

# FCC TEST REPORT

**Product Name:** WiFi/BT Module  
**Trade Mark:** msi  
**Model No. / HVIN:** MWH540S  
**Add. Model No. / HVIN:** N/A  
**Report Number:** 24112914988RFC-2  
**Test Standards:** FCC 47 CFR Part 15 Subpart C  
RSS-247 Issue 3  
RSS-Gen Issue 5  
**FCC ID:** I4L-MWH540S  
**IC:** 3715A-MWH540S  
**Test Result:** PASS  
**Date of Issue:** January 7, 2025

Prepared for:

**Micro-Star Int'l Co., Ltd.**  
**No. 69, Lide St., Zhonghe Dist., New Taipei City 235, Taiwan**

Prepared by:

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## Version

| Version No. | Date            | Description |
|-------------|-----------------|-------------|
| V1.0        | January 7, 2025 | Original    |



## Shenzhen UnionTrust Quality and Technology Co., Ltd.

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## 1. GENERAL INFORMATION

### 1.1 CLIENT INFORMATION

|                                 |                                                              |
|---------------------------------|--------------------------------------------------------------|
| <b>Applicant:</b>               | Micro-Star Int'l Co., Ltd.                                   |
| <b>Address of Applicant:</b>    | No. 69, Lide St., Zhonghe Dist., New Taipei City 235, Taiwan |
| <b>Manufacturer:</b>            | Micro-Star Int'l Co., Ltd.                                   |
| <b>Address of Manufacturer:</b> | No. 69, Lide St., Zhonghe Dist., New Taipei City 235, Taiwan |

### 1.2 EUT INFORMATION

#### 1.2.1 General Description of EUT

|                                                             |                                        |                        |                   |
|-------------------------------------------------------------|----------------------------------------|------------------------|-------------------|
| <b>Product Name:</b>                                        | WiFi/BT Module                         |                        |                   |
| <b>Model No.:</b>                                           | MWH540S                                |                        |                   |
| <b>Add. Model No.:</b>                                      | N/A                                    |                        |                   |
| <b>Trade Mark:</b>                                          | msi                                    |                        |                   |
| <b>DUT Stage:</b>                                           | Identical Prototype                    |                        |                   |
| <b>EUT Supports Function:</b><br>(Provided by the customer) | 2.4 GHz ISM Band:                      | IEEE 802.11b/g/n       |                   |
|                                                             |                                        | Bluetooth 5.0          |                   |
|                                                             | 5 GHz U-NII Bands:                     | 5 150 MHz to 5 350 MHz | IEEE 802.11a/n/ac |
|                                                             |                                        | 5 470 MHz to 5 725 MHz | IEEE 802.11a/n/ac |
|                                                             |                                        | 5 725 MHz to 5 850 MHz | IEEE 802.11a/n/ac |
| <b>Software Version:</b>                                    | N/A (Provided by the customer)         |                        |                   |
| <b>Hardware Version:</b>                                    | V3.00 (Provided by the customer)       |                        |                   |
| <b>Sample Received Date:</b>                                | November 11, 2024                      |                        |                   |
| <b>Sample Tested Date:</b>                                  | December 11, 2024 to December 27, 2024 |                        |                   |

**Remark:**

The above EUT's information was provided by customer. Please refer to the specifications or user's manual for more detailed description.

#### 1.2.2 Description of Accessories

None.

### 1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

|                                                    |                                          |
|----------------------------------------------------|------------------------------------------|
| <b>Frequency Band:</b>                             | 2400 MHz to 2483.5 MHz                   |
| <b>Frequency Range:</b>                            | 2402 MHz to 2480 MHz                     |
| <b>Bluetooth Version:</b>                          | Bluetooth BR + EDR                       |
| <b>Modulation Technique:</b>                       | Frequency Hopping Spread Spectrum (FHSS) |
| <b>Type of Modulation:</b>                         | GFSK, $\pi/4$ DQPSK, 8DPSK               |
| <b>Number of Channels:</b>                         | 79                                       |
| <b>Channel Separation:</b>                         | 1 MHz                                    |
| <b>Hopping Channel Type:</b>                       | Adaptive Frequency Hopping Systems       |
| <b>Antenna Type:</b><br>(Provided by the customer) | Tube Antenna                             |
| <b>Antenna Gain:</b><br>(Provided by the customer) | 3.38 dBi                                 |
| <b>Normal Test Voltage:</b>                        | 3.3 Vdc                                  |

### 1.4 OTHER INFORMATION

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| Operation Frequency Each of Channel          |                                   |
|----------------------------------------------|-----------------------------------|
| $f = 2402 + k \text{ MHz}, k = 0, \dots, 78$ |                                   |
| Note:                                        |                                   |
| <b>f</b>                                     | is the operating frequency (MHz); |
| <b>k</b>                                     | is the operating channel.         |

| Modulation Configure |        |             |             |
|----------------------|--------|-------------|-------------|
| Modulation           | Packet | Packet Type | Packet Size |
| GFSK                 | 1-DH1  | 4           | 27          |
|                      | 1-DH3  | 11          | 183         |
|                      | 1-DH5  | 15          | 339         |
| $\pi/4$ DQPSK        | 2-DH1  | 20          | 54          |
|                      | 2-DH3  | 26          | 367         |
|                      | 2-DH5  | 30          | 679         |
| 8DPSK                | 3-DH1  | 24          | 83          |
|                      | 3-DH3  | 27          | 552         |
|                      | 3-DH5  | 31          | 1021        |

## 1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

### 1) Support Equipment

| Description | Manufacturer | Model No.     | Serial Number | Supplied by |
|-------------|--------------|---------------|---------------|-------------|
| Notebook    | DELL         | Inspiron 5593 | N/A           | UnionTrust  |
| Mouse       | DELL         | MS111         | CN-011D3V-738 | UnionTrust  |

### 2) Support Cable

| Cable No. | Description   | Connector | Length    | Supplied by |
|-----------|---------------|-----------|-----------|-------------|
| 1         | Antenna Cable | SMA       | 0.2 Meter | UnionTrust  |

## 1.6 TEST LOCATION

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## 1.7 TEST FACILITY

The test facility is recognized, certified, or accredited by the following organizations:

**CNAS-Lab Code: L9069**

The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

**A2LA-Lab Certificate No.: 4312.01**

Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

**ISED Wireless Device Testing Laboratories**

CAB identifier: CN0032

**FCC Accredited Lab.**

Designation Number: CN1194

Test Firm Registration Number: 259480

## 1.8 DEVIATION FROM STANDARDS

None.

## 1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

## 1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

## 1.11 MEASUREMENT UNCERTAINTY

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

| No. | Item                            | Measurement Uncertainty           |
|-----|---------------------------------|-----------------------------------|
| 1   | Conducted emission 9kHz-150kHz  | ±3.2 dB                           |
| 2   | Conducted emission 150kHz-30MHz | ±2.7 dB                           |
| 3   | Radiated emission 9kHz-30MHz    | ± 4.7 dB                          |
| 4   | Radiated emission 30MHz-1GHz    | ± 4.9 dB                          |
| 5   | Radiated emission 1GHz-18GHz    | ± 4.8 dB                          |
| 6   | Radiated emission 18GHz-26GHz   | ± 5.1 dB                          |
| 7   | Radiated emission 26GHz-40GHz   | ± 5.1 dB                          |
| 8   | Conducted spurious emissions    | ± 2.7 dB                          |
| 9   | RF Power, Conducted             | ± 0.68 dB                         |
| 10  | Occupied Bandwidth              | ± 1.86 %                          |
| 11  | Radio Frequency                 | 2.4 GHz: ± 6.5 × 10 <sup>-8</sup> |
| 12  | Transmission Time               | ± 0.19 %                          |

