



# **FCC TEST REPORT**

**FCC ID: 2ADMF-MD0456**

On Behalf of

**Shenzhen KEYES DIY Robot co., Ltd**

**ESP32-CAM WiFi Camera Modules**

**Model No.: MD0456**

Prepared for : Shenzhen KEYES DIY Robot co., Ltd  
Address : 9/F Jinxing building, Heping Industrial Park, Hualian community,  
Longhua street, Longhua district, Shenzhen, China.

Prepared By : Shenzhen Alpha Product Testing Co., Ltd.  
Address : Building i, No.2, Lixin Road, Fuyong Street, Bao'an District, 518103,  
Shenzhen, Guangdong, China

Report Number : A2101081-C01-R11  
Date of Receipt : January 14, 2021  
Date of Test : January 14, 2021-February 4, 2021  
Date of Report : February 4, 2021  
Version Number : V0

## TABLE OF CONTENTS

| Description                                                       | Page      |
|-------------------------------------------------------------------|-----------|
| <b>1. Summary of Standards And Results</b> -----                  | <b>6</b>  |
| 1.1. Description of Standards and Results -----                   | 6         |
| <b>2. General Information</b> -----                               | <b>7</b>  |
| 2.1. Description of Device (EUT)-----                             | 7         |
| 2.2. Accessories of Device (EUT) -----                            | 8         |
| 2.3. Tested Supporting System Details-----                        | 8         |
| 2.4. Block Diagram of connection between EUT and simulators ----- | 8         |
| 2.5. Test Mode Description -----                                  | 8         |
| 2.6. Test Conditions -----                                        | 9         |
| 2.7. Test Facility -----                                          | 9         |
| 2.8. Measurement Uncertainty -----                                | 10        |
| 2.9. Test Equipment List -----                                    | 11        |
| <b>3. Spurious Emission</b> -----                                 | <b>12</b> |
| 3.1. Test Limits -----                                            | 12        |
| 3.2. Test Procedure -----                                         | 15        |
| 3.3. Test Setup -----                                             | 15        |
| 3.4. Test Results -----                                           | 16        |
| <b>4. Power line Conducted Emission</b> -----                     | <b>22</b> |
| 4.1. Test Limits -----                                            | 22        |
| 4.2. Test Procedure -----                                         | 22        |
| 4.3. Test Setup -----                                             | 22        |
| 4.4. Test Results -----                                           | 22        |
| <b>5. Conducted Maximum Output Power</b> -----                    | <b>24</b> |
| 5.1. Test limits -----                                            | 24        |
| 5.2. Test Procedure -----                                         | 24        |
| 5.3. Test Setup -----                                             | 24        |
| 5.4. Test Results -----                                           | 24        |
| <b>6. Peak Power Spectral Density</b> -----                       | <b>26</b> |
| 6.1. Test limits -----                                            | 26        |
| 6.2. Test Procedure -----                                         | 26        |
| 6.3. Test Setup -----                                             | 26        |
| 6.4. Test Results -----                                           | 27        |
| <b>7. Bandwidth</b> -----                                         | <b>34</b> |
| 7.1. Test limits -----                                            | 34        |
| 7.2. Test Procedure -----                                         | 34        |
| 7.3. Test Setup -----                                             | 34        |
| 7.4. Test Results -----                                           | 34        |
| <b>8. Band Edge Check</b> -----                                   | <b>48</b> |
| 8.1. Test limits -----                                            | 48        |
| 8.2. Test Procedure -----                                         | 48        |
| 8.3. Test Setup -----                                             | 48        |
| 8.4. Test Results -----                                           | 48        |
| <b>9. Frequency stability</b> -----                               | <b>55</b> |
| 9.1. Test limit -----                                             | 55        |
| 9.2. Test Procedure -----                                         | 55        |
| 9.3. Test Setup -----                                             | 55        |
| 9.4. Test Results -----                                           | 55        |

|                                      |           |
|--------------------------------------|-----------|
| <b>10. Antenna Requirement</b>       | <b>56</b> |
| 10.1. Standard Requirement           | 56        |
| 10.2. Antenna Connected Construction | 56        |
| 10.3. Results                        | 56        |
| <b>11. Test setup photo</b>          | <b>57</b> |
| <b>12. Photos of EUT</b>             | <b>59</b> |

## TEST REPORT DECLARATION

Applicant : Shenzhen KEYES DIY Robot co., Ltd  
Address : 9/F Jinxing building, Heping Industrial Park, Hualian community, Longhua street,  
Longhua district, Shenzhen, China.  
Manufacturer : Shenzhen KEYES DIY Robot co., Ltd  
Address : 9/F Jinxing building, Heping Industrial Park, Hualian community, Longhua street,  
Longhua district, Shenzhen, China.  
EUT  
Description : ESP32-CAM WiFi Camera Modules  
(A) Model No. : MD0456  
(B) Trademark : Keyestudio, KEYES, INLAND

Measurement Standard Used:

**FCC Rules and Regulations Part 15 Subpart C Section 15.247**

**RSS-247 Issue 2, RSS-Gen Issue 5, ANSI C63.10:2013, CISPR 16-1-4:2010**

The device described above is tested by Shenzhen Alpha Product Testing Co., Ltd. to determine the maximum emission levels emanating from the device. The maximum emission levels are compared to the FCC Part 15 Subpart C limits both conducted and radiated emissions. The test results are contained in this test report and Shenzhen Alpha Product Testing Co., Ltd. is assumed of full responsibility for the accuracy and completeness of these tests.

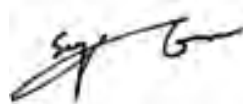
After the test, our opinion is that EUT compliance with the requirement of the above standards.

This report applies to above tested sample only. This report shall not be reproduced in parts without written approval of Shenzhen Alpha Product Testing Co., Ltd.

Tested by (name + signature).....: Lucas Pang  
Project Engineer



Approved by (name + signature).....: Simple Guan  
Project Manager



Date of issue.....: February 4, 2021

**Revision History**

| Revision | Issue Date       | Revisions              | Revised By |
|----------|------------------|------------------------|------------|
| V0       | February 4, 2021 | Initial released Issue | Lucas Pang |

## 1. SUMMARY OF STANDARDS AND RESULTS

### 1.1. Description of Standards and Results

The EUT have been tested according to the applicable standards as referenced below:

| Test Item                                                                                                                                                                                   | Standards Paragraph                                                                              | Result |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--------|
| Conducted Emission                                                                                                                                                                          | FCC Part 15: 15.207<br>RSS-GEN(8.8)<br>ANSI C63.10 :2013                                         | P      |
| 6dB Bandwidth                                                                                                                                                                               | FCC PART 15:15.247(a)(2)<br>RSS-247(5.2 a)<br>ANSI C63.10 :2013                                  | P      |
| Output Power                                                                                                                                                                                | FCC Part 15: 15.247(b)(3)<br>RSS-247(5.4 d)<br>ANSI C63.10 :2013                                 | P      |
| Radiated Spurious Emission                                                                                                                                                                  | FCC Part 15: 15.209<br>FCC Part 15: 15.247(d)<br>RSS-Gen(8.9), RSS-247(5.5)<br>ANSI C63.10 :2013 | P      |
| Conducted Spurious & Band Edge Emission                                                                                                                                                     | FCC Part 15: 15.247(d)<br>RSS-Gen(8.9), RSS-247(5.5)<br>ANSI C63.10 :2013                        | P      |
| Power Spectral Density                                                                                                                                                                      | FCC PART 15:15.247(e)<br>RSS-247(5.2 b)<br>ANSI C63.10 :2013                                     | P      |
| Radiated Band Edge Emission                                                                                                                                                                 | FCC Part 15: 15.247(d)<br>RSS-GEN(6.13)<br>ANSI C63.10 :2013                                     | P      |
| Frequency stability                                                                                                                                                                         | RSS-GEN(6.11)                                                                                    | N/A    |
| Antenna Requirement                                                                                                                                                                         | FCC Part 15: 15.203<br>RSS-GEN(6.8)                                                              | P      |
| Note: <ol style="list-style-type: none"> <li>1. P is an abbreviation for Pass.</li> <li>2. F is an abbreviation for Fail.</li> <li>3. N/A is an abbreviation for Not Applicable.</li> </ol> |                                                                                                  |        |

## 2. GENERAL INFORMATION

### 2.1. Description of Device (EUT)

EUT Name : ESP32-CAM WiFi Camera Modules

Trademark : Keyestudio, KEYES, INLAND

Model No. : MD0456

DIFF. : /

Power supply : DC 4.75-5.25V

2.4G WIFI :

Operation frequency : 2412MHz-2462MHz for IEEE 802.11 b, g, n/HT20  
2422MHz~2452MHz for IEEE802.11n/HT40

Channel No. : 802.11b/802.11g /802.11n(HT20): 11CH  
802.11(HT40): 7CH

Modulation type : IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK)  
IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK)  
IEEE 802.11n :OFDM(64QAM, 16QAM, QPSK, BPSK)

Antenna Type : Internal antenna, Maximum Gain is 2dBi

Software version : V1.0

Hardware version : V1.0

Intend use environment : Residential, commercial and light industrial environment

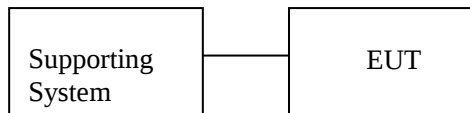
## 2.2. Accessories of Device (EUT)

|              |   |   |
|--------------|---|---|
| Accessories1 | : | / |
| Manufacturer | : | / |
| Model        | : | / |
| Input        | : | / |

## 2.3. Tested Supporting System Details

| No. | Description | Manufacturer | Model | Serial Number | Certification or SDOC |
|-----|-------------|--------------|-------|---------------|-----------------------|
| 1   | DC power    | N/A          | N/A   | N/A           | N/A                   |

## 2.4. Block Diagram of connection between EUT and simulators



## 2.5. Test Mode Description

| Duty cycle :100%Keeping TX                                                                                                          |                            |             |                 |
|-------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------------|-----------------|
| Mode                                                                                                                                | data rate (Mbps)(see Note) | Channel     | Frequency (MHz) |
| IEEE 802.11b                                                                                                                        | 1                          | Low :CH1    | 2412            |
|                                                                                                                                     | 1                          | Middle: CH6 | 2437            |
|                                                                                                                                     | 1                          | High: CH11  | 2462            |
| IEEE 802.11g                                                                                                                        | 6                          | Low :CH1    | 2412            |
|                                                                                                                                     | 6                          | Middle: CH6 | 2437            |
|                                                                                                                                     | 6                          | High: CH11  | 2462            |
| IEEE 802.11 n/HT20                                                                                                                  | 6.5                        | Low :CH1    | 2412            |
|                                                                                                                                     | 6.5                        | Middle: CH6 | 2437            |
|                                                                                                                                     | 6.5                        | High: CH11  | 2462            |
| IEEE 802.11 n/HT40                                                                                                                  | 13                         | Low :CH3    | 2422            |
|                                                                                                                                     | 13                         | Middle: CH6 | 2437            |
|                                                                                                                                     | 13                         | High: CH9   | 2452            |
| Note: According exploratory test, EUT will have maximum output power in those data rate. So those data rate were used for all test. |                            |             |                 |

| Channel list:                    |                 |         |                 |         |                 |
|----------------------------------|-----------------|---------|-----------------|---------|-----------------|
| For IEEE 802.11b, g, n/HT20      |                 |         |                 |         |                 |
| Channel                          | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
| CH1                              | 2412            | CH5     | 2432            | CH9     | 2452            |
| CH2                              | 2417            | CH6     | 2437            | CH10    | 2457            |
| CH3                              | 2422            | CH7     | 2442            | CH11    | 2462            |
| CH4                              | 2427            | CH8     | 2447            |         |                 |
| For IEEE 802.11 n/HT40 with 2.4G |                 |         |                 |         |                 |
| Channel                          | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
| CH1                              | 2422            | CH5     | 2442            |         |                 |
| CH2                              | 2427            | CH6     | 2447            |         |                 |
| CH3                              | 2432            | CH7     | 2452            |         |                 |
| CH4                              | 2437            |         |                 |         |                 |

| Setting output power (Max) |         |               |               |
|----------------------------|---------|---------------|---------------|
| 802.11b                    | 802.11g | 802.11n(HT20) | 802.11n(HT40) |
| 14±3dBm                    | 14±3dBm | 14±3dBm       | 14±3dBm       |

## 2.6.Test Conditions

| Items              | Required  | Actual |
|--------------------|-----------|--------|
| Temperature range: | 15-35℃    | 24℃    |
| Humidity range:    | 25-75%    | 56%    |
| Pressure range:    | 86-106kPa | 98kPa  |

## 2.7.Test Facility

Shenzhen Alpha Product Testing Co., Ltd  
 Building i, No.2, Lixin Road, Fuyong Street, Bao'an District, 518103,  
 Shenzhen, Guangdong, China

June 21, 2018 File on Federal Communication Commission  
 Registration Number: 293961  
 Designation Number: CN1236

July 15, 2019 Certificated by IC  
 Registration Number: CN0085

## 2.8.Measurement Uncertainty

(95% confidence levels, k=2)

| Item                                                                     | Uncertainty          |
|--------------------------------------------------------------------------|----------------------|
| Uncertainty for Power point Conducted Emissions Test                     | 2.74dB               |
| Uncertainty for Radiation Emission test in 3m chamber<br>(below 30MHz)   | 2.13 dB(Polarize: V) |
|                                                                          | 2.57dB(Polarize: H)  |
| Uncertainty for Radiation Emission test in 3m chamber<br>(30MHz to 1GHz) | 3.77dB(Polarize: V)  |
|                                                                          | 3.80dB(Polarize: H)  |
| Uncertainty for Radiation Emission test in 3m chamber<br>(1GHz to 25GHz) | 4.13dB(Polarize: H)  |
|                                                                          | 4.16dB(Polarize: V)  |
| Uncertainty for radio frequency                                          | $5.4 \times 10^{-8}$ |
| Uncertainty for conducted RF Power                                       | 0.37dB               |
| Uncertainty for temperature                                              | 0.2°C                |
| Uncertainty for humidity                                                 | 1%                   |
| Uncertainty for DC and low frequency voltages                            | 0.06%                |

## 2.9.Test Equipment List

| Equipment                   | Manufacture   | Model No.        | Serial No.             | Last cal.  | Cal Interval |
|-----------------------------|---------------|------------------|------------------------|------------|--------------|
| 9*6*6 anechoic chamber      | CHENYU        | 9*6*6            | N/A                    | 2019.09.06 | 3Year        |
| Spectrum analyzer           | ROHDE&SCHWARZ | FSV40-N          | 102137                 | 2020.09.02 | 1Year        |
| Spectrum analyzer           | Agilent       | N9020A           | MY499100060            | 2020.09.02 | 1Year        |
| Receiver                    | ROHDE&SCHWARZ | ESR              | 1316.3003K03-102082-Wa | 2020.09.02 | 1Year        |
| Receiver                    | R&S           | ESCI             | 101165                 | 2020.09.02 | 1Year        |
| Bilog Antenna               | Schwarzbeck   | VULB 9168        | VULB9168-438           | 2020.04.12 | 2Year        |
| Horn Antenna                | SCHWARZBECK   | BBHA 9120 D      | BBHA 9120 D(1201)      | 2020.04.12 | 2Year        |
| Active Loop Antenna         | SCHWARZBECK   | FMZB 1519B       | 00059                  | 2019.09.07 | 2Year        |
| Cable                       | Resenberger   | N/A              | No.1                   | 2020.09.02 | 1Year        |
| Cable                       | Resenberger   | N/A              | No.2                   | 2020.09.02 | 1Year        |
| Cable                       | Resenberger   | N/A              | No.3                   | 2020.09.02 | 1Year        |
| Pre-amplifier               | HP            | HP8347A          | 2834A00455             | 2020.09.02 | 1Year        |
| Pre-amplifier               | Agilent       | 8449B            | 3008A02664             | 2020.09.02 | 1Year        |
| L.I.S.N.#1                  | Schwarzbeck   | NSLK8126         | 8126466                | 2020.09.02 | 1Year        |
| L.I.S.N.#2                  | ROHDE&SCHWARZ | ENV216           | 101043                 | 2020.09.02 | 1 Year       |
| 20db Attenuator             | ICPROBING     | IATS1            | 82347                  | 2020.09.02 | 1 Year       |
| Horn Antenna                | SCHWARZBECK   | BBHA9170         | 00946                  | 2019.09.07 | 2 Year       |
| Preamplifier                | SKET          | LNPA_1840-50     | SK2018101801           | 2020.09.02 | 1 Year       |
| Power Meter                 | Agilent       | E9300A           | MY41496625             | 2020.09.02 | 1 Year       |
| Temp. & Humid. Chamber      | Wei Huang     | WHTH-1000-40-880 | 100631                 | 2020.09.02 | 1 Year       |
| Switching Mode Power Supply | JUNKE         | JK12010S         | 20140927-6             | 2020.09.02 | 1 Year       |

### 3. SPURIOUS EMISSION

#### 3.1. Test Limits

All the emissions appearing within 15.205 restricted frequency bands shall not exceed the limits shown in 15.209, all the other emissions shall be at least 20dB below the fundamental emissions, or comply with 15.209 limits.

##### 15.205 Restricted frequency band

| MHz                        | MHz                   | MHz             | GHz              |
|----------------------------|-----------------------|-----------------|------------------|
| 0.090 - 0.110              | 16.42 - 16.423        | 399.9 - 410     | 4.5 - 5.15       |
| <sup>1</sup> 0.495 - 0.505 | 16.69475 - 16.69525   | 608 - 614       | 5.35 - 5.46      |
| 2.1735 - 2.1905            | 16.80425 - 16.80475   | 960 - 1240      | 7.25 - 7.75      |
| 4.125 - 4.128              | 25.5 - 25.67          | 1300 - 1427     | 8.025 - 8.5      |
| 4.17725 - 4.17775          | 37.5 - 38.25          | 1435 - 1626.5   | 9.0 - 9.2        |
| 4.20725 - 4.20775          | 73 - 74.6             | 1645.5 - 1646.5 | 9.3 - 9.5        |
| 6.215 - 6.218              | 74.8 - 75.2           | 1660 - 1710     | 10.6 - 12.7      |
| 6.26775 - 6.26825          | 108 - 121.94          | 1718.8 - 1722.2 | 13.25 - 13.4     |
| 6.31175 - 6.31225          | 123 - 138             | 2200 - 2300     | 14.47 - 14.5     |
| 8.291 - 8.294              | 149.9 - 150.05        | 2310 - 2390     | 15.35 - 16.2     |
| 8.362 - 8.366              | 156.52475 - 156.52525 | 2483.5 - 2500   | 17.7 - 21.4      |
| 8.37625 - 8.38675          | 156.7 - 156.9         | 2690 - 2900     | 22.01 - 23.12    |
| 8.41425 - 8.41475          | 162.0125 - 167.17     | 3260 - 3267     | 23.6 - 24.0      |
| 12.29 - 12.293             | 167.72 - 173.2        | 3332 - 3339     | 31.2 - 31.8      |
| 12.51975 - 12.52025        | 240 - 285             | 3345.8 - 3358   | 36.43 - 36.5     |
| 12.57675 - 12.57725        | 322 - 335.4           | 3600 - 4400     | ( <sup>2</sup> ) |

