TEST REPORT

Report Number: 102971715MPK-003C
Project Number: G102971715
October 06, 2017

Testing performed on the
M445-403-01-NAA-4
Model Number: M400 WIFI/BT
FCC ID: B32M400WIFIBT
IC: 787C-M400WIFIBT

to
FCC Part 15, Subpart E
RSS-247 Issue 2

For

Verifone, Inc.

Test Performed by:	Test Authorized by:
Intertek	Verifone, Inc.
1365 Adams Court	1400 W Stanford Ranch Rd.
Menlo Park, CA 94025 USA	Rocklin, CA 95765 USA

Prepared by: _____ **Date:** October 06, 2017
Anderson Soungpanya

Reviewed by: _____ **Date:** October 06, 2017
Krishna K Vemuri

VERIFICATION OF COMPLIANCE
Report No. 102971715MPK-003C

Verification is hereby issued to the named APPLICANT and is VALID ONLY for the equipment identified hereon for use under the rules and regulations listed below.

Equipment Under Test:	M445-403-01-NAA-4
Trade Name:	Verifone, Inc.
Model No.:	M400 WIFI/BT
Applicant:	Verifone, Inc.
Contact:	Edwin Mandapat
Address:	1400 W Stanford Ranch Rd. Rocklin, CA 95765
Country	USA
Tel. Number:	(916) 630-0550
Email:	Edwin_M1@Verifone.com
Applicable Regulation:	FCC Part 15, Subpart E RSS-247 Issue 2
Date of Test:	May 01 to August 21, 2017

We attest to the accuracy of this report:

Anderson Soungpanya	Krishna K Vemuri
EMC Project Engineer	Engineering Team Lead

TABLE OF CONTENTS

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
Frequency stability	15.407(g)	RSS-Gen	Complies
Dynamic Frequency Selection (DFS)	15.407(h)	RSS-247, 6.3	Complies
Antenna Requirement	15.203	RSS-Gen	Complies. The EUT uses internal antenna.

EUT receive date: April 07, 2017

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: May 1, 2017

Test completion date: August 21, 2017

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

2.0 General Description

2.1 Product Description

Verifone, Inc. supplied the following description of the EUT:

The M400 WIFI/BT is an Electronic Payment/POS Terminal for Retail. For more information, see user's manual provided by the manufacturer.

The information about the 5GHz radio, installed in the model M400 WIFI/BT, is presented below.

Applicant	Verifone, Inc.
Model No.	M400 WIFI/BT
FCC ID	B32M400WIFIBT
IC	787C-M400WIFIBT
Use of Product	Point of Sale Terminal
Rated RF Output	11.68 dBm for 5500~5700 MHz
Master or Client Device	Client
Frequency Range	U-NII 2C: 5470 – 5725 MHz
Operating Mode	Client Mode without DFS detection capabilities
Type of modulation	OFDM
Antenna(s) & Gain	Internal Antenna, 3.0 dBi peak gain
Manufacturer Name & Address	Verifone, Inc. 1400 W Stanford Ranch Rd. Rocklin, CA 95765 USA

The EUT supports the following configurations:

Channels in 5470 – 5725 MHz band					
Number	Frequency, MHz	802.11a/n 20MHz Channels		802.11n 40MHz Channels	
100	5500	√	X		
102	5510			√	X
104	5520	√			
108	5540	√			
110	5550			√	X
112	5560	√			
116	5580	√	X		
132	5660	√			
134	5670			√	X
136	5680	√			
140	5700	√	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 v01r04 & 905462 D02 UNII DFS Compliance Procedures New Rules v02).

Both AC mains line-conducted and radiated emissions measurements were performed according to the procedures in ANSI C63.4. 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

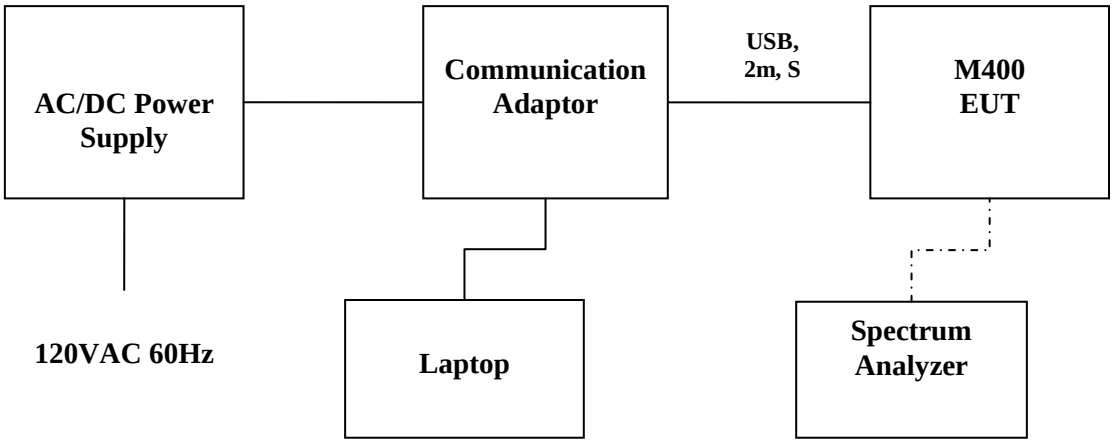
3.1 Support Equipment

Description	Manufacturer	Model No./ Part No.
Laptop	HP	EliteBook 8470p
Communication Adapter	Verifone	NA
AC/DC Power Adapter	I.T.E Power Supply	AU112106u

3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	**Manufacturer**	**Model Number**	**Serial Number**
Electronic Payment Terminal	Verifone	M400	401-148-349

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



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

3.3 Justification

Preliminary testing was performed for all modulation/data rate modes. The following modes, in which the highest power was detected, were selected for final measurements:

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

3.4 Mode of Operation During Test

During transmitter testing, the transmitter was setup to transmit continuously using the maximum RF power setting. Their corresponding output power in dBm can be found in section 4.2 of this report.

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)

4.1.1 Procedure

The Procedure, described in the FCC Publication 789033 D02 General U-NII Test Procedures New Rules v01r04, was used. Specifically Section C for Emission Bandwidth and Minimum Emission Bandwidth for 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:	Anderson Soungpanya
Test Date:	May 1, 2017

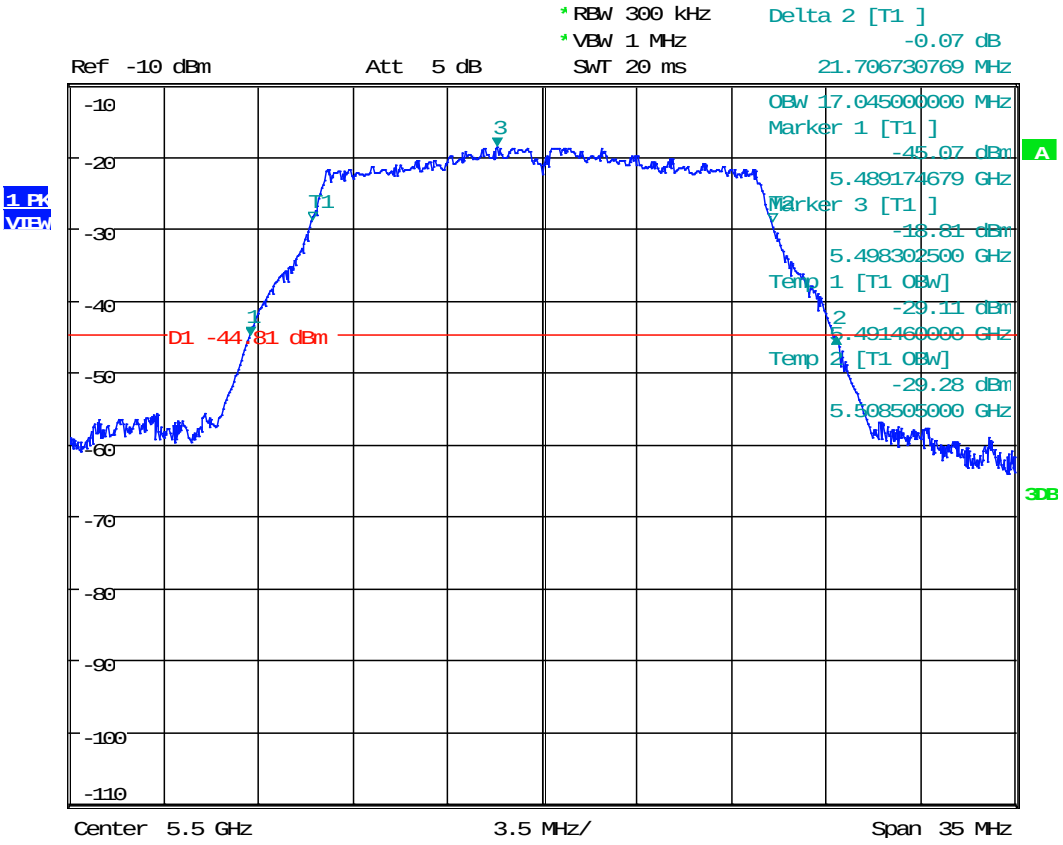
4.1.2 Test Result

Refer to the following plots for the test result:

Mode	Channel	Frequency, MHz	26-dB Bandwidth, MHz	Occupied Bandwidth, MHz	Plot #
802.11a	100	5500	21.71	17.045	1.1
	116	5580	21.59	17.063	1.2
	140	5700	21.93	17.220	1.3
802.11n 20MHz	100	5500	21.71	18.095	1.4
	116	5580	21.59	18.078	1.5
	140	5700	21.93	18.253	1.6
802.11n 40MHz	102	5510	40.00	36.270	1.7
	110	5550	40.00	36.390	1.8
	134	5670	40.13	36.450	1.9

Plot 1. 1

802.11a 5500MHz



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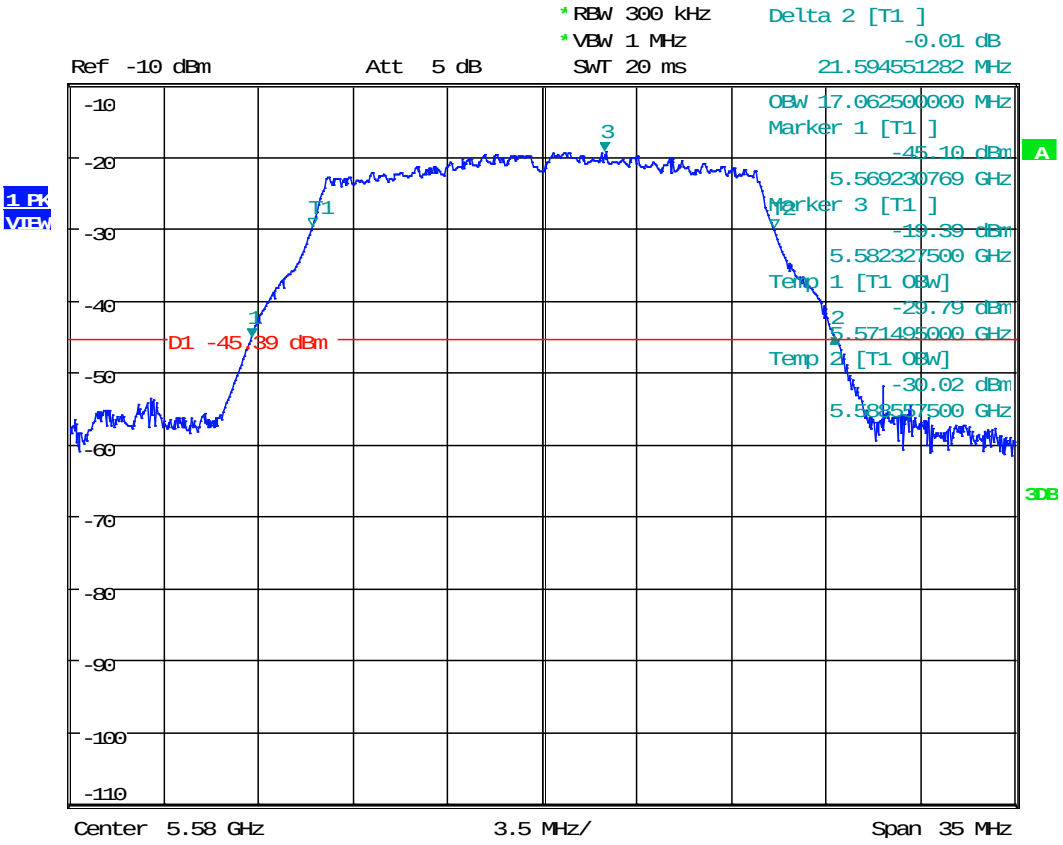
Plot 1. 2

802.11a 5580MHz



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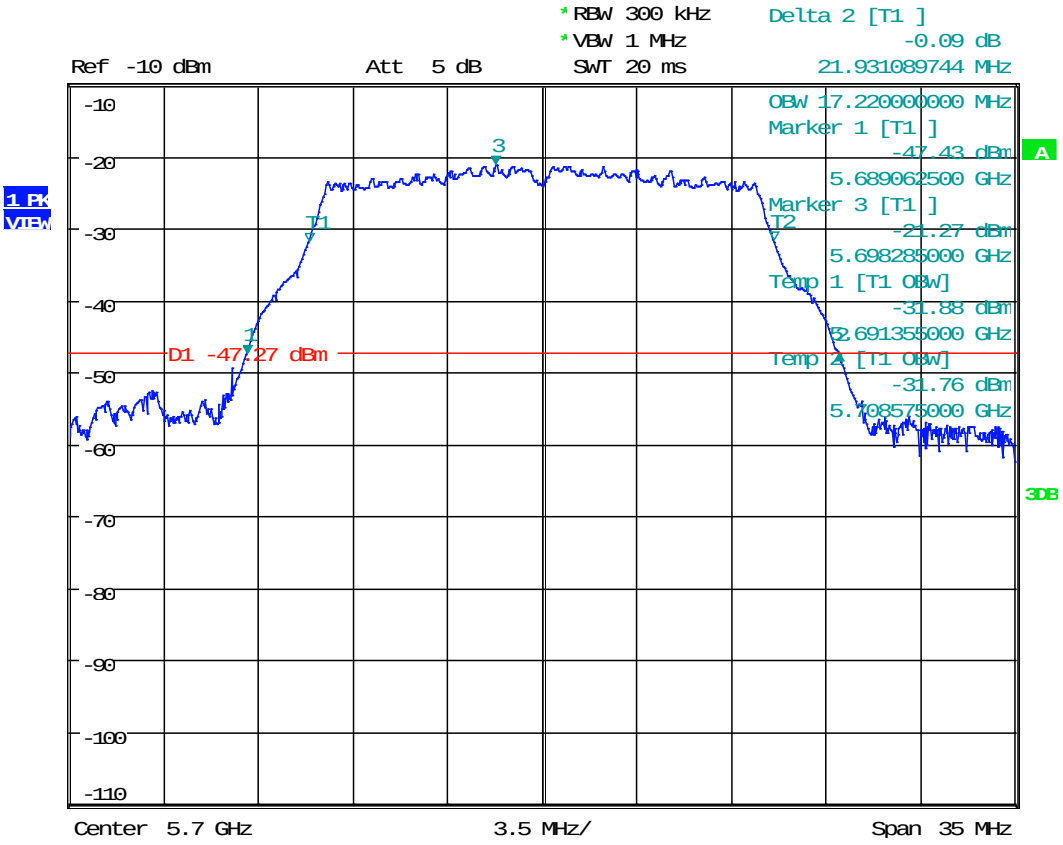
Plot 1. 3

802.11a 5700MHz



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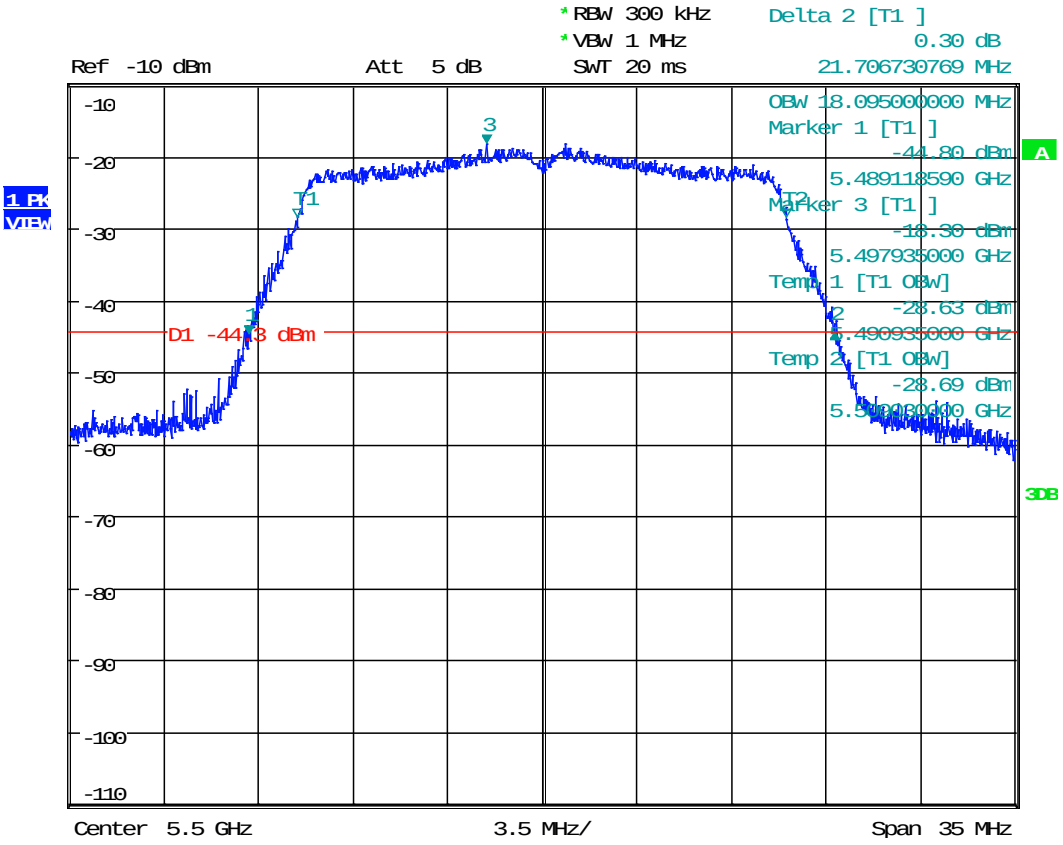
Plot 1. 4

802.11n 20MHz, 5500MHz



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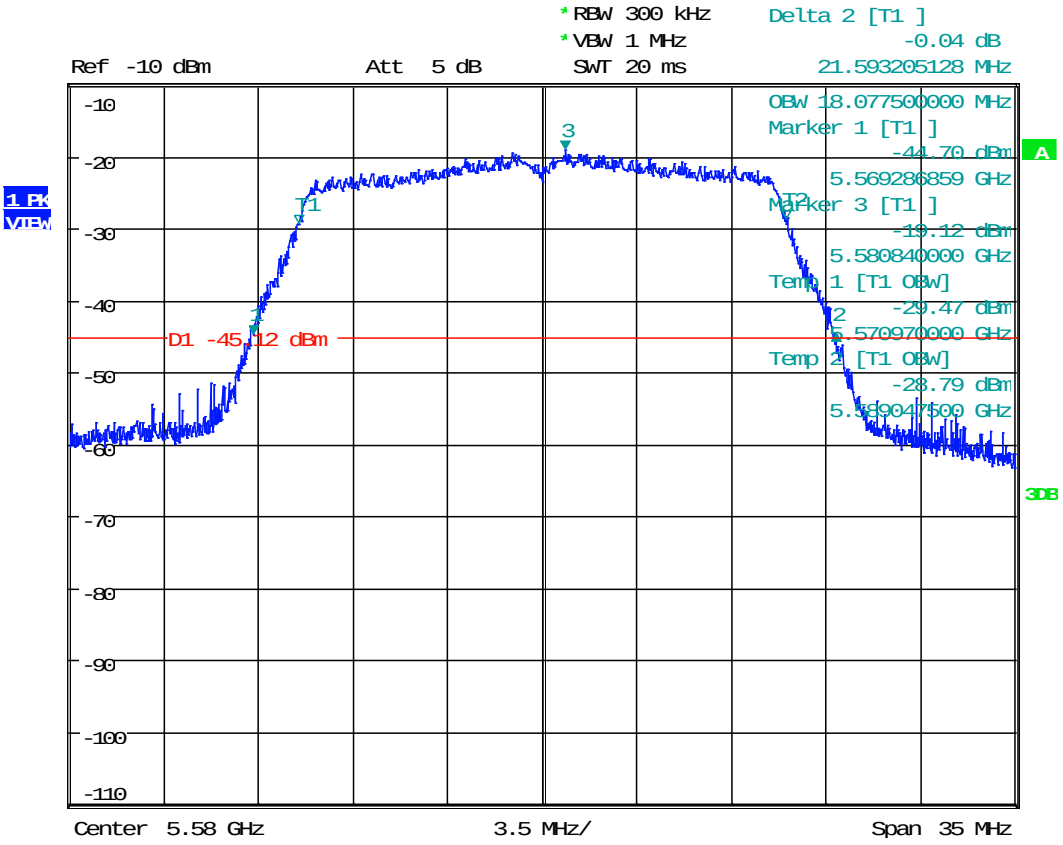
Plot 1. 5

802.11n 20MHz, 5580MHz



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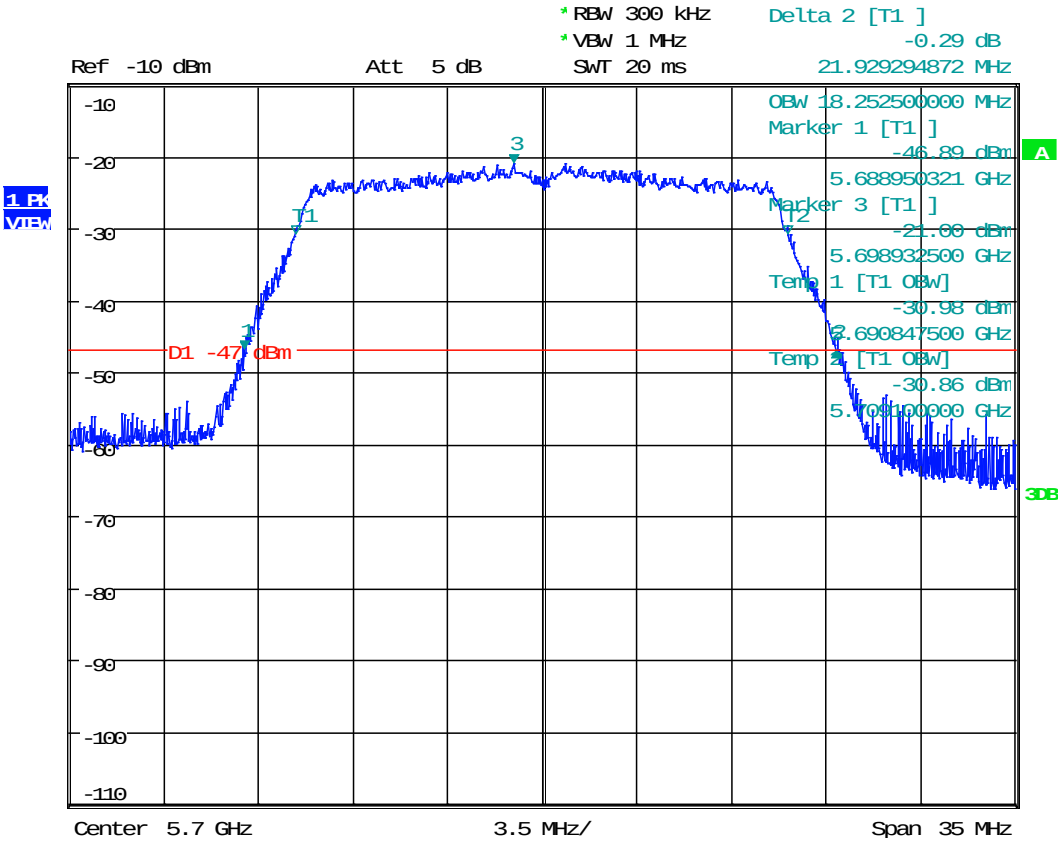
Plot 1. 6

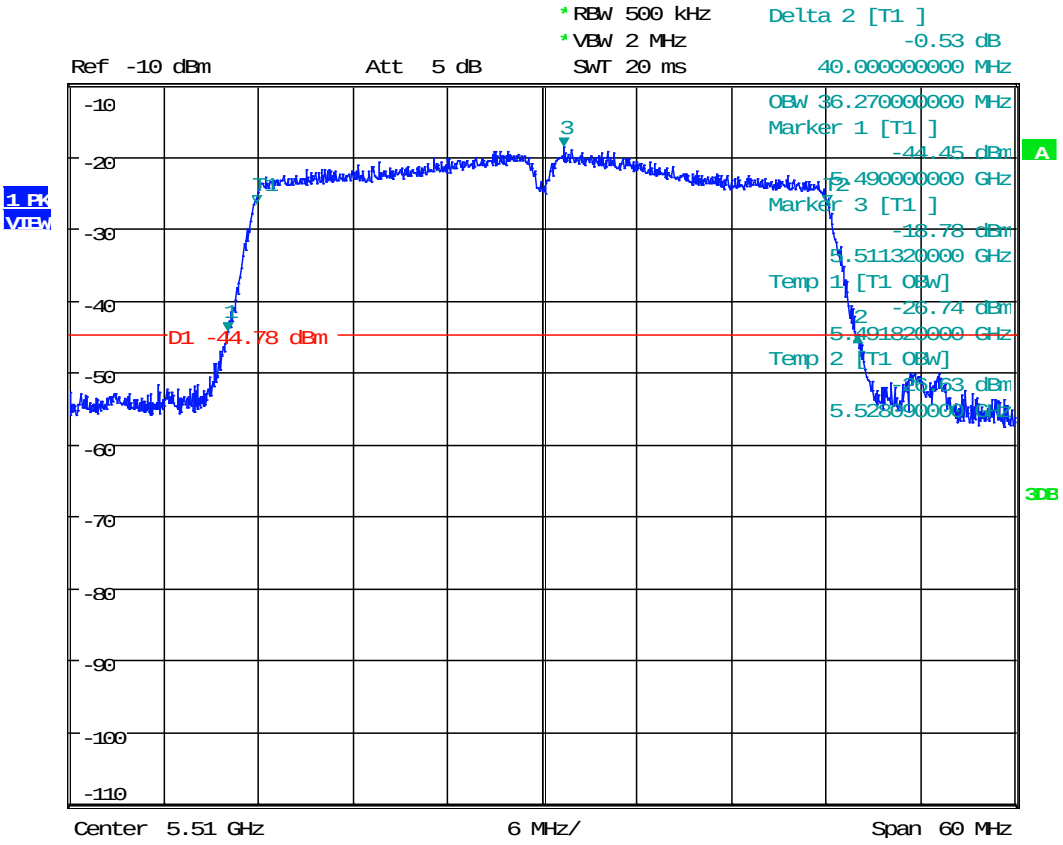
802.11n 20MHz, 5700MHz



Date: 1.MAY.2017 09:23:12

Plot 1. 7

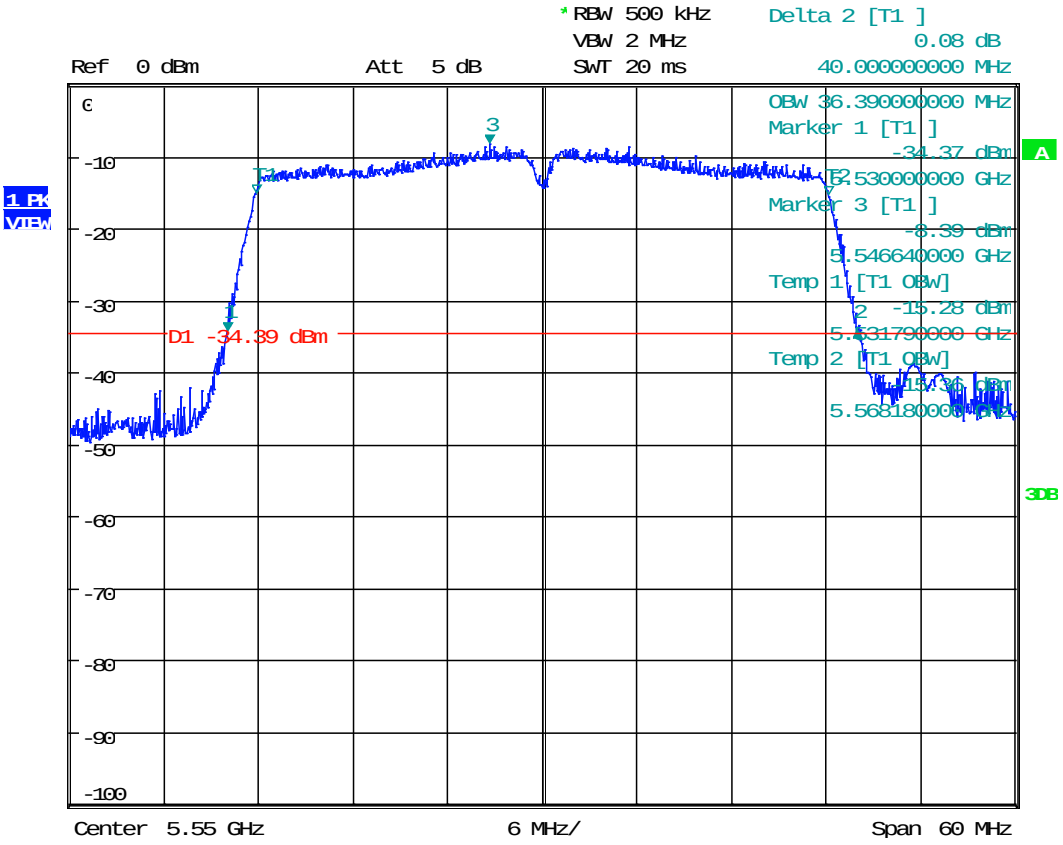
802.11n 40MHz, 5510MHz



Date: 1.MAY.2017 10:27:21

Plot 1. 8

802.11n 40MHz, 5550MHz



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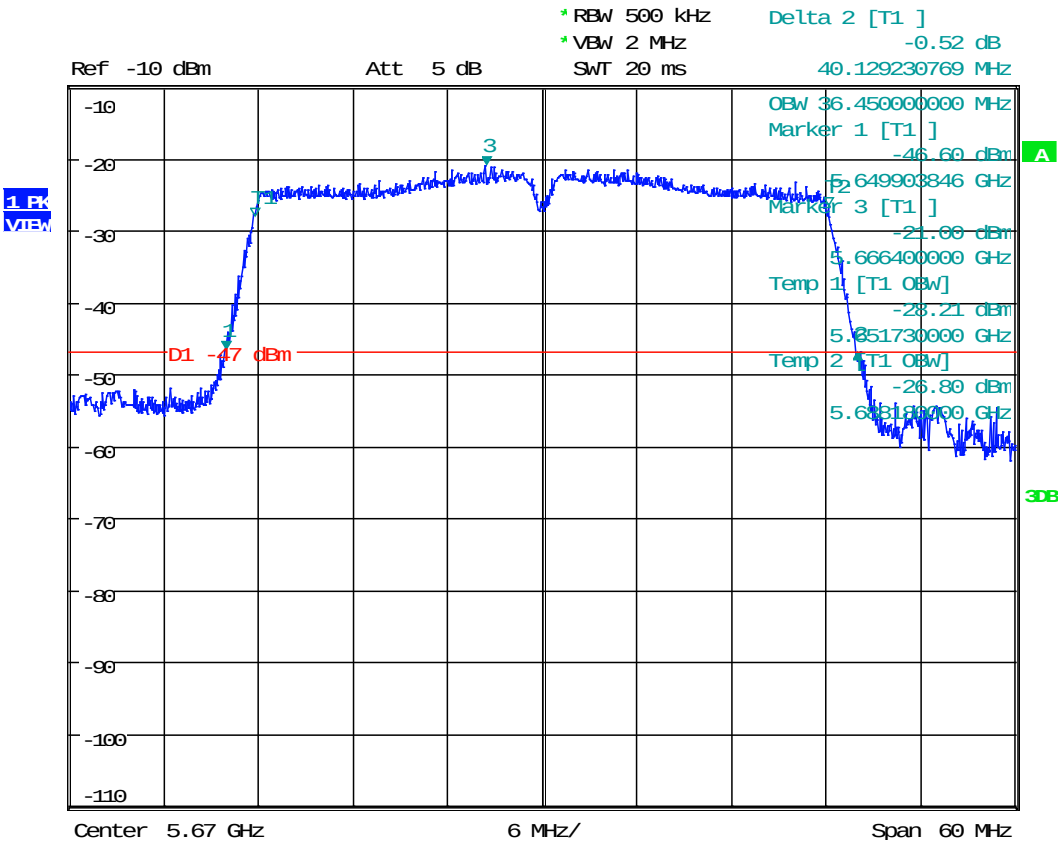
Plot 1. 9

