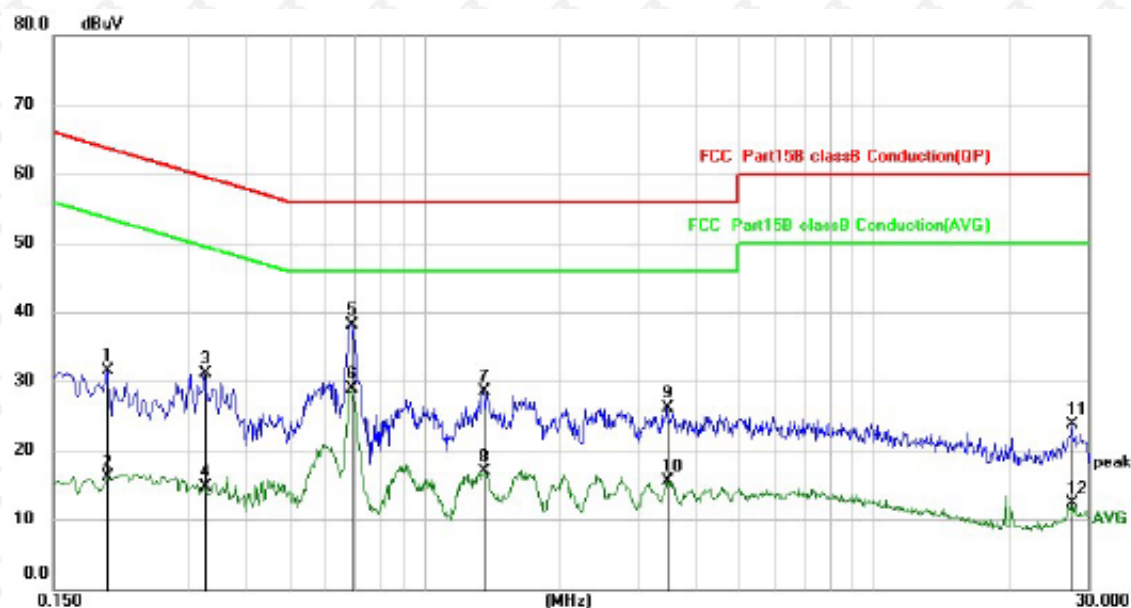
- 1) The mains terminal disturbance voltage test was conducted in a shielded room.
- 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50 $\Omega$ /50 $\mu$ H + 5 $\Omega$  linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
- 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
- 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0,4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane.

This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.

- 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10:2013 on conducted measurement.
- 6) All modes were tested at AC 120V and 240V, only the worst result of AC 120V 60Hz was reported.
- 7) If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.

## 6.4 Test Result

### L: Worst case-LoRa(low channel)

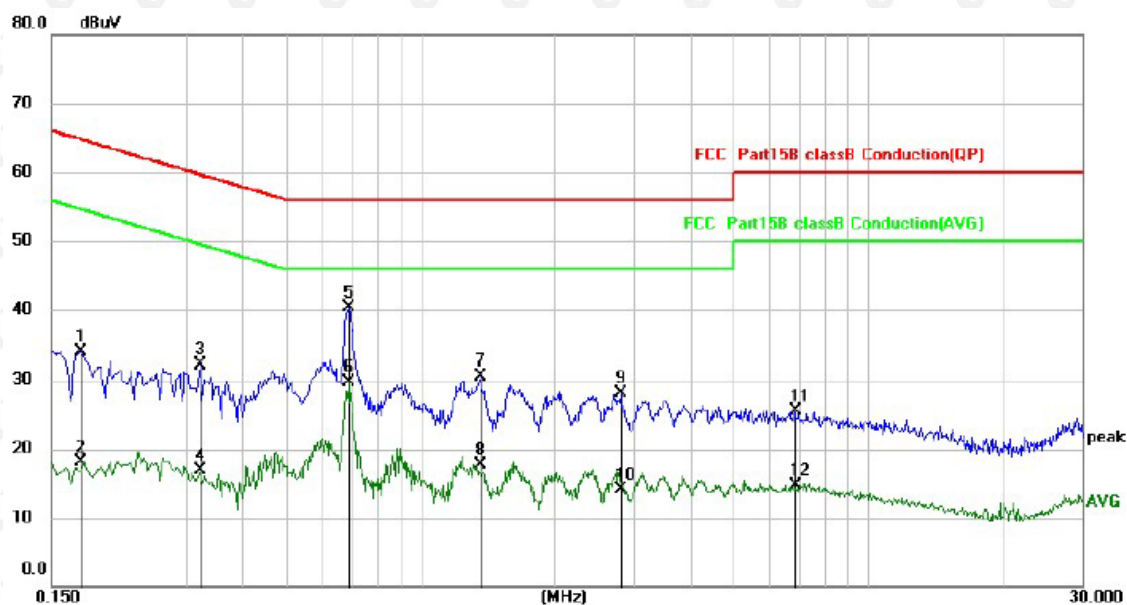


| No. | Mk. | Freq.<br>MHz | Reading<br>Level<br>dBuV | Correct<br>Factor<br>dB | Measure-<br>ment<br>dBuV | Limit<br>dBuV | Over<br>dB | Detector |
|-----|-----|--------------|--------------------------|-------------------------|--------------------------|---------------|------------|----------|
| 1   |     | 0.1980       | 20.69                    | 10.72                   | 31.41                    | 63.69         | -32.28     | QP       |
| 2   |     | 0.1980       | 5.30                     | 10.72                   | 16.02                    | 53.69         | -37.67     | AVG      |
| 3   |     | 0.3260       | 20.44                    | 10.62                   | 31.06                    | 59.55         | -28.49     | QP       |
| 4   |     | 0.3260       | 4.16                     | 10.62                   | 14.78                    | 49.55         | -34.77     | AVG      |
| 5   |     | 0.6900       | 27.33                    | 10.71                   | 38.04                    | 56.00         | -17.96     | QP       |
| 6   | *   | 0.6900       | 18.18                    | 10.71                   | 28.89                    | 46.00         | -17.11     | AVG      |
| 7   |     | 1.3580       | 17.42                    | 11.18                   | 28.60                    | 56.00         | -27.40     | QP       |
| 8   |     | 1.3580       | 5.64                     | 11.18                   | 16.82                    | 46.00         | -29.18     | AVG      |
| 9   |     | 3.4780       | 14.23                    | 11.91                   | 26.14                    | 56.00         | -29.86     | QP       |
| 10  |     | 3.4780       | 3.65                     | 11.91                   | 15.56                    | 46.00         | -30.44     | AVG      |
| 11  |     | 27.6100      | 9.38                     | 14.27                   | 23.65                    | 60.00         | -36.35     | QP       |
| 12  |     | 27.6100      | -1.88                    | 14.27                   | 12.39                    | 50.00         | -37.61     | AVG      |

