Tekniam, LLC
TEST REPORT

SCOPE OF WORK
EMISSIONS TESTING – RUCS Distribution Module, Model: RDM21

REPORT NUMBER
104856862MPK-004

ISSUE DATE **[REVISED DATE]**
February 21, 2022 N/A

PAGES
55

DOCUMENT CONTROL NUMBER
Non-Specific Radio Report Shell Rev. December 2017

Class II Permissive Change
TEST REPORT

Report Number: 104856862MPK-004
Project Number: G104856862
February 21, 2022

Testing performed on the
RUCS Distribution Module
Model Number: RDM21

FCC ID: 2A2SC-RDM21

to
FCC Part 15 Subpart E (15.407)

For

Tekniam, LLC

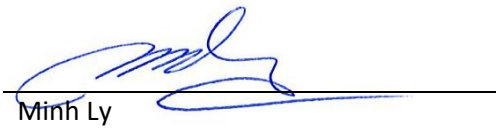
Test Performed by:	**Test Authorized by:**
Intertek	Tekniam, LLC
1365 Adams Court	15501 W. 100th Terr
Menlo Park, CA 94025 USA	Lenexa, KS 66219 USA

Prepared by: _____ **Date:** February 21, 2022
Minh Ly

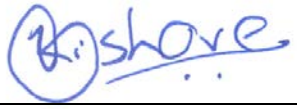
Reviewed by: _____ **Date:** February 21, 2022
Krishna K Vemuri

Report No. 104856862MPK-004	
Equipment Under Test:	RUCS Distribution Module
Trade Name:	Tekniam, LLC
Model Number:	RDM21
Applicant:	Tekniam, LLC
Contact:	Jamie Gilbert
Address:	Tekniam, LLC 15501 W. 100th Terr Lenexa, KS 66219
Country:	USA
Tel. Number:	(563) 449-2998
Email:	Jgilbert@gbasi.com
Applicable Regulation:	FCC Part 15, Subpart E (15.407)
Date of Test:	January 17 – 28, 2022

We attest to the accuracy of this report:



Minh Ly
Project Engineer



Krishna K Vemuri
EMC Manager

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1.0 Introduction

1.1 Summary of Tests

Test	Reference FCC	Result
Conducted Output Power	15.407(a)(1)(2)(3)	Complies
Undesirable Emissions	15.407(b)(1-8)	Complies
Transmitter Radiated Emissions	15.407(b)(1-8) 15.209, 15.205	Complies
AC Line Conducted Emission	15.207	Complies
Antenna Requirement	15.203	Complies. The EUT is for professional installation only.

EUT receive date: December 15, 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: January 17, 2022

Test completion date: January 28, 2022

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

2.0 General Description

2.1 Product Description

Tekniam, LLC supplied the following description of the EUT:

The RUCS Distribution Module (DM) is a high-power, ruggedized, outdoor meshing access point designed for the connection to and extension of existing IP networks and internet services. DMs are connected to the internet through an existing router, or via a RUCS Portable Communications Link (PCL), and then mounted outside in a high location for maximum range.

For 2.4GHz radio module, only 802.11n is enable. All legacy mode and others are disabled by software.
For 5GHz radio module, only 802.11ac is enable. All legacy mode and others are disabled by software.

The information about the 5GHz radio, installed in the model RDM21, is presented below.

Radio Information	
Applicant	Tekniam, LLC
Model Number	RDM21
FCC Identifier	2A2SC-RDM21
Modulation Technique	OFDM
Rated RF Output	21.51 dBm
Frequency Range	U-NII 1: 5150 – 5250 MHz U-NII 3: 5725 – 5850 MHz
Type of modulation	OFDM
Number of Channel(s)	9 for 802.11ac 20 MHz 4 for 802.11ac 40MHz 2 for 802.11ac 80MHz
Antenna(s) & Gain	Internal Antennas, Gain: 5150 – 5850: MHz: 12.0 dBi (un-correlated)
Applicant Name & Address	Tekniam, LLC 15501 W. 100th Terr Lenexa, KS 66219 USA

2.2 Related Submittal(s) Grants

None.

2.3 Test Methodology

Antenna conducted measurements were performed according to the FCC documents “Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E” (789033 D02 General U-NII Test Procedures New Rules v02r01).

Radiated 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 Application.

All other measurements were made in accordance with the procedures in part 2 of CFR 47.

2.4 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.

2.5 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 – 6 GHz	> 6 GHz
RF Power and Power Density – antenna conducted	1.1 dB	1.5 dB	–
Unwanted emissions - antenna conducted	1.2 dB	1.7 dB	2.0 dB
Bandwidth – antenna conducted	50 Hz	100 Hz	–
Radiated emissions	4.2 dB	5.4 dB	
AC mains conducted emissions	2.4 dB	-	-

3.0 System Test Configuration

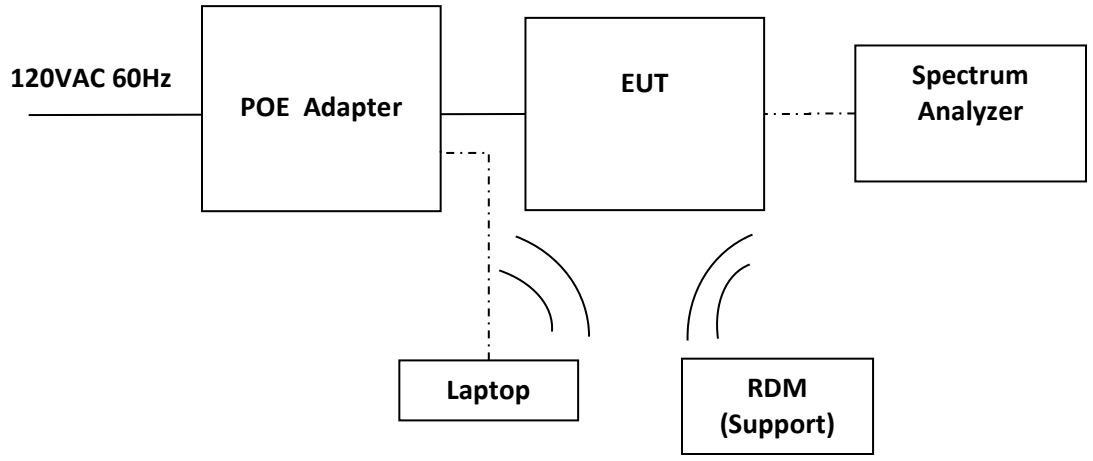
3.1 Support Equipment

Support Equipment		
Description	**Manufacturer**	**Model No./ Serial No.**
Laptop	Lenovo	IdeaPad 3
RUCS Distribution Module (2nd unit)	Tekniam, LLC	RDM21/ 70F503

3.2 Block Diagram of Test Setup

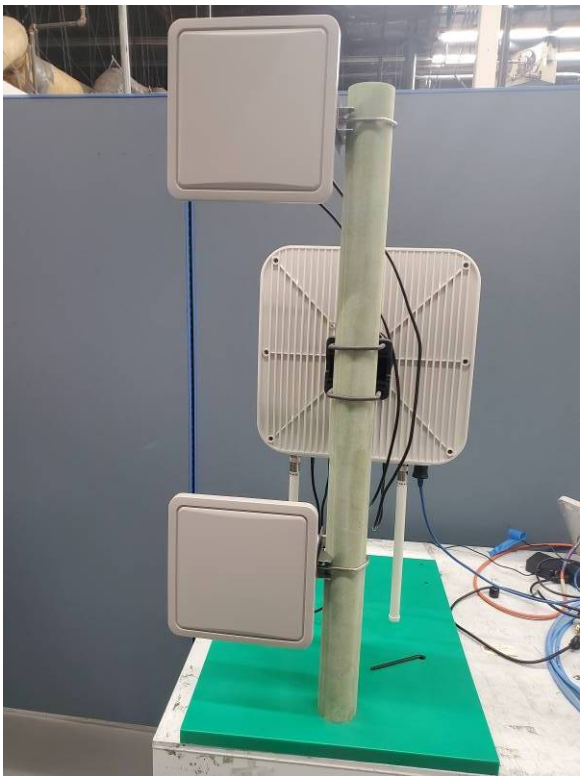
Equipment Under Test			
Description	**Manufacturer**	**Model Number**	**Serial Number**
RUCS Distribution Module (RDM)	Tekniam, LLC	RDM21	27F786
POE Adapter	Alfa Network	APOE48v-1G	2003-0000451

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



S = Shielded **U** = Unshielded	**F** = With Ferrite **M** = Meter

EUT Photos



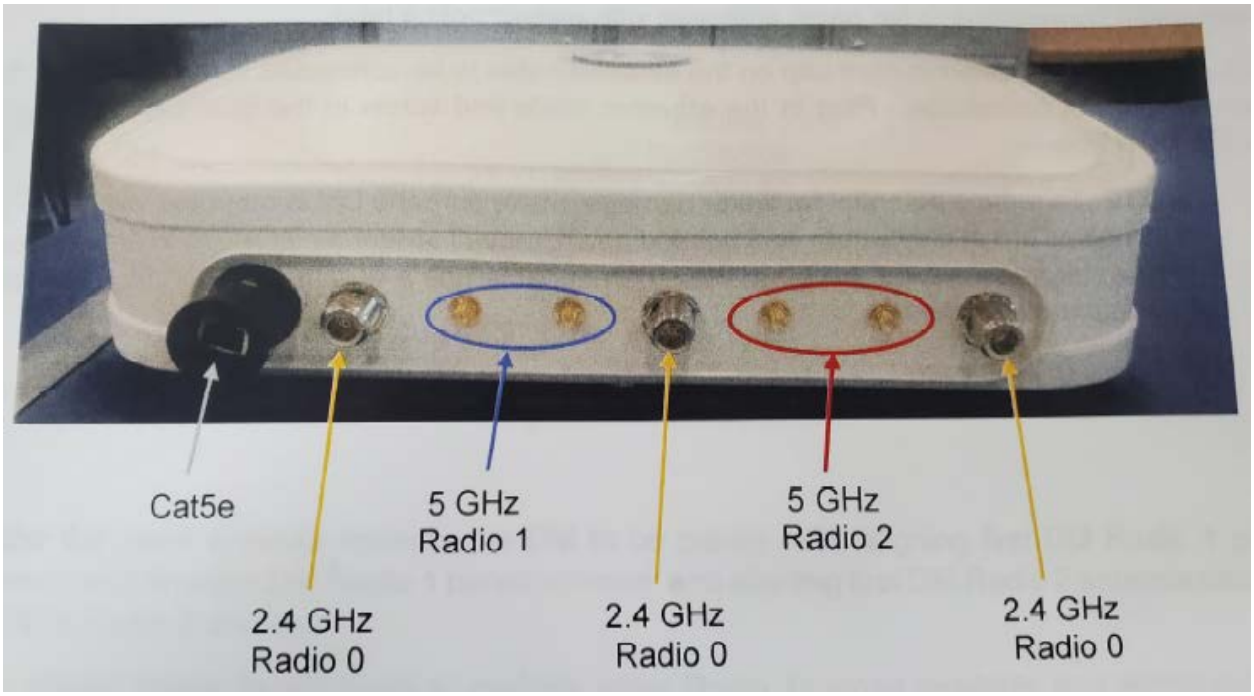
3.3 Justification

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:

OFDM, MCS0 – for 802.11ac 20/40/80 MHz

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

Class II permissive change testing was performed based on Radio Module, Model: DR900VX (FCC ID: 2AG7VDR900VX). Three modules, model: DR900VX, were installed inside the RDM21 with radio 0 operates as a 3x3 MIMO at 2.4GHz, radio 1 operates as a 2x2 MIMO at 5GHz (U-NII 1) and radio 2 operates as a 2x2 MIMO at 5GHz (U-NII 3). The 2.4GHz radio has the Omni antenna with antenna gain of 7dBi and the 5GHz radio has the panel antenna with antenna gain of 12dBi.



3.4 Mode of Operation During Test

During transmitter testing, the transmitter was setup to transmit continuously using the maximum 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.

Channel	Frequency MHz	802.11ac 20MHz BW RF Setting
36	5180	8
40	5200	8
48	5240	8
149	5745	15
157	5785	15
165	5825	15
Channel	**Frequency MHz**	**40MHz BW RF Setting**
38	5190	6
46	5230	6
151	5755	13
159	5795	13
Channel	**Frequency MHz**	**80MHz BW RF Setting**
42	5210	3
155	5775	11

3.5 Modifications required for Compliance

Intertek installed no modifications during compliance testing in order to bring the product into compliance.

3.6 Additions, deviations and exclusions from standards

No additions, deviations or exclusion have been made from standard.

4.0 Measurement Results

4.2 Maximum Conducted Output Power & Power Spectral Density
FCC Rule 15.407(a)(1)(iv)

4.2.1 Requirement

For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1-megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the band 5.725-5.850 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

4.2.2 Procedure

The Procedure, described in the FCC Publication 789033 D02 General U-NII Test Procedures New Rules v02r01, was used. Specifically, Section E (2) (f) Method SA-3 for Maximum Conducted Output Power

Each antenna port of the EUT was connected to the input of a spectrum analyzer to measure the Maximum Conducted Transmitter Output Power.

4.2.3 Test Results

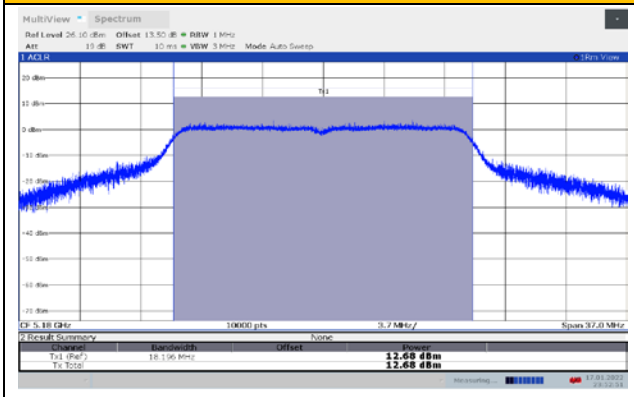
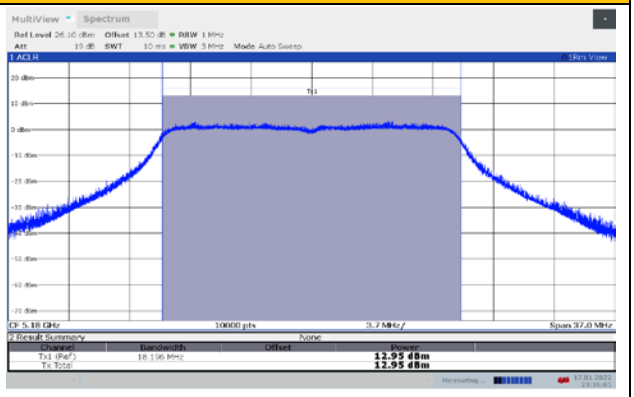
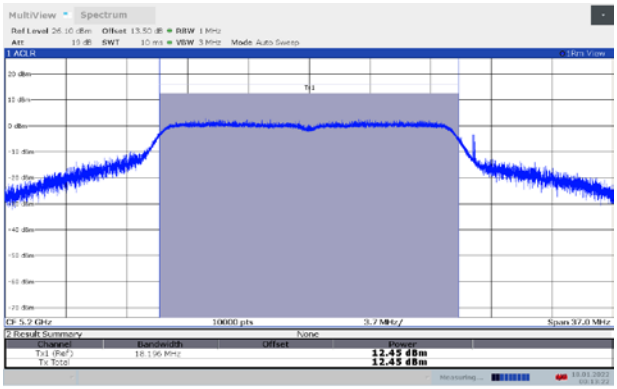
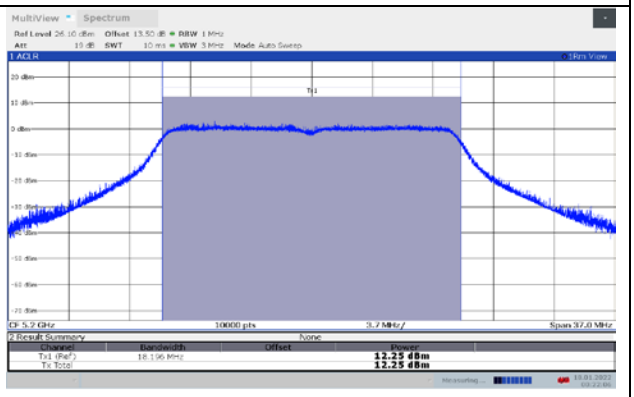
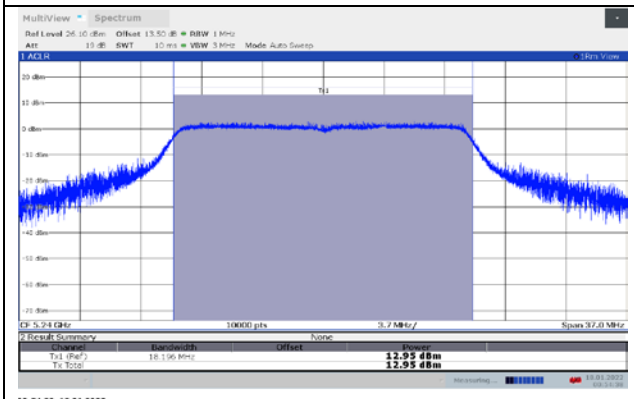
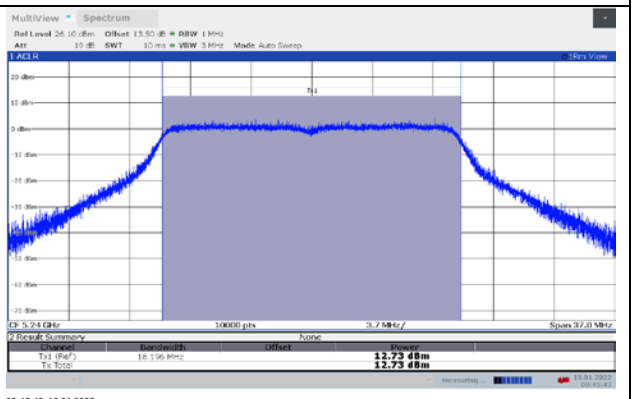
Refer to the following plots for the test result:

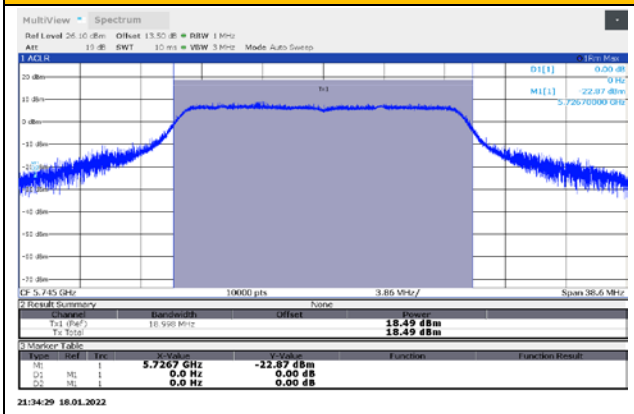
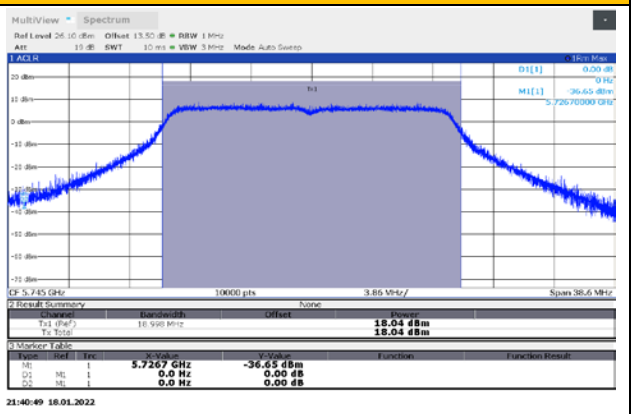
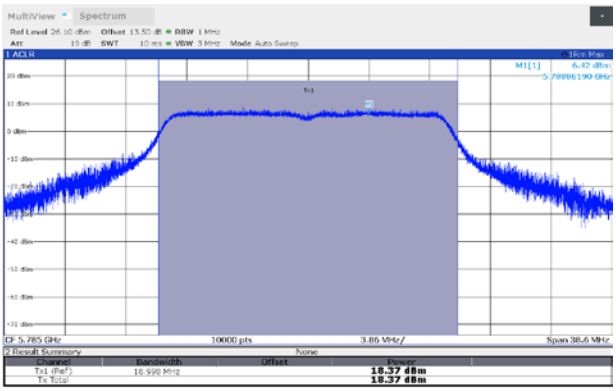
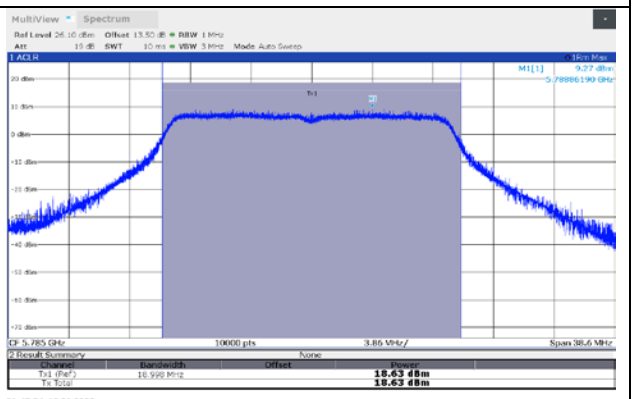
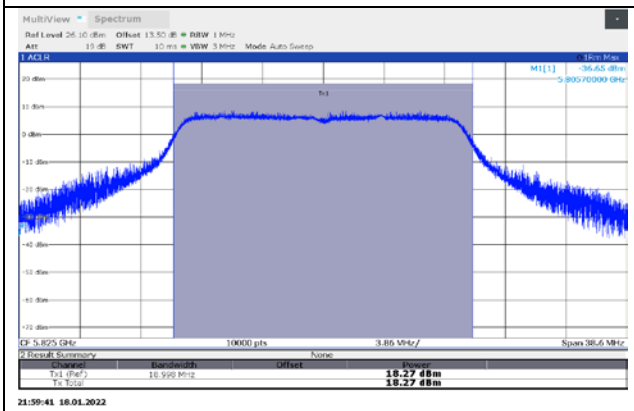
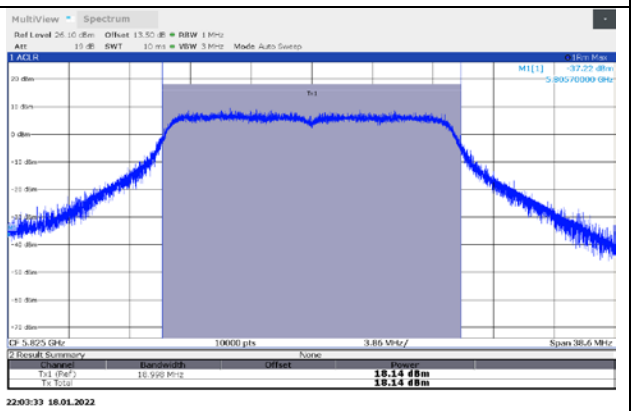
Mode	Channel	Frequency	Antenna Gain	Output Power Ant 2	Output Power Ant 3	Output Power Sum	Output Power Limit
		MHz	dB	dBm	dBm	dBm	dBm
802.11ac 20MHz	36	5180	12	12.68	12.95	15.82	18
	40	5200	12	12.45	12.25	15.36	18
	48	5240	12	12.95	12.73	15.85	18
802.11ac 40MHz	38	5190	12	10.68	11.36	14.04	18
	46	5230	12	11.11	10.88	14.00	18
802.11ac 80MHz	42	5210	12	10.12	9.27	12.72	18

Mode	Channel	Frequency	Antenna Gain	Output Power Ant 5	Output Power Ant 6	Output Power Sum	Output Power Limit
		MHz	dB	dBm	dBm	dBm	dBm
802.11ac 20MHz	149	5745	12	18.49	18.04	21.28	24
	157	5785	12	18.37	18.63	21.51	24
	165	5825	12	18.27	18.14	21.21	24
802.11ac 40MHz	151	5755	12	17.15	17.83	20.51	24
	159	5795	12	17.39	18.15	20.79	24
802.11ac 80MHz	155	5775	12	17.36	17.86	20.62	24

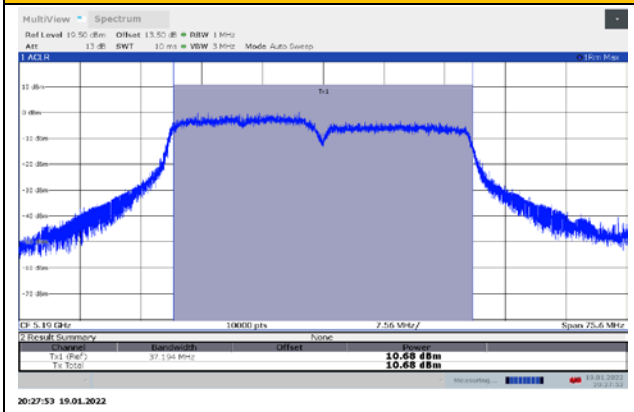
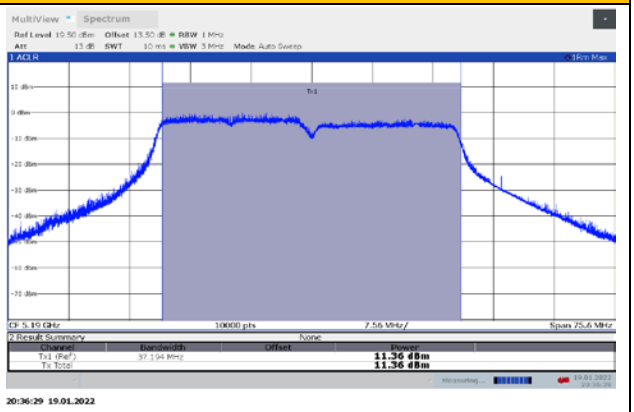
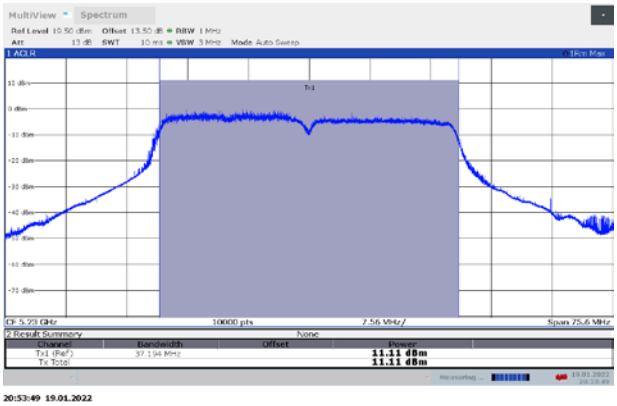
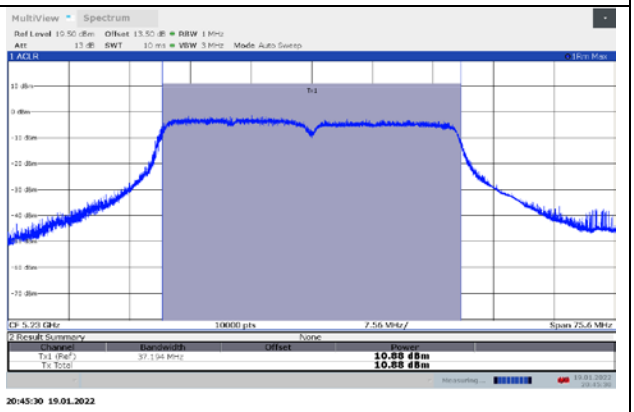
Note: the output power limit is reduced by 6dBm due to the directional gain of the antenna exceeded 6dBi.

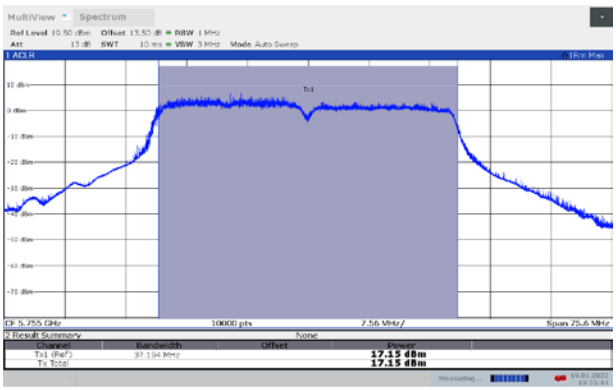
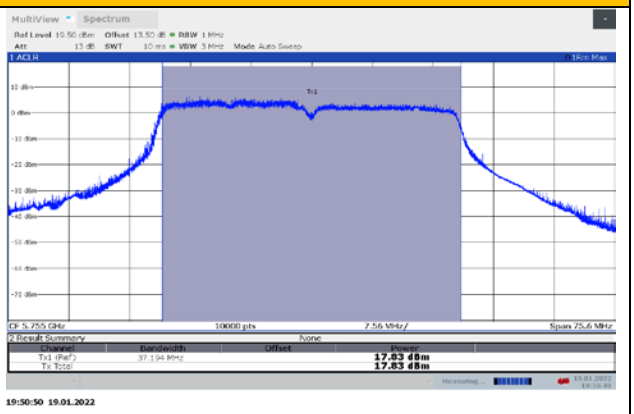
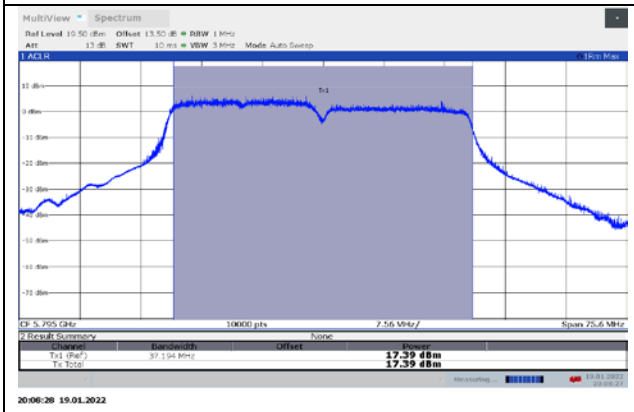
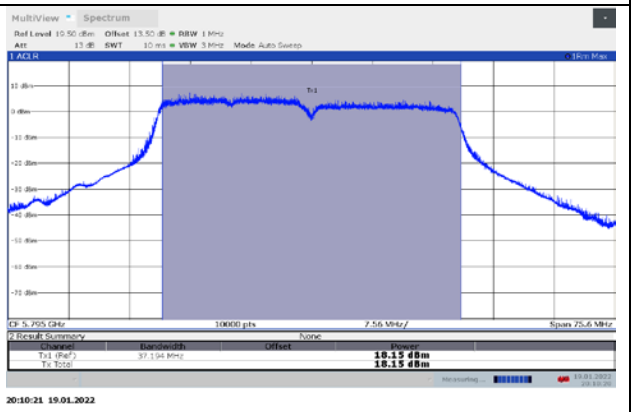
802.11ac 20MHz

Output Power Antenna 2	Output Power Antenna 3
 5180 MHz	 5180 MHz
 5200 MHz	 5200 MHz
 5240 MHz	 5240 MHz

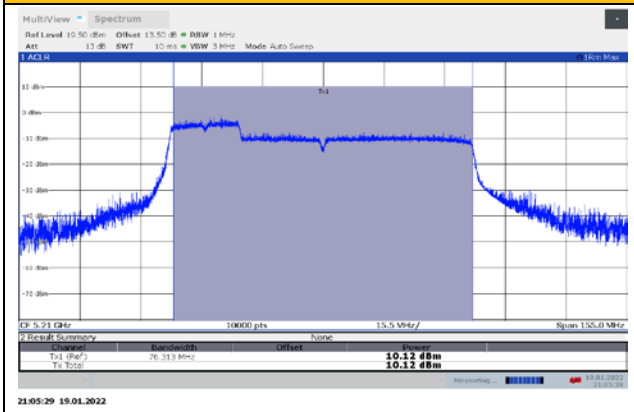
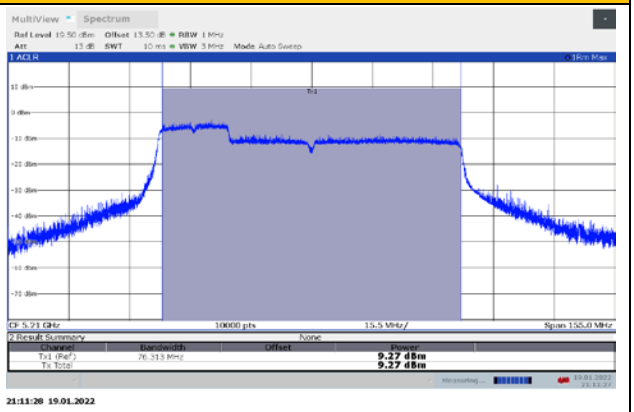
Output Power Antenna 5	Output Power Antenna 6
 5745 MHz	 5745 MHz
 5785 MHz	 5785 MHz
 5825 MHz	 5825 MHz

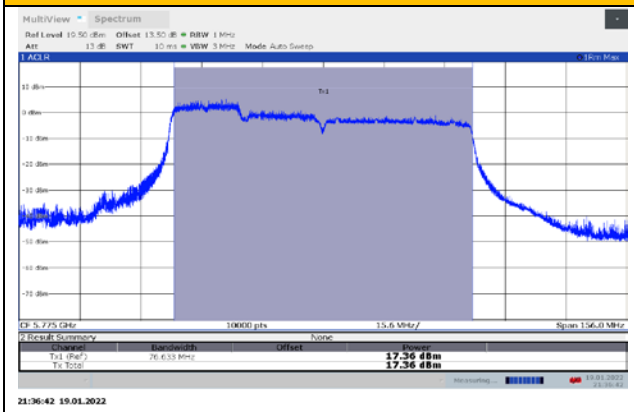
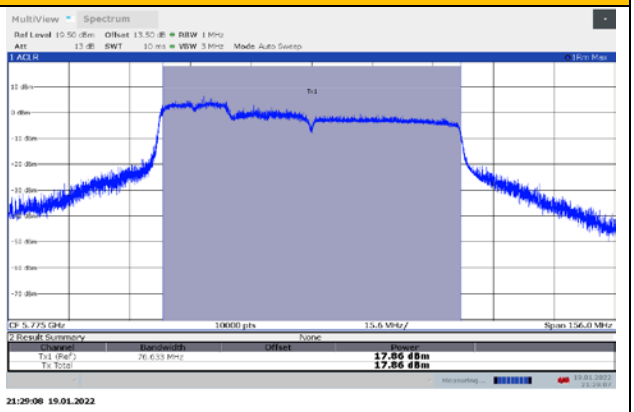
802.11ac 40MHz

Output Power Antenna 2	Output Power Antenna 3
 5190 MHz	 5190 MHz
 5230 MHz	 5230 MHz

Output Power Antenna 5	Output Power Antenna 6
 5755 MHz	 5755 MHz
 5795 MHz	 5795 MHz

802.11ac 80MHz

Output Power Antenna 2	Output Power Antenna 3
	
5210 MHz	5210 MHz

Output Power Antenna 5	Output Power Antenna 6
	
5775 MHz	5775 MHz

4.3 Transmitter Radiated Emissions
FCC Rule 15.407(b) (1-8) 15.209, 15.205

4.3.1 Requirement

(b) Undesirable emission limits. Except as shown in paragraph (b) (7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(1) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(2) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(3) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(4) For transmitters operating in the 5.725-5.85 GHz band:

(i) All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

(5) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.

(6) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.

(7) The provisions of §15.205 apply to intentional radiators operating under this section.

(8) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency band edges as the design of the equipment permits.

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

For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz.

4.3.2 Procedure

Radiated emission measurements were performed from 9 kHz to 40 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 2.4GHz and 5GHz notch filter in place. A preamp was used from 9kHz to 40GHz.

All measurements were made with a Peak Detector and compared to QP limits for 9 kHz – 1GHz and Average limits for 1GHz – 40 GHz.

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.

Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels).

ANSI C63.10-2013; 5.6.2.2
Determining worst-case mode for Spurious emissions:
For devices with multiple operating modes, measurements on the middle channel can be used to determine the worst-case mode(s). The worst-case modes are as follows:

Measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM and direct sequence spread spectrum).