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## 2. TEST SUMMARY

| Test Cases                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                              |                                                 |                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------------------|----------------------------|
| Test Item                                                                                                                                                                                                                                                                                                                                                                                                                                               | Test Requirement                                                                             | Test Method                                     | Result                     |
| Antenna Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                     | FCC 47 CFR Part 15 Subpart C Section 15.203/15.247 (b)<br>RSS-Gen Issue 5, Section 6.8       | N/A                                             | PASS <sup>NOTE 1</sup>     |
| AC Power Line Conducted Emission                                                                                                                                                                                                                                                                                                                                                                                                                        | FCC 47 CFR Part 15 Subpart C Section 15.207<br>RSS-Gen Issue 5, Section 8.8                  | ANSI C63.10-2013 Section 6.2                    | VERIFIED <sup>NOTE 1</sup> |
| Conducted Peak Output Power                                                                                                                                                                                                                                                                                                                                                                                                                             | FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(1)<br>RSS-247 Issue 3, Section 5.4(b)        | ANSI C63.10-2013 Section 7.8.5                  | VERIFIED <sup>NOTE 1</sup> |
| 20 dB Bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                         | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)<br>RSS-247 Issue 3, Section 5.1(a)        | ANSI C63.10-2013 Section 6.9.2                  | VERIFIED <sup>NOTE 1</sup> |
| Occupied Bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                      | RSS-Gen Issue 5, section 6.7                                                                 | RSS-Gen Issue 5 Section 6.7                     | VERIFIED <sup>NOTE 1</sup> |
| Carrier Frequencies Separation                                                                                                                                                                                                                                                                                                                                                                                                                          | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)<br>RSS-247 Issue 3, Section 5.1(b)        | ANSI C63.10-2013 Section 7.8.2                  | VERIFIED <sup>NOTE 1</sup> |
| Number of Hopping Channel                                                                                                                                                                                                                                                                                                                                                                                                                               | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)(iii)<br>RSS-247 Issue 3, Section 5.1(d)   | ANSI C63.10-2013 Section 7.8.3                  | VERIFIED <sup>NOTE 1</sup> |
| Dwell Time                                                                                                                                                                                                                                                                                                                                                                                                                                              | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)<br>RSS-247 Issue 3, Section 5.1(d)        | ANSI C63.10-2013 Section 7.8.4                  | VERIFIED <sup>NOTE 1</sup> |
| Conducted Out of Band Emission                                                                                                                                                                                                                                                                                                                                                                                                                          | FCC 47 CFR Part 15 Subpart C Section 15.247(d)<br>RSS-247 Issue 3, Section 5.5               | ANSI C63.10-2013 Section 6.10.4 & Section 7.8.8 | VERIFIED <sup>NOTE 1</sup> |
| Radiated Emissions                                                                                                                                                                                                                                                                                                                                                                                                                                      | FCC 47 CFR Part 15 Subpart C Section 15.205/15.209<br>RSS-Gen Issue 5, Section 6.13/8.9/8.10 | ANSI C63.10-2013 Section 6.3 & 6.5 & 6.6        | PASS <sup>NOTE 1</sup>     |
| Band Edge Measurement                                                                                                                                                                                                                                                                                                                                                                                                                                   | FCC 47 CFR Part 15 Subpart C Section 15.205/15.209<br>RSS-247 Issue 3, Section 5.5           | ANSI C63.10-2013 Section 6.10.5                 | PASS <sup>NOTE 1</sup>     |
| <b>Note:</b><br>1) N/A: In this whole report not applicable.<br>2) This EUT is powered by batteries<br>3) This report base on previous reports no.: SRTC2024-9004(F)-24032606(D) Issued by The State Radio_monitoring_center Testing Center (SRTC). Change Antenna, after evaluation, all data refer to previous reports except for the EIRP calculation and verifying the all Radiated Spurious Emissions and Band Edge Measurements (Radiated) tests. |                                                                                              |                                                 |                            |
| <b>Disclaimer and Explanations:</b><br>The declared of product specification and data (e.g., antenna gain, RF specification, etc) for EUT presented in the report are provided by the customer, and the customer takes all the responsibilities for the accuracy of product specification.                                                                                                                                                              |                                                                                              |                                                 |                            |

### 3. EQUIPMENT LIST

| Radiated Emission Test Equipment List |                                                      |               |            |                            |             |               |
|---------------------------------------|------------------------------------------------------|---------------|------------|----------------------------|-------------|---------------|
| Used                                  | Equipment                                            | Manufacturer  | Model No.  | Serial Number              | Cal. date   | Cal. Due date |
| <input checked="" type="checkbox"/>   | 3m SAC                                               | ETS-LINDGREN  | 3M         | Euroshiedpn-CT001270-1317  | 11-Nov-2023 | 10-Nov-2026   |
| <input checked="" type="checkbox"/>   | Receiver                                             | R&S           | ESIB26     | 100114                     | 25-Oct-2024 | 24-Oct-2025   |
| <input checked="" type="checkbox"/>   | Loop Antenna                                         | ETS-LINDGREN  | 6502       | 00202525                   | 28-Oct-2024 | 27-Oct-2025   |
| <input checked="" type="checkbox"/>   | Broadband Antenna                                    | ETS-LINDGREN  | 3142E      | 00201566                   | 29-Oct-2024 | 28-Oct-2025   |
| <input checked="" type="checkbox"/>   | 6dB Attenuator                                       | Talent        | RA6A5-N-18 | 18103001                   | 29-Oct-2024 | 28-Oct-2025   |
| <input checked="" type="checkbox"/>   | Preamplifier                                         | HP            | 8447F      | 2805A02960                 | 25-Oct-2024 | 24-Oct-2025   |
| <input checked="" type="checkbox"/>   | Double-Ridged Waveguide Horn Antenna (Pre-amplifier) | ETS-LINDGREN  | 3117-PA    | 00201541                   | 01-Apr-2024 | 31-Mar-2025   |
| <input checked="" type="checkbox"/>   | Pre-amplifier                                        | ETS-LINDGREN  | 00118385   | 00201874                   | 01-Apr-2024 | 31-Mar-2025   |
| <input checked="" type="checkbox"/>   | Double-Ridged Waveguide Horn Antenna (Pre-amplifier) | ETS-LINDGREN  | 3116C-PA   | 00202652                   | 28-Oct-2024 | 27-Oct-2025   |
| <input checked="" type="checkbox"/>   | Pre-amplifier                                        | ETS-LINDGREN  | 00118384   | 00202652                   | 28-Oct-2024 | 27-Oct-2025   |
| <input checked="" type="checkbox"/>   | Band Rejection Filter (2400MHz~2500MHz)              | Micro-Tronics | BRM50702   | G590                       | 17-Jan-2024 | 16-Jan-2025   |
| <input checked="" type="checkbox"/>   | Multi device Controller                              | ETS-LINDGREN  | 7006-001   | 00160105                   | N/A         | N/A           |
| <input checked="" type="checkbox"/>   | Test Software                                        | Audix         | e3         | Software Version: 9.160323 |             |               |

| RF Conducted Test Equipment List    |                           |              |           |               |             |               |
|-------------------------------------|---------------------------|--------------|-----------|---------------|-------------|---------------|
| Used                                | Equipment                 | Manufacturer | Model No. | Serial Number | Cal. date   | Cal. Due date |
| <input checked="" type="checkbox"/> | EXA Spectrum Analyzer     | KEYSIGHT     | N9010A    | MY51440197    | 29-Mar-2024 | 28-Mar-2025   |
| <input type="checkbox"/>            | EXA Spectrum Analyzer     | KEYSIGHT     | N9020A    | MY51286807    | 25-Oct-2024 | 24-Oct-2025   |
| <input checked="" type="checkbox"/> | USB Wideband Power Sensor | KEYSIGHT     | U2021XA   | MY55430035    | 25-Oct-2024 | 24-Oct-2025   |

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## 4. TEST CONFIGURATION

### 4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

#### 4.1.1 Normal or Extreme Test Conditions

| Environment Parameter                                           | Selected Values During Tests |            |                       |
|-----------------------------------------------------------------|------------------------------|------------|-----------------------|
| Test Condition                                                  | Ambient                      |            |                       |
|                                                                 | Temperature (°C)             | Voltage(V) | Relative Humidity (%) |
| NT/NV                                                           | +15 to +35                   | 3.3        | 20 to 75              |
| <b>Remark:</b><br>1) NV: Normal Voltage; NT: Normal Temperature |                              |            |                       |

#### 4.1.2 Record of Normal Environment and Test Sample

| Test Item             | Temp. (°C) | Relative Humidity (%) | Pressure (kPa) | Sample No.          | Tested by  |
|-----------------------|------------|-----------------------|----------------|---------------------|------------|
| Radiated Emissions    | 21.1       | 31.6                  | 100.6          | S202410304552-PJA01 | Jackson Wu |
| Band Edge Measurement |            |                       |                |                     |            |

### 4.2 TEST CHANNELS

| Mode                             | Tx/Rx Frequency      | Test RF Channel Lists |            |            |
|----------------------------------|----------------------|-----------------------|------------|------------|
|                                  |                      | Lowest(L)             | Middle(M)  | Highest(H) |
| GFSK<br>(DH1, DH3, DH5)          | 2402 MHz to 2480 MHz | Channel 0             | Channel 39 | Channel 78 |
|                                  |                      | 2402 MHz              | 2441 MHz   | 2480 MHz   |
| $\pi$ /4DQPSK<br>(DH1, DH3, DH5) | 2402 MHz to 2480 MHz | Channel 0             | Channel 39 | Channel 78 |
|                                  |                      | 2402 MHz              | 2441 MHz   | 2480 MHz   |
| 8DPSK<br>(DH1, DH3, DH5)         | 2402 MHz to 2480 MHz | Channel 0             | Channel 39 | Channel 78 |
|                                  |                      | 2402 MHz              | 2441 MHz   | 2480 MHz   |