##### RSS-GEN Restricted frequency band

**Table 7 – Restricted frequency bandsNote 1**

| MHz               | MHz                   | GHz           |
|-------------------|-----------------------|---------------|
| 0.090 - 0.110     | 149.9 - 150.05        | 9.0 - 9.2     |
| 0.495 - 0.505     | 156.52475 - 156.52525 | 9.3 - 9.5     |
| 2.1735 - 2.1905   | 156.7 - 156.9         | 10.6 - 12.7   |
| 3.020 - 3.026     | 162.0125 - 167.17     | 13.25 - 13.4  |
| 4.125 - 4.128     | 167.72 - 173.2        | 14.47 - 14.5  |
| 4.17725 - 4.17775 | 240 – 285             | 15.35 - 16.2  |
| 4.20725 - 4.20775 | 322 - 335.4           | 17.7 - 21.4   |
| 5.677 - 5.683     | 399.9 - 410           | 22.01 - 23.12 |

|                     |                 |              |
|---------------------|-----------------|--------------|
| 6.215 - 6.218       | 608 - 614       | 23.6 - 24.0  |
| 6.26775 - 6.26825   | 960 - 1427      | 31.2 - 31.8  |
| 6.31175 - 6.31225   | 1435 - 1626.5   | 36.43 - 36.5 |
| 8.291 - 8.294       | 1645.5 - 1646.5 | Above 38.6   |
| 8.362 - 8.366       | 1660 - 1710     |              |
| 8.37625 - 8.38675   | 1718.8 - 1722.2 |              |
| 8.41425 - 8.41475   | 2200 - 2300     |              |
| 12.29 - 12.293      | 2310 - 2390     |              |
| 12.51975 - 12.52025 | 2483.5 - 2500   |              |
| 12.57675 - 12.57725 | 2655 - 2900     |              |
| 13.36 - 13.41       | 3260 – 3267     |              |
| 16.42 - 16.423      | 3332 - 3339     |              |
| 16.69475 - 16.69525 | 3345.8 - 3358   |              |
| 16.80425 - 16.80475 | 3500 - 4400     |              |
| 25.5 - 25.67        | 4500 - 5150     |              |
| 37.5 - 38.25        | 5350 - 5460     |              |
| 73 - 74.6           | 7250 - 7750     |              |
| 74.8 - 75.2         | 8025 – 8500     |              |
| 108 – 138           |                 |              |

Note 1: Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

## 15.209 Limit

| FREQUENCY<br>MHz                                                              | DISTANCE<br>Meters | FIELD STRENGTHS LIMIT                                                                             |                                   |
|-------------------------------------------------------------------------------|--------------------|---------------------------------------------------------------------------------------------------|-----------------------------------|
|                                                                               |                    | $\mu\text{V/m}$                                                                                   | $\text{dB}(\mu\text{V})/\text{m}$ |
| 0.009-0.490                                                                   | 300                | $2400/\text{F}(\text{KHz})$                                                                       | /                                 |
| 0.490-1.705                                                                   | 30                 | $24000/\text{F}(\text{KHz})$                                                                      | /                                 |
| 1.705-30                                                                      | 30                 | 30                                                                                                | 29.5                              |
| 30 ~ 88                                                                       | 3                  | 100                                                                                               | 40.0                              |
| 88 ~ 216                                                                      | 3                  | 150                                                                                               | 43.5                              |
| 216 ~ 960                                                                     | 3                  | 200                                                                                               | 46.0                              |
| 960 ~ 1000                                                                    | 3                  | 500                                                                                               | 54.0                              |
| Above 1000                                                                    | 3                  | 74.0 $\text{dB}(\mu\text{V})/\text{m}$ (Peak)<br>54.0 $\text{dB}(\mu\text{V})/\text{m}$ (Average) |                                   |
| Note 1: The peak limit is 20 dB higher than the average limit                 |                    |                                                                                                   |                                   |
| Note 2: Peak limit applies (AVG limit + 20 dB) as well as RSS-247 Section 5.5 |                    |                                                                                                   |                                   |

Harmonic emissions limits comply with below 54  $\text{dBuV}/\text{m}$  at 3m. Other emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or comply with the radiated emissions limits specified in section 15.209(a) limit in the table below has to be followed.

Table 5 – General field strength limits at frequencies above 30 MHz

| Frequency (MHz) | Field strength ( $\mu\text{V}/\text{m}$ at 3 m) |
|-----------------|-------------------------------------------------|
| 30 – 88         | 100                                             |
| 88 – 216        | 150                                             |
| 216 – 960       | 200                                             |
| Above 960       | 500                                             |

Table 6 – General field strength limits at frequencies below 30 MHz

| Frequency                     | Magnetic field strength (H-Field) ( $\mu\text{A}/\text{m}$ ) | Measurement distance (m) |
|-------------------------------|--------------------------------------------------------------|--------------------------|
| 9 - 490 kHz <sup>Note 1</sup> | $6.37/\text{F}$ (F in kHz)                                   | 300                      |
| 490 - 1705 kHz                | $63.7/\text{F}$ (F in kHz)                                   | 30                       |
| 1.705 - 30 MHz                | 0.08                                                         | 30                       |

**Note 1:** The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

### 3.2. Test Procedure

The measuring distance of 3m shall be used for measurements at frequency up to 1GHz and above 1GHz. The EUT was placed on a rotating 0.8 m high above ground for below 1GHz and 1.5m high for above 1GHz testing, the table was rotated 360 degrees to determine the position of the highest radiation

The Test antenna shall vary between 1m and 4m, both Horizontal and Vertical antenna are set of make measurement.

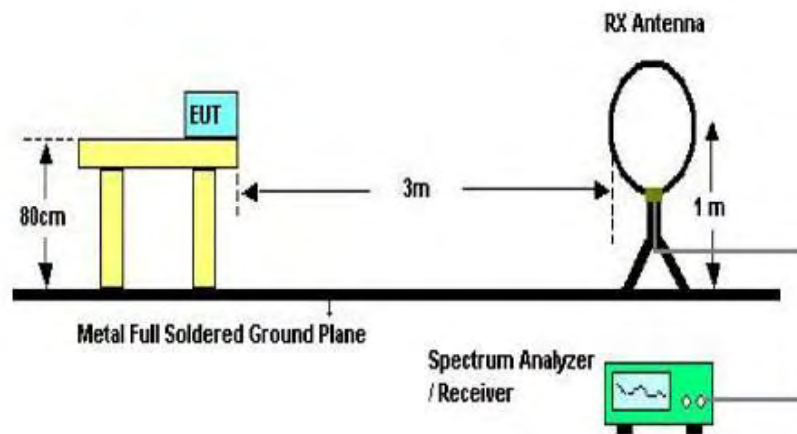
The initial step in collecting radiated emission data is a spectrum analyzer Peak detector mode pre-scanning the measurement frequency range. Significant Peaks are then marked. and then Quasi Peak Detector mode premeasured

If Peak value comply with QP limit below 1GHz, the EUT deemed to comply with QP limit.

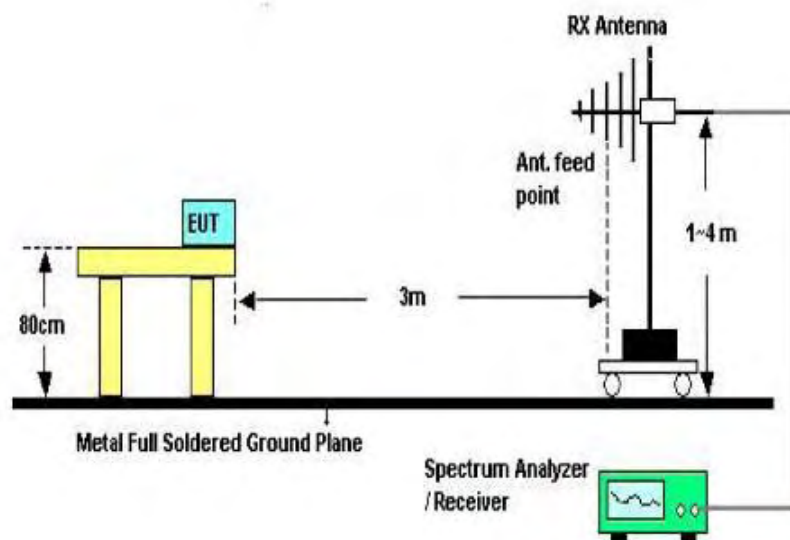
But the Peak value and average value both need to comply with applicable limit above 1GHz.

For the actual test configuration, please see the test setup photo.

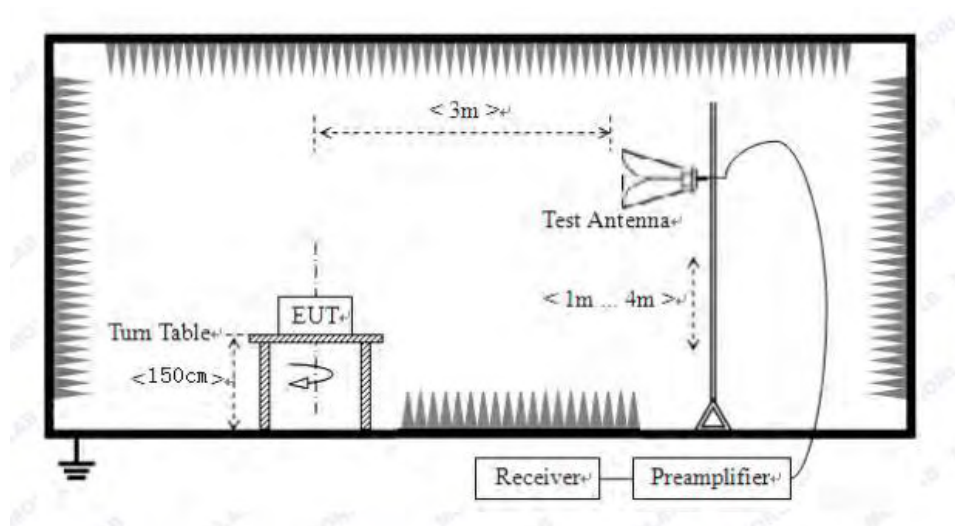
### 3.3. Test Setup



Below 30MHz Test Setup



Above 30MHz Test Setup



Above 1GHz Test Setup

### 3.4. Test Results

Test Condition

Continual Transmitting in maximum power.

|              |           |            |
|--------------|-----------|------------|
| 9KHz~150KHz  | RBW200Hz  | VBW1KHz    |
| 150KHz~30MHz | RBW9KHz   | VBW 30KHz  |
| 30MHz~1GHz   | RBW120KHz | VBW 300KHz |
| Above1GHz    | RBW1MHz   | VBW 3MHz   |

We have scanned the EUT from 9kHz up to the 10th harmonic of the fundamental.

Detailed information please see the following page.

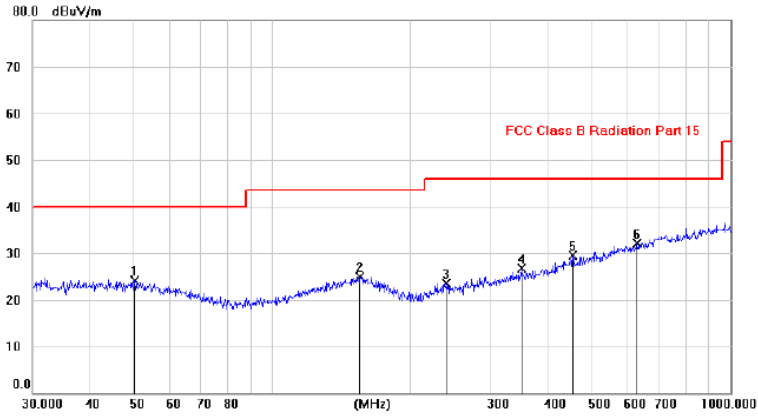
From 9KHz to 30MHz: Conclusion: PASS

Note:1.The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

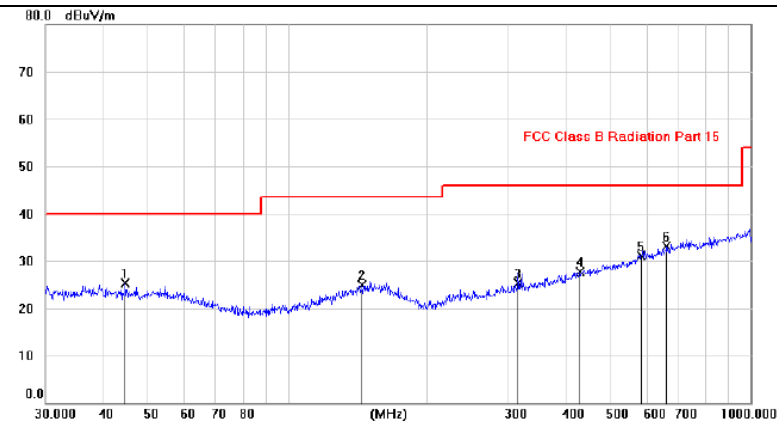
2.Only show the test data of the worst Channel in this report.

From 30MHz to 1000MHz: Conclusion: PASS

|                        |                               |                    |                 |
|------------------------|-------------------------------|--------------------|-----------------|
| <b>EUT Description</b> | ESP32-CAM WiFi Camera Modules | <b>Temperature</b> | 24°C            |
| <b>Model No.</b>       | MD0456                        | <b>Humidity</b>    | 56%             |
| <b>Pol</b>             | Vertical                      | <b>Test mode</b>   | 802.11b 2412MHz |
| <b>Test Voltage</b>    | DC 5V                         |                    |                 |



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree |         |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|---------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | cm             | degree       | Comment |
| 1   |     | 50.0800  | 10.15         | 14.03          | 24.18       | 40.00  | -15.82 | peak           |              |         |
| 2   |     | 155.4007 | 9.95          | 15.05          | 25.00       | 43.50  | -18.50 | peak           |              |         |
| 3   |     | 239.5950 | 10.96         | 12.54          | 23.50       | 46.00  | -22.50 | peak           |              |         |
| 4   |     | 349.6176 | 11.52         | 15.22          | 26.74       | 46.00  | -19.26 | peak           |              |         |
| 5   |     | 454.2038 | 11.80         | 17.61          | 29.41       | 46.00  | -16.59 | peak           |              |         |
| 6   | *   | 625.2973 | 11.44         | 20.72          | 32.16       | 46.00  | -13.84 | peak           |              |         |

**Pol****Horizontal**

| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree |         |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|---------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | cm             | degree       | Comment |
| 1   |     | 44.6338  | 11.06         | 14.15          | 25.21       | 40.00  | -14.79 | peak           |              |         |
| 2   |     | 144.9773 | 10.16         | 14.68          | 24.84       | 43.50  | -18.66 | peak           |              |         |
| 3   |     | 314.3765 | 10.78         | 14.47          | 25.25       | 46.00  | -20.75 | peak           |              |         |
| 4   |     | 428.0693 | 10.63         | 17.01          | 27.64       | 46.00  | -18.36 | peak           |              |         |
| 5   |     | 580.0243 | 11.37         | 19.83          | 31.20       | 46.00  | -14.80 | peak           |              |         |
| 6   | *   | 660.5324 | 11.92         | 21.22          | 33.14       | 46.00  | -12.86 | peak           |              |         |

\*:Maximum data x:Over limit !:over margin

Note: Measurement=Reading Level+Correc Factor. Factor=(LISN or ISN or PLC or Current Probe)Factor+Cable

*Remark: All modes have been tested, and only worst data was listed in this report.*

| Test Mode: IEEE 802.11b TX Low                                                                                                                                                       |                     |             |                       |                |                 |                 |                |             |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------|-----------------------|----------------|-----------------|-----------------|----------------|-------------|--------|
| Freq (MHz)                                                                                                                                                                           | Read Level (dBuV/m) | Polar (H/V) | Antenna Factor (dB/m) | Cable loss(dB) | Amp Factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
| 4824                                                                                                                                                                                 | 46.10               | V           | 33.98                 | 10.22          | 34.25           | 56.05           | 74             | 17.95       | PK     |
| 4824                                                                                                                                                                                 | 35.44               | V           | 33.98                 | 10.22          | 34.25           | 45.39           | 54             | 8.61        | AV     |
| 7236                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| 9648                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| 4824                                                                                                                                                                                 | 46.18               | H           | 33.98                 | 10.22          | 34.25           | 56.13           | 74             | 17.87       | PK     |
| 4824                                                                                                                                                                                 | 34.29               | H           | 33.98                 | 10.22          | 34.25           | 44.24           | 54             | 9.76        | AV     |
| 7236                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| 9648                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| Test Mode: IEEE 802.11b TX Mid                                                                                                                                                       |                     |             |                       |                |                 |                 |                |             |        |
| 4874                                                                                                                                                                                 | 45.94               | V           | 33.98                 | 10.22          | 34.25           | 55.89           | 74             | 18.11       | PK     |
| 4874                                                                                                                                                                                 | 35.97               | V           | 33.98                 | 10.22          | 34.25           | 45.92           | 54             | 8.08        | AV     |
| 7311                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| 9748                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| 4874                                                                                                                                                                                 | 45.91               | H           | 33.98                 | 10.22          | 34.25           | 55.86           | 74             | 18.14       | PK     |
| 4874                                                                                                                                                                                 | 34.89               | H           | 33.98                 | 10.22          | 34.25           | 44.84           | 54             | 9.16        | AV     |
| 7311                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| 9748                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| Test Mode: IEEE 802.11b TX High                                                                                                                                                      |                     |             |                       |                |                 |                 |                |             |        |
| 4924                                                                                                                                                                                 | 46.30               | V           | 33.98                 | 10.22          | 34.25           | 56.25           | 74             | 17.75       | PK     |
| 4924                                                                                                                                                                                 | 35.61               | V           | 33.98                 | 10.22          | 34.25           | 45.56           | 54             | 8.44        | AV     |
| 7386                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| 9848                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| 4924                                                                                                                                                                                 | 46.17               | H           | 33.98                 | 10.22          | 34.25           | 56.12           | 74             | 17.88       | PK     |
| 4924                                                                                                                                                                                 | 34.27               | H           | 33.98                 | 10.22          | 34.25           | 44.22           | 54             | 9.78        | AV     |
| 7386                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| 9848                                                                                                                                                                                 | /                   | /           | /                     | /              | /               | /               | /              | /           | /      |
| <b>Note:</b><br>1, Result = Read level + Antenna factor + cable loss-Amp factor<br>2, All the other emissions not reported were too low to read and deemed to comply with FCC limit. |                     |             |                       |                |                 |                 |                |             |        |

|                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Note:</p> <p>1, Result = Read level + Antenna factor + cable loss-Amp factor</p> <p>2, All the other emissions not reported were too low to read and deemed to comply with FCC limit.</p> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Note:</p> <p>1, Result = Read level + Antenna factor + cable loss-Amp factor</p> <p>2, All the other emissions not reported were too low to read and deemed to comply with FCC limit.</p> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Note:

- 1, Result = Read level + Antenna factor + cable loss-Amp factor
- 2, All the other emissions not reported were too low to read and deemed to comply with FCC limit.

## 4. POWER LINE CONDUCTED EMISSION

### 4.1. Test Limits

| Frequency<br>MHz | Limits dB( $\mu$ V) |               |
|------------------|---------------------|---------------|
|                  | Quasi-peak Level    | Average Level |
| 0.15 -0.50       | 66 -56*             | 56 - 46*      |
| 0.50 -5.00       | 56                  | 46            |
| 5.00 -30.00      | 60                  | 50            |

Notes: 1. \*Decreasing linearly with logarithm of frequency.

2. The lower limit shall apply at the transition frequencies.

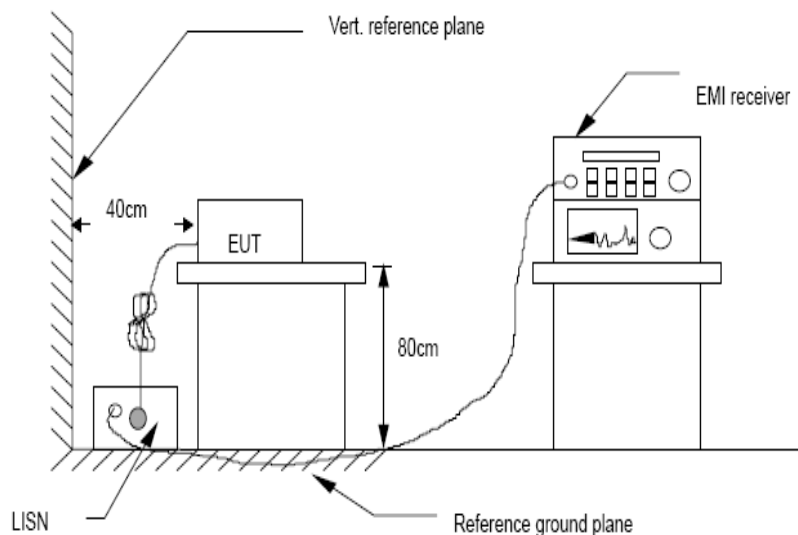
3. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.

### 4.2. Test Procedure

The EUT is put on the plane 0.8m high above the ground by insulating support and is connected to the power mains through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm coupling impedance for the EUT system. Please refer the block diagram of the test setup and photographs. Both sides of AC lines are checked to find out the maximum conducted emission. In order to find the maximum emission levels, the relative positions of equipment and all of the interface cables shall be changed according to ANSI C63.10:2013 on Conducted Emission Measurement.

