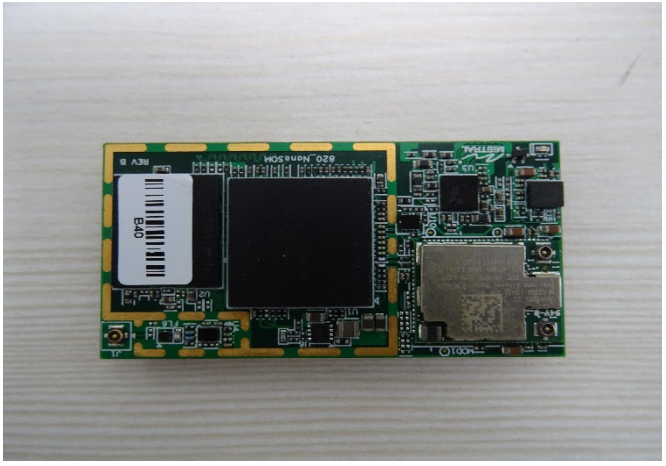
| | | | | |
|---|---|---|---|---|
| **Prüfbericht-Nr.:** *Test report no.:* | **ULR-TC568820300000037F** | **Auftrags-Nr.:** *Order no.:* | **166203252 0030** | Seite 1 von 45 *Page 1 of 45* |
| **Kunden-Referenz-Nr.:** *Client reference no.:* | NA | **Auftragsdatum:** *Order date:* | 2019-11-26 | |
| **Auftraggeber:** *Client:* | Mistral Solutions Private Limited<br>60 Adarsh Regent, 100 feet ring road<br>Domlur Extension, Bangalore-560071,India | | | |
| **Prüfgegenstand:** *Test item:* | SD820 Nano SOM with 2x2 802.11 a/b/g/n/ac WIFI+ Bluetooth Module | | | |
| **Bezeichnung / Serien -Nr.:** *Identification / Serial no.:* | SD820 Nano SOM Rev B | | | |
| **Auftrags-Inhalt:** *Order content:* | Testing & issue of test report | | | |
| **Prüfgrundlage:** *Test specification:* | FCC Part 15 Subpart C 15.247, 15.207,<br>RSS 247 Issue 2 and RSS Gen Issue 5 | | | |
| **Wareneingangsdatum:** *Date of sample receipt:* | 2020-03-10 | | | |
| **Prüfmuster-Nr.:** *Test sample no:* | A001073243-001<br>A001073243-002 | | | |
| **Prüfzeitraum:** *Testing period:* | 2020-08-24 - 2020-08-28 | | | |
| **Ort der Prüfung:** *Place of testing:* | Wireless laboratory,<br>Bangalore | | | |
| **Prüflaboratorium:** *Testing laboratory:* | TÜV Rheinland (India) Pvt.Ltd.,<br>27/B, 2nd Cross,<br>ElectronicCityPhase1<br>Bangalore – 560 100,<br>India | | | |
| **Prüfergebnis*:** *Test result*:* | Pass | | | |



| | | | |
|---|---|---|---|
| **geprüft von:** *tested by:* | | **genehmigt von:** *authorized by:* | |
| **Datum:** *Date:* 2020-11-28 | | **Ausstellatum:** *Issue date:* 2020-11-28 | |
| **Stellung** / *Position:* | **Madhu Karadekere Nagaraju**<br>Senior Engineer | **Stellung** / *Position:* | **Mahammadgouse Kaladagi**<br>Assistant Manager |
| **Sonstiges** / *Other:* | **ULR – TC5688-20300000037F**<br>FCC ID: 2AVEC-QCNFA324<br>IC ID: 26058-QCNFA324 | | |

**Zustand des Prüfgegenstandes bei Anlieferung:** *Condition of the test item at delivery:* — **Prüfmuster vollständig und unbeschädigt** ***Test item complete and undamaged***

| | | | | | |
|---|---|---|---|---|---|
| * Legende: | 1 = sehr gut | 2 = gut | 3 = befriedigend | 4 = ausreichend | 5 = mangelhaft |
| | P(ass) = entspricht o.g. Prüfgrundlage(n) | | F(ail) = entspricht nicht o.g. Prüfgrundlage(n) | N/A = nicht anwendbar | N/T = nicht getestet |
| ** Legend:* | *1 = very good* | *2 = good* | *3 = satisfactory* | *4 = sufficient* | *5 = poor* |
| | *P(ass) = passed a.m. test specification(s)* | | *F(ail) = failed a.m. test specification(s)* | *N/A = not applicable* | *N/T = not tested* |

**Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.**
*This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.*
V05

# TEST SUMMARY

| Test Item | Applicable Standard | | Result |
|---|---|---|---|
| | FCC | ISED | |
| Maximum conducted (average) output power | FCC 15.247(b)(3) | RSS 247 Issue 2, Section 5.4 (d) | *N/T |
| Maximum Power Spectral Density | FCC 15.247(e) | RSS 247 Issue 2, Section 5.2 (b) | *N/T |
| DTS Bandwidth | FCC 15.247(a)(2) | RSS 247 Issue 2, Section 5.2 (a) | *N/T |
| Emissions in non-restricted frequency bands | FCC 15.247(d) | RSS 247 Issue 2, Section 5.5 | *N/T |
| Spurious Radiated Emissions and Restricted Bands of Operation | FCC 15.209 / FCC 15.205 | RSS-Gen Issue 5, Section 8.9 /8.10 | Pass |
| Conducted Emissions on a.c Power Lines | FCC 15.207 | RSS-Gen Issue 5, Section 8.8 | NA |

Product Category: Electronics Testing
Test Discipline: EMC Test Facility

NA: Not Applicable
*N/T: Not tested – These test cases are not tested, the product uses certified RF module **QCNFA324** from **Qualcomm Atheros, Inc.**, with **FCC ID: PPD-QCNFA324 & IC ID: 4104A-QCNFA324**.

# REVISION HISTORY OF THIS REPORT

| Report Number | Version | Description | Issue date |
|---|---|---|---|
| ULR-TC568820300000037F | 01 | Initial issue of report | 07.10.2020 |
| ULR-TC568820300000037F | 02 | Reviewer comments updated | 28.11.2020 |

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# 1 GENERAL REMARKS

## 1.1 Attachments

All attachments are part of this test report and are issued in separate document

1. Test Setup photos
2. EUT External Photos
3. EUT Internal Photos
4. FCC Label and Label Location
5. Block Diagram
6. Specification of EUT
7. Schematic Diagrams
8. Bill of Material
9. User Manual
10. Maximum Permissible Exposure Information

# 2 TEST SITES

## 2.1 Testing Facilities

1. TÜV Rheinland (India) Pvt.Ltd.,
   27/B, 2nd Cross,
   ElectronicCityPhase1
   Bangalore – 560 100,
   India

2. TUV Rheinland (India) Private Limited
   108 , Beside ISBR Business School,
   Electronic city Phase I
   Bangalore - 560 100.
   India

## 2.2 List of Test and Measurement Instruments

**Table 1: List of test and measurement instruments**

| Equipment | Manufacturer | Model Name | Serial Number | Firmware Versions | Calibration Due Date | Periodicity | Test Facility |
|---|---|---|---|---|---|---|---|
| EMI Receiver | Rohde & Schwarz | ESU 40 | 100288 | 4.43 SP3 | 09.06.2021 | Yearly | Radiated Spurious Emission |
| Active loop antenna | Schwarzbeck | FMZB 1519 B | 1519B-00111 | - | 31.01.2021 | Yearly | |
| Biconical Antenna | Schwarzbeck | VHBB9124+BBA 9106 | 9124-1208+9106-0525 | - | 17.02.2021 | Yearly | |
| Baloon and Biconical Antenna | Schwarzbeck mess-elektronik | VHBB-9124 / BBA-9106 | 01028 | - | 02.09.2021 | Yearly | |
| Log - Periodical Antenna | Schwarzbeck | VULP 9118 A | VULP9118A-0733 | - | 13.02.2021 | Yearly | |
| Horn Antenna | Schwarzbeck | BBHA 9170 | BBHA 9170-0904 | - | 29.01.2021 | Yearly | |
| Horn Antenna | Schwarzbeck | BBHA 9120 D | 9120D-1944 | - | 30.01.2021 | Yearly | |
| Semi Anechoic Chamber | Frankonia | - | - | - | - | - | |
| Fully Anechoic Chamber | Albatross | - | - | - | - | - | |
| EMI Receiver | Rohde & Schwarz | ESW 44 | 101732 | - | 10.12.2020 | Yearly | |

**Table 2: Instrument application Software versions**

| SL. No. | Test Type | Application software | Version |
|---|---|---|---|
| 1 | Radiated spurious emission measurement in SAC | EMC 32 | 10.60.00 |
| 2 | Radiated spurious emission measurement in FAC | EMC 32 | 10.60.00 |

# 3 GENERAL PRODUCT INFORMATION

## 3.1 Product Function and Intended Use

The 820 Nano SOM from Mistral is an easy to use, ultra-compact, light-weight System on Module providing very high processing power. The SOM is based on Qualcomm Snapdragon 820 and is ideal for advanced, next-gen embedded applications. With a PCB size of just 51mm x 26mm, this is one of the smallest Snapdragon based SOMs available in the market currently. Equipped with powerful specifications and features, the 820 Nano SOM is ideal for designs requiring 4K Ultra HD HEVC (H.265) video and graphics processing, wireless connectivity, low power consumption and advanced processing power. The feature-rich 820 Nano SOM supports latest features like Type-C functionality, 4K Encode/Decode and integrated 9-axis MEMS on a very small footprint, making it ideal for several powerful applications. The 820 Nano SOM is ideal for designing products like wearable computers, camera solutions, media gateways, Infotainment, drones, assistive devices and other smart gadgets requiring small package and high processing power.

## 3.2 Ratings and System Details of Equipment under Test

**Table 3: Ratings and System Details as declared by Client***

| | | |
|---|---|---|
| **Radio Protocol** | Wi-Fi 2.4GHz | BLE |
| **Operating Frequency Range** | 2412MHz to 2462MHz | 2402MHz to 2480MHz |
| **No. of Channels** | 11 (Refer Table 5) | 40 (Refer Table 6) |
| **Channel Spacing** | 5MHz | 2MHz |
| **Maximum Measured Power (e.i.r.p)** | 21.75 dBm (1Mbps 2437MHz) | 4.55 dBm(1Mbps 2480MHz) |
| **Modulation** | 802.11b: CCK, DQPSK, DBPSK<br>802.11a/g: 64QAM,16QAM, QPSK, BPSK<br>802.11n: 64QAM,16QAM, QPSK, BPSK<br>VHT20 & VHT40 | GFSK |
| **Number of antennas** | 2 | 1 |
| **Antenna Gain** | Peak gain (2.0dBi) Average gain(-0.5dBi) | |
| **Antenna Type & Part No** | SMD Type, SR42W001 | |
| **Supply Voltage to Product** | 4.2 V DC Supply | |
| **Environmental conditions** | 0°C to +70°C Relative Humidity <95% | |
| **EUT Dimension** | 51 x 26 x 1.63 mm (LxWxH) | |

***Disclaimer**: The information/data is supplied by the client and the same is considered to arrive at the final value. Any changes made apart from the specified specification, can directly impact on the tests results. Refer the products user manual for more details.

**Note:** Product SD820 Nano SOM- Wi-Fi Module has multiple protocols. All the supported wireless protocols and their respective test results are issued in separate test reports, refer clause 4.7 Report references

## 3.3 Measurement Uncertainty:

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of *k* = 2

**Table 4: Measurement Uncertainty**

| Parameter | Uncertainty |
|---|---|
| Occupied Channel Bandwidth | ±5 % |
| RF output power, conducted | ±1.5 dB |
| Power Spectral Density, conducted | ±3 dB |
| Unwanted Emissions, conducted | ±3 dB |
| All emissions, radiated | ±6 dB |
| Temperature | ±3 ℃ |
| Supply Voltages | ±3 % |
| Time | ±5 % |

Note: The Listed Measurement Uncertainties are the worst-case uncertainty, for the respective test cases. Above Table is for reporting purpose only and not used in determining Final Pass/Fail verdict.

# 4 TEST SET-UP AND OPERATION MODE

## 4.1 Principle of Configuration Selection

Transmission was enabled with highest possible duty cycle transmission on low, mid and high channel.

## 4.2 Test Operation and Test Software

| | |
|---|---|
| Hardware Version: | RevB |
| Hardware Version Identification Number(s) (HVIN): | QCNFA324 |
| Software Version: | Andr_oreo_8.0 |
| Firmware Version Identification Number(s) (FVIN): | eeprom_ar6320_3p0_NFA324i_5.bin |

## 4.3 Special Accessories and Auxiliary Equipment

- Test laptop and USB cable

## 4.4 Countermeasures to achieve EMC Compliance

- None

## 4.5 Simultaneous Transmission

- Device support simultaneous transmission, measured levels under simultaneous Transmission are same as the stand- alone transmission hence not reported

## 4.6 List of frequencies

| Frequency Band (MHz) | Channel No. | Channel Frequency (MHz) |
|---|---|---|
| 2412 – 2462 | **1** | **2412** |
| | 2 | 2417 |
| | **3** | **2422** |
| | 4 | 2427 |
| | 5 | 2432 |
| | **6** | **2437** |
| | 7 | 2442 |
| | 8 | 2447 |
| | **9** | **2452** |
| | 10 | 2457 |
| | **11** | **2462** |

**Table 5: List of Wi-Fi center Frequencies**

**Channel used for Wi-Fi testing**

Channel Bandwidth 20MHz

Channel low : 2412MHz

Channel mid : 2437MHz

Channel high : 2462MHz

Channel Bandwidth 40MHz

Channel low : 2422MHz

Channel mid : 2437MHz

Channel high : 2452MHz

| Frequency Band (GHz) | Channel No. | Frequency (MHz) |
|---|---|---|
| **BLE (2.4-2.4835)** | **0** | **2402** |
| | 1 | 2404 |
| | 2 | 2406 |
| | 3 | 2408 |
| | : | : |
| | : | : |
| | 18 | 2438 |
| | **19** | **2440** |
| | 20 | 2437 |
| | : | : |
| | : | : |
| | 36 | 2474 |
| | 37 | 2476 |
| | 38 | 2478 |
| | **39** | **2480** |

**Table 6: List of BLE Center frequencies**

**Channel used for BLE testing**

Channel low : 2402MHz

Channel mid : 2440MHz

Channel High : 2480MHz

**Note:**

TUV Sample Identification number : A001073243-002 -Radiated & SAR test Sample
A001073243-001 – Conducted test Sample

## 4.7 Report references

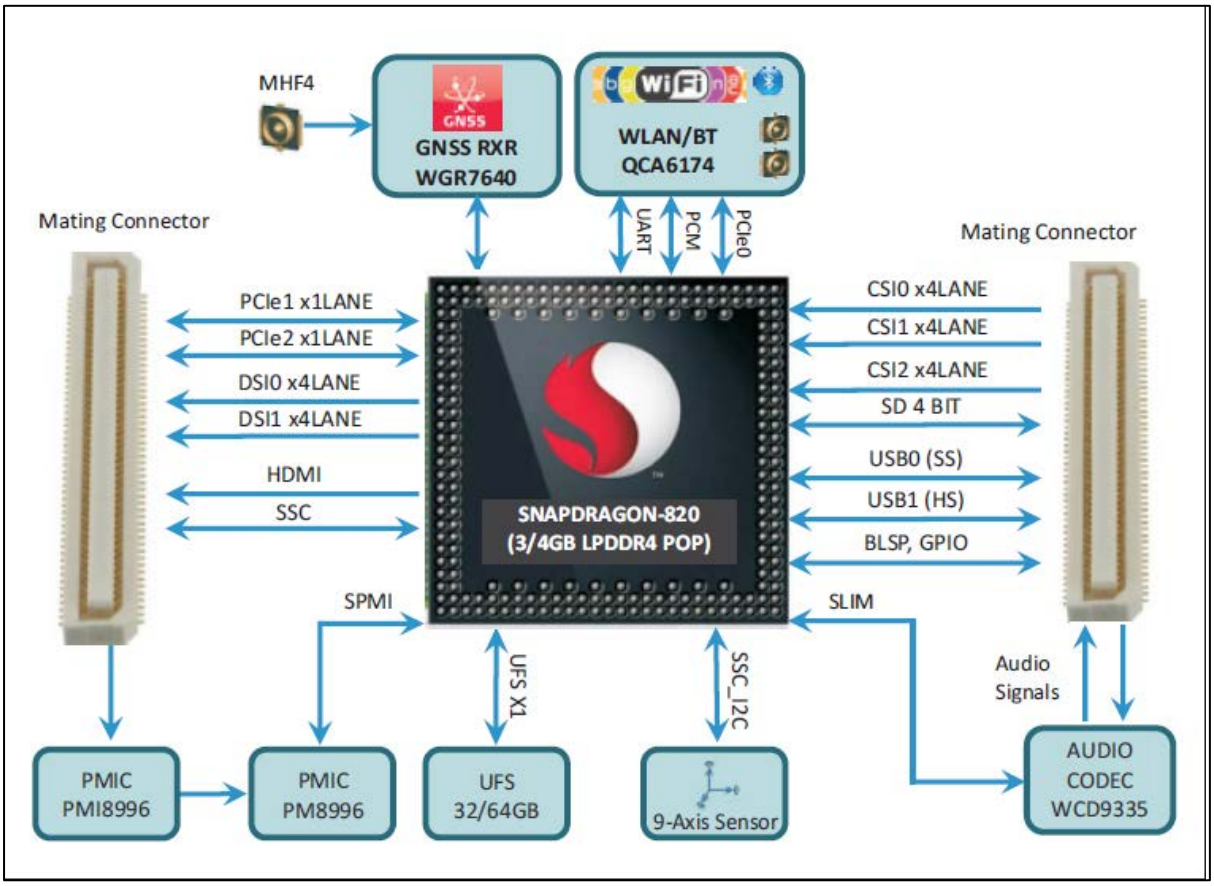
**Note:** Product SD820 Nano SOM- Wifi Module has multiple protocols. All the supported wireless protocols and their respective test results are issued in saparate test reports, following table lists the report numbers.

| Radio Protocol | Report Number |
|---|---|
| RF test report for Wi-Fi (2.4GHz) & BLE (2.4GHz) – (This report) | **ULR-TC568820300000037F** |
| RF test report for BT (2.4GHz) | ULR-TC568820300000038F |
| RF test report for Wi-Fi (5GHz) | ULR-TC568820300000039F |
| SAR test report for Wi-Fi(2.4 & 5GHz) & BT (2.4GHz) | ULR-TC568820300000040F |

# 5 Operational Description

Based on a complete “System on Module” architecture, the 820 Nano SOM consists of ® ™ the 64-bit quad-core Qualcomm Kryo CPU, 2.2GHz capable of 4K Encode/Decode, 3/4GB LPDDR4, 32/64GB UFS and with major interfaces available via inter-board connectors. Application Development on the 820 Nano SOM is enabled with Android and Embedded Linux through a feature-rich carrier board that enables prototyping in record time. Optional Adaptor boards like LCD, Camera, Sensors and Battery Charger are also available for increased scope of development around the 820 Nano SOM.

