# TEST REPORT

**Report Number: 104407842MPK-027**
**Project Number: G104407842**
**December 28, 2020**

**Testing performed on**
**Real Immersive System**
**Model: Xavier 1/Xavier 2**
**Part Number: 18826 (WTM, Wireless Transmitter Module)**

**FCC ID: 2AQU7-REAL02T**
**IC: 24199-REAL02T**
**to**

**FCC Part 15 Subpart C (15.247)**
**Industry Canada RSS-247 Issue 2**

**For**

**Penumbra Inc.**

| **Test Performed by:** | **Test Authorized by:** |
|---|---|
| Intertek | Penumbra Inc. |
| 1365 Adams Court | One Penumbra Place |
| Menlo Park, CA 94025 USA | Alameda, CA 94502 USA |

Prepared by: _____ **Date:** December 28, 2020
Aaron Chang

Reviewed by: _____ **Date:** December 28, 2020
Krishna K Vemuri

| Report No. 104407842MPK-027 | |
|---|---|
| **Equipment Under Test:** | Real Immersive System - Wireless Transmitter Module |
| **Trade Name:** | Penumbra Inc. |
| **Model Number:** | Xavier 1/Xavier 2 |
| **Part Number:** | 18826 |
| **Applicant:** | Penumbra Inc. |
| **Contact:** | Puneet Goyal |
| **Address:** | Penumbra Inc.<br>One Penumbra Place<br>Alameda, CA 94502 |
| **Country:** | USA |
| **Tel. Number:** | 510-440-5598 |
| **Email:** | pgoyal@penumbrainc.com |
| **Applicable Regulation:** | FCC Part 15 Subpart C (15.247)<br>Industry Canada RSS-247 Issue 2 |
| **Date of Test:** | September 21, 2020 to October 4, 2020 |

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

Aaron Chang
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 | Not Applicable – EUT is battery operated and does not operate while charging |
| **Antenna Requirement** | 15.203 | RSS-GEN | Complies (Internal Antenna) |

**EUT receive date:** September 24, 2020

**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:** September 24, 2020

**Test completion date:** October 4, 2020

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

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## 2.0 General Information

### 2.1 Product Description

Penumbra Inc. supplied the following description of the EUT:

Xavier is a digital hardware and software medical device platform utilizing virtual reality technology designed for use in healthcare and focusing on physical, neurorehabilitation and/or wellness needs. Xavier 1 is intended to be used in a clinical environment, or any other facility that may facilitate rehabilitation by healthcare providers who have received appropriate training in rehabilitation therapy. Xavier 2 is intended to be used in a residential environment, or any other facility that may facilitate rehabilitation individuals with physical, neurorehabilitation and/or wellness needs. A caregiver may be optionally present to help the user operate the system. The mode to test is in functional mode when the device is completely removed from the charging station and strapped to a patient/user.

Xavier is composed of:

- All-In-One Head Mounted Display (HMD)
- HMD Controller
- Wireless Sensor Modules (WSM)
- Wireless Transmitter Module (WTM)
- Sensor Charger (charging station)
- Tablet (Xavier 1 configuration only)

For more information, refer to the following product specification, declared by the manufacturer.

Information about the 2.4 GHz radio is presented below:

| | |
|---|---|
| **Applicant** | Penumbra Inc. |
| **Model No.** | Xavier 1/Xavier 2 |
| **FCC Identifier** | 2AQU7-REAL02T |
| **IC Identifier** | 24199-REAL02T |
| **Type of transmission** | Digital Transmission System (DTS) |
| **Rated RF Output** | 4.04 dBm |
| **Antenna(s) & Gain** | Internal Antenna, Peak Gain: 1.3 dBi |
| **Frequency Range** | 2402 – 2479 MHz |
| **Type of modulation/data rate** | Frequency-shift Keying (FSK) / 2Mbit/s |
| **Number of Channel(s)** | 77 |
| **Applicant Name & Address** | Penumbra Inc.<br>One Penumbra Place<br>Alameda, CA 94502<br>USA |

## 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" (558074 D01 15.247 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

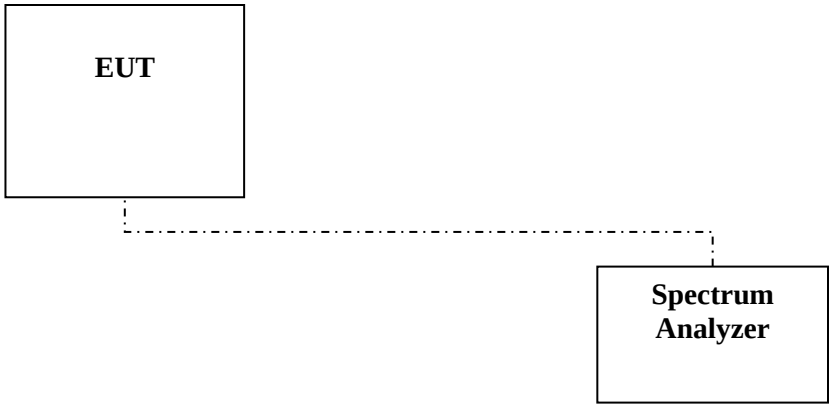
| Support Equipment | | |
|---|---|---|
| **Description** | **Manufacturer** | **Model Number** |
| Laptop* | Dell | Latitude 5400 |

*Laptop was only used to configure radio channels. In normal usage no laptop will be present.

### 3.2 Block Diagram of Test Setup

| Equipment Under Test | | | |
|---|---|---|---|
| **Description** | **Manufacturer** | **Part Number** | **Serial Number (LOT Number)** |
| Radiated Sample of WTM, Wireless Transmitter Module | Penumbra, Inc. | 18826 | E11910 |
| Conducted Sample of WTM, Wireless Transmitter Module | Penumbra, Inc. | 18826 | E11909 |

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




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

## 3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table.

According to the manufacturer, each Real Immersive System will consist of Xavier 1: 5 WSM, 1 WTM & 1 HMD or Xavier 2: 2 WSM, 1 WTM & 1 HMD. The WSMs and WTM will be paired to the HMD. The HMD has two radios and WSM/WTM has one radio each. These pairing in this system will use one out of the 77 available channels at a time. The devices in the system share the channel.

## 3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was provided by Penumbra Inc.

## 3.5 Mode of Operation during Test

As instructed by the manufacturer, the EUT's power setting was set to +4 dBm on the low, middle and high frequencies/channels.

## 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.

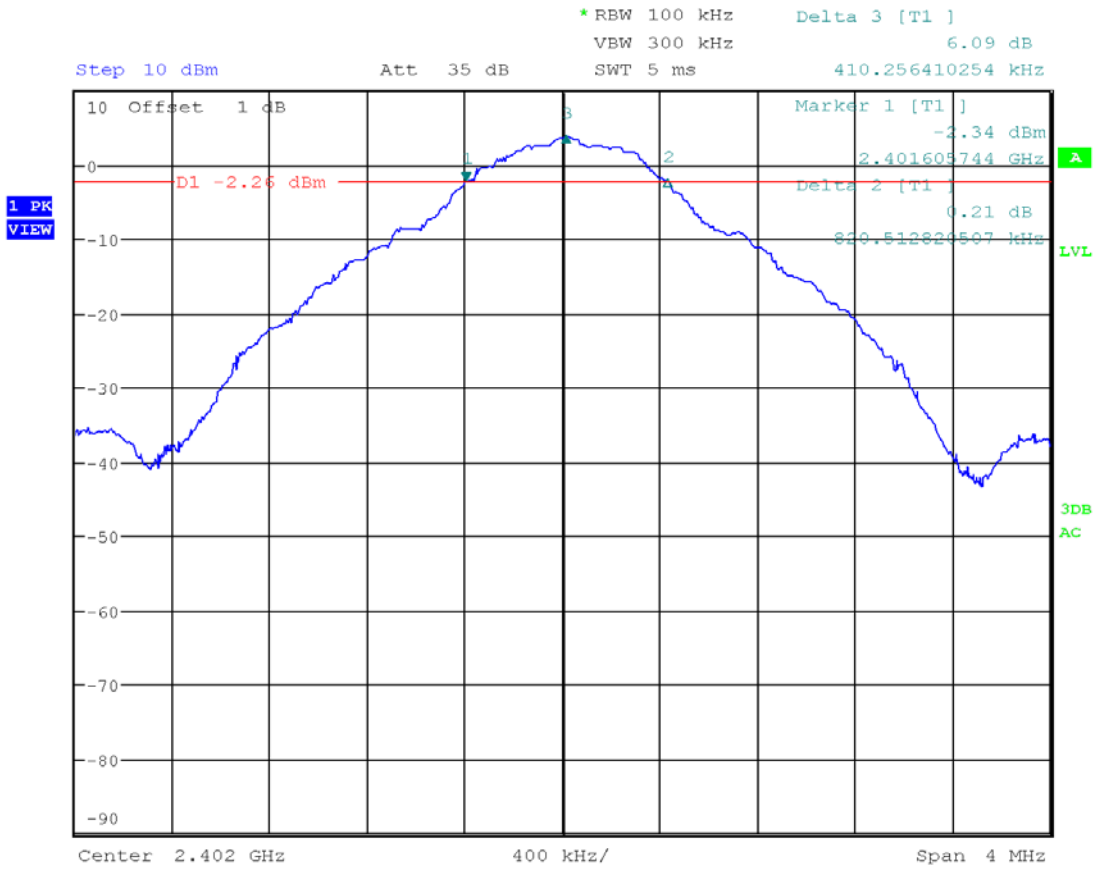
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

4.1.3 Test Result

| Frequency (MHz) | 6-dB bandwidth FCC 15.247 & RSS-GEN | Occupied bandwidth, RSS-GEN | Plot |
|---|---|---|---|
| MHz | kHz | MHz | |
| 2402 | 820.513 | -- | 1.1 |
| | -- | 1.752 | 1.4 |
| 2440 | 865.385 | -- | 1.2 |
| | -- | 1.684 | 1.5 |
| 2479 | 820.513 | -- | 1.3 |
| | -- | 1.680 | 1.6 |

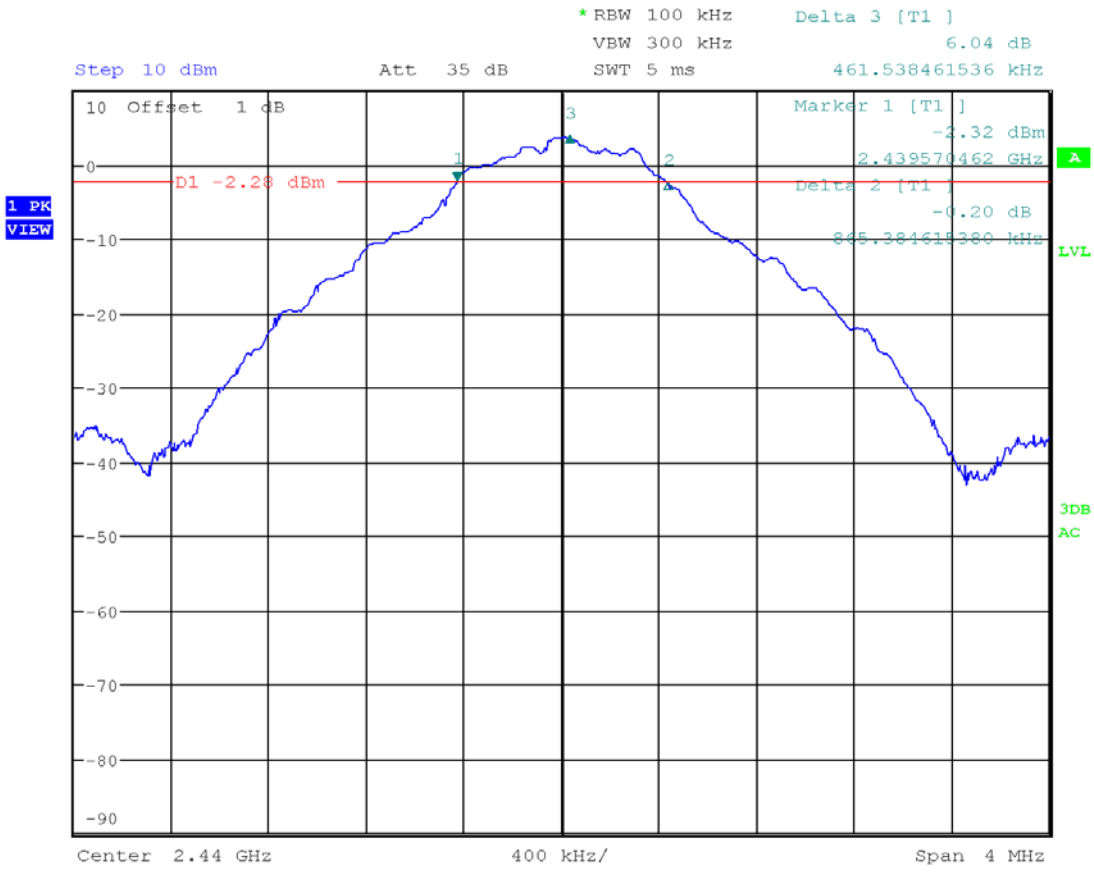
| Tested By | Test Date |
|---|---|
| Aaron Chang | September 24, 2020 |