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit

N: Worst case-LoRa(low channel)



| No. | Mk. | Freq.<br>MHz | Reading<br>Level<br>dBuV | Correct<br>Factor<br>dB | Measure-<br>ment<br>dBuV | Limit<br>dBuV | Over<br>dB | Detector |
|-----|-----|--------------|--------------------------|-------------------------|--------------------------|---------------|------------|----------|
| 1   |     | 0.1740       | 23.18                    | 10.80                   | 33.98                    | 64.77         | -30.79     | QP       |
| 2   |     | 0.1740       | 7.30                     | 10.80                   | 18.10                    | 54.77         | -36.67     | AVG      |
| 3   |     | 0.3220       | 21.50                    | 10.62                   | 32.12                    | 59.66         | -27.54     | QP       |
| 4   |     | 0.3220       | 6.26                     | 10.62                   | 16.88                    | 49.66         | -32.78     | AVG      |
| 5   | *   | 0.6900       | 29.60                    | 10.71                   | 40.31                    | 56.00         | -15.69     | QP       |
| 6   |     | 0.6900       | 19.08                    | 10.71                   | 29.79                    | 46.00         | -16.21     | AVG      |
| 7   |     | 1.3619       | 19.23                    | 11.18                   | 30.41                    | 56.00         | -25.59     | QP       |
| 8   |     | 1.3619       | 6.62                     | 11.18                   | 17.80                    | 46.00         | -28.20     | AVG      |
| 9   |     | 2.8020       | 16.40                    | 11.76                   | 28.16                    | 56.00         | -27.84     | QP       |
| 10  |     | 2.8020       | 2.44                     | 11.76                   | 14.20                    | 46.00         | -31.80     | AVG      |
| 11  |     | 6.8500       | 12.66                    | 12.89                   | 25.55                    | 60.00         | -34.45     | QP       |
| 12  |     | 6.8500       | 1.74                     | 12.89                   | 14.63                    | 50.00         | -35.37     | AVG      |

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit

## 7. RADIATED SPURIOUS EMISSION

### 7.1 Block Diagram Of Test Setup

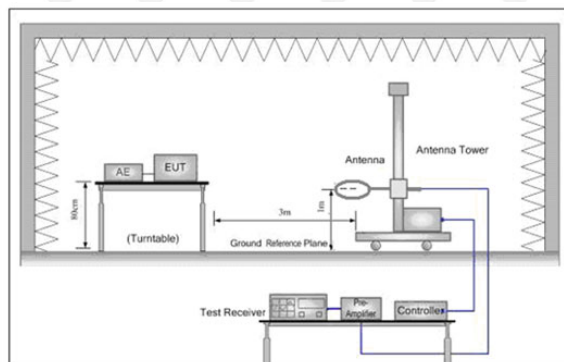


Figure 1. Below 30MHz

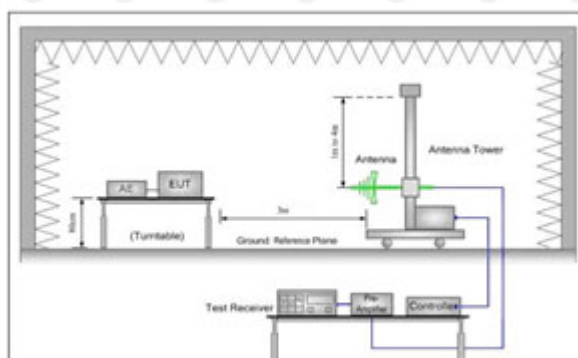


Figure 2. 30MHz to 1GHz

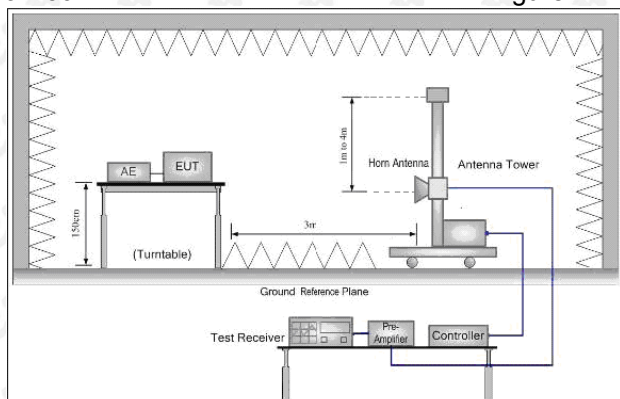


Figure 3. Above 1GHz

### 7.2 Limit

Spurious Emissions:

| Frequency         | Field strength (microvolt/meter) | Limit (dB $\mu$ V/m ) | Remark     | Measurement distance (m) |
|-------------------|----------------------------------|-----------------------|------------|--------------------------|
| 0.009MHz-0.490MHz | 2400/F(kHz)                      | -                     | -          | 300                      |
| 0.490MHz-1.705MHz | 24000/F(kHz)                     | -                     | -          | 30                       |
| 1.705MHz-30MHz    | 30                               | -                     | -          | 30                       |
| 30MHz-88MHz       | 100                              | 40.0                  | Quasi-peak | 3                        |
| 88MHz-216MHz      | 150                              | 43.5                  | Quasi-peak | 3                        |
| 216MHz-960MHz     | 200                              | 46.0                  | Quasi-peak | 3                        |
| 960MHz-1GHz       | 500                              | 54.0                  | Quasi-peak | 3                        |
| Above 1GHz        | 500                              | 54.0                  | Average    | 3                        |

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

### 7.3 Test procedure

#### Below 1GHz test procedure as below:

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

#### Above 1GHz test procedure as below:

- g. Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter( Above 18GHz the distance is 1 meter and table is 1.5 meter).
- h. Test the EUT in the lowest channel ,the middle channel ,the Highest channel
- i. Repeat above procedures until all frequencies measured was complete.
- j. Full battery is used during test

Receiver set:

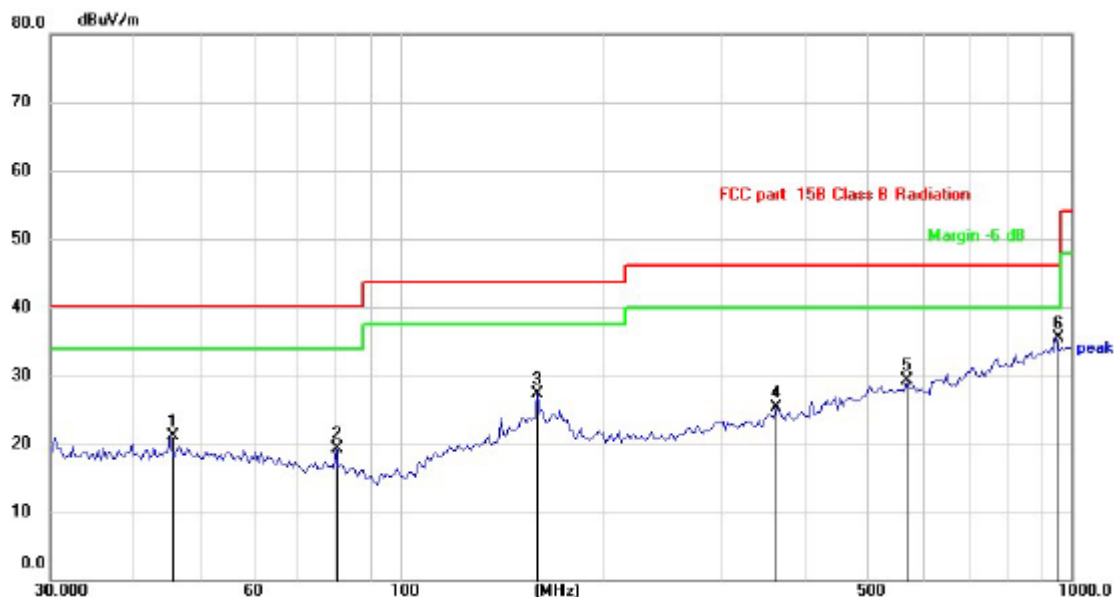
| Frequency         | Detector   | RBW     | VBW    | Remark     |
|-------------------|------------|---------|--------|------------|
| 0.009MHz-0.090MHz | Peak       | 10kHz   | 30KHz  | Peak       |
| 0.009MHz-0.090MHz | Average    | 10kHz   | 30KHz  | Average    |
| 0.090MHz-0.110MHz | Quasi-peak | 10kHz   | 30KHz  | Quasi-peak |
| 0.110MHz-0.490MHz | Peak       | 10kHz   | 30KHz  | Peak       |
| 0.110MHz-0.490MHz | Average    | 10kHz   | 30KHz  | Average    |
| 0.490MHz -30MHz   | Quasi-peak | 10kHz   | 30kHz  | Quasi-peak |
| 30MHz-1GHz        | Quasi-peak | 120 kHz | 300KHz | Quasi-peak |
| Above 1GHz        | Peak       | 1MHz    | 3MHz   | Peak       |
|                   | Peak       | 1MHz    | 10Hz   | Average    |

