# TEST REPORT

**Report Number: 104799910MPK-003**
**Project Number: G104799910**
**Original Issue Date: November 12, 2021**
**Revision Date: February 7, 2022**

**Testing performed on the**
**Minibadge**
**Model: C1000**

**FCC ID: QGZC1000**
**IC: 4362A-C1000**

**to**

**FCC Part 15 Subpart C (15.247)**
**ISED RSS-247, Issue 2**

**For**

**Vocera Communications, Inc.**

| **Test Performed by:** | **Test Authorized by:** |
|---|---|
| Intertek | Vocera Communications, Inc. |
| 1365 Adams Court | 525 Race St, Ste 150 |
| Menlo Park, CA 94025 USA | San Jose, CA 95126 USA |

Prepared by: _____ **Date:** February 7, 2022
Minh Ly

Reviewed by: _____ **Date:** February 7, 2022
Krishna K Vemuri

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| Report No. 104799910MPK-003 | |
|---|---|
| **Equipment Under Test:** | Minibadge |
| **Model Number:** | C1000 |
| **Applicant:** | Vocera Communications, Inc. |
| **Contact:** | Prakash Guda |
| **Address:** | Vocera Communications, Inc.<br>525 Race St, Ste 150<br>San Jose, CA 95126 |
| **Country:** | USA |
| **Tel. Number:** | (408) 882-5100 |
| **Email:** | Pguda@vocera.com |
| **Applicable Regulation:** | FCC Part 15 Subpart C (15.247)<br>ISED RSS-247 Issue 2 |
| **Date of Test:** | October 04 – 22, 2021 |

***We attest to the accuracy of this report:***

Minh Ly
Senior Project Engineer

Krishna K Vemuri
EMC Manager

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## 1.0 Summary of Tests

| Test | Reference FCC | Reference Industry Canada | Result |
|---|---|---|---|
| **RF Output Power** | 15.247(b)(3) | RSS-247, 5.4.d) | Complies |
| **6 dB Bandwidth** | 15.247(a)(2) | RSS-247, 5.2.a) | Complies |
| **Power Density** | 15.247(e) | RSS-247, 5.2.b) | Complies |
| **Out of Band Antenna Conducted Emission** | 15.247(d) | RSS-247, 5.5 | Complies |
| **Transmitter Radiated Emissions** | 15.247(d), 15.209, 15.205 | RSS-247, 5.5 | Complies |
| **AC Line Conducted Emission** | 15.207 | RSS-GEN | Complies |
| **Antenna Requirement** | 15.203 | RSS-GEN | Complies (Internal Antenna) |
| **RF Exposure** | 15.247(i), 2.1093(d) | RSS-102 | Complies |

**EUT receive date:** October 04, 2021

**EUT receive condition:** The pre-production version of the EUT was received in good condition with no apparent damage. As declared by the Applicant, it is identical to the production units.

**Test start date:** October 06, 2021

**Test completion date:** October 22, 2021

The test results in this report pertain only to the item tested.

## 2.0 General Information

### 2.1 Product Description

Vocera Communications, Inc. supplied the following description of the EUT:

A small, lightweight, wearable communication device designed to simplify hospital communication and workflow and improve staff safety. A user can "wake up" and operate the device using only their voice, to stay connected even under restrictive PPE. They can make and receive calls; listen and respond to messages and alarm notifications. Visual indicators enable fast triaging of events. A dedicated panic button provides a direct connection to security personnel. The device can be used as a smartphone companion, or by itself.
For more information, see user's manual provided by the manufacturer.

This test report covers only the 2.4GHz WiFi radio.

Information about the WiFi radio is presented below:

The EUT supports a wide range of data rates in the 2.4GHz band:
IEEE 802.11b
IEEE 802.11g
IEEE 802.11n 20MHz

| Radio Information | |
|---|---|
| **Applicant** | Vocera Communications, Inc. |
| **Model Number** | C1000 |
| **FCC Identifier** | QGZC1000 |
| **IC Identifier** | 4362A-C1000 |
| **Modulation Technique** | DSSS (BPSK, QPSK, CCK), OFDM (BPSK, QPSK, 16QAM, 64QAM) |
| **Rated RF Output** | 802.11b: 17.45 dBm<br>802.11g: 15.71 dBm<br>802.11n 20MHz: 15.90 dBm |
| **Frequency Range** | 2412 – 2462 MHz, 802.11b/g/n |
| **Type of modulation** | BPSK, QPSK, 16QAM, 64QAM |
| **Number of Channel(s)** | 11 for 802.11b/g/n |
| **Antenna(s) & Gain** | Internal Antenna, Gain: +1.45 dBi |
| **Applicant Name & Address** | Vocera Communications, Inc.<br>525 Race St, Ste 150<br>San Jose, CA 95126<br>USA |

The EUT supports the following configurations:

| Channels in 2.4 GHz band | | | |
|---|---|---|---|
| **Channel no.** | **Frequency (MHz)** | **IEEE 802.11b/g/n HT 20 mode** | |
| 1 | 2412 | √ | X |
| 2 | 2417 | √ | |
| 3 | 2422 | √ | |
| 4 | 2427 | √ | |
| 5 | 2432 | √ | |
| 6 | 2437 | √ | X |
| 7 | 2442 | √ | |
| 8 | 2447 | √ | |
| 9 | 2452 | √ | |
| 10 | 2457 | √ | |
| 11 | 2462 | √ | X |

√ = available
X = to be tested

## 2.2 Related Submittal(s) Grants

None.

## 2.3 Test Facility

The test site used to collect the radiated data is site 1 (10-m semi-anechoic chamber). This test facility and site measurement data have been fully placed on file with the FCC, IC and A2LA accredited.

## 2.4 Test Methodology

Antenna conducted measurements were performed according to the FCC documents "Guidance for Performing Compliance Measurement on Digital Transmission Systems (DTS) Operating under §15.247" (KDB 558074 D01 DTS Meas Guidance v05r02), and RSS-247 Issue 2, RSS-GEN Issue 5.

Radiated emissions and AC mains conducted emissions measurements were performed according to the procedures in ANSI C63.10: 2013. Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "Data Sheet" of this report.

## 2.5 Measurement Uncertainty

Compliance with the limits was based on the results of the measurements and doesn't take into account the measurement uncertainty.

Estimated Measurement Uncertainty

| Measurement | Expanded Uncertainty (k=2) | | |
|---|---|---|---|
| | 0.15 MHz – 1 GHz | 1 GHz – 2.5 GHz | > 2.5 GHz |
| RF Power and Power Density – antenna conducted | - | 0.7 dB | - |
| Unwanted emissions – antenna conducted | 1.1 dB | 1.3 dB | 1.9 dB |
| Bandwidth – antenna conducted | - | 30 Hz | - |

| Measurement | Expanded Uncertainty (k=2) | | | |
|---|---|---|---|---|
| | 0.15 MHz – 30MHz | 30 – 200 MHz | 200 MHz – 1 GHz | 1 GHz – 18 GHz |
| Radiated emissions | - | 4.7 | 4.6 | 5.1 dB |
| AC mains conducted emissions | 2.1 dB | - | - | - |

## 3.0 System Test Configuration

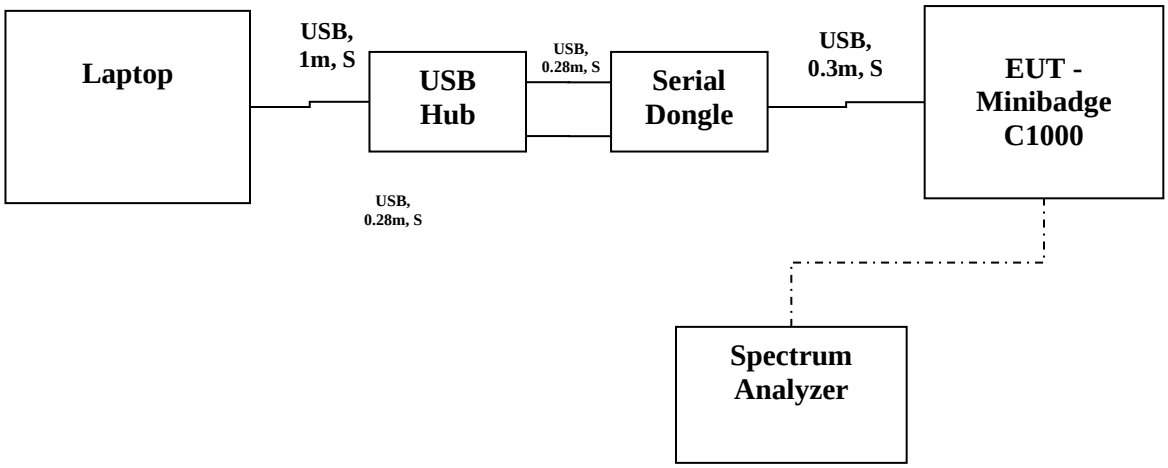
### 3.1 Support Equipment and description

| Support Equipment | | |
|---|---|---|
| **Description** | **Manufacturer** | **Model** |
| Laptop | Lenovo | T440P |
| USB Hub | Tendak | CP-029-BK |
| Serial Dongle | Vocera | 210-01516-B04 |

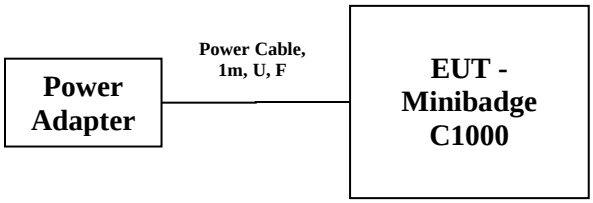
### 3.2 Block Diagram of Test Setup

| Equipment Under Test | | | |
|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **Serial Number/ID** |
| Minibadge – Conducted Unit | Vocera Communications, Inc. | C1000 | AA3301J26008A6 |
| Minibadge – Radiated Unit | Vocera Communications, Inc. | C1000 | AA3301J2600878 |
| Power Adapter | Vocera | WB-10E05R | D0714N55000843 |
| Wired Headset | Vocera | V5000 Headset | 230-02162 |

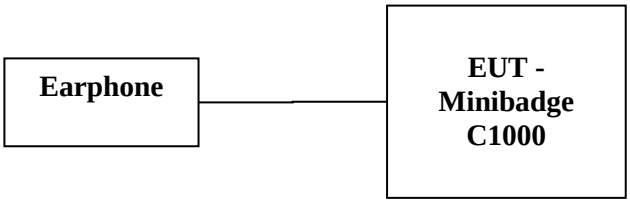
Antenna was removed and co-axial connector was installed for Conducted Measurements.




**Radiated Measurements**
**Charging Mode**




**Radiated Measurements**
**Normal Mode**




| | |
|---|---|
| **S** = Shielded<br>**U** = Unshielded | **F** = With Ferrite<br>**m** = Length in Meters |

## 3.3 Justification

Preliminary testing was performed for all modulation/data rate modes. The worse-case data rate with highest power and widest spectrum were selected for final measurements:

CCK 1 Mbps – for 802.11b
OFDM 6 Mbps – for 802.11g
OFDM MCS0 – for 802.11n

For radiated emission measurements the EUT is placed on a non-conductive table. The EUT was configured to continuously transmit. Different orientation of the EUT were tested and only the worse-case emissions were reported.

The EUT was tested in 2 configurations with EUT in horizontal and upright positions:

A/ Charging mode: tested with power adapter
B/ Normal mode: tested in battery mode and earphone.

## 3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was provided by Vocera Communications, Inc.

## 3.5 Mode of Operation During Test

During transmitter testing, the transmitter was setup to transmit continuously using the RF power setting provided by the manufacturers via test scripts. The corresponding output power in dBm can be found in section 4.2 of this report.

The table below reflects the RF power setting needed to be compliant with radiated restricted band edge requirements of 15.205 & 15.209.

| Channels | 802.11b | 802.11g | 802.11n 20MHz |
|---|---|---|---|
| 1 - 11 | 18 | 16 | 17 |

## 3.6 Modifications Required for Compliance

No modifications were made by the manufacturer or Intertek to the EUT in order to bring the EUT into compliance.

## 3.7 Additions, Deviations and Exclusions from Standards

No additions, deviations or exclusions from the standard were made.

## 4.0 Measurement Results

### 4.1 6-dB Bandwidth and 99% Occupied Bandwidth
FCC Rule: 15.247(a)(2); RSS-247, 5.2.a) and RSS-GEN;

#### 4.1.1 Requirement

The minimum 6-dB bandwidth shall be at least 500 kHz

#### 4.1.2 Procedure

A spectrum analyzer was connected to the antenna port of the transmitter.

For FCC 6dB Channel Bandwidth the Procedure described in the FCC Publication KDB 558074 D01 Meas Guidance v05r02 was used to determine the DTS occupied bandwidth. Section 11.8.1 Option 1 of ANSI 63.10 was used.

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

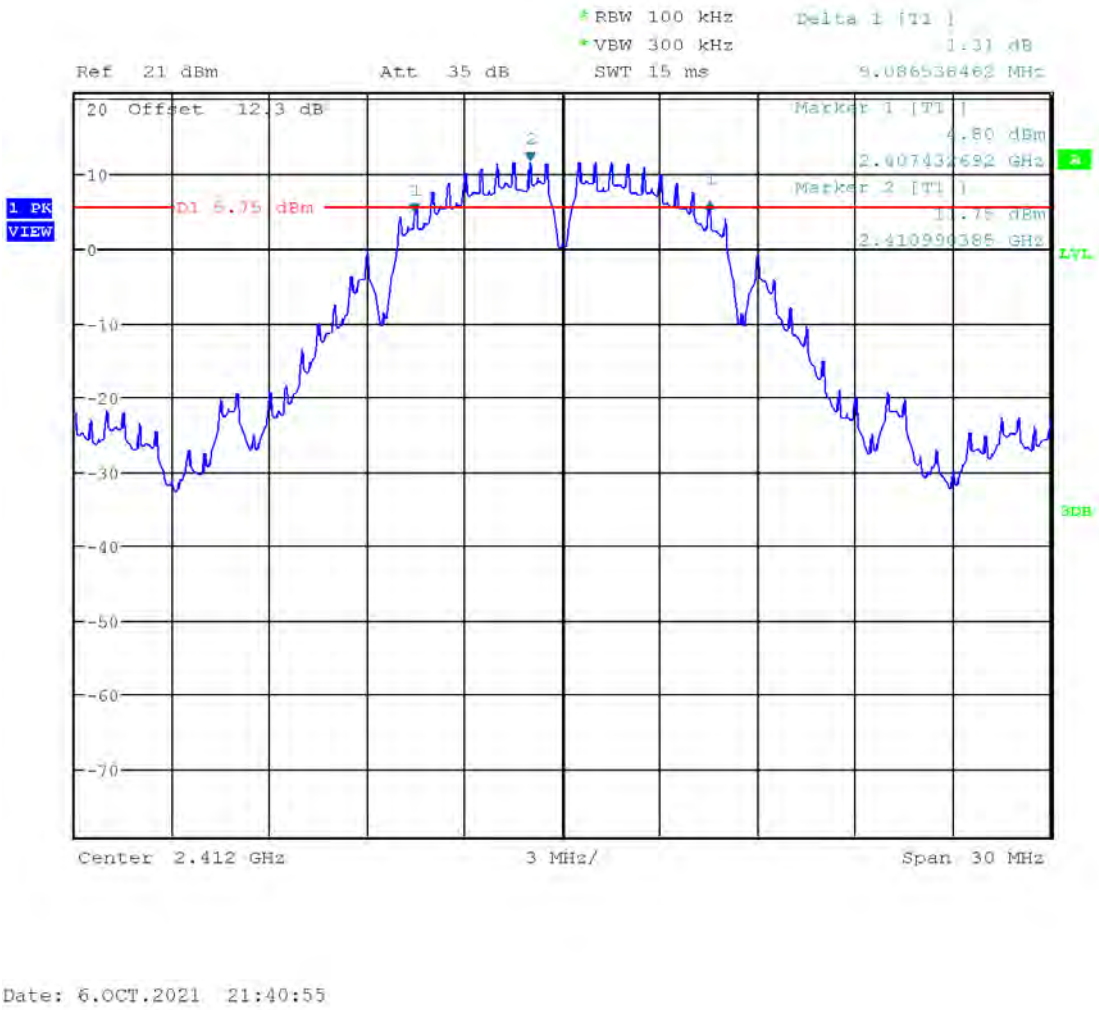
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

| Tested By | Test Date |
|---|---|
| Minh Ly | October 06, 2021 |

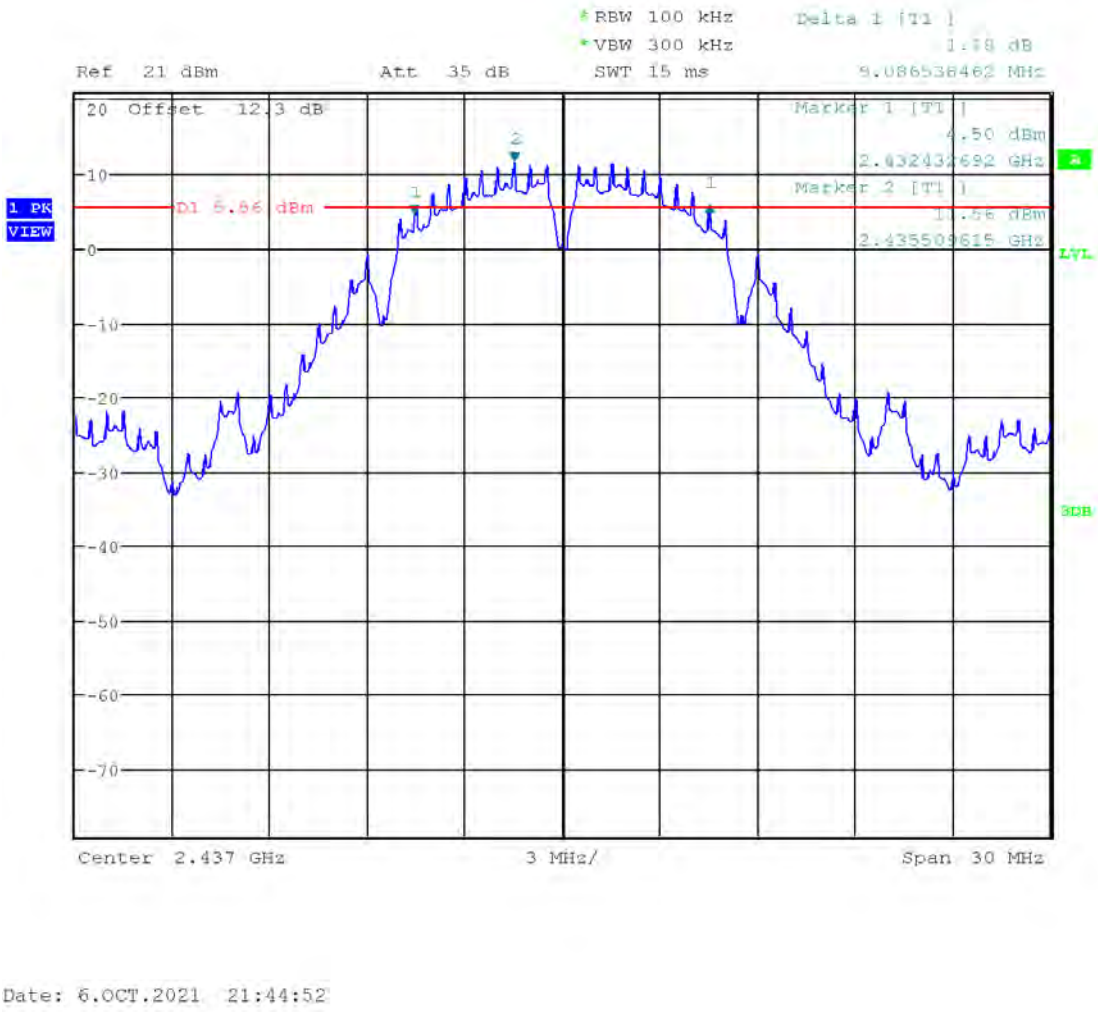
### 4.1.3 Test Result

| Frequency MHz | Ch. | Frequency MHz | 6 dB FCC Bandwidth, MHz | Plot # | 99% Bandwidth, MHz | Plot # |
|---|---|---|---|---|---|---|
| 802.11b | 1 | 2412 | 9.086 | 1.1 | 12.215 | 1.4 |
| | 6 | 2437 | 9.086 | 1.2 | 12.211 | 1.5 |
| | 11 | 2462 | 9.086 | 1.3 | 12.307 | 1.6 |
| 802.11g | 1 | 2412 | 16.057 | 1.7 | 16.875 | 1.10 |
| | 6 | 2437 | 16.346 | 1.8 | 17.019 | 1.11 |
| | 11 | 2462 | 16.057 | 1.9 | 16.826 | 1.12 |
| 802.11n 20MHz | 1 | 2412 | 17.307 | 1.13 | 18.028 | 1.16 |
| | 6 | 2437 | 17.548 | 1.14 | 18.173 | 1.17 |
| | 11 | 2462 | 17.115 | 1.15 | 17.932 | 1.18 |

*Plot 1.1 – 6dB Bandwidth (FCC)*



*Plot 1.2 – 6dB Bandwidth (FCC)*

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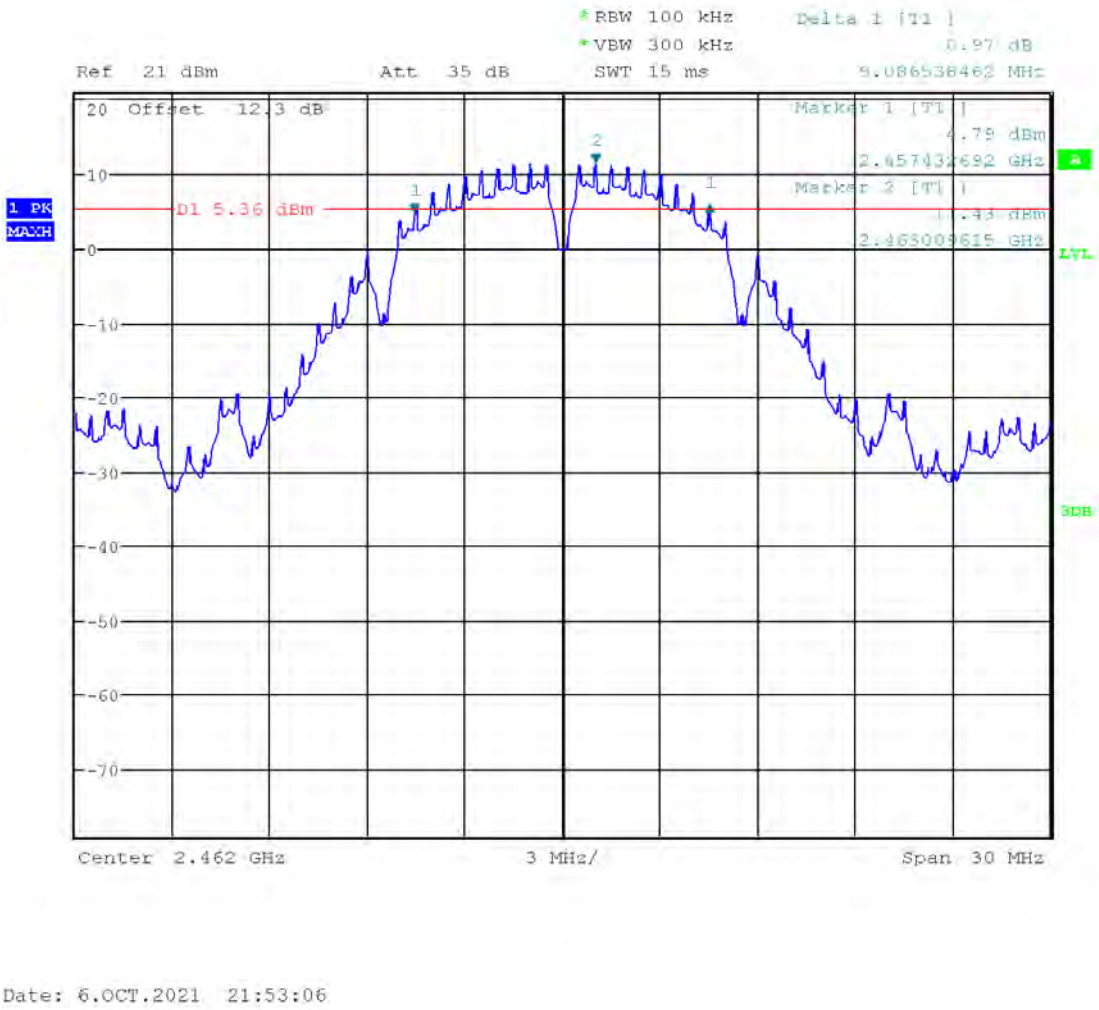
*Plot 1 3 – 6dB Bandwidth (FCC)*

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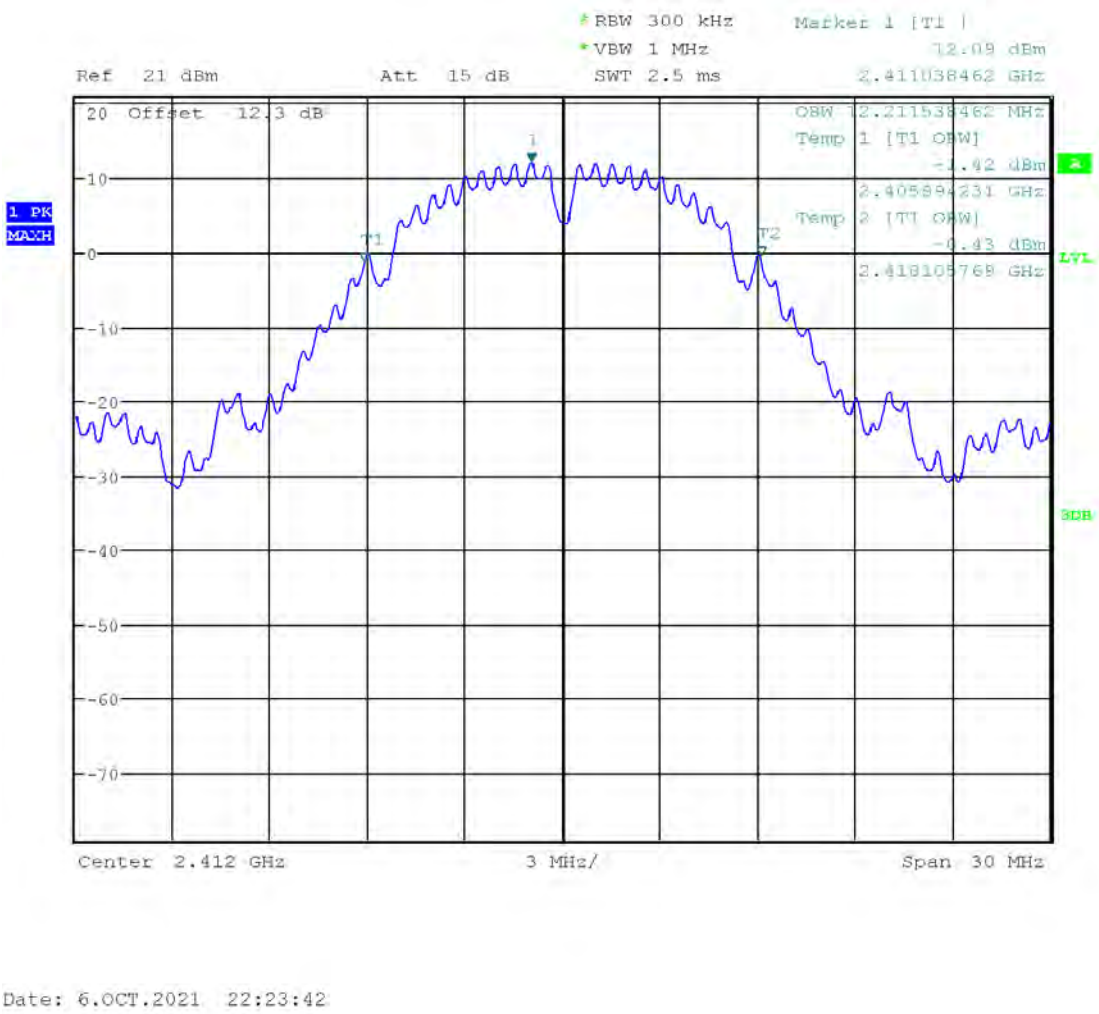
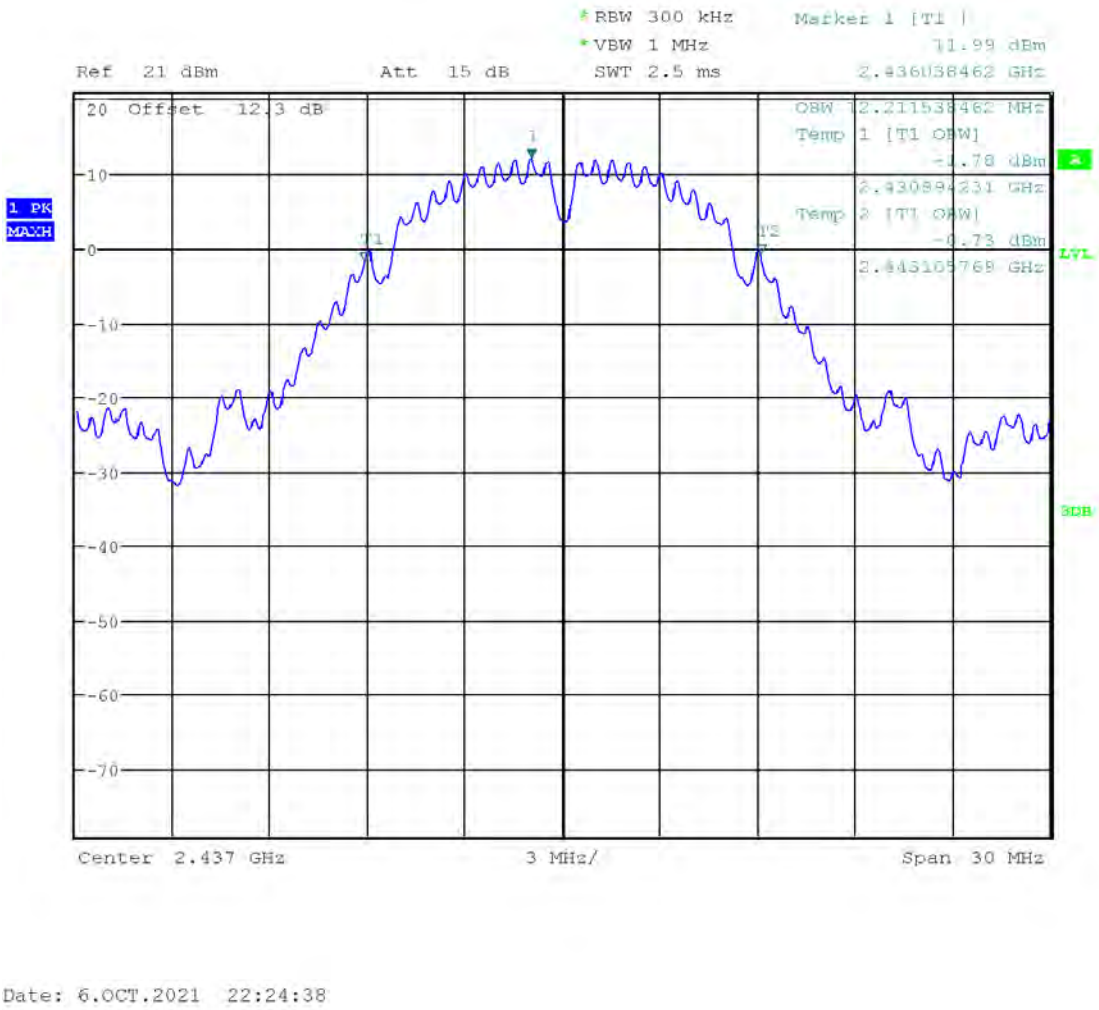
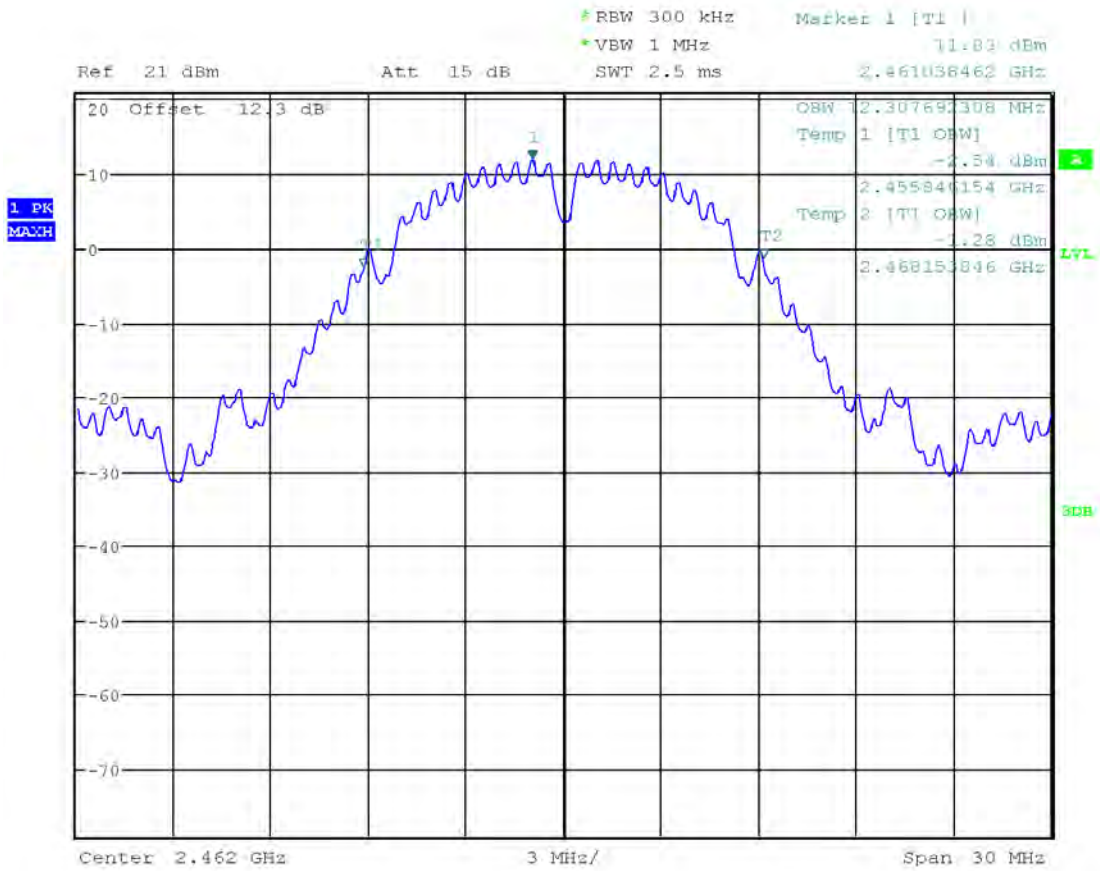
*Plot 1.4 – 99% Bandwidth*



*Plot 1.5 – 99% Bandwidth*



*Plot 1.6 – 99% Bandwidth*

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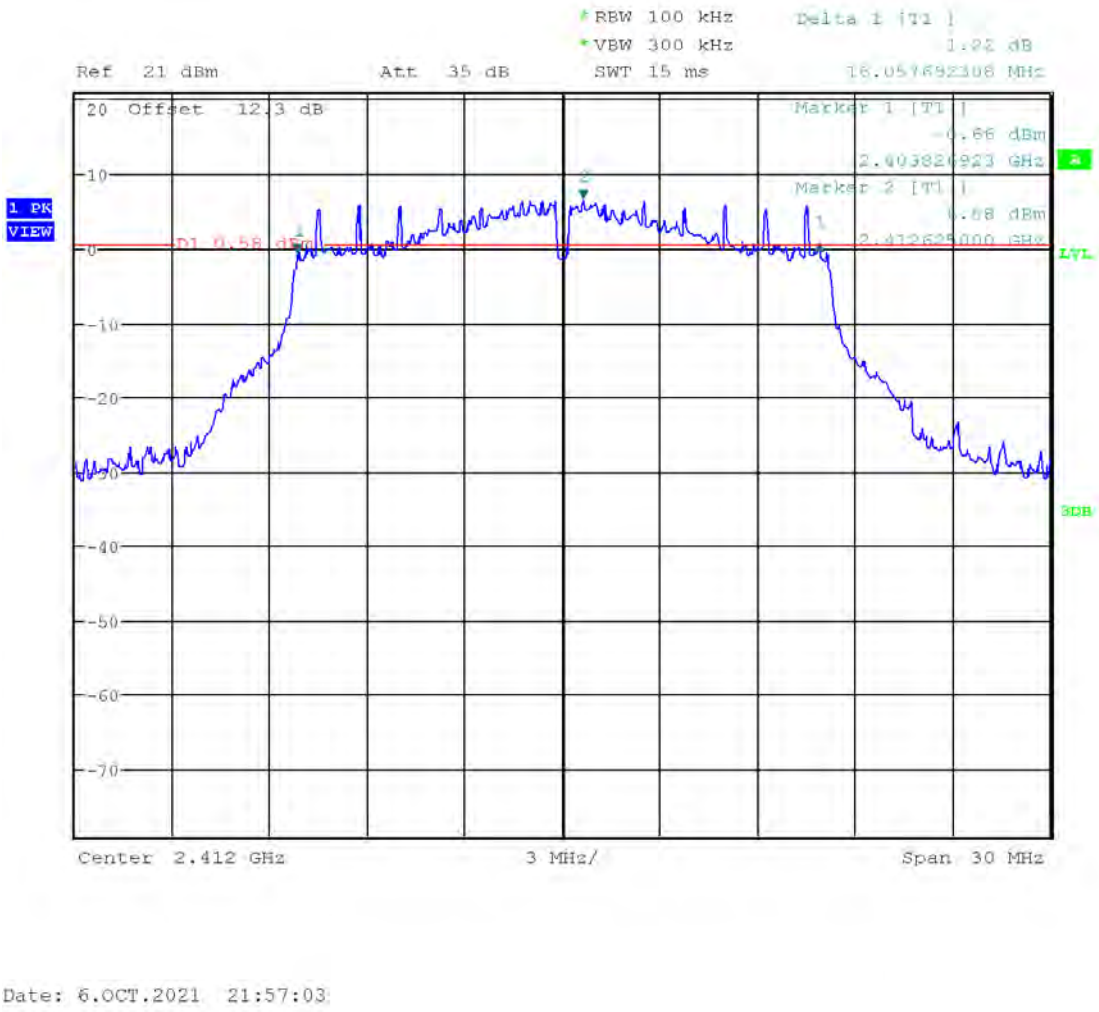
*Plot 1.7 – 6dB Bandwidth (FCC)*

