



Certificate No.: 3745.01



China

## FCC - TEST REPORT

Report Number : **709502102972-00** Date of Issue: August 2, 2021

Model : CR3L-IPEX

Product Type : Wi-Fi and Bluetooth module

Applicant : Hangzhou Tuya Information Technology Co.,Ltd

Address : Room701,Building3,More Center,No.87 GuDun  
Road, Hangzhou, Zhejiang China

Manufacturer : Hangzhou Tuya Information Technology Co.,Ltd

Address : Room701,Building3,More Center,No.87 GuDun  
Road, Hangzhou, Zhejiang China

Test Result : ☒ **Positive** ☐ **Negative**

Total pages including  
Appendices : 48

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## 2 Details about the Test Laboratory

### Details about the Test Laboratory

#### Test Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch  
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Registration  
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### 3 Description of the Equipment under Test

#### Description of the Equipment Under Test

|                            |                                                                                                                                                                   |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product:                   | Wi-Fi and Bluetooth module                                                                                                                                        |
| Model no.:                 | CR3L-IPEX                                                                                                                                                         |
| FCC ID:                    | 2ANDL-CR3L-IPEX                                                                                                                                                   |
| Options and accessories:   | NA                                                                                                                                                                |
| Rating:                    | DC 3.0-3.6V                                                                                                                                                       |
| RF Transmission Frequency: | For 802.11b/g/n-HT20: 2412~2462 MHz<br>For 802.15.1:2402~2480 MHz                                                                                                 |
| No. of Operated Channel:   | 2.4GHz WIFI: 11 for 802.11b/802.11g/802.11n(H20)<br>2.4GHz BLE: 40                                                                                                |
| Modulation:                | For 2.4GHz WIFI:<br>Direct Sequence Spread Spectrum (DSSS) for 802.11b<br>Orthogonal Frequency Division Multiplexing (OFDM) for 802.11g/n<br>For 2.4GHz BLE: GFSK |
| Antenna Type:              | FPC Antenna                                                                                                                                                       |
| Antenna Gain:              | 3.33 dBi                                                                                                                                                          |
| Description of the EUT:    | The Equipment Under Test (EUT) is a low-power embedded Wi-Fi and Bluetooth module (4.2). We tested it and listed the worst data in this report.                   |
| Test sample no.:           | SHA-584963-1                                                                                                                                                      |

The sample's mentioned in this report is/are submitted/ supplied/ manufactured by client. The laboratory therefore assumes no responsibility for accuracy of information on the brand name, model number, origin of manufacture, consignment, antenna gain or any information supplied.



China

#### 4 Summary of Test Standards

| Test Standards                             |                                                                        |
|--------------------------------------------|------------------------------------------------------------------------|
| FCC Part 15 Subpart C<br>10-1-2020 Edition | PART 15 - RADIO FREQUENCY DEVICES<br>Subpart C - Intentional Radiators |

All the test methods were according to KDB 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10 (2013).



## 5 Summary of Test Results

| Technical Requirements |                                             |            |           |                                     |                          |                                     |
|------------------------|---------------------------------------------|------------|-----------|-------------------------------------|--------------------------|-------------------------------------|
| FCC Part 15 Subpart C  |                                             |            |           |                                     |                          |                                     |
| Test Condition         |                                             | Pages      | Test Site | Test Result                         |                          |                                     |
|                        |                                             |            |           | Pass                                | Fail                     | N/A                                 |
| §15.207                | Conducted emission AC power port            | 12-14      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247 (b) (3)        | Conducted peak output power                 | 15         | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247(a)(1)          | 20dB bandwidth                              | ---        | ---       | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| §15.247(a)(1)          | Carrier frequency separation                | ---        | ---       | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| §15.247(a)(1)(iii)     | Number of hopping frequencies               | ---        | ---       | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| §15.247(a)(1)(iii)     | Dwell Time                                  | ---        | ---       | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| §15.247(a)(2)          | 6dB bandwidth and 99% Occupied Bandwidth    | 16-19      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247(e)             | Power spectral density                      | 20-23      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247(d)             | Spurious RF conducted emissions             | 24-33      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247(d)             | Band edge                                   | 34-37      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.247(d) & §15.209   | Spurious radiated emissions for transmitter | 38-44      | Site 1    | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| §15.203                | Antenna requirement                         | See note 1 |           | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |

Remark 1: N/A – Not Applicable.

Note 1: The EUT uses an FPC Antenna, which gain is 3.33dBi. In accordance to §15.203, It is considered sufficiently to comply with the provisions of this section.

## 6 General Remarks

### Remarks

This submittal(s) (test report) is intended for FCC ID: 2ANDL-CR3L-IPEX, complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C Rules.

This report is only for the 2.4GHz Wi-Fi test report, for the 2.4GHz BLE test report please refer to 709502102988-00.

According to the client's declaration, the "ILAC – A2LA Accredited" symbol is added to the report.

### SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

□ - **Not** Performed

The Equipment under Test

■ - **Fulfills** the general approval requirements.

□ - **Does not** fulfill the general approval requirements.

Sample Received Date: July 12, 2021

Testing Start Date: July 14, 2021

Testing End Date: July 23, 2021

-TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch

Reviewed by:

Prepared by:

Tested by:

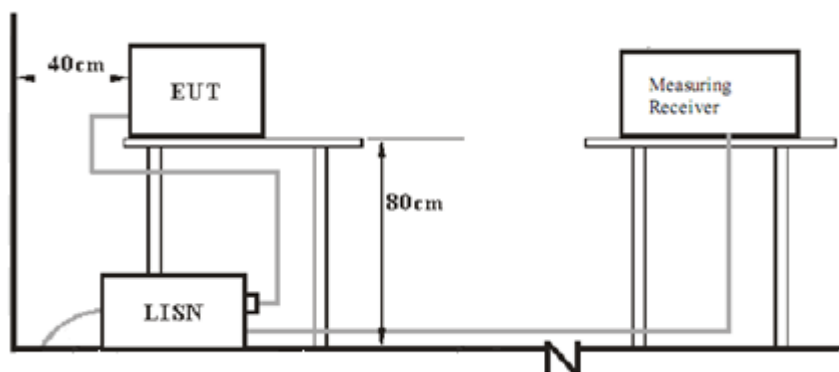
Hui TONG  
EMC Section Manager

Wenqiang LU  
EMC Project Engineer

Yiquan WANG  
EMC Test Engineer

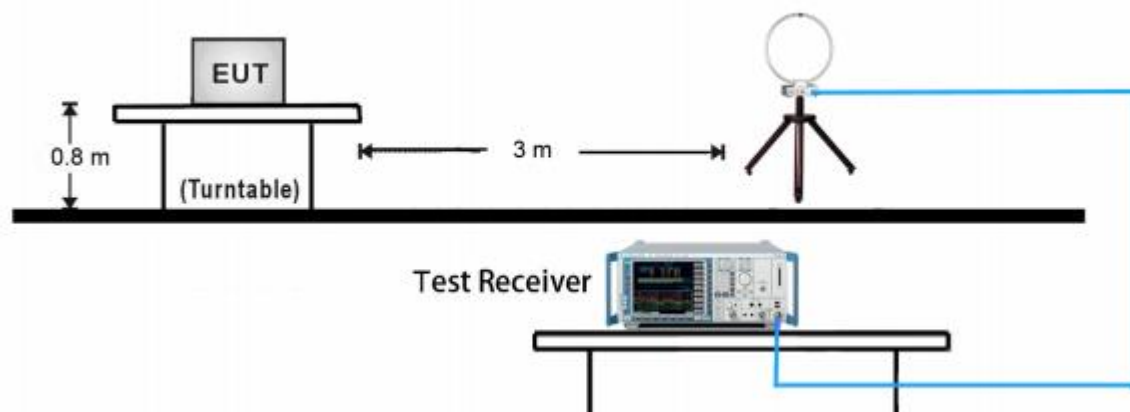
## 7 Test Setups

### 7.1 AC Power Line Conducted Emission test setups



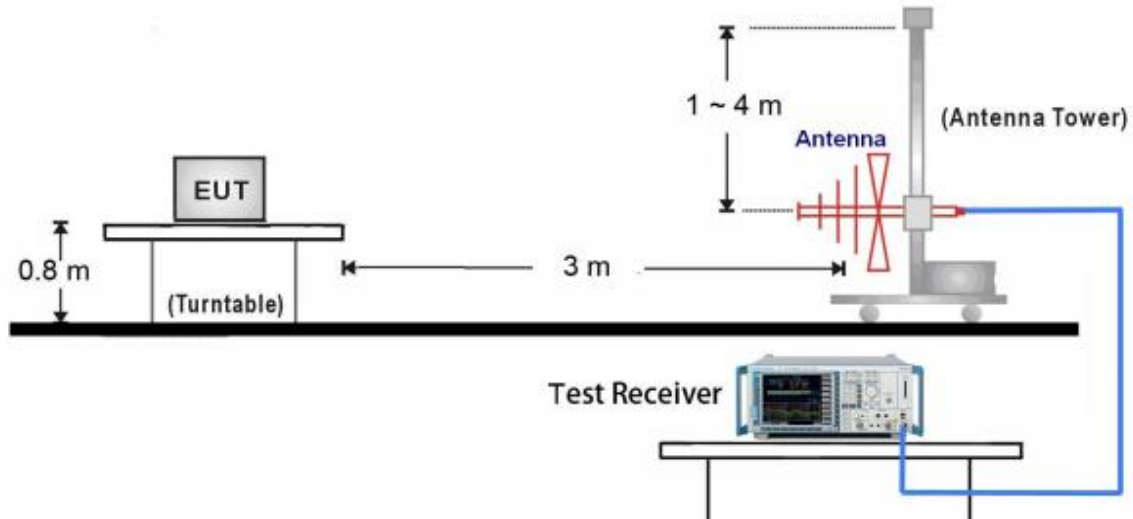
### 7.2 Radiated test setups

#### 9kHz ~ 30MHz Test Setup:

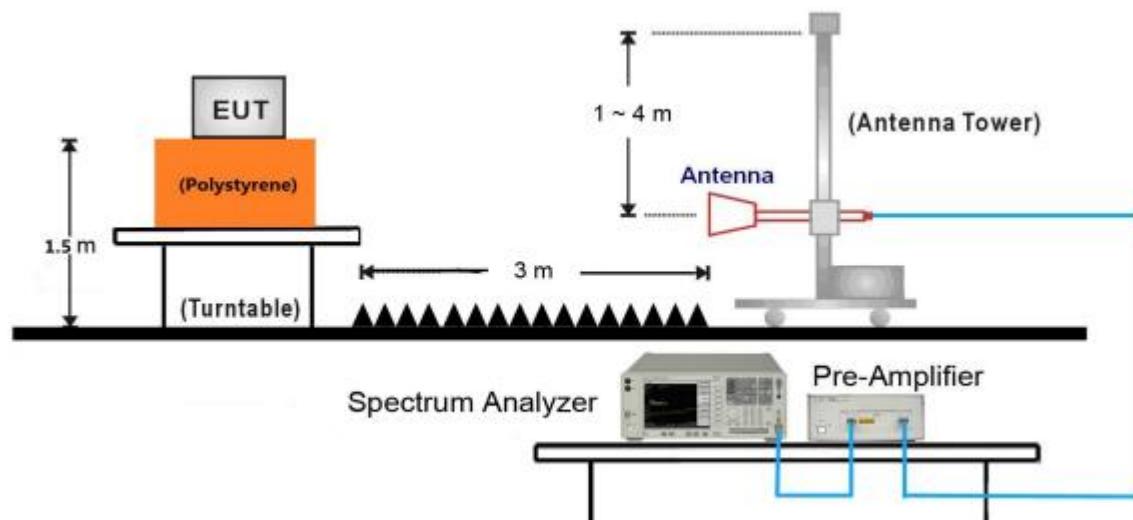




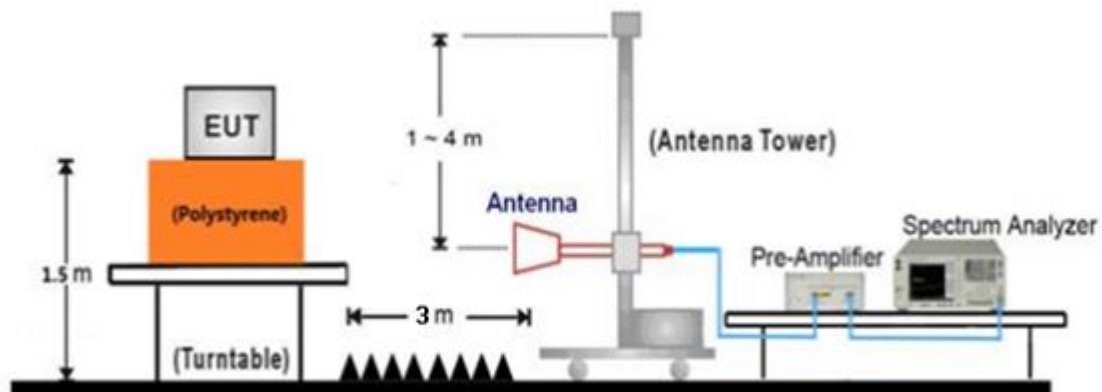
### 30MHz ~ 1GHz Test Setup:



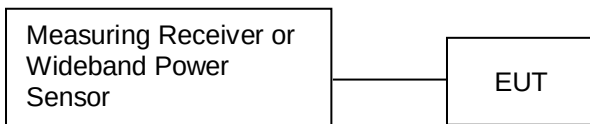
### 1GHz ~ 18GHz Test Setup:



### 18GHz ~ 40GHz Test Setup:



### 7.3 Conducted RF test setups





## 8 Systems test configuration

Auxiliary Equipment Used during Test:

| DESCRIPTION | MANUFACTURER | MODEL NO.(SHIELD) | S/N(LENGTH) |
|-------------|--------------|-------------------|-------------|
| Notebook    | Lenove       | X240              | Notebook    |

Test software: AmebaD\_mptool\_1V3 for Wi-Fi  
Bluetooth RF Test Tool (REALTEK) for BLE

The system was configured to channel 1(2412MHz), 6(2437MHz), and 11(2462MHz) for 802.11 b/g/n HT20 test.

Non-hopping mode: The system was configured to operate at a signal channel transmitting. The test software allows the configuration and operation at the worst-case duty and the highest transmit power.