802.11n 40MHz, 5670MHz



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4.2 Maximum Conducted Output Power
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 v01r04, was used. Specifically Section E (2) (c) Method SA-1 Alternative for Maximum Conducted Output Power

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

Tested By:	Anderson Soungpanya
Test Date:	June 7-8, 2017

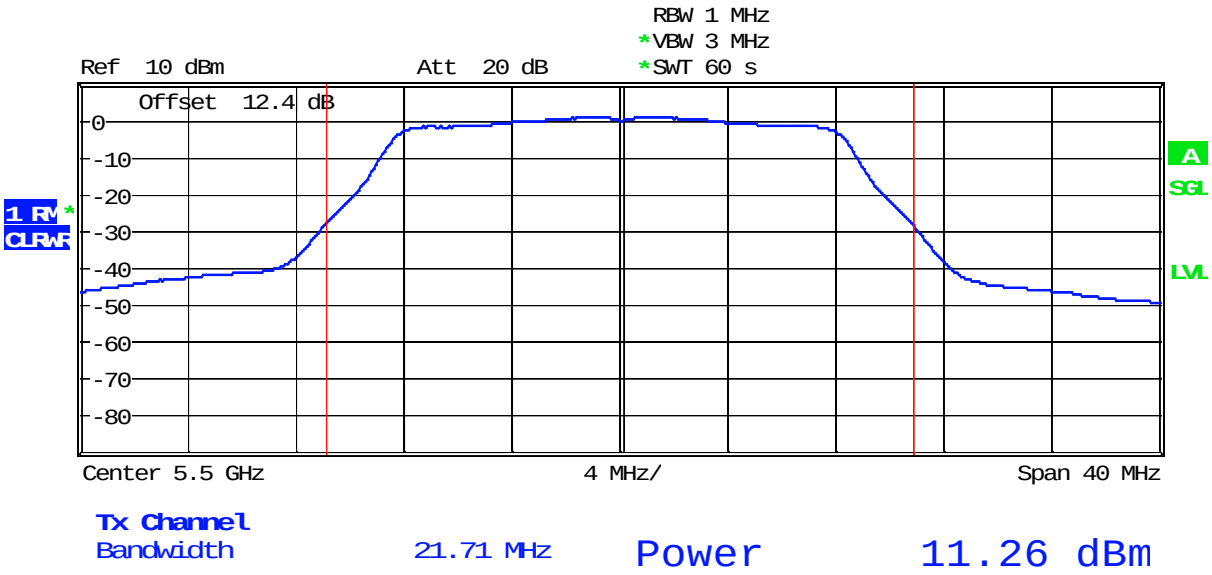
4.2.3 Test Results

Refer to the following plots for the test result:

Mode	Channel	Frequency, MHz	Conducted power (average) dBm	Conducted power Limit dBm	Plot #
802.11a	100	5500	11.26	24	2.1
	116	5580	11.68	24	2.2
	140	5700	11.13	24	2.3
802.11n 20MHz	100	5500	11.09	24	2.4
	116	5580	11.57	24	2.5
	140	5700	10.81	24	2.6
802.11n 40MHz	102	5510	11.11	24	2.7
	110	5550	11.56	24	2.8
	134	5670	10.75	24	2.9

Plot 2. 1

802.11a, 5500MHz



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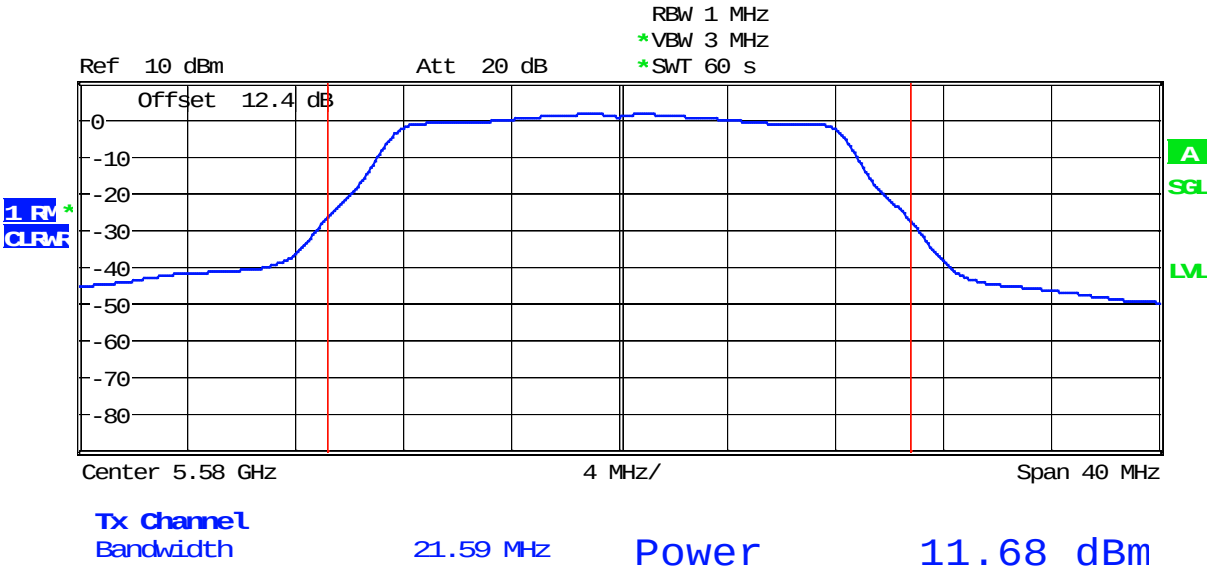
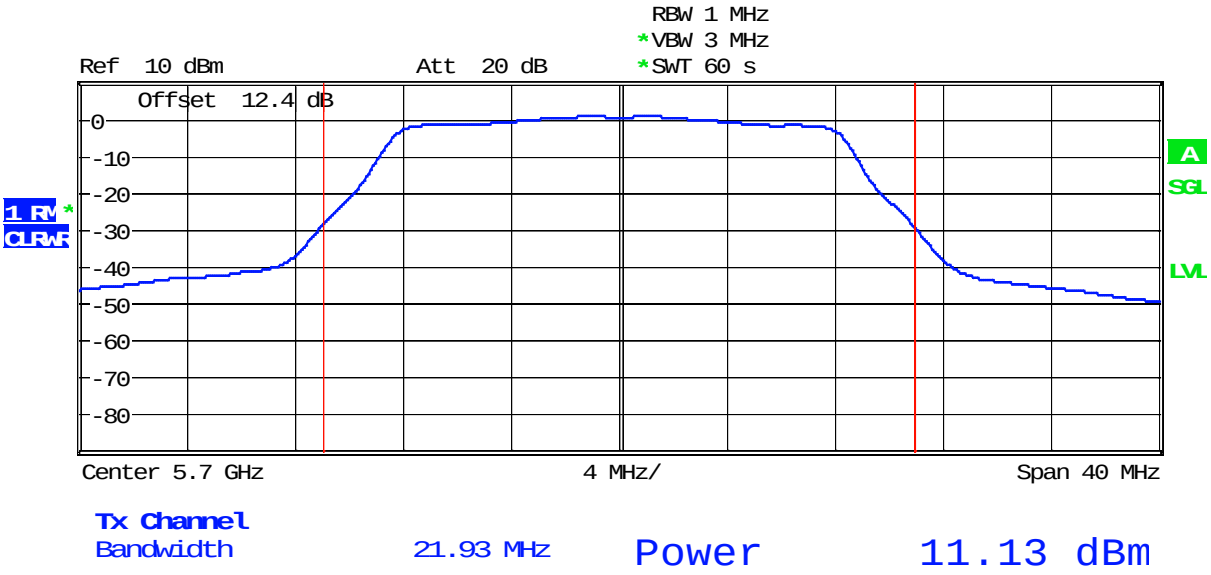
Plot 2. 2

802.11a, 5580MHz



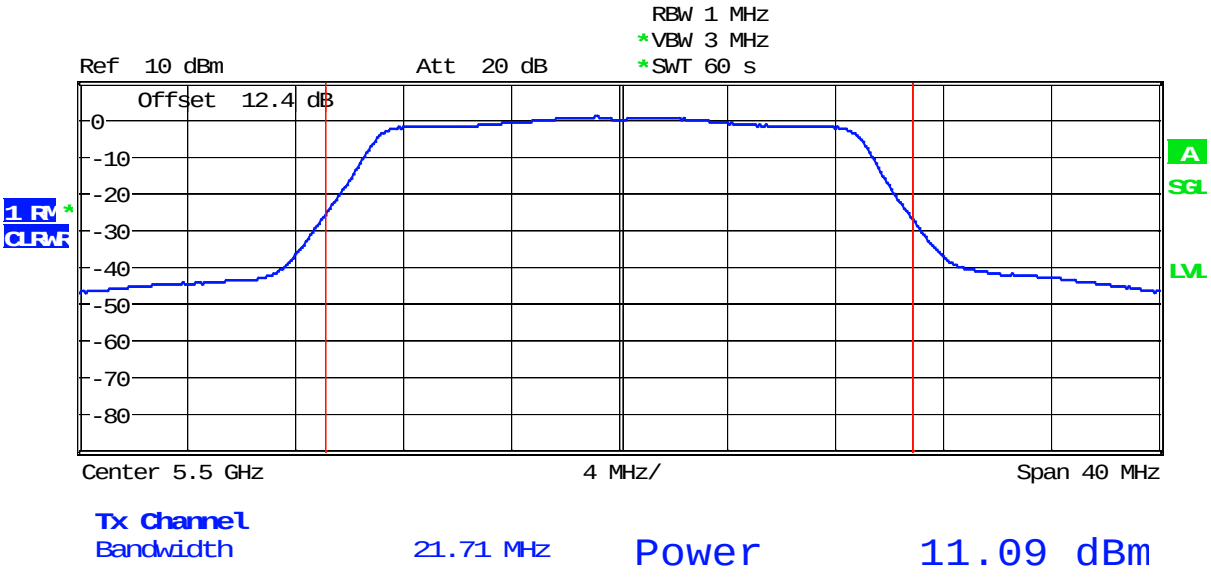
Plot 2. 3

802.11a, 5700MHz



Plot 2. 4

802.11n 20MHz, 5500MHz



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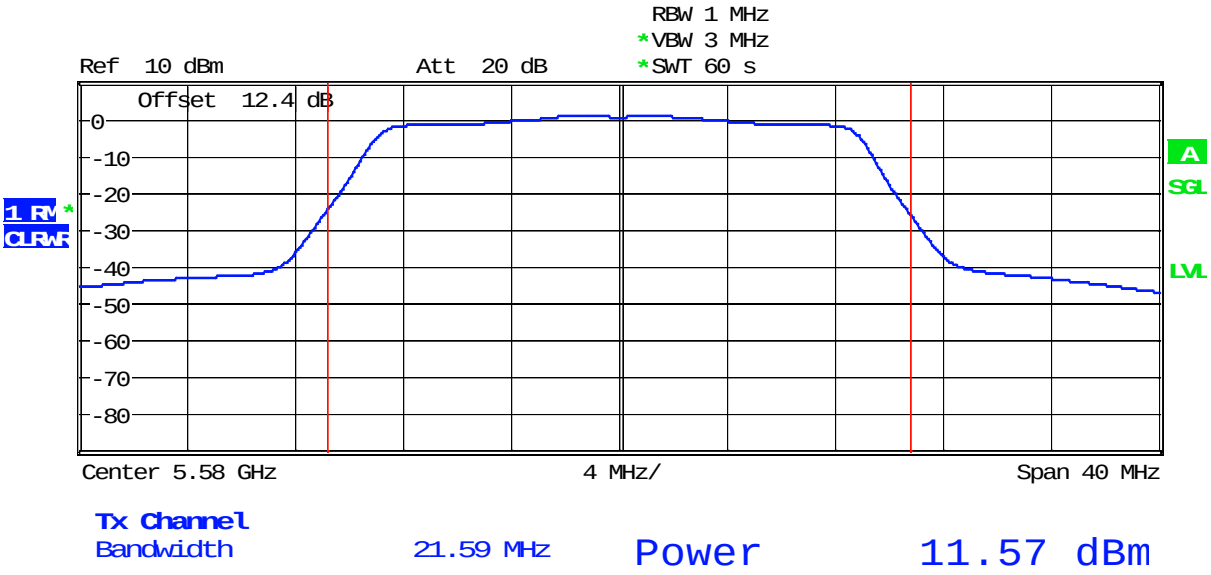
Plot 2. 5

802.11n 20MHz, 5580MHz



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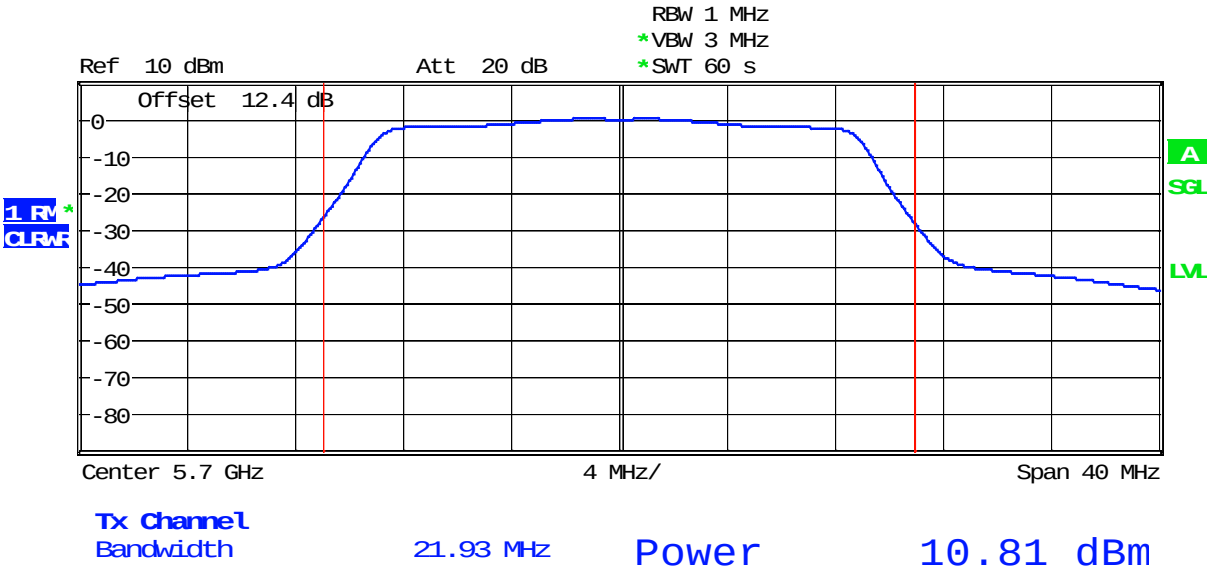
Plot 2. 6

802.11n 20MHz, 5700MHz



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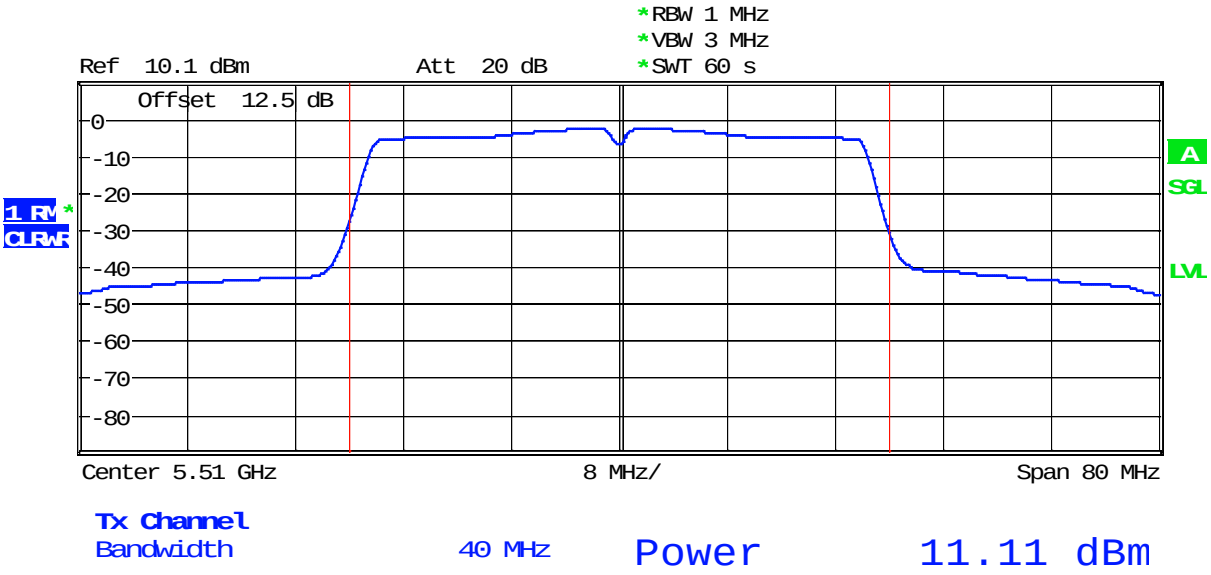
Plot 2. 7

802.11n 40MHz, 5510MHz



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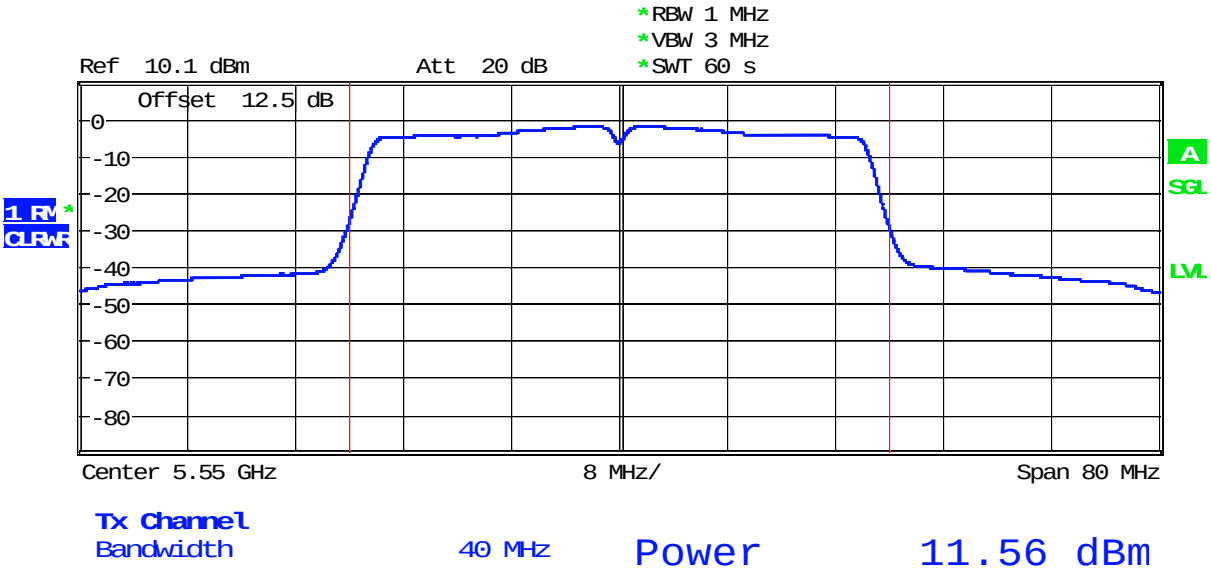
Plot 2. 8

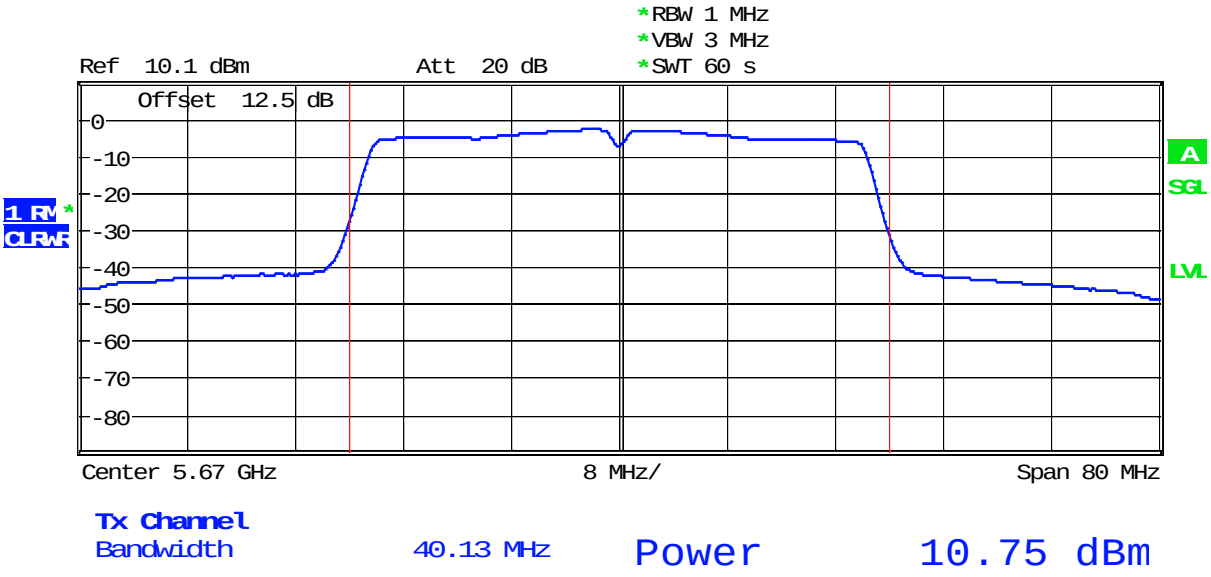
802.11n 40MHz, 5550MHz



Date: 9.JUN.2017 12:51:38

Plot 2. 9

802.11n 40MHz, 5670MHz



Date: 8.JUN.2017 13:43:57

4.3 Peak Power Spectral Density
FCC Rule 15.407(a)(1)(iv)

4.3.1 Requirement

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.

4.3.2 Procedure

Each antenna port of the EUT was connected to the input of a spectrum analyzer to measure the Peak Power Spectral Density (PPSD) and recorded.

The Procedure, described in the FCC Publication 789033 D02 General U-NII Test Procedures New Rules v01r04, was used. Specifically procedure from Section F was utilized for Maximum Power Spectral Density (PSD).

Tested By:	Anderson Soungpanya
Test Date:	June 9, 2017

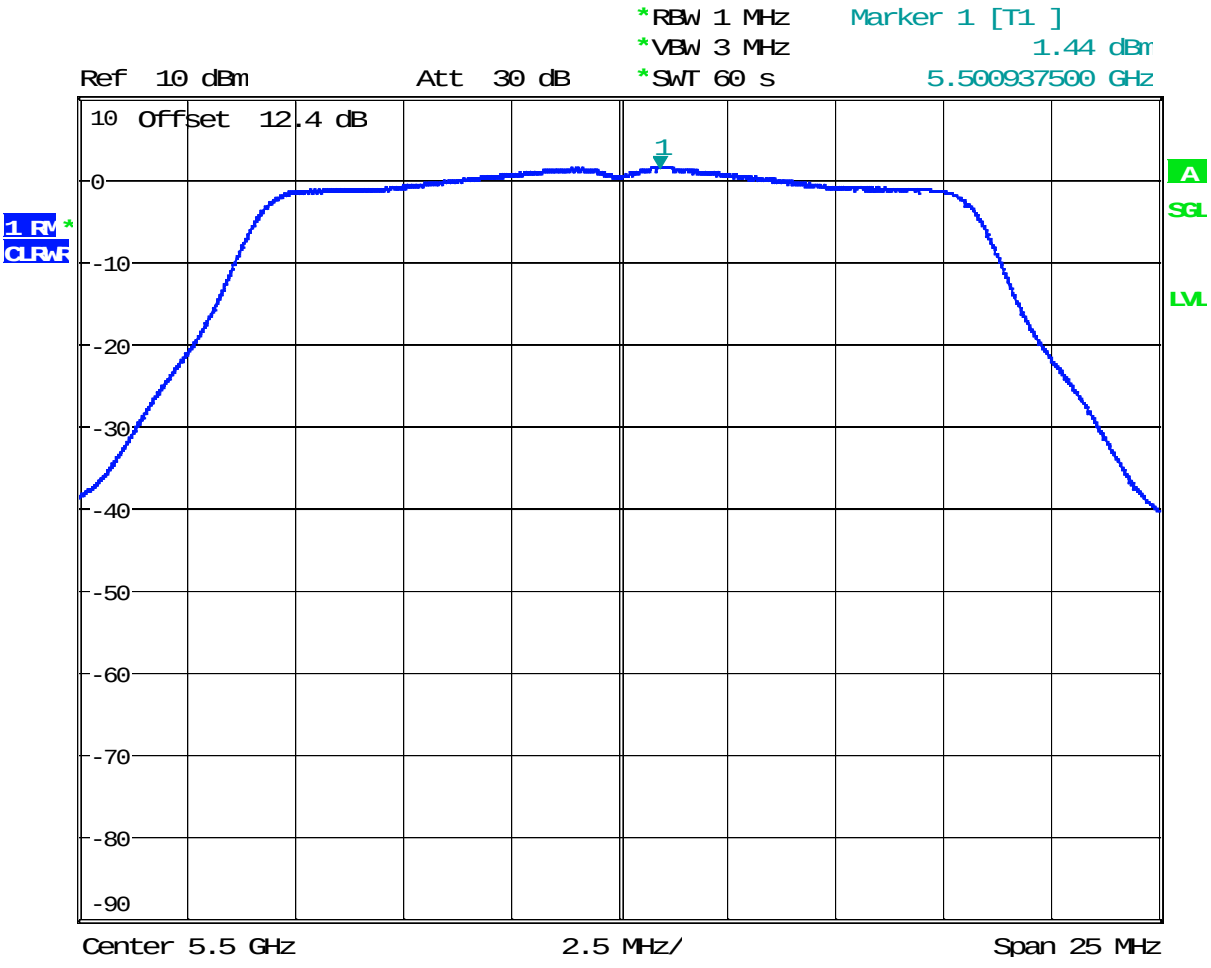
4.3.3 Test Result

Refer to the following plots for the test result:

Mode	Channel	Frequency, MHz	PSD(Peak) dBm	PSD Limit dBm	Plot #
802.11a	100	5500	1.44	11	3.1
	116	5580	1.68	11	3.2
	140	5700	0.78	11	3.3
802.11n 20MHz	100	5500	0.78	11	3.4
	116	5580	0.86	11	3.5
	140	5700	0.03	11	3.6
802.11n 40MHz	102	5510	-2.41	11	3.7
	110	5550	-2.19	11	3.8
	134	5670	-2.72	11	3.9