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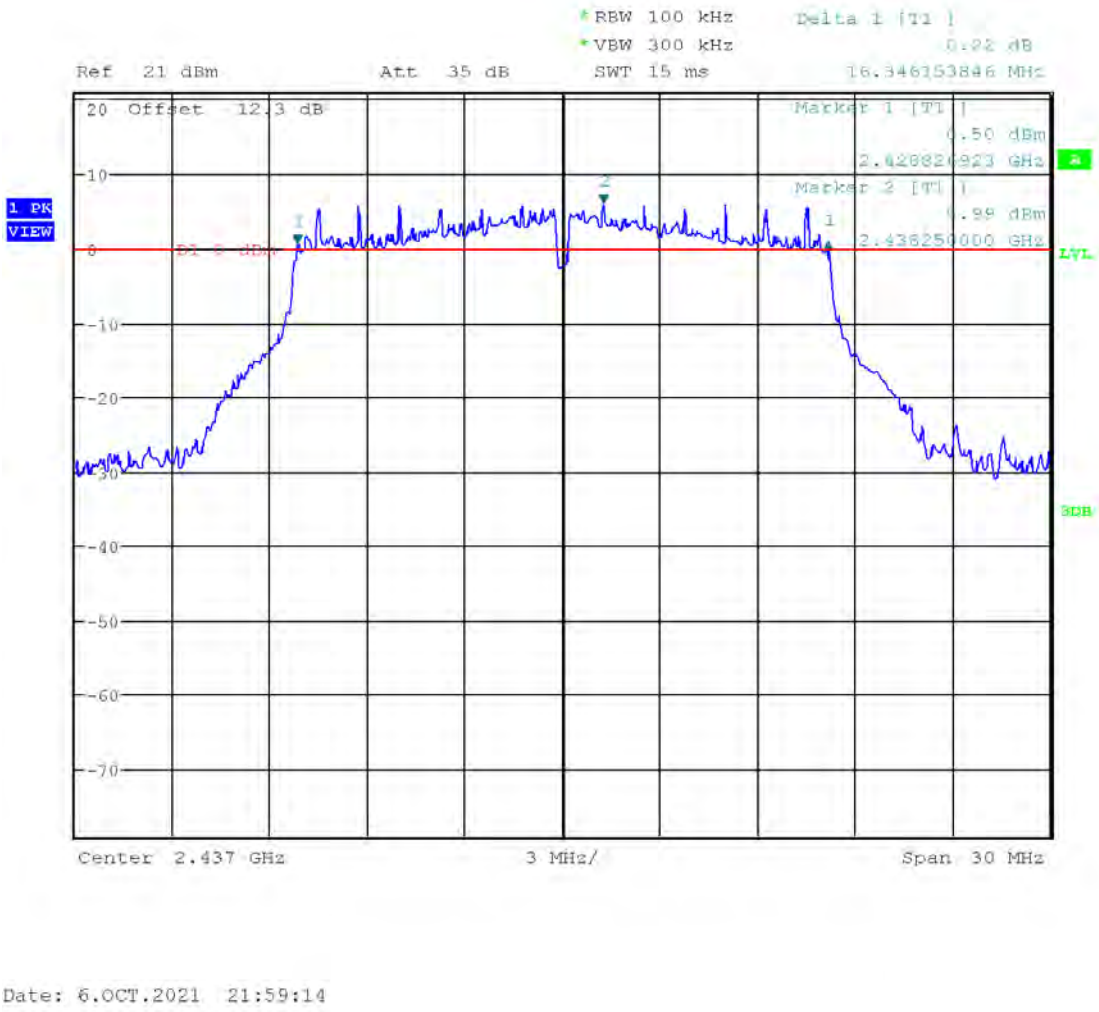
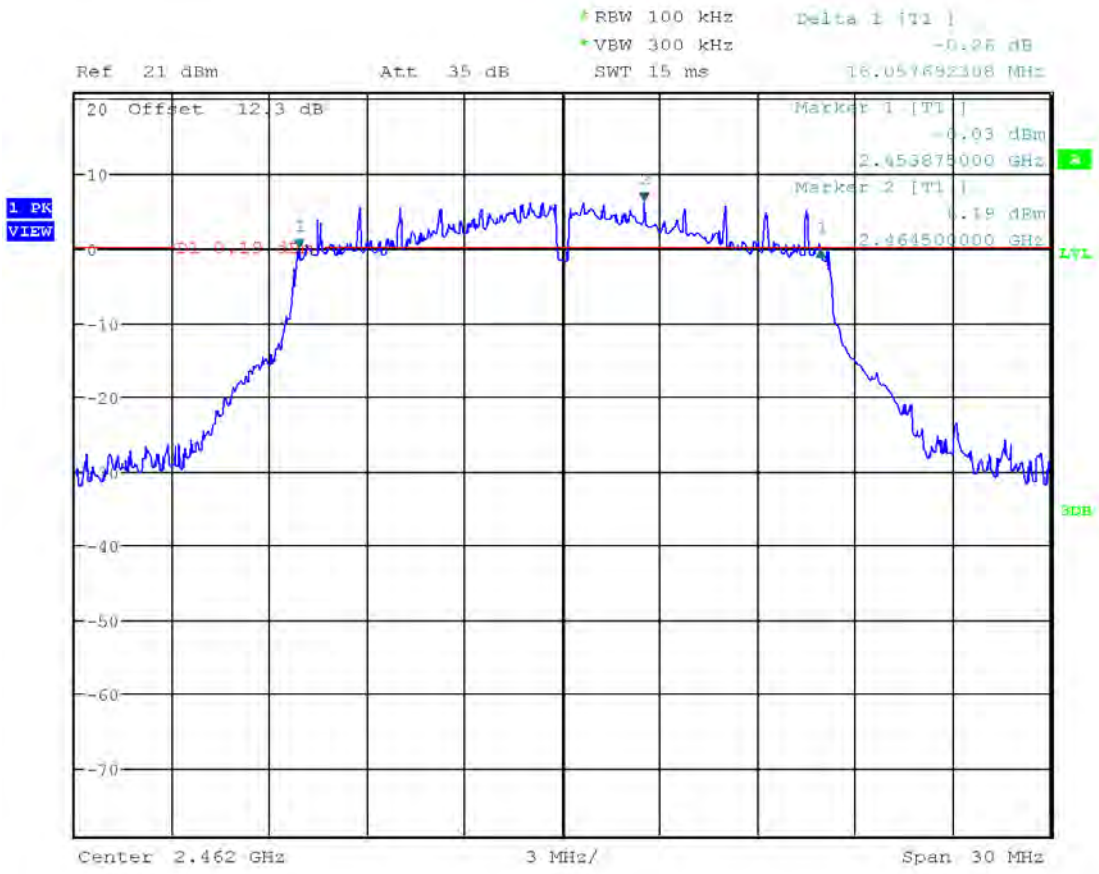
*Plot 1.8 – 6dB Bandwidth (FCC)*



*Plot 1.9 – 6dB Bandwidth (FCC)*

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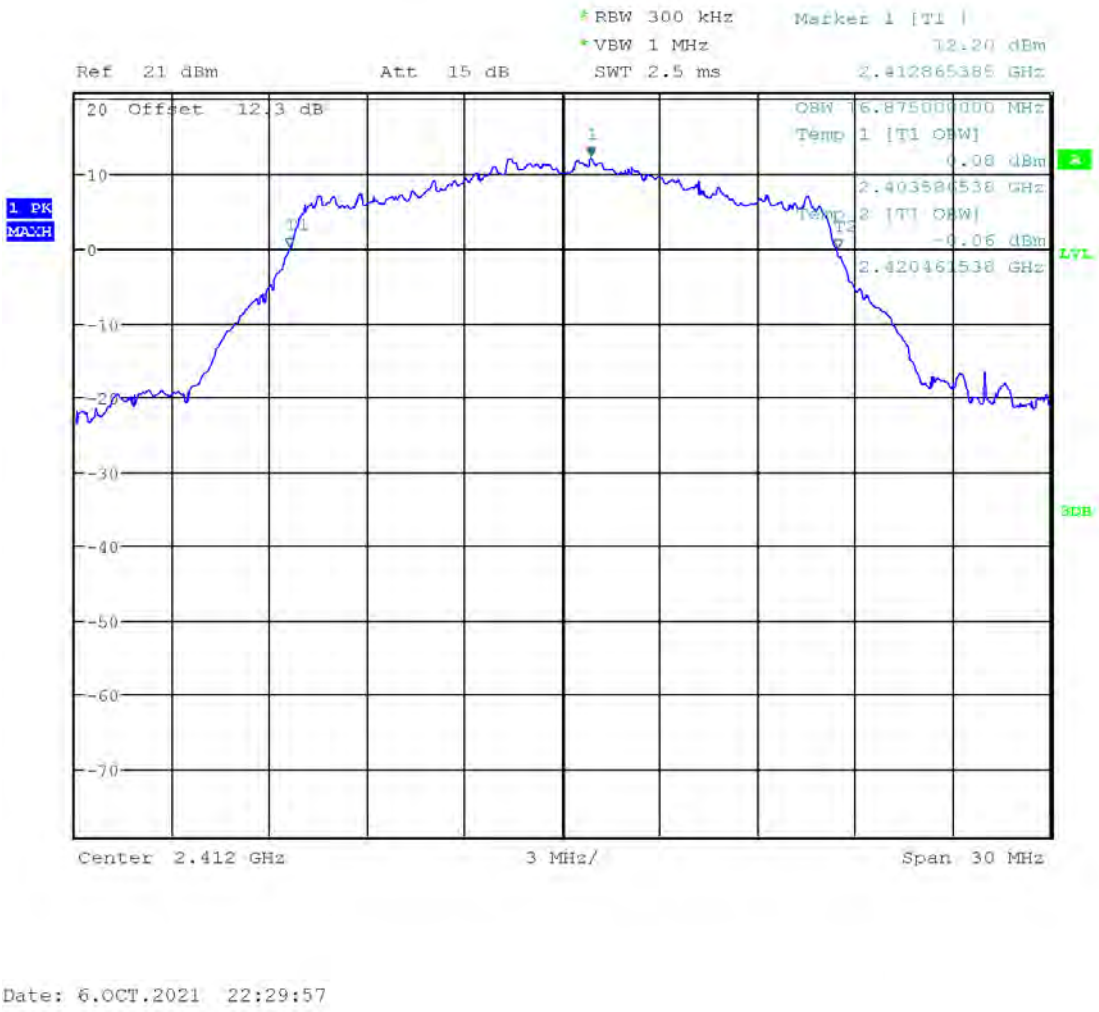
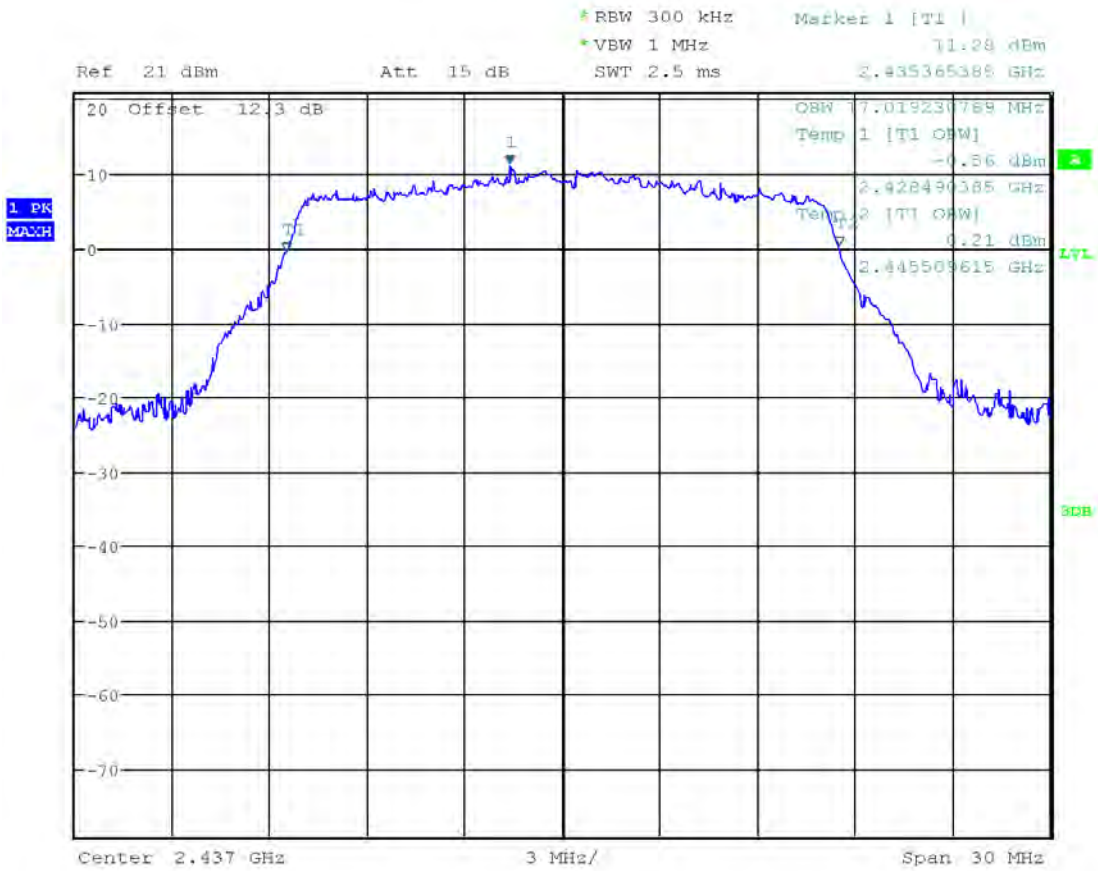
*Plot 1.10 – 99% Bandwidth*



*Plot 1.11 – 99% Bandwidth*

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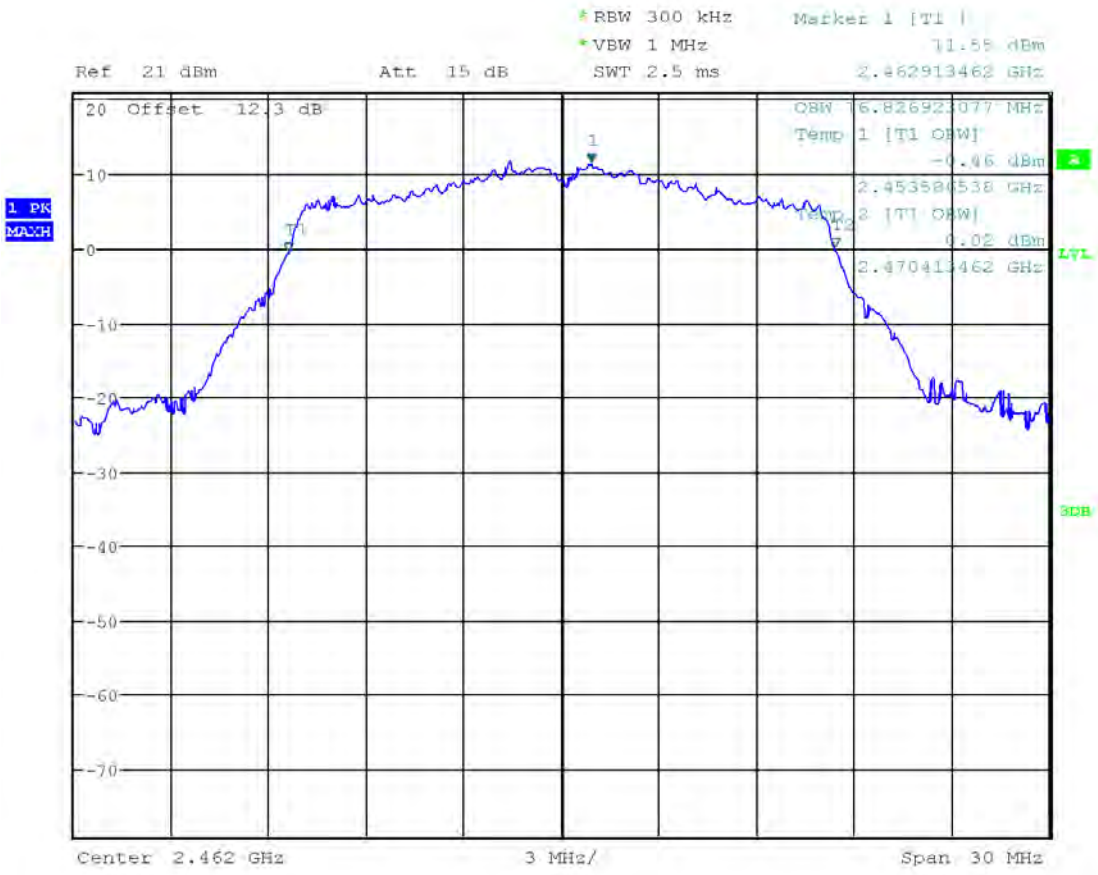
*Plot 1.12 – 99% Bandwidth*

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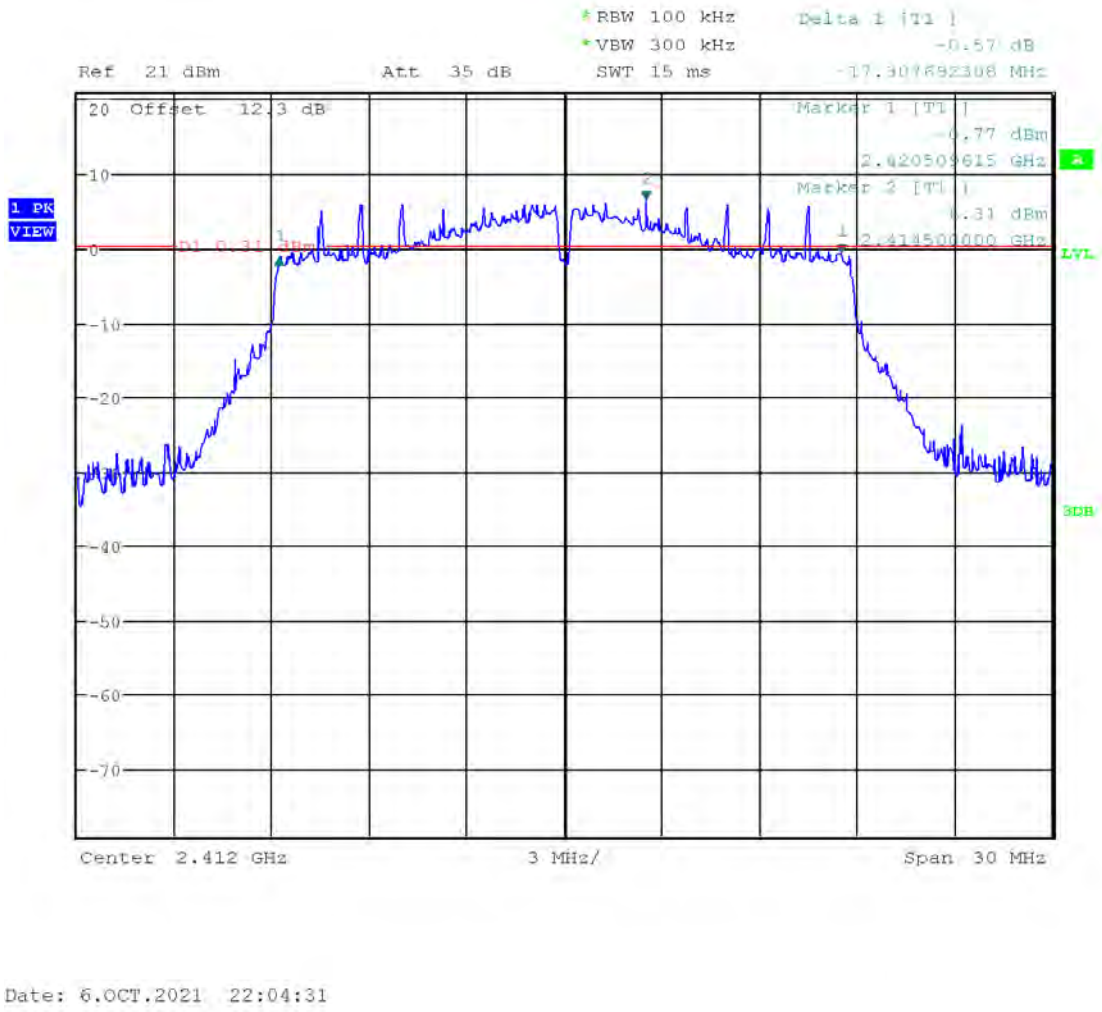
*Plot 1.13 – 6dB Bandwidth (FCC)*

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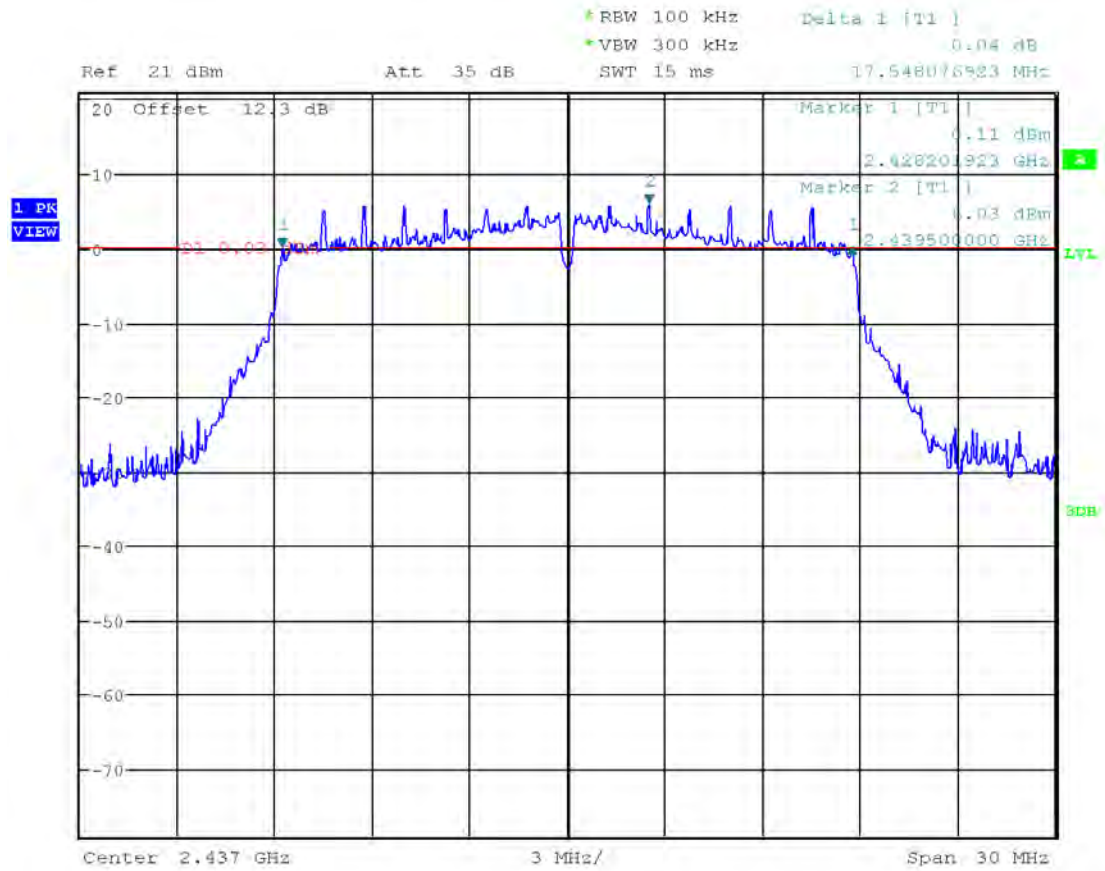
*Plot 1.14 – 6dB Bandwidth (FCC)*

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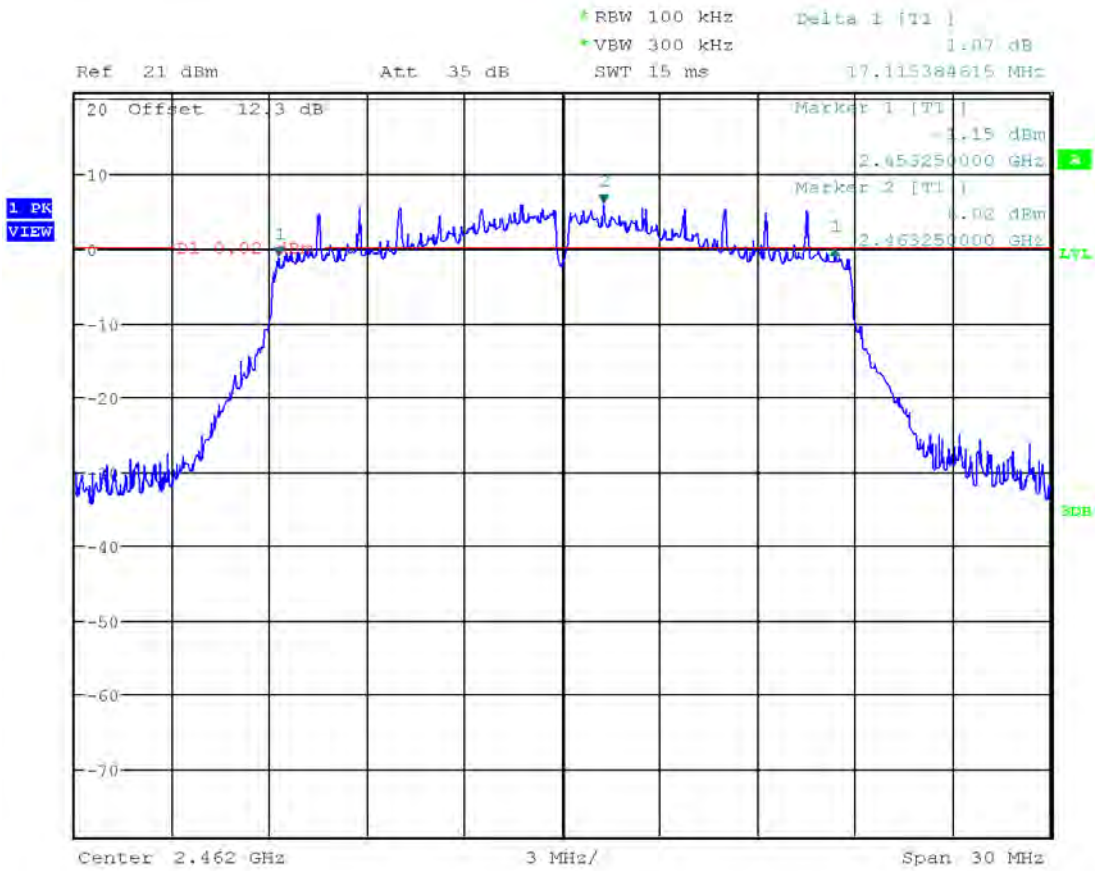
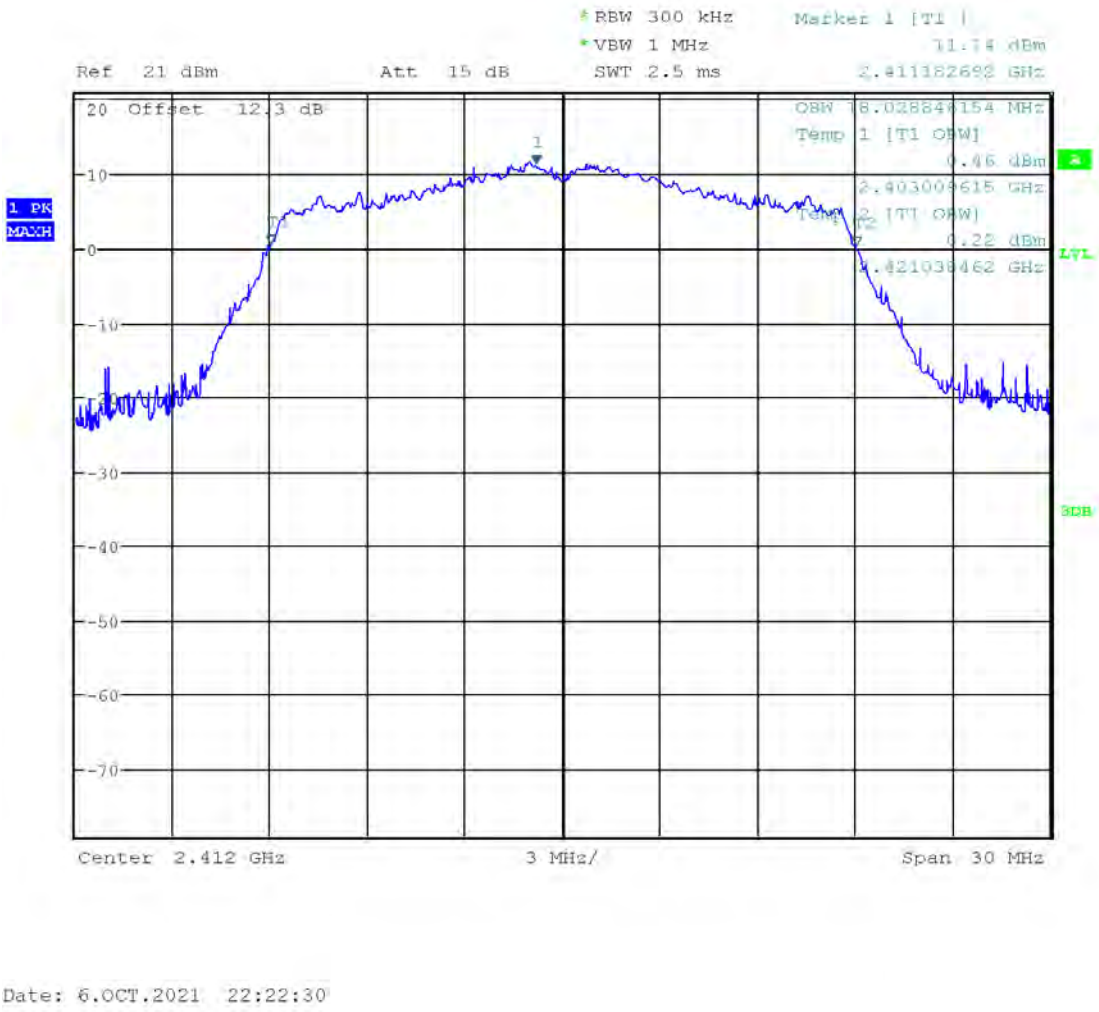
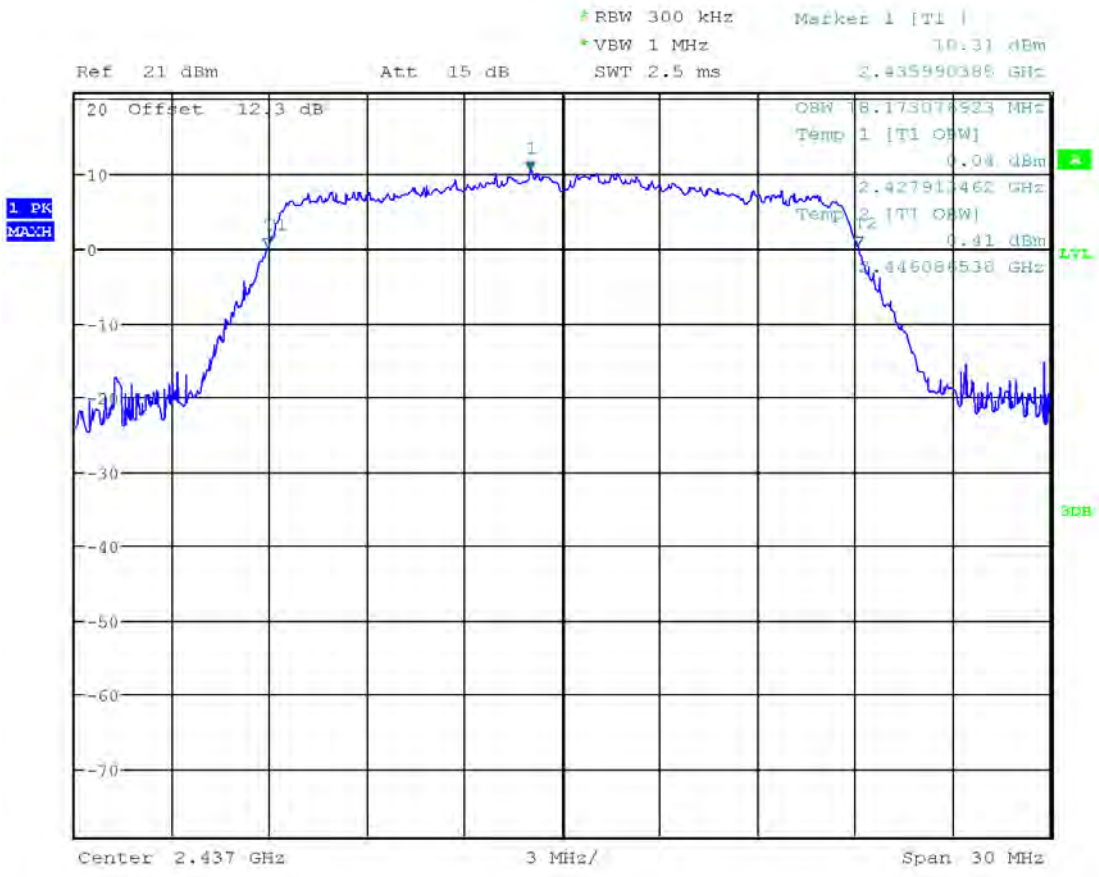
*Plot 1.15 – 6dB Bandwidth (FCC)*



*Plot 1.16 – 99% Bandwidth*

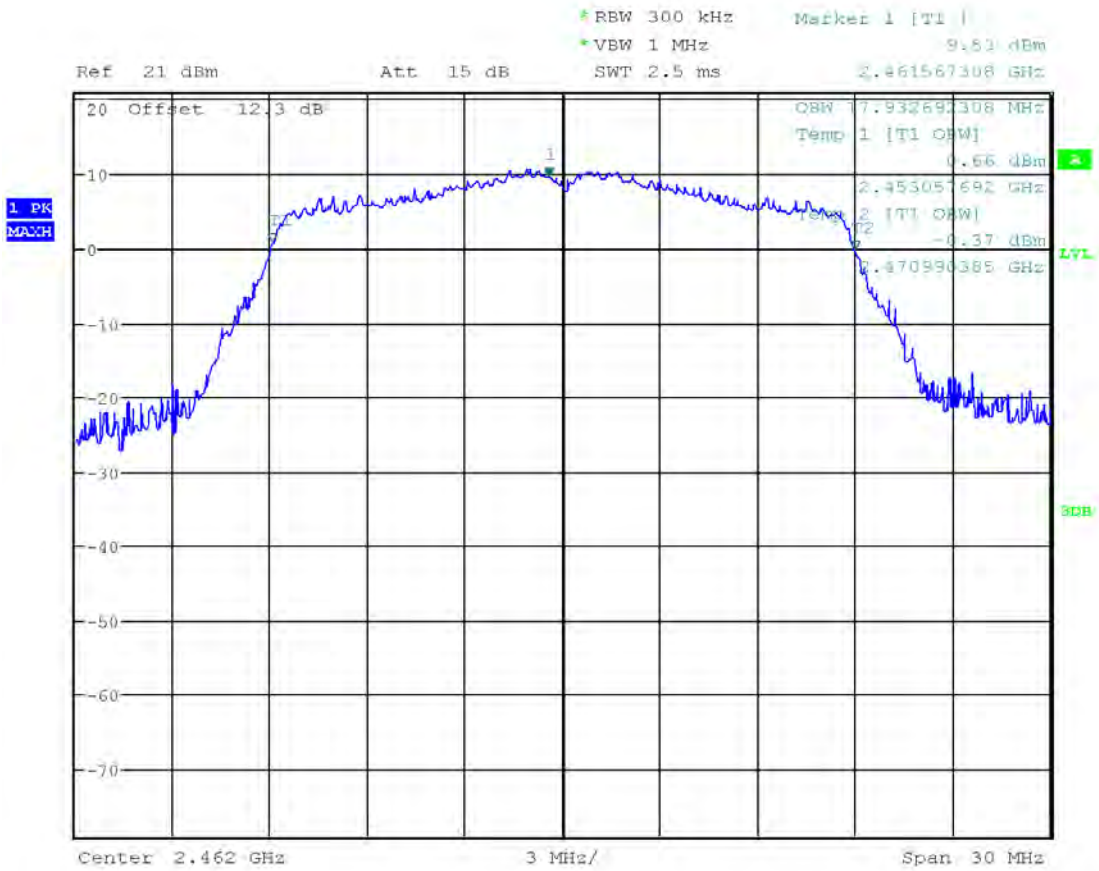


*Plot 1.17 – 99% Bandwidth*




Date: 6.OCT.2021 22:20:16

*Plot 1.18 – 99% Bandwidth*

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## 4.2 Maximum Conducted Output Power at Antenna Terminals
FCC Rule: 15.247(b)(3); RSS-247, 5.4.d);

### 4.2.1 Requirement

For antennas with gains of 6 dBi or less, maximum allowed transmitter output is 1 watt (+30 dBm).
For antennas with gains greater than 6 dBi, transmitter output level must be decreased appropriately, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### 4.2.2 Procedure

The antenna port of the EUT was connected to the input of a spectrum analyzer to measure the Maximum Conducted Transmitter Output Power. The offset programmed on the analyzer is corrected to include cable loss, attenuator and duty cycle correction.

The procedure described in FCC Publication KDB 558074 D01 Meas Guidance v05r02 was used. Specifically, section 11.9.2.2.2 Method AVGSA-1 in ANSI 63.10.