### 4.3 EUT TEST STATUS

| Type of Modulation            | Tx Function | Description                                                                                                                                                      |
|-------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GFSK/ $\pi$ /4DQPSK/<br>8DPSK | 1Tx         | 1. Keep the EUT in continuously transmitting with Modulation test single<br>2. Keep the EUT in continuously transmitting with Modulation test Hopping Frequency. |

| Power Setting (Provided by the customer) |
|------------------------------------------|
| Power Setting: 9                         |

| Test Software (Provided by the customer) |
|------------------------------------------|
| MPTool                                   |

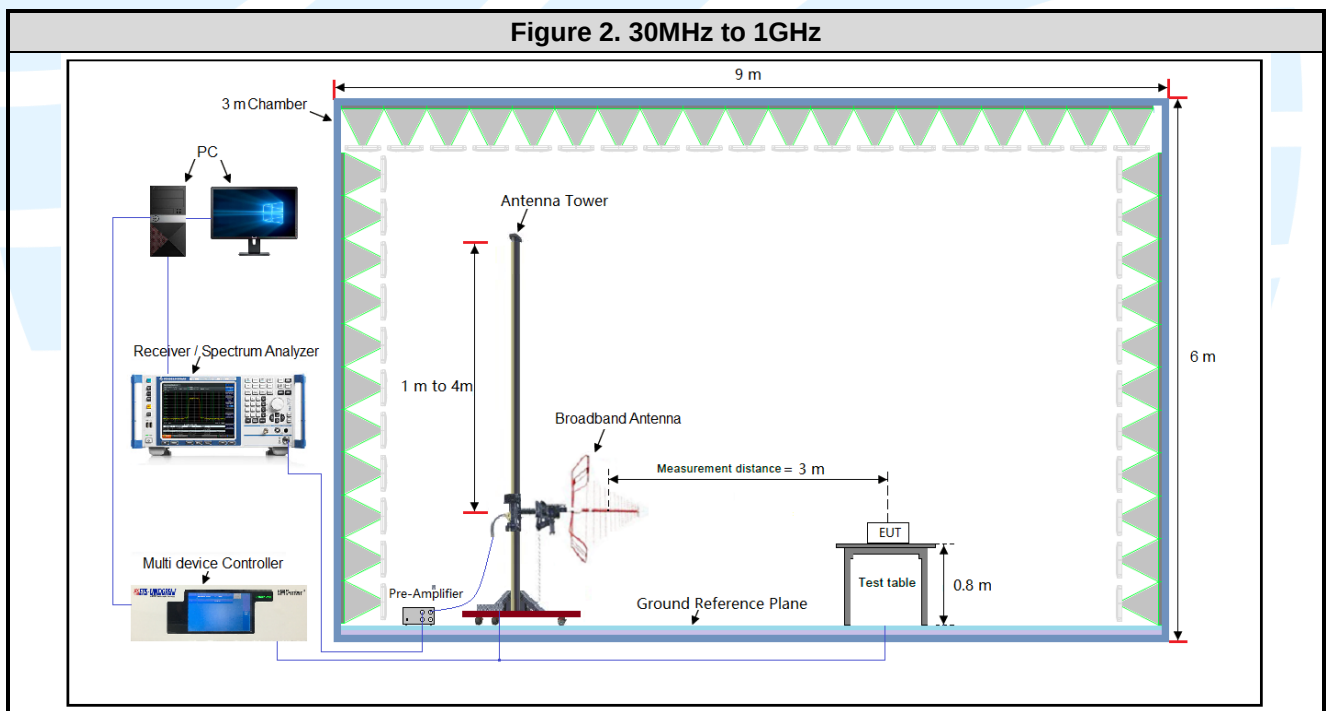
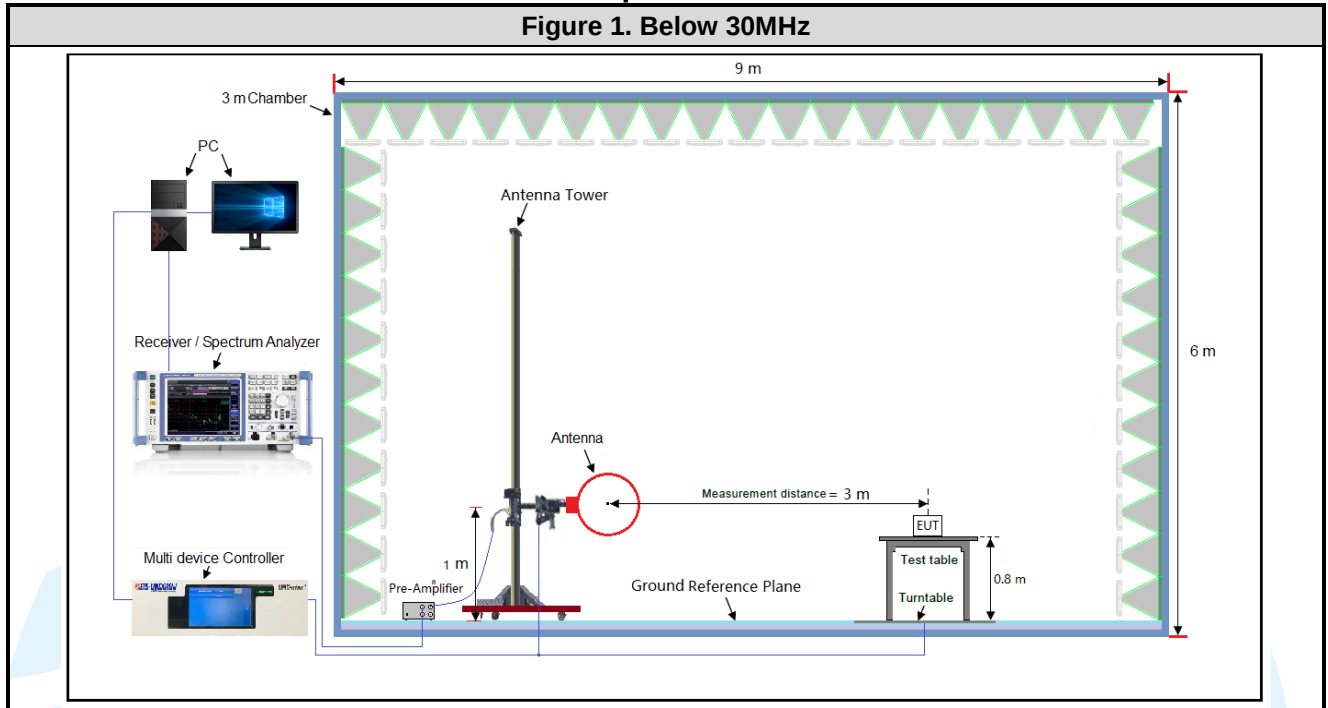
#### 4.4 PRE-SCAN