Plot 1. 1



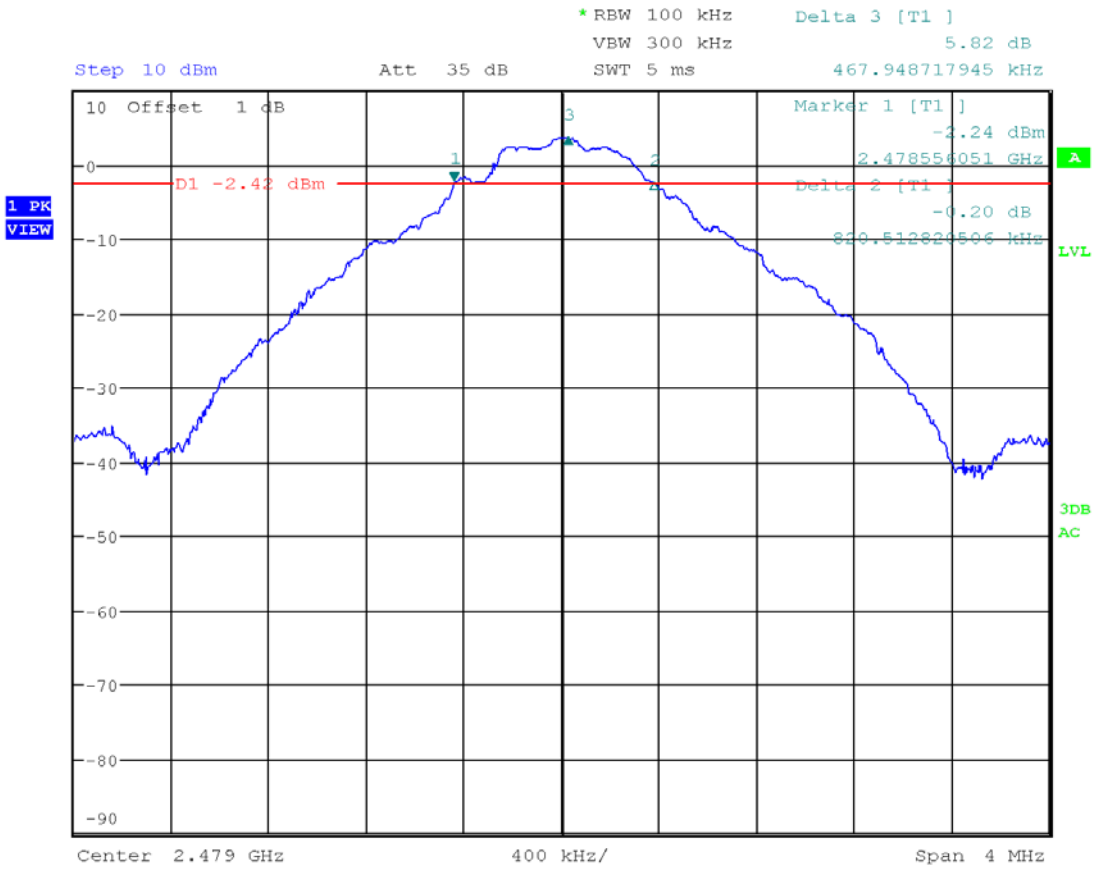

Date: 24.SEP.2020 23:46:55

Plot 1. 2



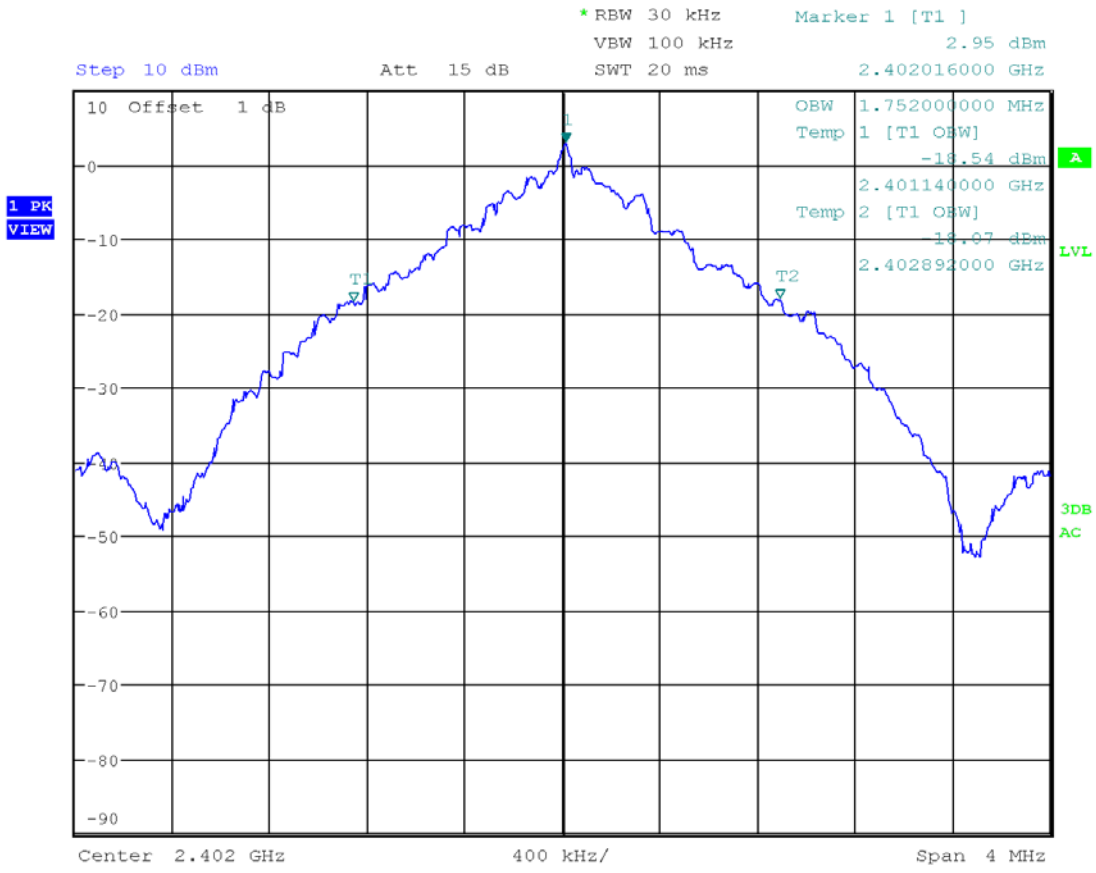

Date: 24.SEP.2020 23:48:33

Plot 1. 3



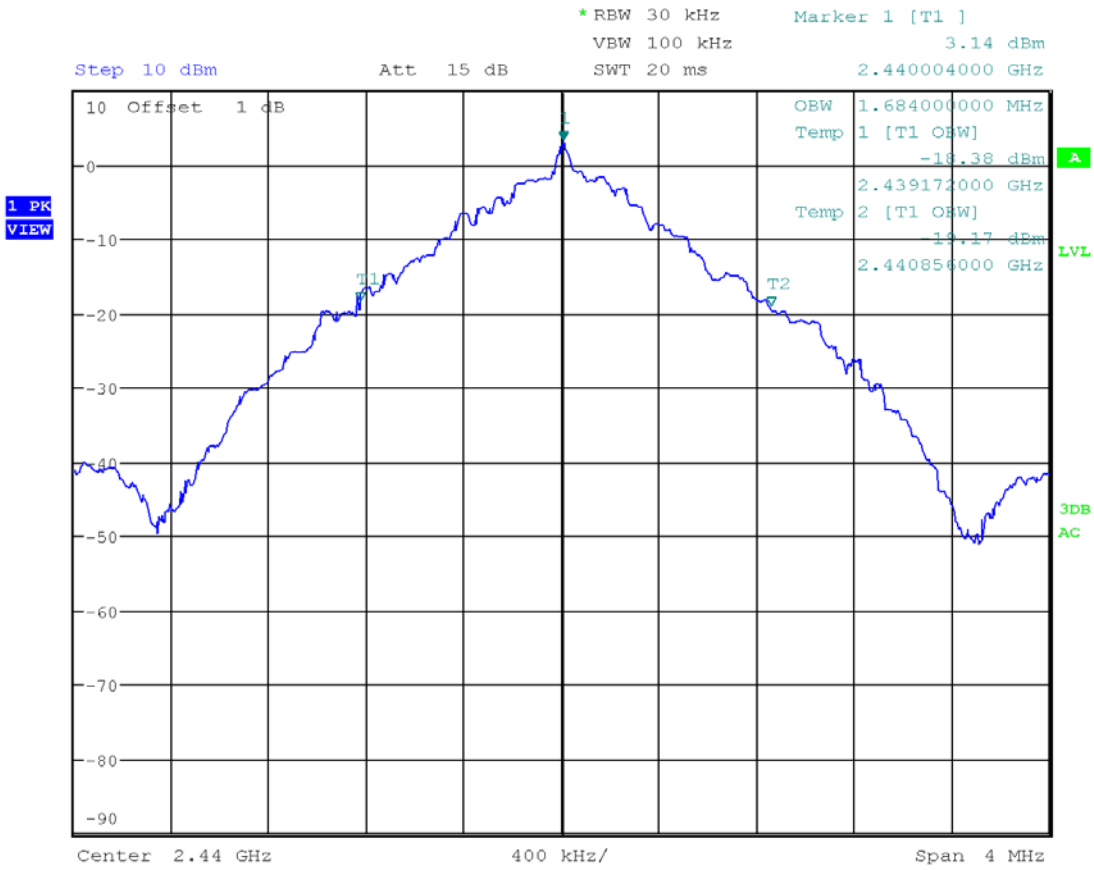

Date: 24.SEP.2020 23:52:04

Plot 1. 4



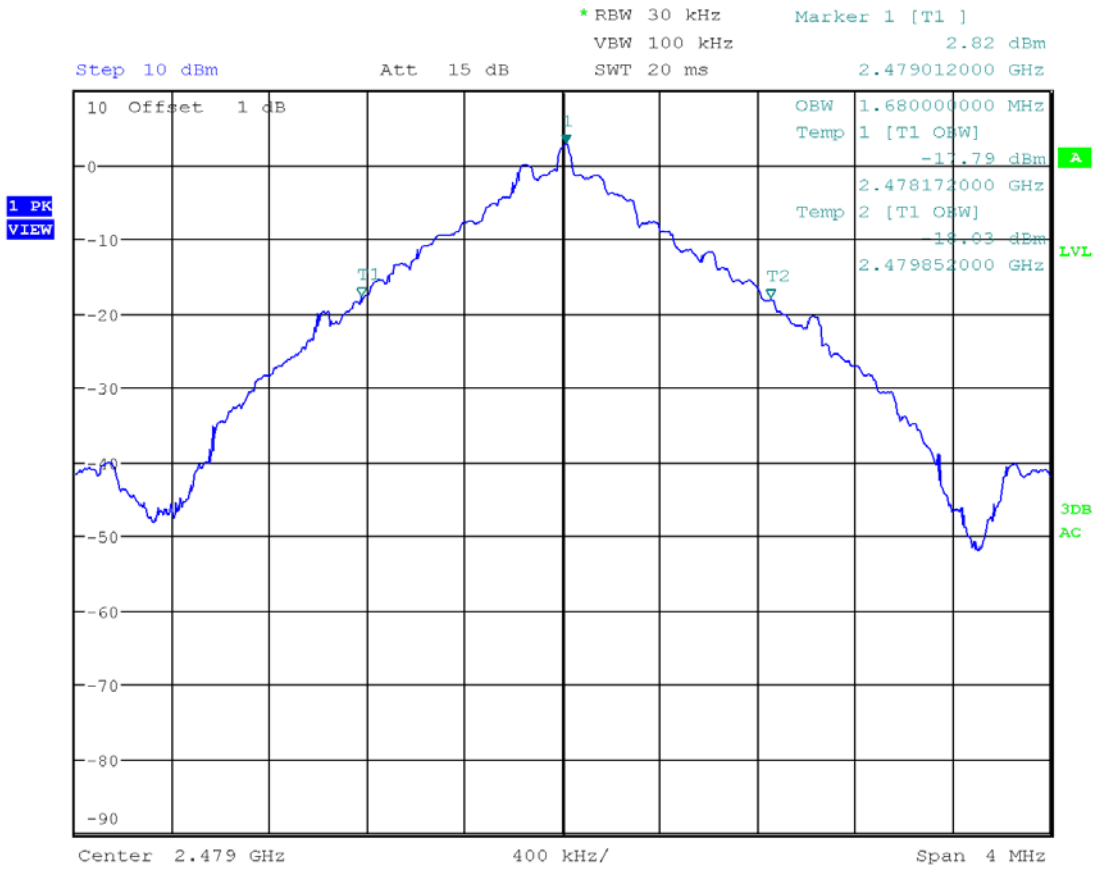

Date: 24.SEP.2020 23:55:24

Plot 1.5




Date: 24.SEP.2020 23:54:27

Plot 1.6




Date: 24.SEP.2020 23:53:32

## 4.2 Maximum Peak 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 or 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 procedure described in FCC Publication KDB 558074 D01 Meas Guidance v05r02 was used. Specifically, section 11.9.1.1 RBW ≥ DTS bandwidth in ANSI 63.10.

1. Set the RBW ≥ DTS Bandwidth
2. Set the VBW ≥ 3 x RBW
3. Set the span ≥ 3 x RBW
4. Detector = Peak
5. Sweep time = Auto couple
6. Trace mode = Max Hold
7. Allow trace to fully stabilize
8. Use peak marker function to determine the peak amplitude level.

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

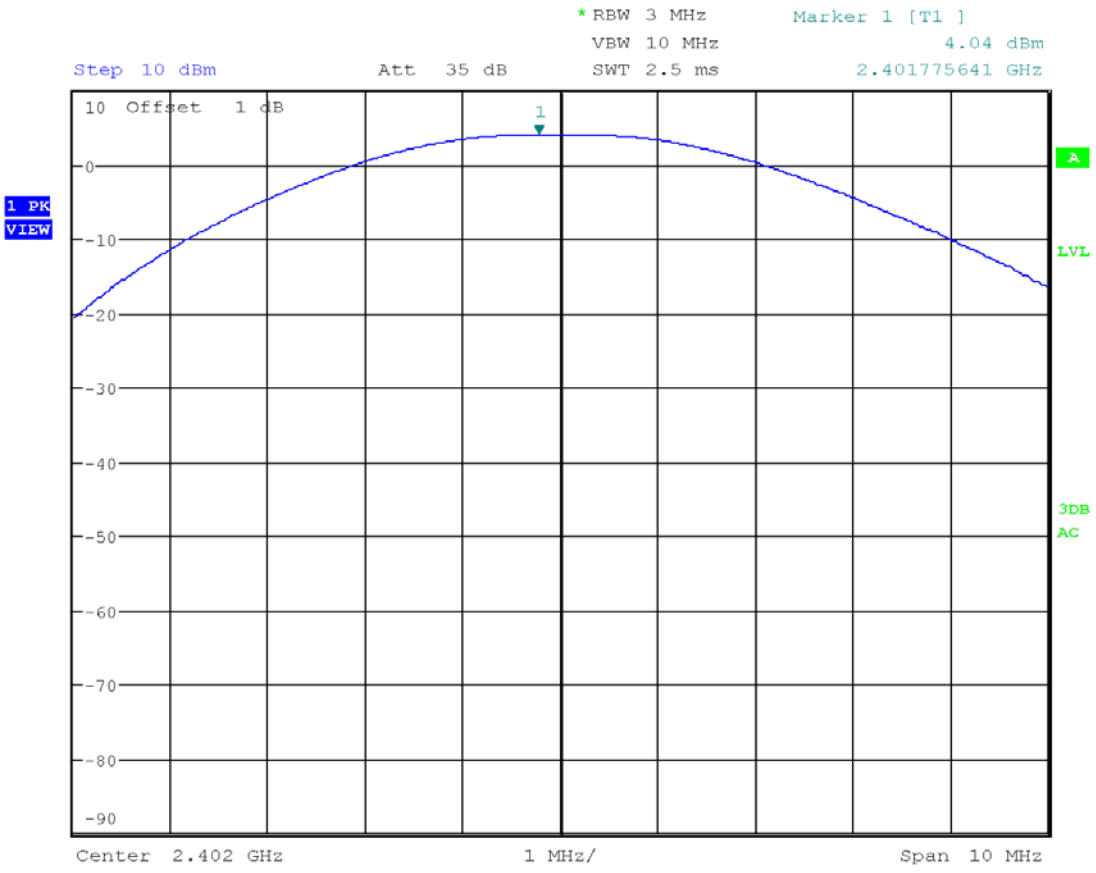
### 4.2.3 Test Result

Refer to the following plots 2.1 – 2.3 for the test details.

| **Frequency** | **Conducted Power (peak)** | | **Plot** |
|---|---|---|---|
| MHz | dBm | mW | |
| 2402 | 4.04 | 2.54 | 2.1 |
| 2440 | 4.03 | 2.53 | 2.2 |
| 2479 | 3.91 | 2.46 | 2.3 |

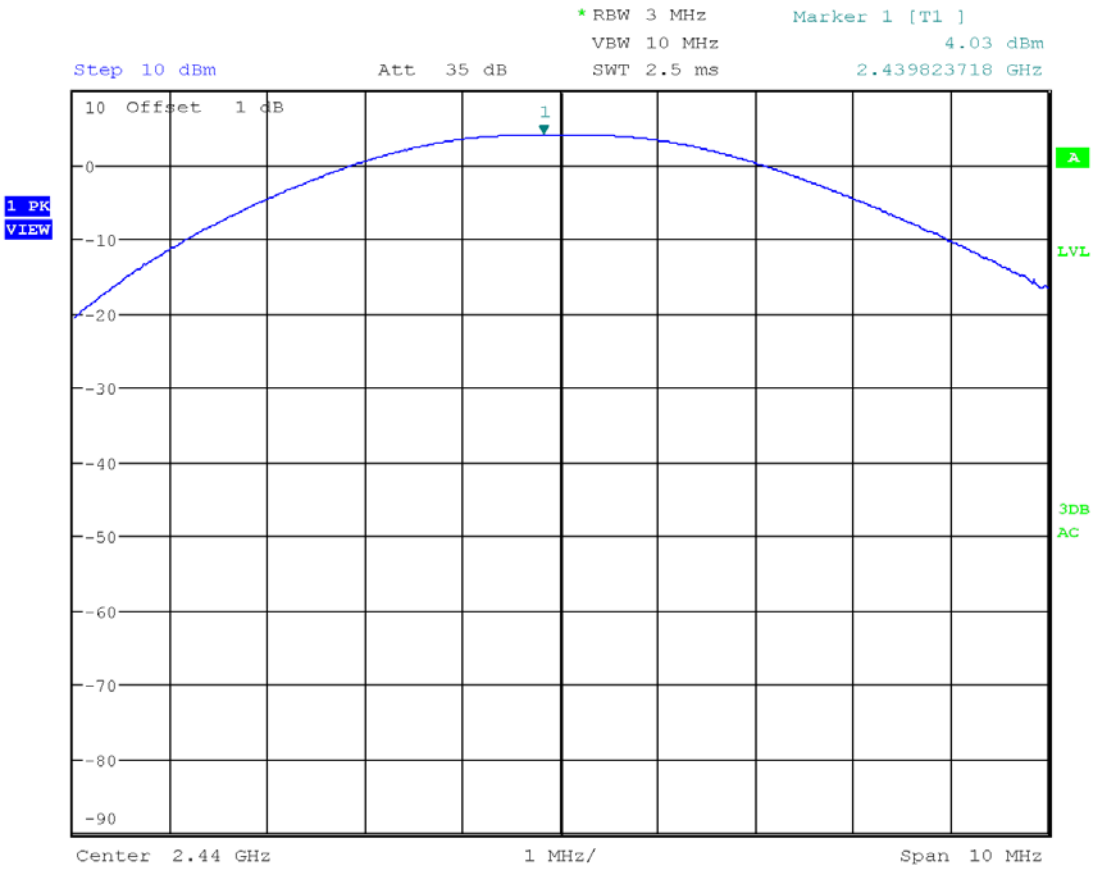
| **Tested By** | **Test Date** |
|---|---|
| Aaron Chang | September 24, 2020 |