The procedure for this method is as follows:

1. Set span to at least 1.5 times the OBW.
2. Set RBW = 1% to 5% of the OBW, not to exceed 1 MHz.
3. Set VBW ≥ [3 · RBW].
4. Number of points in sweep ≥ [2 · span / RBW]. (This gives bin-to-bin spacing ≤ RBW / 2, so that narrowband signals are not lost between frequency bins.
5. Sweep time = auto.
6. Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
7. If transmit duty cycle < 98%, use a sweep trigger with the level set to enable triggering only on full power pulses. The transmitter shall operate at the maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no OFF intervals) or at duty cycle ≥ 98%, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to “free run.”
8. Trace average at least 100 traces in power averaging (rms) mode.
9. Compute power by integrating the spectrum across the OBW of the signal using the instrument’s band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

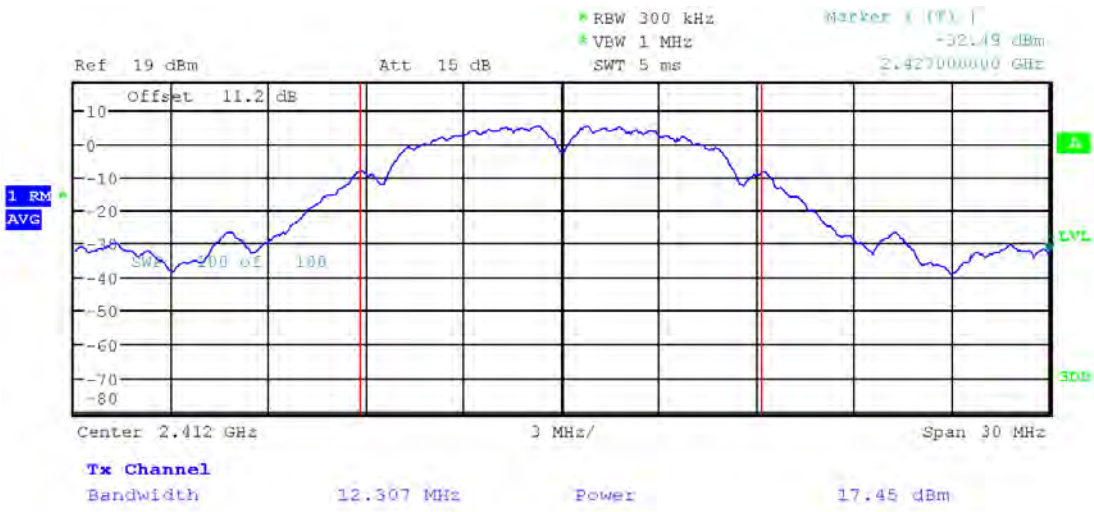
| Tested By | Test Date |
|---|---|
| Minh Ly | October 14, 2021 |

### 4.2.3 Test Result

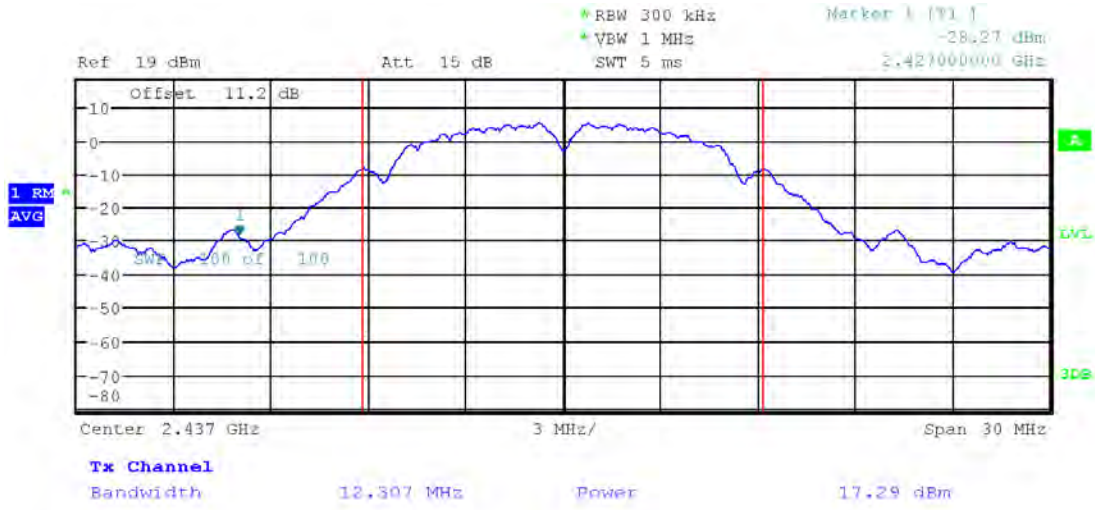
Refer to the following plots for the test result:

| Standard | Data Rate | Channel | Frequency MHz | Conducted Average Power dBm | Conducted Average Power mW | Plot # |
|---|---|---|---|---|---|---|
| 802.11b | 1 Mbps | 1 | 2412 | 17.45 | 55.590 | 2.1 |
| | | 6 | 2437 | 17.29 | 53.579 | 2.2 |
| | | 11 | 2462 | 17.15 | 51.880 | 2.3 |
| 802.11g | 6 Mbps | 1 | 2412 | 15.71 | 37.239 | 2.4 |
| | | 6 | 2437 | 15.43 | 34.914 | 2.5 |
| | | 11 | 2462 | 15.53 | 35.727 | 2.6 |
| 802.11n 20MHz | MCS0 | 1 | 2412 | 15.90 | 38.904 | 2.7 |
| | | 6 | 2437 | 15.77 | 37.757 | 2.8 |
| | | 11 | 2462 | 15.66 | 36.812 | 2.9 |

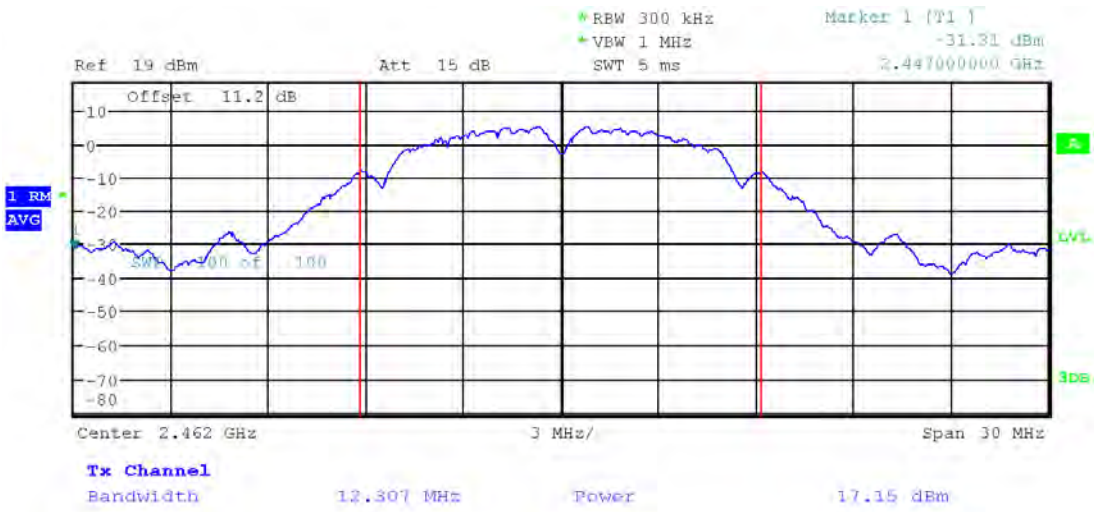
Plot 2. 1



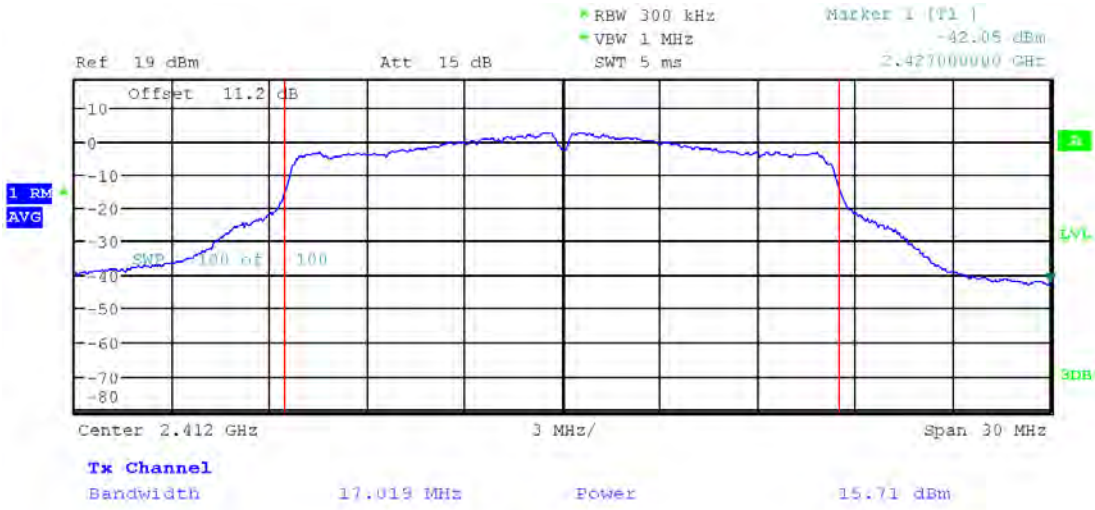

Plot 2. 2



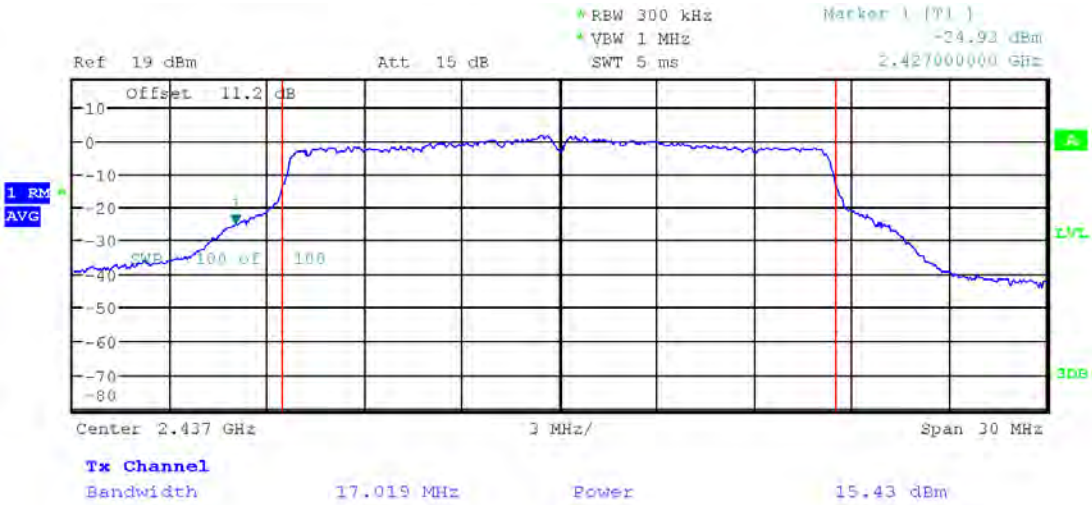
Plot 2. 3



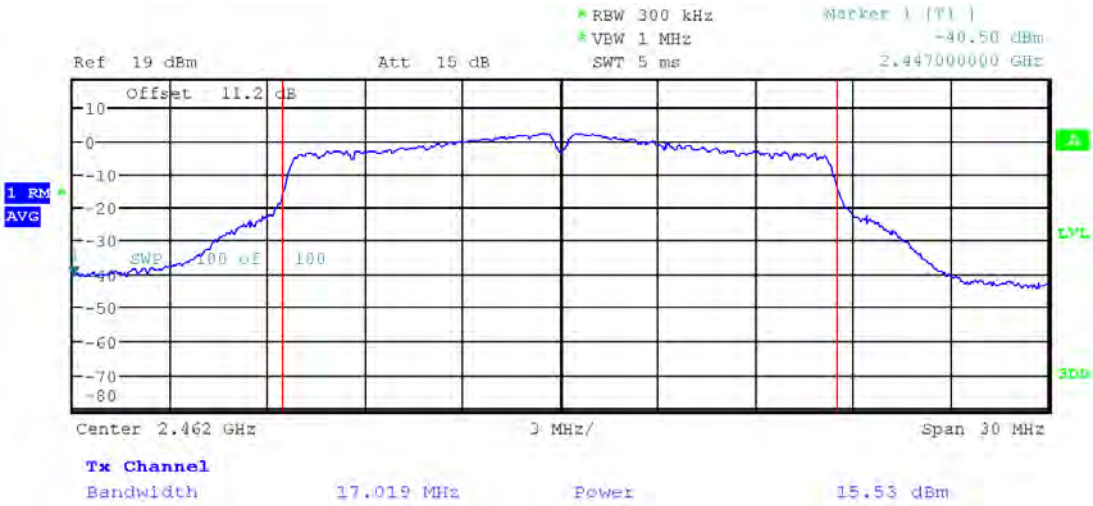

Plot 2. 4



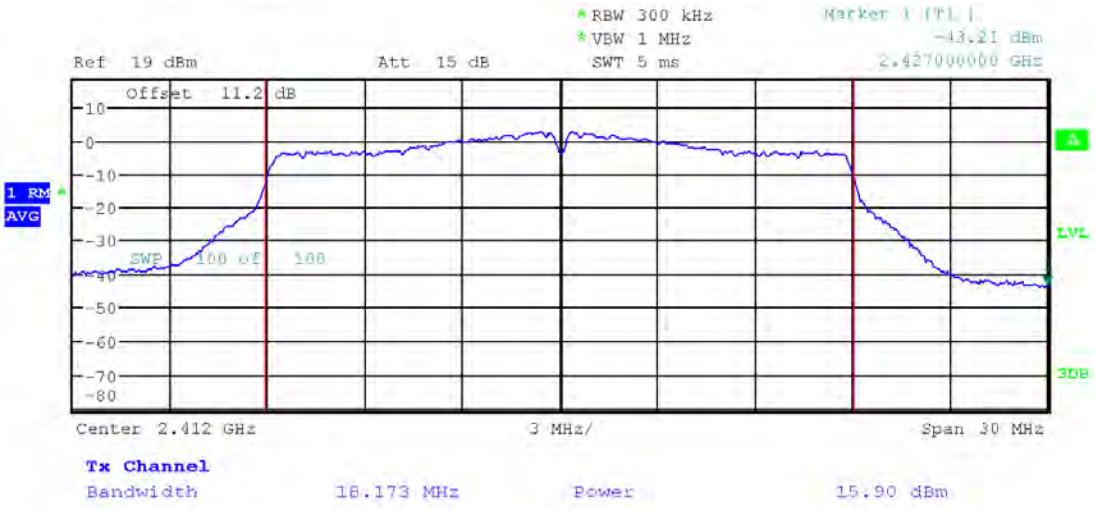
Plot 2. 5



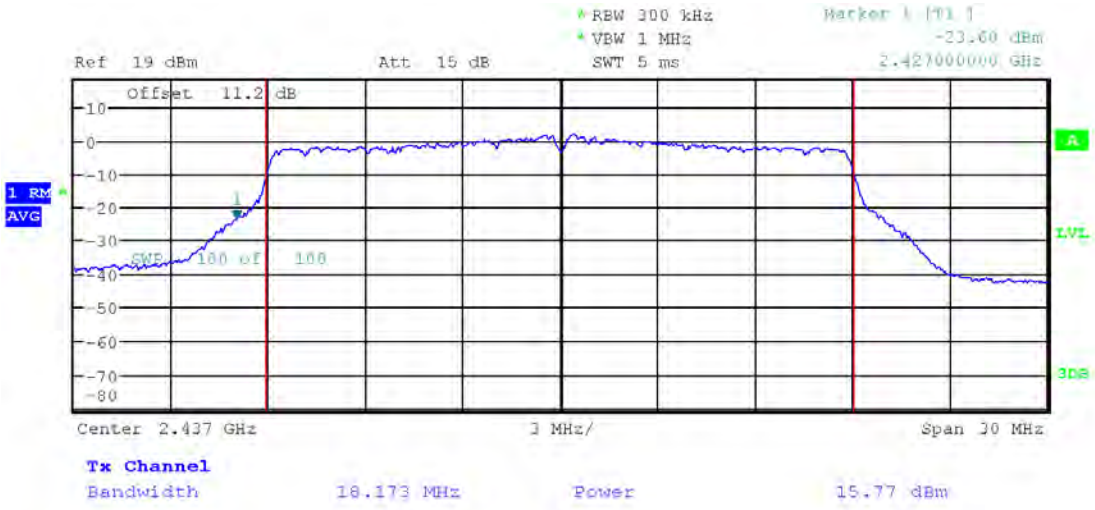

Plot 2. 6



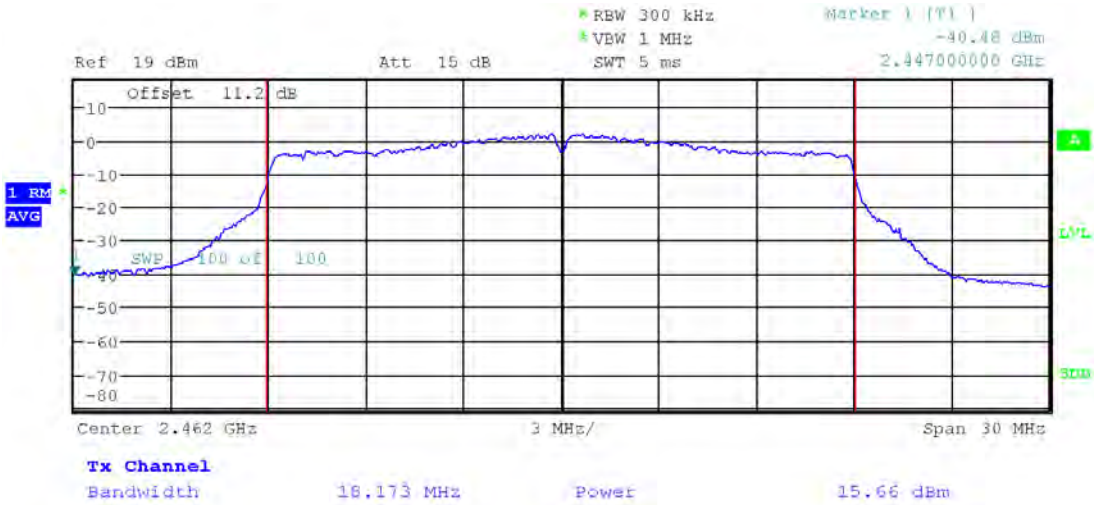
Plot 2. 7




Plot 2. 8



Plot 2. 9


RBW 300 kHz
VBW 1 MHz
SWT 5 ms
Marker 1 [T1 ]
-40.48 dBm
2.447000000 GHz
Ref 19 dBm
Att 15 dB
Offset 11.2 dB
1 RM
AVG
A
LVL
SWP 100 of 100
Center 2.462 GHz
3 MHz/
Span 30 MHz
Tx Channel
Bandwidth 18.173 MHz
Power 15.66 dBm

## 4.3 Power Spectral Density
FCC: 15.247 (e); RSS-247, 5.2.b);

### 4.3.1 Requirement

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna should not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

### 4.3.2 Procedure

The antenna port of the EUT was connected to the input of a spectrum analyzer to measure the Transmitter Power Density (PSD). The offset programmed on the analyzer is corrected to include cable loss, attenuator.

The procedure described in FCC Publication FCC Publication KDB 558074 D01 Meas Guidance v05r02, specifically section 11.10.2 Method PKPSD (peak PSD) of ANSI 63.10.

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the *DTS bandwidth*.
3. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

| Tested By | Test Date |
|---|---|
| Minh Ly | October 12, 2021 |

### 4.3.3 Test Result

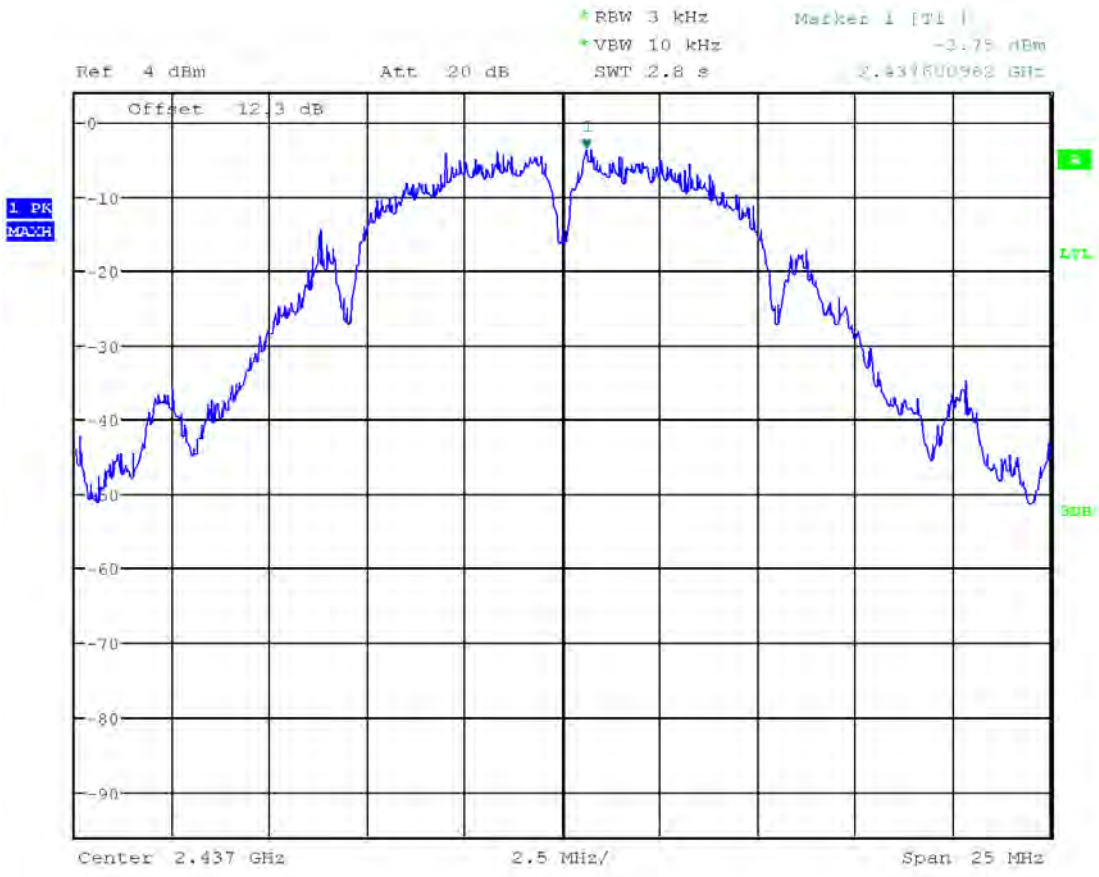
Refer to the following plots for the test result:

| Standard | Channel | Frequency MHz | PSD (Peak) dBm | Margin to 8dBm Limit dB | Plot # |
|---|---|---|---|---|---|
| 802.11b | 1 | 2412 | -3.53 | -11.53 | 3.1 |
| | 6 | 2437 | -3.75 | -11.75 | 3.2 |
| | 11 | 2462 | -3.21 | -11.21 | 3.3 |
| 802.11g | 1 | 2412 | -5.03 | -13.03 | 3.4 |
| | 6 | 2437 | -6.11 | -14.11 | 3.5 |
| | 11 | 2462 | -6.49 | -14.49 | 3.6 |
| 802.11n 20MHz | 1 | 2412 | -6.15 | -14.15 | 3.7 |
| | 6 | 2437 | -5.49 | -13.49 | 3.8 |
| | 11 | 2462 | -4.86 | -12.86 | 3.9 |

*Plot 3. 1*

RBW 3 kHz
VBW 10 kHz
SWT 2.8 s
Marker 1 [T1 ]
-3.53 dBm
2.410637821 GHz
Ref 4 dBm
Att 20 dB
Offset 12.3 dB
1 PK
MAXH
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.412 GHz
2.5 MHz/
Span 25 MHz
Date: 12.OCT.2021 22:04:31

*Plot 3. 2*

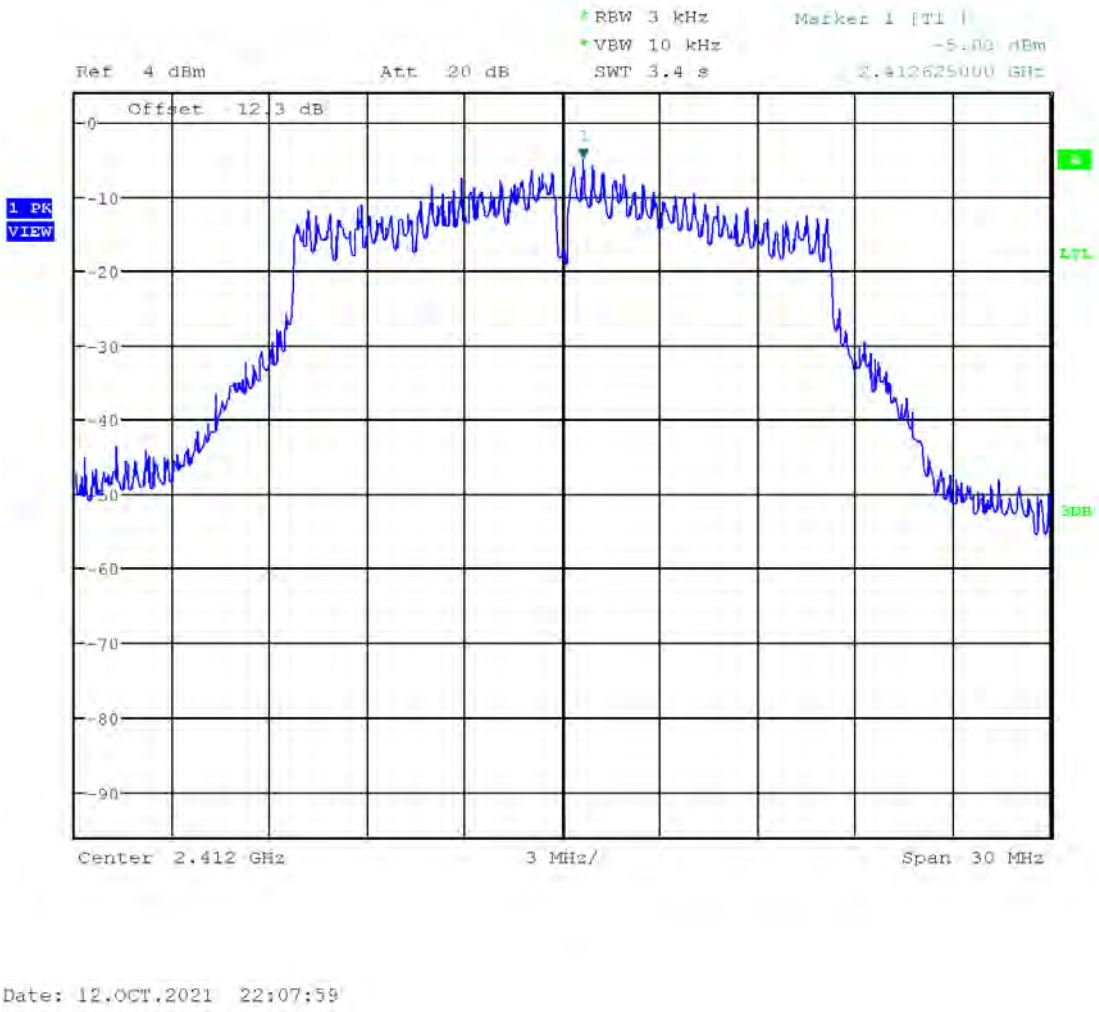



Date: 12.OCT.2021 22:05:48

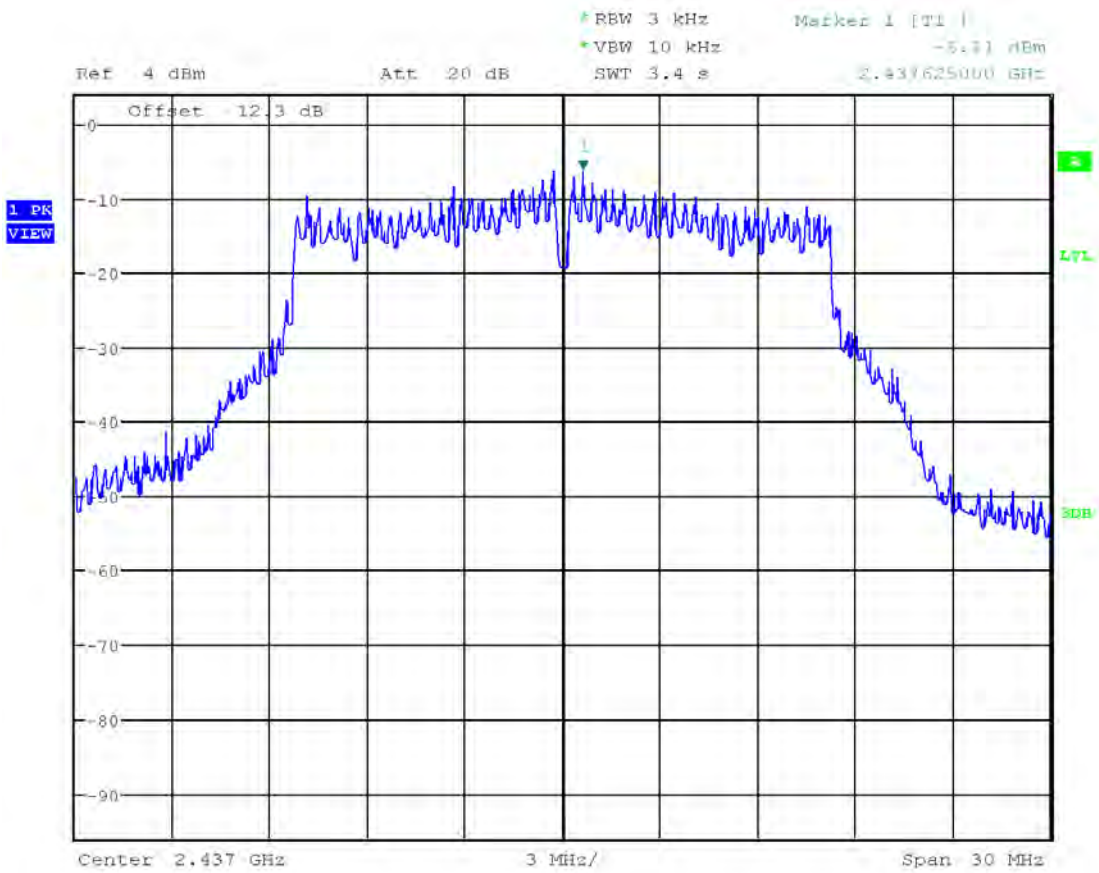
*Plot 3. 3*

RBW 3 kHz
VBW 10 kHz
SWT 2.8 s
Marker 1 [T1 ]
-3.21 dBm
2.461399038 GHz
Ref 4 dBm
Att 20 dB
Offset 12.3 dB
1 PK
VIEW
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.462 GHz
2.5 MHz/
Span 25 MHz
Date: 12.OCT.2021 22:06:44

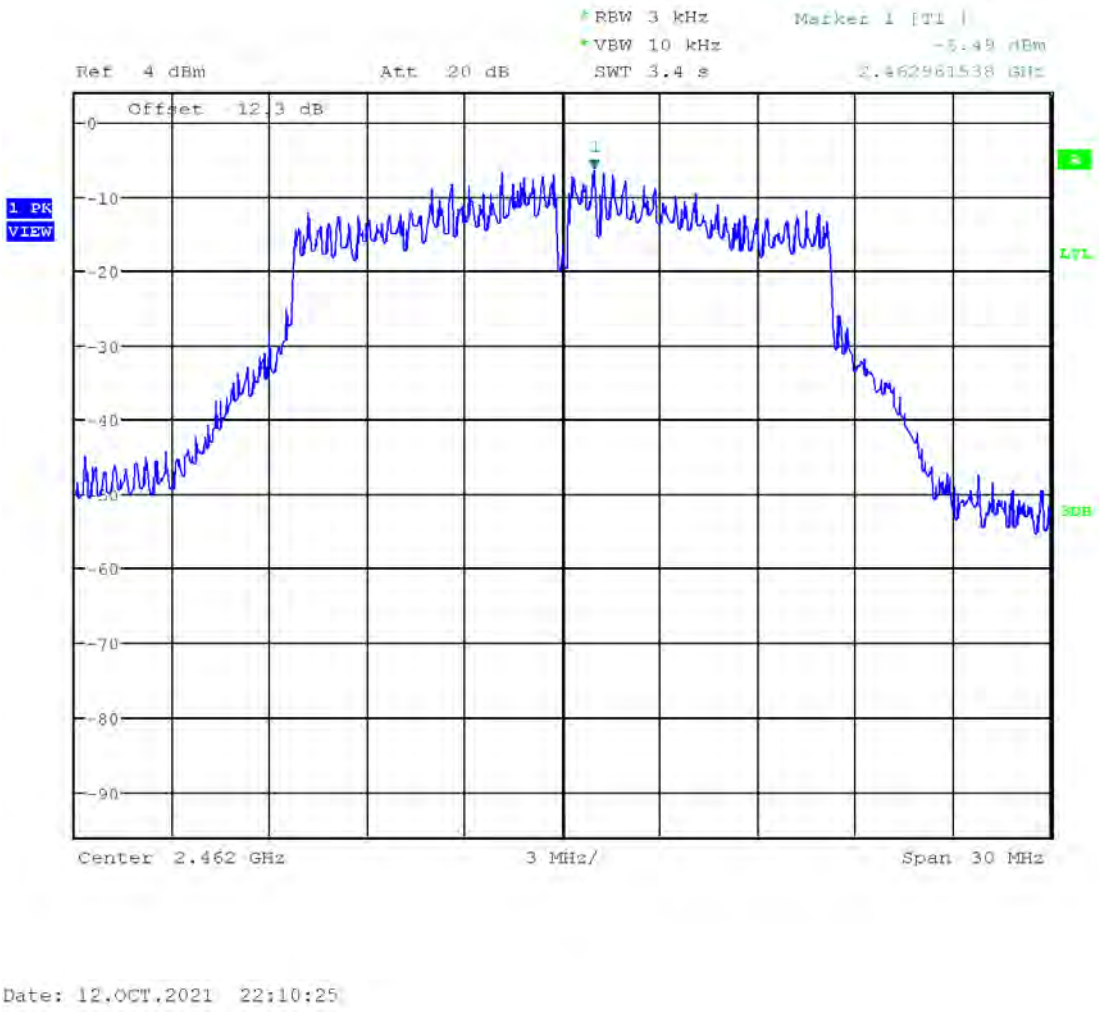
*Plot 3. 4*


RBW 3 kHz
VBW 10 kHz
SWT 3.4 s
Marker 1 [T1 ]
-5.00 dBm
2.412625000 GHz
Ref 4 dBm
Att 20 dB
Offset 12.3 dB
1 PK
VIEW
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
LVL
3DB
Center 2.412 GHz
3 MHz/
Span 30 MHz
Date: 12.OCT.2021 22:07:59

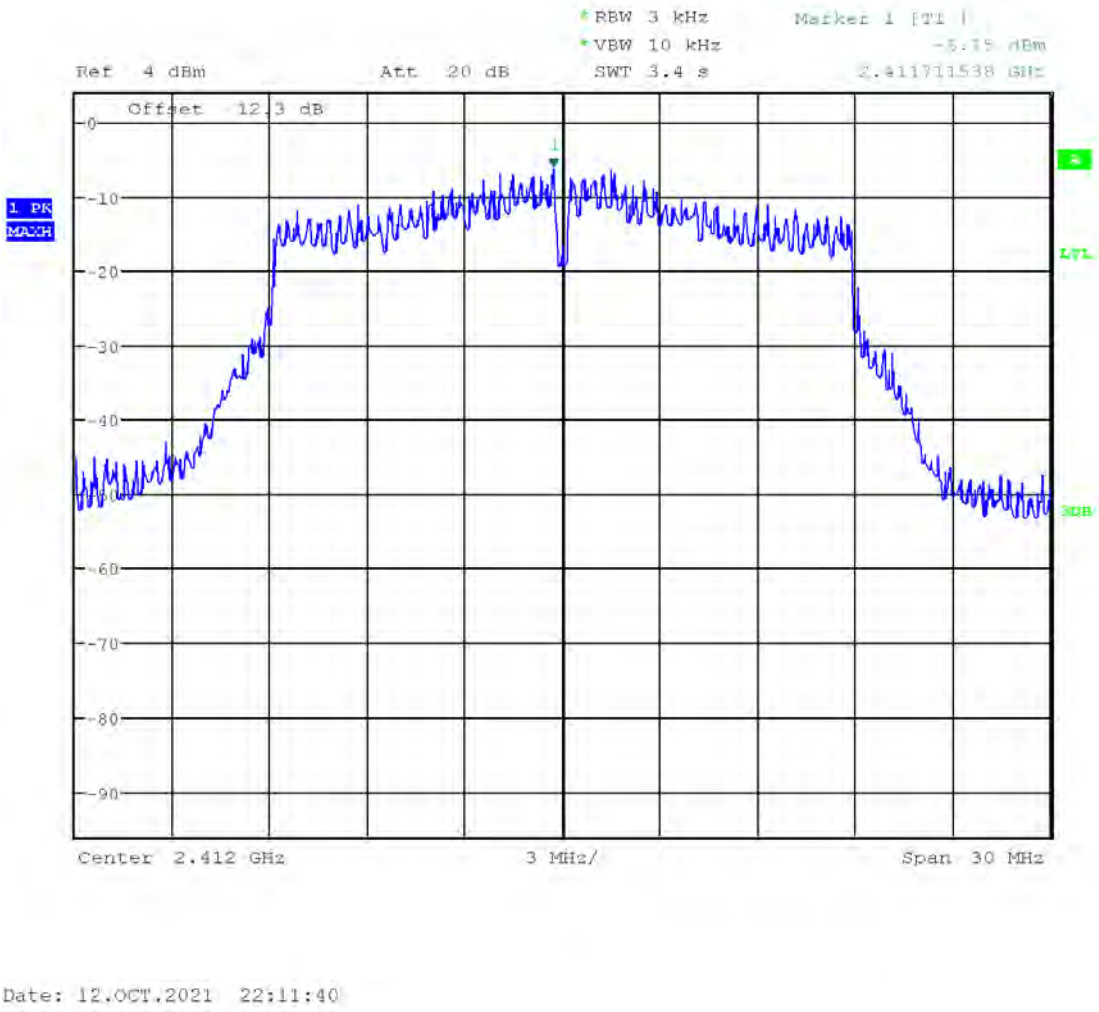
*Plot 3. 5*


RBW 3 kHz
VBW 10 kHz
SWT 3.4 s
Marker 1 [T1 ]
-5.31 dBm
2.437625000 GHz
Ref 4 dBm
Att 20 dB
Offset 12.3 dB
1 PK
VIEW
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.437 GHz
3 MHz/
Span 30 MHz
Date: 12.OCT.2021 22:09:34

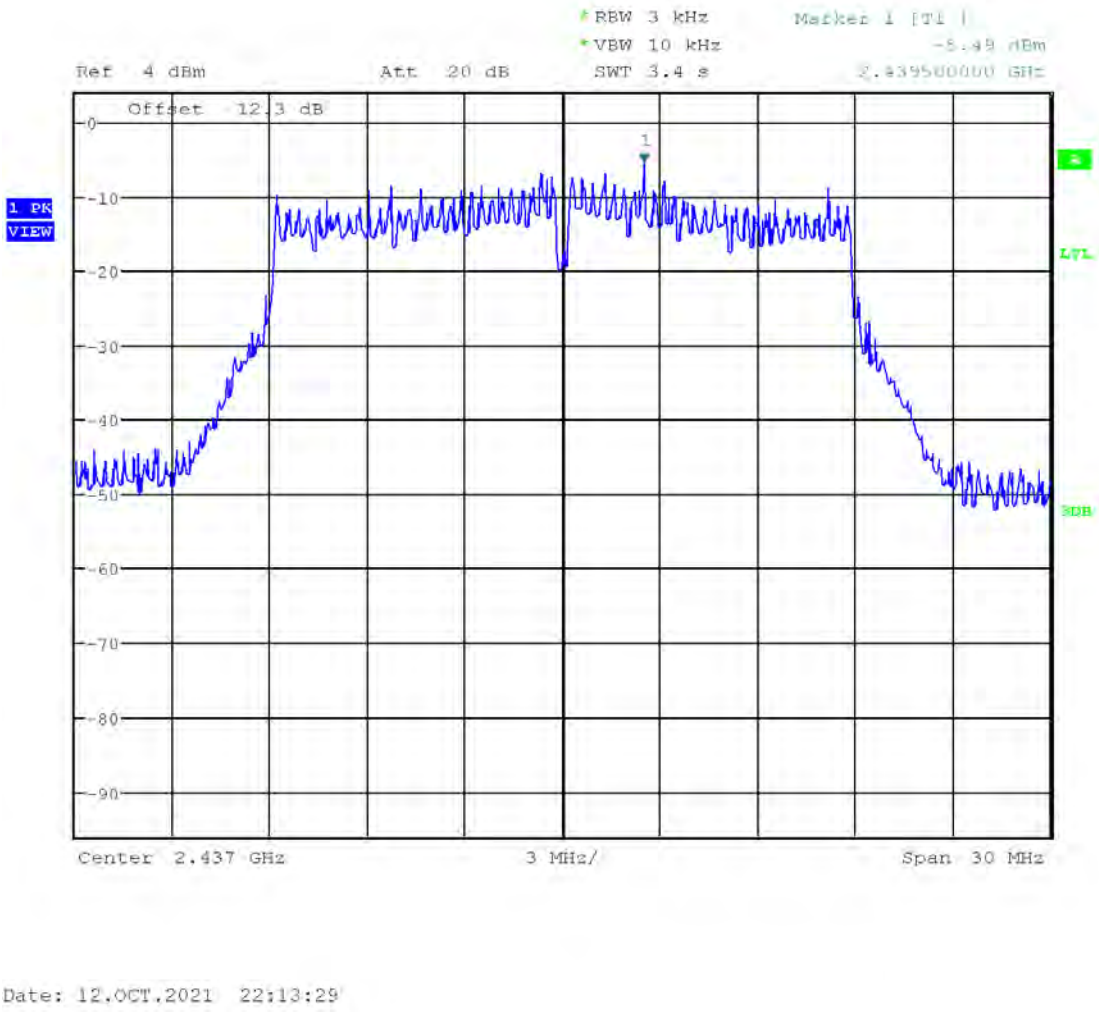
*Plot 3. 6*


RBW 3 kHz
VBW 10 kHz
SWT 3.4 s
Marker 1 [T1 ]
-5.49 dBm
2.462961538 GHz
Ref 4 dBm
Att 20 dB
Offset 12.3 dB
1 PK
VIEW
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
D
LVL
3DB
Center 2.462 GHz
3 MHz/
Span 30 MHz
Date: 12.OCT.2021 22:10:25

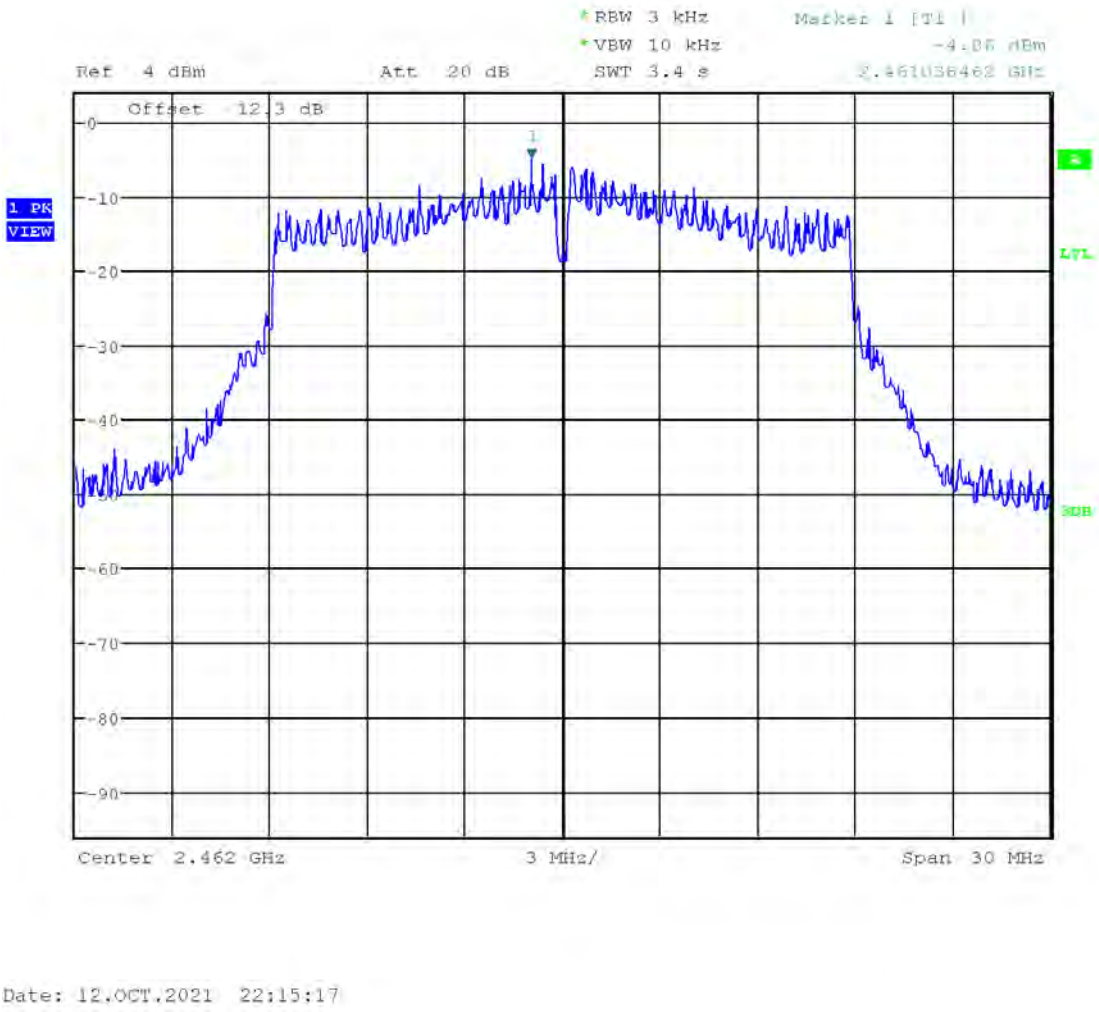
*Plot 3. 7*


RBW 3 kHz
VBW 10 kHz
SWT 3.4 s
Marker 1 [T1 ]
-5.15 dBm
2.411711538 GHz
Ref 4 dBm
Att 20 dB
Offset 12.3 dB
1 PK
MAXH
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
LVL
3DB
Center 2.412 GHz
3 MHz/
Span 30 MHz
Date: 12.OCT.2021 22:11:40

*Plot 3. 8*


RBW 3 kHz
VBW 10 kHz
SWT 3.4 s
Marker 1 [T1 ]
-5.49 dBm
2.439500000 GHz
Ref 4 dBm
Att 20 dB
Offset 12.3 dB
1 PK
VIEW
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
A
LVL
3DB
Center 2.437 GHz
3 MHz/
Span 30 MHz
Date: 12.OCT.2021 22:13:29

*Plot 3. 9*


RBW 3 kHz
VBW 10 kHz
SWT 3.4 s
Marker 1 [T1 ]
-4.06 dBm
2.461036462 GHz
Ref 4 dBm
Att 20 dB
Offset 12.3 dB
1 PK
VIEW
LVL
3DB
Center 2.462 GHz
3 MHz/
Span 30 MHz
Date: 12.OCT.2021 22:15:17

## 4.4 Out-of-Band Conducted Emissions
FCC: 15.247(d); RSS-247, 5.5;

### 4.4.1 Requirement

In any 100 kHz bandwidth outside the EUT pass-band, the RF power shall be below the maximum in-band 100 kHz emissions by at least 20 dB (if peak power of in-band emission is measured) or 30 dB (if average power of in-band emission is measured).

