Certificate #4312.01

# TEST REPORT

| | |
|---|---|
| **Product Name:** | Cordless Wi-Fi IP Phone |
| **Trade Mark:** | GRANDSTREAM |
| **Model No. / HVIN:** | WP822 |
| **Report Number:** | 211126033RFC-2 |
| **Test Standards:** | FCC 47 CFR Part 15 Subpart C<br>RSS-247 Issue 2<br>RSS-Gen Issue 5 |
| **FCC ID:** | YZZWP822 |
| **IC:** | 11964A-WP822 |
| **Test Result:** | PASS |
| **Date of Issue:** | January 21, 2022 |

Prepared for:

**Grandstream Networks, Inc.**
**126 Brookline Ave., 3rd Floor Boston, MA 02215, USA**

Prepared by:

**Shenzhen UnionTrust Quality and Technology Co., Ltd.**
**Unit D/E of 9/F and 16/F, Block A, Building 6, Baoneng science and technology park, Longhua district, Shenzhen, China**
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Prepared by: Gavin Xu — Project Engineer

Reviewed by: Henry Lu — Team Leader

Approved by: Kevin Deng — Assistant Manager

Date: January 21, 2022

# Version

| Version No. | Date | Description |
|---|---|---|
| V1.0 | January 21, 2022 | Original |

# CONTENTS

# 1. GENERAL INFORMATION

## 1.1 CLIENT INFORMATION

| | |
|---|---|
| **Applicant:** | Grandstream Networks, Inc. |
| **Address of Applicant:** | 126 Brookline Ave., 3rd Floor Boston, MA 02215, USA |
| **Manufacturer:** | Grandstream Networks, Inc. |
| **Address of Manufacturer:** | 126 Brookline Ave., 3rd Floor Boston, MA 02215, USA |

## 1.2 EUT INFORMATION

### 1.2.1 General Description of EUT

| | | | |
|---|---|---|---|
| **Product Name:** | Cordless Wi-Fi IP Phone | | |
| **Model No. / HVIN:** | WP822 | | |
| **Trade Mark:** | GRANDSTREAM | | |
| **DUT Stage:** | Identical Prototype | | |
| **EUT Supports Function:** | 2.4 GHz ISM Band: | IEEE 802.11b/g/n | |
| | | Bluetooth 5.0 | |
| | 5 GHz U-NII Bands: | 5 150 MHz to 5 250 MHz | IEEE 802.11a/n/ac |
| | | 5 250 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 |
| **Sample Received Date:** | November 29, 2021 | | |
| **Sample Tested Date:** | November 29, 2021 to January 5, 2022 | | |

### 1.2.2 Description of Accessories

| **Adapter(1)** | |
|---|---|
| **Model No.:** | DSA-6PFG-05 FUS 050100 |
| **Input:** | 100-240 V~50/60 Hz 0.2 A |
| **Output:** | 5.0 V ⎓ 1.0 A 5.0W |
| **DC Cable:** | 1.5 Meter, Unshielded without ferrite |

| **Adapter(2)** | |
|---|---|
| **Model No.:** | GQ06-050100-ZU |
| **Input:** | 100-240 V~50/60 Hz 0.3 A Max |
| **Output:** | 5.0 V ⎓ 1.0 A |
| **DC Cable:** | 1.5 Meter, Unshielded without ferrite |

| **Adapter(3)** | |
|---|---|
| **Model No.:** | NBS05B050100VU |
| **Input:** | 100-240 V~50/60 Hz 0.2 A |
| **Output:** | 5.0 V ⎓ 1.0 A |
| **DC Cable:** | 1.5 Meter, Unshielded without ferrite |

| **Battery** | |
|---|---|
| **Model No.:** | GS-02 |
| **Battery Type:** | Lithium-ion |
| **Rated Voltage:** | 3.7 Vdc |
| **Limited Charge Voltage:** | 4.2 Vdc |

| | |
|---|---|
| **Rated Capacity:** | 2000 mAh |

| **Others** |
|---|
| Charging base+ Back Scaffold |

## 1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

| | |
|---|---|
| **Frequency Band:** | 2400 MHz to 2483.5 MHz |
| **Frequency Range:** | 2402 MHz to 2480 MHz |
| **Bluetooth Version:** | Bluetooth BR + EDR |
| **Modulation Technique:** | Frequency Hopping Spread Spectrum(FHSS) |
| **Type of Modulation:** | GFSK, π/4DQPSK, 8DPSK |
| **Number of Channels:** | 79 |
| **Channel Separation:** | 1 MHz |
| **Hopping Channel Type:** | Adaptive Frequency Hopping Systems |
| **Antenna Type:** | Dipole Antenna |
| **Antenna Gain:** | 3.0 dBi |
| **Maximum Peak Power:** | 7.491 dBm |
| **Normal Test Voltage:** | 3.7 Vdc |

## 1.4 OTHER INFORMATION

| **Operation Frequency Each of Channel** |
|---|
| **f = 2402 + k MHz, k = 0,…,78** |
| Note:<br>**f** is the operating frequency (MHz);<br>**k** 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 |
| π/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 | Latitude 3400 | 16238087894 | UnionTrust |
| Mouse | DELL | MS111 | CN-011D3V-738 | UnionTrust |

2) Support Cable

| Cable No. | Description | Connector | Length | Supplied by |
|---|---|---|---|---|
| 1 | Antenna Cable | SMA | 0.1Meter | UnionTrust |

## 1.6 TEST LOCATION

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

Address: Unit D/E of 9/F and 16/F, Block A, Building 6, Baoneng science and technology park, Longhua district, Shenzhen, China
Telephone: +86 (0) 755 2823 0888
Fax: +86 (0) 755 2823 0886

## 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 x $10^{-8}$ |
| 12 | Transmission Time | ± 0.19 % |

## 2. TEST SUMMARY

| FCC 47 CFR Part 15 Subpart C Test Cases | | | |
|---|---|---|---|
| **Test Item** | **Test Requirement** | **Test Method** | **Result** |
| **Antenna Requirement** | FCC 47 CFR Part 15 Subpart C Section 15.203/15.247 (c)<br>RSS-Gen Issue 5, Section 6.8 | N/A | PASS |
| **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 | PASS |
| **Conducted Peak Output Power** | FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(1)<br>RSS-247 Issue 2, Section 5.4(b) | ANSI C63.10-2013 Section 7.8.5 | PASS |
| **20 dB Bandwidth** | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)<br>RSS-247 Issue 2, Section 5.1(a) | ANSI C63.10-2013 Section 6.9.2 | PASS |
| **Occupied Bandwidth** | RSS-Gen section 6.7 | RSS-Gen section 6.7 | PASS |
| **Carrier Frequencies Separation** | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)<br>RSS-247 Issue 2, Section 5.1(b) | ANSI C63.10-2013 Section 7.8.2 | PASS |
| **Number of Hopping Channel** | FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(1)<br>RSS-247 Issue 2, Section 5.1(d) | ANSI C63.10-2013 Section 7.8.3 | PASS |
| **Dwell Time** | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)<br>RSS-247 Issue 2, Section 5.1(d) | ANSI C63.10-2013 Section 7.8.4 | PASS |
| **Conducted Out of Band Emission** | FCC 47 CFR Part 15 Subpart C Section 15.247(d)<br>RSS-247 Issue 2, Section 5.5 | ANSI C63.10-2013 Section 6.10.4 & Section 7.8.8 | PASS |
| **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 |
| **Band Edge Measurement** | FCC 47 CFR Part 15 Subpart C Section 15.205/15.209<br>RSS-247 Issue 2, Section 5.5 | ANSI C63.10-2013 Section 6.10.5 | PASS |

# 3. EQUIPMENT LIST

| Radiated Emission Test Equipment List | | | | | | |
|---|---|---|---|---|---|---|
| **Used** | **Equipment** | **Manufacturer** | **Model No.** | **Serial Number** | **Cal. date (mm dd, yyyy)** | **Cal. Due date (mm dd, yyyy)** |
| ☒ | 3m SAC | ETS-LINDGREN | 3m | N/A | Jan. 22, 2021 | Jan. 21, 2024 |
| ☒ | Receiver | R&S | ESIB26 | 100114 | Nov. 05, 2021 | Nov. 04, 2022 |
| ☒ | EXA Spectrum Analyzer | KEYSIGHT | N9010A | MY51440197 | Apr. 22, 2021 | Apr. 21, 2022 |
| ☒ | Loop Antenna | ETS-LINDGREN | 6502 | 00202525 | Nov. 11, 2021 | Nov. 10, 2023 |
| ☒ | Broadband Antenna | ETS-LINDGREN | 3142E | 00201566 | Nov. 11, 2021 | Nov. 10, 2023 |
| ☒ | 6dB Attenuator | Talent | RA6A5-N-18 | 18103001 | Nov. 11, 2021 | Nov. 10, 2023 |
| ☒ | Preamplifier | HP | 8447F | 2805A02960 | Nov. 05, 2021 | Nov. 04, 2022 |
| ☒ | Band Rejection Filter (2400MHz~2500MHz) | Micro-Tronics | BRM50702 | G248 | Nov. 06, 2021 | Nov. 05, 2022 |
| ☒ | Double-Ridged Waveguide Horn Antenna (Pre-amplifier) | ETS-LINDGREN | 3117-PA | 00201541 | Apr. 30, 2021 | Apr. 29, 2023 |
| ☒ | Pre-amplifier | ETS-Lindgren | 00118385 | 00201874 | Nov. 06, 2021 | Nov. 05, 2022 |
| ☒ | Double-Ridged Waveguide Horn Antenna (Pre-amplifier) | ETS-LINDGREN | 3116C-PA | 00202652 | Nov. 14, 2020 | Nov. 13, 2023 |
| ☒ | Pre-amplifier | ETS-Lindgren | 00118384 | 00202652 | Nov. 17, 2020 | Nov. 16, 2022 |
| ☒ | Multi device Controller | ETS-LINDGREN | 7006-001 | 00160105 | N/A | N/A |
| ☒ | Test Software | Audix | e3 | Software Version: 9.160323 | | |

| Conducted Emission Test Equipment List | | | | | | |
|---|---|---|---|---|---|---|
| **Used** | **Equipment** | **Manufacturer** | **Model No.** | **Serial Number** | **Cal. date (mm dd, yyyy)** | **Cal. Due date (mm dd, yyyy)** |
| ☒ | Receiver | R&S | ESR7 | 1316.3003K07 -101181-K3 | Nov. 05, 2021 | Nov. 04, 2022 |
| ☒ | Pulse Limiter | R&S | ESH3-Z2 | 0357.8810.54 | Nov. 05, 2021 | Nov. 04, 2022 |
| ☒ | LISN | R&S | ESH2-Z5 | 860014/024 | Nov. 05, 2021 | Nov. 04, 2022 |
| ☒ | LISN | ETS-Lindgren | 3816/2SH | 00201088 | Nov. 05, 2021 | Nov. 04, 2022 |
| ☒ | Test Software | Audix | e3 | Software Version: 9.160323 | | |

| Conducted RF test Equipment List | | | | | | |
|---|---|---|---|---|---|---|
| **Used** | **Equipment** | **Manufacturer** | **Model No.** | **Serial Number** | **Cal. date (mm dd, yyyy)** | **Cal. Due date (mm dd, yyyy)** |
| ☒ | EXA Spectrum Analyzer | KEYSIGHT | N9010A | MY51440197 | Apr. 22, 2021 | Apr. 21, 2022 |
| ☒ | USB Wideband Power Sensor | KEYSIGHT | U2021XA | MY55430035 | Nov. 05, 2021 | Nov. 04, 2022 |
| ☐ | USB Wideband Power Sensor | KEYSIGHT | U2021XA | MY55430023 | Nov. 05, 2021 | Nov. 04, 2022 |
| ☐ | MXG X-Series RF Vector Signal Generator | KEYSIGHT | N5182B | MY51350267 | Nov. 05, 2021 | Nov. 04, 2022 |