Plot 2. 1

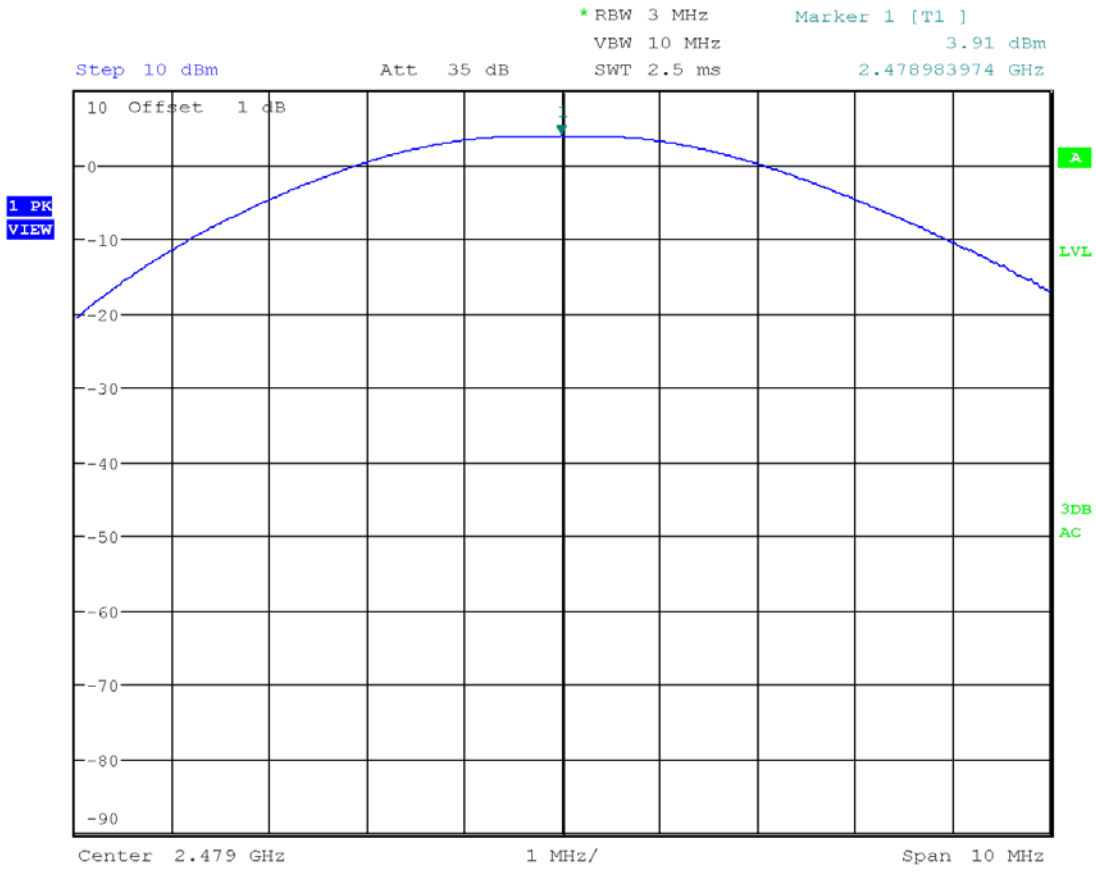



Date: 24.SEP.2020 23:40:07

Plot 2. 2


* RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1 ]
4.03 dBm
2.439823718 GHz
Step 10 dBm
Att 35 dB
10 Offset 1 dB
1 PK
VIEW
A
LVL
3DB
AC
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.44 GHz
1 MHz/
Span 10 MHz
Date: 24.SEP.2020 23:40:59

Plot 2. 3




Date: 24.SEP.2020 23:41:39

## 4.3 Maximum 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 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### 4.3.2 Procedure

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

The procedure described in 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.

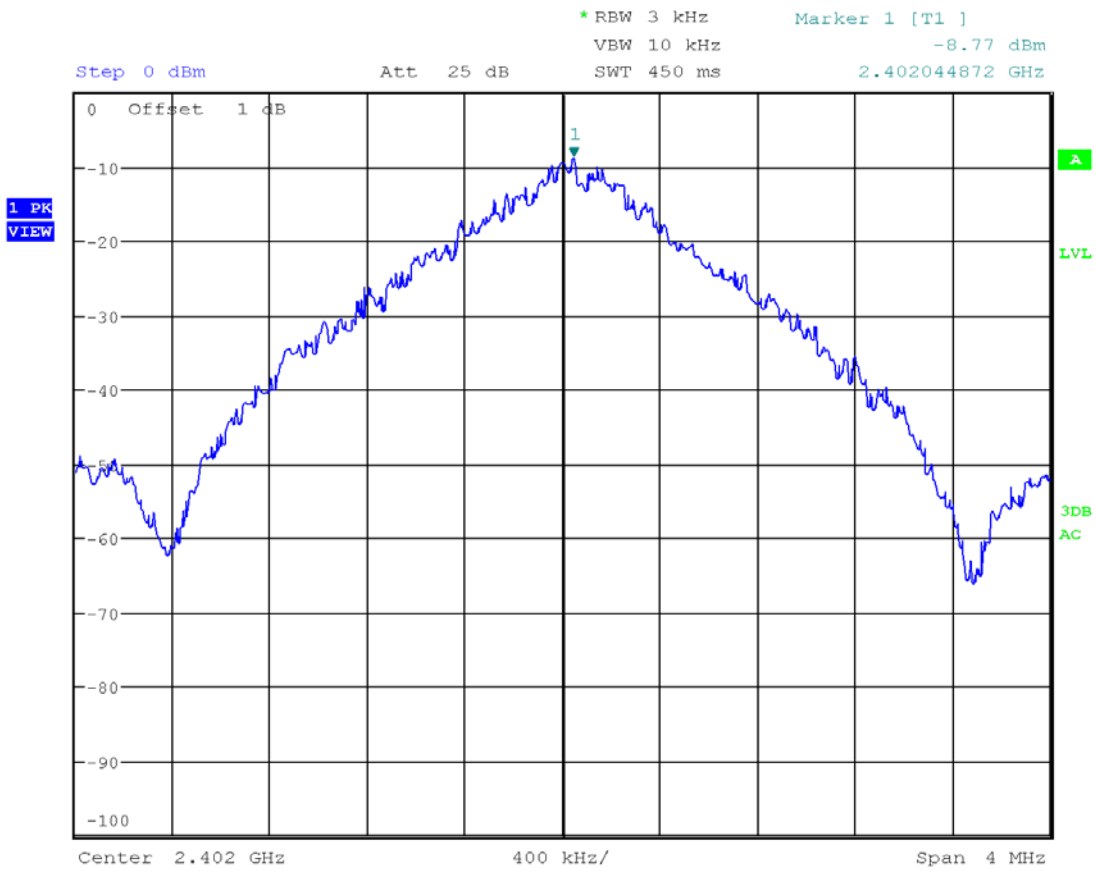
### 4.3.3 Test Result

Refer to the following plots for the test result

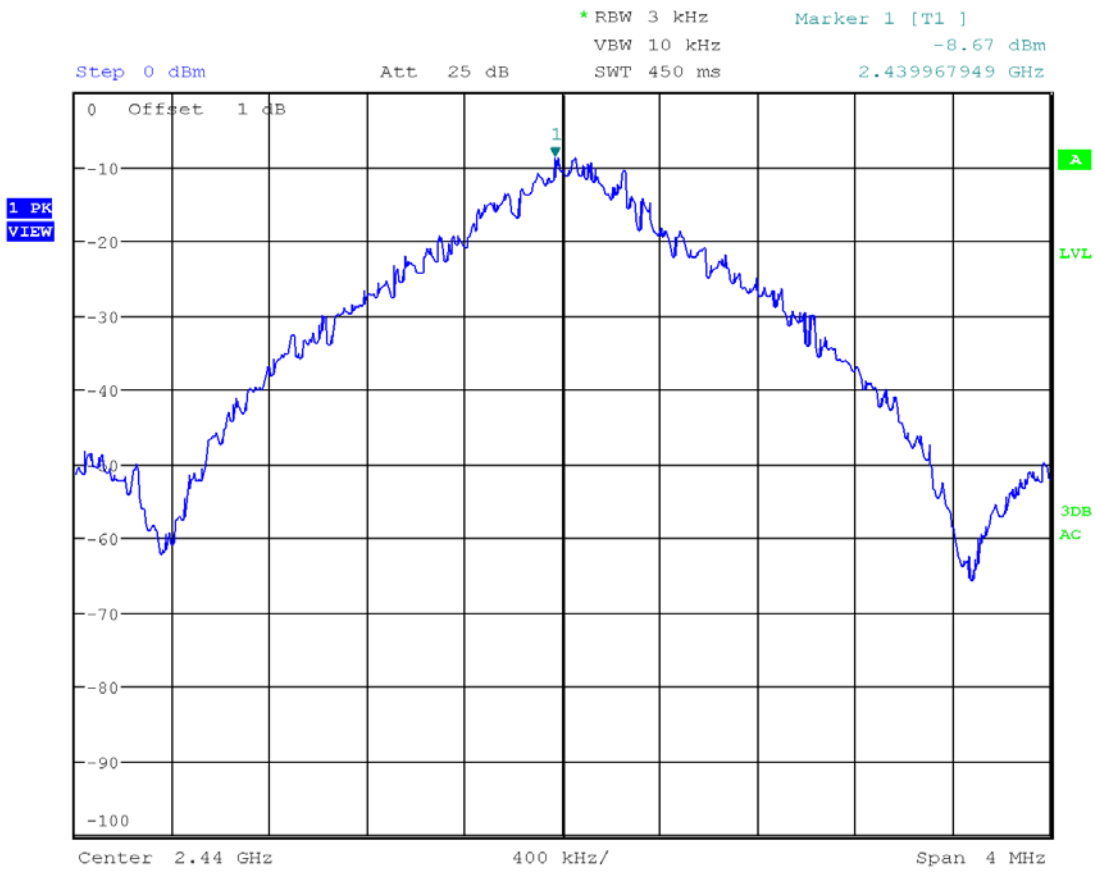
| Frequency, | Maximum Power Spectral Density | Maximum Power Spectral Density Limit | Margin | Plot |
|---|---|---|---|---|
| MHz | dBm | dBm | dB | |
| 2402 | -8.77 | 8.0 | -16.77 | 3.1 |
| 2440 | -8.67 | 8.0 | -16.67 | 3.2 |
| 2479 | -8.57 | 8.0 | -16.57 | 3.3 |

| Tested By | Test Date |
|---|---|
| Aaron Chang | September 24, 2020 |

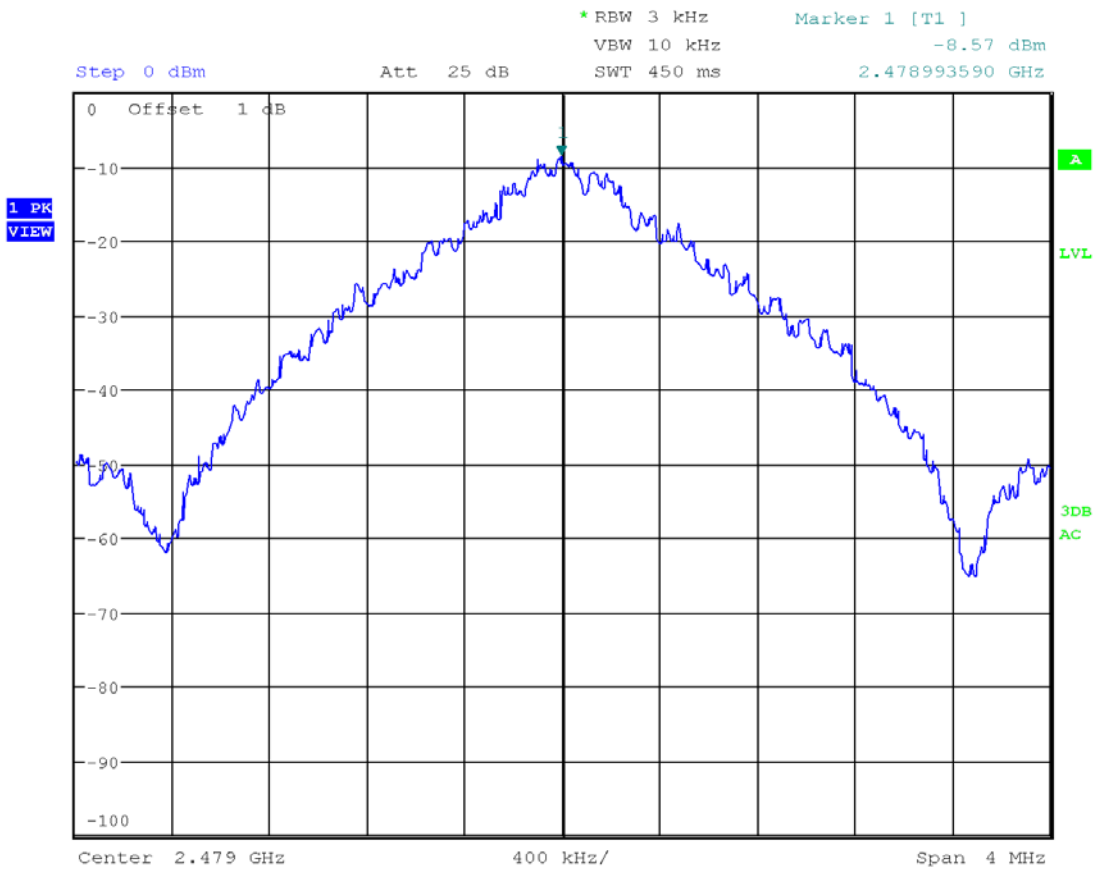
Plot 3. 1


* RBW 3 kHz
VBW 10 kHz
SWT 450 ms
Marker 1 [T1 ]
-8.77 dBm
2.402044872 GHz
Step 0 dBm
Att 25 dB
0 Offset 1 dB
1 PK
VIEW
A
LVL
3DB
AC
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
Center 2.402 GHz
400 kHz/
Span 4 MHz
Date: 24.SEP.2020 23:44:54

Plot 3. 2


* RBW 3 kHz
VBW 10 kHz
SWT 450 ms
Marker 1 [T1 ]
-8.67 dBm
2.439967949 GHz
Step 0 dBm
Att 25 dB
0 Offset 1 dB
1 PK
VIEW
A
LVL
3DB
AC
-10
-20
-30
-40
-60
-70
-80
-90
-100
Center 2.44 GHz
400 kHz/
Span 4 MHz
Date: 24.SEP.2020 23:44:08

Plot 3. 3




Date: 24.SEP.2020 23:43:08

## 4.4 Out of Band Antenna Conducted Emission
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.

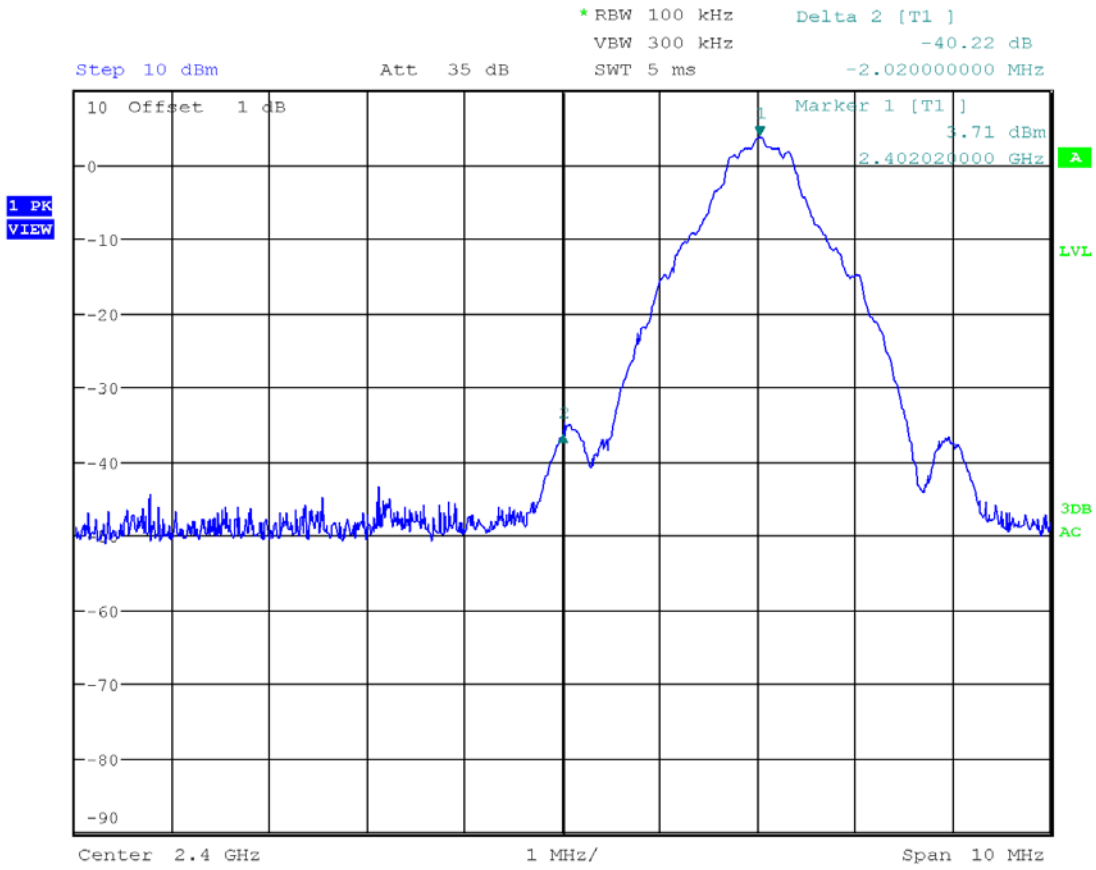
The unwanted emissions were measured from 9 kHz to 26 GHz. Plots below are corrected for cable loss and then compared to the limits.