In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a)

### 4.4.2 Procedure

The procedure described in FCC Publication KDB 558074 D01 Meas Guidance v05r02, specifically section 11.11 DTS Emissions in non-restricted frequency bands of ANSI 63.10.

A spectrum analyzer was connected to the antenna port of the transmitter.

1. Set the RBW = 100 kHz.
2. Set the VBW ≥ 3 x RBW.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

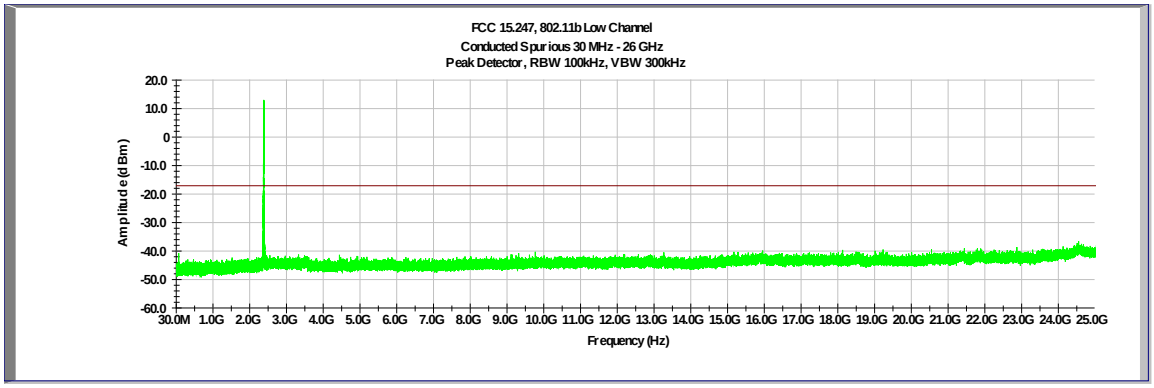
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

### 4.4.3 Test Result

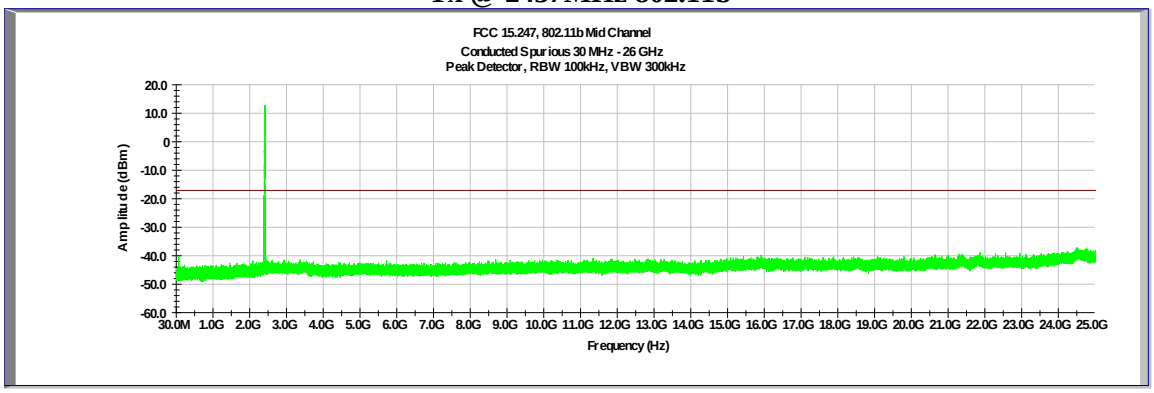
Refer to the following plots 4.1 – 4.9 for unwanted conducted emissions. The plot shows -30dB attenuation limit line.

| Tested By | Test Date |
|---|---|
| Minh Ly | October 12, 2021 |

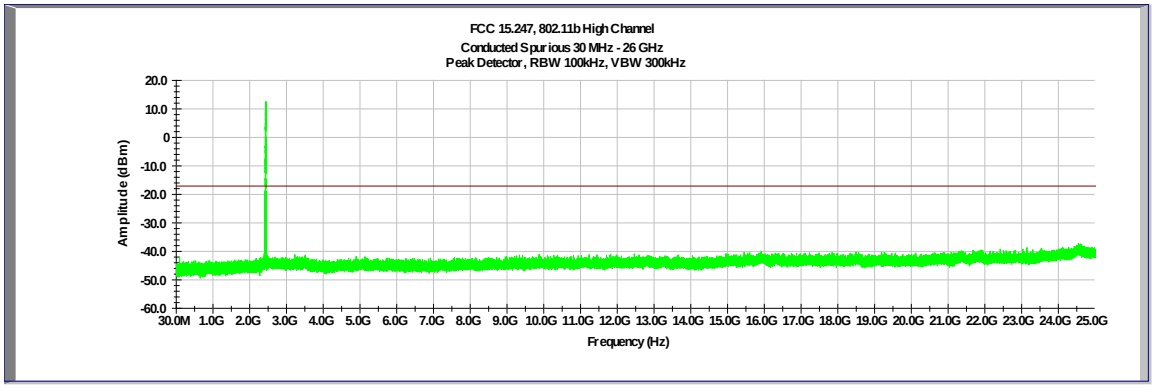
Plot 4.1
**Tx @ 2412MHz 802.11b**



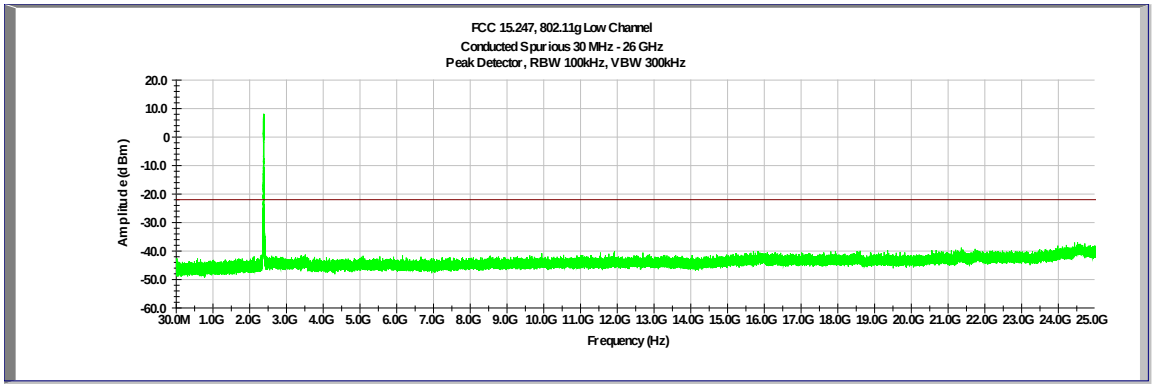

Plot 4.2
**Tx @ 2437MHz 802.11b**



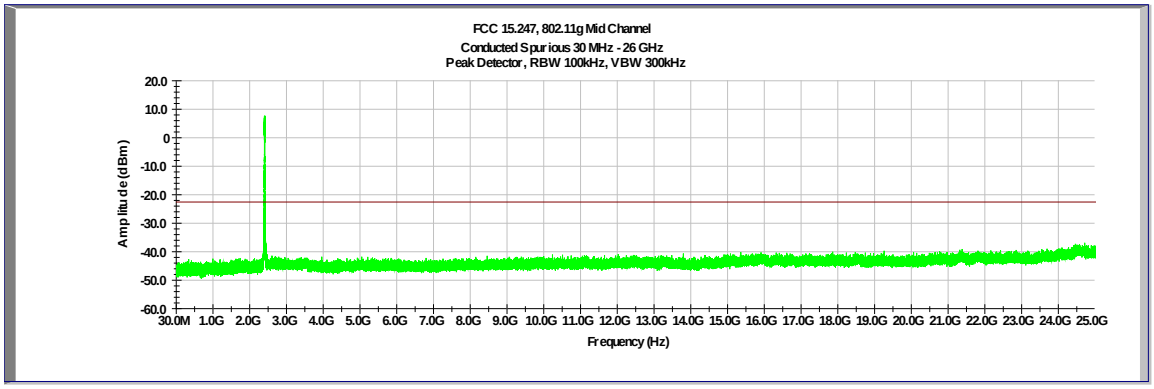

Plot 4.3
**Tx @ 2462MHz 802.11b**



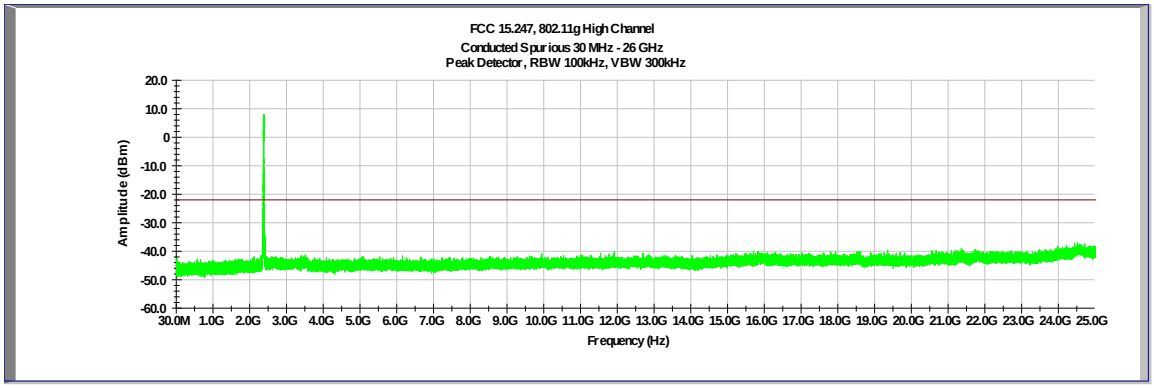
Plot 4.4
**Tx @ 2412MHz 802.11g**



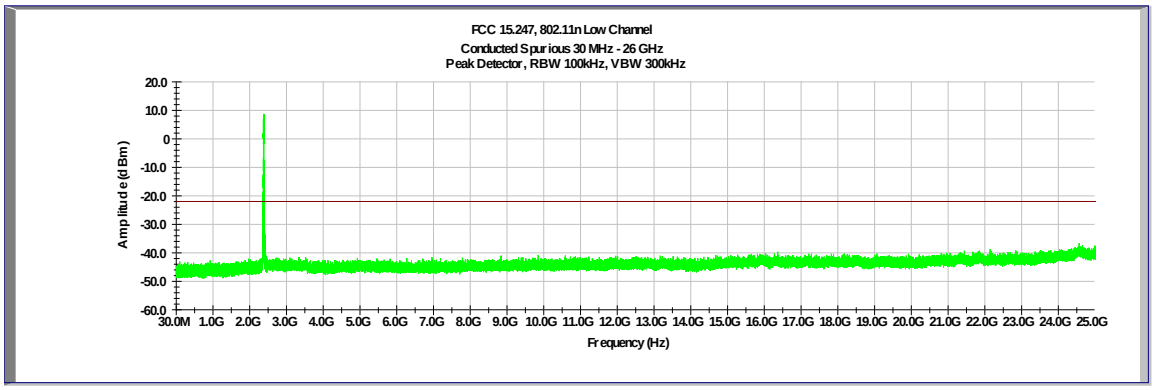

Plot 4.5
**Tx @ 2437MHz 802.11g**



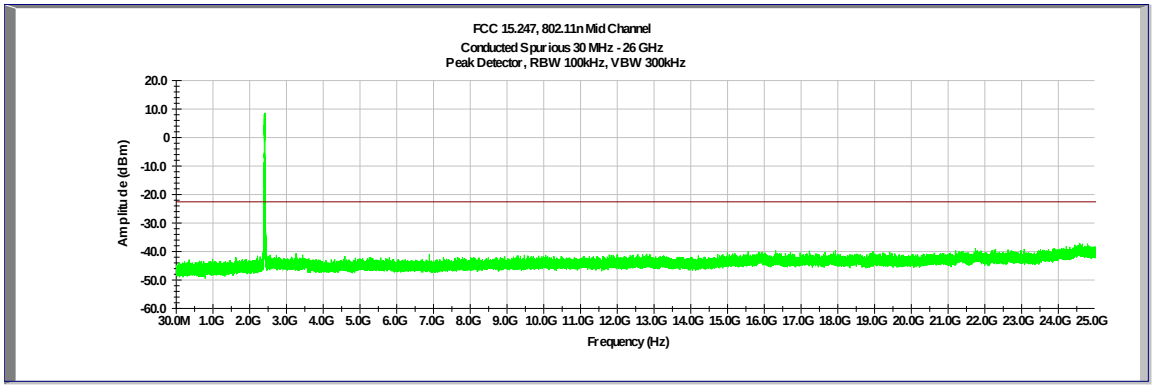

Plot 4.6
**Tx @ 2462MHz 802.11g**



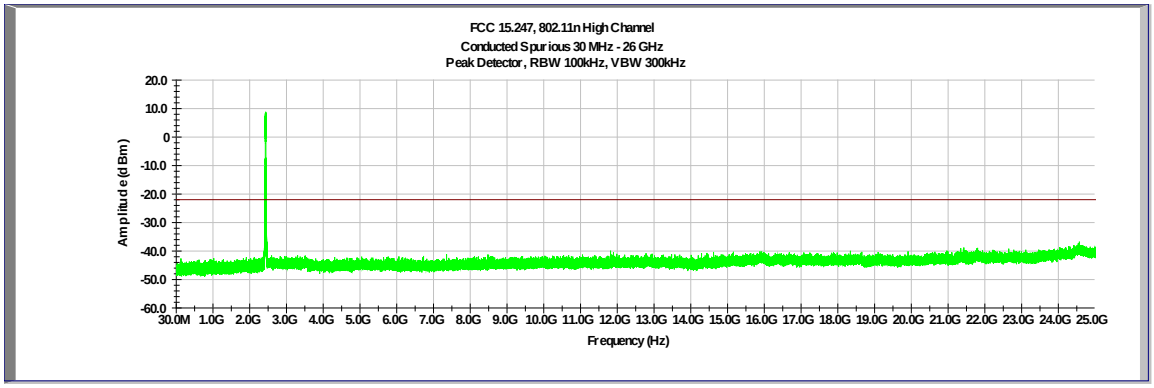
Plot 4.7
**Tx @ 2412MHz 802.11n 20MHz**




Plot 4.8
**Tx @ 2437MHz 802.11n 20MHz**

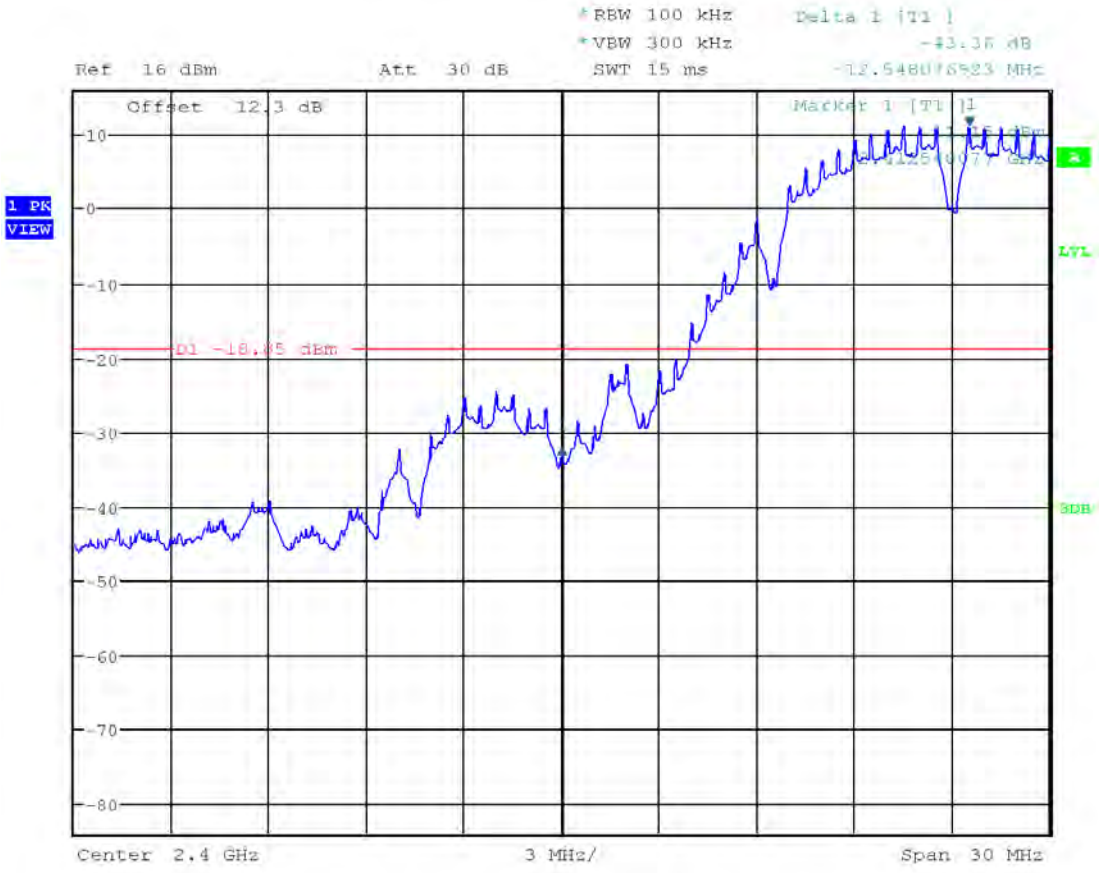



Plot 4.9
**Tx @ 2462MHz 802.11n 20MHz**



Plot 4.10

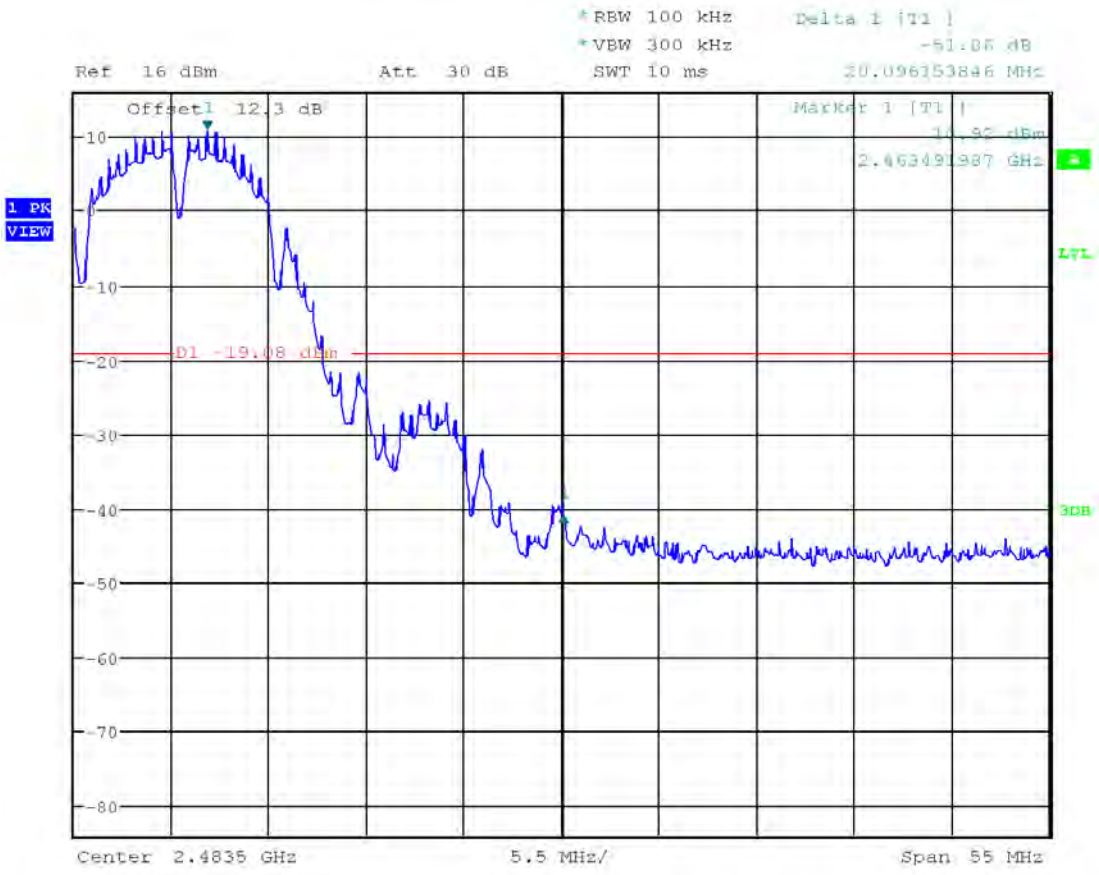
**Conducted Band Edge, Tx @ 2412MHz 802.11b**




Date: 12.OCT.2021 22:20:51

Plot 4.11

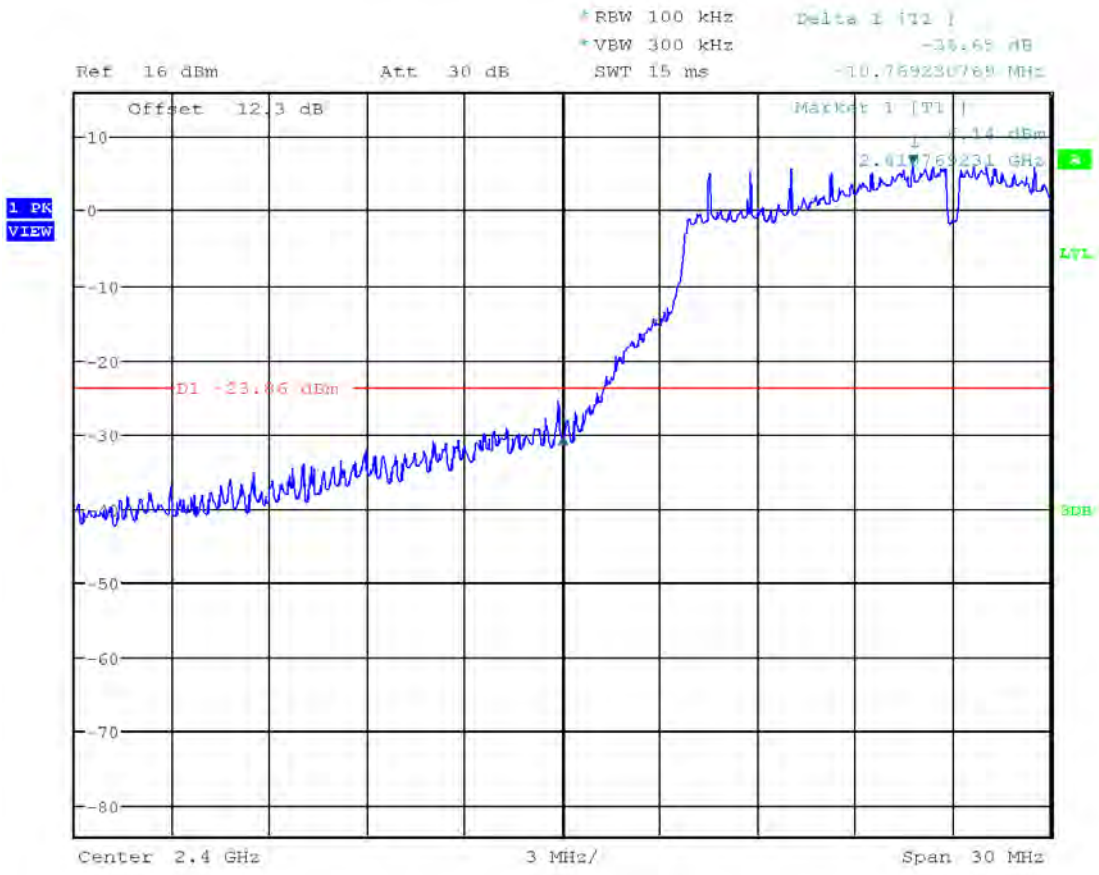
**Conducted Band Edge, Tx @ 2462MHz 802.11b**




Date: 12.OCT.2021 22:25:48

Plot 4.12

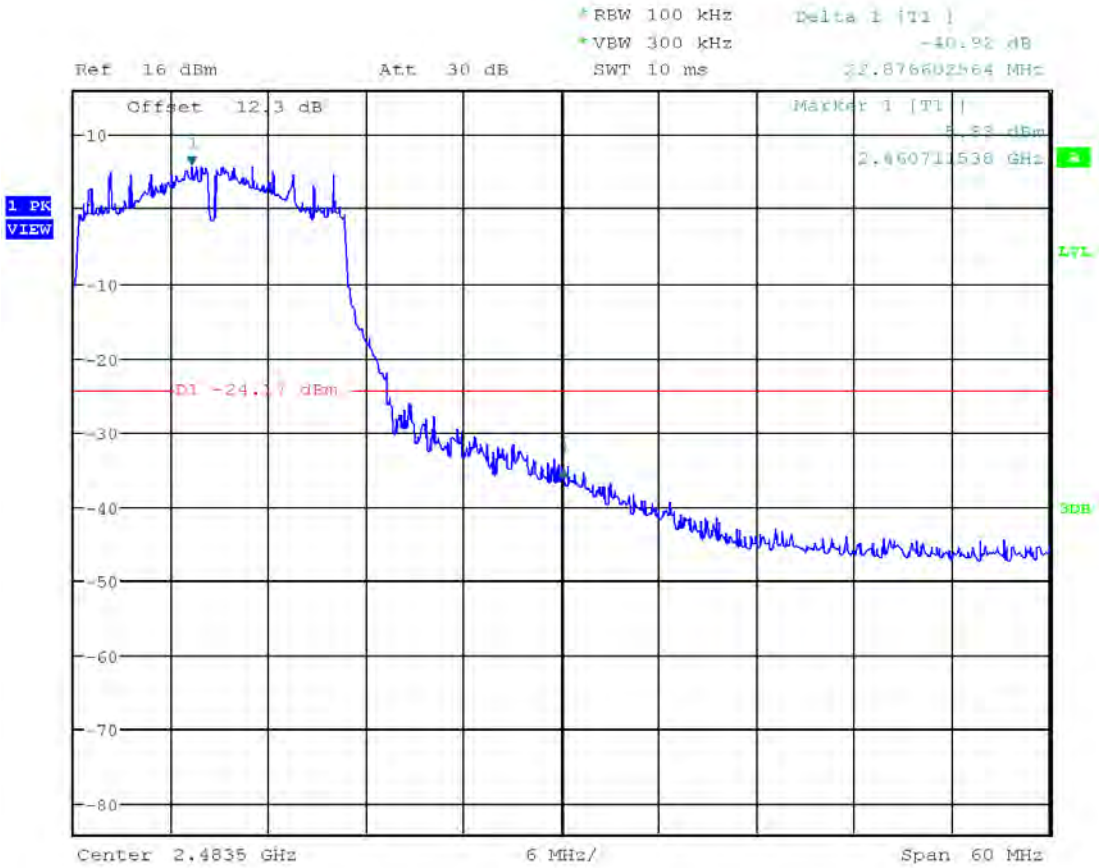
**Conducted Band Edge, Tx @ 2412MHz 802.11g**




Date: 12.OCT.2021 22:22:21

Plot 4.13

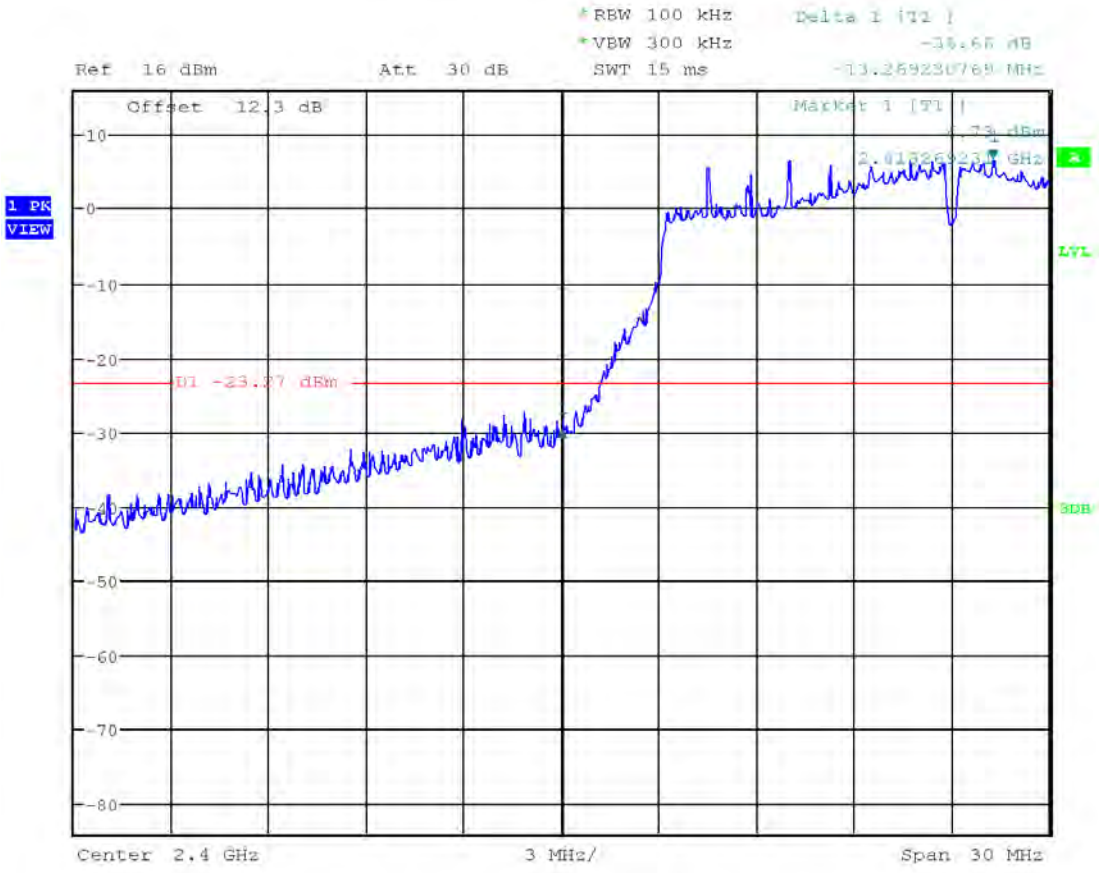
**Conducted Band Edge, Tx @ 2462MHz 802.11g**




Date: 12.OCT.2021 22:28:40

Plot 4.14

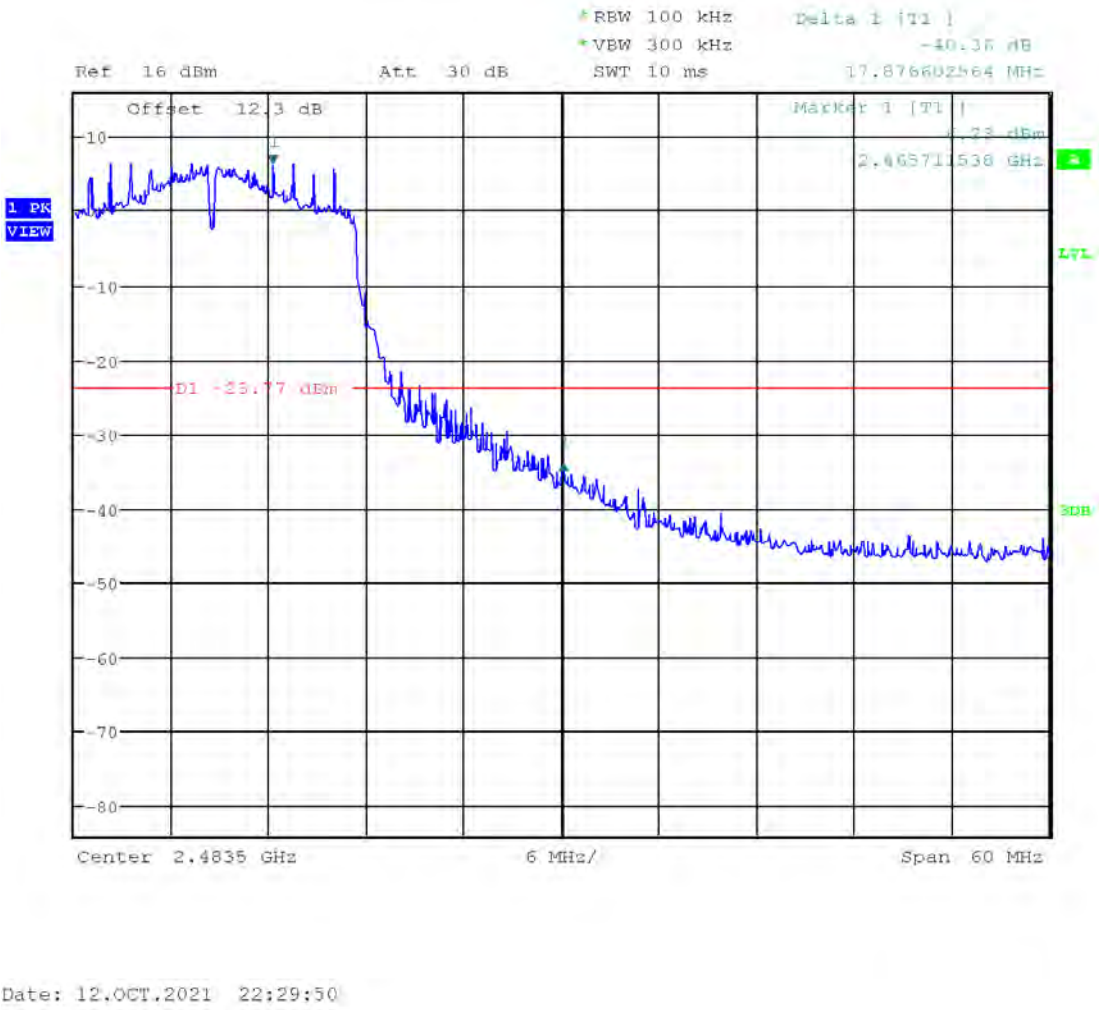
**Conducted Band Edge, Tx @ 2412MHz 802.11n 20MHz**




Date: 12.OCT.2021 22:23:31

Plot 4.15

**Conducted Band Edge, Tx @ 2462MHz 802.11n 20MHz**



## 4.5 Transmitter Radiated Emissions
FCC Rules: 15.247(d), 15.209, 15.205; RSS-247, 5.5;

### 4.5.1 Requirement

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

For out of band radiated emissions (except for frequencies in restricted bands), in any 100 kHz bandwidths outside the EUT pass-band, the RF power shall be at least 20dB (peak) or 30 dB (average) below that of the maximum in-band 100 kHz emissions.

### 4.5.2 Procedure – Radiated Emissions

Radiated emission measurements were performed from 9 kHz to 26.5 GHz according to the procedure described in ANSI C63.10: 2013. Spectrum Analyzer Resolution Bandwidth is 200Hz or greater for frequencies 9kHz to 30MHz, 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz for frequencies above 1000 MHz. Above 1000 MHz Peak and Average measurements were performed.

The EUT is placed on a plastic turntable that is 80 cm in height for below 1000MHz and 1.5m in height for above 1GHz. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables were manipulated to produce worst-case emissions. The signal is maximized through rotation. 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 3 meters for frequencies above 1 GHz and at 10 meters for frequencies below 1 GHz.

Measurements made from 1 GHz to 18GHz had a 2.4-2.5GHz notch filter in place. A preamp was used from 30MHz to 26GHz.

All measurements were made with a Peak Detector and compared to QP limits for 30MHz – 1GHz and Average limits for 1GHz – 26GHz.

Correlation measurements were performed below 30MHz between 10m ALSE and Open Field site according to FCC KDB 414788 D01 Radiated Test Site v01r01 section 2. All readings were within the acceptable tolerance.

EUT was tested in both horizontal and upright position. Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels).

### 4.5.3 Field Strength Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF – AG; if measurement is performed at a distance other than specified in the rule, a Distance Correction Factor (DCF) shall be added.

Where FS = Field Strength in dB(μV/m)
RA = Receiver Amplitude (including preamplifier) in dB(μV); AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB; AG = Amplifier Gain in dB

Assume a receiver reading of 52.0 dB(μV) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving field strength of 32 dB(μV/m). This value in dB(μV/m) was converted to its corresponding level in μV/m.
RA = 52.0 dB(μV)
AF = 7.4 dB(1/m)
CF = 1.6 dB
AG = 29.0 dB
FS = 52.0+7.4+1.6-29.0 = 32 dB(μV/m).
Level in μV/m = Com
mon Antilogarithm [(32 dBμV/m)/20] = 39.8 μV/m.

