TEST REPORT

Report Number: 103615308MPK-009A
Project Number: G103615308
October 30, 2018

Testing performed on the
Vocera V5000 Smartbadge
Model Number: V5000

FCC ID: QGZ V5000
IC: 4362A-V5000

to
FCC Part 15 Subpart E (15.407)
Industry Canada RSS-247, Issue 2

For

Vocera Communications

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

Prepared by: _____ **Date:** October 30, 2018
Anderson Soungpanya

Reviewed by: _____ **Date:** October 30, 2018
Krishna K Vemuri

Report No. 103615308MPK-009A	
Equipment Under Test:	Vocera V5000 Smartbadge
Trade Name:	Vocera Communications
Model Number:	V5000
Part Number:	220-02100
Applicant:	Vocera Communications
Contact:	Prakash Guda
Address:	Vocera Communications 525 Race St, Ste 150 San Jose, CA 95126
Country:	USA
Tel. Number:	(408) 882-5100
Email:	Pguda@vocera.com
Applicable Regulation:	FCC Part 15, Subpart E (15.407) Industry Canada RSS-247, Issue 2
Date of Test:	September 25 – October 29, 2018

We attest to the accuracy of this report:

Anderson Soungpanya
EMC Project Engineer

Krishna K Vemuri
Engineering Team Lead

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1.0 Introduction

1.1 Summary of Tests

Test	Reference FCC	Reference RSS-247	Result
26 dB Emission Band width and 99% Occupied Bandwidth	15.407(a)(1)(2)(3)	RSS-247, 6.2.1	Complies
Conducted Output Power	15.407(a)(1)(2)(3)	RSS-247, 6.2.1	Complies
Peak Power Spectral Density	15.407(a)(1)(2)(3)	RSS-247, 6.2.1	Complies
Undesirable Emissions	15.407(b)(1-8)	RSS-247, 6.2.1	Complies
Transmitter Radiated Emissions	15.407(b)(1-8) 15.209, 15.205	RSS-247, 6.2.1	Complies
AC Line Conducted Emission	15.207	RSS-GEN	Complies
Frequency stability	15.407(g)	RSS-Gen	Complies*
Antenna Requirement	15.203	RSS-Gen	Complies. The EUT uses internal antenna.

*Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

EUT receive date: September 17, 2018

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 25, 2018

Test completion date: October 29, 2018

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

2.0 General Description

2.1 Product Description

Vocera Communications supplied the following description of the EUT:

The V5000 Smartbadge is a wearable communication device powered by a removable, rechargeable Lithium Ion battery. The badge contains a 2.4" color, capacitive touch screen, with an array of microphones, a hands free speaker and an audio receiver.

The information about the 5GHz radio, installed in the model V5000, is presented below.

Radio Information	
Applicant	Vocera Communications
Model Number	V5000
FCC Identifier	QGZ V5000
IC Identifier	4362A-V5000
Modulation Technique	OFDM
Rated RF Output	16.16 dBm for 5180~5240 MHz
Frequency Range	U-NII 1: 5150 – 5250 MHz
Type of modulation	OFDM
Number of Channel(s)	4 for 802.11a/n 20 MHz 2 for 802.11n 40MHz 1 for 802.11ac 80MHz
Antenna(s) & Gain	Internal Antenna, Gain: +3.1 dBi
Applicant Name & Address	Vocera Communications 525 Race St, Ste 150 San Jose, CA 95126 USA

The EUT supports the following configurations:

Channels in 5150 – 5250 MHz band							
Number	**Frequency, MHz**	**802.11a/n 20MHz Channels**		**802.11n 40MHz Channels**		**802.11ac 80MHz Channels**	
36	5180	√	X				
38	5190			√	X		
40	5200	√	X				
42	5210					√	X
44	5220	√					
46	5230			√	X		
48	5240	√	X				

List of channels:
√ - available
X - tested

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

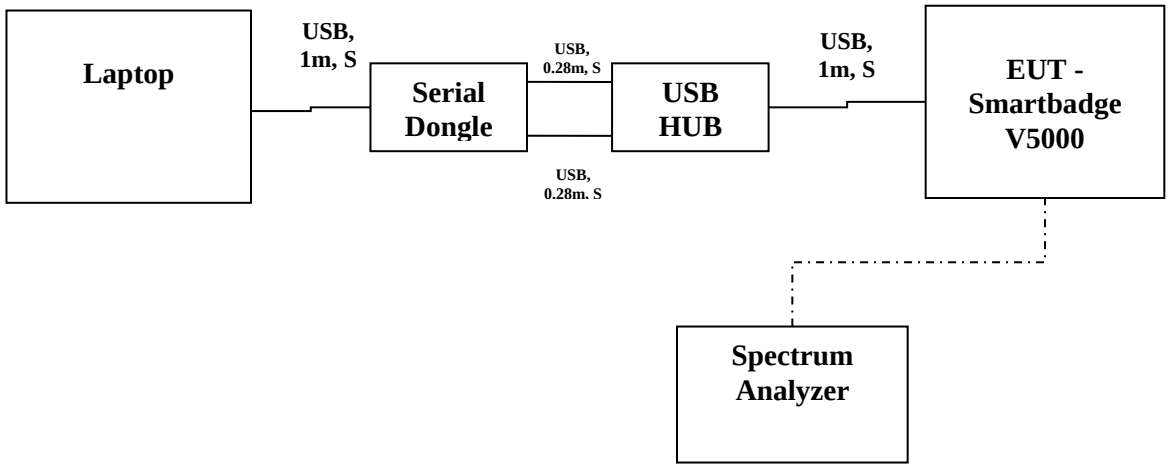
3.1 Support Equipment

Support Equipment		
Description	**Manufacturer**	**Model No./ Part No.**
Laptop	Lenovo	T440P
USB Hub	Tendak	CP-029-BK
Serial Dongle	Vocera	210-01516-B04

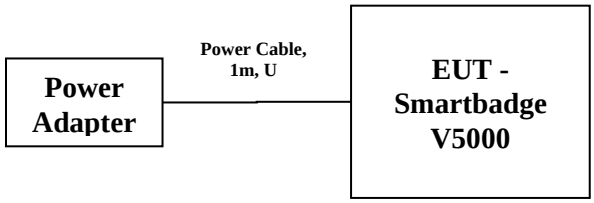
3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	**Manufacturer**	**Model Number**	**Serial Number**
Smartbadge – Conducted Unit	Vocera	V5000	SA3308HF5002D6
Smartbadge – Radiated Unit	Vocera	V5000	SA3308HR50031E
Power Adapter	Asian Power Devices Inc.	WB-10E05R	S8827999000015
Earphone	Kingstate Electronics Corp.	KJFGKS172JJB-01	Not listed

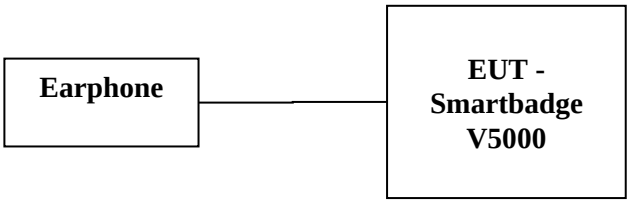
Antenna was removed and co-axial connector was installed for Conducted Measurements.



Radiated Measurements
Charging Mode



Radiated Measurements
Normal Mode



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

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, 6MB/s – for 802.11a
OFDM, MCS0 – for 802.11n 20MHz
OFDM, MCS0 – for 802.11n 40MHz
OFDM, MCS0 – for 802.11ac 80MHz

Different orientation of the EUT were tested and only the worse-case emissions were reported.

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

The EUT was tested in 2 configurations:
A/ Charging mode: tested with power adapter
B/ Normal mode: tested in battery mode and earphone.

Unless otherwise stated in this report, measurements made for, Radiated Spurious were made with the worst-case power setting (mid channel power).

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.

Mode	Channel	Frequency MHz	RF Setting
802.11a	36	5180	13
	40	5200	15
	48	5240	16
802.11n 20MHz	36	5180	14
	40	5200	15
	48	5240	16
802.11n 40MHz	38	5190	11
	46	5230	16
802.11ac 80MHz	42	5210	8

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

4.1 Emission Bandwidth and 99% Occupied Bandwidth

15.407(a)(1)(2)(e)

4.1.1 Requirement

Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500kHz.

4.1.2 Procedure

The Procedure, described in the FCC Publication 789033 D02 General U-NII Test Procedures New Rules v02r01, was used. Specifically, Section C.1 for Emission Bandwidth and Minimum Emission Bandwidth for measuring the Emission Bandwidth (EBW). Section C.2 was utilized for measuring the 6dB Bandwidth in the band 5.725-5.850 GHz. Section D was used for 99% Occupied Bandwidth.

The antenna port of the EUT was connected to the input of a spectrum analyzer (SA). For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier.

The Occupied bandwidth was measured using the build-in spectrum analyzer facility for 99% power bandwidth measurement.

Tested By	Test Date
Anderson Soungpanya	September 25 & 26, 2018

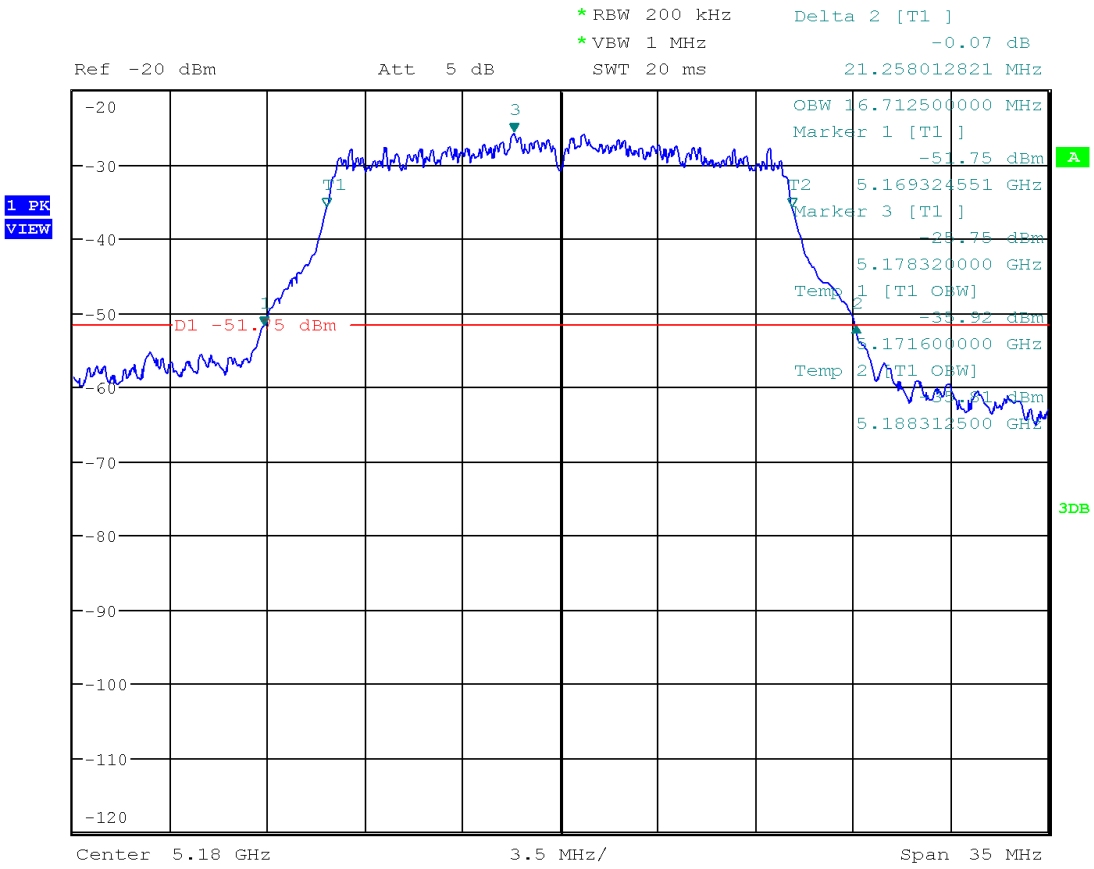
4.1.3 Test Result

Refer to the following plots for the test result:

Mode	Channel	Frequency MHz	26-dB Bandwidth, MHz	Occupied Bandwidth, MHz	Plot #
802.11a	36	5180	21.258	16.713	1.1
	40	5200	21.317	16.730	1.2
	48	5240	21.370	16.730	1.3
802.11n 20MHz	36	5180	21.651	17.868	1.4
	40	5200	21.597	17.955	1.5
	48	5240	21.482	17.868	1.6
802.11n 40MHz	38	5190	40.272	36.260	1.7
	46	5230	40.058	36.295	1.8
802.11ac 80MHz	42	5210	82.340	75.600	1.9

Plot 1. 1

802.11a 5180MHz



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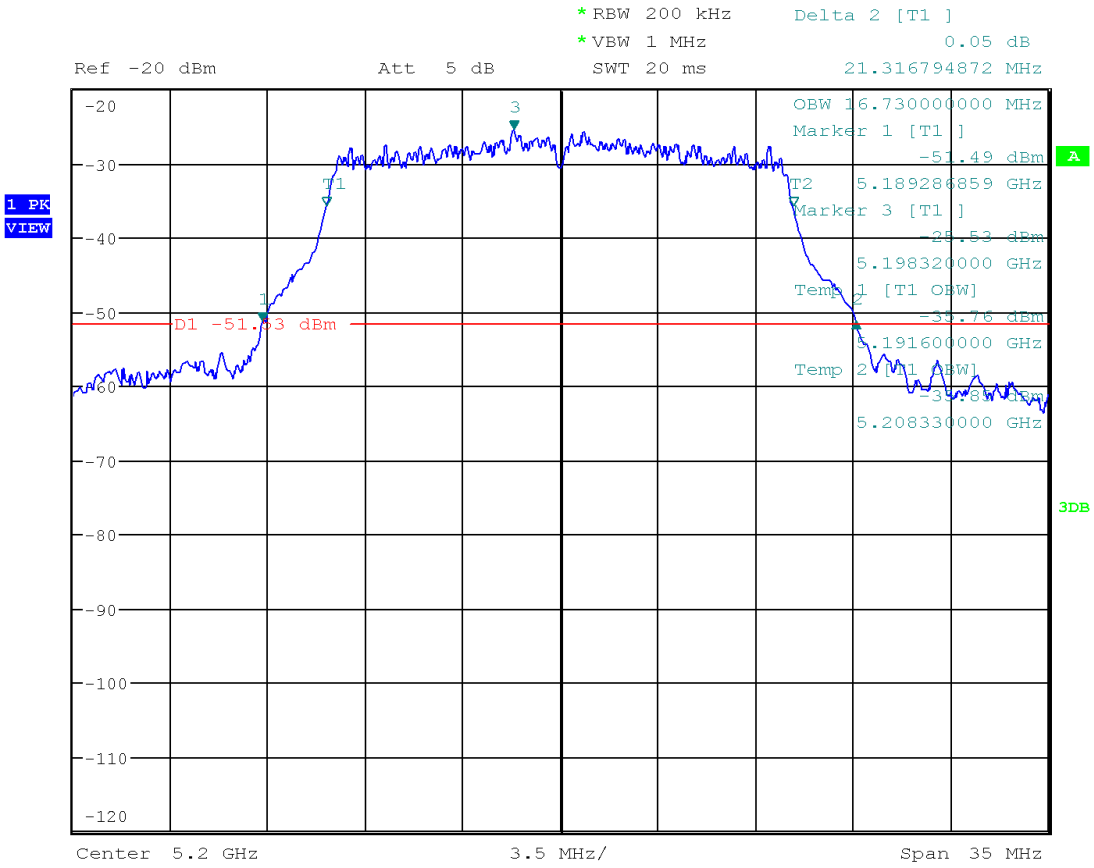
Plot 1. 2

802.11a 5200MHz



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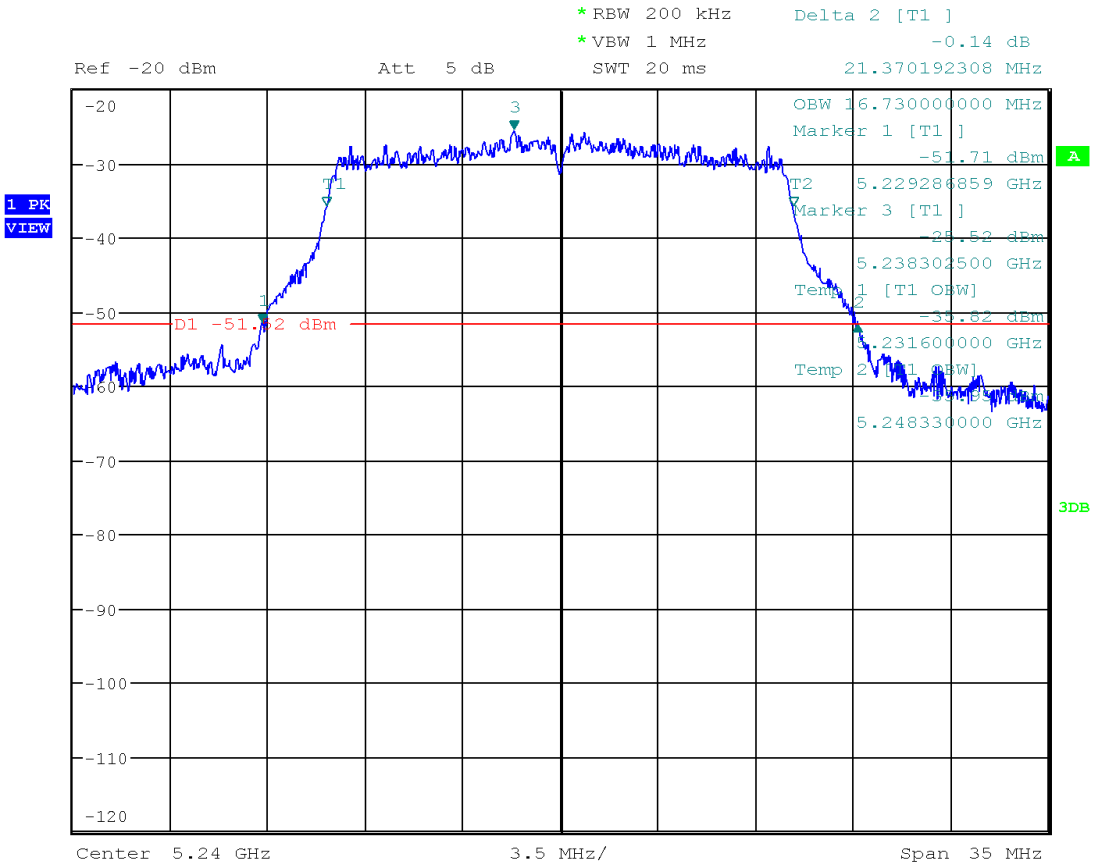
Plot 1. 3

802.11a 5240MHz



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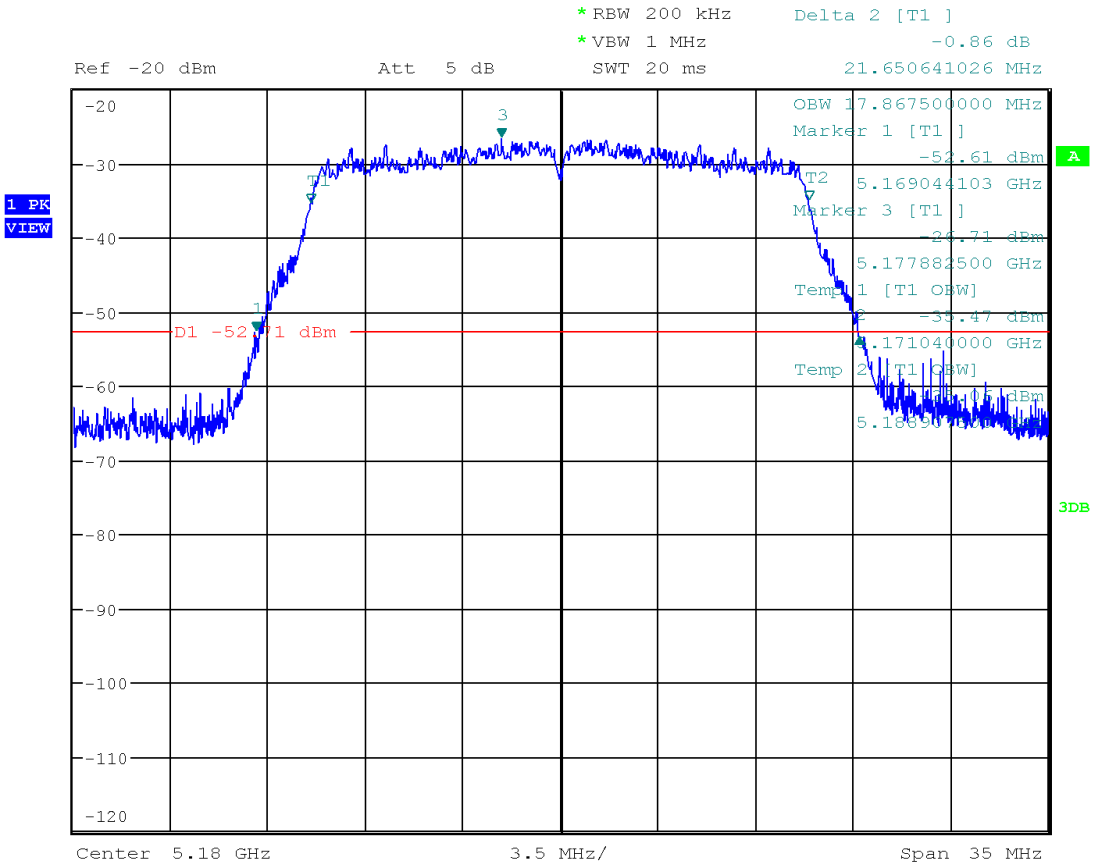
Plot 1. 4

