



# TEST REPORT

Product Name: LoRa Module  
FCC ID: 2ATPO-RA-01SC  
Trademark:   安信可科技  
Ai-Thinker  
Model Number: Ra-01SC  
Prepared For: Shenzhen Ai-Thinker Technology Co., Ltd  
Address: 410, Block C, Huafeng Smart Innovation Port. Gushu 2nd Road,  
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Manufacturer: Shenzhen Ai-Thinker Technology Co., Ltd  
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Prepared By: Shenzhen CTB Testing Technology Co., Ltd.  
Address: Floor 1&2, Building A, No. 26 of Xinghe Road, Xinqiao Street, Baoan  
District, Shenzhen China  
Sample Received Date: May. 14, 2021  
Sample tested Date: May. 14, 2021 - Jun. 25, 2021  
Issue Date: Jun. 25, 2021  
Report No.: CTB210525029RFX  
Test Standards: FCC Part15.231  
ANSI C63.10:2013  
Test Results: PASS  
Remark: This is 433MHz radio test report.

Compiled by:



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Reviewed by:



Bin Mei

Approved by:



Rita Xiao / Director

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*(Note: N/A means not applicable)*

## 1. VERSION

| Report No.      | Issue Date    | Description | Approved |
|-----------------|---------------|-------------|----------|
| CTB210525029RFX | Jun. 25, 2021 | 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<br>Section 15.207               | ANSI C63.10-2013 | PASS   |
| <b>Radiated Emission</b>                | 47 CFR Part 15 Subpart C<br>Section 15.209;<br>15.231(b) | ANSI C63.10-2013 | PASS   |
| <b>Dwell Time</b>                       | 47 CFR Part 15 Subpart C<br>Section<br>15.231 (a)        | ANSI C63.10-2013 | PASS   |
| <b>Occupied Bandwidth</b>               | 47 CFR Part 15 Subpart C<br>Section 15.231(c)            | ANSI C63.10-2013 | PASS   |
| <b>Antenna requirement</b>              | 47 CFR Part 15 Subpart C<br>Section 15.203               | ANSI C63.10-2013 | PASS   |

### 3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in C ISPR 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                                  | $U=\pm 54.3\text{Hz}$        |
| Conducted output power<br>Above 1G                   | $U=\pm 1.0\text{dB}$         |
| Conducted output power<br>below 1G                   | $U=\pm 0.9\text{dB}$         |
| Power Spectral Density , Conduction                  | $U=\pm 1.0\text{dB}$         |
| Conduction spurious emissions                        | $U=\pm 2.8\text{dB}$         |
| Out of band emission                                 | $U=\pm 54\text{Hz}$          |
| 3m chamber Radiated spurious<br>emission(30MHz-1GHz) | $U=\pm 4.3\text{dB}$         |
| 3m chamber Radiated spurious<br>emission(1GHz-18GHz) | $U=\pm 4.5\text{dB}$         |
| humidity uncertainty                                 | $U=\pm 5.3\%$                |
| Temperature uncertainty                              | $U=\pm 0.59^{\circ}\text{C}$ |
| Supply voltages                                      | $U=\pm 3\%$                  |
| Time   | $U=\pm 5\%$                  |

## 4. PRODUCT INFORMATION AND TEST SETUP

### 4.1 Product Information

|                       |                 |
|-----------------------|-----------------|
| Model(s):             | Ra-01SC         |
| Model Description:    | N/A             |
| Hardware Version:     | V1.1            |
| Software Version:     | V1.1            |
| Operation Frequency:  | 410-525MHz      |
| Type of Modulation:   | ASK             |
| Antenna installation: | Spring antenna  |
| Antenna Gain:         | 0dBi            |
| Ratings:              | DC 3.3V from PC |

### 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

| No. | Device Type | Brand  | Model | Series No. | Data Cable | Power Cord |
|-----|-------------|--------|-------|------------|------------|------------|
| 1.  | PC          | lenovo | V130  | N/A        | 1.2        | AC         |

#### Notes:

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 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  |
|--|
| Keep the EUT in transmitting mode with modulation. |

#### 4.5 Test Environment

|                            |       |
|----------------------------|-------|
| Humidity(%):               | 55    |
| Atmospheric Pressure(kPa): | 101.1 |
| Normal Voltage(DC):        | 3.3V  |
| Normal Temperature(°C)     | 25    |

#### 4.6 Test Channel

| Channel    | Frequency (MHz) |
|------------|-----------------|
| <b>01</b>  | <b>410MHz</b>   |
| 02         | 411MHz          |
| ...        | ...             |
| 58         | 467MHz          |
| <b>59</b>  | <b>468MHz</b>   |
| ...        | ...             |
| 115        | 524 MHz         |
| <b>116</b> | <b>525 MHz</b>  |



## 5. TEST FACILITY AND TEST INSTRUMENT USED

### 5.1 Test Facility

All measurement facilities used to collect the measurement data are located at Floor 1&2, Building A, No. 26 of Xinhe Road, Xinqiao Street, Baoan District, Shenzhen 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

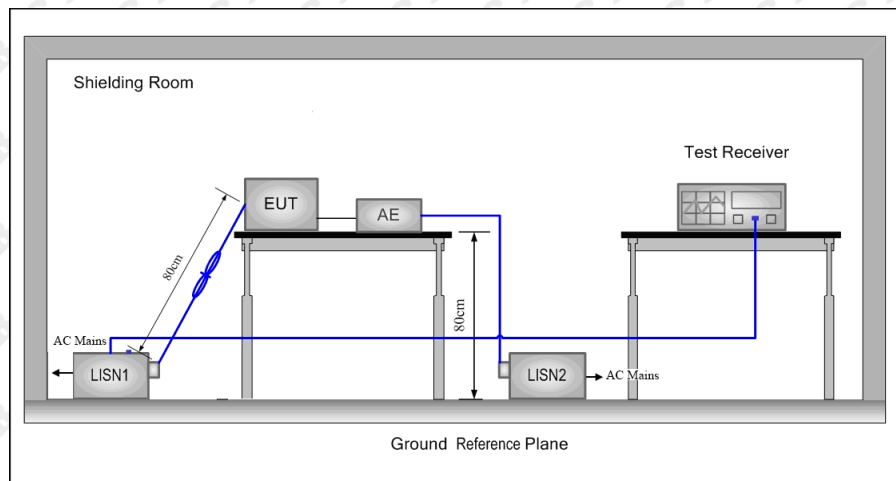
| Item | Equipment                                 | Manufacturer | Type No.                  | Serial No.   | Last calibration | Calibrated until |
|------|---|--------------|---------------------------|--------------|------------------|------------------|
| 1    | Spectrum Analyzer                         | Agilent      | N9020A                    | MY52090073   | Sep. 28, 2020    | Sep. 28, 2021    |
| 2    | Power Sensor                              | Agilent      | U2021XA                   | MY56120032   | Sep. 28, 2020    | Sep. 28, 2021    |
| 3    | Power Sensor                              | Agilent      | U2021XA                   | MY56120034   | Sep. 28, 2020    | Sep. 28, 2021    |
| 4    | Communication test set                    | R&S          | CMW500                    | 108058       | Sep. 28, 2020    | Sep. 28, 2021    |
| 5    | Spectrum Analyzer                         | R&S          | FSP40                     | 100550       | Sep. 28, 2020    | Sep. 28, 2021    |
| 6    | Signal Generator                          | Agilent      | N5181A                    | MY49060920   | Sep. 28, 2020    | Sep. 28, 2021    |
| 7    | Signal Generator                          | Agilent      | N5182A                    | MY47420195   | Sep. 28, 2020    | Sep. 28, 2021    |
| 8    | Communication test set                    | Agilent      | E5515C                    | MY50102567   | Oct. 10, 2020    | Oct. 10, 2021    |
| 9    | band rejection filter                     | Shenxiang    | MSF2400-24<br>83.5MS-1154 | 20181015001  | Sep. 28, 2020    | Sep. 28, 2021    |
| 10   | band rejection filter                     | Shenxiang    | MSF5150-58<br>50MS-1155   | 20181015001  | Sep. 28, 2020    | Sep. 28, 2021    |
| 11   | band rejection filter                     | Xingbo       | XBLBQ-DZA<br>120          | 190821-1-1   | Sep. 28, 2020    | Sep. 28, 2021    |
| 12   | BT&WI-FI Automatic test software          | Microwave    | MTS8310                   | Ver. 2.0.0.0 | \                | \                |
| 13   | Rohde & Schwarz SFU Broadcast Test System | R&S          | SFU                       | 101017       | Sep. 28, 2020    | Sep. 28, 2021    |
| 14   | Temperature humidity chamber              | Hongjing     | TH-80CH                   | DG-15174     | Sep. 28, 2020    | Sep. 28, 2021    |
| 15   | 234G Automatic test software              | Microwave    | MTS8200                   | Ver. 2.0.0.0 | \                | \                |
| 16   | 966 chamber                               | C.R.T.       | 966 Room                  | 966          | Nov. 9, 2019     | Nov. 08, 2022    |
| 17   | Receiver                                  | R&S          | ESPI                      | 100362       | Sep. 28, 2020    | Sep. 28, 2021    |
| 18   | Amplifier                                 | HP           | 8447E                     | 2945A02747   | Sep. 28, 2020    | Sep. 28, 2021    |

|    |                          |             |           |            |               |               |
|----|--------------------------|-------------|-----------|------------|---------------|---------------|
| 19 | Amplifier                | Agilent     | 8449B     | 3008A01838 | Sep. 28, 2020 | Sep. 28, 2021 |
| 20 | TRILOG Broadband Antenna | Schwarzbeck | VULB 9168 | 00869      | Nov. 02, 2020 | Nov. 01, 2021 |
| 21 | Horn Antenna             | Schwarzbeck | BBHA9120D | 1911       | Nov. 02, 2020 | Nov. 01, 2021 |
| 22 | Software                 | Fala        | EZ-EMC    | FA-03A2 RE | \             | \             |
| 23 | 3-Loop Antenna           | Daze        | ZN30401   | 17014      | Sep. 28, 2020 | Sep. 28, 2021 |
| 24 | loop antenna             | ZHINAN      | ZN30900A  | /          | Sep. 28, 2020 | Sep. 28, 2021 |
| 25 | Horn antenna             | A/H/System  | SAS-574   | 588        | Sep. 28, 2020 | Sep. 28, 2021 |
| 26 | Amplifier                | AEROFLEX    | /         | S/N/ 097   | Sep. 28, 2020 | Sep. 28, 2021 |

| Conducted emissions Test |               |          |               |               |               |
|--------------------------|---------------|----------|---------------|---------------|---------------|
| Equipment                | Manufacturer  | Model#   | Serial#       | Last Cal.     | Next Cal.     |
| AMN                      | ROHDE&SCHWARZ | ESH3-Z5  | 100318        | Sep. 28, 2020 | Sep. 28, 2021 |
| Pulse limiter            | ROHDE&SCHWARZ | ESH3Z2   | 357881052     | Sep. 28, 2020 | Sep. 28, 2021 |
| EMI TEST RECEIVER        | ROHDE&SCHWARZ | ESCS30   | 834115/006    | Sep. 28, 2020 | Sep. 28, 2021 |
| Coaxial cable            | ZDECL         | Z302S    | 18091804      | Sep. 28, 2020 | Sep. 28, 2021 |
| ISN                      | TESEQ         | NTFM8158 | 183           | Sep. 28, 2020 | Sep. 28, 2021 |
| EMI TEST RECEIVER        | ROHDE&SCHWARZ | ESCI     | 100428/003    | Sep. 28, 2020 | Sep. 28, 2021 |
| Software                 | Fala          | EZ-EMC   | EMC-CON 3A1.1 | \             | \             |