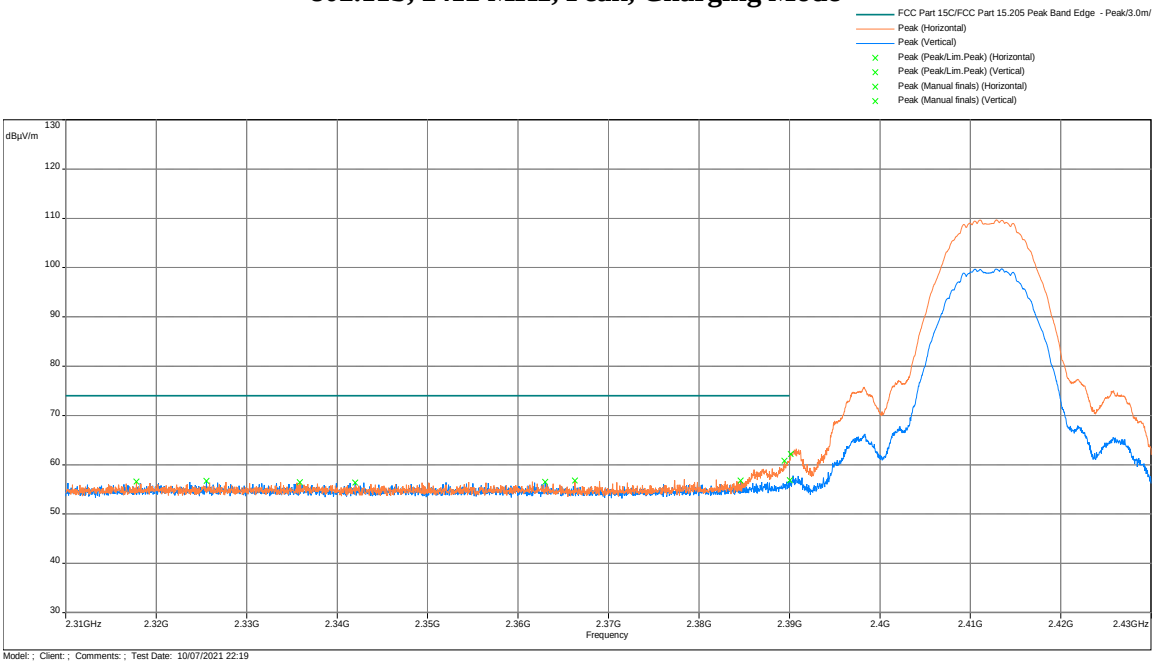
### 4.5.4 Test Results

The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

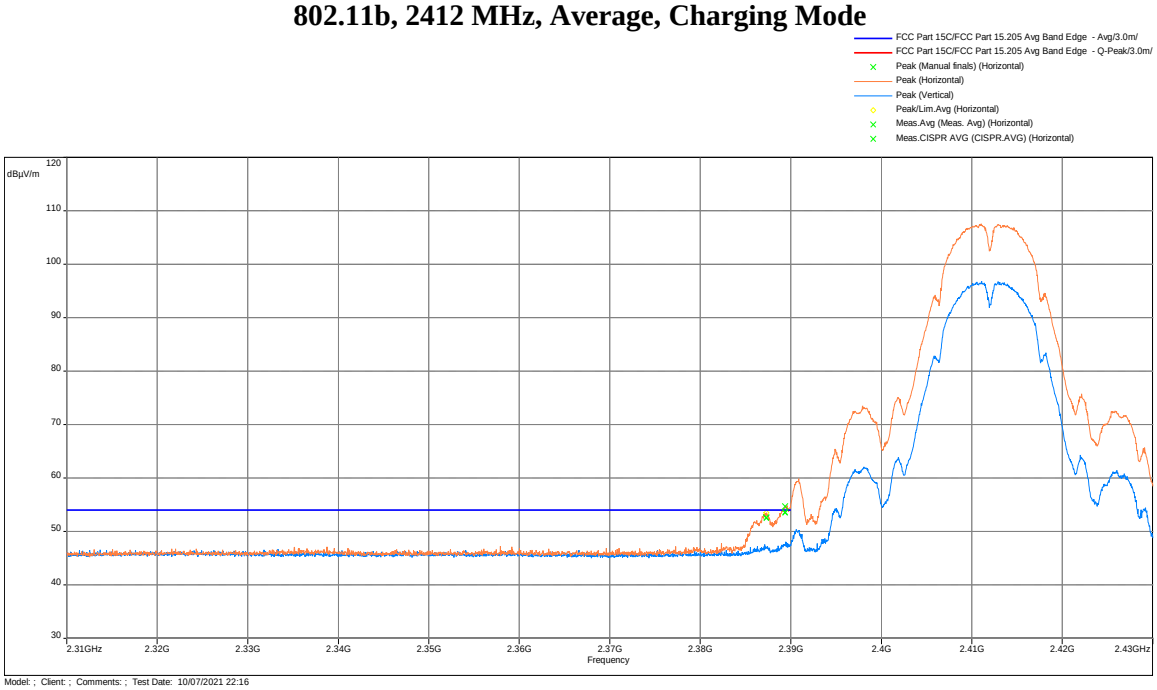
| Tested By | Test Date |
|---|---|
| Minh Ly | October 08 - 11, 2021 |

## Test Results: 15.209/15.205 Radiated Restricted Band Emissions

### Out-of-Band Spurious Emissions at the Band Edge @1m distance
### 802.11b, 2412 MHz, Peak, Charging Mode

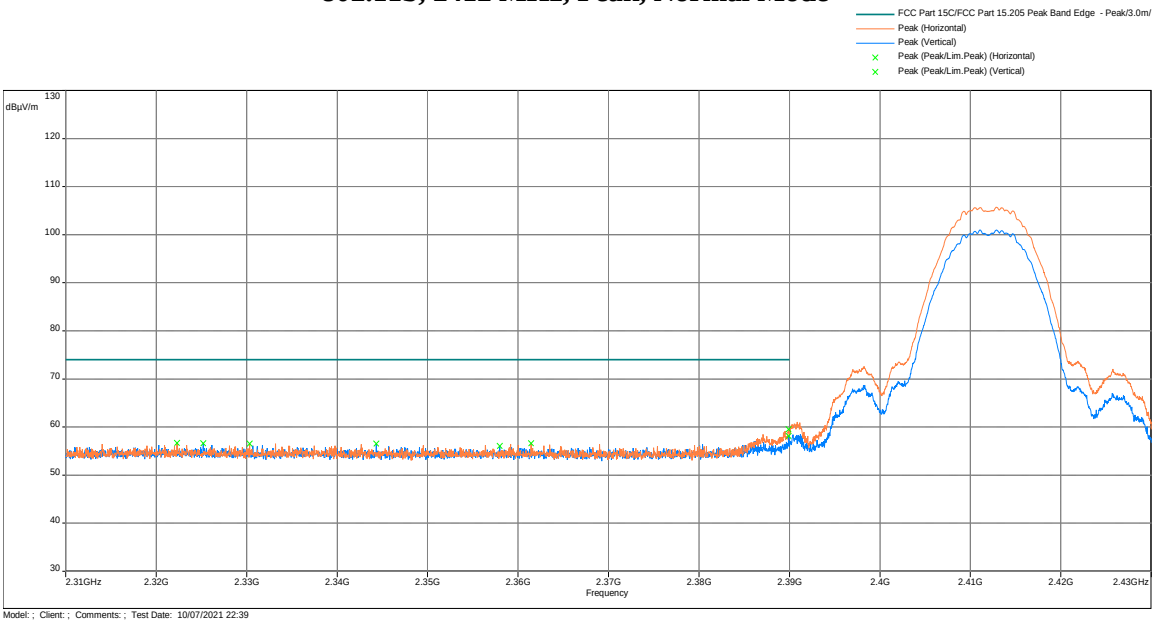



### 802.11b, 2412 MHz, Average, Charging Mode

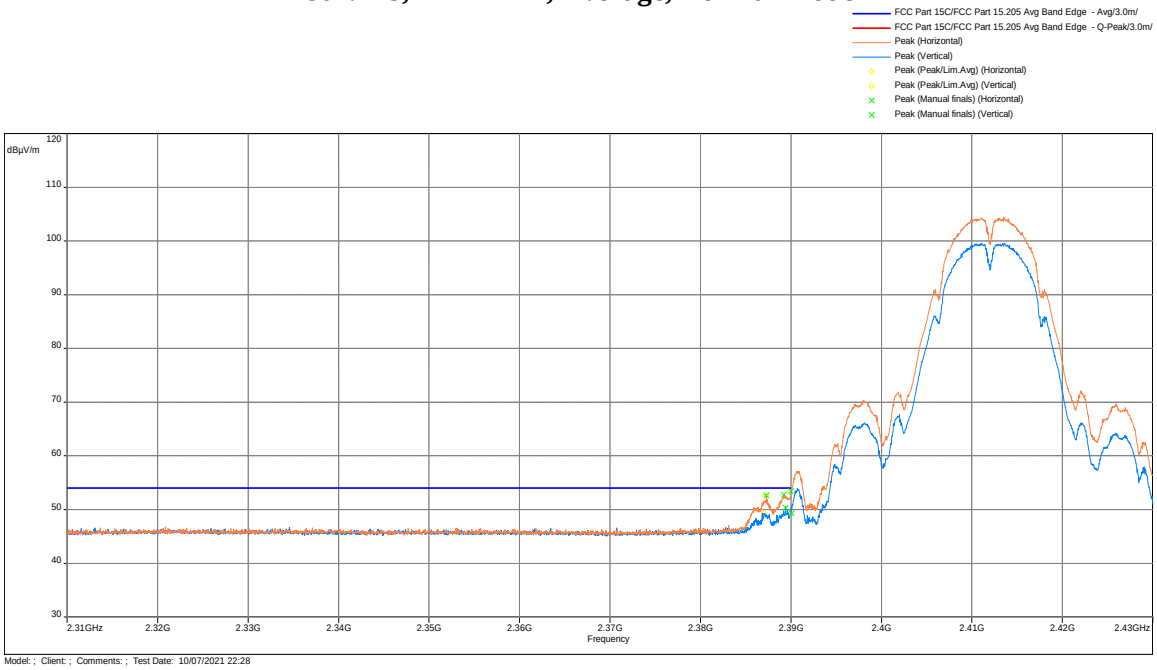



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2387.2 | 52.7 | 54.0 | -1.4 | 150.0 | 198.0 | Horizontal | 21.6 |
| 2390.0 | 53.7 | 54.0 | -0.4 | 150.0 | 190.0 | Horizontal | 21.6 |

## Out-of-Band Spurious Emissions at the Band Edge @1m distance
## 802.11b, 2412 MHz, Peak, Normal Mode

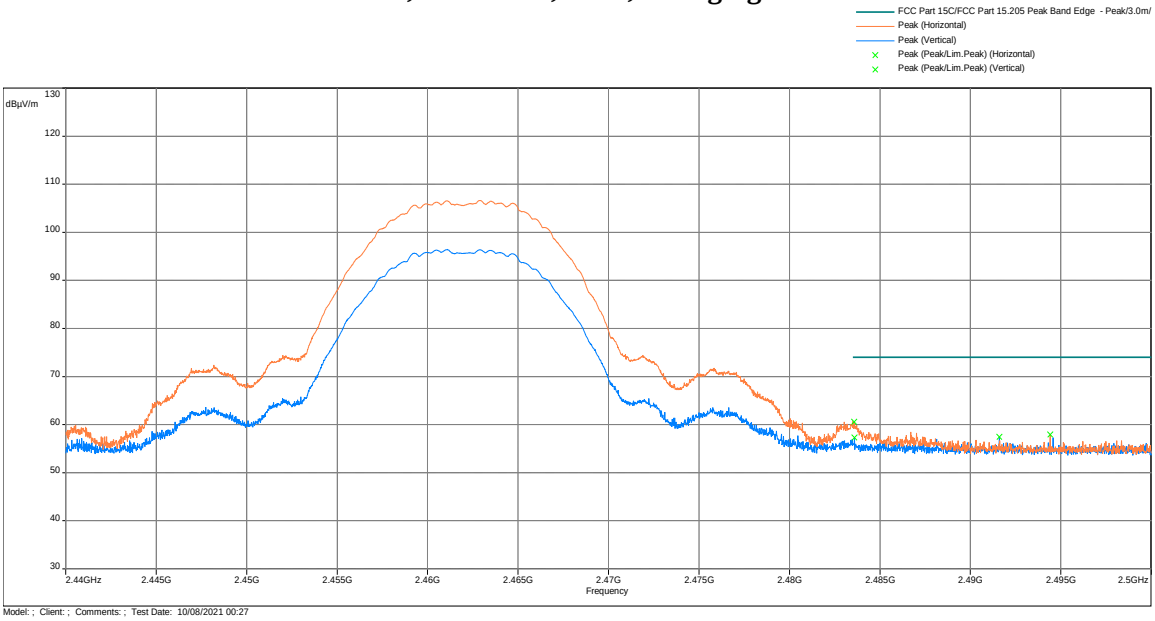



## 802.11b, 2412 MHz, Average, Normal Mode

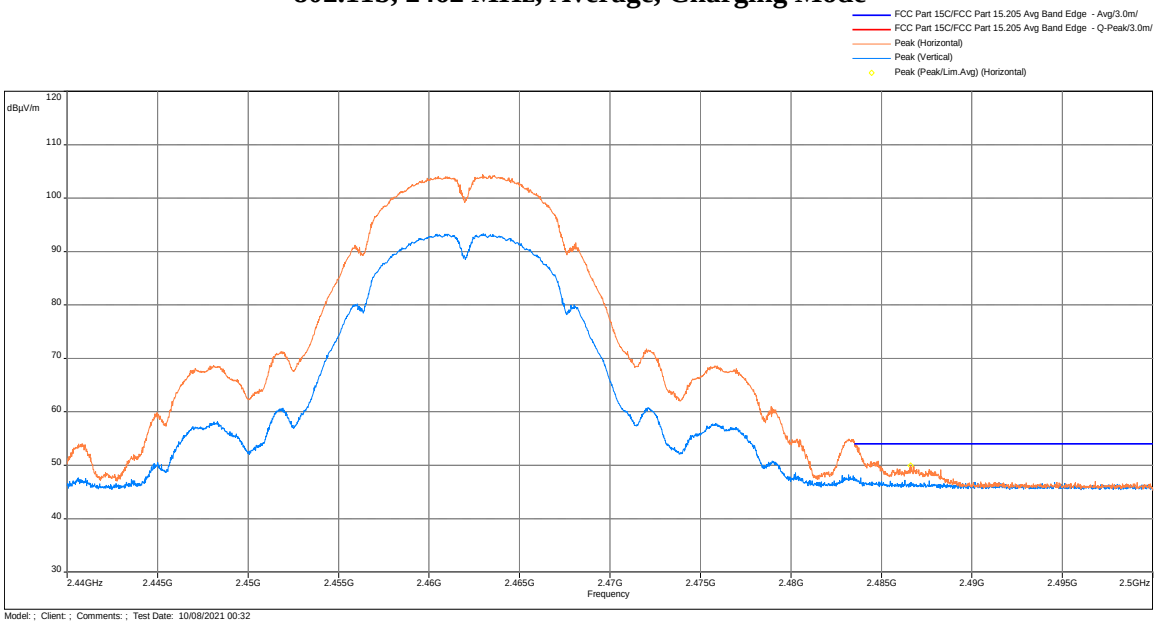



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2387.3 | 52.6 | 54.0 | -1.4 | 1.5 | 181.5 | Horizontal | 21.6 |
| 2389.2 | 52.8 | 54.0 | -1.2 | 1.5 | 181.5 | Horizontal | 21.6 |
| 2390.0 | 53.4 | 54.0 | -0.6 | 1.5 | 181.5 | Horizontal | 21.6 |
| 2389.4 | 50.3 | 54.0 | -3.7 | 1.5 | 286.3 | Vertical | 21.6 |
| 2390.0 | 49.3 | 54.0 | -4.7 | 1.5 | 255.0 | Vertical | 21.6 |

## Out-of-Band Spurious Emissions at the Band Edge @1m distance
## 802.11b, 2462 MHz, Peak, Charging Mode

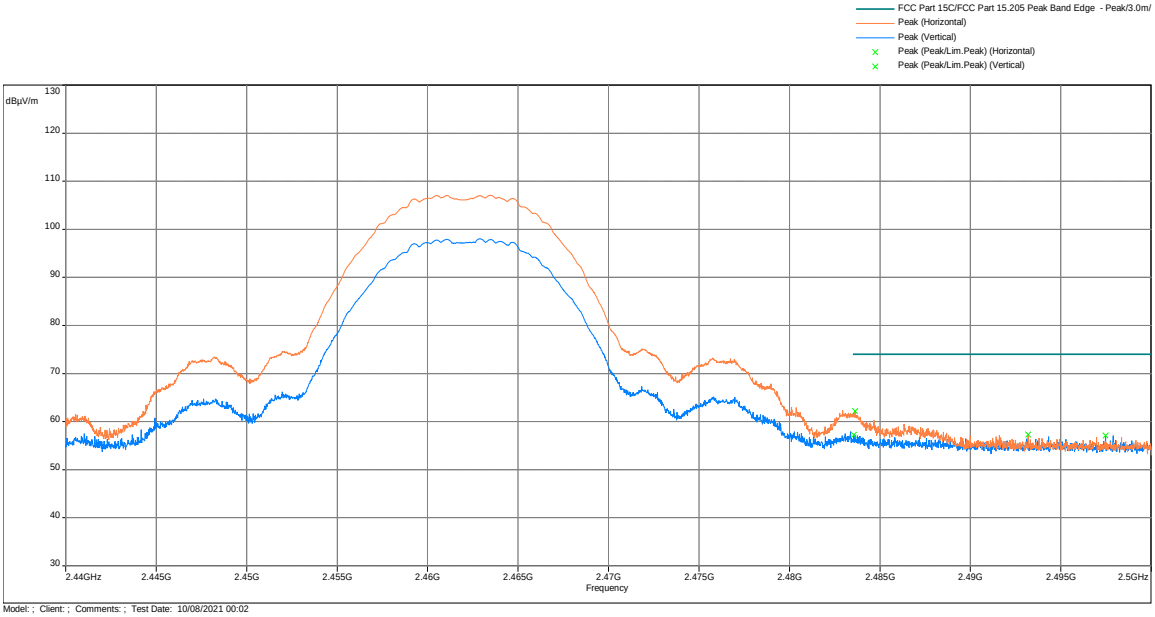



## 802.11b, 2462 MHz, Average, Charging Mode

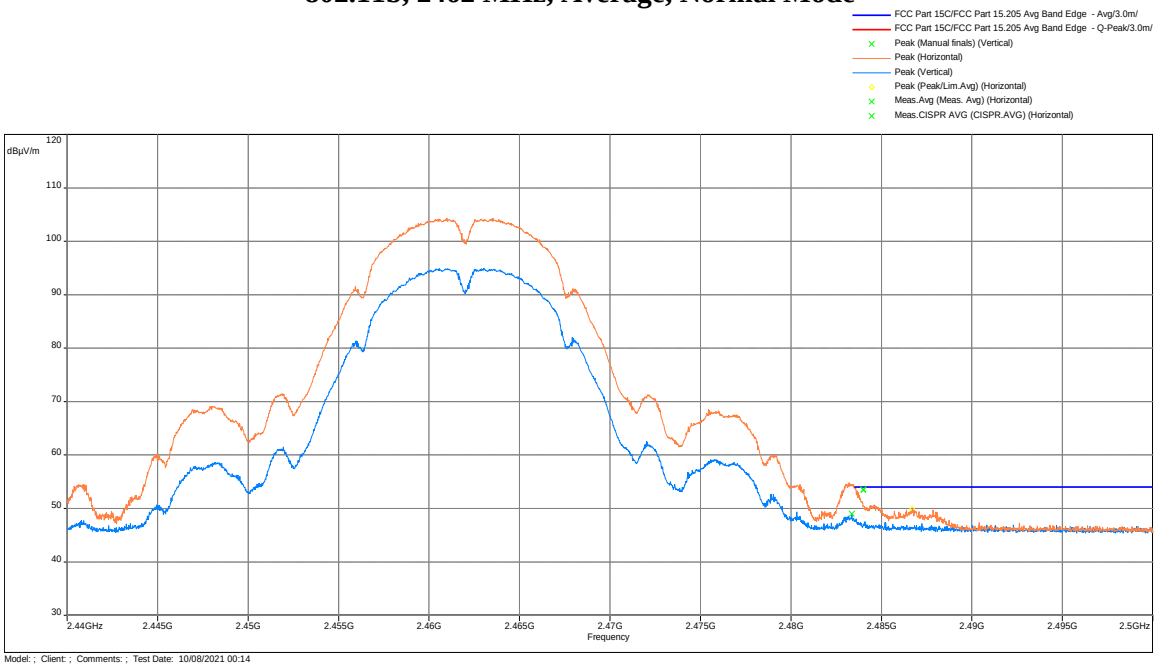



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2483.5 | 53.5 | 54.0 | -0.5 | 1.5 | 58.0 | Horizontal | 22.0 |

## Out-of-Band Spurious Emissions at the Band Edge @1m distance
## 802.11b, 2462 MHz, Peak, Normal Mode

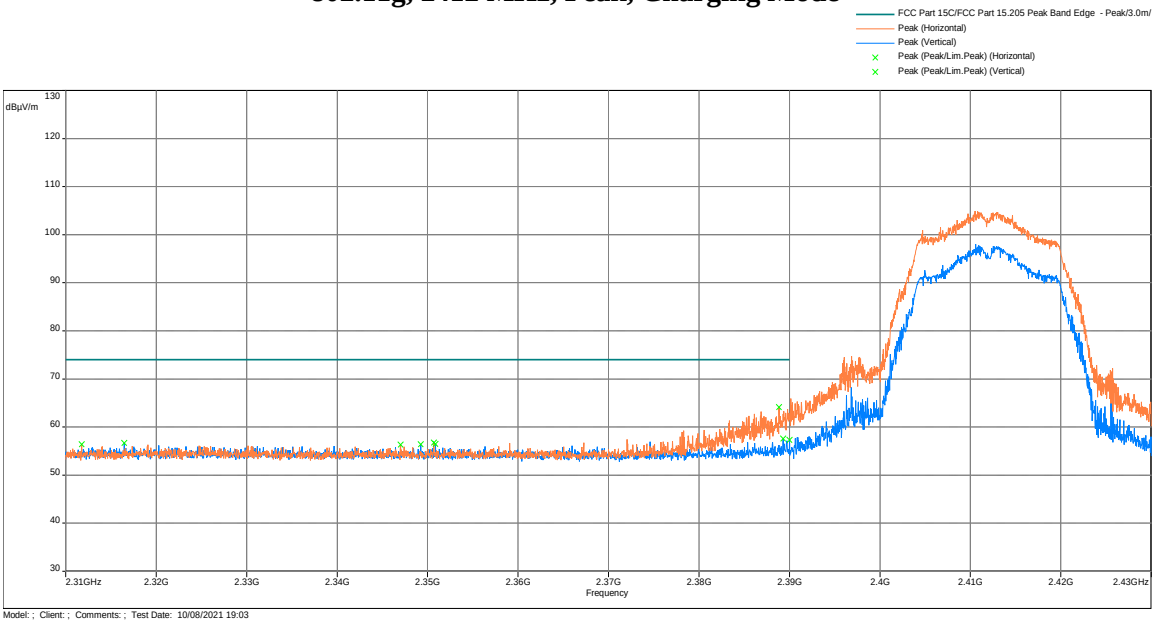



## 802.11b, 2462 MHz, Average, Normal Mode

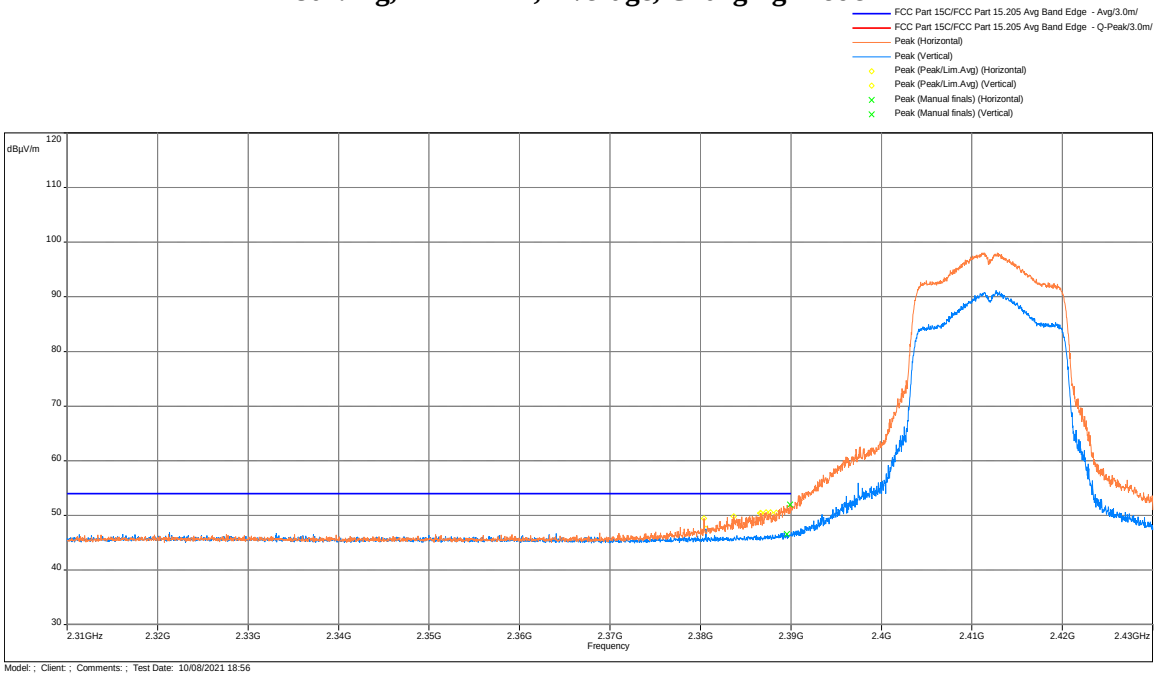



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2483.5 | 53.6 | 54.0 | -0.5 | 1.4 | 193.0 | Horizontal | 22.0 |
| 2483.5 | 49.0 | 54.0 | -5.0 | 1.5 | 0.0 | Vertical | 22.0 |

## Out-of-Band Spurious Emissions at the Band Edge @1m distance
## 802.11g, 2412 MHz, Peak, Charging Mode

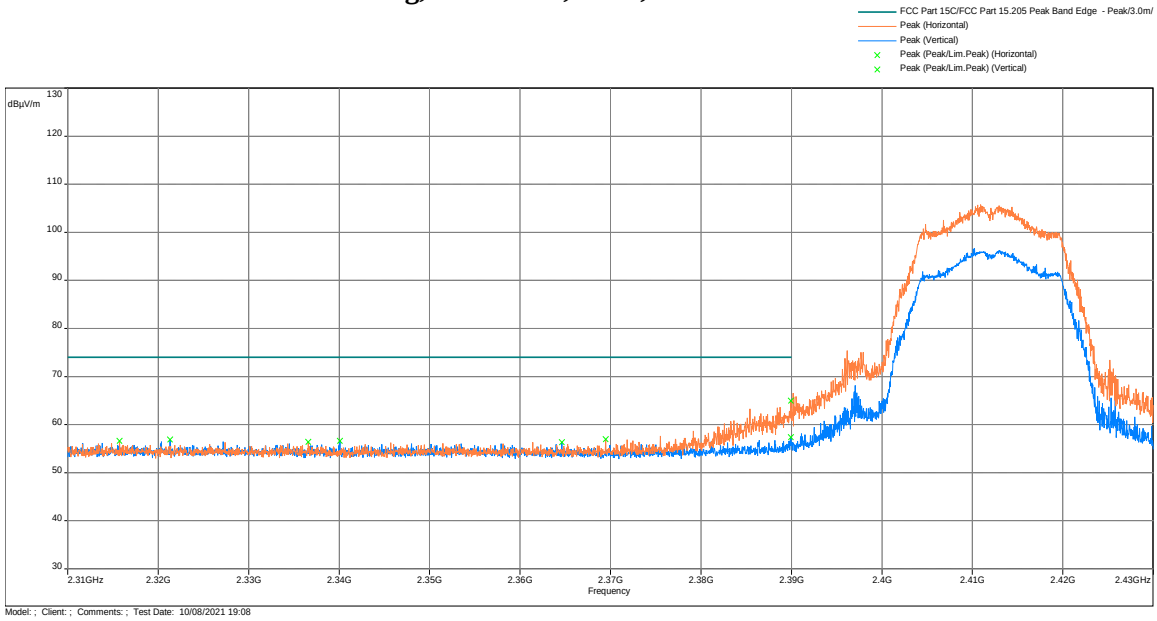



## 802.11g, 2412 MHz, Average, Charging Mode

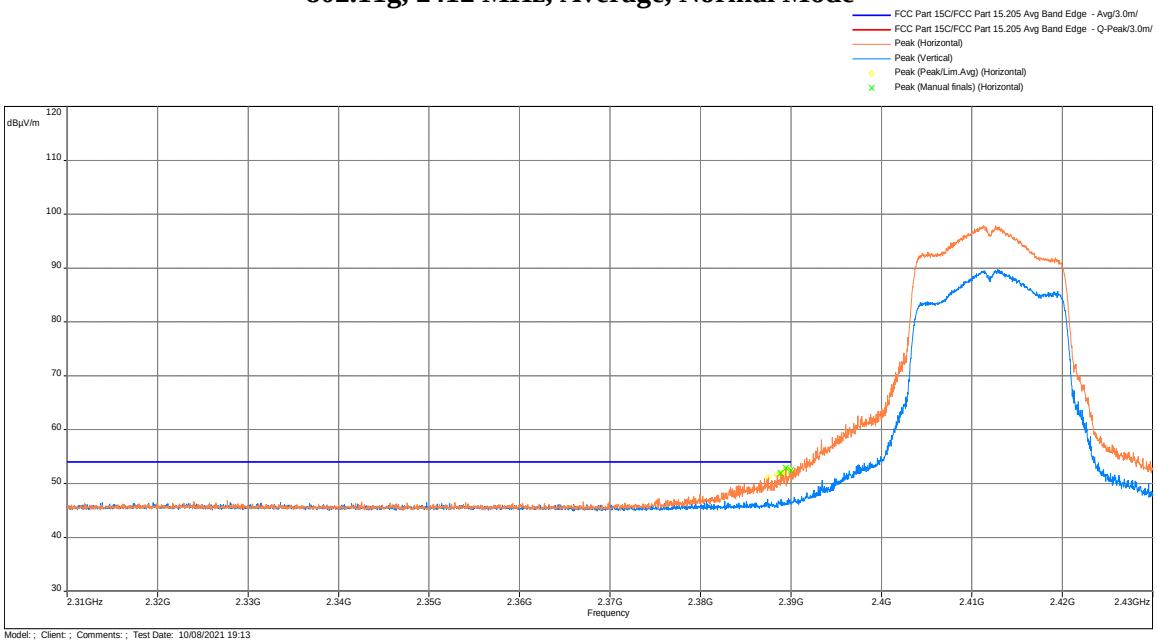



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2390.0 | 51.9 | 54.0 | -2.1 | 1.5 | 123.0 | Horizontal | 21.6 |
| 2390.0 | 46.6 | 54.0 | -7.5 | 1.5 | 162.3 | Vertical | 21.6 |

## Out-of-Band Spurious Emissions at the Band Edge @1m distance
## 802.11g, 2412 MHz, Peak, Normal Mode

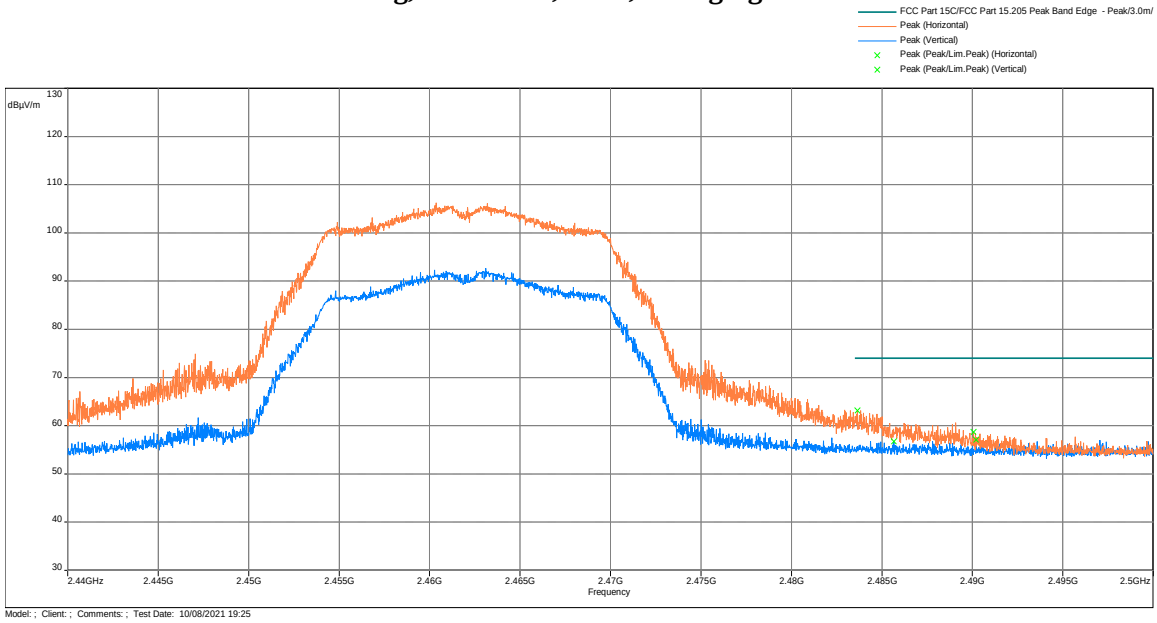



## 802.11g, 2412 MHz, Average, Normal Mode

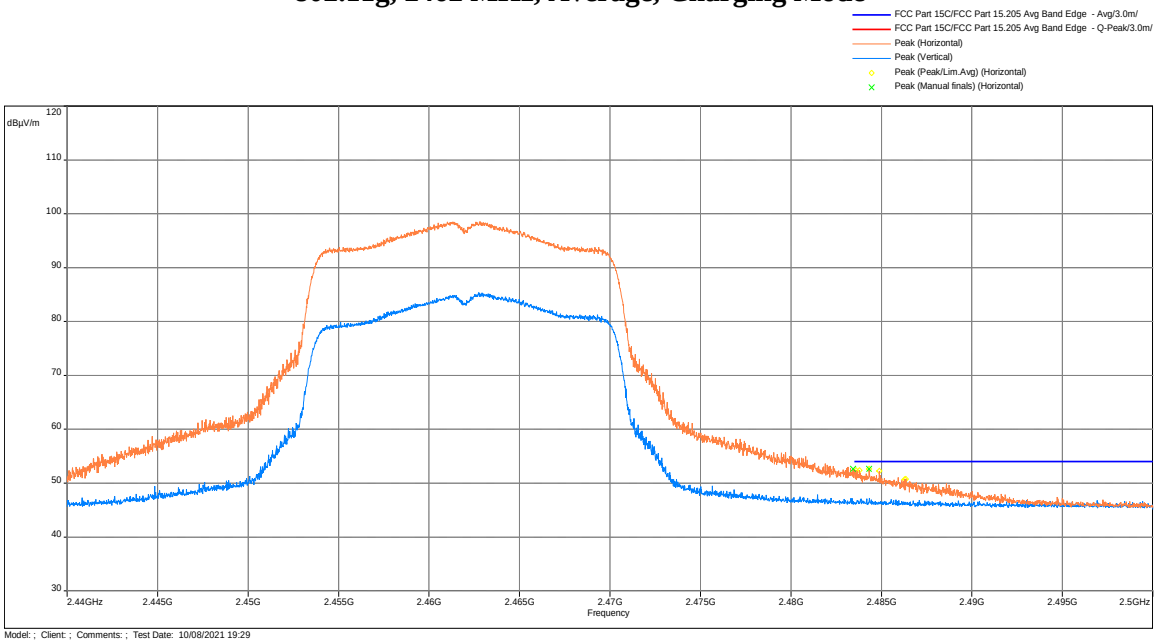



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2388.8 | 51.9 | 54.0 | -2.1 | 1.5 | 63.3 | Horizontal | 21.6 |
| 2389.5 | 52.9 | 54.0 | -1.1 | 1.5 | 63.3 | Horizontal | 21.6 |
| 2390.0 | 52.4 | 54.0 | -1.6 | 1.5 | 63.3 | Horizontal | 21.6 |

## Out-of-Band Spurious Emissions at the Band Edge @1m distance
## 802.11g, 2462 MHz, Peak, Charging Mode

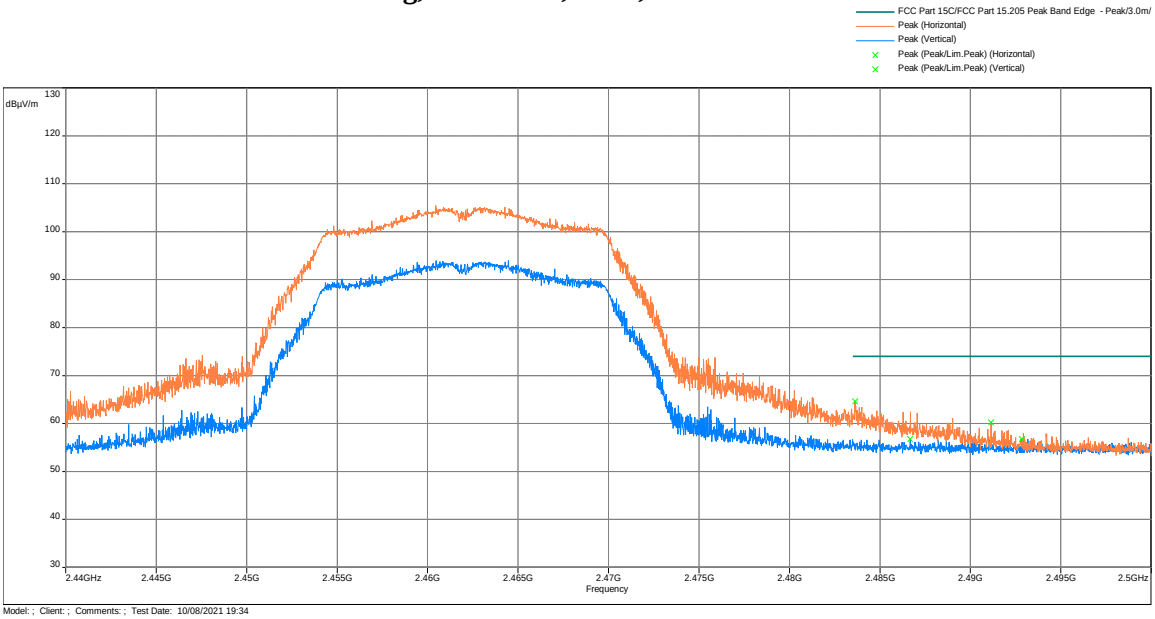



## 802.11g, 2462 MHz, Average, Charging Mode

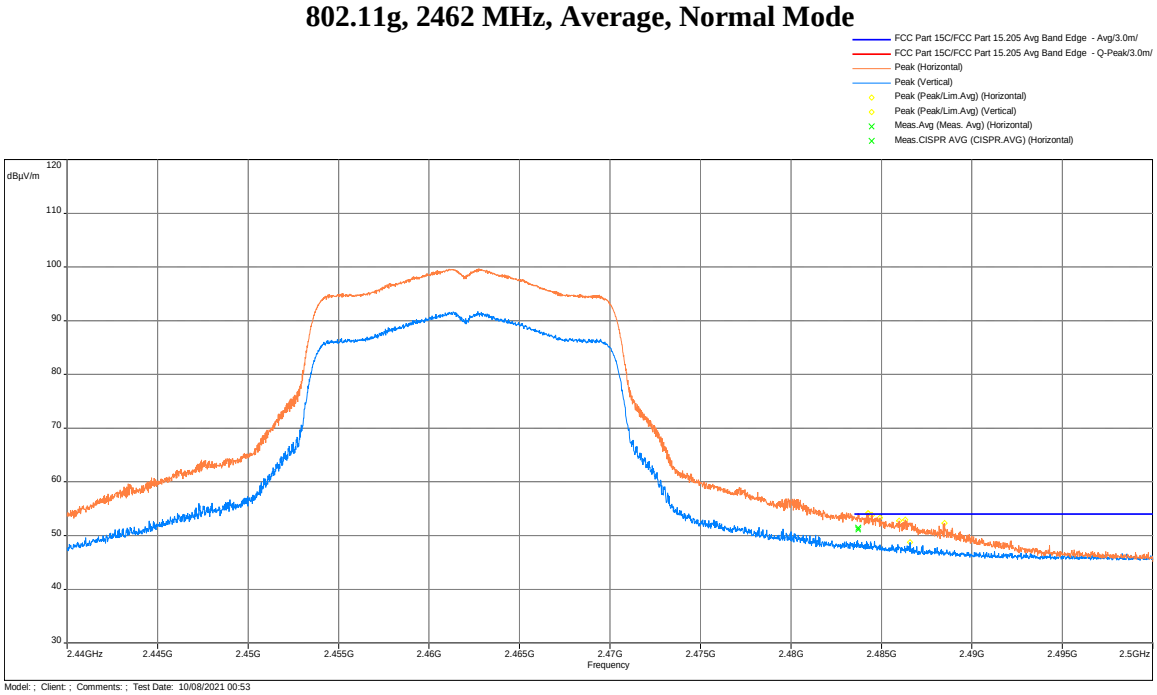



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2483.5 | 52.6 | 54.0 | -1.4 | 1.5 | 183.8 | Horizontal | 22.0 |
| 2484.3 | 52.6 | 54.0 | -1.4 | 1.5 | 183.8 | Horizontal | 21.9 |