The highest output power were found in 802.11ac 20MHz, therefore Spurious emissions were measured using 802.11ac 20MHz bandwidth.

4.3.3 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.

4.3.4 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.

4.3.5 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
where:
E = electric field strength in dBµV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.
f) Compare the resultant electric field strength level to the applicable limit.
g) Perform radiated spurious emission test

4.3.6 Test Results

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

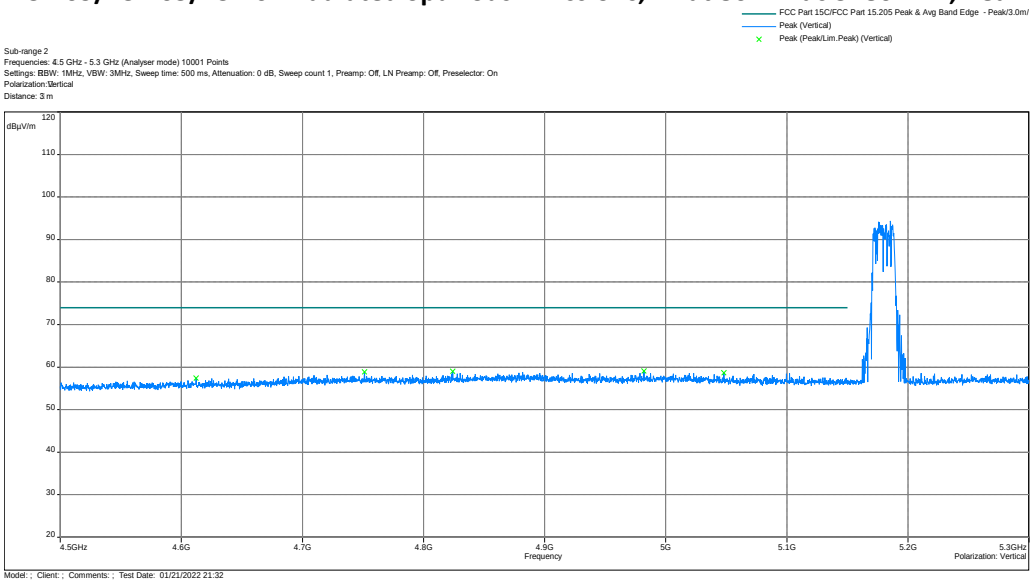
Radiated emission measurements were performed from 9kHz up to 40GHz.

9kHz – 30MHz Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels).

Test Results:

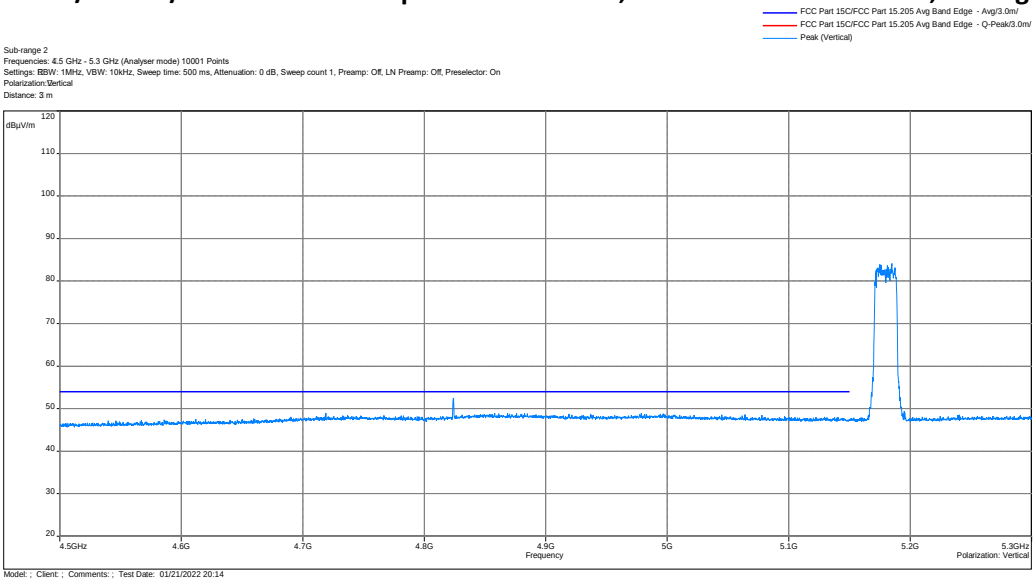
Radiated Out-of-Band Spurious Emissions at the Band Edges/Restricted Bands

15.209/15.205/15.407 Radiated Spurious Emissions, Tx at 802.11ac 5180MHz, Peak



Frequency (MHz)	Detector	Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass / Fail?
5150	Peak	57.8	74	-16.2	Pass

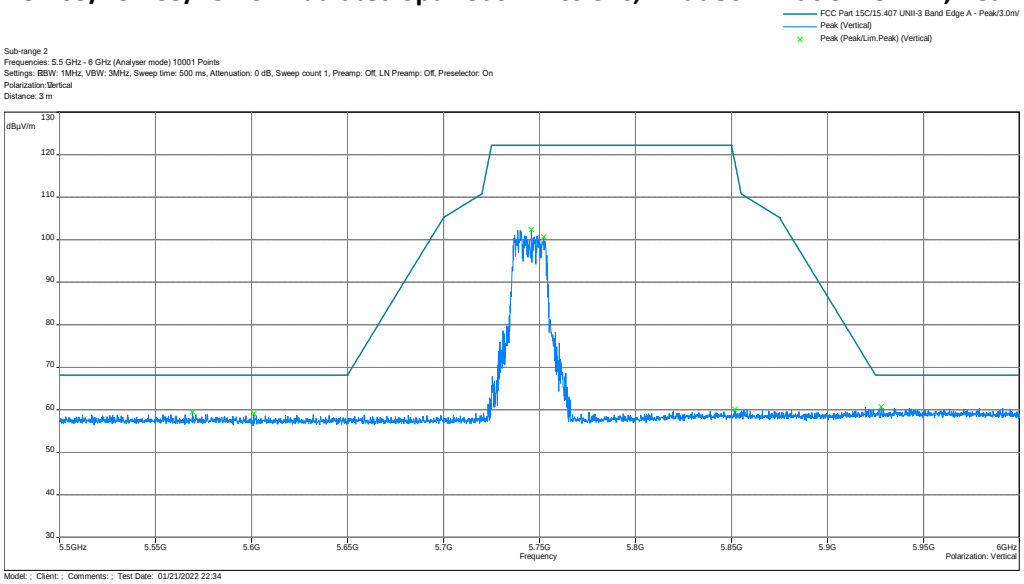
15.209/15.205/15.407 Radiated Spurious Emissions, Tx at 802.11ac 5180MHz, Average



Frequency (MHz)	Detector	Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass / Fail?
4823.9	Average	52.4	54.0	-1.6	Pass
5150.0	Average	47.71	54	-6.29	Pass

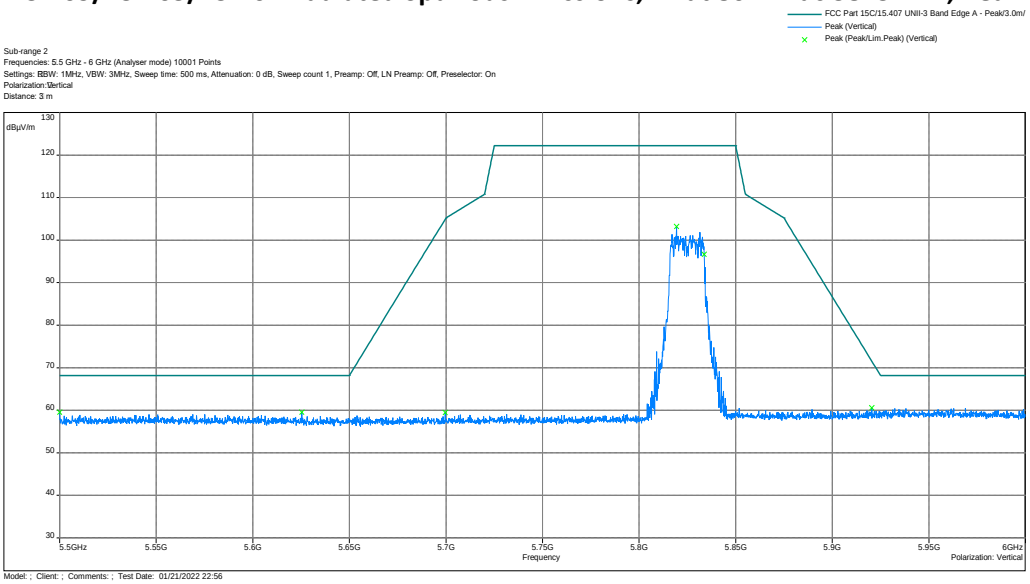
Radiated Out-of-Band Spurious Emissions at the Band Edges/Restricted Bands

15.209/15.205/15.407 Radiated Spurious Emissions, Tx at 802.11ac 5745MHz, Peak



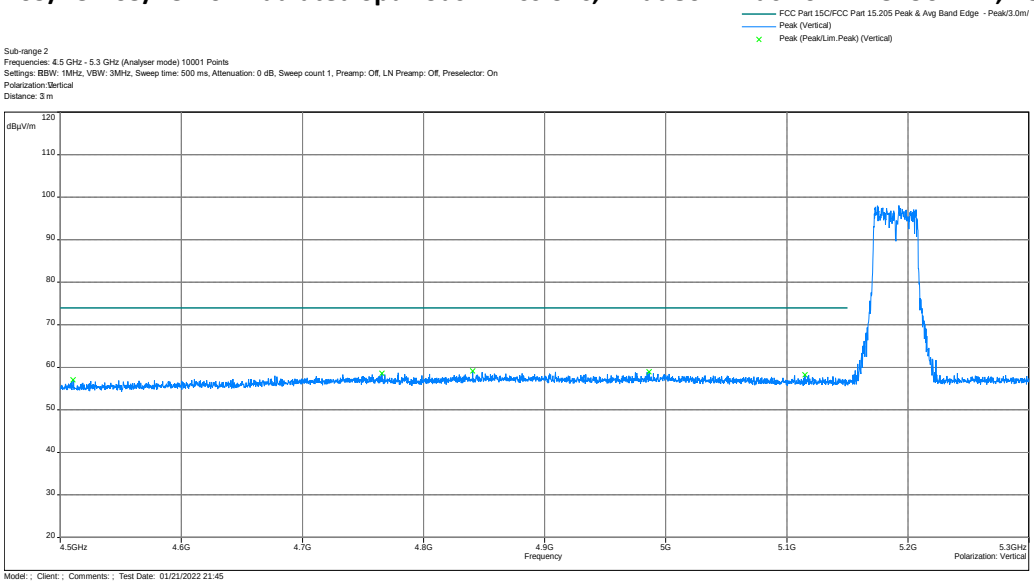
Radiated Out-of-Band Spurious Emissions at the Band Edges/Restricted Bands

15.209/15.205/15.407 Radiated Spurious Emissions, Tx at 802.11ac 5825MHz, Peak



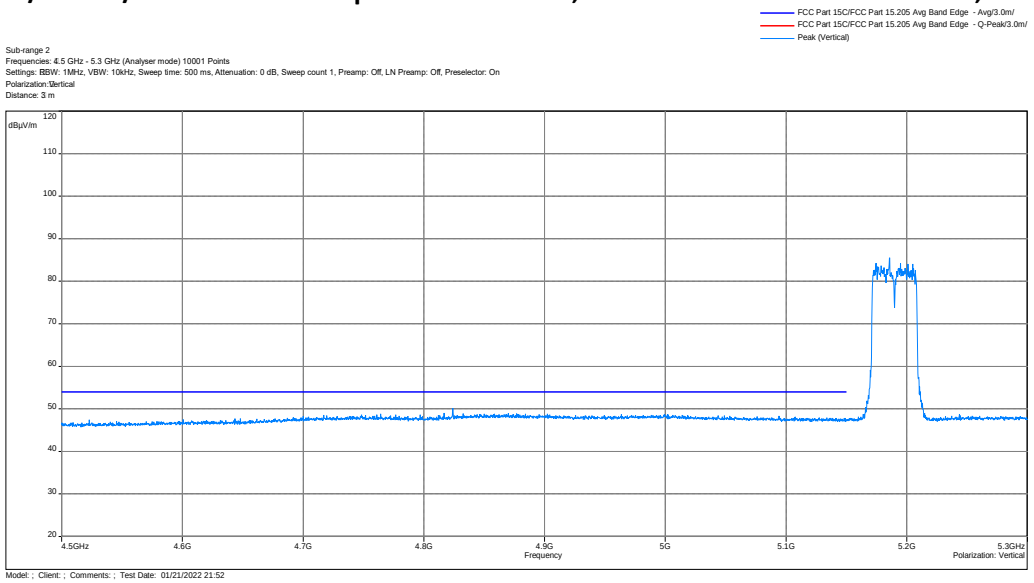
Radiated Out-of-Band Spurious Emissions at the Band Edges/Restricted Bands

15.209/15.205/15.407 Radiated Spurious Emissions, Tx at 802.11ac 40MHz 5190MHz, Peak



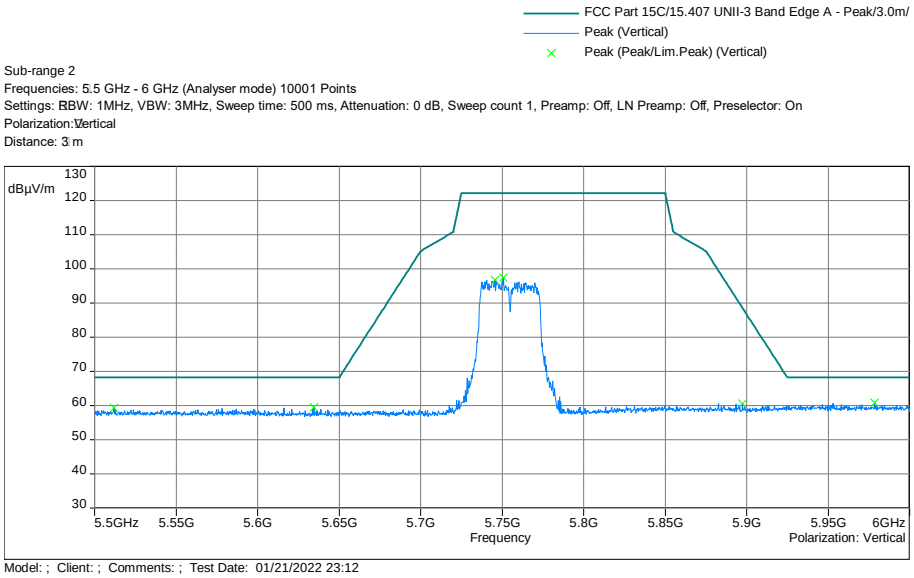
Frequency (MHz)	Detector	Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass / Fail?
5150	Peak	57.21	74	-16.79	Pass

15.209/15.205/15.407 Radiated Spurious Emissions, Tx at 802.11ac 40MHz 5190MHz, Average

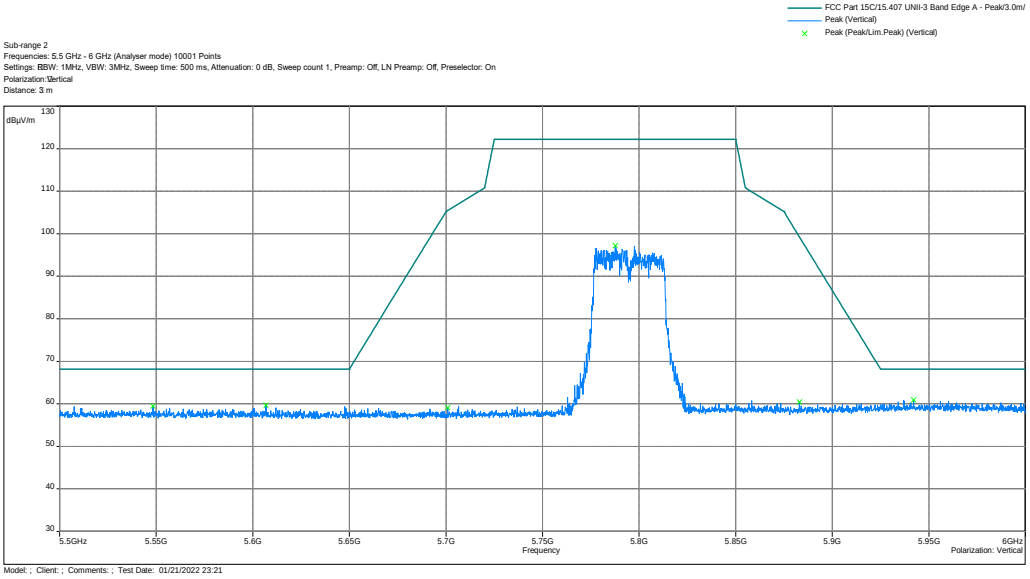


Frequency (MHz)	Detector	Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass / Fail?
5150	Average	47.84	54	-6.16	Pass

15.209/15.205/15.407 Radiated Spurious Emissions, Tx at 802.11ac 40MHz 5755MHz, Peak