# 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 (%) |
| NV/NT | +15 to +35 | 3.7 | 20 to 75 |
| **Remark:**<br>1) NV: Normal Voltage; NT: Normal Temperature | | | |

### 4.1.2 Record of Normal Environment

| Test Item | Temperature (°C) | Relative Humidity (%) | Pressure (kPa) | Tested by |
|---|---|---|---|---|
| AC Power Line Conducted Emission | 24.6 | 47 | 101.1 | David Zhang |
| Conducted Peak Output Power | 23.6 | 42 | 100.3 | Bert Xiong |
| 20 dB Bandwidth & Occupied Bandwidth | 23.6 | 42 | 100.3 | Bert Xiong |
| Carrier Frequencies Separation | 23.6 | 42 | 100.3 | Bert Xiong |
| Number of Hopping Channel | 23.6 | 42 | 100.3 | Bert Xiong |
| Dwell Time | 23.6 | 42 | 100.3 | Bert Xiong |
| Conducted Out of Band Emission | 23.6 | 42 | 100.3 | Bert Xiong |
| Radiated Emissions | 23.5 | 45 | 100.3 | Fire Huo |
| Band Edge Measurement | 23.5 | 45 | 100.3 | Fire Huo |

## 4.2 TEST CHANNELS

| Mode | Tx/Rx Frequency | Test RF Channel Lists | | |
|---|---|---|---|---|
| | | Lowest(L) | Middle(M) | Highest(H) |
| GFSK (DH1, DH3, DH5) | 2402 MHz to 2480 MHz | Channel 0 | Channel 39 | Channel 78 |
| | | 2402 MHz | 2441 MHz | 2480 MHz |
| π/4DQPSK (DH1, DH3, DH5) | 2402 MHz to 2480 MHz | Channel 0 | Channel 39 | Channel 78 |
| | | 2402 MHz | 2441 MHz | 2480 MHz |
| 8DPSK (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/π/4DQPSK/ 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 |
|---|
| Power Setting: not applicable, test used software default power level. |

| Test Software |
|---|
| Test software name: Putty commands; |

## 4.4 PRE-SCAN

### 4.4.1 Worst-case data packets

| Type of Modulation | Worst-case data rates |
|---|---|
| **GFSK** | 1-DH5 |
| **π/4DQPSK** | 2-DH5 |
| **8DPSK** | 3-DH5 |

### 4.4.2 Tested channel detail

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** | | | **π/4DQPSK** | | | **8DPSK** | | |
|---|---|---|---|---|---|---|---|---|---|
| Data Packets | 1-DH 1 | 1-DH 3 | 1-DH 5 | 2-DH 1 | 2-DH 3 | 2-DH 5 | 3-DH 1 | 3-DH 3 | 3-DH 5 |
| Available Channel | 0 to 78 | | | | | | | | |
| **Test Item** | **Test channel and choose of data packets** | | | | | | | | |
| AC Power Line Conducted Emission | Frequency Hopping Channel 0 to 78 | | | | | | | | |
| | Link | | | | | | | | |
| Conducted Peak Output Power | Channel 0 & 39 & 78 | | | | | | | | |
| | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ |
| 20 dB Bandwidth | Channel 0 & 39 & 78 | | | | | | | | |
| | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ |
| Carrier Frequencies Separation | Frequency Hopping Channel 0 to 78 | | | | | | | | |
| | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ |
| Number of Hopping Channel | Frequency Hopping Channel 0 to 78 | | | | | | | | |
| | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ |
| Dwell Time | Channel 39 | | | | | | | | |
| | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| Conducted Out of Band Emission | Channel 0 & 39 & 78 | | | | | | | | |
| | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ |
| Radiated Emissions | Channel 0 & 39 & 78 | | | | | | | | |
| | ☐ | ☐ | ☒ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Band Edge Measurements (Radiated) | Channel 0 & 78 | | | | | | | | |
| | ☐ | ☐ | ☒ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 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