## 7.4 Test Result

Below 1GHz Test Results:

Antenna polarity: H

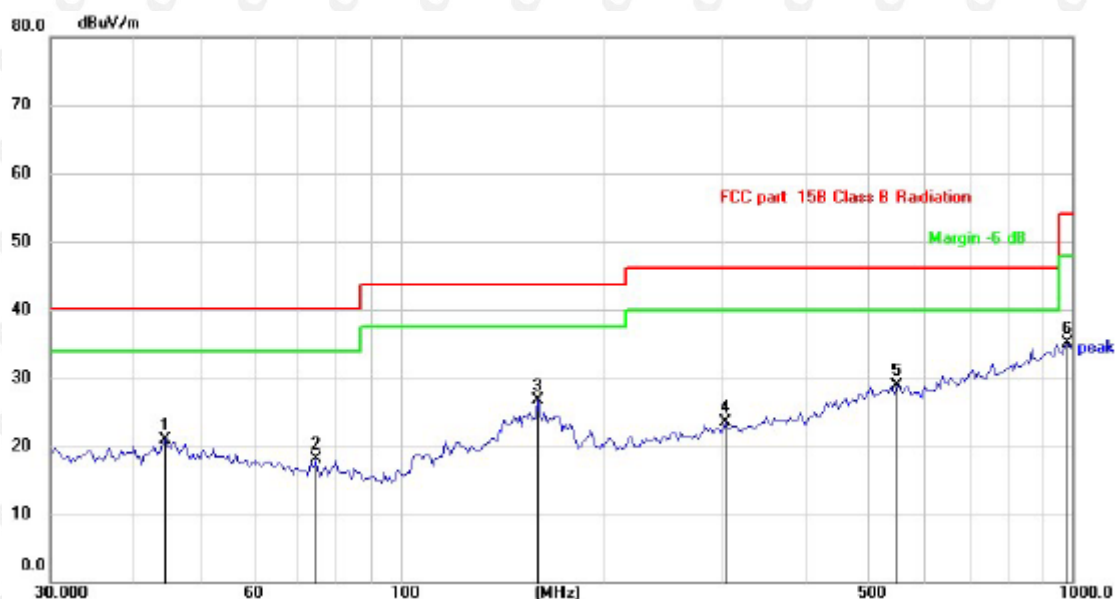
Worst case-LoRa(low channel)



| No. | Mk. | Freq.<br>MHz | Reading<br>Level<br>dBuV | Correct<br>Factor<br>dB | Measure-<br>ment<br>dBuV/m | Limit<br>dB/m | Over<br>dB | Detector |
|-----|-----|--------------|--------------------------|-------------------------|----------------------------|---------------|------------|----------|
| 1   |     | 45.2960      | 27.82                    | -6.75                   | 21.07                      | 40.00         | -18.93     | QP       |
| 2   |     | 80.0806      | 27.90                    | -8.69                   | 19.21                      | 40.00         | -20.79     | QP       |
| 3   |     | 160.0648     | 28.14                    | -0.84                   | 27.30                      | 43.50         | -16.20     | QP       |
| 4   |     | 364.8987     | 26.84                    | -1.49                   | 25.35                      | 46.00         | -20.65     | QP       |
| 5   |     | 570.6100     | 26.11                    | 3.14                    | 29.25                      | 46.00         | -16.75     | QP       |
| 6   | *   | 948.7610     | 26.91                    | 8.60                    | 35.51                      | 46.00         | -10.49     | QP       |

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement- Limit

Antenna polarity: V  
Worst case-LoRa(low channel)



| No. | Mk. | Freq.<br>MHz | Reading<br>Level<br>dBuV | Correct<br>Factor<br>dB | Measure-<br>ment<br>dBuV/m | Limit<br>dB/m | Over<br>dB | Detector |
|-----|-----|--------------|--------------------------|-------------------------|----------------------------|---------------|------------|----------|
| 1   |     | 44.5087      | 27.70                    | -6.77                   | 20.93                      | 40.00         | -19.07     | QP       |
| 2   |     | 74.6568      | 26.73                    | -8.69                   | 18.04                      | 40.00         | -21.96     | QP       |
| 3   | *   | 160.0648     | 27.59                    | -0.84                   | 26.75                      | 43.50         | -16.75     | QP       |
| 4   |     | 306.2163     | 26.35                    | -2.76                   | 23.59                      | 46.00         | -22.41     | QP       |
| 5   |     | 550.9480     | 26.01                    | 2.86                    | 28.87                      | 46.00         | -17.13     | QP       |
| 6   |     | 982.6200     | 26.35                    | 8.84                    | 35.19                      | 54.00         | -18.81     | QP       |

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement- Limit

Above 1 GHz Test Results:  
CH Low

Horizontal:

| Frequency                                                     | Meter Reading | Factor | Emission Level | Limits   | Margin | Detector Type |
|---------------------------------------------------------------|---------------|--------|----------------|----------|--------|---------------|
| (MHz)                                                         | (dBμV)        | (dB)   | (dBμV/m)       | (dBμV/m) | (dB)   |               |
| 1804.6                                                        | 108.35        | -5.84  | 52.69          | 74       | -21.31 | peak          |
| 1804.6                                                        | 95.53         | -5.84  | 43.65          | 54       | -10.35 | AVG           |
| 2706.9                                                        | 56.27         | -3.64  | 52.63          | 74       | -21.37 | peak          |
| 2706.9                                                        | 47.19         | -3.64  | 43.55          | 54       | -10.45 | AVG           |
| 3609.2                                                        | 58.15         | -0.95  | 57.20          | 74       | -16.80 | peak          |
| 3609.2                                                        | 48.04         | -0.95  | 47.09          | 54       | -6.91  | AVG           |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. |               |        |                |          |        |               |

Vertical:

| Frequency                                                     | Meter Reading | Factor | Emission Level | Limits   | Margin | Detector Type |
|---------------------------------------------------------------|---------------|--------|----------------|----------|--------|---------------|
| (MHz)                                                         | (dBμV)        | (dB)   | (dBμV/m)       | (dBμV/m) | (dB)   |               |
| 1804.6                                                        | 108.40        | -5.84  | 52.69          | 74       | -21.31 | peak          |
| 1804.6                                                        | 95.59         | -5.84  | 43.65          | 54       | -10.35 | AVG           |
| 2706.9                                                        | 56.31         | -3.64  | 52.67          | 74       | -21.33 | peak          |
| 2706.9                                                        | 47.17         | -3.64  | 43.53          | 54       | -10.47 | AVG           |
| 3609.2                                                        | 58.17         | -0.95  | 57.22          | 74       | -16.78 | peak          |
| 3609.2                                                        | 48.05         | -0.95  | 47.10          | 54       | -6.90  | AVG           |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. |               |        |                |          |        |               |