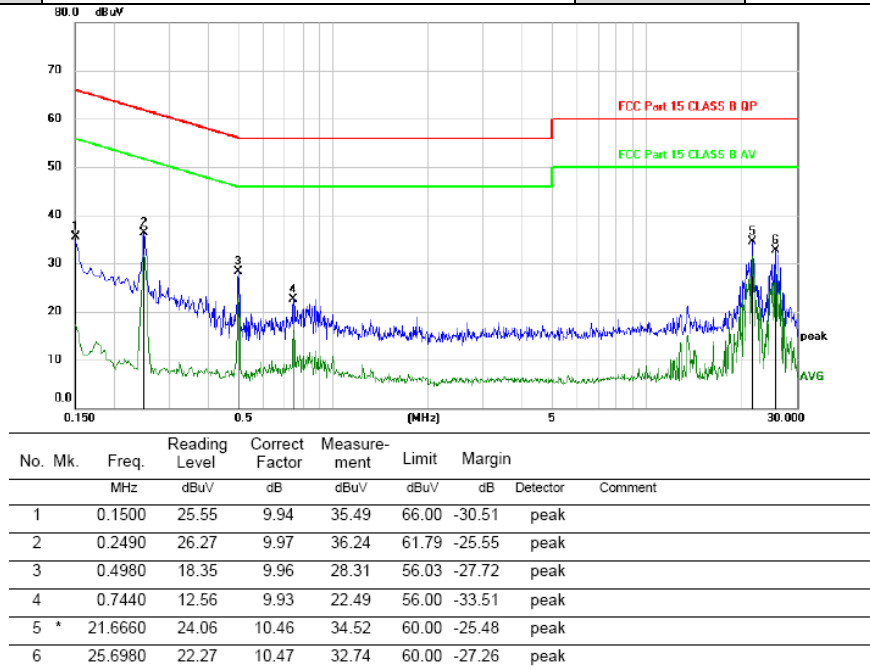
The bandwidth of test receiver is set at 9 kHz.

### 4.3. Test Setup

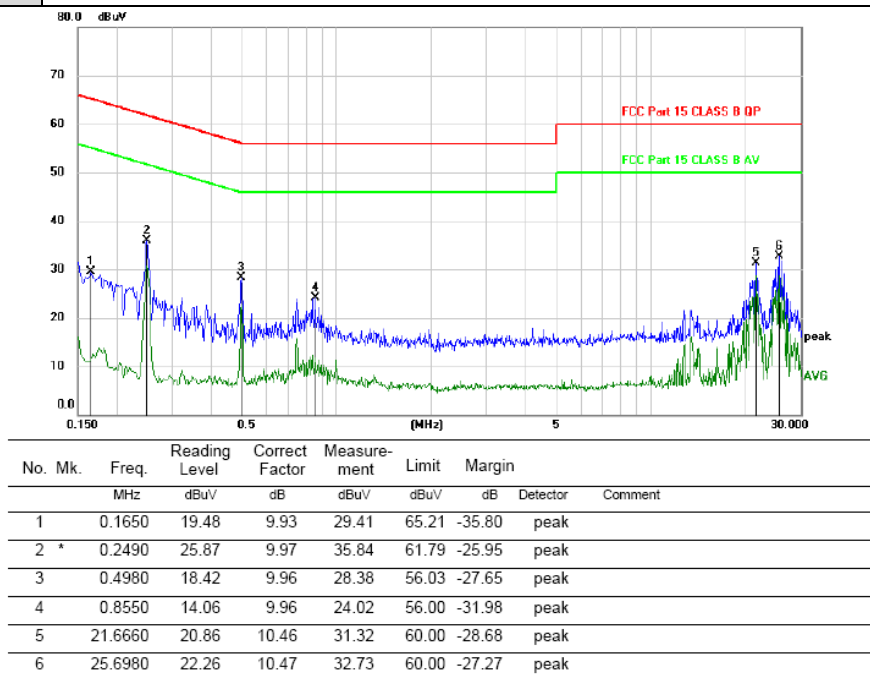


### 4.4. Test Results

|                        |                               |                  |                 |
|------------------------|-------------------------------|------------------|-----------------|
| <b>EUT Description</b> | ESP32-CAM WiFi Camera Modules | <b>Model No.</b> | MD0456          |
| <b>Temperature</b>     | 24°C                          | <b>Humidity</b>  | 56%             |
| <b>Pol</b>             | Line                          | <b>Test mode</b> | 802.11b 2412MHz |
| <b>Test Voltage</b>    | AC 120V/60Hz                  |                  |                 |



|            |         |
|------------|---------|
| <b>Pol</b> | Neutral |
|------------|---------|



\*:Maximum data x:Over limit !:over margin

Note: Measurement=Reading Level+Correc Factor. Factor=(LISN or ISN or PLC or Current Probe)Factor+Cable

## 5. CONDUCTED MAXIMUM OUTPUT POWER

### 5.1. Test limits

Please refer RSS-247 & FCC PART 15: 15.247.

Regulation 15.247(b) The limit of Maximum Peak Output Power Measurement is 1 W(30dBm)

### 5.2. Test Procedure

Details see the KDB558074 D01 Meas Guidance v05r02

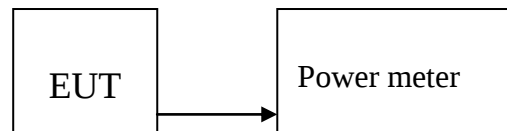
5.2.1 Place the EUT on the table and set it in transmitting mode.

5.2.2 Connected the EUT's antenna port to peak power meter by 20dB attenuator.

5.2.3 Measure out each mode and each bands peak output power of EUT.

Note: The cable loss and attenuator loss were offset into measure device as amplitude offset.

### 5.3. Test Setup



### 5.4. Test Results

PASS

Detailed information please see the following page.

| Condition | Mode | Frequency (MHz) | Antenna | Conducted Power (dBm) | Duty Factor (dB) | Total Power (dBm) | Limit (dBm) | Verdict |
|-----------|------|-----------------|---------|-----------------------|------------------|-------------------|-------------|---------|
| NVNT      | b    | 2412            | Ant1    | 13.621                | 0                | 13.621            | 30          | Pass    |
| NVNT      | b    | 2437            | Ant1    | 16.861                | 0                | 16.861            | 30          | Pass    |
| NVNT      | b    | 2462            | Ant1    | 12.504                | 0                | 12.504            | 30          | Pass    |
| NVNT      | g    | 2412            | Ant1    | 11.659                | 0                | 11.659            | 30          | Pass    |
| NVNT      | g    | 2437            | Ant1    | 15.002                | 0                | 15.002            | 30          | Pass    |
| NVNT      | g    | 2462            | Ant1    | 11.321                | 0                | 11.321            | 30          | Pass    |
| NVNT      | n20  | 2412            | Ant1    | 11.436                | 0                | 11.436            | 30          | Pass    |
| NVNT      | n20  | 2437            | Ant1    | 14.756                | 0                | 14.756            | 30          | Pass    |
| NVNT      | n20  | 2462            | Ant1    | 11.052                | 0                | 11.052            | 30          | Pass    |
| NVNT      | n40  | 2422            | Ant1    | 13.372                | 0                | 13.372            | 30          | Pass    |
| NVNT      | n40  | 2437            | Ant1    | 14.139                | 0                | 14.139            | 30          | Pass    |
| NVNT      | n40  | 2452            | Ant1    | 13.226                | 0                | 13.226            | 30          | Pass    |

## 6. PEAK POWER SPECTRAL DENSITY

### 6.1. Test limits

6.1.1 Please refer RSS-247 & FCC PART 15: 15.247.

6.1.2 For direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.

6.1.3 The direct sequence operating of the hybrid system, with the frequency hopping operation turned off, shall comply with the power density requirements of paragraph (d) of this section.

### 6.2. Test Procedure

Details see the KDB558074 D01 Meas Guidance v05r02

6.2.1 Place the EUT on the table and set it in transmitting mode.

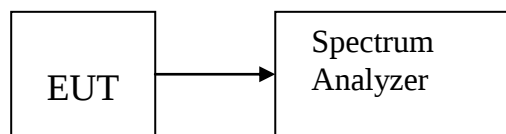
6.2.2 Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

6.2.3 Set the spectrum analyzer as  $RBW = 100\text{kHz}$  (Set the  $RBW$  to:  $3\text{ kHz} \leq RBW \leq 100\text{ kHz}$ .),  $VBW = 300\text{kHz}$  (Set the  $VBW \geq 3 \times RBW$ ),  $\text{span} \geq 1.5 \times \text{DTS bandwidth}$ ., detail see the test plot.

6.2.4 Record the max reading.

6.2.5 Repeat the above procedure until the measurements for all frequencies are completed.

### 6.3. Test Setup



## 6.4. Test Results

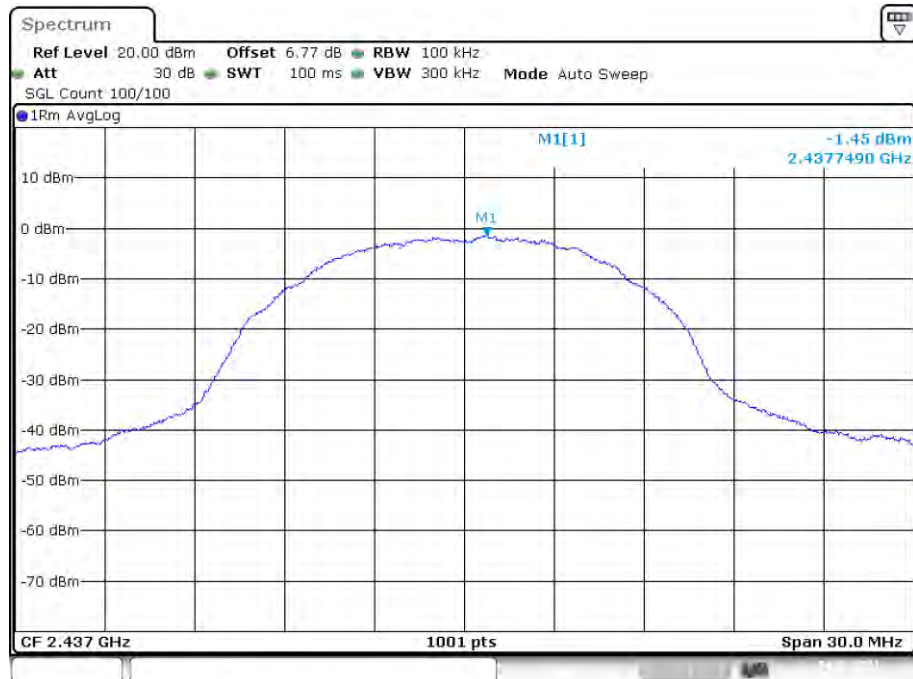
| Condition | Mode | Frequency (MHz) | Antenna | Max PSD (dBm) | Limit (dBm) | Verdict |
|-----------|------|-----------------|---------|---------------|-------------|---------|
| NVNT      | b    | 2412            | Ant1    | -4.952        | 8           | Pass    |
| NVNT      | b    | 2437            | Ant1    | -1.449        | 8           | Pass    |
| NVNT      | b    | 2462            | Ant1    | -5.905        | 8           | Pass    |
| NVNT      | g    | 2412            | Ant1    | -8.355        | 8           | Pass    |
| NVNT      | g    | 2437            | Ant1    | -4.75         | 8           | Pass    |
| NVNT      | g    | 2462            | Ant1    | -8.681        | 8           | Pass    |
| NVNT      | n20  | 2412            | Ant1    | -8.635        | 8           | Pass    |
| NVNT      | n20  | 2437            | Ant1    | -5.159        | 8           | Pass    |
| NVNT      | n20  | 2462            | Ant1    | -9.112        | 8           | Pass    |
| NVNT      | n40  | 2422            | Ant1    | -8.363        | 8           | Pass    |
| NVNT      | n40  | 2437            | Ant1    | -8.464        | 8           | Pass    |
| NVNT      | n40  | 2452            | Ant1    | -8.804        | 8           | Pass    |