## 6. AC POWER LINE CONDUCTED EMISSION

### 6.1 Block Diagram Of Test Setup



### 6.2 Limit

\* Decreasing linearly with the logarithm of the frequency

| Frequency (MHz) | Maximum RF Line Voltage (dB $\mu$ V) |      |         |        |
|-----------------|--------------------------------------|------|---------|--------|
|                 | CLASS A                              |      | CLASS B |        |
|                 | Q.P.                                 | Ave. | Q.P.    | Ave.   |
| 0.15 - 0.50     | 79                                   | 66   | 66-56*  | 56-46* |
| 0.50 - 5.00     | 73                                   | 60   | 56      | 46     |
| 5.00 - 30.0     | 73                                   | 60   | 60      | 50     |

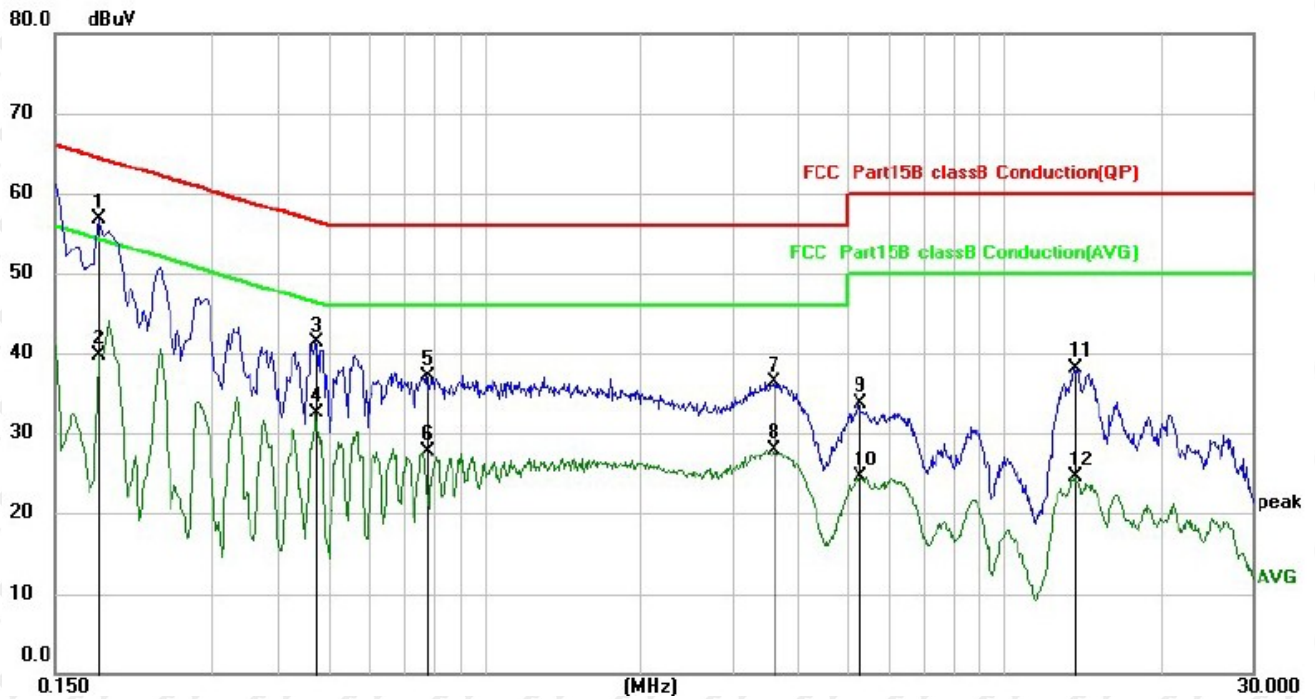
### 6.3 Test procedure

- 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  $50\Omega/50\mu\text{H} + 5\Omega$  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 on conducted measurement.

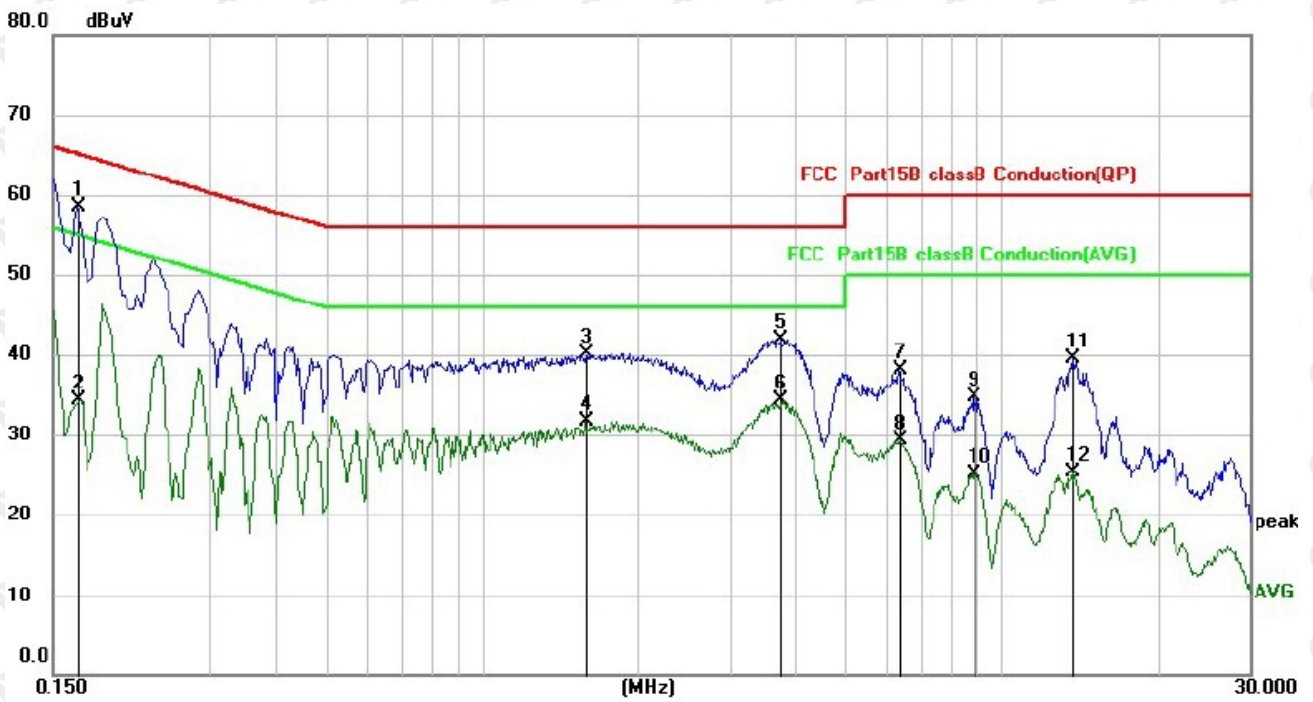
## 6.4 Test Result

L:



| No. | Mk. | Freq.   | Reading Level | Correct Factor | Measurement | Limit | Margin | Detector |
|-----|-----|---------|---------------|----------------|-------------|-------|--------|----------|
|     |     | MHz     | dBuV          | dB             | dBuV        | dBuV  | dB     |          |
| 1   | *   | 0.1819  | 46.81         | 9.96           | 56.77       | 64.40 | -7.63  | QP       |
| 2   |     | 0.1819  | 29.75         | 9.96           | 39.71       | 54.40 | -14.69 | AVG      |
| 3   |     | 0.4740  | 31.44         | 9.96           | 41.40       | 56.44 | -15.04 | QP       |
| 4   |     | 0.4740  | 22.50         | 9.96           | 32.46       | 46.44 | -13.98 | AVG      |
| 5   |     | 0.7780  | 27.16         | 9.96           | 37.12       | 56.00 | -18.88 | QP       |
| 6   |     | 0.7780  | 17.78         | 9.96           | 27.74       | 46.00 | -18.26 | AVG      |
| 7   |     | 3.6220  | 26.25         | 10.10          | 36.35       | 56.00 | -19.65 | QP       |
| 8   |     | 3.6220  | 17.81         | 10.10          | 27.91       | 46.00 | -18.09 | AVG      |
| 9   |     | 5.2740  | 23.49         | 10.20          | 33.69       | 60.00 | -26.31 | QP       |
| 10  |     | 5.2740  | 14.36         | 10.20          | 24.56       | 50.00 | -25.44 | AVG      |
| 11  |     | 13.6260 | 27.21         | 10.92          | 38.13       | 60.00 | -21.87 | QP       |
| 12  |     | 13.6260 | 13.65         | 10.92          | 24.57       | 50.00 | -25.43 | AVG      |

N:



Remark:

| No. | Mk. | Freq.<br>MHz | Reading<br>Level<br>dBuV | Correct<br>Factor<br>dB | Measure-<br>ment<br>dBuV | Limit<br>dBuV | Margin<br>dB | Detector |
|-----|-----|--------------|--------------------------|-------------------------|--------------------------|---------------|--------------|----------|
| 1   | *   | 0.1660       | 48.63                    | 9.96                    | 58.59                    | 65.16         | -6.57        | QP       |
| 2   |     | 0.1660       | 24.42                    | 9.96                    | 34.38                    | 55.16         | -20.78       | AVG      |
| 3   |     | 1.5900       | 30.11                    | 9.99                    | 40.10                    | 56.00         | -15.90       | QP       |
| 4   |     | 1.5900       | 21.63                    | 9.99                    | 31.62                    | 46.00         | -14.38       | AVG      |
| 5   |     | 3.7620       | 31.80                    | 10.10                   | 41.90                    | 56.00         | -14.10       | QP       |
| 6   |     | 3.7620       | 24.17                    | 10.10                   | 34.27                    | 46.00         | -11.73       | AVG      |
| 7   |     | 6.3620       | 27.80                    | 10.34                   | 38.14                    | 60.00         | -21.86       | QP       |
| 8   |     | 6.3620       | 19.03                    | 10.34                   | 29.37                    | 50.00         | -20.63       | AVG      |
| 9   |     | 8.8260       | 24.03                    | 10.65                   | 34.68                    | 60.00         | -25.32       | QP       |
| 10  |     | 8.8260       | 14.49                    | 10.65                   | 25.14                    | 50.00         | -24.86       | AVG      |
| 11  |     | 13.7180      | 28.65                    | 10.93                   | 39.58                    | 60.00         | -20.42       | QP       |
| 12  |     | 13.7180      | 14.45                    | 10.93                   | 25.38                    | 50.00         | -24.62       | AVG      |

Factor = Cable loss + LISN factor, Margin = Measurement – Limit  
 All modes have been tested with only the worst data 411MHz