CH Middle

Horizontal:

| Frequency                                                     | Meter Reading | Factor | Emission Level | Limits   | Margin | Detector Type |
|---------------------------------------------------------------|---------------|--------|----------------|----------|--------|---------------|
| (MHz)                                                         | (dBμV)        | (dB)   | (dBμV/m)       | (dBμV/m) | (dB)   |               |
| 1817.4                                                        | 108.39        | -5.71  | 52.67          | 74       | -21.33 | peak          |
| 1817.4                                                        | 95.15         | -5.71  | 45.61          | 54       | -8.39  | AVG           |
| 2726.1                                                        | 56.08         | -3.51  | 52.57          | 74       | -21.43 | peak          |
| 2726.1                                                        | 46.79         | -3.51  | 43.28          | 54       | -10.72 | AVG           |
| 3634.8                                                        | 57.99         | -0.82  | 57.17          | 74       | -16.83 | peak          |
| 3634.8                                                        | 47.86         | -0.82  | 47.04          | 54       | -6.96  | AVG           |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. |               |        |                |          |        |               |

Vertical:

| Frequency                                                     | Meter Reading | Factor | Emission Level | Limits   | Margin | Detector Type |
|---------------------------------------------------------------|---------------|--------|----------------|----------|--------|---------------|
| (MHz)                                                         | (dBμV)        | (dB)   | (dBμV/m)       | (dBμV/m) | (dB)   |               |
| 1817.4                                                        | 108.25        | -5.71  | 52.67          | 74       | -21.33 | peak          |
| 1817.4                                                        | 95.16         | -5.71  | 45.61          | 54       | -8.39  | AVG           |
| 2726.1                                                        | 56.07         | -3.51  | 52.56          | 74       | -21.44 | peak          |
| 2726.1                                                        | 46.91         | -3.51  | 43.40          | 54       | -10.60 | AVG           |
| 3634.8                                                        | 57.97         | -0.82  | 57.15          | 74       | -16.85 | peak          |
| 3634.8                                                        | 48.00         | -0.82  | 47.18          | 54       | -6.82  | AVG           |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. |               |        |                |          |        |               |

CH High

Horizontal:

| Frequency                                                     | Meter Reading | Factor | Emission Level | Limits   | Margin | Detector Type |
|---------------------------------------------------------------|---------------|--------|----------------|----------|--------|---------------|
| (MHz)                                                         | (dBμV)        | (dB)   | (dBμV/m)       | (dBμV/m) | (dB)   |               |
| 1829.8                                                        | 56.40         | -5.65  | 52.36          | 74       | -21.64 | peak          |
| 1829.8                                                        | 47.31         | -5.65  | 46.89          | 54       | -7.11  | AVG           |
| 2744.7                                                        | 56.21         | -3.43  | 52.78          | 74       | -21.22 | peak          |
| 2744.7                                                        | 47.45         | -3.43  | 44.02          | 54       | -9.98  | AVG           |
| 3659.6                                                        | 57.23         | -0.75  | 56.48          | 74       | -17.52 | peak          |
| 3659.6                                                        | 47.62         | -0.75  | 46.87          | 54       | -7.13  | AVG           |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. |               |        |                |          |        |               |

Vertical:

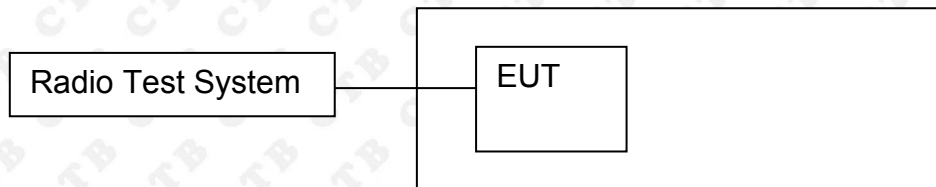
| Frequency                                                     | Meter Reading | Factor | Emission Level | Limits   | Margin | Detector Type |
|---------------------------------------------------------------|---------------|--------|----------------|----------|--------|---------------|
| (MHz)                                                         | (dBμV)        | (dB)   | (dBμV/m)       | (dBμV/m) | (dB)   |               |
| 1829.8                                                        | 56.48         | -5.65  | 52.36          | 74       | -21.64 | peak          |
| 1829.8                                                        | 47.30         | -5.65  | 46.89          | 54       | -7.11  | AVG           |
| 2744.7                                                        | 56.09         | -3.43  | 52.66          | 74       | -21.34 | peak          |
| 2744.7                                                        | 47.29         | -3.43  | 43.86          | 54       | -10.14 | AVG           |
| 3659.6                                                        | 57.27         | -0.75  | 56.52          | 74       | -17.48 | peak          |
| 3659.6                                                        | 47.63         | -0.75  | 46.88          | 54       | -7.12  | AVG           |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. |               |        |                |          |        |               |

Remark:

- (1) Measuring frequencies from 1 GHz to the 25 GHz .
- (2). All modes of operation were investigated and the worst-case emissions are reported.
- (3). Radiated emission test from 9kHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9kHz to 30MHz and not recorded in this report.

## 8. BAND EDGE AND RF CONDUCTED SPURIOUS EMISSIONS

### 8.1 Block Diagram Of Test Setup



### 8.2 Limit

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)).

### 8.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer:

Below 30MHz:

RBW = 100kHz, VBW = 300kHz, Sweep = auto

Detector function = peak, Trace = max hold

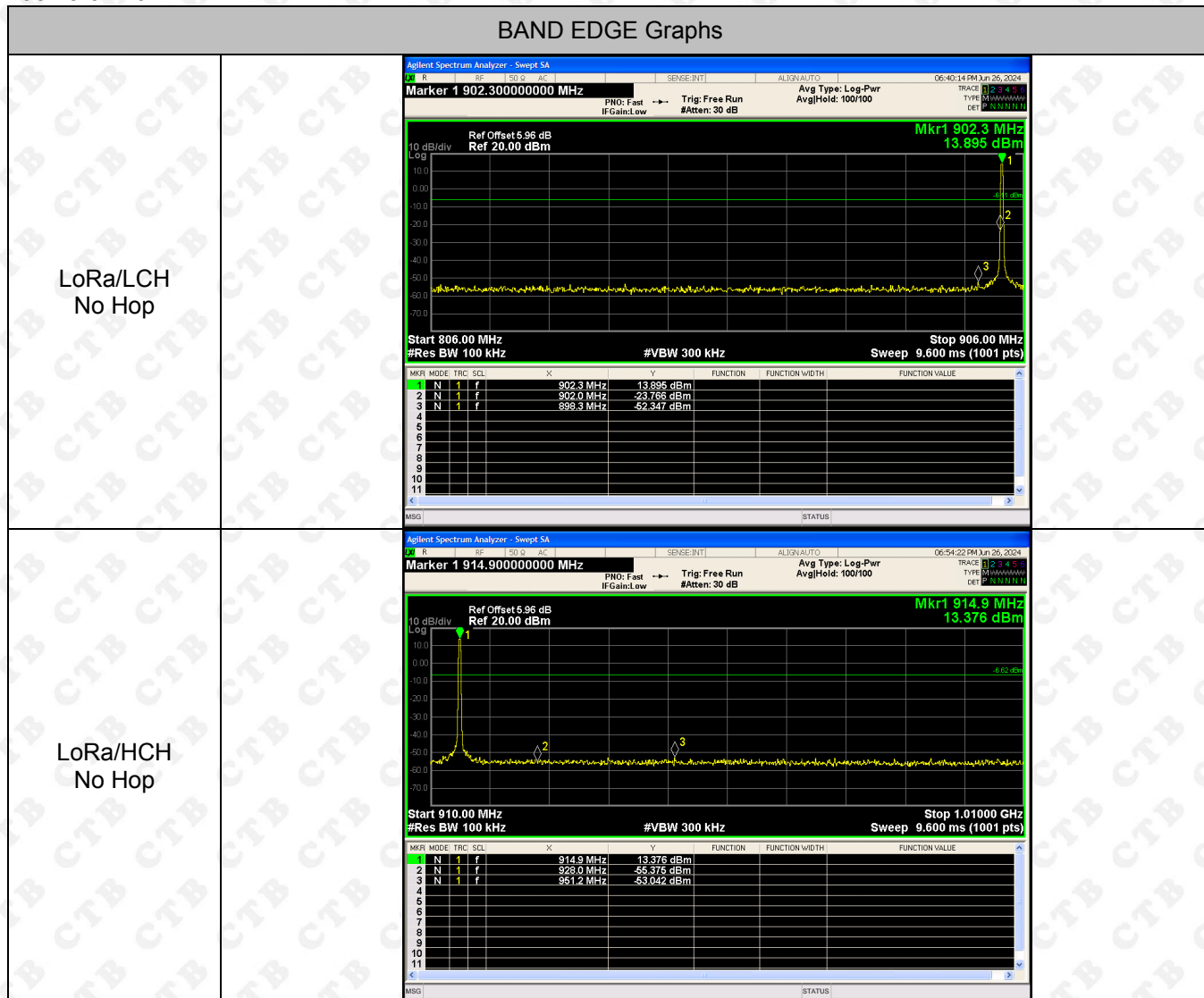
Above 30MHz:

RBW = 100KHz, VBW = 300KHz, Sweep = auto

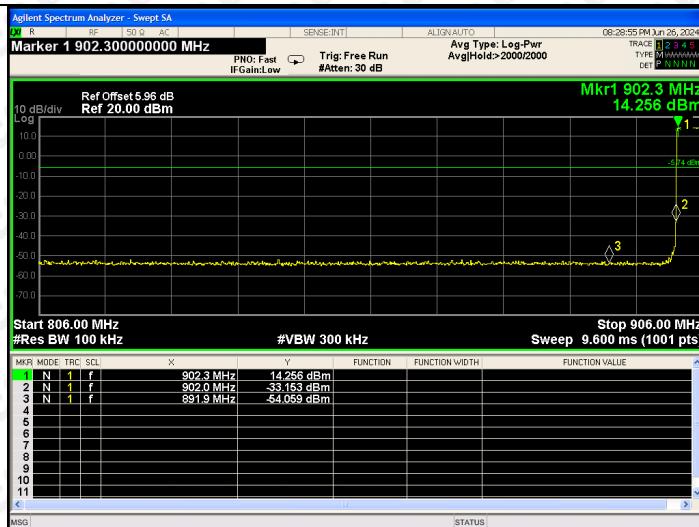
Detector function = peak, Trace = max hold

## 8.4 Test Result

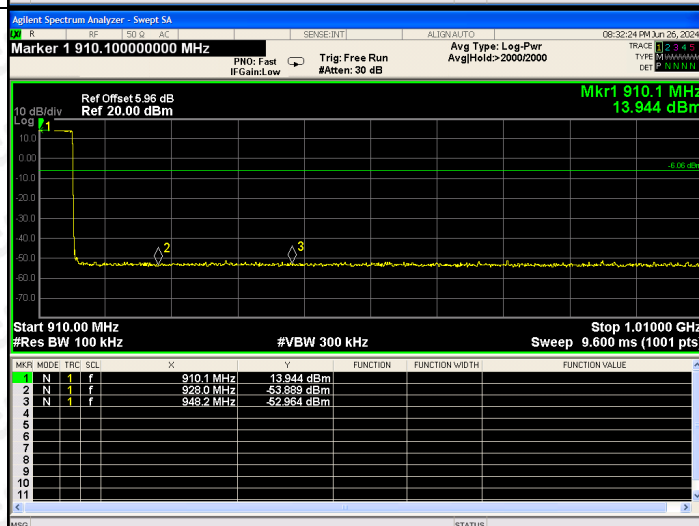
902.3-914.9MHz:



LoRa/LCH  
Hop

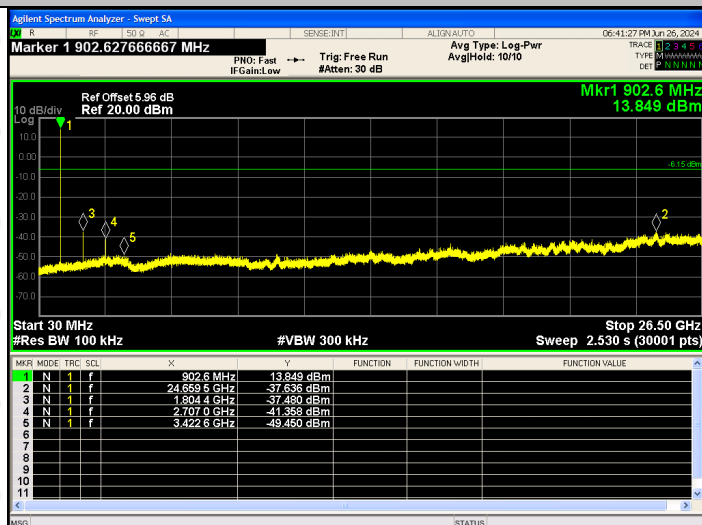


LoRa/HCH  
Hop

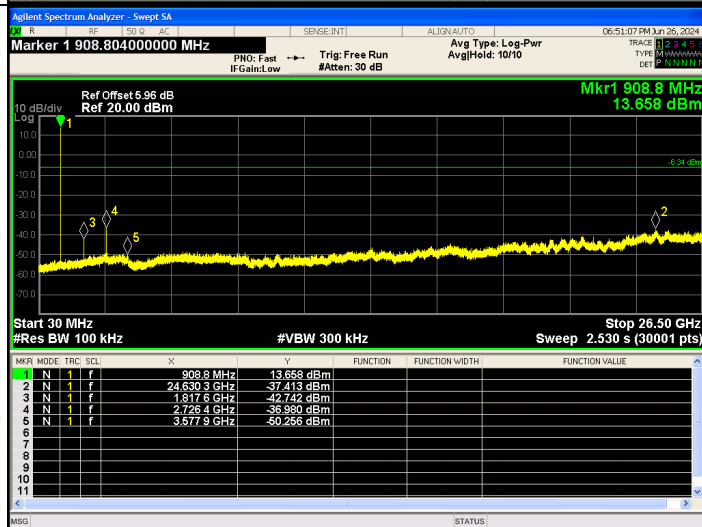


## RF Conducted Spurious Emissions Graphs

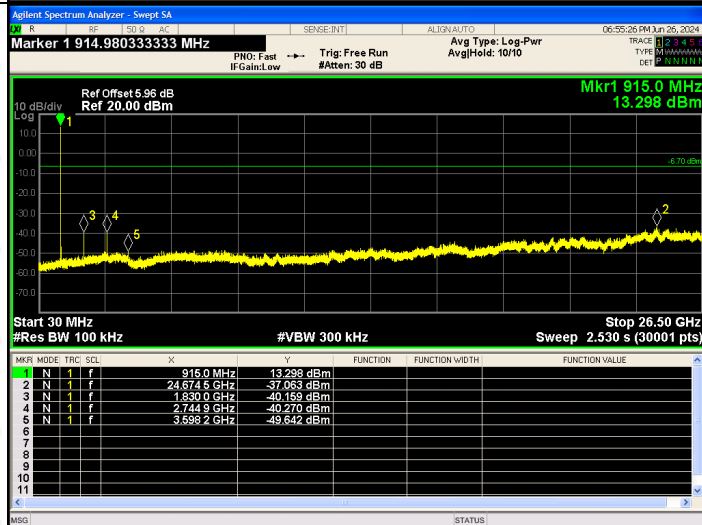
LoRa/LCH



LoRa/MCH

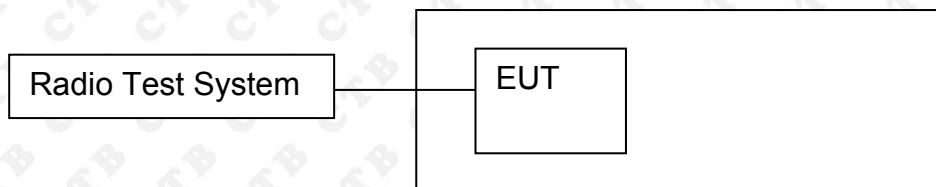


LoRa/HCH



## 9. COUDUCTED PEAK OUTPUT POWER

### 9.1 Block Diagram Of Test Setup



### 9.2 Limit

| FCC Part15 (15.247) , Subpart C |              |                 |                       |        |
|---------------------------------|--------------|-----------------|-----------------------|--------|
| Section                         | Test Item    | Limit           | Frequency Range (MHz) | Result |
| 15.247(b)(3)                    | Output Power | 1 watt or 30dBm | 902-928               | PASS   |