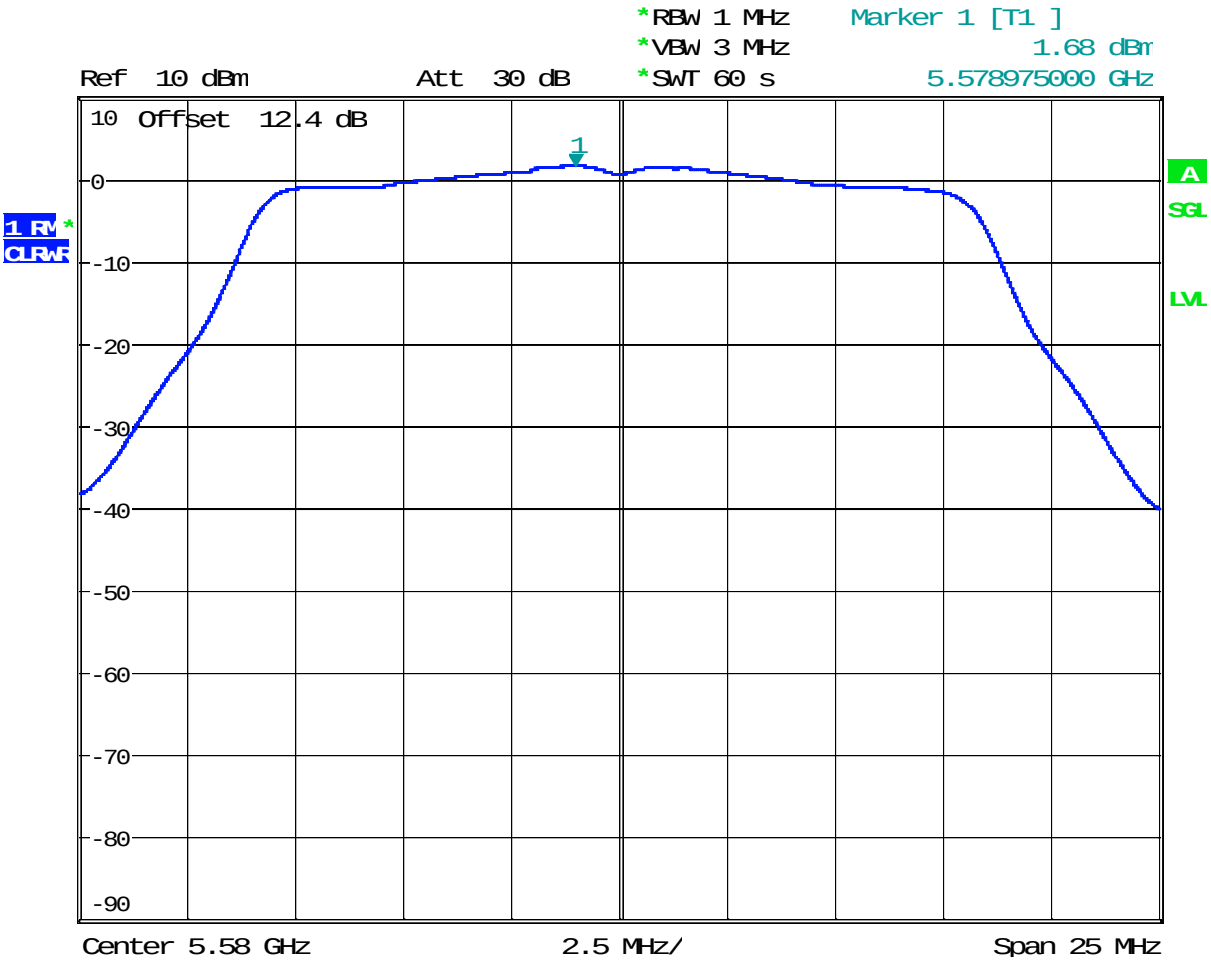
Plot 3. 9

802.11a, 5500MHz



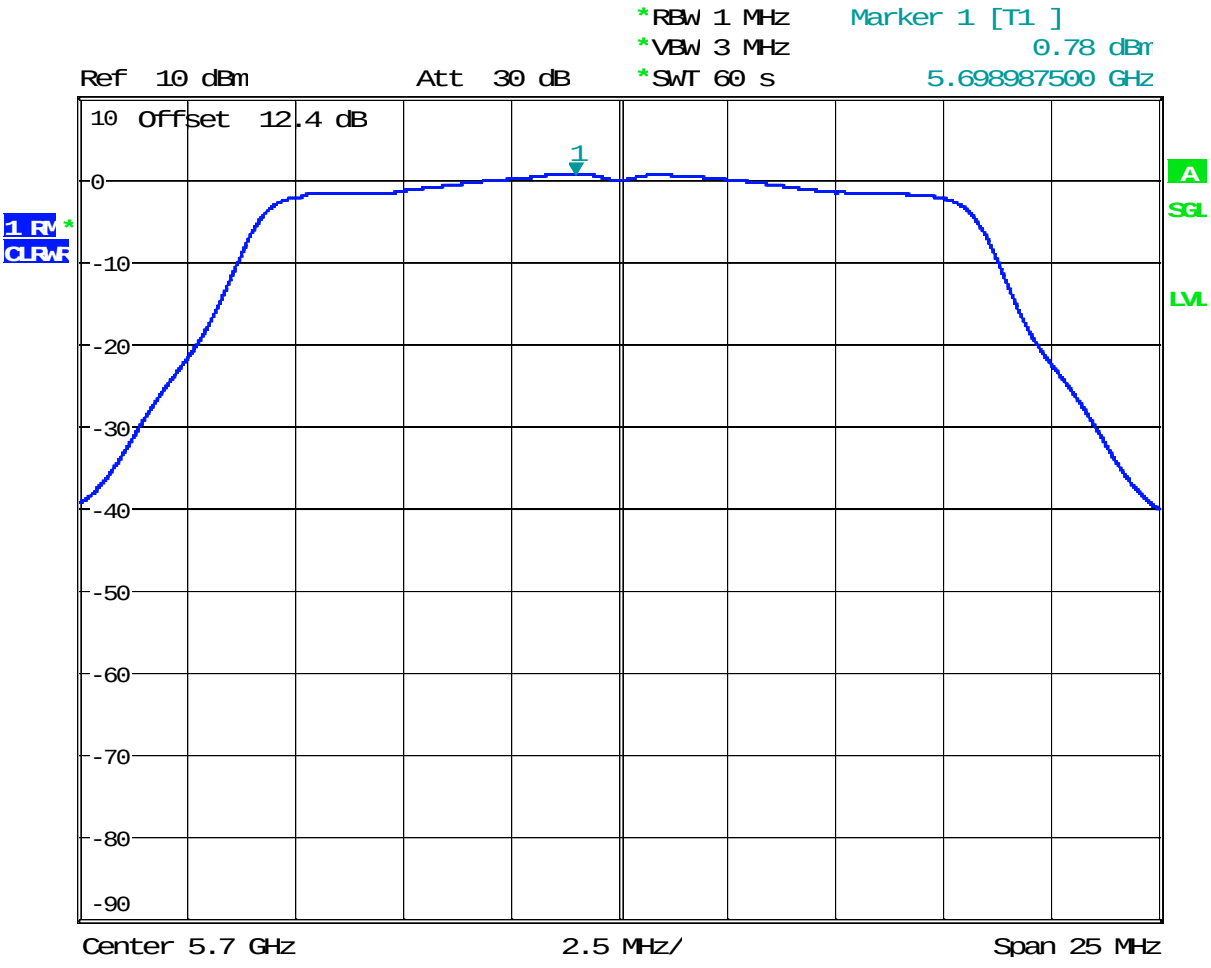
Plot 3. 10

802.11a, 5580MHz



Plot 3. 11

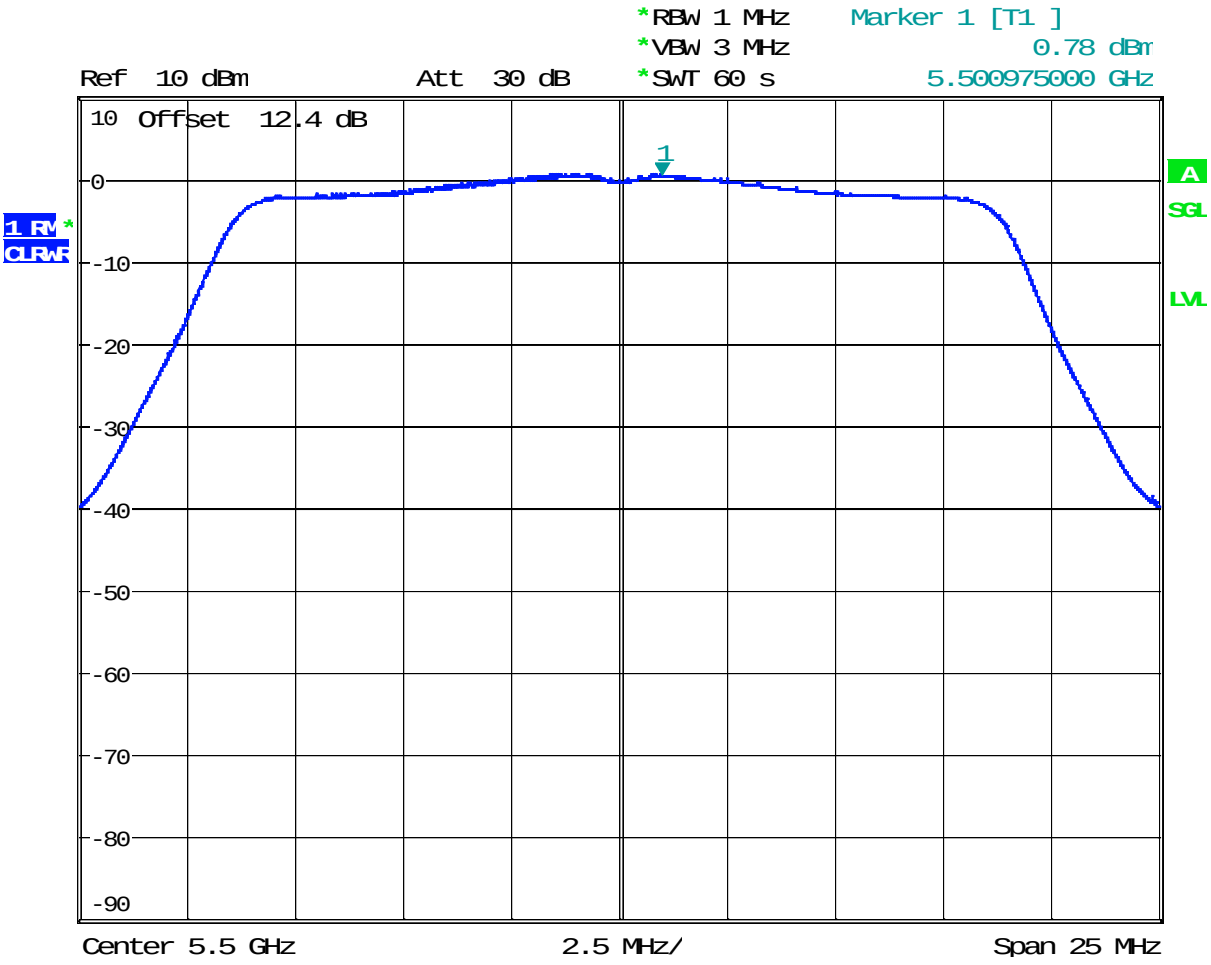
802.11a, 5700MHz



Date: 9.JUN.2017 10:56:12

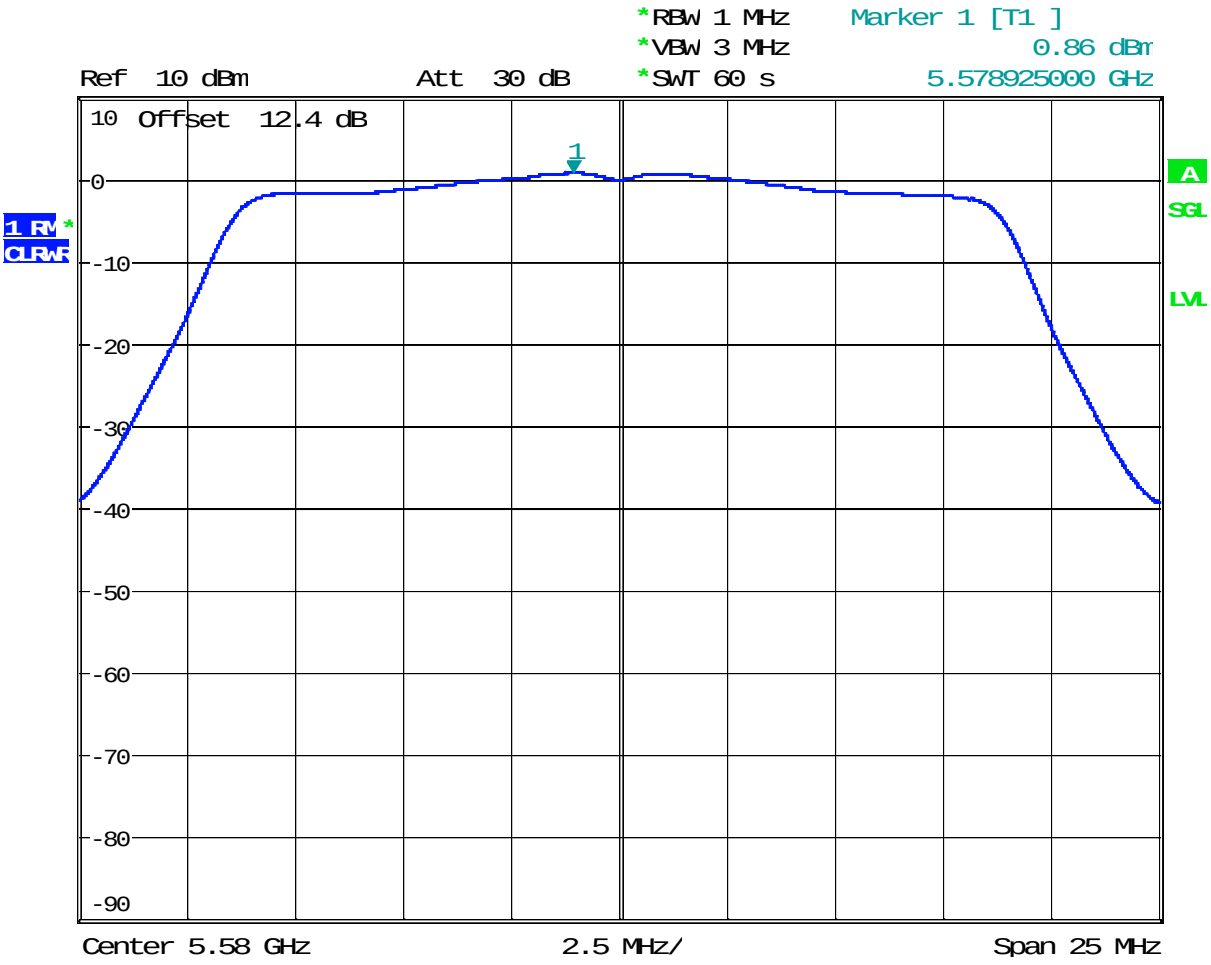
Plot 3. 12

802.11n 20MHz, 5500MHz



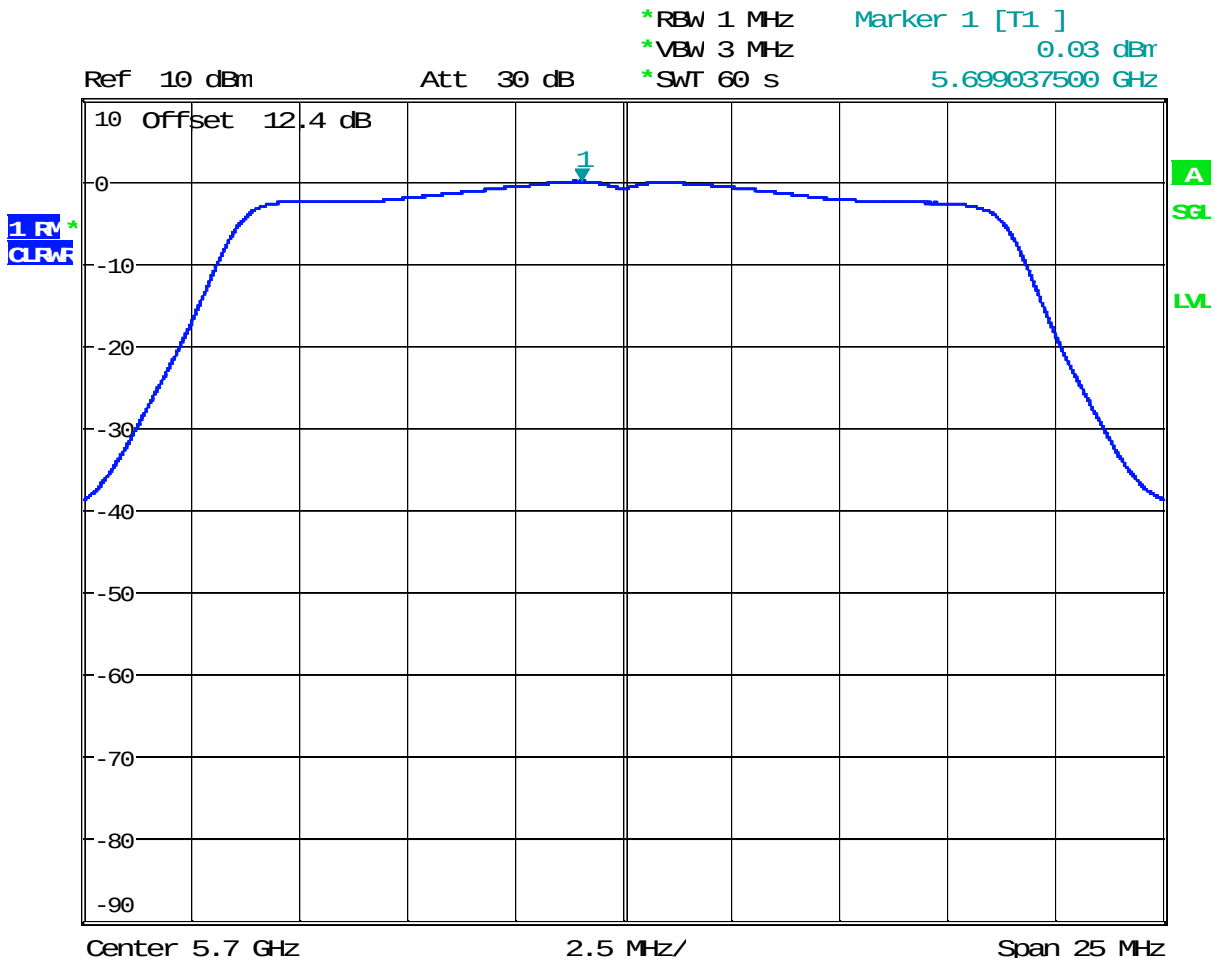
Plot 3. 13

802.11n 20MHz, 5580MHz



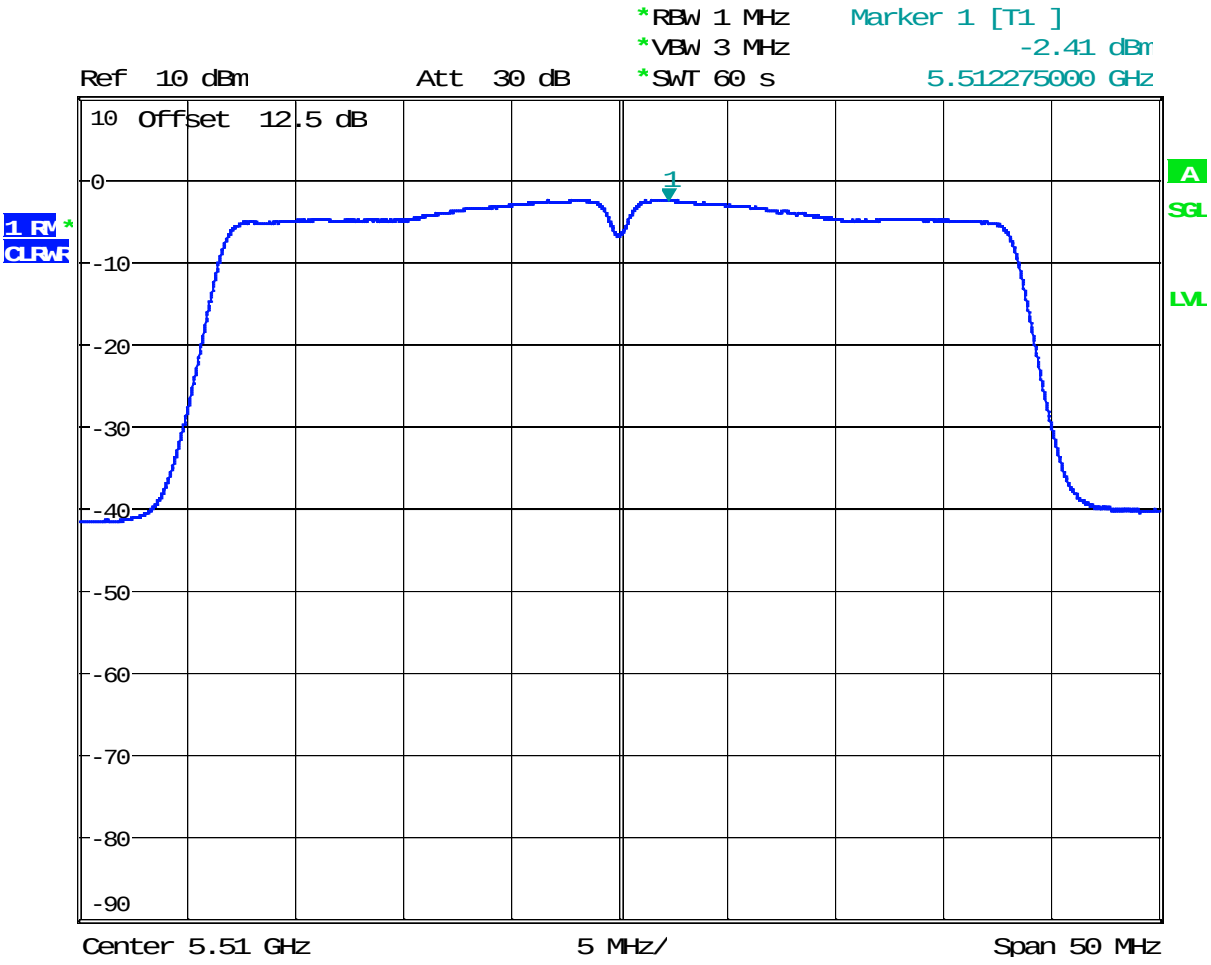
Plot 3. 14

802.11n 20MHz, 5700MHz



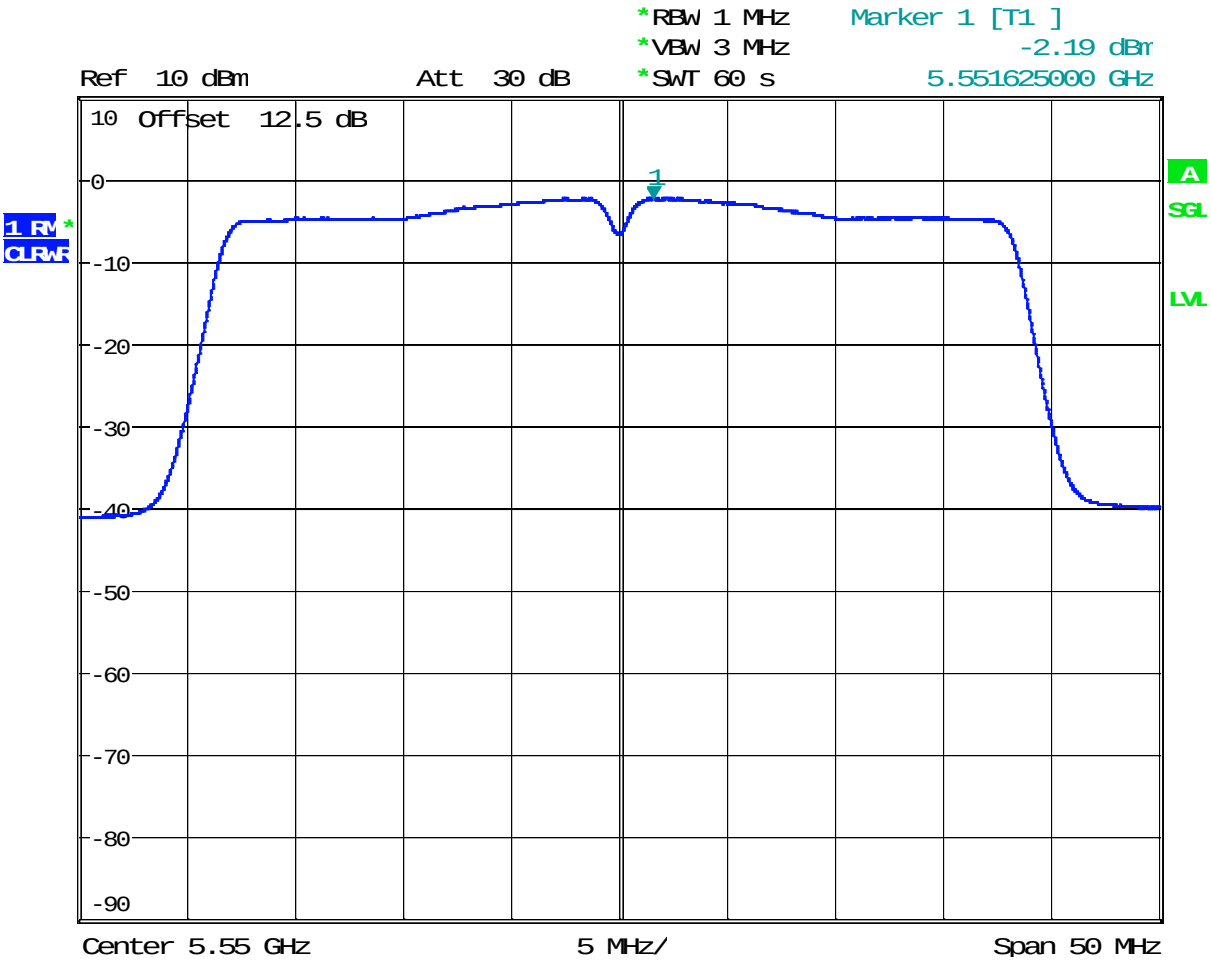
Plot 3. 15

802.11n 40MHz, 5510MHz



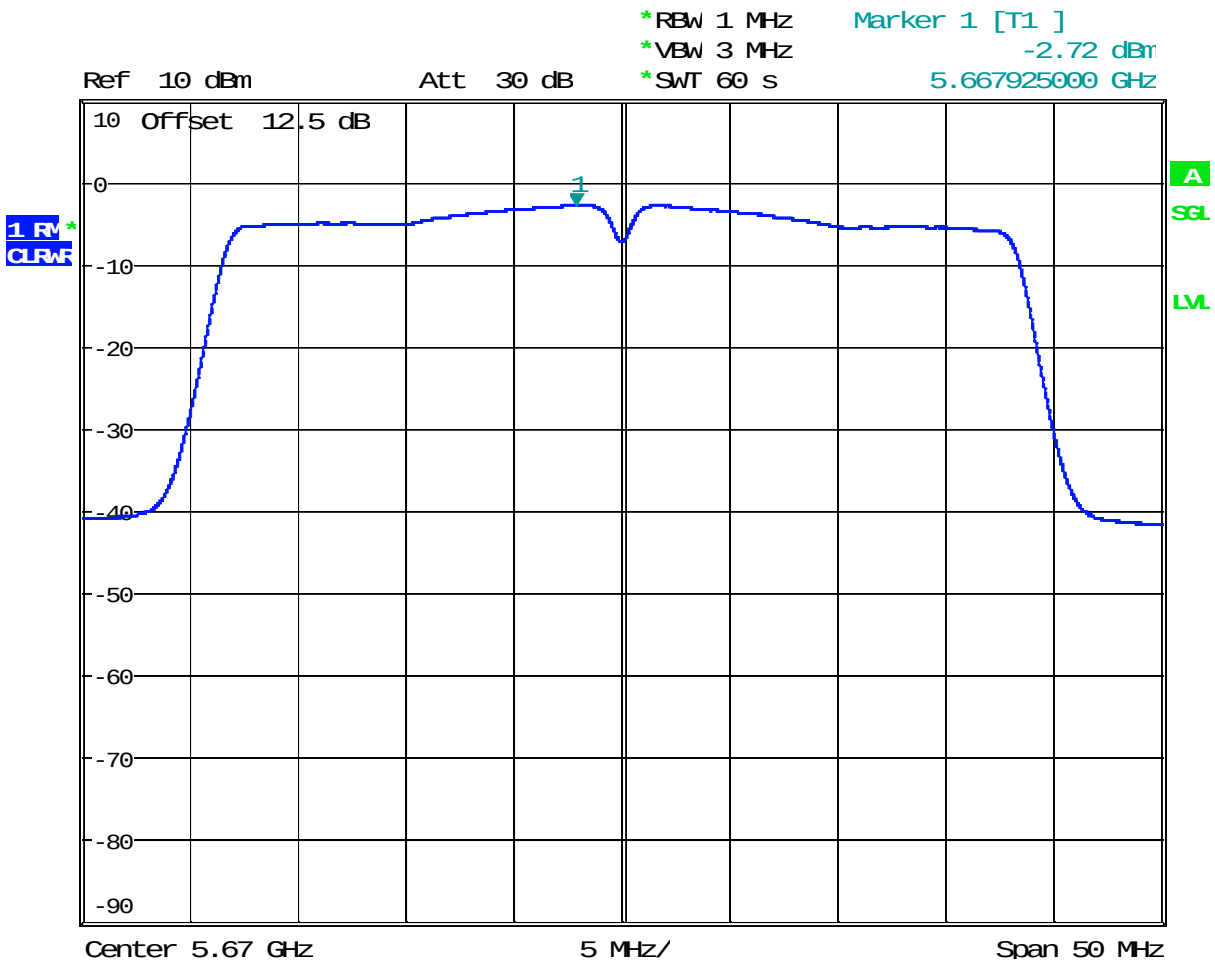
Plot 3. 16

802.11n 40MHz, 5550MHz



Plot 3. 9

802.11n 40MHz, 5670MHz



Date: 9.JUN.2017 12:07:19

4.4 Frequency stability
FCC 15.407(g)

4.4.1 Requirement

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.

4.4.2 Procedure

The EUT was placed in a temperature chamber and setup to transmit. Procedures for frequency stability in ANSIC63.10:2013 section 6.8 was utilized.

The carrier frequency was measured with the spectrum analyzer with resolution bandwidth of 1 kHz. The temperature was varied from -20°C to 75°C, as stated in the user manual.

The radio module in this report is powered by 12.0VDC which was varied to 85% and 115% for testing. Testing was performed at a temperature of 20° C.

After the temperature stabilized for approximately 20 minutes, the transmitting frequency was measured.

Tested By:	Anderson Soungpanya
Test Date:	July 19, 2017

4.4.3 Result

Temperature, ^{0}C	-26dB Band Edge at nominal voltage, (MHz)	Maximum deviation from frequency at 20°C, ppm
Nominal Frequency: 5700 MHz		
75	5489.142564	13.125
70	5489.132244	11.245
60	5489.112515	7.650
50	5489.112131	7.581
40	5489.095150	4.487
30	5489.084547	2.555
20	5489.070521	0.000
10	5489.070015	0.092
0	5489.017750	9.614
-10	5489.009128	11.185
-20	5489.001850	12.510
Voltage at 20^{0}C	**-26dB Band Edge at nominal voltage, (MHz)**	**Maximum deviation from frequency at 20°C, ppm**
12V – 15%	5489.063457	1.287
12V + 15%	5489.064440	1.108

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

4.5.1 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.

4.5.2 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 limits for 1GHz – 40 GHz.

EUT was positioned vertically and horizontally and emissions were measured. Data and pictures recorded below is the worst-case configuration (the configuration which resulted in the highest emission levels).

4.5.3 Field Strength Calculation

Field Strength Calculation

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

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

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

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

4.5.4 Antenna-port conducted measurements

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

4.5.6 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

4.5.7 Test Results

The data on the following pages list the significant emission frequencies, the limit and the margin of compliance where emissions are within 3dB of the limit.

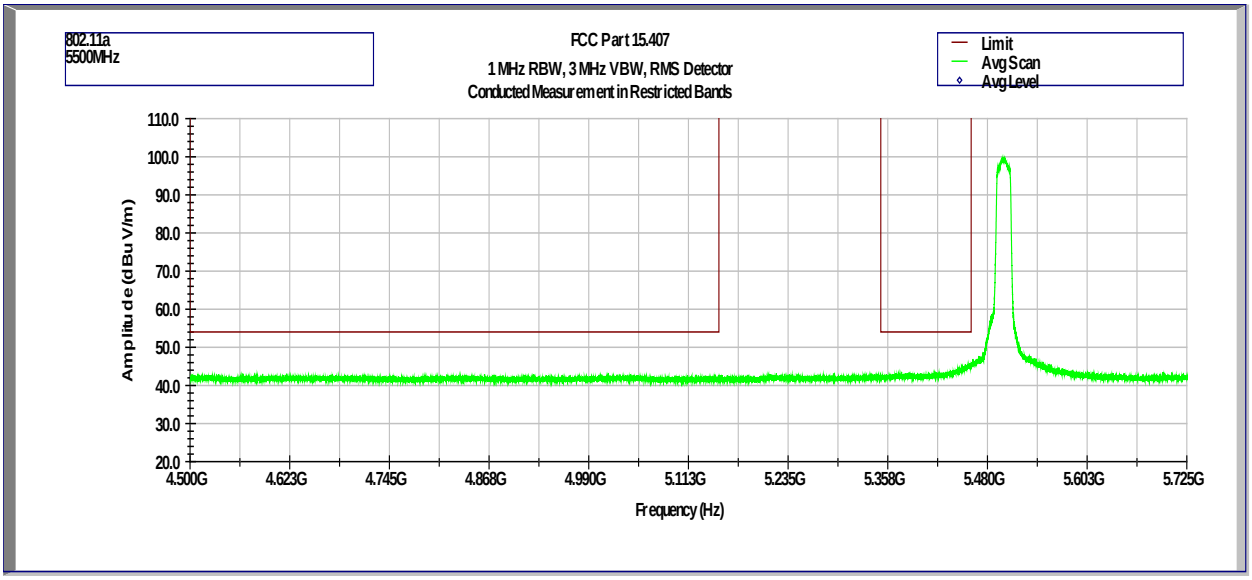
All conducted antenna port plots are corrected with the consideration of a 3.0 dBi Antenna Gain.

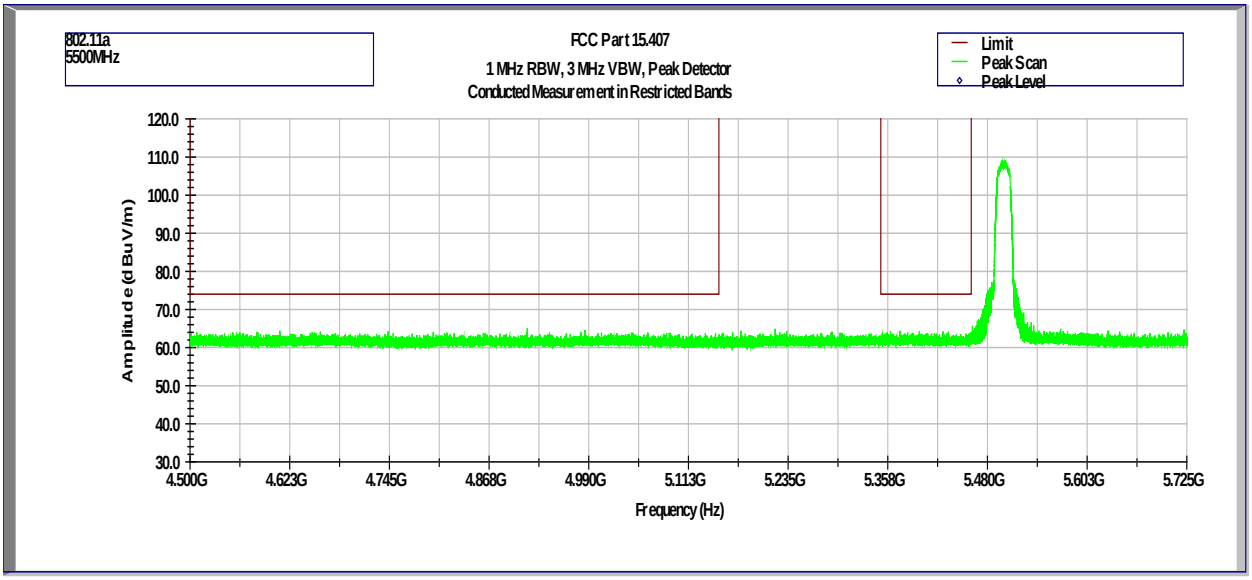
Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz.