## 7. RADIATED EMISSION

### 7.1 Block Diagram Of Test Setup

Figure 1. Below 30MHz

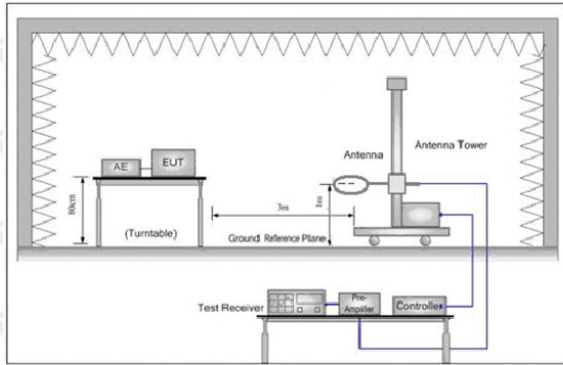


Figure 2. 30MHz to 1GHz

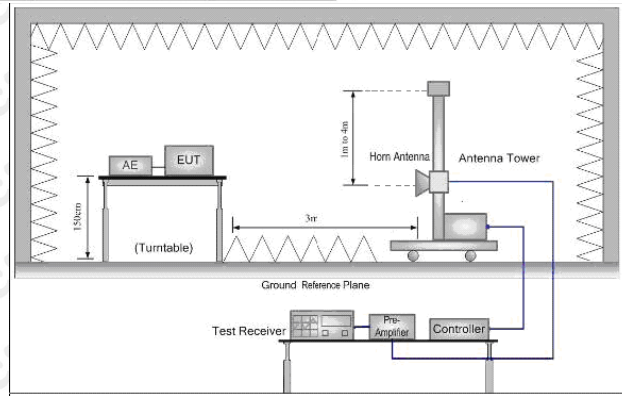
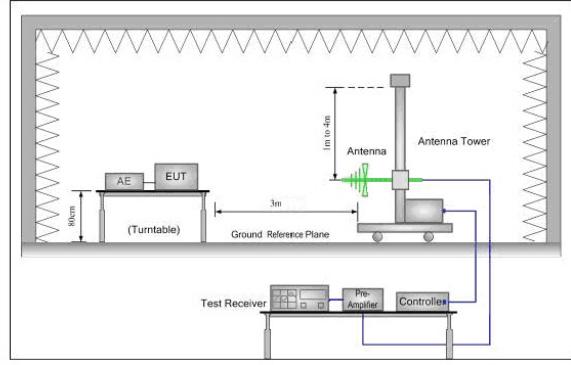


Figure 3. Above 1GHz

### 7.2 Limit

Spurious Emissions:

| Frequency         | Field strength (dB $\mu$ V/m) | Remark     | Measurement distance (m) |
|-------------------|-------------------------------|------------|--------------------------|
| 0.009MHz-0.490MHz | $20\log 2400/F$ (kHz) + 80    | -          | 3                        |
| 0.490MHz-1.705MHz | $20\log 24000/F$ (kHz) + 40   | -          | 3                        |
| 1.705MHz-30MHz    | $20\log 30$ + 40              | -          | 3                        |
| 30MHz-88MHz       | 40.0                          | Quasi-peak | 3                        |
| 88MHz-216MHz      | 43.5                          | Quasi-peak | 3                        |
| 216MHz-960MHz     | 46.0                          | Quasi-peak | 3                        |
| 960MHz-1GHz       | 54.0                          | Quasi-peak | 3                        |
| Above 1GHz        | 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.

**Field Strength of Fundamental Limit:**

| Fundamental and harm onics emission limits Frequency(MHz) | Field strength of Fundamental((microvolts/meter) | Field strength of spurious emissions(microvolts/meter) |
|---|--|--|
| 40.66-40.70   | 2280   | 225  |
| 70-130  | 1250   | 125  |
| 130-174   | 1250 to 3750**                                   | 125 to 375**   |
| 174-260   | 3750   | 375  |
| 260-470   | 3750 to 12500**                                  | 375 to 1250**  |
| Above 470   | 12500  | 1250   |

\*\* 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,  $\mu\text{V/m}$  at 3 meters =  $56.81818(F) - 6136.3636$ ; for the band 260-470 MHz,  $\mu\text{V/m}$  at 3 meters =  $41.6667(F) - 7083.3333$ . The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.]

| Frequency | Limit (dB $\mu\text{V/m}$ @3m) | Remark        |
|-----------|--------------------------------|---------------|
| 410MHz    | 80                             | Average Value |
|           | 100                            | Peak Value    |

**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 rotating 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 from 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
- j. Repeat above procedures until all frequencies measured was complete.

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    |

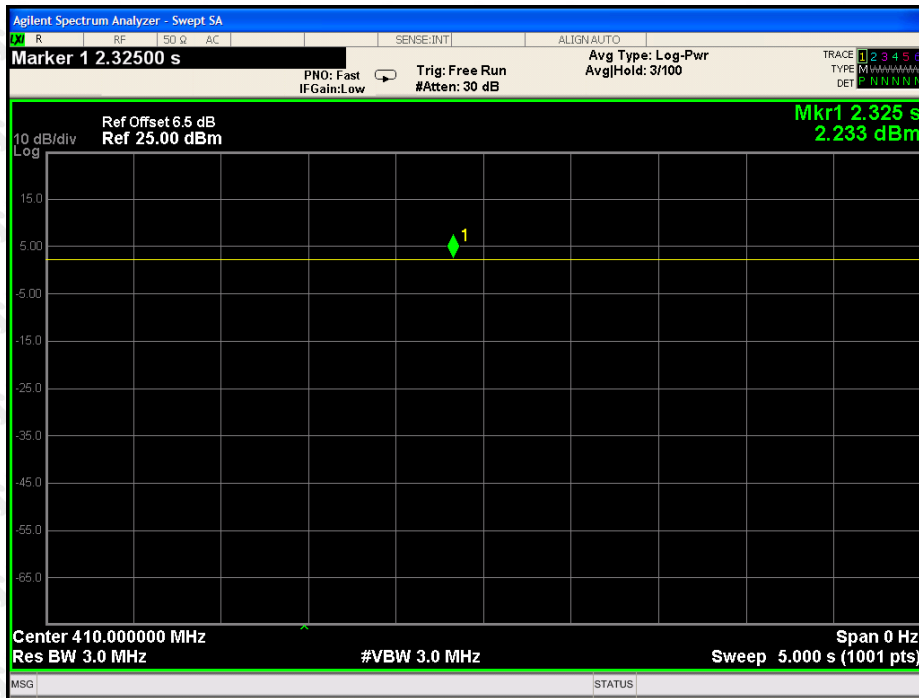
|                 |            |         |        |            |
|-----------------|------------|---------|--------|------------|
| 0.490MHz -30MHz | Quasi-peak | 10kHz   | 30kHz  | Quasi-peak |
| 30MHz-1GHz      | Quasi-peak | 100 kHz | 300KHz | Quasi-peak |
| Above 1GHz      | Peak       | 1MHz    | 3MHz   | Peak       |
|                 | Peak       | 1MHz    | 10Hz   | Average    |

## 7.4 Test Result

### Calculation of average factor

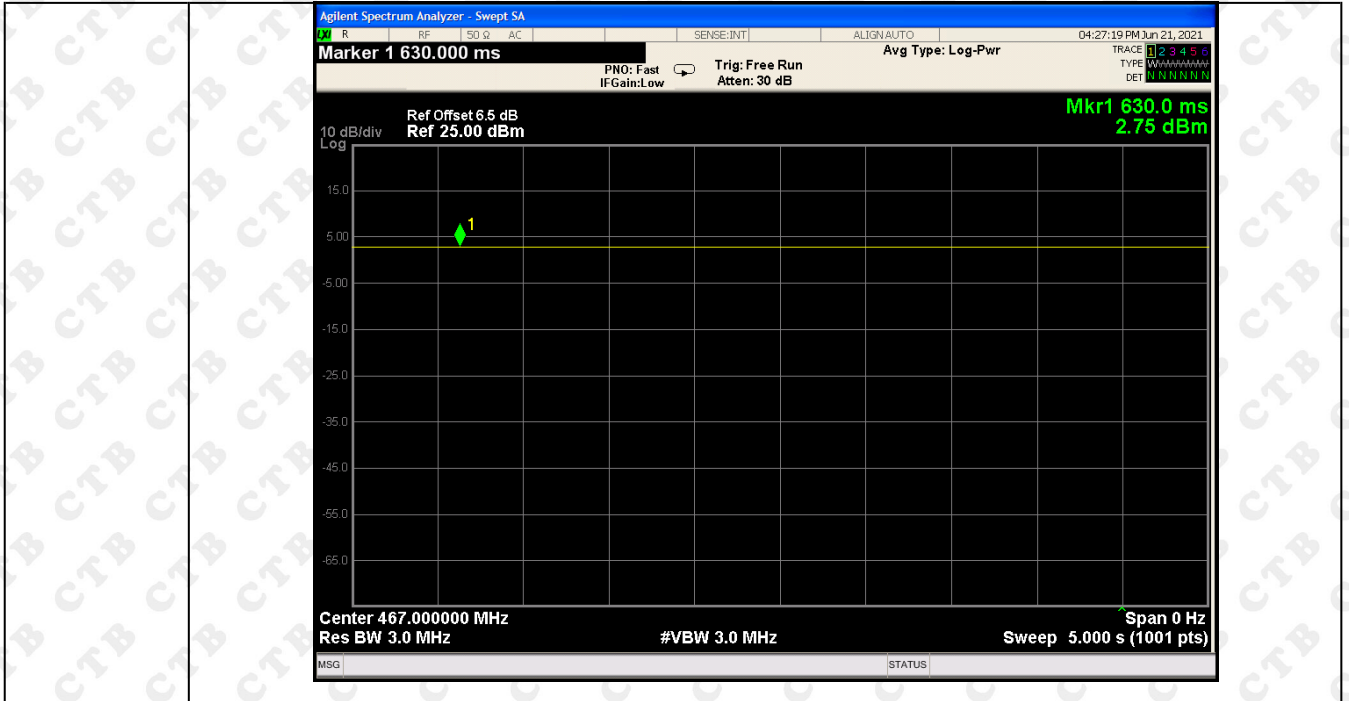
The output field strengths of specification in accordance with the FCC rules specify measurements with an average detector. During the test, a spectrum analyzer incorporating a peak detector was used. Therefore, a reduction factor can be applied to the resultant peak signal level and compared to the limit for measurement instrumentation incorporating an average detector. The duty cycle is measured in 100 ms or the repetition cycle period, whichever is a shorter time frame. The duty cycle is measured by placing the spectrum analyzer to set zero span at 100kHz resolution bandwidth.