802.11n 20MHz, 5180MHz



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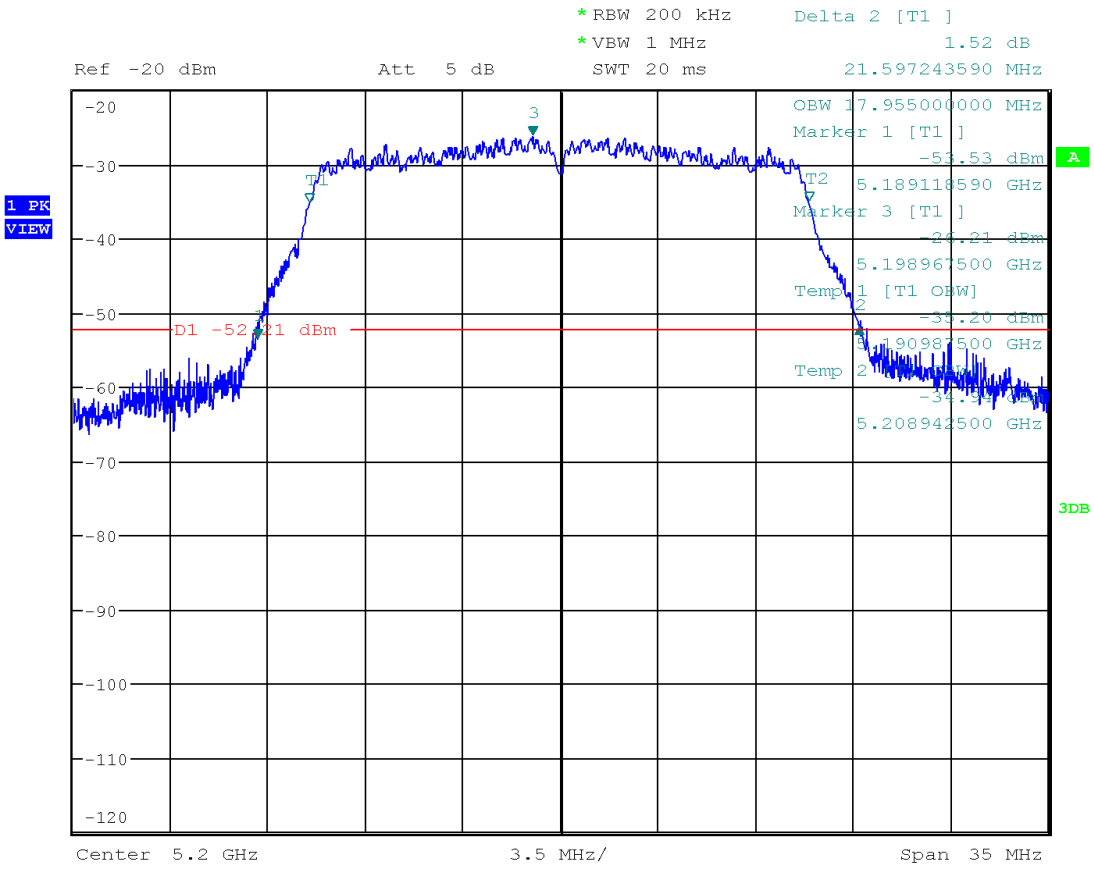
Plot 1. 5

802.11n 20MHz, 5200MHz



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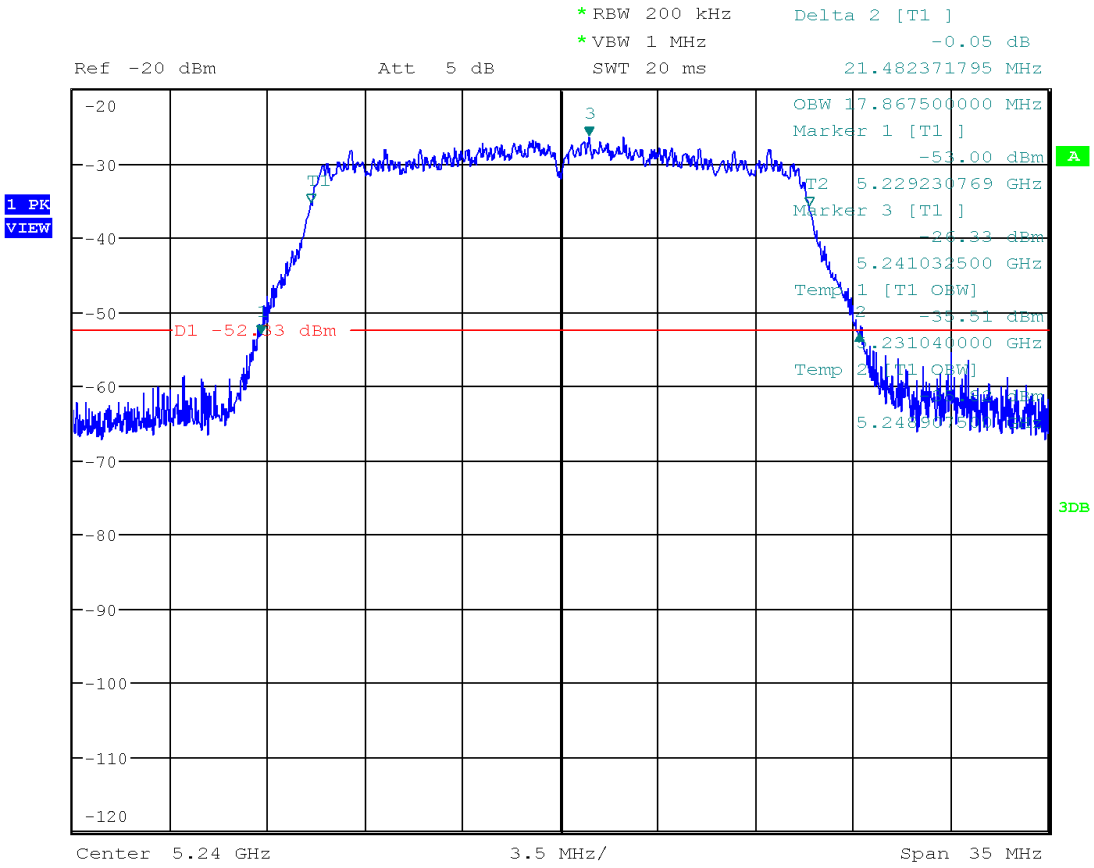
Plot 1. 6

802.11n 20MHz, 5240MHz



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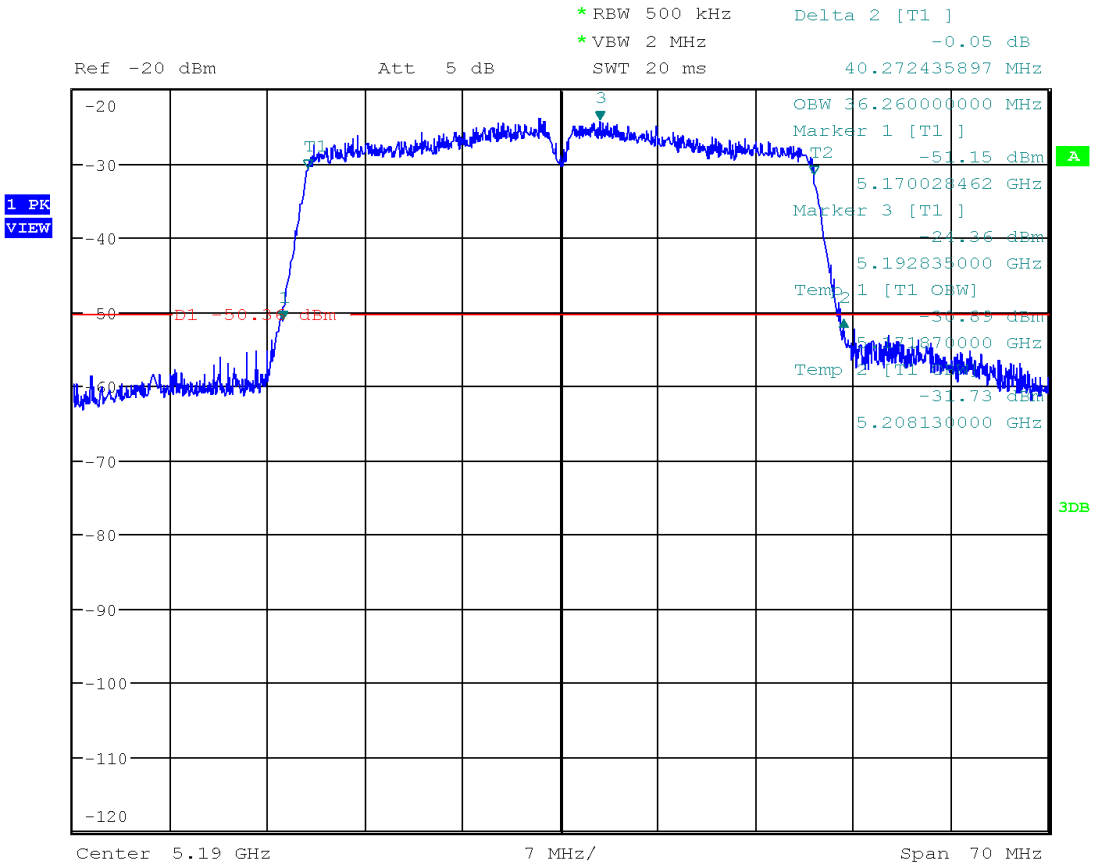
Plot 1. 7

802.11n 40MHz, 5190MHz



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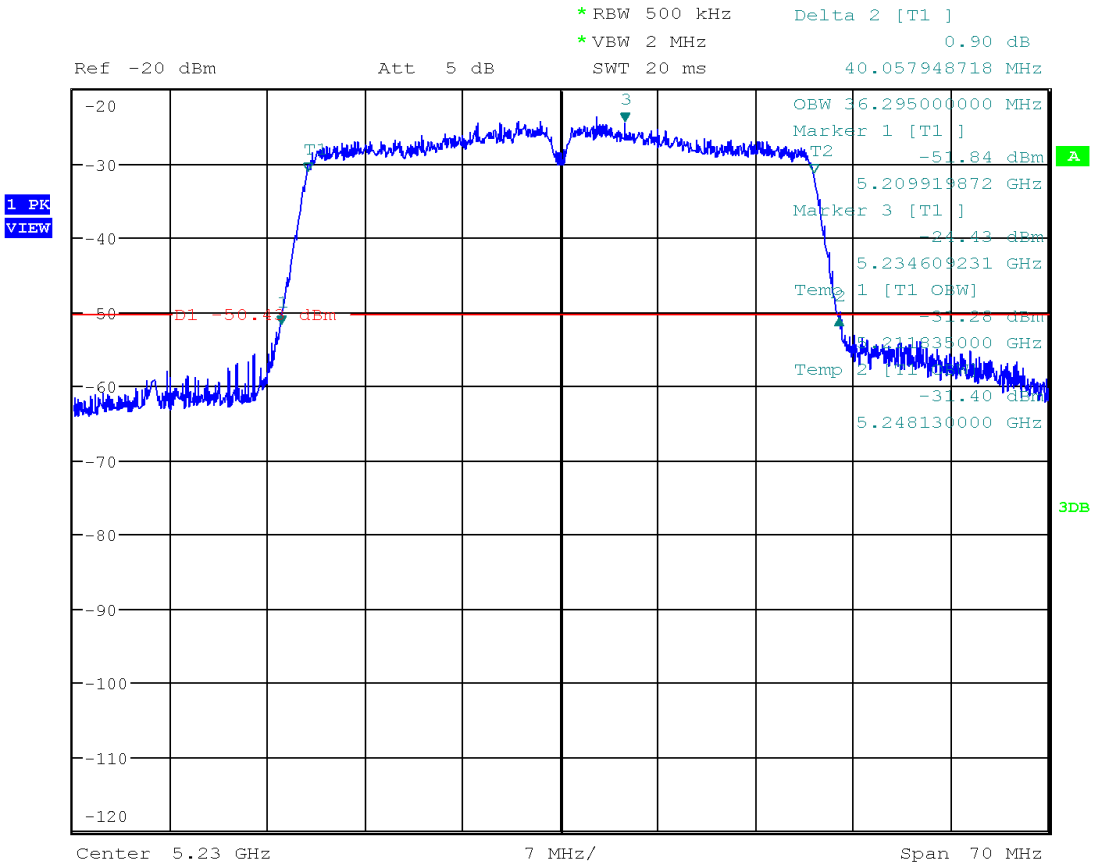
Plot 1. 8

802.11n 40MHz, 5230MHz



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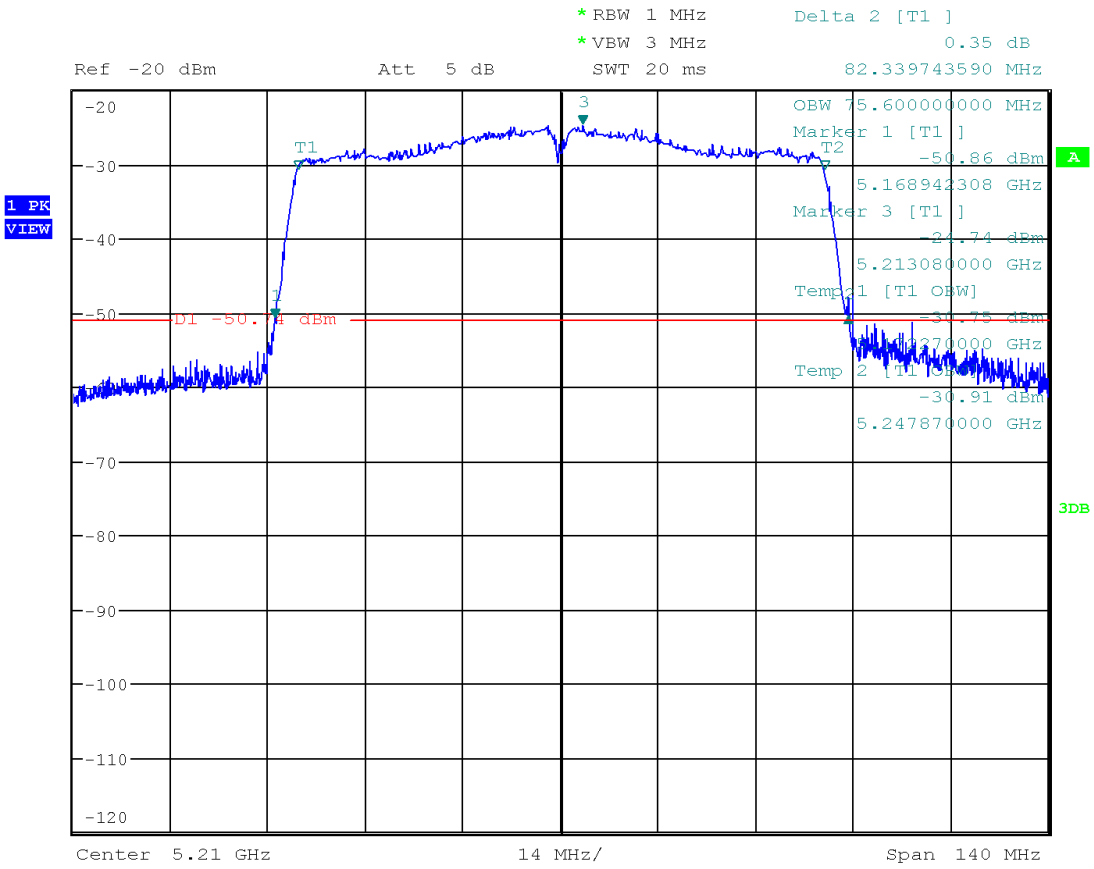
Plot 1. 9

802.11ac 80MHz, 5210MHz



Date: 26.SEP.2018 10:52:30

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

4.2.1 Requirement

For mobile and portable 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.

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) (c) Method SA-1 for Maximum Conducted Output Power

The Procedure, described in the FCC Publication 789033 D02 General U-NII Test Procedures New Rules v02r01, was used. Specifically, procedure from Section F was utilized for Maximum Power Spectral Density (PSD).

Each antenna port of the EUT was connected to the input of a spectrum analyzer to measure the Maximum Conducted Transmitter Output Power & Peak Power Spectral Density (PPSD).

Tested By	Test Date
Anderson Soungpanya	October 3 & 4, 2018

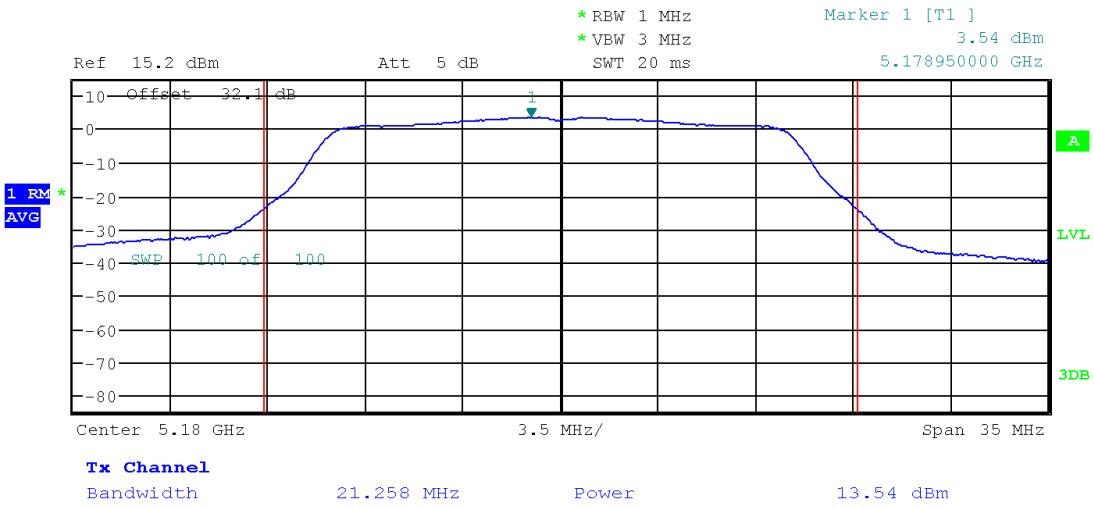
4.2.3 Test Results

Refer to the following plots for the test result:

Mode	Channel	Frequency MHz	Conducted power (average) dBm	Conducted power Limit dBm	PSD (Peak) dBm	PSD Limit dBm	Plot #
802.11a	36	5180	13.54	24	3.54	11	2.1
	40	5200	15.28	24	5.25	11	2.2
	48	5240	16.16	24	6.12	11	2.3
802.11n 20MHz	36	5180	14.08	24	3.80	11	2.4
	40	5200	15.06	24	4.82	11	2.5
	48	5240	15.55	24	5.51	11	2.6
802.11n 40MHz	38	5190	11.31	24	-1.71	11	2.7
	46	5230	15.70	24	2.67	11	2.8
802.11ac 80MHz	42	5210	8.09	24	-7.55	11	2.9