PSD NVNT b 2412MHz Ant1



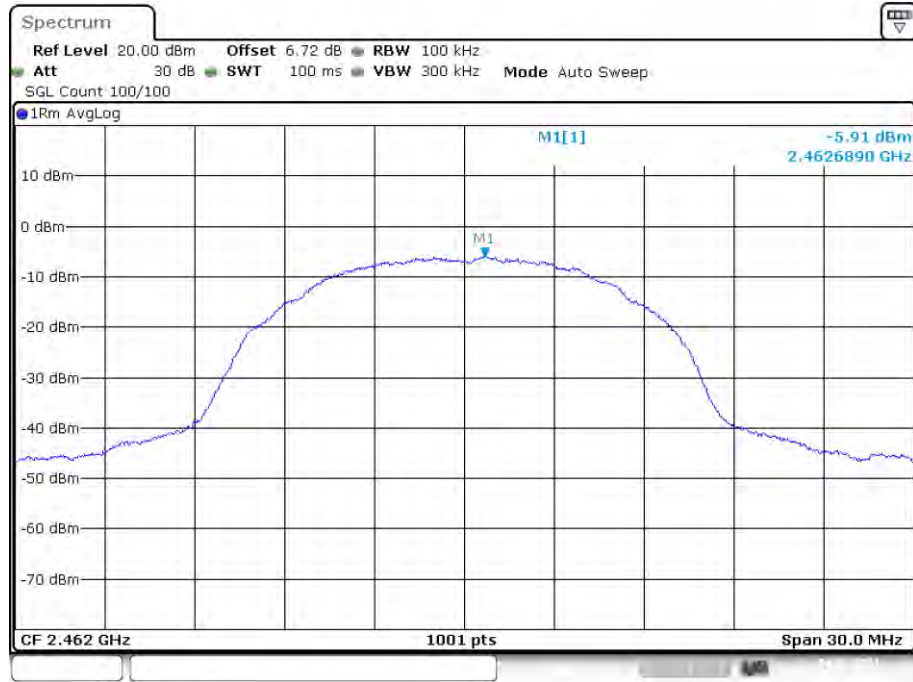
Date: 4.FEB.2021 02:57:09

PSD NVNT b 2437MHz Ant1



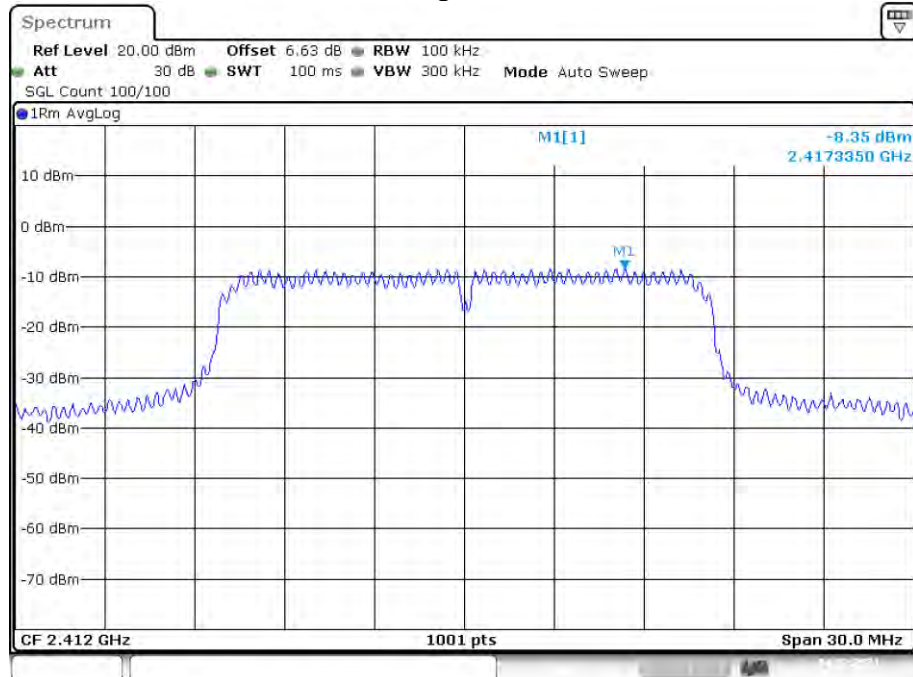
Date: 4.FEB.2021 02:58:41

PSD NVNT b 2462MHz Ant1



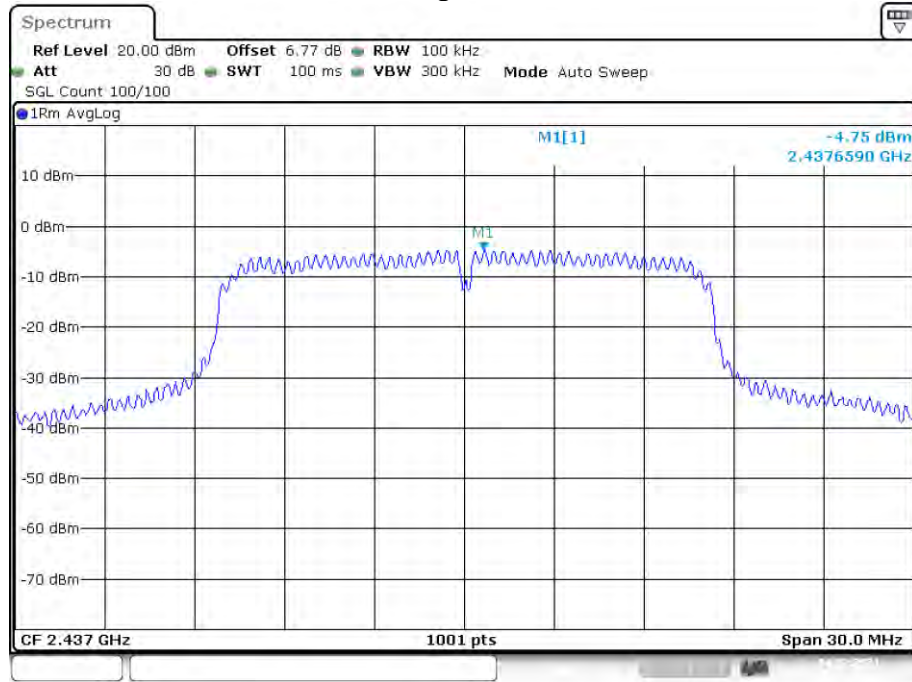
Date: 4.FEB.2021 03:00:50

PSD NVNT g 2412MHz Ant1



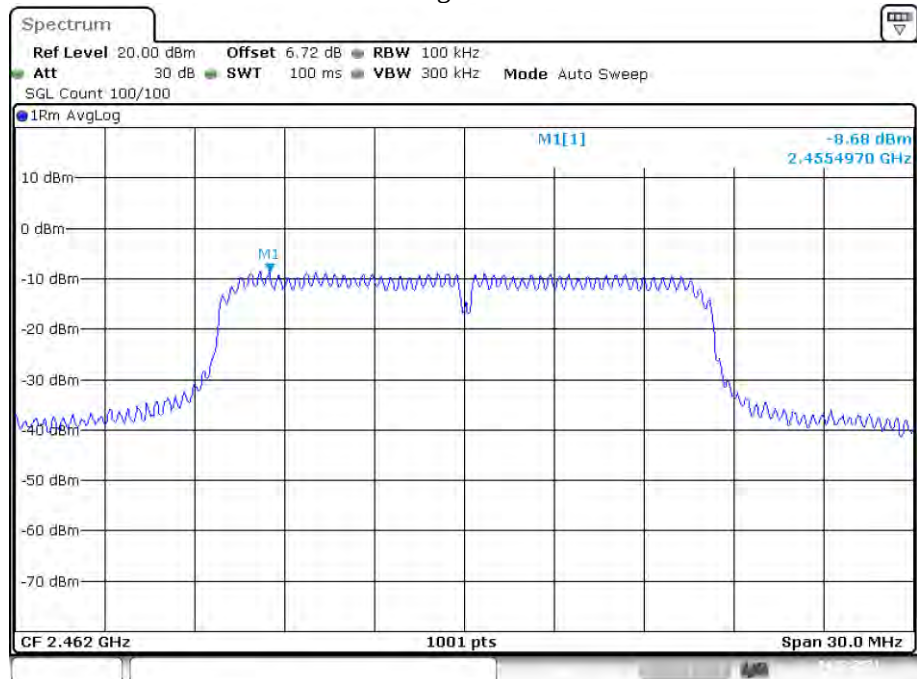
Date: 4.FEB.2021 03:03:31

PSD NVNT g 2437MHz Ant1



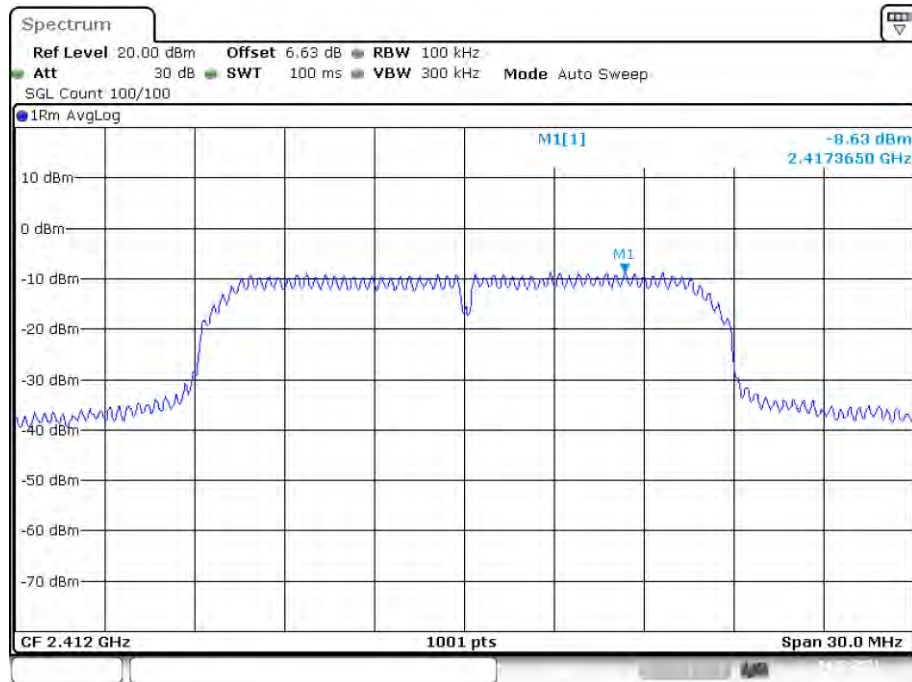
Date: 4.FEB.2021 03:07:55

PSD NVNT g 2462MHz Ant1



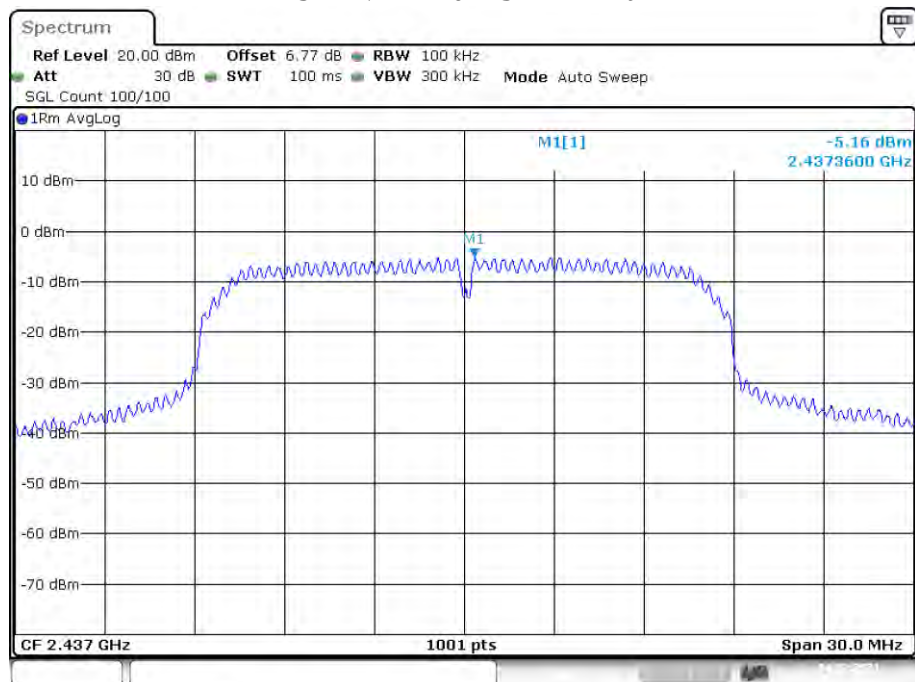
Date: 4.FEB.2021 03:10:09

## PSD NVNT n20 2412MHz Ant1



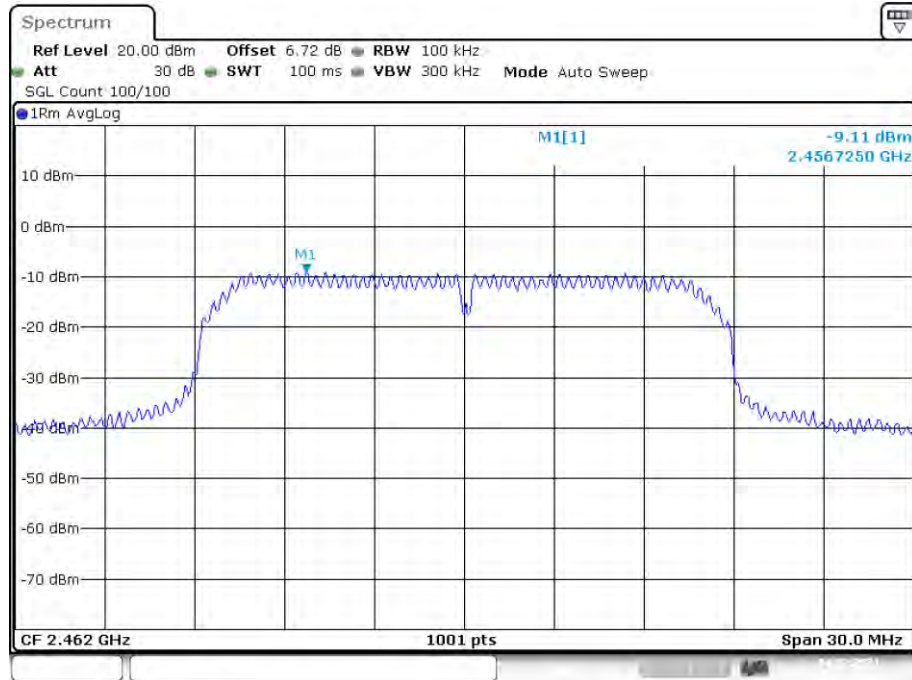
Date: 4.FEB.2021 03:13:55

## PSD NVNT n20 2437MHz Ant1



Date: 4.FEB.2021 03:18:00

## PSD NVNT n20 2462MHz Ant1



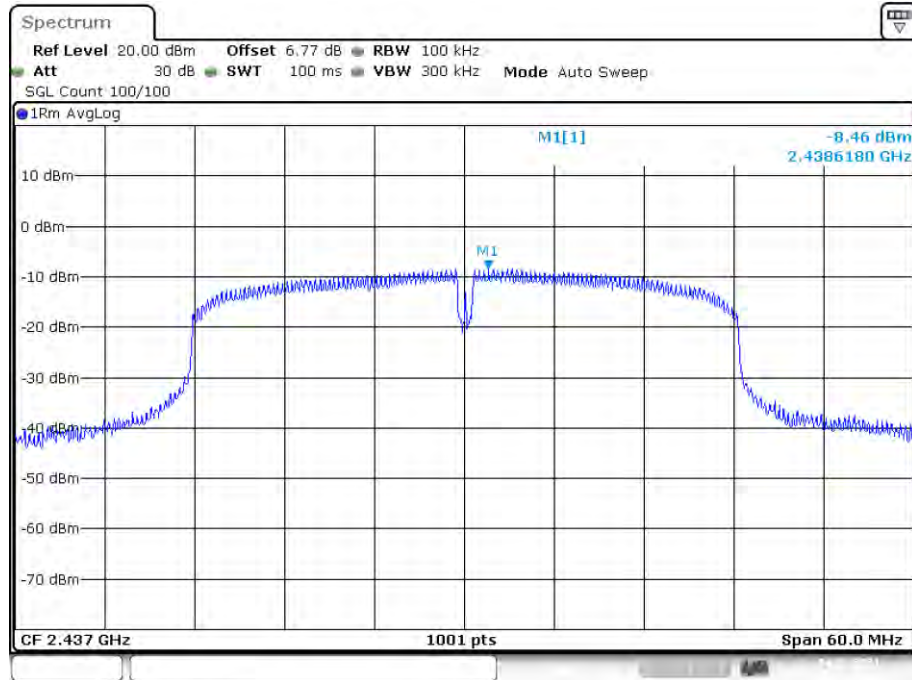
Date: 4.FEB.2021 03:20:22

## PSD NVNT n40 2422MHz Ant1



Date: 4.FEB.2021 03:23:30

## PSD NVNT n40 2437MHz Ant1



Date: 4.FEB.2021 03:28:34

## PSD NVNT n40 2452MHz Ant1



Date: 4.FEB.2021 03:31:28

## 7. BANDWIDTH

### 7.1. Test limits

Please refer RSS-247 & FCC PART 15: 15.247

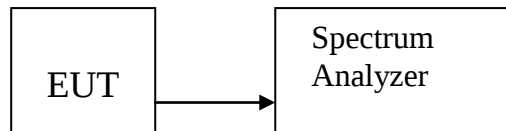
For direct sequence systems, the minimum 6dB bandwidth shall be at least 500 kHz.

### 7.2. Test Procedure

Details see the KDB558074 D01 Meas Guidance v05r02

- a) The bandwidth is measured at an amplitude level reduced 6dB from the reference level. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency. Once the reference level is established, the equipment is conditioned with typical modulating signal to produce the worst-case (i.e. the widest) bandwidth.
- b) The test receiver set RBW = 100kHz, VBW  $\geq 3 \times$  RBW = 300kHz,, Peak Detector, Sweep time set auto, detail see the test plot.

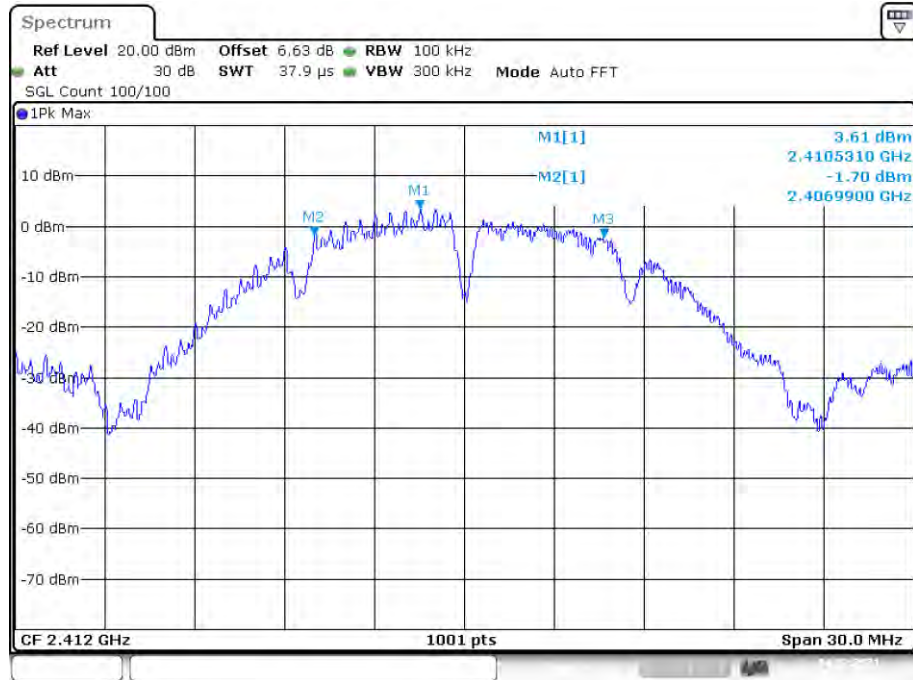
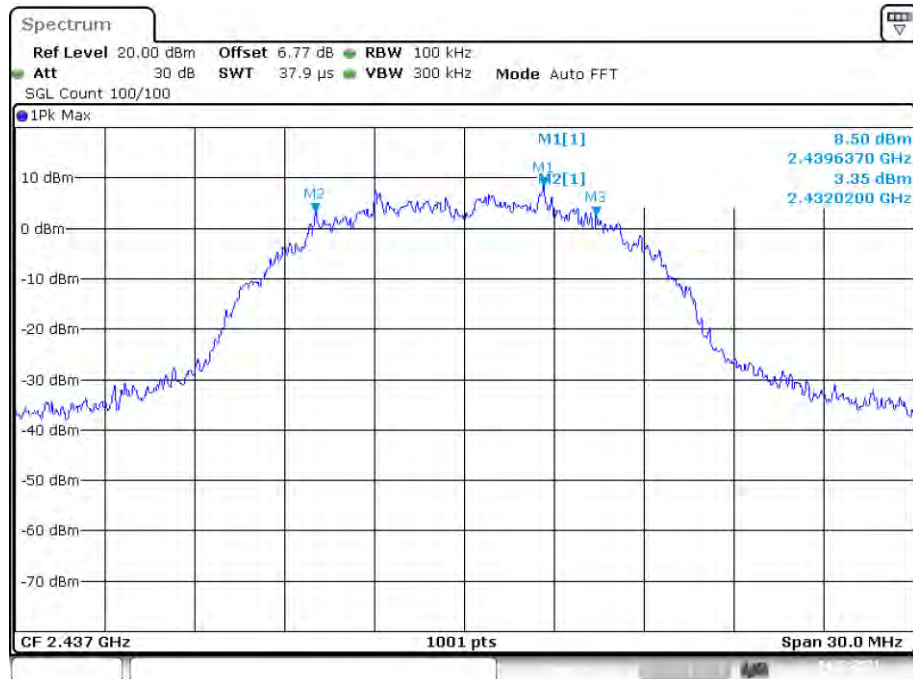
### 7.3. Test Setup

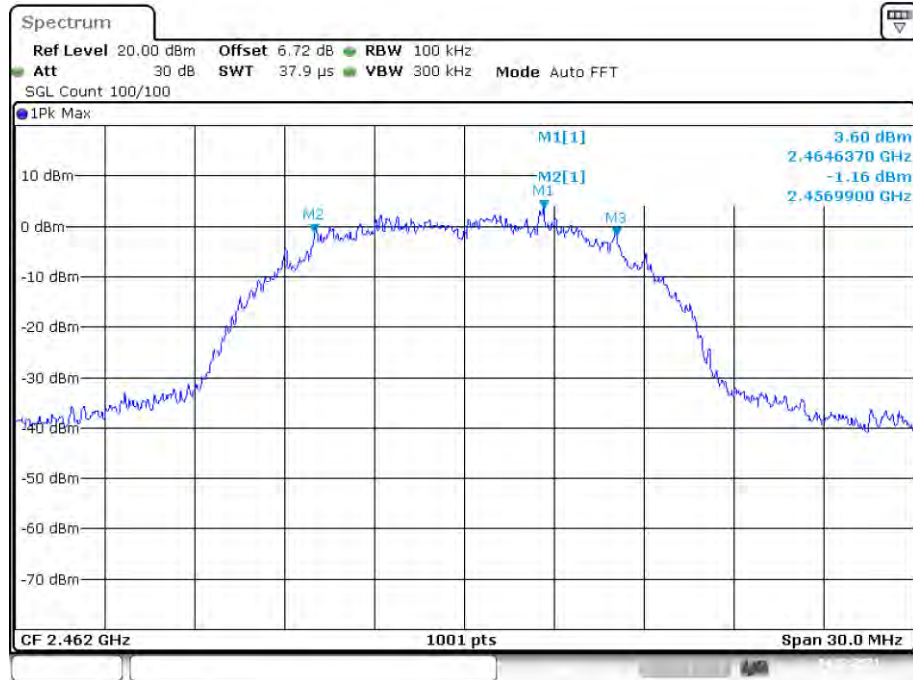


### 7.4. Test Results

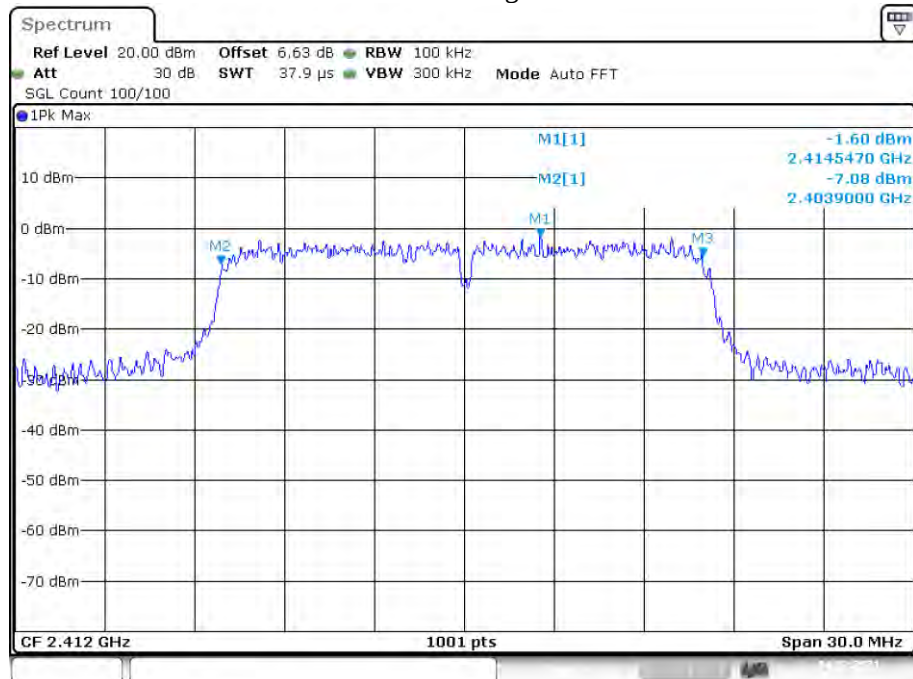
#### -6dB Bandwidth

| Condition | Mode | Frequency (MHz) | Antenna | -6 dB Bandwidth (MHz) | Limit -6 dB Bandwidth (MHz) | Verdict |
|-----------|------|-----------------|---------|-----------------------|-----------------------------|---------|
| NVNT      | b    | 2412            | Ant1    | 9.66                  | 0.5                         | Pass    |
| NVNT      | b    | 2437            | Ant1    | 9.39                  | 0.5                         | Pass    |
| NVNT      | b    | 2462            | Ant1    | 10.08                 | 0.5                         | Pass    |
| NVNT      | g    | 2412            | Ant1    | 16.05                 | 0.5                         | Pass    |
| NVNT      | g    | 2437            | Ant1    | 15.69                 | 0.5                         | Pass    |
| NVNT      | g    | 2462            | Ant1    | 16.08                 | 0.5                         | Pass    |
| NVNT      | n20  | 2412            | Ant1    | 16.35                 | 0.5                         | Pass    |
| NVNT      | n20  | 2437            | Ant1    | 15.78                 | 0.5                         | Pass    |
| NVNT      | n20  | 2462            | Ant1    | 16.56                 | 0.5                         | Pass    |
| NVNT      | n40  | 2422            | Ant1    | 34.80                 | 0.5                         | Pass    |
| NVNT      | n40  | 2437            | Ant1    | 33.24                 | 0.5                         | Pass    |
| NVNT      | n40  | 2452            | Ant1    | 34.2                  | 0.5                         | Pass    |