### 411 MHz

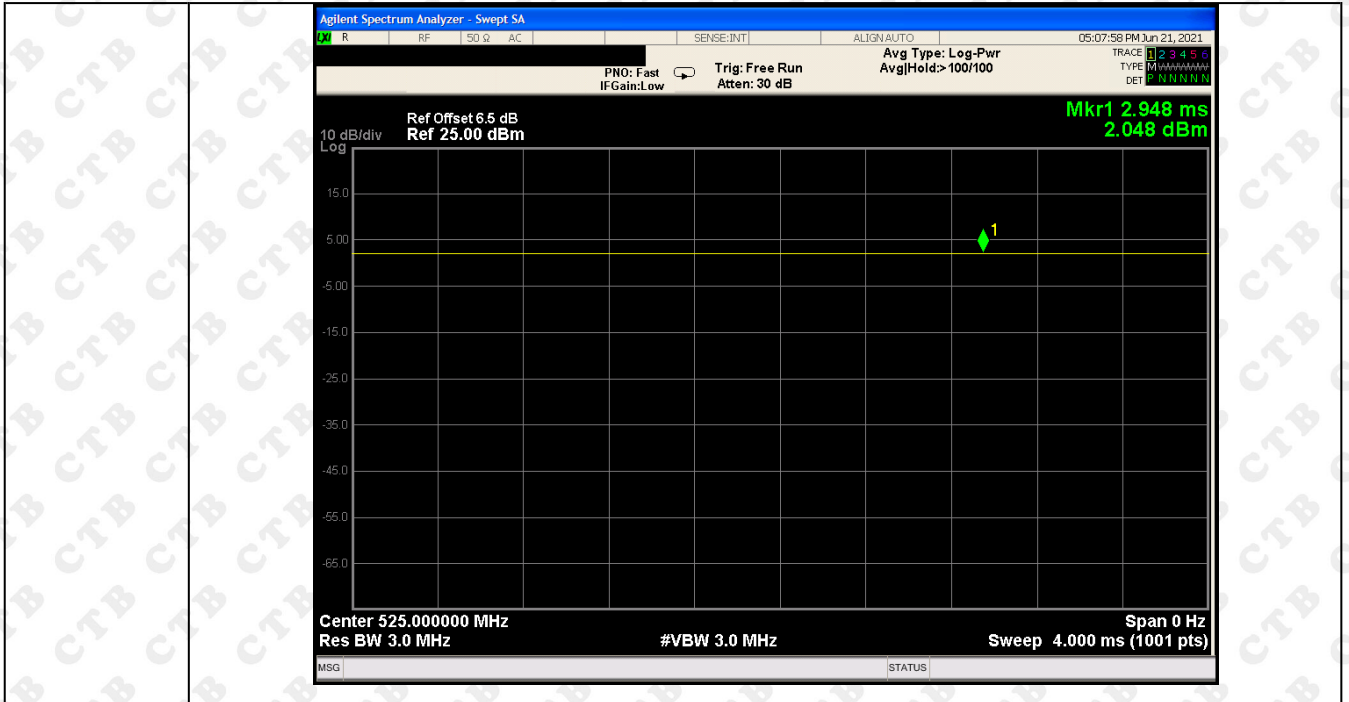




467 MHz



525 MHz



Duty cycle = T on time / T period = 100%  
PDCF = 0

**Radiated Spurious Emission****Frequency Range (9 kHz-30MHz)**

| Frequency (MHz) | Level@3m (dB $\mu$ V/m) | Limit@3m (dB $\mu$ V/m) |
|-----------------|-------------------------|-------------------------|
| --              | --                      | --                      |
| --              | --                      | --                      |
| --              | --                      | --                      |
| --              | --                      | --                      |

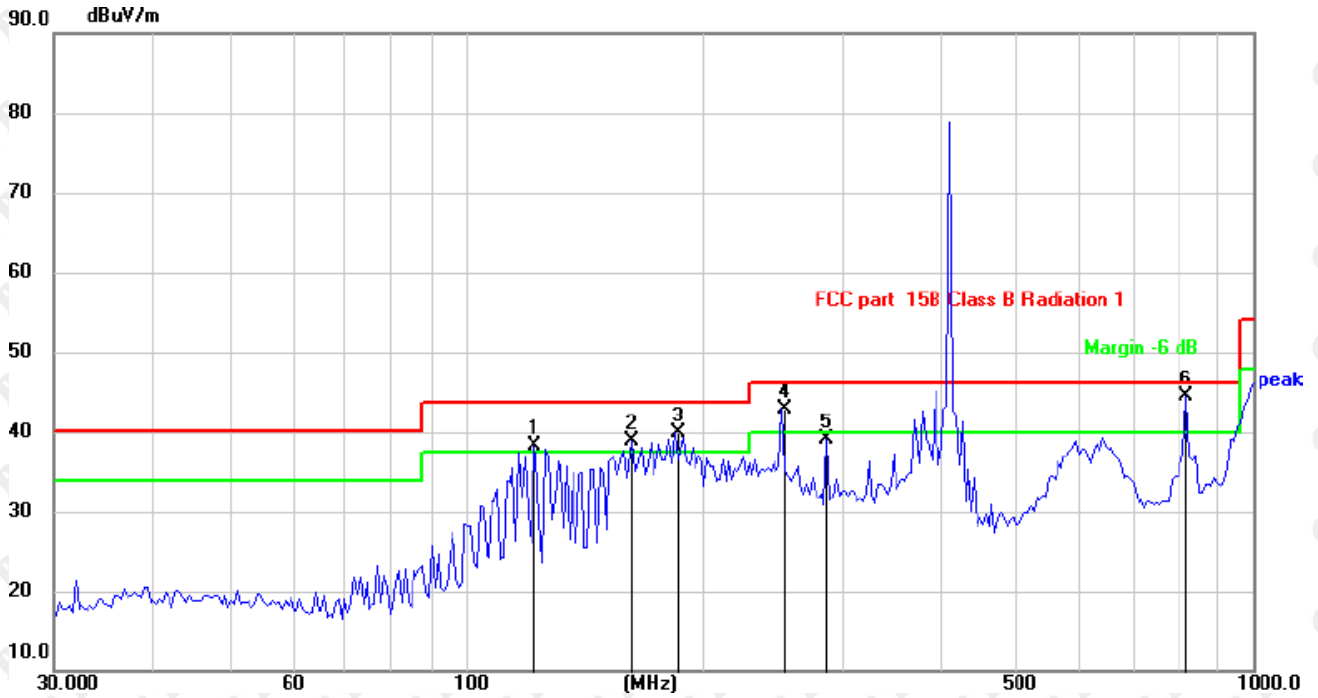
**Note:** 1. Emission Level=Reading+ Cable loss-Antenna factor-Amp factor

2. The emission levels are 20 dB below the limit value, which are not reported. It is deemed to comply with the requirement

**About 30MHz-1GHz Test Results:**

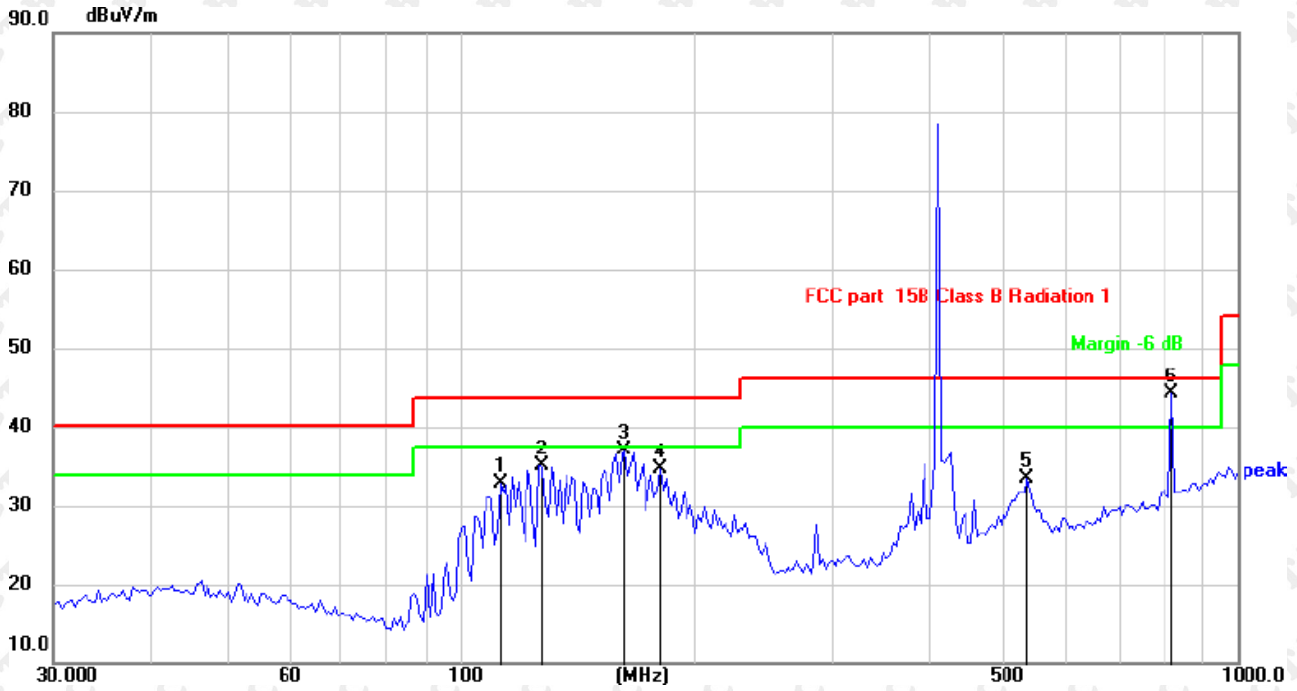
**410MHz**

Antenna polarity: H



| Frequency<br>(MHz) | Meter Reading<br>(dB $\mu$ V) | Factor<br>(dB) | Emission Level<br>(dB $\mu$ V/m) | Limits<br>(dB $\mu$ V/m) | Margin<br>(dB) | Detector Type |
|--------------------|-------------------------------|----------------|----------------------------------|--------------------------|----------------|---------------|
| 121.9755           | 46.72                         | -8.50          | 38.22                            | 43.50                    | -5.28          | QP            |
| 162.8959           | 45.90                         | -6.95          | 38.95                            | 43.50                    | -4.55          | QP            |
| 184.1667           | 48.88                         | -9.01          | 39.87                            | 43.5                     | -3.63          | QP            |
| 252.5051           | 50.87                         | -8.01          | 42.86                            | 46.00                    | -3.14          | QP            |
| 287.9904           | 46.27                         | -7.08          | 39.19                            | 46.00                    | -6.81          | QP            |
| 410.0287           | 82.76                         | -4.73          | 78.03                            | 100.00                   | -21.97         | PK            |
| 822.5968           | 39.96                         | 4.59           | 44.55                            | 80.04                    | -35.45         | PK            |