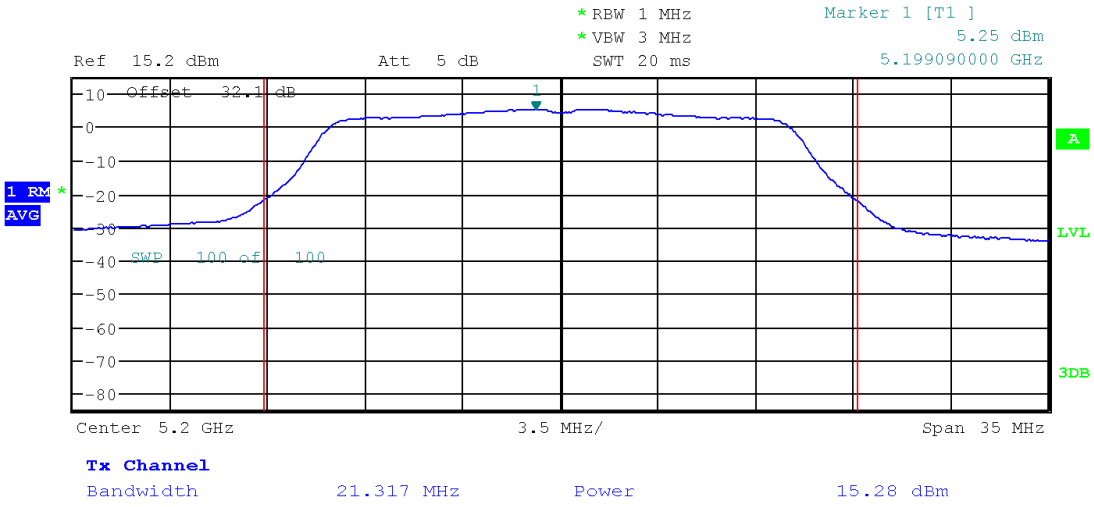
Plot 2. 1

802.11a, 5180MHz



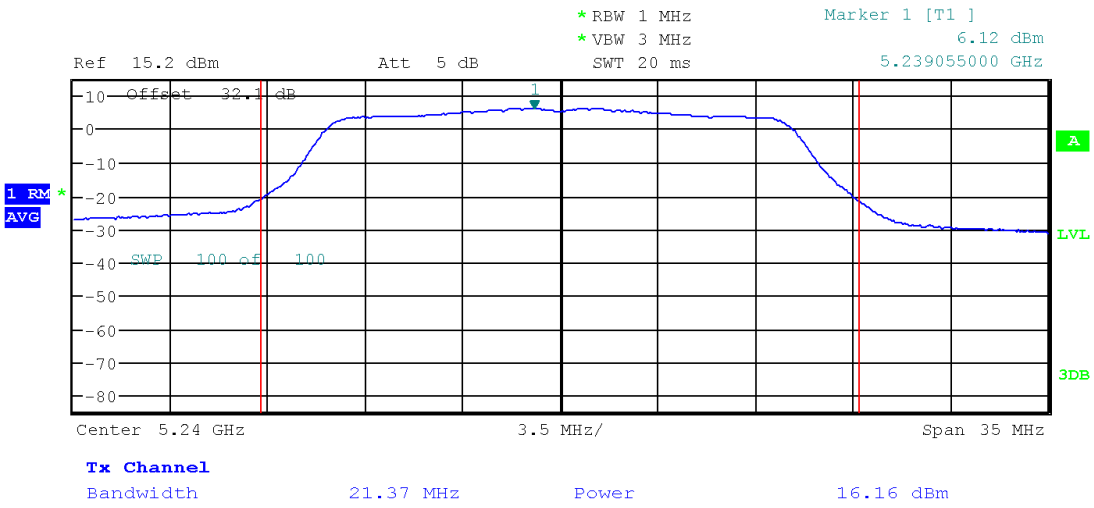
Plot 2. 2

802.11a, 5200MHz



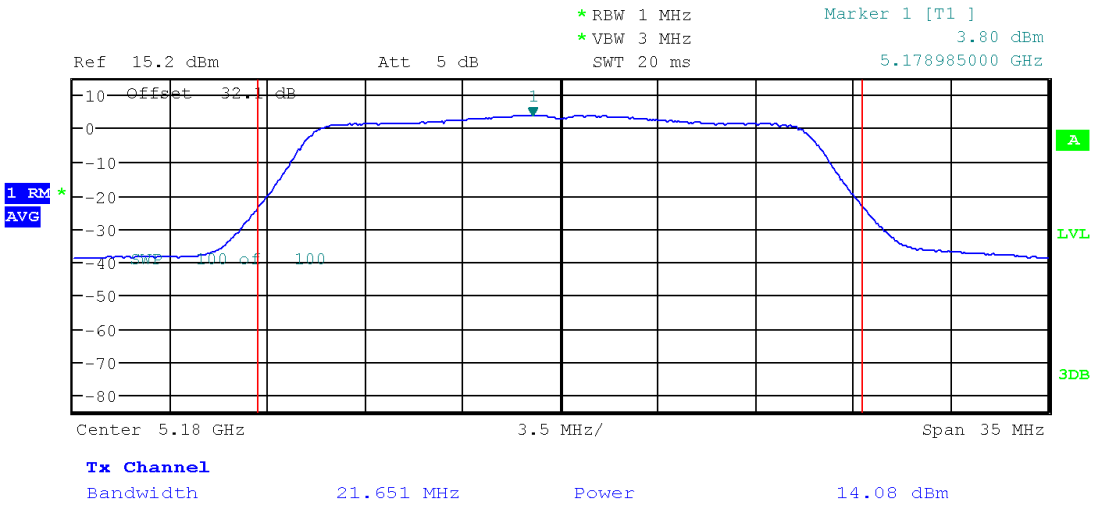
Plot 2. 3

802.11a, 5240MHz



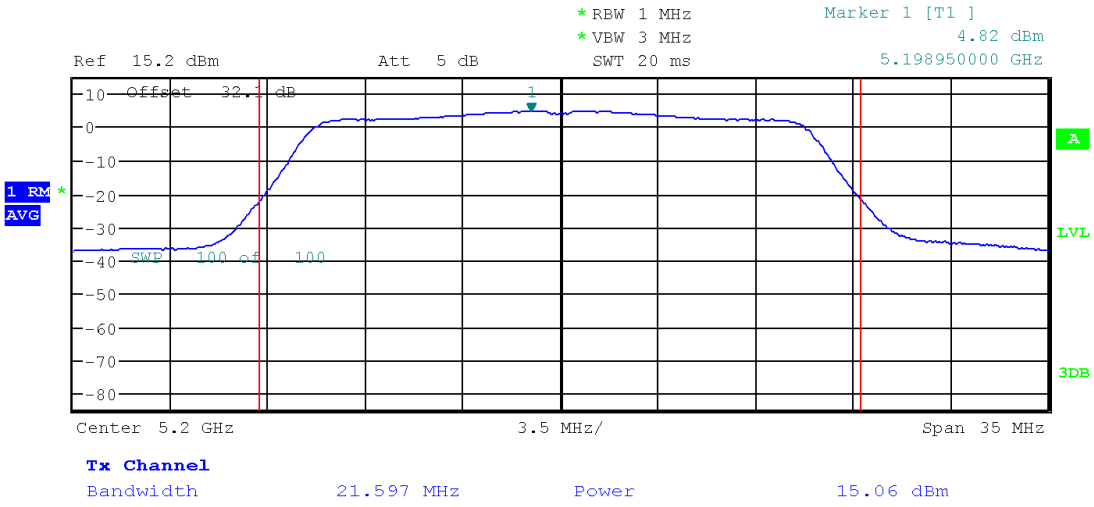
Plot 2. 4

802.11n 20MHz, 5180MHz



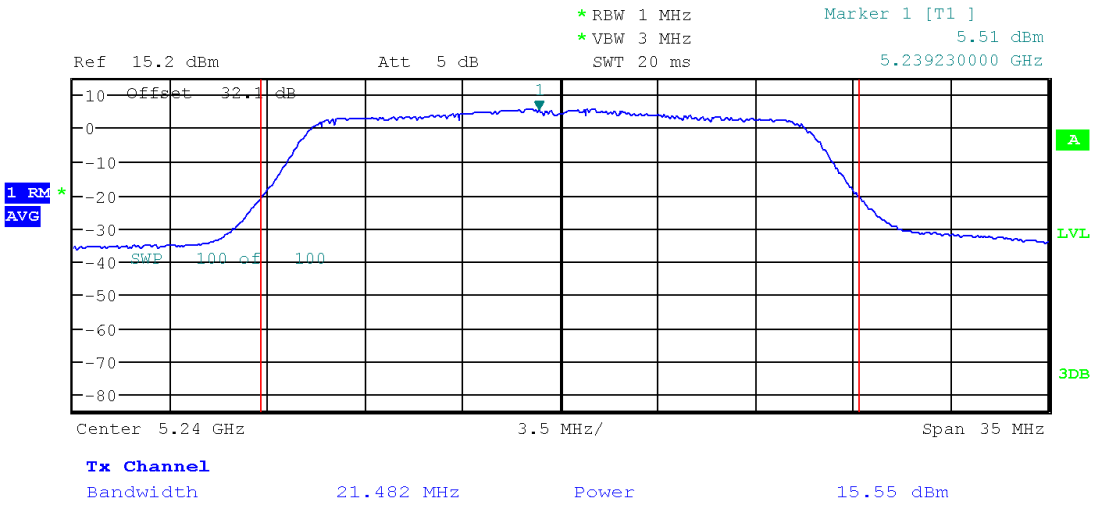
Plot 2. 5

802.11n 20MHz, 5200MHz



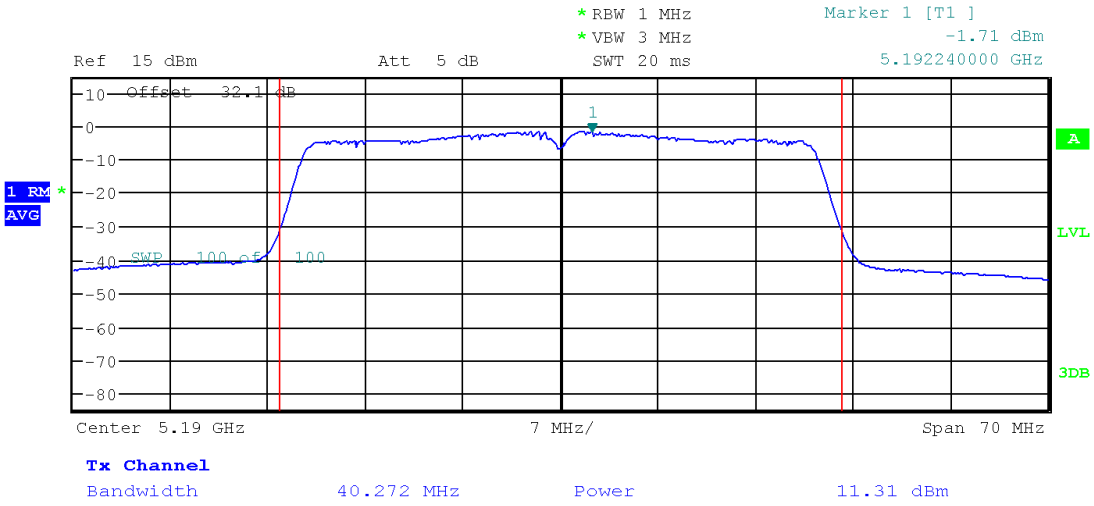
Plot 2. 6

802.11n 20MHz, 5240MHz



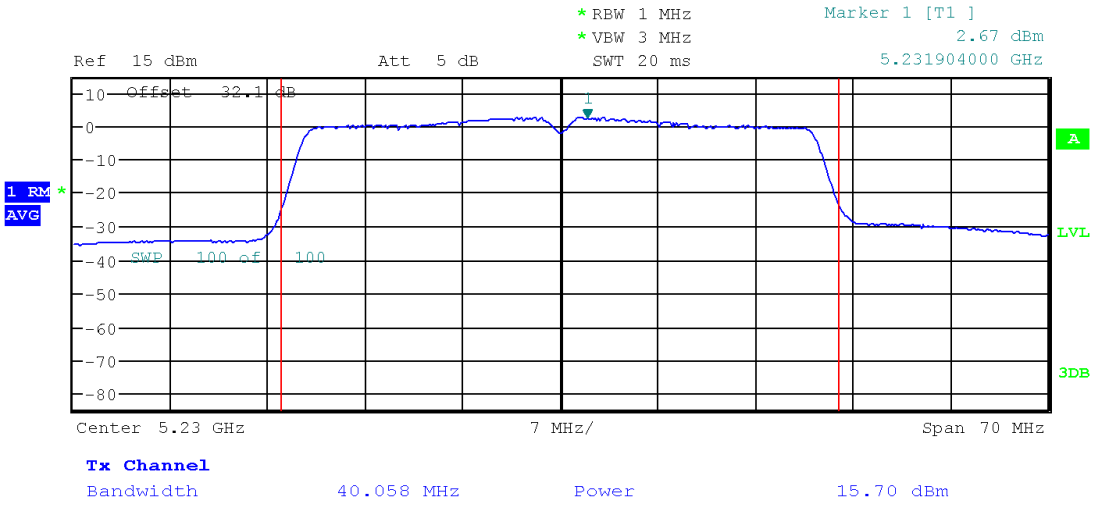
Plot 2. 7

802.11n 40MHz, 5190MHz



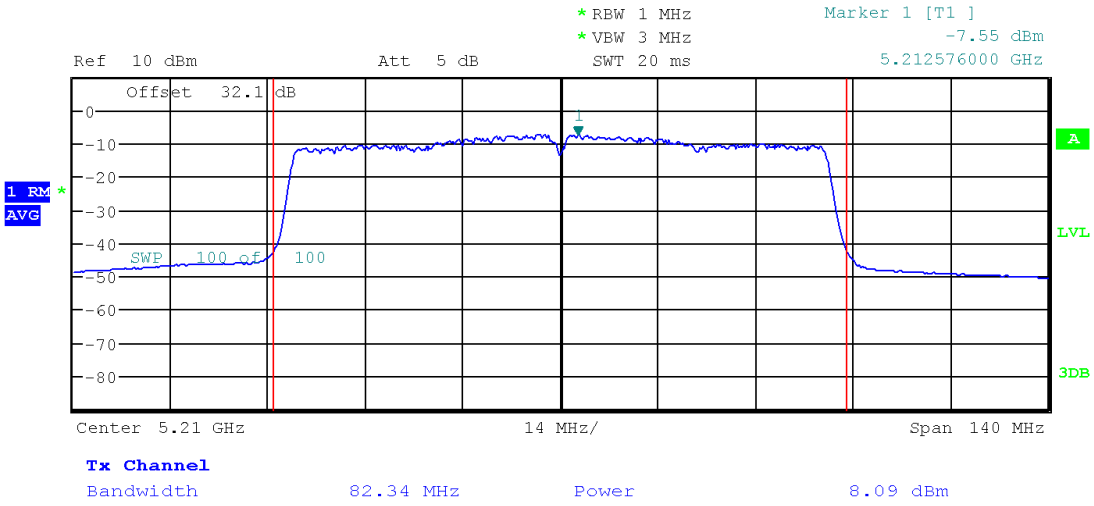
Plot 2. 8

802.11n 40MHz, 5230MHz



Plot 2. 9

802.11ac 80MHz, 5210MHz



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.

Note: An out-of-band emission that complies with both the average and peak limits of Section 15.209 is not required to satisfy the -27 dBm/MHz peak emission limit.

4.3.2 Procedure

Radiated emission measurements were performed from 30 MHz to 40 GHz according to the procedure described in ANSI C64.10. Spectrum Analyzer Resolution Bandwidth is 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 30 MHz to 40 GHz were measured with 50 ohm terminator on the output of the EUT RF port. A preamp was used from 30MHz to 40GHz.

All measurements were made with a Peak Detector and compared to QP limits for 30MHz – 1GHz and Average & Peak limits for 1GHz – 40 GHz.

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

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:
$E = EIRP - 20\log D + 104.8$
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.

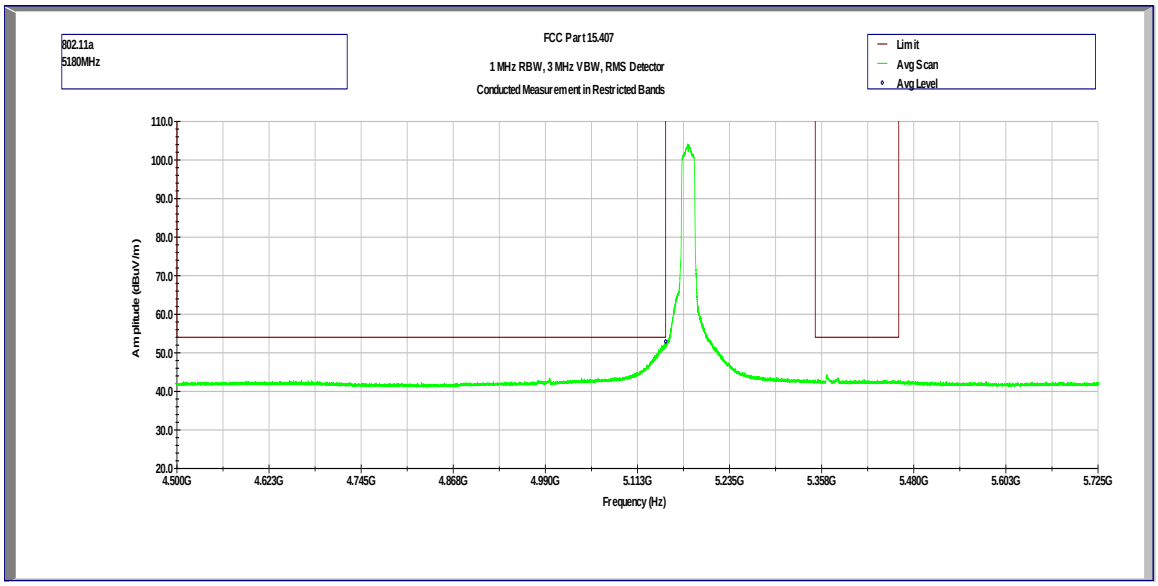
All conducted antenna port plots are corrected with the consideration of a 3.1 dBi Antenna Gain.

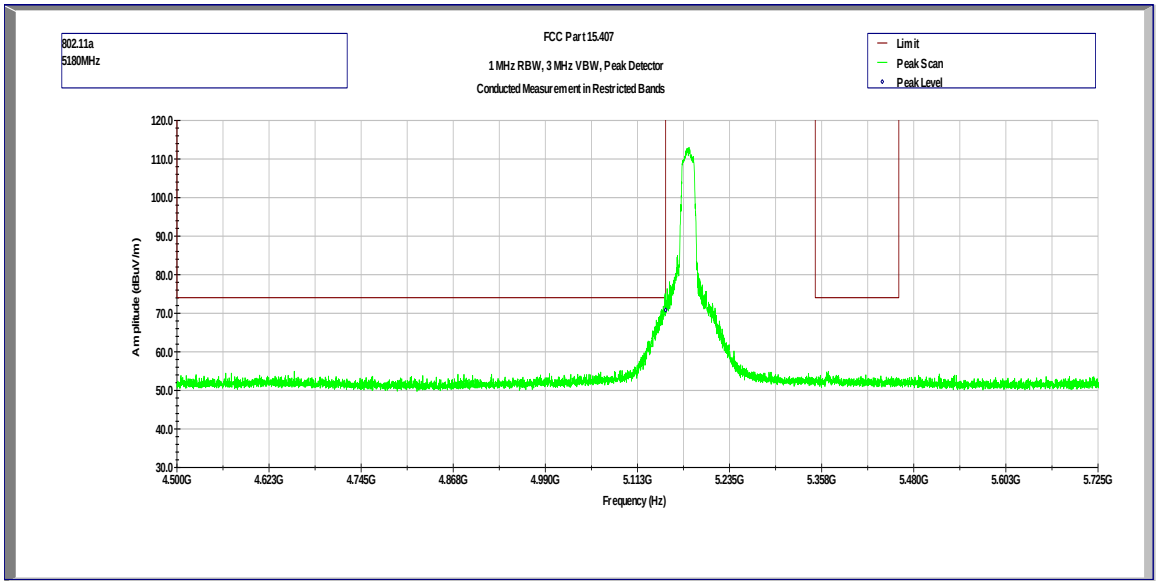
Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz.