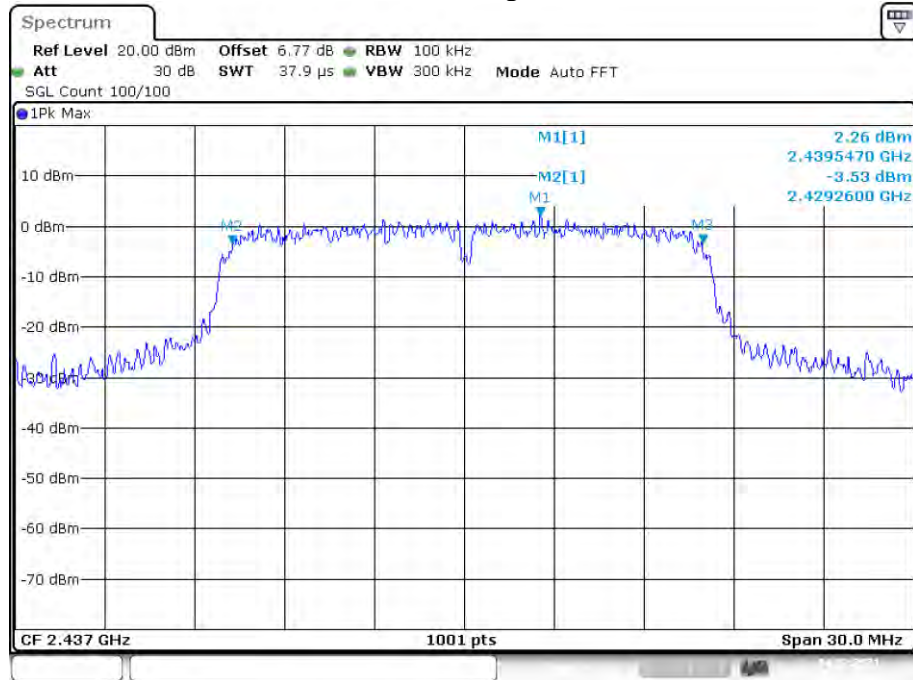
**-6dB Bandwidth NVNT b 2412MHz Ant1****-6dB Bandwidth NVNT b 2437MHz Ant1**

**-6dB Bandwidth NVNT b 2462MHz Ant1**

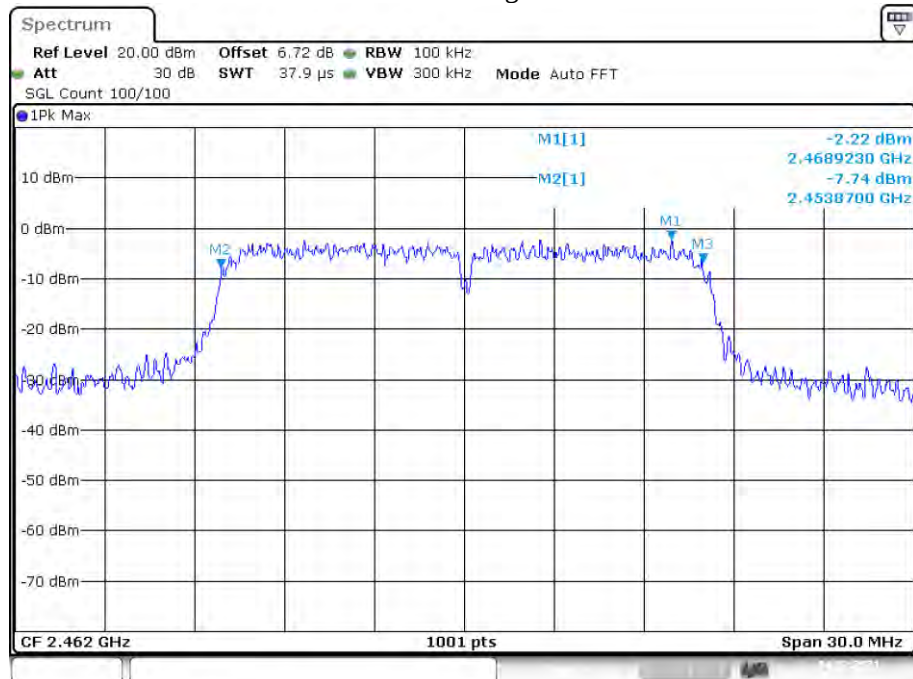
Date: 4.FEB.2021 03:00:29

**-6dB Bandwidth NVNT g 2412MHz Ant1**

Date: 4.FEB.2021 03:03:09

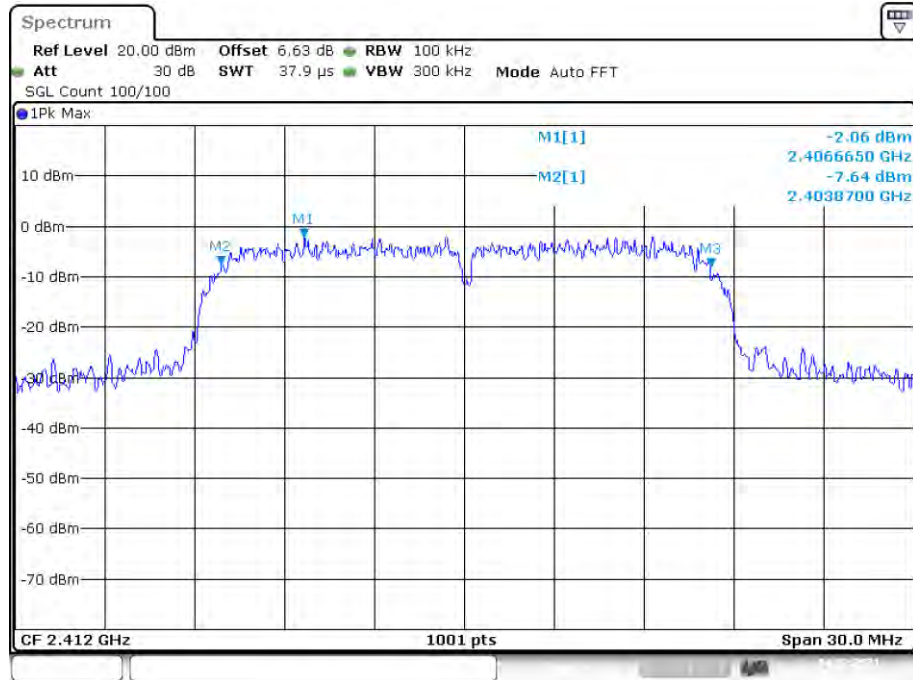
**-6dB Bandwidth NVNT g 2437MHz Ant1**

Date: 4.FEB.2021 03:07:29

**-6dB Bandwidth NVNT g 2462MHz Ant1**

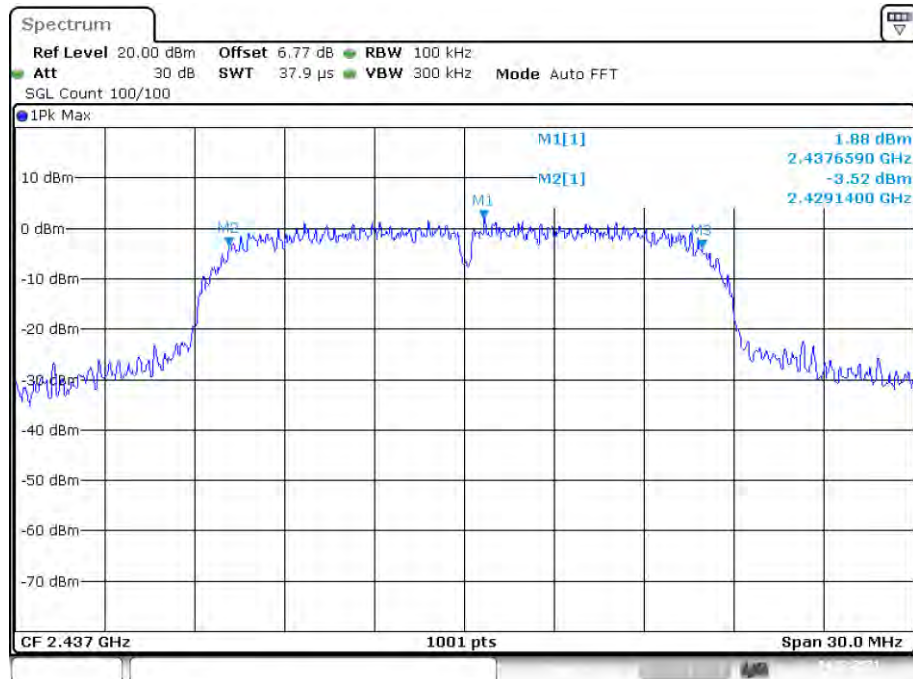
Date: 4.FEB.2021 03:09:42

## -6dB Bandwidth NVNT n20 2412MHz Ant1

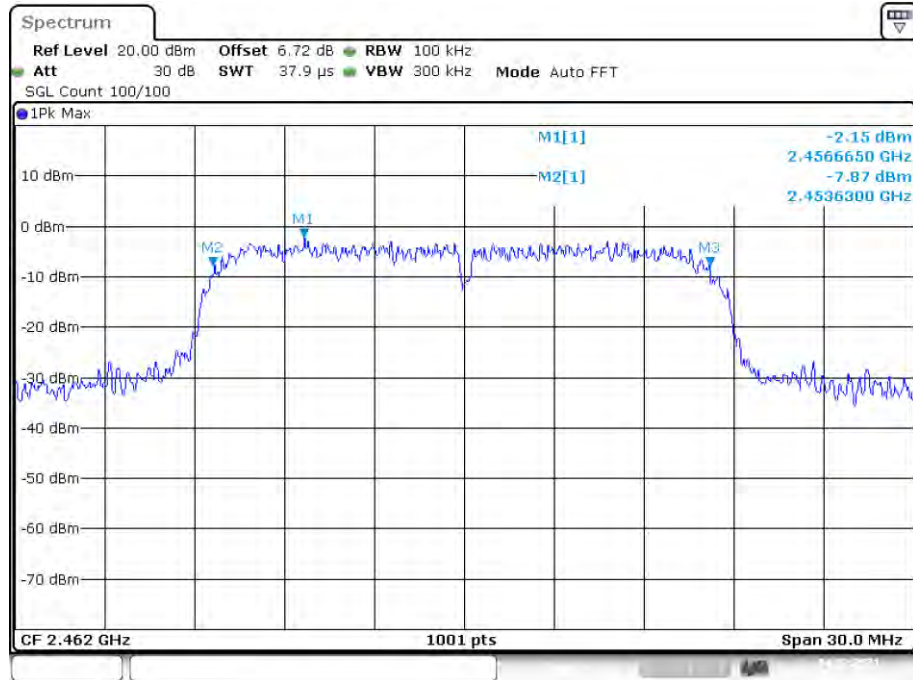


Date: 4.FEB.2021 03:13:31

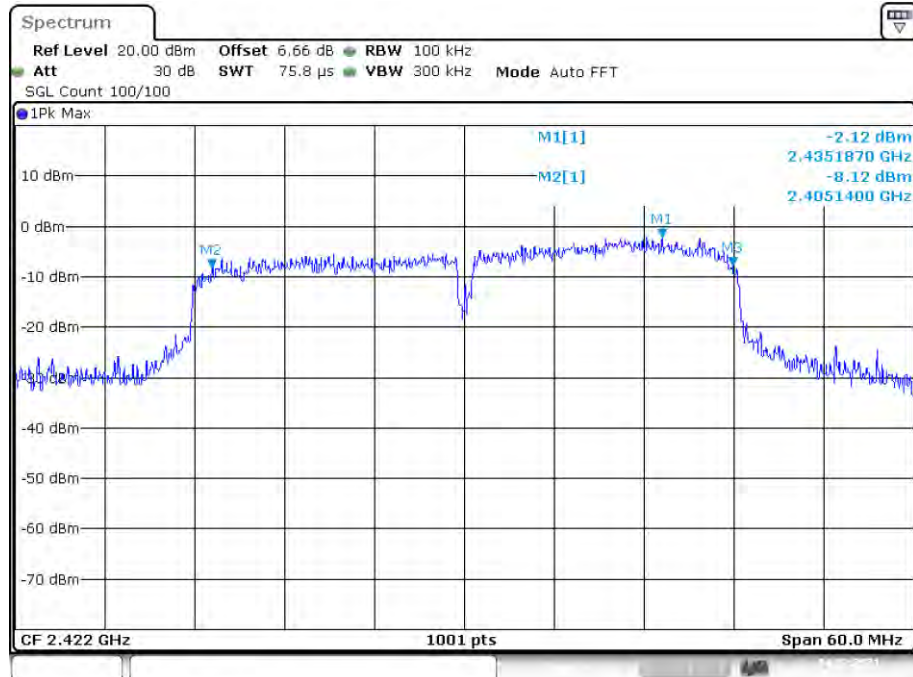
## -6dB Bandwidth NVNT n20 2437MHz Ant1



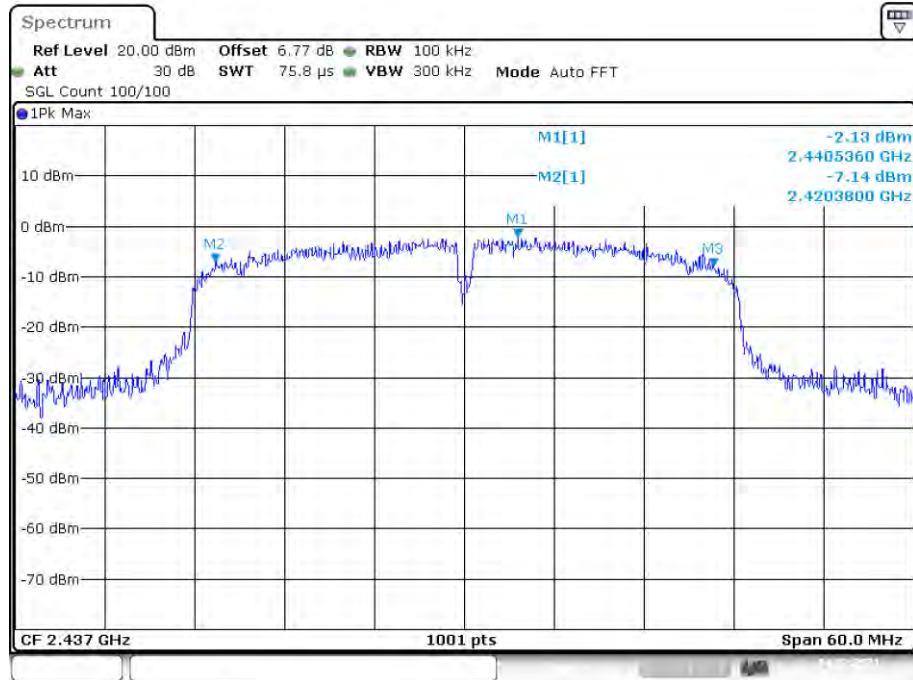
Date: 4.FEB.2021 03:17:35

**-6dB Bandwidth NVNT n20 2462MHz Ant1**

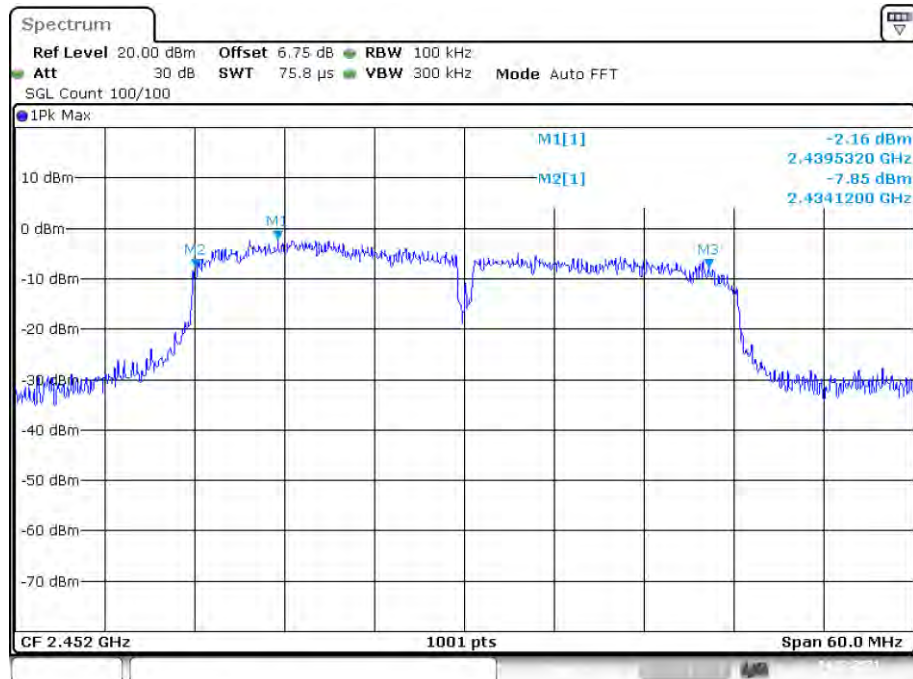
Date: 4.FEB.2021 03:19:56

**-6dB Bandwidth NVNT n40 2422MHz Ant1**

Date: 4.FEB.2021 03:23:06

**-6dB Bandwidth NVNT n40 2437MHz Ant1**

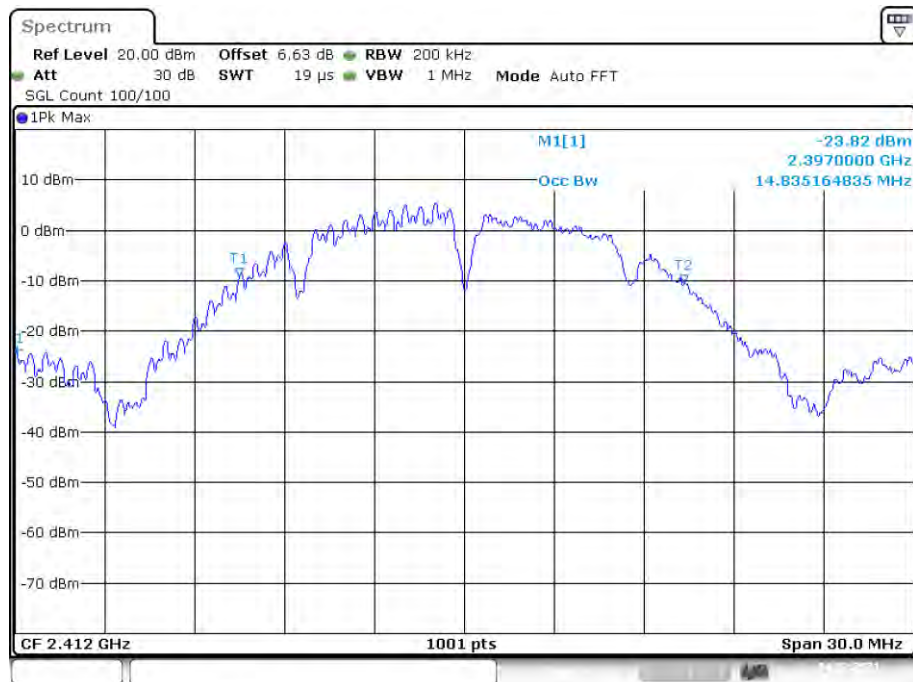
Date: 4.FEB.2021 03:28:10

**-6dB Bandwidth NVNT n40 2452MHz Ant1**

Date: 4.FEB.2021 03:31:03

**Occupied Channel Bandwidth**

| Condition | Mode | Frequency (MHz) | Antenna | 99% OBW (MHz) |
|-----------|------|-----------------|---------|---------------|
| NVNT      | b    | 2412            | Ant1    | 14.835        |
| NVNT      | b    | 2437            | Ant1    | 12.887        |
| NVNT      | b    | 2462            | Ant1    | 13.217        |
| NVNT      | g    | 2412            | Ant1    | 16.364        |
| NVNT      | g    | 2437            | Ant1    | 16.124        |
| NVNT      | g    | 2462            | Ant1    | 16.274        |
| NVNT      | n20  | 2412            | Ant1    | 17.083        |
| NVNT      | n20  | 2437            | Ant1    | 16.783        |
| NVNT      | n20  | 2462            | Ant1    | 16.993        |
| NVNT      | n40  | 2422            | Ant1    | 36.144        |
| NVNT      | n40  | 2437            | Ant1    | 35.485        |
| NVNT      | n40  | 2452            | Ant1    | 35.844        |