# 6 Block Diagram



# 7 TEST METHODOLOGY

## 7.1 Radiated Emission Test

The radiated emission measurement was performed according to the procedures in ANSI C63.10-2013. The equipment under test (EUT) was placed at the middle of the 80 cm high turntable for below 1 GHz & 1.5 m height for above 1 GHz measurement, and the EUT is 3 meters far from the measuring antenna. The turntable was rotated 360° for obtaining the maximum emission. The height of the measuring antennas was scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Repeat the measurement steps until the maximum emissions were obtained. The measurement above 1000 MHz was performed by horn antenna, The measurement below 30 MHz was performed by loop antenna, Measurement from 30 MHz to 200 MHz was performed by Baloon and Biconical Antenna, and mesurement from 200 MHz to 1 GHz was performed by Log-Periodic Antenna.

The EUT was rotated around the X-, Y-, and Z-Axis and the results from worst case axis are recorded

### 7.1.1 Test Setup Configuration

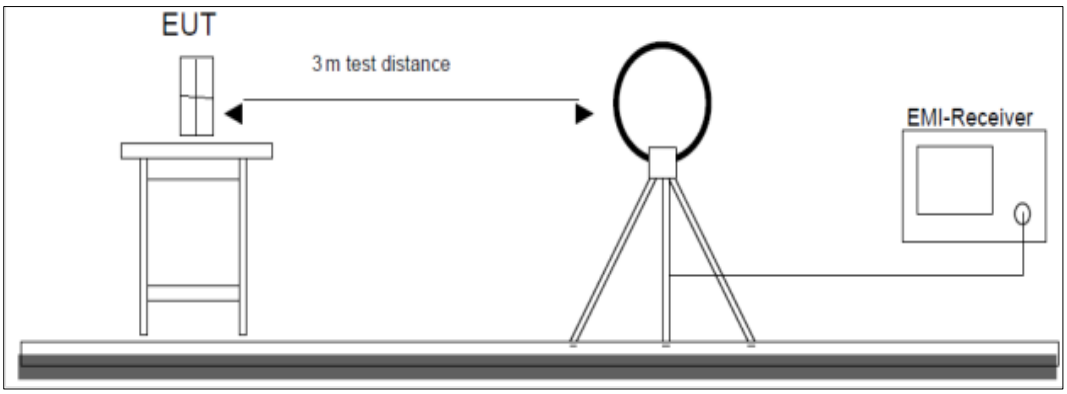



**Figure 1: Frequency Range 9 kHz- 30 MHz**

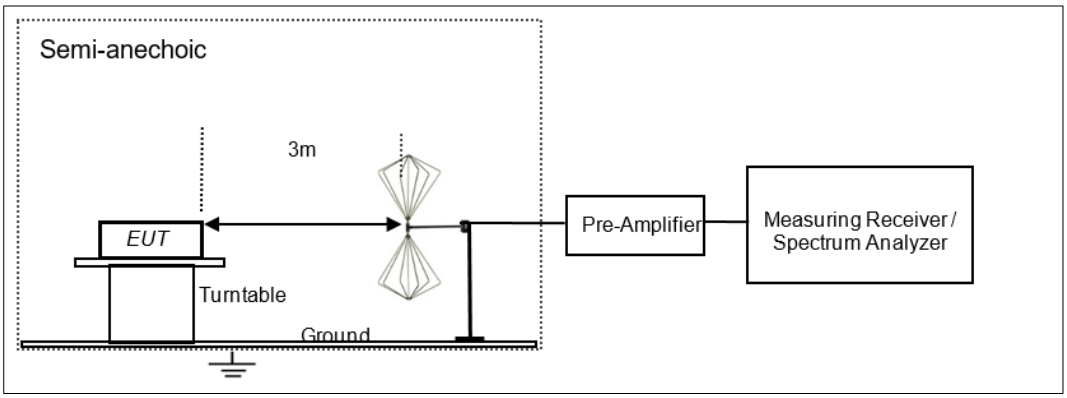



**Figure 2: Frequency Range 30 MHz – 200 MHz**

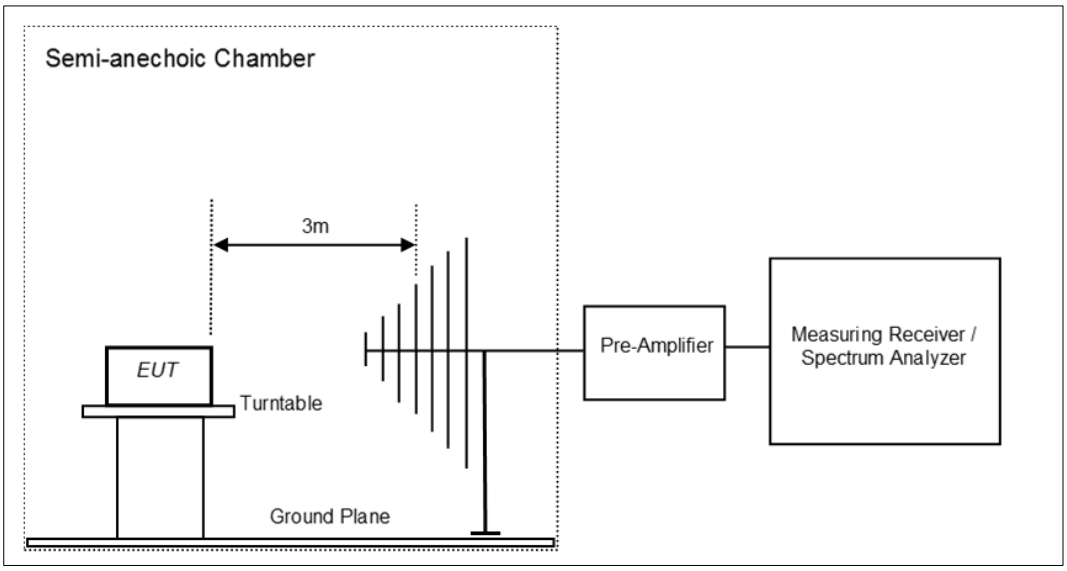



**Figure 3: Frequency Range 200 MHz - 1GHz**

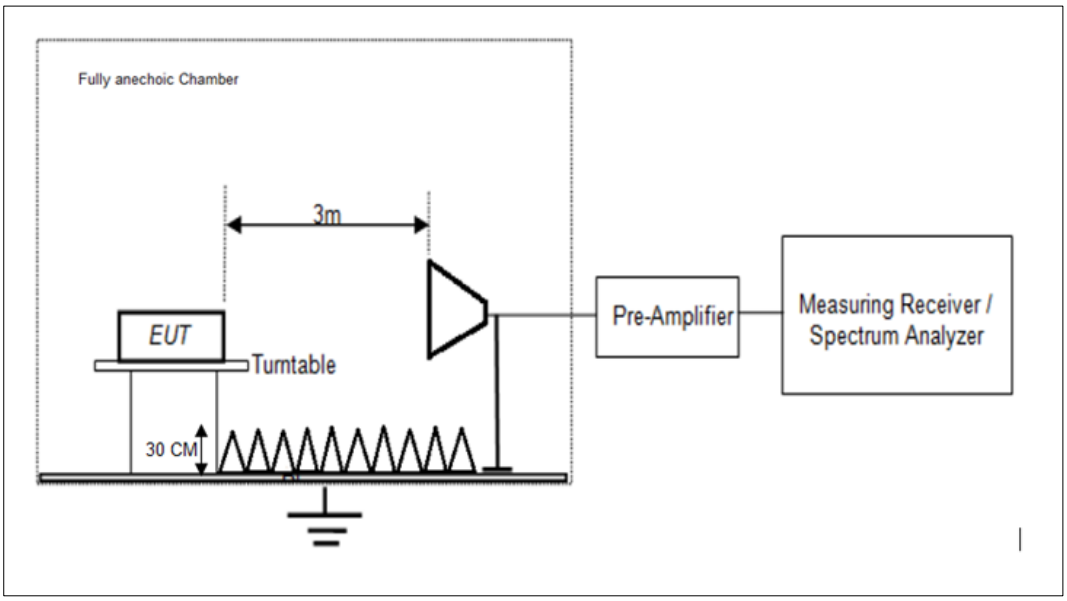



**Figure 4: Frequency Range above 1 GHz**

# 8 TEST RESULTS FOR Wi-Fi-2.4GHz

## 8.1 Spurious Radiated Emissions & Restricted Bands of Operation

***Result*** ***Pass***

| | |
|---|---|
| Test Specification | FCC part 15 Subpart C 15.247 (d) / (15.209 & 15.205) / IC RSS-GEN, Section 8.9 and 8.10 |
| Test Method | ANSI C63.10 |
| Measurement Location | Semi Anechoic Chamber 30MHz - 1 GHz<br>Fully Anechoic Chamber 1 GHz - 40GHz |
| Measurement Bandwidth | 100 kHz for frequency range < 1GHz<br>1 MHz for Frequency range >1GHz |
| Detector | Refer remarks below |
| Measuring Distance | 3 m |
| Requirement | As per the limits mentioned in the below table |
| Test setup | Reffer TEST METHODOLOGY |

**Table 7: Transmitter limits for Radiated emission**

| Frequency (MHz) | Field strength (µV/m) | Field strength (dBµV/m) | Distance of Measurement (m) |
|---|---|---|---|
| 0.009 – 0.490 | 2400/F(kHz) | 48.50 – 13.80 | 300* |
| 0.490 – 1.705 | 24000/F(kHz) | 33.80 – 23.00 | 30* |
| 1.705 -30 | 30 | 29.54 | 30* |
| 30-88 | 100 | 40.0 | 3 |
| 88-216 | 150 | 43.5 | 3 |
| 216-960 | 200 | 46.0 | 3 |
| Above 960 | 500 | 54.0 | 3 |

Remark: * The limit shows in the table above of frequency range 0.009 – 0.490, 0.490 – 1.705 MHz and 1.705-30MHz is at 300 meter, 30 meter and 30 meter range respectively, which corresponds to 128.51 – 93.80, 73.80 – 62.96 and 69.54 dBµV/m at 3m range by extrapolation calculation and the measurement of loop antenna.

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz Radiated emission limits in these three bands are based on measurements employing an average detector.

**Test Conditions:**

Temperature (Norm) = + 23.5 °C Voltage = 4.2VDC input Relative humidity = 62 %

## Test results:

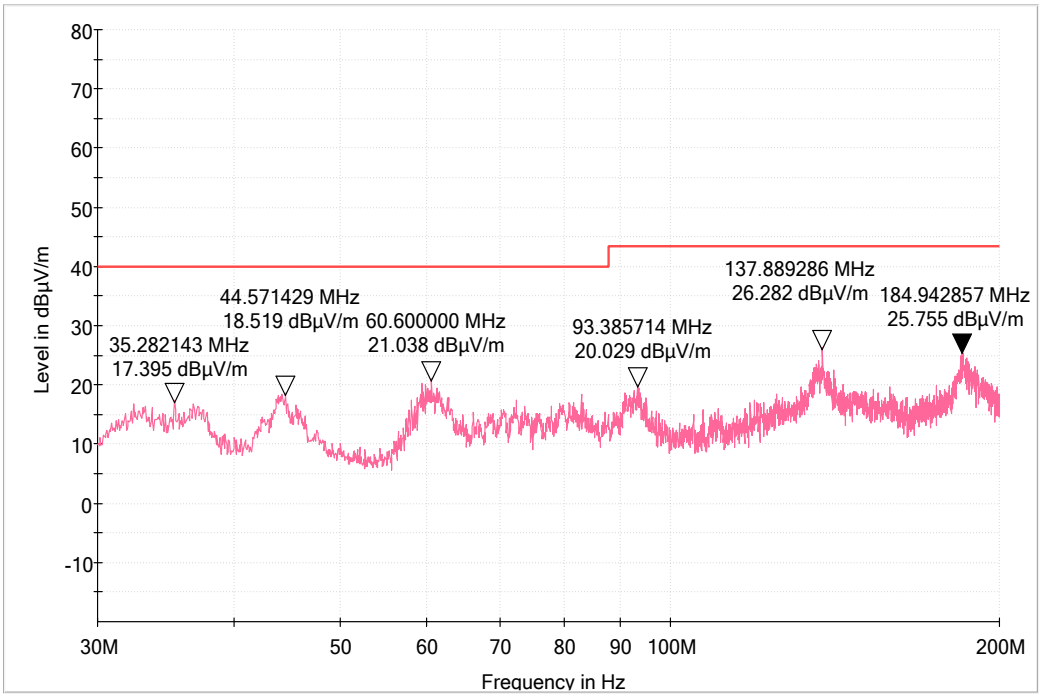
Note: All the losses are included during measurement and final values are mentioned in the test report. Refer TEST METHODOLOGY**.** for more details

**Test results for frequency range 9kHz – 30MHz**

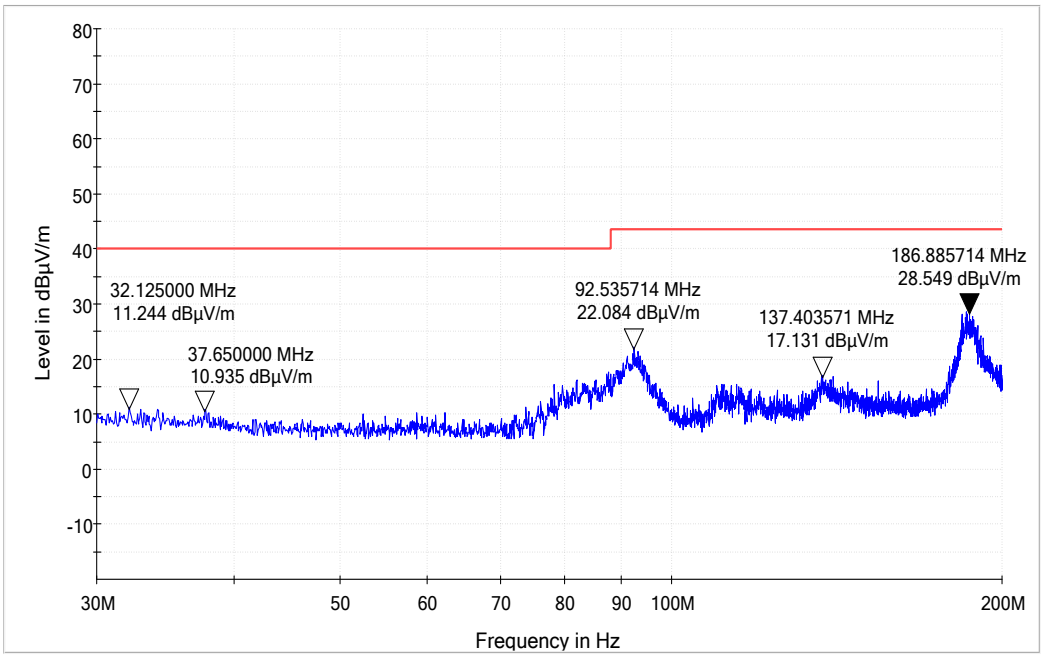
No emissions found in frequency range 9 kHz to 30 MHz, and measured levels are below 20dB from the limit line, hence not reported

**Test results for frequency range 30MHz – 200MHz**

| Antenna Polarization | Frequency (MHz) | Peak (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|
| Vertical | 35.28 | 17.39 | 40.00 | -22.61 |
| | 44.57 | 18.51 | 40.00 | -21.49 |
| | 93.38 | 20.02 | 43.50 | -23.48 |
| | 184.94 | 25.75 | 43.50 | -17.75 |
| Horizontal | 32.12 | 11.24 | 40.00 | -28.76 |
| | 37.65 | 10.93 | 40.00 | -29.07 |
| | 92.53 | 22.08 | 43.50 | -21.42 |
| | 186.88 | 28.54 | 43.50 | -14.96 |