Tested By	Test Date
Anderson Soungpanya	September 27 -October 11, 2018

Test Results: 15.209/15.205 Restricted Band Emissions at Antenna Port

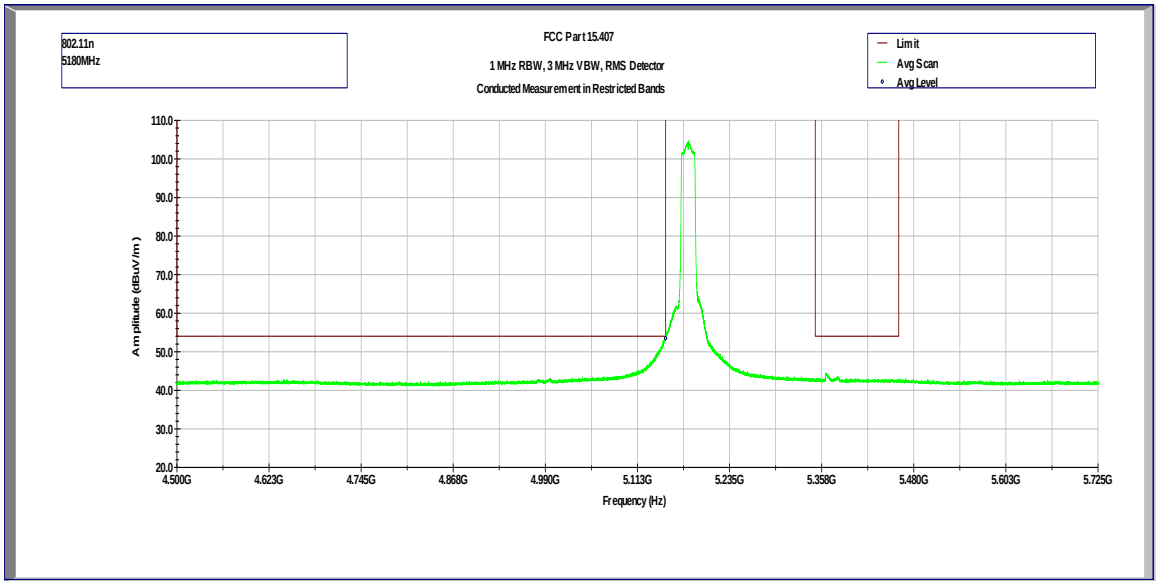
Out-of-Band Spurious Emissions at the Band Edge - 802.11a, 5180 MHz

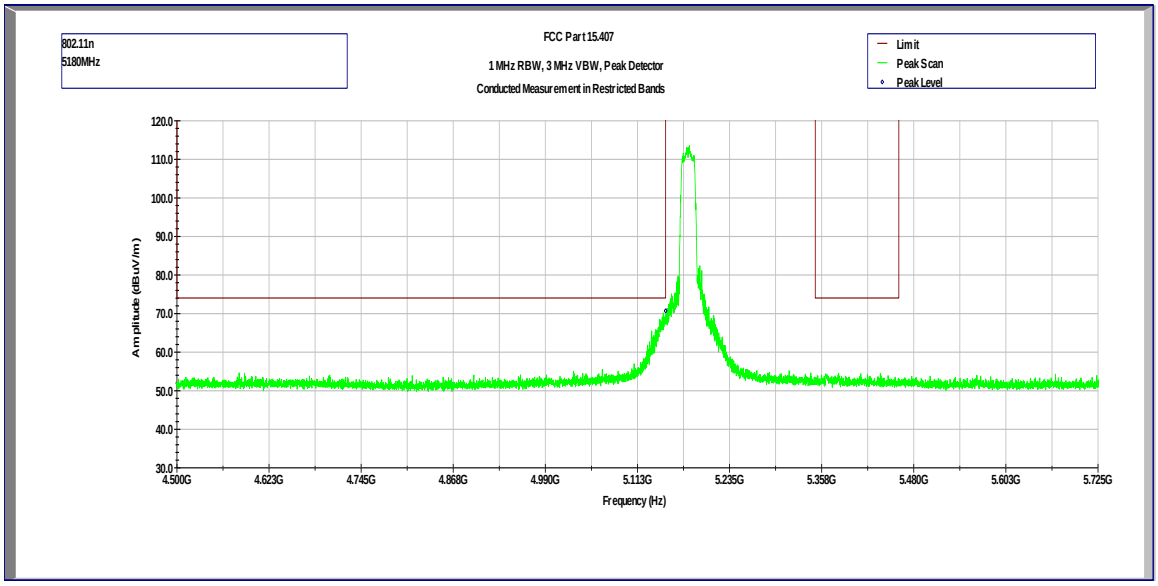




Frequency (MHz)	Detector	Amplitude dB(µV/m)	Limit dB(µV/m)	Margin (dB)	Pass / Fail?
5150	Average	52.90	54	-2.10	Pass
5150	Peak	70.80	74	-3.20	Pass

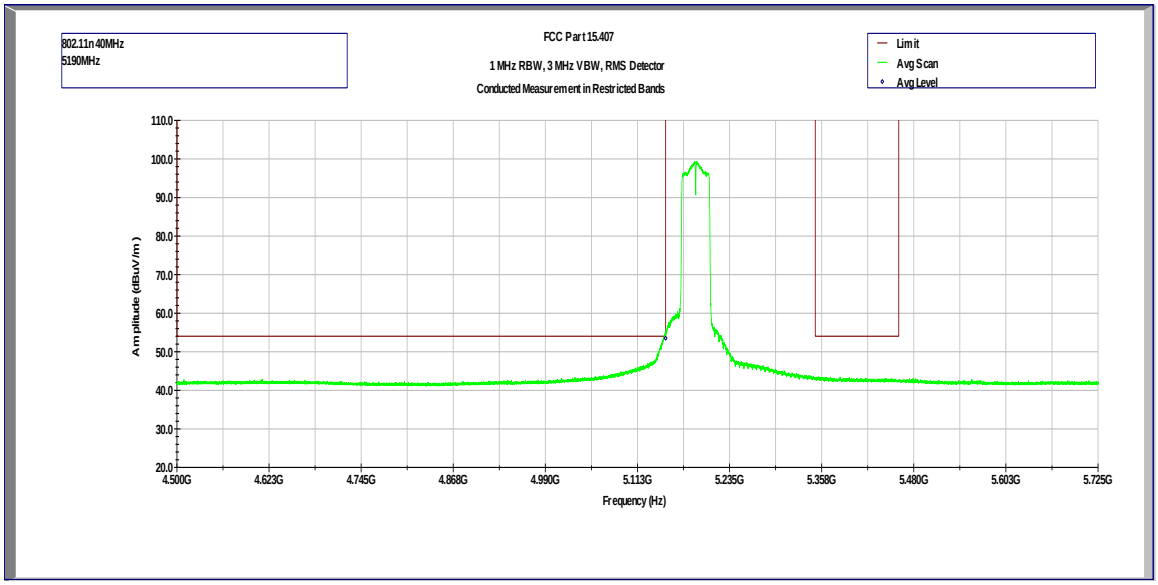
Out-of-Band Spurious Emissions at the Band Edge - 802.11 n 20MHz, 5180 MHz

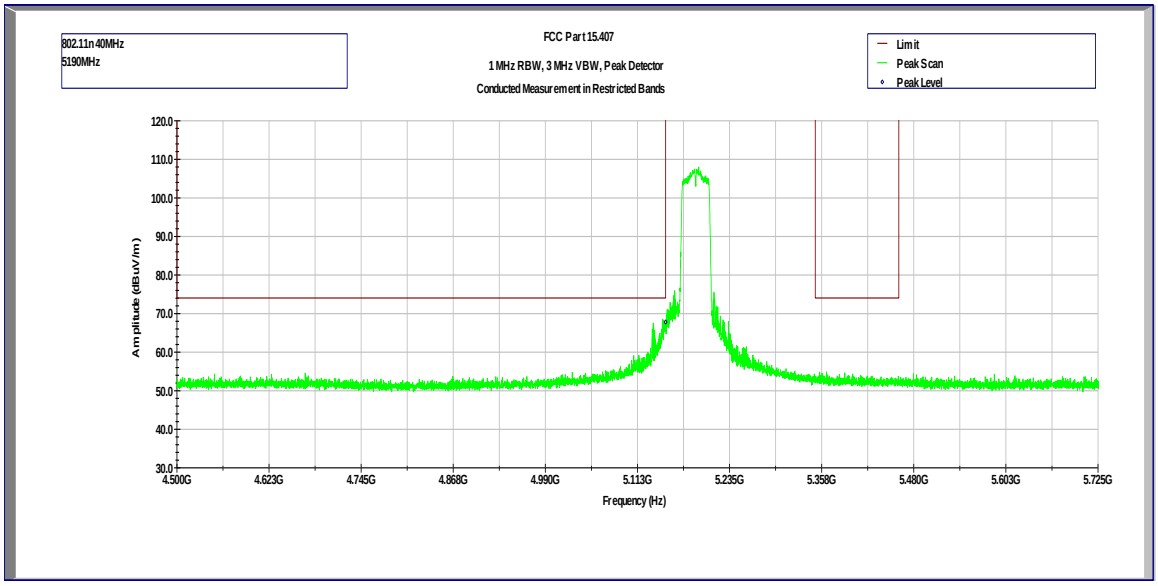




Frequency (MHz)	Detector	Amplitude dB(µV/m)	Limit dB(µV/m)	Margin (dB)	Pass / Fail?
5150	Average	53.50	54	-0.50	Pass
5150	Peak	70.70	74	-3.30	Pass

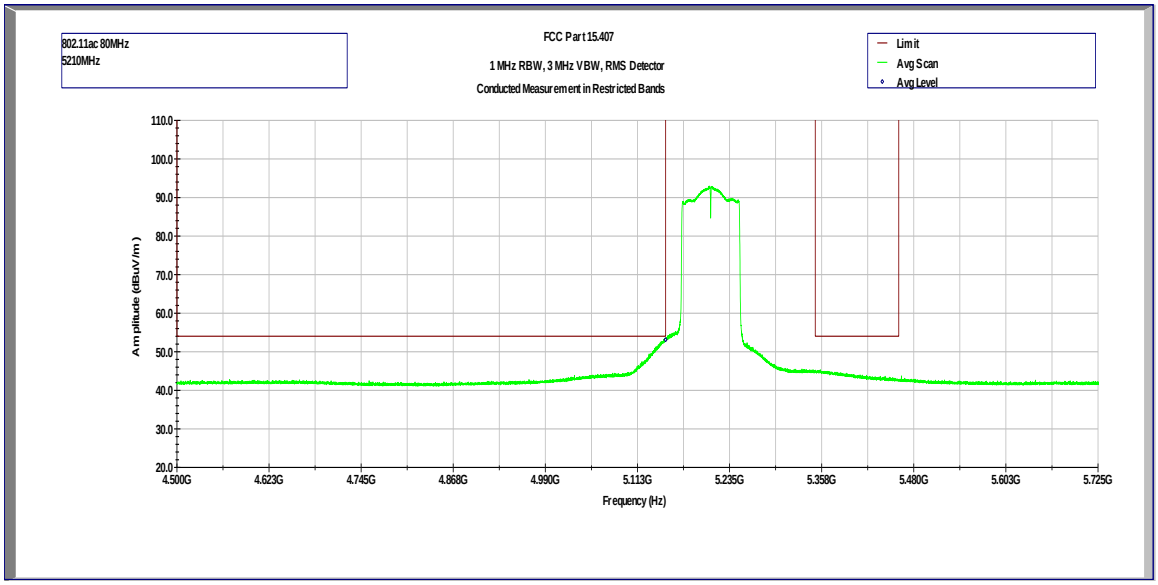
Out-of-Band Spurious Emissions at the Band Edge - 802.11n 40MHz, 5190 MHz

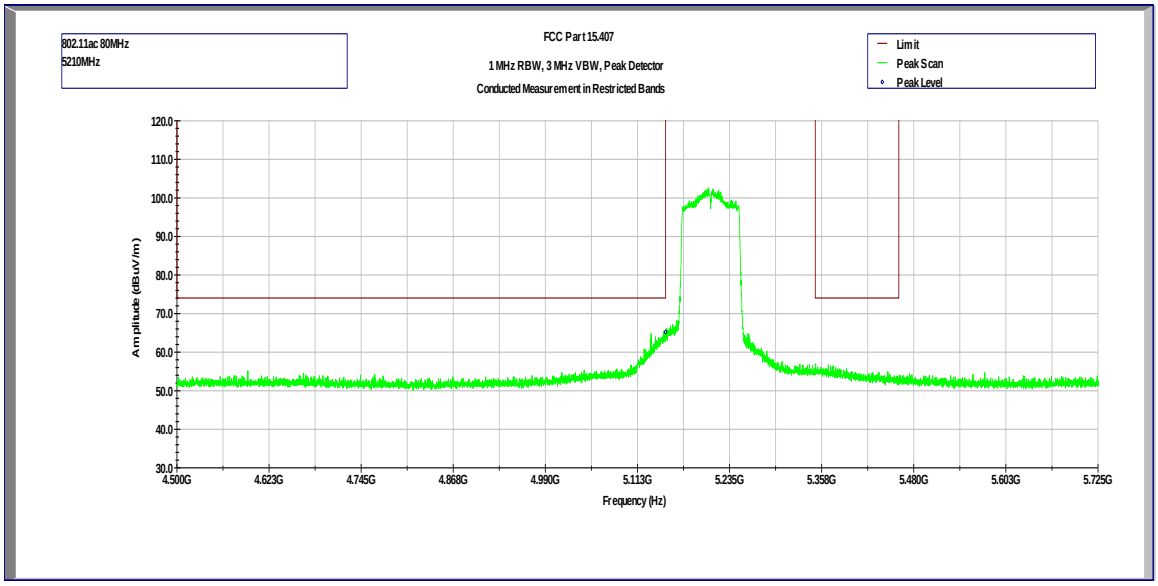




Frequency (MHz)	Detector	Amplitude dB(µV/m)	Limit dB(µV/m)	Margin (dB)	Pass / Fail?
5150	Average	53.50	54	-0.50	Pass
5150	Peak	67.80	74	-6.20	Pass

Out-of-Band Spurious Emissions at the Band Edge - 802.11ac 80MHz, 5210 MHz



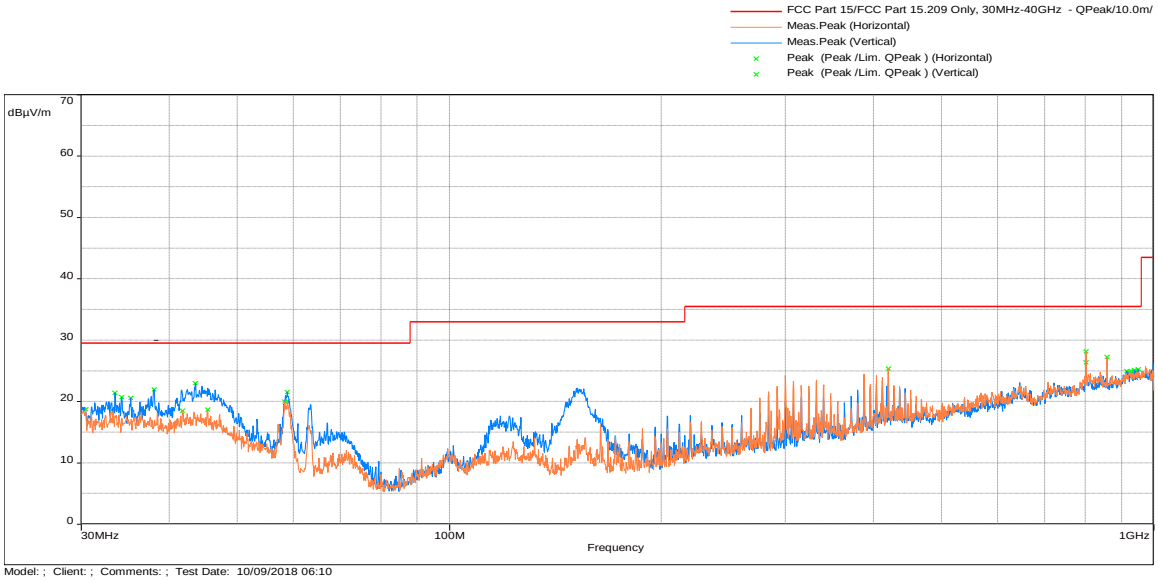


Frequency (MHz)	Detector	Amplitude dB(µV/m)	Limit dB(µV/m)	Margin (dB)	Pass / Fail?
5150	Average	53.10	54	-0.90	Pass
5150	Peak	65.20	74	-8.80	Pass

Out-of-Band Radiated Spurious Emissions (Charge Mode)

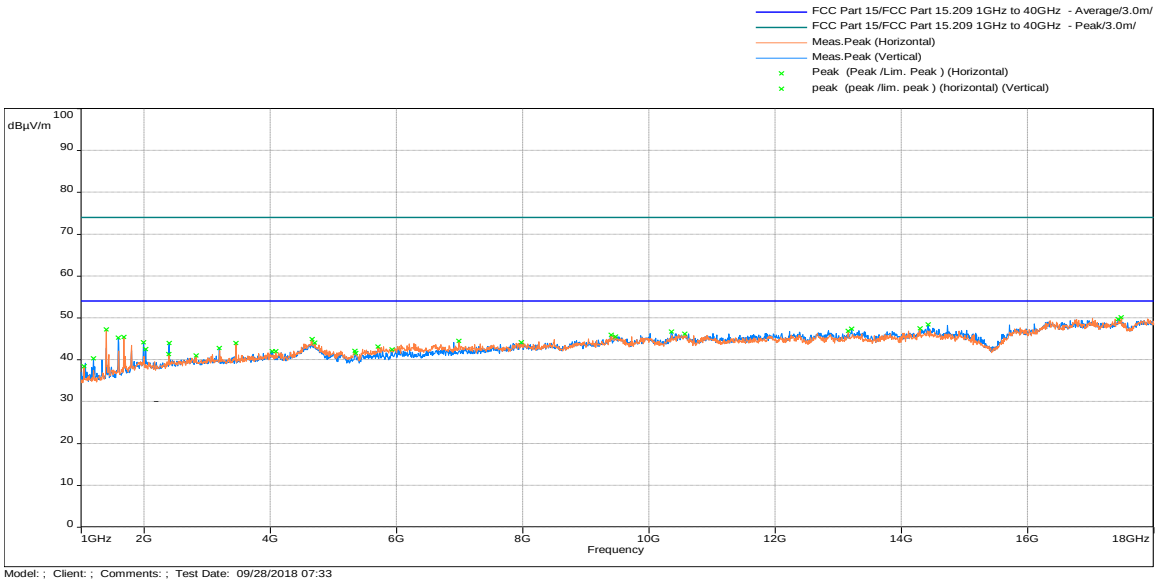
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11a 5180MHz

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



Model: ; Client: ; Comments: ; Test Date: 10/09/2018 06:10

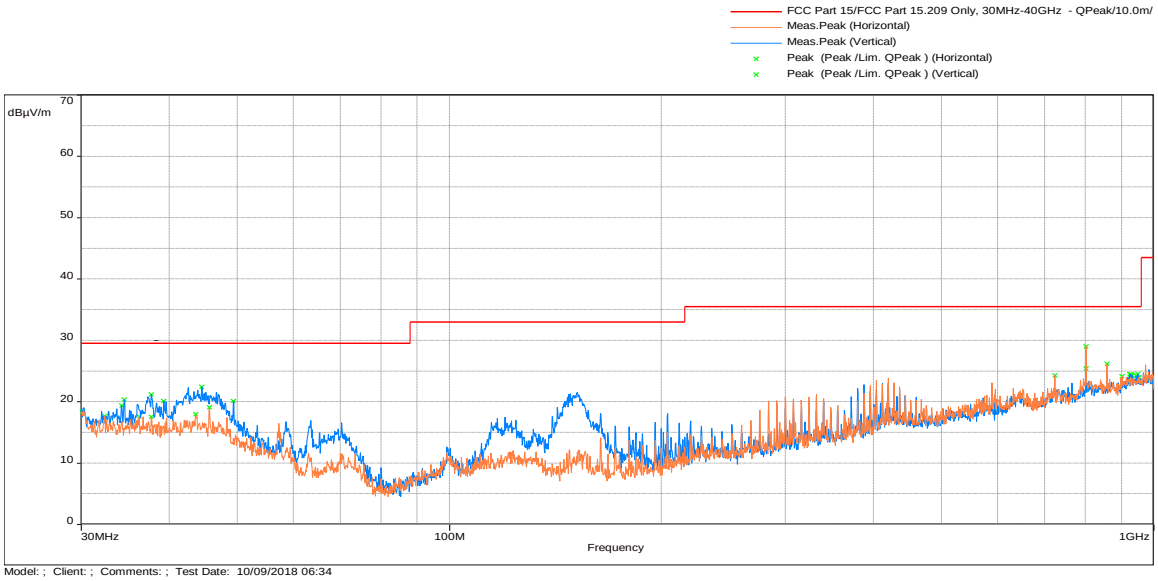
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



Model: ; Client: ; Comments: ; Test Date: 09/28/2018 07:33

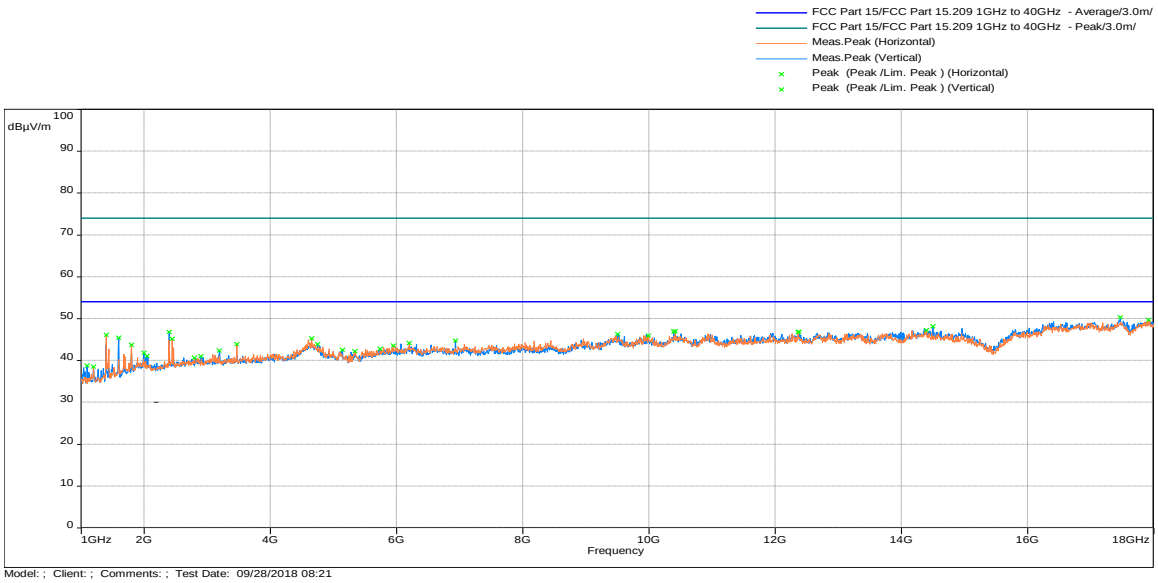
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11a 5200MHz