## Out-of-Band Spurious Emissions at the Band Edge @1m distance
## 802.11g, 2462 MHz, Peak, Normal Mode

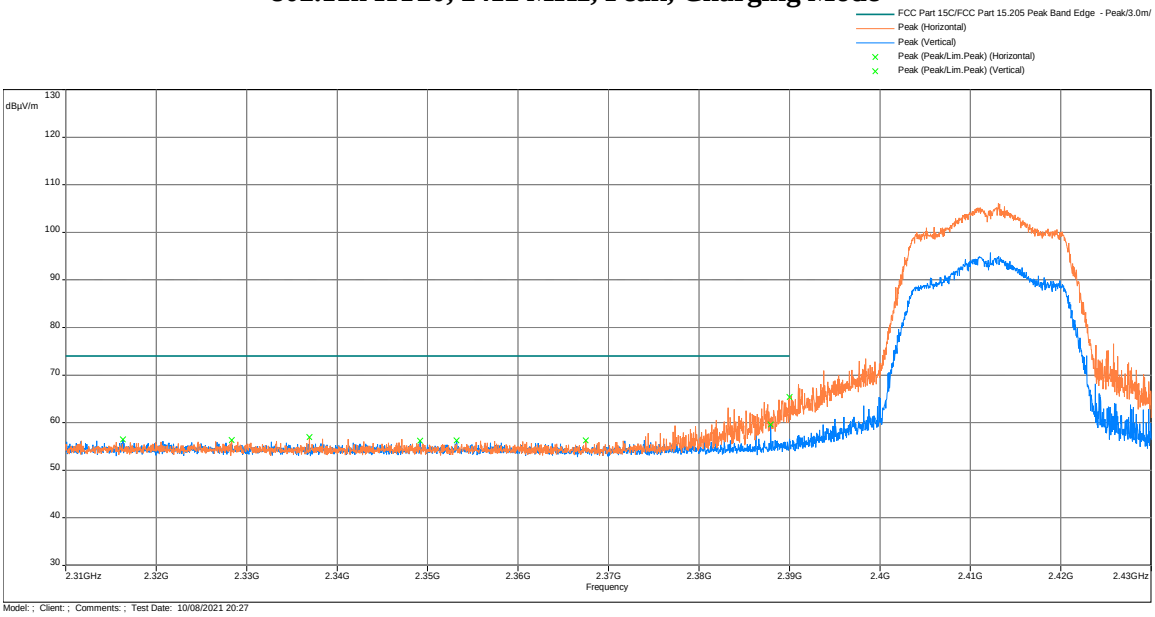



## 802.11g, 2462 MHz, Average, Normal Mode

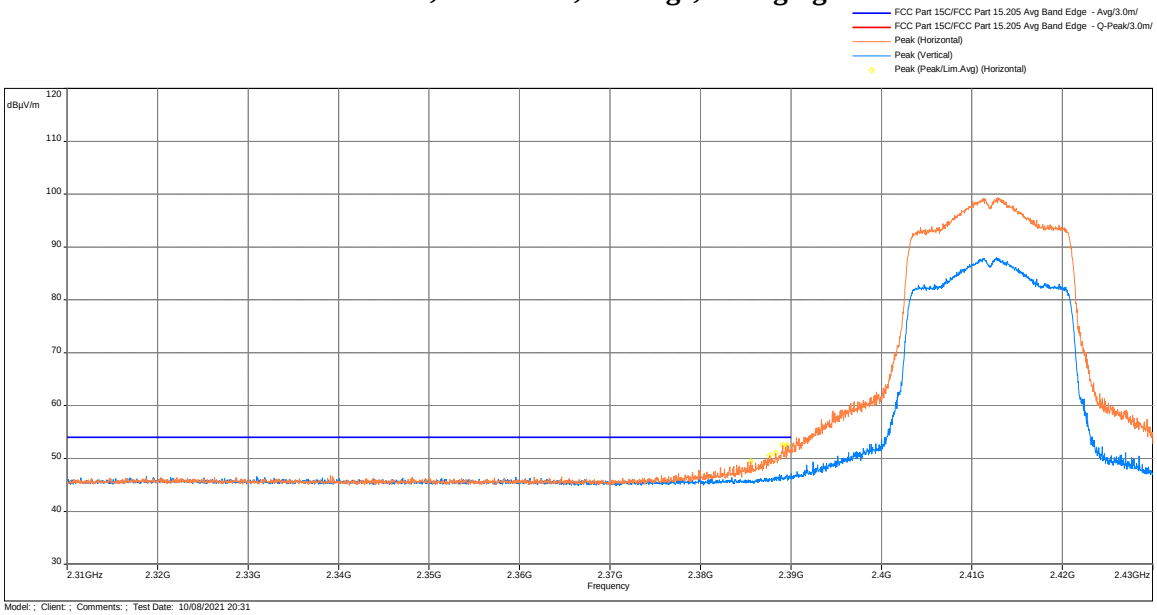



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2483.5 | 51.4 | 54.0 | -2.6 | 1.5 | 196.0 | Horizontal | 22.0 |
| 2483.5 | 51.1 | 54.0 | -2.9 | 1.5 | 122.0 | Vertical | 22.0 |

## Out-of-Band Spurious Emissions at the Band Edge @1m distance
## 802.11n HT20, 2412 MHz, Peak, Charging Mode

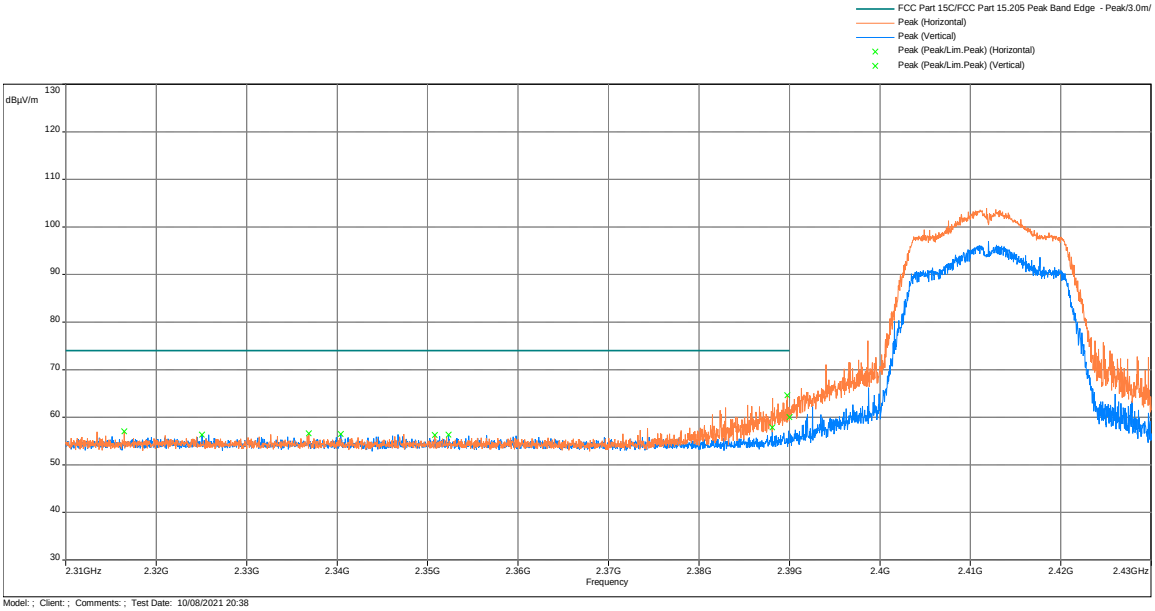



## 802.11n HT20, 2412 MHz, Average, Charging Mode

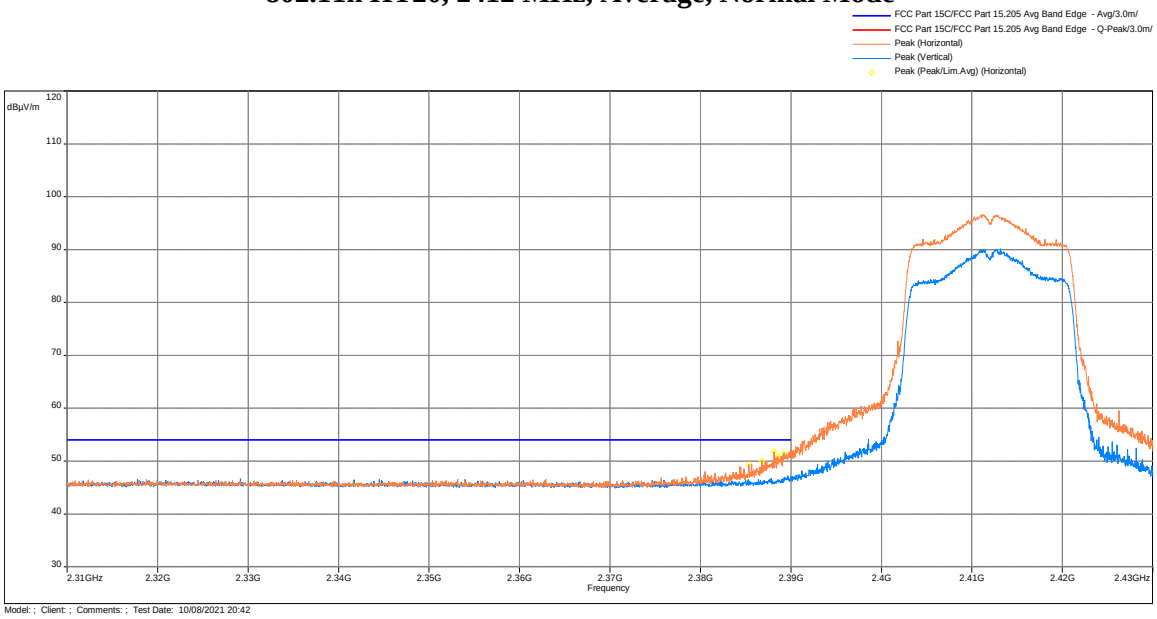



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2389.6 | 52.2 | 54.0 | -1.8 | 1.5 | 183.0 | Horizontal | 21.6 |
| 2390.0 | 52.5 | 54.0 | -1.5 | 1.5 | 242.5 | Horizontal | 21.6 |

## Out-of-Band Spurious Emissions at the Band Edge @1m distance
## 802.11n HT20, 2412 MHz, Peak, Normal Mode

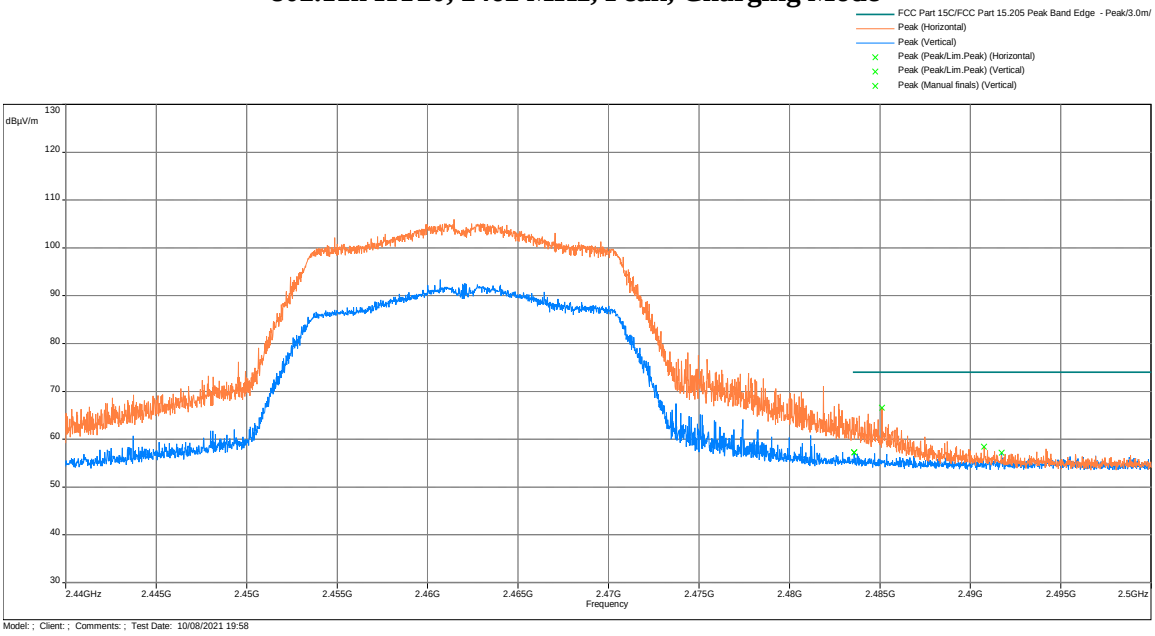



## 802.11n HT20, 2412 MHz, Average, Normal Mode

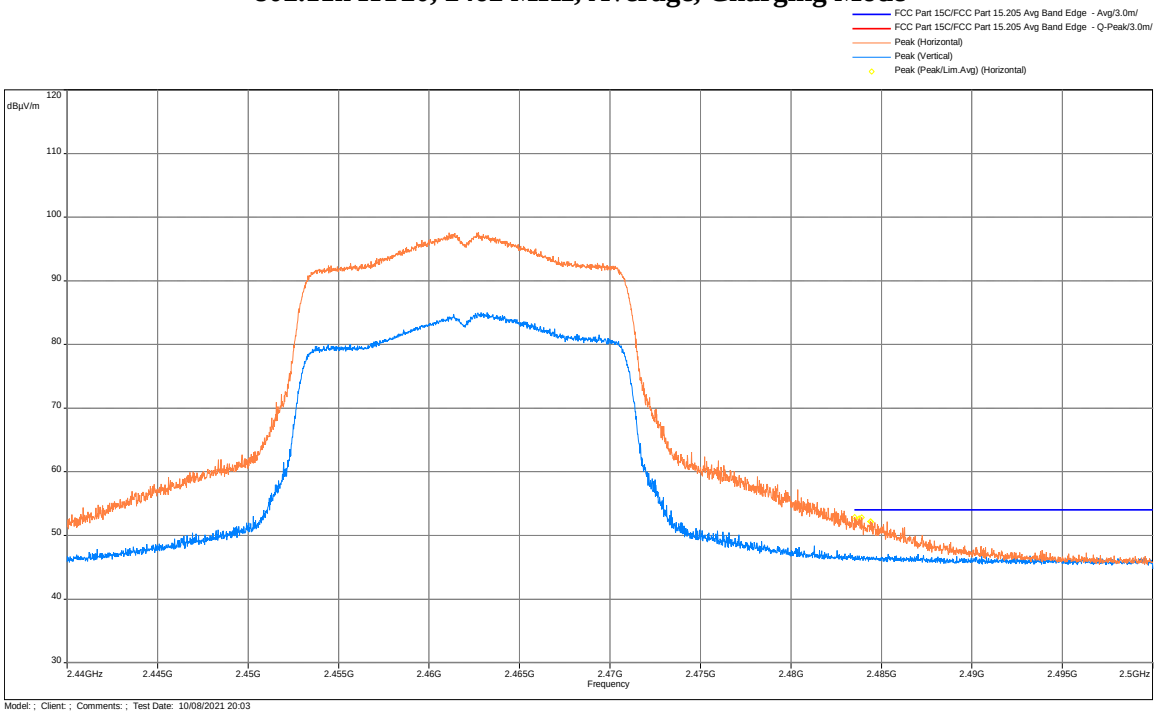



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2389.2 | 51.6 | 54.0 | -2.4 | 1.5 | 242.8 | Horizontal | 21.6 |
| 2390.0 | 52.3 | 54.0 | -1.7 | 1.5 | 242.8 | Horizontal | 21.6 |

## Out-of-Band Spurious Emissions at the Band Edge @1m distance
## 802.11n HT20, 2462 MHz, Peak, Charging Mode

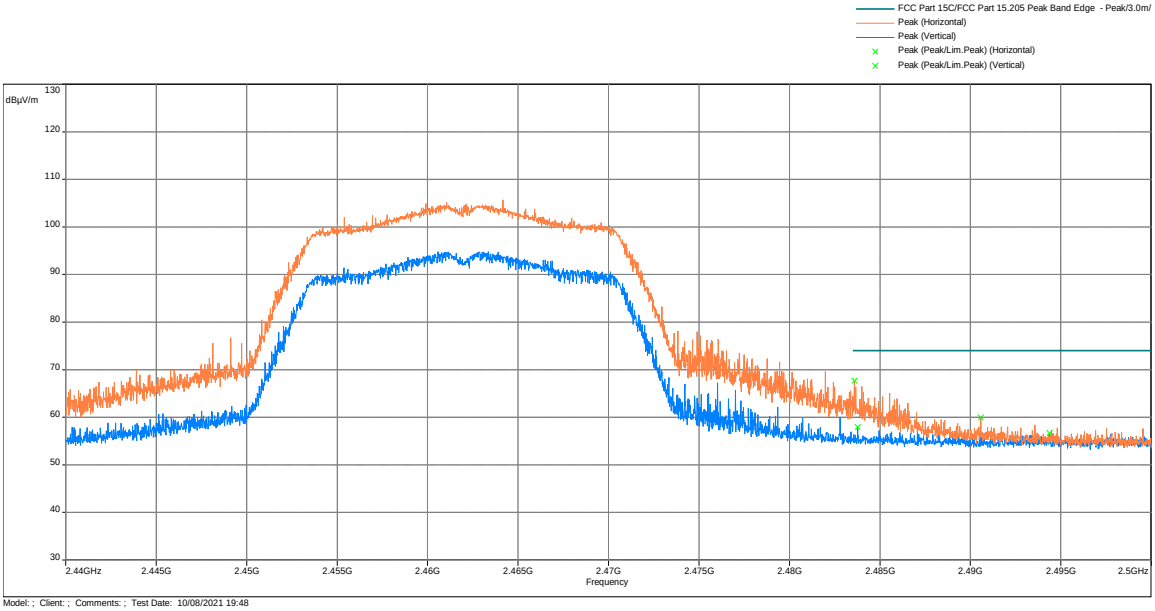



## 802.11n HT20, 2462 MHz, Average, Charging Mode

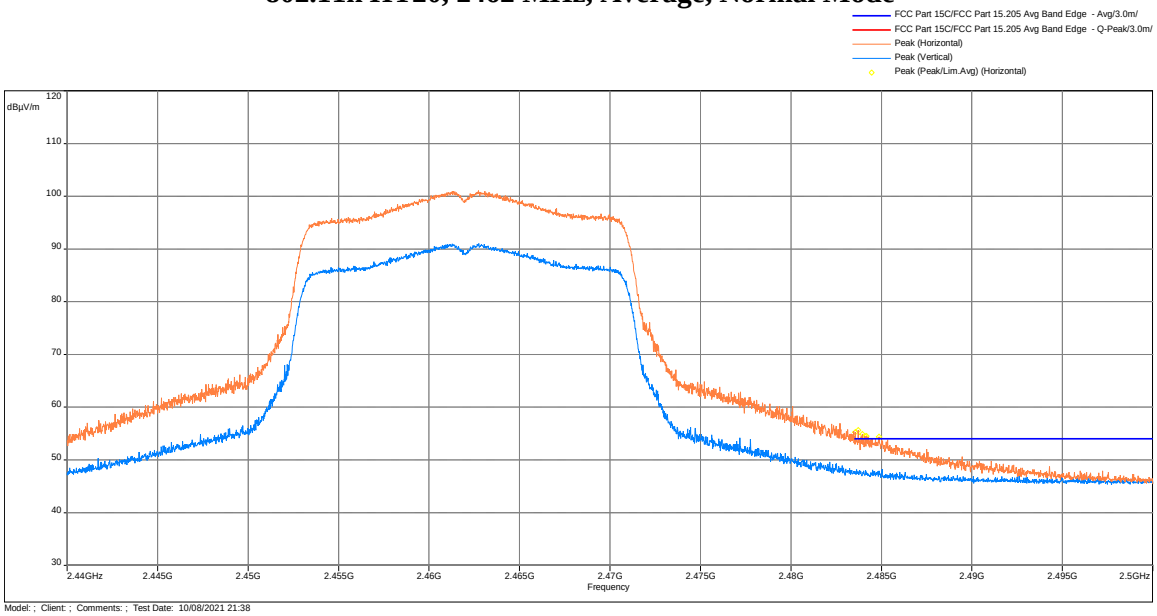



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2483.5 | 1.0 | 52.9 | 54.0 | -1.2 | 1.5 | 184.3 | Horizontal |
| 2483.6 | 1.0 | 52.4 | 54.0 | -1.6 | 1.5 | 184.3 | Horizontal |
| 2483.8 | 1.0 | 52.6 | 54.0 | -1.4 | 1.5 | 184.3 | Horizontal |

## Out-of-Band Spurious Emissions at the Band Edge @1m distance
## 802.11n HT20, 2462 MHz, Peak, Normal Mode




## 802.11n HT20, 2462 MHz, Average, Normal Mode

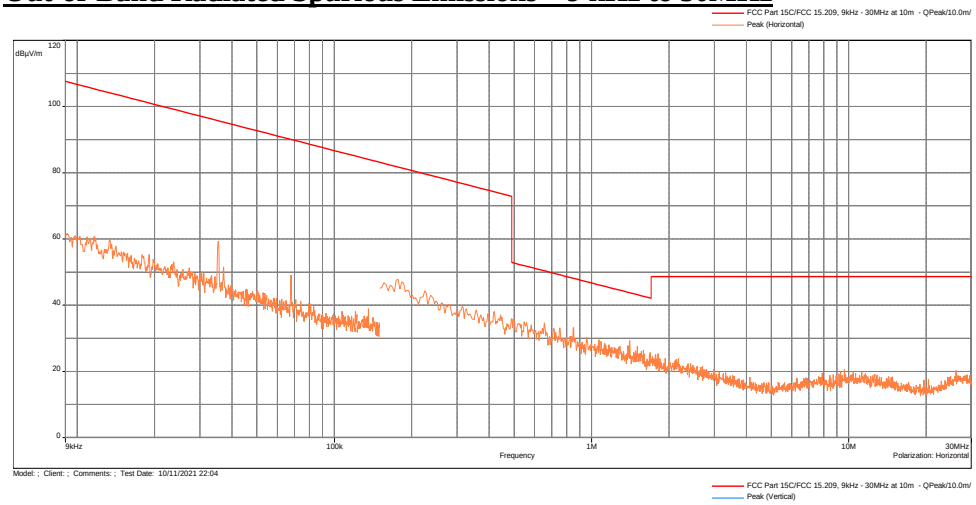



| Freq. MHz | Ave@3m dB(uV/m) | Ave Limit dB(µV/m) | Margin dB | Height m | Azimuth deg | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 2483.5 | 52.9 | 54.0 | -1.1 | 1.5 | 0.0 | Horizontal | 22.0 |
| 2483.7 | 53.2 | 54.0 | -0.8 | 1.4 | 199.0 | Horizontal | 22.0 |
| 2483.8 | 52.6 | 54.0 | -1.4 | 1.5 | 4.0 | Horizontal | 22.0 |
| 2484.0 | 52.6 | 54.0 | -1.4 | 1.5 | 180.0 | Horizontal | 22.0 |

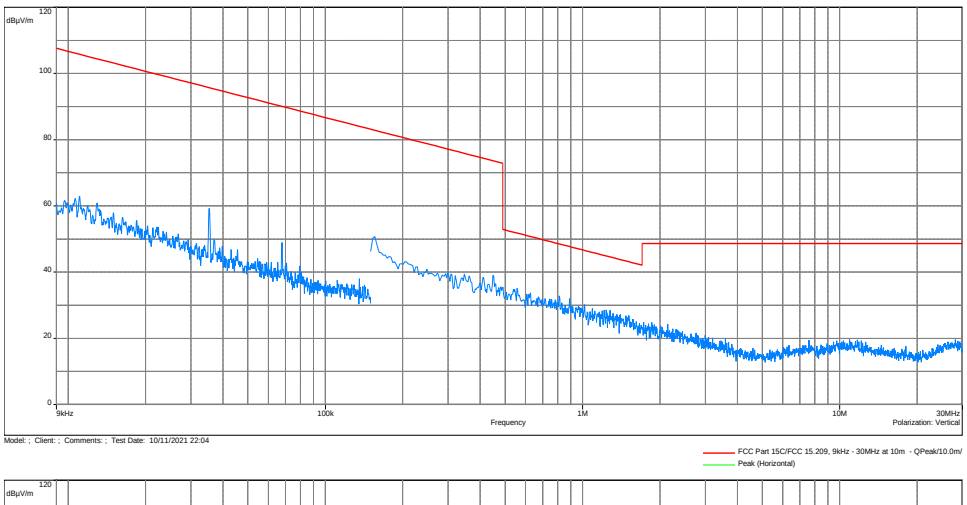
| | |
|---|---|
| **Results** | **Complies** |

## Out-of-Band Radiated Spurious Emissions – 9 kHz to 30MHz

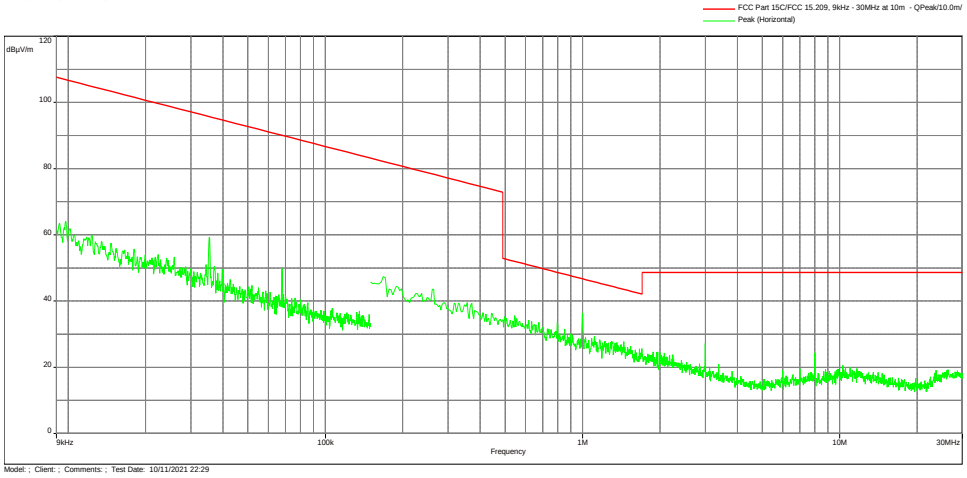
Antenna Position - Coaxial




Antenna Position - Coplanar

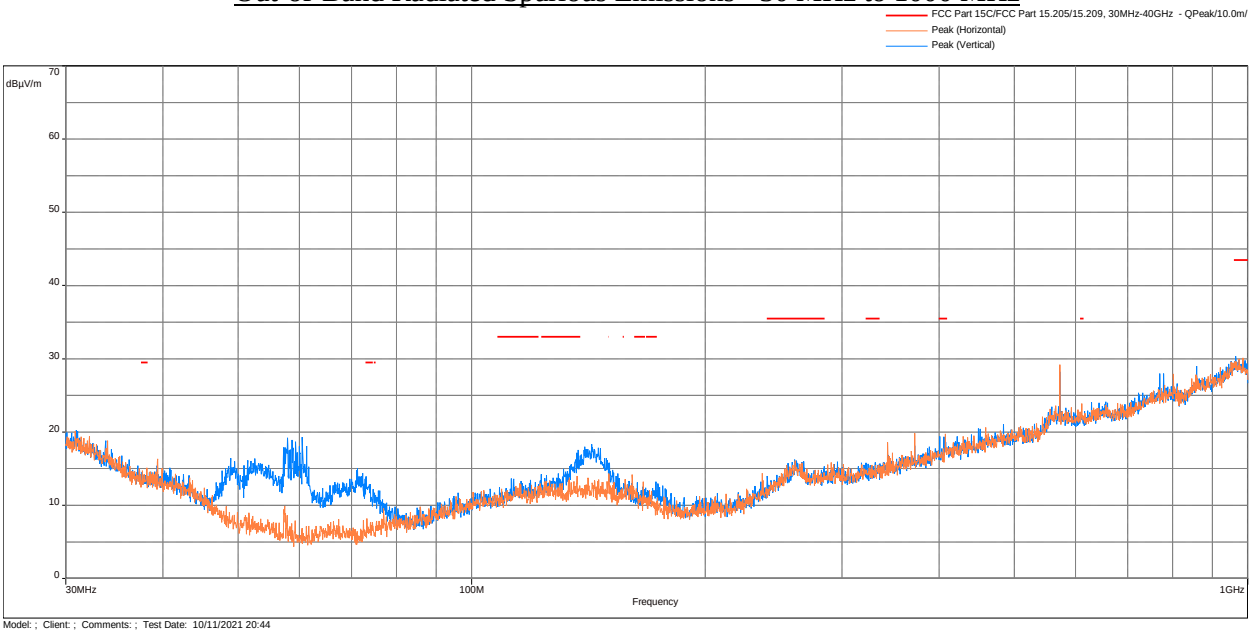



Antenna Position - Horizontal

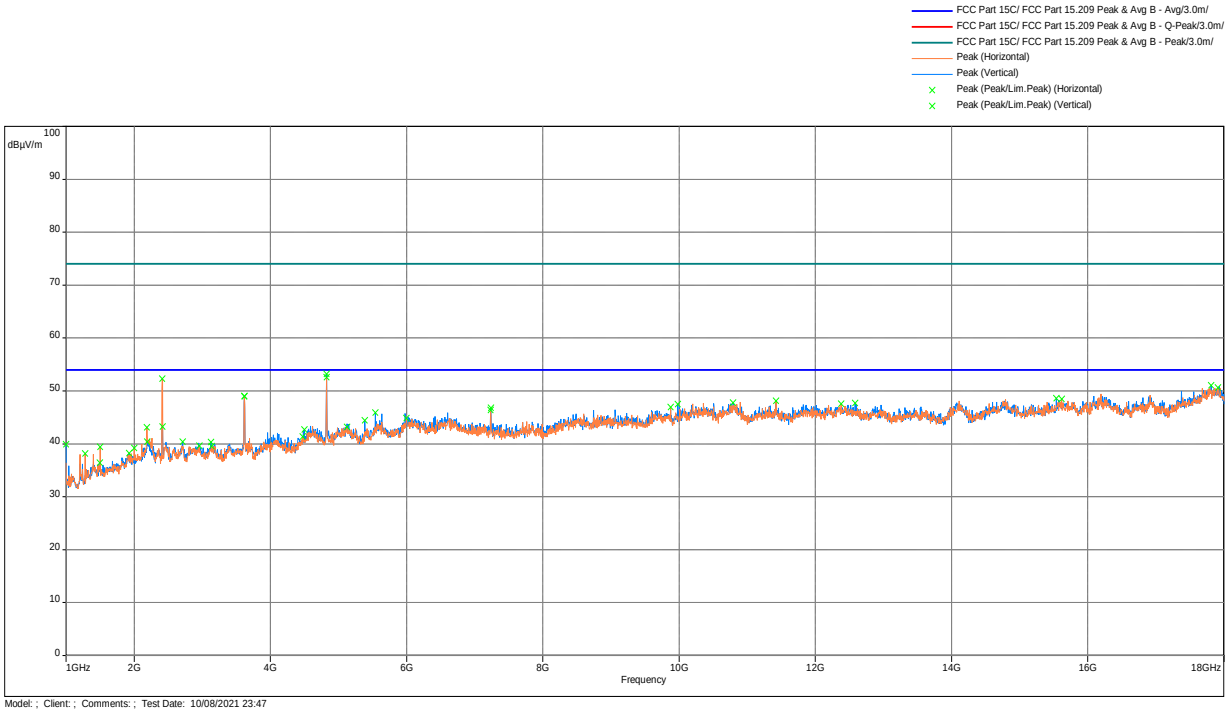


## Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11b 2412MHz

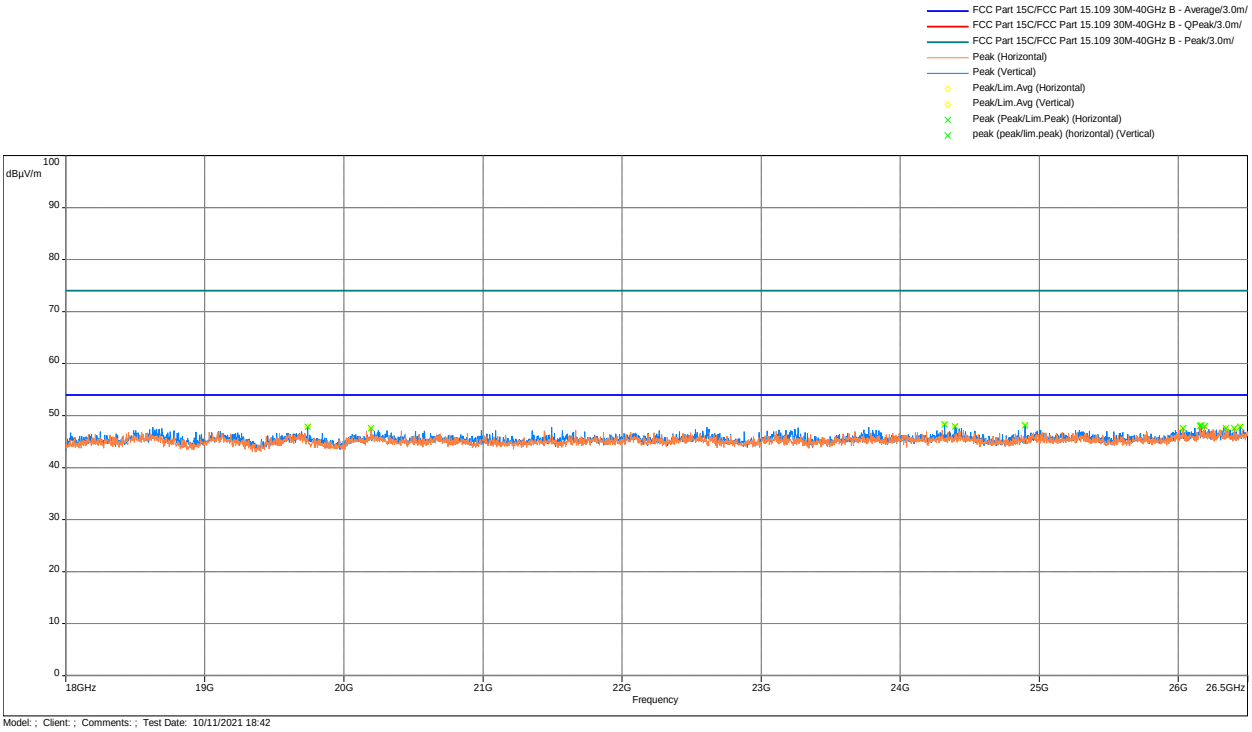
Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz




Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



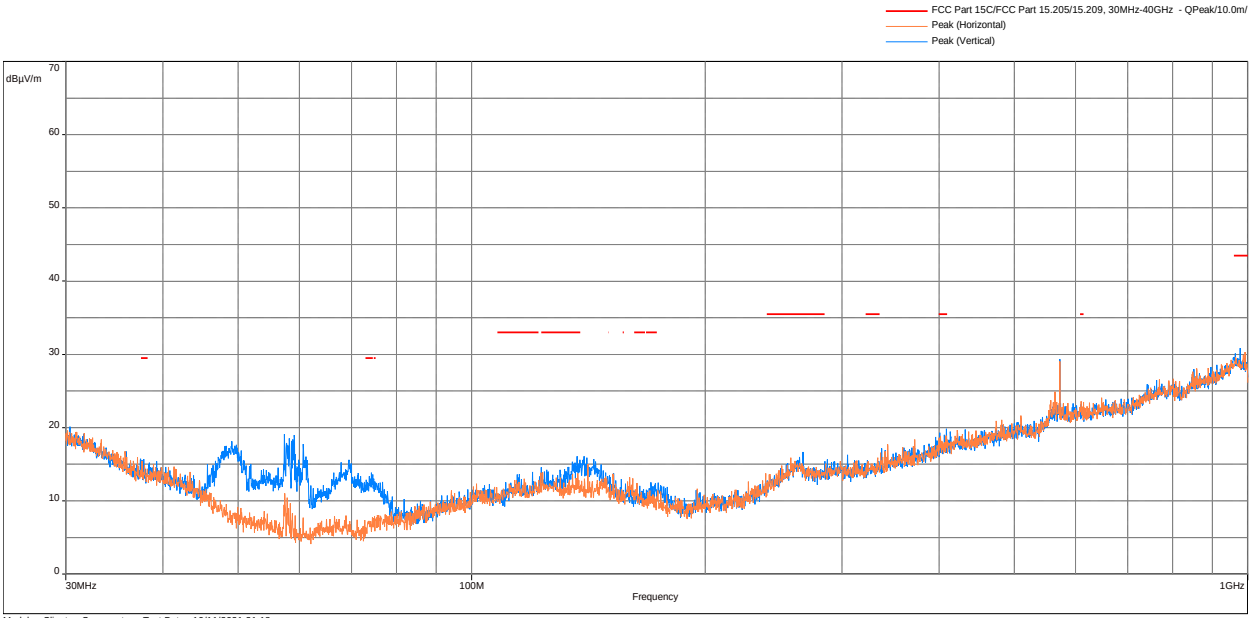

| Frequency (MHz) | Peak FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 3616.9 | 49.0 | 54.0 | -5.0 | 1.5 | 57.8 | Vertical | -6.9 |
| 3618.6 | 49.0 | 54.0 | -5.0 | 1.5 | 57.5 | Horizontal | -6.9 |
| 4823.9 | 53.2 | 54.0 | -0.8 | 1.5 | 92.0 | Vertical | -4.7 |
| 4823.9 | 52.6 | 54.0 | -1.4 | 1.5 | 57.5 | Horizontal | -4.7 |
| 15539.5 | 48.6 | 54.0 | -5.4 | 1.5 | 337.0 | Vertical | 5.1 |
| 15616.6 | 48.5 | 54.0 | -5.6 | 1.5 | 0.0 | Horizontal | 5.7 |
| 17907.6 | 50.6 | 54.0 | -3.4 | 2.5 | 91.3 | Horizontal | 10.1 |

Note: Correction = AF + CF - Preamp

| | |
|---|---|
| **Results** | **Complies** |

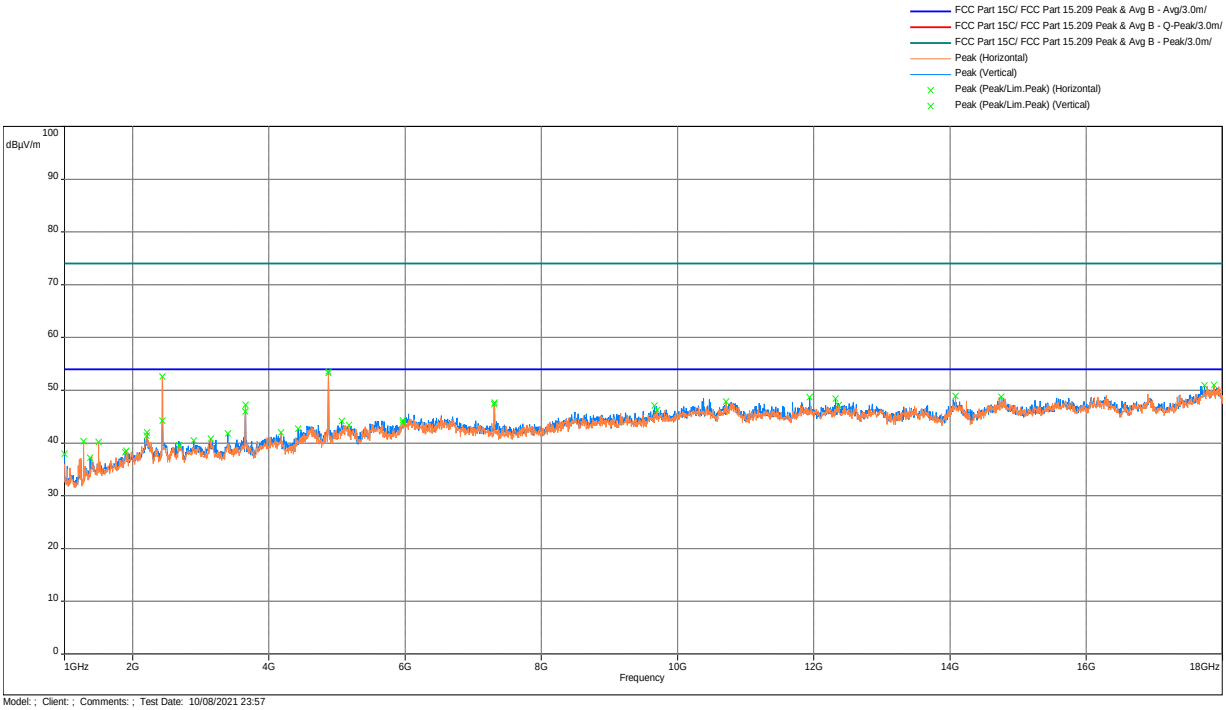
## Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11b 2437MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