### 4.4.3 Test Result

Refer to the following plots 4.1 – 4.5 for unwanted conducted emissions. The plot shows -20dB attenuation limit line.

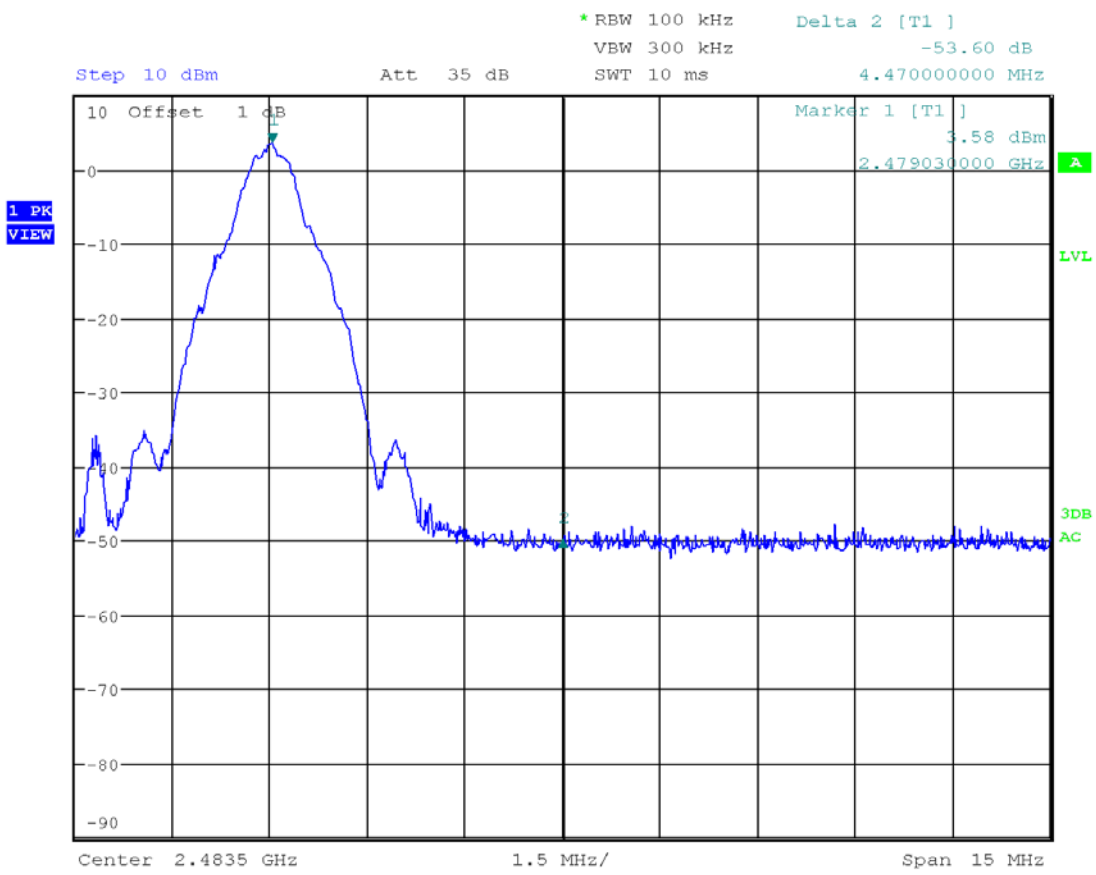
| Tested By | Test Date |
|---|---|
| Aaron Chang | September 24, 2020 |

Tx @ Low Channel, 2400 MHz Band Edge
Plot 4.1



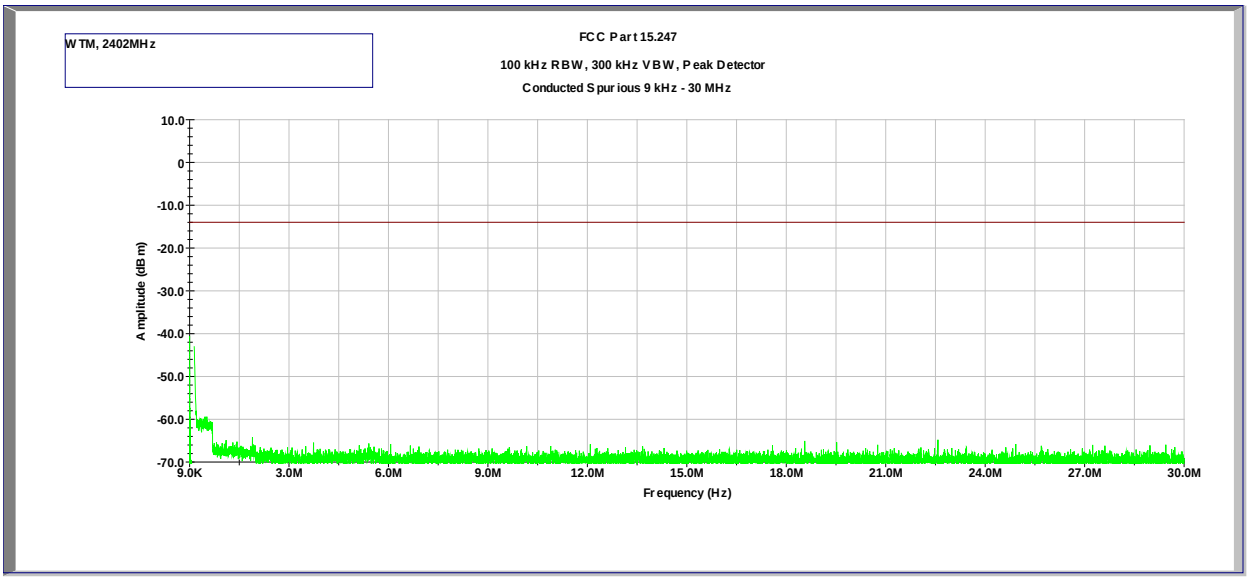

Date: 24.SEP.2020 23:57:06

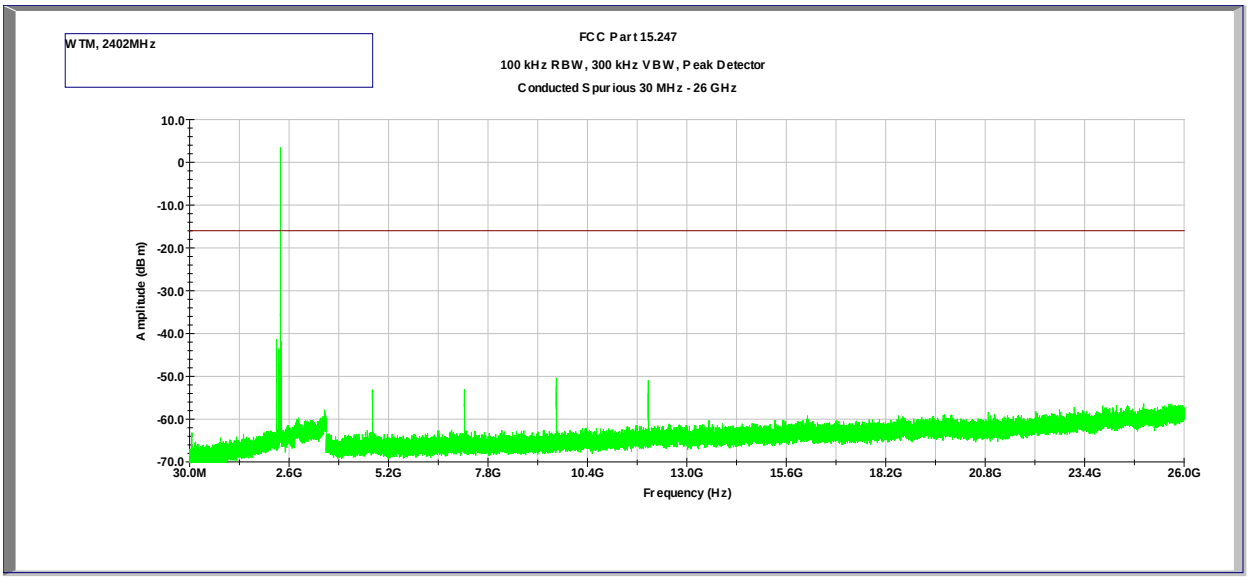
Tx @ Low Channel, 2483.5 MHz Band Edge
Plot 4.2



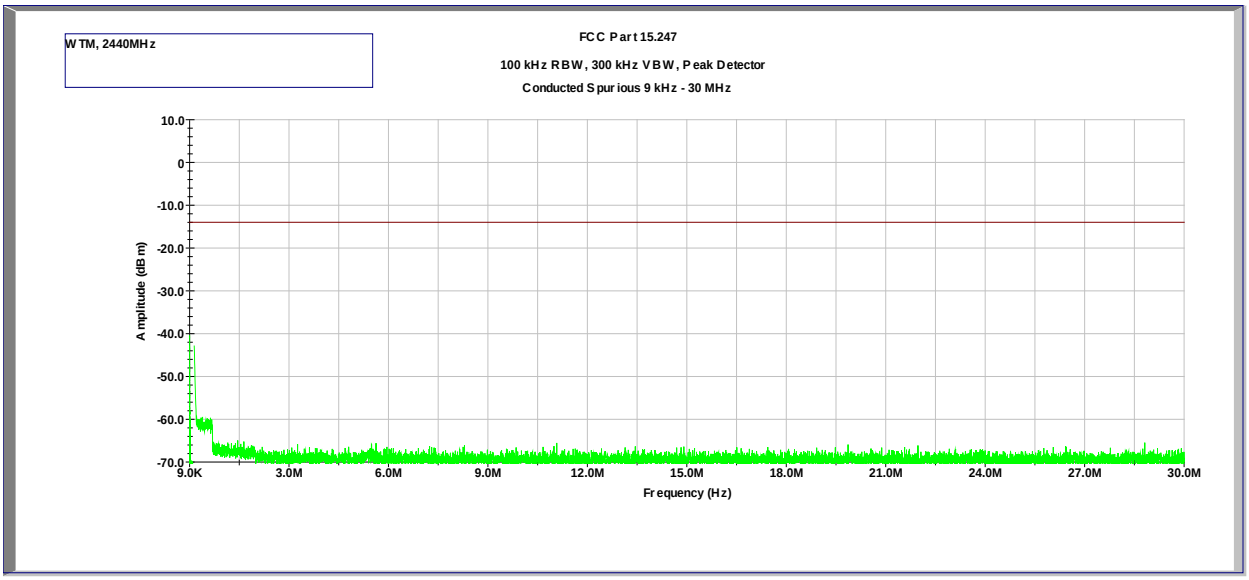

Date: 24.SEP.2020 23:58:08

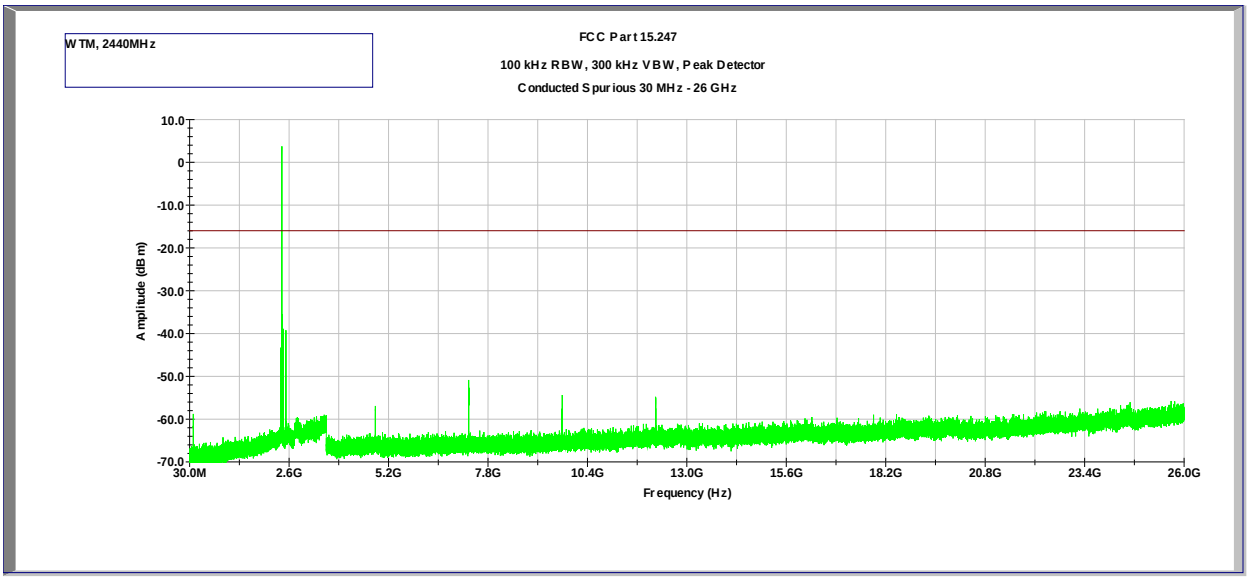
Tx @ Low Channel, 2402 MHz
9kHz -26GHz Conducted Spurious
Plot 4.3



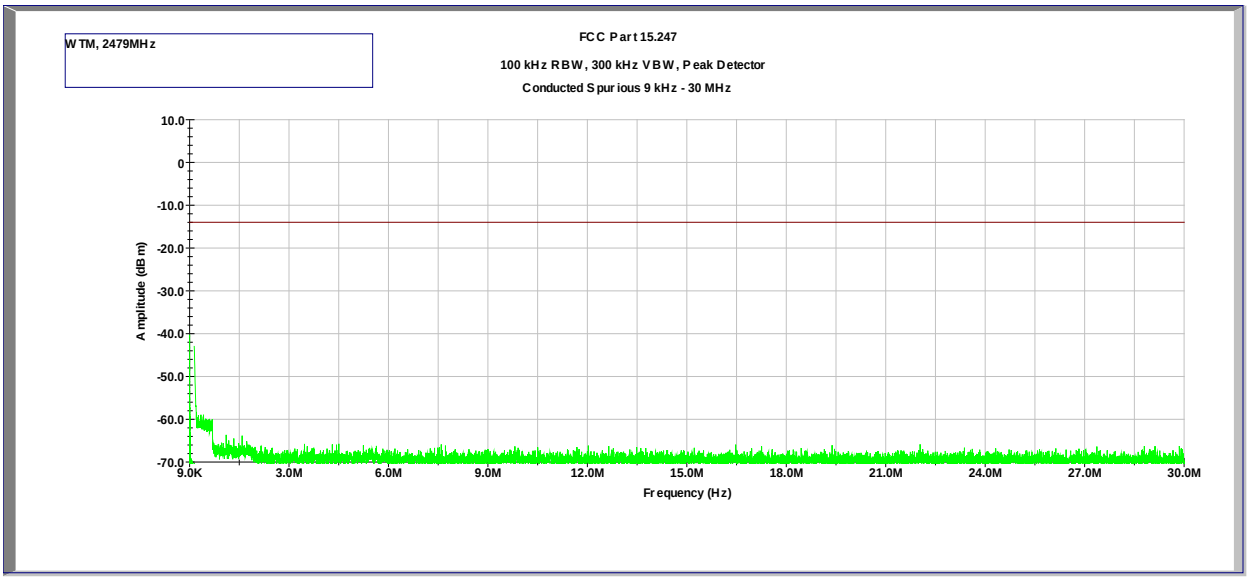



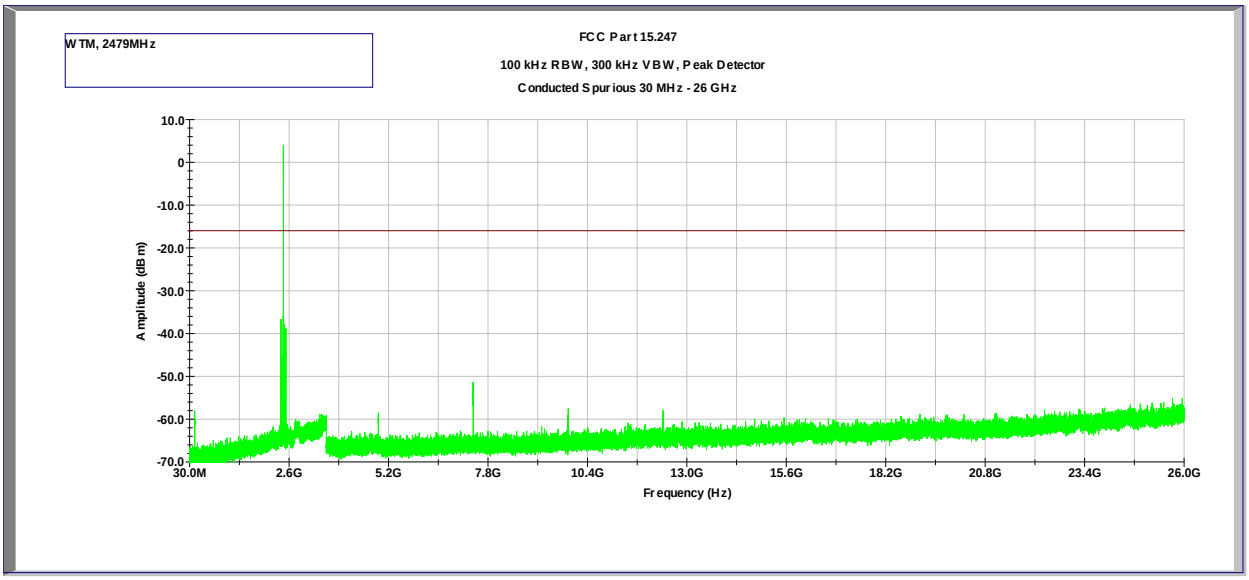
Tx @ Mid Channel, 2440 MHz
9kHz -26GHz Conducted Spurious
Plot 4.4



Tx @ High Channel, 2479 MHz
9kHz -26GHz Conducted Spurious
Plot 4.5



## 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 emission measurements were performed from 9 kHz to 26 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.