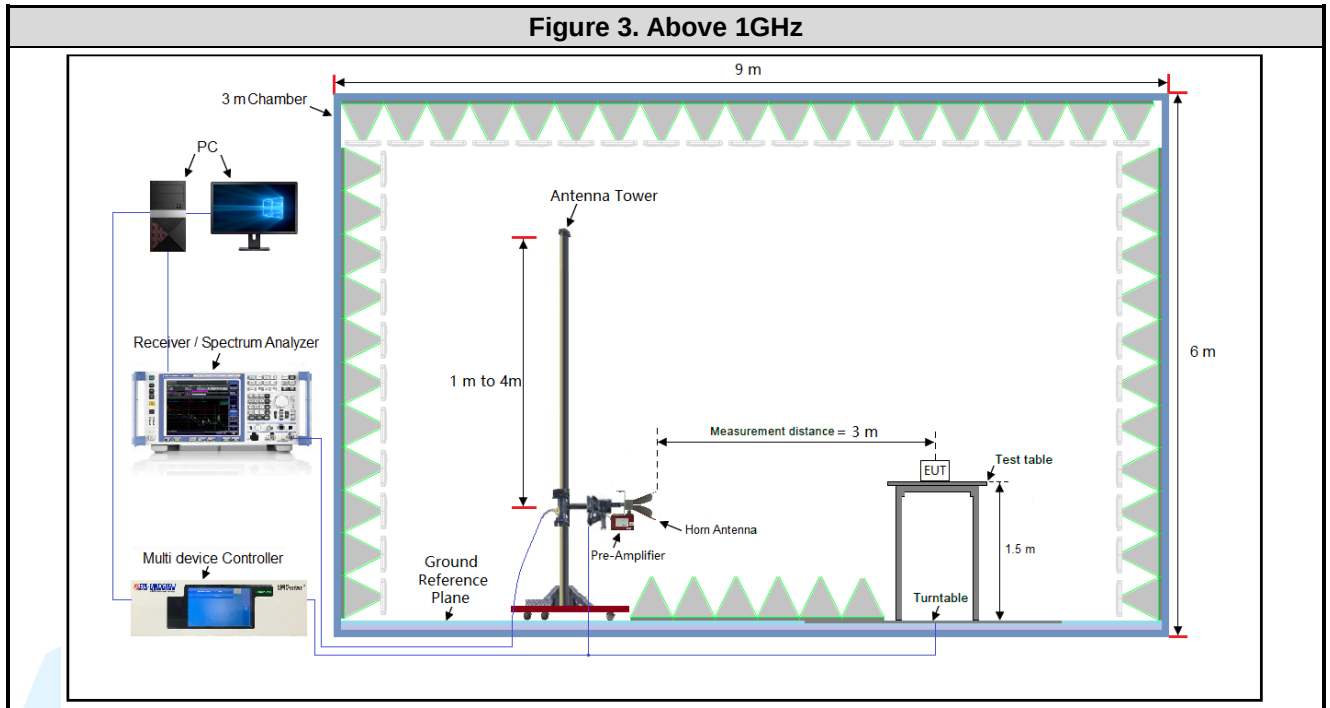
Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data packets and antenna ports (if EUT with antenna diversity architecture). Following channel(s) was (were) selected for the final test as listed below.

| Type of Modulation                                                                                          | GFSK                                    |                          |                          | $\pi/4$ DQPSK            |                          |                          | 8DPSK                    |                          |                                     |
|-------------------------------------------------------------------------------------------------------------|-----------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|-------------------------------------|
| Data Packets                                                                                                | 1-DH<br>1                               | 1-DH<br>3                | 1-DH<br>5                | 2-DH<br>1                | 2-DH<br>3                | 2-DH<br>5                | 3-DH<br>1                | 3-DH<br>3                | 3-DH<br>5                           |
| Available Channel                                                                                           | 0 to 78                                 |                          |                          |                          |                          |                          |                          |                          |                                     |
| Test Item                                                                                                   | Test channel and choose of data packets |                          |                          |                          |                          |                          |                          |                          |                                     |
| Radiated Emissions                                                                                          | Channel 0 & 39 & 78                     |                          |                          |                          |                          |                          |                          |                          |                                     |
|                                                                                                             | <input type="checkbox"/>                | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Band Edge Measurements<br>(Radiated)                                                                        | Channel 0 & 78                          |                          |                          |                          |                          |                          |                          |                          |                                     |
|                                                                                                             | <input type="checkbox"/>                | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Remark:<br>1. The mark "☑" means is chosen for testing;<br>2. The mark "☐" means is not chosen for testing. |                                         |                          |                          |                          |                          |                          |                          |                          |                                     |

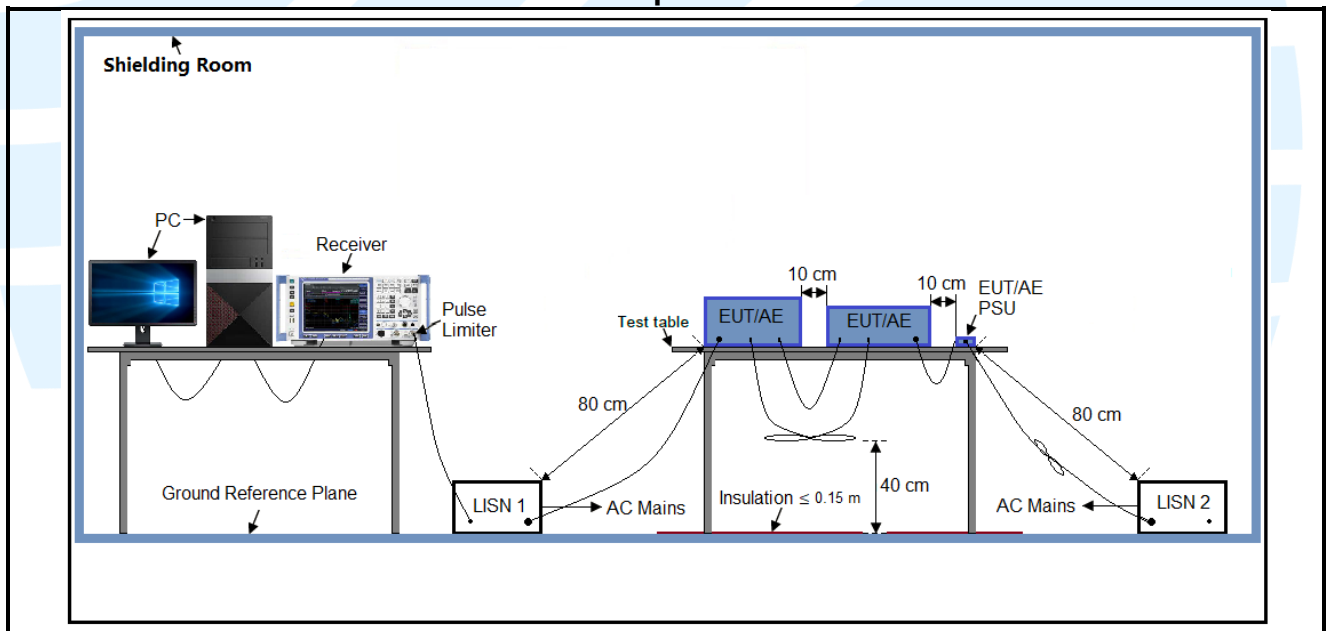
## 4.5 TEST SETUP

### 4.5.1 For Radiated Emissions test setup

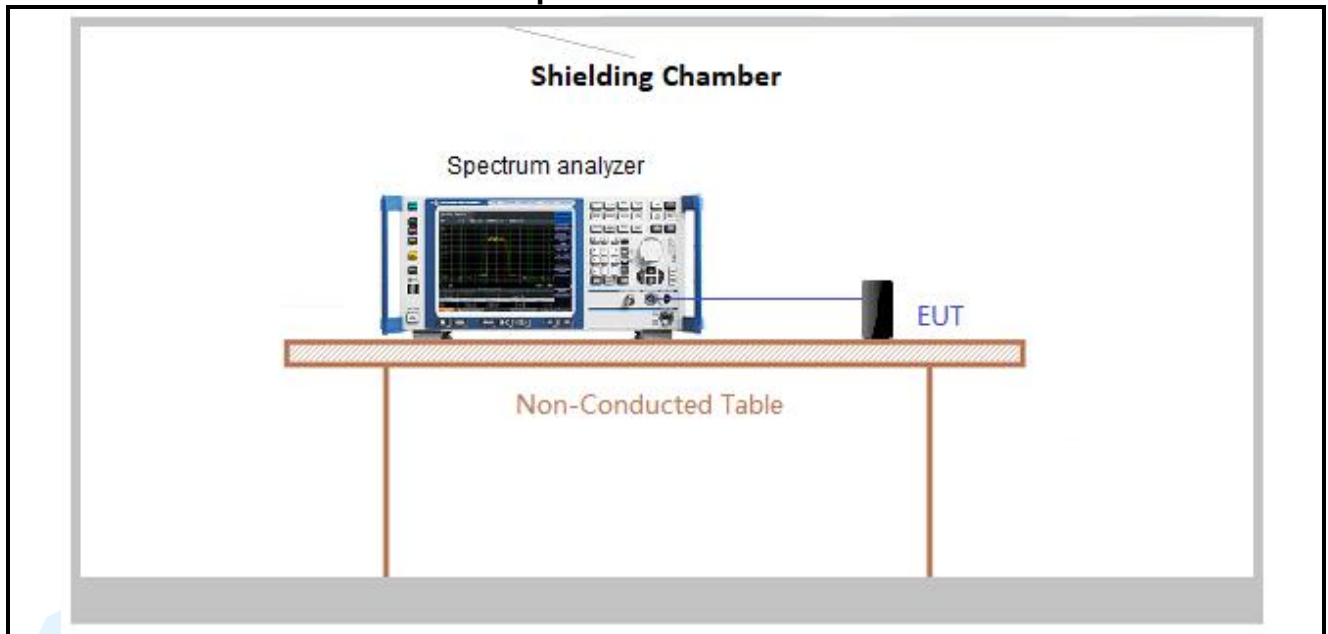




#### 4.5.2 For Conducted Emissions test setup



#### 4.5.3 For Conducted RF test setup



### 4.6 SYSTEM TEST CONFIGURATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. It was powered by a 3.3V battery. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Therefore, all final radiated testing was performed with the EUT in orientation.