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

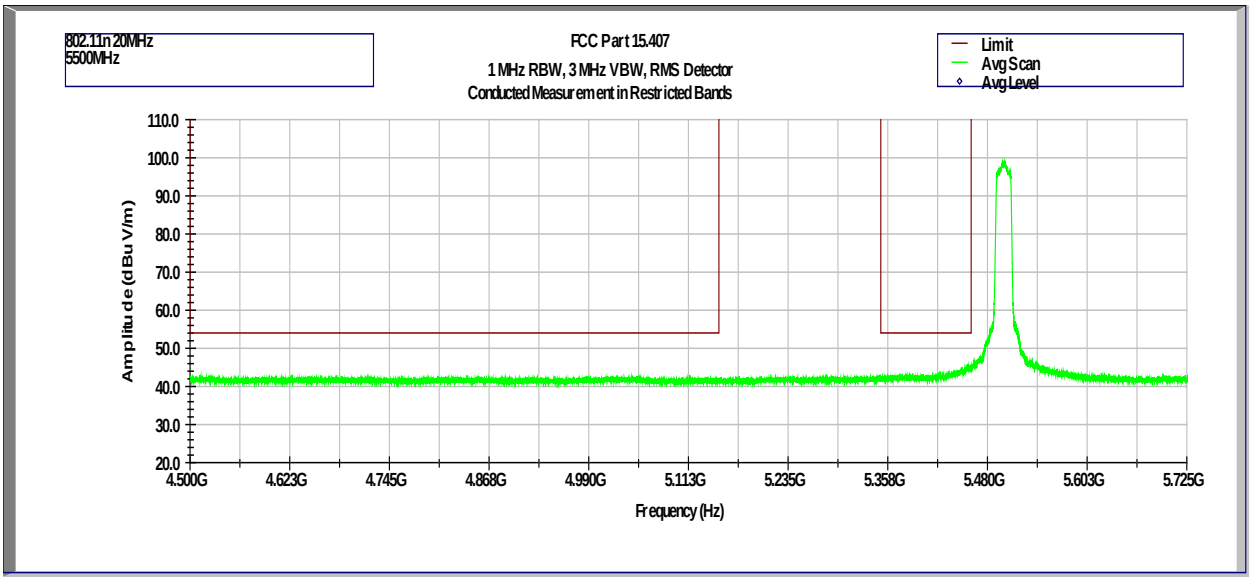
Tested By:	Anderson Soungpanya
Test Date:	June 9-20, 2017

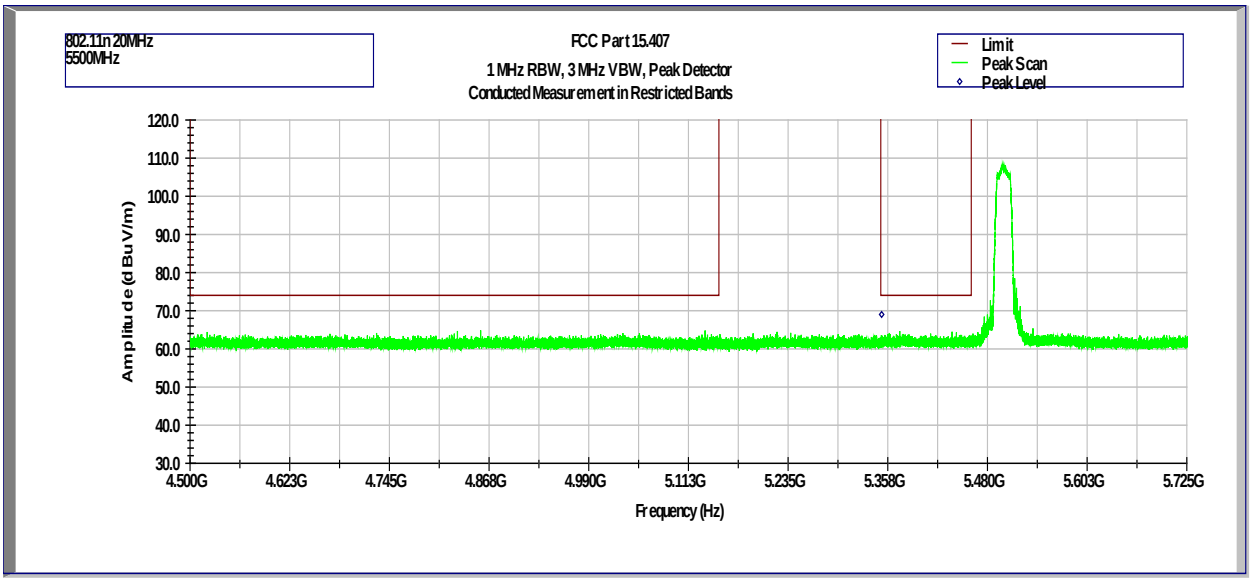
Out-of-Band Spurious Emissions at the Band Edge - 802.11a, 5500 MHz



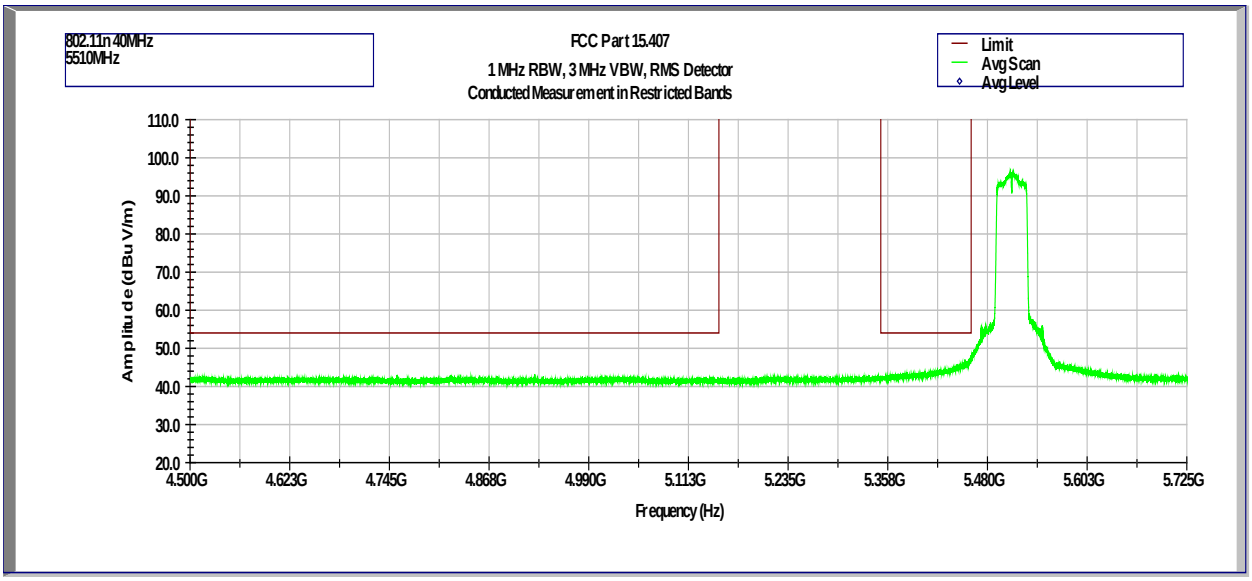


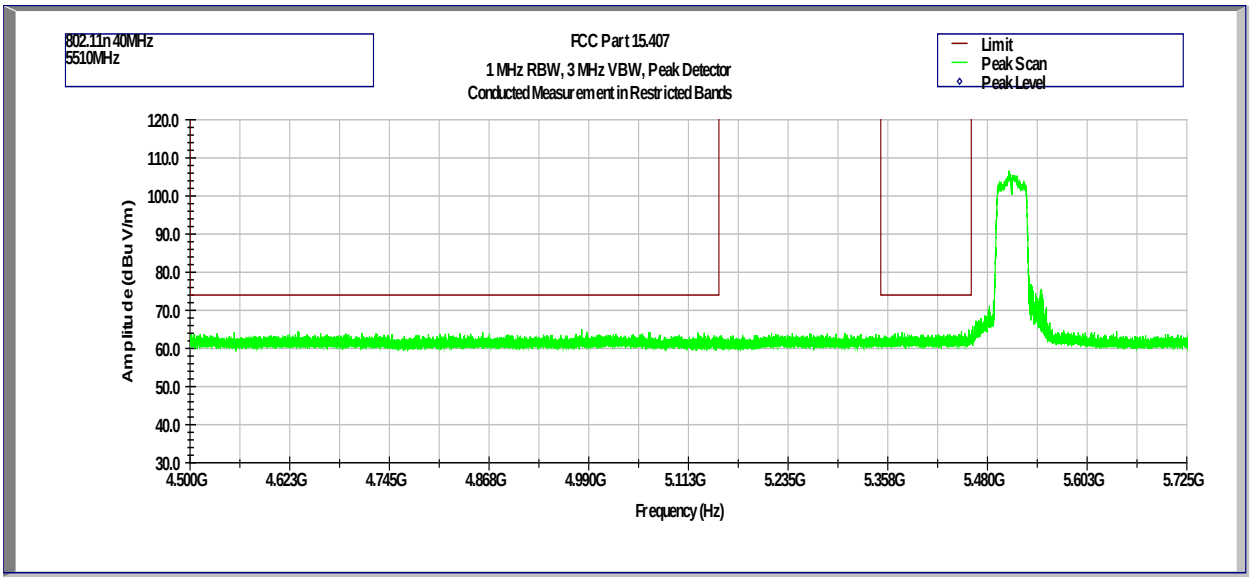
Out-of-Band Spurious Emissions at the Band Edge - 802.11n 20MHz, 5500 MHz





Out-of-Band Spurious Emissions at the Band Edge - 802.11n 40MHz, 5510 MHz

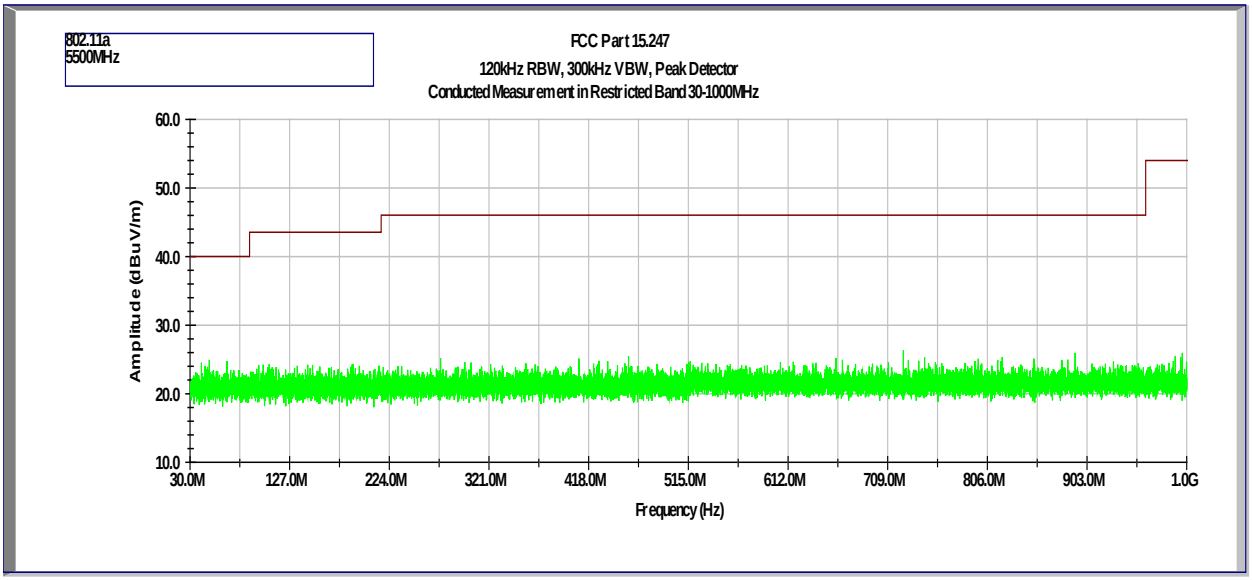




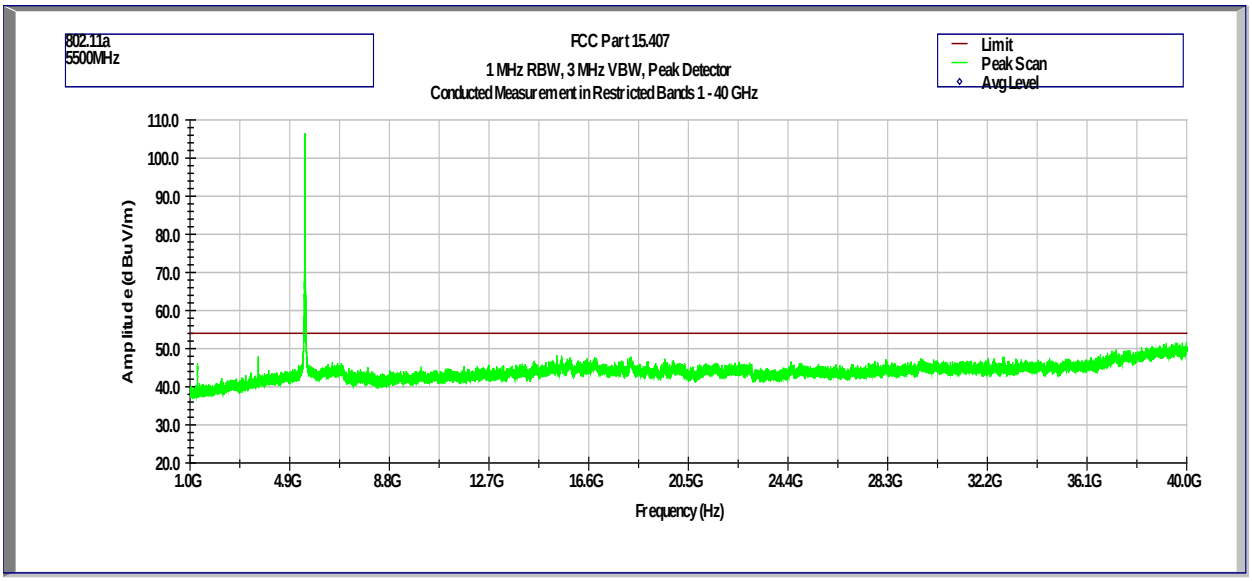
Out-of-Band Conducted Spurious Emissions (at Antenna Port)