## 9 Technical Requirement

### 9.1 Conducted Emission

#### Test Method

1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through an Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. An EMI test receiver is used to test the emissions from both sides of AC line

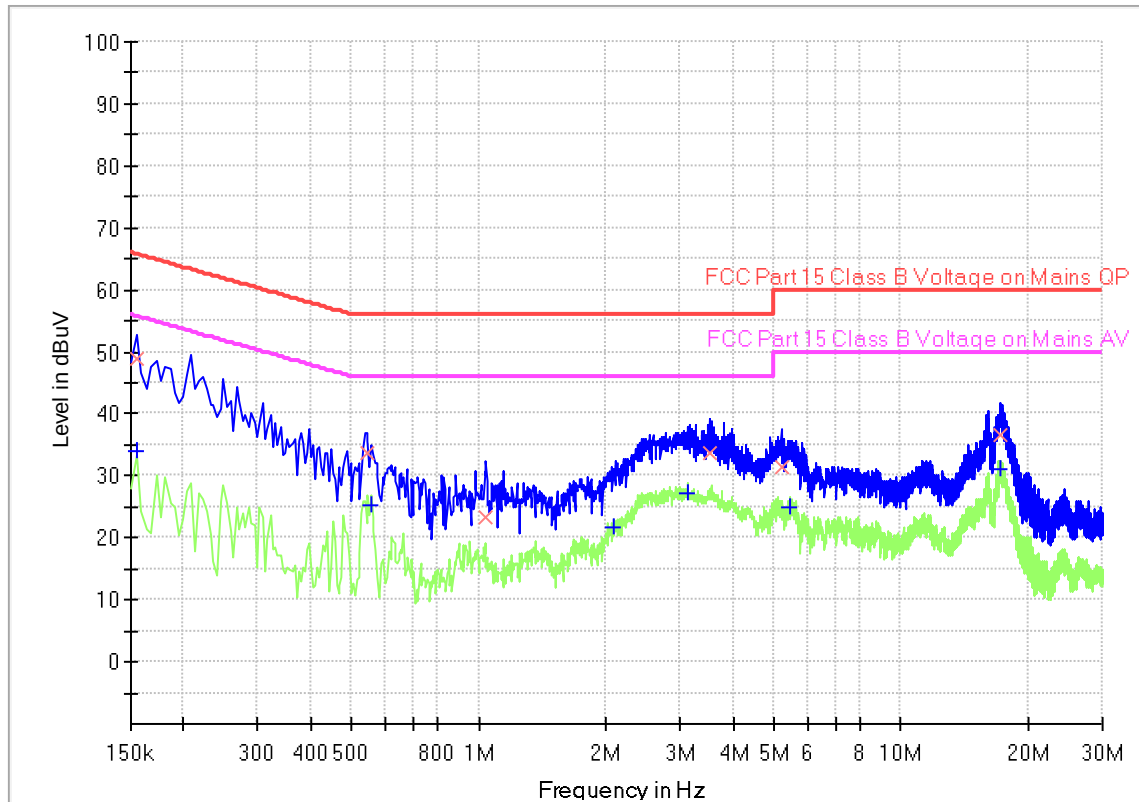
#### Limit

According to §15.207, conducted emissions limit as below:

| Frequency<br>MHz | QP Limit<br>dB $\mu$ V | AV Limit<br>dB $\mu$ V |
|------------------|------------------------|------------------------|
| 0.150-0.500      | 66-56*                 | 56-46*                 |
| 0.500-5          | 56                     | 46                     |
| 5-30             | 60                     | 50                     |

Decreasing linearly with logarithm of the frequency

Product Type : Wi-Fi and Bluetooth module  
 M/N : CR3L-IPEX  
 Operating Condition : Mode 1: Tx\_2412MHz for 802.11g (worst case)  
 Test Specification : L-line  
 Comment : AC 120V/60Hz (powered by notebook)

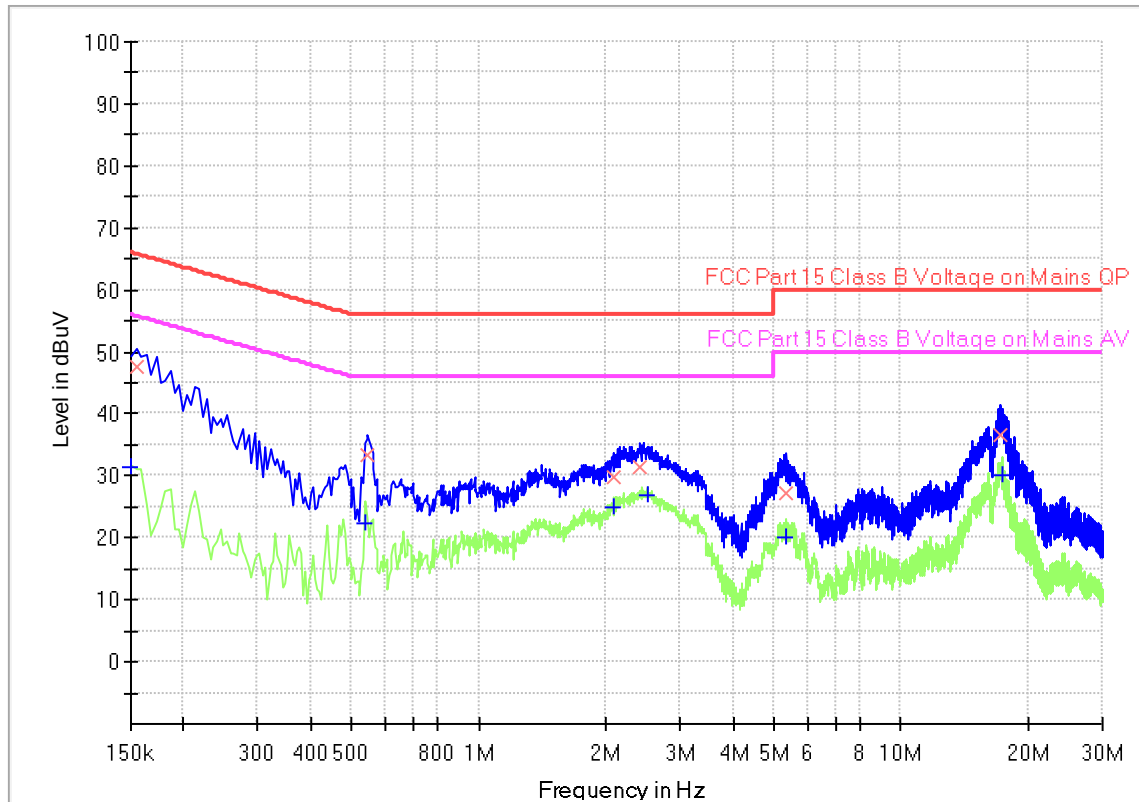


## Final Result

| Frequency (MHz) | Quasi Peak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | Corr. (dB) |
|-----------------|-------------------|-----------------|--------------|-------------|-----------------|-----------------|------|------------|
| 0.154500        | ---               | 33.91           | 55.75        | 21.84       | 1000.0          | 9.000           | L1   | 19.5       |
| 0.154500        | 48.78             | ---             | 65.75        | 16.97       | 1000.0          | 9.000           | L1   | 19.5       |
| 0.541500        | 33.76             | ---             | 56.00        | 22.24       | 1000.0          | 9.000           | L1   | 19.5       |
| 0.555000        | ---               | 25.18           | 46.00        | 20.82       | 1000.0          | 9.000           | L1   | 19.5       |
| 1.041000        | 23.23             | ---             | 56.00        | 32.77       | 1000.0          | 9.000           | L1   | 19.5       |
| 2.094000        | ---               | 21.77           | 46.00        | 24.23       | 1000.0          | 9.000           | L1   | 19.5       |
| 3.115500        | ---               | 27.10           | 46.00        | 18.90       | 1000.0          | 9.000           | L1   | 19.5       |
| 3.520500        | 33.52             | ---             | 56.00        | 22.48       | 1000.0          | 9.000           | L1   | 19.5       |
| 5.199000        | 31.36             | ---             | 60.00        | 28.64       | 1000.0          | 9.000           | L1   | 19.5       |
| 5.482500        | ---               | 24.98           | 50.00        | 25.02       | 1000.0          | 9.000           | L1   | 19.5       |
| 17.200500       | ---               | 30.96           | 50.00        | 19.04       | 1000.0          | 9.000           | L1   | 19.7       |
| 17.200500       | 36.66             | ---             | 60.00        | 23.34       | 1000.0          | 9.000           | L1   | 19.7       |

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)  
 Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

Product Type : Wi-Fi and Bluetooth module  
 M/N : CR3L-IPEX  
 Operating Condition : Mode 1: Tx\_2412MHz for 802.11g (worst case)  
 Test Specification : N-line  
 Comment : AC 120V/60Hz (powered by notebook)



## Final Result

| Frequency (MHz) | Quasi Peak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | Corr. (dB) |
|-----------------|-------------------|-----------------|--------------|-------------|-----------------|-----------------|------|------------|
| 0.150000        | ---               | 31.49           | 56.00        | 24.51       | 1000.0          | 9.000           | N    | 19.5       |
| 0.154500        | 47.61             | ---             | 65.75        | 18.14       | 1000.0          | 9.000           | N    | 19.5       |
| 0.537000        | ---               | 22.35           | 46.00        | 23.65       | 1000.0          | 9.000           | N    | 19.5       |
| 0.546000        | 33.44             | ---             | 56.00        | 22.56       | 1000.0          | 9.000           | N    | 19.5       |
| 2.085000        | 29.79             | ---             | 56.00        | 26.21       | 1000.0          | 9.000           | N    | 19.5       |
| 2.094000        | ---               | 25.09           | 46.00        | 20.91       | 1000.0          | 9.000           | N    | 19.5       |
| 2.418000        | 31.43             | ---             | 56.00        | 24.57       | 1000.0          | 9.000           | N    | 19.6       |
| 2.503500        | ---               | 26.99           | 46.00        | 19.01       | 1000.0          | 9.000           | N    | 19.6       |
| 5.316000        | ---               | 20.01           | 50.00        | 29.99       | 1000.0          | 9.000           | N    | 19.6       |
| 5.365500        | 27.25             | ---             | 60.00        | 32.75       | 1000.0          | 9.000           | N    | 19.6       |
| 17.250000       | 36.66             | ---             | 60.00        | 23.34       | 1000.0          | 9.000           | N    | 19.8       |
| 17.353500       | ---               | 30.13           | 50.00        | 19.87       | 1000.0          | 9.000           | N    | 19.8       |

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)  
 Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

## 9.2 Conducted peak output power

### Test Method

1. Use the following spectrum analyzer settings:  
RBW > the 6 dB bandwidth of the emission being measured, VBW $\geq$ 3RBW, Span $\geq$ 3RBW  
Sweep = auto, Detector function = peak, Trace = max hold.
2. Add a correction factor to the display.
3. Use a power meter to measure the conducted peak output power.

### Limits

According to §15.247 (b) (3), conducted peak output power limit as below:

| Frequency Range<br>MHz | Limit<br>W | Limit<br>dBm |
|------------------------|------------|--------------|
| 2400-2483.5            | $\leq 1$   | $\leq 30$    |

Test result as below table

#### 802.11B

| Frequency<br>MHz       | Conducted Peak<br>Output Power<br>dBm | Result |
|------------------------|---------------------------------------|--------|
| Low channel 2412MHz    | 16.88                                 | Pass   |
| Middle channel 2437MHz | 16.84                                 | Pass   |
| High channel 2462MHz   | 16.81                                 | Pass   |

#### 802.11G

| Frequency<br>MHz       | Conducted Peak<br>Output Power<br>dBm | Result |
|------------------------|---------------------------------------|--------|
| Low channel 2412MHz    | 23.34                                 | Pass   |
| Middle channel 2437MHz | 23.33                                 | Pass   |
| High channel 2462MHz   | 23.05                                 | Pass   |

#### 802.11N20

| Frequency<br>MHz       | Conducted Peak<br>Output Power<br>dBm | Result |
|------------------------|---------------------------------------|--------|
| Low channel 2412MHz    | 22.86                                 | Pass   |
| Middle channel 2437MHz | 22.96                                 | Pass   |
| High channel 2462MHz   | 22.70                                 | Pass   |

### 9.3 6dB bandwidth

#### Test Method

1. Use the following spectrum analyzer settings:  
RBW=100K, VBW $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
2. Use the automatic bandwidth measurement capability of an instrument, may be employed using the X dB bandwidth mode with X set to 6 dB, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be  $\geq$  6 dB.
3. Allow the trace to stabilize, record the X dB Bandwidth value.

#### Limit

Limit [kHz]

$\geq 500$

Test result  
802.11B

| Frequency<br>MHz       | 6dB bandwidth<br>MHz | Result |
|------------------------|----------------------|--------|
| Low channel 2412MHz    | 9.083                | Pass   |
| Middle channel 2437MHz | 9.081                | Pass   |
| High channel 2462MHz   | 9.076                | Pass   |

802.11G

| Frequency<br>MHz       | 6dB bandwidth<br>MHz | Result |
|------------------------|----------------------|--------|
| Low channel 2412MHz    | 16.563               | Pass   |
| Middle channel 2437MHz | 16.559               | Pass   |
| High channel 2462MHz   | 16.563               | Pass   |

802.11N20

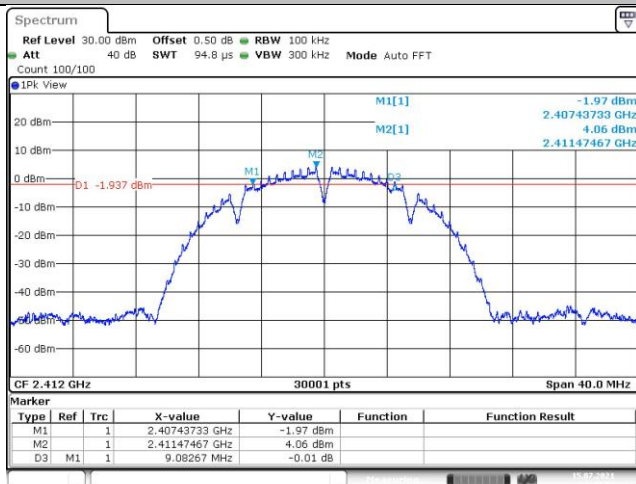
| Frequency<br>MHz       | 6dB bandwidth<br>MHz | Result |
|------------------------|----------------------|--------|
| Low channel 2412MHz    | 17.776               | Pass   |
| Middle channel 2437MHz | 17.793               | Pass   |
| High channel 2462MHz   | 17.797               | Pass   |



## 6 dB Bandwidth

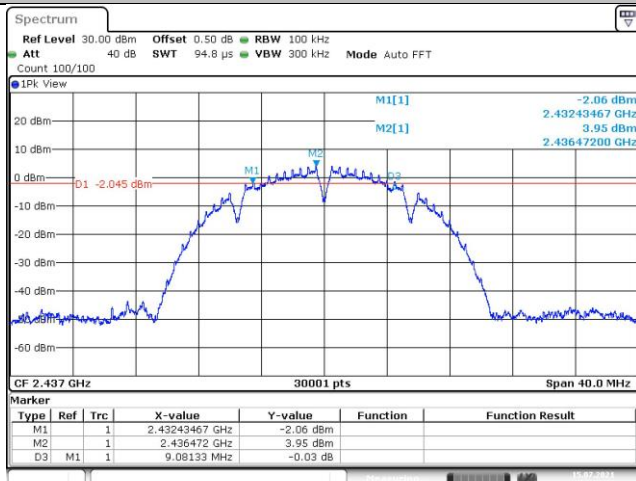
802.11B

2412



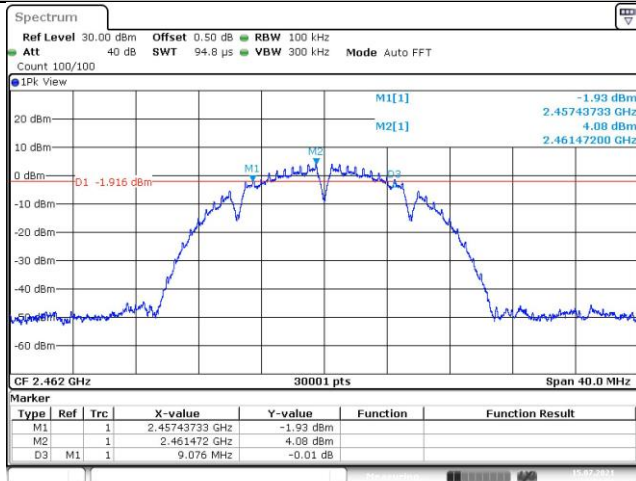
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2437



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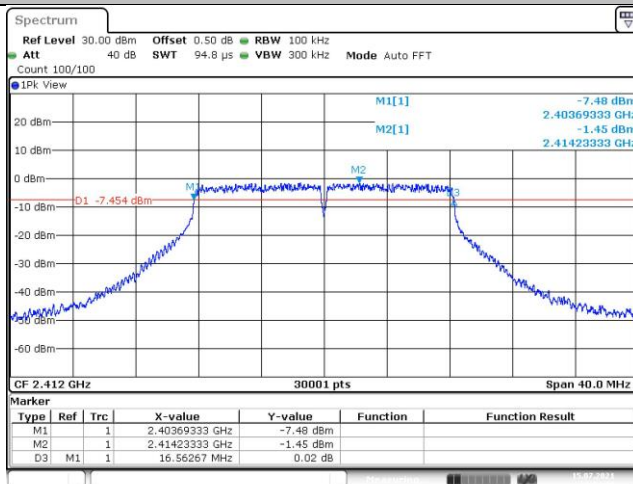
2462