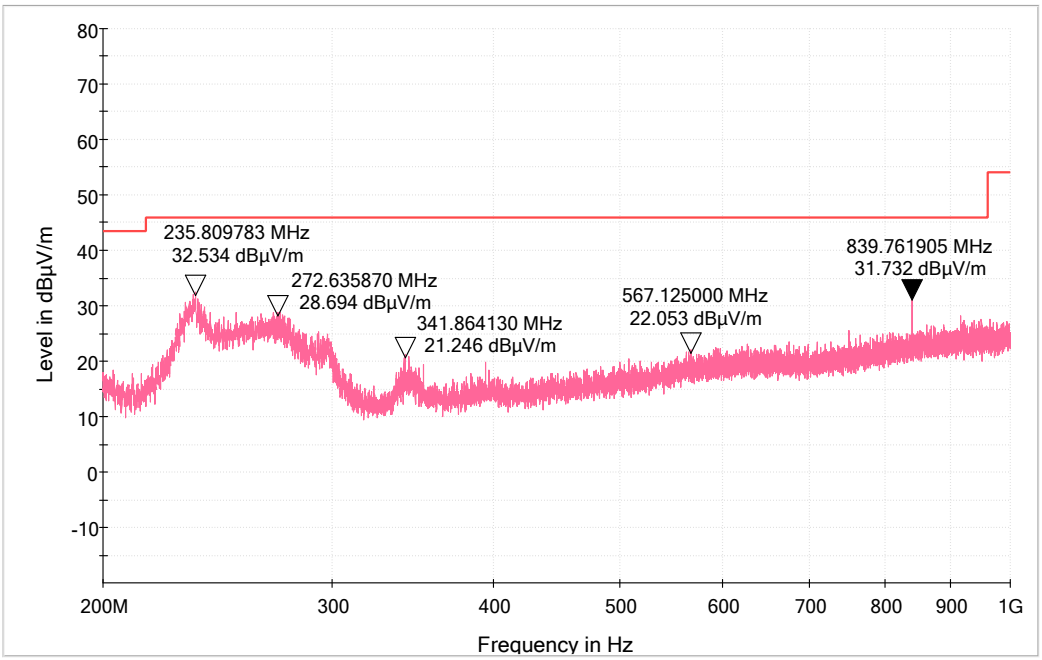

**Channel Frequency 30MHz – 200MHz** **Polarization Vertical**



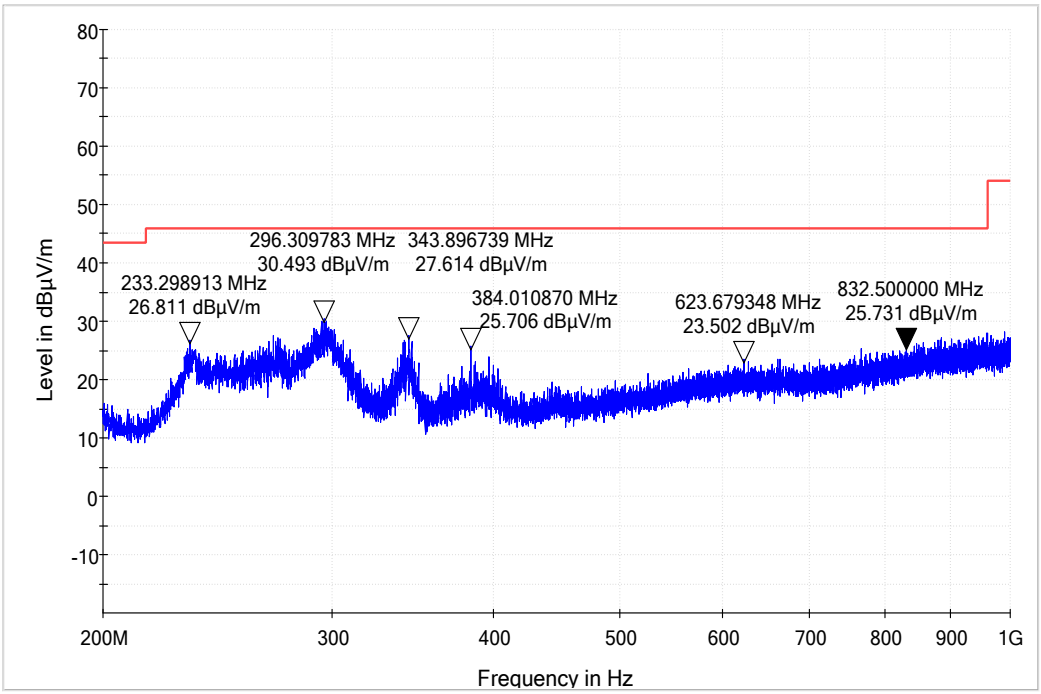

**Channel Frequency 30MHz – 200MHz** **Polarization Horizontal**

**Test results for frequency range 200MHz – 1GHz**

| Antenna Polarization | Frequency (MHz) | Peak (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|
| Vertical | 235.80 | 32.53 | 46.00 | -13.47 |
| | 272.63 | 28.69 | 46.00 | -17.31 |
| | 567.12 | 22.05 | 46.00 | -23.95 |
| | 839.76 | 31.73 | 46.00 | -14.27 |
| Horizontal | 233.29 | 26.81 | 46.00 | -19.19 |
| | 384.01 | 25.70 | 46.00 | -20.30 |
| | 623.67 | 23.50 | 46.00 | -22.50 |
| | 832.50 | 25.73 | 46.00 | -20.27 |




**Channel Frequency 200MHz – 1GHz** **Polarization Vertical**




**Channel Frequency 200MHz – 1GHz** **Polarization Horizontal**

**Test results for the frequencies in the range 1 GHz to 26.5 GHz**

**Modulation: 802.11b**

**Data Rate: 1Mbps**

| Channel Frequency (MHz) | Antenna Polarization | Measured Frequency (MHz) | Field Strength (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|
| 2412 | Vertical | **2390(Pk)** | **48.89** | **74*** | **-25.11** |
| | | **2390(Av)** | **37.40** | **54*** | **-16.6** |
| | | **2412(Pk)** | **100.93** | **-** | **-** |
| | | **2412(Av)** | **98.09** | **-** | **-** |
| | | **4824(Pk)** | **51.98** | **74** | **-22.02** |
| | | **4824(Av)** | **48.61** | **54** | **-5.39** |
| | | **7236(Pk)** | **No Harmonics Found** | | |
| | | **7236(Av)** | | | |
| | Horizontal | **2390(Pk)** | **53.09** | **74*** | **-20.91** |
| | | **2390(Av)** | **41.76** | **54*** | **-12.24** |
| | | **2412(Pk)** | **105.44** | **-** | **-** |
| | | **2412(Av)** | **103.03** | **-** | **-** |
| | | **4824(Pk)** | **47.80** | **74** | **-26.2** |
| | | **4824(Av)** | **43.17** | **54** | **-10.83** |
| | | **7236(Pk)** | **No Harmonics Found** | | |
| | | **7236(Av)** | | | |
| 2437 | Vertical | 2437(Pk) | 100.07 | - | - |
| | | 2437(Av) | 97.63 | - | - |
| | | 4874(Pk) | 48.28 | 74 | -25.72 |
| | | 4874(Av) | 44.17 | 54 | -9.83 |
| | | 7311(Pk) | No Harmonics Found | | |
| | | 7311(Av) | | | |
| | Horizontal | 2437(Pk) | 102.09 | - | - |
| | | 2437(Av) | 99.62 | - | - |
| | | 4874(Pk) | 46.57 | 74 | -27.43 |
| | | 4874(Av) | 40.33 | 54 | -13.67 |
| | | 7311(Pk) | No Harmonics Found | | |
| | | 7311(Av) | | | |
| 2462 | Vertical | 2462(Pk) | 100.10 | - | - |
| | | 2462(Av) | 97.73 | - | - |
| | | 2483.5(Pk) | 46.96 | 74* | -27.04 |
| | | 2483.5(Av) | 34.85 | 54* | -19.15 |
| | | 4924(Pk) | 49.60 | 74 | -24.4 |
| | | 4924(Av) | 45.28 | 54 | -8.72 |
| | | 7386(Pk) | No Harmonics Found | | |
| | | 7386(Av) | | | |
| | | 2462(Pk) | 102.36 | - | - |
| | | 2462(Av) | 99.89 | - | - |
| | | 2483.5(Pk) | 50.83 | 74* | -23.17 |
| | | 2483.5(Av) | 38.09 | 54* | -15.91 |
| | | 4924(Pk) | 47.46 | 74 | -26.54 |
| | | 4924(Av) | 41.08 | 54 | -12.92 |
| | | 7386(Pk) | No Harmonics Found | | |
| | | 7386(Av) | | | |

*** : Indicate restricted band of operation §15.205**
**Pk: Peak Detector; Av: Average Detector**

**Modulation: 802.11g**
**Data Rate: 6Mbps**

| Channel Frequency (MHz) | Antenna Polarization | Measured Frequency (MHz) | Field Strength (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|
| 2412 | Vertical | **2390(Pk)** | **58.4** | **74*** | **-15.6** |
| | | **2390(Av)** | **44.46** | **54*** | **-9.54** |
| | | **2412(Pk)** | **103.24** | **-** | **-** |
| | | **2412(Av)** | **92.44** | **-** | **-** |
| | | **4824(Pk)** | **56.86** | **74** | **-17.14** |
| | | **4824(Av)** | **43.67** | **54** | **-10.33** |
| | | **7236(Pk)** | **No Harmonics Found** | | |
| | | **7236(Av)** | | | |
| | Horizontal | **2390(Pk)** | **62.07** | **74*** | **-11.93** |
| | | **2390(Av)** | **46.15** | **54*** | **-7.85** |
| | | **2412(Pk)** | **104.97** | **-** | **-** |
| | | **2412(Av)** | **95** | **-** | **-** |
| | | **4824(Pk)** | **52.83** | **74** | **-21.17** |
| | | **4824(Av)** | **39.49** | **54** | **-14.51** |
| | | **7236(Pk)** | **No Harmonics Found** | | |
| | | **7236(Av)** | | | |
| 2437 | Vertical | 2437(Pk) | 102.44 | - | - |
| | | 2437(Av) | 92.43 | - | - |
| | | 4874(Pk) | 58.91 | 74 | -15.09 |
| | | 4874(Av) | 46.23 | 54 | -7.77 |
| | | 7311(Pk) | No Harmonics Found | | |
| | | 7311(Av) | | | |
| | Horizontal | 2437(Pk) | 104.89 | - | - |
| | | 2437(Av) | 94.6 | - | - |
| | | 4874(Pk) | 54.29 | 74 | -19.71 |
| | | 4874(Av) | 40.54 | 54 | -13.46 |
| | | 7311(Pk) | No Harmonics Found | | |
| | | 7311(Av) | | | |
| 2462 | Vertical | 2462(Pk) | 101.72 | - | - |
| | | 2462(Av) | 92.1 | - | - |
| | | 2483.5(Pk) | 51.72 | 74* | -22.28 |
| | | 2483.5(Av) | 39.47 | 54* | -14.53 |
| | | 4924(Pk) | 60.3 | 74 | -13.7 |
| | | 4924(Av) | 47.36 | 54 | -6.64 |
| | | 7386(Pk) | No Harmonics Found | | |
| | | 7386(Av) | | | |
| | Horizontal | 2462(Pk) | 104.51 | - | - |
| | | 2462(Av) | 94.67 | - | - |
| | | 2483.5(Pk) | 54.66 | 74* | -19.34 |
| | | 2483.5(Av) | 42.01 | 54* | -11.99 |
| | | 4924(Pk) | 54.01 | 74 | -19.99 |
| | | 4924(Av) | 40.18 | 54 | -13.82 |
| | | 7386(Pk) | No Harmonics Found | | |
| | | 7386(Av) | | | |

*** : Indicate restricted band of operation §15.205**
**Pk: Peak Detector; Av: Average Detector**

**Modulation: VHT20**
**Data Rate: MCS0**

| Channel Frequency (MHz) | Antenna Polarization | Measured Frequency (MHz) | Field Strength (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|
| 2412 | Vertical | 2390(Pk) | 59.96 | 74* | -14.04 |
| | | 2390(Av) | 45.31 | 54* | -8.69 |
| | | 2412(Pk) | 102.96 | - | - |
| | | 2412(Av) | 92.93 | - | - |
| | | 4824(Pk) | 56.16 | 74 | -17.84 |
| | | 4824(Av) | 43.75 | 54 | -10.25 |
| | | 7236(Pk) | No Harmonics Found | | |
| | | 7236(Av) | | | |
| | Horizontal | 2390(Pk) | 62.12 | 74* | -11.88 |
| | | 2390(Av) | 48.3 | 54* | -5.7 |
| | | 2412(Pk) | 104.53 | - | - |
| | | 2412(Av) | 95.55 | - | - |
| | | 4824(Pk) | 51.11 | 74 | -22.89 |
| | | 4824(Av) | 37.61 | 54 | -16.39 |
| | | 7236(Pk) | No Harmonics Found | | |
| | | 7236(Av) | | | |
| **2437** | **Vertical** | **2437(Pk)** | **102.95** | **-** | **-** |
| | | **2437(Av)** | **92.5** | **-** | **-** |
| | | **4874(Pk)** | **59.17** | **74** | **-14.83** |
| | | **4874(Av)** | **45.79** | **54** | **-8.21** |
| | | **7311(Pk)** | **No Harmonics Found** | | |
| | | **7311(Av)** | | | |
| | **Horizontal** | **2437(Pk)** | **104.63** | **-** | **-** |
| | | **2437(Av)** | **95.12** | **-** | **-** |
| | | **4874(Pk)** | **53.46** | **74** | **-20.54** |
| | | **4874(Av)** | **39.39** | **54** | **-14.61** |
| | | **7311(Pk)** | **No Harmonics Found** | | |
| | | **7311(Av)** | | | |
| 2462 | Vertical | 2462(Pk) | 102.76 | - | - |
| | | 2462(Av) | 92.55 | - | - |
| | | 2483.5(Pk) | 53.77 | 74* | -20.23 |
| | | 2483.5(Av) | 39.61 | 54* | -14.39 |
| | | 4924(Pk) | 60.52 | 74 | -13.48 |
| | | 4924(Av) | 47.22 | 54 | -6.78 |
| | | 7386(Pk) | No Harmonics Found | | |
| | | 7386(Av) | | | |
| | Horizontal | 2462(Pk) | 103.89 | - | - |
| | | 2462(Av) | 94.52 | - | - |
| | | 2483.5(Pk) | 57.19 | 74* | -16.81 |
| | | 2483.5(Av) | 43.24 | 54* | -10.76 |
| | | 4924(Pk) | 54.67 | 74 | -19.33 |
| | | 4924(Av) | 40.56 | 54 | -13.44 |
| | | 7386(Pk) | No Harmonics Found | | |
| | | 7386(Av) | | | |

*** : Indicate restricted band of operation §15.205**
**Pk: Peak Detector; Av: Average Detector**

**Modulation: VHT40**
**Data Rate: MCS0**

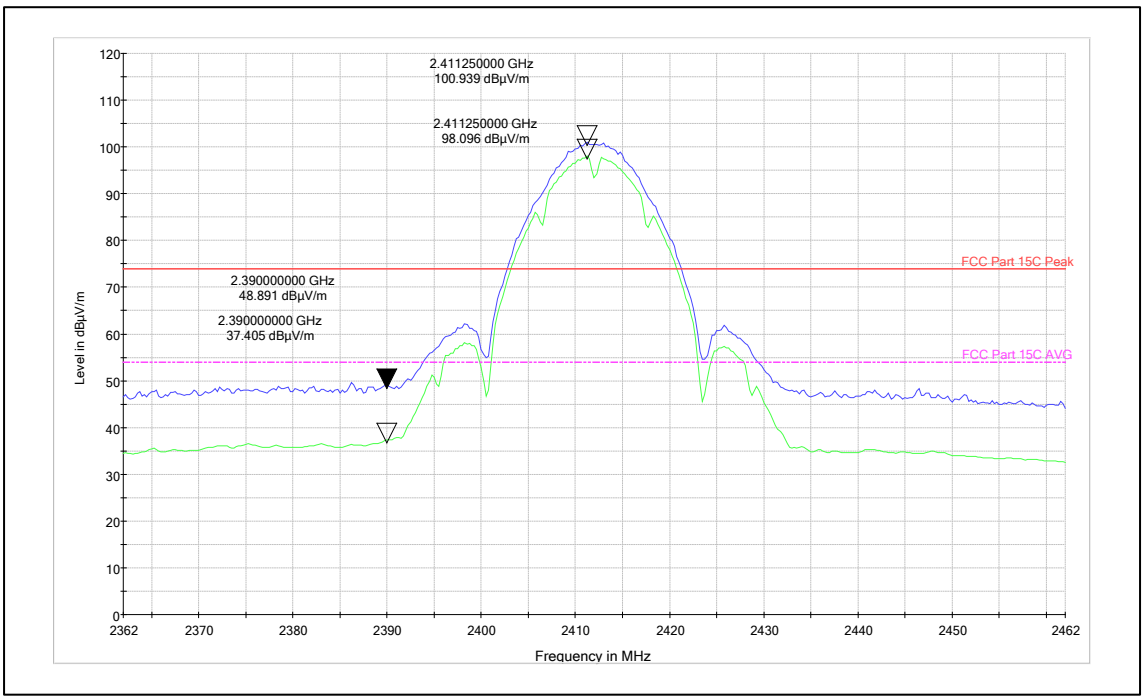
| Channel Frequency (MHz) | Antenna Polarization | Measured Frequency (MHz) | Field Strength (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|
| 2422 | Vertical | 2390(Pk) | 64.73 | 74* | -9.27 |
| | | 2390(Av) | 48.43 | 54* | -5.57 |
| | | 2422(Pk) | 98.49 | - | - |
| | | 2422(Av) | 88.03 | - | - |
| | | 4844(Pk) | 57.22 | 74 | -16.78 |
| | | 4844(Av) | 43.45 | 54 | -10.55 |
| | | 7266(Pk) | No Harmonics Found | | |
| | | 7266(Av) | | | |
| | Horizontal | 2390(Pk) | 65.84 | 74* | -8.16 |
| | | 2390(Av) | 51.51 | 54* | -2.49 |
| | | 2422(Pk) | 100.93 | - | - |
| | | 2422(Av) | 90.63 | - | - |
| | | 4844(Pk) | 52.49 | 74 | -21.51 |
| | | 4844(Av) | 38.62 | 54 | -15.38 |
| | | 7266(Pk) | No Harmonics Found | | |
| | | 7266(Av) | | | |
| 2437 | Vertical | 2437(Pk) | 97.54 | - | - |
| | | 2437(Av) | 86.95 | - | - |
| | | 4874(Pk) | 58.37 | 74 | -15.63 |
| | | 4874(Av) | 44.86 | 54 | -9.14 |
| | | 7311(Pk) | No Harmonics Found | | |
| | | 7311(Av) | | | |
| | Horizontal | 2437(Pk) | 99.31 | - | 99.31 |
| | | 2437(Av) | 89.55 | - | 89.55 |
| | | 4874(Pk) | 53.31 | 74 | -20.69 |
| | | 4874(Av) | 39.93 | 54 | -14.07 |
| | | 7311(Pk) | No Harmonics Found | | |
| | | 7311(Av) | | | |
| 2452 | Vertical | 2452(Pk) | 97.64 | - | - |
| | | 2452(Av) | 87.33 | - | - |
| | | 2483.5(Pk) | 59.80 | 74* | -14.20 |
| | | 2483.5(Av) | 39.57 | 54* | -14.43 |
| | | 4904(Pk) | 59.89 | 74 | -14.11 |
| | | 4904(Av) | 45.93 | 54 | -8.07 |
| | | 7356(Pk) | No Harmonics Found | | |
| | | 7356(Av) | | | |
| | Horizontal | 2452(Pk) | 100.78 | - | - |
| | | 2452(Av) | 90.08 | - | - |
| | | 2483.5(Pk) | 63.13 | 74* | -10.87 |
| | | 2483.5(Av) | 44.07 | 54* | -9.93 |
| | | 4904(Pk) | 54.69 | 74 | -19.31 |
| | | 4904(Av) | 41.02 | 54 | -12.98 |
| | | 7356(Pk) | No Harmonics Found | | |
| | | 7356(Av) | | | |