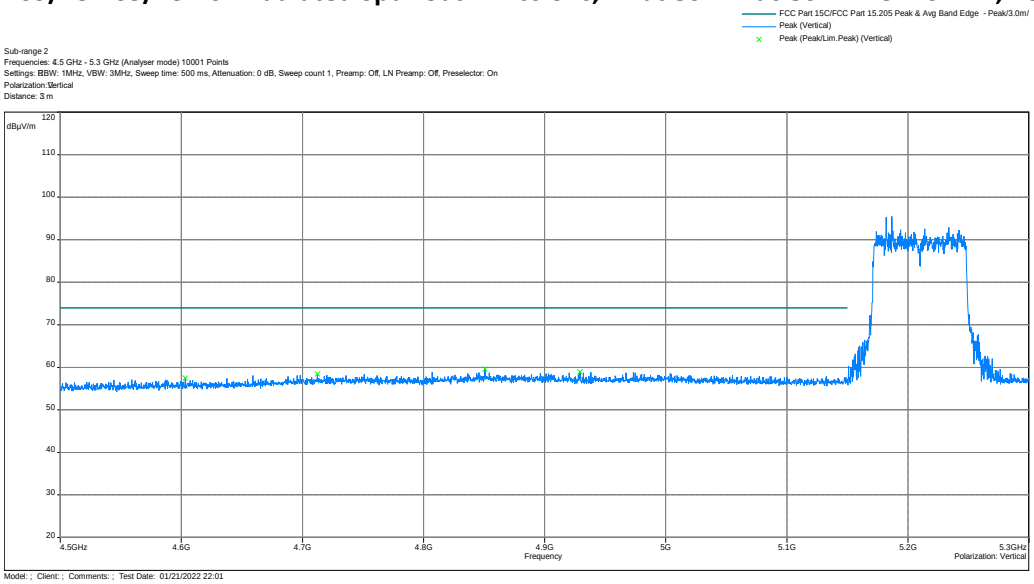


15.209/15.205/15.407 Radiated Spurious Emissions, Tx at 802.11ac 40MHz 5795MHz, Peak



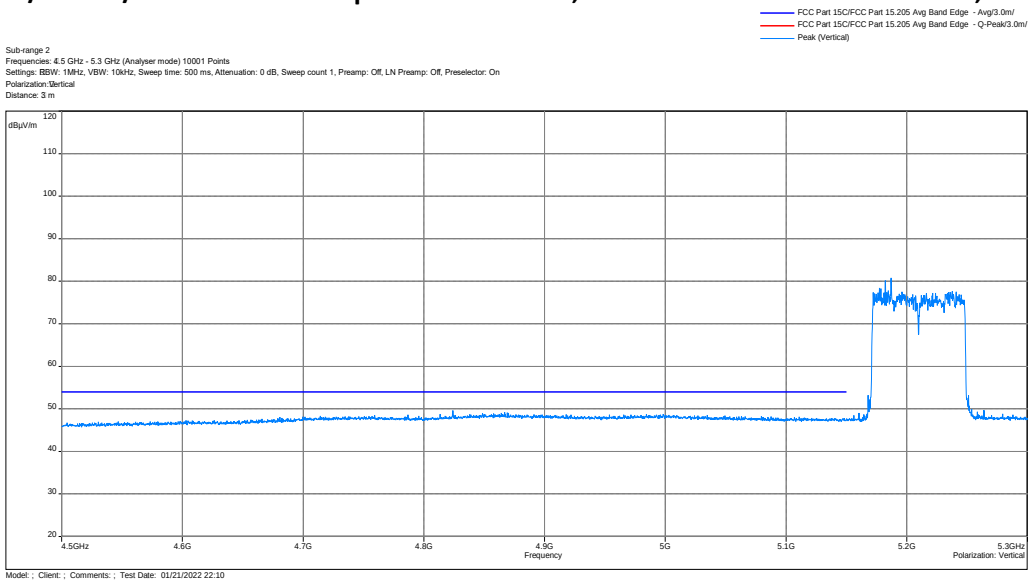
Radiated Out-of-Band Spurious Emissions at the Band Edges/Restricted Bands

15.209/15.205/15.407 Radiated Spurious Emissions, Tx at 802.11ac 80MHz 5210MHz, Peak



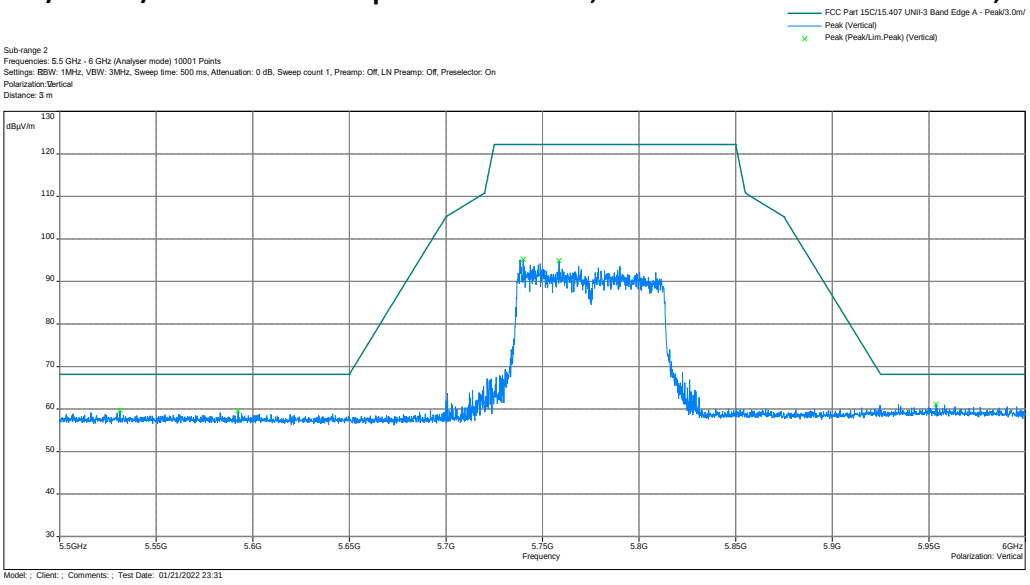
Frequency (MHz)	Detector	Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass / Fail?
5150	Peak	60.24	74	-13.76	Pass

15.209/15.205/15.407 Radiated Spurious Emissions, Tx at 802.11ac 80MHz 5210MHz, Average



Frequency (MHz)	Detector	Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pass / Fail?
4823.7	Average	49.6	54.0	-4.4	Pass
5150.0	Average	47.81	54	-6.19	Pass

15.209/15.205/15.407 Radiated Spurious Emissions, Tx at 802.11ac 80MHz 5775MHz, Peak

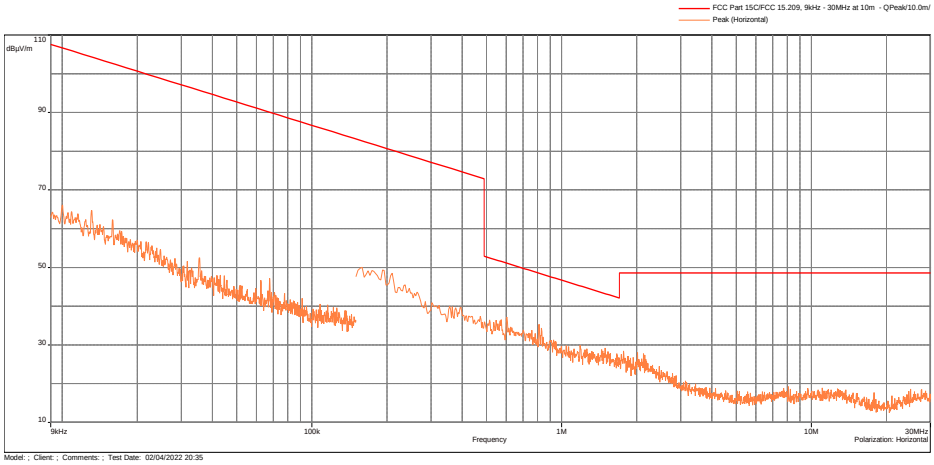


Out-of-Band Radiated Spurious Emissions

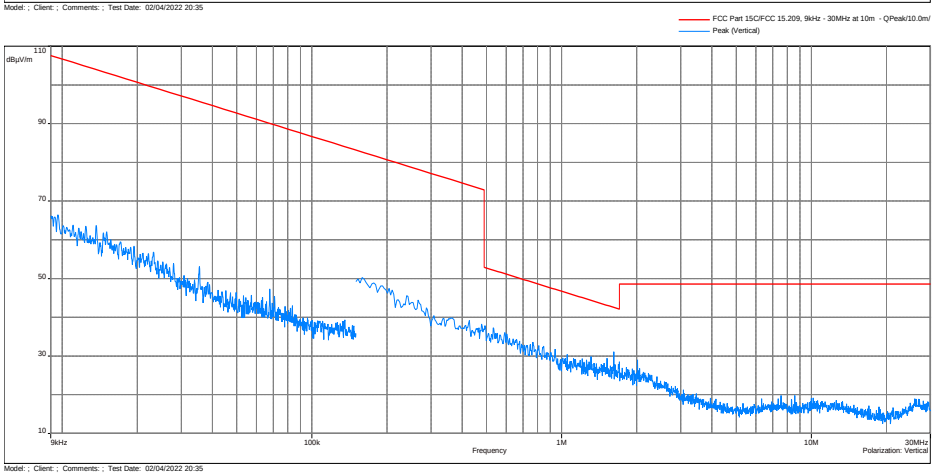
Test Results: 15.209 Radiated Spurious Emissions, Tx at 802.11ac

Radiated Spurious Emissions 9 kHz to 30 MHz, Peak Scan vs QP Limit

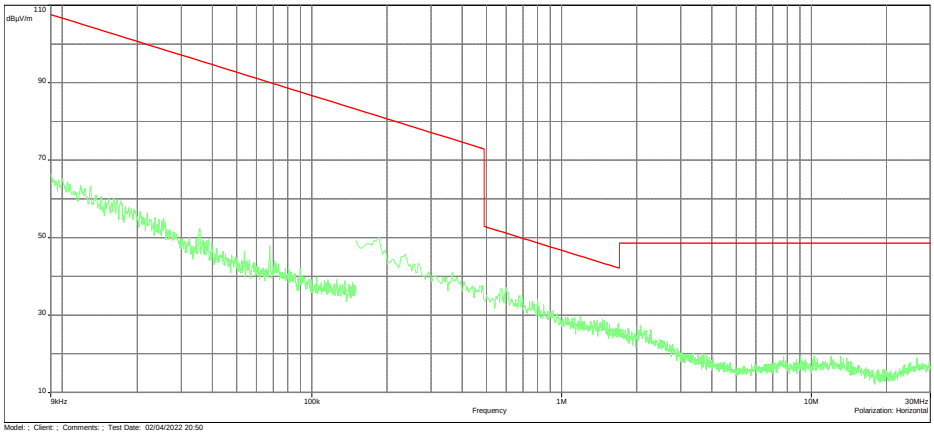
Antenna Position - Coaxial



Antenna Position - Coplanar

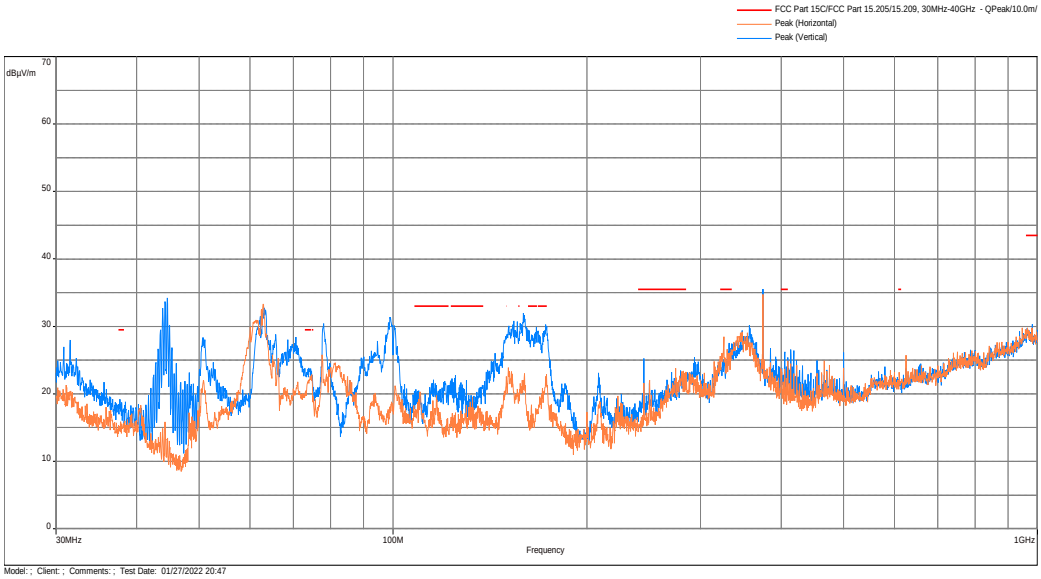


Antenna Position - Horizontal

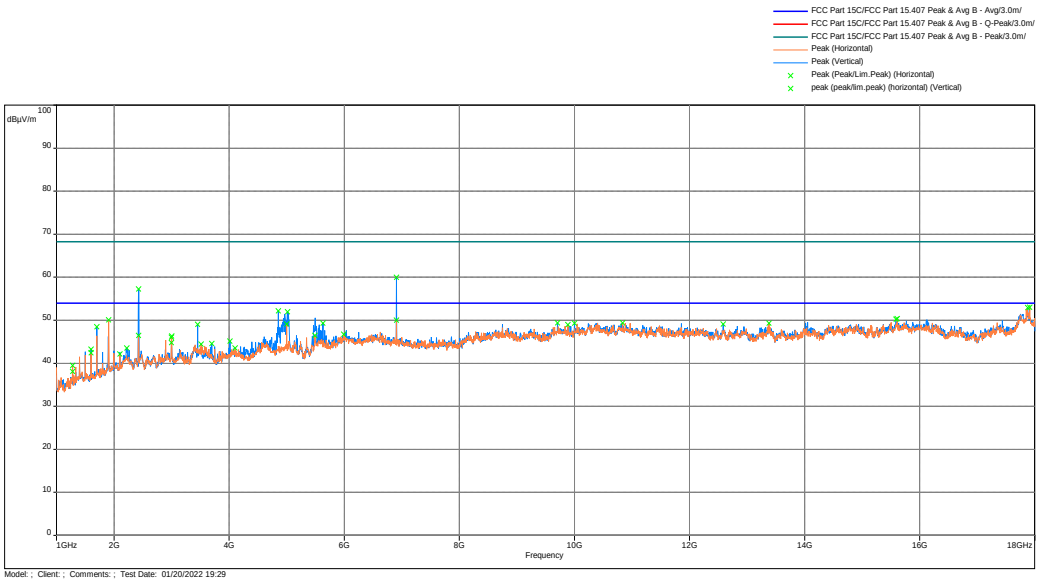


Test Results: 15.209 Radiated Spurious Emissions, Tx at 802.11ac 5180MHz

Radiated Spurious Emissions 30 MHz to 1000 MHz, Peak Scan vs QP Limit

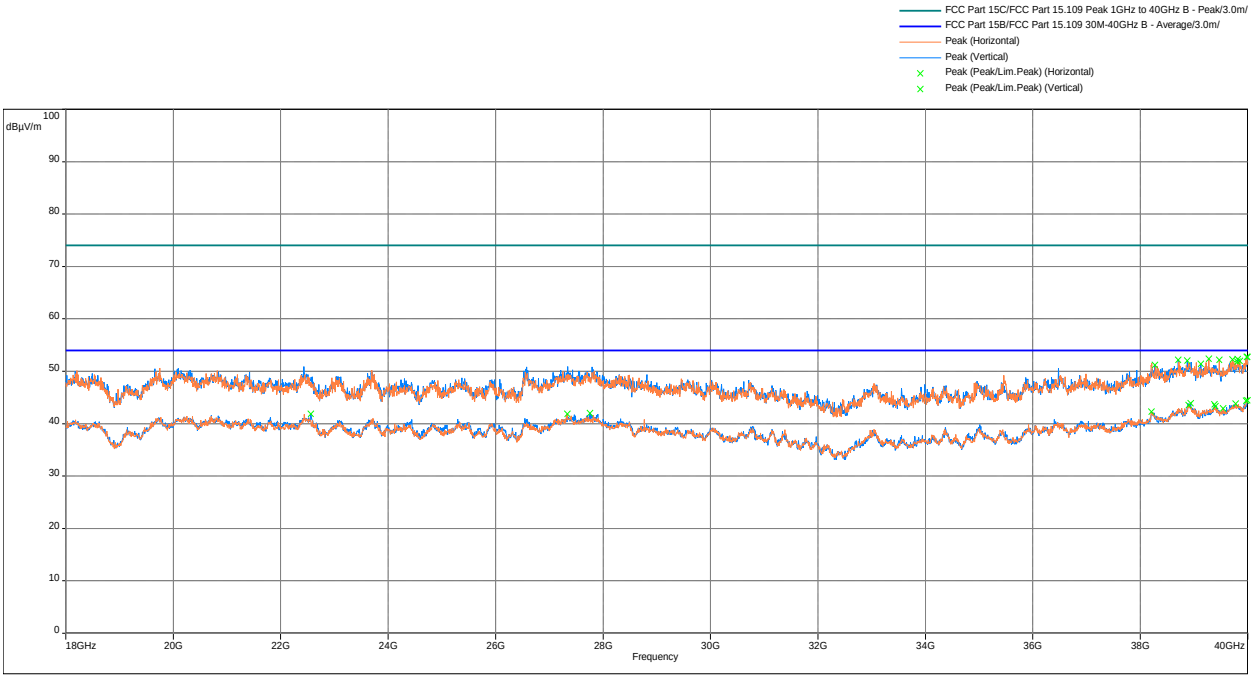


Radiated Spurious Emissions 1000 to 18000 MHz, Peak Scan vs Peak & Avg Limit



Note: 2412MHz peak is fundamental frequency of the 2.4GHz radio.