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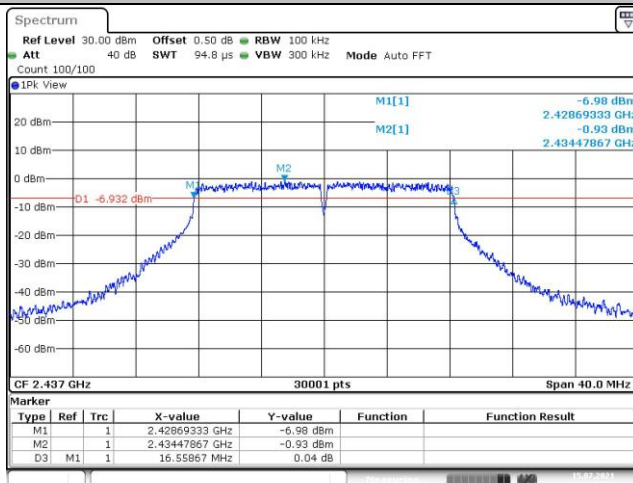
802.11G

2412



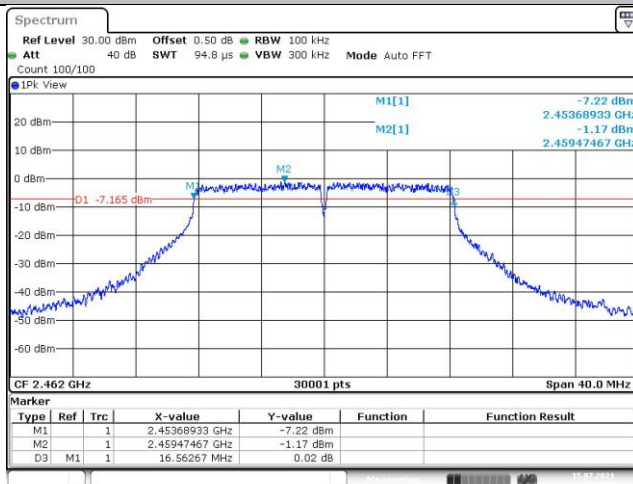
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2437



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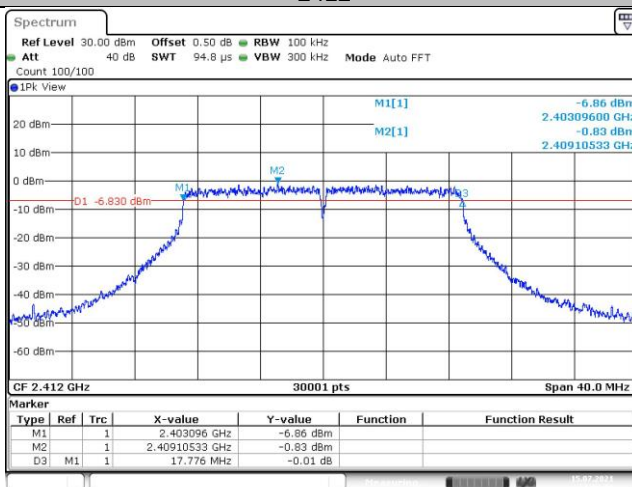
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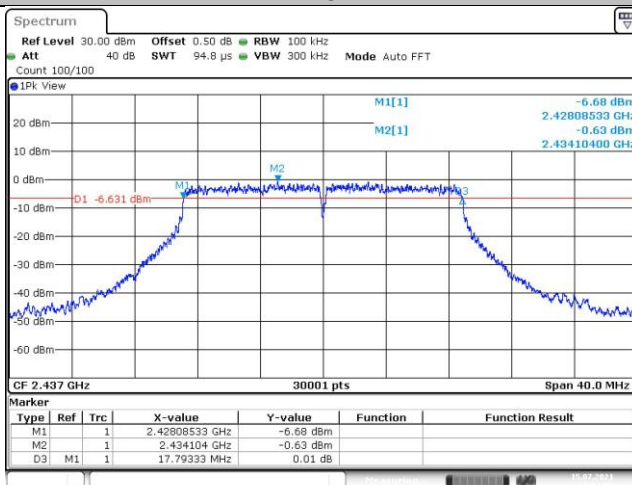
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## 802.11N20

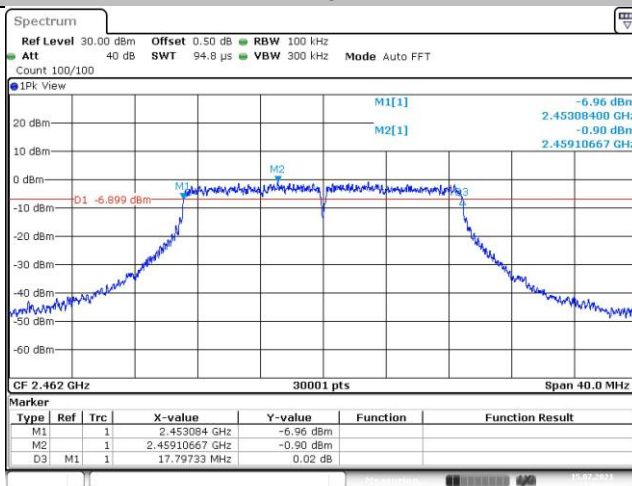
2412



2437



2462



## 9.4 Power spectral density

### Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

1. Set analyzer center frequency to DTS channel center frequency. RBW=3kHz, VBW $\geq$ 3RBW, Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold.
2. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
3. Repeat above procedures until other frequencies measured were completed.

### Limit

Limit [dBm/3kHz]

$\leq 8$

### Test result

#### 802.11 B

| Frequency<br>MHz       | Power spectral<br>density<br>dBm/3kHz | Result |
|------------------------|---------------------------------------|--------|
| Low channel 2412MHz    | -16.57                                | Pass   |
| Middle channel 2437MHz | -16.60                                | Pass   |
| High channel 2462MHz   | -16.51                                | Pass   |

#### 802.11 G

| Frequency<br>MHz       | Power spectral<br>density<br>dBm/3kHz | Result |
|------------------------|---------------------------------------|--------|
| Low channel 2412MHz    | -15.79                                | Pass   |
| Middle channel 2437MHz | -15.41                                | Pass   |
| High channel 2462MHz   | -15.48                                | Pass   |

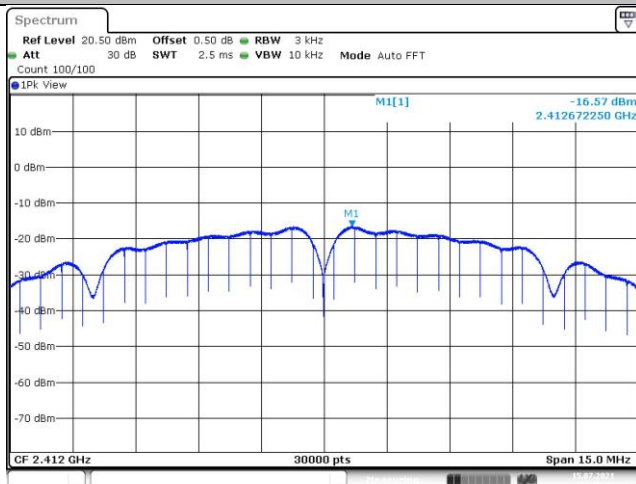
#### 802.11 N20

| Frequency<br>MHz       | Power spectral<br>density<br>dBm/3kHz | Result |
|------------------------|---------------------------------------|--------|
| Low channel 2412MHz    | -14.99                                | Pass   |
| Middle channel 2437MHz | -14.73                                | Pass   |
| High channel 2462MHz   | -15.03                                | Pass   |

**Power spectral density**

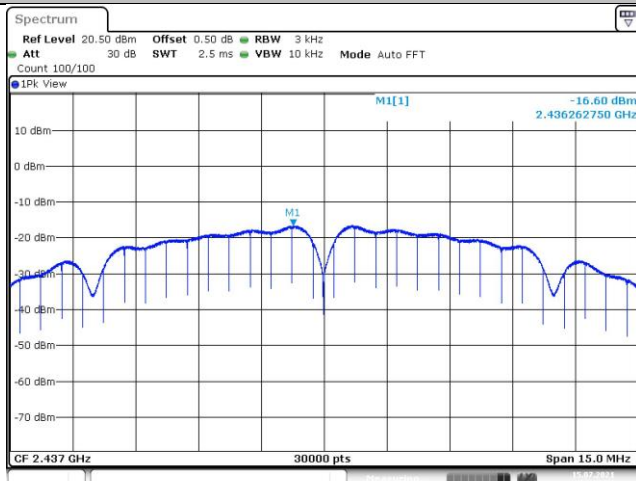
802.11B

2412



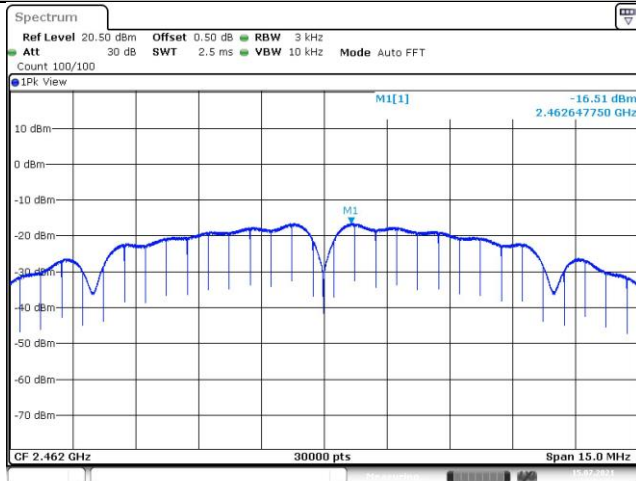
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2437



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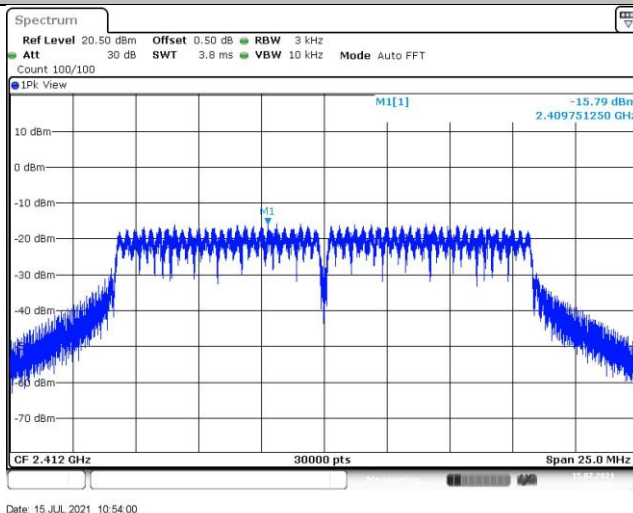
2462



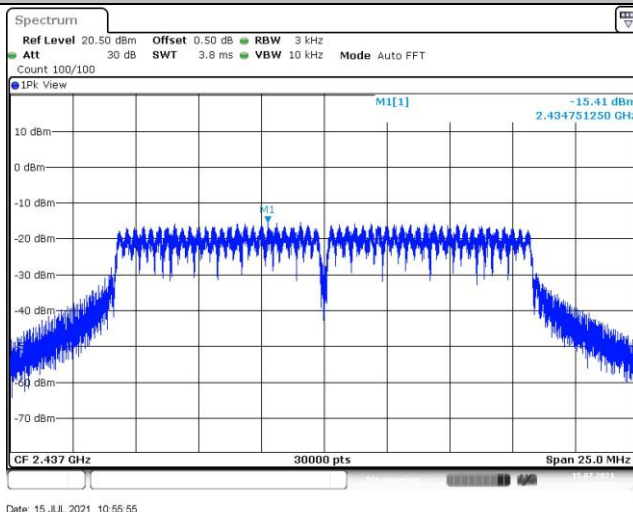
Date: 15 JUL 2021 10:51:23

## 802.11G

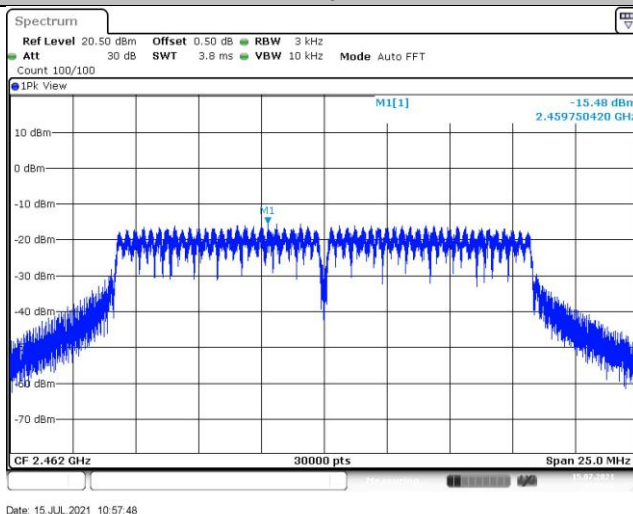
2412



2437

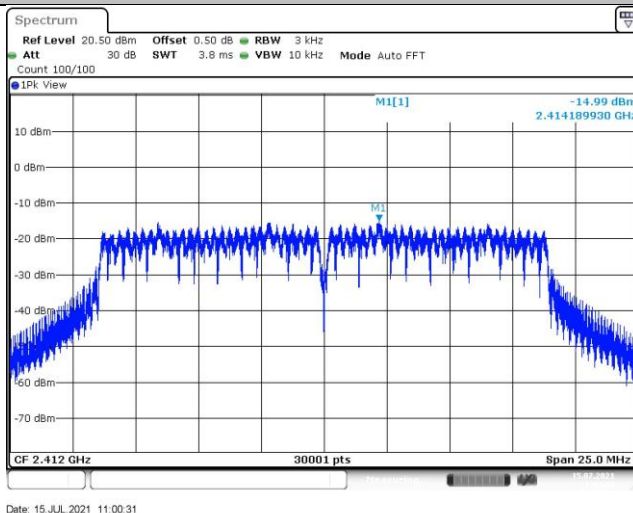


2462

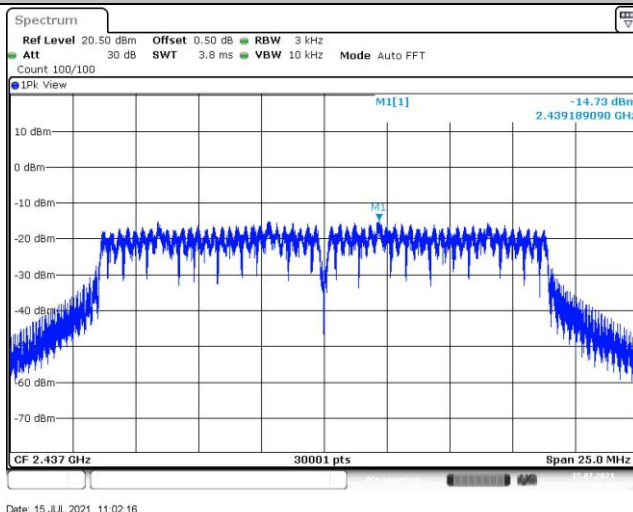


## 802.11N20

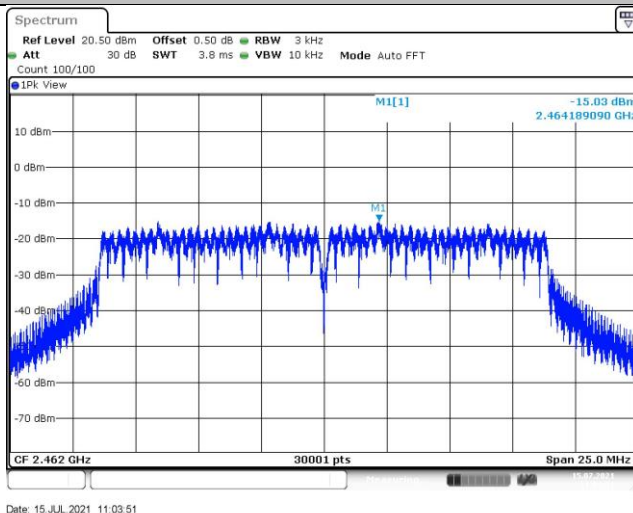
2412



2437



2462





## 9.5 Spurious RF conducted emissions

### Test Method

1. Establish a reference level by using the following procedure:
  - a. Set RBW=100 kHz. VBW $\geq$ 3RBW. Detector =peak, Sweep time = auto couple, Trace mode = max hold.
  - b. Allow trace to fully stabilize, use the peak marker function to determine the maximum PSD level.
2. Use the maximum PSD level to establish the reference level.
  - a. Set the center frequency and span to encompass frequency range to be measured.
  - b. Use the peak marker function to determine the maximum amplitude level. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements, report the three highest emissions relative to the limit.
3. Repeat above procedures until other frequencies measured were completed.