Antenna polarity: V

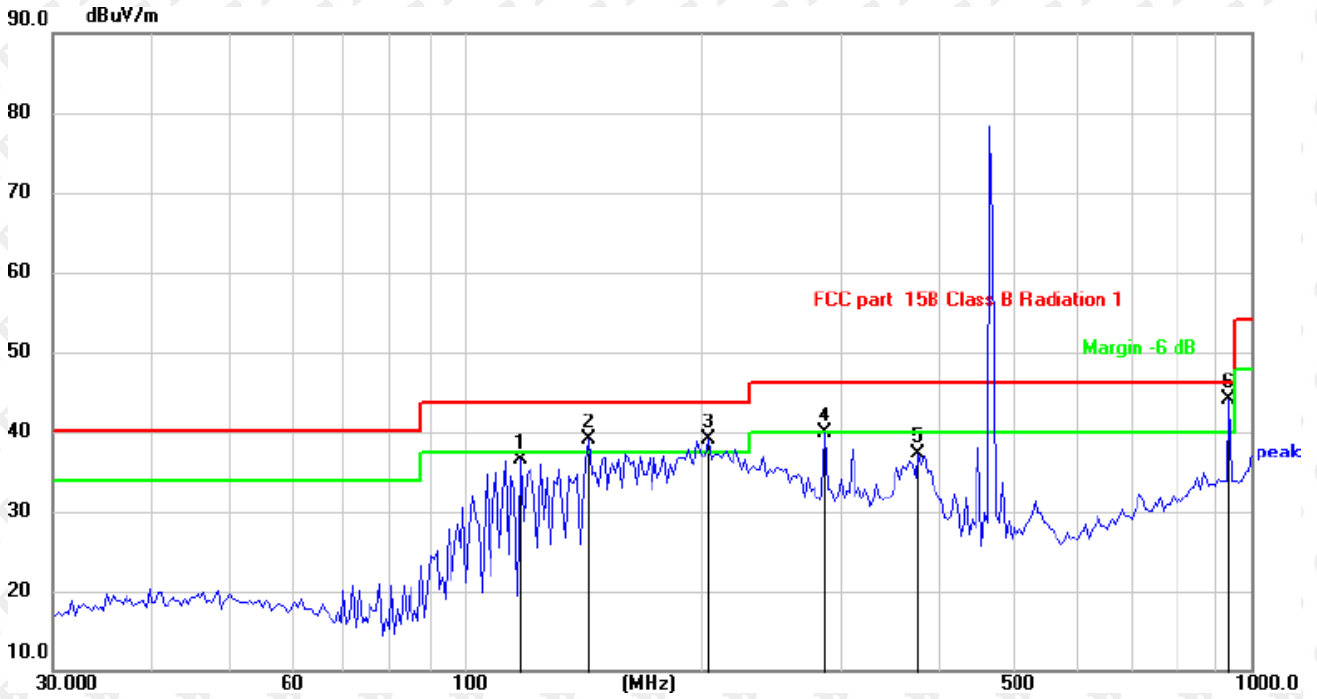


| Frequency<br>(MHz) | Meter Reading<br>(dBμV) | Factor<br>(dB) | Emission Level<br>(dBμV/m) | Limits<br>(dBμV/m) | Margin<br>(dB) | Detector Type |
|--------------------|-------------------------|----------------|----------------------------|--------------------|----------------|---------------|
| 112.7218           | 42.10                   | -9.17          | 32.93                      | 43.50              | -10.57         | QP            |
| 126.3286           | 43.50                   | -8.31          | 35.19                      | 43.50              | -8.31          | QP            |
| 162.8959           | 44.14                   | -6.95          | 37.19                      | 43.50              | -6.31          | QP            |
| 180.9658           | 43.41                   | -8.65          | 34.76                      | 43.50              | -8.74          | QP            |
| 410.0287           | 83.26                   | -4.73          | 78.53                      | 100.00             | -21.47         | PK            |
| 536.6473           | 34.70                   | -1.17          | 33.53                      | 46.00              | -12.47         | QP            |
| 822.5968           | 39.71                   | 4.59           | 44.30                      | 80.00              | -35.70         | PK            |

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

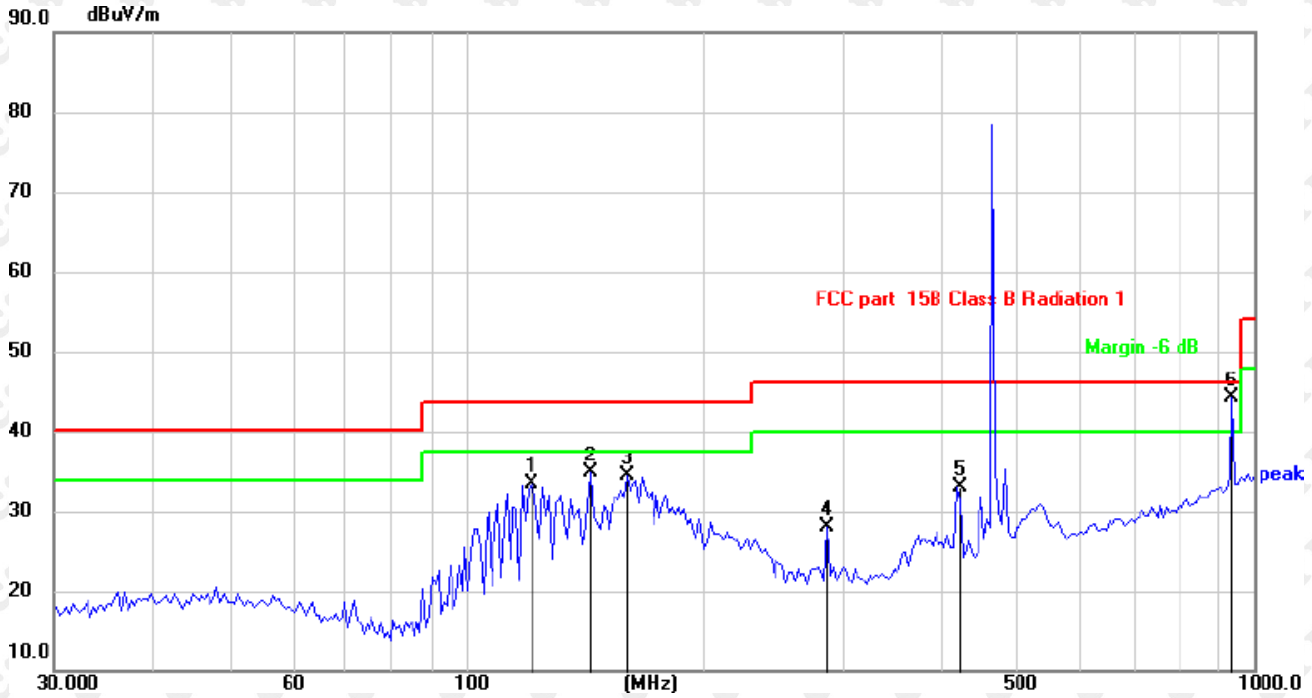
**467MHz**

Antenna polarity: H



| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|-----------------|----------------------|-------------|-------------------------|-----------------|-------------|---------------|
| 117.7725        | 45.29                | -8.77       | 36.52                   | 43.50           | -6.98       | QP            |
| 144.0819        | 46.28                | -7.20       | 39.08                   | 43.50           | -4.42       | QP            |
| 204.5961        | 49.17                | -10.05      | 39.12                   | 43.5            | -4.38       | QP            |
| 287.9904        | 47.80                | -7.08       | 40.00                   | 46.00           | -6.00       | QP            |
| 377.9211        | 42.34                | -5.12       | 37.22                   | 46.00           | -8.78       | QP            |
| 467.0287        | 83.58                | -4.65       | 78.93                   | 101.85          | -22.92      | PK            |
| 940.4801        | 37.08                | 6.98        | 44.06                   | 81.85           | -37.79      | PK            |

Antenna polarity: V

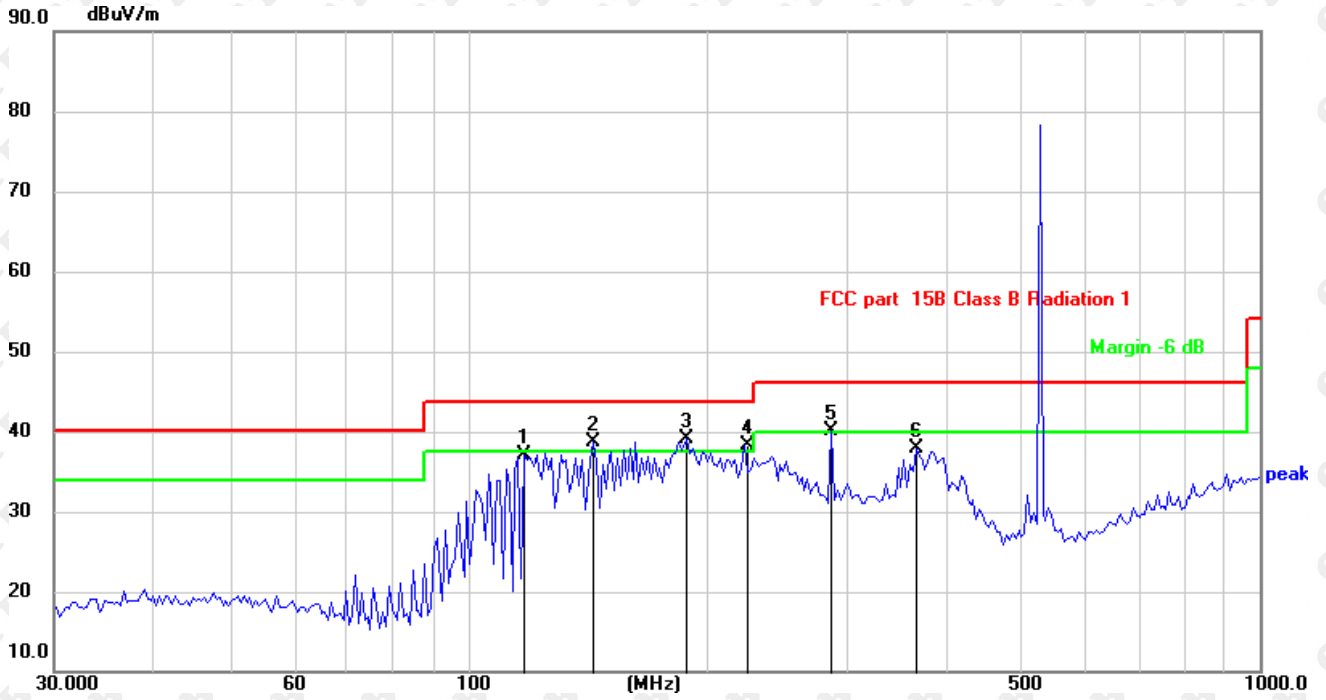


| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|-----------------|----------------------|-------------|-------------------------|-----------------|-------------|---------------|
| 12.9109         | 42.00                | -8.55       | 33.45                   | 43.50           | -10.05      | QP            |
| 144.0819        | 42.06                | -7.20       | 34.86                   | 43.50           | -8.64       | QP            |
| 160.0648        | 41.10                | -6.60       | 34.50                   | 43.5            | -9.00       | QP            |
| 287.9904        | 35.27                | -7.08       | 28.19                   | 46.00           | -17.81      | QP            |
| 419.8436        | 37.26                | -4.19       | 33.07                   | 46              | -12.93      | QP            |
| 467.0287        | 83.46                | -4.65       | 78.81                   | 101.85          | -23.04      | PK            |
| 940.4801        | 37.31                | 6.98        | 44.29                   | 81.85           | -37.56      | QP            |