Tx @ 5500MHz 802.11a

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

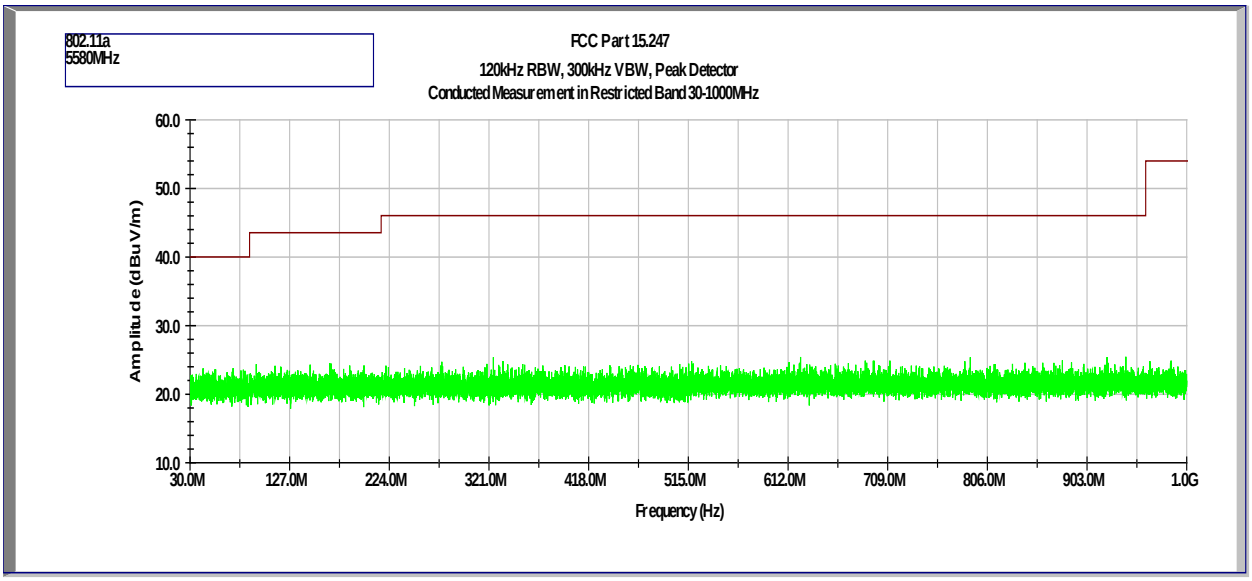


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 40 GHz

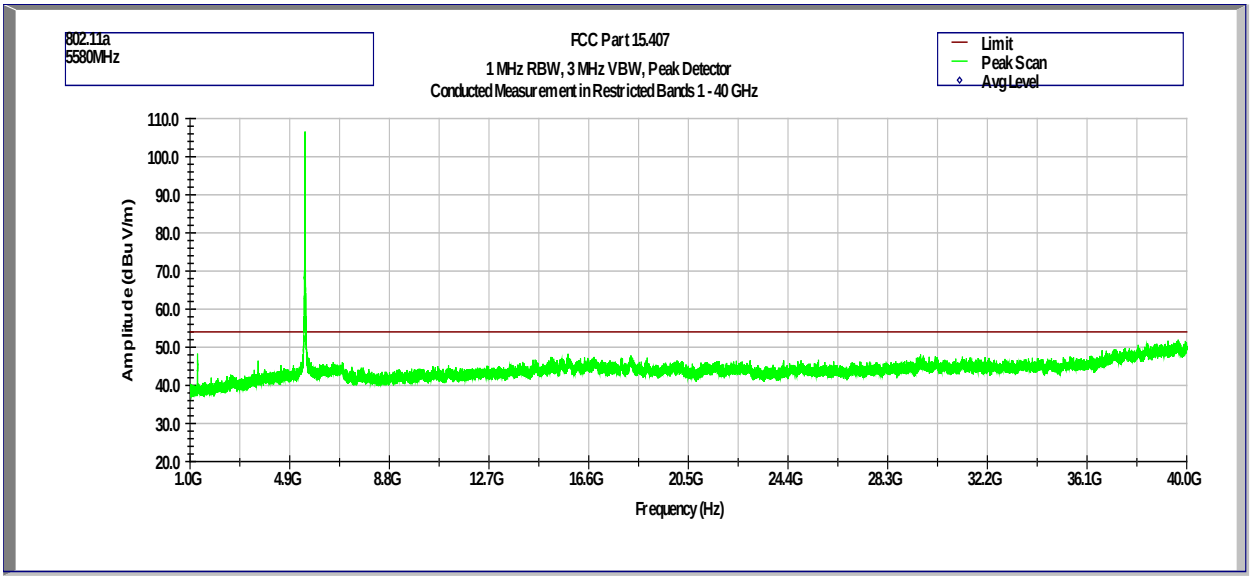


Tx @ 5580MHz 802.11a

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

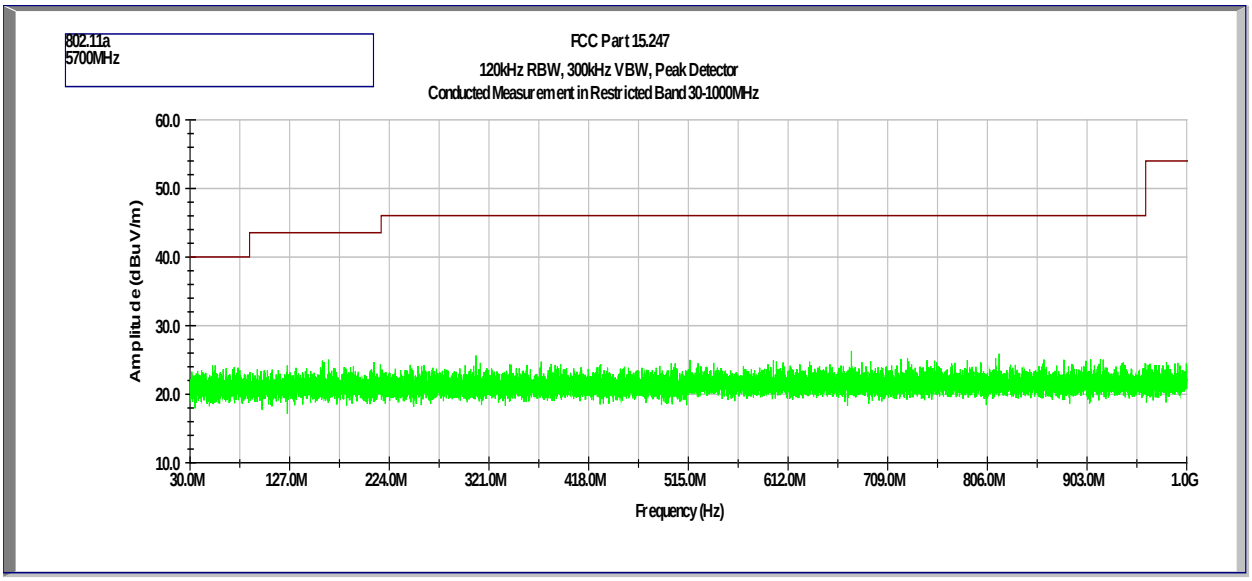


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 40 GHz

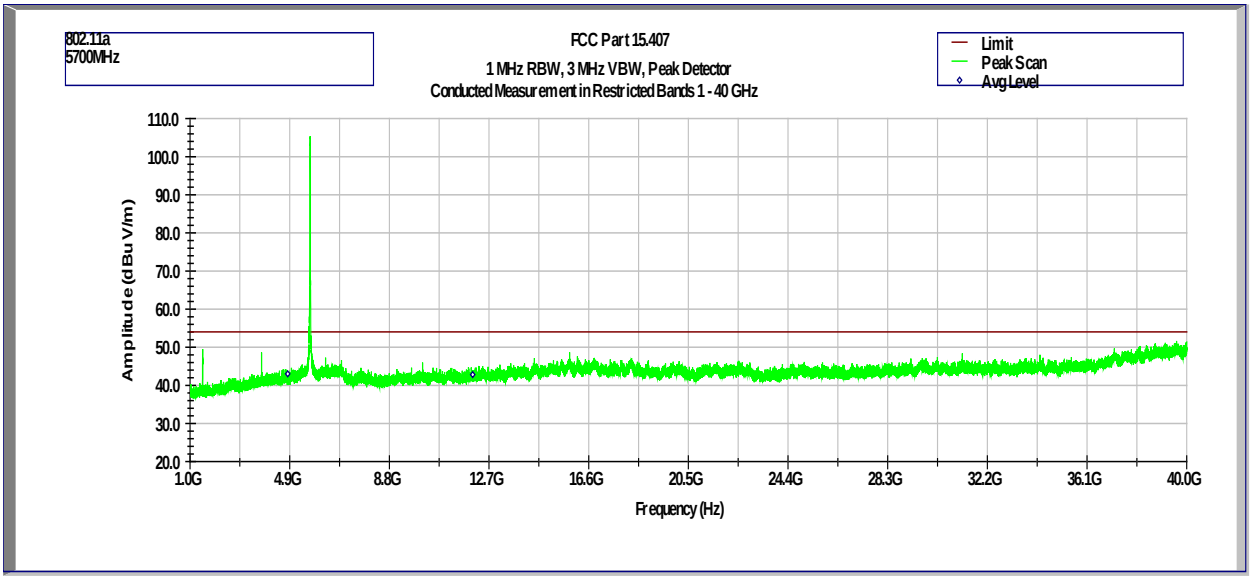


Tx @ 5700MHz 802.11a

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

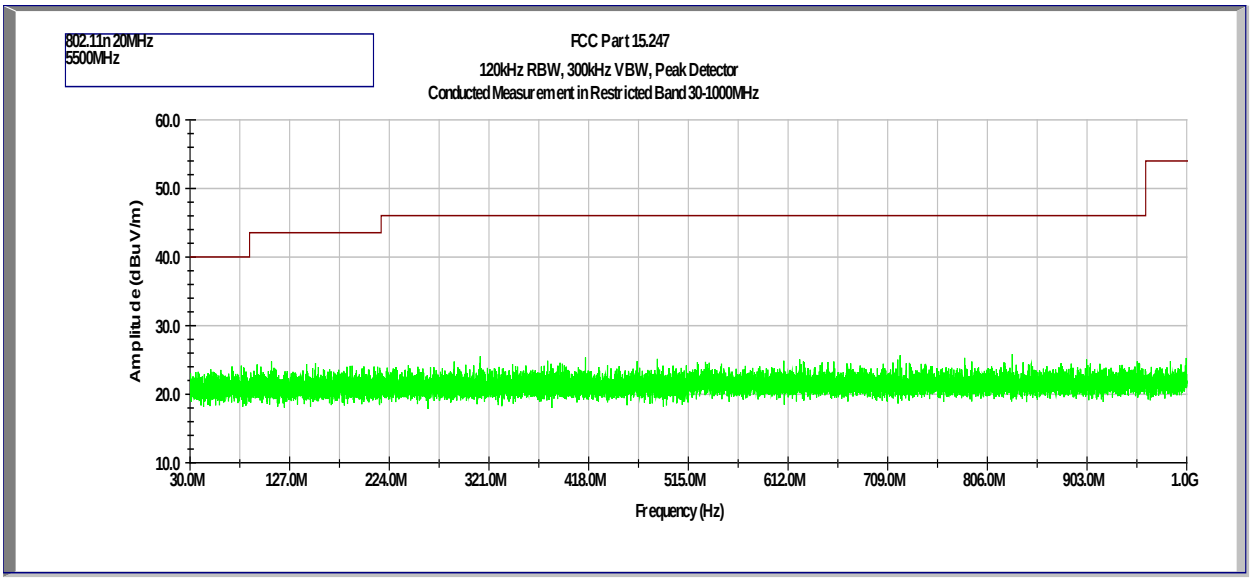


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 40 GHz

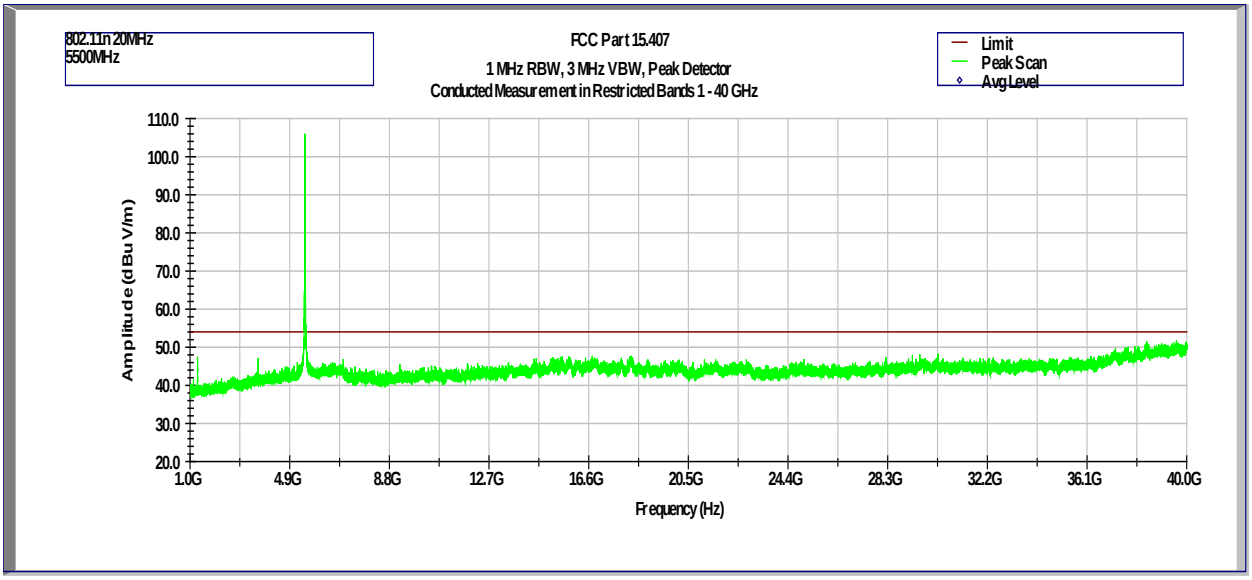


Tx @ 5500MHz 802.11n 20MHz

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

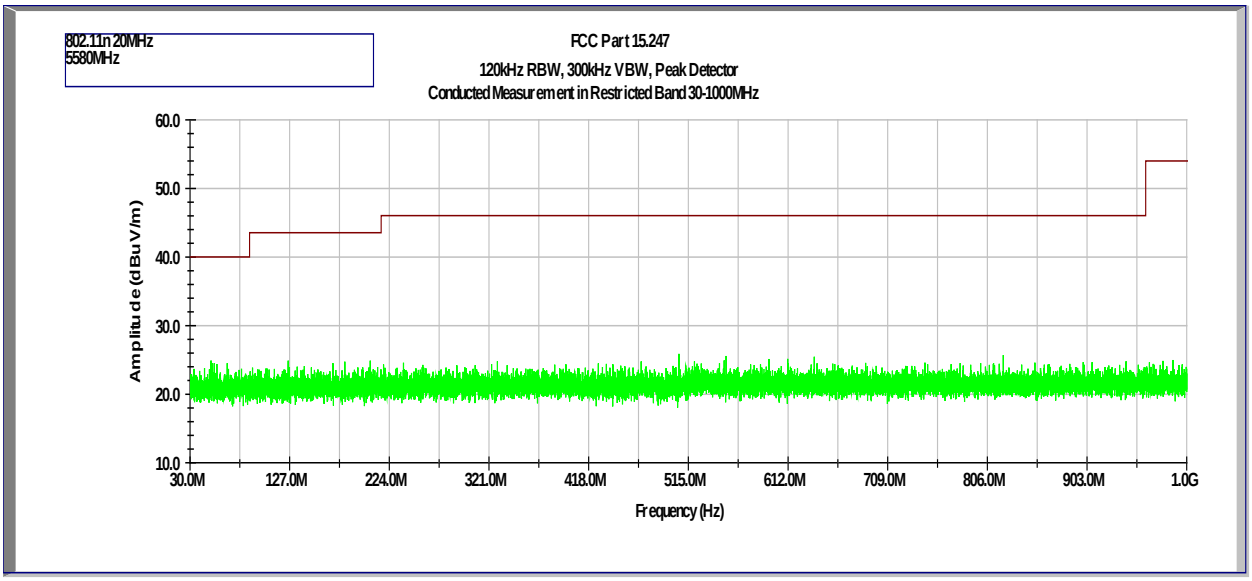


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 40 GHz

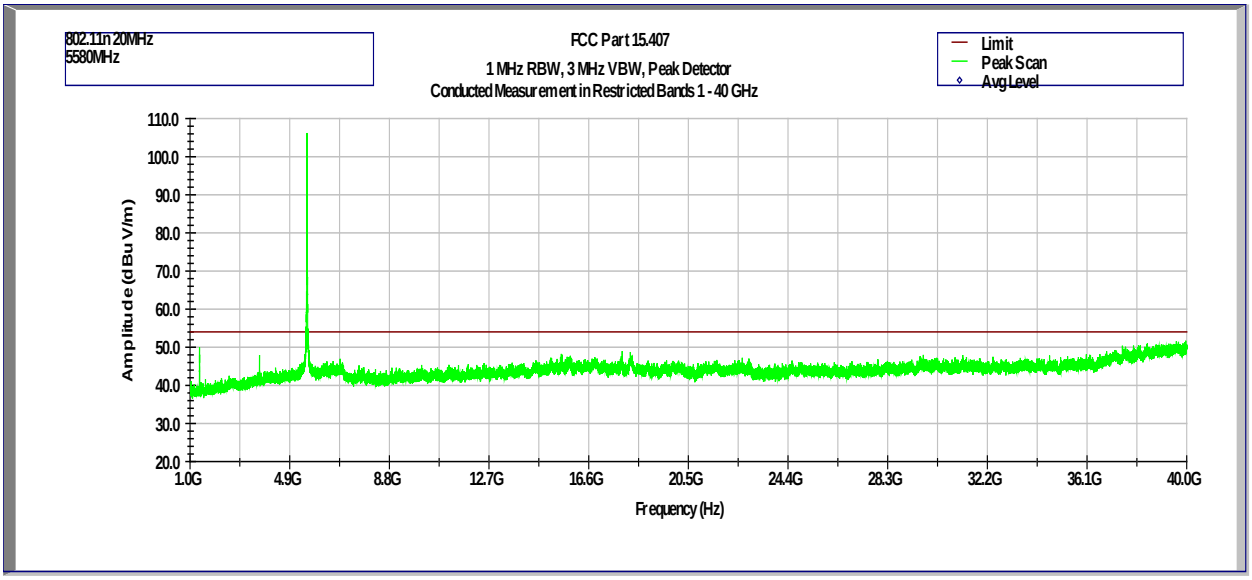


Tx @ 5580MHz 802.11n 20MHz

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

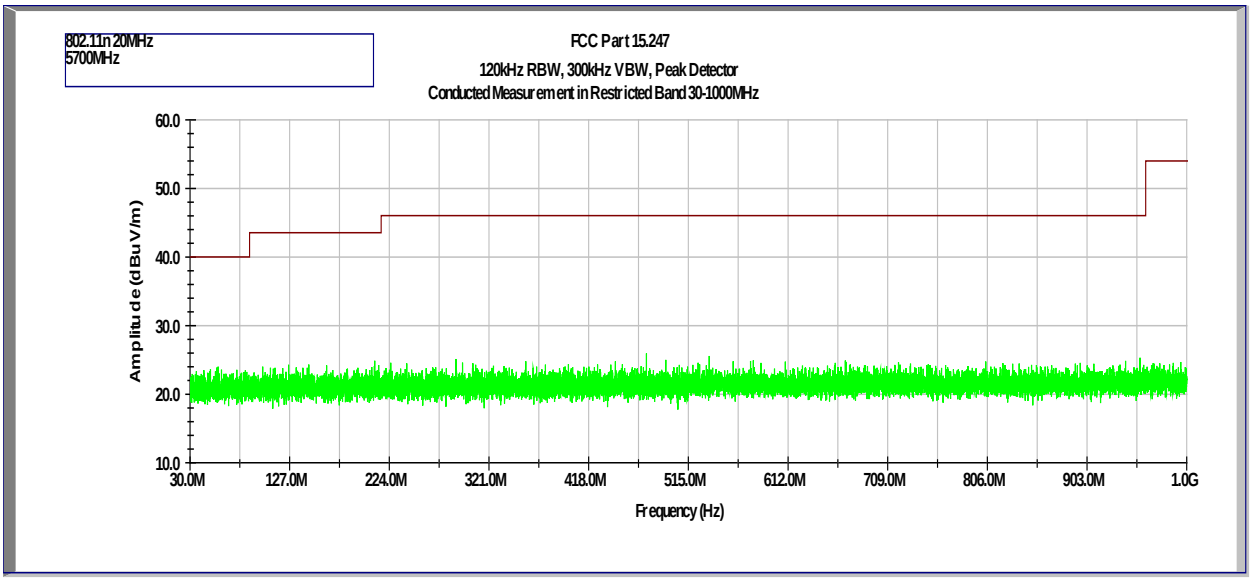


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 40 GHz

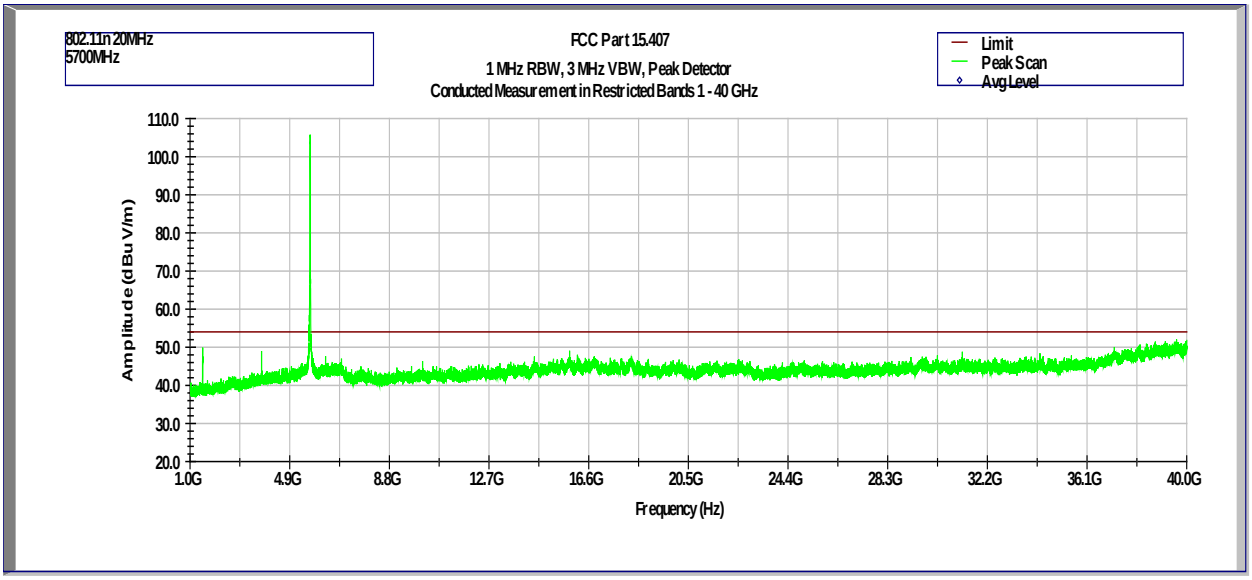


Tx @ 5700MHz 802.11n 20MHz

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

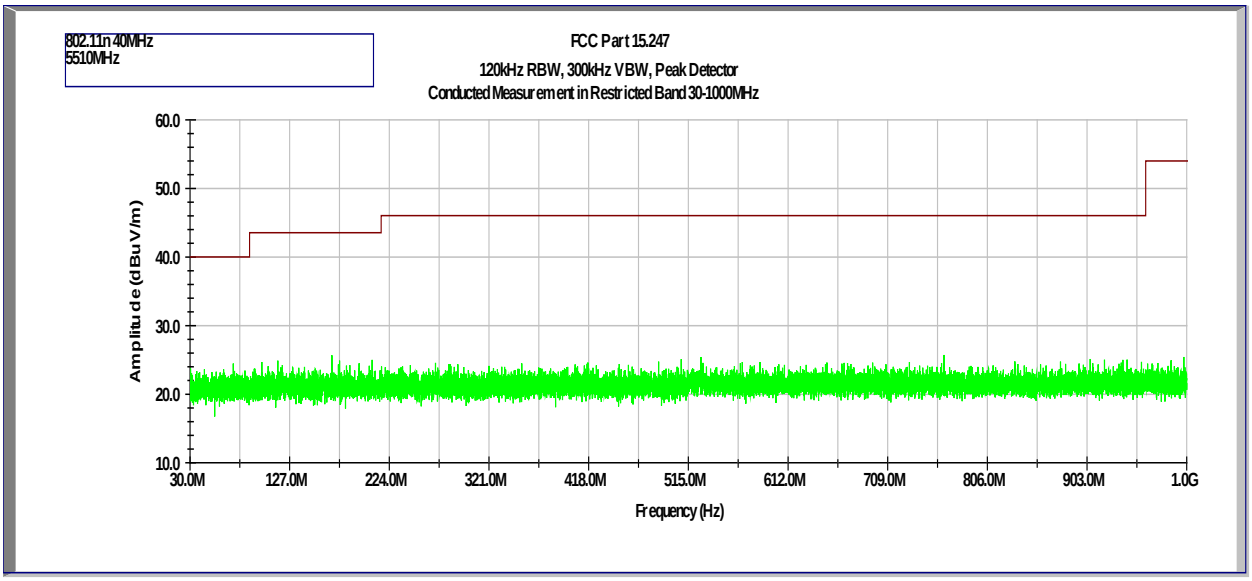


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 40 GHz

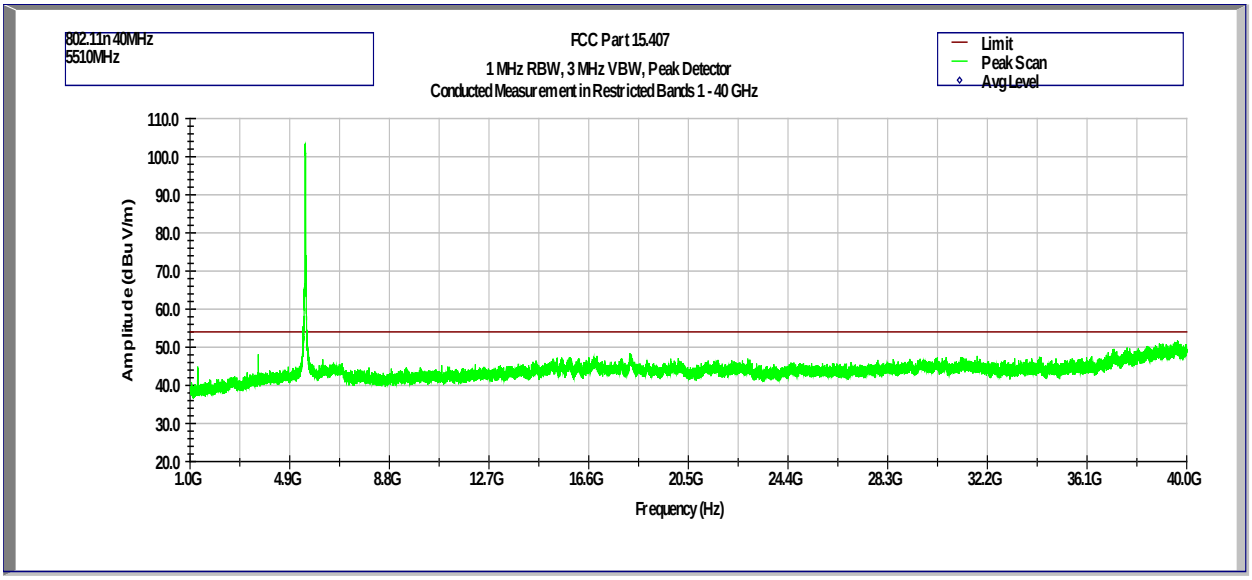


Tx @ 5510MHz 802.11n 40MHz

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

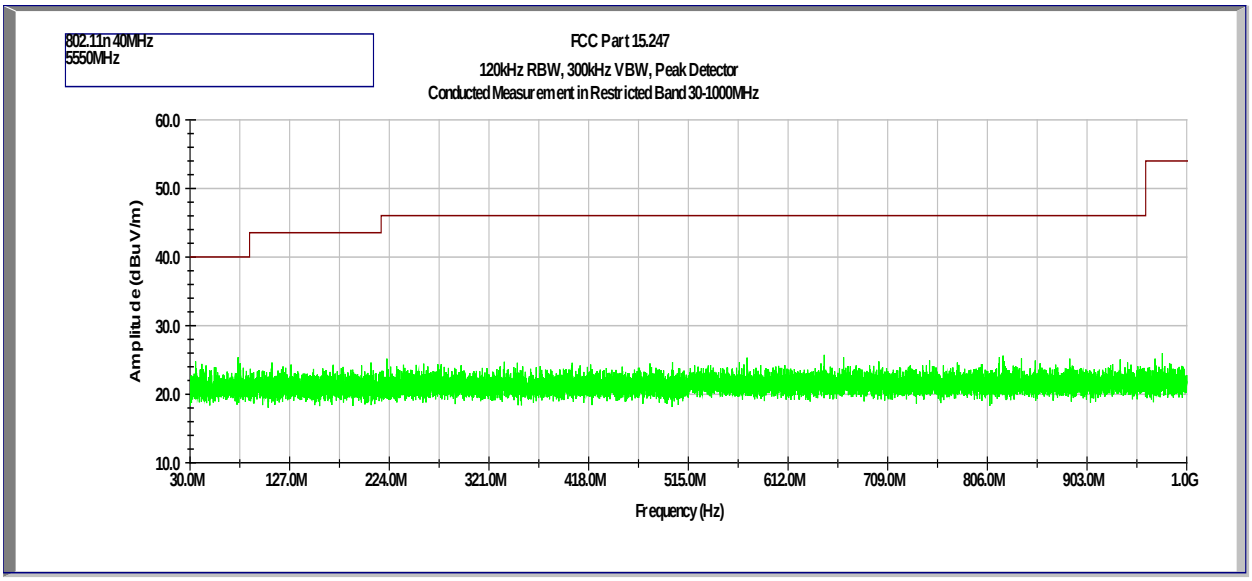


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 40 GHz

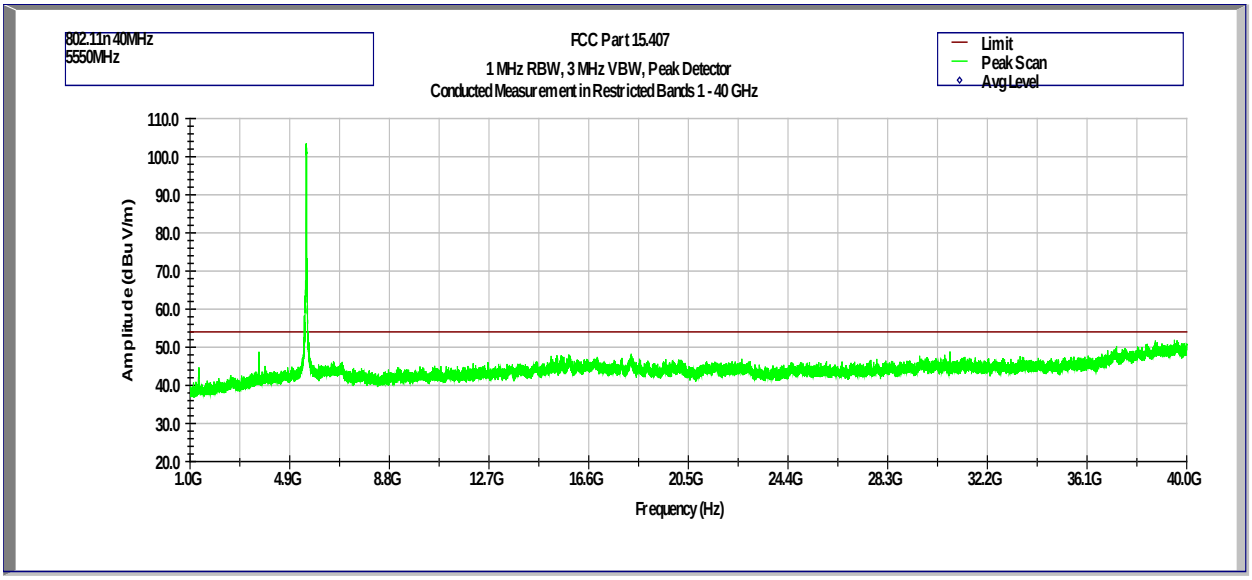


Tx @ 5550MHz 802.11n 40MHz

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

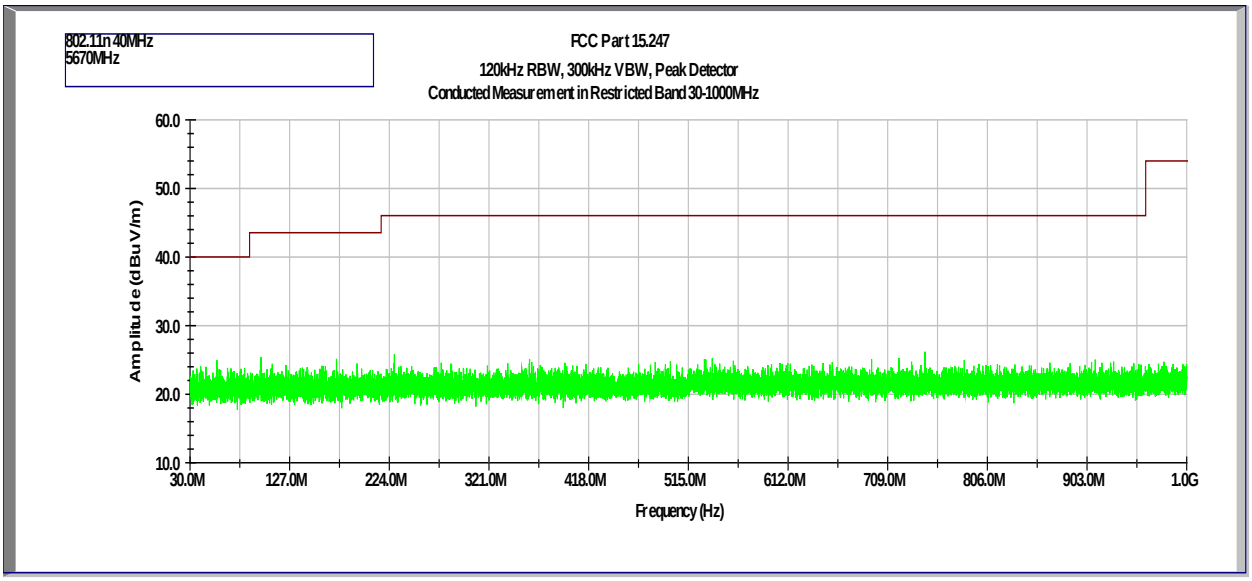


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 40 GHz

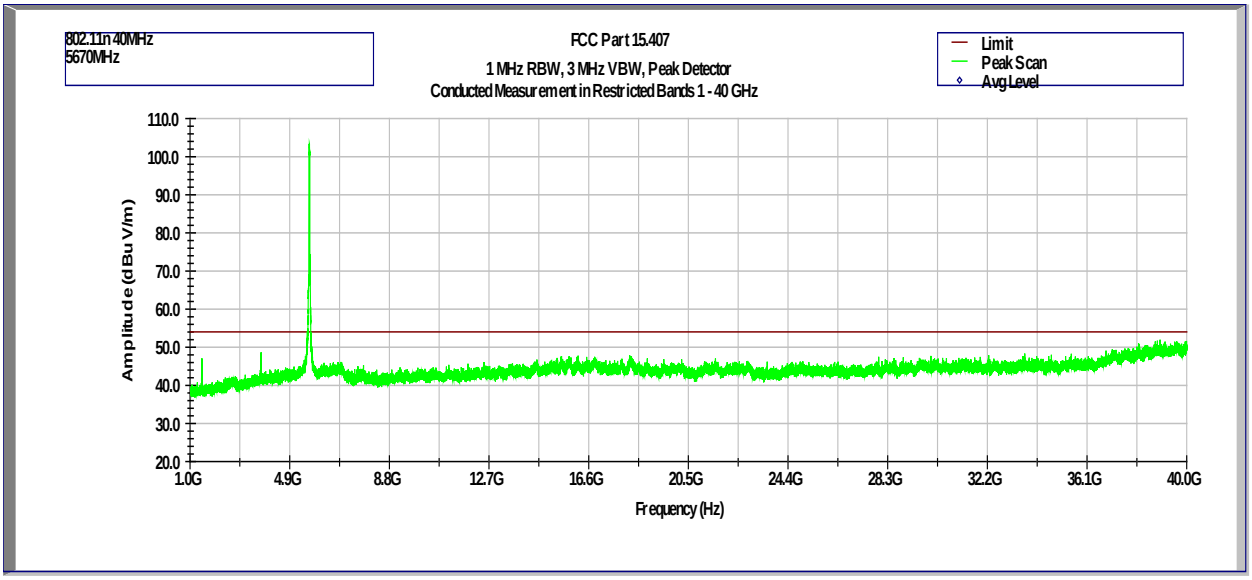


Tx @ 5670MHz 802.11n 40MHz

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz



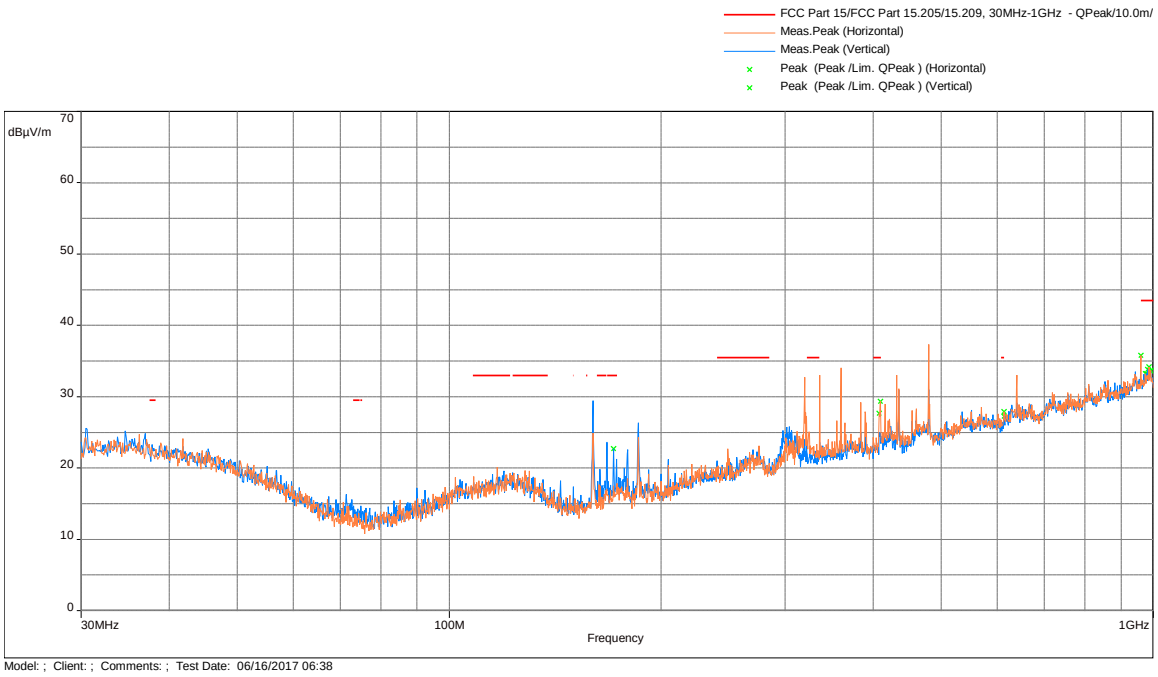
Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 40 GHz



Out-of-Band Radiated Spurious Emissions (Cabinet Radiation)

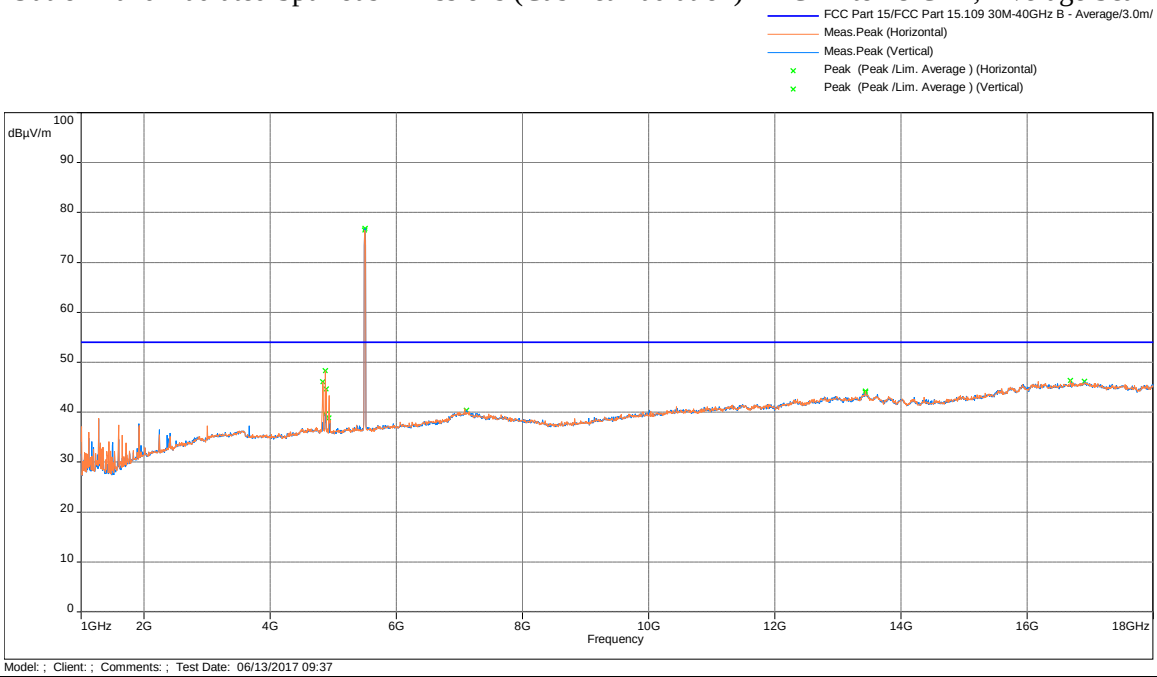
Tested By:	Anderson Soungpanya
Test Date:	June 13-16, 2017

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11a 5500MHz
Radiated Spurious Emissions 30 MHz - 1000 MHz



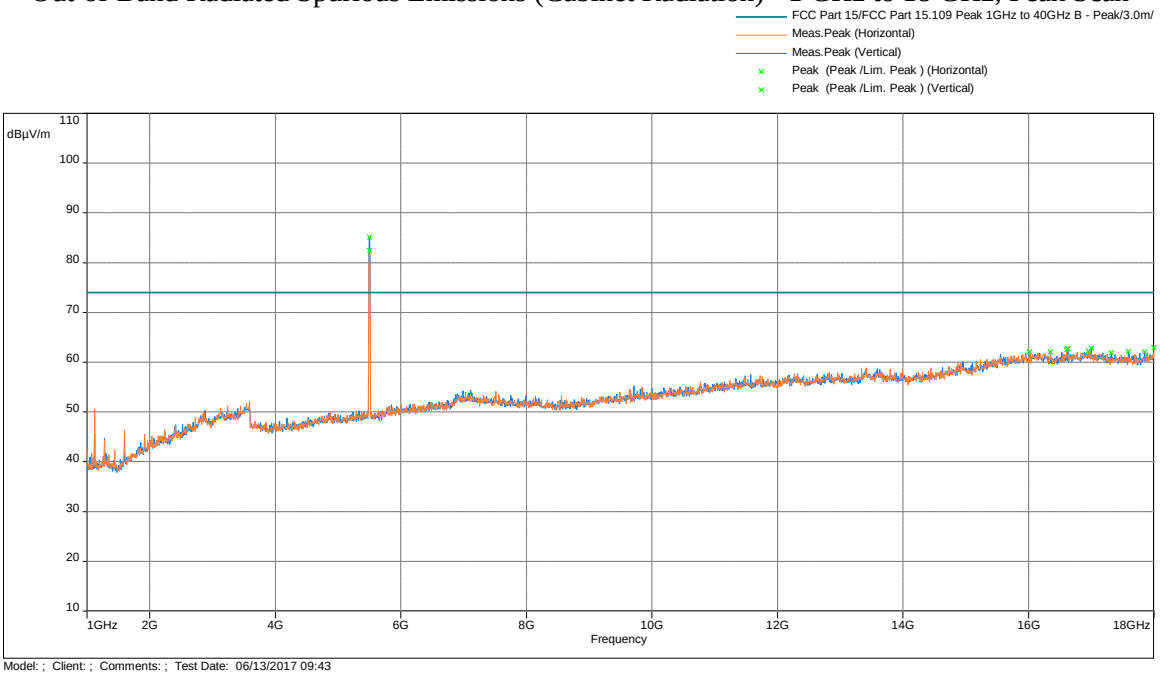
Frequency (MHz)	Peak (dBµV/m)	Lim. QP (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
409.464	29.35	35.5	-6.15	2	225	Horizontal	-3.83

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Average Scan



Frequency (MHz)	Ave (dBµV/m)	Lim. Average (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4869.2	48.31	54	-5.69	1.98	231	Horizontal	8.8

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Peak Scan

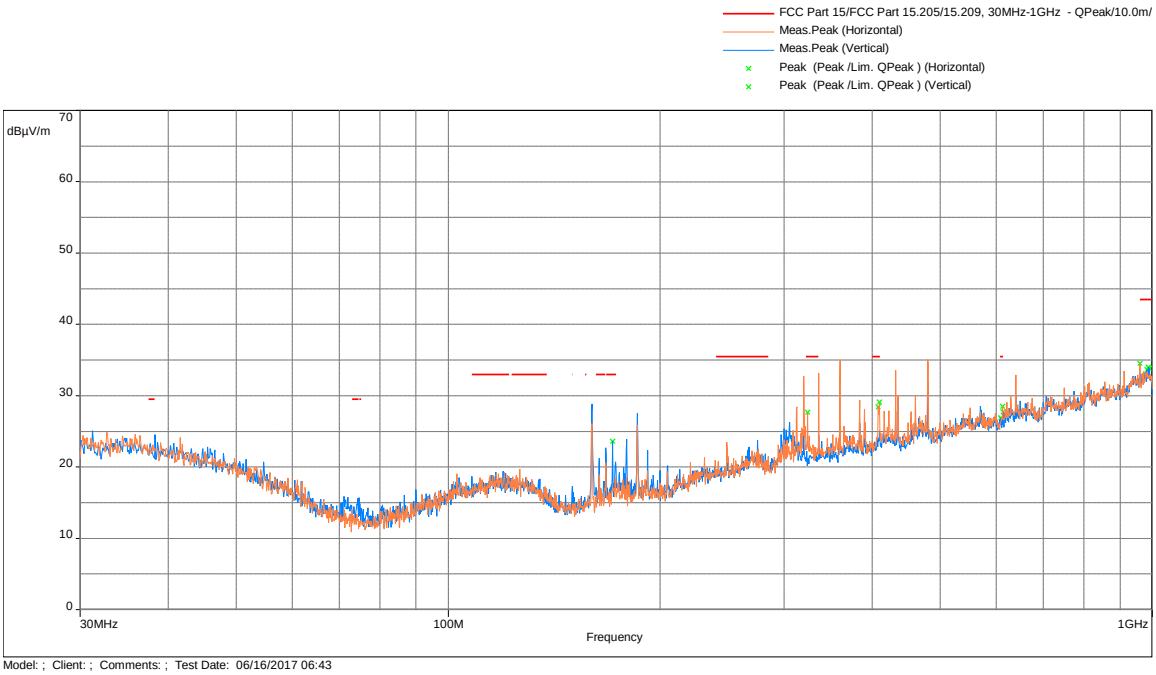


Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz

Note: FS@3m = RA + AF + CF - Preamp

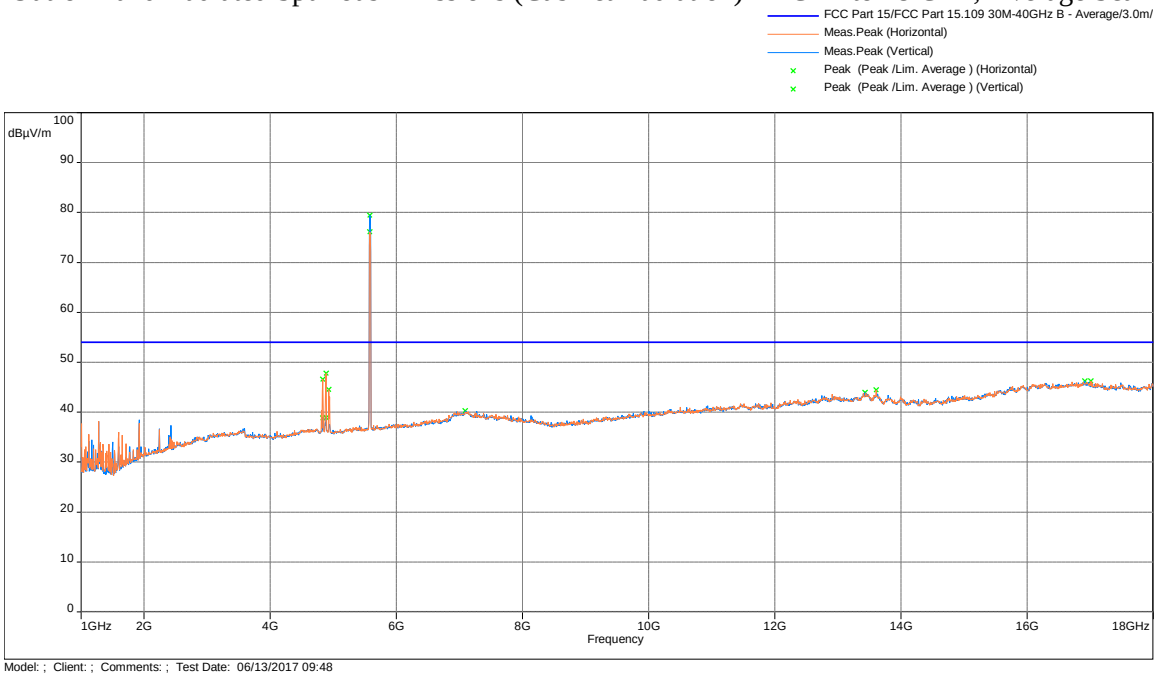
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11a 5580MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