### Limit

| Frequency Range<br>MHz | Limit (dBc) |
|------------------------|-------------|
| 30-25000               | -20         |



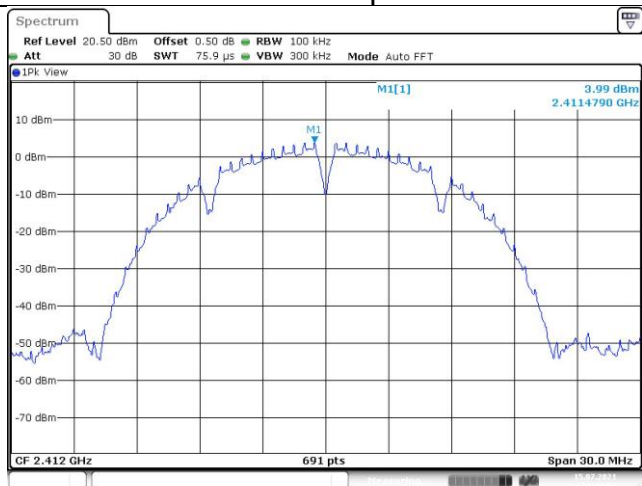
**Spurious RF conducted emissions**

802.11 B

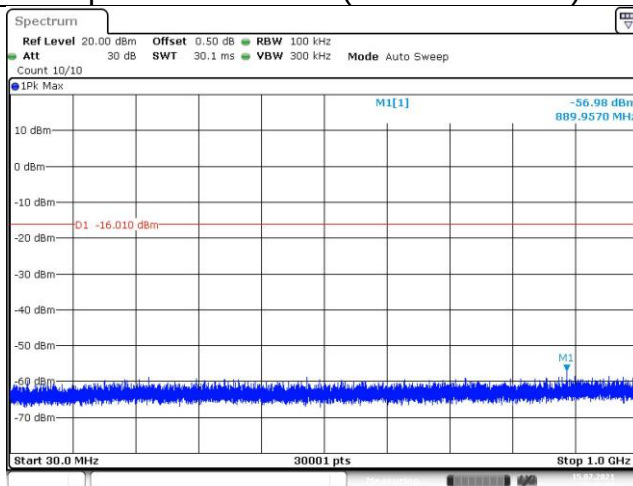
Out-of-Band Emissions

Channel 1 (2412MHz)

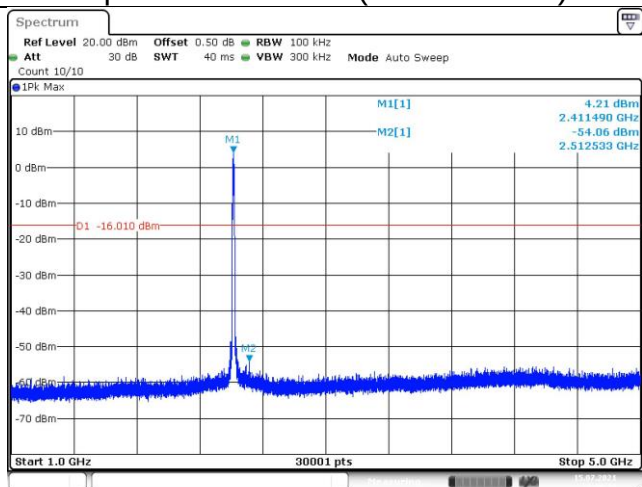
Reference point



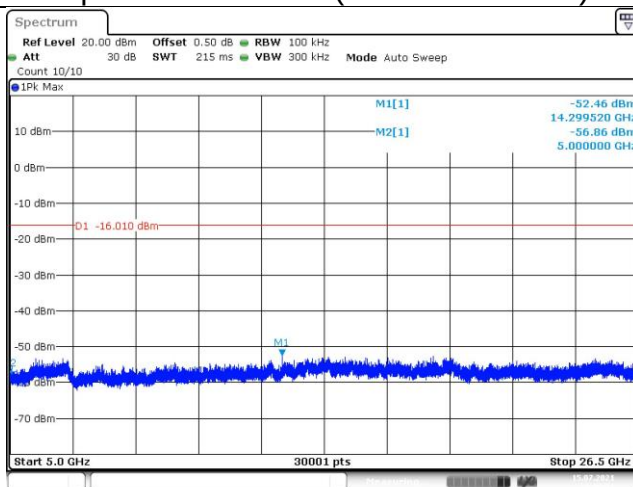
Spurious Emission (30MHz – 1GHz)



Spurious Emission (1GHz –5GHz)



Spurious Emission (5GHz –26.5GHz)

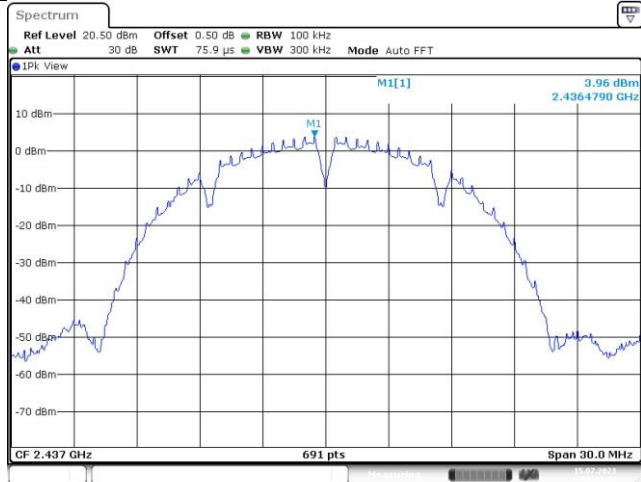


Note: The emission which exceed the limit is the fundamental.

## Out-of-Band Emissions

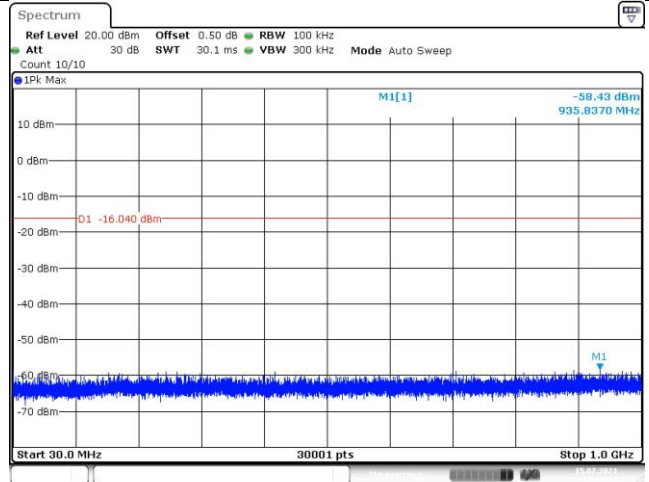
## Channel 6 (2437MHz)

## Reference point



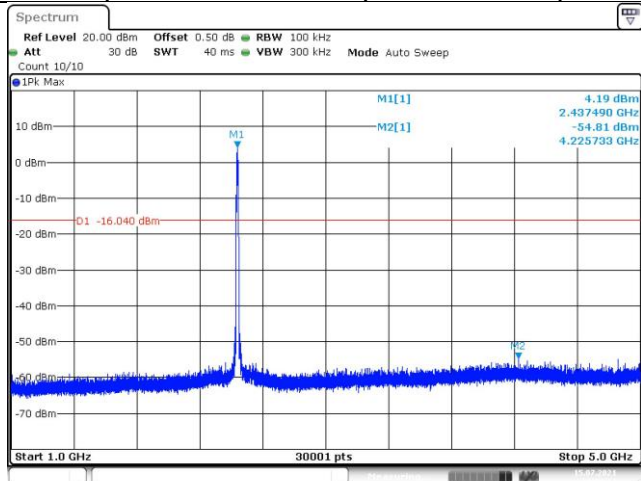
Date: 15 JUL 2021 10:49:54

## Spurious Emission (30MHz – 1GHz)



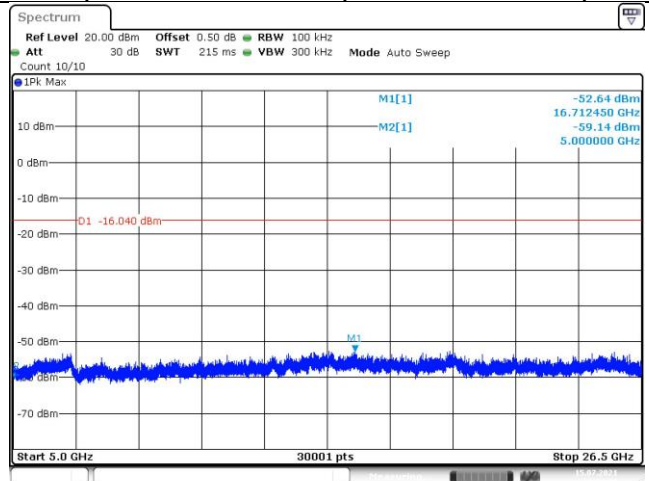
Date: 15 JUL 2021 10:49:59

## Spurious Emission (1GHz –5GHz)



Date: 15 JUL 2021 10:50:11

## Spurious Emission (5GHz –26.5GHz)



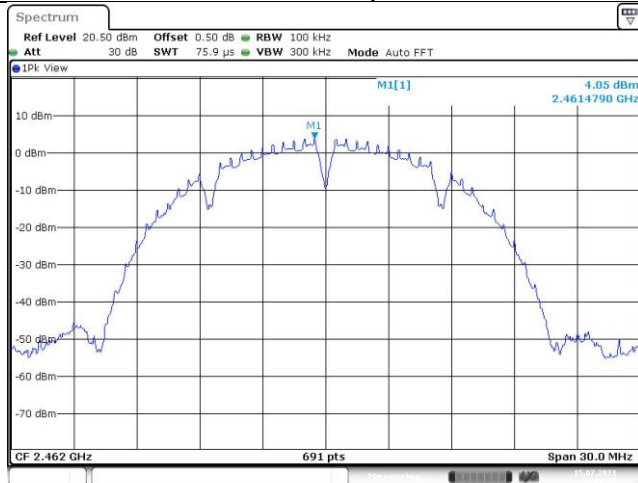
Date: 15 JUL 2021 10:50:42

Note: The emission which exceed the limit is the fundamental.

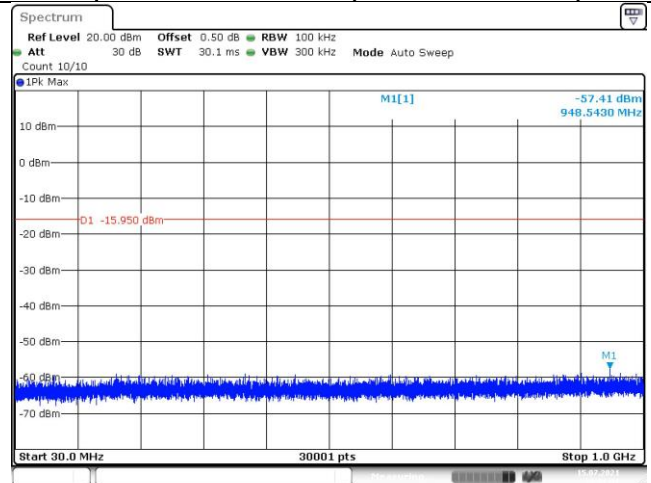
## Out-of-Band Emissions

## Channel 11 (2462MHz)

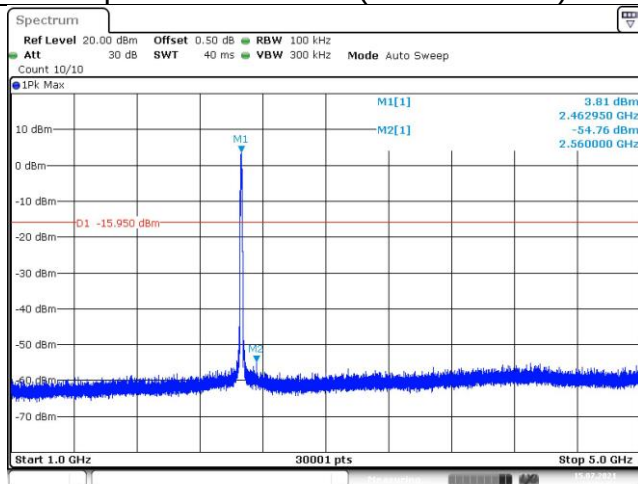
## Reference point



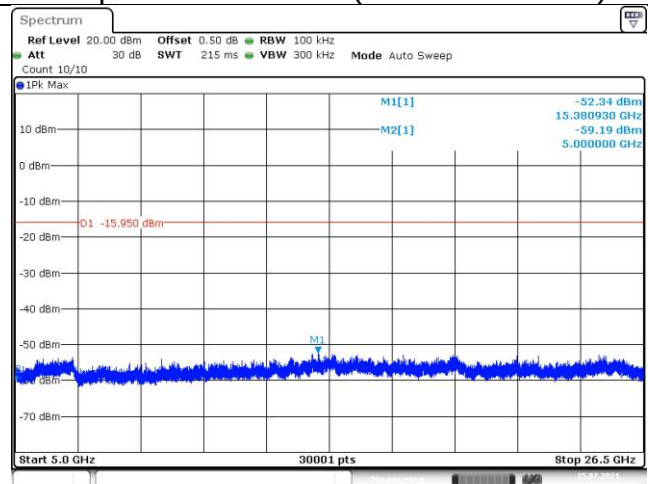
## Spurious Emission (30MHz – 1GHz)



## Spurious Emission (1GHz – 5GHz)



## Spurious Emission (5GHz – 26.5GHz)



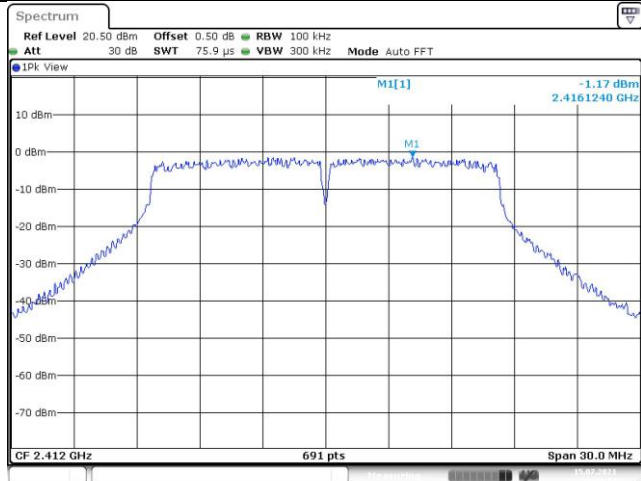
Note: The emission which exceed the limit is the fundamental.