Radiated measurements were performed on the X, Y and Z orientation of the EUT. Data is presented with the worst-case configuration (the configuration which resulted in the highest emission levels).

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.

### 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 = Common Antilogarithm [(32 dBμV/m)/20] = 39.8 μV/m.

### 4.5.4 Antenna-port conducted measurements

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

### 4.5.5 General Procedure for conducted measurements in restricted bands

a) Measure the conducted output power (in dBm) using the detector specified for determining quasi-peak, peak, and average conducted output power, respectively.

b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)

c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).

d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (*e.g.*, Watts, mW).

e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:
E = EIRP – 20log D + 104.8+DCF (DCF for Average measurements)
where:
E = electric field strength in dBμV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.
DCF = Duty Cycle Correction Factor
f) Compare the resultant electric field strength level to the applicable limit.
g) Perform radiated spurious emission test

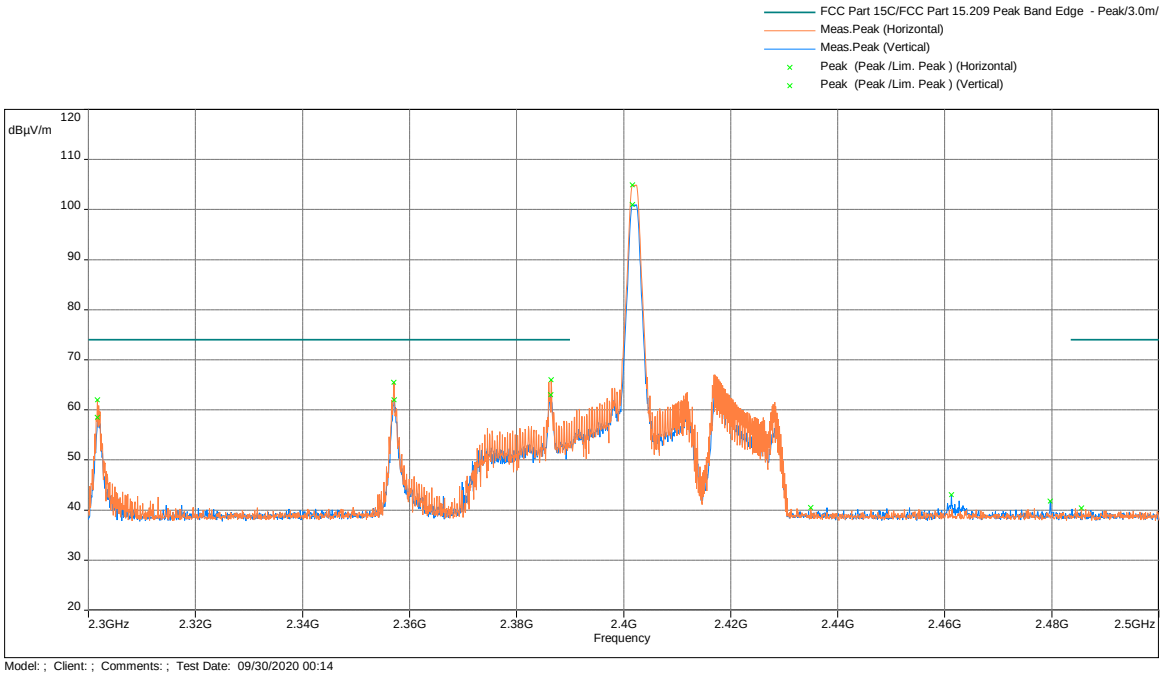
### 4.5.6 Test Results

All testing in this section were performed by radiated measurements.

| Tested By | Test Date |
|---|---|
| Aaron Chang | September 25 – 30, 2020 |

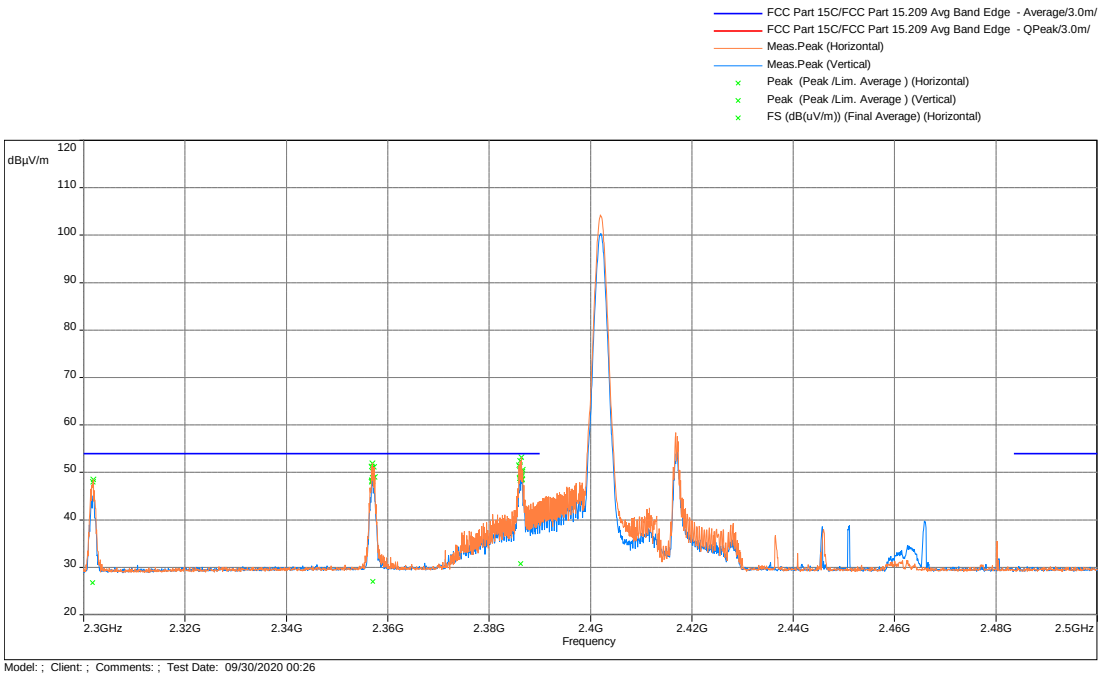
## Test Results: 15.209/15.205 Radiated Restricted Band Emissions

Radiated Out-of-Band Spurious Emissions at the Band Edge with antenna – Tx @ 2402 MHz, Peak




Model: ; Client: ; Comments: ; Test Date: 09/30/2020 00:14

Radiated Out-of-Band Spurious Emissions at the Band Edge with antenna – Tx @ 2402 MHz, Average

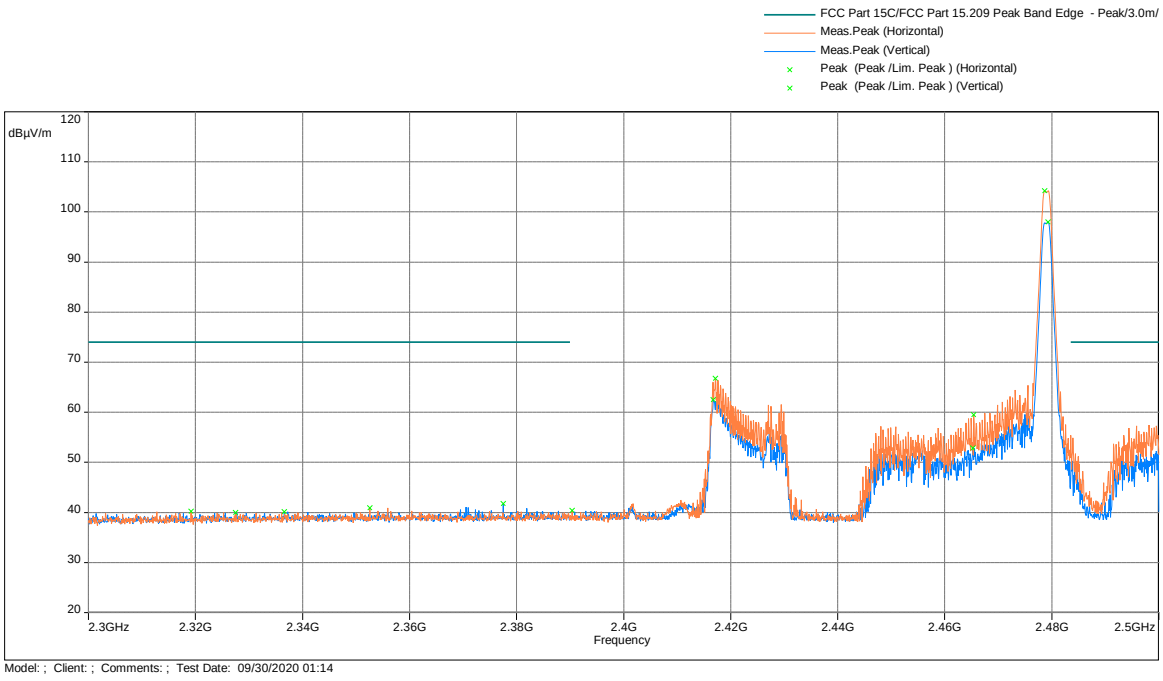



Model: ; Client: ; Comments: ; Test Date: 09/30/2020 00:26

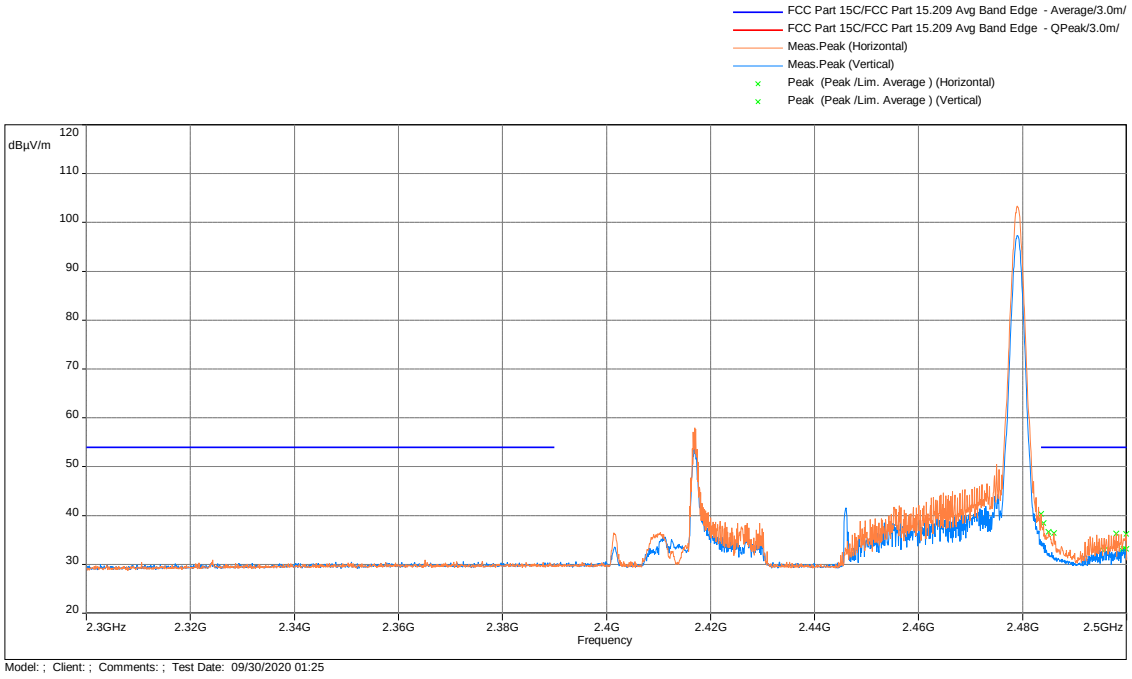
| Frequency MHz | Peak@3m dBµV/m | Lim.@3m Peak dBµV/m | Margin (dB) | Height (m) | Angle (°) | Comment | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 2301.660 | 61.99 | 74 | -12.01 | 1.02 | 275.75 | Horizontal | -13.81 |
| 2357.093 | 65.49 | 74 | -8.51 | 1.02 | 283.25 | Horizontal | -13.29 |
| 2386.487 | 65.97 | 74 | -8.03 | 1.02 | 283.25 | Horizontal | -13.18 |

| Frequency MHz | Avg@3m dBµV/m | Lim.@3m Avg dBµV/m | Margin (dB) | Height (m) | Angle (°) | Comment | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 2301.9 | 48.51 | 54 | -5.49 | 1.02 | 276 | Horizontal | -13.81 |
| 2356.953 | 51.93 | 54 | -2.07 | 1.02 | 266 | Horizontal | -13.29 |
| 2386.373 | 53.21 | 54 | -0.79 | 1.02 | 283.25 | Horizontal | -13.19 |

Radiated Out-of-Band Spurious Emissions at the Band Edge with antenna – Tx @ 2479 MHz, Peak




Radiated Out-of-Band Spurious Emissions at the Band Edge with antenna – Tx @ 2479 MHz, Average