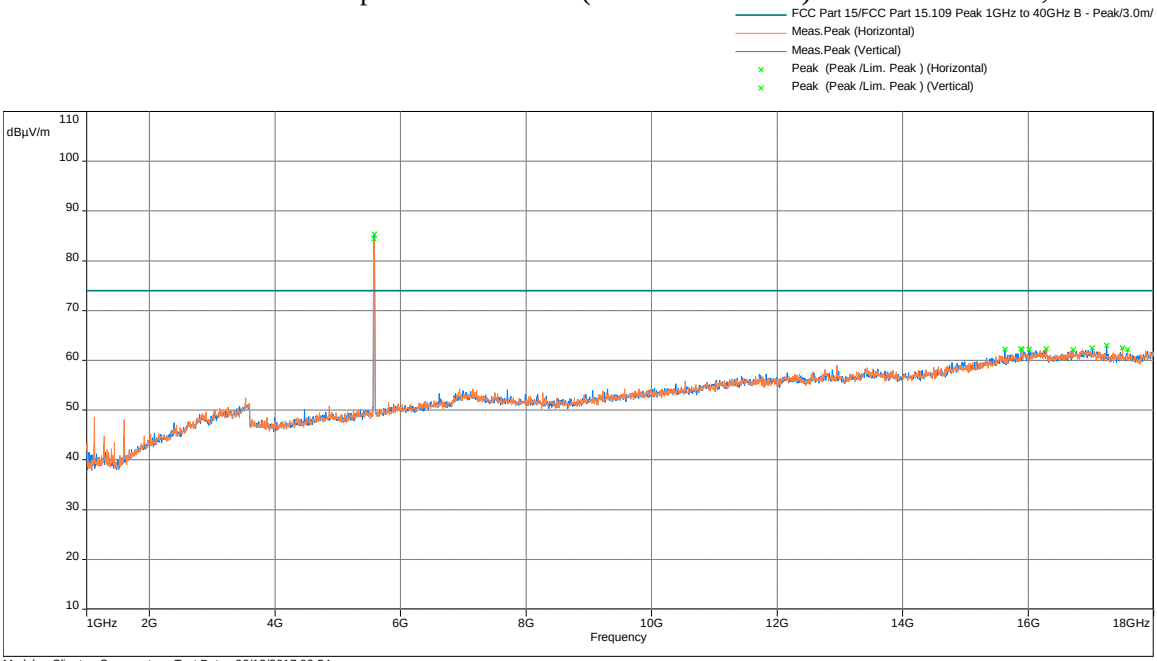
Model: ; Client: ; Comments: ; Test Date: 06/16/2017 06:43

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Average Scan



Model: ; Client: ; Comments: ; Test Date: 06/13/2017 09:48

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Peak Scan



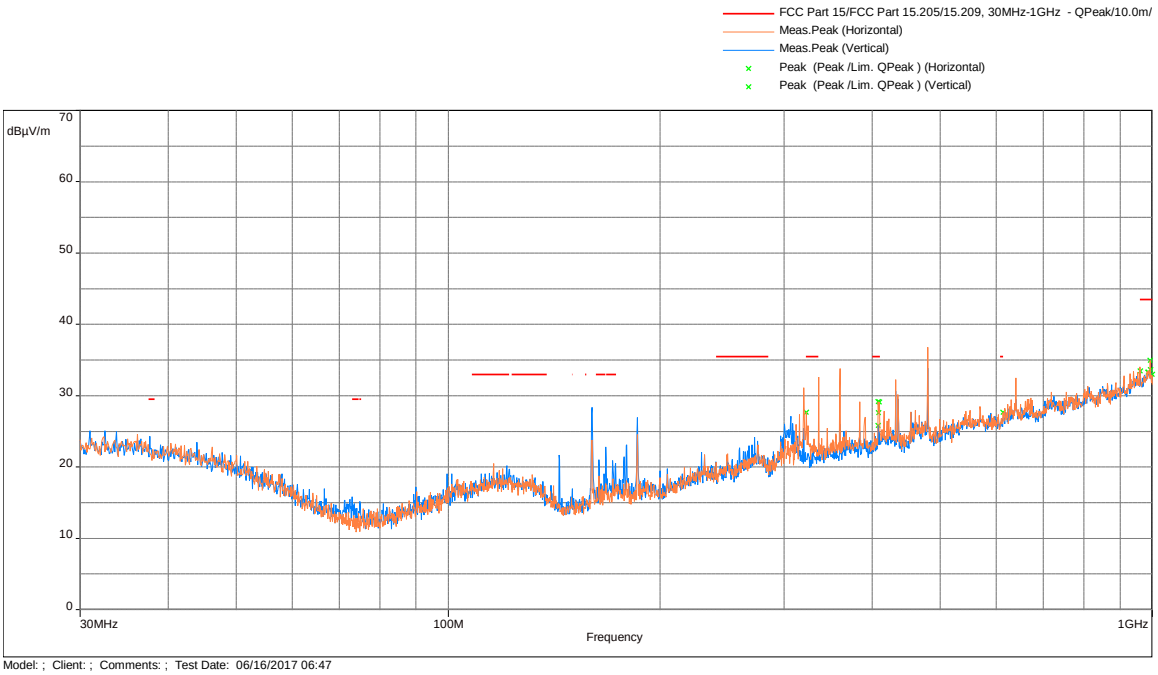
Model: ; Client: ; Comments: ; Test Date: 06/13/2017 09:54

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

Note: FS@3m = RA + AF + CF - Preamp

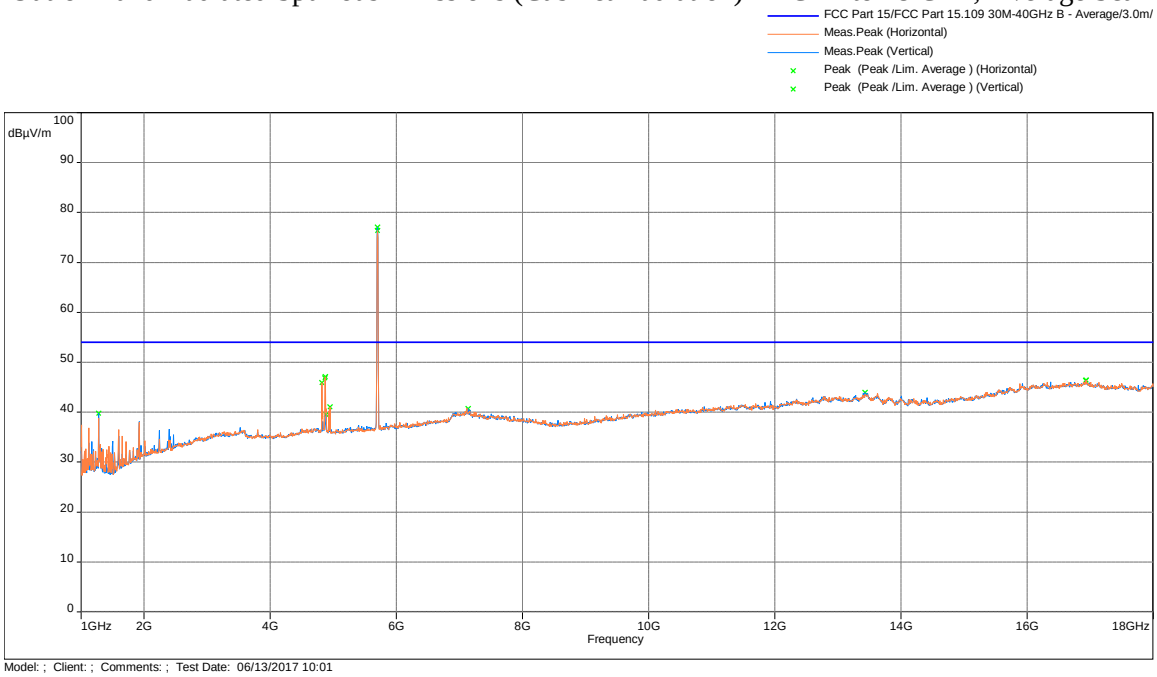
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11a 5700MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



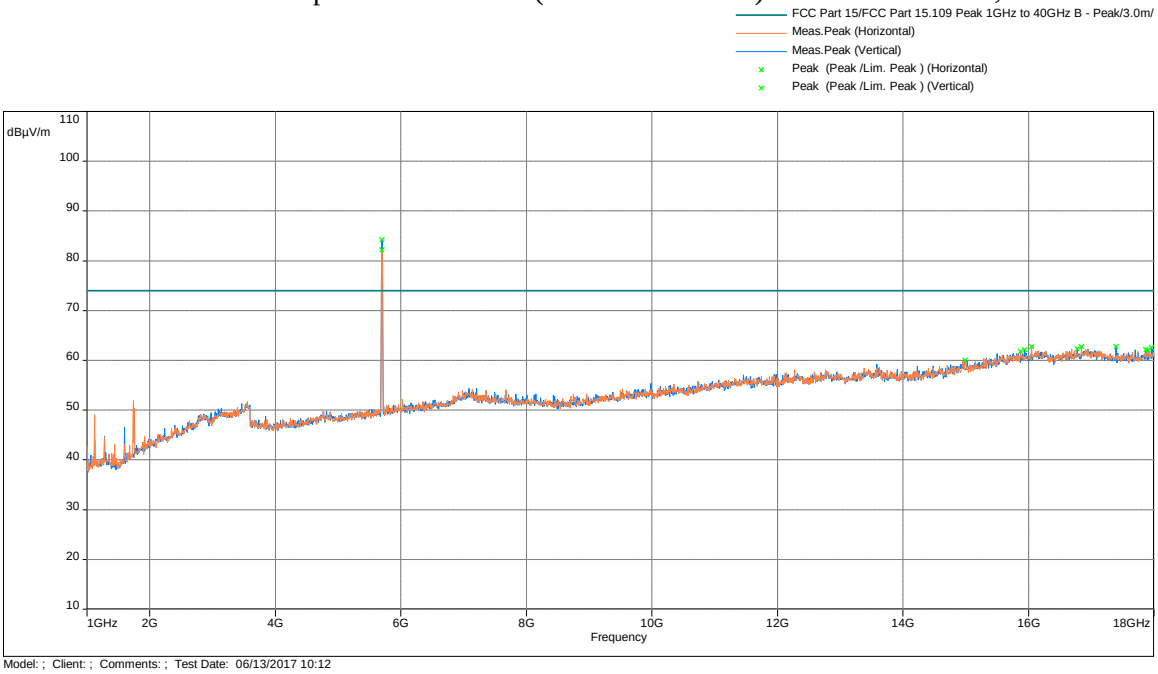
Model: ; Client: ; Comments: ; Test Date: 06/16/2017 06:47

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Average Scan



Model: ; Client: ; Comments: ; Test Date: 06/13/2017 10:01

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Peak Scan



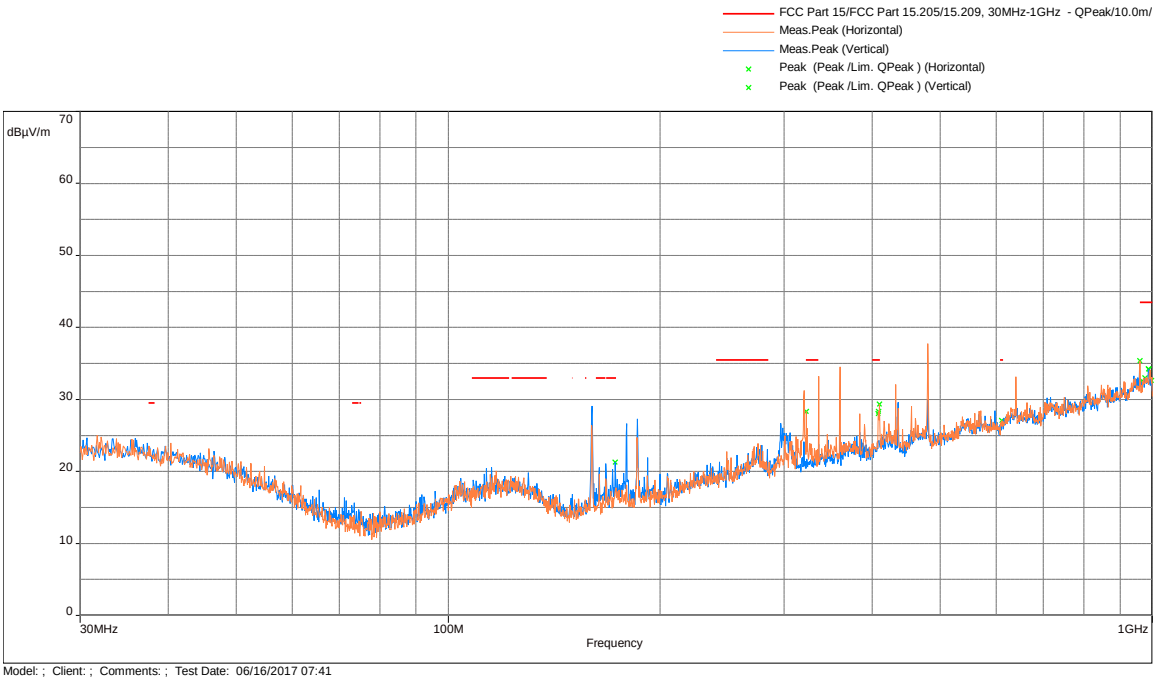
Model: ; Client: ; Comments: ; Test Date: 06/13/2017 10:12

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

Note: FS@3m = RA + AF + CF - Preamp

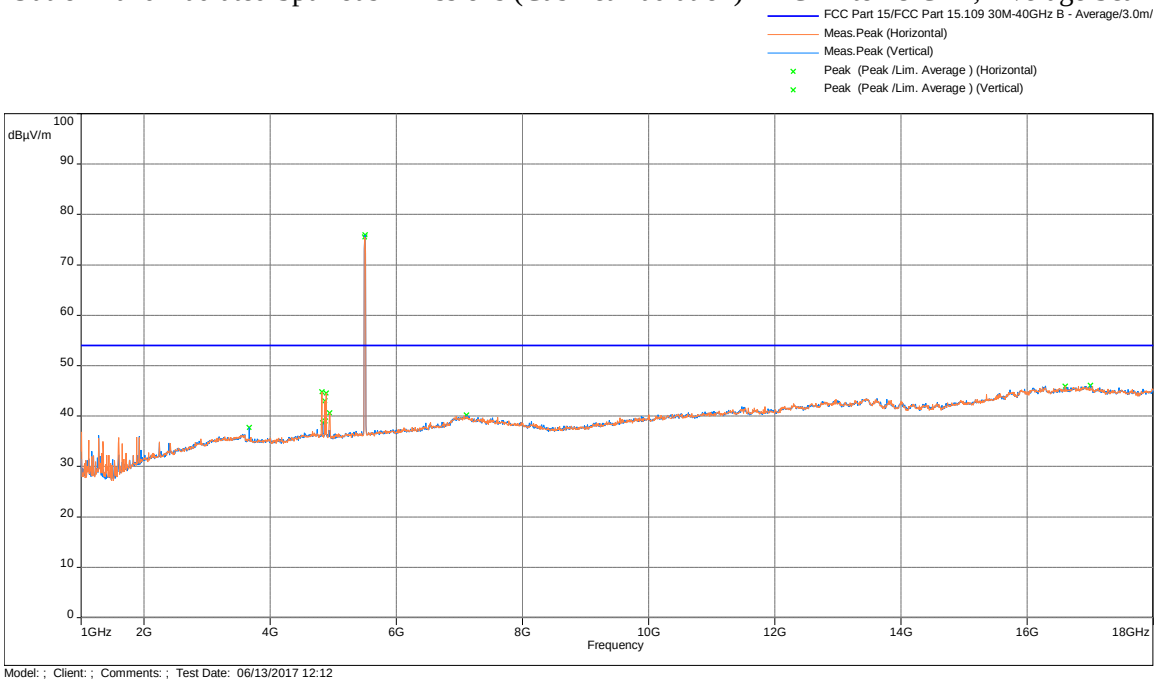
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz 5500MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



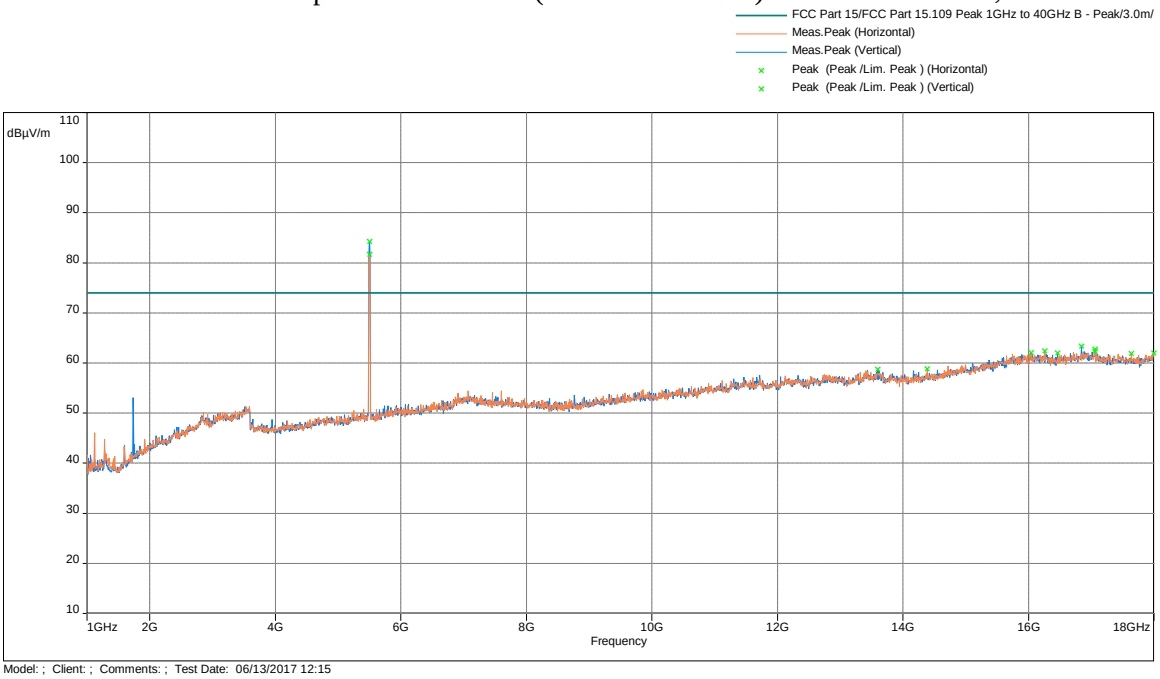
Model: ; Client: ; Comments: ; Test Date: 06/16/2017 07:41

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Average Scan



Model: ; Client: ; Comments: ; Test Date: 06/13/2017 12:12

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Peak Scan



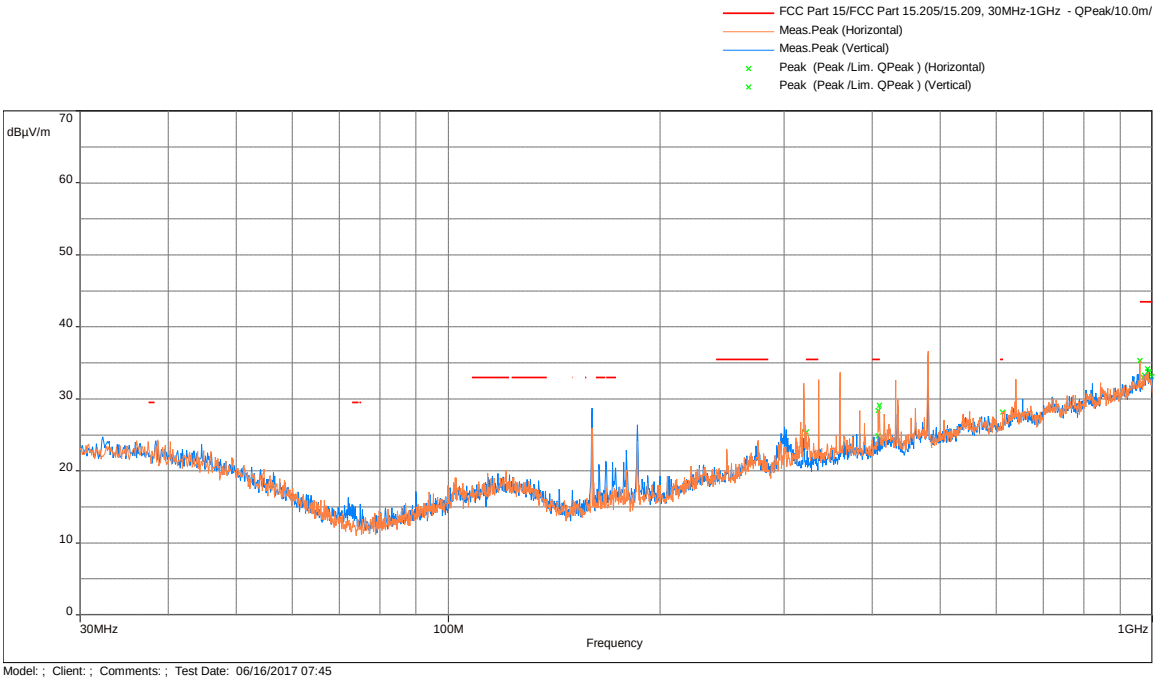
Model: ; Client: ; Comments: ; Test Date: 06/13/2017 12:15

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

Note: FS@3m = RA + AF + CF - Preamp

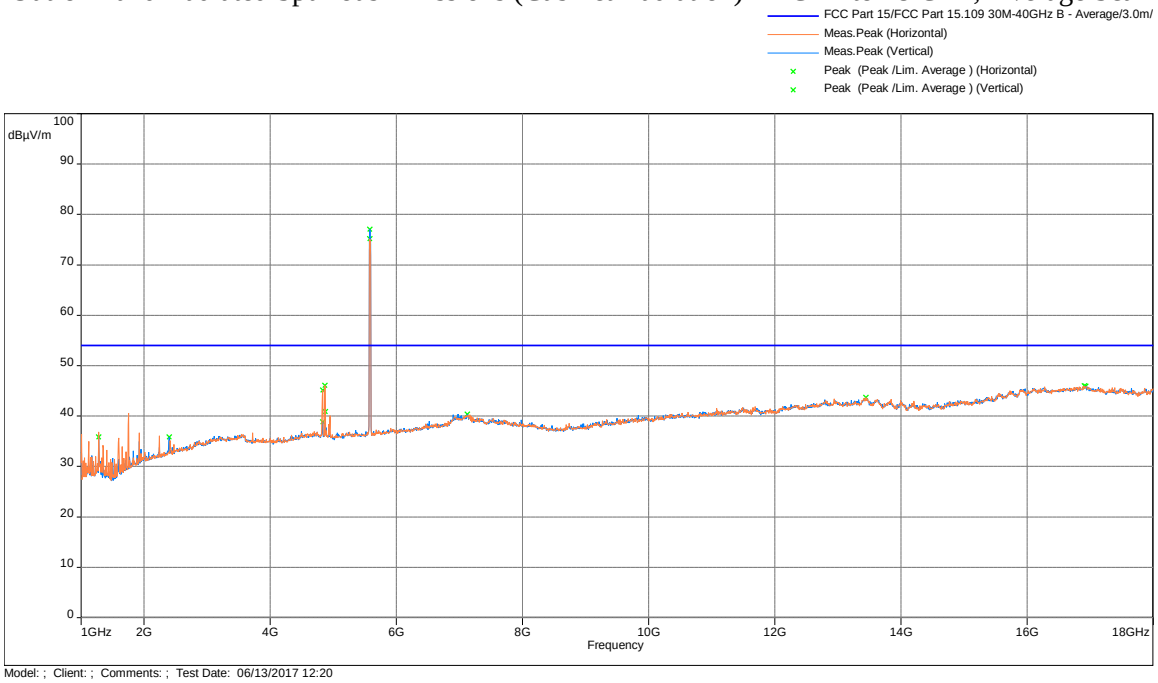
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz 5580MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



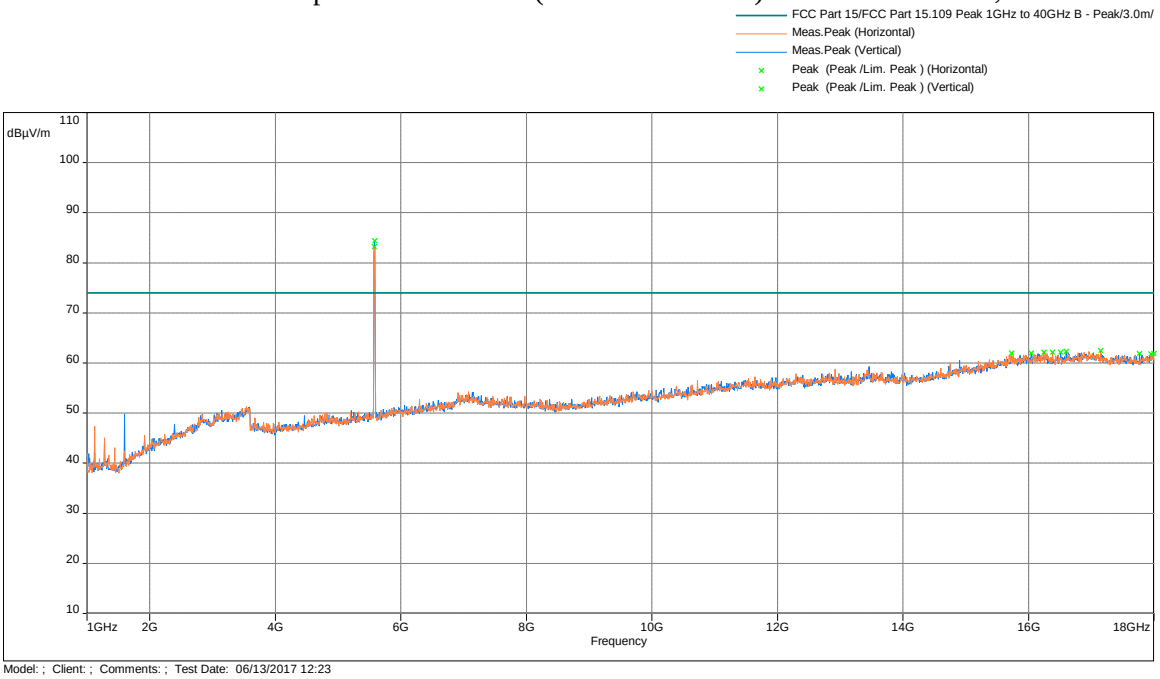
Model: ; Client: ; Comments: ; Test Date: 06/16/2017 07:45

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Average Scan



Model: ; Client: ; Comments: ; Test Date: 06/13/2017 12:20

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Peak Scan



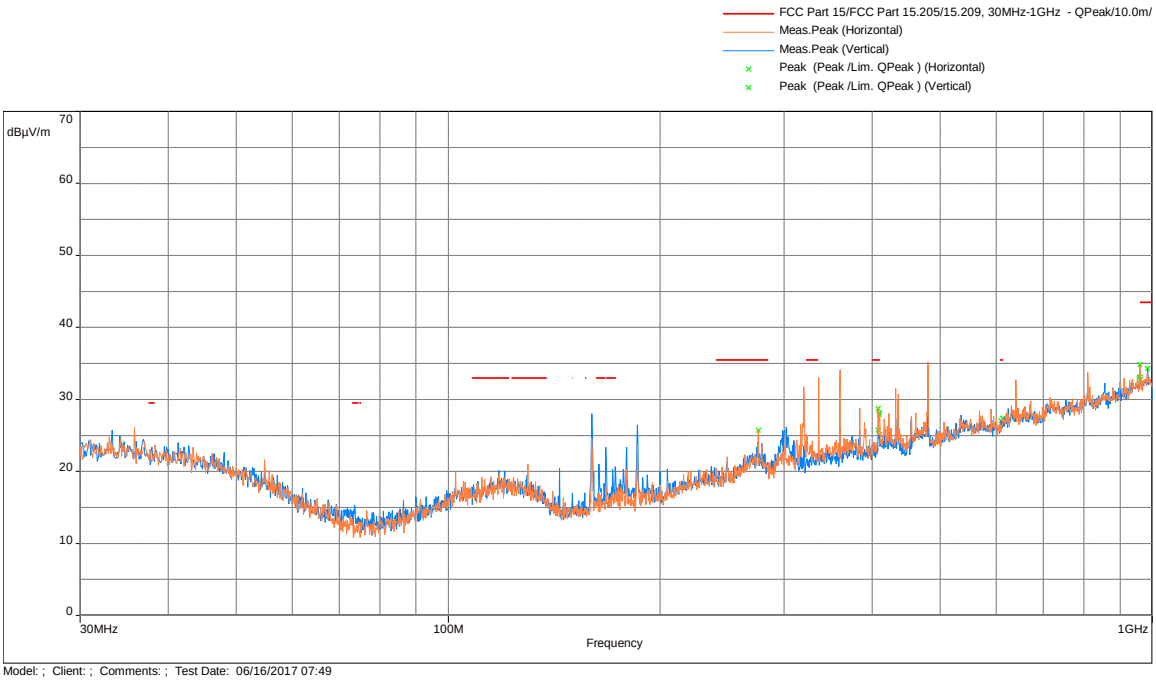
Model: ; Client: ; Comments: ; Test Date: 06/13/2017 12:23

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

Note: FS@3m = RA + AF + CF - Preamp

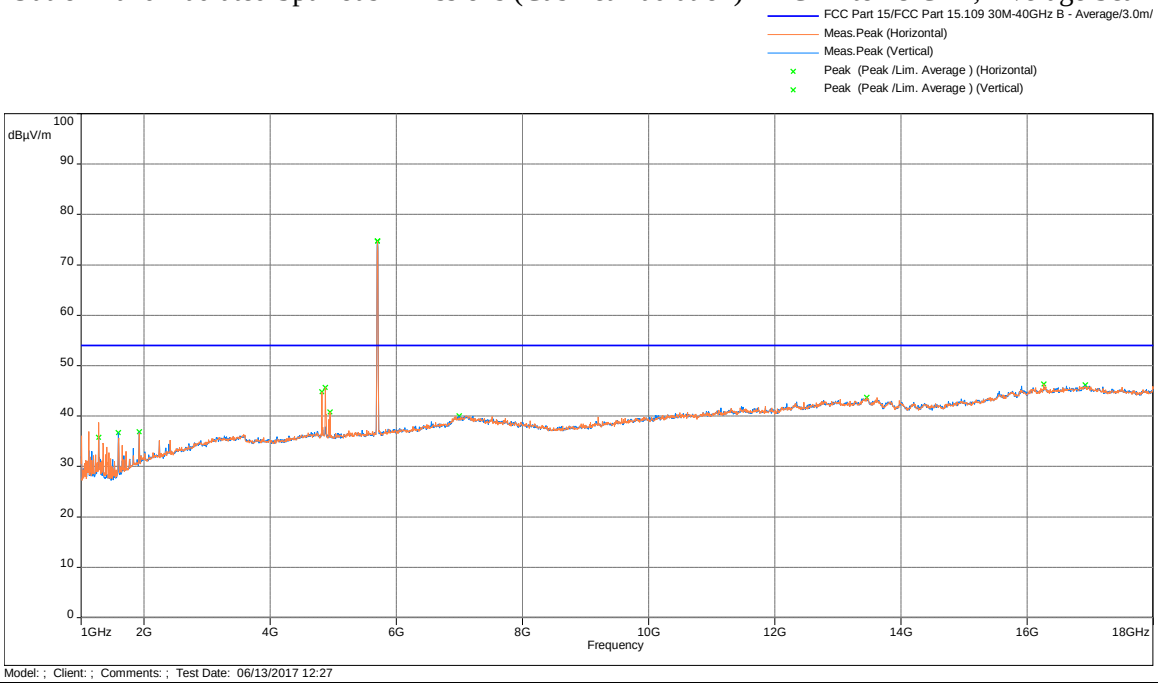
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 20MHz 5700MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