802.11 G

## Out-of-Band Emissions

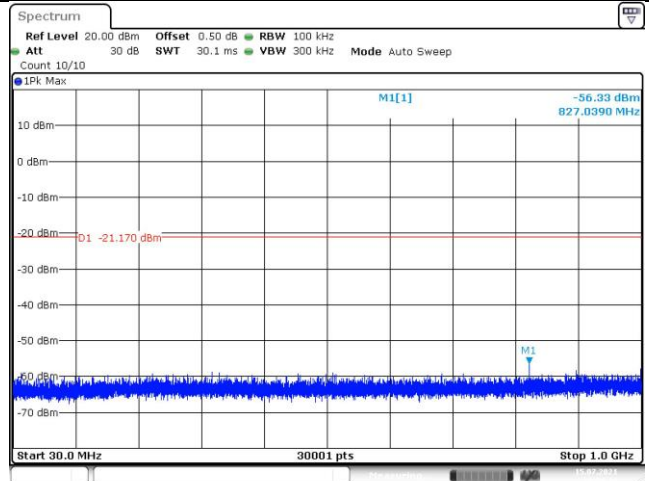
Channel 1 (2412MHz)

## Reference point



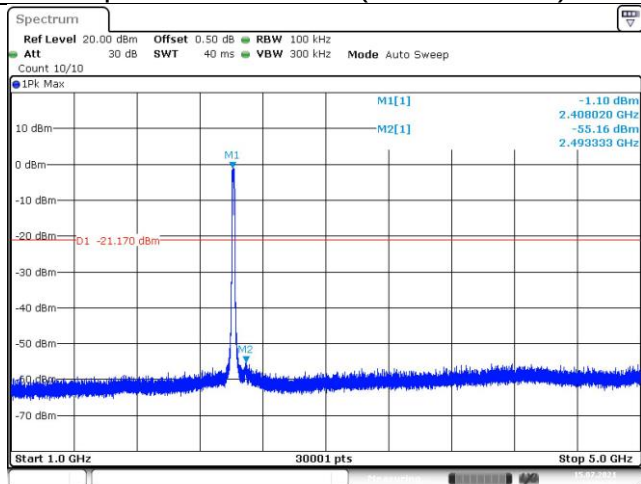
Date: 15 JUL 2021 10:54:14

## Spurious Emission (30MHz – 1GHz)



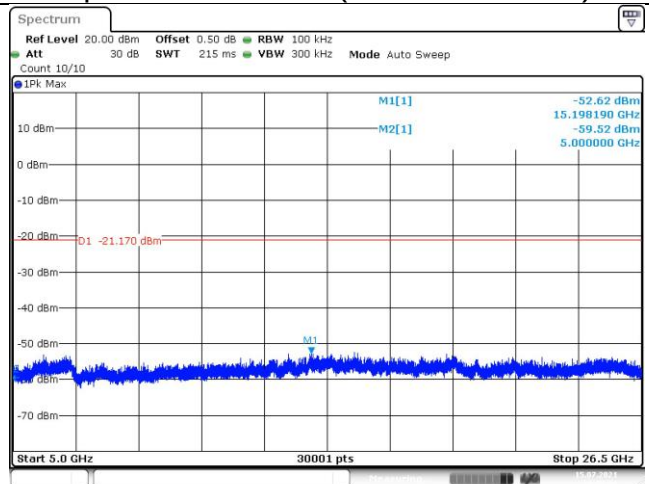
Date: 15 JUL 2021 10:54:19

## Spurious Emission (1GHz – 5GHz)



Date: 15 JUL 2021 10:54:31

## Spurious Emission (5GHz – 26.5GHz)

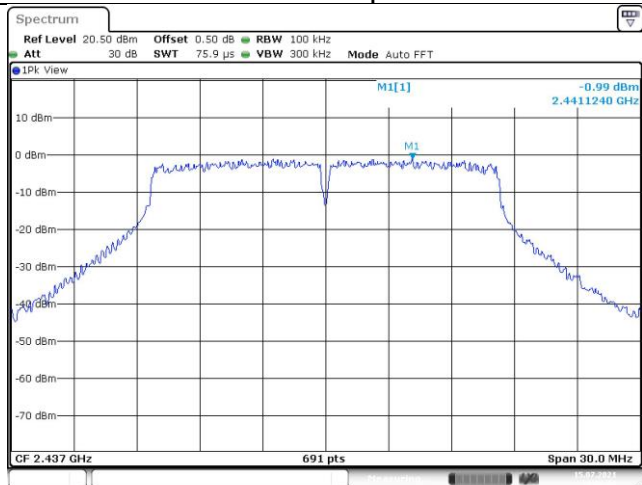


Date: 15 JUL 2021 10:55:02

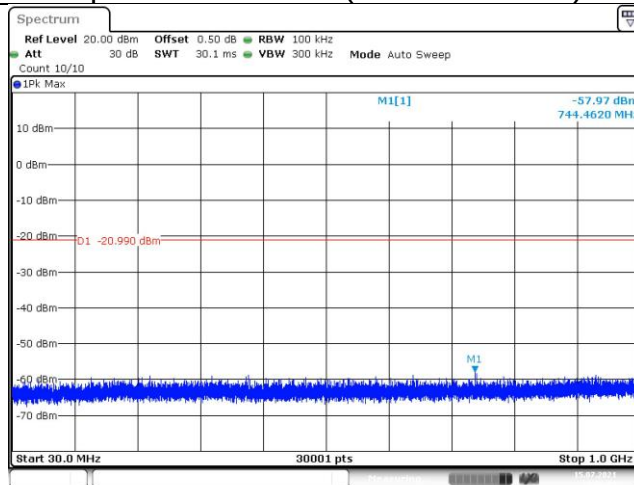
Note: The emission which exceed the limit is the fundamental.

## Out-of-Band Emissions Channel 6 (2437MHz)

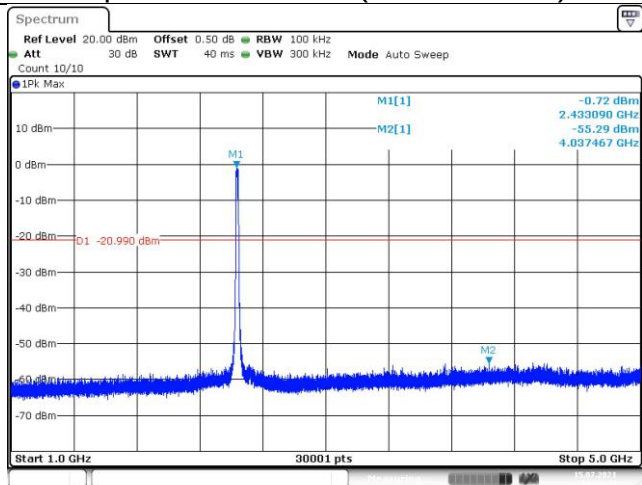
### Reference point



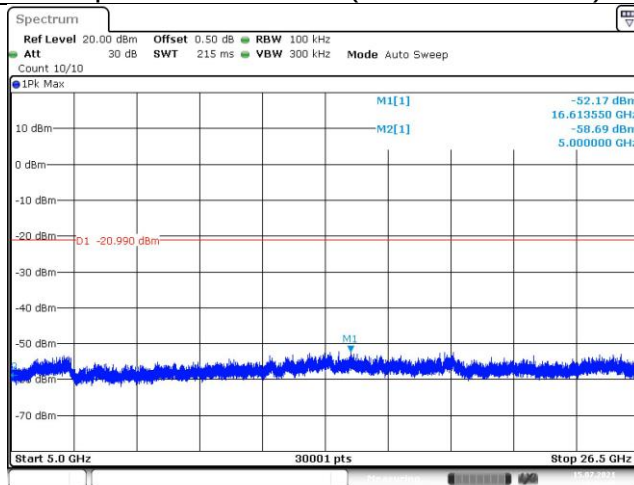
### Spurious Emission (30MHz – 1GHz)



### Spurious Emission (1GHz –5GHz)



### Spurious Emission (5GHz –26.5GHz)

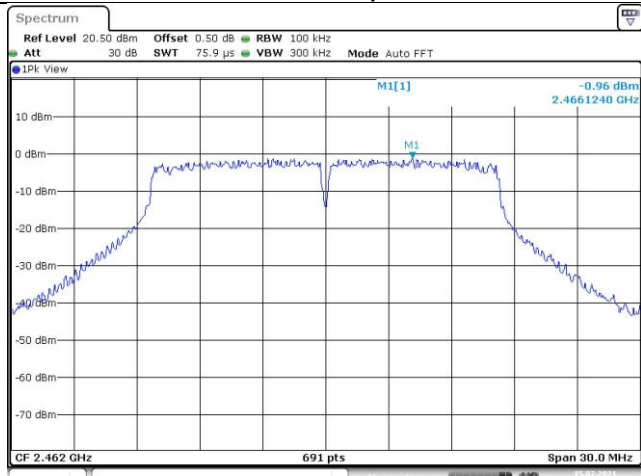


Note: The emission which exceed the limit is the fundamental.



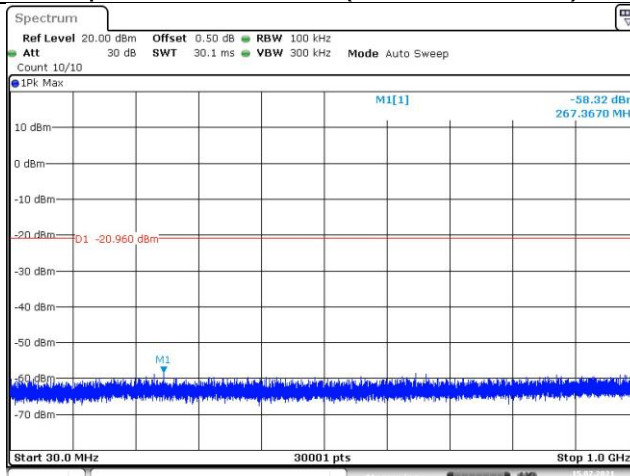
## Out-of-Band Emissions Channel 11 (2462MHz)

### Reference point



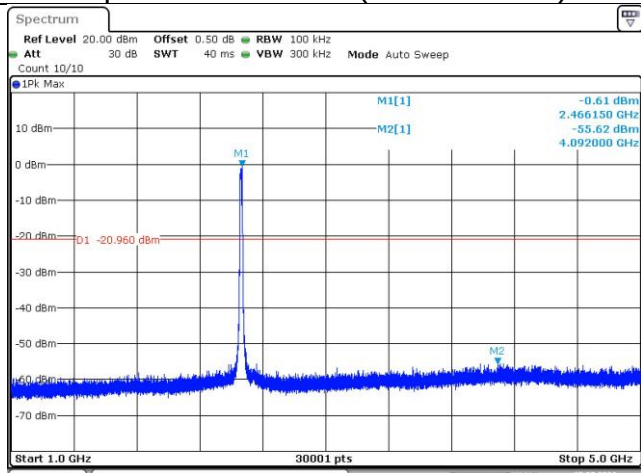
Date: 15 JUL 2021 10:58:02

### Spurious Emission (30MHz – 1GHz)



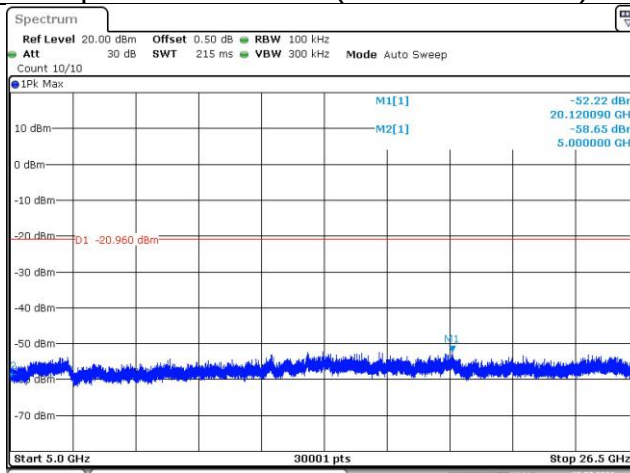
Date: 15 JUL 2021 10:58:07

### Spurious Emission (1GHz – 5GHz)



Date: 15 JUL 2021 10:58:19

### Spurious Emission (5GHz – 26.5GHz)



Date: 15 JUL 2021 10:58:50

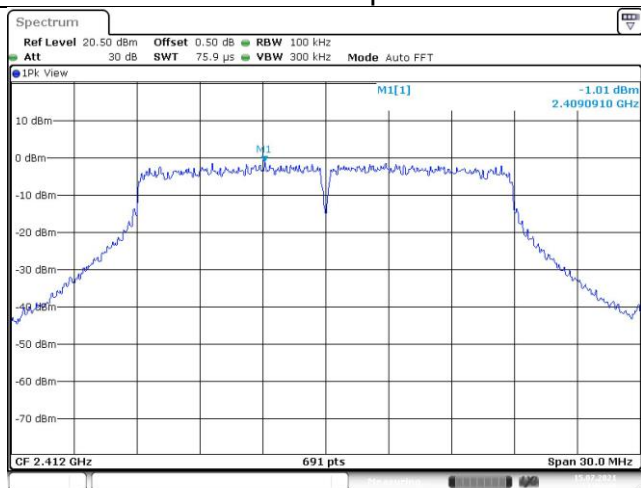
Note: The emission which exceed the limit is the fundamental.

## 802.11 N20

## Out-of-Band Emissions

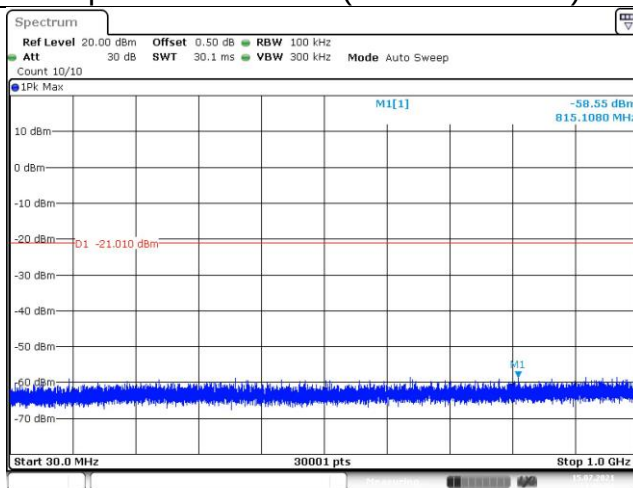
## Channel 1 (2412MHz)