*** : Indicate restricted band of operation §15.205**
**Pk: Peak Detector; Av: Average Detector**

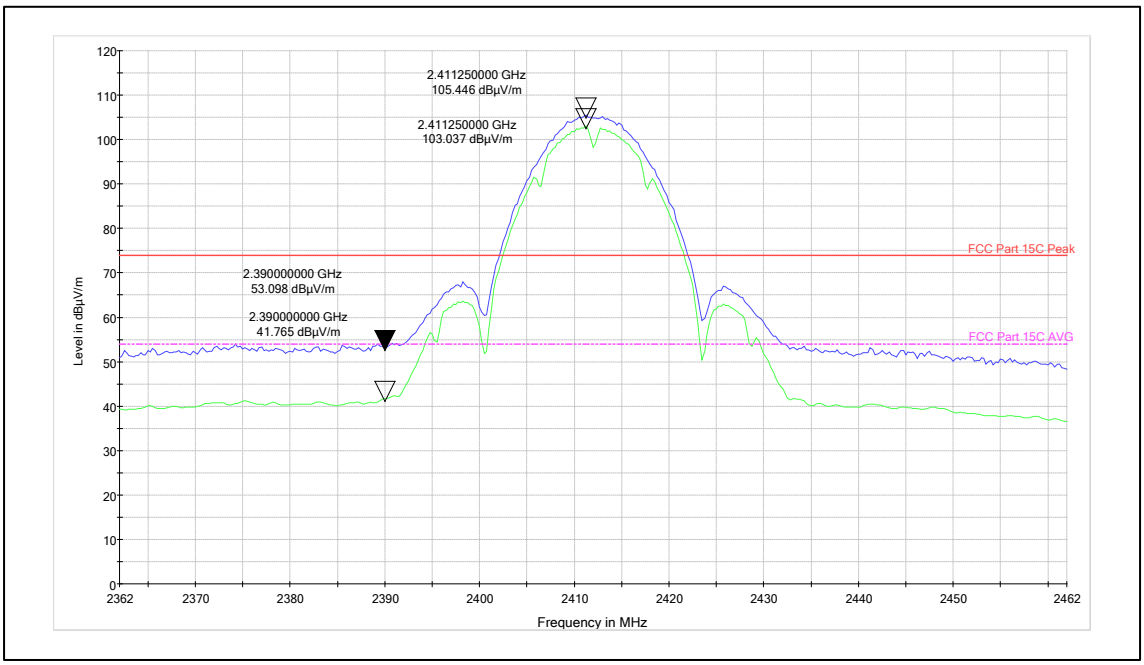
**Worst case Plots**

**Data Rate: 1Mbps**

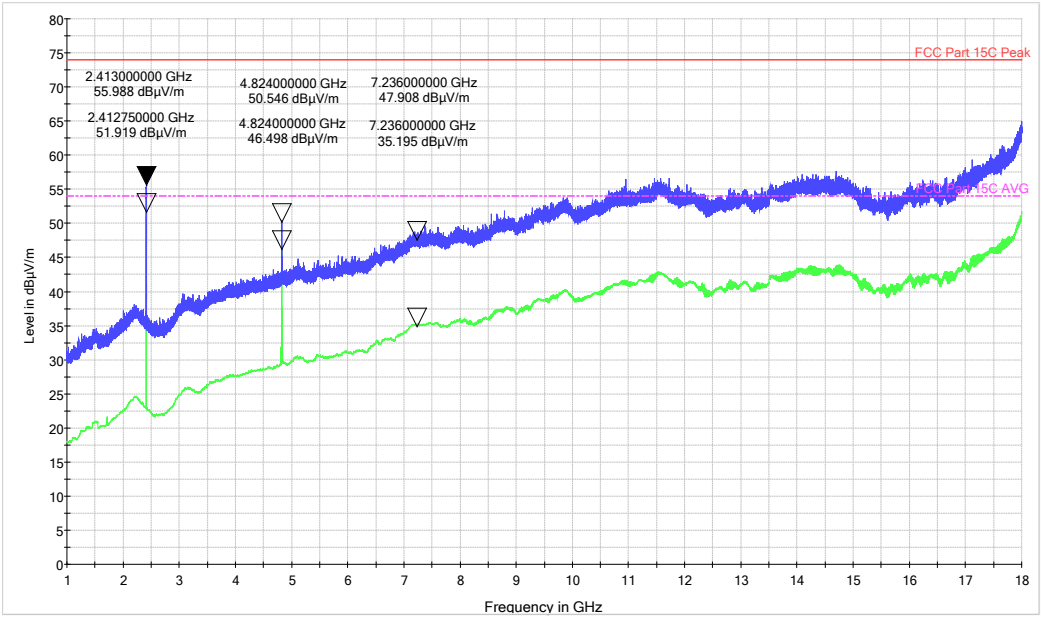
**Channel Frequency 2412MHz**



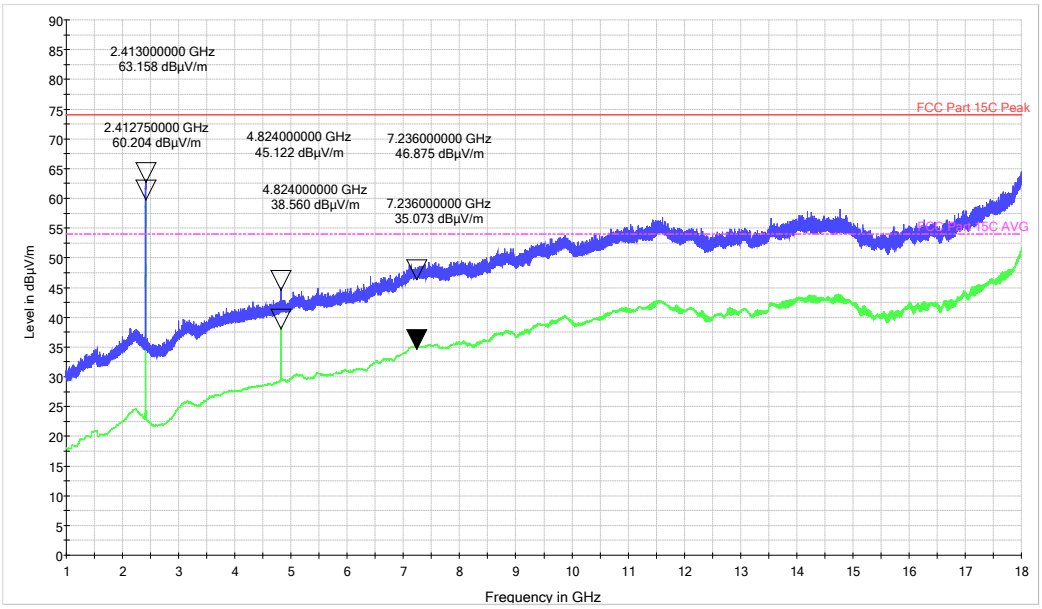

Channel Frequency: 2412MHz Polarization: Vertical



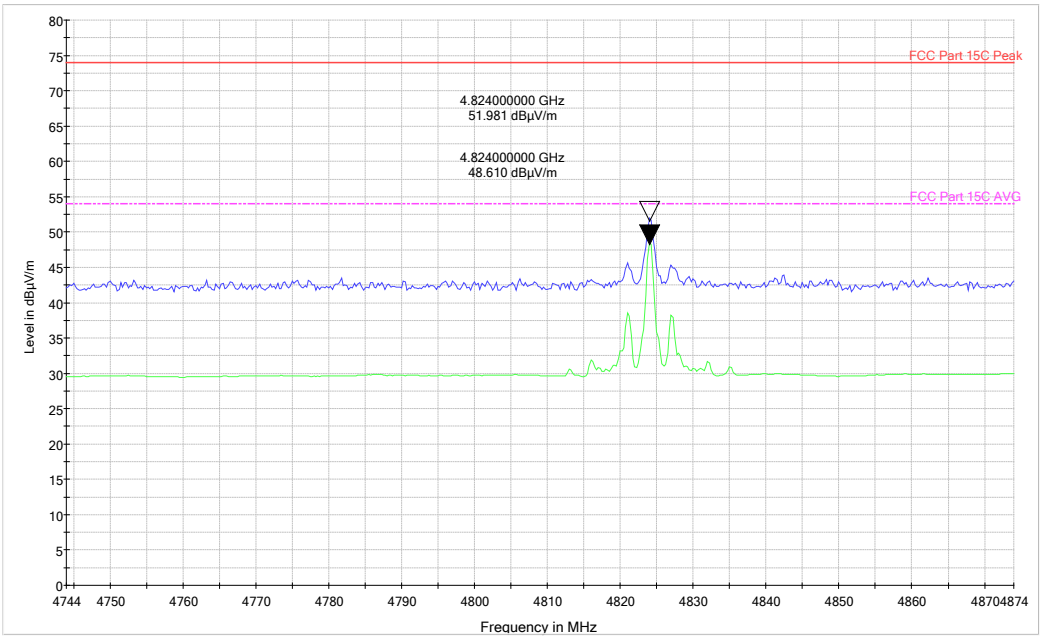

Channel Frequency: 2412MHz Polarization: Horizontal



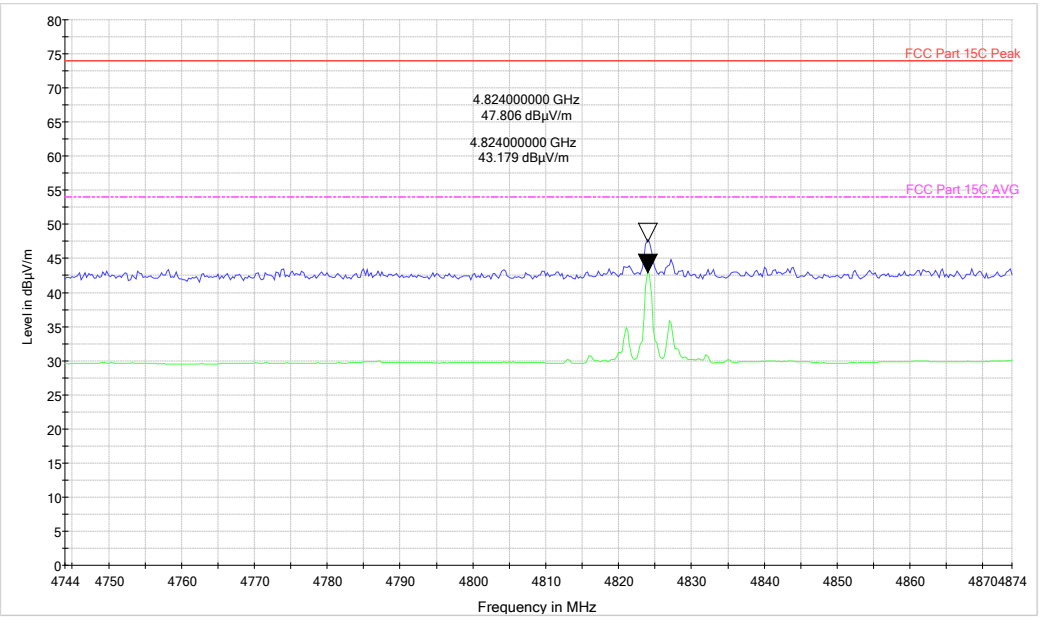

Channel Frequency: 1 - 18 GHz Polarization: Vertical



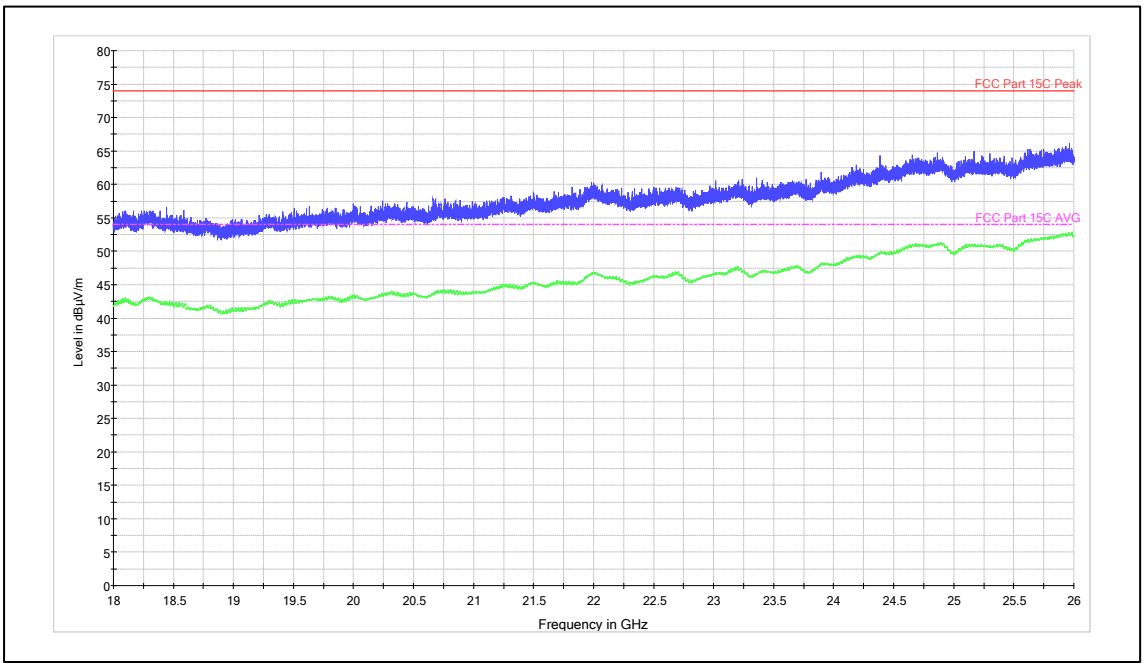

Channel Frequency: 1 - 18 GHz Polarization: Horizontal



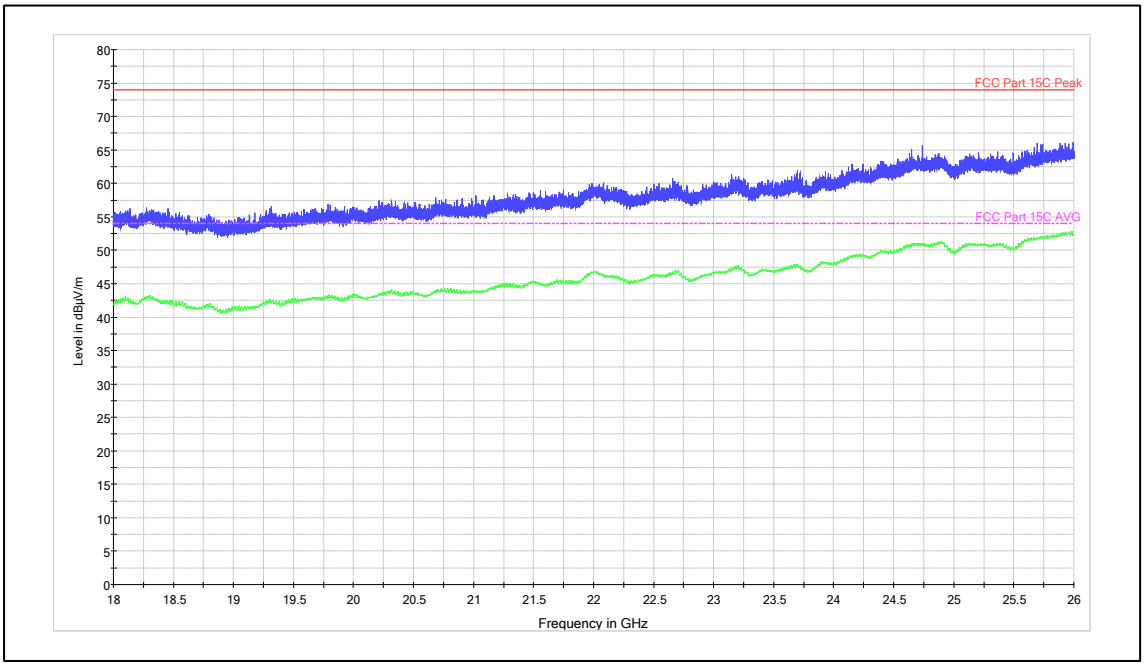

Channel Frequency: 2nd Harmonics Polarization: Vertical




Channel Frequency: 2nd Harmonics Polarization: Horizontal



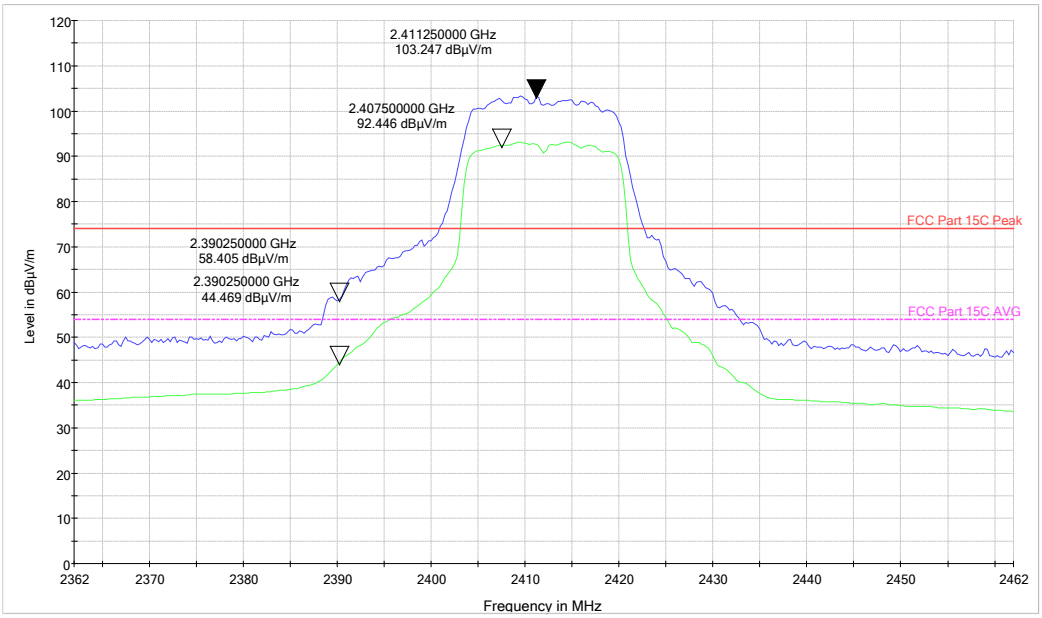

Channel Frequency: 18 - 26 GHz Polarization: Vertical



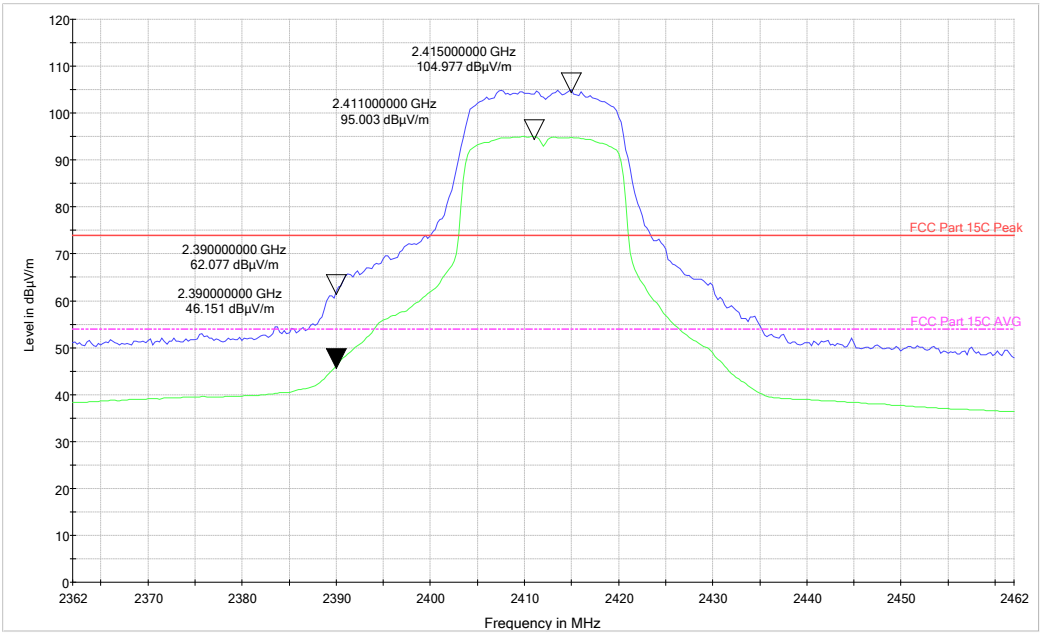

Channel Frequency: 18 - 26 GHz Polarization: Horizontal

**Data Rate: 6Mbps**

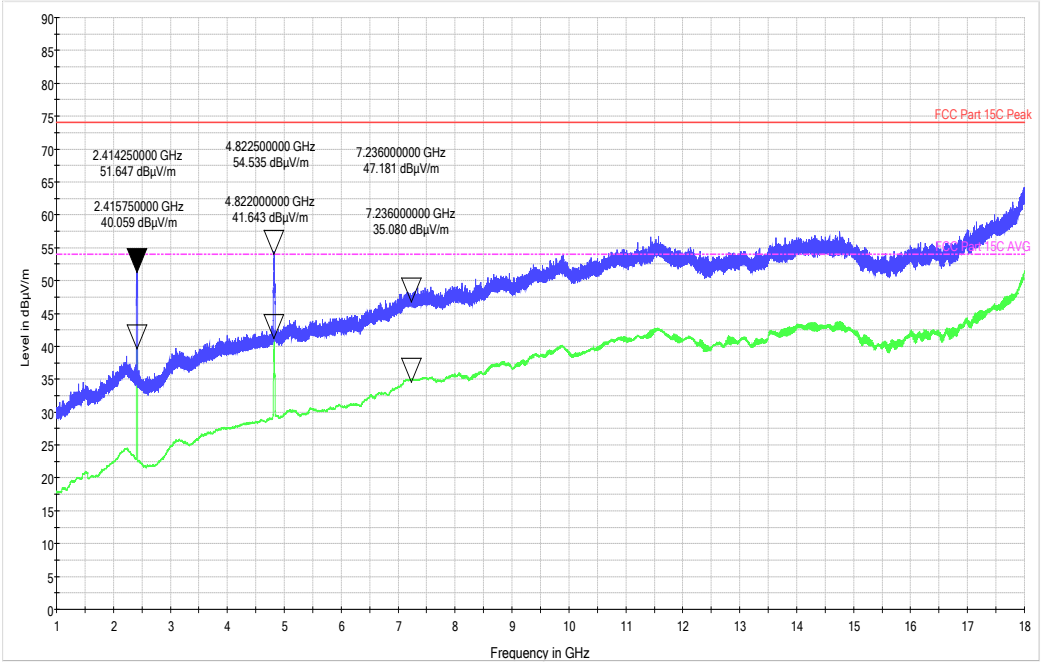
**Channel Frequency 2412MHz**



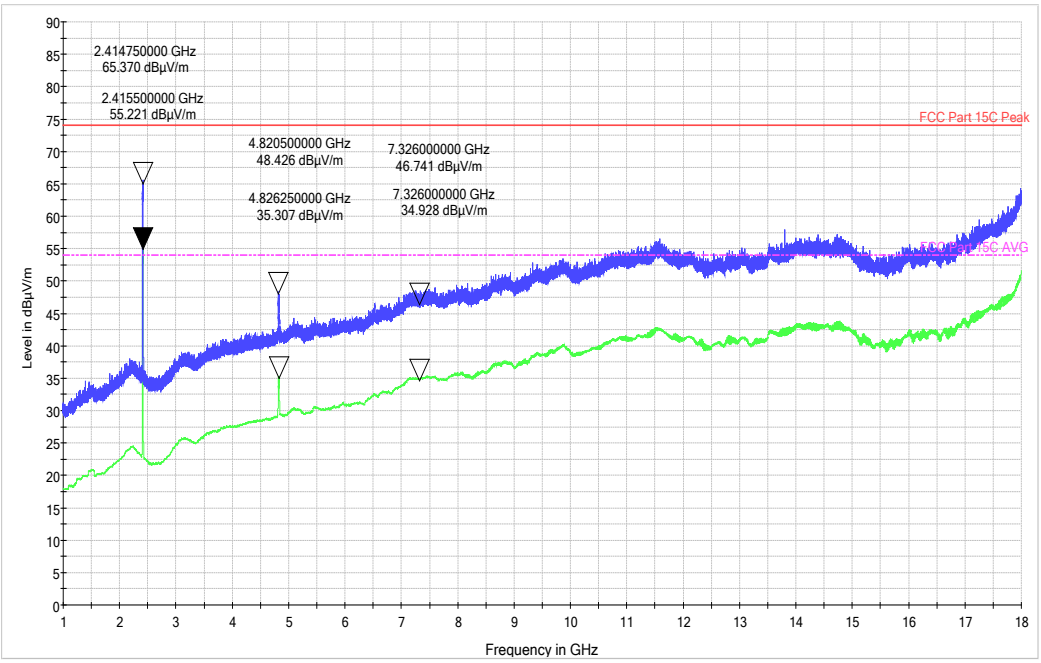

Channel Frequency: 2412MHz Polarization: Vertical



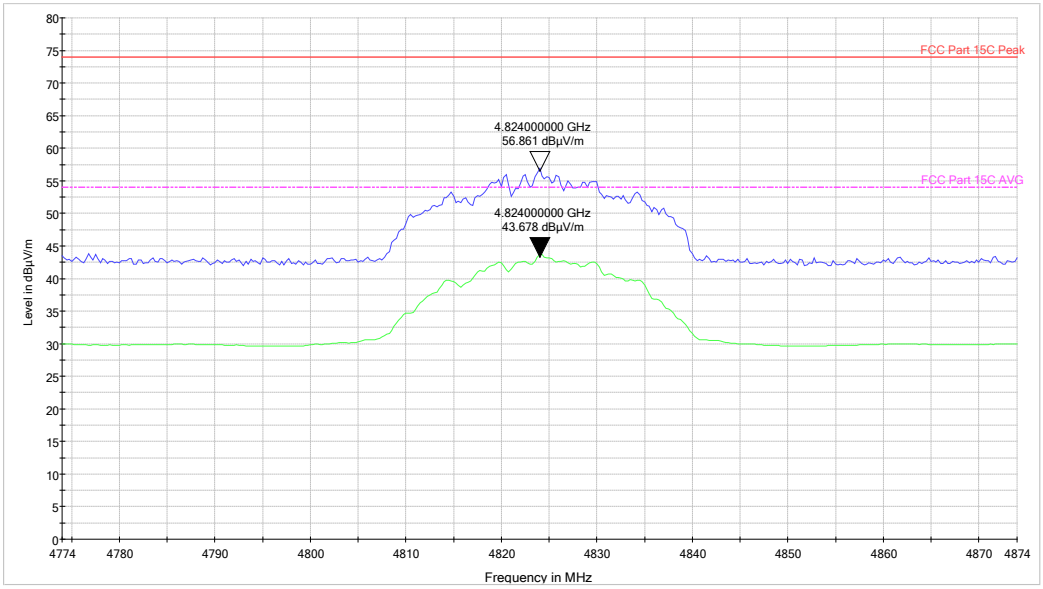

Channel Frequency: 2412MHz Polarization: Horizontal



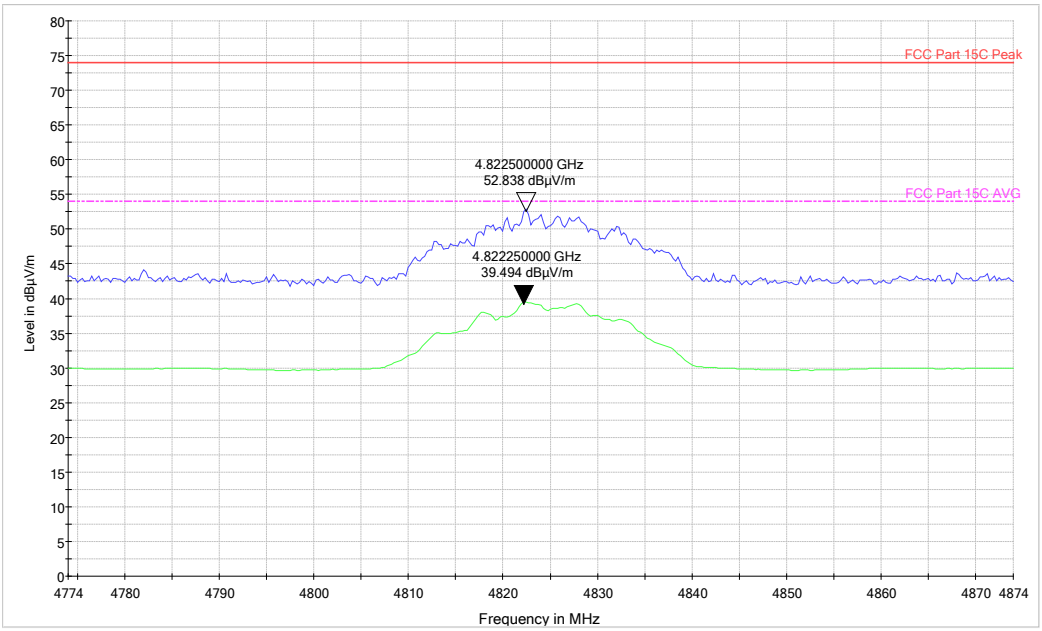

Channel Frequency: 1 - 18 GHz Polarization: Vertical




Channel Frequency: 1 - 18 GHz Polarization: Horizontal



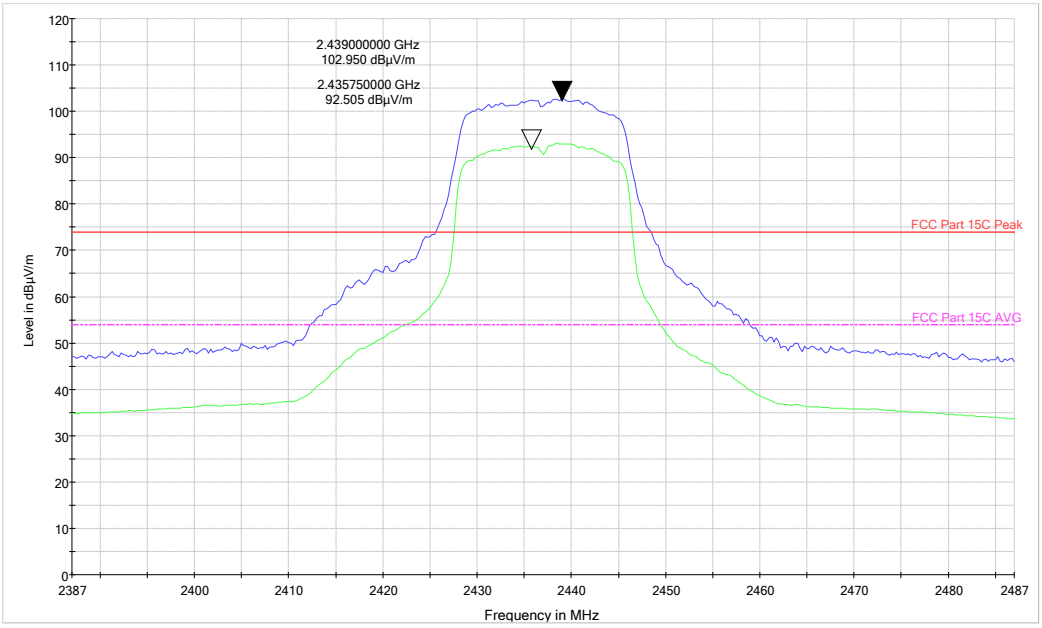

Channel Frequency: 2nd Harmonics Polarization: Vertical