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

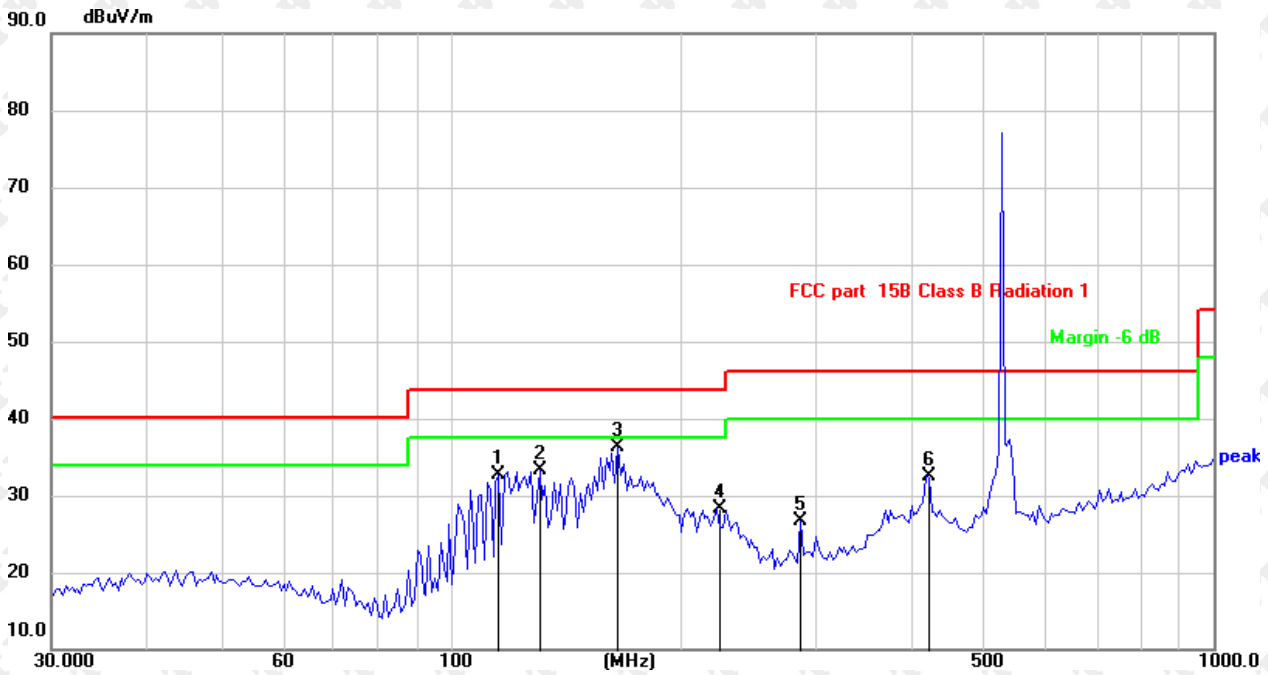
**525MHz**

Antenna polarity: H



| Frequency<br>(MHz) | Meter Reading<br>(dBμV) | Factor<br>(dB) | Emission Level<br>(dBμV/m) | Limits<br>(dBμV/m) | Margin<br>(dB) | Detector Type |
|--------------------|-------------------------|----------------|----------------------------|--------------------|----------------|---------------|
| 117.7725           | 45.95                   | -8.7           | 37.18                      | 43.50              | -6.32          | QP            |
| 144.0819           | 45.91                   | -7.20          | 38.71                      | 43.50              | -4.79          | QP            |
| 189.0743           | 48.70                   | -9.56          | 39.14                      | 43.5               | -4.36          | QP            |
| 223.3415           | 47.38                   | -8.99          | 38.39                      | 43.5               | -5.11          | QP            |
| 287.9904           | 47.25                   | -7.08          | 40.17                      | 46.0               | -5.83          | QP            |
| 368.1116           | 43.31                   | -5.33          | 37.98                      | 46.0               | -8.02          | QP            |
| 511.0287           | 83.16                   | -4.13          | 79.03                      | 101.94             | -22.91         | PK            |

Antenna polarity: V



| Frequency<br>(MHz) | Meter Reading<br>(dBμV) | Factor<br>(dB) | Emission Level<br>(dBμV/m) | Limits<br>(dBμV/m) | Margin<br>(dB) | Detector Type |
|--------------------|-------------------------|----------------|----------------------------|--------------------|----------------|---------------|
| 115.7256           | 41.59                   | -8.93          | 32.66                      | 43.50              | -10.84         | QP            |
| 130.8369           | 41.43                   | -8.07          | 33.36                      | 43.50              | -10.14         | QP            |
| 165.7771           | 43.69                   | -7.31          | 36.38                      | 43.5               | -7.12          | QP            |
| 223.3415           | 37.25                   | -8.99          | 28.26                      | 43.5               | -15.24         | QP            |
| 287.9904           | 33.69                   | -7.08          | 26.61                      | 46                 | -19.39         | QP            |
| 419.8436           | 36.72                   | -4.19          | 32.53                      | 46.00              | -13.47         | QP            |
| 511.0287           | 83.02                   | -4.13          | 78.89                      | 101.94             | -23.05         | PK            |

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



**For average Emission**

| Frequency MHz | Peak Level dBuV/m | Duty cycle factor | Average Level dBuV/m | Limit AV | Margin | Polarization |
|---------------|-------------------|-------------------|----------------------|----------|--------|--------------|
| 410.00        | 78.03             | 0                 | 78.03                | 80.00    | -1.97  | Horizontal   |
| 467.00        | 78.93             | 0                 | 78.93                | 81.85    | -2.92  | Horizontal   |
| 525.00        | 79.03             | 0                 | 79.03                | 81.94    | -2.91  | Horizontal   |
| 820.00        | 44.55             | 0                 | 44.55                | 60.00    | -15.45 | Horizontal   |
| 934.00        | 44.06             | 0                 | 44.06                | 61.85    | -17.79 | Horizontal   |
| 410.00        | 78.53             | 0                 | 78.53                | 80.00    | -1.47  | Vertical     |
| 467.00        | 78.81             | 0                 | 78.81                | 81.85    | -3.04  | Vertical     |
| 525.00        | 78.89             | 0                 | 78.89                | 81.94    | -3.05  | Vertical     |
| 820.00        | 44.3              | 0                 | 44.3                 | 60.00    | -15.70 | Vertical     |
| 934.00        | 44.29             | 0                 | 44.29                | 61.85    | -17.56 | Vertical     |

Notes: Average emission Level = Peak Level + Duty cycle factor

**Above 1GHz Test Results**

410MHz

| Frequency MHz | Peak Level dBuV/m | Duty cycle factor | Average Level dBuV/m | Limit |      | Margin dB |        | Polarization |
|---------------|-------------------|-------------------|----------------------|-------|------|-----------|--------|--------------|
|               |                   |                   |                      | PK    | AV   | PK        | AV     |              |
| 1231.71       | 50.20             | 0.00              | 50.20                | 80.0  | 60.0 | -29.80    | -9.80  | Vertical     |
| 1641.26       | 46.61             | 0.00              | 46.61                | 80.0  | 60.0 | -33.39    | -13.39 | Vertical     |
| 2461.56       | 43.40             | 0.00              | 43.40                | 80.0  | 60.0 | -36.60    | -16.60 | Vertical     |
| 2871.43       | 39.64             | 0.00              | 39.64                | 80.0  | 60.0 | -40.36    | -20.36 | Vertical     |
| 3281.35       | 40.36             | 0.00              | 40.36                | 80.0  | 60.0 | -39.64    | -19.64 | Vertical     |
| 3691.24       | 40.74             | 0.00              | 40.74                | 80.0  | 60.0 | -39.26    | -19.26 | Vertical     |
| 1231.71       | 49.88             | 0.00              | 49.88                | 80.0  | 60.0 | -30.12    | -10.12 | Horizontal   |
| 1641.26       | 47.90             | 0.00              | 47.90                | 80.0  | 60.0 | -32.10    | -12.10 | Horizontal   |
| 2461.56       | 43.65             | 0.00              | 43.65                | 80.0  | 60.0 | -36.35    | -16.35 | Horizontal   |
| 2871.43       | 40.03             | 0.00              | 40.03                | 80.0  | 60.0 | -39.97    | -19.97 | Horizontal   |
| 3281.35       | 41.73             | 0.00              | 41.73                | 80.0  | 60.0 | -38.27    | -18.27 | Horizontal   |
| 3691.24       | 41.06             | 0.00              | 41.06                | 80.0  | 60.0 | -38.94    | -18.94 | Horizontal   |

Notes: Average emission Level = Peak Level + Duty cycle factor

**467MHz**

| Frequency MHz | Peak Level dBuV/m | Duty cycle factor | Average Level dBuV/m | Limit |       | Margin dB |        | Polarization |
|---------------|-------------------|-------------------|----------------------|-------|-------|-----------|--------|--------------|
|               |                   |                   |                      | PK    | AV    | PK        | AV     |              |
| 1401.71       | 49.04             | 0.00              | 49.04                | 81.85 | 61.85 | -32.81    | -12.81 | Vertical     |
| 1868.26       | 48.57             | 0.00              | 48.57                | 81.85 | 61.85 | -33.28    | -13.28 | Vertical     |
| 2335.56       | 42.32             | 0.00              | 42.32                | 81.85 | 61.85 | -39.53    | -19.53 | Vertical     |
| 2802.43       | 43.10             | 0.00              | 43.10                | 81.85 | 61.85 | -38.75    | -18.75 | Vertical     |
| 3269.35       | 40.48             | 0.00              | 40.48                | 81.85 | 61.85 | -41.37    | -21.37 | Vertical     |
| 3736.24       | 40.13             | 0.00              | 40.13                | 81.85 | 61.85 | -41.72    | -21.72 | Vertical     |
| 1401.71       | 50.58             | 0.00              | 50.58                | 81.85 | 61.85 | -31.27    | -11.27 | Horizontal   |
| 1868.26       | 46.22             | 0.00              | 46.22                | 81.85 | 61.85 | -35.63    | -15.63 | Horizontal   |
| 2335.56       | 42.90             | 0.00              | 42.90                | 81.85 | 61.85 | -38.95    | -18.95 | Horizontal   |
| 2802.43       | 43.20             | 0.00              | 43.20                | 81.85 | 61.85 | -38.65    | -18.65 | Horizontal   |
| 3269.35       | 41.65             | 0.00              | 41.65                | 81.85 | 61.85 | -40.20    | -20.20 | Horizontal   |
| 3736.24       | 41.59             | 0.00              | 41.59                | 81.85 | 61.85 | -40.26    | -20.26 | Horizontal   |