## Reference point



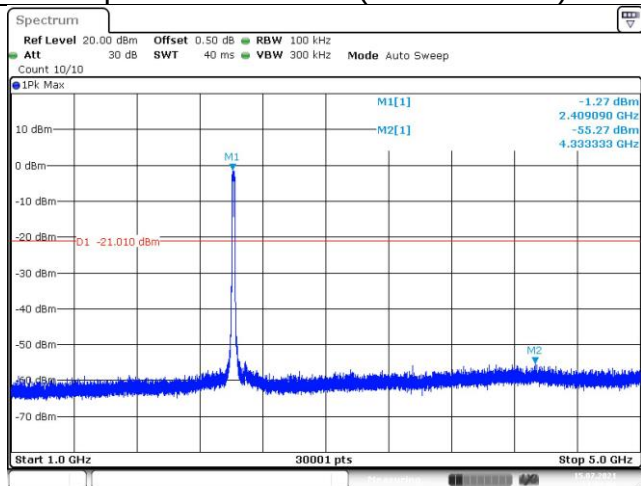
Date: 15 JUL 2021 11:00:45

## Spurious Emission (30MHz – 1GHz)



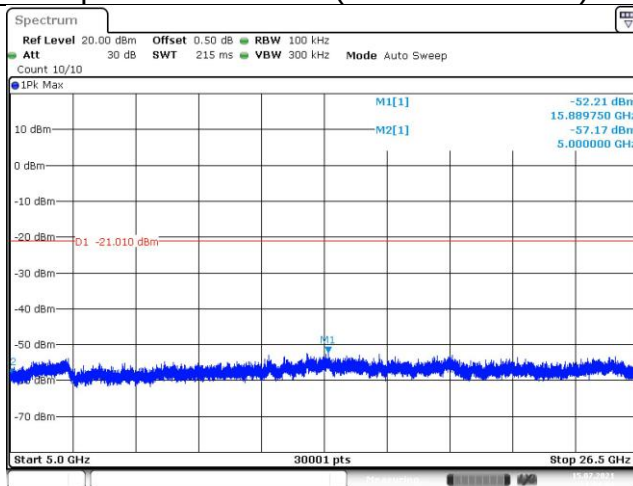
Date: 15 JUL 2021 11:00:50

## Spurious Emission (1GHz – 5GHz)



Date: 15 JUL 2021 11:01:02

## Spurious Emission (5GHz – 26.5GHz)

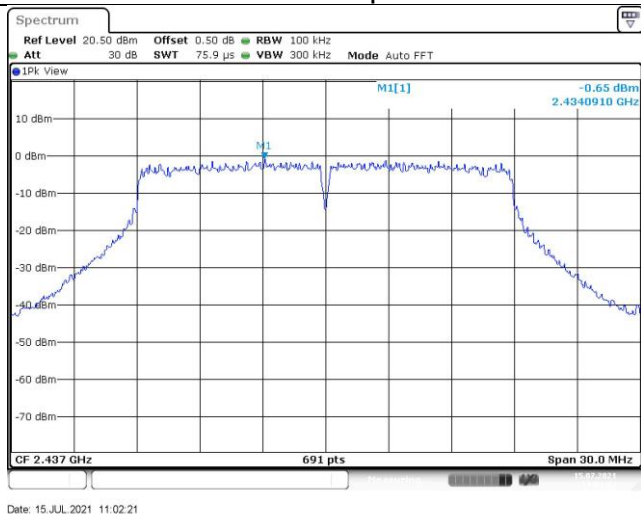


Date: 15 JUL 2021 11:01:33

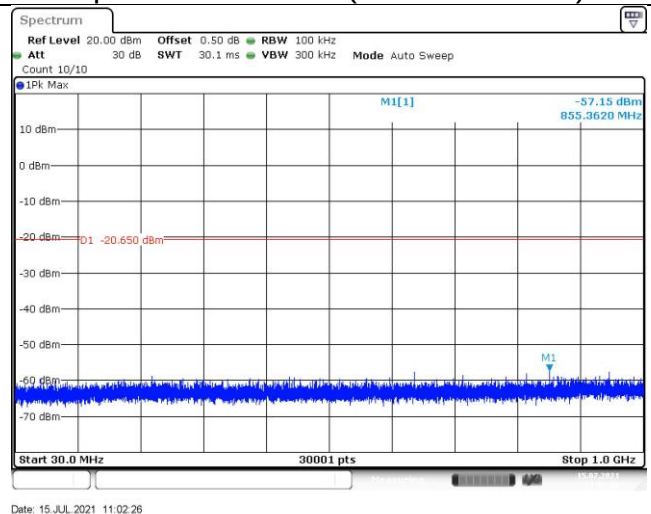
Note: The emission which exceed the limit is the fundamental.

## Out-of-Band Emissions Channel 6 (2437MHz)

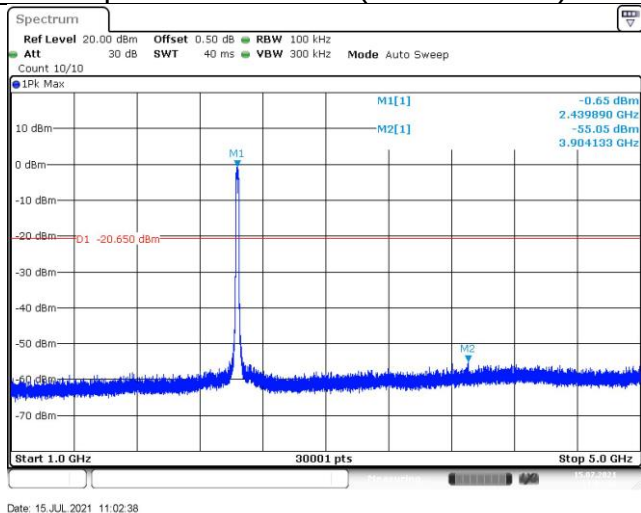
### Reference point



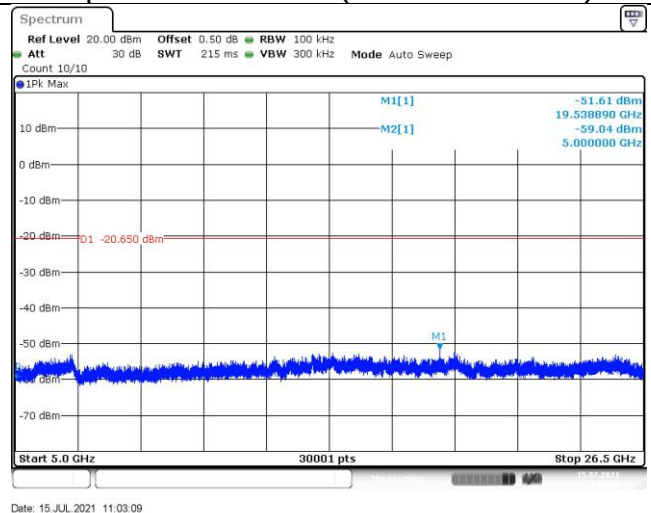
### Spurious Emission (30MHz – 1GHz)



### Spurious Emission (1GHz – 5GHz)



### Spurious Emission (5GHz – 26.5GHz)

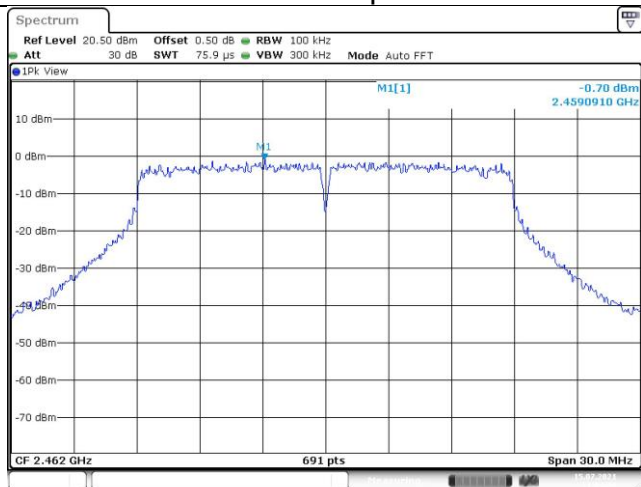


Note: The emission which exceed the limit is the fundamental.



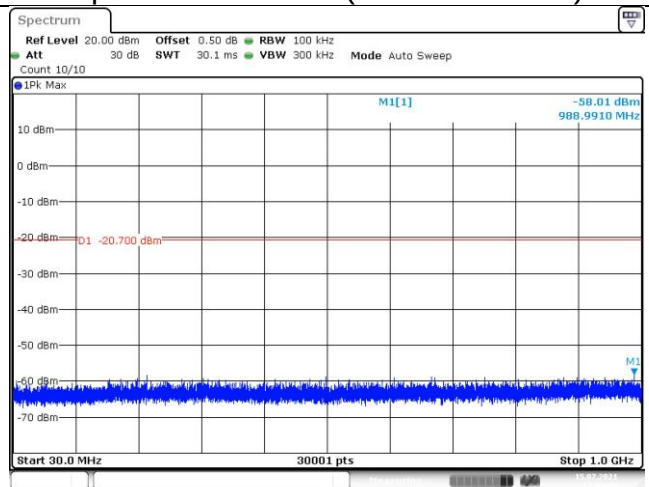
## Out-of-Band Emissions Channel 11 (2462MHz)

### Reference point



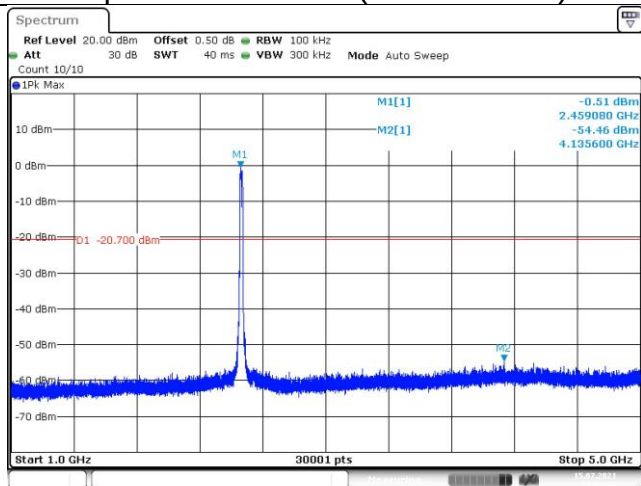
Date: 15 JUL 2021 11:04:06

### Spurious Emission (30MHz – 1GHz)



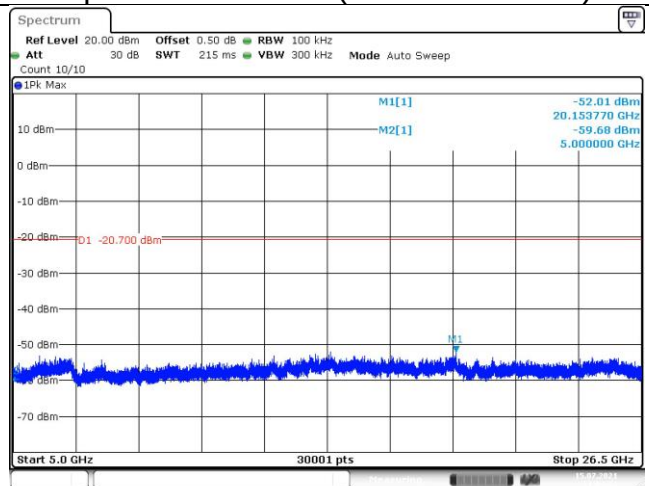
Date: 15 JUL 2021 11:04:10

### Spurious Emission (1GHz –5GHz)



Date: 15 JUL 2021 11:04:22

### Spurious Emission (5GHz –26.5GHz)



Date: 15 JUL 2021 11:04:54

Note: The emission which exceed the limit is the fundamental.



## 9.6 Band edge

### Test Method

- 1 Use the following spectrum analyzer settings:  
Span = wide enough to capture the peak level of the in-band emission and all spurious  
RBW = 100 kHz, VBW $\geq$ RBW, Sweep = auto, Detector function = peak, Trace = max hold.
- 2 Allow the trace to stabilize, use the peak and delta measurement to record the result.
- 3 The level displayed must comply with the limit specified in this Section.

### Limit

According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum 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. 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 Section 15.205(c)).