### 9.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 2MHz. VBW = 6MHz. Channel power measurement. Sweep = auto; Detector Function = peak.
3. Keep the EUT in transmitting at lowest, middle and highest channel individually. Record the max value.

#### 9.4 Test Result

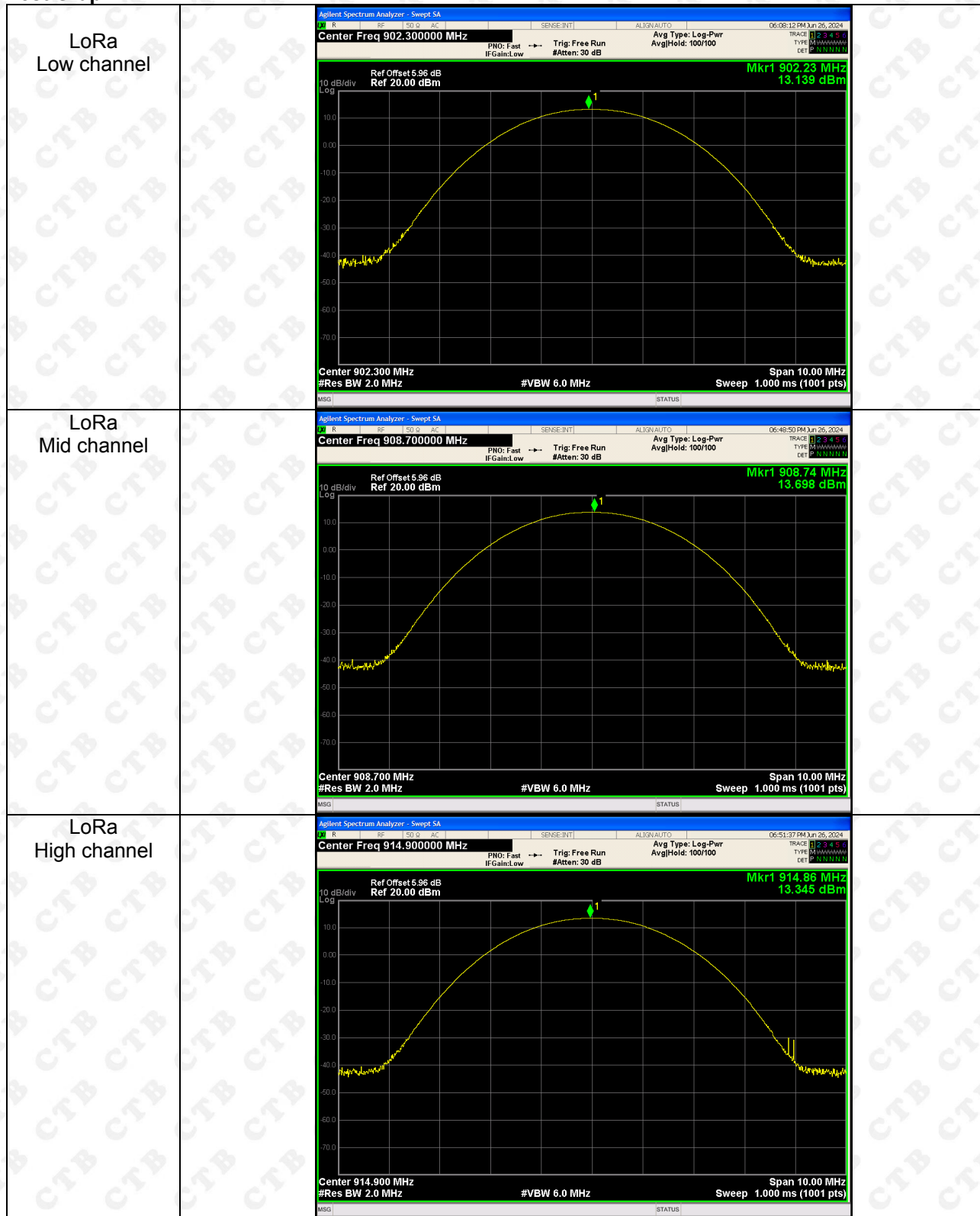
| Mode | Channel. | Maximum Output Power [dBm] | Limit[dBm] | Verdict |
|------|----------|----------------------------|------------|---------|
| LoRa | LCH      | 13.139                     | 30         | PASS    |
|      | MCH      | 13.698                     | 30         | PASS    |
|      | HCH      | 13.345                     | 30         | PASS    |

#### Duty Cycle

| Mode | Channel. | Duty Cycle(%) | Correction Factor (dB) |
|------|----------|---------------|------------------------|
| LoRa | LCH      | 100           | 0                      |
|      | MCH      | 100           | 0                      |
|      | HCH      | 100           | 0                      |

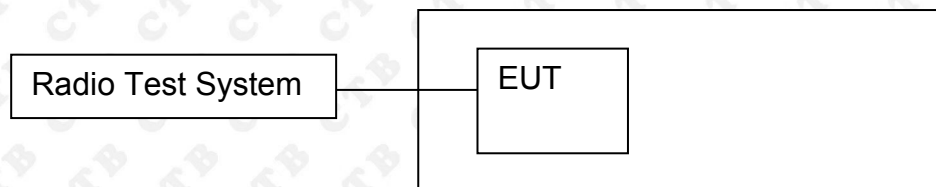
902.3-914.9MHz:

Test Graph:



## 10. 20DB OCCUPIED BANDWIDTH

### 10.1 Block Diagram Of Test Setup



### 10.2 Limit

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies

### 10.3 Test procedure

1. Rem1. Set RBW = 30 kHz.
2. Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

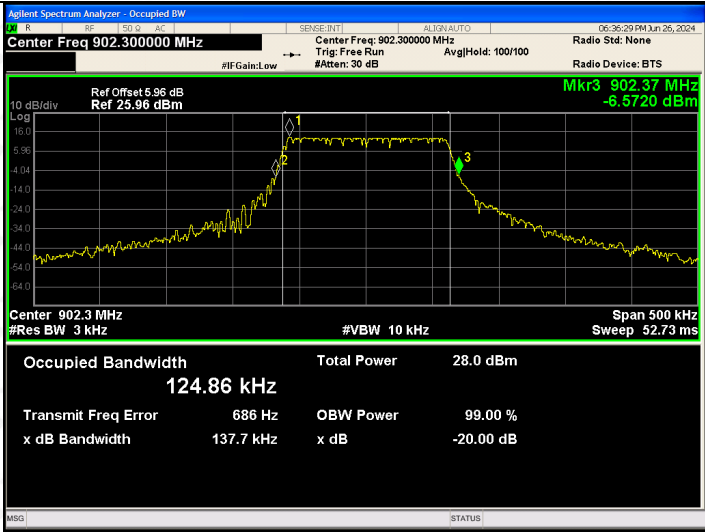
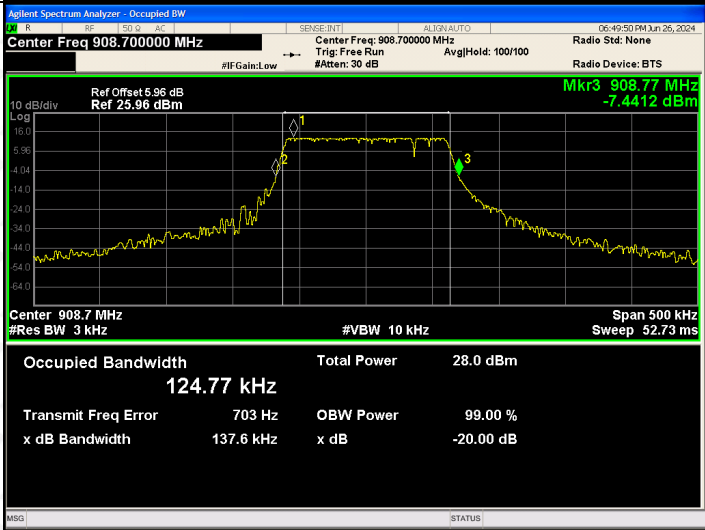
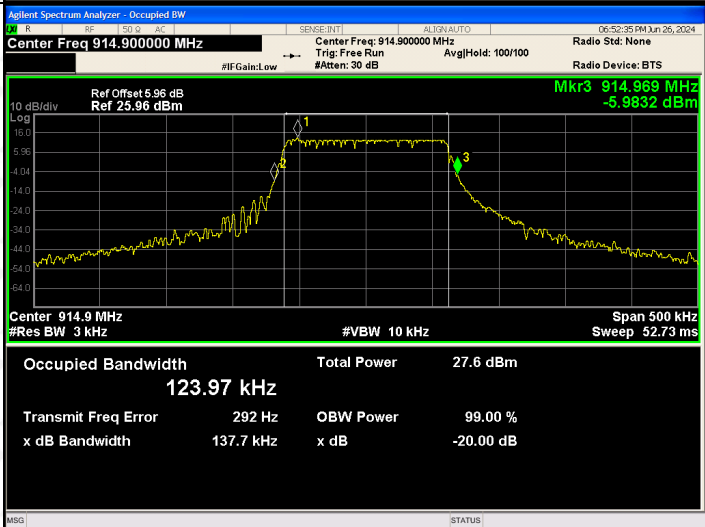
### 10.4 Test Result

902.3-914.9MHz:

| Test Mode | Frequency    | 20dB Bandwidth (MHz) | Result      |
|-----------|--------------|----------------------|-------------|
| LoRa      | Low channel  | 0.138                | <b>PASS</b> |
|           | Mid channel  | 0.138                | <b>PASS</b> |
|           | High channel | 0.138                | <b>PASS</b> |

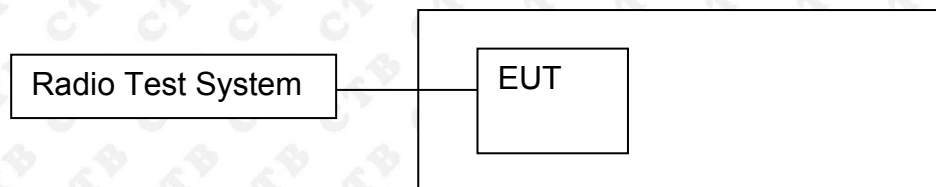
Note: All modes of operation were Pre-scan and the worst-case emissions are reported.

## Test Graph:

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>LoRa<br/>Low channel</p>  |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 902.300000 MHz</p> <p>Ref Offset 5.96 dB<br/>Ref 25.96 dBm</p> <p>Occupied Bandwidth<br/>124.86 kHz</p> <p>Total Power<br/>28.0 dBm</p> <p>Transmit Freq Error<br/>686 Hz</p> <p>OBW Power<br/>99.00 %</p> <p>x dB Bandwidth<br/>137.7 kHz</p> <p>x dB<br/>-20.00 dB</p>   |
| <p>LoRa<br/>Mid channel</p>  |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 908.700000 MHz</p> <p>Ref Offset 5.96 dB<br/>Ref 25.96 dBm</p> <p>Occupied Bandwidth<br/>124.77 kHz</p> <p>Total Power<br/>28.0 dBm</p> <p>Transmit Freq Error<br/>703 Hz</p> <p>OBW Power<br/>99.00 %</p> <p>x dB Bandwidth<br/>137.6 kHz</p> <p>x dB<br/>-20.00 dB</p>  |
| <p>LoRa<br/>High channel</p> |  <p>Agilent Spectrum Analyzer - Occupied BW</p> <p>Center Freq 914.900000 MHz</p> <p>Ref Offset 5.96 dB<br/>Ref 25.96 dBm</p> <p>Occupied Bandwidth<br/>123.97 kHz</p> <p>Total Power<br/>27.6 dBm</p> <p>Transmit Freq Error<br/>292 Hz</p> <p>OBW Power<br/>99.00 %</p> <p>x dB Bandwidth<br/>137.7 kHz</p> <p>x dB<br/>-20.00 dB</p> |

## 11. CARRIER FREQUENCIES SEPARATION

### 11.1 Block Diagram Of Test Setup



### 11.2 Limit

At least 25kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

### 11.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz , Span = 2MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

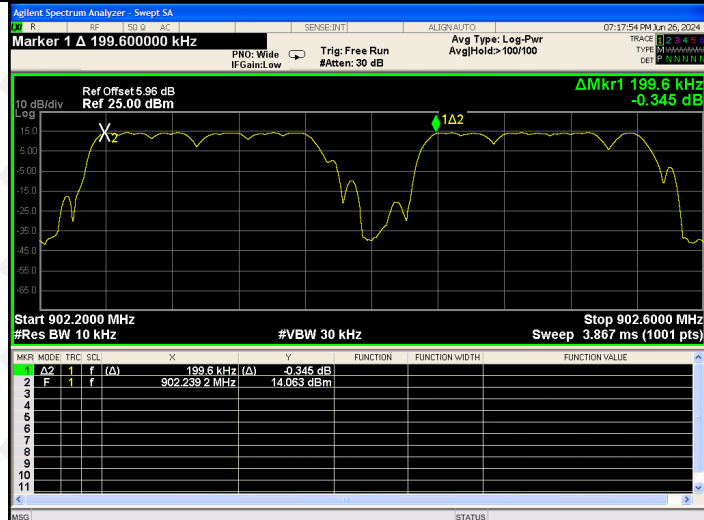
### 11.4 Test Result

| Mode | Channel. | Carrier Frequency Separation [MHz] | Verdict |
|------|----------|------------------------------------|---------|
| LoRa | LCH      | 0.1996                             | PASS    |
| LoRa | MCH      | 0.2036                             | PASS    |
| LoRa | HCH      | 0.2000                             | PASS    |