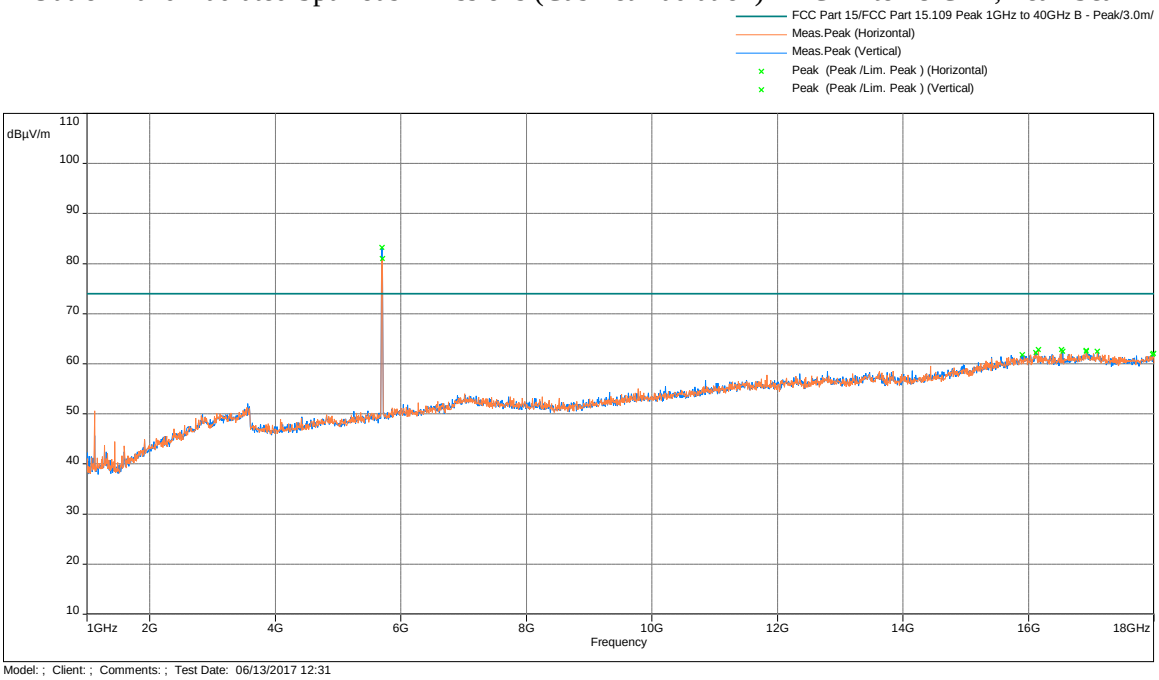
Frequency (MHz)	Peak (dBµV/m)	Lim. QP (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
408.009	28.74	35.5	-6.76	2	206	Horizontal	-3.97

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Average Scan



Frequency (MHz)	Ave (dBµV/m)	Lim. Average (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4869.2	45.7	54	-8.3	1.59	213.75	Horizontal	8.8

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Peak Scan

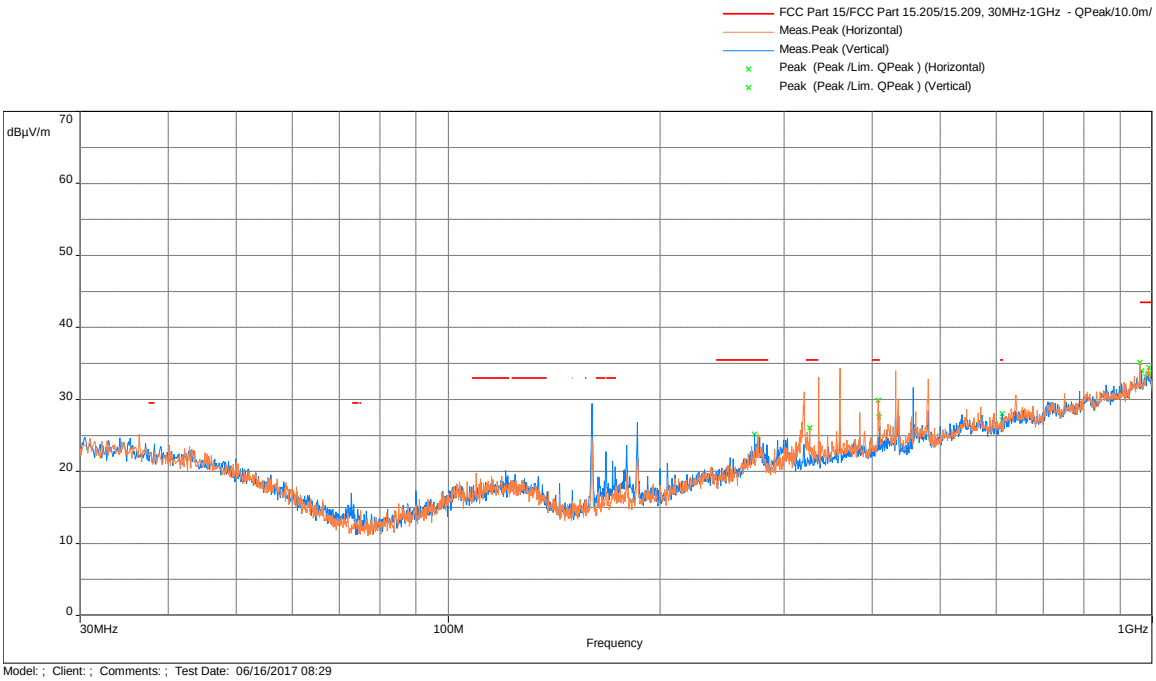


Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz

Note: FS@3m = RA + AF + CF - Preamp

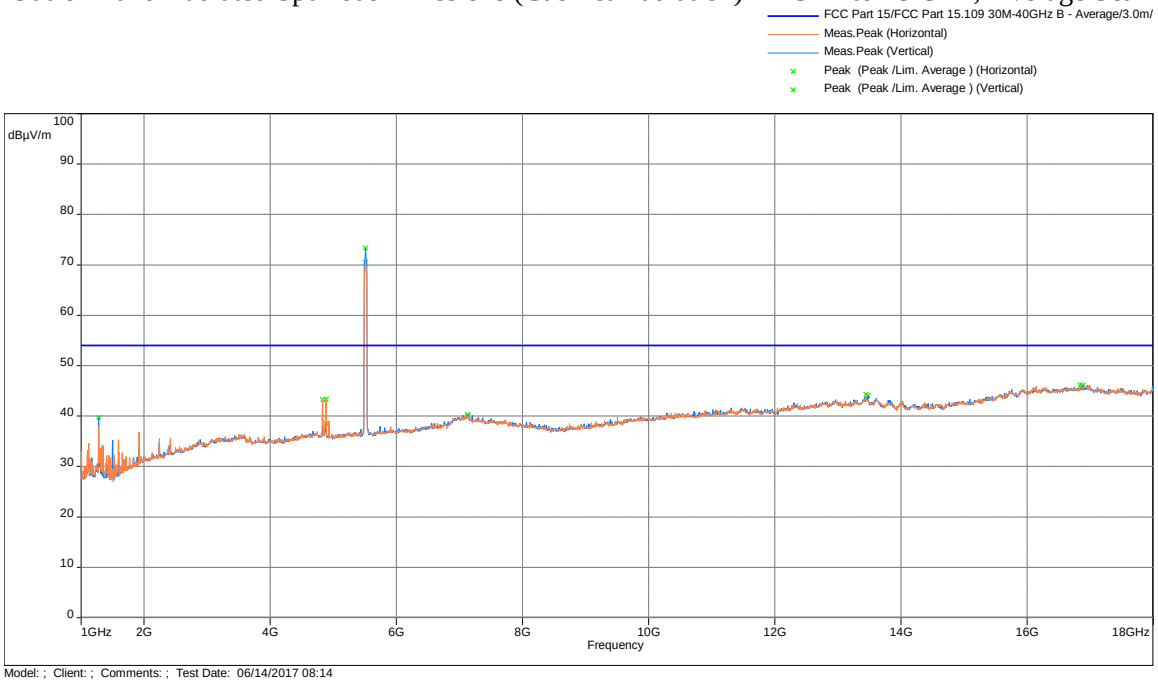
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 40MHz 5510MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



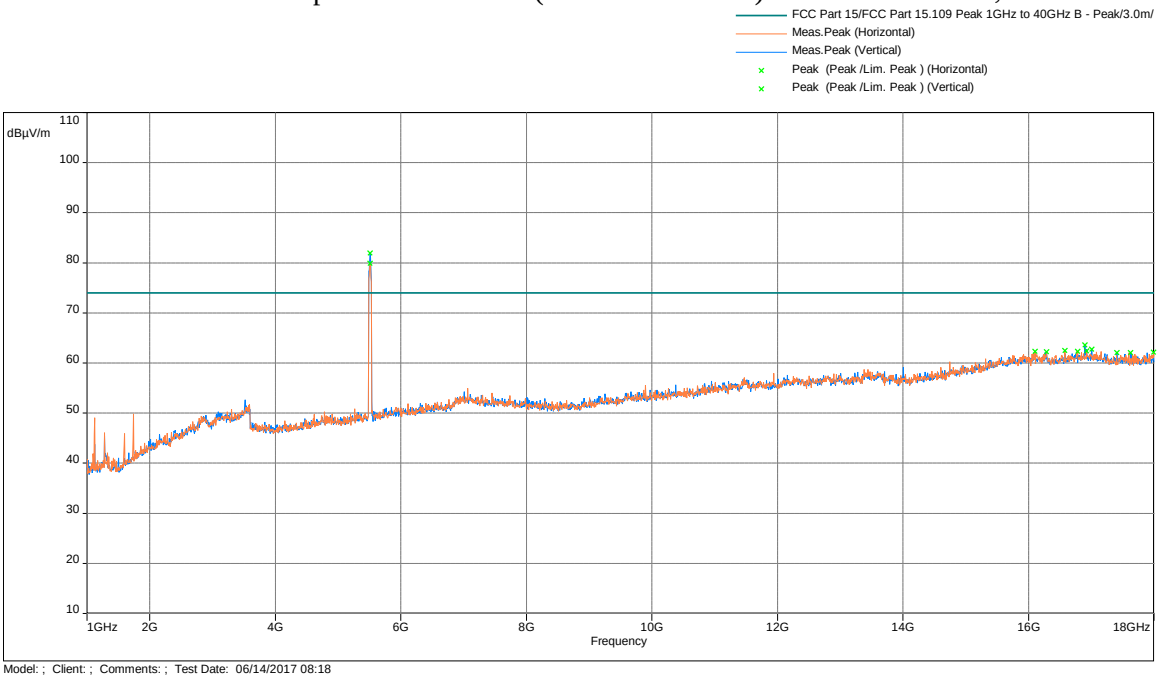
Model: ; Client: ; Comments: ; Test Date: 06/16/2017 08:29

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Average Scan



Model: ; Client: ; Comments: ; Test Date: 06/14/2017 08:14

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Peak Scan



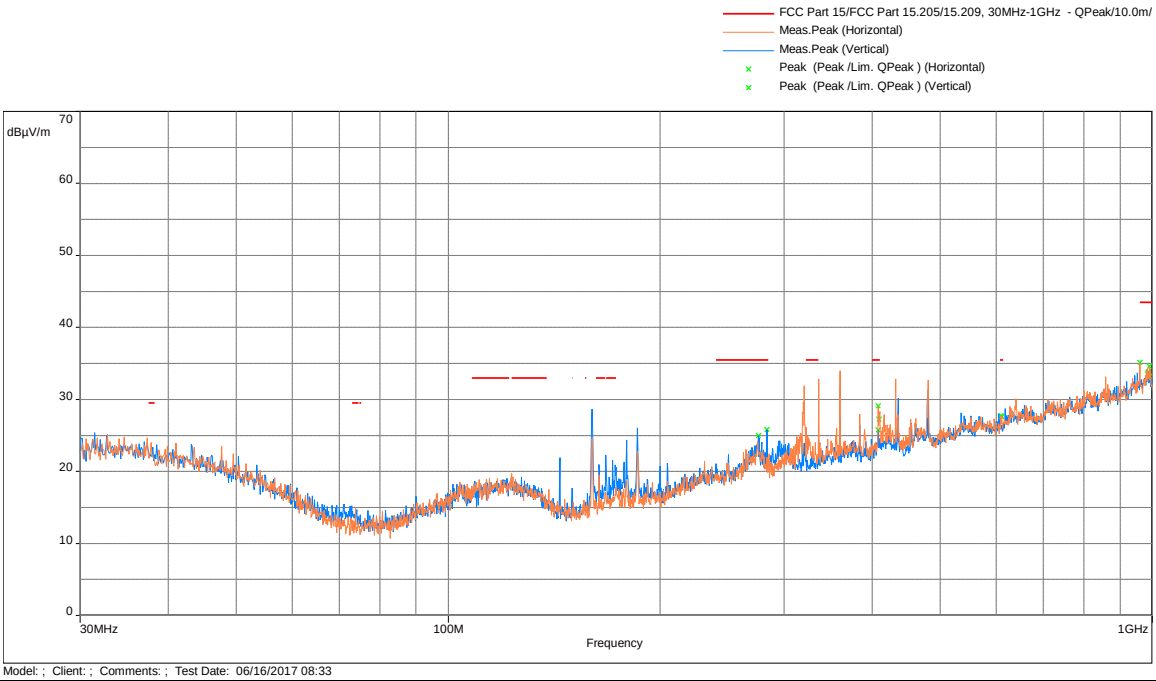
Model: ; Client: ; Comments: ; Test Date: 06/14/2017 08:18

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

Note: FS@3m = RA + AF + CF - Preamp

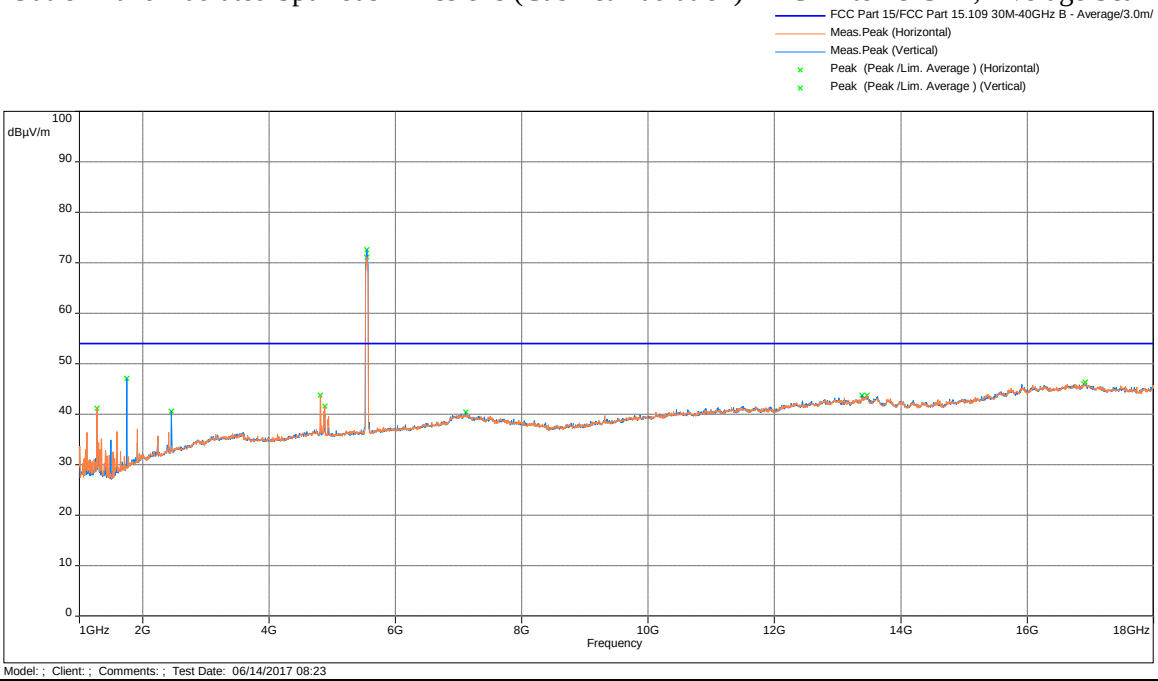
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 40MHz 5550MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Frequency (MHz)	Peak (dBµV/m)	Lim. QP (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
408.009	29.08	35.5	-6.42	1.91	20	Horizontal	-3.97

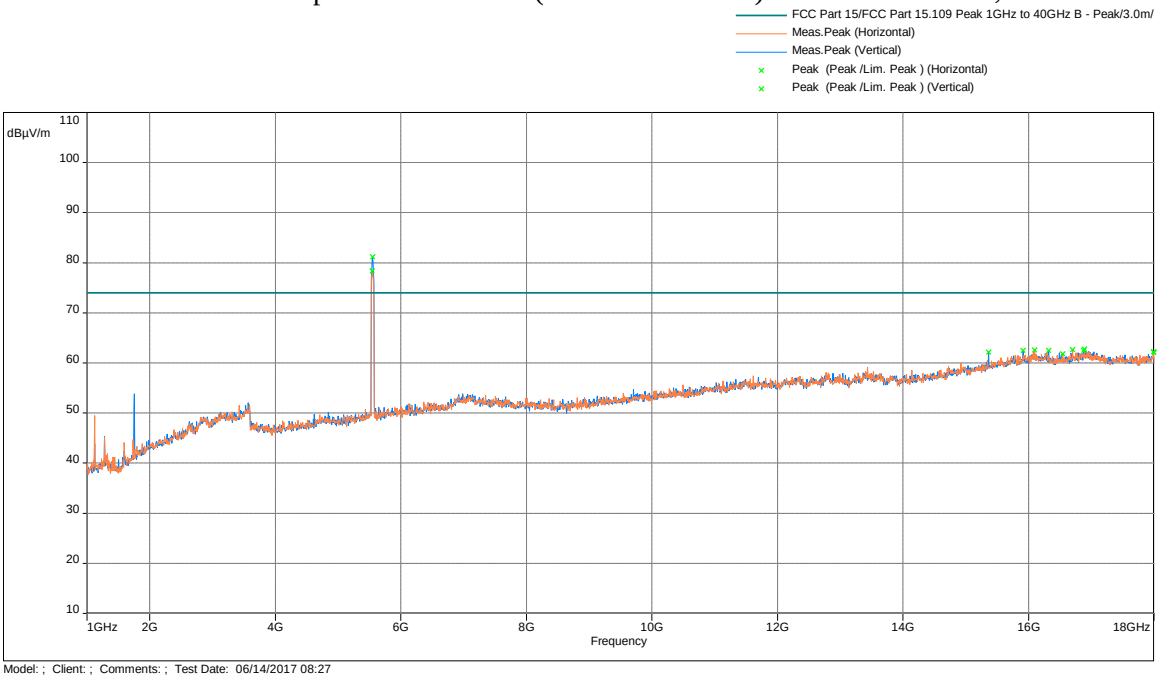
Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Average Scan



Model: ; Client: ; Comments: ; Test Date: 06/14/2017 08:23

Frequency (MHz)	Ave (dBµV/m)	Lim. Average (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
1753.1	47.07	54	-6.93	1.54	242	Vertical	1.14

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Peak Scan



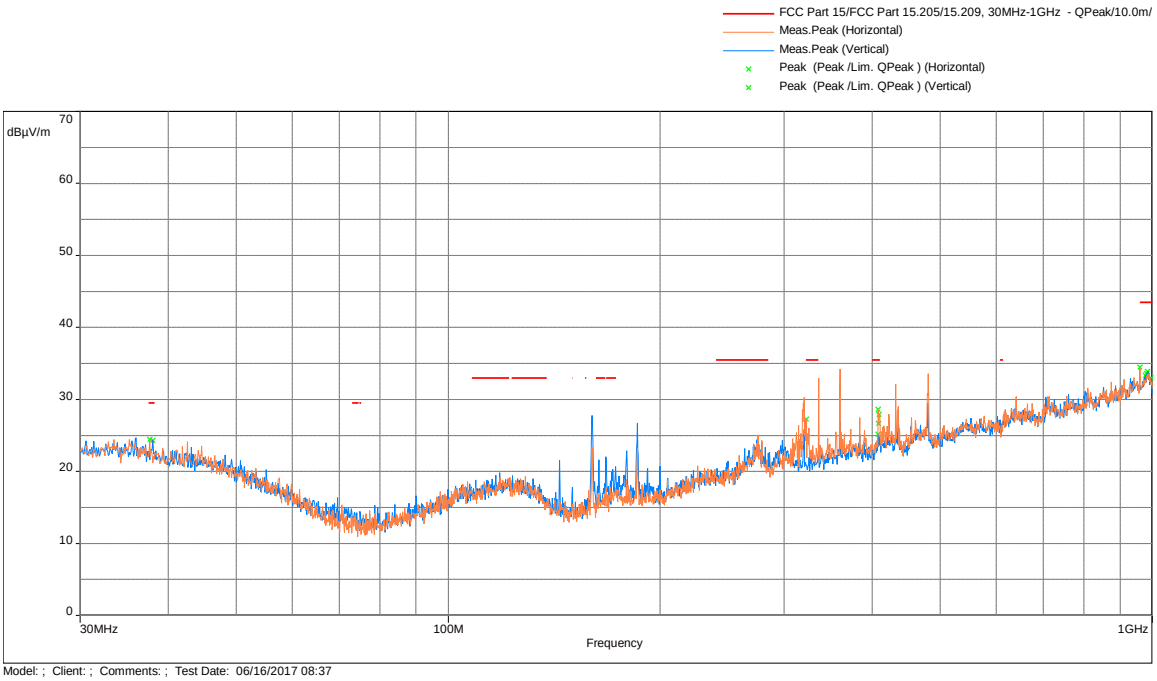
Model: ; Client: ; Comments: ; Test Date: 06/14/2017 08:27

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

Note: FS@3m = RA + AF + CF - Preamp

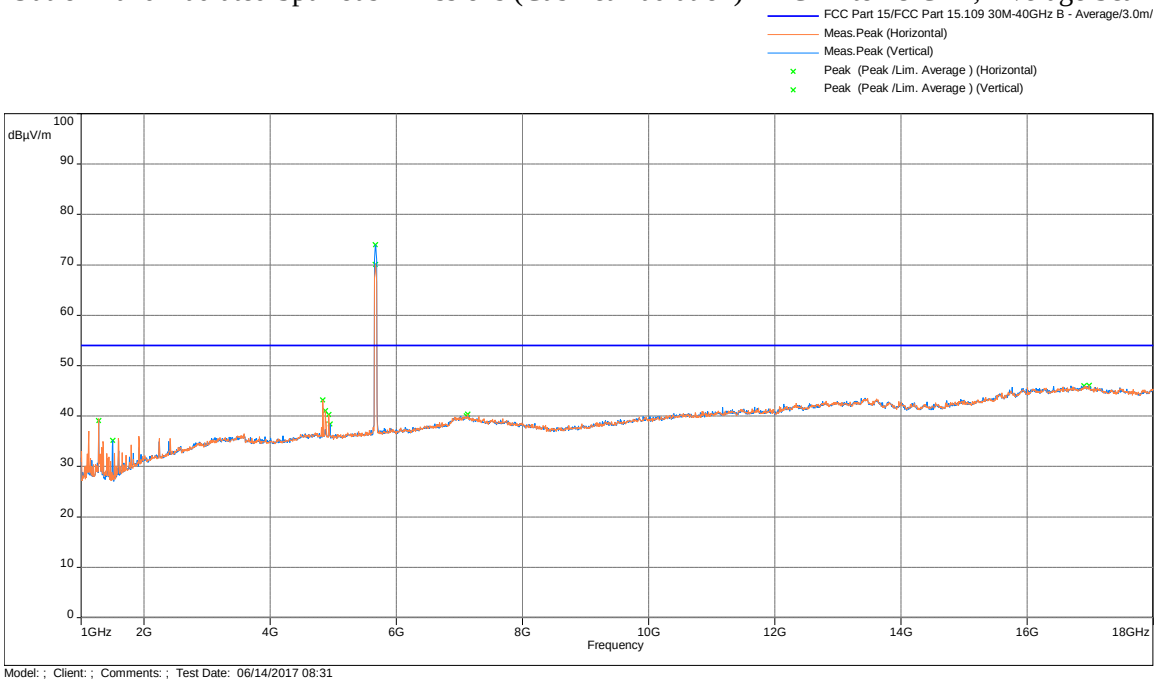
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 802.11n 40MHz 5670MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



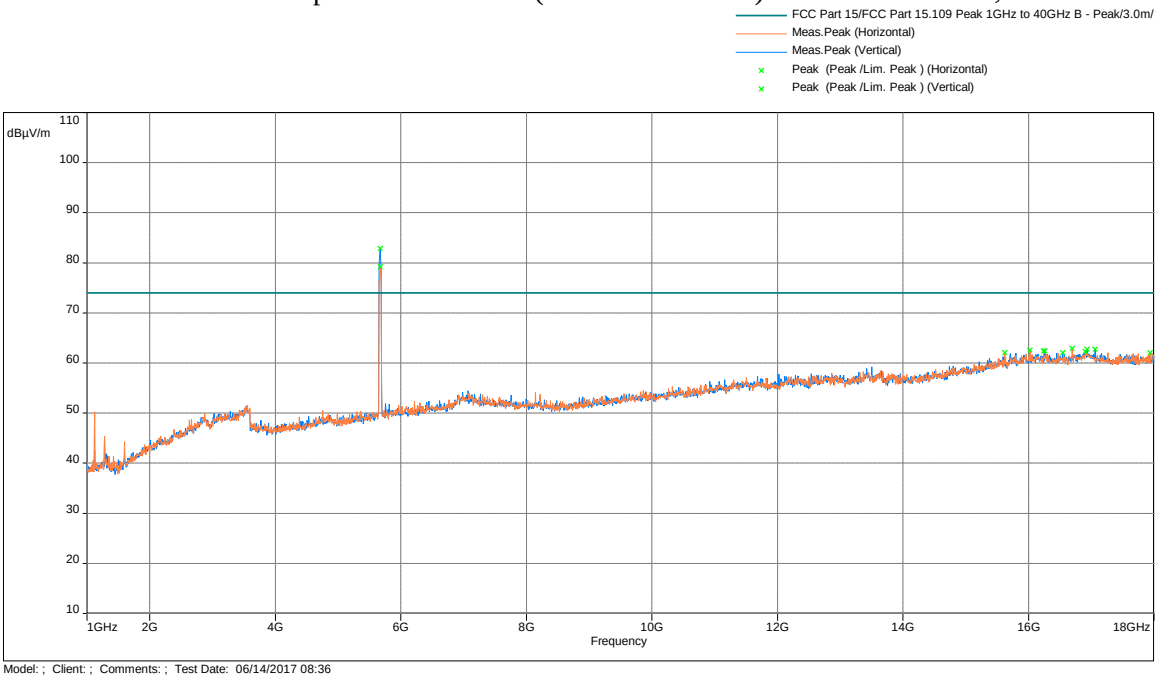
Model: ; Client: ; Comments: ; Test Date: 06/16/2017 08:37

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Average Scan



Model: ; Client: ; Comments: ; Test Date: 06/14/2017 08:31

Out-of-Band Radiated Spurious Emissions (Cabinet Radiation) - 1 GHz to 18 GHz, Peak Scan



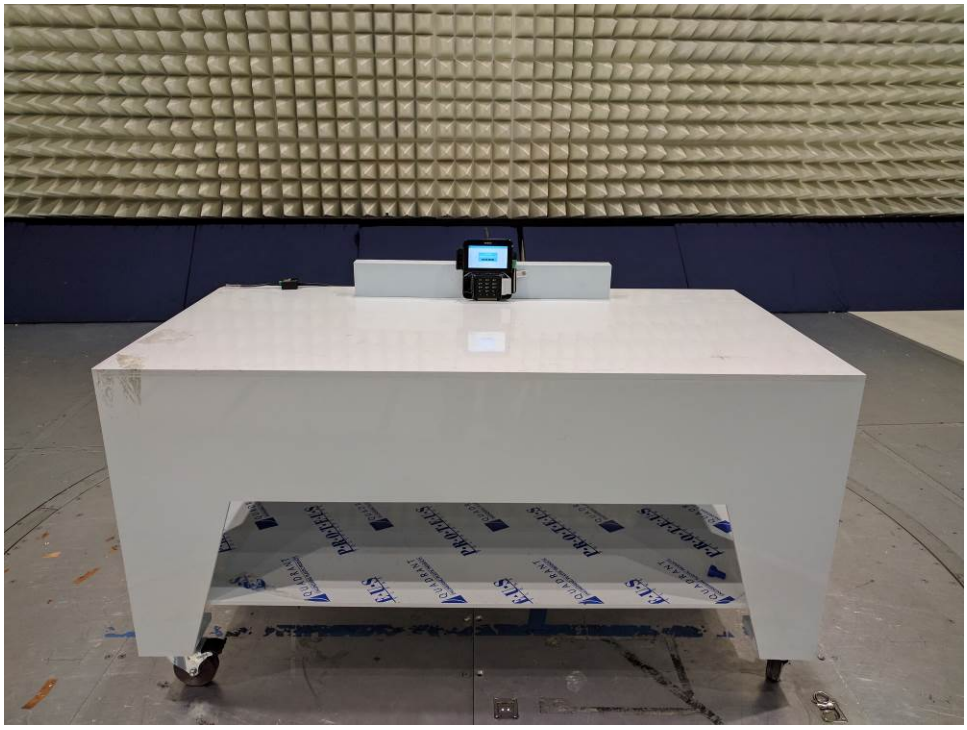
Model: ; Client: ; Comments: ; Test Date: 06/14/2017 08:36

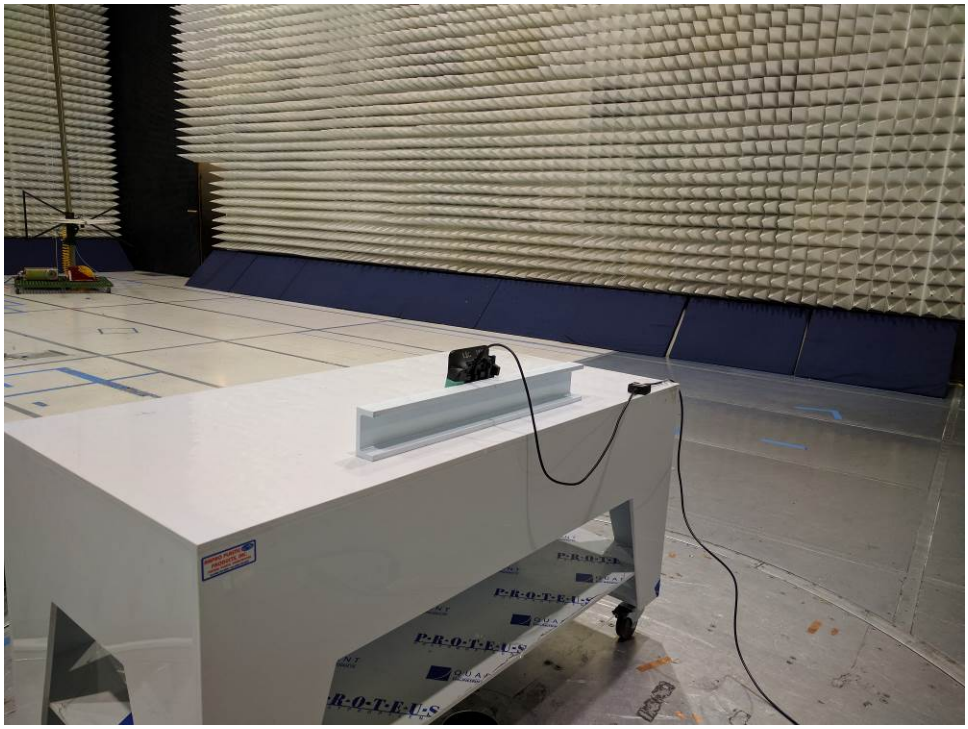
Note: Radiated emission measurements were performed up to 40GHz. No Emissions were identified when scanned from 18-40 GHz

Note: FS@3m = RA + AF + CF - Preamp

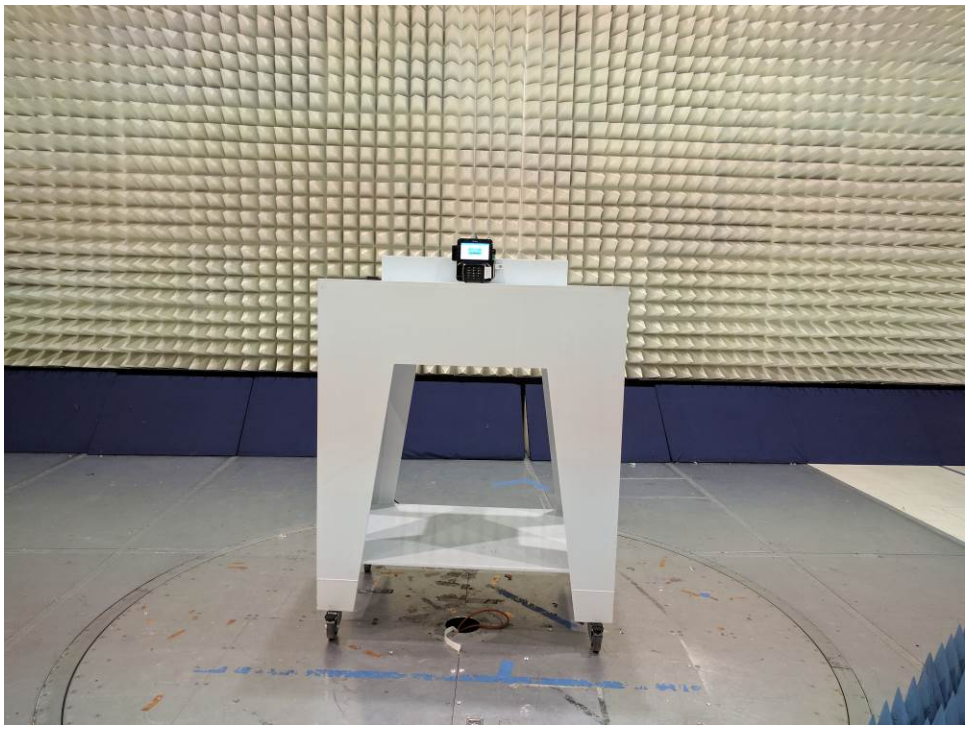
4.5.8 Test setup photographs

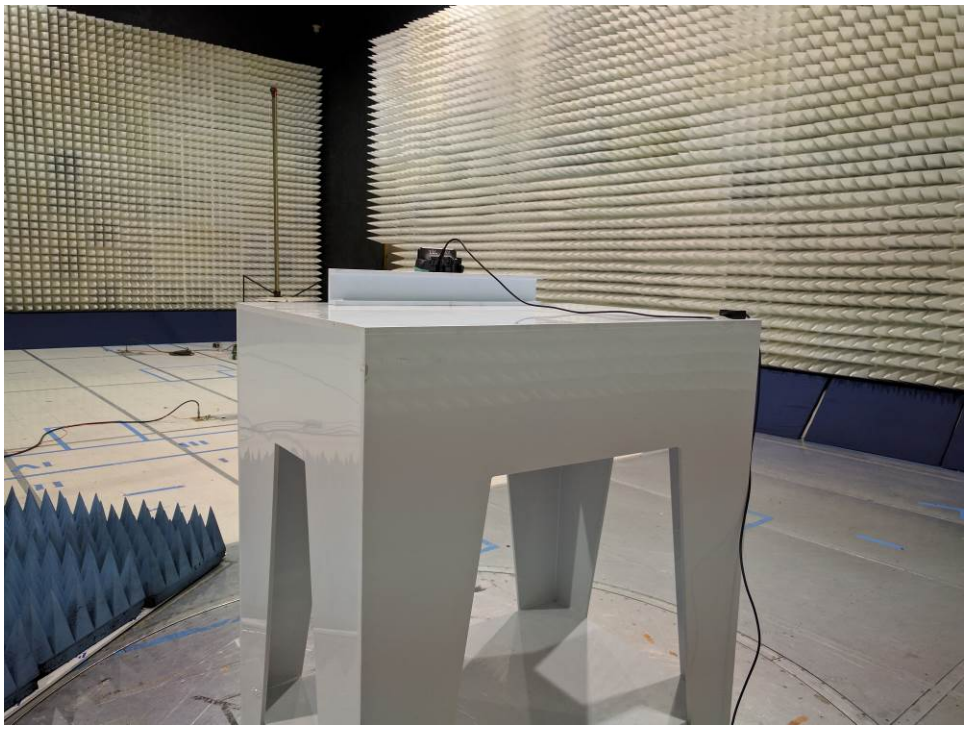
The following photographs show the testing configurations used.