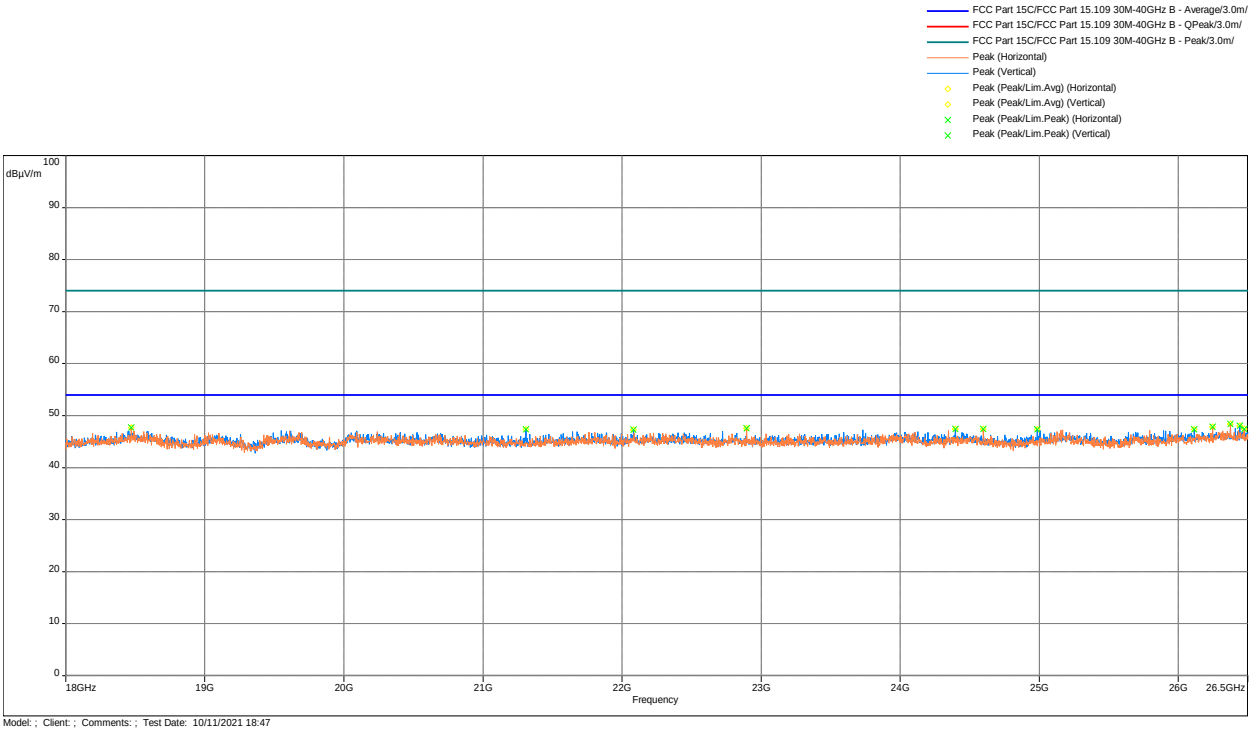

Model: ; Client: ; Comments: ; Test Date: 10/11/2021 21:18

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit




Model: ; Client: ; Comments: ; Test Date: 10/08/2021 23:57

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



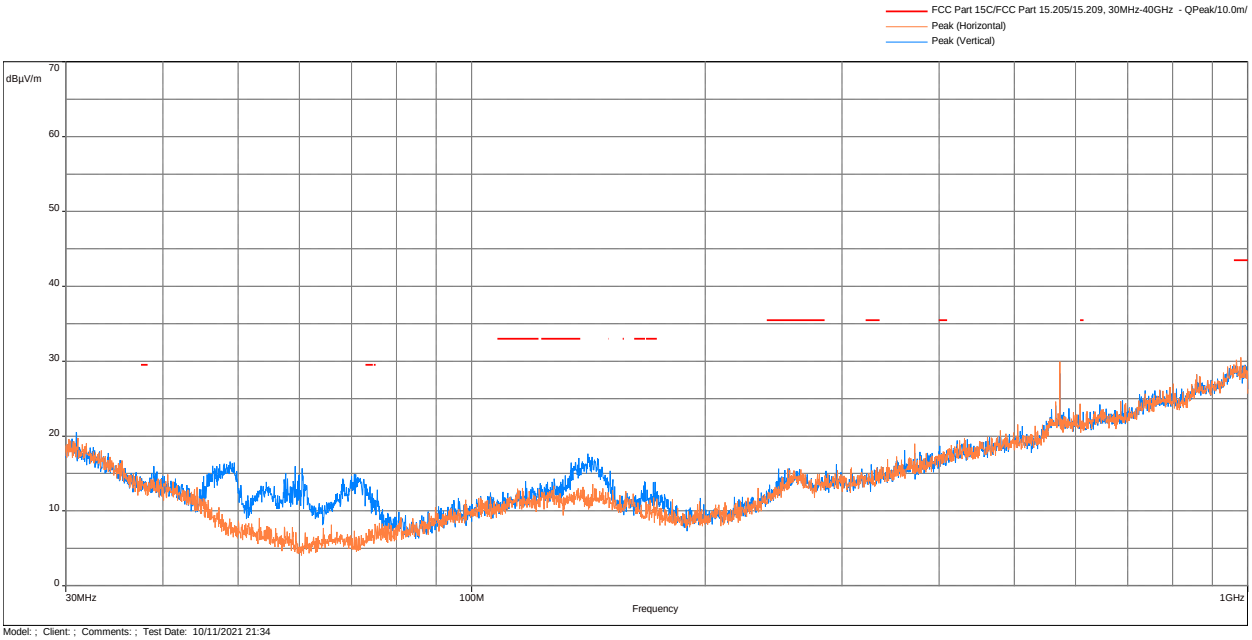

| Frequency (MHz) | Peak FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 3656.0 | 47.2 | 54.0 | -6.8 | 1.5 | 57.5 | Horizontal | -6.9 |
| 4873.7 | 53.5 | 54.0 | -0.5 | 1.5 | 320.0 | Vertical | -4.4 |
| 4873.7 | 53.3 | 54.0 | -0.7 | 1.5 | 5.8 | Horizontal | -4.4 |
| 7311.0 | 47.7 | 54.0 | -6.4 | 1.5 | 0.0 | Vertical | -2.2 |
| 17736.5 | 50.9 | 54.0 | -3.1 | 1.5 | 353.8 | Vertical | 9.7 |
| 17873.6 | 51.0 | 54.0 | -3.0 | 1.5 | 57.5 | Horizontal | 10.3 |

Note: Correction = AF + CF - Preamp

| | |
|---|---|
| **Results** | **Complies** |

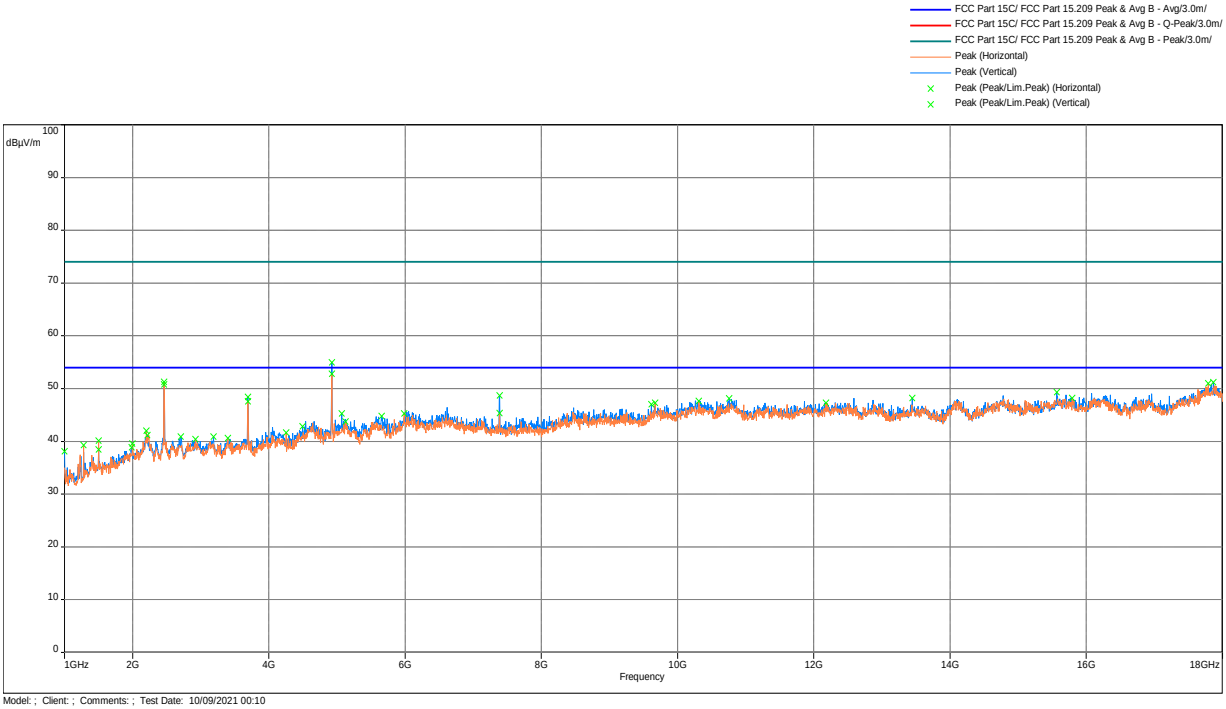
## Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11b 2462MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



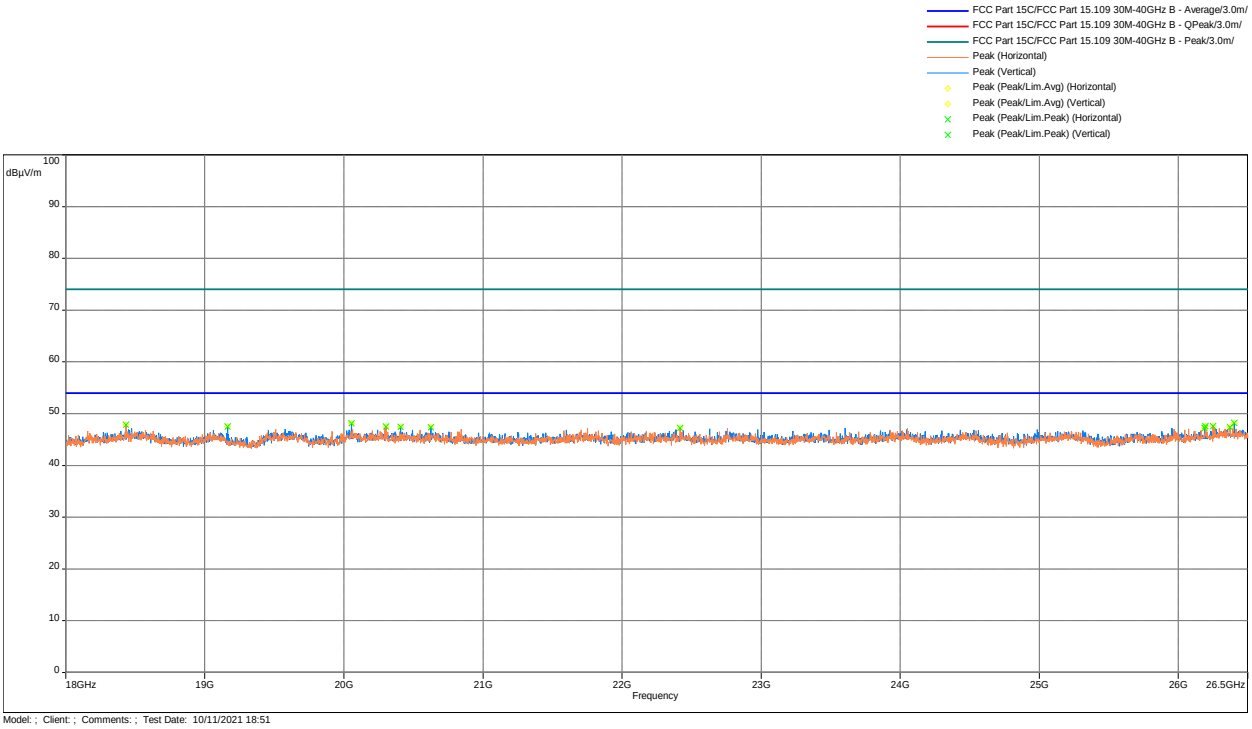

Model: ; Client: ; Comments: ; Test Date: 10/11/2021 21:34

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit




Model: ; Client: ; Comments: ; Test Date: 10/09/2021 00:10

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit




| Frequency (MHz) | Peak FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 3691.1 | 48.4 | 54.0 | -5.6 | 1.5 | 23.0 | Vertical | -7.0 |
| 7385.2 | 48.7 | 54.0 | -5.3 | 1.5 | 0.0 | Vertical | -2.2 |
| 15568.4 | 49.3 | 54.0 | -4.7 | 1.5 | 0.0 | Vertical | 5.4 |
| 17788.1 | 51.0 | 54.0 | -3.0 | 2.5 | 286.0 | Horizontal | 10.2 |
| 17864.6 | 51.2 | 54.0 | -2.8 | 1.5 | 0.0 | Vertical | 10.3 |

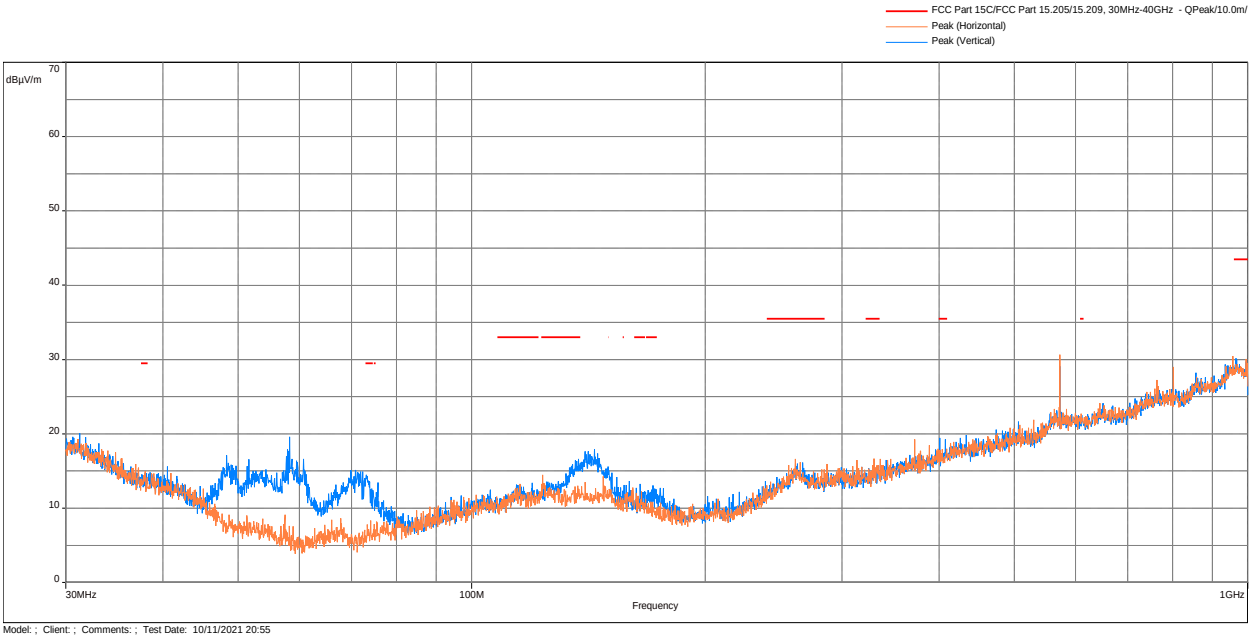
| Frequency (MHz) | Ave FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 4923.6 | 52.8 | 54.0 | -1.2 | 1.5 | 41.0 | Horizontal | -4.3 |
| 4924.0 | 50.5 | 54.0 | -3.5 | 242.0 | 317.0 | Vertical | -4.3 |

Note: Correction = AF + CF - Preamp

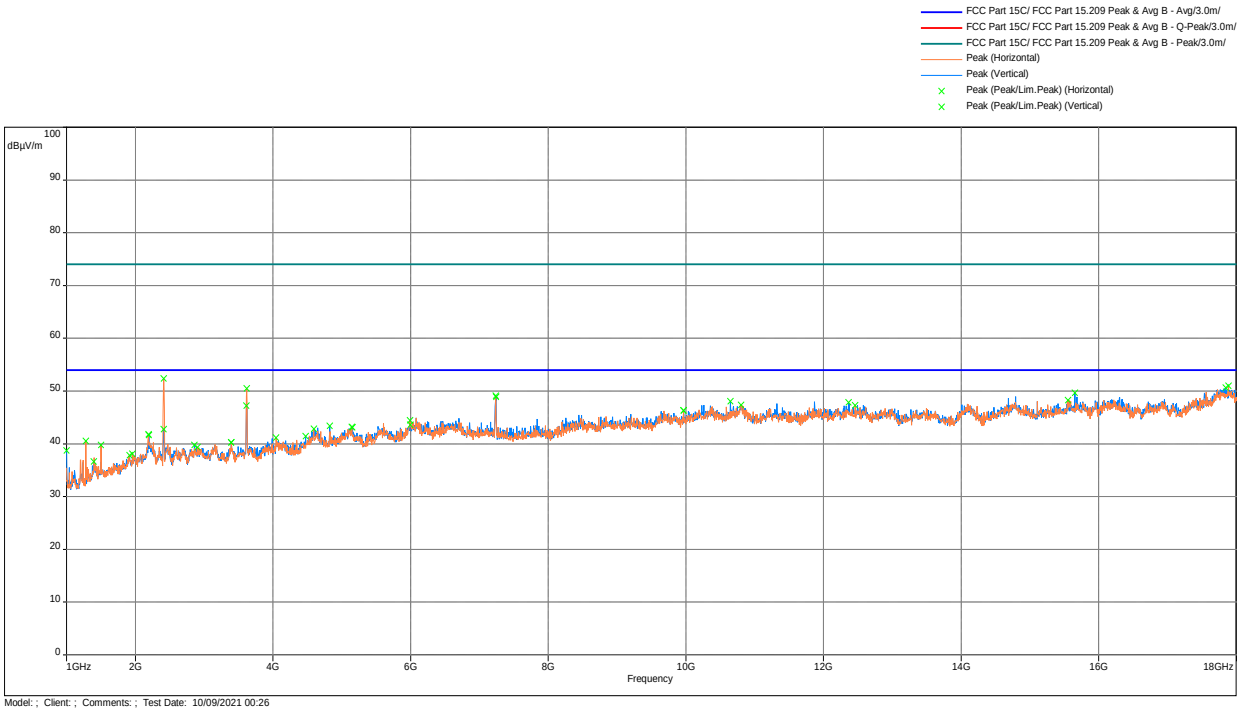
| | |
|---|---|
| **Results** | **Complies** |

## Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11g 2412MHz

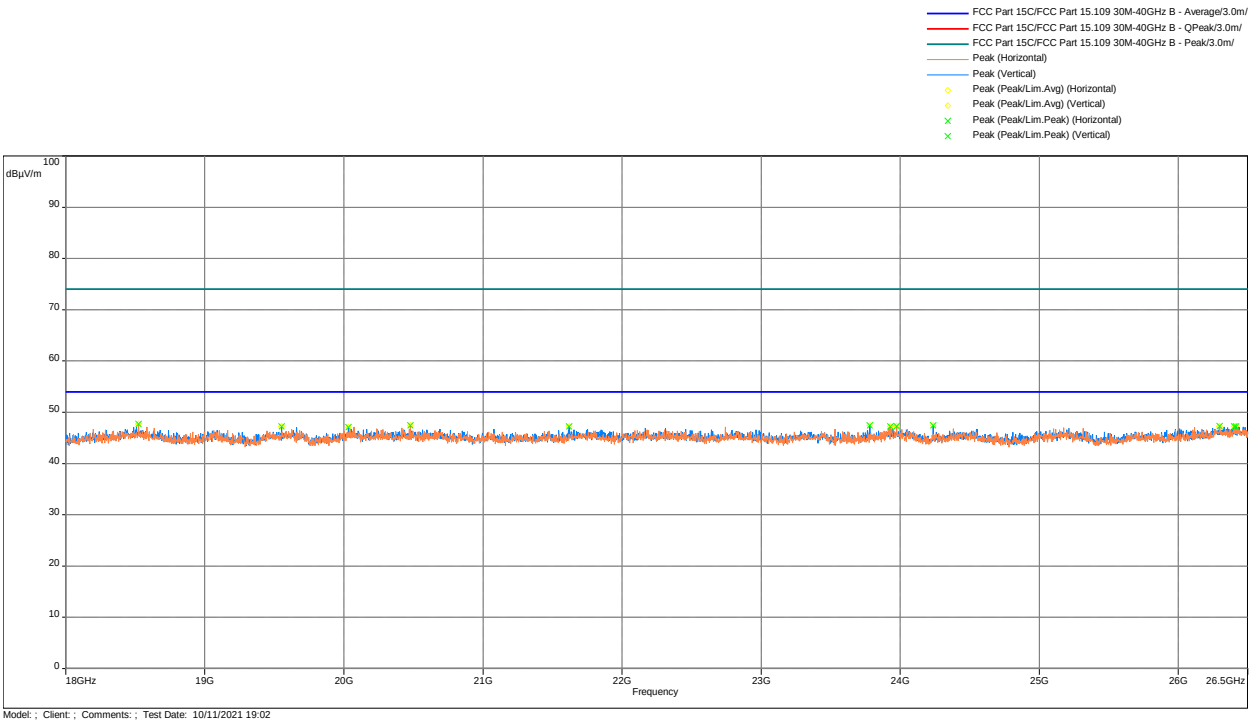
Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz




Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



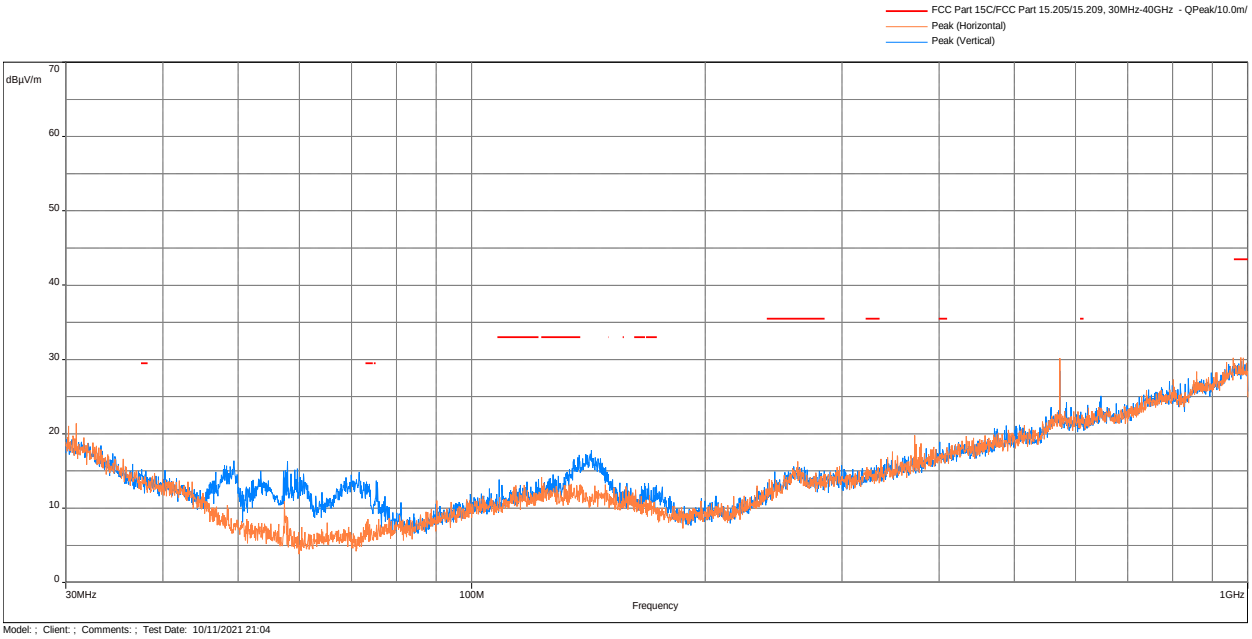

| Frequency (MHz) | Peak FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 3619.1 | 50.5 | 54.0 | -3.5 | 1.5 | 23.0 | Horizontal | -6.9 |
| 7235.6 | 49.1 | 54.0 | -4.9 | 2.5 | 57.0 | Horizontal | -2.4 |
| 7240.1 | 48.9 | 54.0 | -5.1 | 1.5 | 301.5 | Vertical | -2.4 |
| 15650.0 | 49.6 | 54.0 | -4.4 | 1.5 | 28.5 | Vertical | 5.8 |
| 17844.2 | 50.6 | 54.0 | -3.4 | 2.5 | 180.8 | Vertical | 10.1 |
| 17886.7 | 51.0 | 54.0 | -3.0 | 2.5 | 319.8 | Horizontal | 10.2 |

Note: Correction = AF + CF - Preamp

| | |
|---|---|
| **Results** | **Complies** |

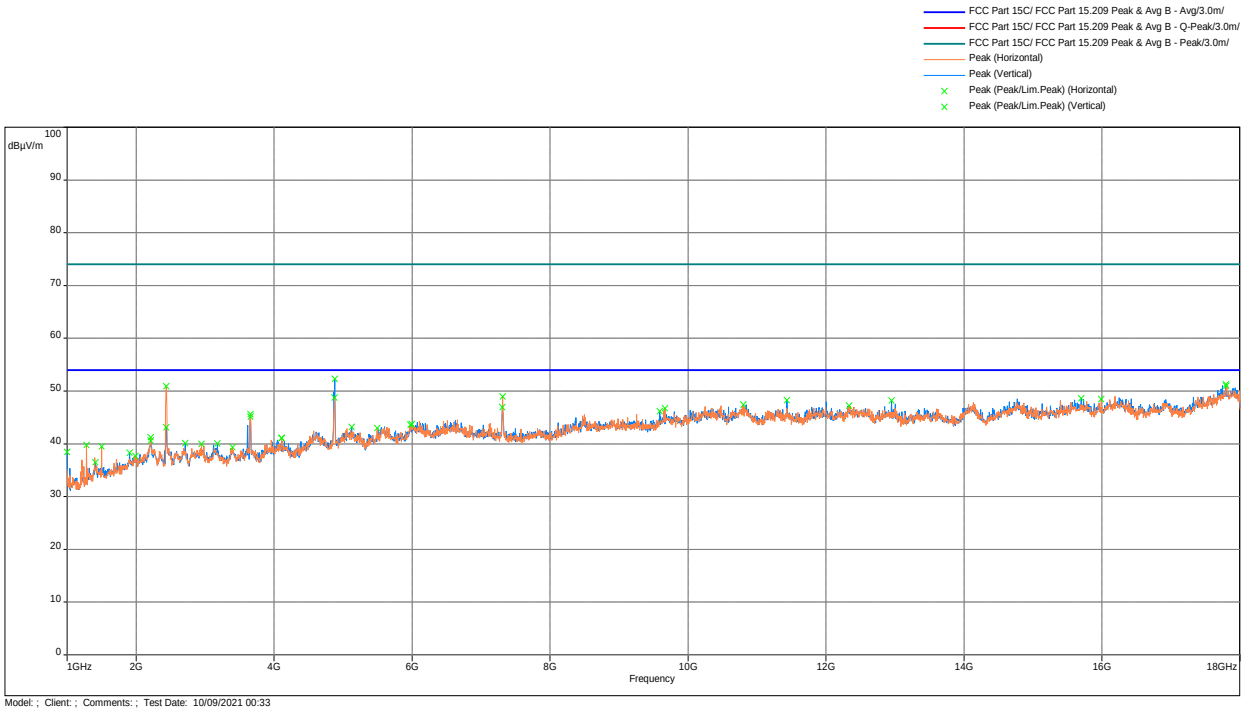
## Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11g 2437MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



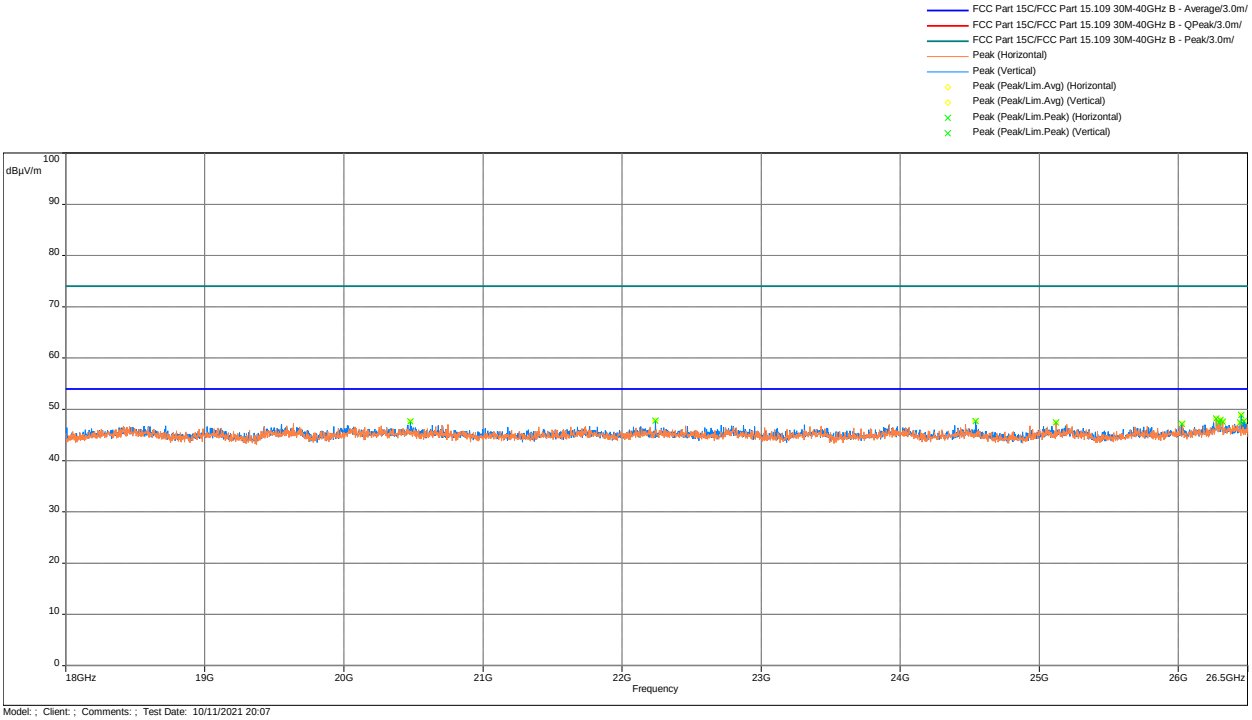

Model: ; Client: ; Comments: ; Test Date: 10/11/2021 21:04

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit




Model: ; Client: ; Comments: ; Test Date: 10/09/2021 00:33

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



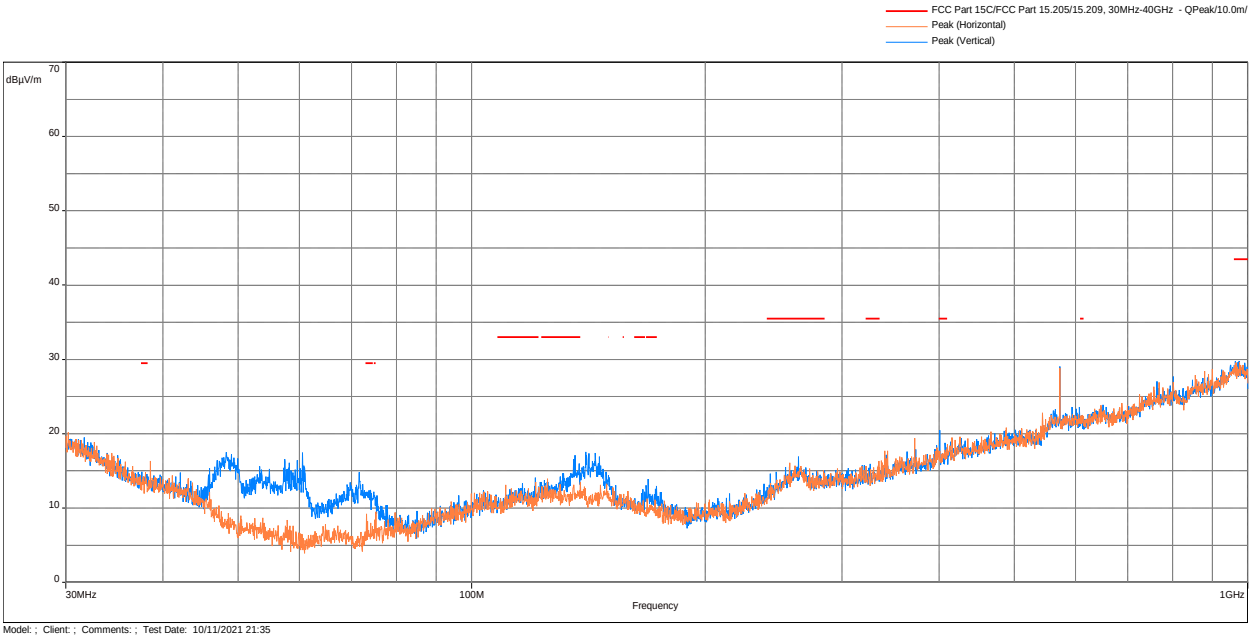

| Frequency (MHz) | Peak FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 4875.4 | 48.7 | 54.0 | -5.3 | 1.5 | 75.3 | Horizontal | -4.4 |
| 4877.7 | 52.3 | 54.0 | -1.7 | 1.5 | 57.5 | Vertical | -4.4 |
| 7308.1 | 46.9 | 54.0 | -7.1 | 1.5 | 353.8 | Vertical | -2.2 |
| 7310.4 | 49.0 | 54.0 | -5.1 | 2.5 | 91.5 | Horizontal | -2.2 |
| 17797.1 | 51.2 | 54.0 | -2.8 | 2.5 | 5.8 | Vertical | 10.2 |
| 17801.1 | 51.0 | 54.0 | -3.0 | 1.5 | 318.0 | Horizontal | 10.2 |

Note: Correction = AF + CF - Preamp

| | |
|---|---|
| **Results** | **Complies** |

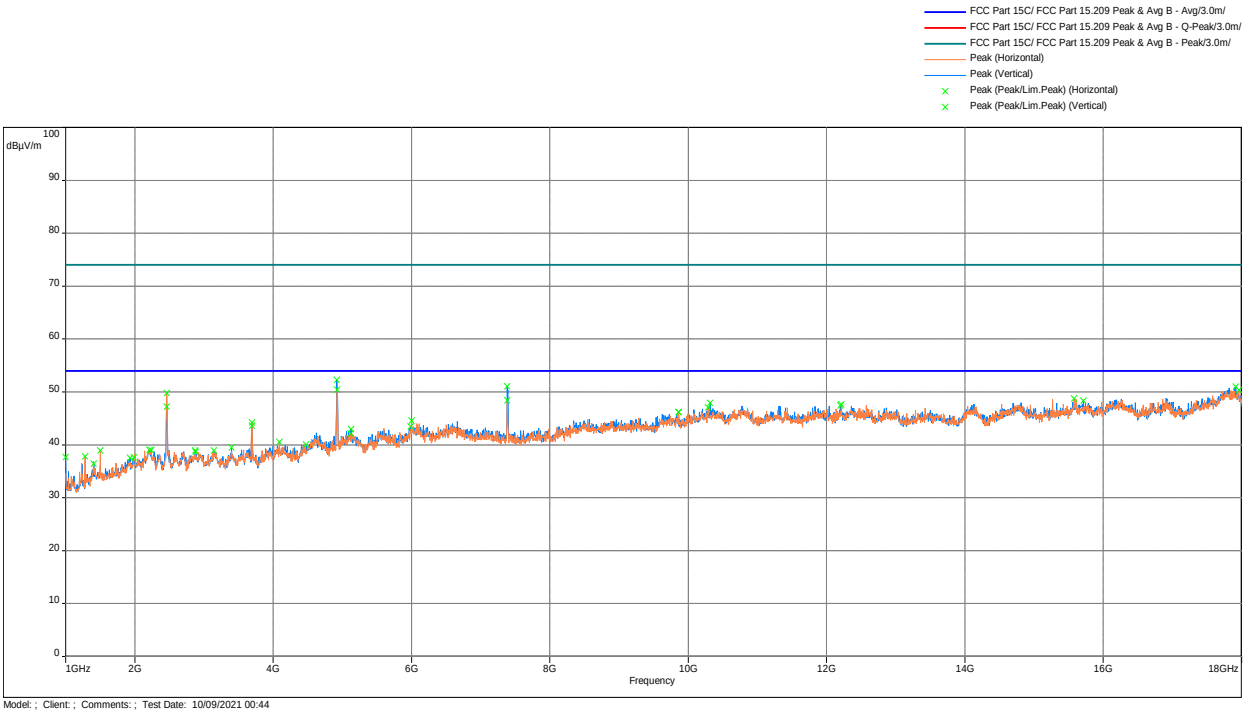
## Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11g 2462MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



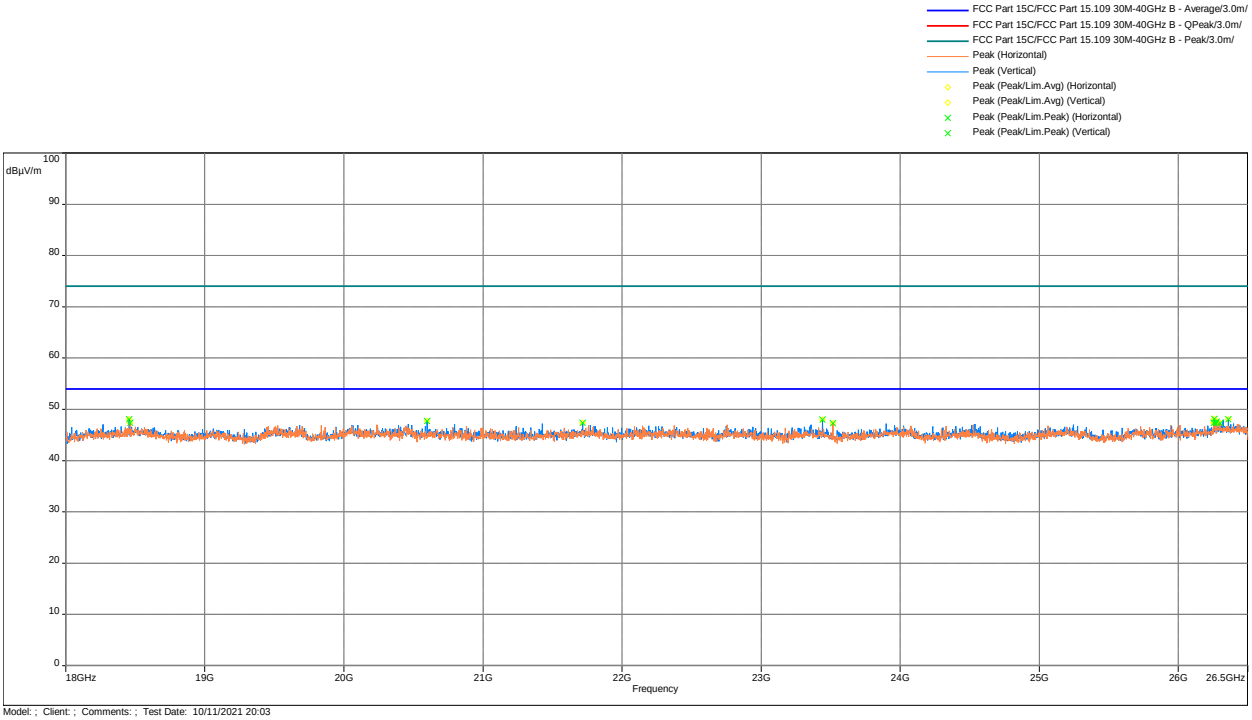

Model: ; Client: ; Comments: ; Test Date: 10/11/2021 21:35

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit




Model: ; Client: ; Comments: ; Test Date: 10/09/2021 00:44

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



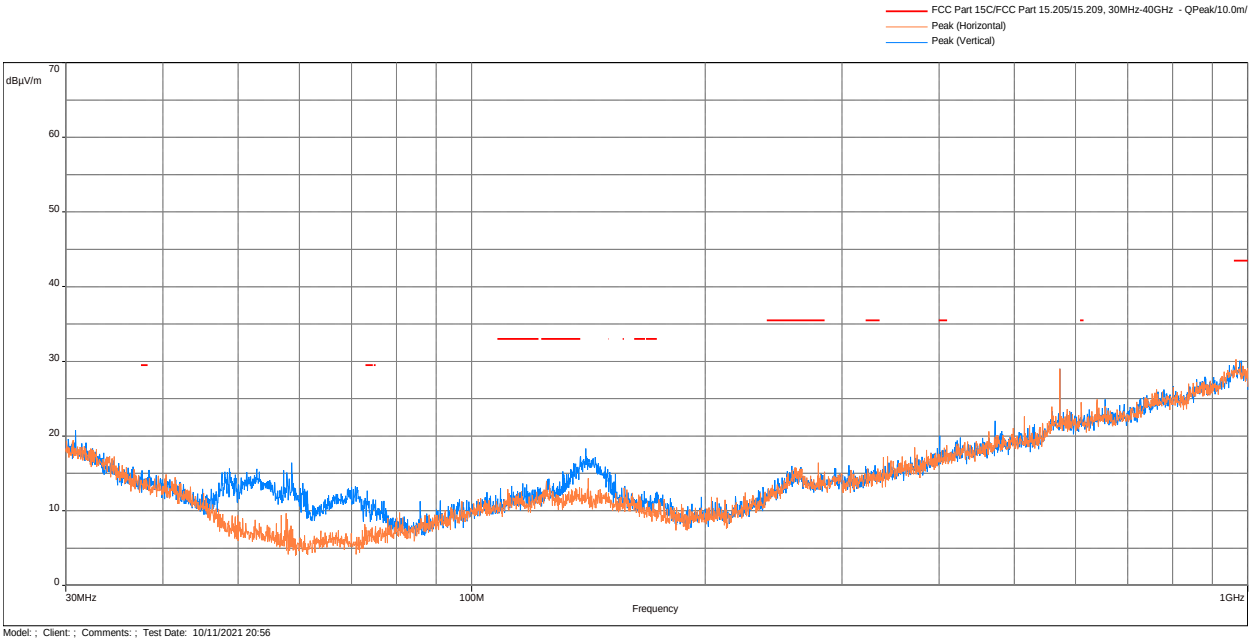

| Frequency (MHz) | Peak FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 4920.8 | 52.3 | 54.0 | -1.7 | 1.5 | 108.0 | Vertical | -4.3 |
| 4923.0 | 50.5 | 54.0 | -3.6 | 1.5 | 268.0 | Horizontal | -4.3 |
| 7382.4 | 48.4 | 54.0 | -5.6 | 2.5 | 213.5 | Horizontal | -2.2 |
| 7383.5 | 51.1 | 54.0 | -2.9 | 1.5 | 13.5 | Vertical | -2.2 |
| 15579.8 | 48.8 | 54.0 | -5.2 | 2.5 | 57.0 | Horizontal | 5.5 |
| 17913.9 | 51.0 | 54.0 | -3.0 | 2.5 | 0.0 | Vertical | 10.1 |
| 17962.0 | 50.4 | 54.0 | -3.6 | 2.5 | 353.5 | Horizontal | 9.5 |