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



Model: ; Client: ; Comments: ; Test Date: 10/09/2018 06:34

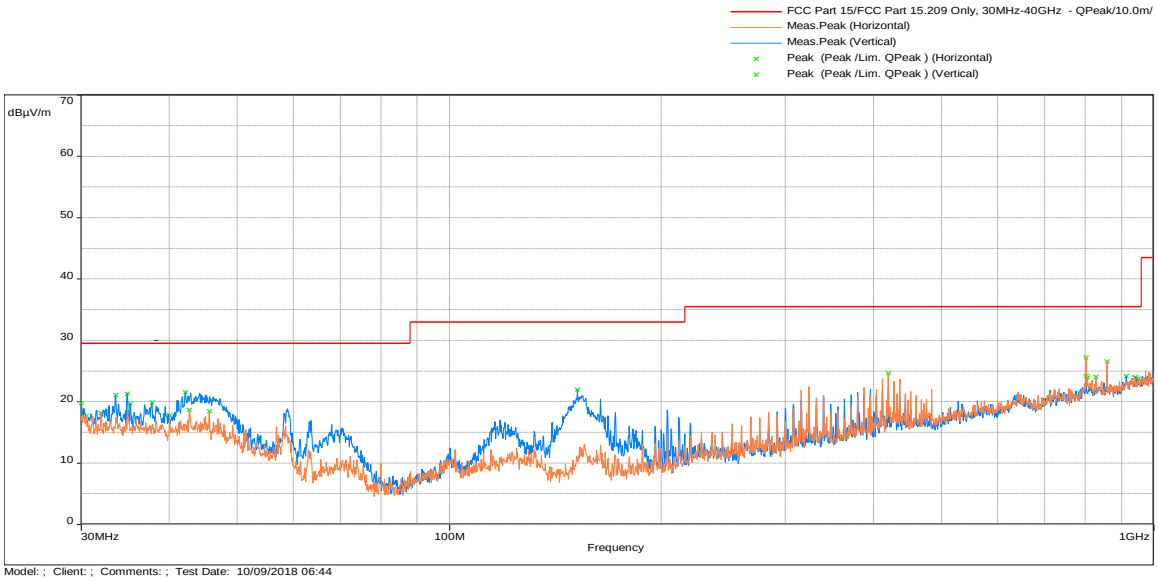
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



Model: ; Client: ; Comments: ; Test Date: 09/28/2018 08:21

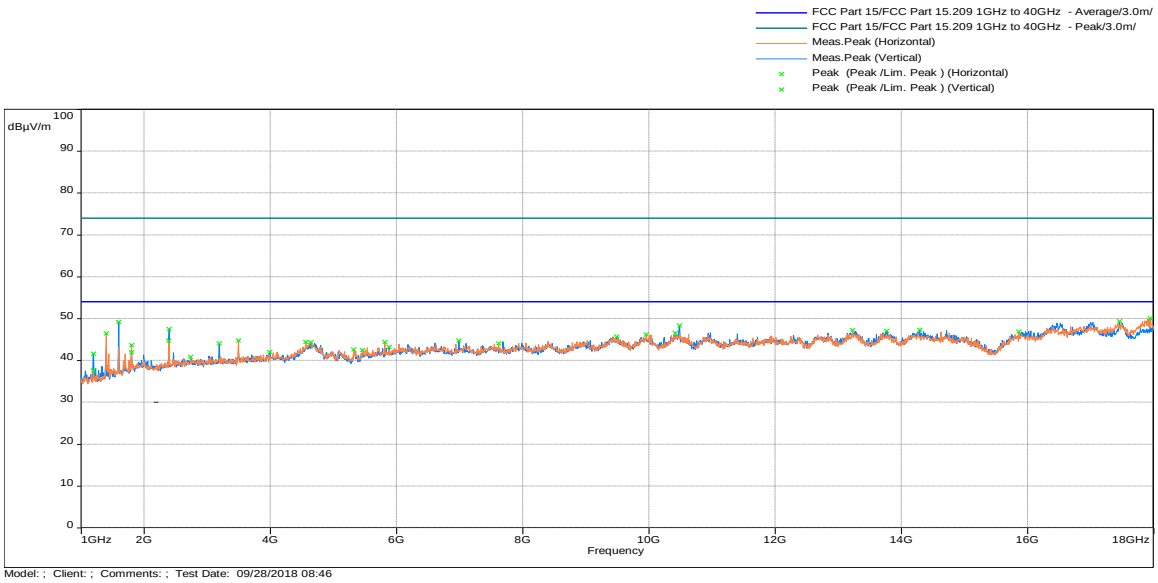
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11a 5240MHz

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



Model: ; Client: ; Comments: ; Test Date: 10/09/2018 06:44

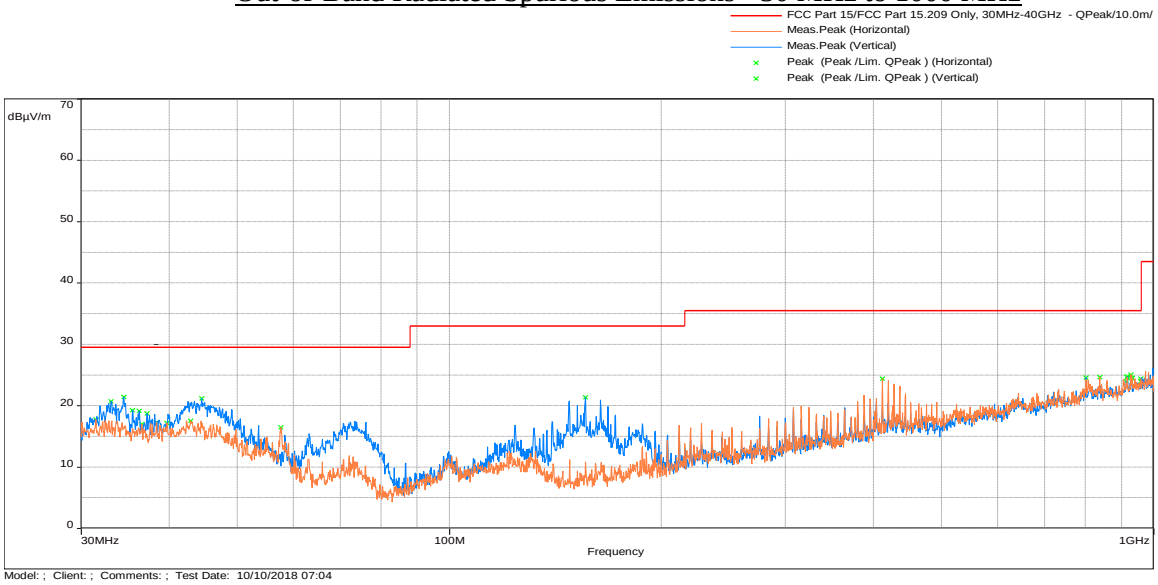
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



Model: ; Client: ; Comments: ; Test Date: 09/28/2018 08:46

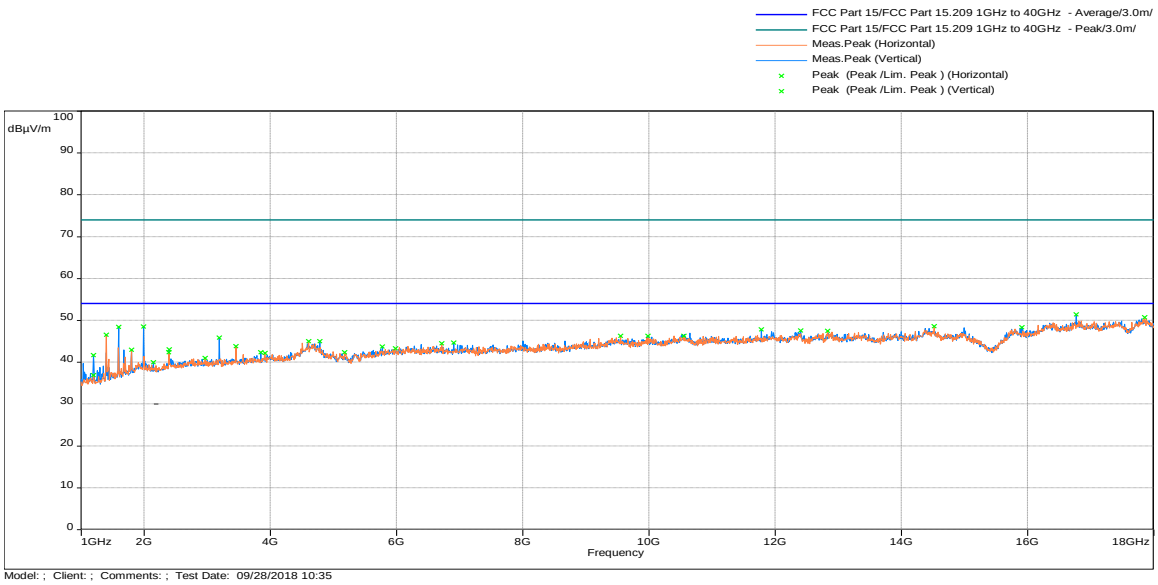
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz 5180MHz

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



Model: ; Client: ; Comments: ; Test Date: 10/10/2018 07:04

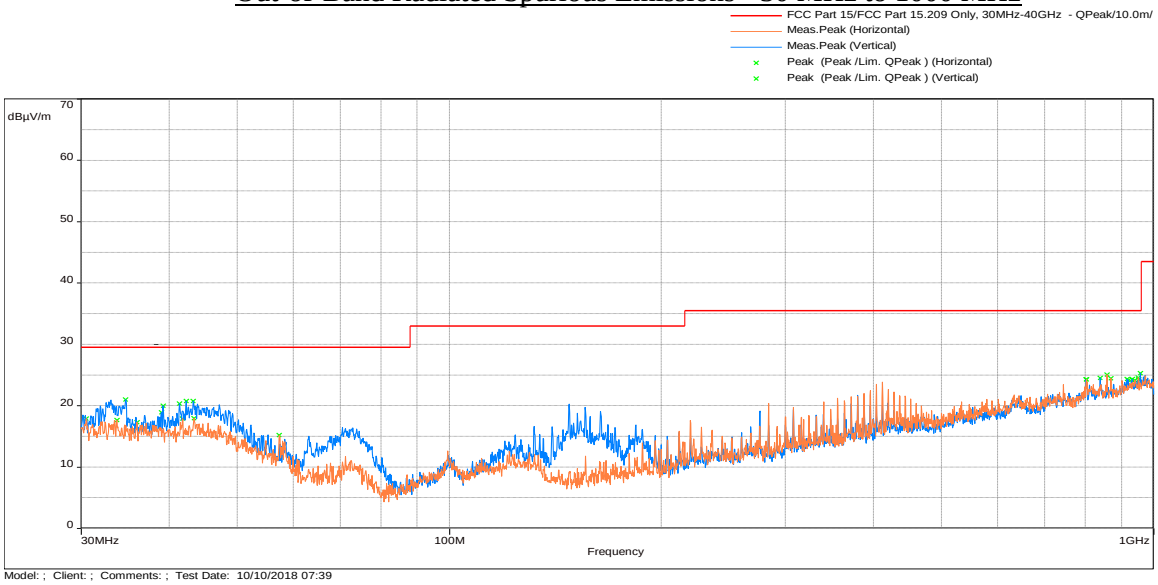
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



Model: ; Client: ; Comments: ; Test Date: 09/28/2018 10:35

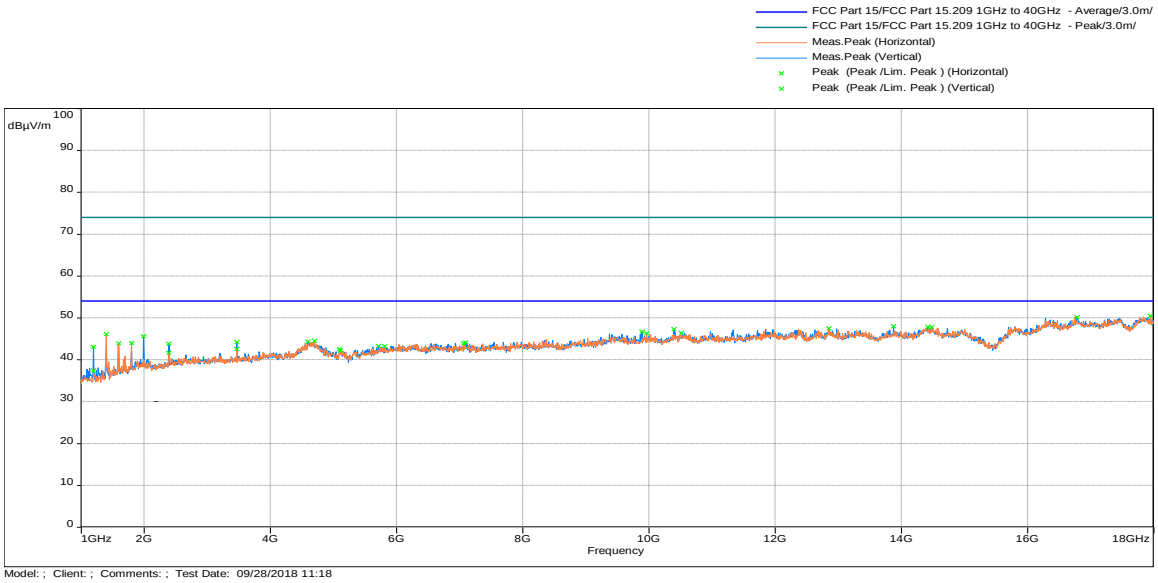
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz 5200MHz

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



Model: ; Client: ; Comments: ; Test Date: 10/10/2018 07:39

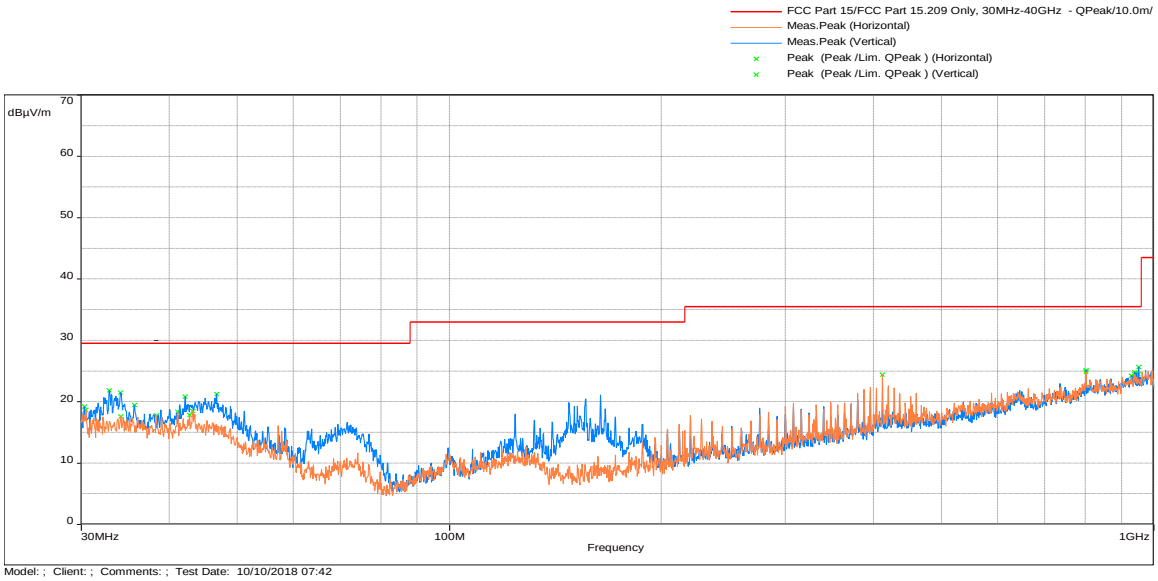
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



Model: ; Client: ; Comments: ; Test Date: 09/28/2018 11:18

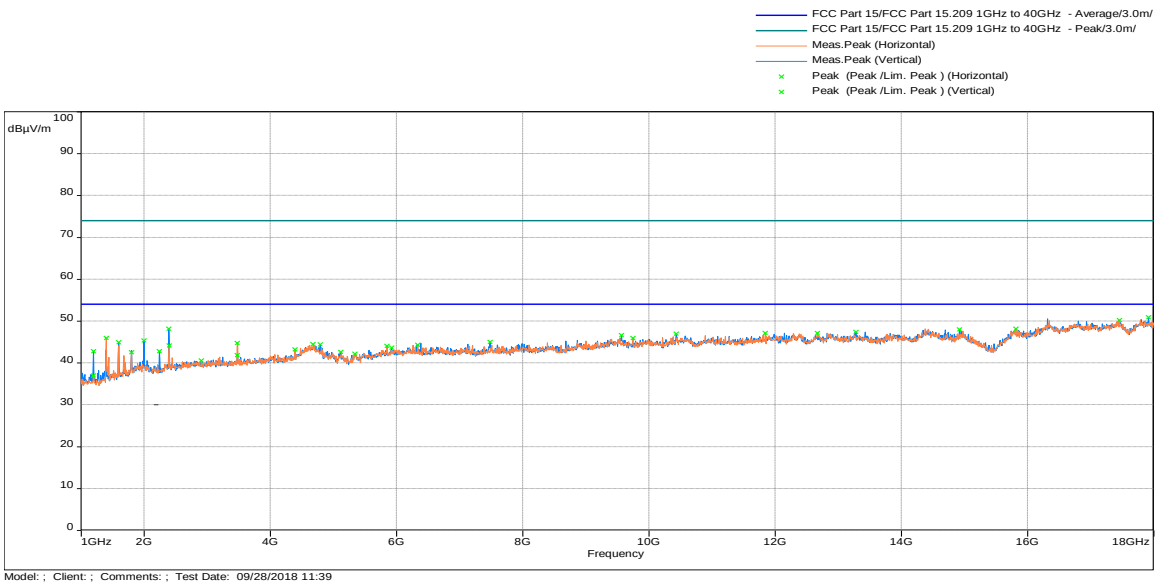
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz 5240MHz

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



Model: ; Client: ; Comments: ; Test Date: 10/10/2018 07:42

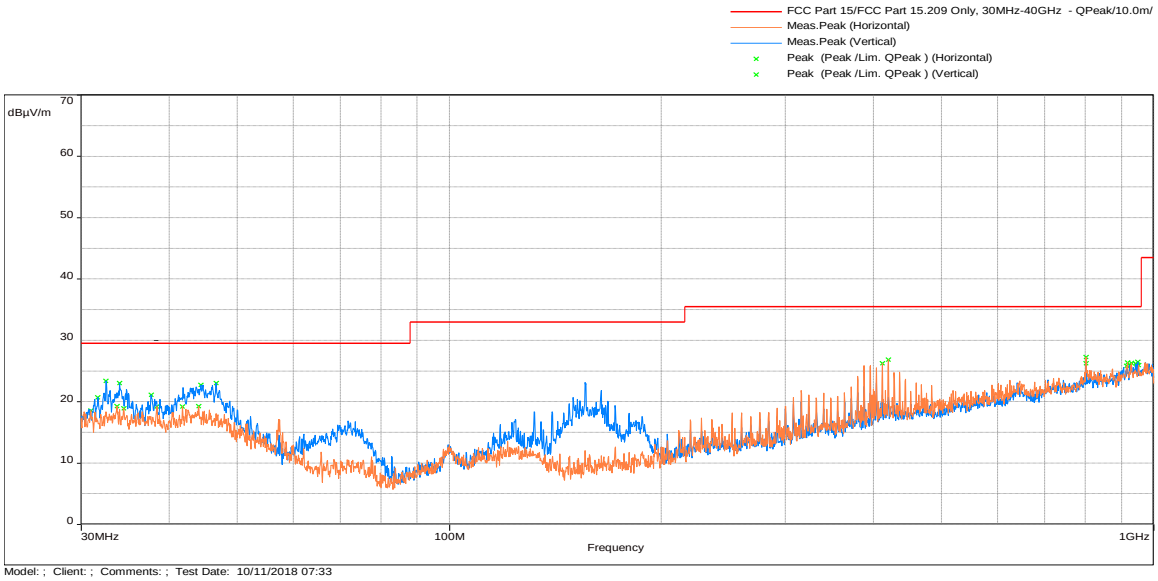
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