**OBW NVNT b 2412MHz Ant1**

Date: 4.FEB.2021 02:55:04

## OBW NVNT b 2437MHz Ant1



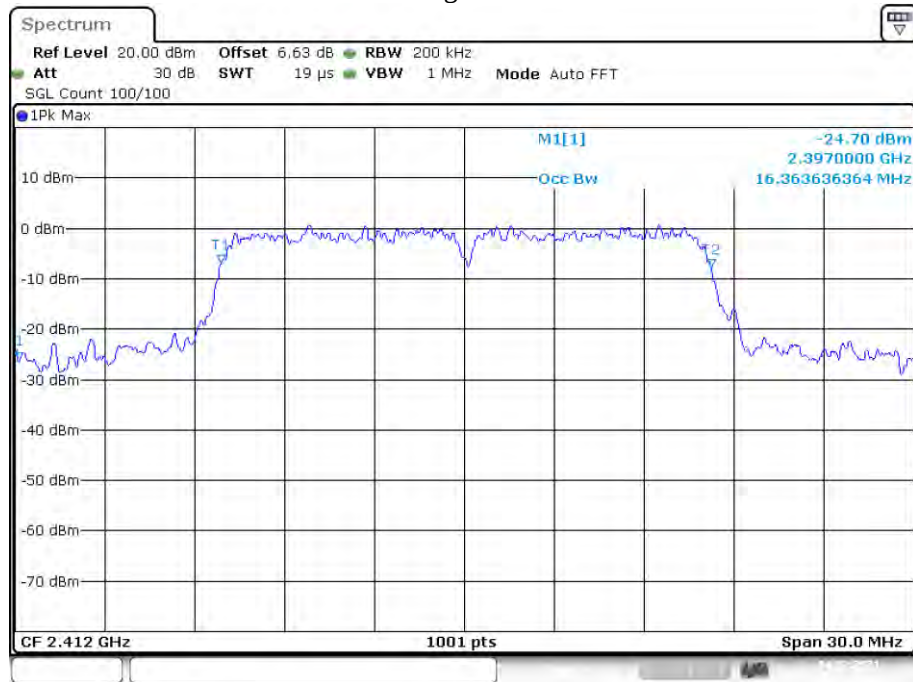
Date: 4.FEB.2021 02:58:10

## OBW NVNT b 2462MHz Ant1



Date: 4.FEB.2021 03:00:19

## OBW NVNT g 2412MHz Ant1



Date: 4.FEB.2021 03:02:59

## OBW NVNT g 2437MHz Ant1



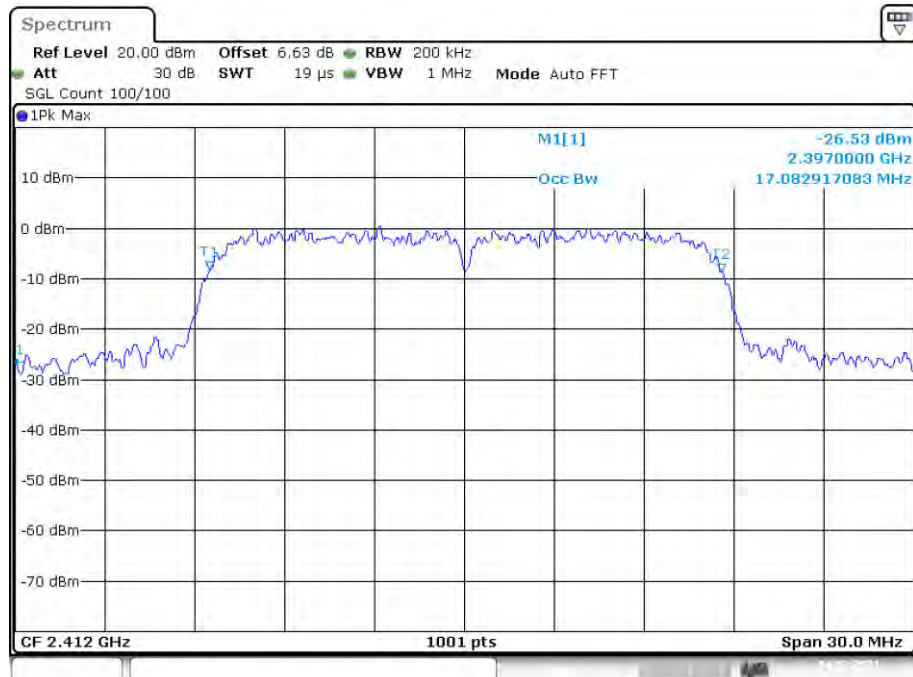
Date: 4.FEB.2021 03:07:16

## OBW NVNT g 2462MHz Ant1



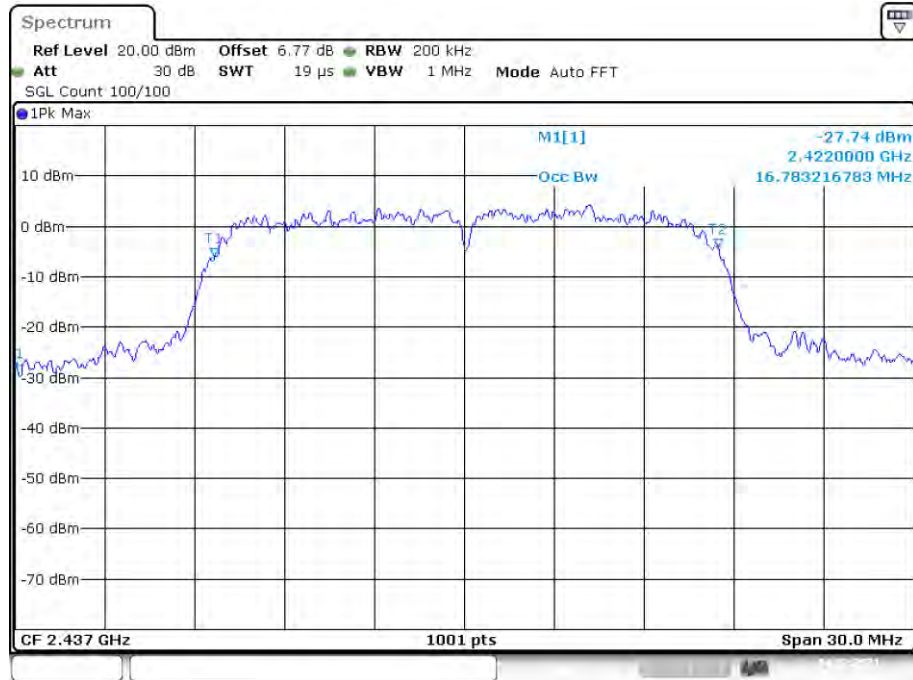
Date: 4.FEB.2021 03:09:28

## OBW NVNT n20 2412MHz Ant1



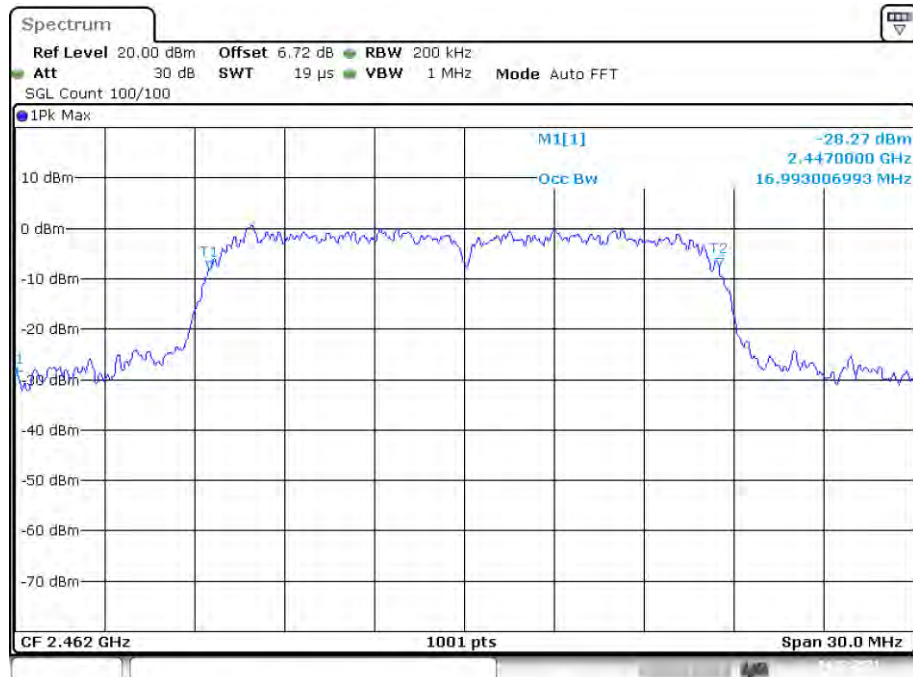
Date: 4.FEB.2021 03:13:19

## OBW NVNT n20 2437MHz Ant1



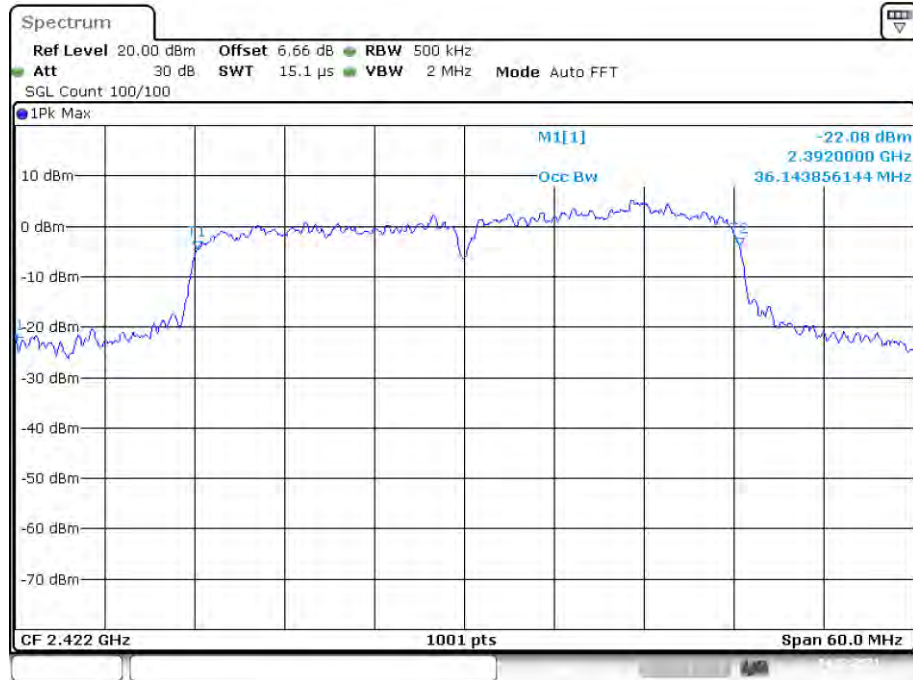
Date: 4.FEB.2021 03:17:22

## OBW NVNT n20 2462MHz Ant1



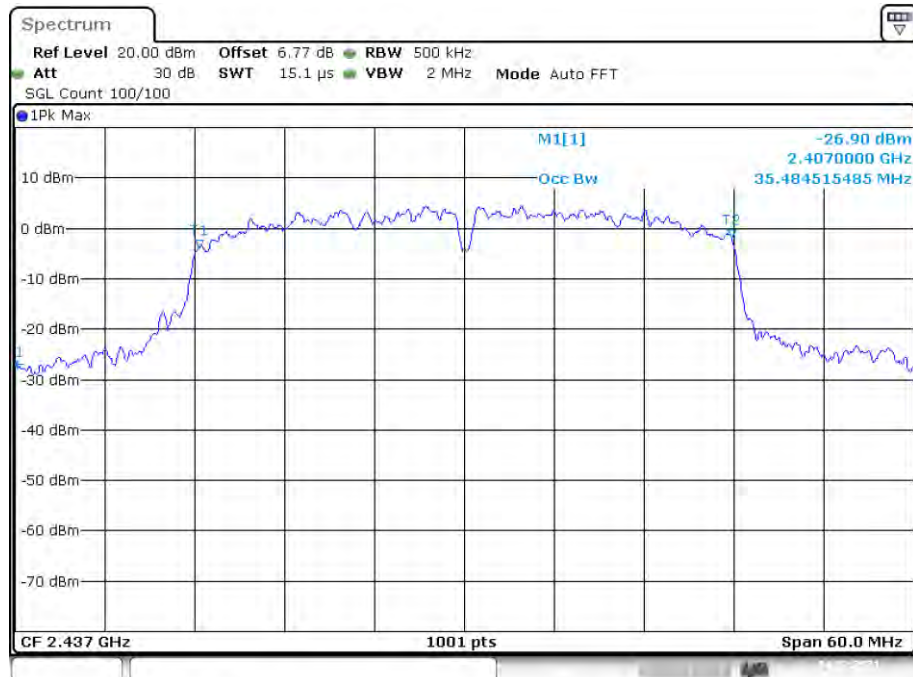
Date: 4.FEB.2021 03:19:43

## OBW NVNT n40 2422MHz Ant1



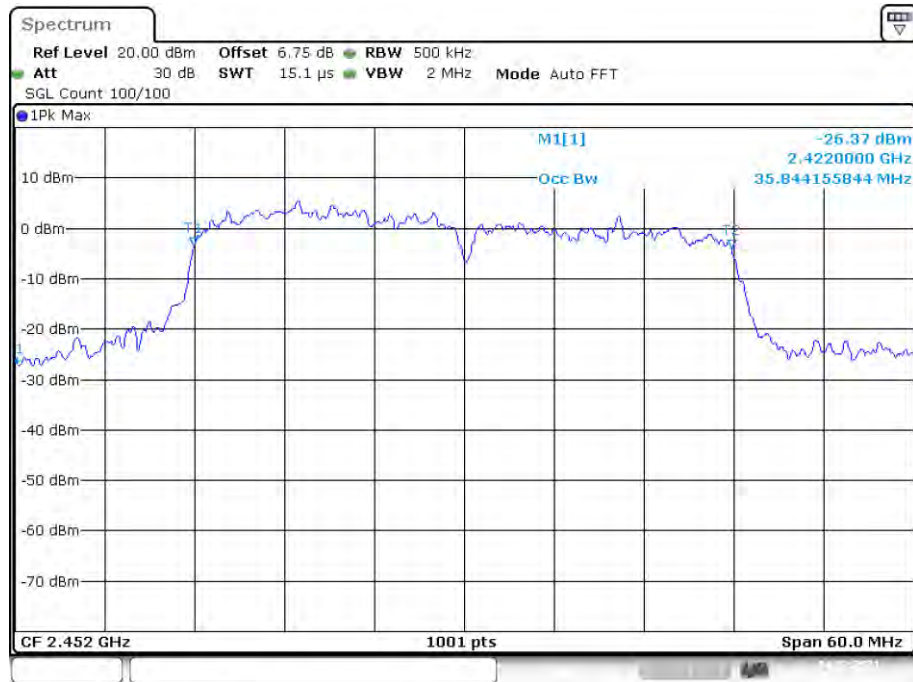
Date: 4.FEB.2021 03:22:51

## OBW NVNT n40 2437MHz Ant1



Date: 4.FEB.2021 03:27:43

## OBW NVNT n40 2452MHz Ant1



Date: 4.FEB.2021 03:30:47

## **8. BAND EDGE CHECK**

### **8.1. Test limits**

Please refer RSS-GEN & FCC PART 15: 15.247

All the lower and upper band-edges emissions appearing within 2310MHz to 2390MHz and 2483.5MHz to 2500MHz restricted frequency bands shall not exceed the limits shown in 15.209, all the other emissions outside operation frequency band 2400MHz to 2483.5MHz shall be at least 20dB below the fundamental emissions, or comply with 15.209 limits and RSS-GEN limits.

### **8.2. Test Procedure**

Details see the KDB558074 D01 Meas Guidance v05r02

8.2.1 Put the EUT on a 1.5m high table, power on the EUT. Emissions were scanned and measured rotating the EUT to 360 degrees, Find the maximum Emission

8.2.2 Check the spurious emissions out of band.

8.2.3 RBW 1MHz, VBW 3MHz, peak detector for peak value , RBW 1MHz ,VBW 10Hz , RMS detector for AV value.

### **8.3. Test Setup**

Same as 5.2.2.

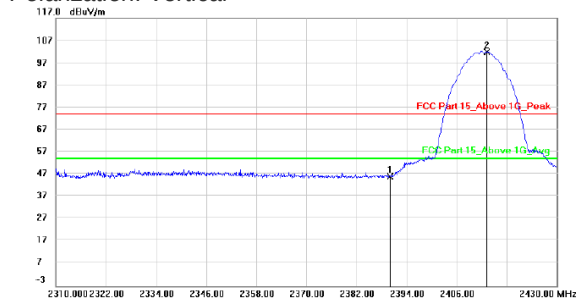
### **8.4. Test Results**

PASS.

Detailed information please see the following page.

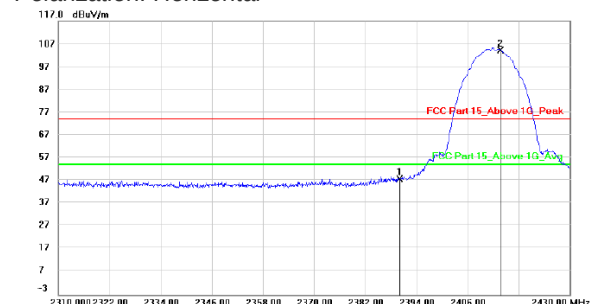
Test Mode: IEEE 802.11b-Low

Polarization: Vertical



| No. | Mk. | Freq.    | Reading | Correct | Measure- | Limit | Margin | Antenna | Table  |         |
|-----|-----|----------|---------|---------|----------|-------|--------|---------|--------|---------|
|     |     | MHz      | Level   | Factor  | ment     |       |        | Height  | Degree |         |
|     |     |          | dBuV    | dB      | dBuV/m   | dB    | dB     | cm      | degree | Comment |
| 1   |     | 2390.000 | 49.40   | -3.40   | 46.00    | 74.00 | -28.00 | peak    |        |         |
| 2   | *   | 2413.200 | 105.32  | -3.41   | 101.91   | 74.00 | 27.91  | peak    |        |         |

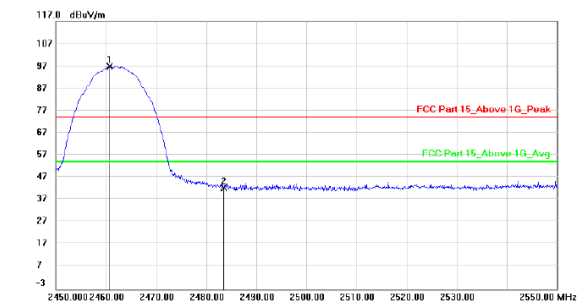
Polarization: Horizontal



| No. | Mk. | Freq.    | Reading | Correct | Measure- | Limit | Margin | Antenna | Table  |         |
|-----|-----|----------|---------|---------|----------|-------|--------|---------|--------|---------|
|     |     | MHz      | Level   | Factor  | ment     |       |        | Height  | Degree |         |
|     |     |          | dBuV    | dB      | dBuV/m   | dB    | dB     | cm      | degree | Comment |
| 1   |     | 2390.000 | 51.19   | -3.40   | 47.79    | 74.00 | -26.21 | peak    |        |         |
| 2   | *   | 2413.800 | 107.64  | -3.41   | 104.23   | 74.00 | 30.23  | peak    |        |         |

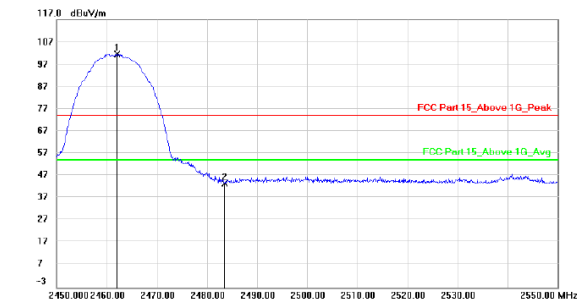
Test Mode: IEEE 802.11b-High

Polarization: Vertical



| No. | Mk. | Freq.    | Reading | Correct | Measure- | Limit | Margin | Antenna | Table  |         |
|-----|-----|----------|---------|---------|----------|-------|--------|---------|--------|---------|
|     |     | MHz      | Level   | Factor  | ment     |       |        | Height  | Degree |         |
|     |     |          | dBuV    | dB      | dBuV/m   | dB    | dB     | cm      | degree | Comment |
| 1   | *   | 2460.700 | 100.16  | -3.39   | 96.77    | 74.00 | 22.77  | peak    |        |         |
| 2   |     | 2483.500 | 45.93   | -3.38   | 42.55    | 74.00 | -31.45 | peak    |        |         |