**Figure 1. Below 30MHz**

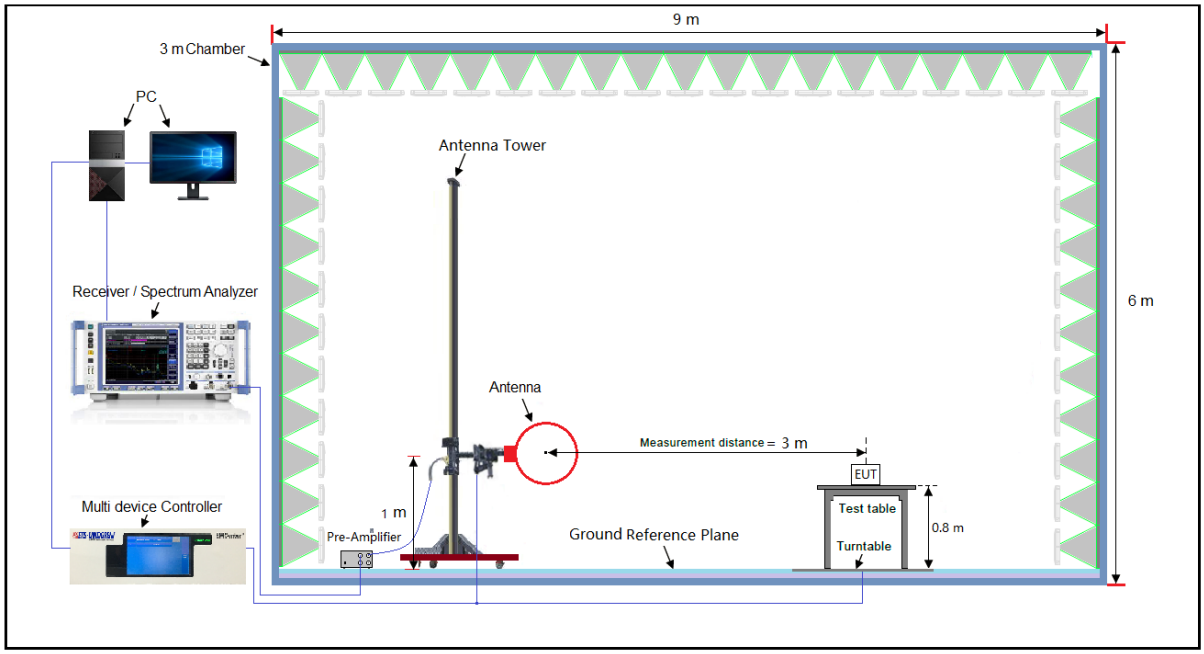



**Figure 2. 30MHz to 1GHz**

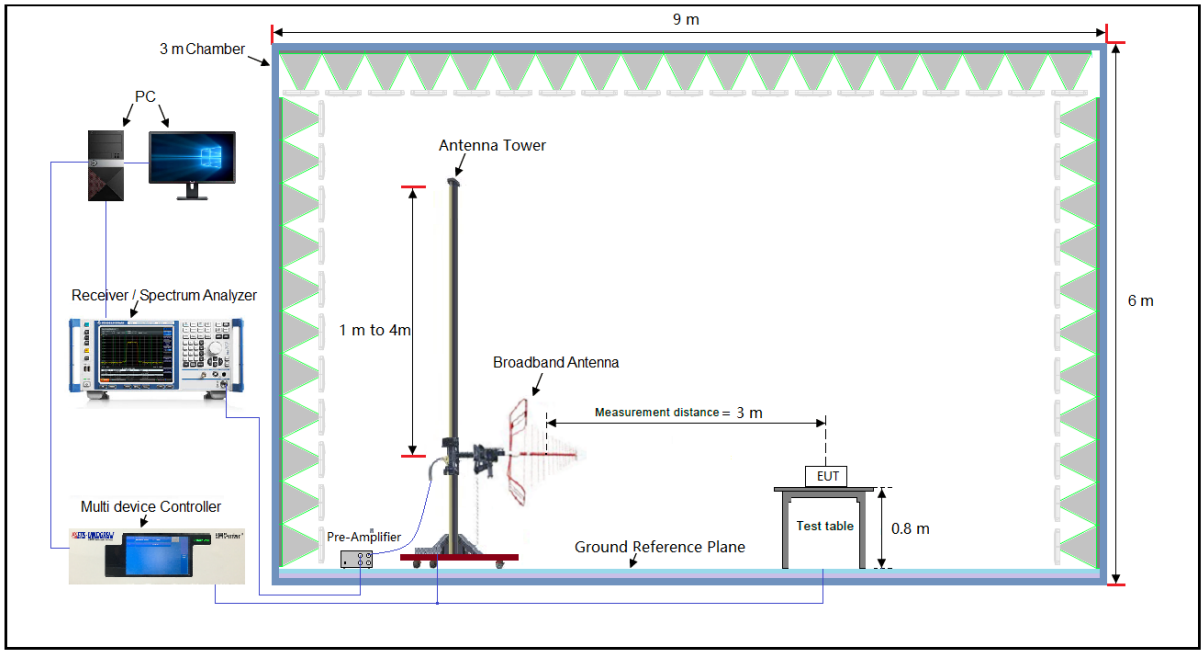
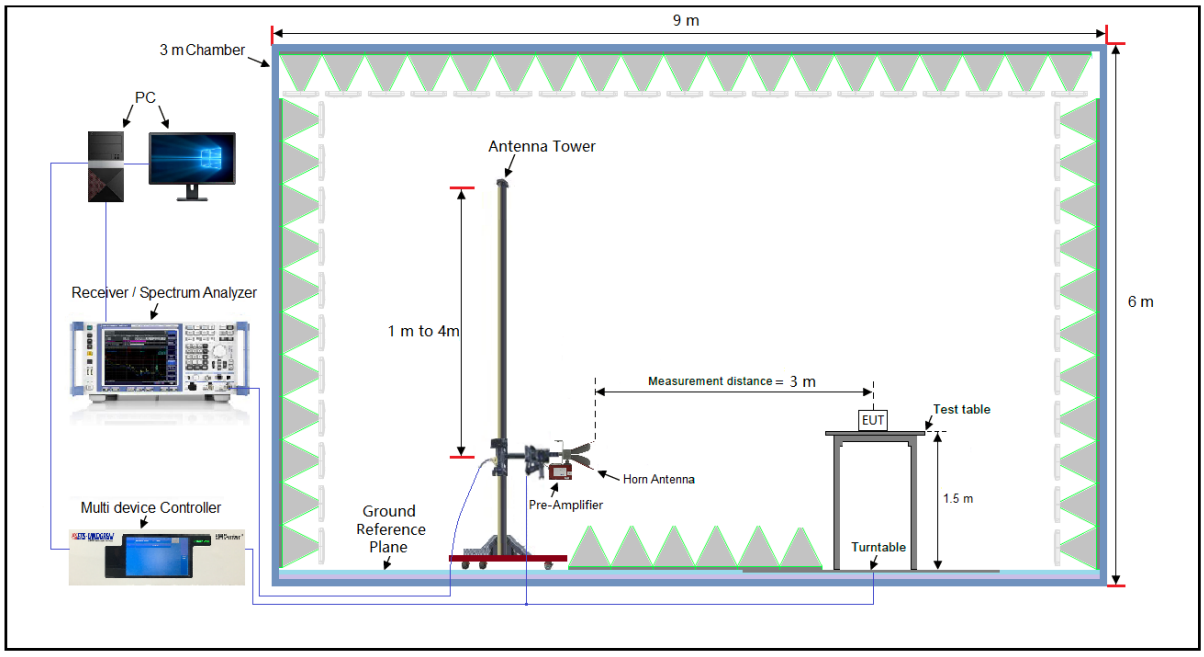
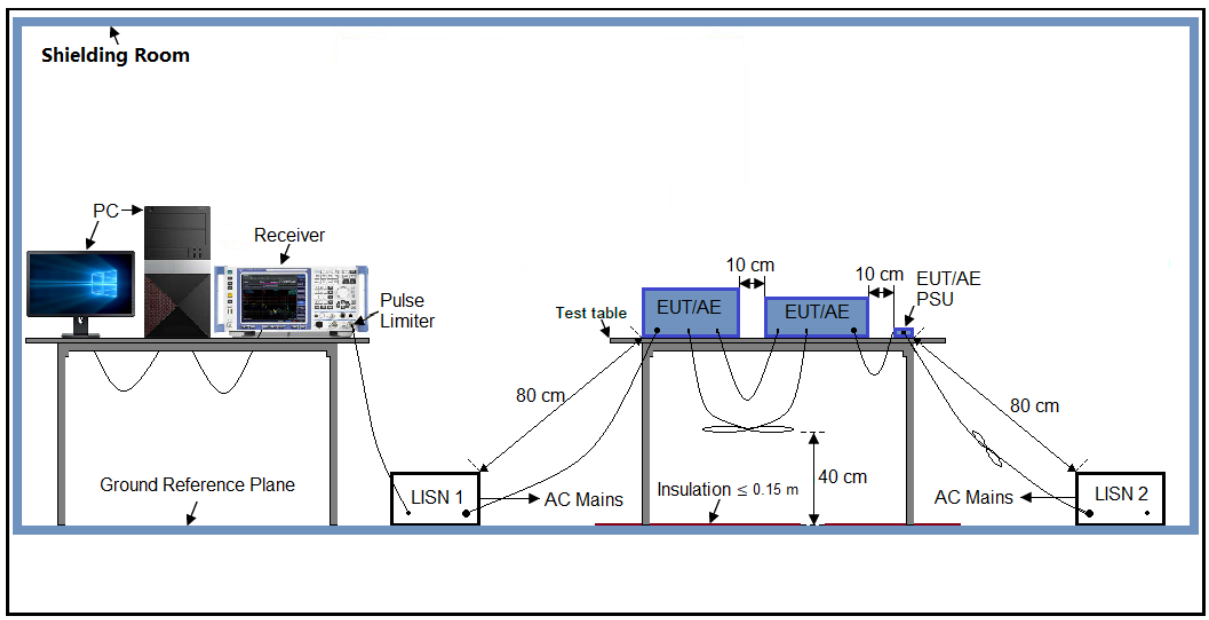


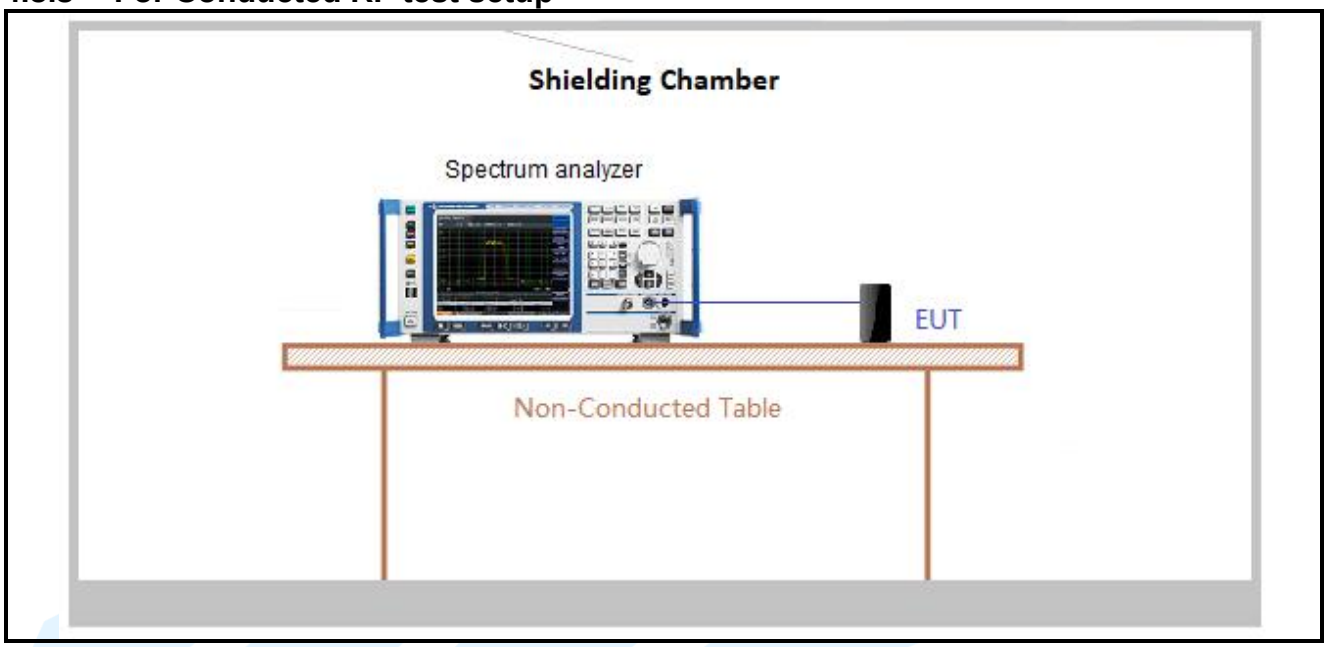
**Figure 3. Above 1GHz**




## 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. 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 (see table below) orientation.

| Frequency | Mode | Antenna Port | Worst-case axis positioning |
|---|---|---|---|
| Above 1GHz | 1TX | Chain 0 | Y axis |

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.

## 4.7 DUTY CYCLE

**Test Procedure:** ANSI C63.10-2013 Clause 11.6.

**Test Results**

| Type of Modulation | Packets | On Time (msec) | Period (msec) | Duty Cycle (linear) | Duty Cycle (%) | Duty Cycle Factor (dB) | 1/ T Minimum VBW (kHz) | Average Factor (dB) |
|---|---|---|---|---|---|---|---|---|
| GFSK | 1-DH5 | 2.8650 | 3.7500 | 0.76 | 76.40 | 1.17 | 0.35 | -2.34 |

**Remark:**

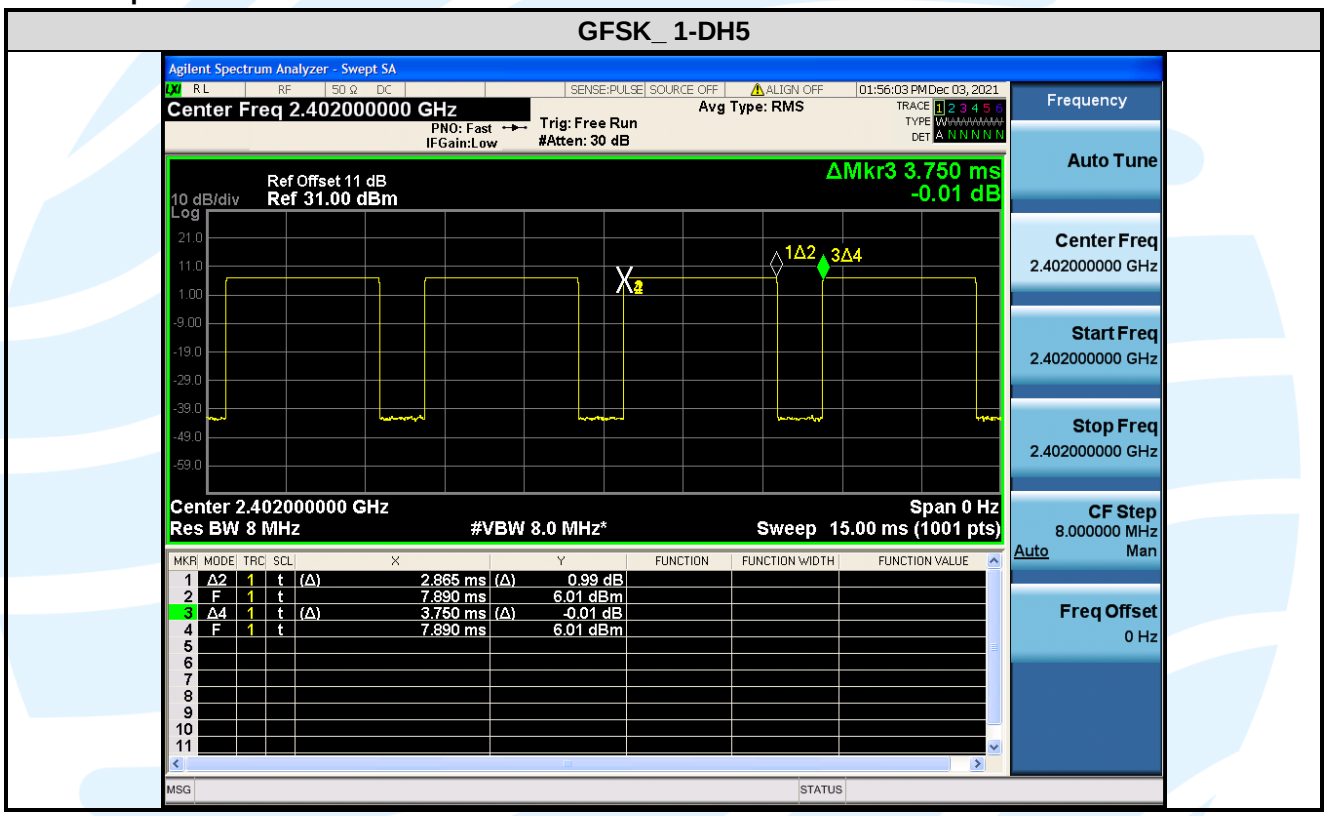
1) Duty cycle= On Time/ Period;