Model: ; Client: ; Comments: ; Test Date: 09/28/2018 11:39

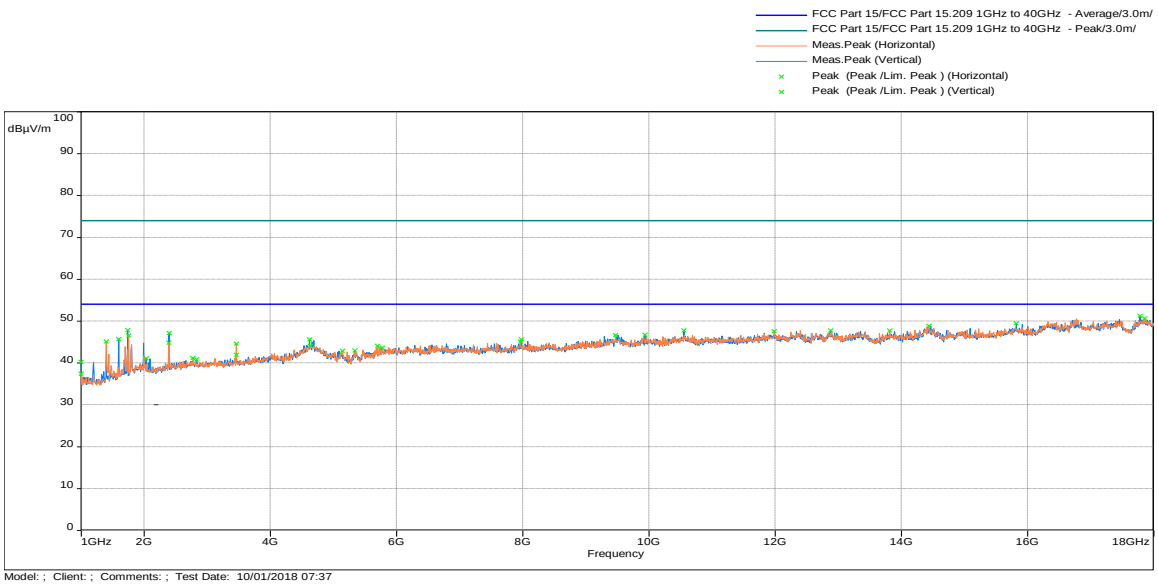
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 40MHz 5190MHz

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



Model: ; Client: ; Comments: ; Test Date: 10/11/2018 07:33

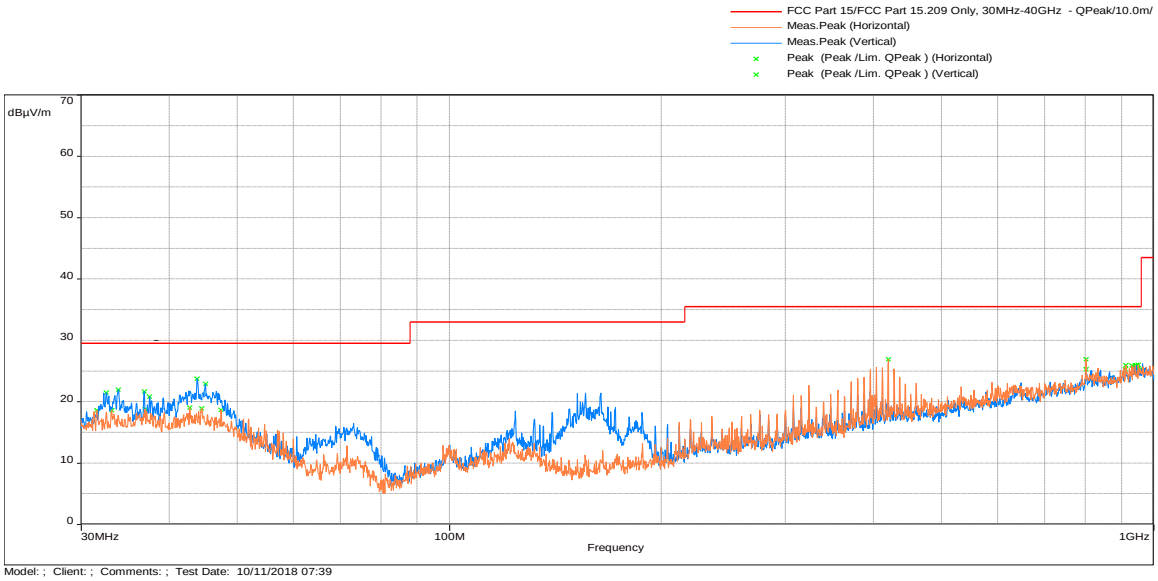
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



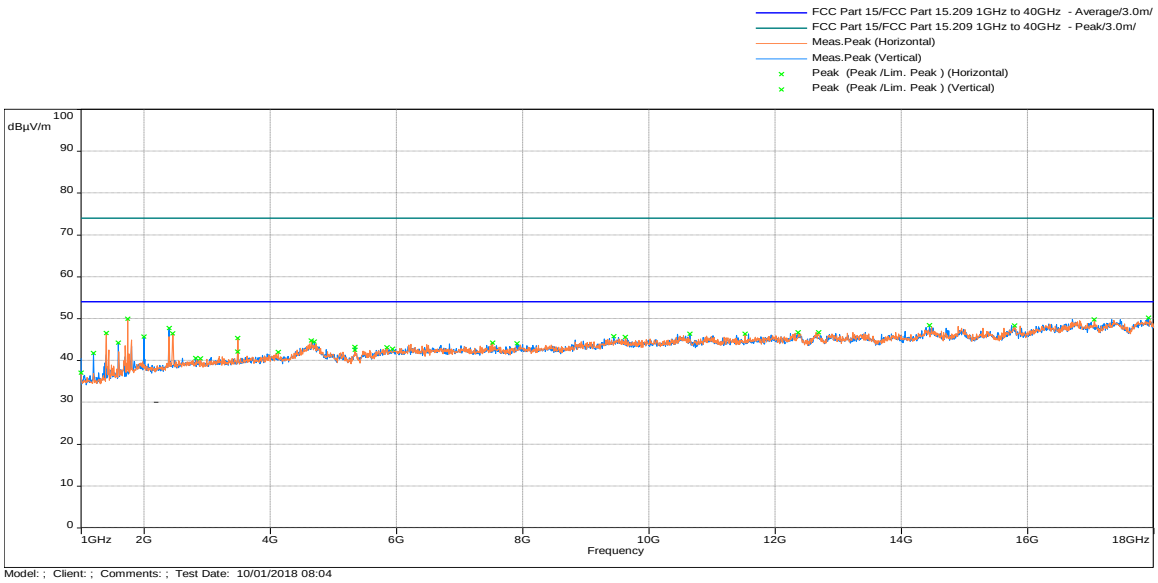
Model: ; Client: ; Comments: ; Test Date: 10/01/2018 07:37

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 40MHz 5230MHz

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



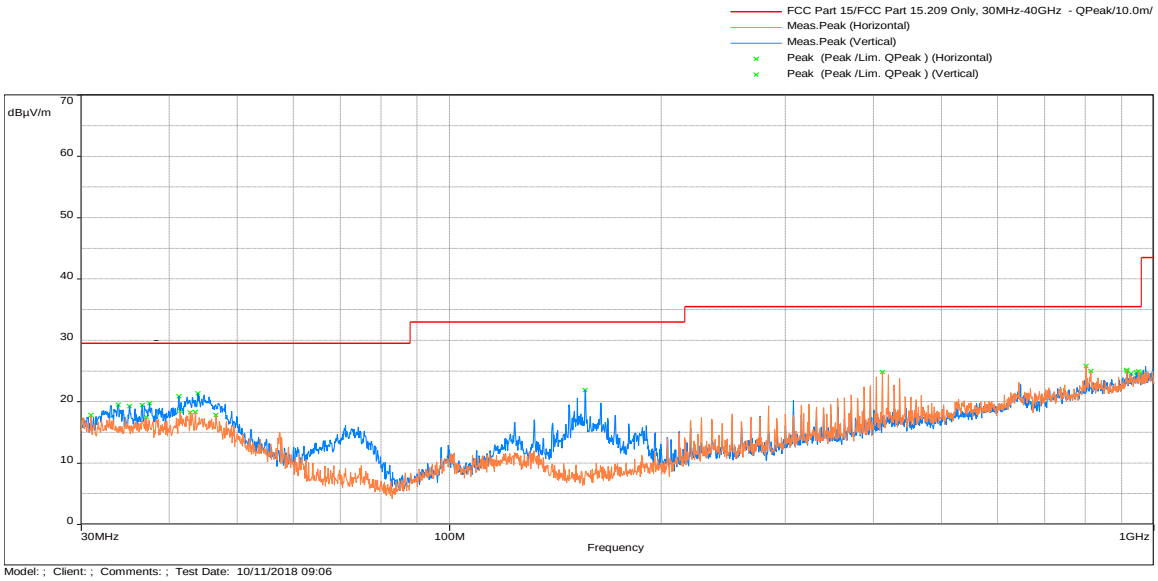
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



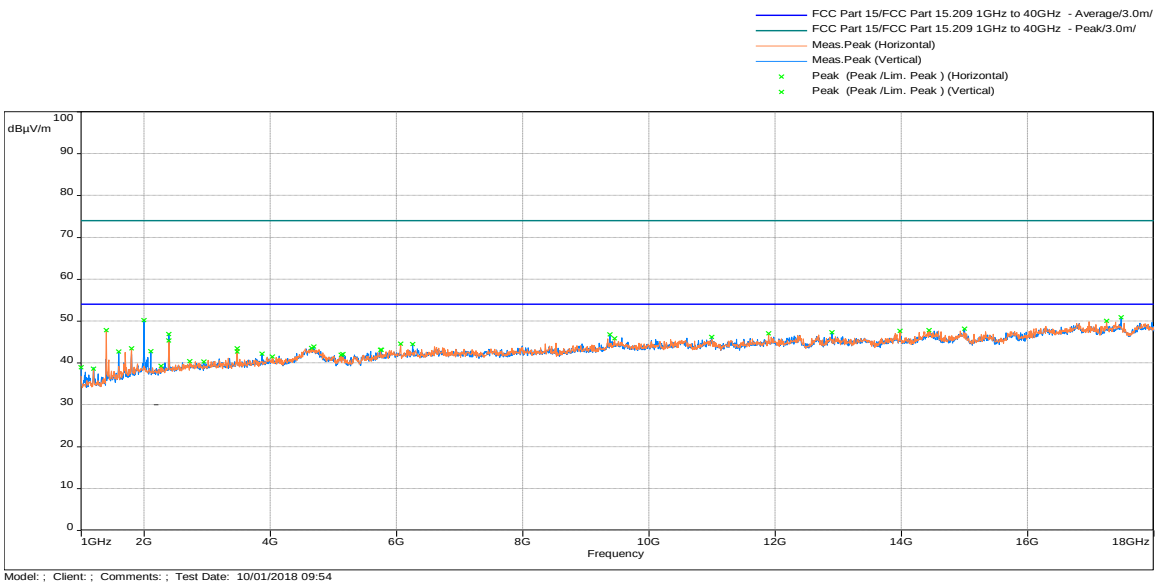
Frequency MHz	Detector	FS@3m dB(uV/m)	Limit@3m dB(uV/m)	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	Correction dB
1739.50	Peak	49.91	54	-4.09	240	1.83	Horizontal	-16.30
17916.70	Peak	50.20	54	-3.80	357	1.55	Vertical	6.85

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11ac 80MHz 5210MHz

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



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

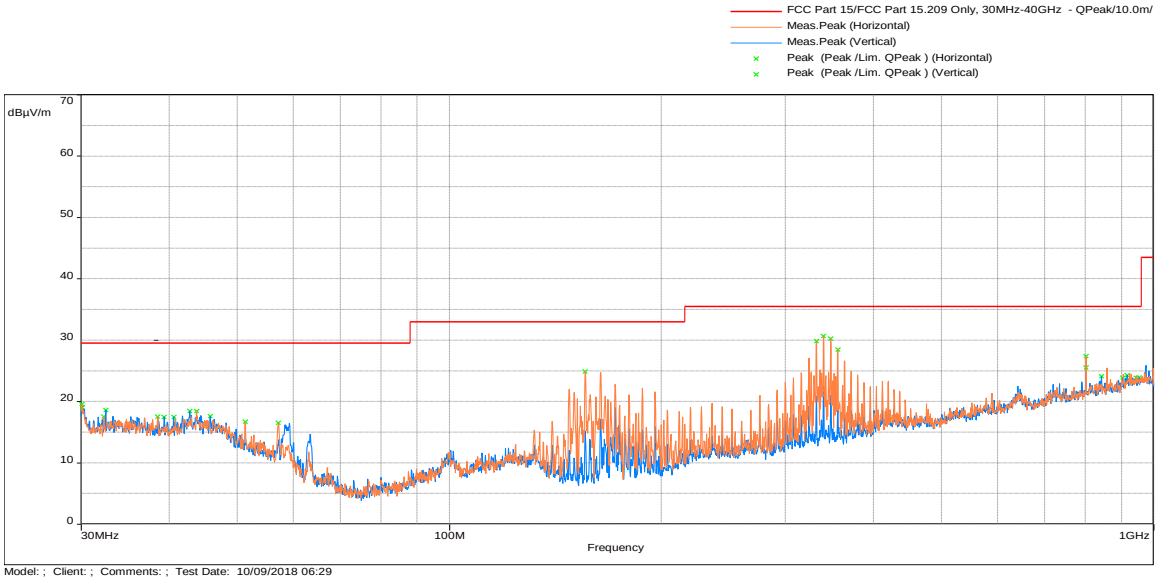


Frequency	Detector	FS@3m	Limit@3m	Margin	Azimuth	Height	Polarity	Correction
MHz		dB(uV/m)	dB(uV/m)	(dB)	(deg)	(m)		dB
1399.50	Peak	47.75	54	-6.25	96	1.82	Horizontal	-17.58
1996.20	Peak	50.15	54	-3.85	0	1.71	Vertical	-14.77
17483.20	Peak	50.84	54	-3.16	265	1.44	Vertical	4.43

Out-of-Band Radiated Spurious Emissions (Normal Mode)

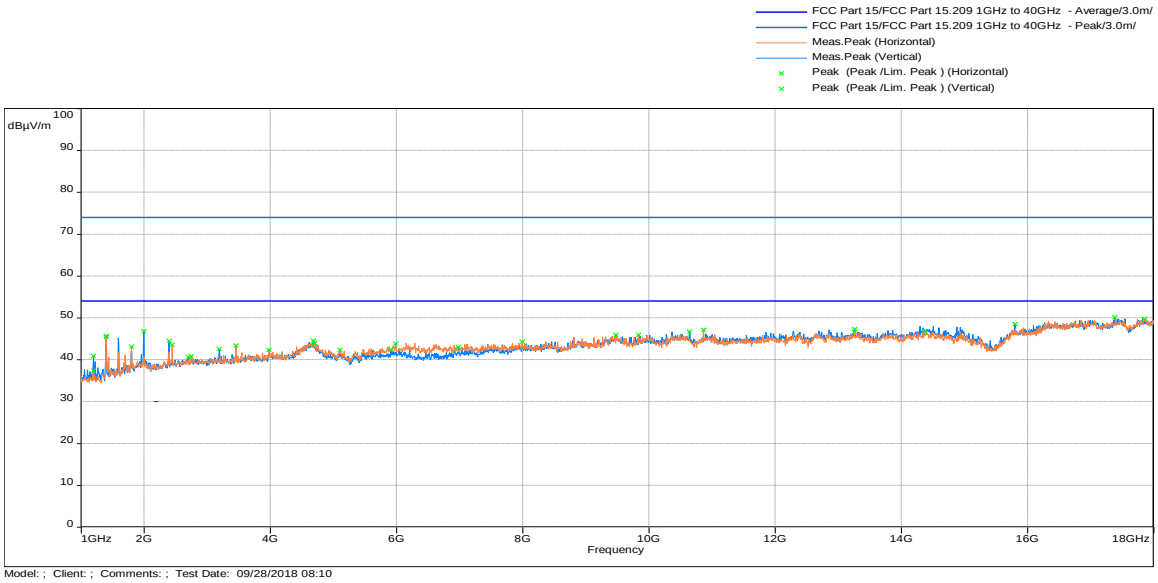
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11a 5180MHz

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



Model: ; Client: ; Comments: ; Test Date: 10/09/2018 06:29

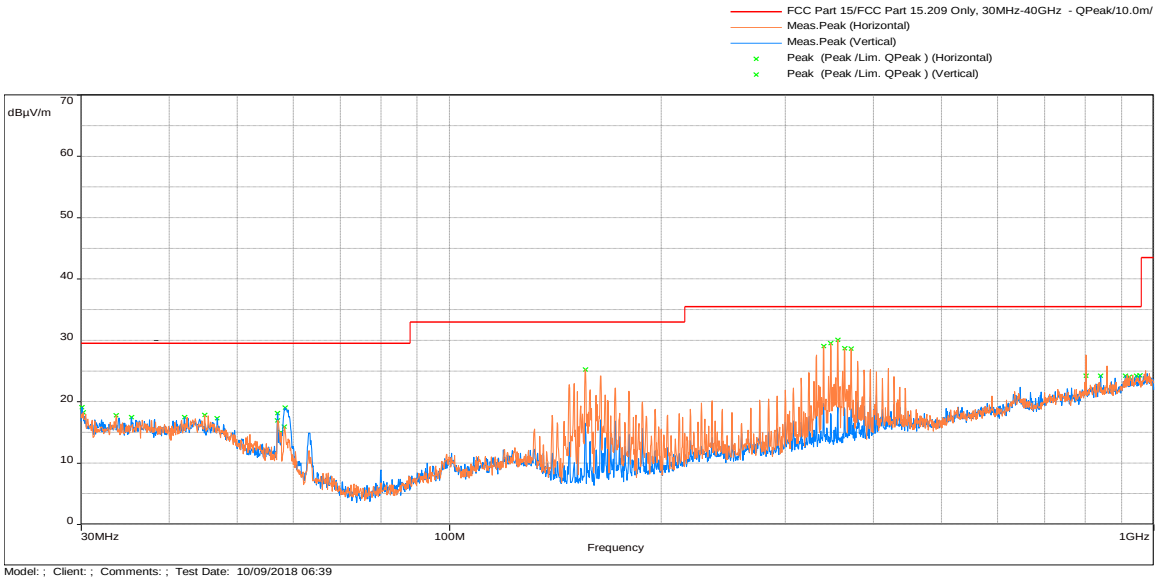
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



Model: ; Client: ; Comments: ; Test Date: 09/28/2018 08:10

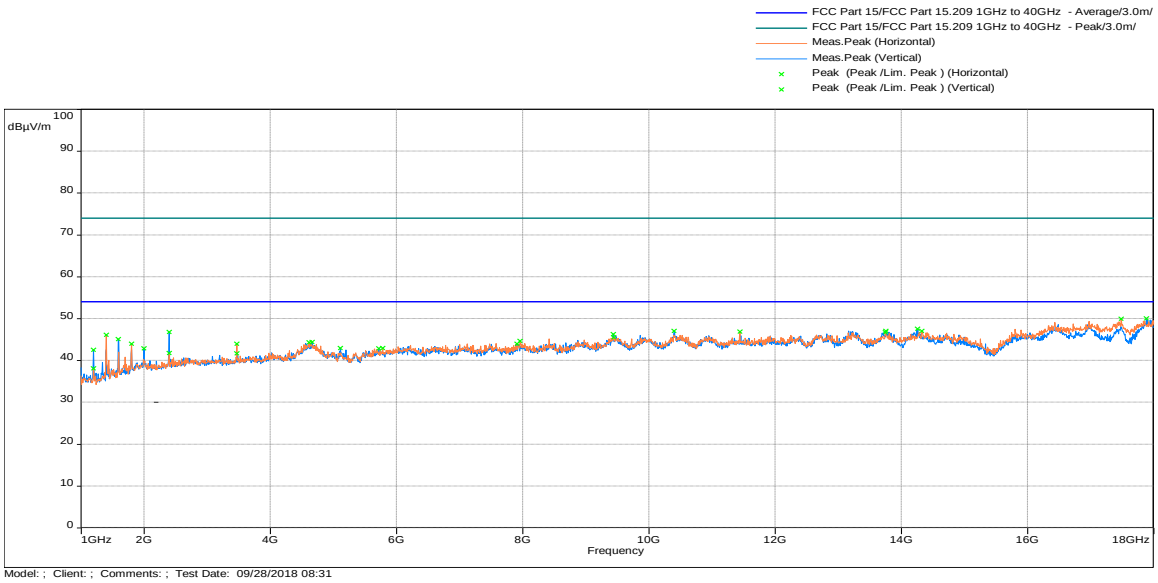
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11a 5200MHz