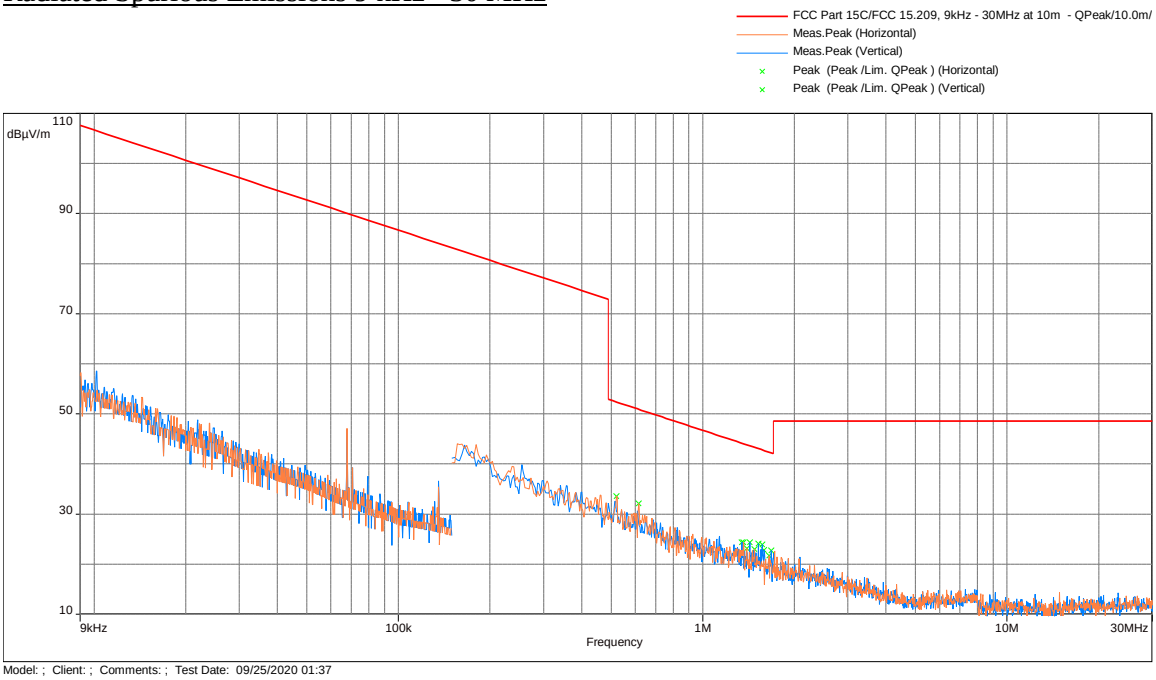



| Frequency MHz | Avg@3m dBµV/m | Lim.@3m Avg dBµV/m | Margin (dB) | Height (m) | Angle (°) | Comment | Correction (dB) |
|---|---|---|---|---|---|---|---|
| 2483.5 | 40.29 | 54 | -13.71 | 1.02 | 279 | Horizontal | -13.13 |

## Out-of-Band Radiated Spurious Emissions

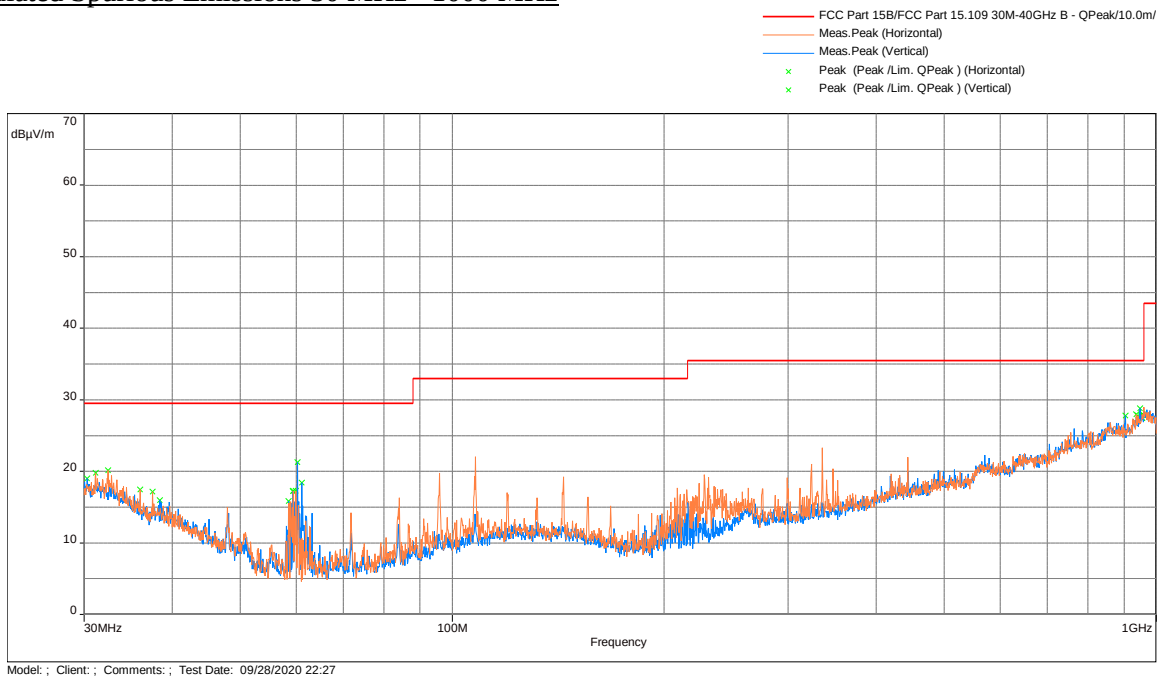
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 9 kHz - 30 MHz




Model: ; Client: ; Comments: ; Test Date: 09/25/2020 01:37

Radiated Spurious Emissions 30 MHz - 1000 MHz

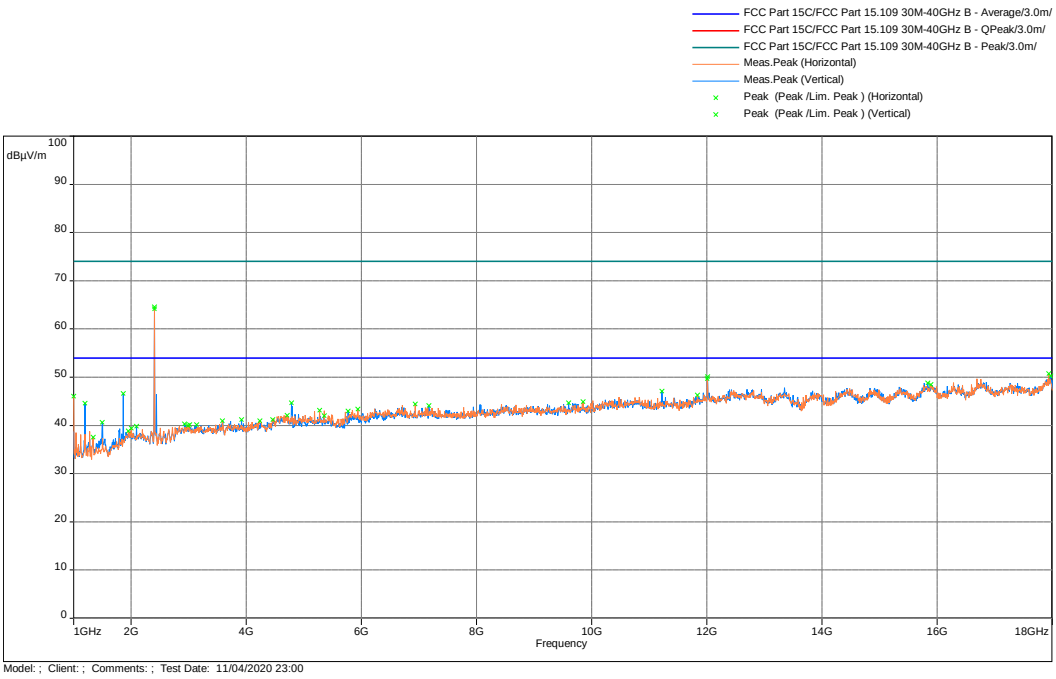



Model: ; Client: ; Comments: ; Test Date: 09/28/2020 22:27

| Frequency | QP@10m | Limit@10m | Margin | Height | Angle | Polarization | Correction |
|---|---|---|---|---|---|---|---|
| MHz | dB(µV/m) | dB(µV/m) | (dB) | (m) | (°) | | (dB) |
| 948.784 | 28.77 | 35.5 | -6.73 | 3.98 | 99.75 | Vertical | 1.83 |

Note: FS = RA + Correction
Correction = AF + CF – Preamp

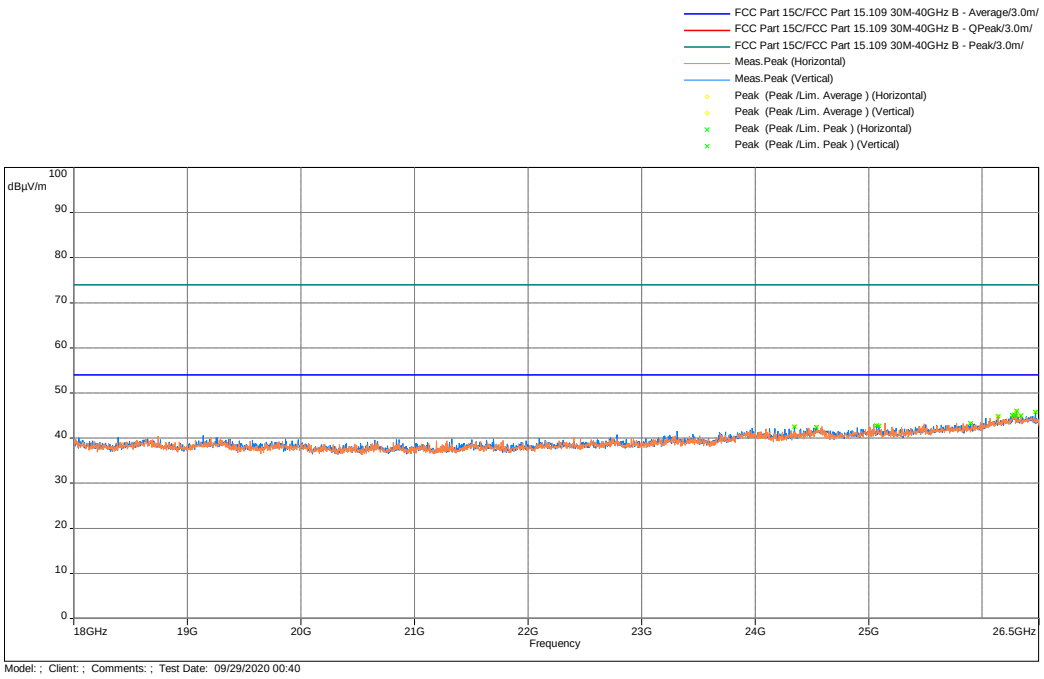
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Avg & Peak Limit




| Freq. MHz | Peak@3m dB(uV/m) | Ave Limit@3m dB(µV/m) | Margin dB | Azimuth deg | Height m | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 12011.47 | 50.11 | 44 | -3.89 | 128.5 | 2.0 | Vertical | -0.11 |

Note: FS = RA + Correction
Correction = AF + CF – Preamp

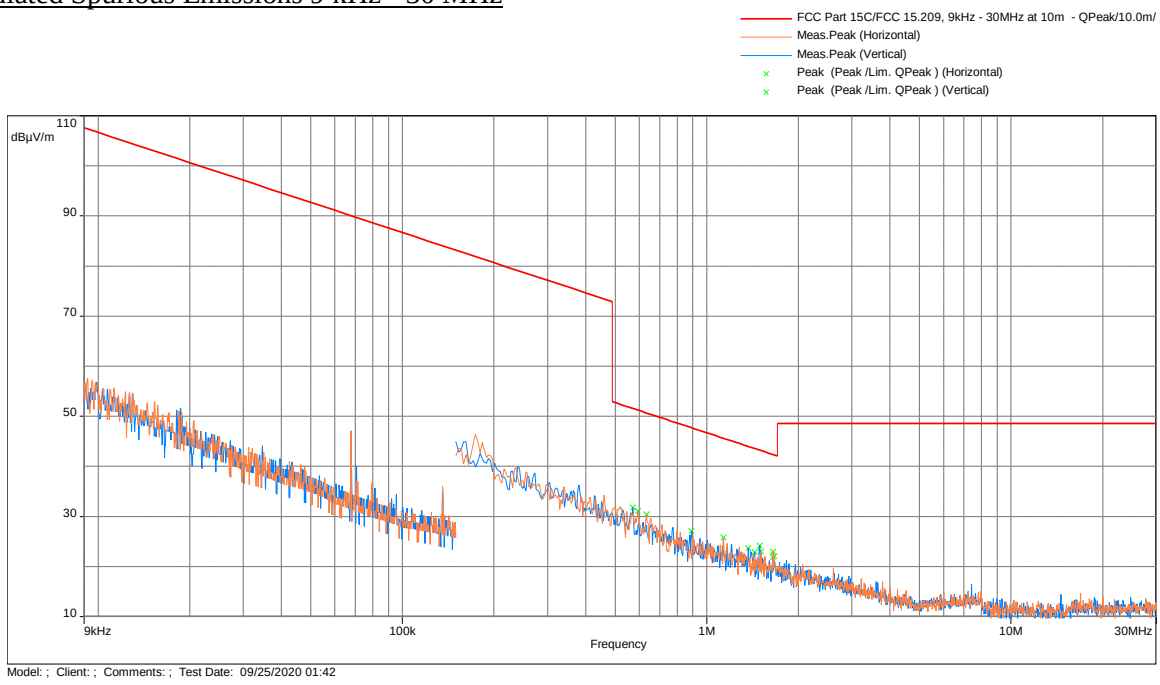
Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Avg & Peak Limit



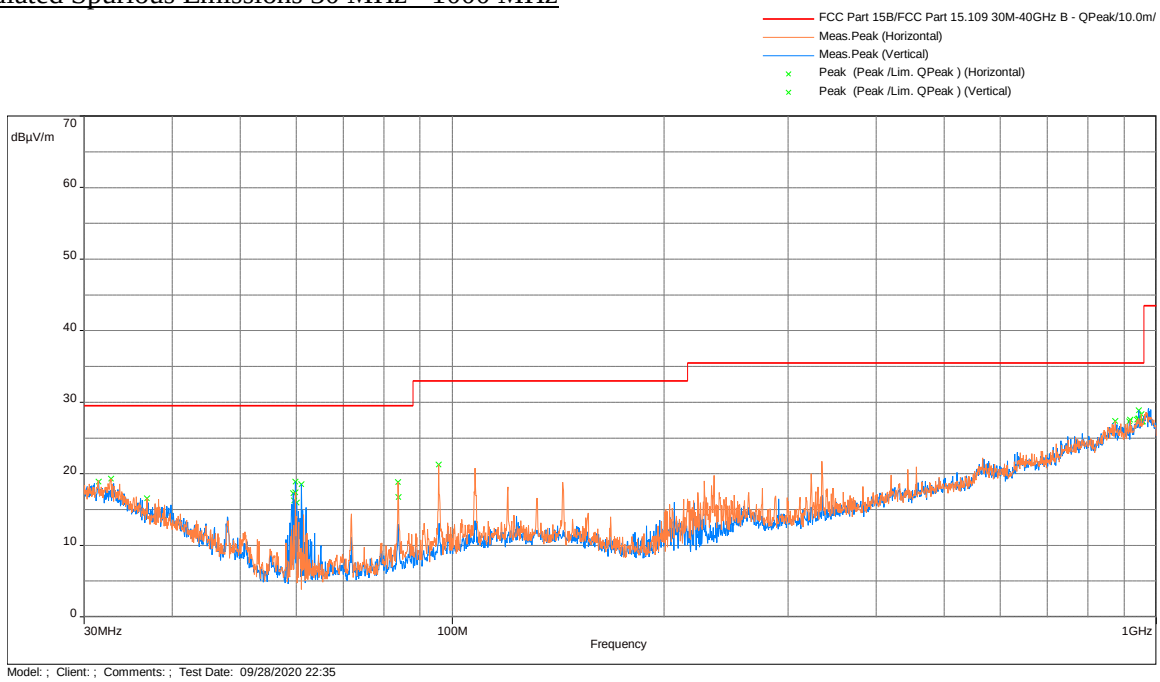

| **Results** | **Complies** |
|---|---|

Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2440MHz

Radiated Spurious Emissions 9 kHz - 30 MHz



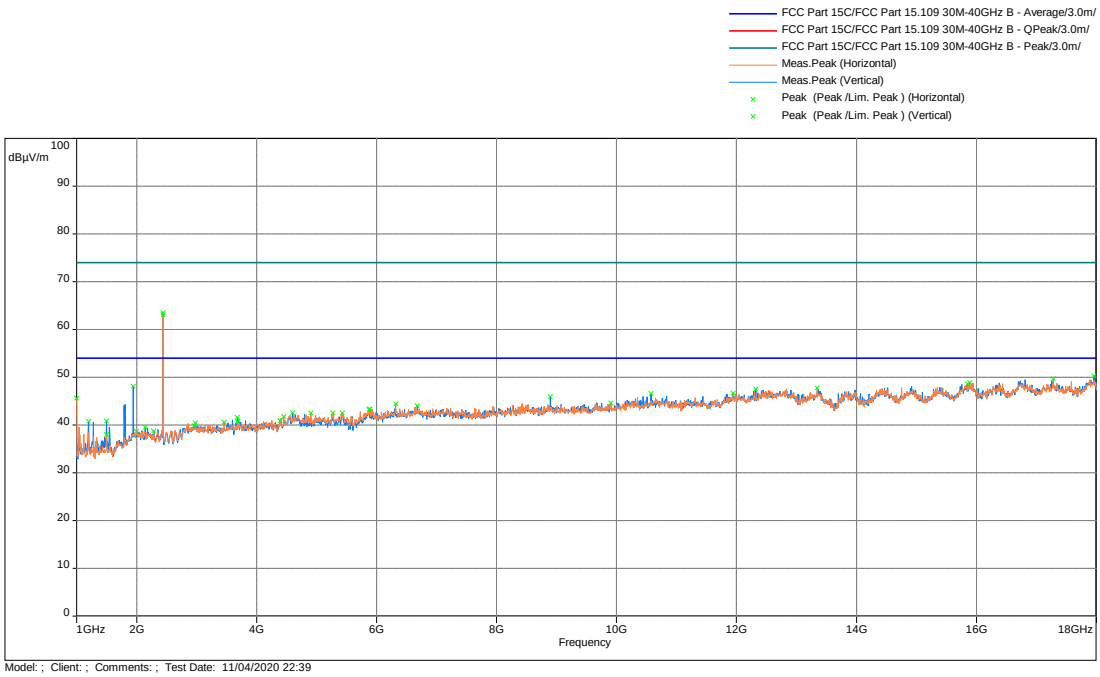

Radiated Spurious Emissions 30 MHz - 1000 MHz




| Frequency | QP@10m | Limit@10m | Margin | Height | Angle | Polarization | Correction |
|---|---|---|---|---|---|---|---|
| MHz | dB(µV/m) | dB(µV/m) | (dB) | (m) | (°) | | (dB) |
| 944.3543 | 28.85 | 35.5 | -6.65 | 3.98 | 178.5 | Vertical | 1.54 |