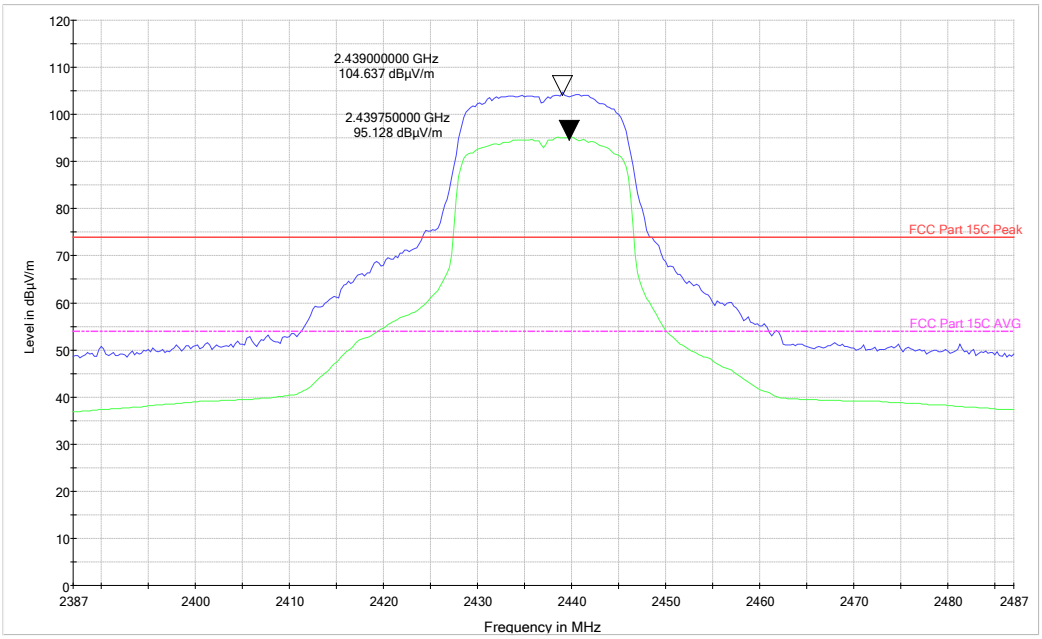

Channel Frequency: 2nd Harmonics Polarization: Horizontal

**Data Rate: MCS0_n Mode 20MHz**

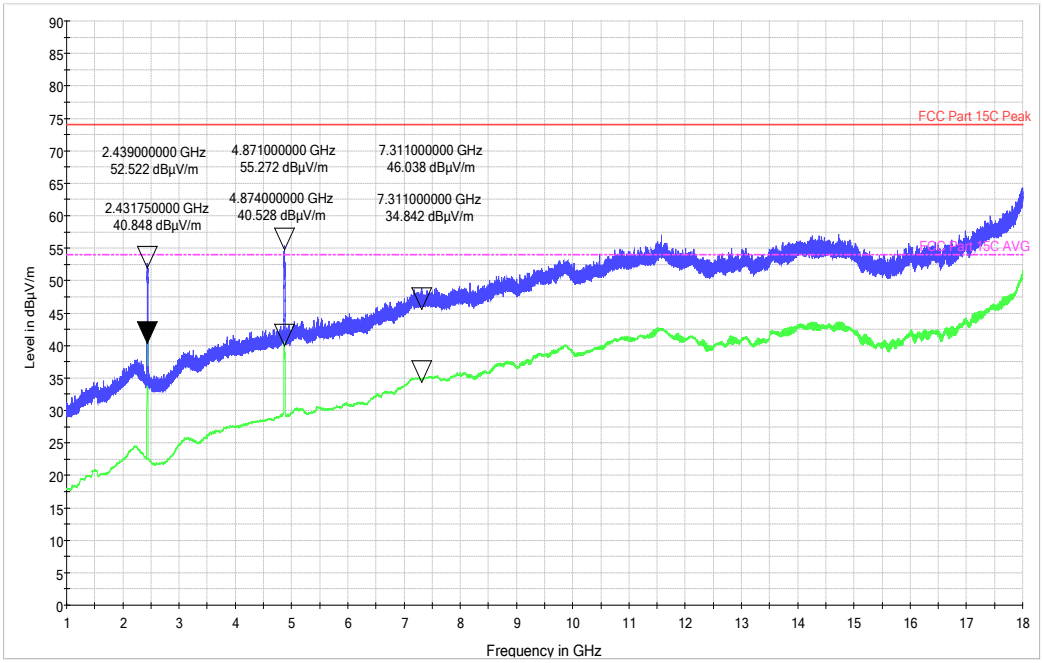
**Channel Frequency 2437MHz**



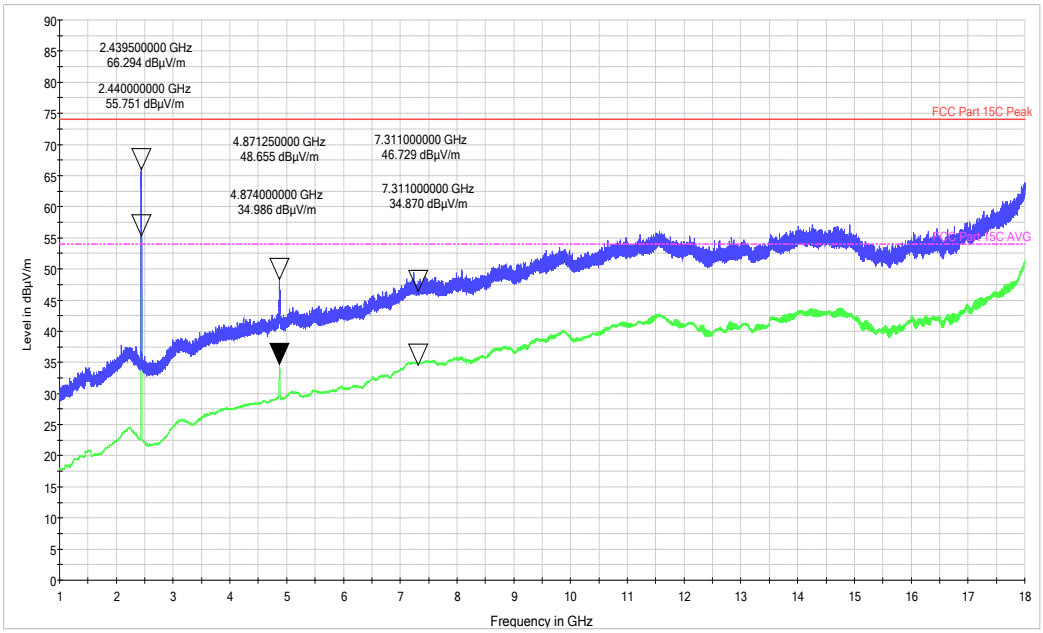

Channel Frequency: 2437MHz Polarization: Vertical



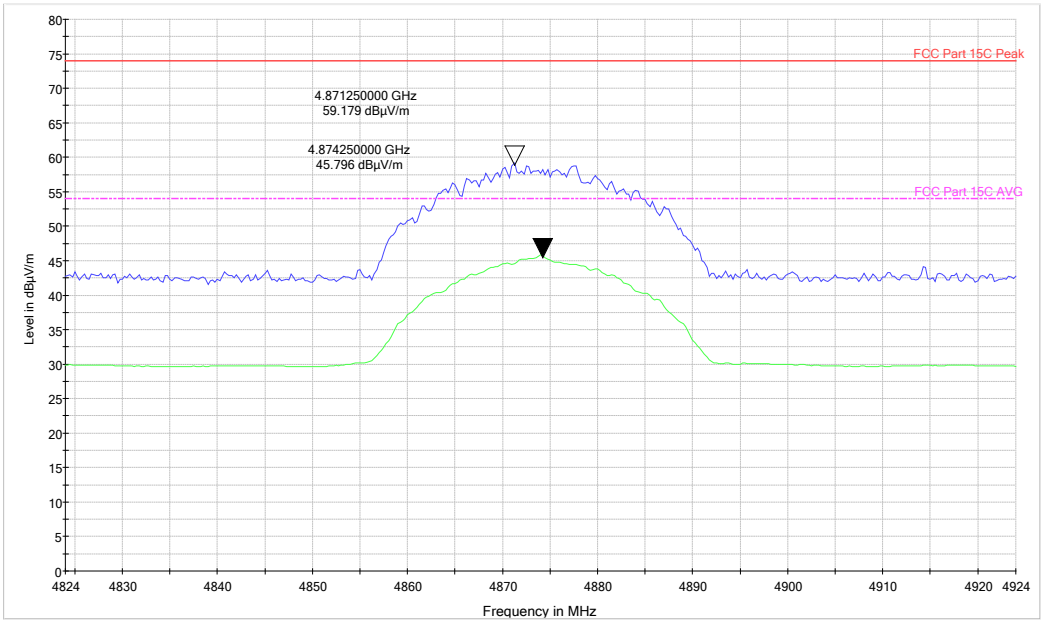

Channel Frequency: 2437MHz Polarization: Horizontal



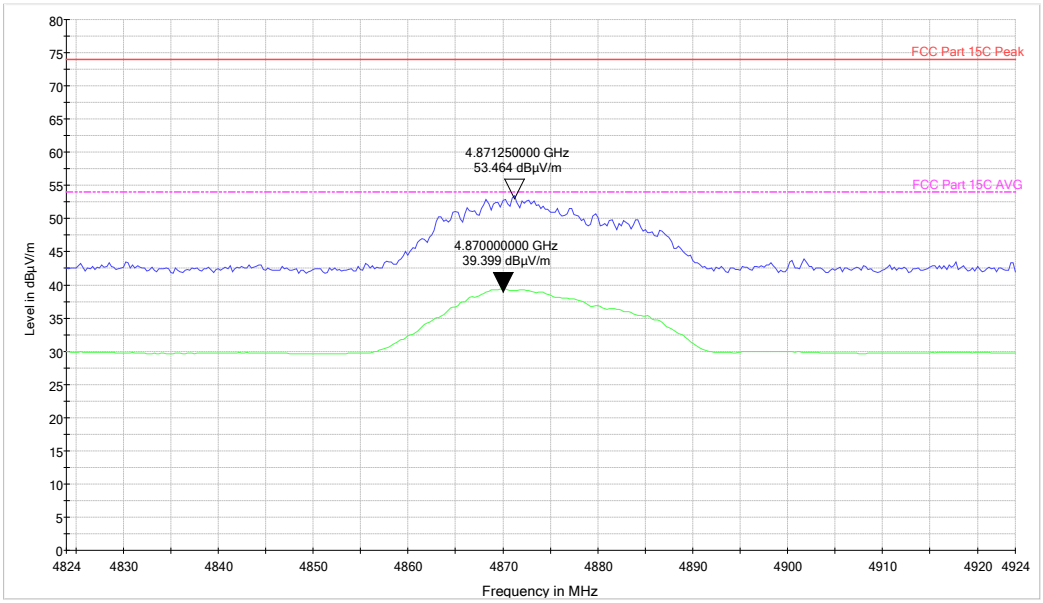

Channel Frequency: 1 - 18 GHz Polarization: Vertical




Channel Frequency: 1 - 18 GHz Polarization: Horizontal



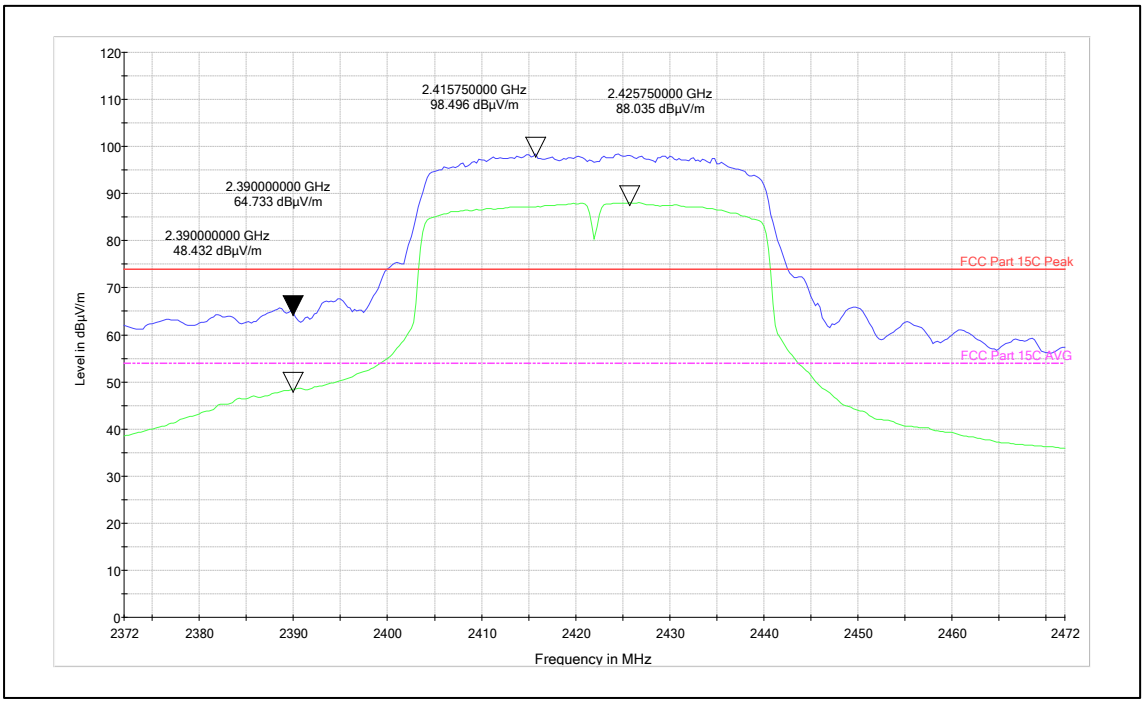

Channel Frequency: 2nd Harmonics Polarization: Vertical



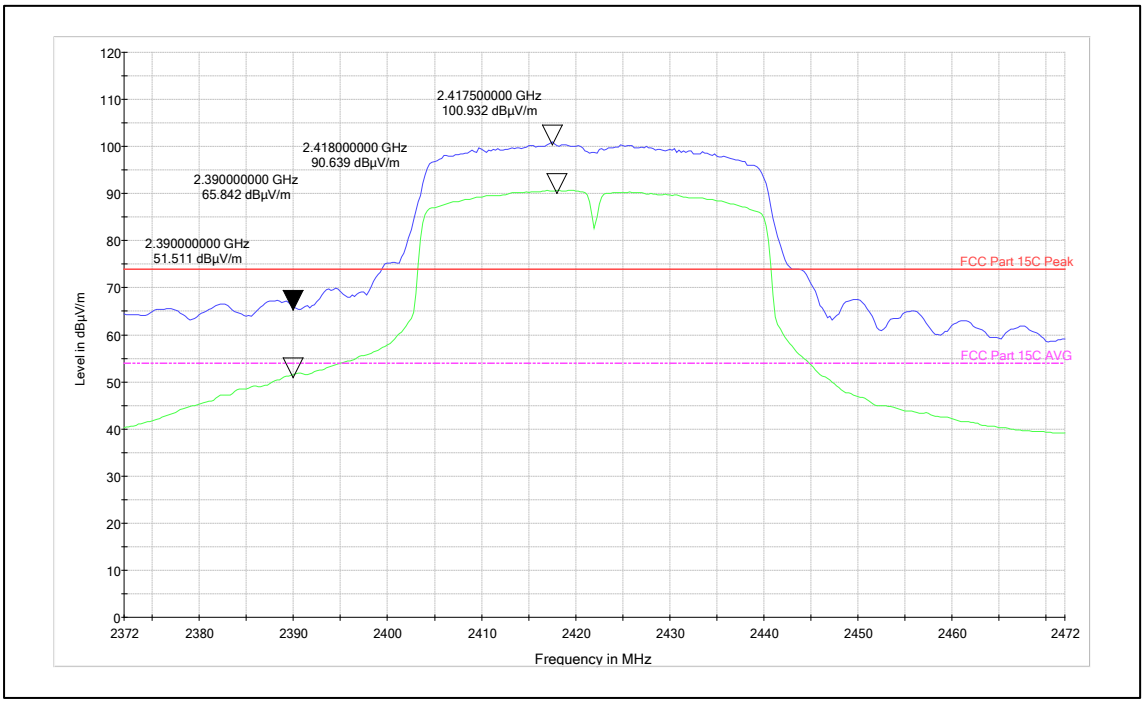

Channel Frequency: 2nd Harmonics Polarization: Horizontal

**Data Rate: MCS0_n Mode 40MHz**

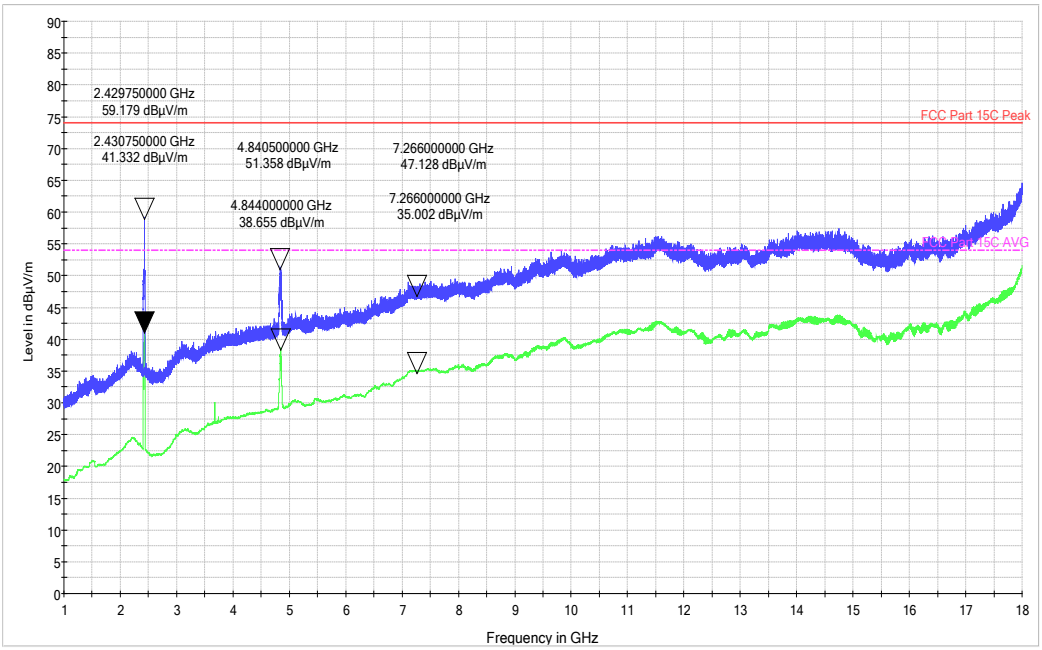
**Channel Frequency 2422MHz**



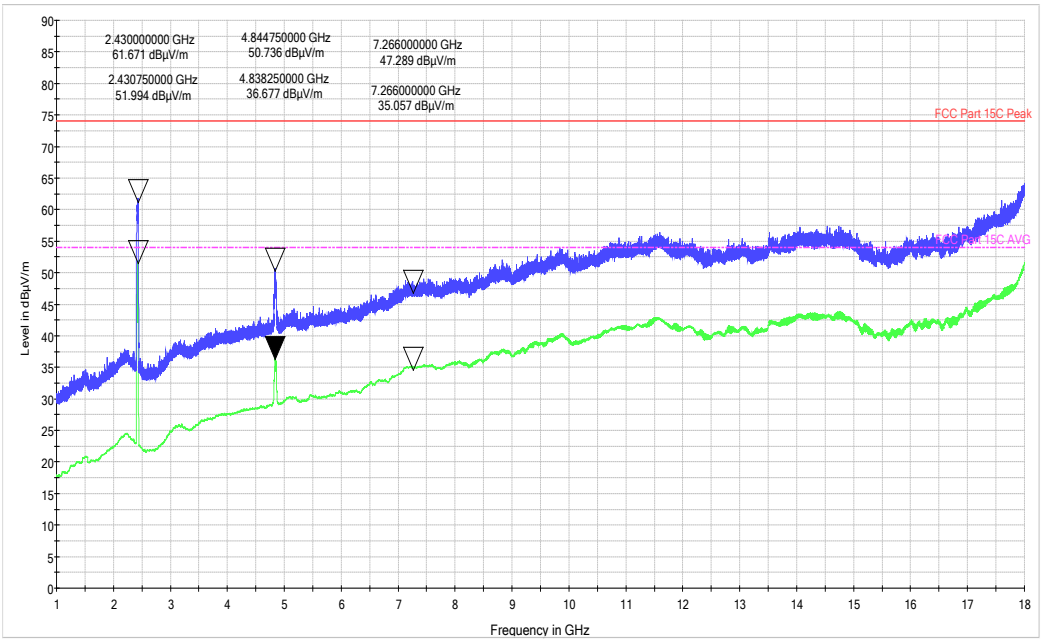

Channel Frequency: 2422MHz Polarization: Vertical



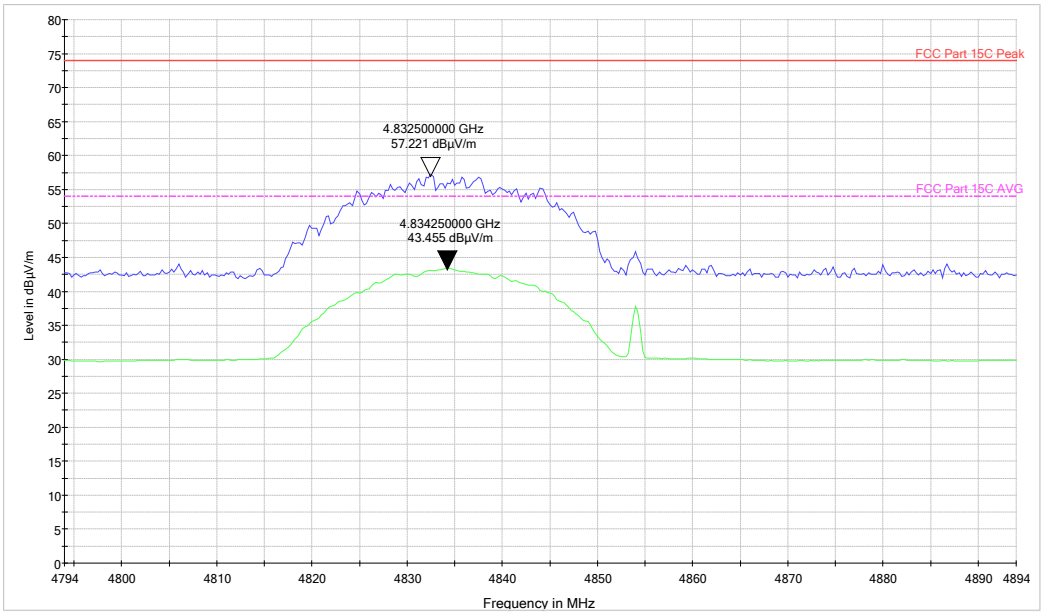

Channel Frequency: 2422MHz Polarization: Horizontal



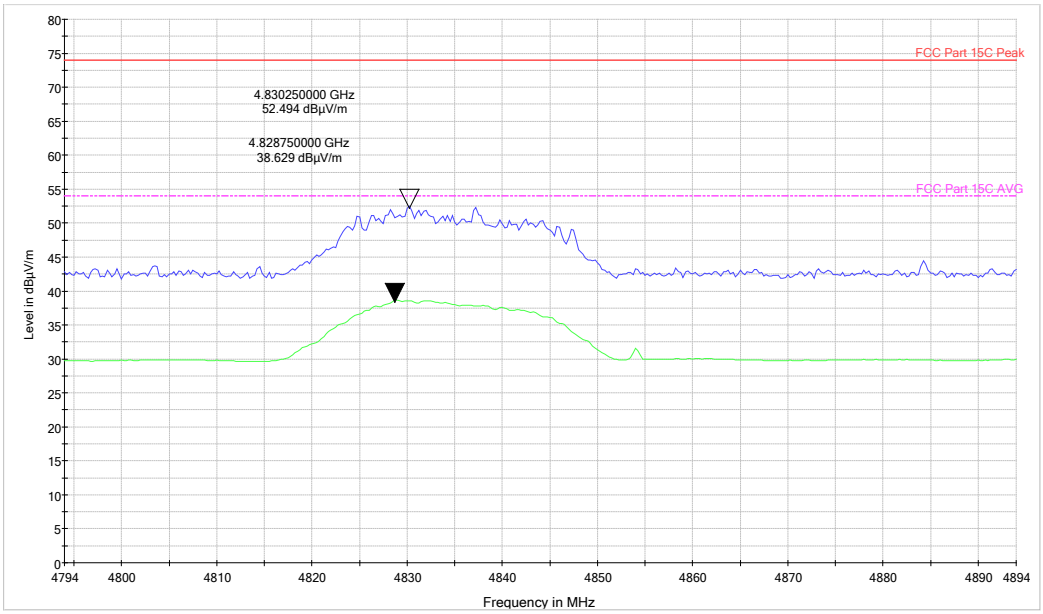

Channel Frequency: 1 - 18 GHz Polarization: Vertical




Channel Frequency: 1 - 18 GHz Polarization: Horizontal




Channel Frequency: 2nd Harmonics Polarization: Vertical




Channel Frequency: 2nd Harmonics Polarization: Horizontal

# 9 TEST RESULTS FOR BLUETOOTH LOW ENERGY

## 9.1 Spurious Radiated Emissions & Restricted Bands of Operation

***Result*** ***Pass***

| | |
|---|---|