4.5.8 Test Setup Photographs





4.6 Dynamic Frequency Selection (DFS)

4.6.1 Requirement

Applicability of DFS Requirements Prior to Use of a Channel

Requirement	Operational Mode		
	Master	**Client Without Radar Detection**	**Client With Radar Detection**
Non-Occupancy Period	Yes	Not Required	Yes
DFS Detection Threshold	Yes	Not Required	Yes
Channel Availability Check Time	Yes	Not Required	Not Required
U-NII Detection Bandwidth	Yes	Not Required	Yes

Applicability of DFS requirements during normal operation

Requirement	Operational Mode	
	Master Device or Client with Radar Detection	**Client With Radar Detection**
DFS Detection Threshold	Yes	Not Required
Channel Closing Transmission Time	Yes	Yes
Channel Move Time	Yes	Yes
U-NII Detection Bandwidth	Yes	Not Required

Additional requirements for devices with multiple bandwidth modes	**Master Device or Client with Radar Detection**	**Client Without Radar Detection**
U-NII Detection Bandwidth and Statistical Performance Check	All BW modes must be tested	Not required
Channel Move Time and Channel Closing Transmission Time	Test using widest BW mode available	Test using the widest BW mode available for the link
All other tests	Any single BW mode	Not required
Note: Frequencies selected for statistical performance check should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequency.		

4.6.1.1 DFS Detection Thresholds for Master or Client Devices with DFS Detection

Maximum Transmit Power	Values (See Notes 1, 2, and 3)
EIRP ≥ 200 milliwatt	-64 dBm
EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-64 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna. **Note 2:** Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response. **Note3:** EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01	

Parameter	Value
Non-Occupancy Period	Minimum 30 minutes
Channel Availability Check Time	60 Seconds
Channel Move Time	10 seconds (see note 1)
Channel Closing Transmission Time	200 ms + an aggregate of 60 ms over remaining 10 Second period. (see note 1 and 2)
U-NII Detection Bandwidth	Minimum 100% of the U-NII 99% transmission power bandwidth. (see note 3)
Note 1: *Channel Move Time* and the *Channel Closing Transmission Time* should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst. **Note 2:** The *Channel Closing Transmission Time* is comprised of 200 milliseconds starting at the beginning of the *Channel Move Time* plus any additional intermittent control signals required to facilitate a *Channel* move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions. **Note 3:** During the *U-NII Detection Bandwidth* detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.	

4.6.1.2 Test Waveform

Radar Type	Pulse Width (µsec)	PRI (µsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{\text{PRI}_{\mu\text{sec}}}\right)\right\}$	60.00%	30
		Test B: 15 unique PRI values randomly selected within the range of 518-3066 µsec, with a minimum increment of 1 µsec, excluding PRI values selected in Test A			
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120
Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.					

Radar Type	Pulse Width (µsec)	Chrip Width (MHz)	PRI (µsec)	Number of Pulses per Burst	Number of Burst	Minimum Percentage of Successful Detection	Minimum Number of Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

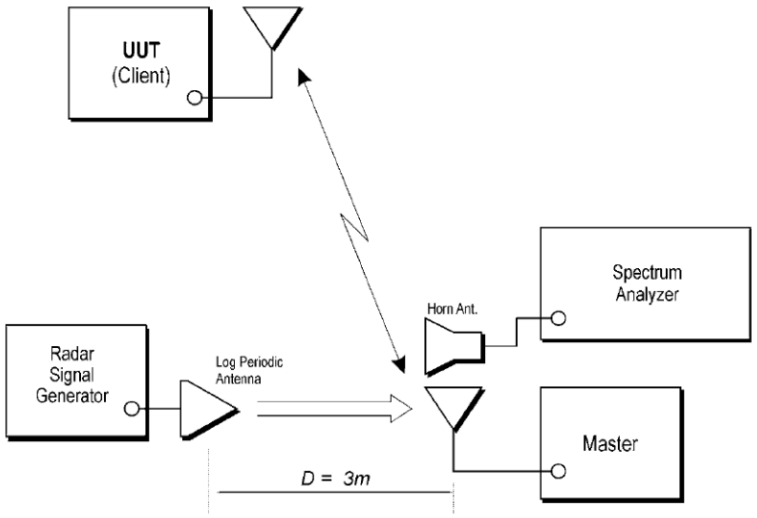
Radar Type	Pulse Width (µsec)	PRI (µsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

4.6.2 Procedure

DFS Waveform Calibration

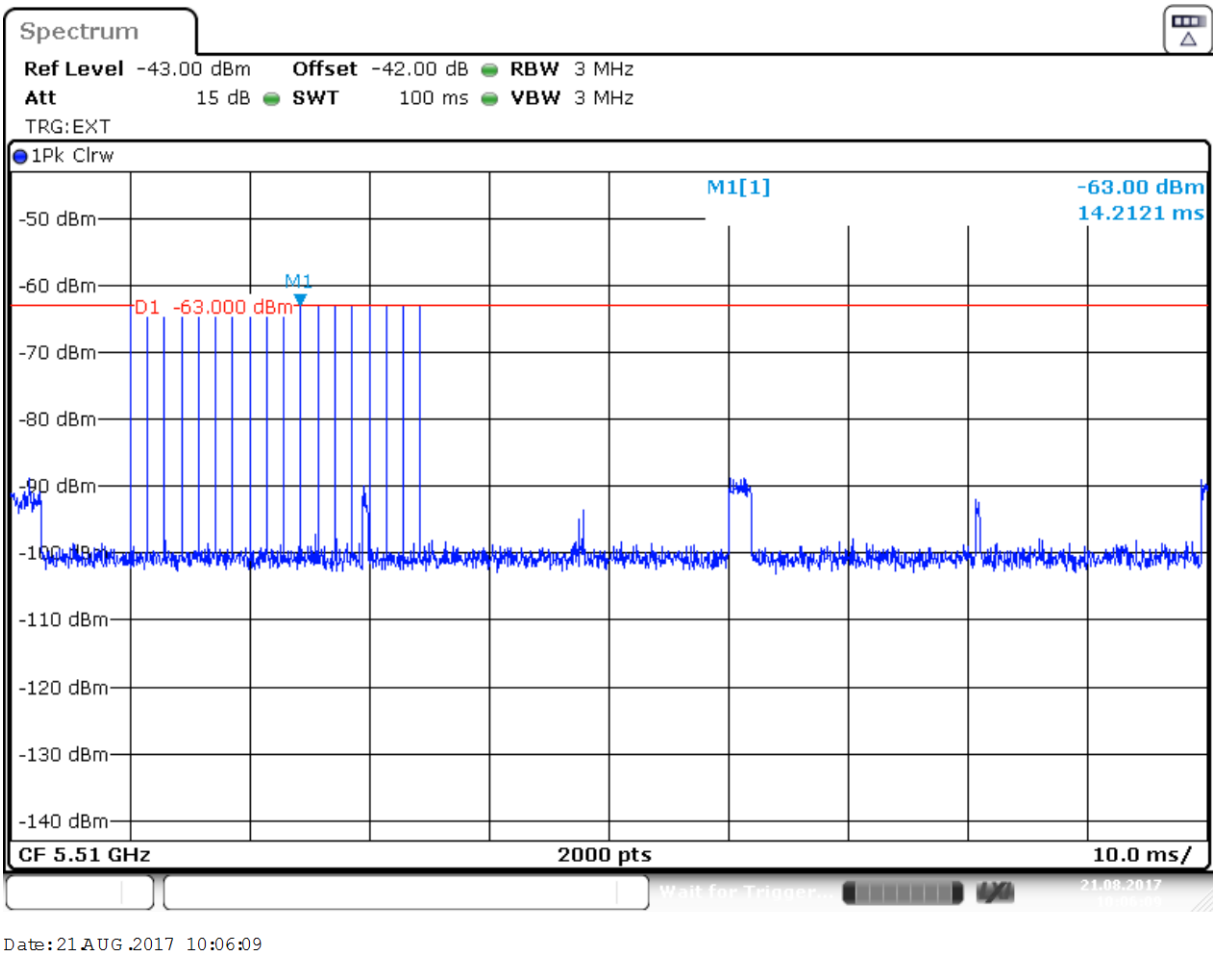
Calibration Procedure

For the DFS signal, horn antenna was attached to a signal generator (RS SMU700A). On the Receive side another horn antenna was attached to a spectrum analyzer with a preamp inline. The spectrum analyzer's resolution bandwidth was set to 3 MHz and the video bandwidth was set to 3 MHz with peak detection. The field was corrected to account for cable loss, antenna gain and preamp. The DFS signal was calibrated to a field strength of -63 dBm. Test wave form 0 was utilized. The calibration setup is diagrammed below along with a setup picture.



Tested By:	Anderson Soungpanya
Test Date:	August 21, 2016

Radar Type 0 Calibration 5530MHz



The Spectrum Analyzer Reference Level Offset is System Gain + Cable Loss

Frequency	**Cable loss**	**System Gain (Preamp and Antenna Gain)**	**Reference Offset**
MHz	dB	dBi	dB
5510	3.2	-45.2	-42.0

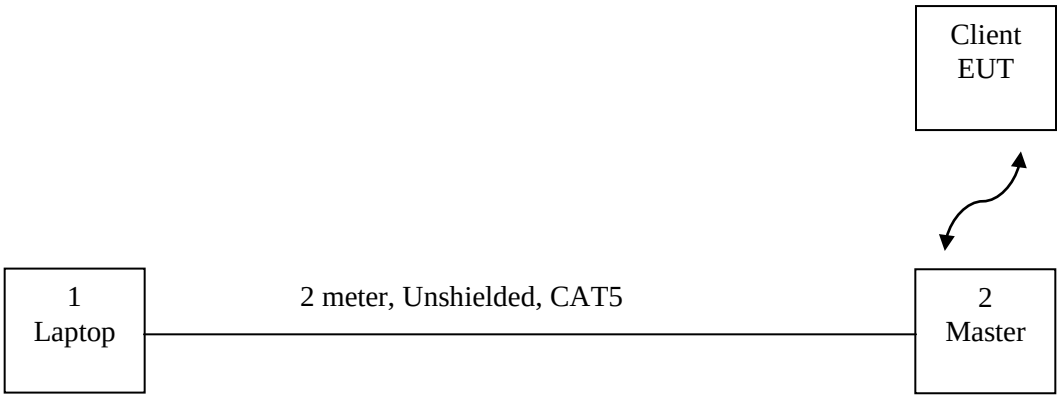
DFS Setup & Procedure

Test Procedure

Test procedures were made in accordance to 905462 D02 UNII DFS Compliance Procedures New Rules v02.

A radiated test method was used and the test setup was made as depicted in the diagram below. DFS testing was setup as a client with injection into the master.

The diagram below depicts the setup of the EUT along with associated support equipment.



Item	Description	Model	Serial
1	HP Laptop	EliteBook 8460p	CNU14429SL
2	Ruckus Wireless, Inc.	R710 Access Point FCC ID: S9GR710	421503700725

Test Procedure Continued

The Master and Client (EUT) were placed in a semi-anechoic chamber. The simulated radar waveform was transmitted from a horn antenna towards the Master. The signal level of the simulated radar waveform was set 10 dB higher than calibrated level to -53 dBm and was applied to the Master. The horn antenna was connected to the spectrum analyzer and positioned towards the client with a level higher than emissions from the Master.

A Rhode & Schwarz Vector Signal Generator with Pulse Sequencer Software was used to generate the DFS radar signals. A Rhode & Schwarz Spectrum Analyzer was used to monitor the transmissions of the Client. The trigger of the spectrum analyzer was aligned with the end of the radar waveform burst from the signal generator.

Channel closing transmission time and channel move time were measured by applying a radar signal to the Master device. The EUT transmissions were observed while Type 0 Radar waveforms were applied. The time between the end of the applied radar waveform and the final transmission on the channel is the channel move time. The channel closing transmission time comprises only those fragments of the channel move time during which the EUT transmits.

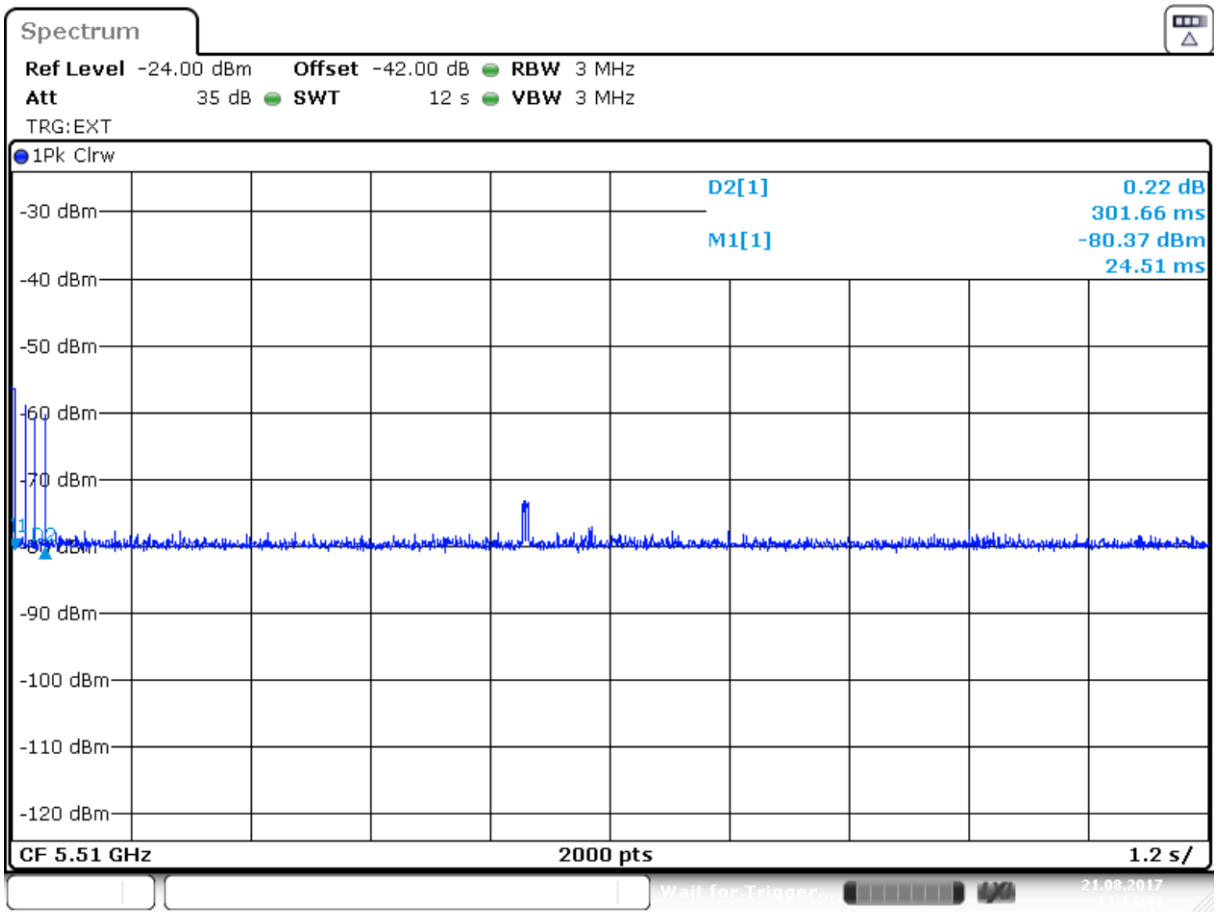
The EUT (client without DFS detection) was configured to communicate with a Master wirelessly. The test file/data was streamed from the Master to the Client. The channel load is recorded and presented in test results below.

4.6.3 Test Results

Channel Move Time Test Summary						
Description	**Plot #**	**Radar Type**	**Frequency MHz**	**Measured Value**	**Limit Requirements**	**Results**
Channel Move Time	1	0	5510	301.66ms	10s	Pass
Channel Closing Transmission Time Test Summary						
Description	**Plot #**	**Radar Type**	**Frequency MHz**	**Aggregate Measured Value**	**Limit Requirements**	**Results**
Closing Transmission Time	2	0	5510	<260ms	260ms	Pass

Plot 1

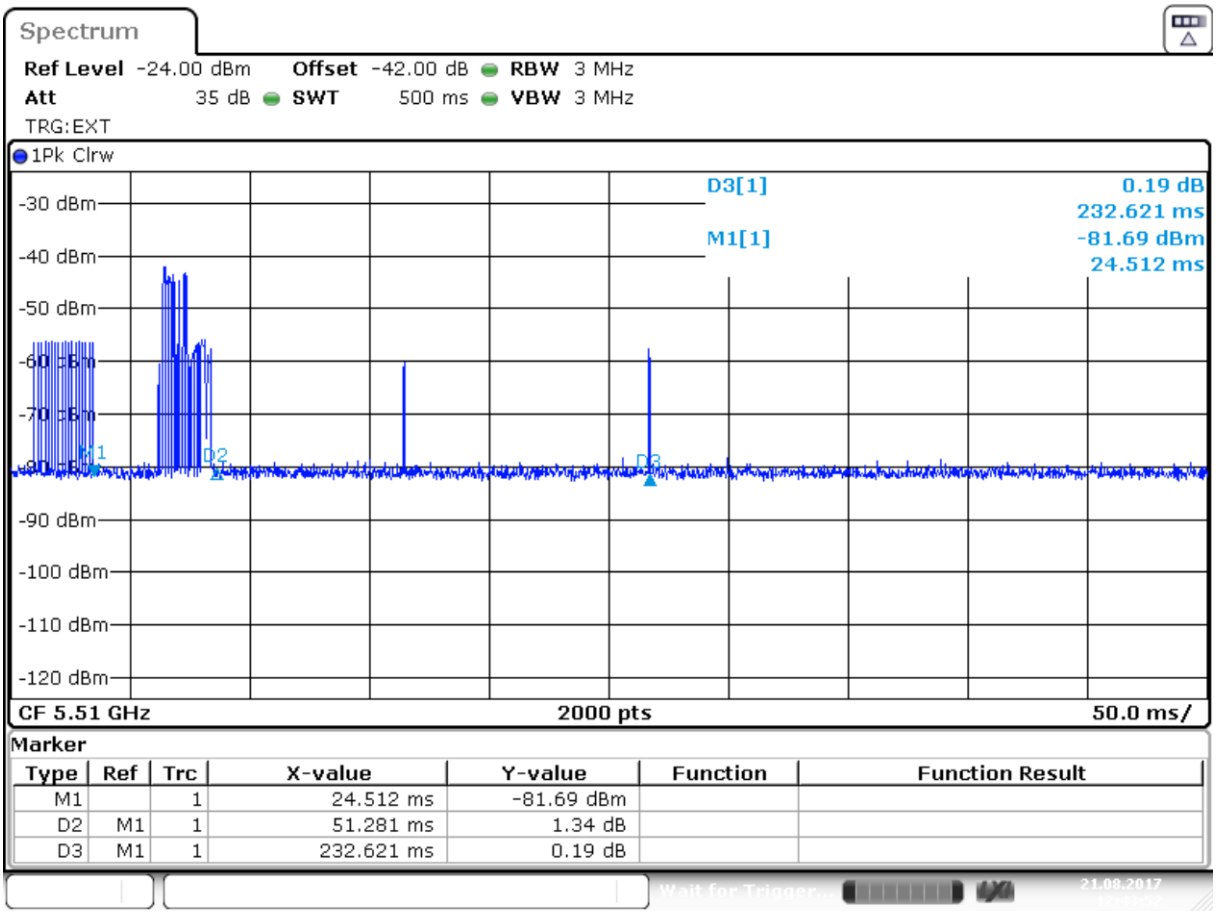
Channel Move Time (CMT), @ 5510 MHz, 802.11n 40MHz



Date: 21.AUG.2017 13:14:41

Plot 2

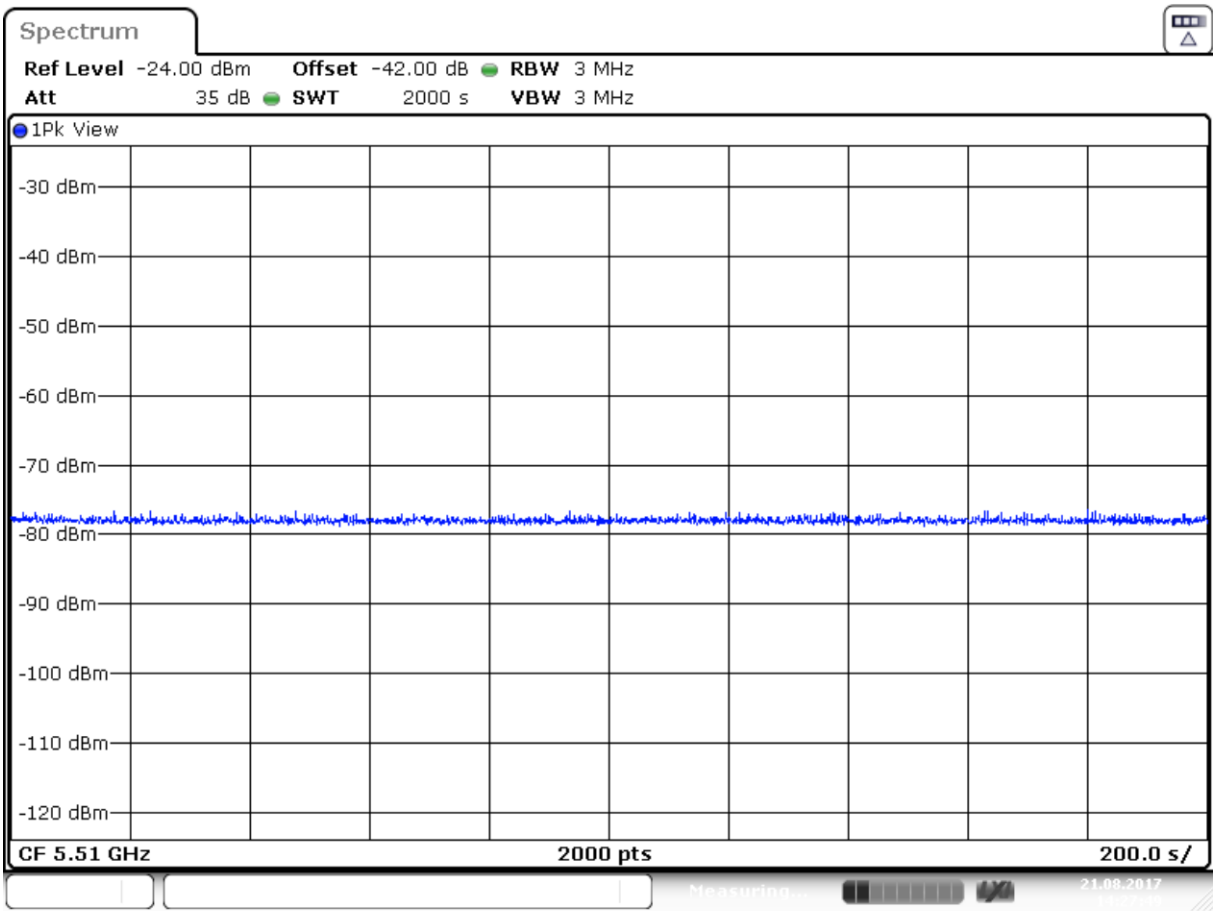
Channel Closing Transmission Time (CCTT), @ 5510 MHz, 802.11n 40MHz



Date: 21.AUG.2017 12:43:53

Plot 3

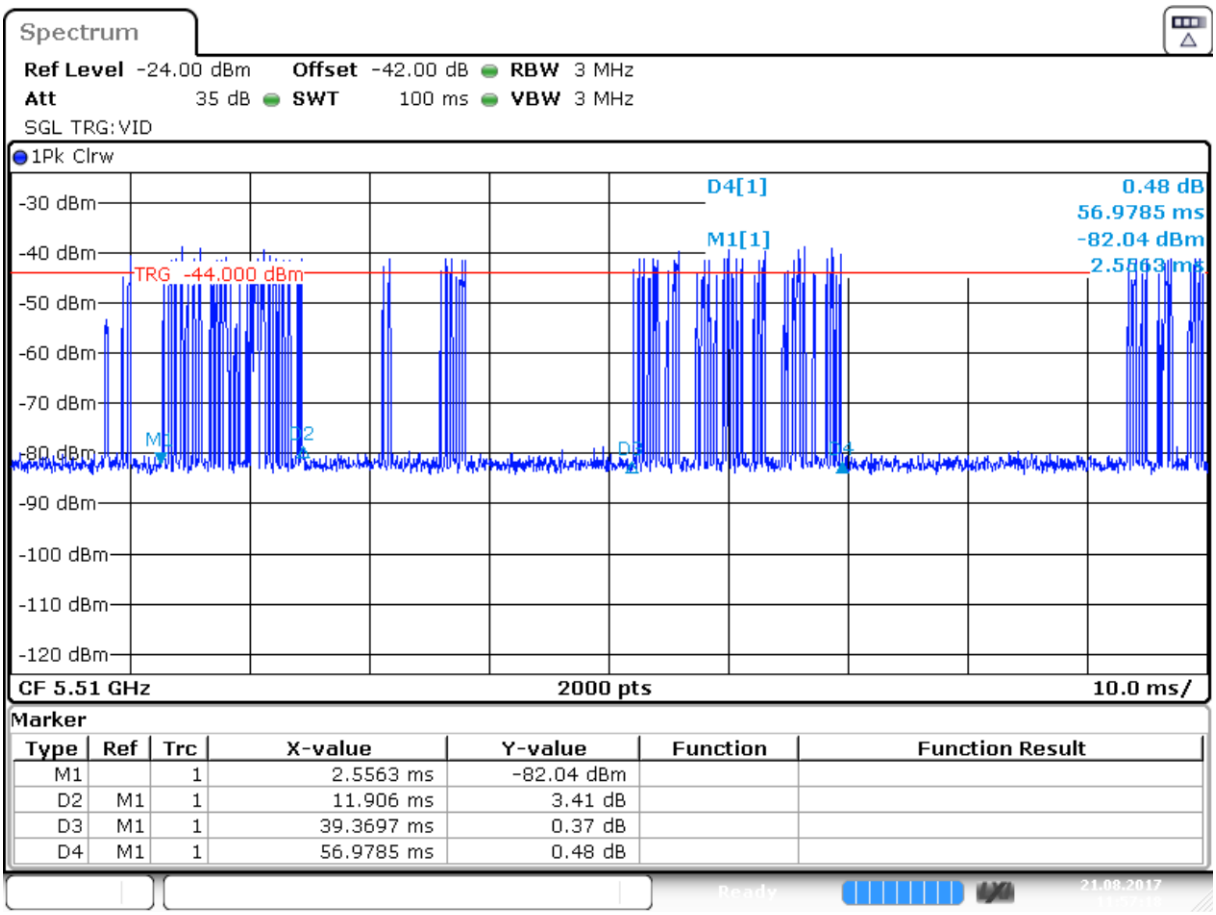
30 Minute Non-Occupancy time @ 5510 MHz, 802.11n 40MHz



Date: 21.AUG.2017 14:27:49

Plot 4

Channel Loading 5510MHz



Date: 21.AUG.2017 11:57:18

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	01/12/18
Pyramidal Horn Antenna	EMCO	3160-09	ITS 00571	#	#
Pre-Amplifier (18-40GHz)	Miteq	TTA1840-35-S-M	ITS 01393	12	04/18/18
Pre-Amplifier (1-18GHz)	Miteq	AMF-4D-001180-24-10P	ITS 00526	12	09/29/17
Horn Antenna	ETS-Lindgren	3117	ITS 01325	12	09/07/17
Horn Antenna	EMCO	3115	ITS 01595	12	02/13/18
EMI Receiver	Rohde and Schwarz	ESU	ITS 00961	12	07/10/18
BI-Log Antenna	Antenna Research	LPB-2513	ITS 00355	12	09/09/17
Pre-Amplifier	Sonoma Instrument	310	ITS 01493	12	09/28/17
RF Cable	TRU Corporation	TRU CORE 300	ITS 01462	12	08/19/18
RF Cable	TRU Corporation	TRU CORE 300	ITS 01465	12	08/19/18
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	08/19/18
Spectrum Analyzer	Rohde and Schwarz	FSV	ITS 01534	12	05/16/18
Attenuator	Mini Circuits	BW-N3W5+	ITS 01315	12	10/19/17
Notch Filter	MICRO-TRONICS	BRM50702	ITS 01166	12	12/08/18
Attenuator	Narda	FSCM99899	ITS 01583	12	08/31/18
RF Cable	Megaphase	EMC1-K1K1-236	ITS 01538	12	06/13/18
RF Cable	Megaphase	EMC1-K1K1-19	ITS 01482	12	08/25/17
RF Cable	Megaphase	TM40-K1K1-19	ITS 01154	12	01/26/18
Transient Limiter	COM-POWER	LIT-153A	ITS 01452	12	06/19/18
RF Cable	TRU Corporation	TRU CORE 300	ITS 01462	12	08/24/17
RF Cable	Megaphase	TM40-K1K1-59 RF	ITS 01156	12	01/26/18
Environmental Chamber	Espec	BTX-475	ITS 01436	12	09/06/17

No Calibration required

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
Tile	Quantum Change	3.4.K.22	Conducted Restricted Band Edge_Avg Conducted Restricted Band Edge_Peak Conducted Restricted Band_1-40GHz Conducted Restricted Band_30M-1GHz Conducted Spurious_30M-40GHz
BAT-EMC	Nexio	3.16.0.64	102971715_Verifone.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 / G102971715	AS	KV	October 06, 2017	Original document