Note: FS = RA + Correction
Correction = AF + CF – Preamp

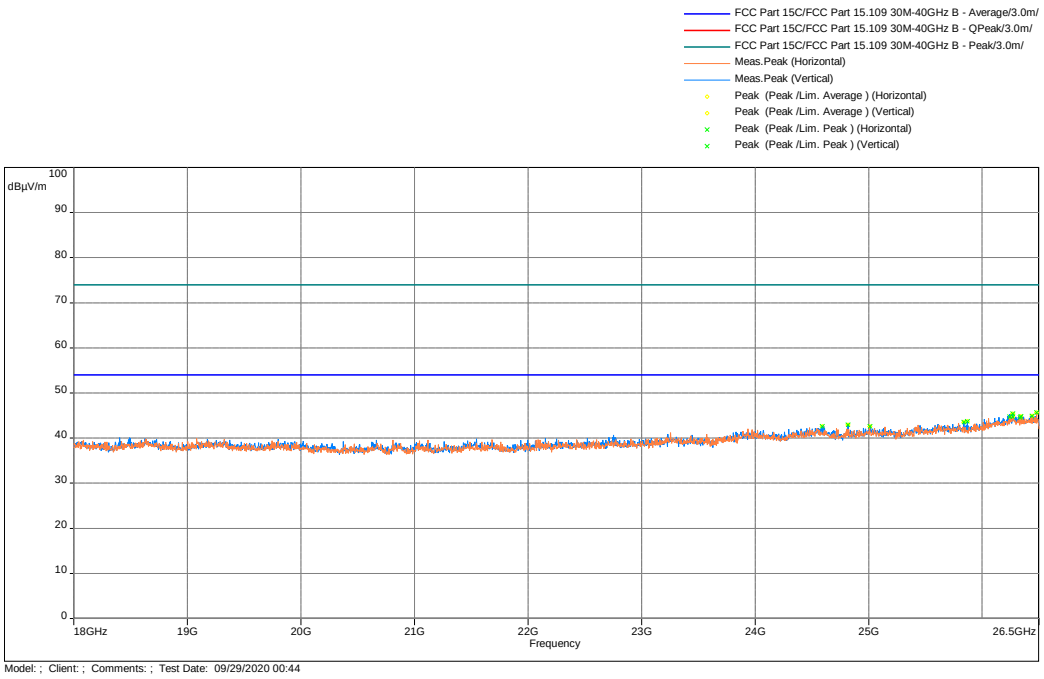
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Avg & Peak Limit




| Freq. MHz | Peak@3m dB(uV/m) | Ave Limit@3m dB(µV/m) | Margin dB | Azimuth deg | Height m | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 1499.8 | 37.55 | 54 | -16.45 | 359.25 | 1.52 | Vertical | -18.75 |

Note: FS = RA + Correction
Correction = AF + CF – Preamp

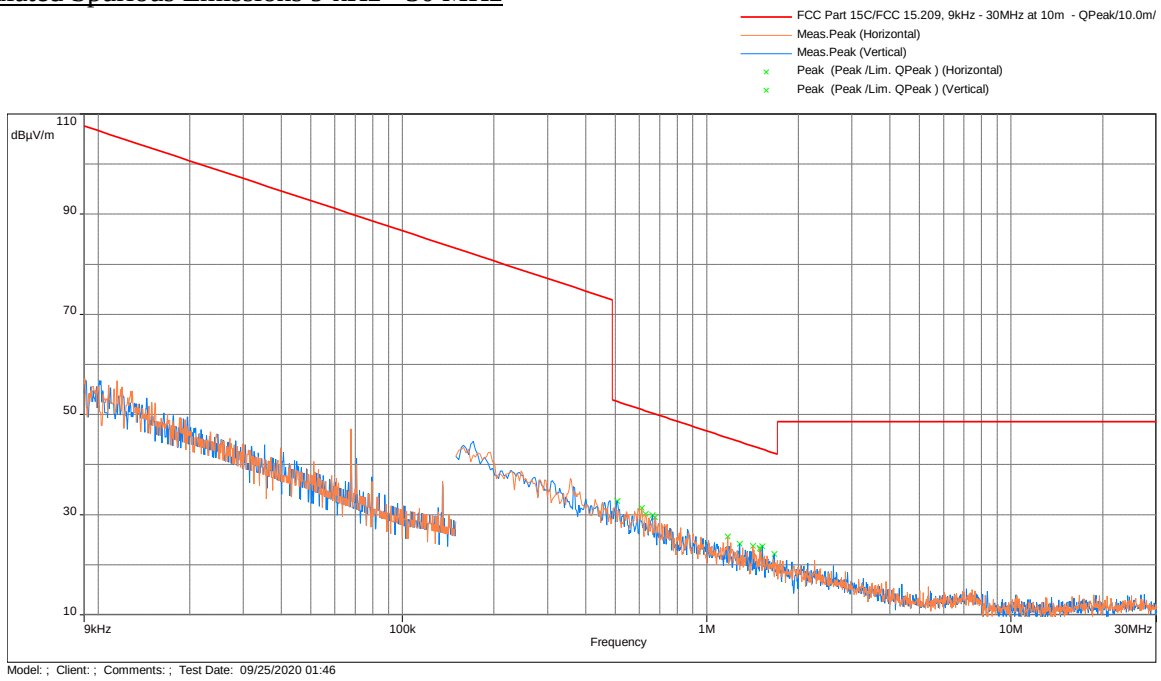
Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Avg & Peak Limit



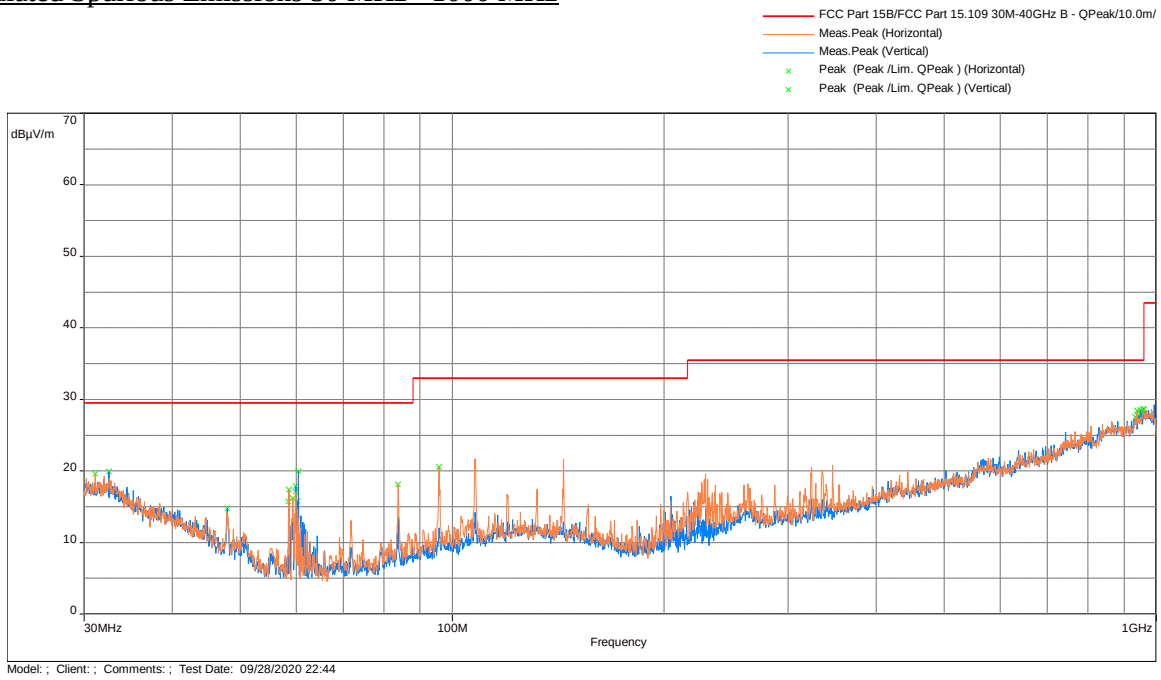

| **Results** | **Complies** |
|---|---|

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2479 MHz

Radiated Spurious Emissions 9 kHz - 30 MHz



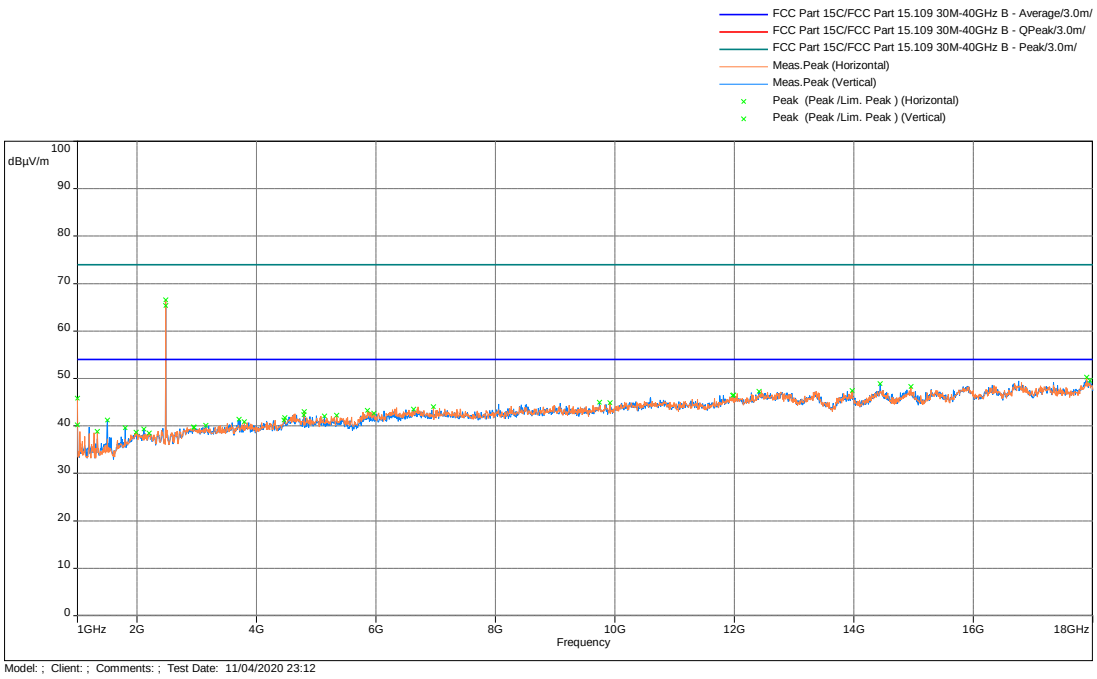

Radiated Spurious Emissions 30 MHz - 1000 MHz




| Frequency | QP@10m | Limit@10m | Margin | Height | Angle | Polarization | Correction |
|---|---|---|---|---|---|---|---|
| MHz | dB(µV/m) | dB(µV/m) | (dB) | (m) | (°) | | (dB) |
| 958.775 | 28.69 | 35.5 | -6.81 | 0.99 | 305.25 | Vertical | 2.26 |

Note: FS = RA + Correction
Correction = AF + CF – Preamp

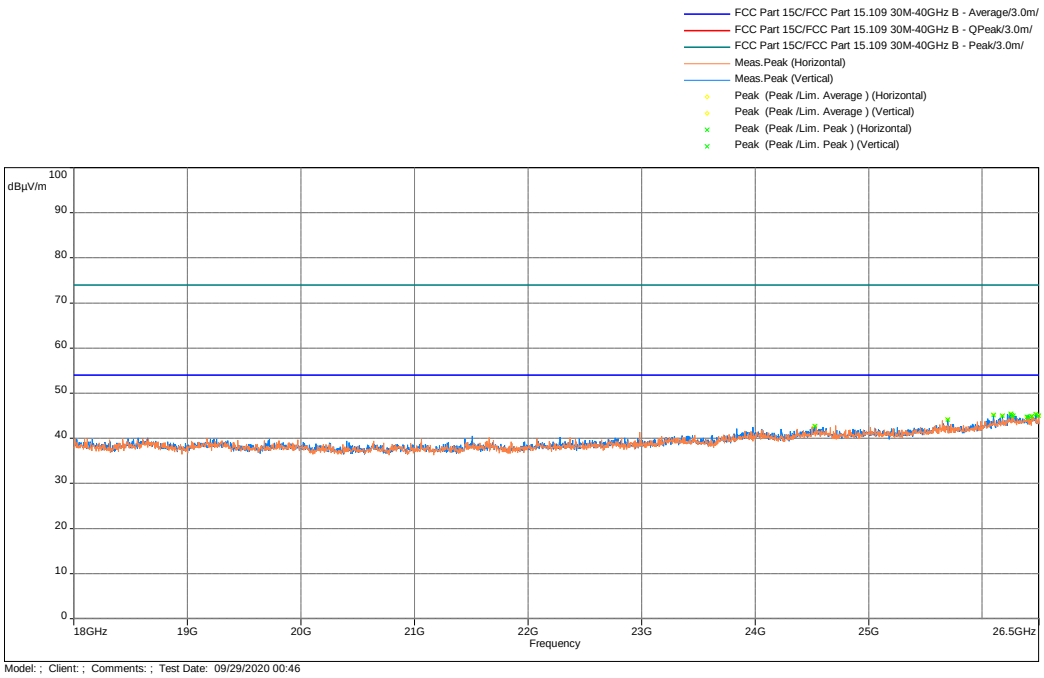
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Avg & Peak Limit




| Freq. MHz | Peak@3m dB(uV/m) | Ave Limit@3m dB(µV/m) | Margin dB | Azimuth deg | Height m | Polarity | Correction dB |
|---|---|---|---|---|---|---|---|
| 1499.8 | 37.75 | 54 | -16.25 | 35.75 | 1.48 | Vertical | -18.75 |

Note: FS = RA + Correction
Correction = AF + CF – Preamp

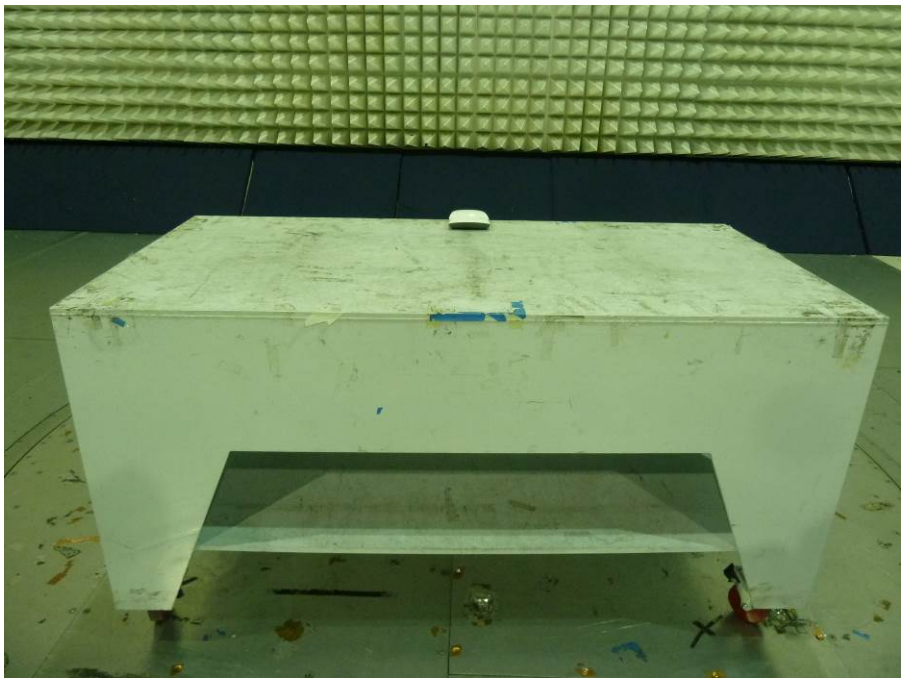
Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Avg & Peak Limit