| Test Specification | FCC part 15 Subpart C 15.247 (d) / (15.209 & 15.205) / IC RSS-GEN, Section 8.9 and 8.10 |
| Test Method | ANSI C63.10 |
| Measurement Location | Semi Anechoic Chamber 30MHz - 1 GHz<br>Fully Anechoic Chamber 1 GHz - 40GHz |
| Measurement Bandwidth | 100 kHz for frequency range < 1GHz<br>1 MHz for Frequency range >1GHz |
| Detector | Refer remarks below |
| Measuring Distance | 3 m |
| Requirement | As per the limits mentioned in the below table |
| Test setup | Refer TEST METHODOLOGY |

**Table 8: Transmitter limits for Radiated emission**

| Frequency (MHz) | Field strength (µV/m) | Field strength (dBµV/m) | Distance of Measurement (m) |
|---|---|---|---|
| 0.009 – 0.490 | 2400/F(kHz) | 48.50 – 13.80 | 300* |
| 0.490 – 1.705 | 24000/F(kHz) | 33.80 – 23.00 | 30* |
| 1.705 -30 | 30 | 29.54 | 30* |
| 30-88 | 100 | 40.0 | 3 |
| 88-216 | 150 | 43.5 | 3 |
| 216-960 | 200 | 46.0 | 3 |
| Above 960 | 500 | 54.0 | 3 |

Remark: * The limit shows in the table above of frequency range 0.009 – 0.490, 0.490 – 1.705 MHz and 1.705-30MHz is at 300 meter, 30 meter and 30 meter range respectively, which corresponds to 128.51 – 93.80, 73.80 – 62.96 and 69.54 dBµV/m at 3m range by extrapolation calculation and the measurement of loop antenna.

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz Radiated emission limits in these three bands are based on measurements employing an average detector.

**Test Conditions:**

Temperature (Norm) = + 23.5 °C Voltage = 4.2VDC input Relative humidity = 64 %

## Test results:

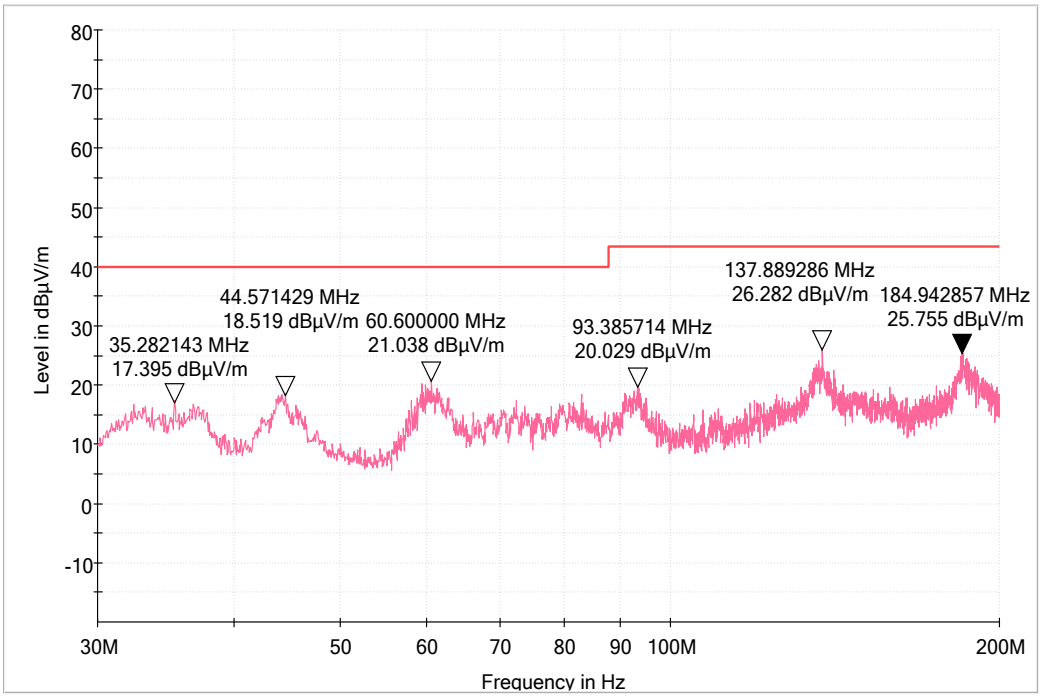