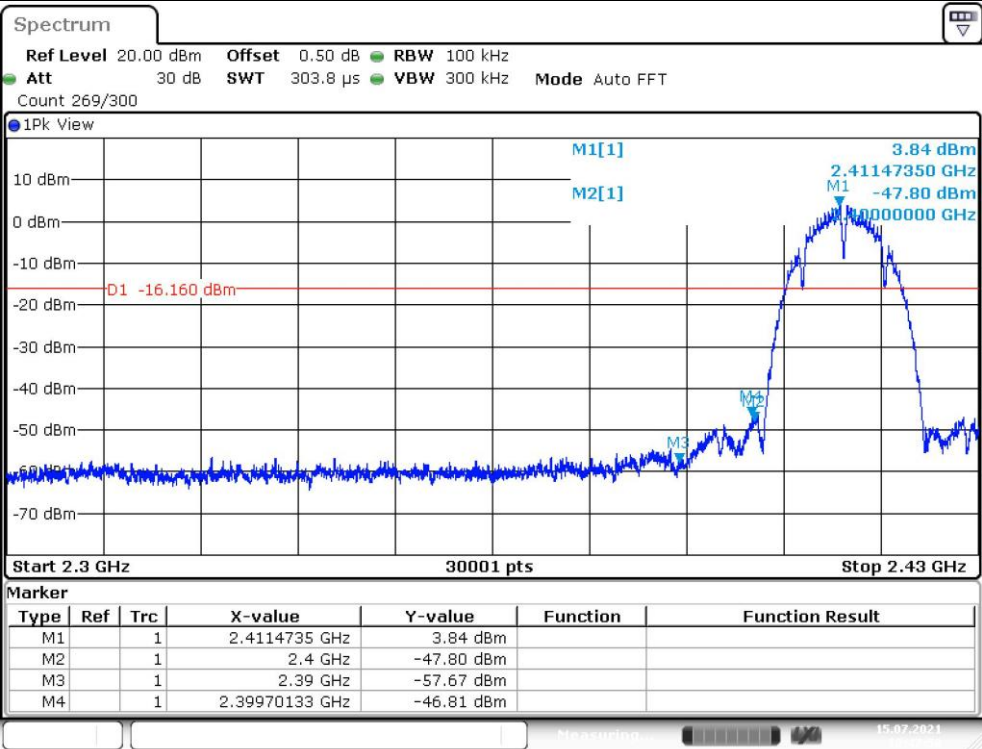


China

Test result

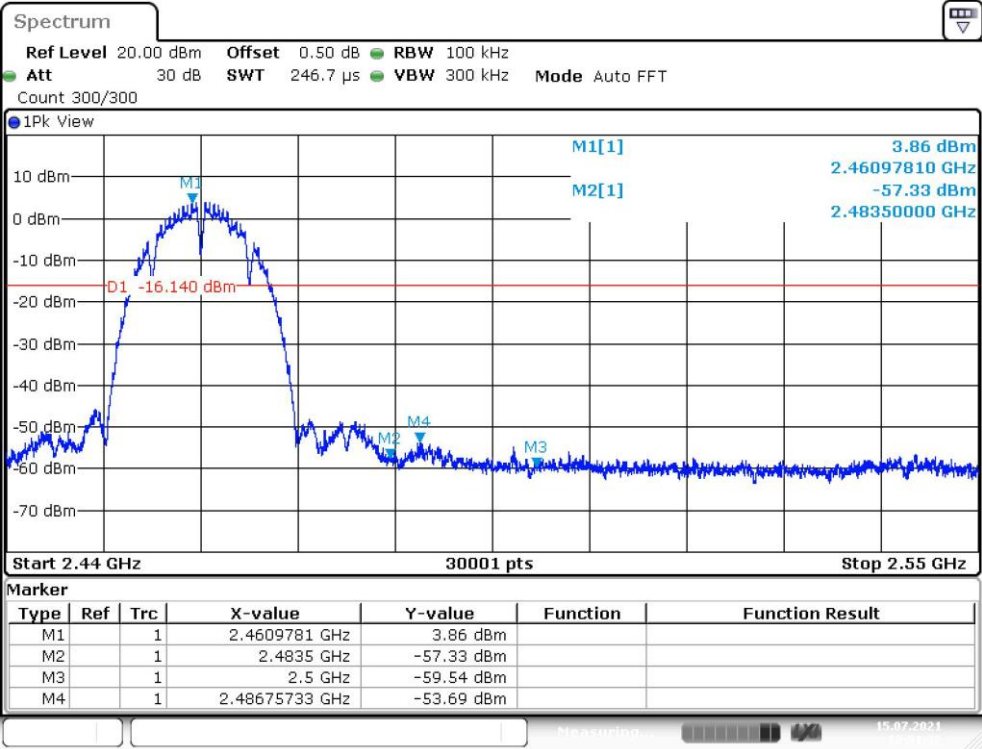
802.11 B

Low 2412



Date: 15.JUL.2021 10:47:58

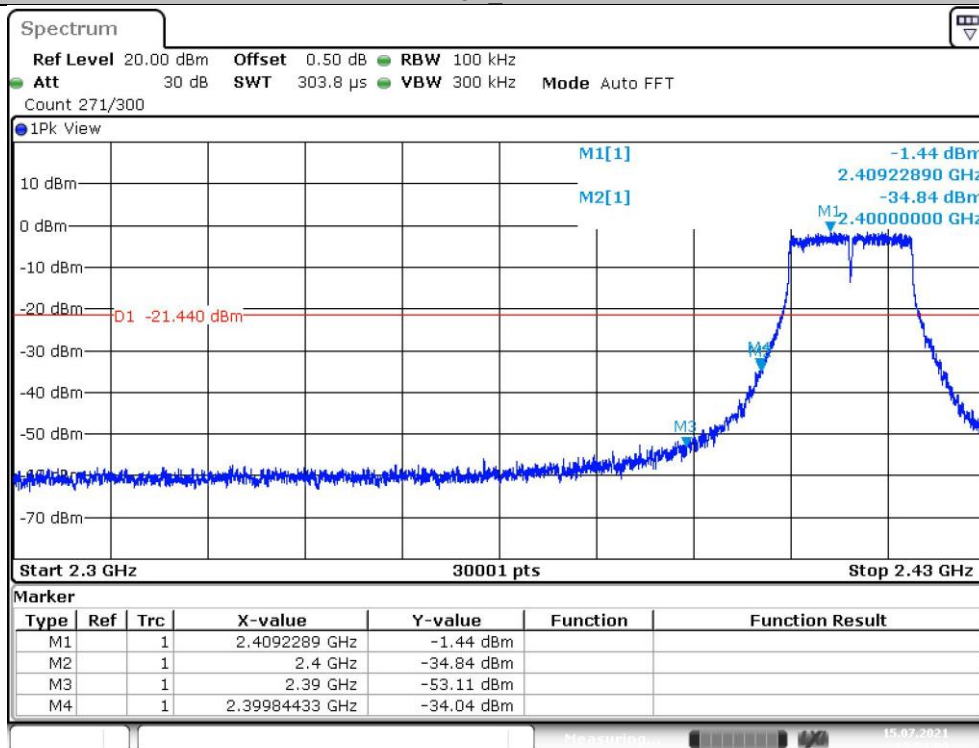
High 2462



Date: 15.JUL.2021 10:51:32

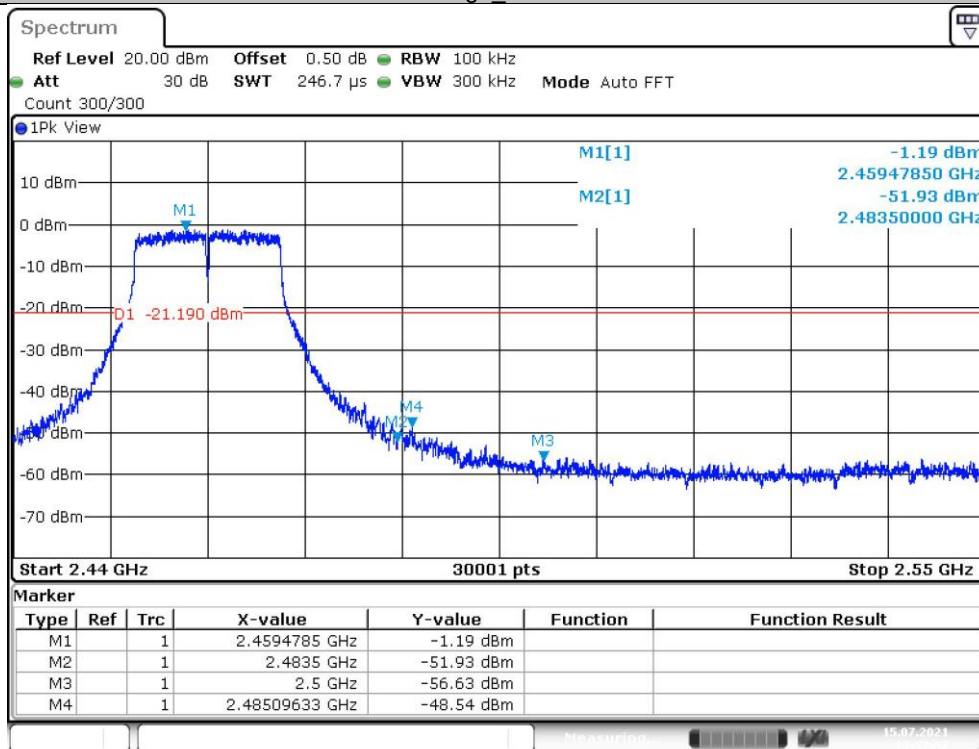
802.11 G

Low 2412



Date: 15.JUL.2021 10:54:09

High\_2462



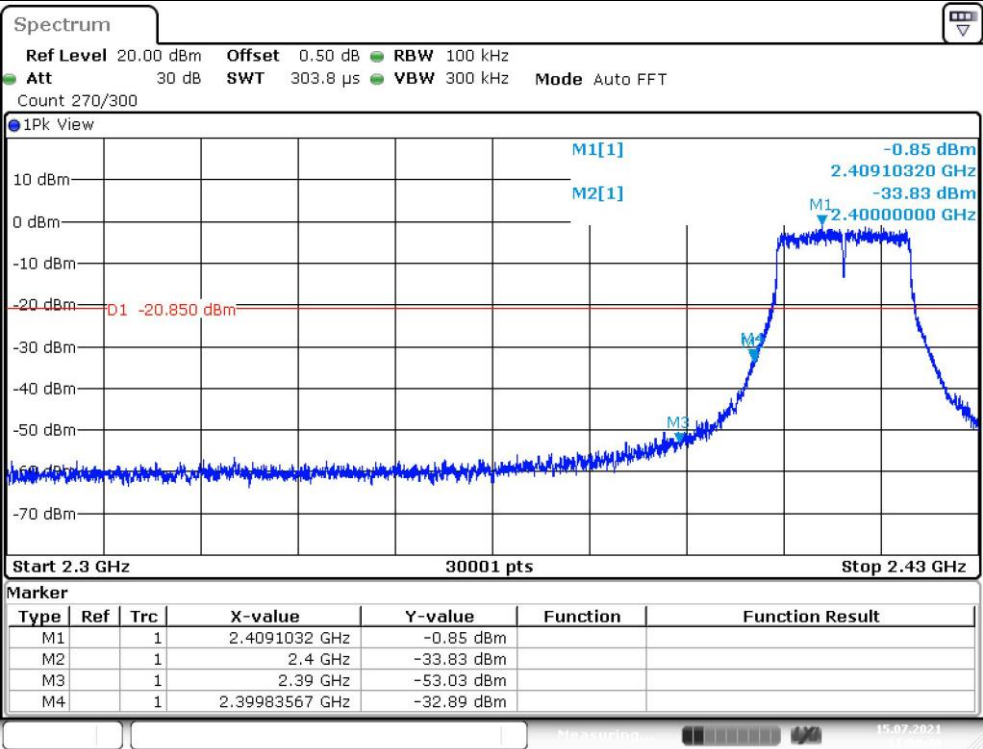
Date: 15.JUL.2021 10:57:57



China

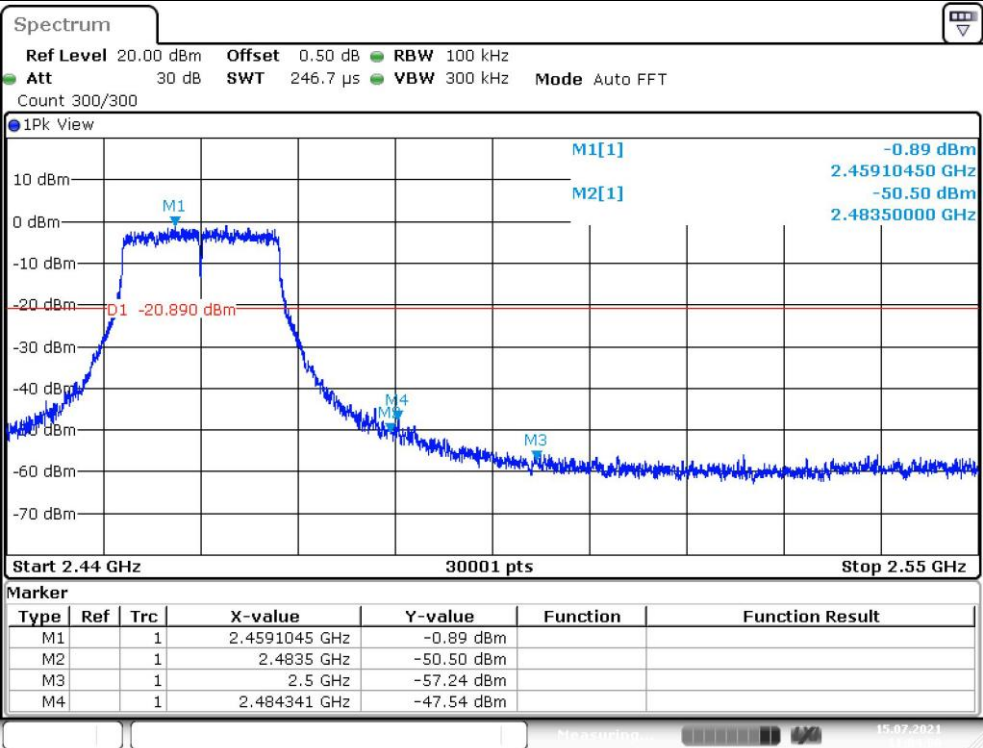
802.11 N20

Low 2412



Date: 15.JUL.2021 11:00:40

High\_2462



Date: 15.JUL.2021 11:04:00

## 9.7 Spurious radiated emissions for transmitter

### Test Method

1. The EUT was placed on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
3. The height of antenna 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.
4. 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 and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. Use the following spectrum analyzer settings According to C63.10:

#### For Below 1GHz

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious  
 RBW = 100 kHz to 120 kHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

#### For Peak unwanted emissions Above 1GHz:

Span = wide enough to capture the peak level of the in-band emission and all spurious  
 RBW = 1MHz, VBW ≥ RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

#### Procedures for average unwanted emissions measurements above 1000 MHz

- a) RBW = 1MHz.
- b) VBW ≥  $[3 \times \text{RBW}]$ .
- c) Detector = RMS (power averaging), if  $[\text{span} / (\# \text{ of points in sweep})] \leq \text{RBW} / 2$ .  
 Satisfying this condition can require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, then the detector mode shall be set to peak.
- d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set for linear voltage averaging. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.)
- e) Sweep time = auto.
- f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of  $1 / D$ , where D is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)
- g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then a correction factor shall be added to the measurement results prior to comparing with the emission limit, to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:  
 1) If power averaging (rms) mode was used in the preceding step e), then the correction



factor is  $[10 \log (1 / D)]$ , where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.

2) If linear voltage averaging mode was used in the preceding step e), then the correction factor is  $[20 \log (1 / D)]$ , where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 6 dB shall be added to the measured emission levels.

3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

## Limit

The radio emission outside the operating frequency band 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. Radiated emissions which fall in the restricted bands, as defined in section 15.205 must comply with the radiated emission limits specified in section 15.209.

| Frequency<br>MHz | Field Strength<br>uV/m | Measured Distance<br>Meters |
|------------------|------------------------|-----------------------------|
| 0.009~0.490      | 2400/F (kHz)           | 300                         |
| 0.490~1.705      | 24000/F (kHz)          | 30                          |
| 1.705~30         | 30                     | 30                          |

| Frequency<br>MHz | Field Strength<br>uV/m | Field Strength<br>dBμV/m | Detector |
|------------------|------------------------|--------------------------|----------|
| 30-88            | 100                    | 40                       | QP       |
| 88-216           | 150                    | 43.5                     | QP       |
| 216-960          | 200                    | 46                       | QP       |
| 960-1000         | 500                    | 54                       | QP       |
| Above 1000       | 500                    | 54                       | AV       |
| Above 1000       | 5000                   | 74                       | PK       |

### Spurious radiated emissions for transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

Transmitting spurious emission test result as below:

| Test mode: 802.11B  |                        |                |             |          |              |
|---------------------|------------------------|----------------|-------------|----------|--------------|
| Channel 1 (2412MHz) |                        |                |             |          |              |
| Frequency (MHz)     | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 2385.3              | 46.9                   | 74.0           | 27.1        | Peak     | Horizontal   |
| 4823.9              | 44.7                   | 74.0           | 29.3        | Peak     | Horizontal   |
| 2386.0              | 46.6                   | 74.0           | 27.4        | Peak     | Vertical     |
| 4823.9              | 44.6                   | 74.0           | 29.4        | Peak     | Vertical     |

| Test mode: 802.11B  |                        |                |             |          |              |
|---------------------|------------------------|----------------|-------------|----------|--------------|
| Channel 6 (2437MHz) |                        |                |             |          |              |
| Frequency (MHz)     | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 8293.0              | 51.0                   | 74.0           | 23          | Peak     | Horizontal   |
| 4873.7              | 43.5                   | 74.0           | 30.5        | Peak     | Vertical     |

| Test mode: 802.11B   |                        |                |             |          |              |
|----------------------|------------------------|----------------|-------------|----------|--------------|
| Channel 11 (2462MHz) |                        |                |             |          |              |
| Frequency (MHz)      | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 2483.7               | 48.1                   | 74.0           | 25.9        | Peak     | Horizontal   |
| 4924.2               | 44.0                   | 74.0           | 30          | Peak     | Horizontal   |
| 2483.5               | 47.0                   | 74.0           | 27          | Peak     | Vertical     |
| 4924.2               | 44.1                   | 74.0           | 29.9        | Peak     | Vertical     |

Remark:

- (1) Emission level= Original Receiver Reading + Correct Factor
- (2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
- (3) Margin = limit – Corrected Reading



| Test mode: 802.11G  |                        |                |             |          |              |
|---------------------|------------------------|----------------|-------------|----------|--------------|
| Channel 1 (2412MHz) |                        |                |             |          |              |
| Frequency (MHz)     | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 2388.9              | 56.8                   | 74.0           | 17.2        | Peak     | Horizontal   |
| 2388.9              | 46.8                   | 54.0           | 7.2         | Average  | Horizontal   |
| 4925.9              | 42.5                   | 74.0           | 31.5        | Peak     | Horizontal   |
| 2389.6              | 52.3                   | 74.0           | 21.7        | Peak     | Vertical     |
| 2389.6              | 42.2                   | 54.0           | 11.8        | Average  | Vertical     |
| 4826.1              | 42.8                   | 74.0           | 31.2        | Peak     | Vertical     |

| Test mode: 802.11G  |                        |                |             |          |              |
|---------------------|------------------------|----------------|-------------|----------|--------------|
| Channel 6 (2437MHz) |                        |                |             |          |              |
| Frequency (MHz)     | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 4870.9              | 42.9                   | 74.0           | 31.1        | Peak     | Horizontal   |
| 4873.2              | 42.4                   | 74.0           | 31.6        | Peak     | Vertical     |

| Test mode: 802.11G   |                        |                |             |          |              |
|----------------------|------------------------|----------------|-------------|----------|--------------|
| Channel 11 (2462MHz) |                        |                |             |          |              |
| Frequency (MHz)      | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 2483.7               | 60.9                   | 74.0           | 13.1        | Peak     | Horizontal   |
| 2483.7               | 50.9                   | 54.0           | 3.1         | Average  | Horizontal   |
| 4924.2               | 43.4                   | 74.0           | 30.6        | Peak     | Horizontal   |
| 2483.5               | 58.5                   | 74.0           | 15.5        | Peak     | Vertical     |
| 2483.5               | 47.7                   | 54.0           | 6.3         | Average  | Vertical     |
| 4925.9               | 44.3                   | 74.0           | 29.7        | Peak     | Vertical     |