Note: Correction = AF + CF - Preamp

| **Results** | **Complies** |
|---|---|

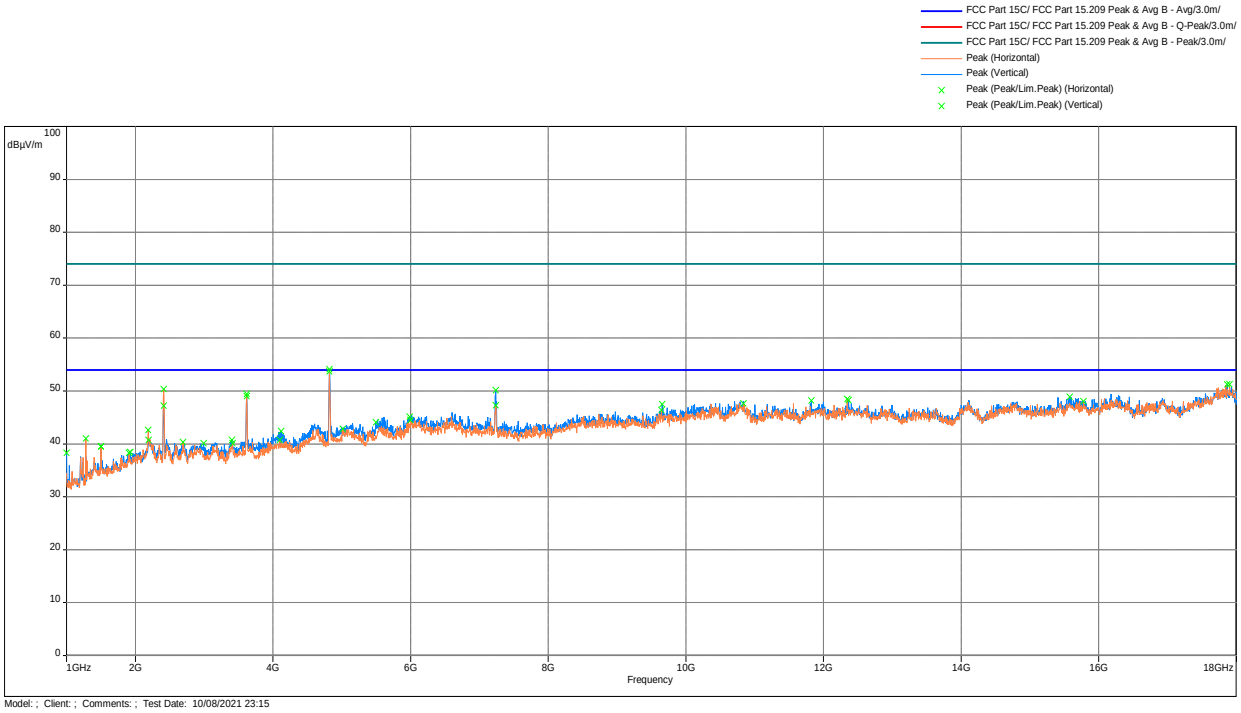
## Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz, 2412MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



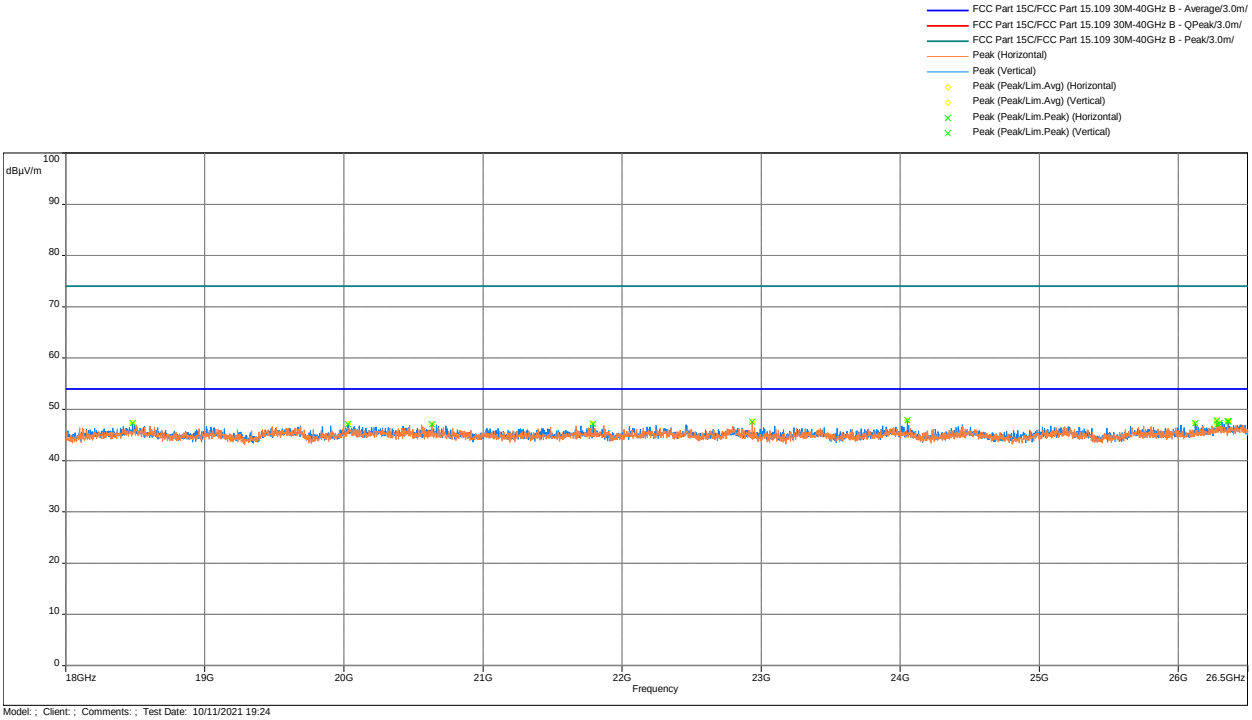

Model: ; Client: ; Comments: ; Test Date: 10/11/2021 20:56

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit




Model: ; Client: ; Comments: ; Test Date: 10/08/2021 23:15

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit




| Frequency (MHz) | Peak FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 3617.4 | 49.1 | 54.0 | -4.9 | 1.5 | 14.0 | Vertical | -6.9 |
| 3618.6 | 49.4 | 54.0 | -4.6 | 1.5 | 83.0 | Horizontal | -6.9 |
| 7239.6 | 50.2 | 54.0 | -3.8 | 1.5 | 348.0 | Vertical | -2.4 |
| 17867.4 | 51.2 | 54.0 | -2.8 | 1.5 | 1.8 | Vertical | 10.3 |
| 17900.8 | 51.2 | 54.0 | -2.8 | 1.5 | 288.0 | Horizontal | 10.2 |

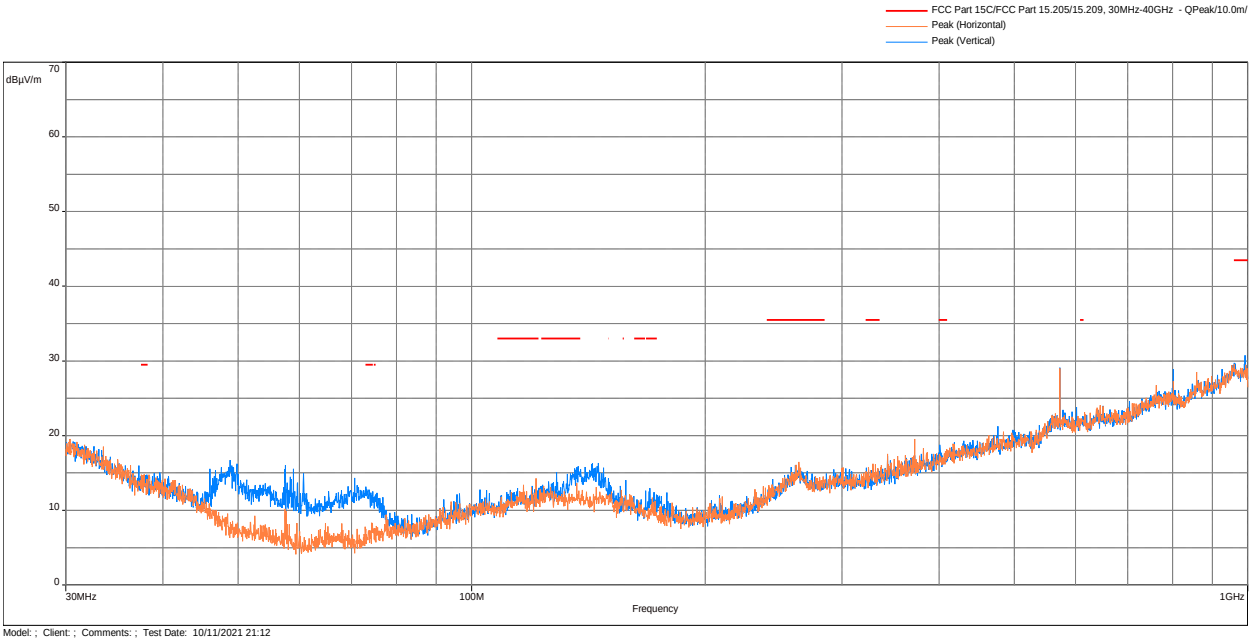
| Frequency (MHz) | Ave FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 4817.3 | 35.9 | 54.0 | -18.1 | 1.5 | 322.0 | Horizontal | -4.7 |
| 4821.8 | 39.1 | 54.0 | -14.9 | 125.0 | 266.0 | Vertical | -4.7 |

Note: Correction = AF + CF - Preamp

| **Results** | **Complies** |
|---|---|

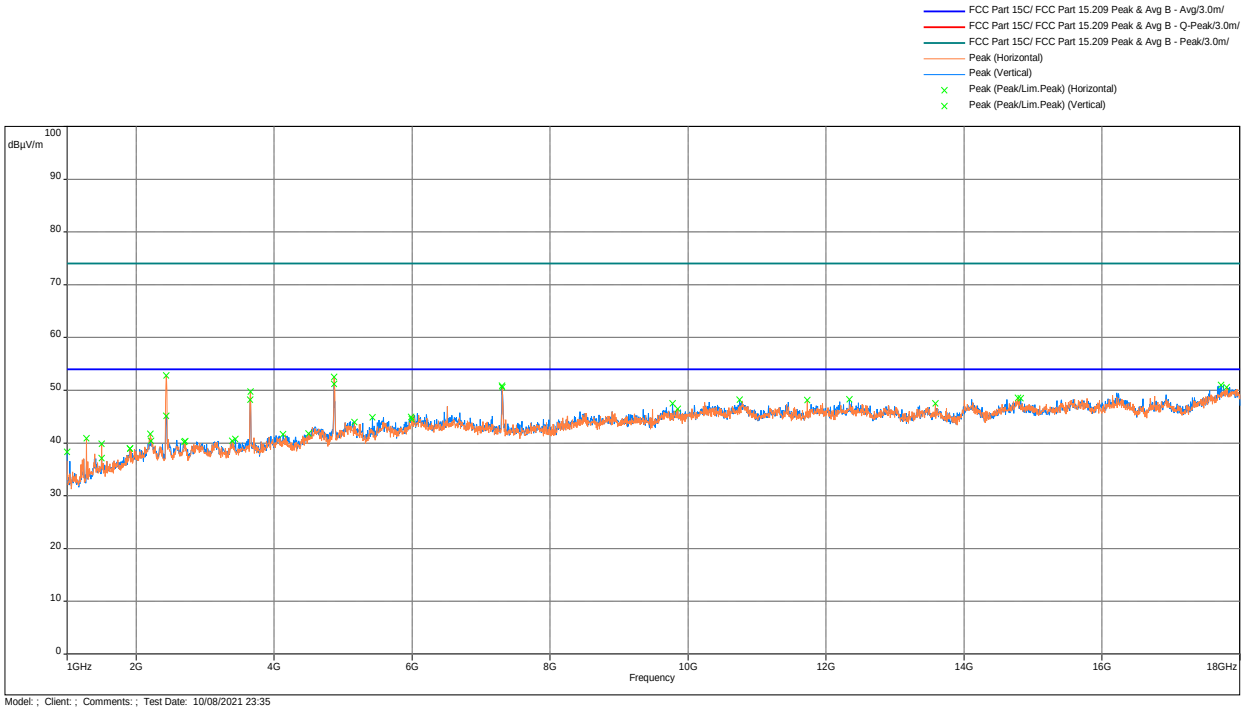
## Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz, 2437MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



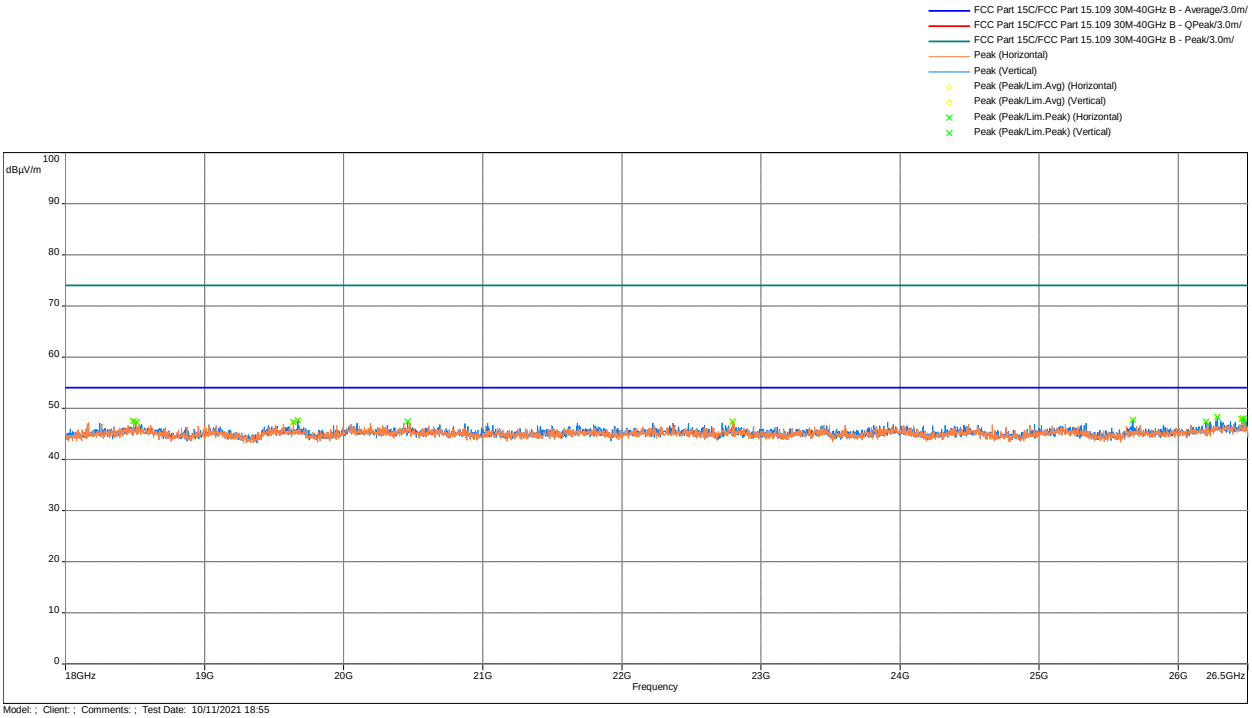

Model: ; Client: ; Comments: ; Test Date: 10/11/2021 21:12

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit




Model: ; Client: ; Comments: ; Test Date: 10/08/2021 23:35

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



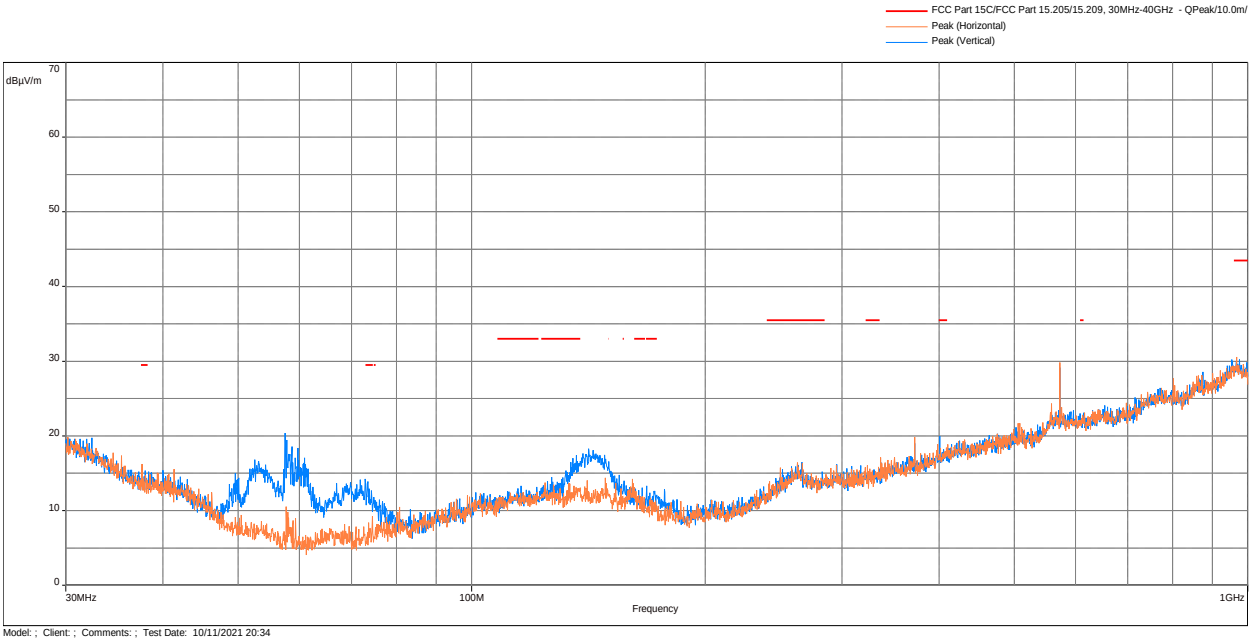

| Frequency (MHz) | Peak FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 3657.1 | 49.7 | 54.0 | -4.3 | 1.5 | 23.0 | Horizontal | -6.9 |
| 4869.2 | 52.5 | 54.0 | -1.5 | 1.5 | 268.0 | Horizontal | -4.4 |
| 4870.9 | 51.2 | 54.0 | -2.8 | 1.5 | 1.0 | Vertical | -4.4 |
| 7303.6 | 50.9 | 54.0 | -3.2 | 1.5 | 336.5 | Vertical | -2.2 |
| 7307.6 | 50.6 | 54.0 | -3.4 | 2.5 | 284.0 | Horizontal | -2.2 |
| 17725.2 | 51.0 | 54.0 | -3.0 | 2.5 | 0.5 | Vertical | 9.5 |
| 17805.1 | 50.6 | 54.0 | -3.4 | 1.5 | 318.0 | Horizontal | 10.2 |

Note: Correction = AF + CF - Preamp

| | |
|---|---|
| **Results** | **Complies** |

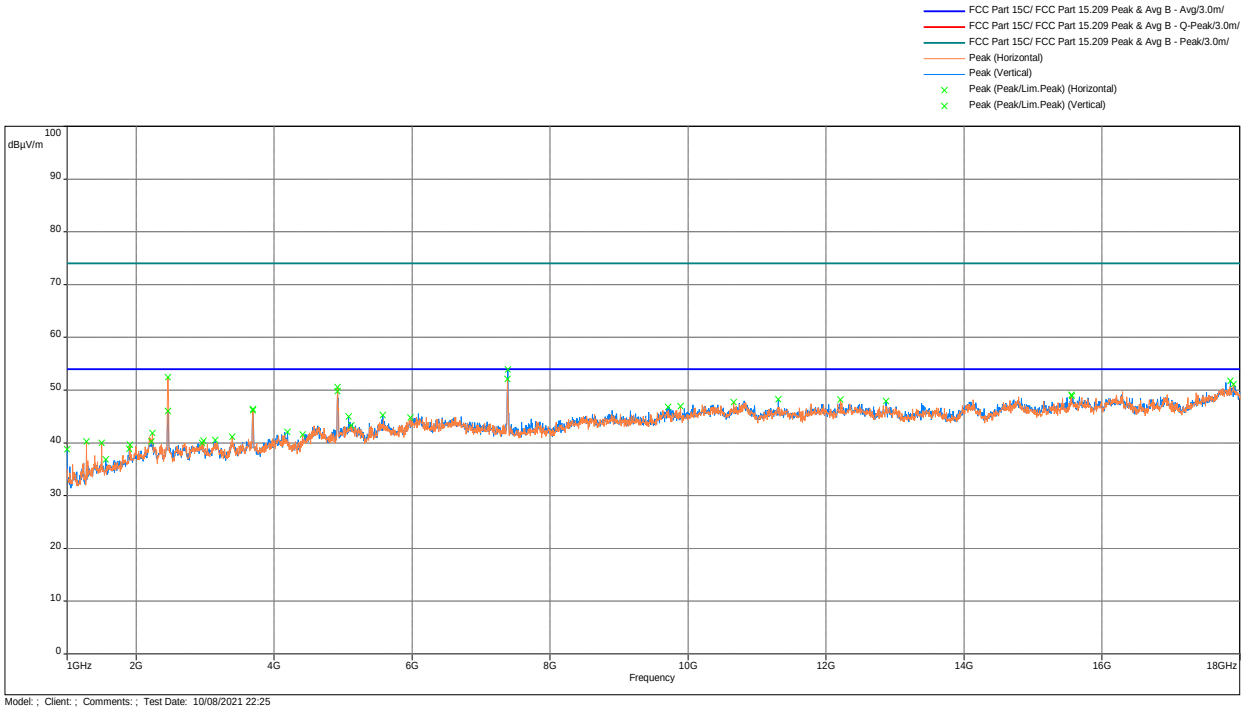
## Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz, 2462MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



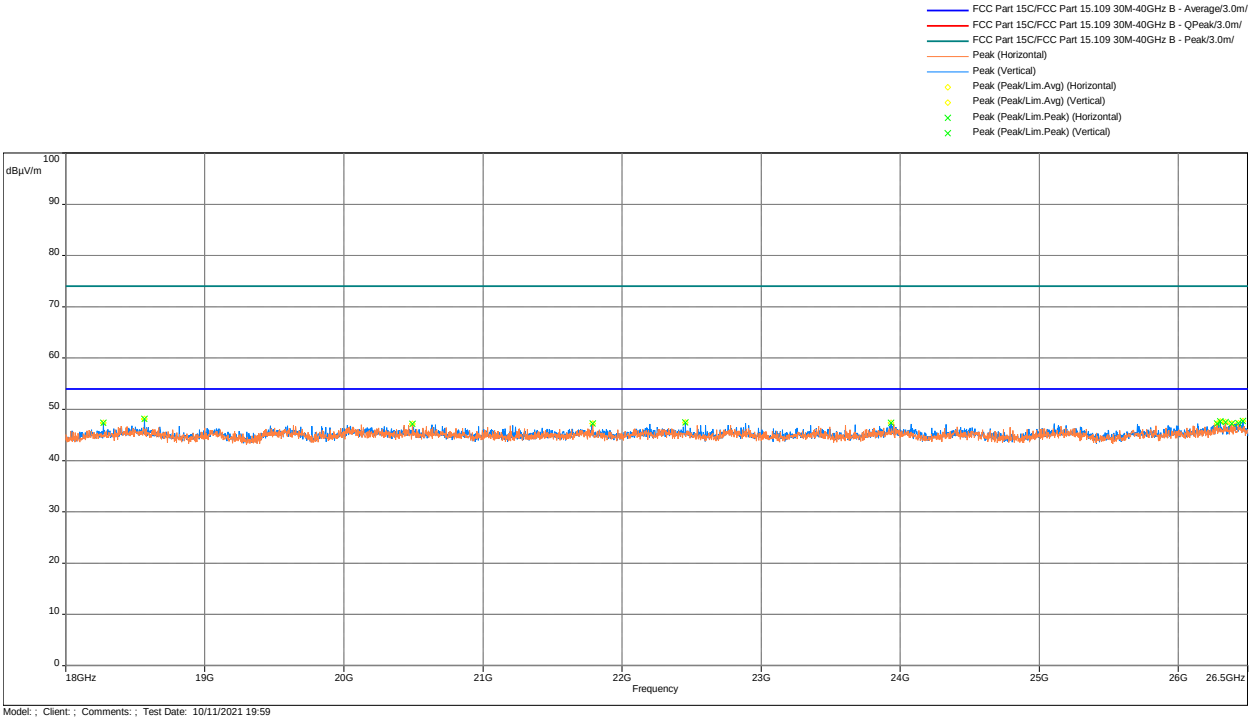

Model: ; Client: ; Comments: ; Test Date: 10/11/2021 20:34

Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit




Model: ; Client: ; Comments: ; Test Date: 10/08/2021 22:25

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit




| Frequency (MHz) | Peak FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 4919.1 | 49.8 | 54.0 | -4.2 | 1.5 | 319.0 | Vertical | -4.3 |
| 4920.8 | 50.6 | 54.0 | -3.4 | 1.5 | 0.0 | Horizontal | -4.3 |
| 17857.8 | 51.8 | 54.0 | -2.3 | 2.5 | 220.5 | Vertical | 10.2 |
| 17904.8 | 51.1 | 54.0 | -2.9 | 2.5 | 266.0 | Horizontal | 10.2 |

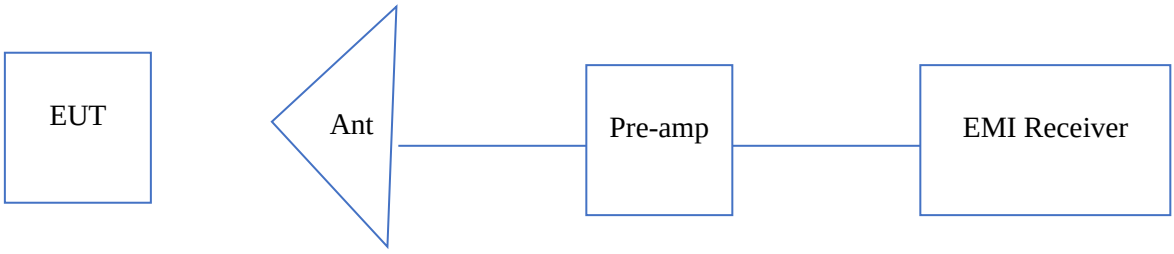
| Frequency (MHz) | Ave FS@3m (dBµV/m) | Avg Limit@3m (dB(uV/m)) | Margin (dB) | Height (m) | Azimuth (deg) | Polarity | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 7381.2 | 52.1 | 54.0 | -1.9 | 3.5 | 324.5 | Horizontal | -2.2 |
| 7386.7 | 38.1 | 54.0 | -15.9 | 1.3 | 22.0 | Vertical | -2.2 |

Note: Correction = AF + CF - Preamp

| | |
|---|---|
| **Results** | **Complies** |

### 4.5.5 Test Setup Photographs

**The following photographs show the testing configurations used.**



## 4.6 AC Line Conducted Emission
FCC: 15.207; RSS-GEN

### 4.6.1 Requirement

| Frequency Band MHz | FCC Part 15.207 Limits | |
|---|---|---|
| | Quasi-Peak | Average |
| 0.15-0.50 | 66 to 56 * | 56 to 46 * |
| 0.50-5.00 | 56 | 46 |
| 5.00-30.00 | 60 | 50 |

*Note: *Decreases linearly with the logarithm of the frequency*
*At the transition frequency the lower limit applies.*

### 4.6.2 Procedure

Measurements are carried out using quasi-peak and average detector receivers in accordance with CISPR 16. An AMN is required to provide a defined impedance at high frequencies across the power feed at the point of measurement of terminal voltage and also to provide isolation of the circuit under test from the ambient noise on the power lines. An AMN as defined in CISPR 16 shall be used.

The EUT is located so that the distance between the boundary of the EUT and the closest surface of the AMN is 0.8m.

Where a flexible mains cord is provided by the manufacturer, this shall be 1m long or if in excess of 1m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4m in length.

The EUT is arranged and connected with cables terminated in accordance with the product specification.

Conducted disturbance is measured between the phase lead and the reference ground, and between the neutral lead and the reference ground. Both measured values are reported.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground plane not being part of the EUT. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.

Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

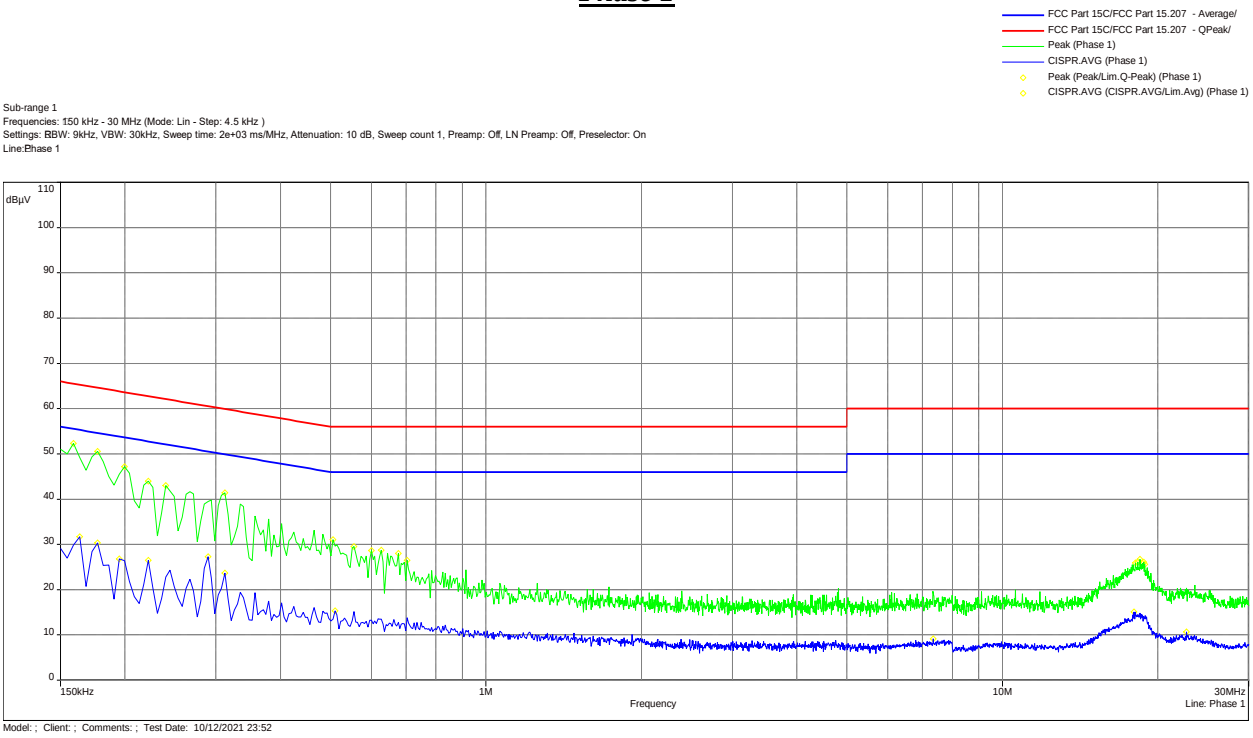
Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.10: 2013.

| Tested By | Test Date |
|---|---|
| Minh Ly | October 12, 2021 |

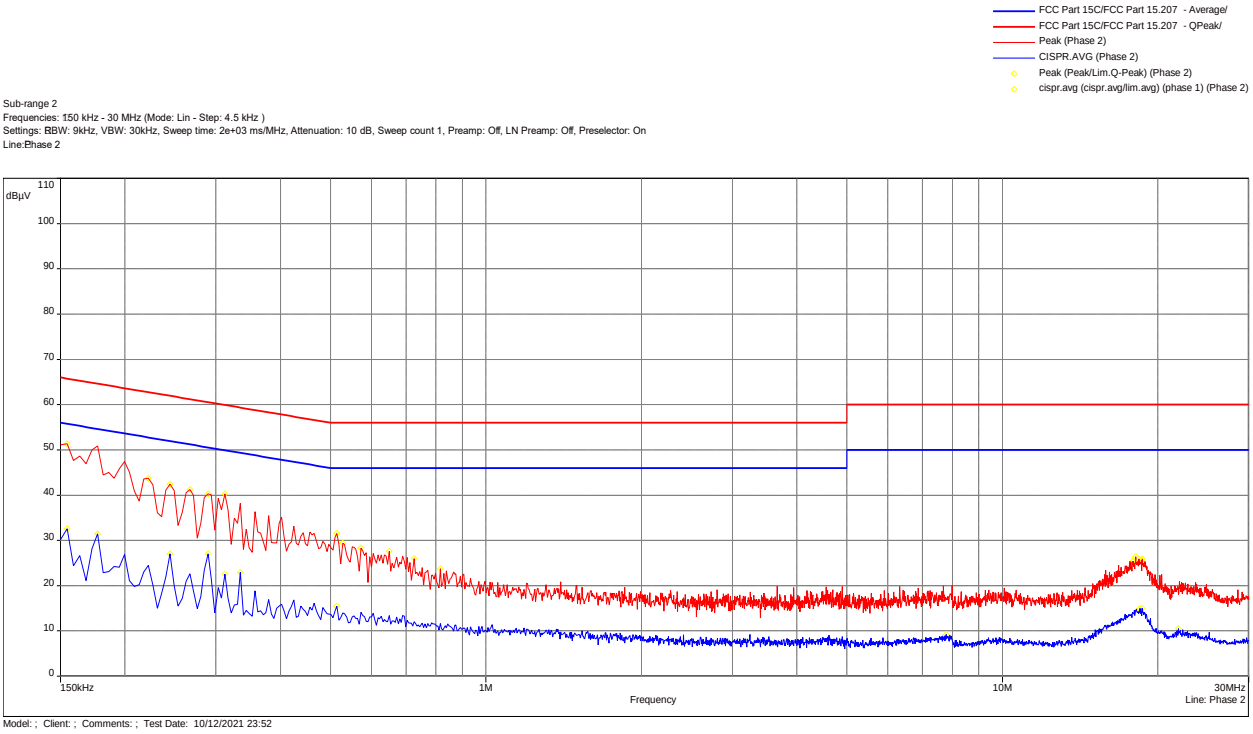
### 4.6.3 Test Results

15.207: Conducted Emissions 120VAC 60Hz

***Phase 1***




***Phase 2***



4.6.3 Test Results (Continued)

| Frequency (MHz) | Q-Peak (dBµV) | Limit Q-Peak (dBµV) | Margin Q-Peak (dB) | Line | Correction (dB) |
|---|---|---|---|---|---|
| 0.155 | 51.4 | 65.8 | -14.4 | Phase 2 | 11.0 |
| 0.159 | 52.4 | 65.5 | -13.2 | Phase 1 | 11.0 |
| 0.177 | 50.5 | 64.6 | -14.1 | Phase 1 | 11.0 |
| 0.200 | 47.2 | 63.6 | -16.5 | Phase 1 | 11.0 |
| 0.222 | 43.9 | 62.7 | -18.8 | Phase 1 | 11.0 |
| 0.312 | 41.4 | 59.9 | -18.5 | Phase 1 | 11.0 |

| Frequency (MHz) | CISPR AVG (dBµV) | Limit Avg (dBµV) | Margin Avg (dB) | Line | Correction (dB) |
|---|---|---|---|---|---|
| 0.155 | 32.6 | 55.8 | -23.2 | Phase 2 | 11.0 |
| 0.164 | 31.7 | 55.3 | -23.6 | Phase 1 | 11.0 |
| 0.177 | 31.5 | 54.6 | -23.2 | Phase 2 | 11.0 |
| 0.177 | 30.3 | 54.6 | -24.3 | Phase 1 | 11.0 |
| 0.290 | 27.3 | 50.5 | -23.3 | Phase 1 | 11.0 |
| 0.290 | 27.1 | 50.5 | -23.5 | Phase 2 | 11.0 |

**Results:** **Complies** by 13.2 dB

## 5.0 List of Test Equipment

Measurement equipment used for emission compliance testing utilized the equipment on the following list:

| Equipment | Manufacturer | Model/Type | Asset # | Cal Int | Cal Due |
|---|---|---|---|---|---|
| EMI Receiver | Rohde and Schwarz | ESU40 | ITS 00961 | 12 | 03/09/22 |
| LISN | FCC | FCC-LISN-50-50 | ITS 00551 | 12 | 11/16/21 |
| Horn Antenna | ETS Lindgren | 3117PA | ITS 01636 | 12 | 12/17/21 |
| 18-40GHz Preamp | uComp Nordic | MCNS-50-18004000335P | ITS 01799 | 12 | 03/19/22 |
| Pyramidal Horn Antenna | EMCO | 3160-09 | ITS 00571 | # | # |
| Loop Antenna | EMCO | 6512 | ITS 01598 | 12 | 11/03/21 |
| BI-Log Antenna | Teseq | CBL 6111D | ITS 01505 | 12 | 03/22/22 |
| Pre-Amplifier | Sonoma Instrument | 310N | ITS 00942 | 12 | 04/19/22 |
| RF Cable | Mega Phase | TM40-K1K1-59 | ITS 01655 | 12 | 10/05/21 |
| RF Cable | Mega Phase | TM40-K1K1-19 | ITS 01155 | 12 | 04/28/22 |
| Notch Filter | MICRO-TRONICS | BRM50702 | ITS 01166 | 12 | 06/29/22 |
| RF Cable | Mega Phase | EMC1-K1K1-236 | ITS 01484 | 12 | 06/29/22 |
| 10m Semi-anechoic chamber | Panashield | 10m Chamber | ITS 00984 | 36 | 07/29/23 |

# Calibration not required.

Software used for emission compliance testing utilized the following:

| Name | Manufacturer | Version | Template/Profile |
|---|---|---|---|
| BAT-EMC | Nexio | 3.20.0.14 | ESU and ESR Intertek Emissions Template |
| Tile | Quantum Change | 3.4.K.22 | Conducted Spurious_30M-26GHz |
| RS Commander | Rohde Schwarz | 1.6.4 | Not Applicable (Screen grabber) |

## 6.0 Document History

| Revision/ Job Number | Writer Initials | Reviewers Initials | Date | Change |
|---|---|---|---|---|
| 1.0 / G104799910 | ML | KV | November 12, 2021 | Original document |
| 1.1 / G104799910 | AS | KV | February 7, 2022 | Updated Block Diagram |

***END OF REPORT***