Radiated Spurious Emissions 18000 to 40000 MHz, Peak & Avg Scan vs Peak & Avg Limit



Frequency	FS@10m	Limit@ 10m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
74.8	22.9	29.5	-6.6	3.2	359.8	Horizontal	-19.5
162.6	29.4	33.0	-3.6	1.1	162.5	Vertical	-15.4
166.8	29.9	33.0	-3.1	1.3	171.5	Vertical	-15.7
170.9	29.0	33.0	-4.0	1.0	171.5	Vertical	-16.1
172.6	30.3	33.0	-2.7	1.4	171.5	Vertical	-16.2
326.3	28.5	35.5	-7.0	2.9	170.5	Horizontal	-11.0

Note: Correction = AF + CF - Preamp

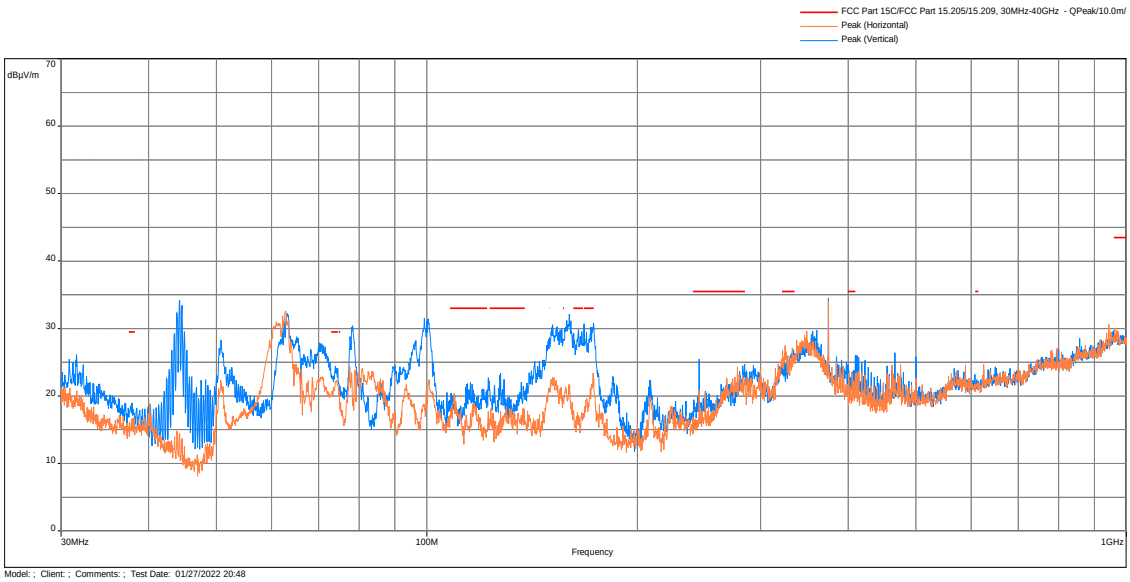
Frequency	Pk@3m	Pk Limit @3m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
6906.367*	60.0	68.2	-8.2	1.5	138.8	Vertical	-2.4

Note: Correction = AF + CF - Preamp

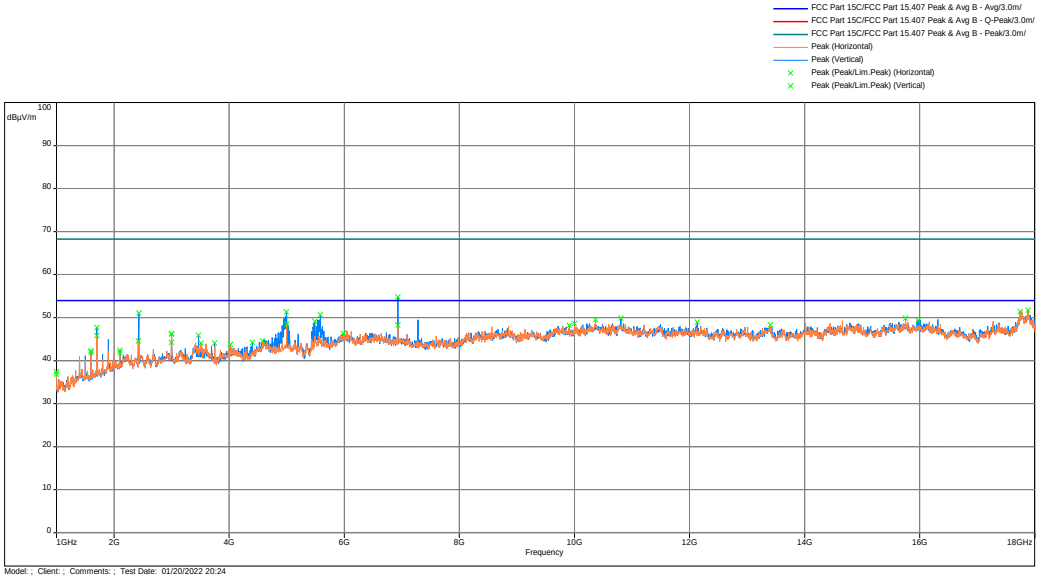
*Spurious emission frequencies does not fall under the restricted bands of 15.205, therefore the 15.209 limits does not apply to these frequencies. Limit applied is -27dBm EIRP which converts to 68.2 dBuV/m at 3m.

Test Results: 15.209 Radiated Spurious Emissions, Tx at 802.11ac 5200MHz

Radiated Spurious Emissions 30 MHz to 1000 MHz, Peak Scan vs QP Limit

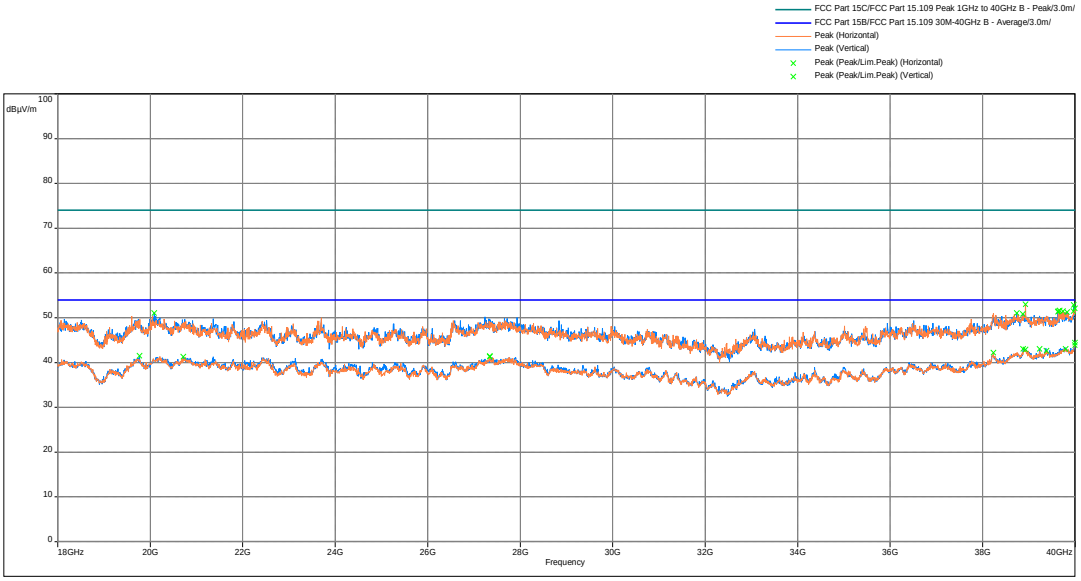


Radiated Spurious Emissions 1000 to 18000 MHz, Peak Scan vs Peak & Avg Limit



Note: 2412MHz peak is fundamental frequency of the 2.4GHz radio.

Radiated Spurious Emissions 18000 to 40000 MHz, Peak & Avg Scan vs Peak & Avg Limit



Frequency	FS@10m	Limit@ 10m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
74.3	22.4	29.5	-7.1	3.5	206.5	Horizontal	-19.6
162.1	29.3	33.0	-3.7	1.1	153.3	Vertical	-15.4
164.7	29.8	33.0	-3.2	1.2	153.3	Vertical	-15.5
167.7	30.7	33.0	-2.3	1.1	171.0	Vertical	-15.8
169.1	29.5	33.0	-3.5	1.0	190.5	Vertical	-15.9
172.9	30.8	33.0	-2.3	1.6	171.0	Vertical	-16.2

Note: Correction = AF + CF - Preamp

Frequency	Pk@3m	Limit@3m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
6933.0*	54.8	68.2	-13.5	1.5	146.8	Vertical	-2.3

Note: Correction = AF + CF - Preamp

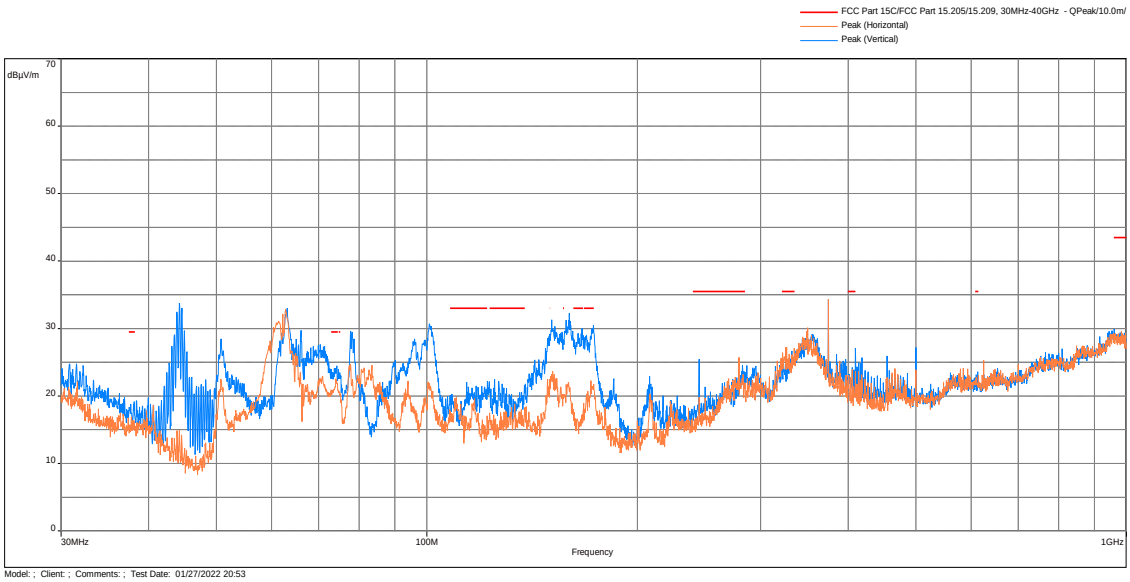
*Spurious emission frequencies does not fall under the restricted bands of 15.205, therefore the 15.209 limits does not apply to these frequencies. Limit applied is -27dBm EIRP which converts to 68.2 dBuV/m at 3m.

Frequency	Avg@3m	Limit@3m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
4997.3	51.4	54.0	-2.7	2.5	142.5	Vertical	-4.2

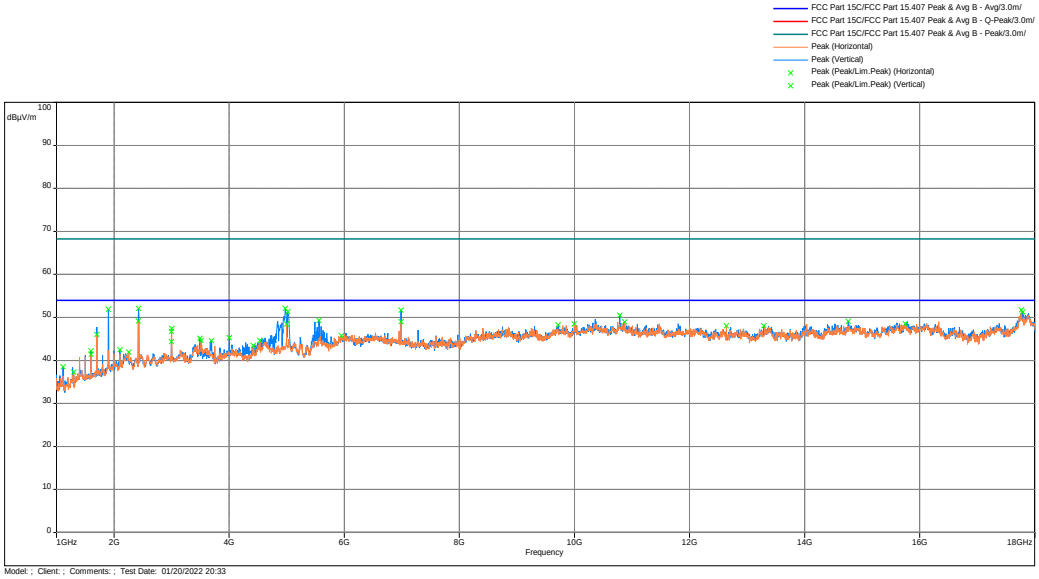
Note: Correction = AF + CF - Preamp

Test Results: 15.209 Radiated Spurious Emissions, Tx at 802.11ac 5240MHz

Radiated Spurious Emissions 30 MHz to 1000 MHz, Peak Scan vs QP Limit

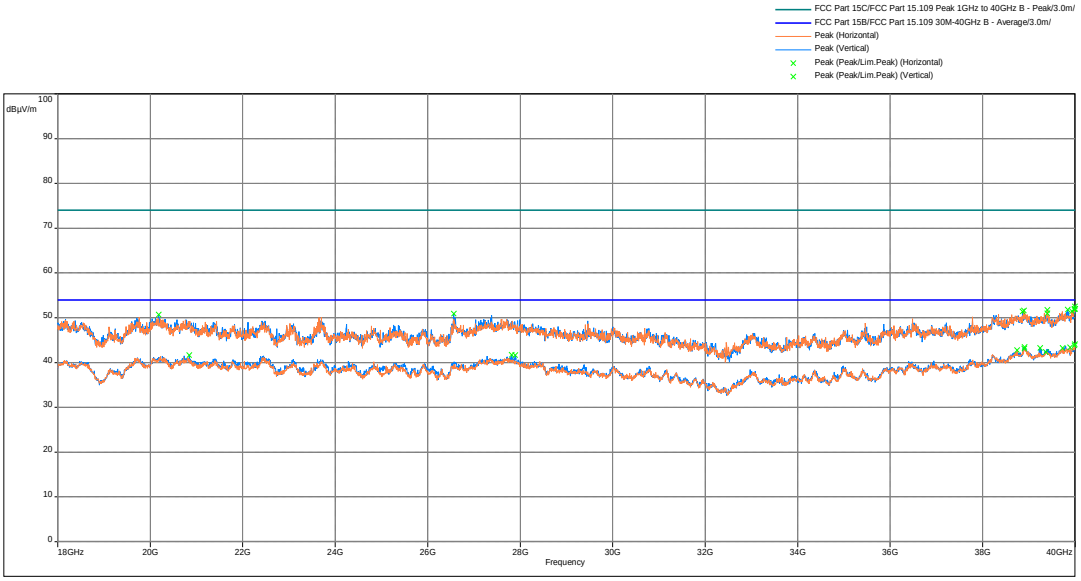


Radiated Spurious Emissions 1000 to 18000 MHz, Peak Scan vs Peak & Avg Limit



Note: 2412MHz peak is fundamental frequency of the 2.4GHz radio.

Radiated Spurious Emissions 18000 to 40000 MHz, Peak & Avg Scan vs Peak & Avg Limit



Frequency	FS@10m	Limit@ 10m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
150.0	29.2	33.0	-3.8	2.7	144.0	Vertical	-14.7
166.5	29.8	33.0	-3.2	1.2	162.3	Vertical	-15.7
166.8	30.0	33.0	-3.0	1.4	171.3	Vertical	-15.7
169.2	29.0	33.0	-4.0	1.5	181.5	Vertical	-15.9
173.0	30.5	33.0	-2.5	1.0	191.5	Vertical	-16.2
326.9	27.2	35.5	-8.3	2.0	190.0	Horizontal	-11.0

Note: Correction = AF + CF - Preamp

Frequency	Pk@3m	Limit@3m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
4975.2*	52.1	68.2	-16.1	2.5	140.3	Vertical	-4.3
1900.4*	51.9	68.2	-16.3	2.3	154.0	Vertical	-12.0
6986.3*	51.7	68.2	-16.5	2.5	57.3	Vertical	-2.4

Note: Correction = AF + CF - Preamp

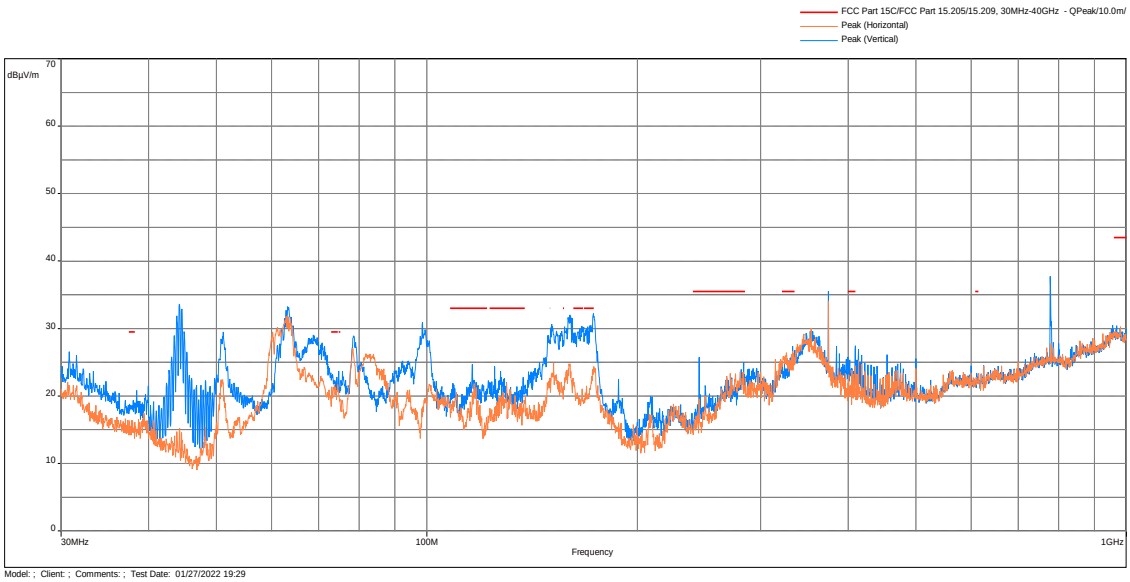
*Spurious emission frequencies does not fall under the restricted bands of 15.205, therefore the 15.209 limits does not apply to these frequencies. Limit applied is -27dBm EIRP which converts to 68.2 dBuV/m at 3m.