Note: All the losses are included during measurement and final values are mentioned in the test report. Refer TEST METHODOLOGY for more details

**Test results for frequency range 9kHz – 30MHz**

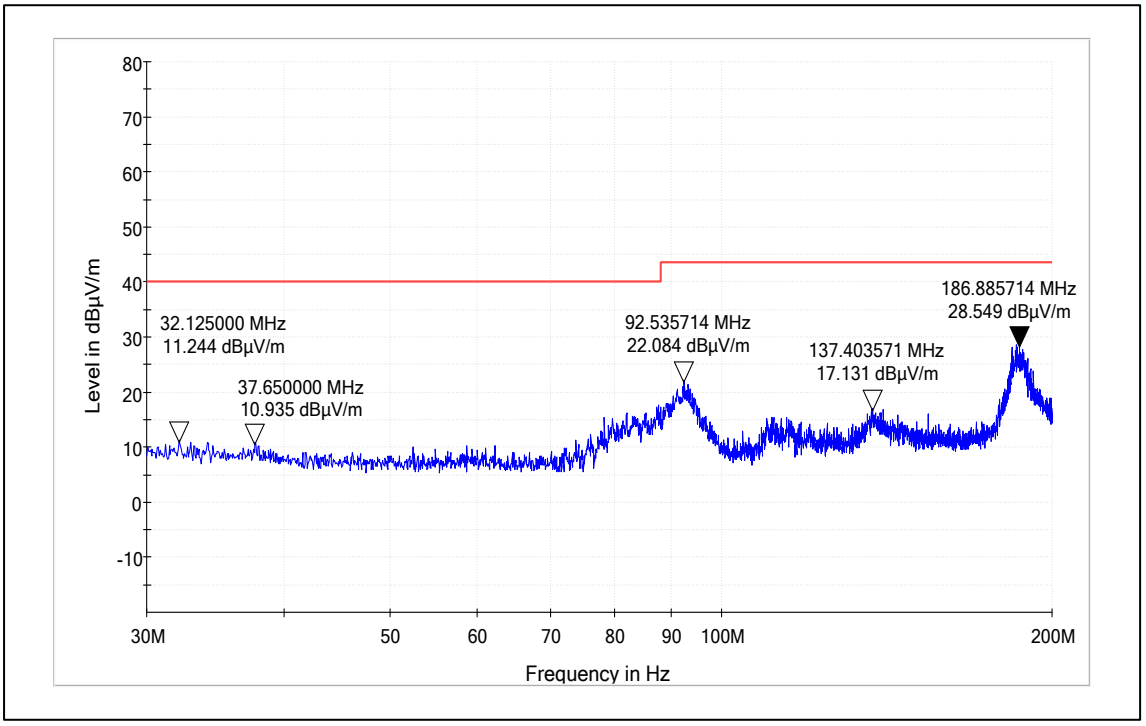
No emissions found in frequency range 9 kHz to 30 MHz, and measured levels are below 20dB from the limit line, henve not reported

**Test results for frequency range 30MHz – 200MHz**

| Antenna Polarization | Frequency (MHz) | Peak (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|
| Vertical | 35.28 | 17.39 | 40.00 | -22.61 |
| | 44.57 | 18.51 | 40.00 | -21.49 |
| | 93.38 | 20.02 | 43.50 | -23.48 |
| | 184.94 | 25.75 | 43.50 | -17.75 |
| Horizontal | 32.12 | 11.24 | 40.00 | -28.76 |
| | 37.65 | 10.93 | 40.00 | -29.07 |
| | 92.53 | 22.08 | 43.50 | -21.42 |
| | 186.88 | 28.54 | 43.50 | -14.96 |



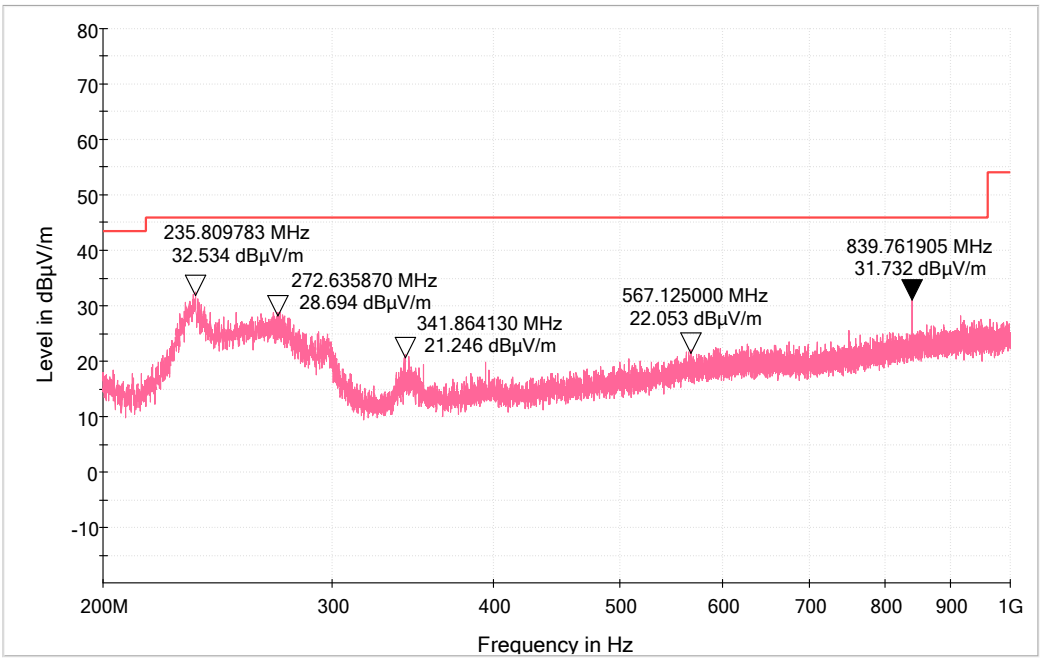

**Channel Frequency 30MHz – 200MHz** **Polarization Vertical**



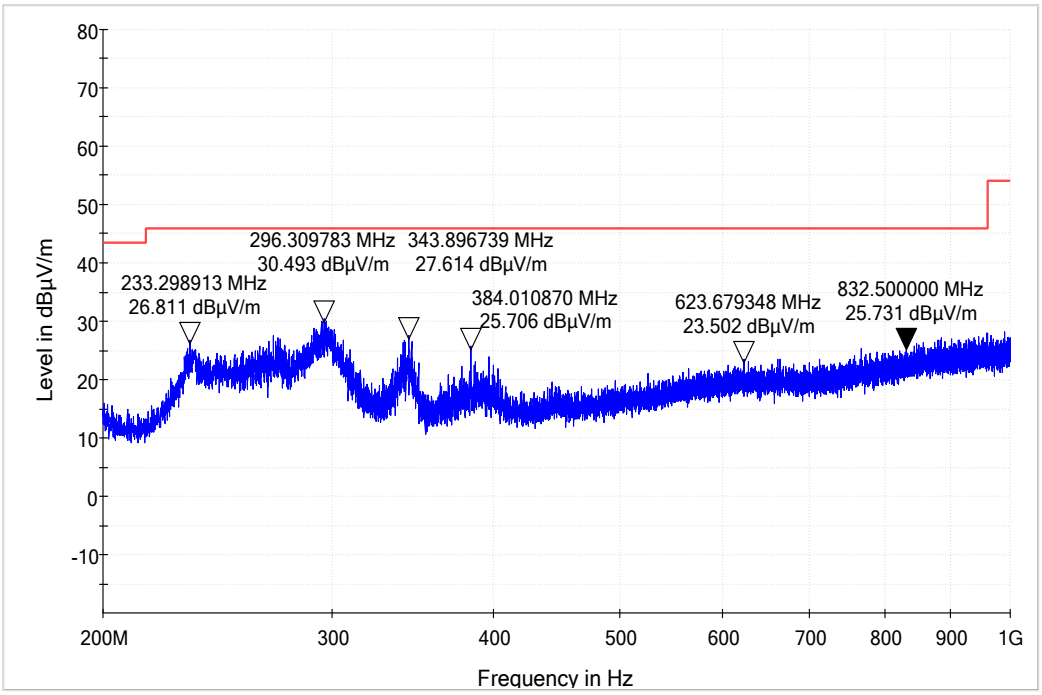

**Channel Frequency 30MHz – 200MHz** **Polarization Horizontal**

**Test results for frequency range 200MHz – 1GHz**

| Antenna Polarization | Frequency (MHz) | Peak (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|
| Vertical | 235.80 | 32.53 | 46.00 | -13.47 |
| | 272.63 | 28.69 | 46.00 | -17.31 |
| | 567.12 | 22.05 | 46.00 | -23.95 |
| | 839.76 | 31.73 | 46.00 | -14.27 |
| Horizontal | 233.29 | 26.81 | 46.00 | -19.19 |
| | 384.01 | 25.70 | 46.00 | -20.3 |
| | 623.67 | 23.50 | 46.00 | -22.5 |
| | 832.50 | 25.73 | 46.00 | -20.27 |