# 902.3-914.9MHz: Test Graph

## Graphs

LoRa/LCH



LoRa/MCH

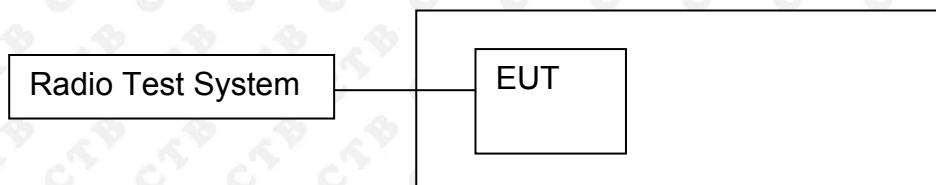


LoRa/HCH



## 12. HOPPING CHANNEL NUMBER

### 12.1 Block Diagram Of Test Setup



### 12.2 Limit

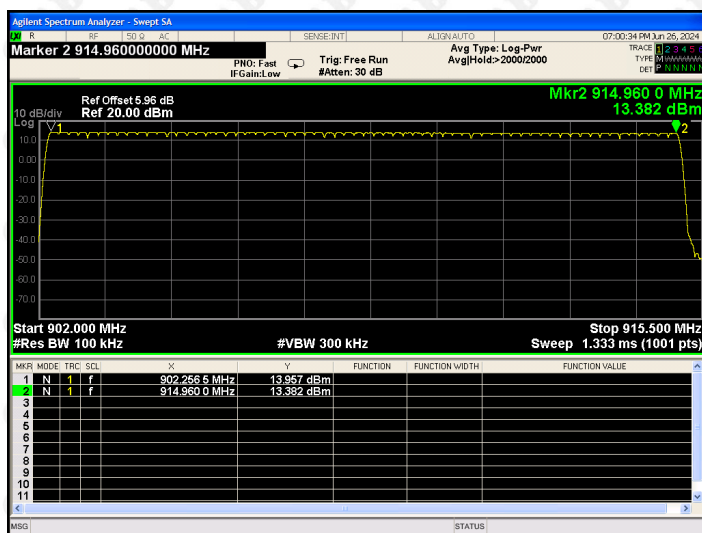
Frequency hopping systems in the 920-928 MHz band shall use at least 50 channels.

### 12.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.
4. Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.4835GHz. Sweep=auto;

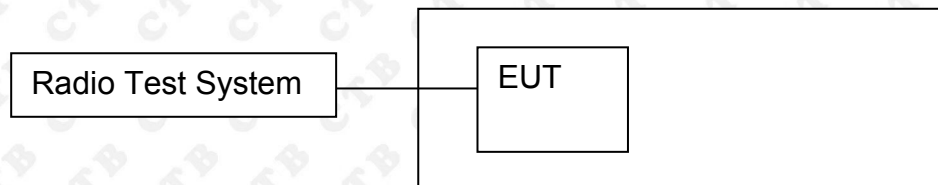
### 12.4 Test Result

| Mode | Channel. | Number of Hopping Channel | Limit     | Verdict |
|------|----------|---------------------------|-----------|---------|
| LoRa | Hop      | 64                        | $\geq 50$ | PASS    |



### 13. DWELL TIME

#### 13.1 Block Diagram Of Test Setup



#### 13.2 Limit

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

#### 13.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set spectrum analyzer span = 0. Centred on a hopping channel;
3. Set RBW = 1MHz and VBW = 3MHz. Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.
4. Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

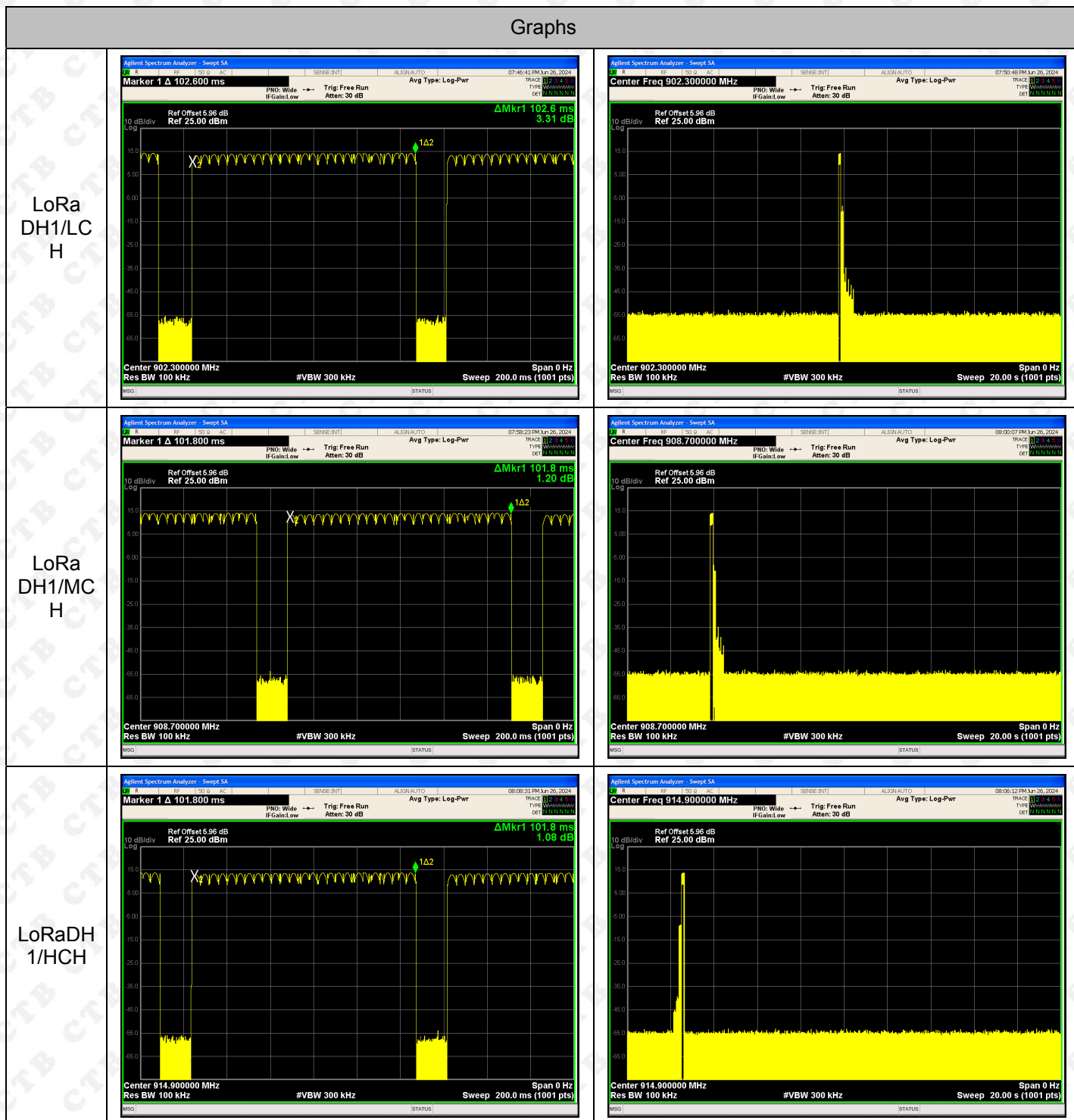
#### 13.4 Test Result

| Channel | No. of transmission in 10s(a) | Pulse Time (ms)(b) | Total Dwell Time in 20s (ms) (c) | Limit (ms) | Verdict |
|---------|-------------------------------|--------------------|----------------------------------|------------|---------|
| LCH     | 1                             | 102.6              | 102.6                            | 400        | PASS    |
| MCH     | 1                             | 101.8              | 101.8                            | 400        | PASS    |
| HCH     | 1                             | 101.8              | 101.8                            | 400        | PASS    |

Remark: Total dwell time in 20s, c=(a)\*(b)

# Test Graph

## Graphs



## 14. ANTENNA REQUIREMENT

### 15.203 requirement:

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, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

### 15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### EUT Antenna:

The antenna is Internal antenna. The best case gain of the antenna is -1.96dBi,

## 15. EUT TEST SETUP PHOTOGRAPHS

### Radiated Emission

Below 1G



Above 1G



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