Notes: Average emission Level = Peak Level + Duty cycle factor

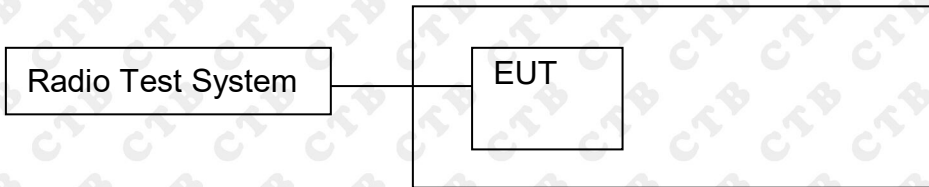
**525MHz**

| Frequency MHz | Peak Level dBuV/m | Duty cycle factor | Average Level dBuV/m | Limit |       | Margin dB |        | Polarization |
|---------------|-------------------|-------------------|----------------------|-------|-------|-----------|--------|--------------|
|               |                   |                   |                      | PK    | AV    | PK        | AV     |              |
| 1050.71       | 51.02             | 0.00              | 51.02                | 81.94 | 61.94 | -30.92    | -10.92 | Vertical     |
| 1575.26       | 48.80             | 0.00              | 48.80                | 81.94 | 61.94 | -33.14    | -13.14 | Vertical     |
| 2625.56       | 44.31             | 0.00              | 44.31                | 81.94 | 61.94 | -37.63    | -17.63 | Vertical     |
| 3150.43       | 41.30             | 0.00              | 41.30                | 81.94 | 61.94 | -40.64    | -20.64 | Vertical     |
| 3269.35       | 41.83             | 0.00              | 41.83                | 81.94 | 61.94 | -40.11    | -20.11 | Vertical     |
| 3675.24       | 41.25             | 0.00              | 41.25                | 81.94 | 61.94 | -40.69    | -20.69 | Vertical     |
| 1050.71       | 50.50             | 0.00              | 50.50                | 81.94 | 61.94 | -31.44    | -11.44 | Horizontal   |
| 1575.26       | 48.86             | 0.00              | 48.86                | 81.94 | 61.94 | -33.08    | -13.08 | Horizontal   |
| 2625.56       | 44.48             | 0.00              | 44.48                | 81.94 | 61.94 | -37.46    | -17.46 | Horizontal   |
| 3150.43       | 43.45             | 0.00              | 43.45                | 81.94 | 61.94 | -38.49    | -18.49 | Horizontal   |
| 3269.35       | 41.76             | 0.00              | 41.76                | 81.94 | 61.94 | -40.18    | -20.18 | Horizontal   |
| 3675.24       | 41.55             | 0.00              | 41.55                | 81.94 | 61.94 | -40.39    | -20.39 | Horizontal   |

Notes: Average emission Level = Peak Level + Duty cycle factor

## 8. DWELL TIME

### 8.1 Block Diagram Of Test Setup



### 8.2 Limit

According to FCC 15.231(a) requirement:

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

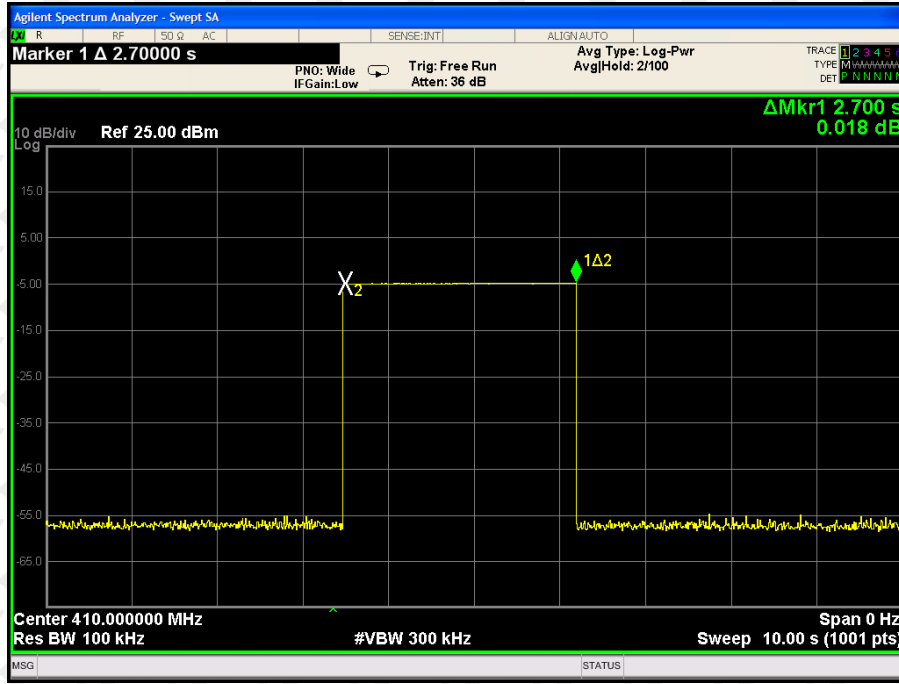
### 8.3 Test procedure

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

### 8.4 Test Result

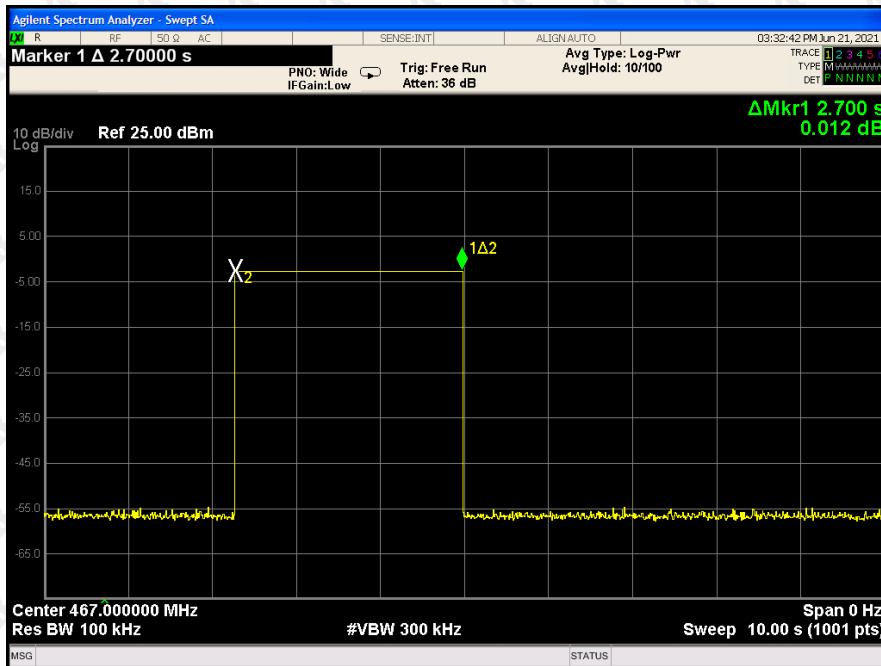
410MHz

| Transmitting time(S) | Limit (S) | Results |
|----------------------|-----------|---------|
| 2.700                | ≤5        | Pass    |



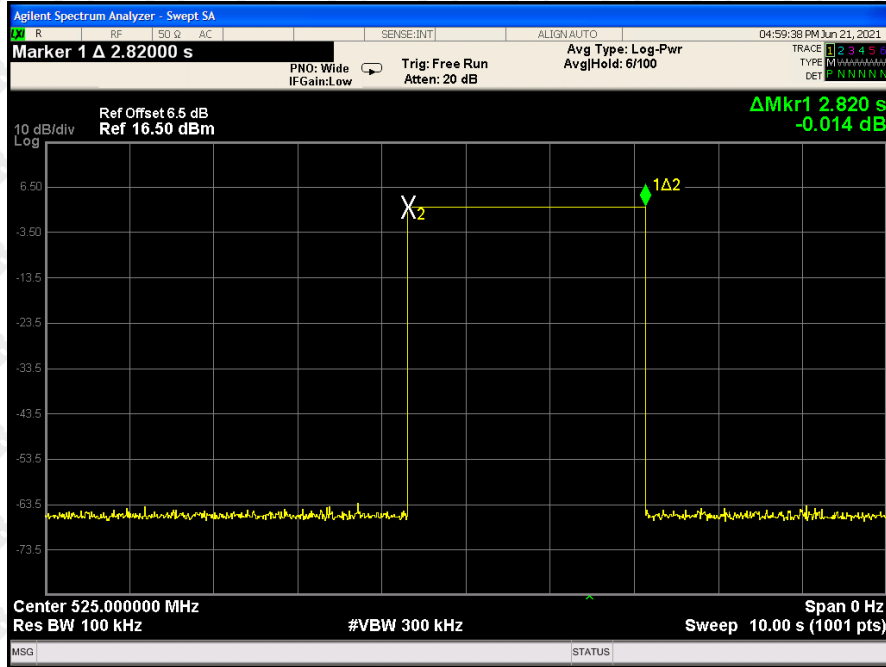
467MHz

| Transmitting time(S) | Limit (S) | Results |
|----------------------|-----------|---------|
| 2.700                | ≤5        | Pass    |



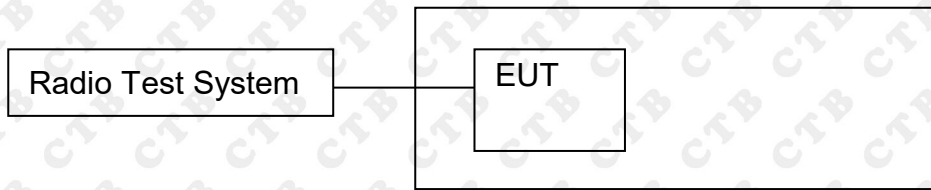
525MHz

| Transmitting time(S) | Limit (S) | Results |
|----------------------|-----------|---------|
| 2.820                | ≤5        | Pass    |



## 9. OCCUPIED BANDWIDTH

### 9.1 Block Diagram Of Test Setup



### 9.2 Limit

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.

B.W (20dBc) Limit = 0.25% \* f(MHz) = 0.25% \* 411MHz = 1.0275MHz

B.W (20dBc) Limit = 0.25% \* f(MHz) = 0.25% \* 467MHz = 1.1675MHz

B.W (20dBc) Limit = 0.25% \* f(MHz) = 0.25% \* 525MHz = 1.3125MHz

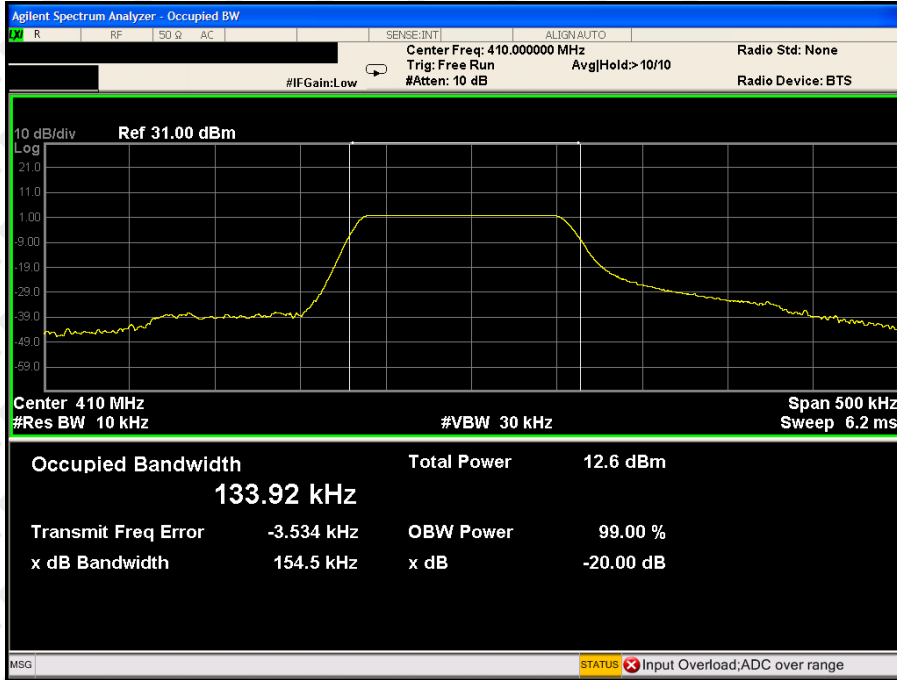
### 9.3 Test procedure

1. Set RBW = 10 kHz.
2. Set the video bandwidth (VBW)  $\geq$  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 20 dB relative to the maximum level measured in the fundamental emission.