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



Model: ; Client: ; Comments: ; Test Date: 10/09/2018 06:39

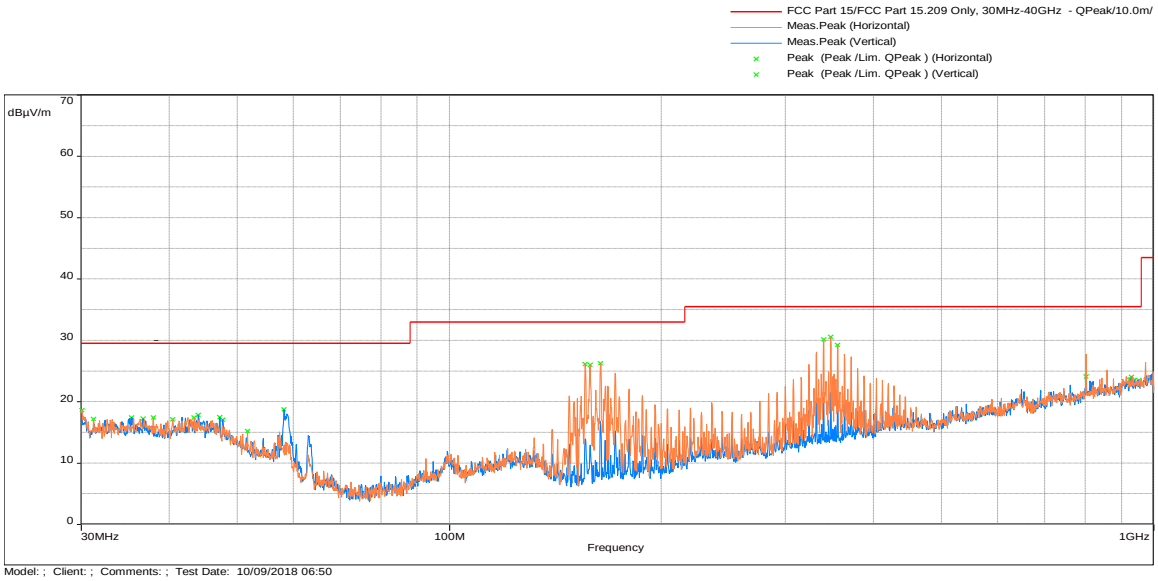
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



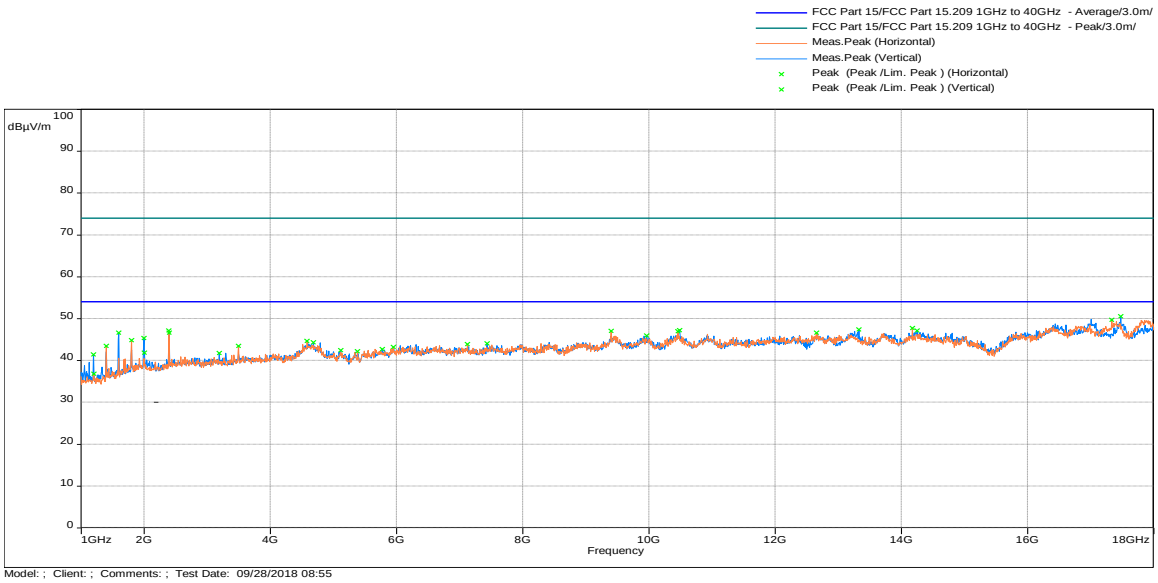
Model: ; Client: ; Comments: ; Test Date: 09/28/2018 08:31

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11a 5240MHz

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



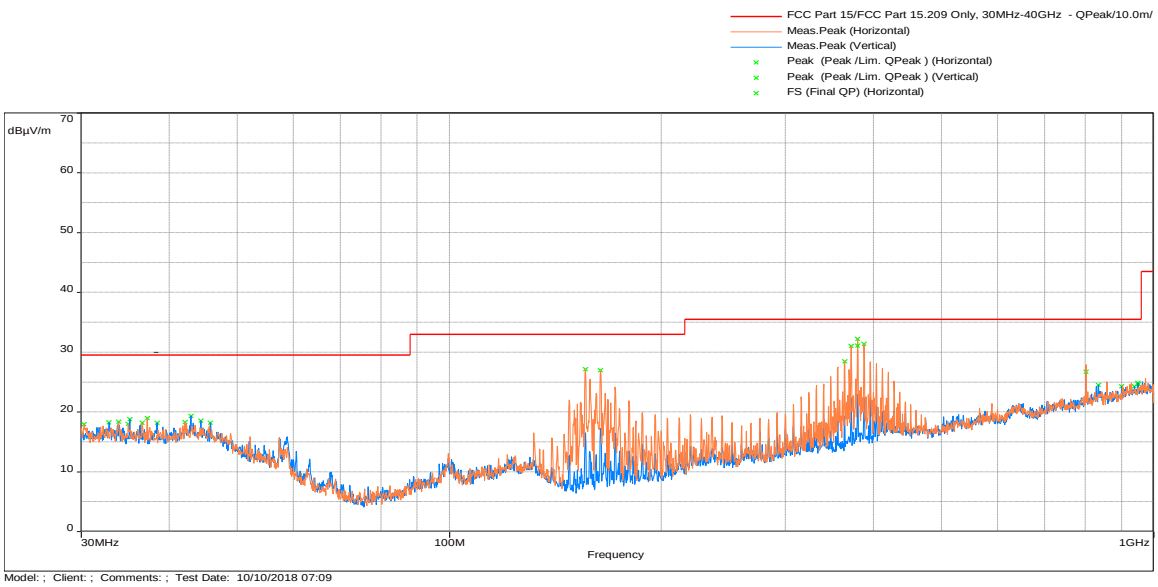
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



Frequency MHz	Detector	FS@3m dB(uV/m)	Limit@3m dB(uV/m)	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	Correction dB
1596.70	Peak	49.18	54	-4.82	124	1.71	Horizontal	-16.90
10489.40	Peak	48.31	54	-5.69	296	1.66	Vertical	-2.06

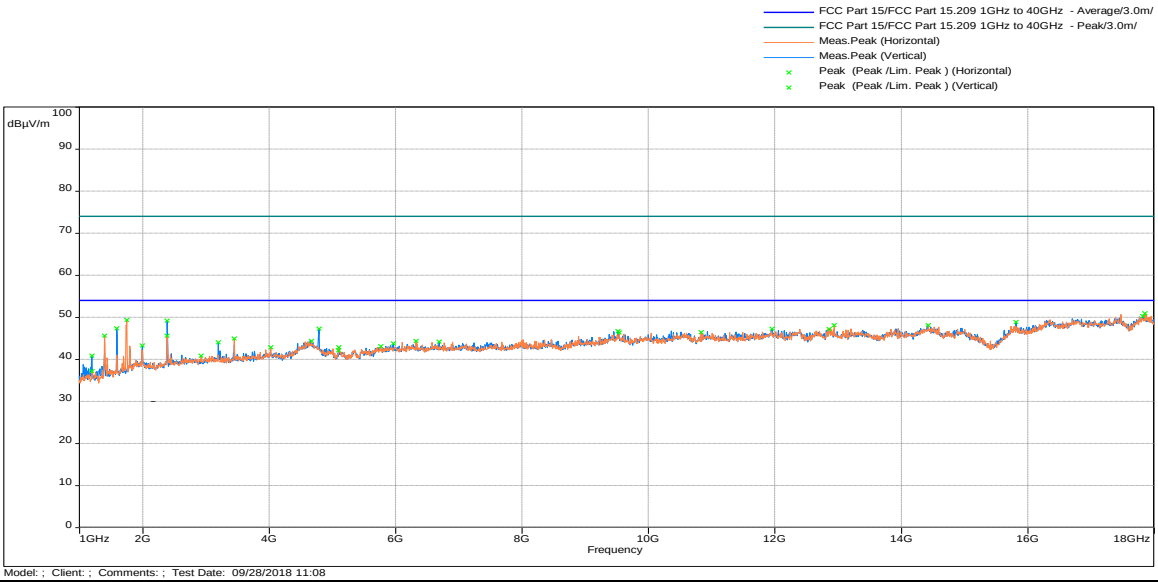
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz 5180MHz

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



Frequency (MHz)	FS@10m (dB(uV/m))	Limit@10m (dB(uV/m))	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
379.970	31.04	35.5	-4.46	341	1.96	Horizontal	41.12	-10.08

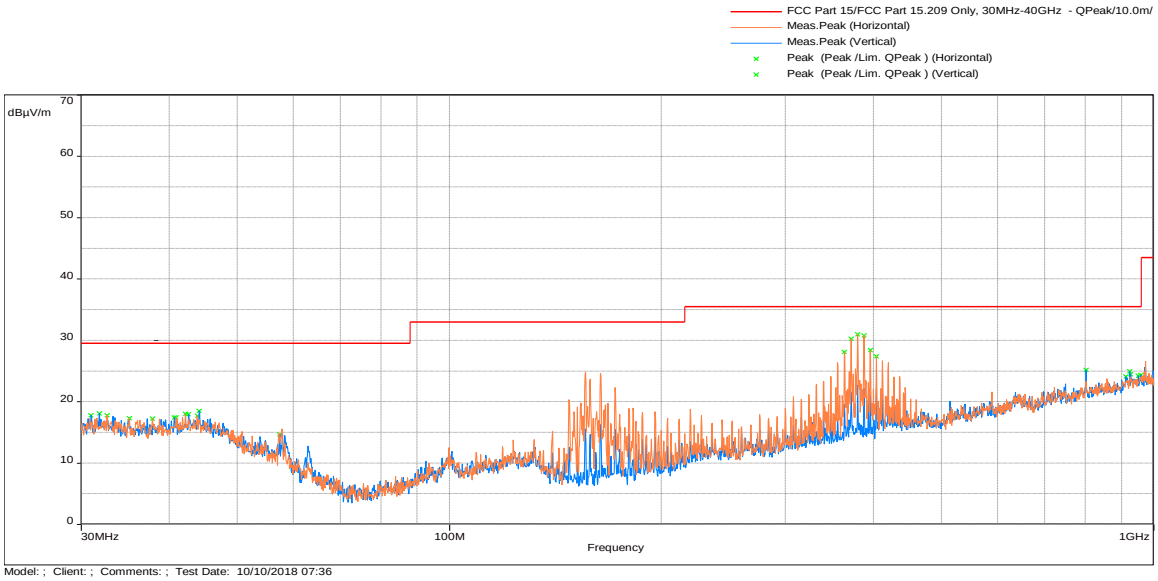
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



Frequency MHz	Detector	FS@3m dB(uV/m)	Limit@3m dB(uV/m)	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	Correction dB
1753.10	Peak	49.33	54	-4.67	73	1.36	Horizontal	-16.25
4791.00	Peak	47.26	54	-6.74	297	1.51	Vertical	-7.68

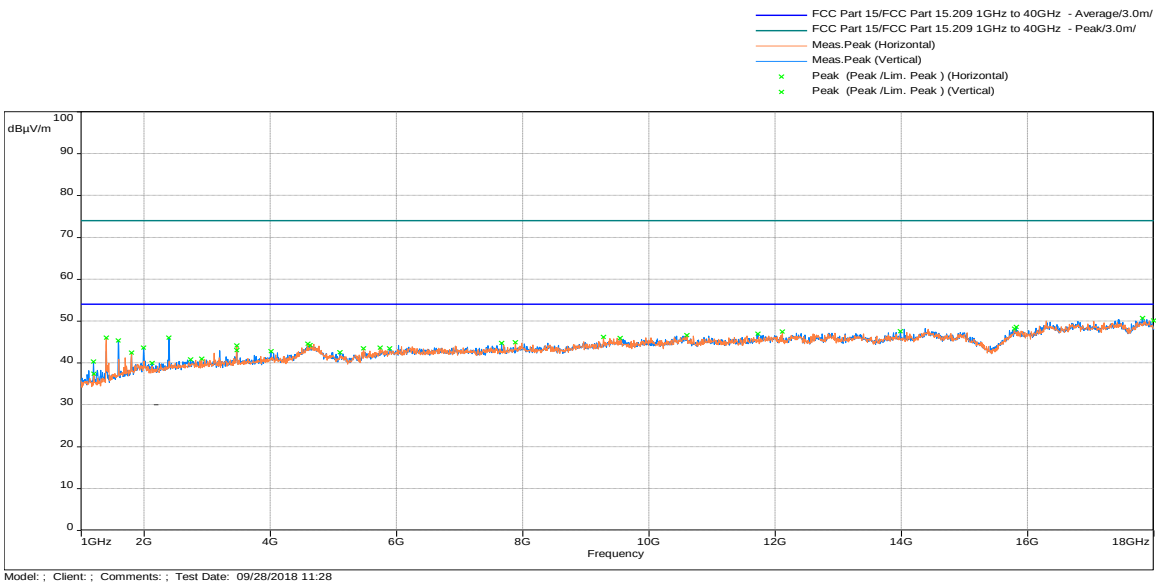
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz 5200MHz

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



Model: ; Client: ; Comments: ; Test Date: 10/10/2018 07:36

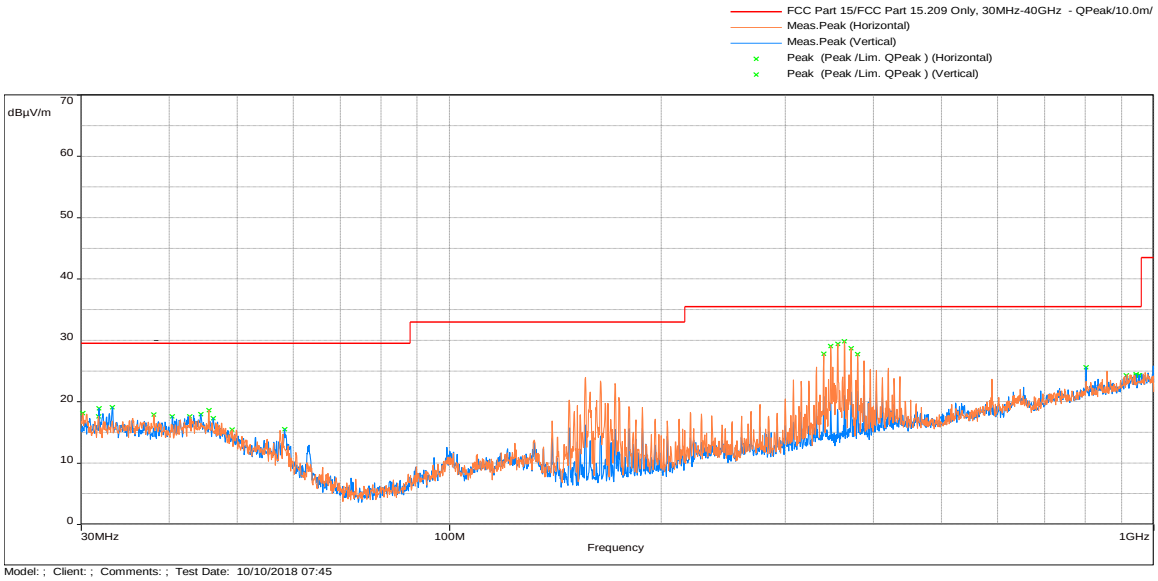
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



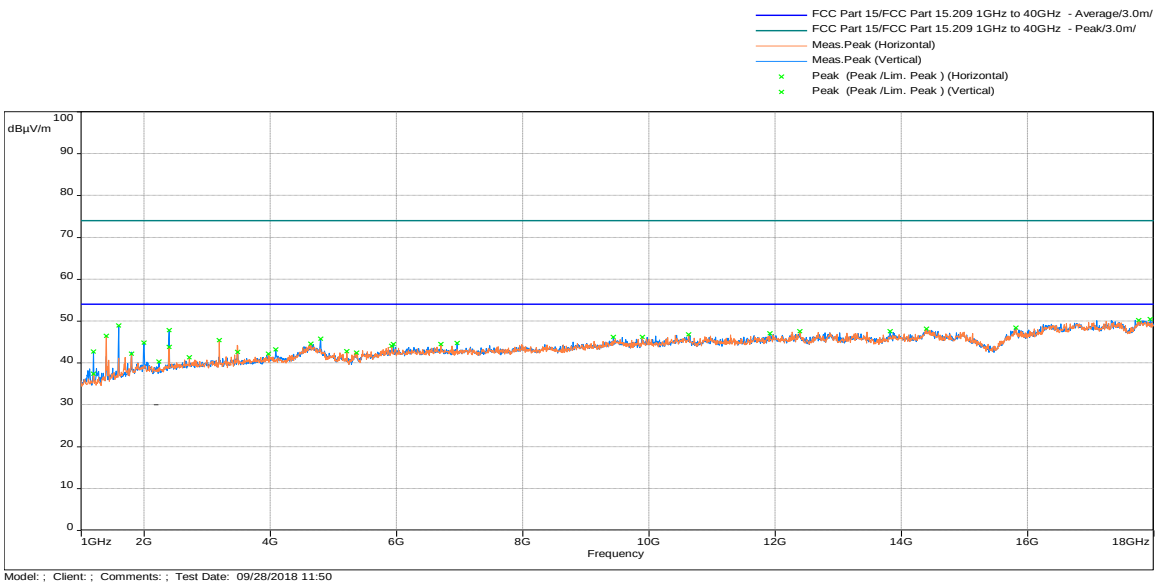
Model: ; Client: ; Comments: ; Test Date: 09/28/2018 11:28

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz 5240MHz

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

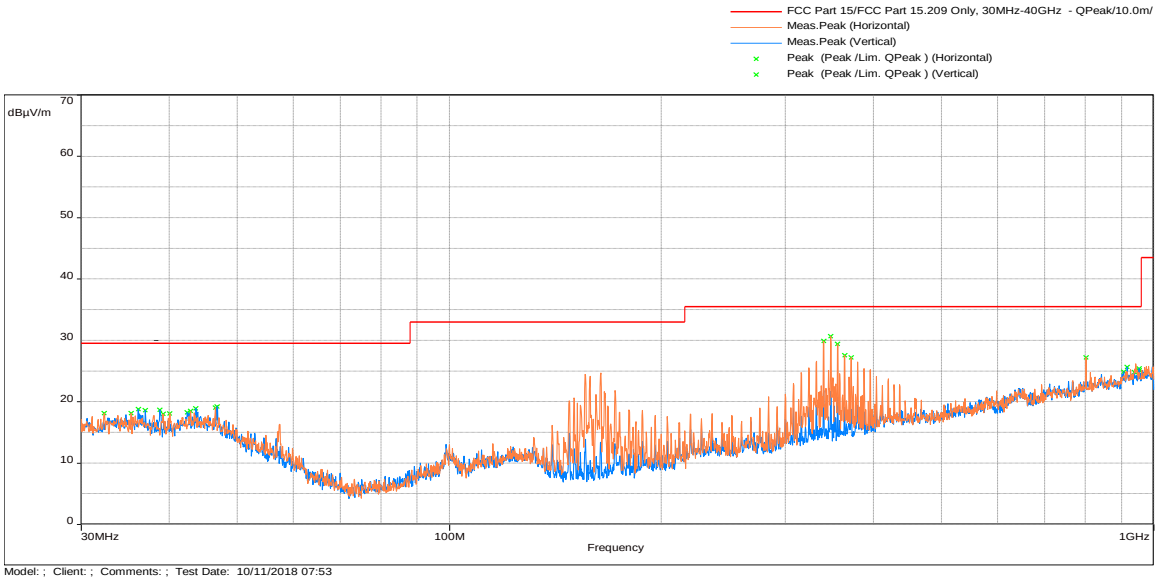


Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



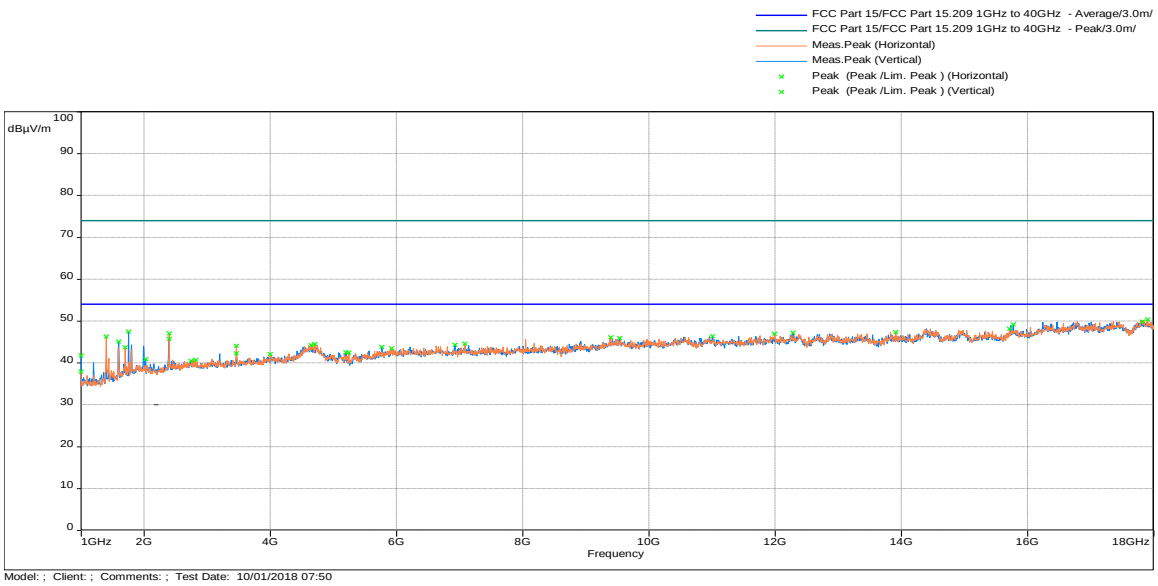
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 40MHz 5190MHz