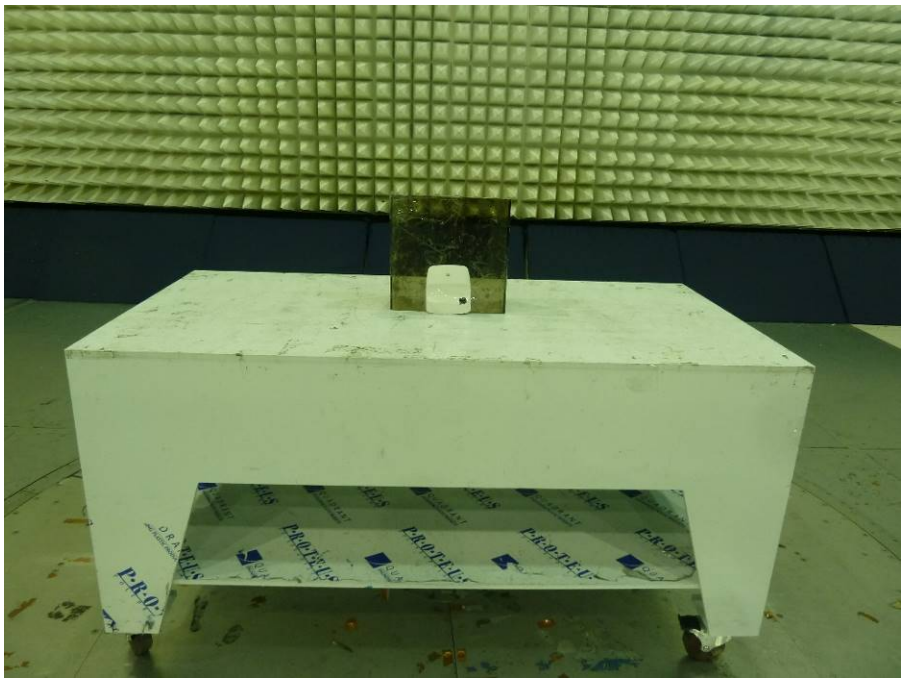



| **Results** | **Complies** |
|---|---|

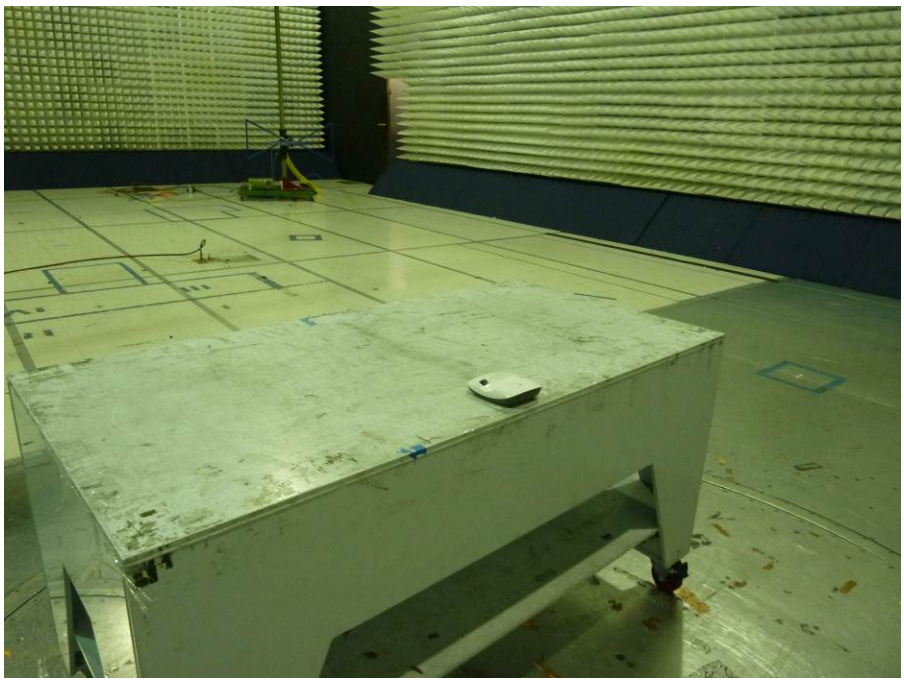
### 4.5.7 Test Setup Configuration

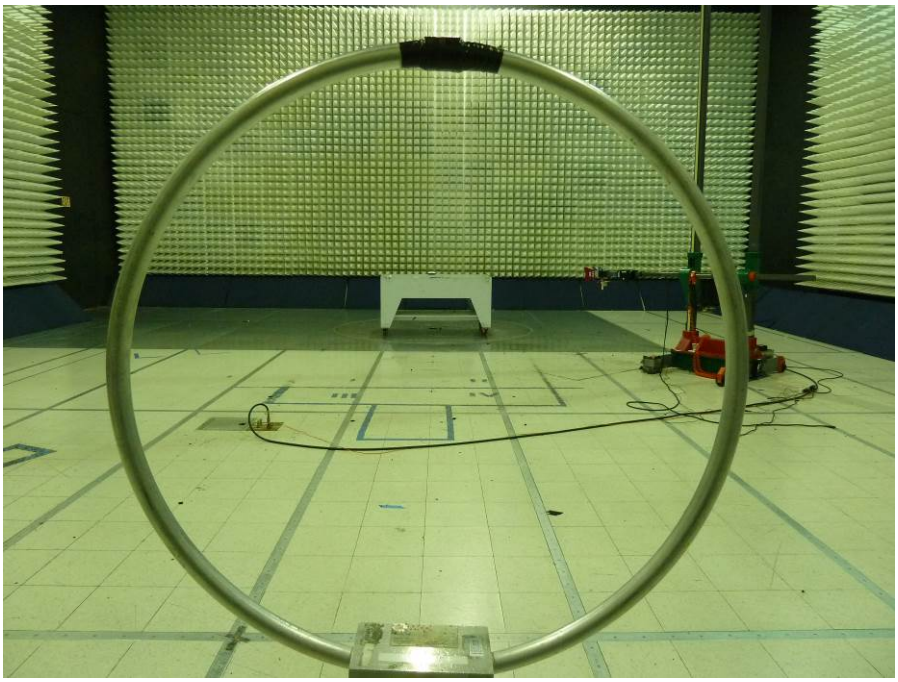
**The following photographs show the testing configurations used.**



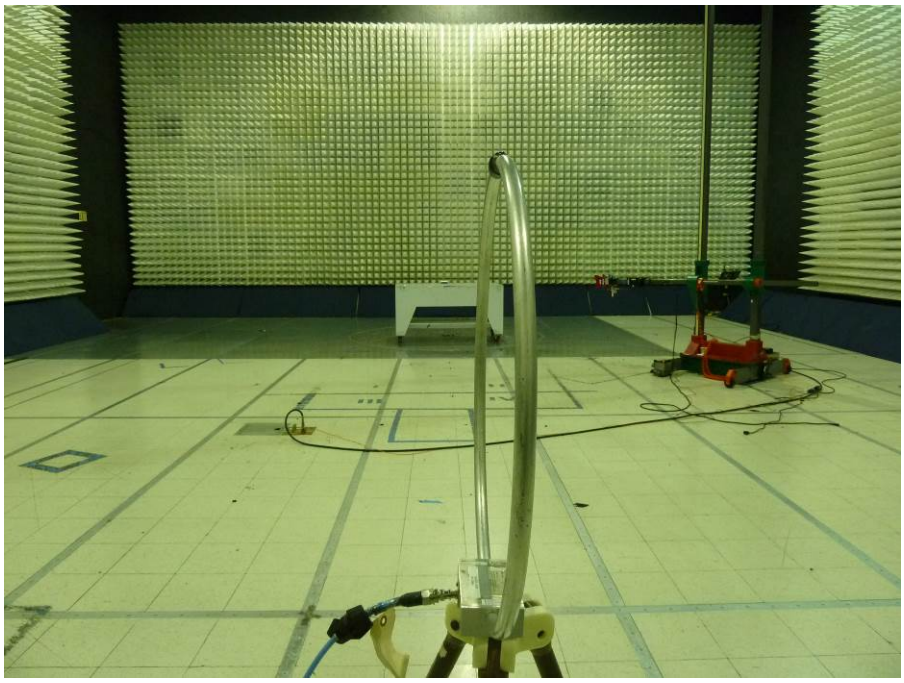


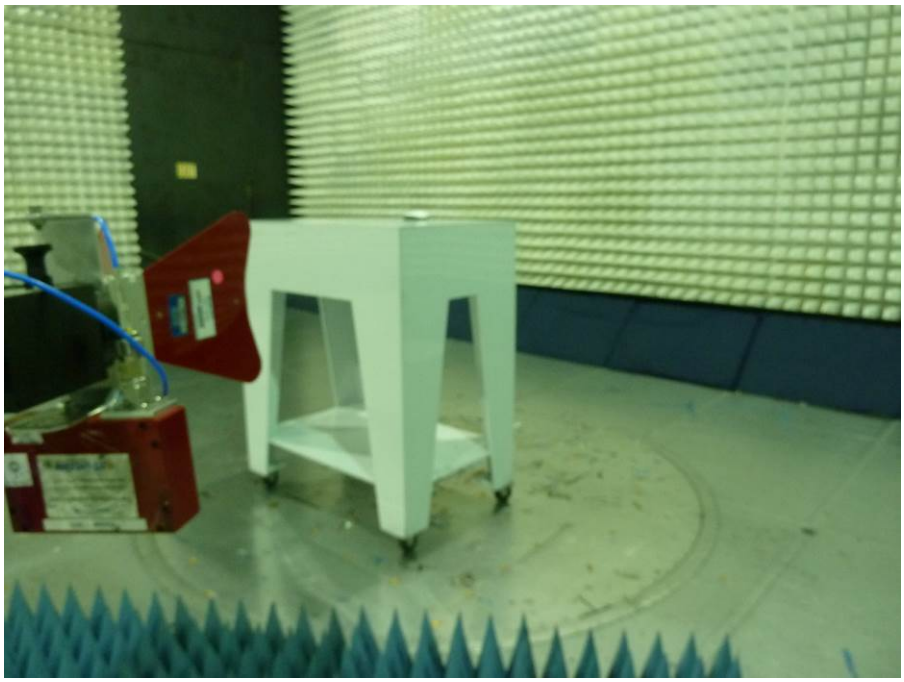
4.5.8 Test Setup Configuration (Continued)



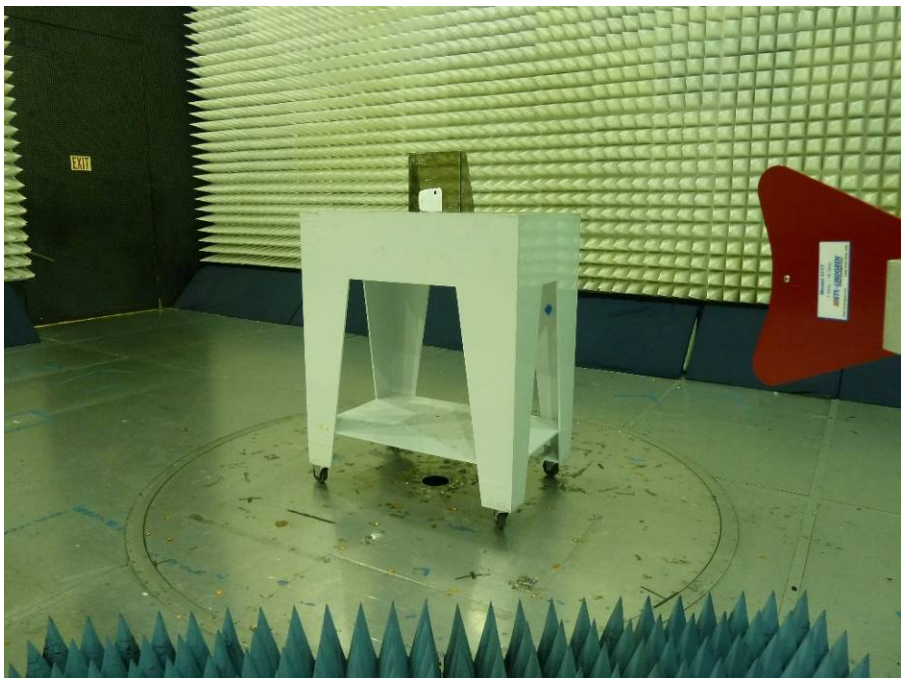


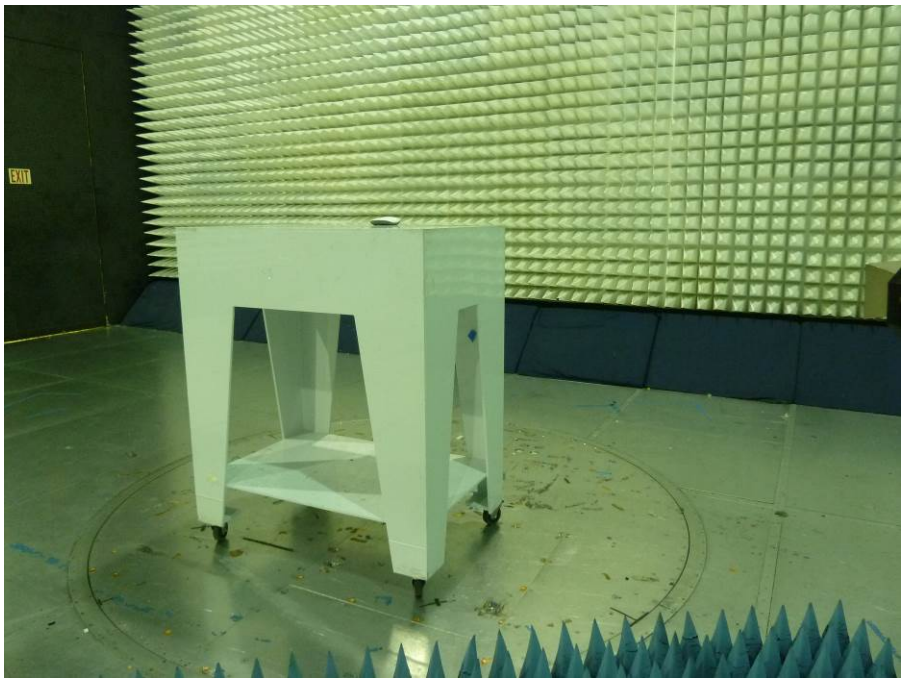
4.5.8 Test Setup Configuration (Continued)





4.5.8 Test Setup Configuration (Continued)



## 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 | 04/02/21 |
| Pre-Amplifier (18-40GHz) | Miteq | TTA1840-35-S-M | ITS 01393 | 12 | 03/02/21 |
| Active Horn Antenna | ETS-Lindgren | 3117-PA | ITS 01824 | 12 | 08/04/21 |
| Pyramidal Horn Antenna | EMCO | 3160-09 | ITS 00571 | # | # |
| Bilog Antenna 30-1000MHz | Teseq | CBL6111D | 01505 | 12 | 03/11/21 |
| Pre-Amplifier | Sonoma Instrument | 310 | ITS 00942 | 12 | 04/14/21 |
| RF Cable | TRU Corporation | TRU CORE 300 | ITS 01336 | 12 | 07/04/21 |
| RF Cable | TRU Corporation | TRU CORE 300 | ITS 01339 | 12 | 07/04/21 |
| RF Cable | TRU Corporation | TRU CORE 300 | ITS 01334 | 12 | 07/04/21 |
| RF Cable | TRU Corporation | TRU CORE 300 | ITS 01340 | 12 | 07/04/21 |
| Notch Filter | MICRO-TRONICS | BRM50702 | ITS 01166 | 12 | 06/11/22 |
| RF Cable | Mega Phase | EMC1-K1K1-236 | ITS 01484 | 12 | 06/12/21 |
| 10m chamber | Panashield | 10m Semi- | ITS 00984 | 36 | 07/29/23 |

# No Calibration required

Software used for emission compliance testing utilized the following:

| Name | Manufacturer | Version | Template/Profile |
|---|---|---|---|
| Tile | Quantum Change | 3.4.K.22 | Conducted Spurious_30M-26GHz |
| BAT-EMC | Nexio | 3.17.0.10 | 103902894_Penumbra.bpp |
| 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 / G104407842 | AC | KV | December 28, 2020 | Original document |