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

## 5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

### 5.1 REFERENCE DOCUMENTS FOR TESTING

| No. | Identity                                   | Document Title                                                                                                                                                                            |
|-----|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | FCC 47 CFR Part 2                          | Frequency allocations and radio treaty matters; general rules and regulations                                                                                                             |
| 2   | FCC 47 CFR Part 15                         | Radio Frequency Devices                                                                                                                                                                   |
| 3   | ANSI C63.10-2013                           | American National Standard for Testing Unlicensed Wireless Devices                                                                                                                        |
| 4   | KDB 558074 D01 15.247 Meas Guidance v05r02 | Guidance for compliance measurements on Digital Transmission Systems, Frequency Hopping Spread Spectrum system, and Hybrid system devices operating under Section 15.247 of the FCC rules |
| 5   | RSS-247 Issue 3                            | Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices                                                              |
| 6   | RSS-Gen Issue 5                            | General Requirements for Compliance of Radio Apparatus                                                                                                                                    |

### 5.2 ANTENNA REQUIREMENT

| Standard Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>15.203 requirement:</b><br/>An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.</p> <p><b>15.247(b) (4) requirement:</b><br/>The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.</p> <p><b>RSS-Gen Issue 5, Section 6.8 requirement:</b><br/>According to RSS-Gen Issue 5, Section 6.8, a transmitter can only be sold or operated with antennas with which it was certified. A transmitter may be certified with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns.</p> <p><b>EUT Antenna:</b><br/>The antenna adopts IPEX interface and no consideration of replacement. The gain of the antenna is 3.38 dBi.</p> |

### 5.3 CONDUCTED PEAK OUTPUT POWER

**Test Requirement:** RSS-247 Issue 3, Section 5.4(b)

**Test Method:** ANSI C63.10-2013 Section 7.8.5

**Limit:** For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

**Test Procedure:** Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

- a) Use the following spectrum analyzer settings:
  - 1) Span: Approximately 5 x 20 dB bandwidth, centered on a hopping channel.
  - 2) RBW > 20 dB bandwidth of the emission being measured.
  - 3) VBW  $\geq$  RBW.
  - 4) Sweep: Auto.
  - 5) Detector function: Peak.
  - 6) Trace: Max hold.
- b) Allow trace to stabilize.
- c) Use the marker-to-peak function to set the marker to the peak of the emission.
- d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
- e) A plot of the test results and setup description shall be included in the test report.

**Test Setup:** Refer to section 4.5.3 for details.

**Instruments Used:** Refer to section 3 for details

**Test Mode:** Transmitter mode

**Test Results:** Pass

| Modulation    | Frequency | Max. Peak Power | Peak Power Limit | EIRP  | EIRP Limit | Max. Avg. Power | Result |
|---------------|-----------|-----------------|------------------|-------|------------|-----------------|--------|
|               | (MHz)     | (dBm)           | (dBm)            | (dBm) | (dBm)      | (dBm)           |        |
| GFSK          | 2402      | 5.66            | 20.97            | 9.04  | 36.02      | 2.94            | Pass   |
|               | 2441      | 7.22            | 20.97            | 10.60 | 36.02      | 3.70            | Pass   |
|               | 2480      | 7.64            | 20.97            | 11.02 | 36.02      | 4.02            | Pass   |
| $\pi/4$ DQPSK | 2402      | 5.75            | 20.97            | 9.13  | 36.02      | 4.32            | Pass   |
|               | 2441      | 8.38            | 20.97            | 11.76 | 36.02      | 5.44            | Pass   |
|               | 2480      | 8.40            | 20.97            | 11.78 | 36.02      | 2.16            | Pass   |
| 8DPSK         | 2402      | 5.98            | 20.97            | 9.36  | 36.02      | 4.34            | Pass   |
|               | 2441      | 7.82            | 20.97            | 11.20 | 36.02      | 3.83            | Pass   |
|               | 2480      | 8.47            | 20.97            | 11.85 | 36.02      | 4.05            | Pass   |

Note: 1. The antenna gain of 3.38 dBi less than 6dBi maximum permission antenna gain value based on 125 mW (21 dBm) peak output power limit.

2. The maximum EIRP is calculated from max output power and antenna gain, the antenna gain provided by the customer, and the customer takes all the responsibilities for the accuracy of antenna gain.

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## 5.4 RADIATED SPURIOUS EMISSIONS

**Test Requirement:** FCC 47 CFR Part 15 Subpart C Section 15.205/15.209  
RSS-Gen Issue 5, Section 6.13/8.9/8.10

**Test Method:** ANSI C63.10-2013 Section 6.3 & 6.5 & 6.6

**Receiver Setup:**

| Frequency           | RBW         |
|---------------------|-------------|
| 0.009 MHz-0.150 MHz | 200/300 kHz |
| 0.150 MHz -30 MHz   | 9/10 kHz    |
| 30 MHz-1 GHz        | 100/120 kHz |
| Above 1 GHz         | 1 MHz       |

**Limits:**

**Spurious Emissions**

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

**Remark:**

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dB $\mu$ V/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

**Test Setup:** Refer to section 4.5.1 for details.

**Test Procedures:**

1. From 30 MHz to 1GHz test procedure as below:

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

2. Above 1GHz test procedure as below:

- 1) Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter (Above 18GHz the distance is 1 meter and table is 1.5 meter).

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- 2) Test the EUT in the lowest channel, middle channel, the Highest channel
- 3) The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the Y axis positioning which it is worse case.
- 4) Repeat above procedures until all frequencies measured was complete.

**Equipment Used:** Refer to section 3 for details.

**Test Result:** Pass

**The worst measurement data as follows:**

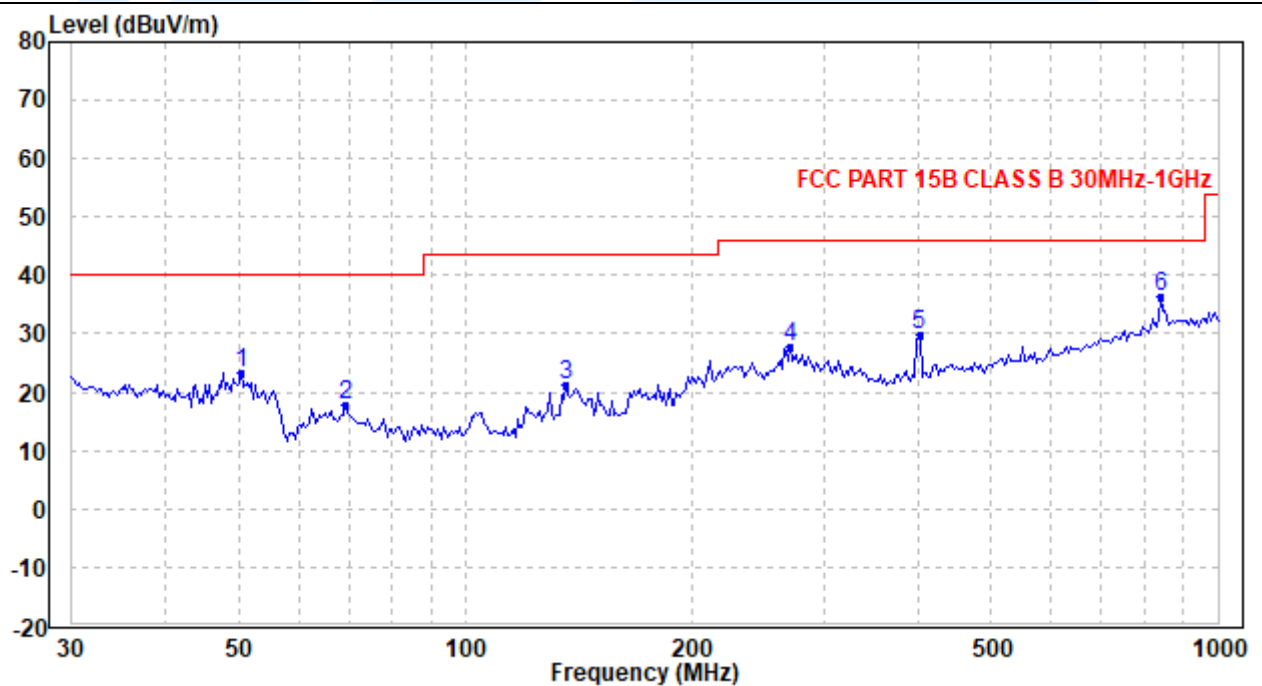
#### Radiated Emission Test Data (9 kHz ~ 30 MHz):