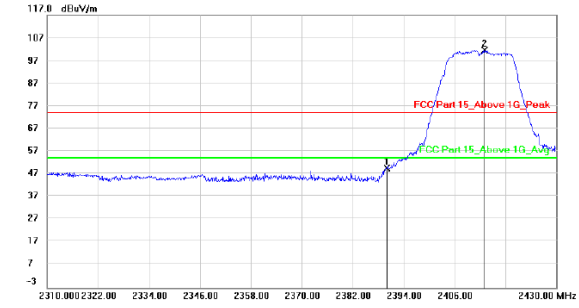
Polarization: Horizontal



| No. | Mk. | Freq.    | Reading | Correct | Measure- | Limit | Margin | Antenna | Table  |         |
|-----|-----|----------|---------|---------|----------|-------|--------|---------|--------|---------|
|     |     | MHz      | Level   | Factor  | ment     |       |        | Height  | Degree |         |
|     |     |          | dBuV    | dB      | dBuV/m   | dB    | dB     | cm      | degree | Comment |
| 1   | *   | 2462.000 | 104.87  | -3.40   | 101.47   | 74.00 | 27.47  | peak    |        |         |
| 2   |     | 2483.500 | 46.89   | -3.38   | 43.51    | 74.00 | -30.49 | peak    |        |         |

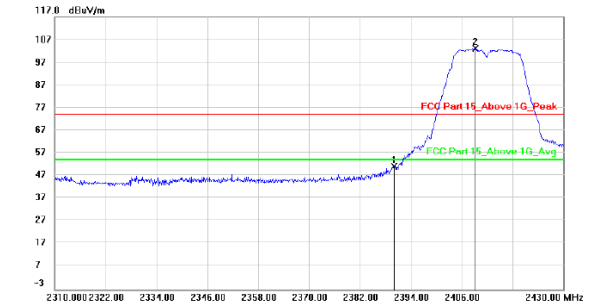
Test Mode: IEEE 802.11g-Low

Polarization: Vertical



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree | Comment |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|---------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | cm             | degree       |         |
| 1   |     | 2390.000 | 53.05         | -3.40          | 49.65       | 74.00  | -24.35 |                |              | peak    |
| 2   | *   | 2413.080 | 104.89        | -3.41          | 101.48      | 74.00  | 27.48  |                |              | peak    |

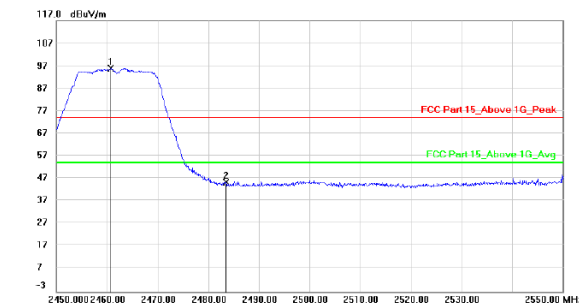
Polarization: Horizontal



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree | Comment |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|---------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | cm             | degree       |         |
| 1   |     | 2390.000 | 54.52         | -3.40          | 51.12       | 74.00  | -22.88 |                |              | peak    |
| 2   | *   | 2409.240 | 106.45        | -3.40          | 103.05      | 74.00  | 29.05  |                |              | peak    |

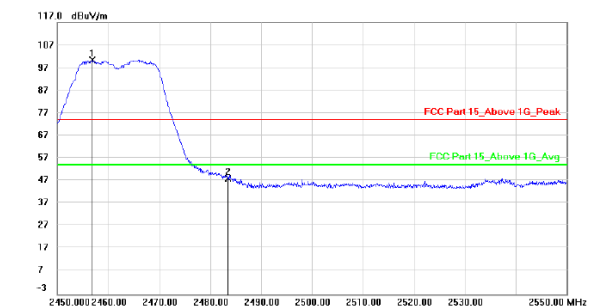
Test Mode: IEEE 802.11g-High

Polarization: Vertical



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree | Comment |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|---------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | cm             | degree       |         |
| 1   | *   | 2460.700 | 99.34         | -3.39          | 95.95       | 74.00  | 21.95  |                |              | peak    |
| 2   |     | 2483.500 | 48.80         | -3.38          | 45.42       | 74.00  | -28.58 |                |              | peak    |

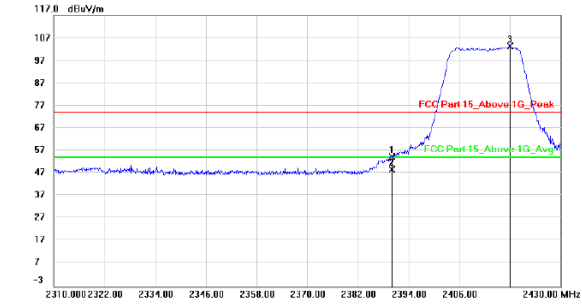
Polarization: Horizontal



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree | Comment |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|---------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | cm             | degree       |         |
| 1   | *   | 2456.900 | 103.75        | -3.39          | 100.36      | 74.00  | 26.36  |                |              | peak    |
| 2   |     | 2483.500 | 51.57         | -3.38          | 48.19       | 74.00  | -25.81 |                |              | peak    |

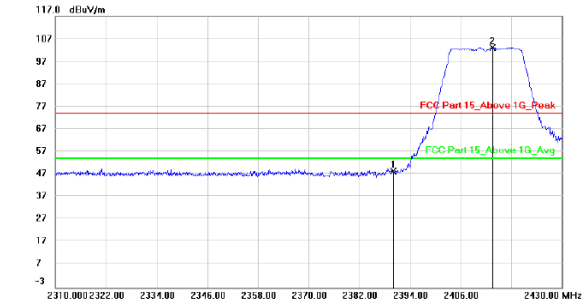
Test Mode: IEEE 802.11n20-Low

Polarization: Vertical



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree |        |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|--------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | Detector       | cm           | degree |
| 1   |     | 2390.000 | 57.96         | -3.40          | 54.56       | 74.00  | -19.44 | peak           |              |        |
| 2   |     | 2390.000 | 52.02         | -3.40          | 48.62       | 54.00  | -5.38  | AVG            |              |        |
| 3   | *   | 2418.000 | 106.64        | -3.41          | 103.23      | 74.00  | 29.23  | peak           |              |        |

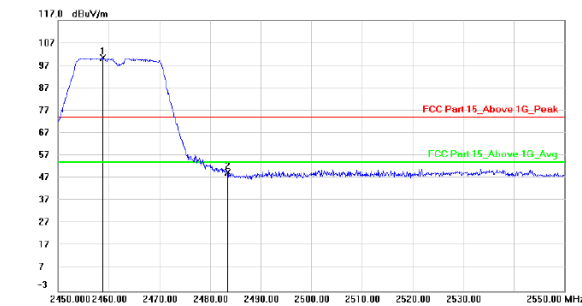
Polarization: Horizontal



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree |        |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|--------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | Detector       | cm           | degree |
| 1   |     | 2390.000 | 51.76         | -3.40          | 48.36       | 74.00  | -25.64 | peak           |              |        |
| 2   | *   | 2413.560 | 106.58        | -3.41          | 103.17      | 74.00  | 29.17  | peak           |              |        |

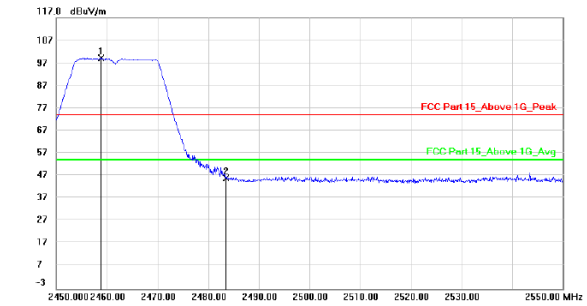
Test Mode: IEEE 802.11n20-High

Polarization: Vertical



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree |        |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|--------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | Detector       | cm           | degree |
| 1   | *   | 2458.800 | 103.83        | -3.39          | 100.44      | 74.00  | 26.44  | peak           |              |        |
| 2   |     | 2483.500 | 52.97         | -3.38          | 49.59       | 74.00  | -24.41 | peak           |              |        |

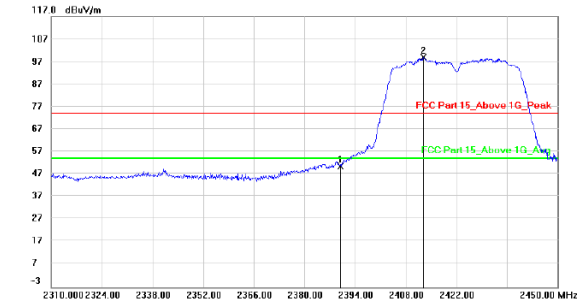
Polarization: Horizontal



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree |        |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|--------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | Detector       | cm           | degree |
| 1   | *   | 2458.800 | 102.62        | -3.39          | 99.23       | 74.00  | 25.23  | peak           |              |        |
| 2   |     | 2483.500 | 49.30         | -3.38          | 45.92       | 74.00  | -28.08 | peak           |              |        |

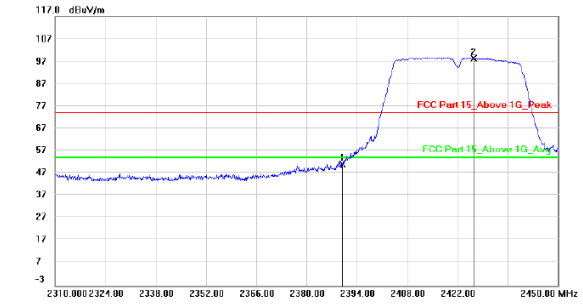
Test Mode: IEEE 802.11n40-Low

Polarization: Vertical



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree | Comment |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|---------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | cm             | degree       |         |
| 1   |     | 2390.000 | 54.01         | -3.40          | 50.61       | 74.00  | -23.39 | peak           |              |         |
| 2   | *   | 2412.900 | 102.33        | -3.41          | 98.92       | 74.00  | 24.92  | peak           |              |         |

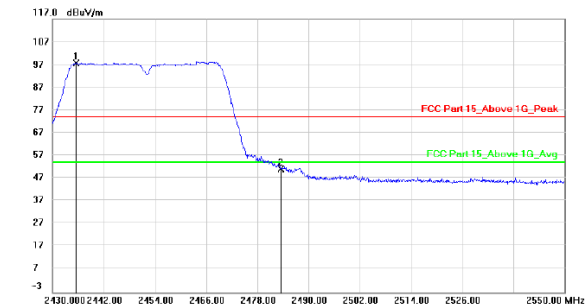
Polarization: Horizontal



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree | Comment |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|---------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | cm             | degree       |         |
| 1   |     | 2390.000 | 54.65         | -3.40          | 51.25       | 74.00  | -22.75 | peak           |              |         |
| 2   | *   | 2426.620 | 101.69        | -3.40          | 98.29       | 74.00  | 24.29  | peak           |              |         |

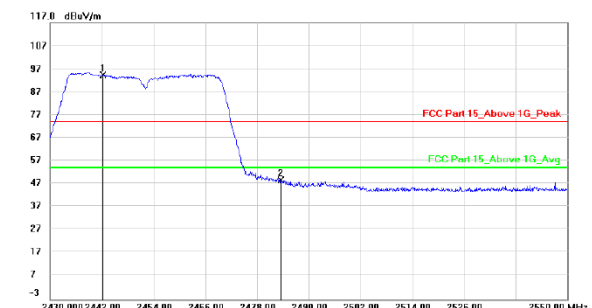
Test Mode: IEEE 802.11n40-High

Polarization: Vertical



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree | Comment |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|---------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | cm             | degree       |         |
| 1   | *   | 2435.520 | 100.98        | -3.40          | 97.58       | 74.00  | 23.58  | peak           |              |         |
| 2   |     | 2483.500 | 54.46         | -3.38          | 51.08       | 74.00  | -22.92 | peak           |              |         |

Polarization: Horizontal



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Margin | Antenna Height | Table Degree | Comment |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------------|--------------|---------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | cm             | degree       |         |
| 1   | *   | 2442.240 | 97.85         | -3.40          | 94.45       | 74.00  | 20.45  | peak           |              |         |
| 2   |     | 2483.500 | 52.24         | -3.38          | 48.86       | 74.00  | -25.14 | peak           |              |         |

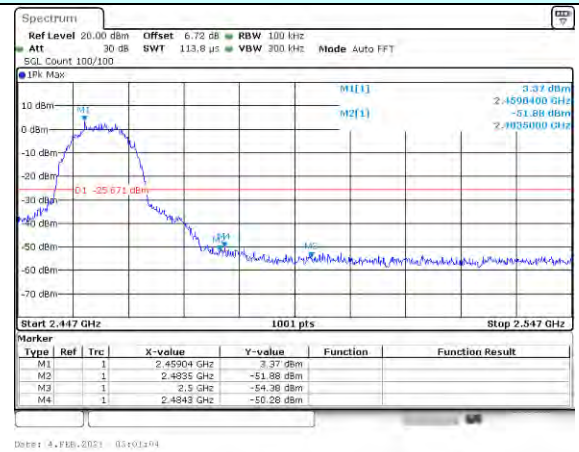
Note: 1. \*:Maximum data; x:Over limit; !:over margin.

2.Measurement=Reading Level + Correct Factor; Correct Factor=Antenna Factor + Cable Loss.

## Test mode: 802.11b



Lowest channel

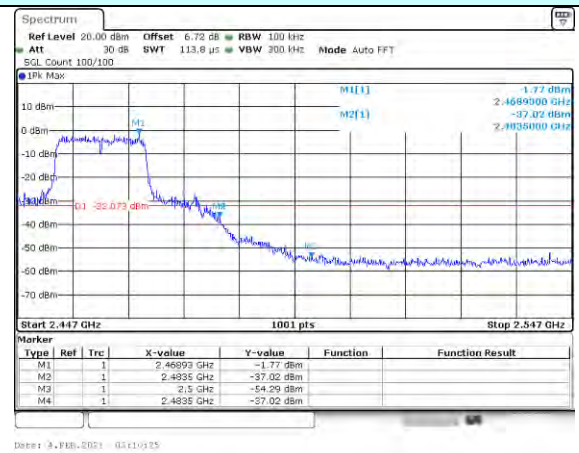


Highest channel

## Test mode: 802.11g

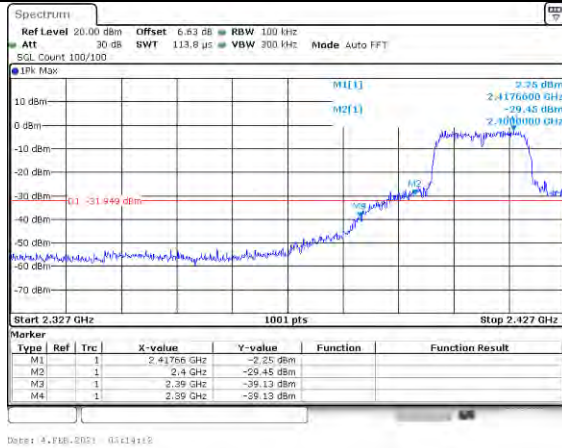


Lowest channel



Highest channel

## Test mode: 802.11n(HT20)

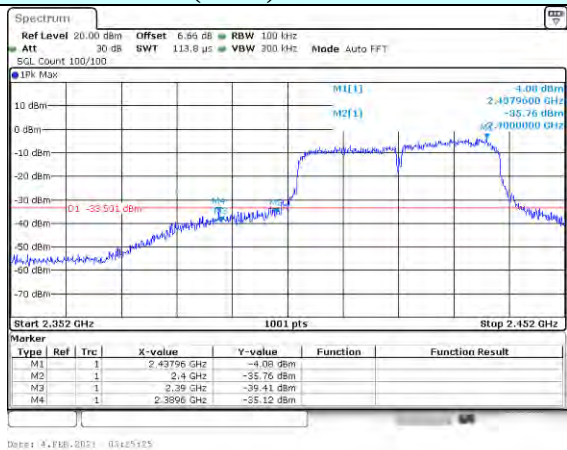


Lowest channel

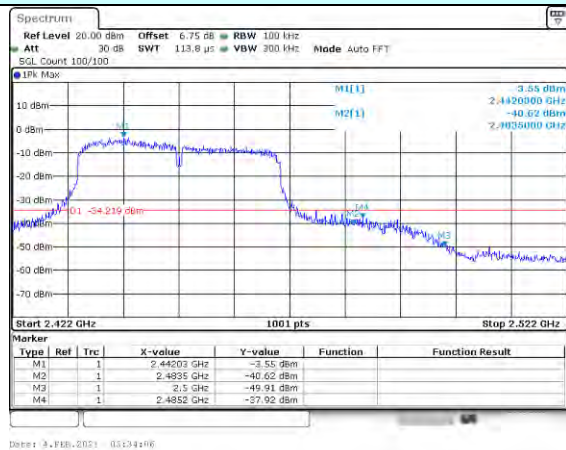


Highest channel

Test mode: 802.11n(HT40)



Lowest channel



Highest channel

## 9. FREQUENCY STABILITY

### 9.1. Test limit

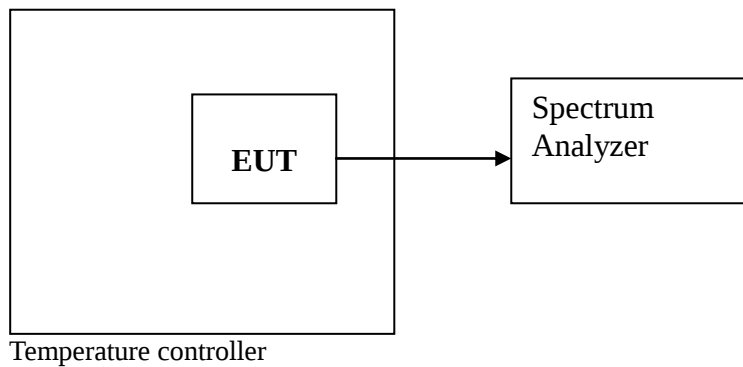
Please refer section RSS-Gen.

Regulation RSS-Gen If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80% of its permitted operating frequency band in order to minimize the possibility of out-of-band operation. In addition, its occupied bandwidth shall be entirely outside the restricted bands and the prohibited TV bands of 54-72 MHz, 76-88 MHz, 174-216 MHz, and 470-602 MHz, unless otherwise indicated.

### 9.2. Test Procedure

The following equipment are installed on the emission measurement to meet the commission requirements and operating regulations in a manner which tends to maximize its emission characteristics in normal application.

### 9.3. Test Setup



### 9.4. Test Results

*Not applicable.*

## **10.ANTENNA REQUIREMENT**

### **10.1.Standard 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 shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

### **10.2.Antenna Connected Construction**

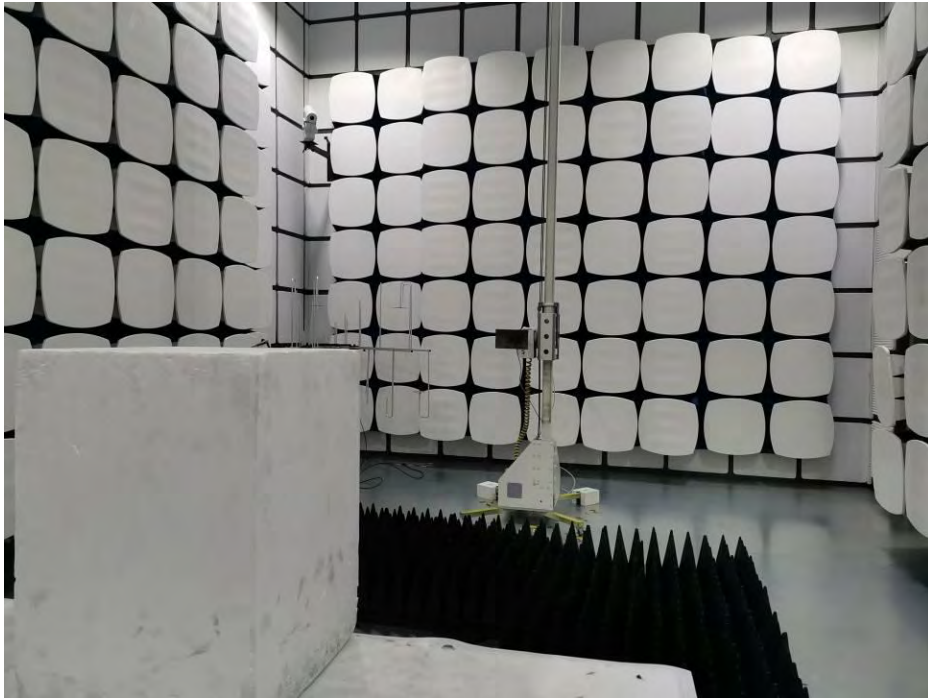
The antenna is PCB antenna and no consideration of replacement. Please see EUT photo for details.