Frequency	Avg@3m	Limit@3m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
4975.2	52.1	54.0	-2.1	2.5	140.3	Vertical	-4.3

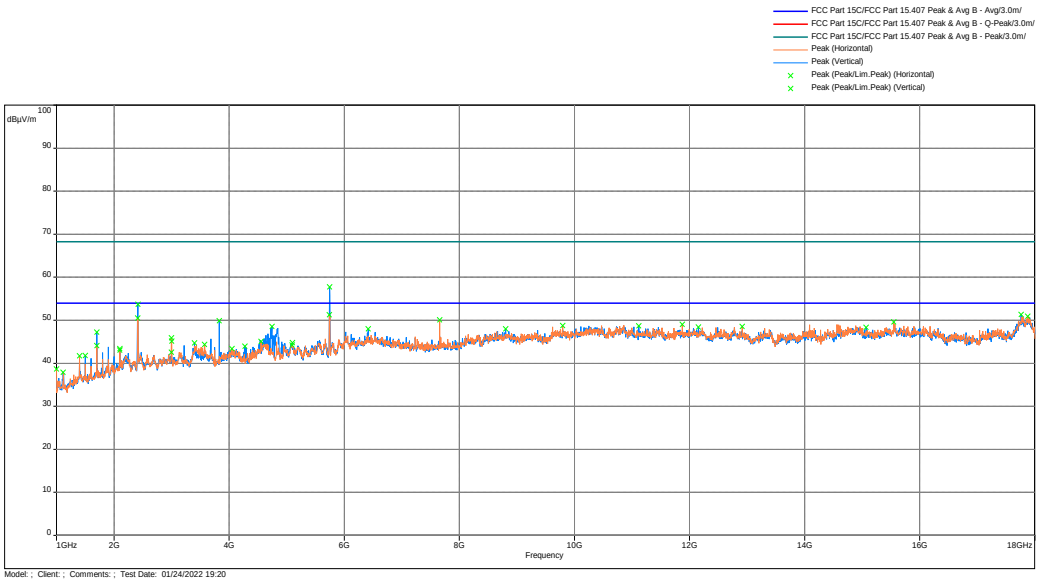
Note: Correction = AF + CF - Preamp

Test Results: 15.209 Radiated Spurious Emissions, Tx at 802.11ac 5745MHz

Radiated Spurious Emissions 30 MHz to 1000 MHz, Peak Scan vs QP Limit

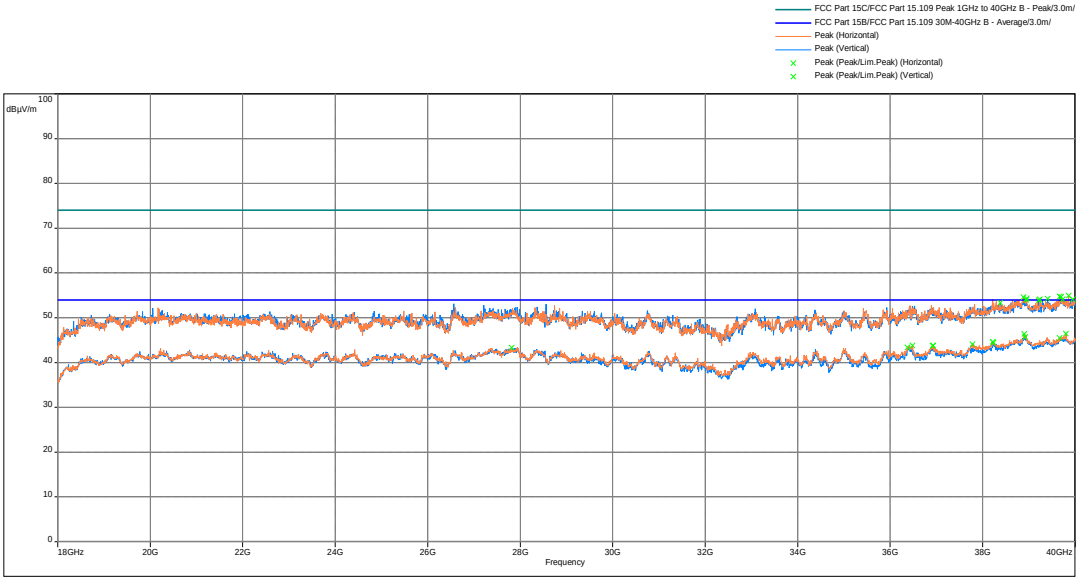


Radiated Spurious Emissions 1000 to 18000 MHz, Peak Scan vs Peak & Avg Limit



Note: 2412MHz peak is fundamental frequency of the 2.4GHz radio.

Radiated Spurious Emissions 18000 to 40000 MHz, Peak & Avg Scan vs Peak & Avg Limit



Frequency	FS@10m	Limit@ 10m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
74.8	23.7	29.5	-5.8	2.0	298.0	Vertical	-19.5
165.5	30.0	33.0	-3.0	1.1	169.8	Vertical	-15.6
166.6	30.4	33.0	-2.6	1.3	155.8	Vertical	-15.7
169.2	30.0	33.0	-3.0	1.2	155.8	Vertical	-15.9
170.9	30.4	33.0	-2.6	1.5	164.8	Vertical	-16.1
173.0	32.2	33.0	-0.8	1.3	160.5	Vertical	-16.2

Note: Correction = AF + CF - Preamp

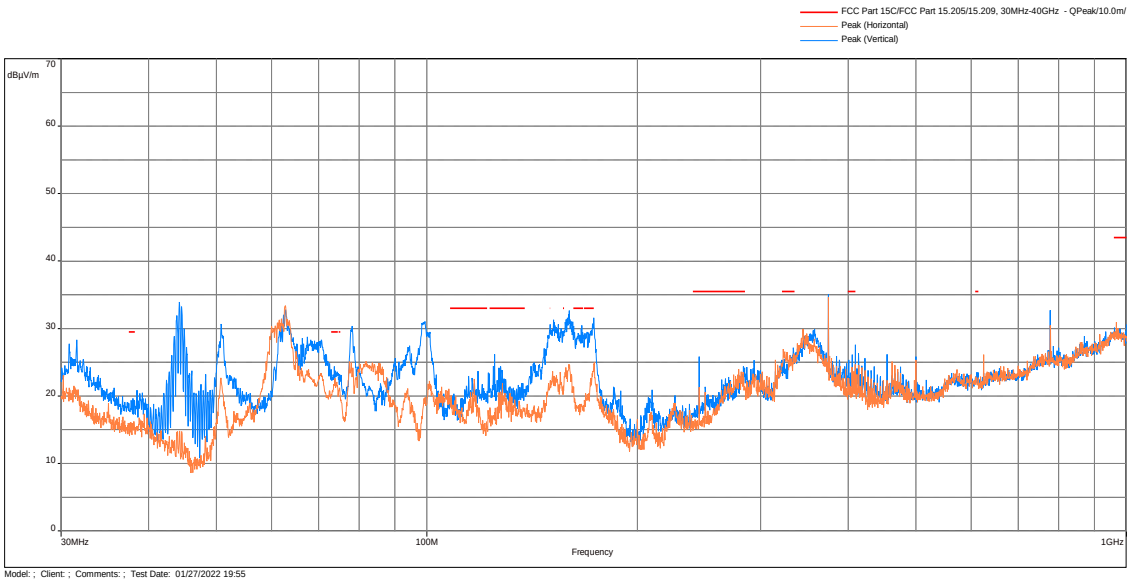
Frequency	Pk@3m	Limit@3m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
5744.1*	57.8	68.2	-10.5	3.5	336.0	Vertical	-3.7

Note: Correction = AF + CF - Preamp

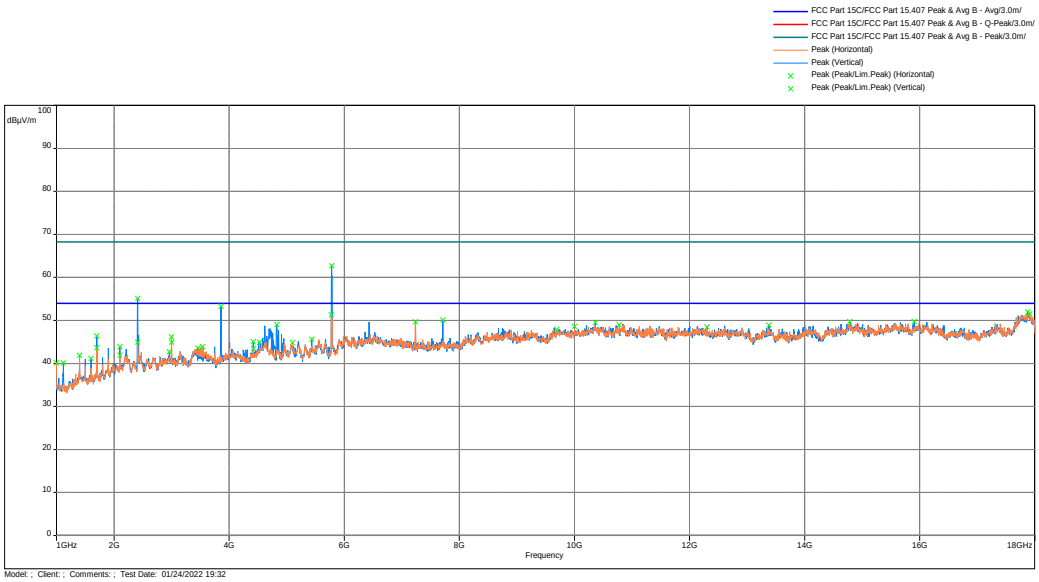
*Spurious emission frequencies does not fall under the restricted bands of 15.205, therefore the 15.209 limits does not apply to these frequencies. Limit applied is -27dBm EIRP which converts to 68.2 dBuV/m at 3m.

Test Results: 15.209 Radiated Spurious Emissions, Tx at 802.11ac 5785MHz

Radiated Spurious Emissions 30 MHz to 1000 MHz, Peak Scan vs QP Limit

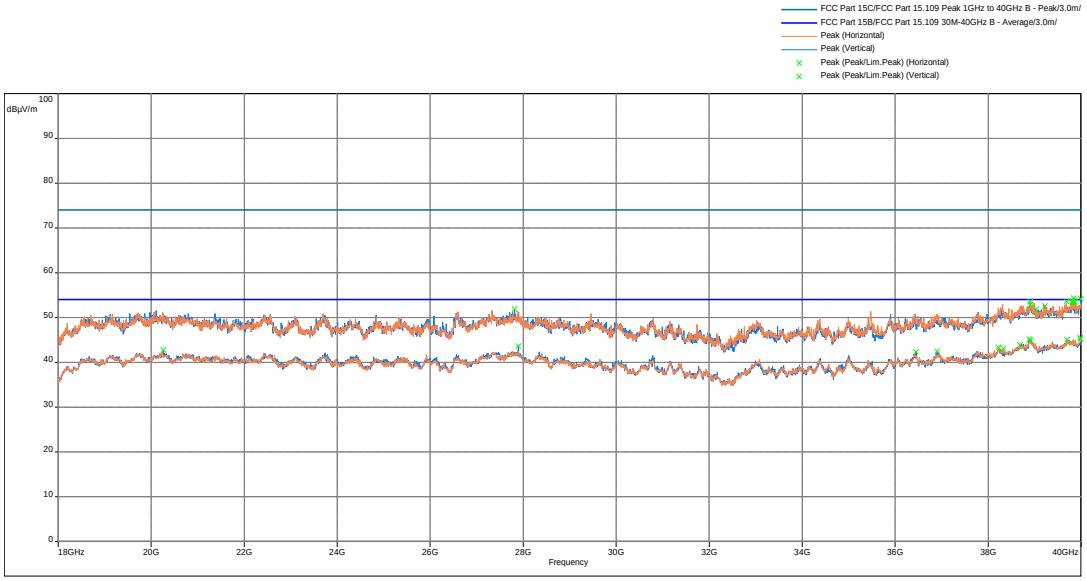


Radiated Spurious Emissions 1000 to 18000 MHz, Peak Scan vs Peak & Avg Limit



Note: 2412MHz peak is fundamental frequency of the 2.4GHz radio.

Radiated Spurious Emissions 18000 to 40000 MHz, Peak & Avg Scan vs Peak & Avg Limit



Frequency	FS@10m	Limit@ 10m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
73.9	22.6	29.5	-6.9	3.2	311.8	Horizontal	-19.6
150.0	30.6	33.0	-2.4	1.1	118.5	Vertical	-14.7
162.2	30.4	33.0	-2.6	1.3	159.8	Vertical	-15.4
166.6	30.5	33.0	-2.5	1.5	188.8	Vertical	-15.7
169.5	29.5	33.0	-3.5	1.6	150.8	Vertical	-16.0
170.4	29.4	33.0	-3.6	1.4	173.5	Vertical	-16.1

Note: Correction = AF + CF - Preamp

Frequency	Pk@3m	Limit@3m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
5782.1*	62.7	68.2	-5.6	3.5	0.0	Vertical	-3.8

Note: Correction = AF + CF - Preamp

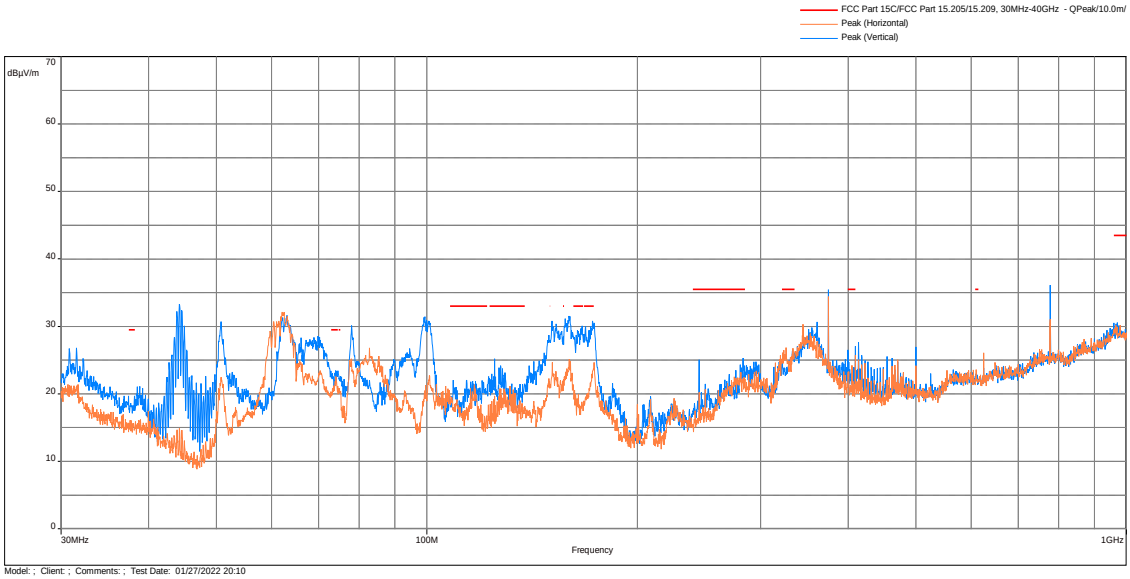
*Spurious emission frequencies does not fall under the restricted bands of 15.205, therefore the 15.209 limits does not apply to these frequencies. Limit applied is -27dBm EIRP which converts to 68.2 dBuV/m at 3m.

Frequency	Avg@3m	Limit@3m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
3856.0	53.3	54.0	-0.7	2.5	128.8	Vertical	-7.2

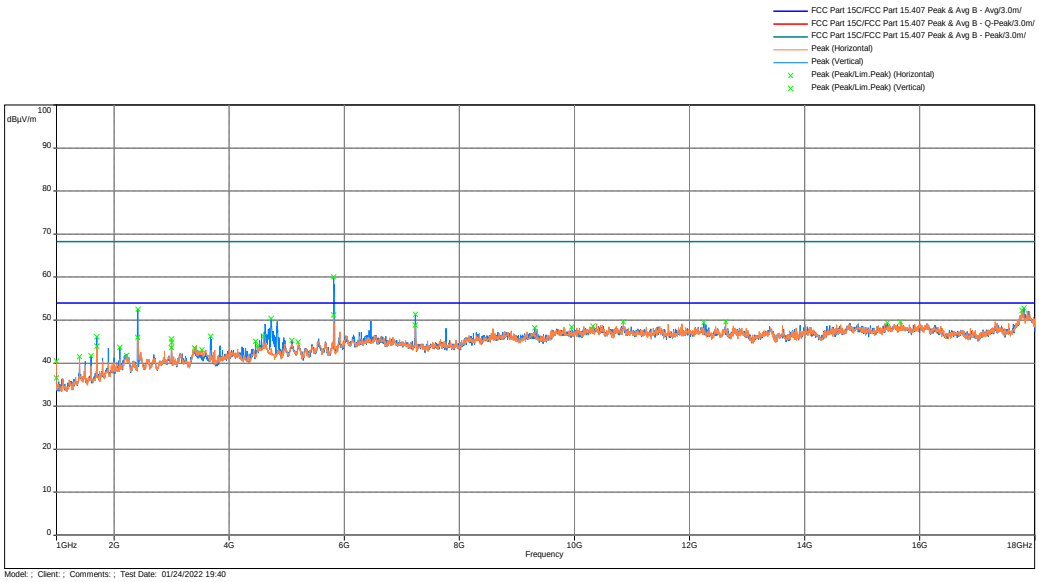
Note: Correction = AF + CF - Preamp

Test Results: 15.209 Radiated Spurious Emissions, Tx at 802.11ac 5825MHz

Radiated Spurious Emissions 30 MHz to 1000 MHz, Peak Scan vs QP Limit

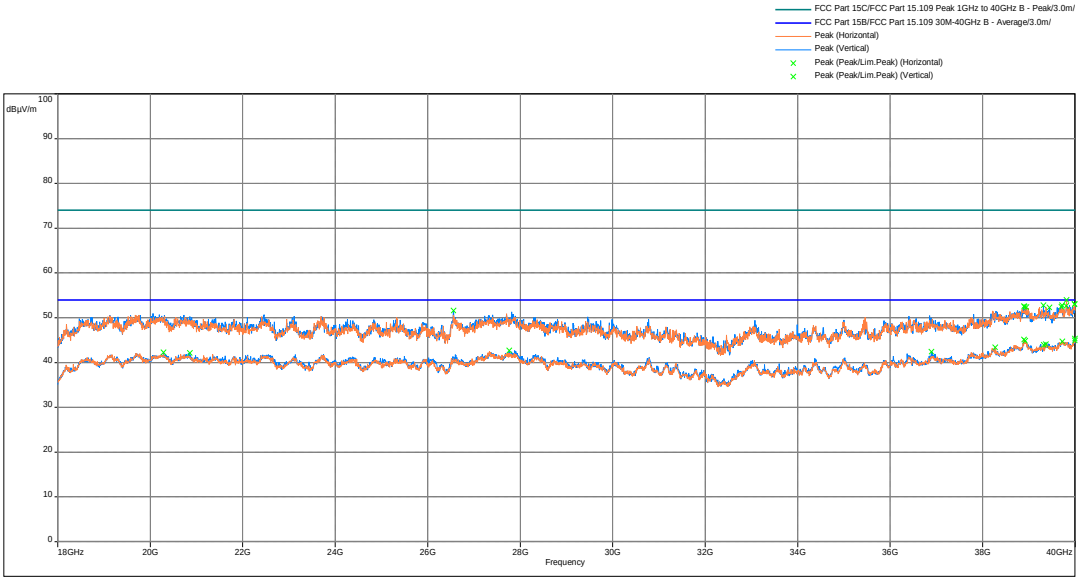


Radiated Spurious Emissions 1000 to 18000 MHz, Peak Scan vs Peak & Avg Limit



Note: 2412MHz peak is fundamental frequency of the 2.4GHz radio.