2) Duty Cycle factor = 10 * log(1/ Duty cycle);

3) Average factor = 20 $\log_{10}$ Duty Cycle.

**The test plot as follows**

**GFSK_ 1-DH5**



# 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 | RSS-247 Issue 2 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| 4 | RSS-Gen Issue 5 | General Requirements for Compliance of Radio Apparatus |
| 5 | ANSI C63.10-2013 | American National Standard for Testing Unlicesed Wireless Devices |
| 6 | 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 |

## 5.2 ANTENNA REQUIREMENT

| Standard Requirement |
|---|
| **15.203 requirement:**<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.<br>**15.247(b) (4) requirement:**<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.<br>**RSS-Gen Issue 5, Section 6.8 requirement:**<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. |
| **EUT Antenna:** |
| Antenna in the interior of the equipment and no consideration of replacement. The gain of the antenna is 3.0 dBi. |

## 5.3 CONDUCTED PEAK OUTPUT POWER

**Test Requirement:** FCC 47 CFR Part 15 Subpart C Section15.247 (b)(1)
RSS-247 Issue 2, 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 ≥ 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

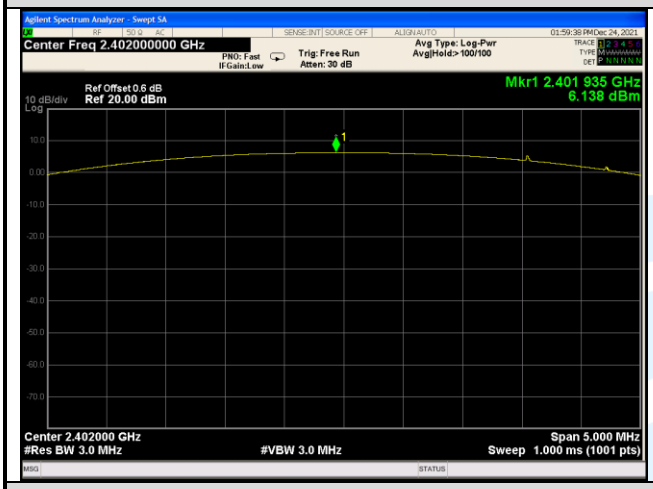
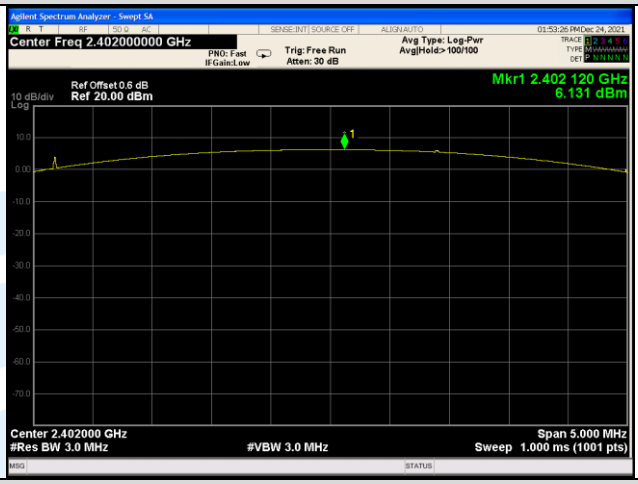
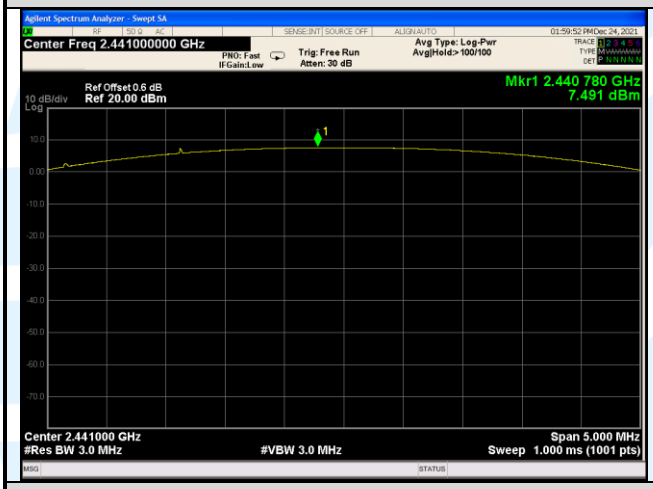
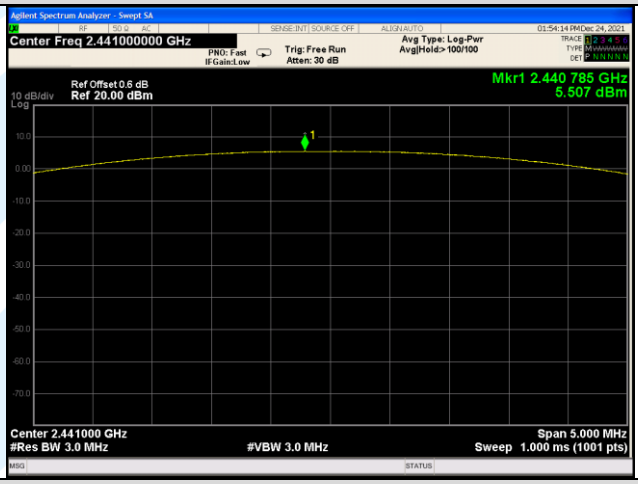
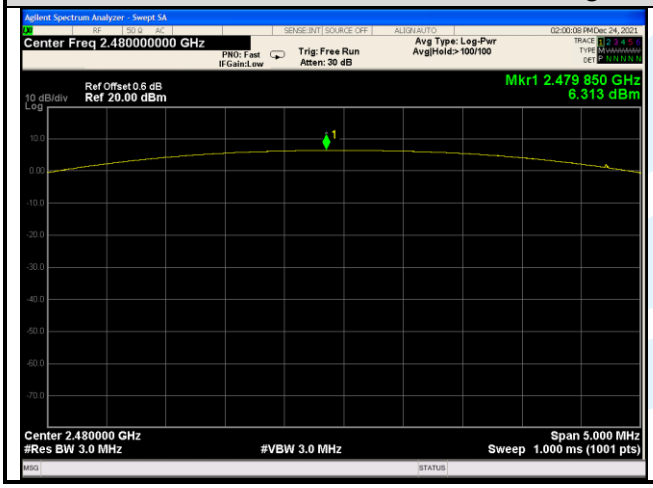
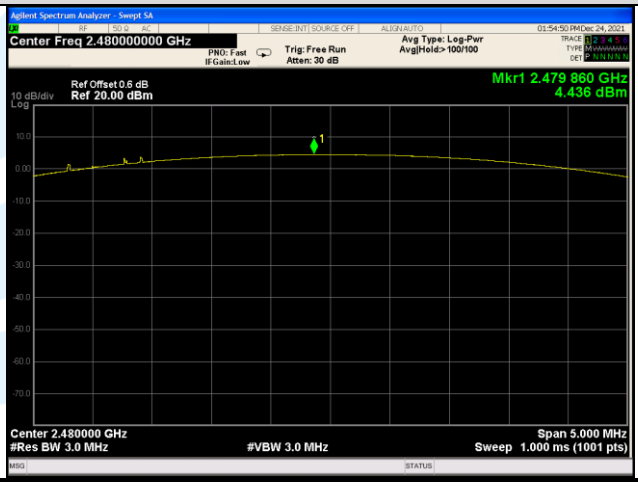
**Test Results:** Pass