The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

#### Radiated Emission Test Data (30 MHz ~ 1 GHz):

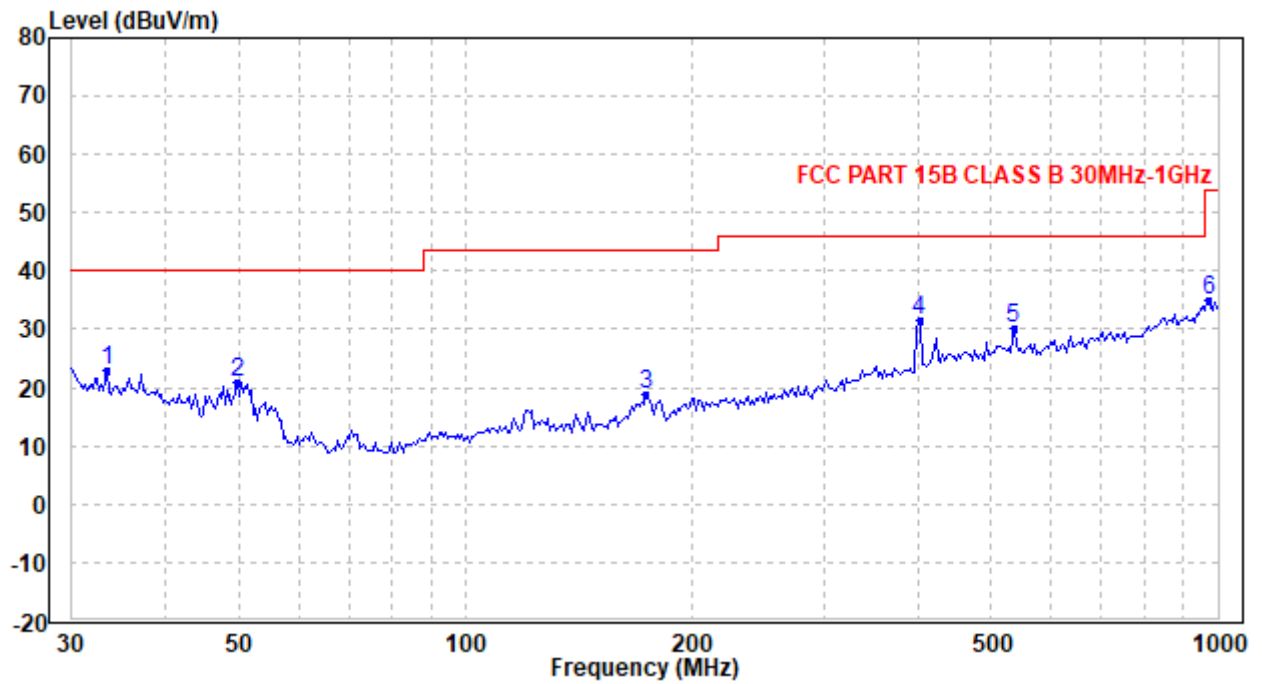
##### Worst-Case Configuration

##### Horizontal



| No. | Frequency (MHz) | Reading (dBuV) | Correction factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|-----|-----------------|----------------|------------------------|-----------------|----------------|-------------|----------|
| 1   | 50.461          | 37.12          | -13.75                 | 23.37           | 40.00          | -16.63      | QP       |
| 2   | 69.230          | 35.41          | -17.71                 | 17.70           | 40.00          | -22.30      | QP       |
| 3   | 135.916         | 36.57          | -15.36                 | 21.21           | 43.50          | -22.29      | QP       |
| 4   | 270.616         | 37.59          | -9.97                  | 27.62           | 46.00          | -18.38      | QP       |
| 5   | 401.105         | 34.50          | -4.73                  | 29.77           | 46.00          | -16.23      | QP       |
| 6   | 838.887         | 32.80          | 3.71                   | 36.51           | 46.00          | -9.49       | QP       |

# Vertical



| No. | Frequency (MHz) | Reading (dBuV) | Correction factor (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|-----|-----------------|----------------|------------------------|-----------------|----------------|-------------|----------|
| 1   | 33.335          | 29.42          | -6.46                  | 22.96           | 40.00          | -17.04      | QP       |
| 2   | 49.757          | 34.55          | -13.54                 | 21.01           | 40.00          | -18.99      | QP       |
| 3   | 173.815         | 30.19          | -11.36                 | 18.83           | 43.50          | -24.67      | QP       |
| 4   | 401.105         | 36.32          | -4.73                  | 31.59           | 46.00          | -14.41      | QP       |
| 5   | 535.038         | 31.96          | -1.77                  | 30.19           | 46.00          | -15.81      | QP       |
| 6   | 972.283         | 29.41          | 5.45                   | 34.86           | 54.00          | -19.14      | QP       |

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| Radiated Emission Test Data (Above 1GHz): |                 |                |                          |                 |                |             |          |                 |
|-------------------------------------------|-----------------|----------------|--------------------------|-----------------|----------------|-------------|----------|-----------------|
| 3DH5_Lowest Channel:                      |                 |                |                          |                 |                |             |          |                 |
| No.                                       | Frequency (MHz) | Reading (dBμV) | Correction factor (dB/m) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector | Antenna Polaxis |
| 1                                         | 4804            | 35.20          | -2.08                    | 33.12           | 54.00          | -20.88      | Average  | Horizontal      |
| 2                                         | 4804            | 48.41          | -2.08                    | 46.33           | 74.00          | -27.67      | Peak     | Horizontal      |
| 3                                         | 7206            | 33.50          | 1.30                     | 34.80           | 54.00          | -19.20      | Average  | Horizontal      |
| 4                                         | 7206            | 45.26          | 1.30                     | 46.56           | 74.00          | -27.44      | Peak     | Horizontal      |
| 5                                         | 4804            | 35.22          | -2.08                    | 33.14           | 54.00          | -20.86      | Average  | Vertical        |
| 6                                         | 4804            | 46.89          | -2.08                    | 44.81           | 74.00          | -29.19      | Peak     | Vertical        |
| 7                                         | 7206            | 33.43          | 1.30                     | 34.73           | 54.00          | -19.27      | Average  | Vertical        |
| 8                                         | 7206            | 45.78          | 1.30                     | 47.08           | 74.00          | -26.92      | Peak     | Vertical        |
| 3DH5_Middle Channel:                      |                 |                |                          |                 |                |             |          |                 |
| 1                                         | 4880            | 35.25          | -2.05                    | 33.20           | 54.00          | -20.80      | Average  | Horizontal      |
| 2                                         | 4880            | 47.40          | -2.05                    | 45.35           | 74.00          | -28.65      | Peak     | Horizontal      |
| 3                                         | 7320            | 34.78          | 1.31                     | 36.09           | 54.00          | -17.91      | Average  | Horizontal      |
| 4                                         | 7320            | 47.07          | 1.31                     | 48.38           | 74.00          | -25.62      | Peak     | Horizontal      |
| 5                                         | 4880            | 35.17          | -2.05                    | 33.12           | 54.00          | -20.88      | Average  | Vertical        |
| 6                                         | 4880            | 46.75          | -2.05                    | 44.70           | 74.00          | -29.30      | Peak     | Vertical        |
| 7                                         | 7320            | 34.91          | 1.31                     | 36.22           | 54.00          | -17.78      | Average  | Vertical        |
| 8                                         | 7320            | 47.08          | 1.31                     | 48.39           | 74.00          | -25.61      | Peak     | Vertical        |
| 3DH5_Highest Channel:                     |                 |                |                          |                 |                |             |          |                 |
| 1                                         | 4960            | 34.54          | -2.02                    | 32.52           | 54.00          | -21.48      | Average  | Horizontal      |
| 2                                         | 4960            | 46.69          | -2.02                    | 44.67           | 74.00          | -29.33      | Peak     | Horizontal      |
| 3                                         | 7440            | 34.86          | 1.32                     | 36.18           | 54.00          | -17.82      | Average  | Horizontal      |
| 4                                         | 7440            | 47.07          | 1.32                     | 48.39           | 74.00          | -25.61      | Peak     | Horizontal      |
| 5                                         | 4960            | 34.59          | -2.02                    | 32.57           | 54.00          | -21.43      | Average  | Vertical        |
| 6                                         | 4960            | 46.69          | -2.02                    | 44.67           | 74.00          | -29.33      | Peak     | Vertical        |
| 7                                         | 7440            | 34.73          | 1.32                     | 36.05           | 54.00          | -17.95      | Average  | Vertical        |
| 8                                         | 7440            | 46.88          | 1.32                     | 48.20           | 74.00          | -25.80      | Peak     | Vertical        |

#### Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

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## 5.5 BAND EDGE MEASUREMENTS (RADIATED)

**Test Requirement:** FCC 47 CFR Part 15 Subpart C Section 15.205/15.209  
RSS-247 Issue 3, Section 5.5

**Test Method:** ANSI C63.10-2013 Section 6.10.5

**Limits:**

Radiated emissions which fall in the restricted bands, as defined in section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a).

| Frequency       | Limit (dB $\mu$ V/m @3m) | Remark           |
|-----------------|--------------------------|------------------|
| 30 MHz-88 MHz   | 40.0                     | Quasi-peak Value |
| 88 MHz-216 MHz  | 43.5                     | Quasi-peak Value |
| 216 MHz-960 MHz | 46.0                     | Quasi-peak Value |
| 960 MHz-1 GHz   | 54.0                     | Quasi-peak Value |
| Above 1 GHz     | 54.0                     | Average Value    |
|                 | 74.0                     | Peak Value       |

**Test Setup:** Refer to section 4.5.1 for details.

**Test Procedures:**

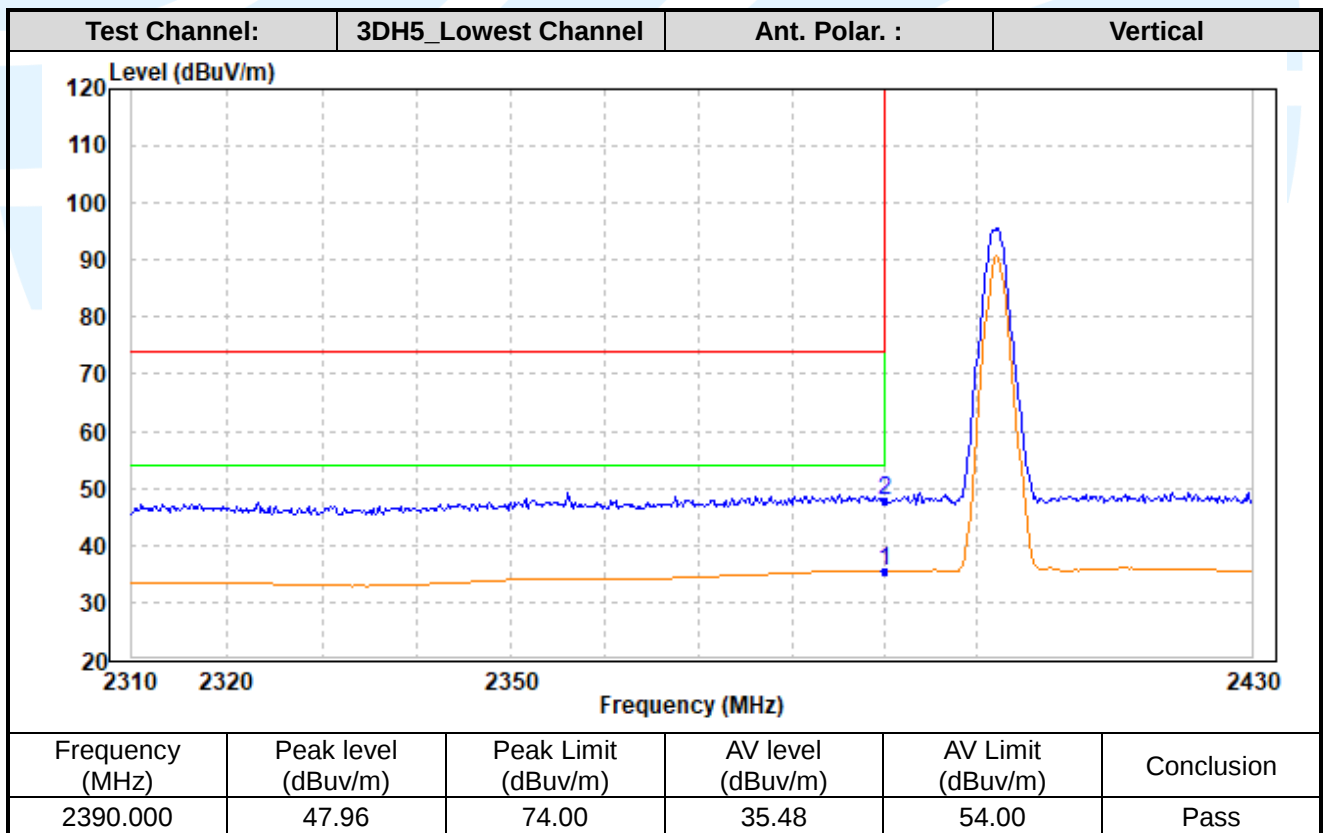
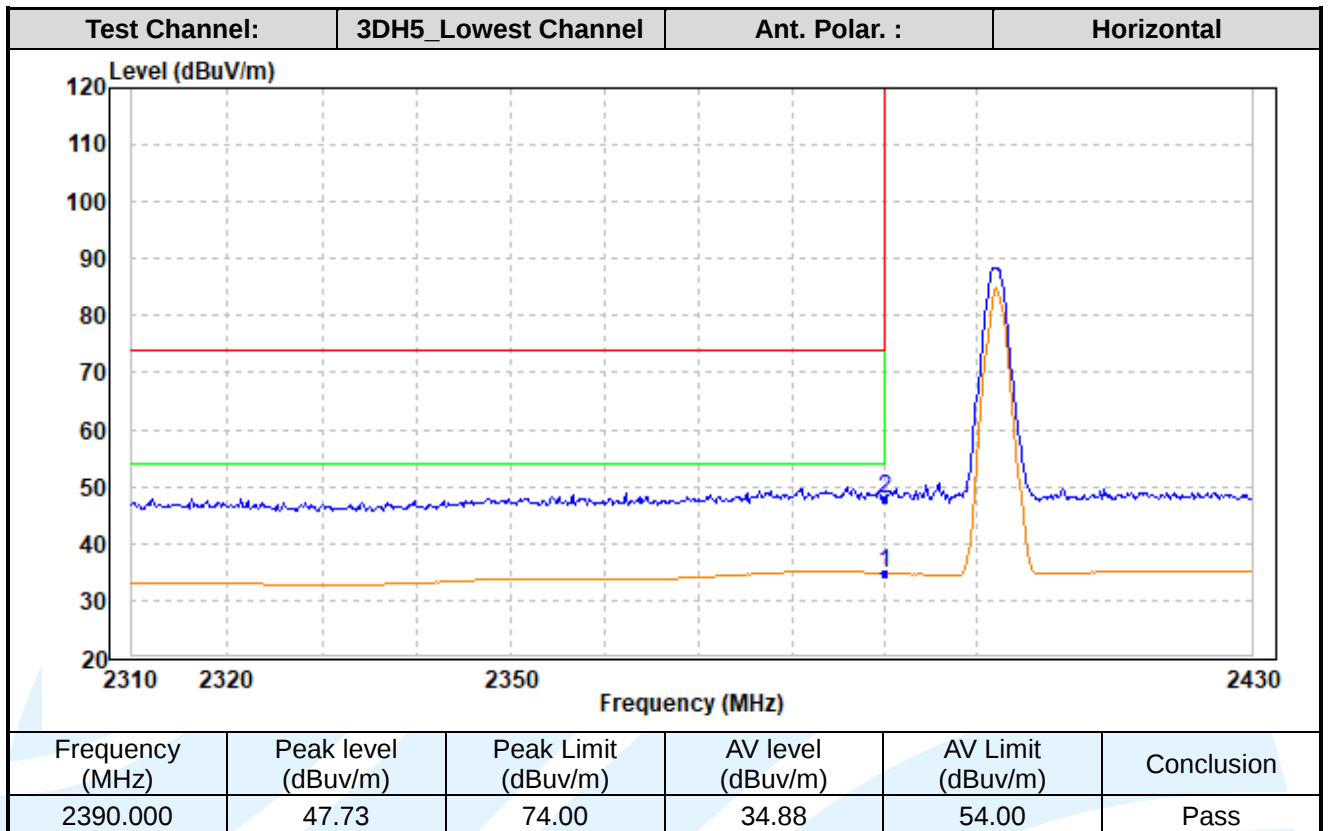
Radiated band edge measurements at 2390 MHz and 2483.5 MHz were made with the unit transmitting in the low end of the channel range and the high end closest to the restricted bands respectively. The emissions were made on the 966 Semi-Chamber. Use (resolution bandwidth (RBW) = 1 MHz, video bandwidth (VBW) = 3 MHz for peak levels and RBW = 1 MHz and VBW = 10 Hz or 1/T for average levels).