Radiated Spurious Emissions 18000 to 40000 MHz, Peak & Avg Scan vs Peak & Avg Limit



Frequency	FS@10m	Limit@ 10m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
74.0	23.5	29.5	-6.1	2.3	280.8	Vertical	-19.6
164.2	29.5	33.0	-3.5	1.1	150.8	Vertical	-15.5
166.8	30.1	33.0	-2.9	1.4	164.0	Vertical	-15.7
168.6	30.0	33.0	-3.0	1.6	141.3	Vertical	-15.9
170.9	29.4	33.0	-3.6	1.4	169.0	Vertical	-16.1
172.6	30.8	33.0	-2.2	1.3	155.5	Vertical	-16.2

Note: Correction = AF + CF - Preamp

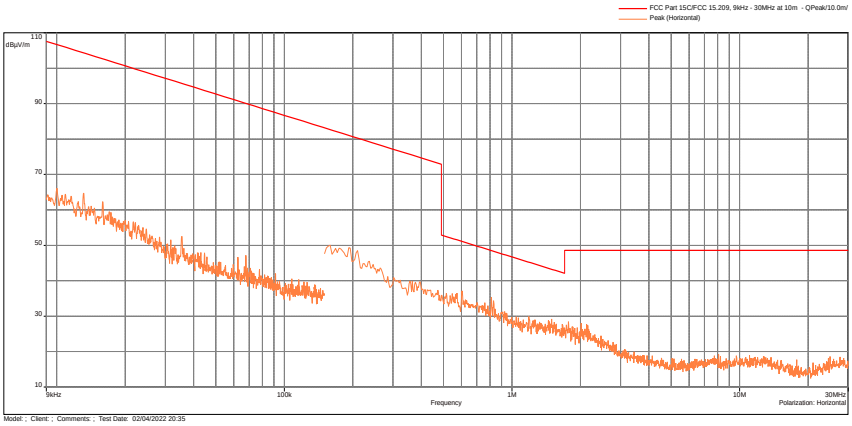
Frequency	Pk@3m	Limit@3m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
5817.2*	60.0	68.2	-8.2	3.5	74.0	Vertical	-3.6

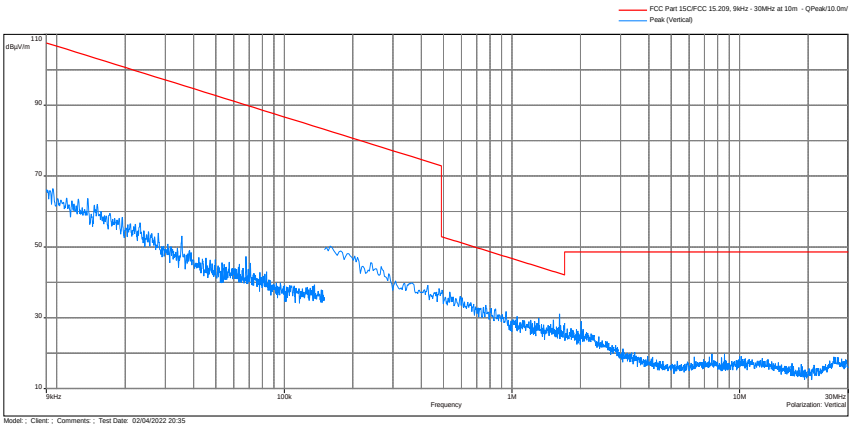
Note: Correction = AF + CF - Preamp

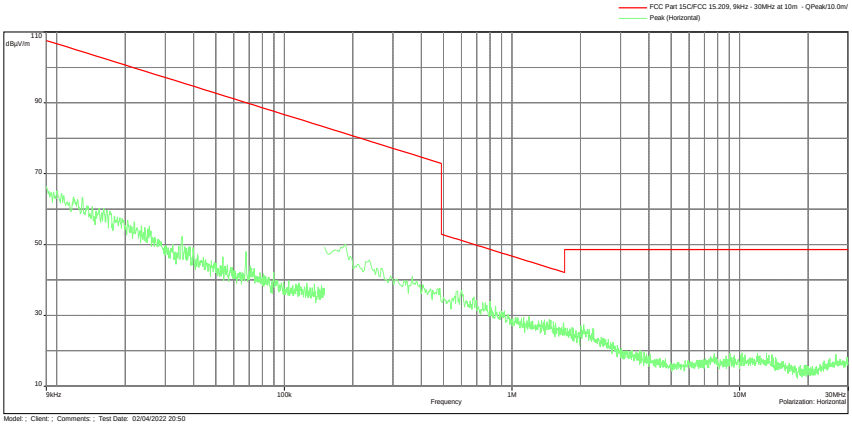
*Spurious emission frequencies does not fall under the restricted bands of 15.205, therefore the 15.209 limits does not apply to these frequencies. Limit applied is -27dBm EIRP which converts to 68.2 dBuV/m at 3m.

Test Results: 15.209 Radiated Spurious Emissions Simultaneous Transmission
2.4GHz Tx at 2412MHz,
5GHz WiFi 802.11ac 20MHz at 5240MHz, and 5GHz WiFi 802.11ac 20MHz at 5785MHz

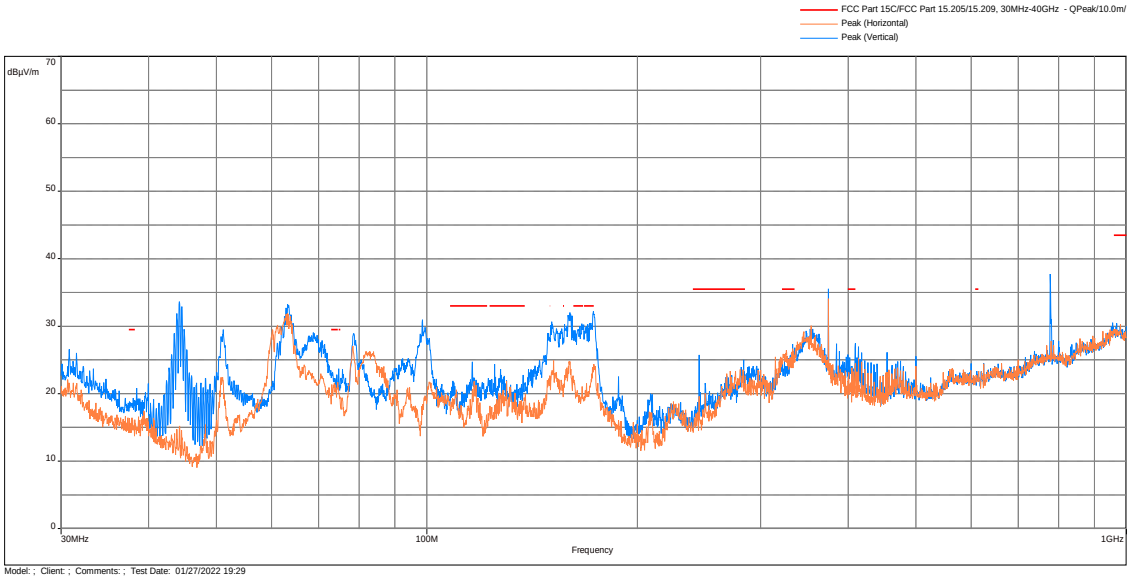
Radiated Spurious Emissions – 9kHz - 30 MHz



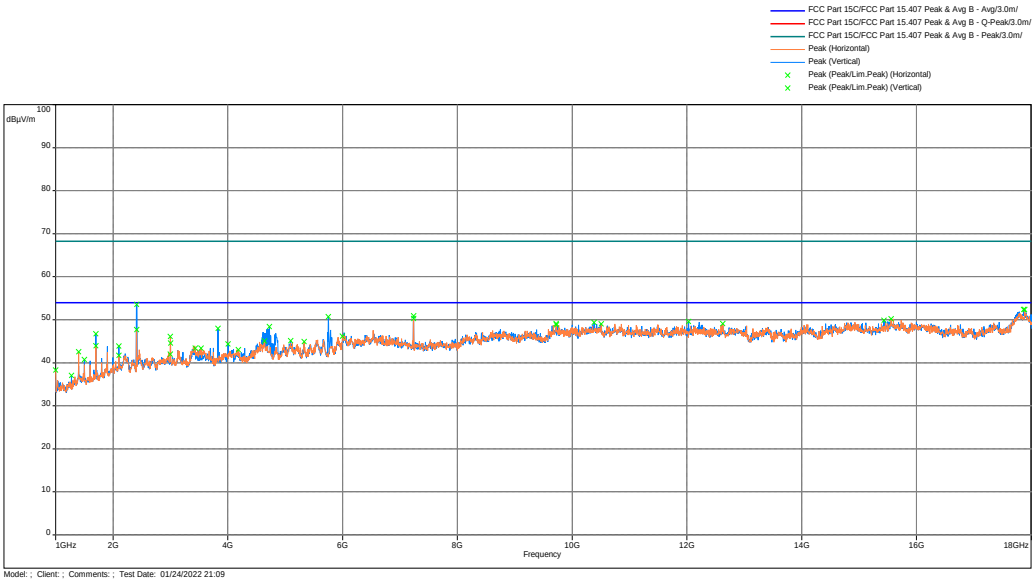




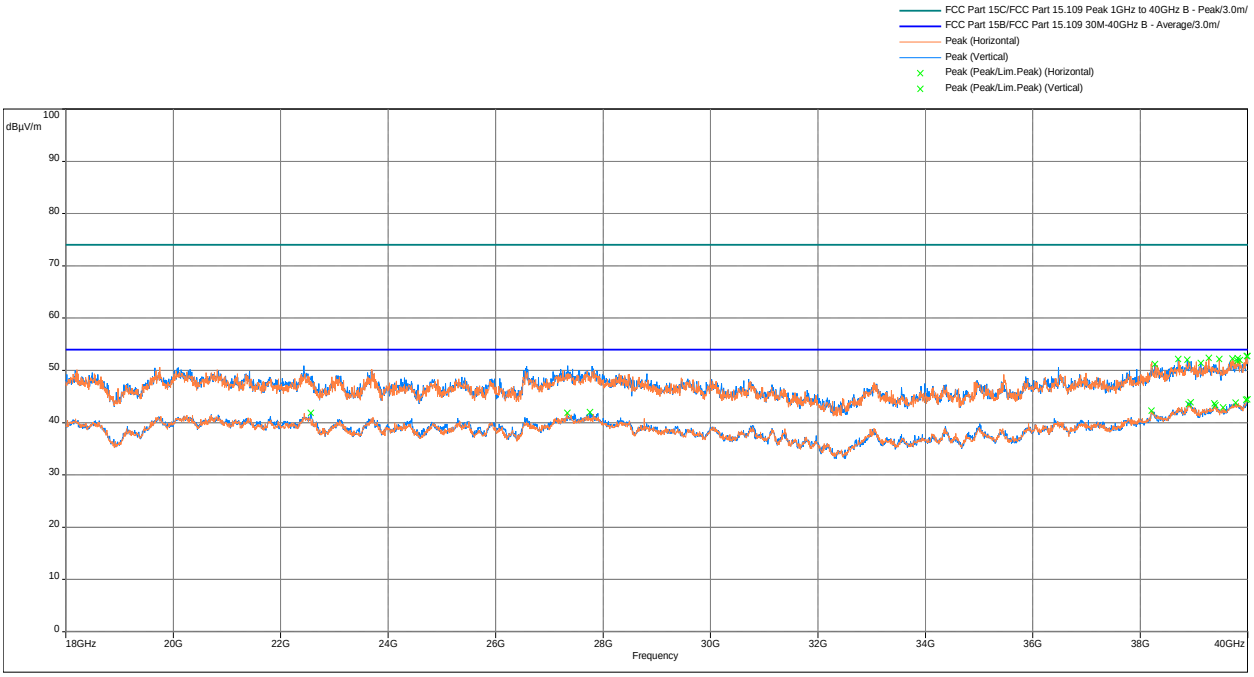
Radiated Spurious Emissions - 30 MHz to 1000 MHz



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



Radiated Spurious Emissions 18000 - 40000 MHz, Peak & Avg Scan vs Peak & Avg Limit



Frequency	FS@10m	Limit@ 10m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
74.8	23.7	29.5	-5.8	2.0	298.0	Vertical	-19.5
165.5	30.0	33.0	-3.0	1.4	169.8	Vertical	-15.6
166.6	30.4	33.0	-2.6	1.3	155.8	Vertical	-15.7
169.2	30.0	33.0	-3.0	1.5	155.8	Vertical	-15.9
170.9	30.4	33.0	-2.6	1.2	164.8	Vertical	-16.1
173.0	32.2	33.0	-0.8	1.0	160.5	Vertical	-16.2

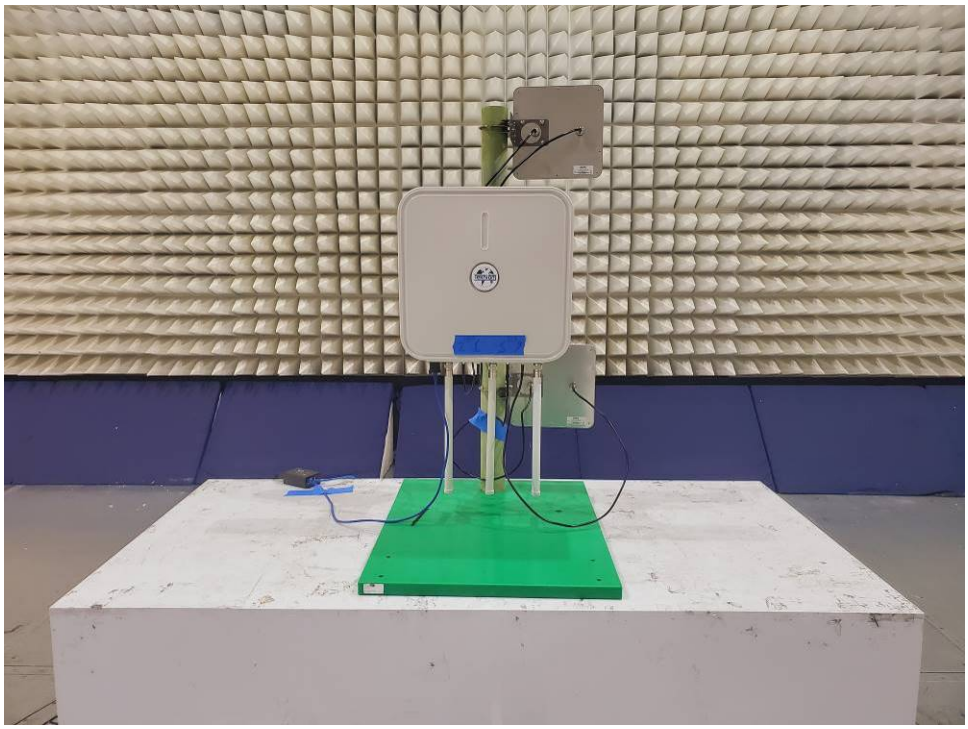
Note: Correction = AF + CF - Preamp

Frequency	Pk@3m	Limit@3m	Margin	Height	Azimuth	Polarity	Correction
MHz	dBuV/m	dBuV/m	(dB)	(m)	(deg)		dB
7237.3*	50.9	68.2	-17.3	3.5	283.8	Vertical	-2.4

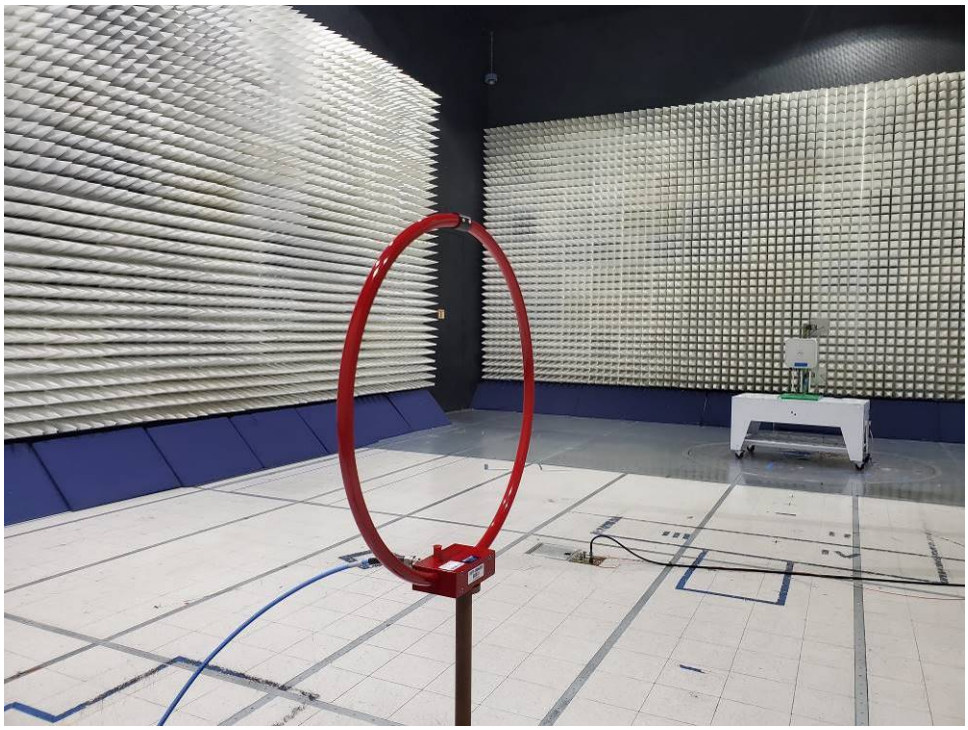
*Spurious emission frequencies does not fall under the restricted bands of 15.205, therefore the 15.209 limits does not apply to these frequencies. Limit applied is -27dBm EIRP which converts to 68.2 dBuV/m at 3m.