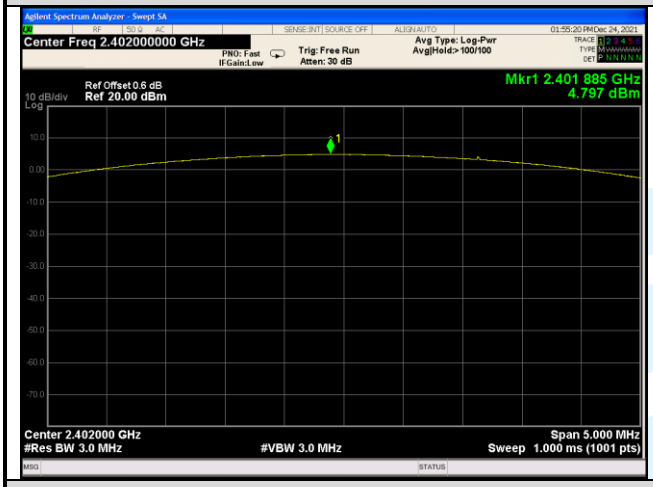
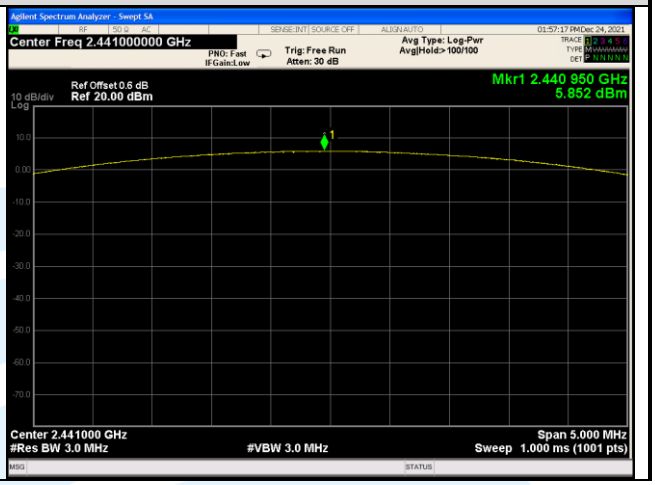
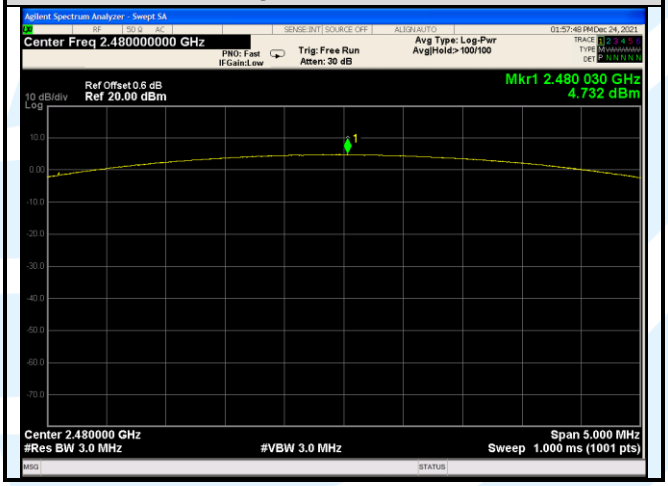
| Type of Modulation | Peak Output Power (dBm) | | | Peak Output Power (mW) | | |
|---|---|---|---|---|---|---|
| | Channel 0 | Channel 39 | Channel 78 | Channel 0 | Channel 39 | Channel 78 |
| GFSK | 6.138 | **7.491** | 6.313 | 4.11 | **5.61** | 4.28 |
| π/4 DQPSK | 6.131 | 5.507 | 4.436 | 4.10 | 3.55 | 2.78 |
| 8DPSK | 4.797 | 5.852 | 4.732 | 3.02 | 3.85 | 2.97 |

| Type of Modulation | Average Output Power (dBm) | | | Average Output Power (mW) | | |
|---|---|---|---|---|---|---|
| | Channel 0 | Channel 39 | Channel 78 | Channel 0 | Channel 39 | Channel 78 |
| GFSK | 5.32 | **6.61** | 5.52 | 3.40 | **4.58** | 3.56 |
| π/4 DQPSK | 1.92 | 2.91 | 2.04 | 1.56 | 1.95 | 1.60 |
| 8DPSK | 1.90 | 2.95 | 2.07 | 1.55 | 1.97 | 1.61 |

Note: The antenna gain of 3.0 dBi less than 6dBi maximum permission antenna gain value based on 125 mW peak output power limit.

**The test plots as follows:**

| GFSK | π/4 DQPSK |
|---|---|
| **Lowest Channel** | |
|  |  |
| **Middle Channel** | |
|  |  |
| **Highest Channel** | |
|  |  |

| 8DPSK | |
|---|---|
| **Lowest Channel** | **Middle Channel** |
|  |  |
| **Highest Channel** | |
|  | |

# 5.4 20 DB BANDWIDTH & OCCUPIED BANDWIDTH

| | |
|---|---|
| **Test Requirement:** | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)<br>RSS-247 Issue 2, Section 5.1(a)<br>RSS-Gen section 6.7 |
| **Test Method:** | ANSI C63.10-2013 Section 6.9.2<br>RSS-Gen section 6.7 |
| **Limit:** | None; for reporting purposes only. |
| **Test Procedure:** | Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.<br>Use the following spectrum analyzer settings:<br><br>a) Span = approximately 2 to 5 times the OBW, centered on a hopping channel.<br>b) RBW = 1% to 5% of the OBW.<br>c) VBW ≥ 3 x RBW<br>d) Sweep = auto;<br>e) Detector function = peak<br>f) Trace = max hold<br>g) All the trace to stabilize, use the marker-to-peak function to set the marker to the peak of the emission, use the marker-delta function to measure and record the 20dB down bandwidth of the emission.<br><br>Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset. |
| **Test Setup:** | Refer to section 4.5.3 for details. |
| **Instruments Used:** | Refer to section 3 for details |
| **Test Results:** | Pass |

Test data reference attachment

## 5.5 CARRIER FREQUENCIES SEPARATION

| | |
|---|---|
| **Test Requirement:** | FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)<br>RSS-247 Issue 2, Section 5.1(b) |
| **Test Method:** | ANSI C63.10-2013 Section 7.8.2 |
| **Limit:** | Frequency hopping systems operating in the 2400-2483.5 MHz band 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.<br>Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band 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 the systems operate with an output power no greater than 125 mW. |
| **Test Procedure:** | Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.<br>Use the following spectrum analyzer settings:<br><br>a) Span: Wide enough to capture the peaks of two adjacent channels.<br>b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.<br>c) Video (or average) bandwidth (VBW) ≥ RBW.<br>d) Sweep: Auto.<br>e) Detector function: Peak.<br>f) Trace: Max hold.<br>g) Allow the trace to stabilize.<br>h) Use the marker-delta function to determine the separation between the peaks of the adjacent channels.<br><br>Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset. |
| **Test Setup:** | Refer to section 4.5.3 for details. |
| **Instruments Used:** | Refer to section 3 for details |
| **Test Results:** | Pass |

Test data reference attachment

## 5.6 NUMBER OF HOPPING CHANNEL

| | |
|---|---|
| **Test Requirement:** | FCC 47 CFR Part 15 Subpart C Section 15.247(b)(1)<br>RSS-247 Issue 2, Section 5.1(d) |
| **Test Method:** | ANSI C63.10-2013 Section 7.8.3 |
| **Limit:** | Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels. |
| **Test Procedure:** | Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.<br>Use the following spectrum analyzer settings:<br><br>a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.<br>b) RBW < 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.<br>c) VBW ≥ RBW.<br>d) Sweep: Auto.<br>e) Detector function: Peak.<br>f) Trace: Max hold.<br>g) Allow the trace to stabilize.<br><br>Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset. |
| **Test Setup:** | Refer to section 4.5.3 for details. |
| **Instruments Used:** | Refer to section 3 for details |
| **Test Results:** | Pass |

Test data reference attachment

## 5.7 DWELL TIME

| | |
|---|---|
| **Test Requirement:** | FCC 47 CFR Part 15 Subpart C Section 15.247(a)(1)<br>RSS-247 Issue 2, Section 5.1(d) |
| **Test Method:** | ANSI C63.10-2013 Section 7.8.4 |
| **Limit:** | Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. |
| **Test Procedure:** | Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.<br>Use the following spectrum analyzer settings:<br><br>a) Span = zero span, centered on a hopping channel<br>b) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.<br>c) Sweep = As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.<br>d) Detector function = peak<br>e) Trace = max hold<br>f) Use the marker-delta function to determine the dwell time<br><br>Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset. |
| **Test Setup:** | Refer to section 4.5.3 for details. |
| **Instruments Used:** | Refer to section 3 for details |
| **Test Results:** | Pass |

Test data reference attachment

## 5.8 CONDUCTED OUT OF BAND EMISSION

| | |
|---|---|
| **Test Requirement:** | FCC 47 CFR Part 15 Subpart C Section 15.247(d)<br>RSS-247 Issue 2, Section 5.5 |
| **Test Method:** | ANSI C63.10-2013 Section 6.10.4 & Section 7.8.8 |
| **Limit:** | In any 100kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power. |
| **Test Procedure:** | Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.<br>Use the following spectrum analyzer settings: |

**Step 1:Measurement Procedure REF**

a) Set instrument center frequency to 2400 MHz or 2483.5 MHz.
b) Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Sweep points ≥ 2 x Span/RBW
h) Trace mode = max hold.
i) Allow the trace to stabilize.
j) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.

**Step 2:Measurement Procedure OOBE**

a) Set RBW = 100 kHz.
b) Set VBW ≥ 300 kHz.
c) Detector = peak.
d) Sweep = auto couple.
e) Trace Mode = max hold.
f) Allow trace to fully stabilize.
g) Use the peak marker function to determine the maximum amplitude level.

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

| | |
|---|---|
| **Test Setup:** | Refer to section 4.5.3 for details. |
| **Instruments Used:** | Refer to section 3 for details |
| **Test Mode:** | Hopping Frequencies Transmitter mode |
| **Test Results:** | Pass |

Test data reference attachment

## 5.9 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 (dBμV/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 (dBuV/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 camber. 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).