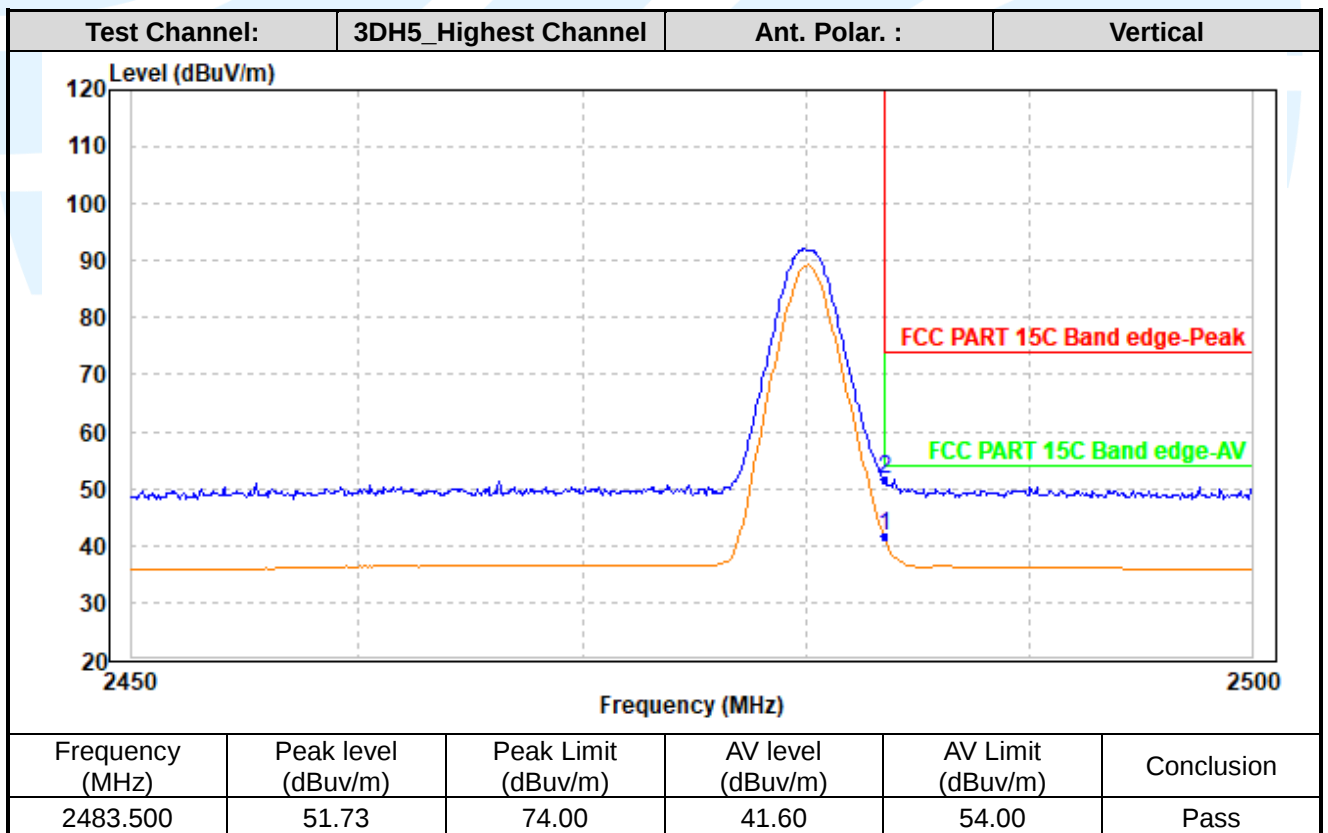
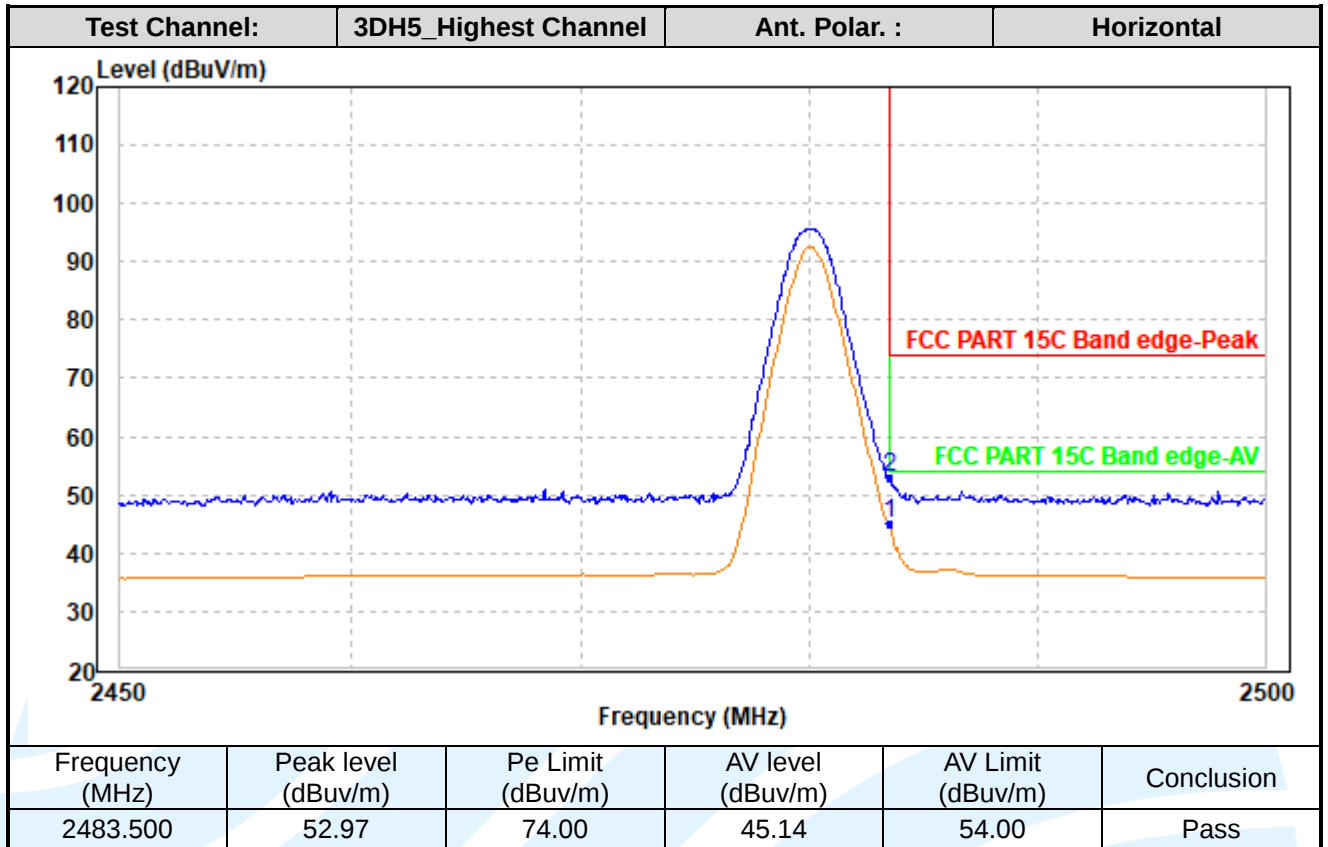
1. Use radiated spurious emission test procedure described in clause 5.10. The transmitter output (antenna port) was connected to the test receiver.
2. Set the PK and AV limit line.
3. Record the fundamental emission and emissions out of the band-edge.
4. Determine band-edge compliance as required.

**Equipment Used:** Refer to section 3 for details.

**Test Result:** Pass

**The worst measurement data as follows:**





## APPENDIX 1 PHOTOS OF TEST SETUP

See test photos attached in Appendix 1 for the actual connections between Product and support equipment.

## APPENDIX 2 PHOTOS OF EUT CONSTRUCTIONAL DETAILS

Refer to Appendix 2 for EUT external and internal photos.

\*\*\* End of Report \*\*\*

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