### 9.4 Test Result

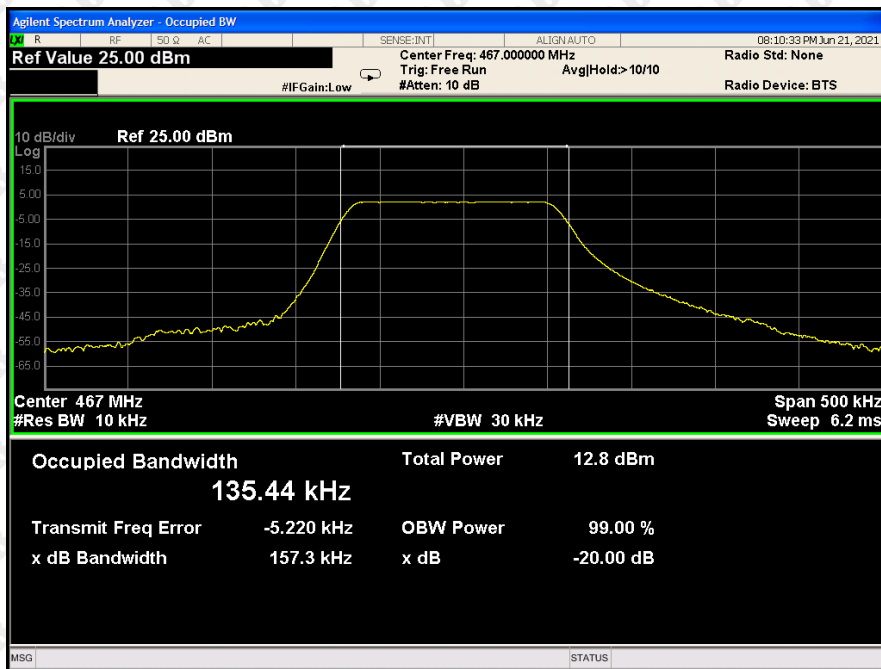
410MHz

| 20dB bandwidth (kHz) | Limit (MHz) | Results |
|----------------------|-------------|---------|
| 154.5                | 1.0275      | Pass    |



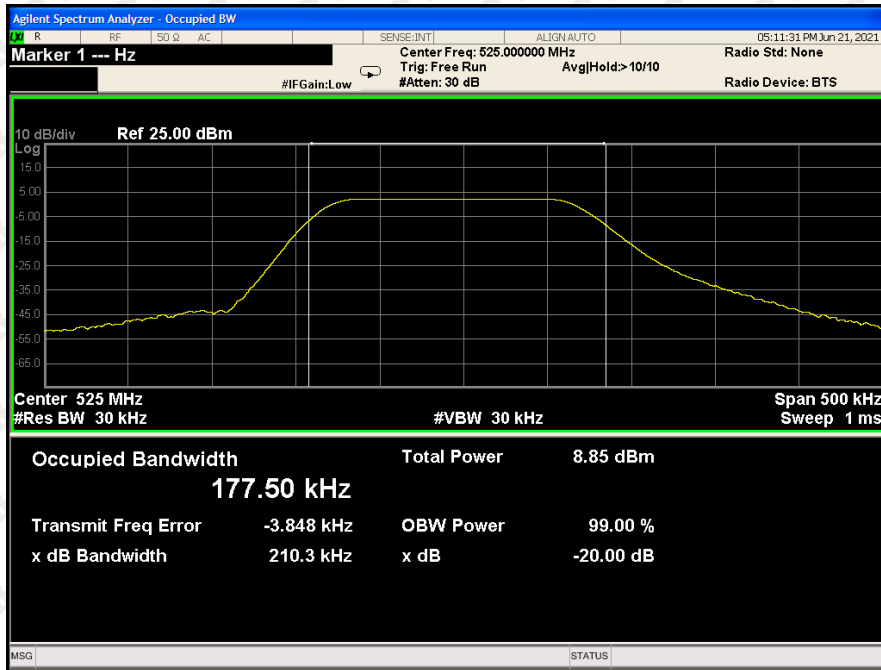
467MHz

| 20dB bandwidth (kHz) | Limit (MHz) | Results |
|----------------------|-------------|---------|
| 157.3                | 1.1675      | Pass    |



525MHz

|                      |             |         |
|----------------------|-------------|---------|
| 20dB bandwidth (kHz) | Limit (MHz) | Results |
| 210.3                | 1.3125      | Pass    |





## 10. ANTENNA REQUIREMENT

15.203 requirement:

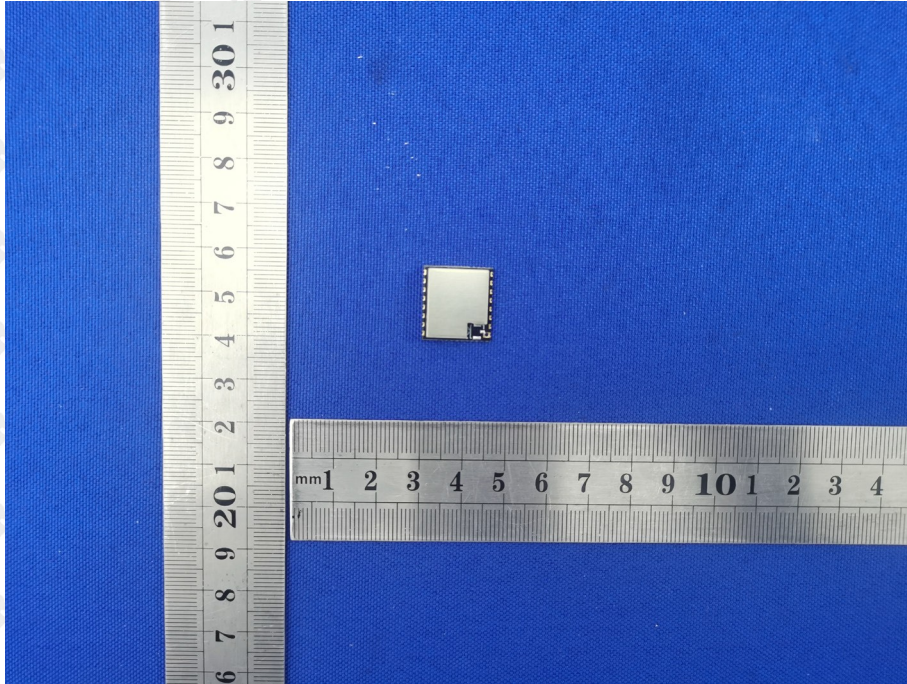
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

**EUT Antenna:**

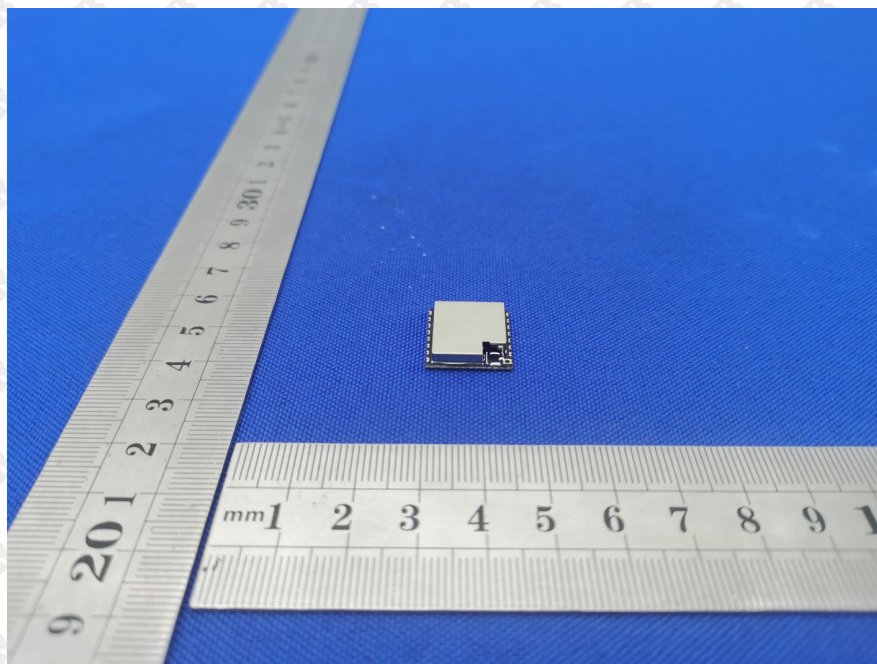
The antenna is Spring antenna and no consideration of replacement. The best case gain of the antenna is 0dBi.

## 11. EUT PHOTOGRAPHS

### External Photos EUT Photo 1



### EUT Photo 2



## 2. EUT TEST SETUP PHOTOGRAPHS

Radiated Emission

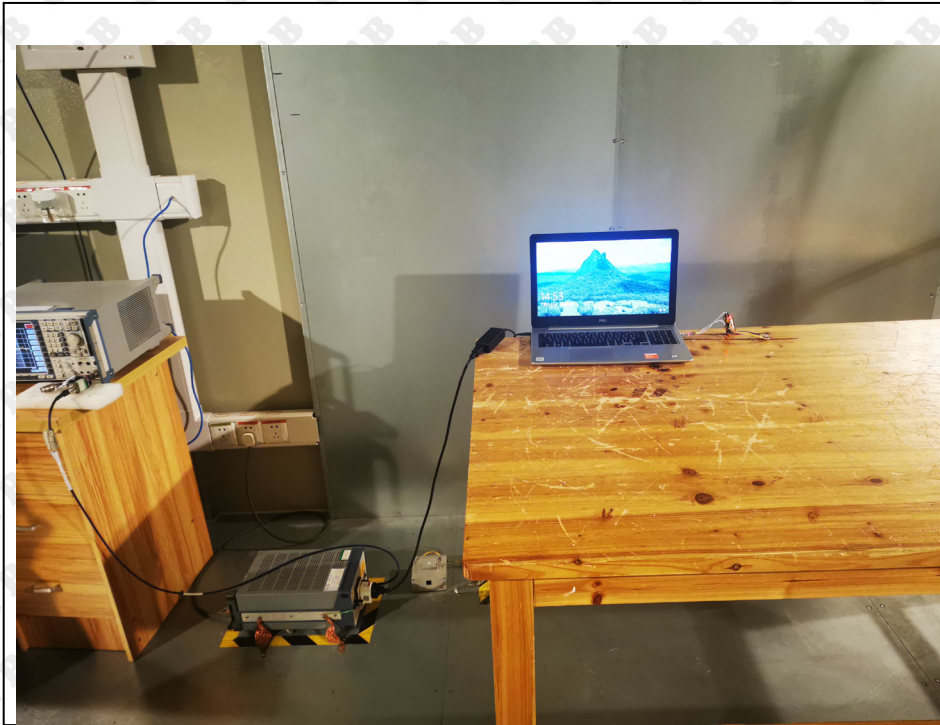
Below 1GHz



Above 1GHz



## Conducted emissions



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