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



Model: ; Client: ; Comments: ; Test Date: 10/11/2018 07:53

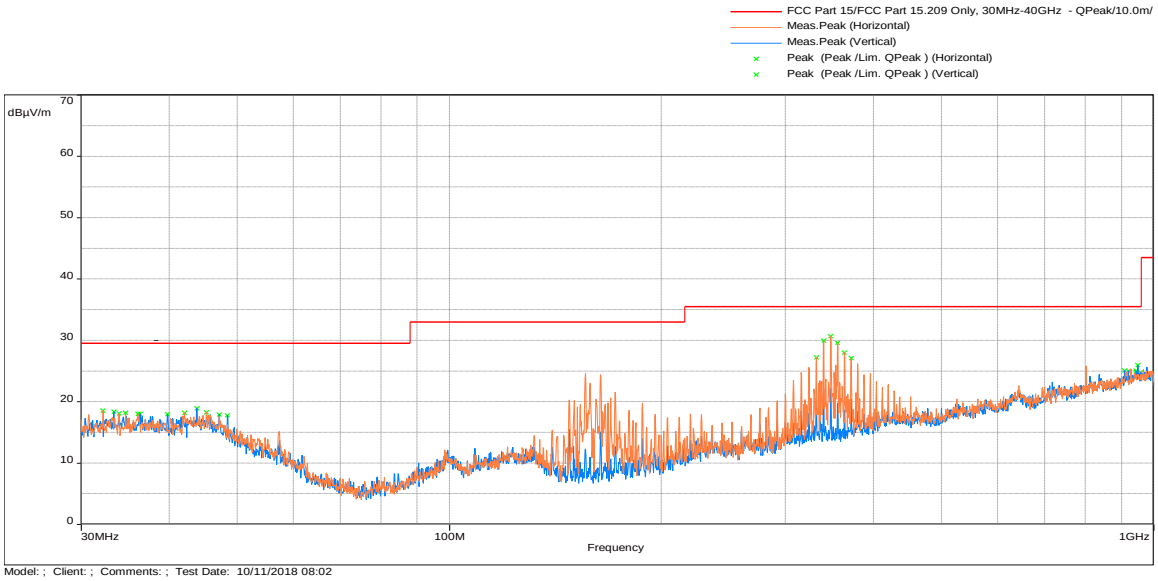
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



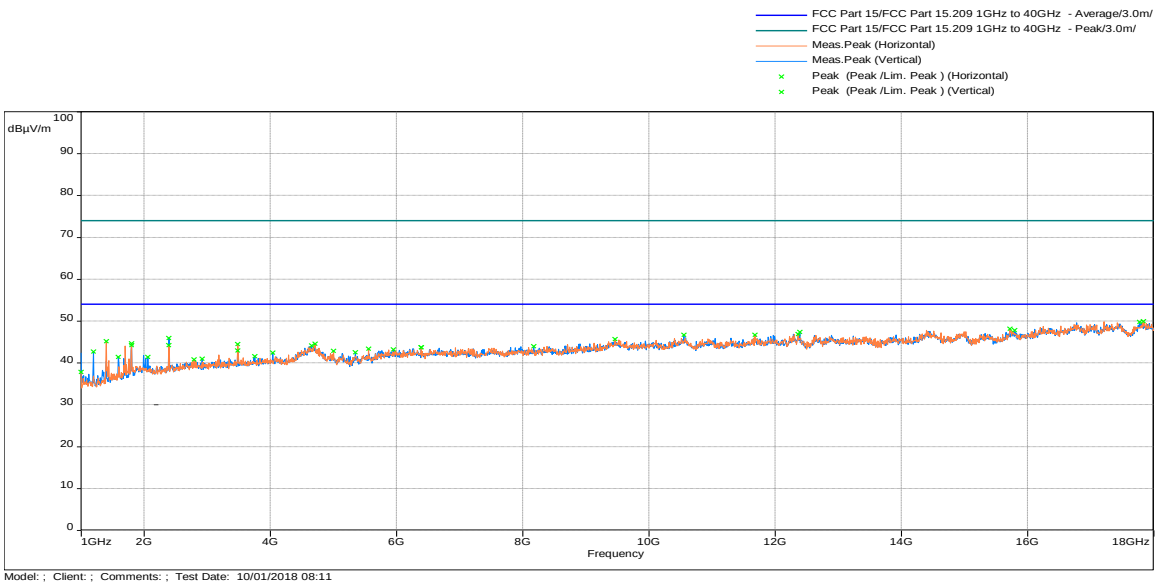
Model: ; Client: ; Comments: ; Test Date: 10/01/2018 07:50

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 40MHz 5230MHz

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

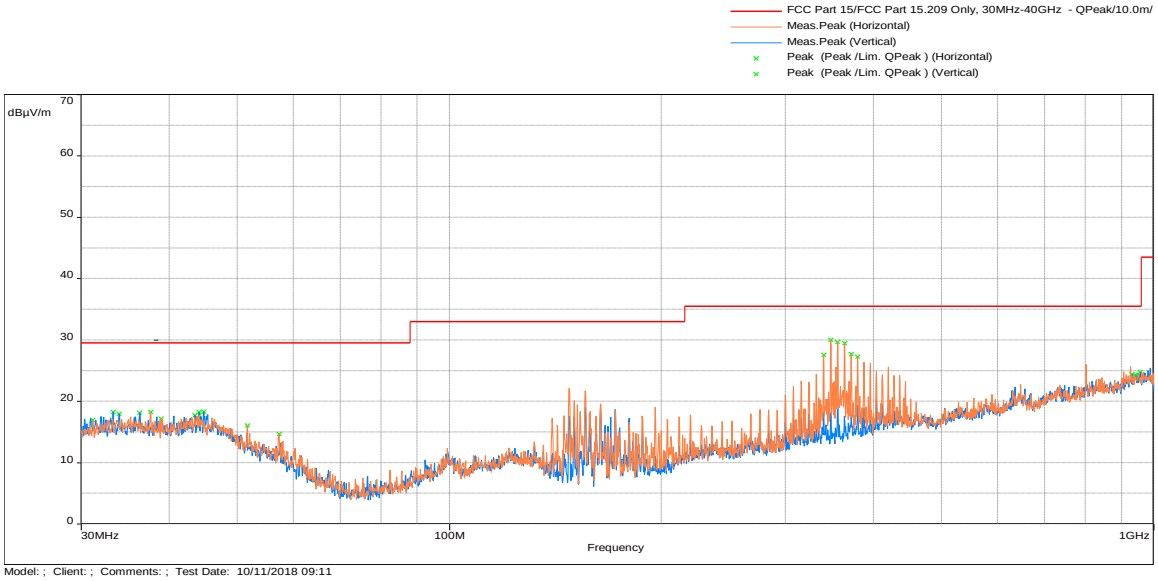


Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit

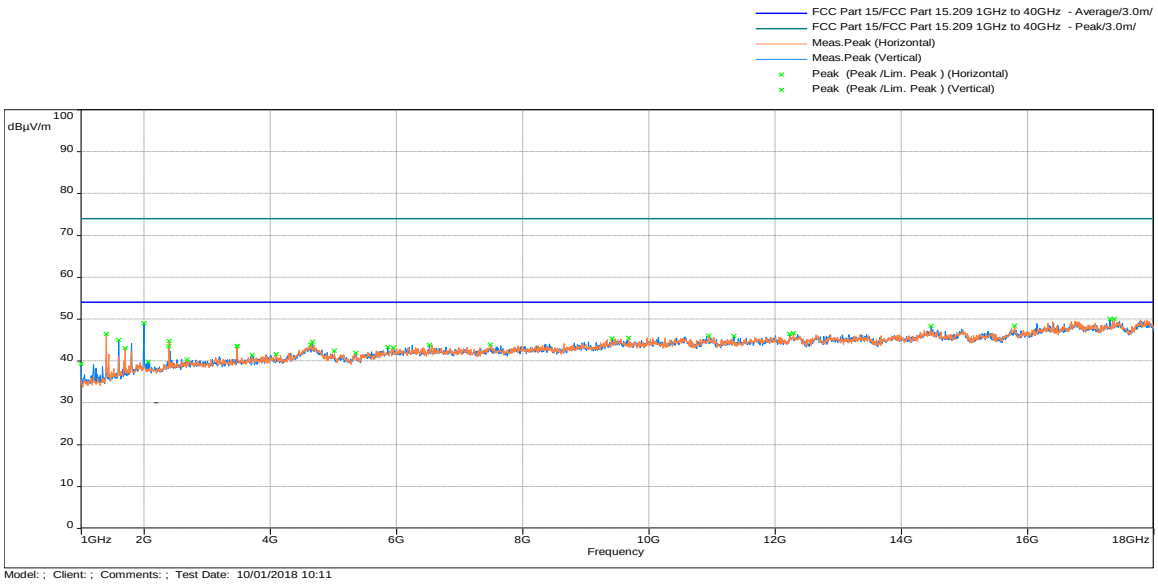


Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11ac 80MHz 5210MHz

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

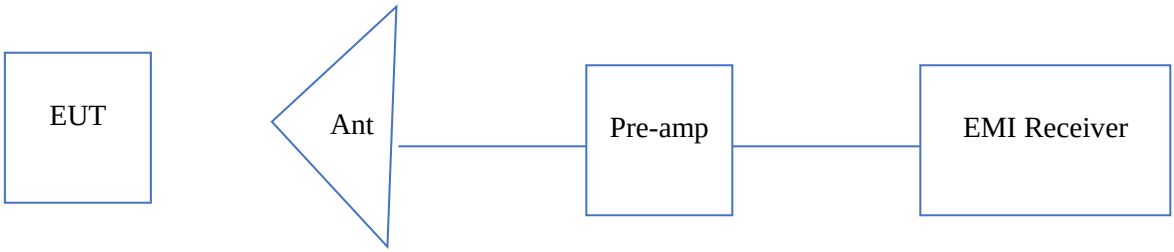


Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Avg Limit



4.3.7 Test setup

The following photographs show the testing configurations used.



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.

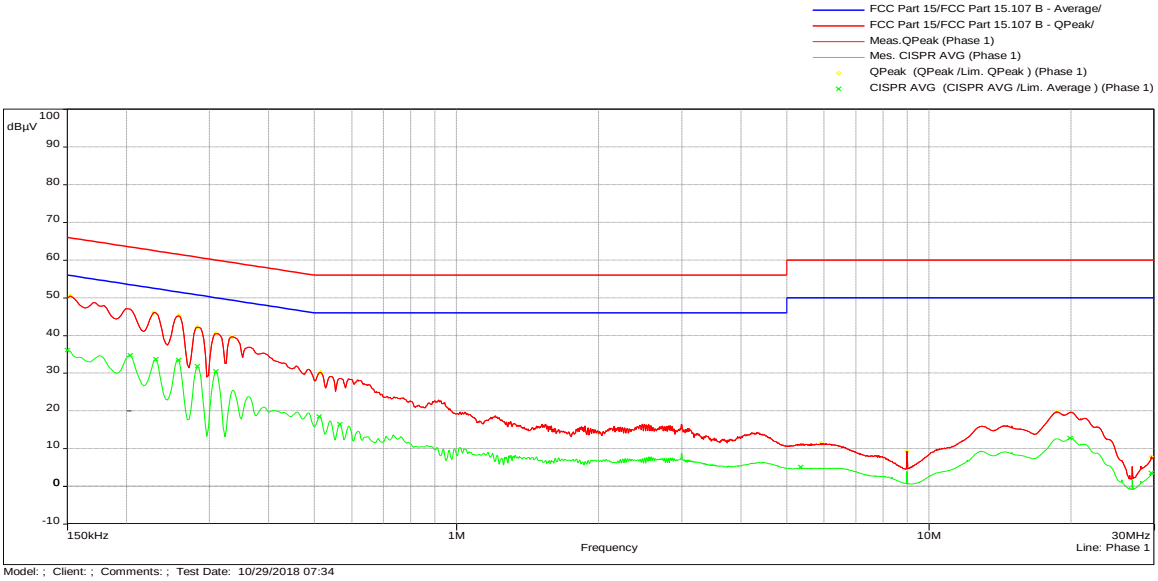
Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.4:2014.

Tested By	Test Date
Anderson Soungpanya	October 29, 2018

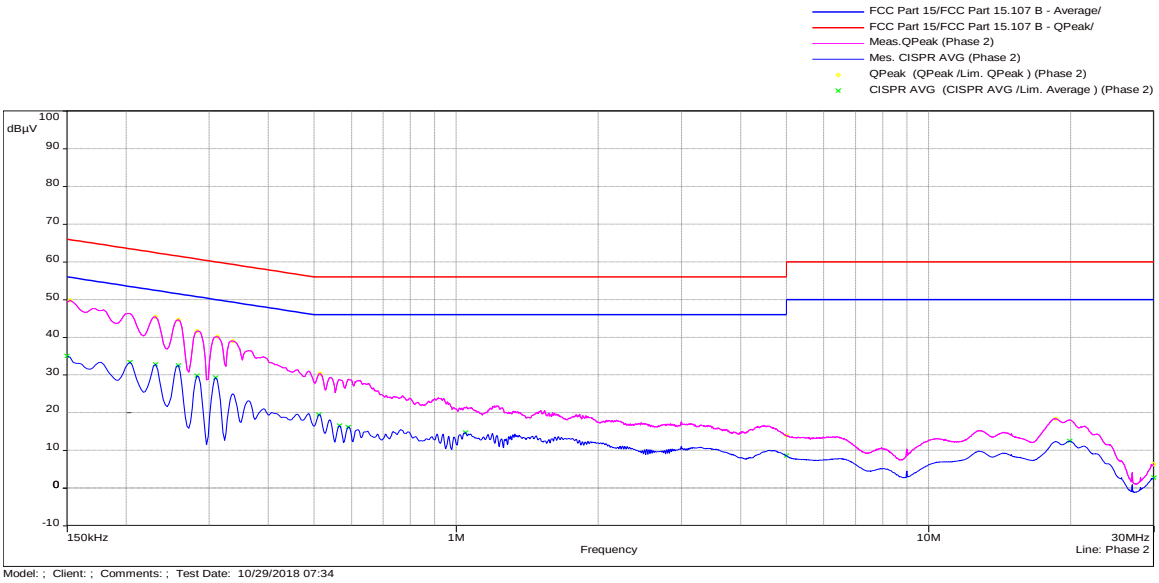
4.4.3 Test Results

15.207: Conducted Emissions 120VAC 60Hz

Phase 1



Phase 2



4.4.3 Test Results (Continued)

Quasi Peak Table					
Frequency (MHz)	QPeak (dBµV)	Lim. QPeak (dBµV)	QPeak-Lim (dB)	Phase	Correction (dB)
0.152	49.76	65.88	-16.12	Phase 2	1.05
0.152	50.42	65.88	-15.46	Phase 1	1.05
0.229	46.03	62.49	-16.46	Phase 1	1.07
0.231	45.37	62.41	-17.04	Phase 2	1.06
0.258	45.16	61.50	-16.34	Phase 1	1.08
0.258	44.65	61.50	-16.84	Phase 2	1.08
0.283	41.63	60.73	-19.10	Phase 2	1.07
0.283	42.16	60.73	-18.58	Phase 1	1.07
0.310	40.46	59.98	-19.52	Phase 1	1.09
0.312	40.11	59.92	-19.81	Phase 2	1.09
0.335	39.66	59.34	-19.68	Phase 1	1.07
0.337	39.01	59.28	-20.27	Phase 2	1.07
0.515	30.32	56.00	-25.68	Phase 2	1.10
0.515	30.20	56.00	-25.80	Phase 1	1.10
5.006	13.94	60.00	-46.06	Phase 2	1.33
5.906	11.42	60.00	-48.58	Phase 1	1.36
8.990	9.20	60.00	-50.80	Phase 1	1.43
18.620	18.39	60.00	-41.61	Phase 2	1.61
18.663	19.70	60.00	-40.30	Phase 1	1.61
29.591	7.79	60.00	-52.21	Phase 1	1.78
29.933	6.29	60.00	-53.71	Phase 2	1.78

4.4.3 Test Results (Continued)

Average Table					
Frequency (MHz)	AVG (dBµV)	Lim. Average (dBµV)	AVG-Lim (dB)	Phase	Correction (dB)
0.150	35.02	56.00	-20.98	Phase 2	1.05
0.150	36.04	56.00	-19.96	Phase 1	1.05
0.204	33.33	53.45	-20.12	Phase 2	1.05
0.204	34.73	53.45	-18.71	Phase 1	1.05
0.231	33.63	52.41	-18.79	Phase 1	1.06
0.231	32.78	52.41	-19.64	Phase 2	1.06
0.258	33.46	51.50	-18.04	Phase 1	1.08
0.258	32.48	51.50	-19.02	Phase 2	1.08
0.283	31.75	50.73	-18.98	Phase 1	1.07
0.283	29.74	50.73	-20.99	Phase 2	1.07
0.310	30.39	49.98	-19.59	Phase 1	1.09
0.310	29.29	49.98	-20.69	Phase 2	1.09
0.512	19.49	46.00	-26.51	Phase 2	1.10
0.512	18.52	46.00	-27.48	Phase 1	1.10
0.566	16.42	46.00	-29.58	Phase 1	1.10
0.566	16.49	46.00	-29.51	Phase 2	1.10
0.591	16.19	46.00	-29.81	Phase 2	1.11
1.048	14.71	46.00	-31.29	Phase 2	1.15
5.006	8.55	50.00	-41.45	Phase 2	1.33
5.348	5.04	50.00	-44.96	Phase 1	1.33
19.912	12.76	50.00	-37.24	Phase 1	1.63
19.921	12.49	50.00	-37.51	Phase 2	1.63
29.591	3.52	50.00	-46.48	Phase 1	1.78
29.981	2.74	50.00	-47.26	Phase 2	1.78

Results: **Complies** by 15.46 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
Spectrum Analyzer	Rohde and Schwarz	FSU	ITS 00913	12	01/24/19
Horn Antenna (10-40 GHz)	ETS-Lindgren	3116C	ITS 01376	12	04/25/19
Pre-Amplifier (18-40GHz)	Miteq	TTA1840-35-S-M	ITS 01393	12	01/19/19
Active Horn Antenna (1-18GHz)	ETS-Lindgren	3117-PA	ITS 01325	12	01/25/19
EMI Receiver	Rohde and Schwarz	ESW44	ITS 01669	12	07/30/19
BI-Log Antenna	Antenna Research	LPB-2513	ITS 00355	12	02/21/19
Pre-Amplifier	Sonoma Instrument	310N	ITS 01493	12	10/20/18
Notch Filter	MICRO-TRONICS	BRM50703	ITS 01167	12	03/14/19
LISN	FCC	FCC-LISN-50-50-M-	ITS 00551	12	10/04/19
RF Cable	Megaphase	EMC1-K1K1-236	ITS 01538	12	06/25/19
RF Cable	Megaphase	TM40-K1K1-59	ITS 01657	12	06/26/19
RF Cable	TRU Corporation	TRU CORE 300	ITS 01330	12	11/29/18
RF Cable	TRU Corporation	TRU CORE 300	ITS 01465	12	08/16/19
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	08/16/19
Attenuator	Fairview	SA 18H-30	ITS 01633	12	#

Verify before use

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
Tile	Quantum Change	3.4.K.22	Conducted Restricted Band Edge_Avg Conducted Restricted Band Edge_Peak
BAT-EMC	Nexio	3.16.0.64	103615308_Vocera 5GWIFI.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 / G103615308	AS	KV	October 30, 2018	Original document