4.3.7 Test setup

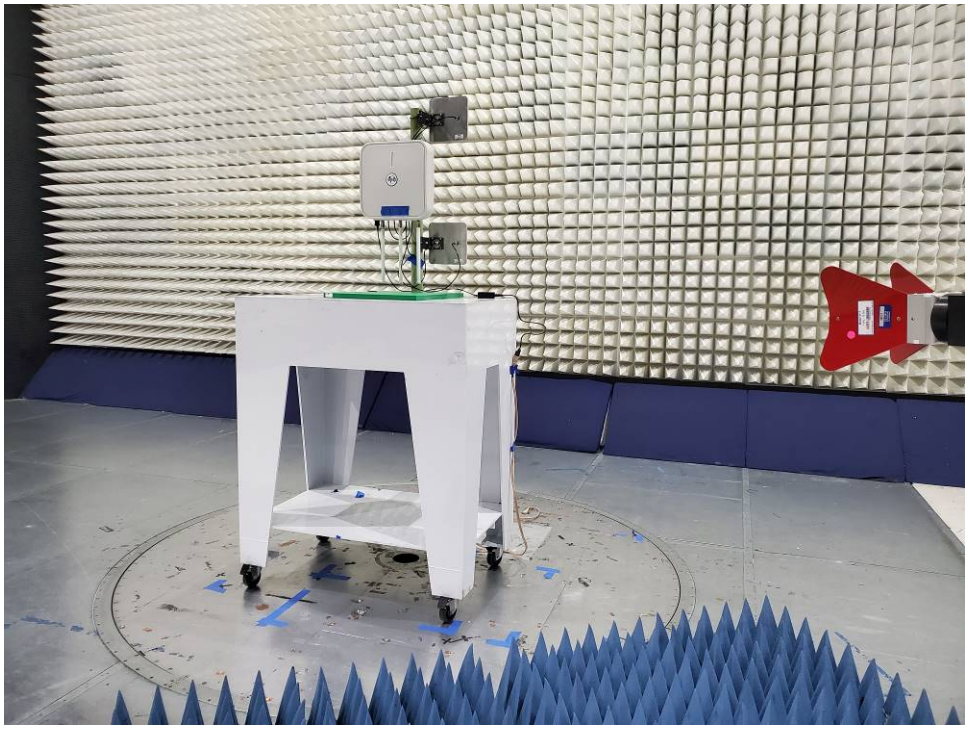
The following photographs show the testing configurations used.



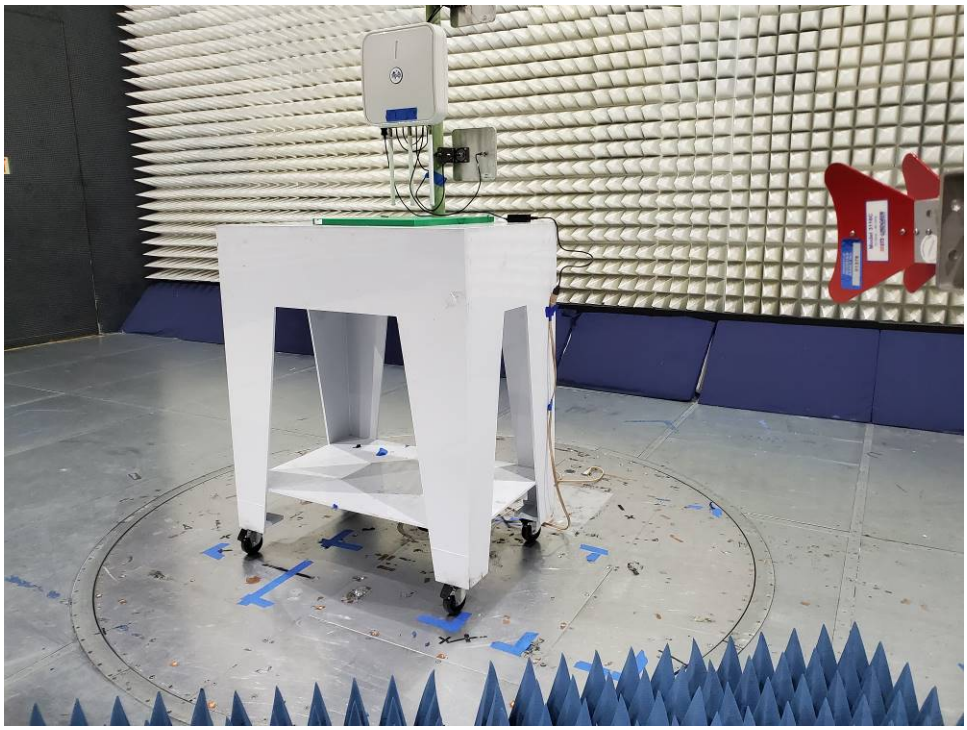
4.3.7 Test Setup Configuration (Continued)



4.3.7 Test Setup Configuration (Continued)



4.3.7 Test Setup Configuration (Continued)



4.4 AC Line Conducted Emission
FCC: 15.207; RSS-GEN

4.4.1 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.

4.4.2 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.

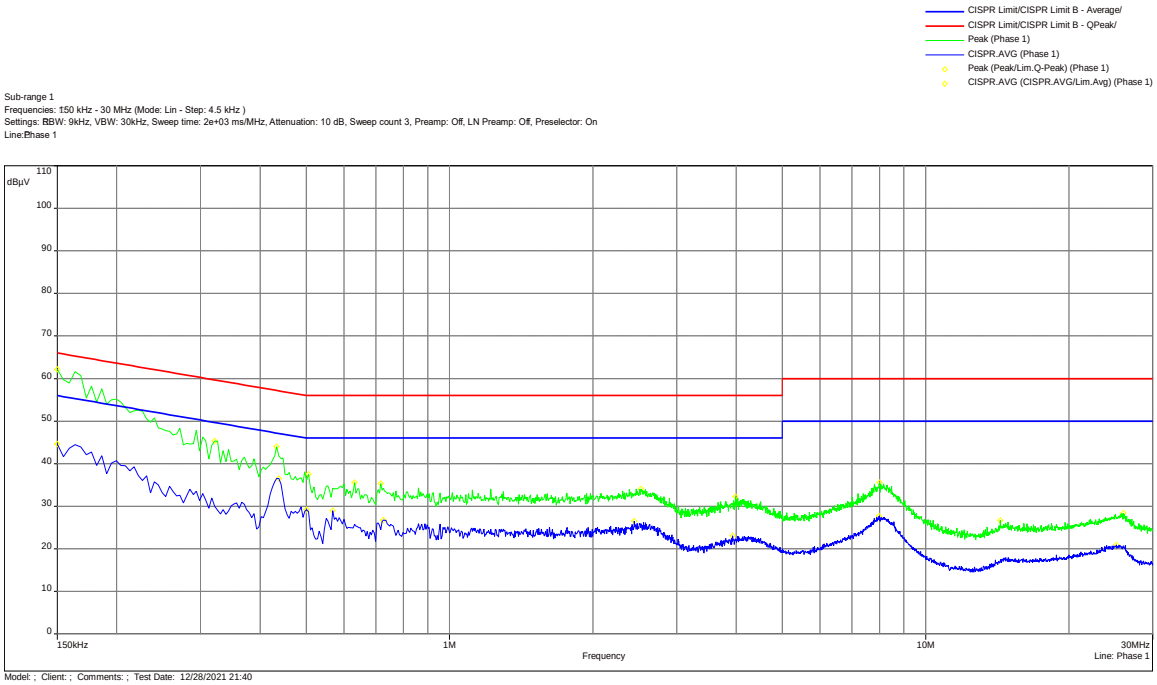
Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

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

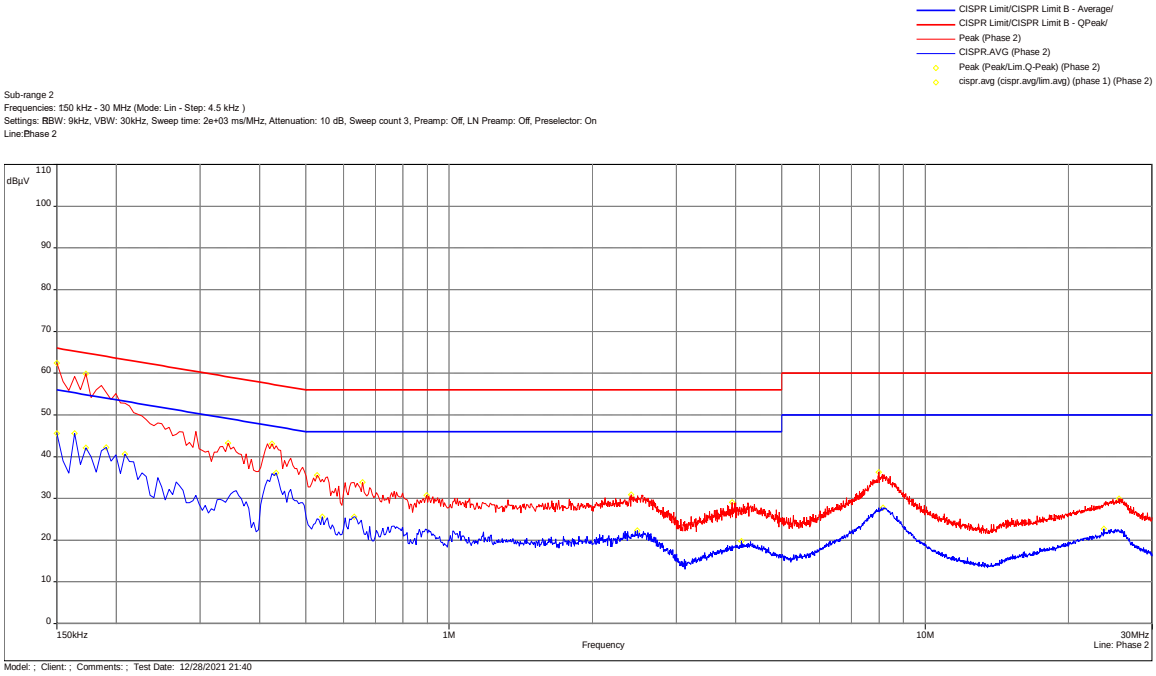
4.4.3 Test Results

15.207: Conducted Emissions 120VAC 60Hz

Phase 1



Phase 2



4.4.3 Test Results (Continued)

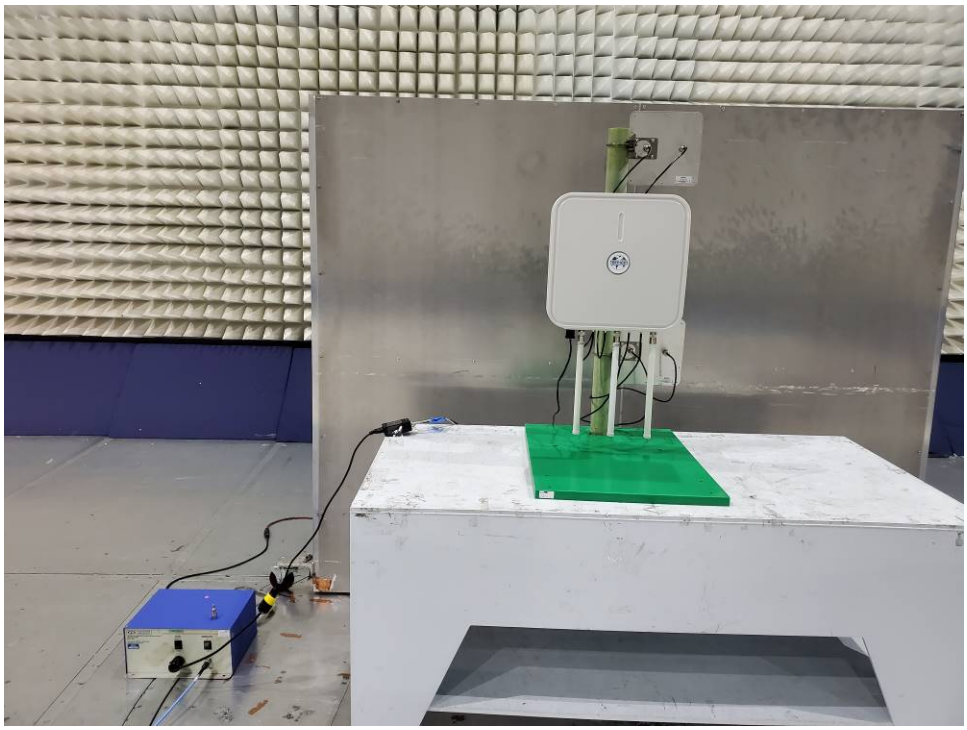
Frequency (MHz)	Q-Peak (dBµV)	Limit Q-Peak (dBµV)	Margin Q-Peak (dB)	Line	Correction (dB)
0.150	62.4	66.0	-3.6	Phase 2	11.0
0.150	62.1	66.0	-3.9	Phase 1	11.0
0.173	59.8	64.8	-5.0	Phase 2	11.0
0.321	45.3	59.7	-14.4	Phase 1	11.0
0.344	43.3	59.1	-15.9	Phase 2	11.1
0.425	43.1	57.4	-14.3	Phase 2	11.1
0.434	44.0	57.2	-13.2	Phase 1	11.1
0.506	37.5	56.0	-18.5	Phase 1	11.1
0.632	35.6	56.0	-20.4	Phase 1	11.1

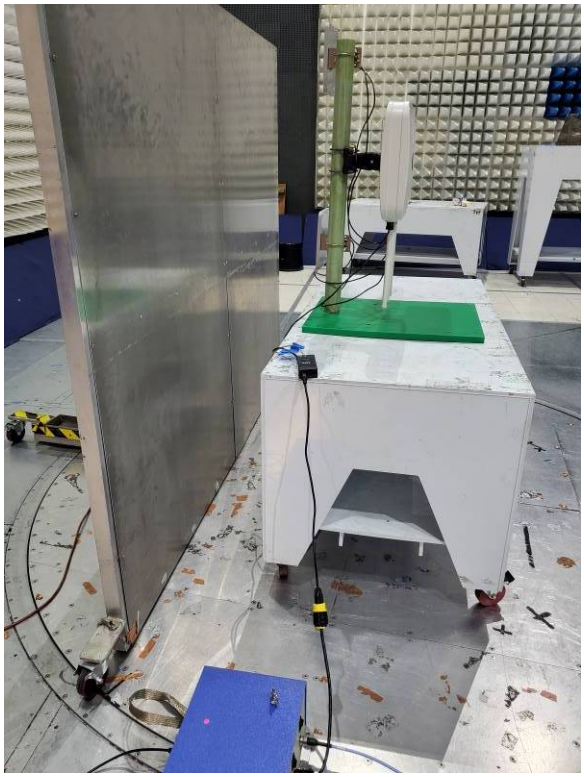
Frequency (MHz)	CISPR AVG (dBµV)	Limit Avg (dBµV)	Margin Avg (dB)	Line	Correction (dB)
0.150	45.6	56.0	-10.4	Phase 2	11.0
0.150	44.7	56.0	-11.4	Phase 1	11.0
0.164	45.6	55.3	-9.7	Phase 2	11.0
0.173	42.2	54.8	-12.7	Phase 2	11.0
0.191	42.2	54.0	-11.8	Phase 2	11.0
0.209	40.6	53.3	-12.7	Phase 2	11.0
0.434	36.1	47.2	-11.1	Phase 2	11.1
0.438	36.6	47.1	-10.6	Phase 1	11.1
0.501	29.2	46.0	-16.8	Phase 1	11.1

Results: **Complies** by 3.6 dB

4.4.4 Test Setup Photographs

The following photographs show the testing configurations used.





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
EMI Receiver	Rohde and Schwarz	FSW	ITS 01818	12	07/16/22
Loop Antenna	ETS	6512	ITS 01573	12	11/09/22
Active Horn Antenna	ETS-Lindgren	3117-PA	ITS 01365	12	04/20/22
Horn Antenna	ETS-Lindgren	3115	ITS 00982	12	05/13/22
Horn Antenna	ETS-Lindgren	3116c	ITS 01376	12	05/13/22
BI-Log Antenna	Teseq	CBL611D	ITS 01774	12	04/21/22
Pre-Amplifier	Sonoma Instrument	310N	ITS 00942	12	04/19/22
18-40GHz Preamp	uComp Nordic	MCNS-50-18004000335P	ITS 01799	12	03/19/22
LISN	FCC	LIN-120A	ITS 01400	12	12/14/22
RF Cable	TRU Corporation	TRU CORE 300	ITS 01462	12	09/14/22
RF Cable	TRU Corporation	TRU CORE 300	ITS 01465	12	09/14/22
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	09/14/22
RF Cable	TRU Corporation	TRU CORE 300	ITS 01342	12	09/14/22
RF Cable	Mega Phase	EMC1-K1K1-236	ITS 01781	12	02/19/22
RF Cable	Mega Phase	TM40-K1K1-19	ITS 01155	12	04/28/22
Band Reject Filter	MICRO-TRONICS	BRM50716	ITS 01798	12	02/26/22
10m Semi-anechoic chamber	Panashield	10m Chamber	ITS 00984	36	07/29/23

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
BAT-EMC	Nexio	3.20.0.23	Tekniam_ML.bpp
RS Commander	Rohde Schwarz	1.6.4	Not Applicable (Screen grabber)

6.0 Document History

Revision/ Job Number	Writer Initials	Reviewer Initials	Date	Change
1.0 / G104856862	ML	KV	February 21, 2022	Original document

END OF REPORT