## Remark:

- (1) Emission level= Original Receiver Reading + Correct Factor
- (2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
- (3) Margin = limit – Corrected Reading

| Test mode: 802.11N20 |                        |                |             |          |              |
|----------------------|------------------------|----------------|-------------|----------|--------------|
| Channel 1 (2412MHz)  |                        |                |             |          |              |
| Frequency (MHz)      | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 2388.0               | 56.5                   | 74.0           | 17.5        | Peak     | Horizontal   |
| 2388.0               | 46.2                   | 54.0           | 7.8         | Average  | Horizontal   |
| 4829.0               | 42.8                   | 74.0           | 31.2        | Peak     | Horizontal   |
| 2388.2               | 53.3                   | 74.0           | 20.7        | Peak     | Vertical     |
| 2388.2               | 43.7                   | 54.0           | 10.3        | Average  | Vertical     |
| 4830.7               | 43.7                   | 74.0           | 30.3        | Peak     | Vertical     |

| Test mode: 802.11N20 |                        |                |             |          |              |
|----------------------|------------------------|----------------|-------------|----------|--------------|
| Channel 6 (2437MHz)  |                        |                |             |          |              |
| Frequency (MHz)      | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 5941.9               | 48.0                   | 74.0           | 26          | Peak     | Horizontal   |
| 4920.8               | 45.3                   | 74.0           | 28.7        | Peak     | Vertical     |

| Test mode: 802.11N20 |                        |                |             |          |              |
|----------------------|------------------------|----------------|-------------|----------|--------------|
| Channel 11 (2462MHz) |                        |                |             |          |              |
| Frequency (MHz)      | Measure Level (dBuV/m) | Limit (dBuV/M) | Margin (dB) | Detector | Polarization |
| 2483.5               | 58.9                   | 74.0           | 15.1        | Peak     | Horizontal   |
| 2483.5               | 48.7                   | 54.0           | 5.3         | Average  | Horizontal   |
| 4812.5               | 44.5                   | 74.0           | 29.5        | Peak     | Horizontal   |
| 2483.6               | 59.4                   | 74.0           | 14.6        | Peak     | Vertical     |
| 2483.6               | 48.2                   | 54.0           | 5.8         | Average  | Vertical     |
| 5034.7               | 46.4                   | 74.0           | 27.6        | Peak     | Vertical     |

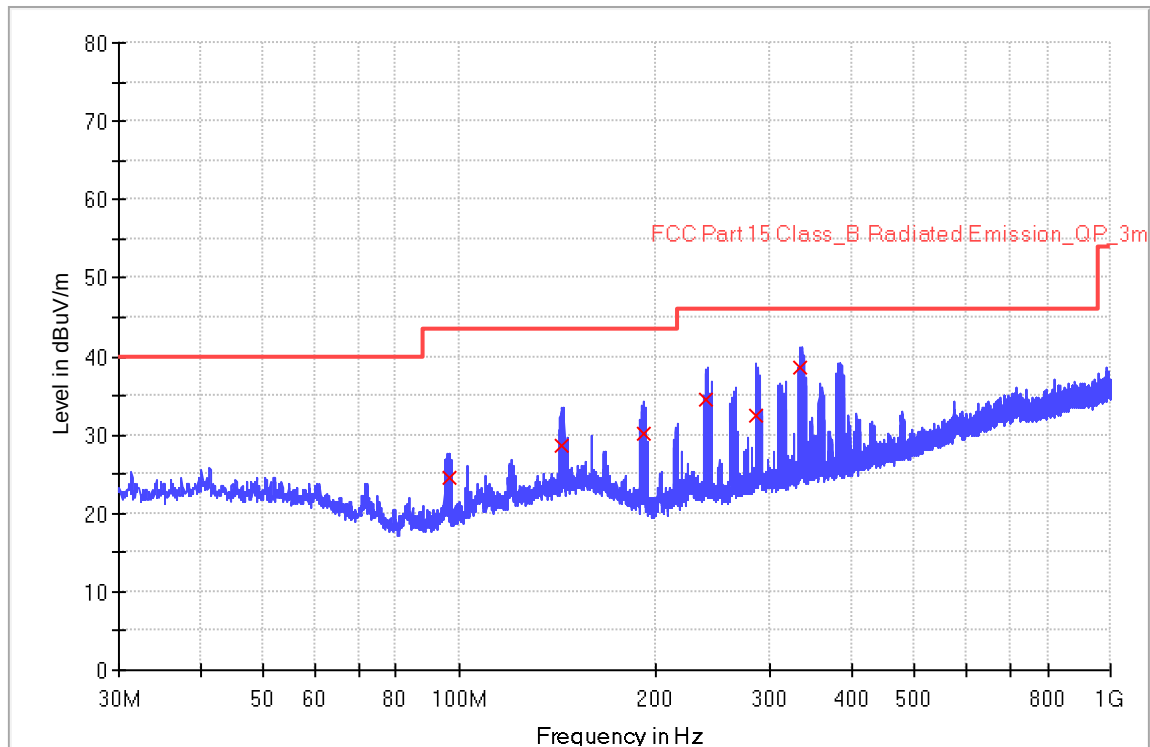
## Remark:

- (1) Emission level= Original Receiver Reading + Correct Factor
- (2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
- (3) Margin = limit – Corrected Reading

The worst case of Radiated Emission below 1GHz:

|                                                                     |                          |
|---------------------------------------------------------------------|--------------------------|
| Site: 3 meter chamber                                               | Time: 2021/07/16 - 14:47 |
| Limit: FCC_Part15.209 and RSS-GEN 8.8_RE(3m)                        | Engineer: Wenqiang LU    |
| Probe: VULB9168                                                     | Polarity: Horizontal     |
| UT: Wi-Fi and Bluetooth module, Model no: CR3L-IPEX                 | Power: 120VAC, 60Hz      |
| Note: Transmit by at channel 2412MHz 802.11g (worst case).          |                          |
| Note: Pre-scan with three orthogonal axis and worst case as X axis. |                          |

RE\_VULB9168\_pre\_Cont\_30-1000



## Limit and Margin

| Frequency (MHz) | QuasiPeak (dBuV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) | Margin - QPK (dB) | Limit - QPK (dBuV/m) |
|-----------------|--------------------|-----------------|-----------------|-------------|-----|---------------|------------|-------------------|----------------------|
| 96.440000       | 24.6               | 1000.0          | 120.000         | 100.4       | H   | 347.0         | 11.1       | 18.9              | 43.5                 |
| 144.040000      | 28.7               | 1000.0          | 120.000         | 100.4       | H   | 112.0         | 15.2       | 14.8              | 43.5                 |
| 192.040000      | 30.1               | 1000.0          | 120.000         | 100.4       | H   | 294.0         | 12.1       | 13.5              | 43.5                 |
| 239.560000      | 34.5               | 1000.0          | 120.000         | 100.4       | H   | 172.0         | 13.4       | 11.5              | 46.0                 |
| 286.120000      | 32.4               | 1000.0          | 120.000         | 100.4       | H   | 242.0         | 14.7       | 13.6              | 46.0                 |
| 333.840000      | 38.6               | 1000.0          | 120.000         | 100.4       | H   | 32.0          | 15.9       | 7.5               | 46.0                 |

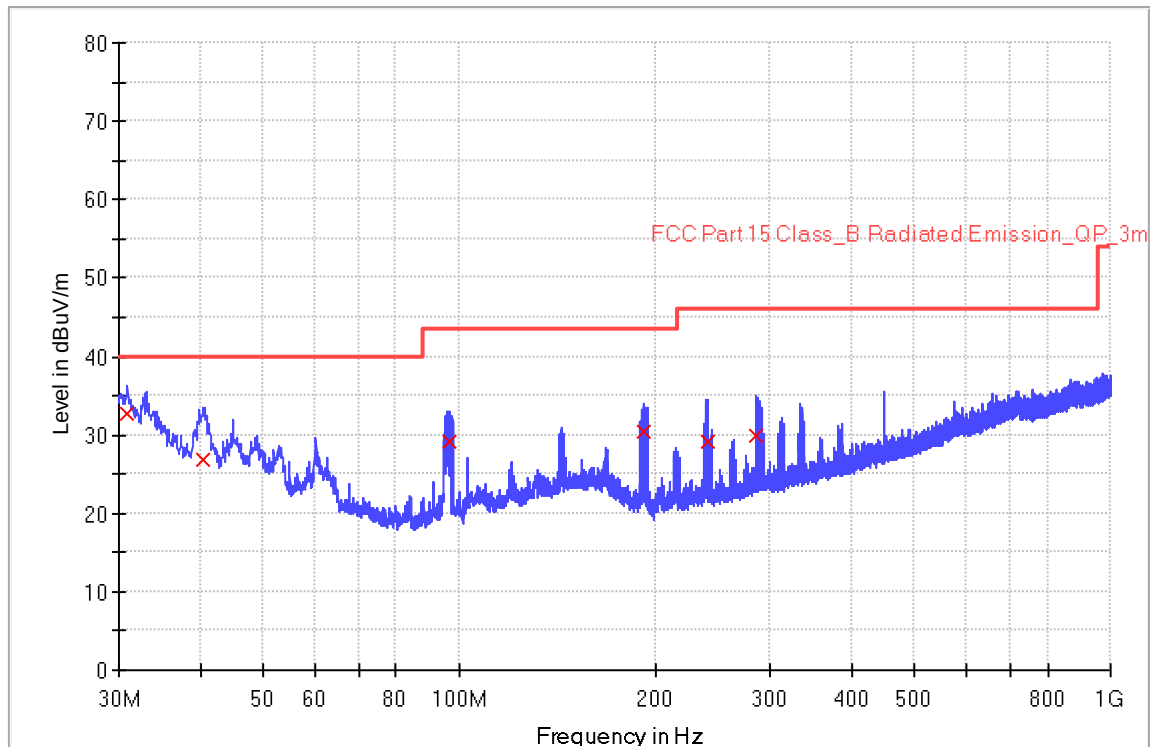
Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.

|                                                                     |                          |
|---------------------------------------------------------------------|--------------------------|
| Site: 3 meter chamber                                               | Time: 2021/07/16 - 13:23 |
| Limit: FCC_Part15.209 and RSS-GEN 8.8_RE(3m)                        | Engineer: Wenqiang LU    |
| Probe: VULB9168                                                     | Polarity: Vertical       |
| UT: Wi-Fi and Bluetooth module, Model no: CR3L-IPEX                 | Power: 120VAC, 60Hz      |
| Note: Transmit by at channel 2412MHz 802.11g (worst case).          |                          |
| Note: Pre-scan with three orthogonal axis and worst case as X axis. |                          |

RE\_VULB9168\_pre\_Cont\_30-1000



## Limit and Margin

| Frequency (MHz) | QuasiPeak (dBuV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) | Margin - QPK (dB) | Limit - QPK (dBuV/m) |
|-----------------|--------------------|-----------------|-----------------|-------------|-----|---------------|------------|-------------------|----------------------|
| 30.920000       | 32.6               | 1000.0          | 120.000         | 100.4       | V   | 16.0          | 13.9       | 7.4               | 40.0                 |
| 40.320000       | 27.0               | 1000.0          | 120.000         | 100.4       | V   | 92.0          | 14.7       | 13.1              | 40.0                 |
| 96.240000       | 29.1               | 1000.0          | 120.000         | 100.4       | V   | 212.0         | 11.0       | 14.4              | 43.5                 |
| 192.480000      | 30.4               | 1000.0          | 120.000         | 100.4       | V   | 331.0         | 12.1       | 13.1              | 43.5                 |
| 240.000000      | 29.1               | 1000.0          | 120.000         | 100.4       | V   | 0.0           | 13.4       | 16.9              | 46.0                 |
| 286.080000      | 30.0               | 1000.0          | 120.000         | 100.4       | V   | 0.0           | 14.7       | 16.0              | 46.0                 |

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.

## 10 Test Equipment List

List of Test Instruments  
Test Site1

|                                  | DESCRIPTION                                                       | MANUFACTURER                 | MODEL NO.   | SERIAL NO. | CAL. DATE  | CAL. DUE DATE |
|----------------------------------|-------------------------------------------------------------------|------------------------------|-------------|------------|------------|---------------|
| C                                | Signal Analyzer                                                   | Rohde & Schwarz              | FSV40       | 101091     | 2020-8-4   | 2021-8-3      |
|                                  | Wideband power sensor                                             | Rohde & Schwarz              | NRP-Z81     | 104782     | 2020-12-23 | 2021-12-22    |
| RE                               | EMI Test Receiver                                                 | Rohde & Schwarz              | ESR3        | 101906     | 2020-8-4   | 2021-8-3      |
|                                  | Signal Analyzer                                                   | Rohde & Schwarz              | FSV40       | 101091     | 2020-8-4   | 2021-8-3      |
|                                  | Trilog Super Broadband Test Antenna                               | Schwarzbeck                  | VULB 9168   | 961        | 2019-3-16  | 2022-3-15     |
|                                  | Horn Antenna                                                      | Rohde & Schwarz              | HF907       | 102393     | 2021-4-13  | 2024-4-12     |
|                                  | Pre-amplifier                                                     | Rohde & Schwarz              | SCU-18D     | 19006451   | 2020-8-4   | 2021-8-3      |
|                                  | Loop antenna                                                      | Rohde & Schwarz              | HFH2-Z2     | 100443     | 2021-5-21  | 2022-5-20     |
|                                  | DOUBLE-RIDGED WAVEGUIDE HORN WITH PRE-AMPLIFIER (18 GHZ - 40 GHZ) | ETS-Lindgren                 | 3116C-PA    | 002222727  | 2020-9-23  | 2021-9-22     |
|                                  | 3m Semi-anechoic chamber                                          | TDK                          | 9X6X6       | ----       | 2021-5-8   | 2024-5-7      |
| CE                               | EMI Test Receiver                                                 | Rohde & Schwarz              | ESR3        | 101907     | 2020-8-4   | 2021-8-3      |
|                                  | LISN                                                              | Rohde & Schwarz              | ENV216      | 101924     | 2020-8-4   | 2021-8-3      |
| Measurement Software Information |                                                                   |                              |             |            |            |               |
| Test Item                        | Software                                                          | Manufacturer                 | Version     |            |            |               |
| C                                | Power Viewer                                                      | Rohde & Schwarz              | V 11.0      |            |            |               |
| C                                | Bluetooth and WiFi Test System                                    | Shenzhen JS tonscond co.,ltd | 2.6.77.0518 |            |            |               |
| RE                               | EMC 32                                                            | Rohde & Schwarz              | V9.15.00    |            |            |               |
| CE                               | EMC 32                                                            | Rohde & Schwarz              | V9.15.03    |            |            |               |

### C - Conducted RF tests

- Conducted peak output power
- 6dB bandwidth and 99% Occupied Bandwidth
- Power spectral density\*
- Spurious RF conducted emissions
- Band edge

## 11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

| Items                                    | Extended Uncertainty                                                                                                                                           |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Conducted Disturbance at Mains Terminals | 150kHz to 30MHz, LISN, $\pm 3.16\text{dB}$                                                                                                                     |
| Radiated Disturbance                     | 30MHz to 1GHz, $\pm 5.03\text{dB}$ (Horizontal)<br>$\pm 5.12\text{dB}$ (Vertical)<br>1GHz to 18GHz, $\pm 5.49\text{dB}$<br>18GHz to 40GHz, $\pm 5.63\text{dB}$ |
| Carrier power conducted measurement      | 50MHz~18GHz, $\pm 1.238\text{dB}$                                                                                                                              |
| Spurious Emission Conducted Measurement  | 9kHz ~40GHz, $\pm 1.224\text{dB}$                                                                                                                              |



## 12 Photographs of Test Set-ups

Refer to the < Test Setup photos >.



## **13 Photographs of EUT**

Refer to the < External Photos > & < Internal Photos >.

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THE END