**Channel Frequency 200MHz – 1GHz** **Polarization Vertical**



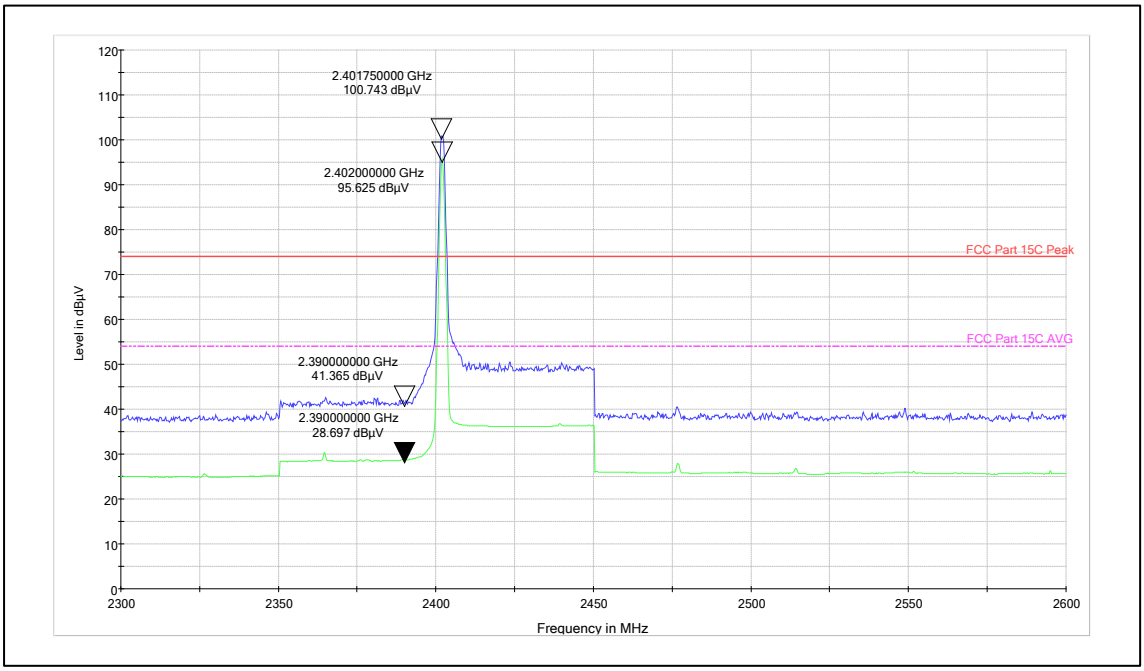

**Channel Frequency 200MHz – 1GHz** **Polarization Horizontal**

**Test results for the frequencies above 1GHz**

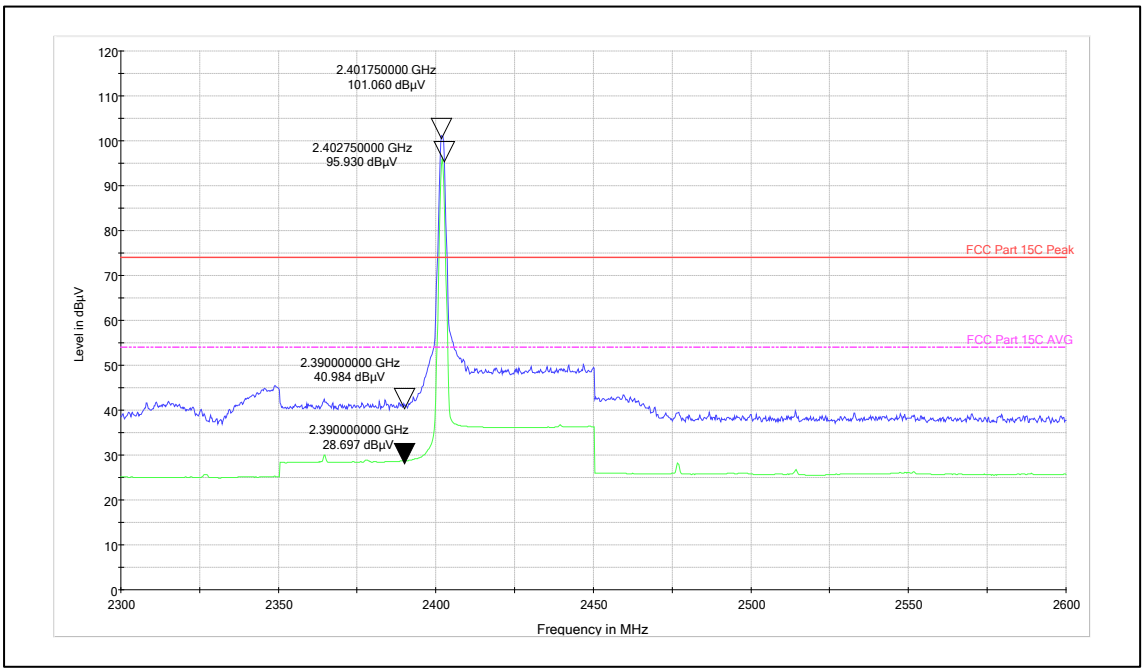
| Channel Frequency (MHz) | Antenna Polarization | Measured Frequency (MHz) | Field Strength (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|
| **2402** | **V** | **2390(Pk)** | **38.04** | **74*** | **-35.96** |
| | | **2390(Av)** | **85.67** | **54*** | **31.67** |
| | | **2402(Pk)** | **90.34** | **-** | **-** |
| | | **2402(Av)** | **85.67** | **-** | **-** |
| | | **4804(Pk)** | **36.94** | **74** | **-37.06** |
| | | **4804(Av)** | **28.39** | **54** | **-25.61** |
| | | **7206(Pk)** | **No Harmonics Found** | | |
| | | **7206(Av)** | | | |
| | **H** | **2390(Pk)** | **41.55** | **74*** | **-32.45** |
| | | **2390(Av)** | **25.86** | **54*** | **-28.14** |
| | | **2402(Pk)** | **98.80** | **-** | **-** |
| | | **2402(Av)** | **94.13** | **-** | **-** |
| | | **4804(Pk)** | **35.29** | **74** | **-38.71** |
| | | **4804(Av)** | **23.44** | **54** | **-30.56** |
| | | **7206(Pk)** | **No Harmonics Found** | | |
| | | **7206(Av)** | | | |
| 2440 | V | 2440(Pk) | 89.86 | - | - |
| | | 2440(Av) | 85.16 | - | - |
| | | 4880(Pk) | 42.60 | 74 | -31.40 |
| | | 4880(Av) | 30.03 | 54 | -23.97 |
| | | 7320(Pk) | No Harmonics Found | | |
| | | 7320(Av) | | | |
| | H | 2440(Pk) | 97.90 | - | - |
| | | 2440(Av) | 92.16 | - | - |
| | | 4880(Pk) | 44.48 | 74 | -29.52 |
| | | 4880(Av) | 30.68 | 54 | -23.32 |
| | | 7320(Pk) | No Harmonics Found | | |
| | | 7320(Av) | | | |
| 2480 | V | 2480(Pk) | 90.73 | - | - |
| | | 2480(Av) | 86.03 | - | - |
| | | 2483.5(Pk) | 42.16 | 74* | -31.84 |
| | | 2483.5(Av) | 25.40 | 54* | -28.60 |
| | | 4960(Pk) | 43.61 | 74 | -30.39 |
| | | 4960(Av) | 31.78 | 54 | -22.22 |
| | | 7440(Pk) | No Harmonics Found | | |
| | | 7440(Av) | | | |
| | H | 2480(Pk) | 97.28 | - | - |
| | | 2480(Av) | 92.54 | - | - |
| | | 2483.5(Pk) | 46.70 | 74* | -27.30 |
| | | 2483.5(Av) | 28.01 | 54* | -25.99 |
| | | 4960(Pk) | 44.48 | 74 | -29.52 |
| | | 4960(Av) | 30.68 | 54 | -23.32 |
| | | 7440(Pk) | No Harmonics Found | | |
| | | 7440(Av) | | | |

*** : Indicate restricted band of operation §15.205**
**Pk: Peak Detector; Av: Average Detector**

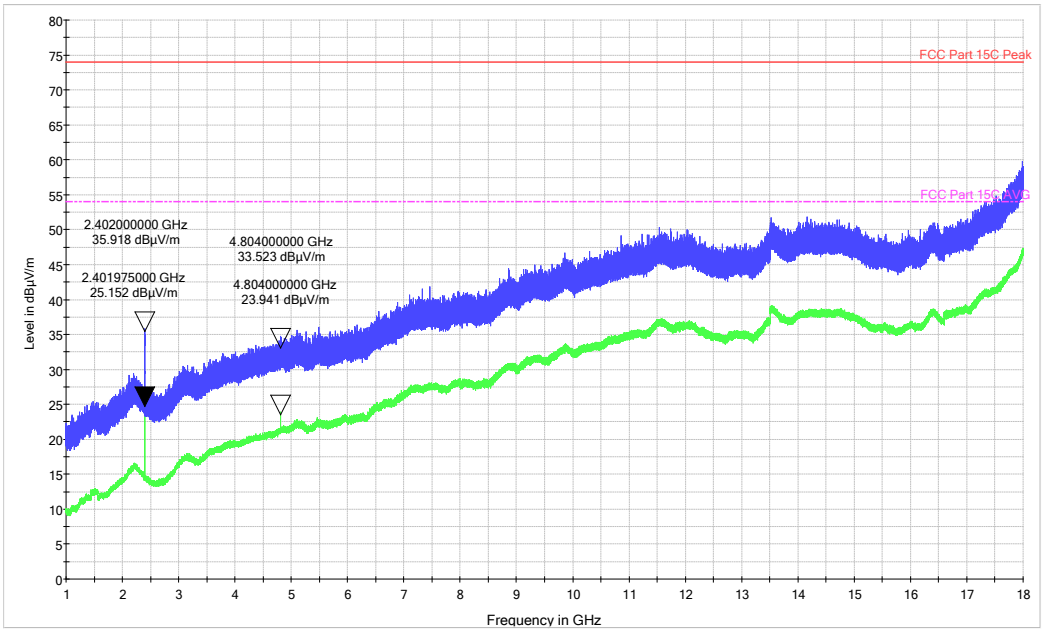
**Worst case Plots**
**Channel Frequency 2402MHz**



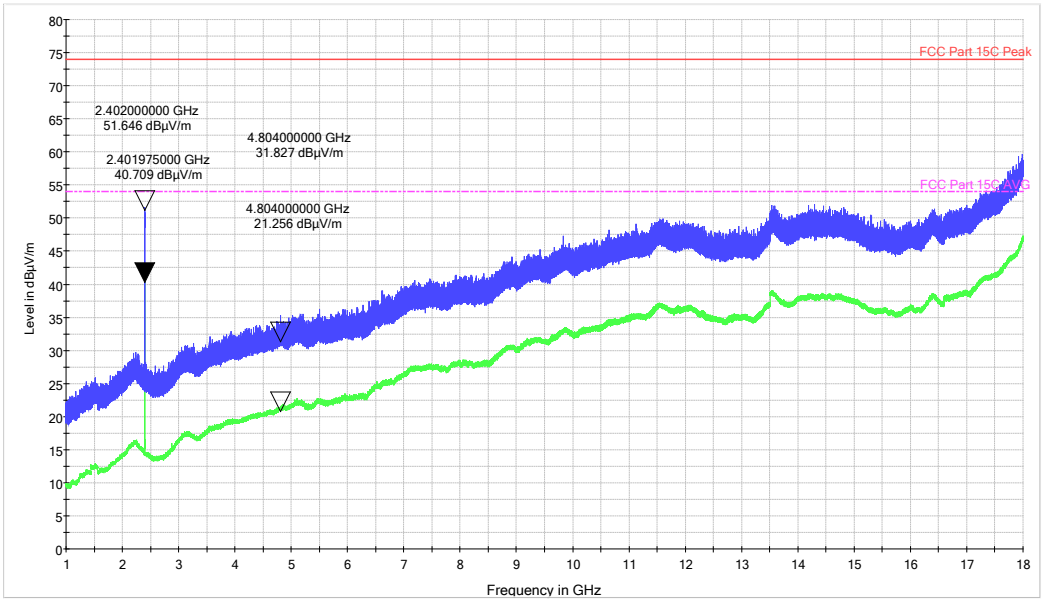

Channel Frequency: 2402MHz Polarization: Vertical



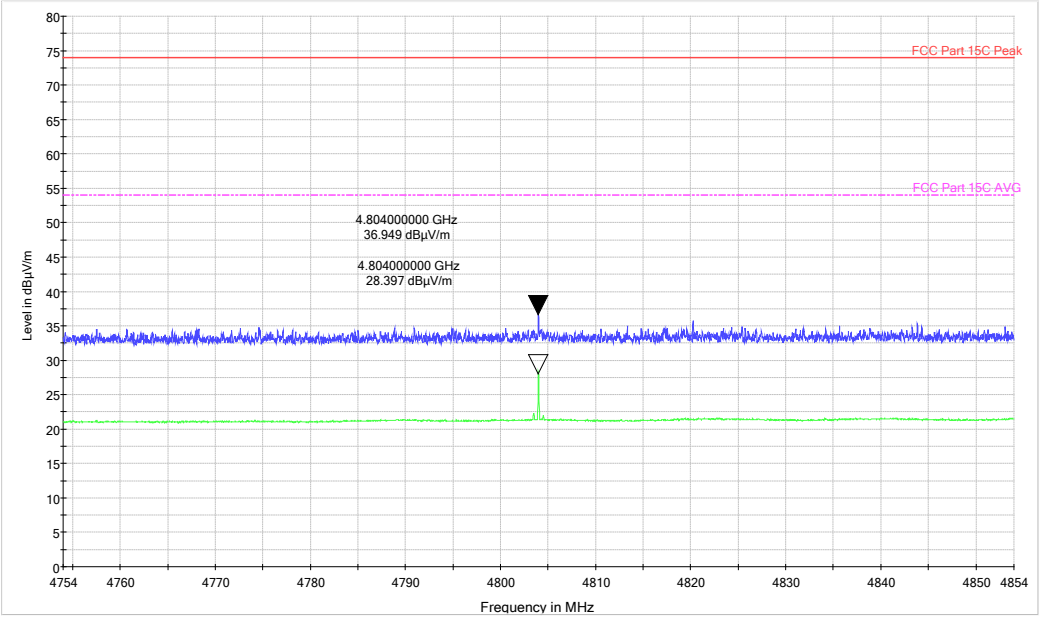

Channel Frequency: 2402MHz Polarization: Horizontal



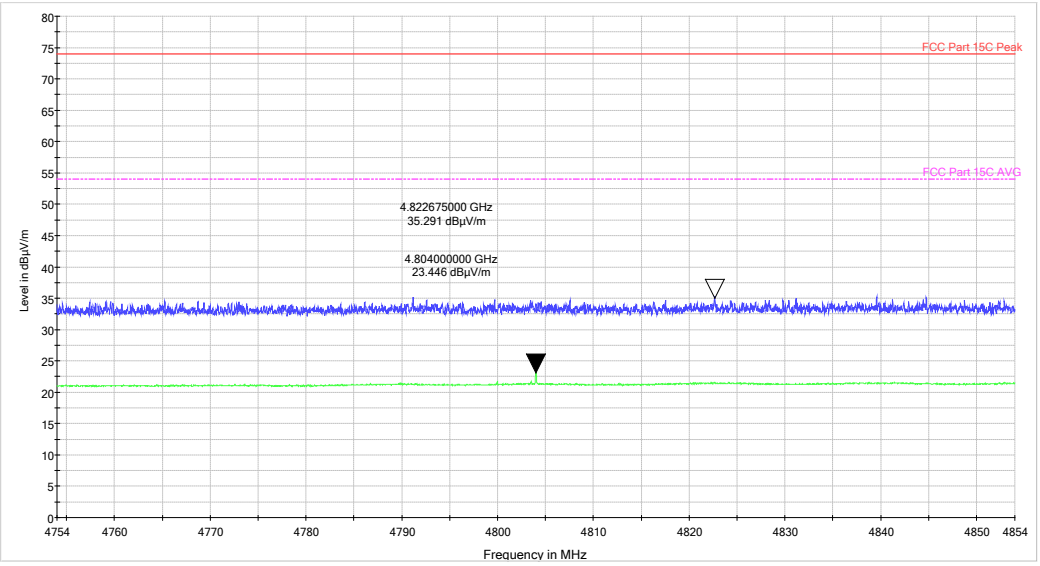

Channel Frequency: 1-18GHz Polarization: Vertical




Channel Frequency: 1-18GHz Polarization: Horizontal




Channel Frequency: 2nd Harmonics Polarization: Vertical




Channel Frequency: 2nd Harmonics Polarization: Horizontal

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*****END OF TEST REPORT*****