### **10.3.Results**

The EUT antenna is Integrated antenna. It complies with the standard requirement.

## 11. TEST SETUP PHOTO

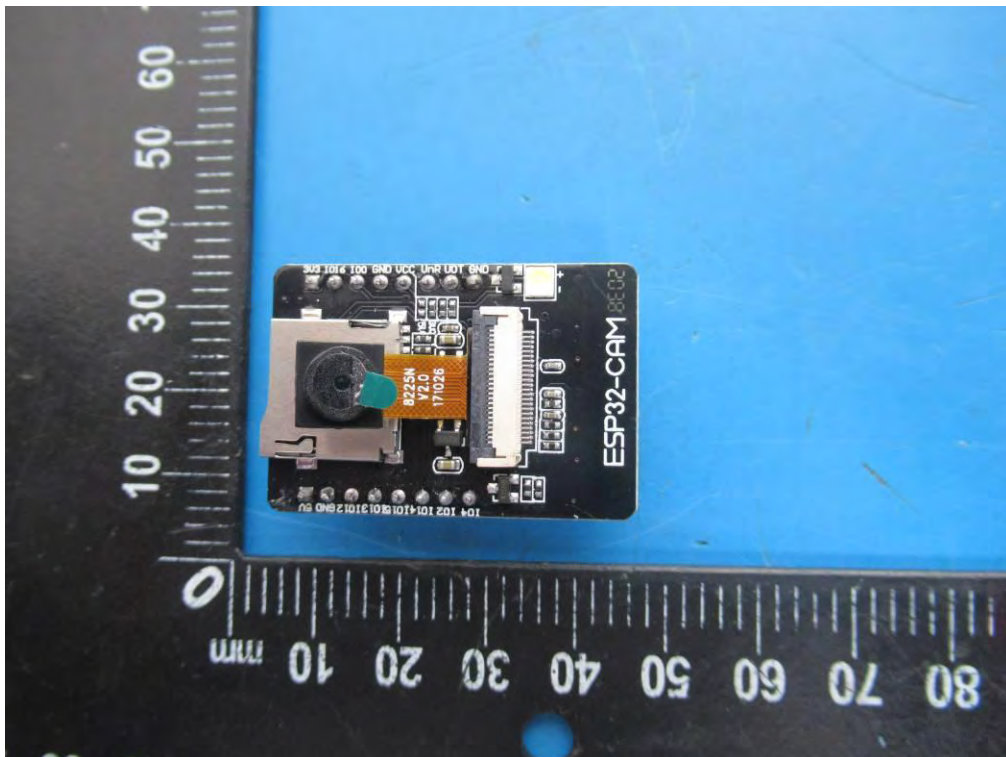
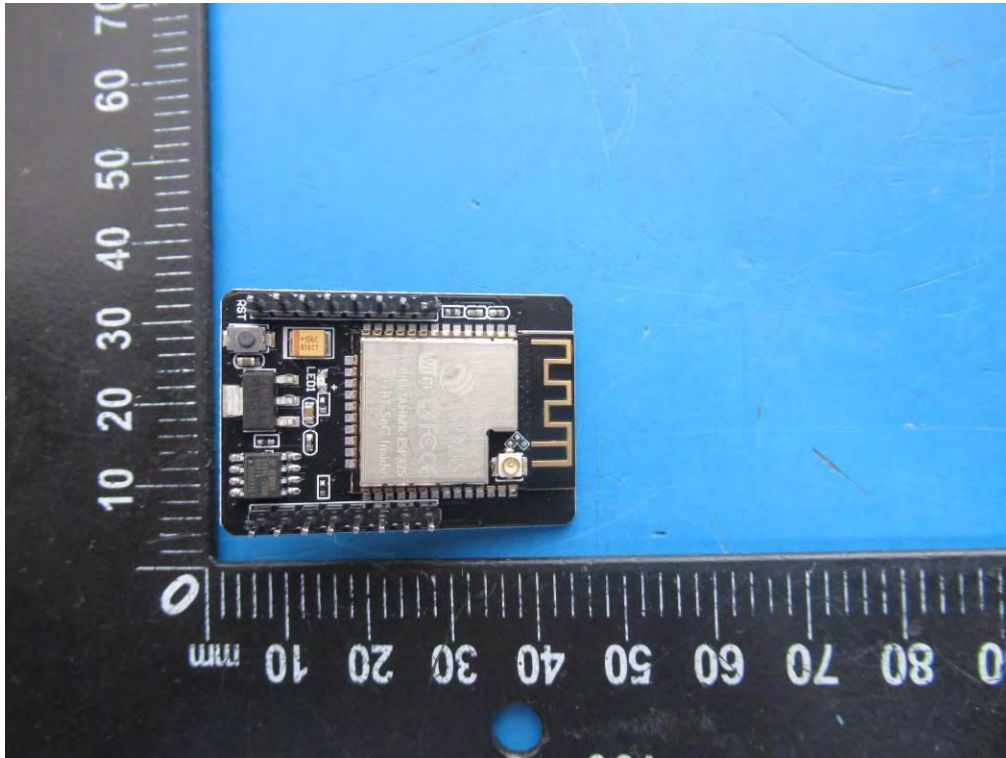
### Photos of Radiated emission

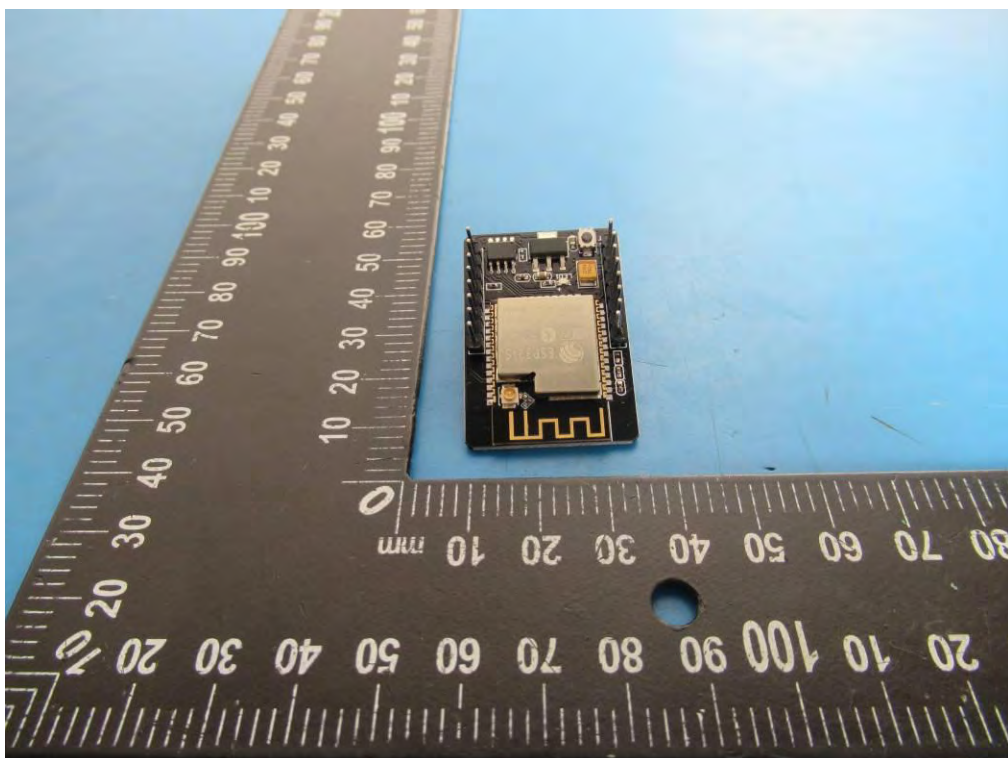
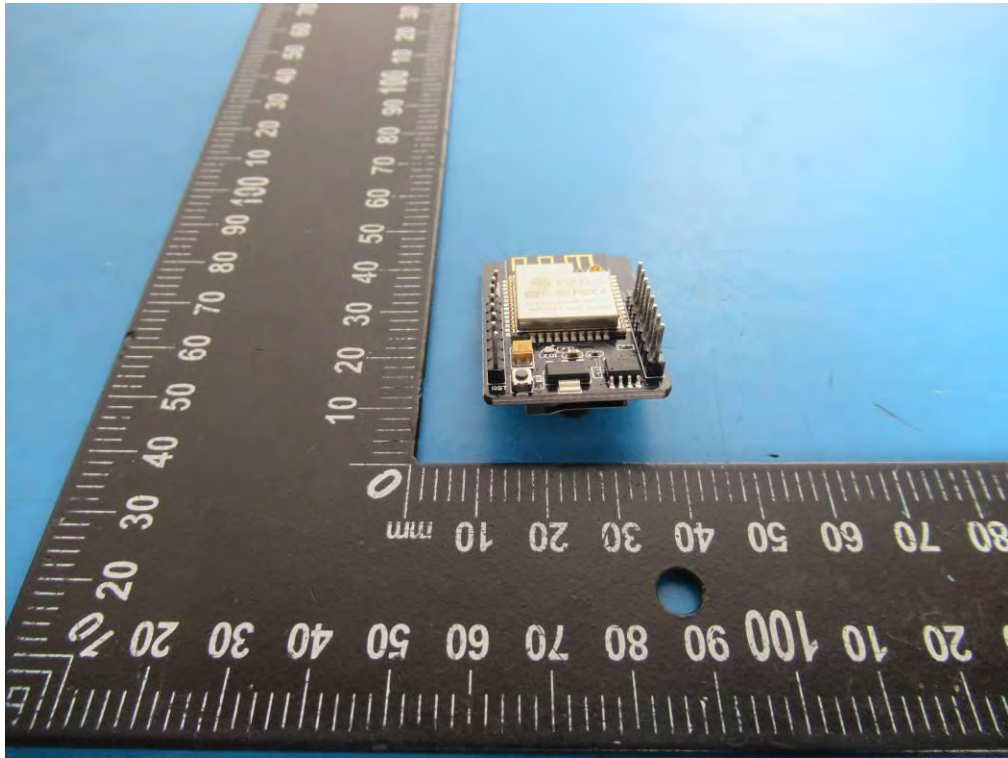


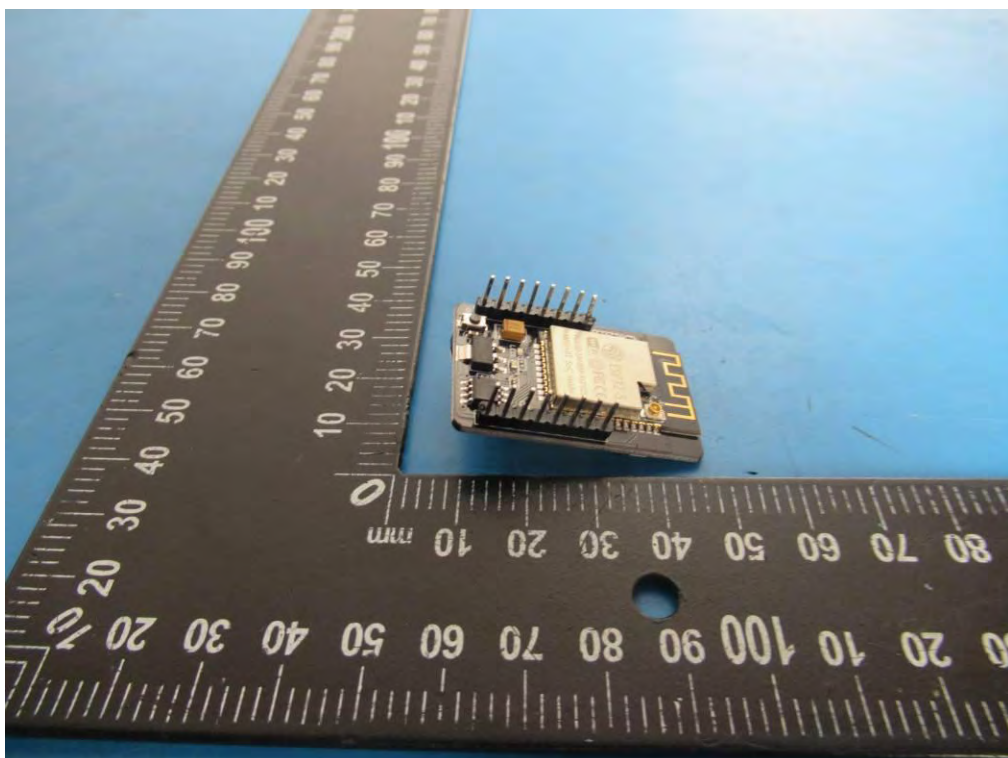
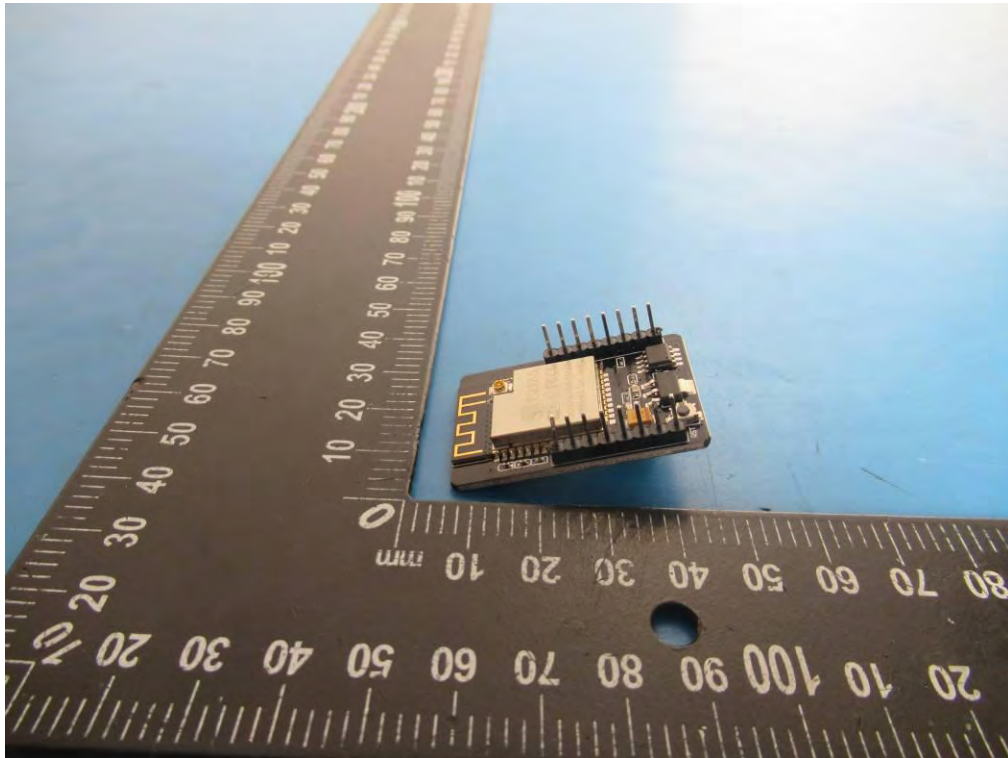
## Photos of Power Line Conducted Emission Test

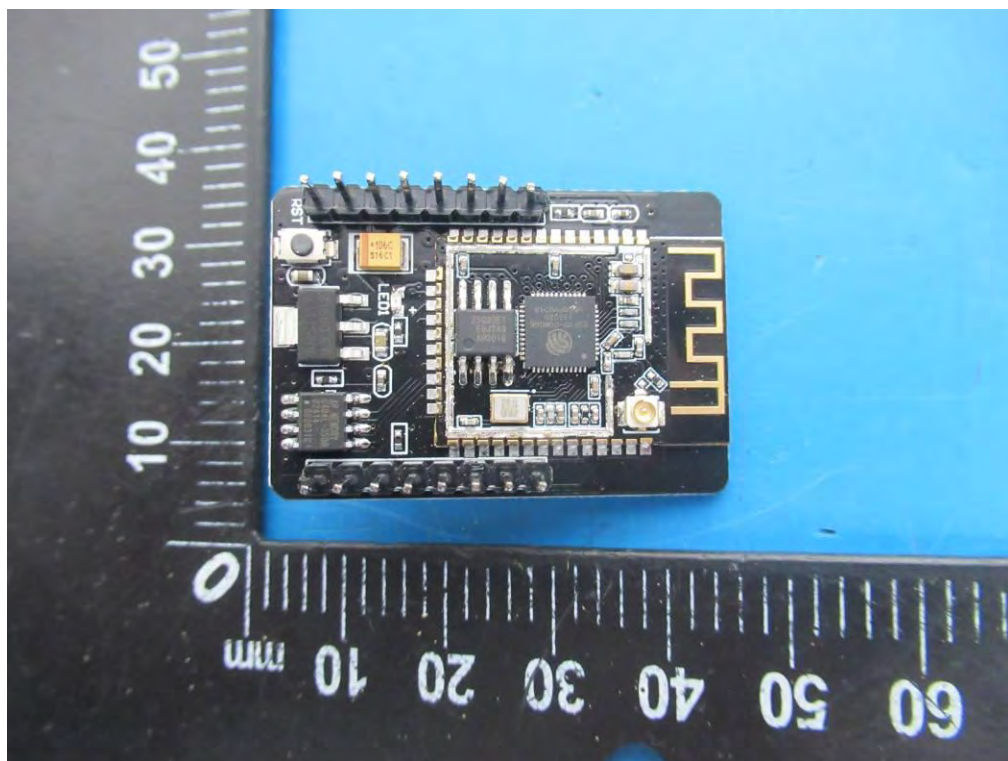
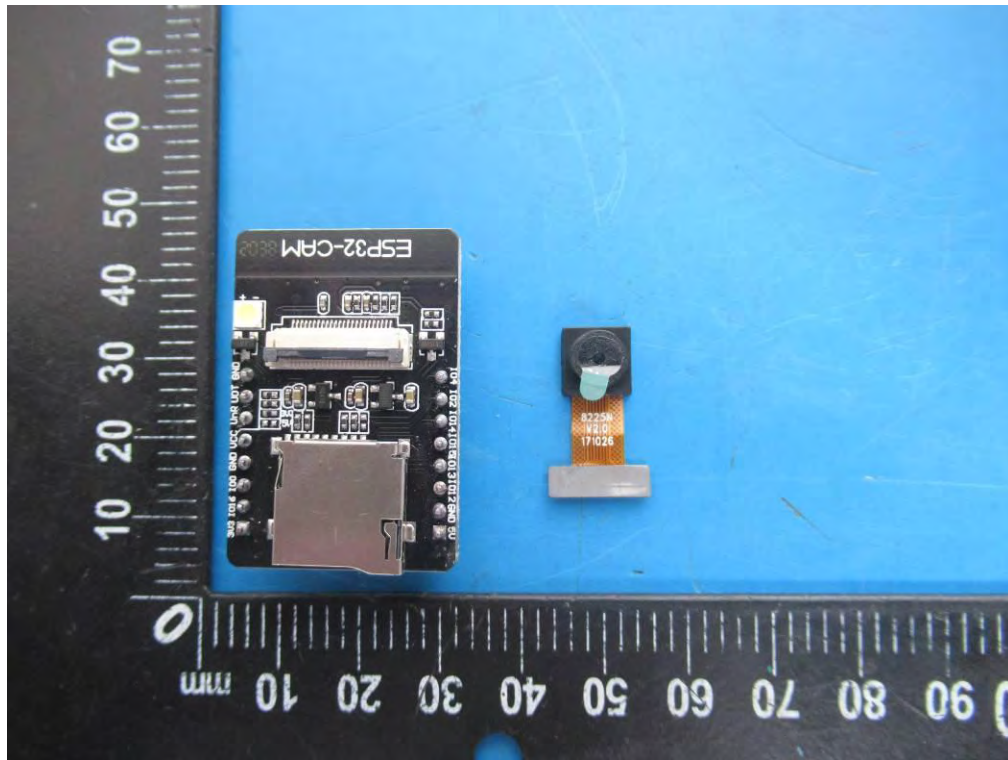


## 12. PHOTOS OF EUT









-----THE END OF REPORT-----