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

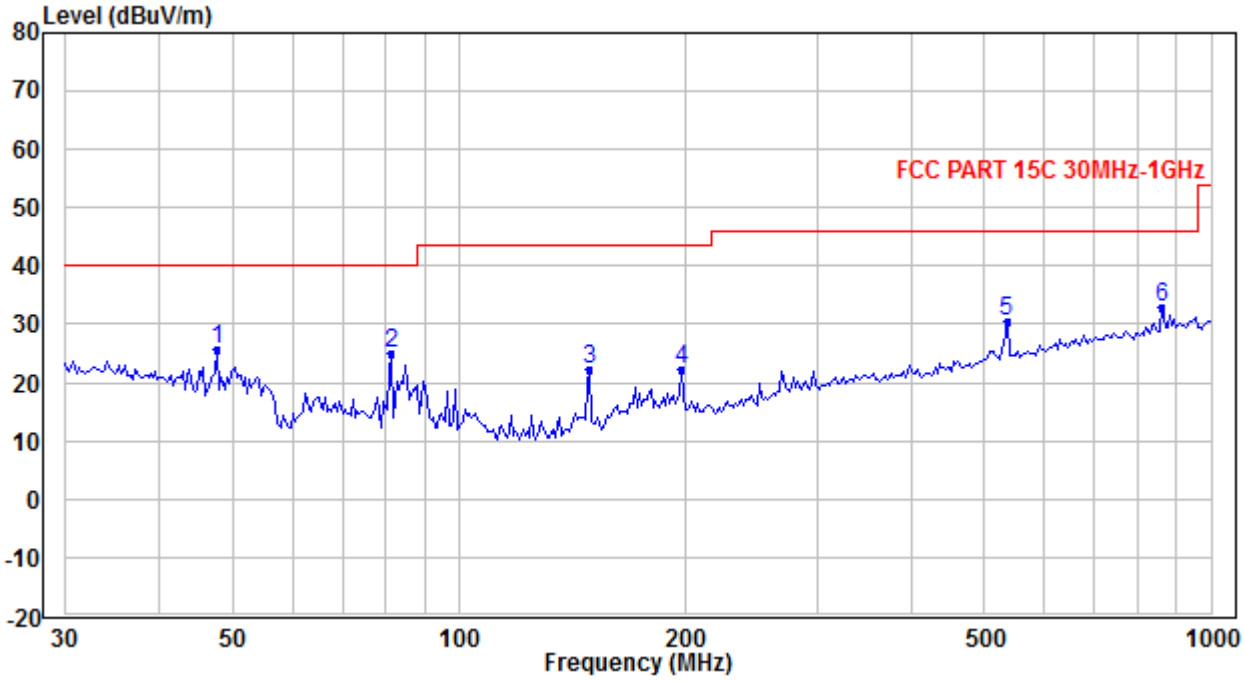
**The measurement data as follows:**

| **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):**

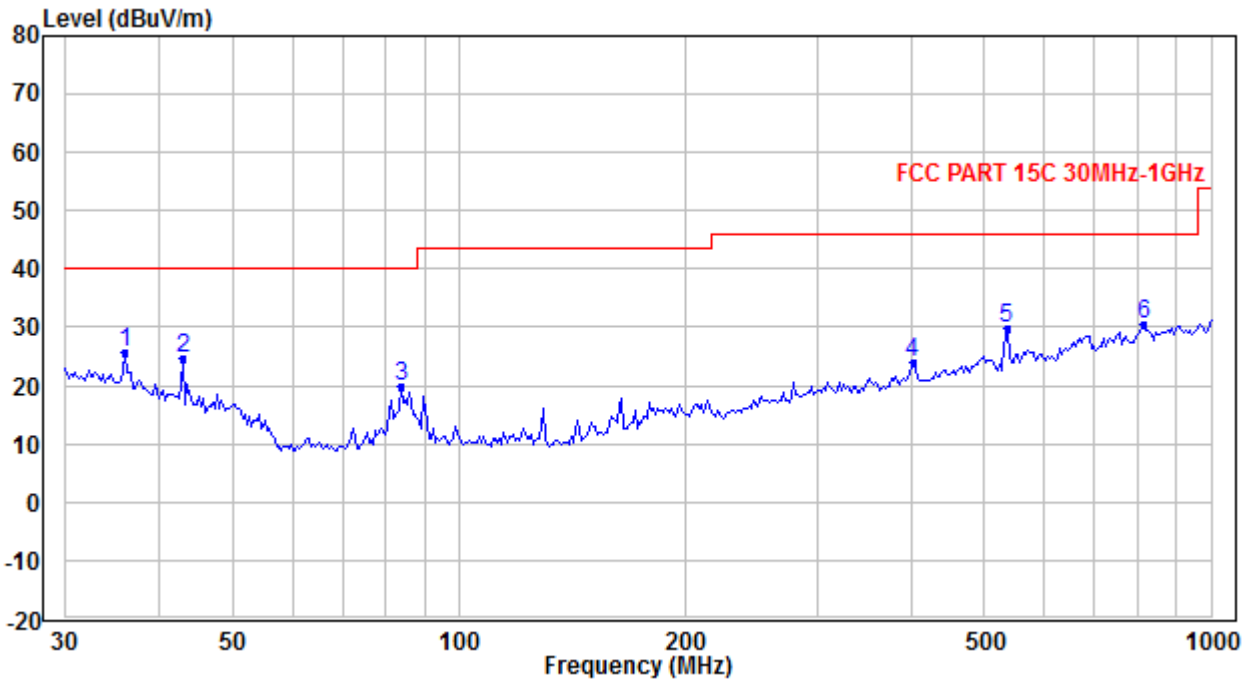
**Worst-Case Configuration**

**Horizontal**




| No. | Frequency (MHz) | Reading (dBμV/m) | Correction factor (dB/m ) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 | 47.703 | 38.89 | -13.14 | 25.75 | 40.00 | -14.25 | QP |
| 2 | 81.374 | 42.43 | -17.55 | 24.88 | 40.00 | -15.12 | QP |
| 3 | 148.917 | 37.74 | -15.32 | 22.42 | 43.50 | -21.08 | QP |
| 4 | 197.251 | 32.96 | -10.64 | 22.32 | 43.50 | -21.18 | QP |
| 5 | 535.038 | 32.63 | -2.12 | 30.51 | 46.00 | -15.49 | QP |
| 6 | 862.802 | 29.57 | 3.36 | 32.93 | 46.00 | -13.07 | QP |

**Vertical**




| No. | Frequency (MHz) | Reading (dBμV/m) | Correction factor (dB/m ) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 | 36.014 | 31.09 | -5.53 | 25.56 | 40.00 | -14.44 | QP |
| 2 | 42.931 | 34.47 | -9.81 | 24.66 | 40.00 | -15.34 | QP |
| 3 | 83.694 | 37.03 | -17.02 | 20.01 | 40.00 | -19.99 | QP |
| 4 | 401.105 | 28.41 | -4.53 | 23.88 | 46.00 | -22.12 | QP |
| 5 | 535.038 | 32.04 | -2.12 | 29.92 | 46.00 | -16.08 | QP |
| 6 | 815.635 | 28.19 | 2.48 | 30.67 | 46.00 | -15.33 | QP |

**Radiated Emission Test Data (Above 1GHz):**

**Lowest Channel:**

| No. | Frequency (MHz) | Reading (dBμV/m) | Correction factor (dB) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector | Antenna Polaxis |
|---|---|---|---|---|---|---|---|---|
| 1 | 4804.00 | 42.95 | -2.34 | 40.61 | 74.00 | -33.39 | Peak | Horizontal |
| 2 | 4804.00 | 32.40 | -2.34 | 30.06 | 54.00 | -23.94 | Average | Horizontal |
| 3 | 7206.00 | 42.19 | 1.43 | 43.62 | 74.00 | -30.38 | Peak | Horizontal |
| 4 | 7206.00 | 27.90 | 1.43 | 29.33 | 54.00 | -24.67 | Average | Horizontal |
| 5 | 4804.00 | 43.15 | -2.34 | 40.81 | 74.00 | -33.19 | Peak | Vertical |
| 6 | 4804.00 | 31.73 | -2.34 | 29.39 | 54.00 | -24.61 | Average | Vertical |
| 7 | 7206.00 | 39.56 | 1.43 | 40.99 | 74.00 | -33.01 | Peak | Vertical |
| 8 | 7206.00 | 28.29 | 1.43 | 29.72 | 54.00 | -24.28 | Average | Vertical |

**Middle Channel:**

| No. | Frequency (MHz) | Reading (dBμV/m) | Correction factor (dB) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector | Antenna Polaxis |
|---|---|---|---|---|---|---|---|---|
| 1 | 4882.00 | 43.29 | -2.30 | 40.99 | 74.00 | -33.01 | Peak | Horizontal |
| 2 | 4882.00 | 30.25 | -2.30 | 27.95 | 54.00 | -26.05 | Average | Horizontal |
| 3 | 7323.00 | 39.66 | 1.61 | 41.27 | 74.00 | -32.73 | Peak | Horizontal |
| 4 | 7323.00 | 29.17 | 1.61 | 30.78 | 54.00 | -23.22 | Average | Horizontal |
| 5 | 4882.00 | 42.25 | -2.30 | 39.95 | 74.00 | -34.05 | Peak | Vertical |
| 6 | 4882.00 | 31.49 | -2.30 | 29.19 | 54.00 | -24.81 | Average | Vertical |
| 7 | 7323.00 | 41.28 | 1.61 | 42.89 | 74.00 | -31.11 | Peak | Vertical |
| 8 | 7323.00 | 29.85 | 1.61 | 31.46 | 54.00 | -22.54 | Average | Vertical |

**Highest Channel:**

| No. | Frequency (MHz) | Reading (dBμV/m) | Correction factor (dB) | Result (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector | Antenna Polaxis |
|---|---|---|---|---|---|---|---|---|
| 1 | 4960.00 | 42.38 | -2.25 | 40.13 | 74.00 | -33.87 | Peak | Horizontal |
| 2 | 4960.00 | 30.68 | -2.25 | 28.43 | 54.00 | -25.57 | Average | Horizontal |
| 3 | 7440.00 | 41.07 | 1.81 | 42.88 | 74.00 | -31.12 | Peak | Horizontal |
| 4 | 7440.00 | 31.31 | 1.81 | 33.12 | 54.00 | -20.88 | Average | Horizontal |
| 5 | 4960.00 | 42.70 | -2.25 | 40.45 | 74.00 | -33.55 | Peak | Vertical |
| 6 | 4960.00 | 30.85 | -2.25 | 28.60 | 54.00 | -25.40 | Average | Vertical |
| 7 | 7440.00 | 41.53 | 1.81 | 43.34 | 74.00 | -30.66 | Peak | Vertical |
| 8 | 7440.00 | 28.64 | 1.81 | 30.45 | 54.00 | -23.55 | Average | 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

## 5.10 BAND EDGE MEASUREMENTS (RADIATED)

**Test Requirement:** FCC 47 CFR Part 15 Subpart C Section 15.205/15.209
RSS-247 Issue 2, 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 (dBμV/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).

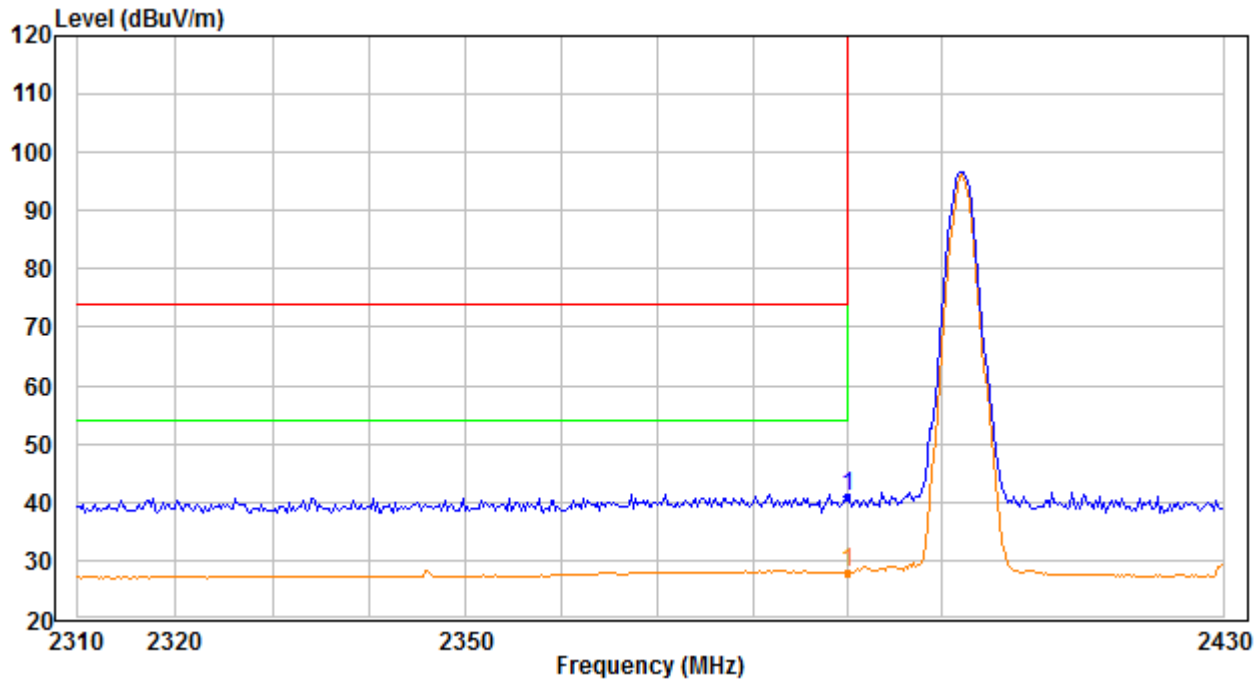
1. Use radiated spurious emission test procedure described in clause 5.10. The transmitter output (antenna port) was connected to the test receiver.
2. Set the PK and AV limit line.
3. Record the fundamental emission and emissions out of the band-edge.
4. Determine band-edge compliance as required.

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

**Test Result:** Pass

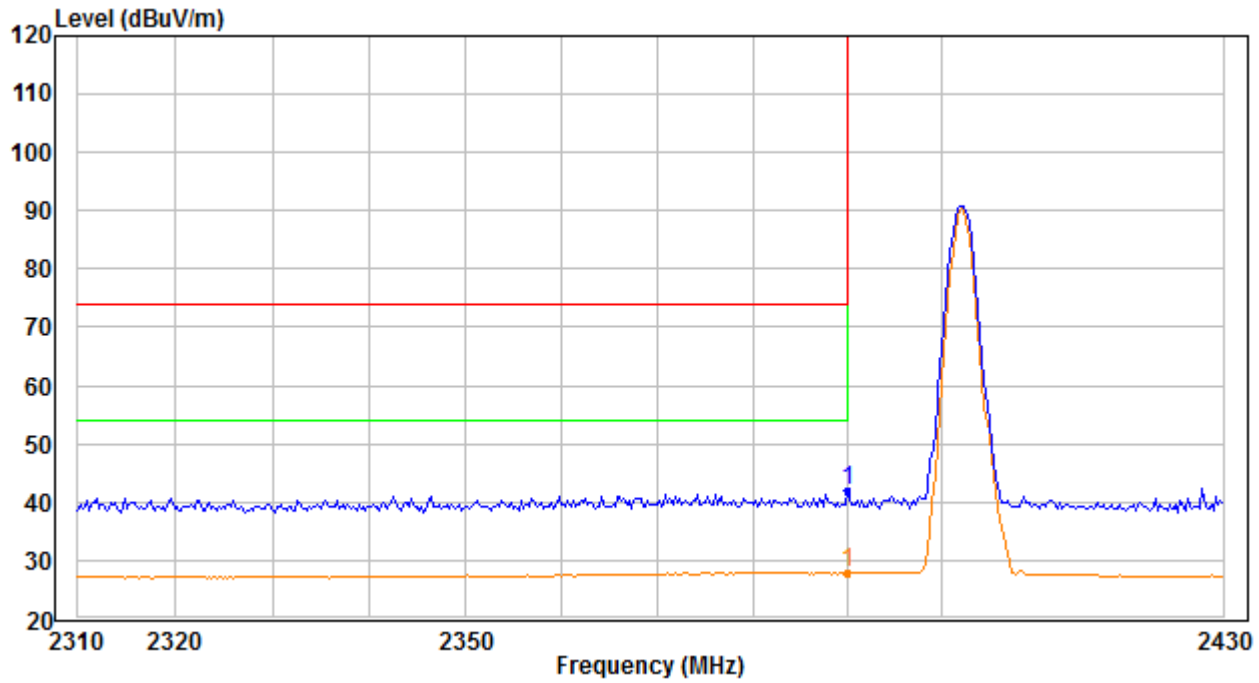
**The measurement data as follows:**

| Test Channel: | Lowest Channel | Ant. Polar. : | Horizontal |
|---|---|---|---|



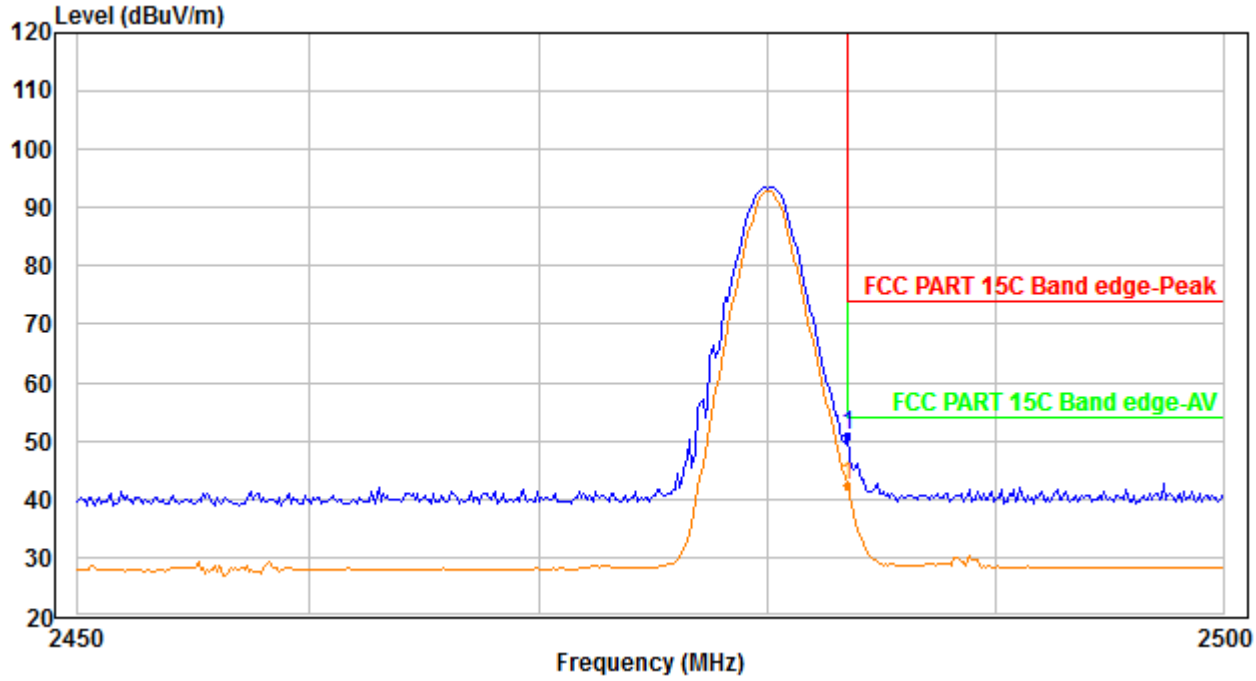

| Frequency (MHz) | Peak level (dBμV/m) | Peak Limit (dBμV/m) | AV level (dBμV/m) | AV Limit (dBμV/m) | Conclusion |
|---|---|---|---|---|---|
| 2390.0000 | 41.11 | 74.00 | 27.94 | 54.00 | Pass |

| Test Channel: | Lowest Channel | Ant. Polar. : | Vertical |
|---|---|---|---|



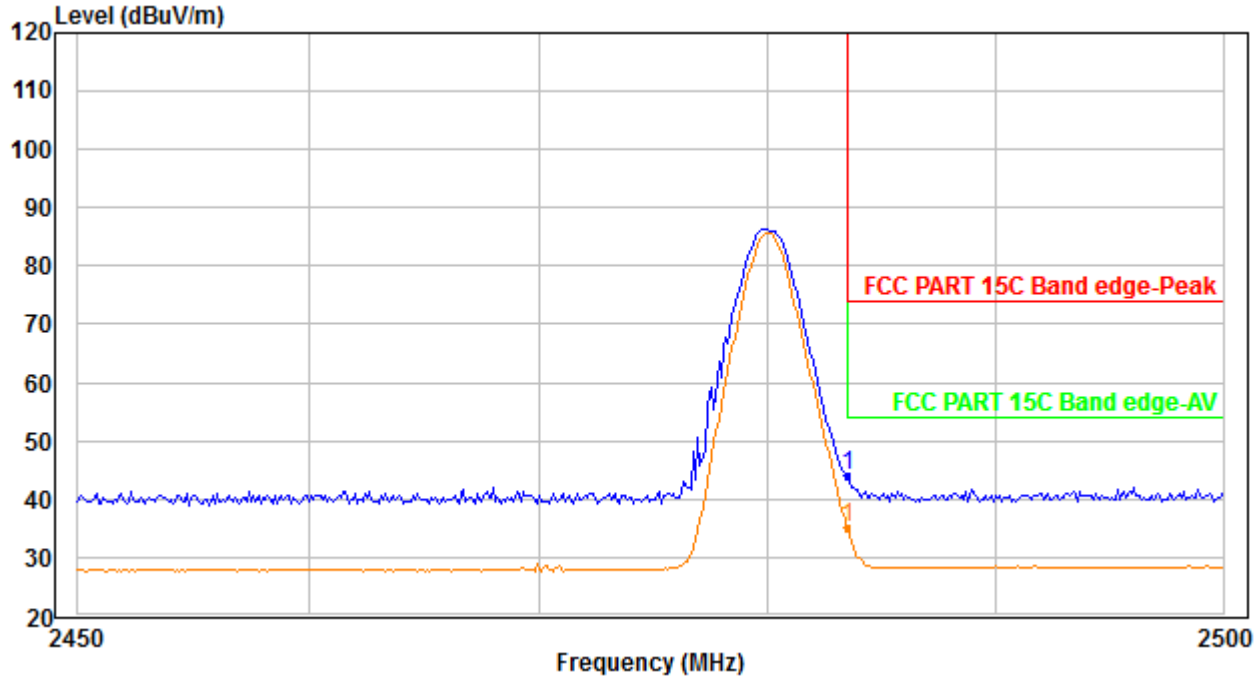

| Frequency (MHz) | Peak level (dBμV/m) | Peak Limit (dBμV/m) | AV level (dBμV/m) | AV Limit (dBμV/m) | Conclusion |
|---|---|---|---|---|---|
| 2390.0000 | 42.10 | 74.00 | 27.74 | 54.00 | Pass |

| Test Channel: | Highest Channel | Ant. Polar. : | Horizontal |
|---|---|---|---|




| Frequency (MHz) | Peak level (dBμV/m) | Peak Limit (dBμV/m) | AV level (dBμV/m) | AV Limit (dBμV/m) | Conclusion |
|---|---|---|---|---|---|
| 2483.5000 | 50.79 | 74.00 | 42.17 | 54.00 | Pass |

| Test Channel: | Highest Channel | Ant. Polar. : | Vertical |
|---|---|---|---|




| Frequency (MHz) | Peak level (dBμV/m) | Peak Limit (dBμV/m) | AV level (dBμV/m) | AV Limit (dBμV/m) | Conclusion |
|---|---|---|---|---|---|
| 2483.5000 | 43.97 | 74.00 | 35.13 | 54.00 | Pass |

## 5.11 CONDUCTED EMISSION

**Test Requirement:** 47 CFR Part 15C Section 15.207
RSS-Gen Issue 5, Section 8.8

**Test Method:** ANSI C63.10-2013 Section 6.2

**Limits:**

| Frequency range (MHz) | Limits (dB(μV)) | |
|---|---|---|
| | Quasi-peak | Average |
| 0,15 to 0,50 | 66 to 56 | 56 to 46 |
| 0,50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |

**Remark:**

1. The lower limit shall apply at the transition frequencies.
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15 to 0.50 MHz.

**Test Setup:** Refer to section 4.5.2 for details.

**Test Procedures:**

Test frequency range :150KHz-30MHz

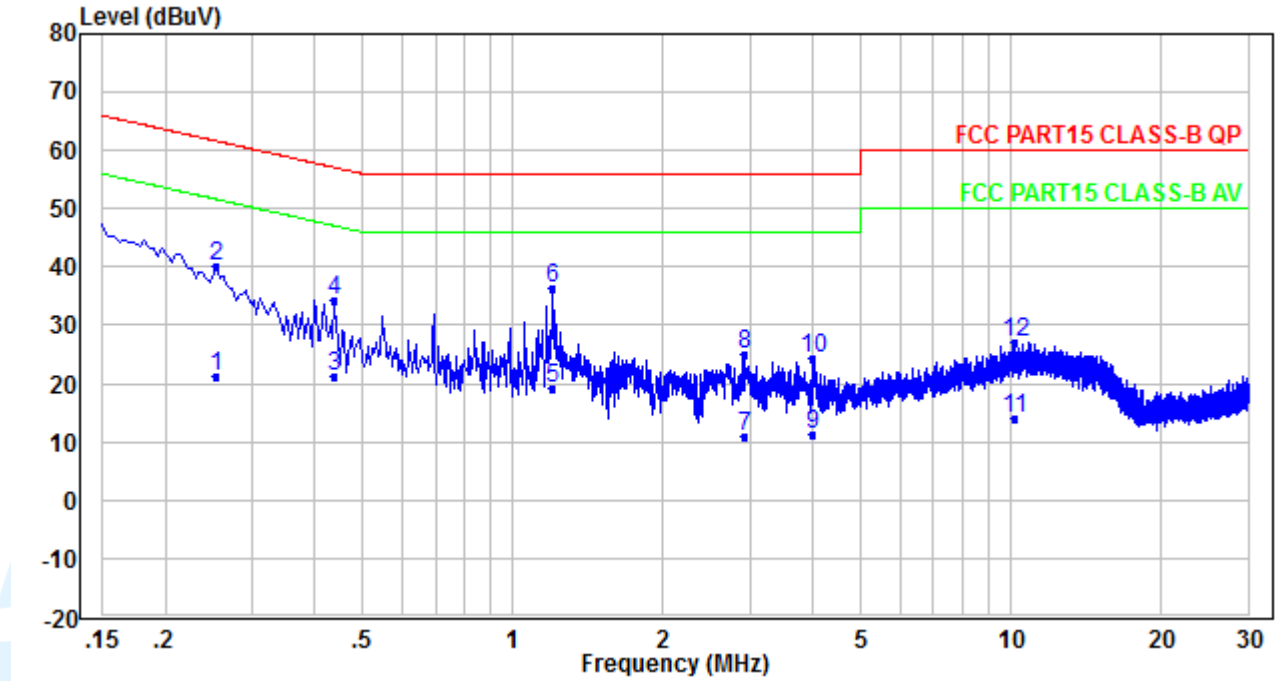
1) The mains terminal disturbance voltage test was conducted in a shielded room.
2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.
5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.

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

**Test Result:** Pass

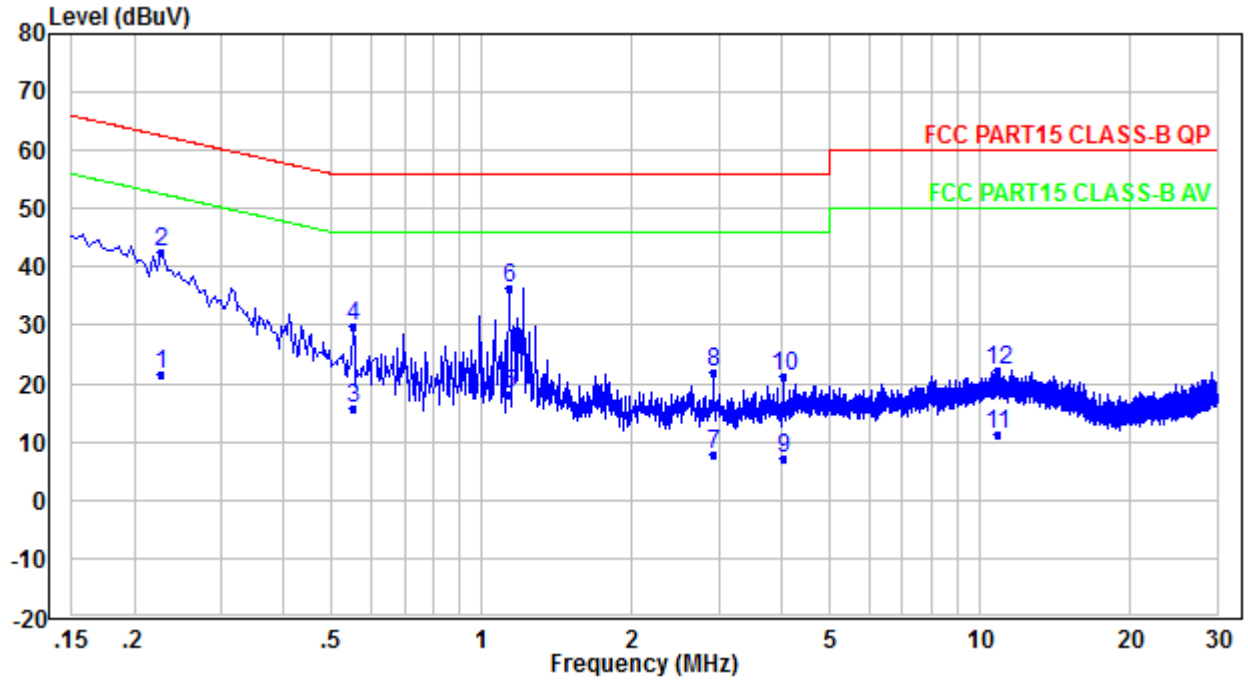
**The measurement data as follows:**
**Quasi Peak and Average:**
**Mode: BT Link**

**Live Line**




| No. | Frequency (MHz) | Reading (dBμV) | Correction factor (dB) | Result (dBμV) | Limit (dBμV) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 | 0.254 | 11.33 | 9.75 | 21.08 | 51.63 | -30.55 | Average |
| 2 | 0.254 | 30.33 | 9.75 | 40.08 | 61.63 | -21.55 | QP |
| 3 | 0.438 | 11.45 | 9.81 | 21.26 | 47.10 | -25.84 | Average |
| 4 | 0.438 | 24.45 | 9.81 | 34.26 | 57.10 | -22.84 | QP |
| 5 | 1.202 | 9.36 | 9.90 | 19.26 | 46.00 | -26.74 | Average |
| 6 | 1.202 | 26.36 | 9.90 | 36.26 | 56.00 | -19.74 | QP |
| 7 | 2.910 | 0.92 | 9.96 | 10.88 | 46.00 | -35.12 | Average |
| 8 | 2.910 | 14.92 | 9.96 | 24.88 | 56.00 | -31.12 | QP |
| 9 | 4.014 | 1.10 | 10.11 | 11.21 | 46.00 | -34.79 | Average |
| 10 | 4.014 | 14.10 | 10.11 | 24.21 | 56.00 | -31.79 | QP |
| 11 | 10.177 | 3.89 | 10.24 | 14.13 | 50.00 | -35.87 | Average |
| 12 | 10.177 | 16.89 | 10.24 | 27.13 | 60.00 | -32.87 | QP |

**Neutral Line**




| No. | Frequency (MHz) | Reading (dBμV) | Correction factor (dB) | Result (dBμV) | Limit (dBμV) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 | 0.226 | 11.88 | 9.74 | 21.62 | 52.60 | -30.98 | Average |
| 2 | 0.226 | 32.88 | 9.74 | 42.62 | 62.60 | -19.98 | QP |
| 3 | 0.550 | 6.00 | 9.79 | 15.79 | 46.00 | -30.21 | Average |
| 4 | 0.550 | 20.00 | 9.79 | 29.79 | 56.00 | -26.21 | QP |
| 5 | 1.134 | 8.39 | 9.83 | 18.22 | 46.00 | -27.78 | Average |
| 6 | 1.134 | 26.39 | 9.83 | 36.22 | 56.00 | -19.78 | QP |
| 7 | 2.918 | -2.10 | 9.98 | 7.88 | 46.00 | -38.12 | Average |
| 8 | 2.918 | 11.90 | 9.98 | 21.88 | 56.00 | -34.12 | QP |
| 9 | 4.038 | -2.87 | 10.05 | 7.18 | 46.00 | -38.82 | Average |
| 10 | 4.038 | 11.13 | 10.05 | 21.18 | 56.00 | -34.82 | QP |
| 11 | 10.889 | 1.06 | 10.37 | 11.43 | 50.00 | -38.57 | Average |
| 12 | 10.889 | 12.06 | 10.37 | 22.43 | 60.00 | -37.57 | QP |

Remark:

1. Correct Factor = LISN Factor + Cable Loss + Pulse Limiter Factor, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result - Limit
4. An initial pre-scan was performed on the Phase and neutral lines with peak detector. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.
5. All possible modes of operation were investigated, and testing at two nominal voltages of 240V/50Hz and 120V/60Hz, only the worst case emissions reported.

# 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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